University of Cantabria / University of Granada

Organizers:

REHABEND 2020

Euro-American Congress

CONSTRUCTION PATHOLOGY, REHABILITATION TECHNOLOGY AND HERITAGE MANAGEMENT

Granada (Spain) - March 24th-27th, 2020

Sponsor entities:

REHABEND 2020

CONSTRUCTION PATHOLOGY, REHABILITATION TECHNOLOGY AND HERITAGE MANAGEMENT

(8th REHABEND Congress)

Granada (Spain), March 24th-27th, 2020

PERMANENT SECRETARIAT:

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8TH EURO-AMERICAN CONGRESS ON CONSTRUCTION PATHOLOGY, REHABILITATION TECHNOLOGY AND HERITAGE MANAGEMENT

REHABEND 2020

ORGANIZED BY:

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The **Euro-American Congress REHABEND 2020** on **Construction Pathology, Rehabilitation Technology and Heritage Management** was carried out in **Granada (Spain)**, in **March 2020**. The event was organized by seventeen organizations of **eight European and American countries**, and it was co-chaired by the **University of Cantabria**, through its Building Technology R&D Group (GTED-UC), and the **University of Granada**.

REHABEND 2020 **continued the series of the seven previous REHABEND international events**, which had been developed **since 2006 in different Spanish cities**. The previous one, in **2018**, was carried out in **Caceres**. In 2018 edition, **around 310 papers** by Professionals and Researchers of more than **30 countries** were presented and it became a conference of great interest according to the people who attended the congress.

Construction Pathology, Rehabilitation Technology and Heritage Management currently have great importance for construction sector. This prompted the organizers to propose the **technical event on these topics in Granada**, which Alhambra fortress, the magnificent gardens of the Generalife and the residential district of the Albaycín, a rich repository of Moorish vernacular architecture, have been declared as UNESCO World Heritage Site. This event aimed to collect the **advances obtained in the last two years** in the **theoretical knowledge** and **practical realizations** carried out on the referred topics. The Congress met more than **300 technical contributions** coming from professionals, academics and specialists.

Based on previous experiences, the Congress **was proposed once again in the Euro-American cultural space**. The **official languages** were **English**, **Italian**, **Portuguese** and **Spanish**. Organizers understand that technical articles and oral presentations, with the support of graphic material and schemes, may be understood by the people who take part in the congress, as it was evident in previous editions of REHABEND.

Under these premises and the successful previous editions, the Congress was sponsored by the **Government of Spain**, the **Government of Andalusia**, the **Provincial Government of Granada**, the **Municipality of Granada**, the **Andalusian Institute of Historical Heritage (IAPH)**, the **Council of the Alhambra and the Generalife**, **Tecnalia**, **Sika**, **Mapei**, **Kerakoll**, **Acerinox**, **Grupo Puma**, the **University of Cantabria** and the **University of Granada**. In addition, several Universities, Technical and Professional Associations, Institutes, Foundations and Companies committed their collaboration in order to the success of this initiative.

REHABEND 2020 organizers would like to thank the multiple received supports: to the **Sponsor and Collaborating Entities**; to the **Scientific Committee Members** for their hard work in the revision of the different technical contributions, ensuring the required level of quality of an international event; to the **Keynote Speakers**; to the different **Speakers** for their relevant contributions and, in general, to the **people who attended the congress** for the confidence shown in the event. Sincerely, many thanks to all.

Dr. Ignacio Lombillo
Chairman of the REHABEND 2020 Congress
Associate Professor
University of Cantabria

Dr. María Paz Sáez
Chairman of the REHABEND 2020 Congress
Associate Professor
University of Granada

The University of Cantabria, through its Building Technology R&D Group (GTED-UC), was the promoter of the REHABEND Congresses on Construction Pathology, Rehabilitation Technology and Heritage Management.

The 1st REHABEND Congress was set in motion in Santander in November 2006. It became established in the 2nd (Santander, 2007), 3rd (Valencia, 2008), 4th (Bilbao, 2009), 5th (Santander, 2014), 6th (Burgos, 2016) and 7th Congress (Caceres, 2018), all of them carried out in Spanish cities. The ability to convene of the seven perfomed editions was prominent, gathering an appreciable number of experts in the topics of the Congress. As a reference, in the 7th edition (REHABEND 2018) took part around 310 speakers from more than 30 countries from all over the world.

The 3rd edition of the Congress (REHABEND 2008) was organized together with the Construction Technologic Institute of the Valencian Autonomous Community (AIDICO), and the 4rd and 5th editions (REHABEND 2009 and 2014), in addition to AIDICO, the Congresses were co-organized with TECNALIA Research&Innovation. Since the 6th edition (REHABEND 2016) the congress has been co-organized by several entities from different Euro-American countries.

The covers and ISBN of the books corresponding to the previous congresses are attached below. The ISSN of the series of REHABEND books is 2386-8198.

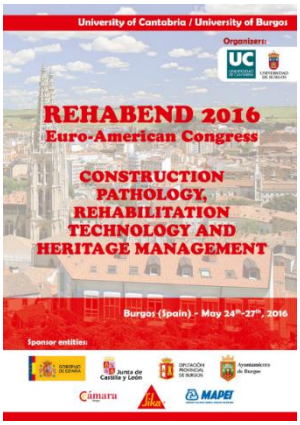
REHABEND 2006
(Book of Papers)
ISBN: 978-84-690-5269-3
(several languages)

REHABEND 2007
(Book of Papers)
ISBN: 978-84-691-3612-6
(several languages)

REHABEND 2008
(Book of Papers)
ISBN: 978-84-692-5650-3
(several languages)

REHABEND 2009
(Book of Papers)
ISBN: 978-84-8873-404-4
(several languages)

REHABEND 2014 (Book of Abstracts)
ISBN: 978-84-606-6738-4 (in English)
ISBN: 978-84-616-8862-3 (several languages)
REHABEND 2014 (Digital Book of Papers)
ISBN: 978-84-616-8863-0 (several languages)



REHABEND 2016 (Book of Abstracts)
ISBN: 978-84-608-7940-4 (in English)
REHABEND 2016 (Digital Book of Papers)
ISBN: 978-84-608-7941-1 (several languages)

REHABEND 2018 (Book of Abstracts)
ISBN: 978-84-697-7032-0 (in English)
REHABEND 2018 (Digital Book of Papers)
ISBN: 978-84-697-7033-7 (several languages)

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Provincial Government of Granada

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Andalusian Institute of Historical Heritage (IAPH)

Council of the Alhambra and the Generalife

Tecnalia Research & Innovation

Sika

Mapei

Kerakoll

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COLLABORATING ENTITIES

The Collaborating Entities have been presented grouped in countries, following an alphabetical order. As Collaborating Entities have been considered to all that have contributed at least with two accepted articles in the Congress, or that some of its members formed part of the International Scientific Committee of the Congress / keynote speakers. Finally, in each country, the Collaborating Entities have been ordered according to the number of accepted articles.

UNIVERSITIES

Albania-Epoka University

Algeria-Ecole Polytech. d'Architecture et d'Urbanisme

Algeria-University of Blida1

Argentina-Universidad Tecnológica Nacional

Bosnia and Herzegovina-University of Sarajevo

Brazil-Universidade de Brasília

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Brazil-Universidade Federal do Rio de Janeiro

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Brazil-Univ. Estadual Paulista

Brazil-Universidade Federal de Minas Gerais

Canada-University of Ottawa

Canada-Ryerson University

Chile-Universidad Austral de Chile

Chile-Pontificia Universidad Católica de Chile

Chile-Universidad de Chile

Colombia-Institución Universitaria Colegio Mayor de Antioquia

Colombia-Universidad Nacional de Colombia

Croatia-Josip Juraj Strossmayer University Osijek

Cuba-Universidad Central "Marta Abreu" de las Villas

Cyprus-University of Cyprus

Dominican Rep.-Pontificia Universidad Católica Madre y Maestra

Dominican Rep.-Universidad Nacional Pedro Henríquez Ureña

Ecuador-Universidad de Cuenca

Ecuador-Pontificia Universidad Católica del Ecuador

Egypt-Cairo University

Greece-University of Patras

Greece-National Technical University of Athens

Hungary-Budapest Univ. of Technology and Economics

Italy-Università degli studi di Firenze

Italy-Università degli studi della Basilicata

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Italy-Politécnico di Bari

Italy-Università degli Studi di Catania

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Italy-Universita' degli Studi di Messina

Italy-Università degli Studi di Perugia

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Mexico-Universidad Iberoamericana

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Norway-Western Norway University of Applied Sciences

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Peru-Universidad Nacional de San Martín

Peru-Universidad Privada Antenor Orrego

Poland-Cracow University of Technology

Poland-Lodz University of Technology

Portugal-Universidade do Porto

Portugal-Universidade do Algarve

Portugal-Universidade da Beira Interior

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Portugal-Instituto Politécnico de Bragança

Portugal-Universidade de Coimbra

Portugal-Instituto Politécnico de Viseu

Portugal-Universidade de Aveiro

Portugal-Universidade do Minho

Portugal-Universidade de Trás-os-Montes e Alto Douro

Portugal-Universidade Nova de Lisboa

Potugal-Instituto Politecnico de Leiria

Qatar-Qatar University

Romania-Technical University of Cluj Napoca

Serbia-University of Belgrade

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Spain-Universidad Politécnica de Madrid

Spain-Universidad de Burgos

Spain-Universidad de La Coruña

Spain-Universidad de Huelva

Spain-Universidad de Navarra

Spain-Universidad de Alicante

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Spain-Universidad de Valladolid

Spain-Universidad Europea Miguel de Cervantes

Spain-Universidad Politécnica de Cartagena

Spain-Universidad Politécnica de Valencia

Spain-Universidad de Oviedo

Spain-Universidad Internacional de Cataluña

Spain-Universidad de Extremadura

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Switzerland-University of applied sciences and arts of southern Switzerland

Turkey-Yildiz Technical University

United Kingdom-Northumbria University

United Kingdom-University of Dundee

United Kingdom-University College London

United States of America-New Mexico State University

United States of America-University of Illinois

United States of America-University of Miami

Uruguay-Universidad de la República

ASSOCIATIONS, FOUNDATIONS & PUBLIC ENTITIES

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Argentina-LEMIT Laboratorio de Entrenamiento Multidisciplinario para la Investigación

Italy-Eurac Research
"Task 59 - Renovating Historic Buildings towards Zero Energy" Project (IEA- International Energy Agency)

Italy-CNR Consiglio Nazionale delle Ricerche | Istituto per le tecnologie applicate ai beni culturali

México-Instituto de Ingeniería de la UNAM

Portugal-Laboratório Nacional de Engenharia Civil

Portugal-Instituto da Construção - UPorto

Portugal-ITECONS - UCoimbra

Portugal-Centre of Materials and Building Technologies C-MADE

Portugal-Institute for Sustainability and Innovation in Structural Engineering

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Spain-Centro de Estudios y Experimentación de Obras Públicas

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Spain- Building Technology R&D Group - UC

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MDPI – *Infrastructures* (ISSN 2412-3811)

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Uruguay	MSc. Gonzalo Cetrangolo	Universidad de la República

1.- PREVIOUS STUDIES	1.1.- Studies of conservation (historical, archaeological, etc.). 1.2.- Heritage and territory. 1.3.- Urban regeneration. 1.4.- Economical and financial policies. 1.5.- Processes of social participation and socio-cultural aspects in rehabilitation projects. 1.6.- Pathology in construction. 1.7.- Diagnostic techniques and structural assessment (no destructive testing, monitoring and numerical modeling). 1.8.- Guides and regulations.
2.- PROJECT	2.1.- Criteria theoretical of the intervention project. 2.2.- Traditional materials and construction methods. 2.3.- Applicable novelty products and new technologies. 2.4.- Sustainable design and energy efficiency.
3.- BUILDING INTERVENTION	3.1.- Intervention plans. 3.2.- Rehabilitation and durability. 3.3.- Reinforcement technologies. 3.4.- Restoration of artworks. 3.5.- Conservation of industrial heritage. 3.6.- Examples of intervention.
4.- MAINTENANCE	4.1.- Construction maintenance. 4.2.- Preventive conservation of built heritage.
5.- DIFFUSION AND PROMOTION	5.1.- Heritage and cultural tourism. 5.2.- Formation. 5.3.- New technologies applied to the heritage diffusion. 5.4.- Accessibility to cultural heritage. 5.5.- Working networks in the cultural heritage. 5.6.- Management of of built heritage.

ABSTRACTS OF THE CONGRESS

1.- PREVIOUS STUDIES

1.1.- Multidisciplinary studies (historical, archaeological, etc.).

1.2.- Heritage and territory.

1.6.- Construction pathology.

1.7.- Diagnostic techniques and structural assessment (no destructive testing, monitoring and numerical modeling).

1.8.- Guides and regulations.

2.- PROJECT

2.1.- Theoretical criteria of the intervention project.

2.2.- Traditional materials and construction methods.

2.3.- Novelty products applicable and new technologies.

2.4.- Sustainable design and energy efficiency.

3.- BUILDING INTERVENTION

3.1.- Intervention plans.

3.2.- Rehabilitation and durability.

3.3.- Reinforcement technologies.

3.6.- Examples of intervention.

4.- MAINTENANCE

4.1.- Construction maintenance.

4.2.- Preventive conservation of built heritage.

5.- DIFFUSION AND PROMOTION

5.1.- Heritage and cultural tourism.

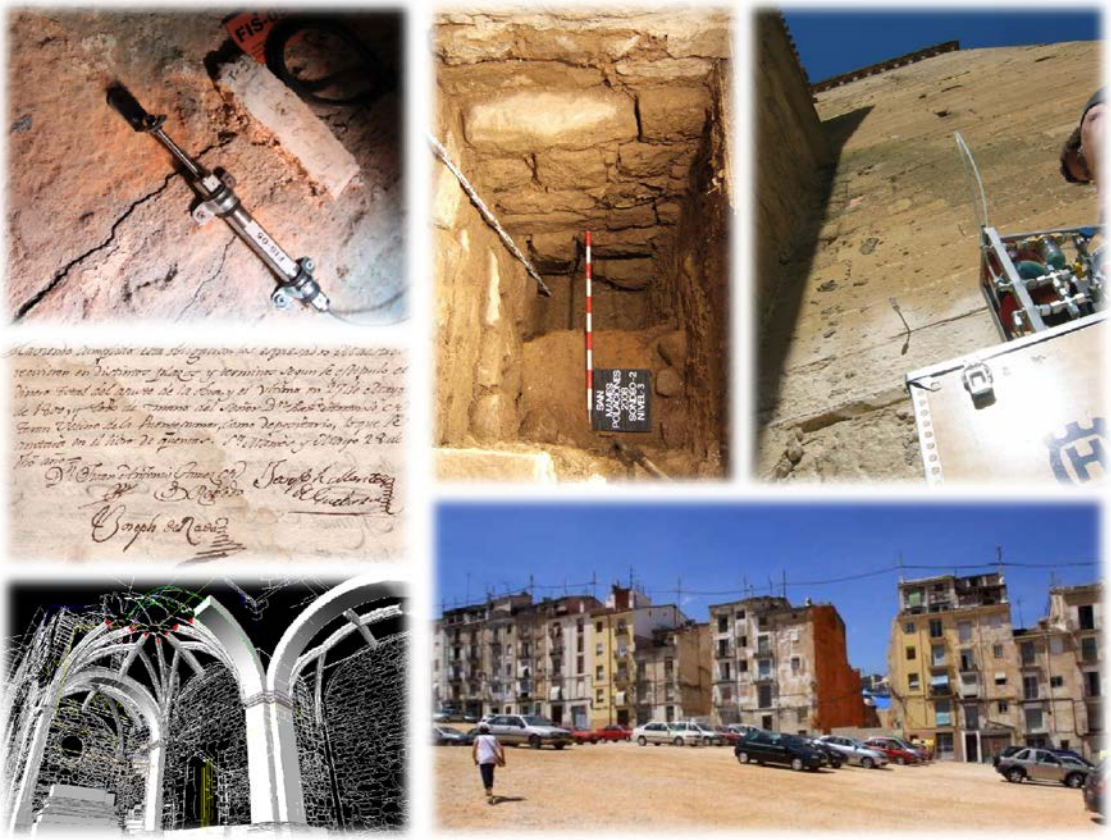
5.2.- Teaching and training.

5.3.- New technologies applied to the heritage diffusion.

5.4.- Accessibility to cultural heritage.

5.5.- Working networks in the cultural heritage.

1.- PREVIOUS STUDIES



CODE 21

METHODOLOGY FOR PREVENTIVE CONSERVATION OF LINEAR LANDSCAPE IN CITIES

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KEYWORDS: Cultural heritage; laser scanning; art nouveau; architecture; evolution; digital photogrammetry.

ABSTRACT

The abrupt social, political and economic changes that cities experiment, suppose furthermore a great urbanistic, esthetic and decorative change that is reflected in the linear landscape of their streets.
In this investigation, a methodology of work is presented to document and represent graphically the most representative changes that part of the streets in the historic center of any city have suffered. It is developed by historical and documental study and using techniques such us digital photogrammetry and laser scanner, so that is possible to compare facades in different periods.
As the result of this work, it is possible to achieve a detailed register and catalogue of the interesting preserved elements, in addiction to an exhaustive documentation that includes other have disappeared architectural elements from de same period.
This methodology becomes easier a deeper knowledge derived from changes produced by the evolution and it can achieve greater awareness that allows to improve the conservation of cultural heritage.

CODE 32

THE EVOLUTION OF CONSTRUCTION TECHNIQUE THROUGH THE HISTORY OF ENTERPRISE: THE FEAL

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KEYWORDS: Modern architecture; Industrialization; Milan; Feal; Marco Zanuso.

ABSTRACT

The paper aims to propose the study of a housing complex built in Milan in the years 1961-63, designed by Marco Zanuso. The complex consists of twin buildings, which are rotated 90 degrees one from the other. The housing complex was commissioned by Feal (Fonderie Elettriche Allluminio e Leghe), an Italian company that was very committed to the technological innovation that, in the 1950s and 1960s, had an important role in both Italian construction and the international scene.
The buildings have a steel bearing structure with beams and pillars that are connected by bolts and semi-prefabricated slabs, completed by a cast in place. The façades are of prefabricated gray trachyte panels, a material that referred to the Lombard tradition and was compared to the programmatic technological updating pursued in the two buildings.
The constructive system adopted on this occasion was greatly appreciated by the architectural criticism of that time as it was a rare example of the transfer of the use of the prefabricated metal component to the high-bourgeois home, which, until then, had been limited essentially to industrial building typologies or to low-cost residential typologies.
The reconstruction of the building history, in light of Zanuso's contemporary production and the framework of the construction industry conditions of those years, investigated through the consultation of archival materials, seeks to offer a contribution to the knowledge of Italian construction development in the twentieth century.

CODE 34

DOCUMENTING CULTURAL HERITAGE THROUGH INVENTORY

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KEYWORDS: Inventory; patrimony; memory; Campos dos Goytacazes.

ABSTRACT

This paper addresses the issue of inventory as one of the instruments of protection of material historical heritage inserted in the urban fabric of a city. Using as object of study the Historic Center Trade Zone (ZCH) of Campos dos Goytacazes, located in the north of Rio de Janeiro State, Brazil, our general objective is to contribute with reflections on the notions of memory, identity and belonging through the use of the inventory as a tool for urban conservation. Using as methodological tool the historical and architectural survey model developed within extension research projects, linked to the course of Architecture and Urbanism of the Fluminense Federal Institute (IFF), it is intended to provide bases for reflection on future actions of interventions in the city. We understand that this type of inventory constitutes an action of preservation of the built heritage, as it allows access and the production of knowledge about what is registered, providing data for interdisciplinary interpretation and diagnostics, thus contributing to the debate and subsequent action on the planning and management processes of cities. It is the elaboration of a physical and virtual register that includes photographic, documentary and historiographic surveys of cultural goods, in order to provide an examination of the patrimonial and cultural potentialities of the municipality. We understand that through these projects we are highlighting the importance of studying and recording the existing architecture in the historic centers of cities, pointing to the need for awareness and preservation of their heritage as a historical and architectural document, so that those responsible for its preservation understand the historic city ensembles no longer as a set of buildings whose stylistic values must be preserved, but as places that hold significant cultural values linked to their roles in the collective memory of their population and visitors.

CODE 52

THE CONSTRUCTION TECHNOLOGY IN SPANISH COLONIES. A CATHEDRAL IN WESTERN COLOMBIA

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KEYWORDS: Religious architecture; Spanish colony; building systems; cathedrals; heritage; Colombia.

ABSTRACT

This article describes some of the results obtained in the study of the construction technique of the Cathedral of Santa Fe de Antioquia, a town of the Spanish colony, former provincial capital in western Colombia, with high heritage value. Historical, technical, laboratory and field explorations in research were used. It also aimed to make a review of the several interventions of the cathedral, to leave a report about materials and construction techniques used as part of the historical background required for future studies. It was concluded that there is insufficient information to determine the construction techniques used. From field explorations could define the constitution of the building systems and the recent reports of intervention managed to leave the track record and current status of the Cathedral.

CODE 78

THE TRANSFORMATION OF MEDIEVAL CHURCHES DURING THE BAROQUE ERA IN SZEKLERLAND

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KEYWORDS: Szeklerland; medieval church; baroque architecture; transformation.

ABSTRACT

This paper aims to investigate the motivation behind the transformation of medieval churches. The secluded territory of the Szeklers on the eastern outskirts of the Hungarian Kingdom contributed to the late arrival of Western Europen styles. The Baroque era in Szeklerland lasted between the 17th and 18th centuries. In that time practically all of the churches suffered some alterations. Here we cannot find ambitious, large-scale architectural monuments on pair with their western counterparts, in turn, we can discover numerous medieval buildings that were preserved in a brand-new baroque 'gown'. The least invasive interventions meant the complete changeover of the interior furniture: the pulpit, the gallery, the benches, etc. Some churches, however, were demolished and reconstructed from zero.
This study wishes to answer the following questions: What was the cause behind the transformations, was it necessary because the religious community grew? Was it simply because of aesthetic reasons? Are there other contributing factors? This research tries to summarize the scale of interventions that can be translated into statistical numbers. Furthermore, it wishes to discover the possible examples that were followed, the possible western churches that the builders were trying to imitate.
So far 50 of the churches were visited and documented in the central parts of the historical Szeklerland. Out of these 50 buildings, 44 of them remain in their baroque form, four of them however were transformed a second time at the beginning of the 19th century. The scale of interventions varies from church to church and from religion to religion. The three major religions that have a significant presence in Szeklerland are the Roman Catholic Church, the Calvinist Church and the Unitarian Church. There is a striking difference between the lavish Catholic interiors and the austere interiors of Protestant churches. One can only assume that they have had different notions of Baroque style beauty because of the difference between religious teachings. Their sources of inspiration are yet to be determined.

CODE 97

GOTHIC TRACE OF CARAGOL SOBIRANES OF SANTA CATERINA'S TOWER OF TORTOSA'S CATHEDRAL

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KEYWORDS: Gothic outline; medieval geometry; geometriae practice; spiral staircase; Tortosa cathedral.

ABSTRACT

At the beginning of the construction of the Gothic station of Tortosa (1345) the towers of San Pedro (1383) and Santa Caterina (1424) were built to access the roof through spiral staircases. The staircase of Santa Caterina, the *caragol sobiranes*, known as the great snail, is *caragol de boto redo* with a central turnip and spiral of 14 risers, in which the helicoid and the circumference needs to be divided into thirteen landings. Spiral staricases in the Gothic period have been one of the greatest exponents of knowledge of the *magister operis*. It concentrates the arithmetic and geometric knowledge. For its construction the *gabarits* are used, which need the contest of the polygonal division of the circumference. Regular polygons of 11, 13, 14, 17 and 19 faces that do not appear in the *Elementa* or in the *Almagest*, nor in the scarce *Geometriae Practice* of the time. These polygons can be built by using a two-armed square, with the reiterated support of the cathetus on the hypotenuse. The staircase of Santa Caterina is built by means of square shaped steps, which can be constructed by means of a square by rotation as an abacus.

CODE 115

THE "PALAZZO DEL GOVERNO" IN TARANTO: AT BEGINNINGS OF A TYPICAL "ITALIAN" STYLE

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KEYWORDS: Modern movement; constructive sperimentation; new materials.

ABSTRACT

At the beginning of the 20th Century, characterized by the spirit of a new *"faith"* towards the potentialities of *"purely"* Italian resources, it was developed new industries, that start their activities by the most brilliant italian minds and that led to the experimentation of new materials and construction systems; they represented Italy's technological vanguard in the world.
In this context, architecture and its decorative arts, through large exhibitions and impressive public works (government buildings, community buildings, after-work buildings, etc.) became the international symbol towards affirmation of a national style, echo of the classic architectural tradition and shining example of the most prestigious constructive avantgardes, proudly defined as 'Italian'.
The architects and designers role was complicate in order to responde to the requirements of each architecture; they had to combine the much more innovative materials and construction systems of the Modernity. The buildings became, therefore, complex architectural systems, symbol of a continuous formal research towards the memory of a past and - at the same time - expression of the constructive innovation of the present. Among these, the "Palazzo del Governo" in Taranto, built on a project by the architect Armando Brasini and inaugurated in 1934 by Benito Mussolini, represented an emblematic garrison of Government.
Although in the image it mimes the reflection of an architecture of ancient times, the "Palazzo del Governo" hides inside a complex structural system made of beams and pillars in reinforced concrete, whose construction techniques and structural innovations is comparable to the well-known "Palazzo della Civiltà Italiana" in Rome (built only a few years later, 1938-53).
The research, therefore, aims to show how architecture, with its own shapes, stylistic features and constructive characters, represents and describes the social and cultural events of a community; the preservation of these architectures becomes a means through which to recover the history of a people, thus allowing to transfer to future generations a cultural heritage not inferior to that received from the past.

CODE 138

PROPOSAL AND APPLICATION OF MASSH – A HOUSING HEALTH AND SAFETY ASSESSMENT MODEL FOR PORTUGAL

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KEYWORDS: MASSH; housing; health; safety; evaluation.

ABSTRACT

Nowadays people spend a large amount of their time inside their homes. However, prevailing indoor conditions in terms of comfort and environmental quality could represent high health risks to the inhabitants. Therefore, a good indoor environmental quality is essential, since in addition to the hazards present in indoor air (e.g., industrial chemicals), extreme temperatures, relative humidity levels, swarms, mold, infestations, noise, airborne infectious diseases, contamination through tap water and tracked soil, have the potential to cause physical lesions, respiratory diseases, internal organ damage, and poisoning as well as malicious effects in the dwellers' mental health. Thus, the importance of this new approach to the topic of habitability is demonstrated.

Given this problem, evaluation models were considered together with the main types of hazard that could affect residents' health and an evaluation model for housing health and safety is proposed, in accordance with household composition, and adequate to Portuguese homes. This model was created based on a set of functional and regulatory requirements that were identified for housing.

For the purpose of validating the method and utility of the model, it was applied to a set of dwellings with different construction dates, locations and household compositions, allowing for the identification of hazard classes and reaching some conclusions as to the application of the model.

CODE 159

VISUAL RELATIONSHIP BETWEEN MONUMENTS FROM THE PAST AND CONTEMPORARY ARCHITECTURE. MASTERPIECES BY ANDREA PALLADIO AND NEW SPATIAL CONNECTIONS

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KEYWORDS: Memories; imaginary city; urban setting.

ABSTRACT

This paper focuses on the opportunity to build new architecture next to relevant monuments constructed during past centuries. The theme was carried with reference to several famous works by the well-known Italian architect Andrea Palladio, who lived in the XVI century. The Basilica Palladiana, Palazzo Chiericati, the Palazzo del Capitaniato are artificially located in close proximity to other important but contemporary buildings. The freedom to assemble figures or fragments, to place them in another context, highlighted the effectiveness and decisiveness of a reading of urban design in which the figurative force is the result of consideration based on the visual relationships.
The juxtaposition of well-known architectures by Palladio and other famous contemporary buildings provides form to new spatial connections in the environment and verifies new unthought-of opportunities to compose buildings and monuments that modify the space. The inventions resulting from the union of individual architectures into unitary visions that do not organically belong together is a particular iconography in which buildings abandon the passive and ornamental function thanks to which we have got to know them and reacquire an actively elevated role in the project.
A similar procedure was experimented by the Venetian painter Canaletto, and can be seen in one of his best known canvasses called Caprice with buildings by Palladio (1756-59). So the project of the Rialto Bridge over the Grand Canal in Venice developed two centuries beforehand by Andrea Palladio, that never was built, is painted together with two other buildings by Palladio, Palazzo Chiericati and the Basilica. The paper is the result of students' workshops, developed in the framework of the course on "Architectural and Urban Composition 2" taught on the master's degree in Architectural Engineering at the Department of Civil, Environmental and Architectural Engineering of the University of Padua.

CODE 188

FACTORS THAT PREVENT EFFECTIVE ARTICULATION OF THE PROVINCE OF THE UNION WITH THE PROGRESSIVE DEVELOPMENT OF THE AREQUIPA REGION

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KEYWORDS: Rural development factors; joint; interdisciplinary.

ABSTRACT

The Union is the poorest province in the Arequipa region, it is a typical example of disarticulation and socioeconomic and legal inequality; With respect to poverty they exceed 50% and in terms of Human Development Index the difference is even greater and shows the disconnection of the Urban sector and the rural sector. The role of the University and civil society is to show the large inequality gaps by proposing development alternatives and improving current legislation. The objective is to identify the factors that disrupt the Province of La Unión with the progressive Development of the Arequipa Region, to propose Strategic Development alternatives.
As for methodology, it is an applied research of the mixed type (qualitative-quantitative), descriptive with non-experimental analytical character. The techniques used The Survey, The Interview and the Observation. 408 surveys were applied in 11 districts, 48 interviews with authorities and community leaders, and Observation Sheets; there are 3,500 photographs several hours of videos; 60 selected photographs and 10 reports will be exhibited.
The results, 8 axes were analyzed. 1. Roads and tourism; Limited infrastructure, inaccessible, without asphalt and maintenance-free roads. 2. Education; distance to inadequate educational institutions and shelters. 3. Health, inadequate infrastructure and lack of ambulances and medical personnel. 4. Agriculture, poor tenure and poor and inappropriate cultivation. 5. Livestock, inappropriate and without technical capacity. 6. Interculturality, use of language by the State, 7. Justice, inappropriate and deficient legalism. 8. Information Technology, limited and non-existent. To this governmental neglect we present a bill that compensates for the Protected Natural Area; These elements are fully demonstrated through the applied instruments and official sources.

CODE 197

ANCIENT LIME KILNS: TRADITION, MANUFACTURING AND USE OF LIME IN THE PROVINCE OF GRANADA (ANDALUCIA)

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KEYWORDS: Lime; lime kiln; Granada; heritage; valorization.

ABSTRACT

The tradition and manufacturing of lime as building material has a relevant historic importance. Recently, its use as binder is being re-treated as a high-value material, especially in restoration interventions, due to its sustainability, compatibility and reversibility. In a similar way, attention is being paid to recover the traditional manufacturing process of lime in ancient kilns, some of them dating back to the prehistory.

In this work we claim to gather all existing information about the traditional and handicraft production of lime in both existent and extinct kilns of the province of Granada. This province, located in the Eastern part of Andalusia, shows a lime tradition limited to small vestiges, mostly preserved in dilapidated condition and with a very scarce or even absent information on them. A different reality is instead found in western Andalusia, highlighting Morón de la Frontera (Seville).

To address the study of these abandoned lime kilns, a bibliographic search has been carried out through libraries, archives and online resources. In addition, all the still existing kilns were visited to be precisely located with geographic coordinates and to collect materials for their study in the laboratory, by means of X-ray diffraction (XRD) and optical microscopy, so as to study their mineralogic composition and textural properties, with the aim to find information about the manufacturing technique and type of lime produced.

Finally, technical sheets including identification, geographic localisation, historical, technical and photographical description, conservation state and proposed measures for restoration have been prepared for each lime kiln.

The final aim of this research is to make this forbidden heritage known to the community and to highlight its importance, thus raising awareness through the population about the value of their territory and its belonging assets.

This study was funded by Junta de Andalucía Research Group RNM179 and by the Research Project MAT2016-75889-R.

CODE 200

CHEMICAL, MINERALOGICAL AND PHYSICAL CHARACTERIZATION OF LIGHTWEIGHT BRICKS WITH THE ADDITION OF SAWDUST FOR USE IN CONSTRUCTION AND PRESERVATION OF ARCHITECTURAL HERITAGE

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KEYWORDS: Solid bricks; sawdust; mineralogy; physical properties.

ABSTRACT

The production of replacement bricks to be used both in new constructions and in the restoration of historic buildings can be a challenge on many occasions. The choice of the clay material, the types and amount of additives to be added, the firing temperature and the atmosphere of the oven (oxidizing or reducing) are the factors that will influence the quality of the final product. The possibility of recycling industrial wastes in brick production is currently being studied, thus reducing production costs and contributing to environmental protection.

In this work, solid bricks were hand-crafted using a raw material from Jun (Granada, Spain), which is rich in quartz and contains significant amounts of carbonates and gypsum. Sawdust was added (by weight) to the clayey material in three different percentages: 2.5, 5 and 10%. After this, bricks were fired in an electric oven at 800, 950 and 1100 °C.

Bricks were characterized from chemical, physical and mineralogical points of view using different analytical techniques. The bricks with sawdust became a little darker compared to bricks without additive, suggesting that a partially reductive atmosphere may developed during firing by the combustion of organic matter. This would have led to the reduction of hematite content and generated maghemite. Unfortunately, the overlap of the diffraction peaks of this oxide with other mineral phases present in the bricks prevented it from being identified unequivocally by X-ray diffraction. In general, the main change generated by the addition of sawdust was the increase in porosity and a decrease in density. Because of this change in the porous system, these samples acquired interesting thermal insulation properties.

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CODE 229

FROM HISTORICAL ANALYSIS TO STRUCTURAL STRENGTHENING. THE CASE OF THE FORMER CONVENT OF SAN ROCCO IN SORAGNA (PR)

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KEYWORDS: Reuse; integrated conservation; structural strengthening; historical documentation.

ABSTRACT

The proposed paper aims at presenting a study conducted with the final purpose of restoring and revitalizing a 17th century cloister located in Soragna (Parma), which – after last century consistent and mostly destructive transformations – currently lies in a state of dangerous abandonment. Starting from the historical and constructive analysis of the complex, the project of reuse herein proposed has dealt not only with structural and safety issues, but also with the "use" choice, which descends directly from social and territorial aspects.
The significance of this intervention is hence related both to its compliance with the principles of the "integrated conservation process" as defined by R. Di Stefano during the 80's, and to the actual architectural and strengthening project, developed on the bases of a throughout historical research.
As a matter of fact, the study of historical documentation has shed light on forgotten information that, in the project phase, have turned into design opportunities. The ancient trace of a demolished wing of the complex has become an occasion to place a new portion of the building which, at the same time, meets three different objectives: an efficient functional distribution, the strengthening of the structure and an enhancement of its historical value. At the end of this path, in balance between structural strengthening, functional renewal and preservation of built heritage, the monument will increase its cultural and economic value, gaining a new (social) life.
The final aim is thus to show that structural strengthening should always be related to the historical analysis, in order to acquire a thorough understanding of the effects caused by the changes that shaped the building over time (R. Di Stefano, 1981).

CODE 259

TRADITIONAL HOUSING IN LAMBAYEQUE - PERU - REMARKABLE AND HERITAGE VALUE ASPECTS THAT CONTRIBUTE TO ITS SUSTAINABILITY

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KEYWORDS: Housing; vernacle; traditional; sustainability; heritage.

ABSTRACT

The research focuses on the study of vernacular architecture, traditional in the Lambayeque region, in northern Peru. This research was based on the knowledge of a permanence in the spatial patterns and of an evolution of the construction processes with local materials from the viceregal time to the present, so this study characterizes, identifies, catalogs and analyzes as a building and as an architectural space, systematizing the information so that it is possible to demonstrate the values that have allowed it to endure over time as an important option to inhabit for the common population, and that must be conserved as a witness and contribution of the adaptation of the vital space to the way of life, to the place, to existing resources, etc., constituting itself as an heritage for Lambayeque citizens, which must be defended and disseminated by promoting the contemporary application of the knowledge acquired by many centuries of adaptation of the inhabitants of this region to their most immediate habitat: the family.

To achieve this, a selected sample of buildings (some of them exist and other were demolished so they were virtually reconstructed) was analyzed, and through this, their predominant characteristics were determined, which then allowed to conclude that there are spatial and constructive solutions – that today are almost forgotten by the implementation of foreign models - which should be considered as design guidelines for current popular housing. The results focus on the importance of decision-making when implementing, prioritizing the place, the orientation, the environment and local materials, as well as the construction techniques resulting from the millenary experience and its miscegenation with the arrivals from Spain, whose adaptation produced important results. It also proposes recommendations for the design of the main architectural and construction elements for new houses. Finally, it is important to point out that the main contribution of this study is to contribute to the solution of the problems of current housing through the revaluation of its historical models.

CODE 260

VICEREGAL HOUSING FACADES IN LAMBAYEQUE - PERU: STUDIES FOR THEIR ENHANCEMENT

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KEYWORDS: Viceregal housing; facades; heritage; enhancement; Peru.

ABSTRACT

This research focuses on the study of heritage architecture in the monumental area of Lambayeque, which once was a outstanding village of indians located in the north coast of the viceroyalty of Peru, considering the absence of comprehensive information -graphic and technical- that allows to identify these buildings, characterize them, analyze them and guide the actions for their enhancement.
In this article, partial results of this research are presented, specifically those related to the study of viceregal housing. The main objective was to identify these buildings and carry out a constructive architectural analysis, in this case, of their facades, in order to generate the bases that will contribute to the formulation of strategies for the mentioned enhancement.
A sample of buildings was selected for convenience, and documentary and field data were gathered, processing them through its analysis and subsequent registration in inventory sheets designed to show its architectural characteristics, construction aspects and relations with the urban environment. Thereby, main attributes were determined and subtypes were established, cataloguing these buildings.
The main result of this work is to obtain new knowledge, presented through an organized record in an architectural catalog of the facades of the buildings studied, with comprehensive information about them, which after having been analyzed, are understood as components that present particular characteristics of functional, formal and constructive organization. These facades, denote western influence but with local contributions, as a result of cultural miscegenation, and also today, several of them are the result of subsequent interventions. The generation of this knowledge will allow to move towards the proposal of strategies to be considered in future urban-architectural interventions and enhancement in the historic center of Lambayeque.

CODE 261

THE MODERN MOVEMENT HERITAGE: PROTO-BIOCLIMATIC SOLUTIONS AND BUILDING ELEMENTS

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KEYWORDS: Modern movement heritage; proto-bioclimatic; solar shading solutions; sustainable heritage; passive thermal control.

ABSTRACT

Before the publication of the book *Design with climate: a bioclimatic approach to architectural regionalism* (1963), which established its author, V. Olgyay, as an international figure in the bioclimatic design, several works of the Modern Movement (hereafter MoMo) had already revealed a variety of passive thermal solutions/elements.

Le Corbusier's *brise-soleil* has spread throughout the world the concern of merging *arté* and *teknê* in the design of shading elements increasingly adaptable to control changes in light radiation, since the 1920s. Natural ventilation building solutions are integral parts of the iconic architectures designed by F.L. Wright masterfully revealing some paradigms of climatic sustainability into the material heritage of the MoMo. Forward-thinking Italian architects have started testing an impressive combination of new thermo-insulation autarkic materials (e.g. Eraclit, Populit, Faesite) to design performative climate-responsive building envelopes also suitable for colonial buildings.

By considering the 'anatomy' of the building, our study focuses on the identification, analysis, and categorisation of proto-bioclimatic building solutions conceived by the architects of the MoMo to achieve both the clime adaptability of building elements and adaptation of the International Style to diverse climatic conditions.

Our critical survey goes beyond a single discipline as it is the result of an integrated process of interpretation of the history of architecture, building design and construction history. This process has assumed a reductionist paradigm to highlight those systems seeking to reduce the negative impact of the building through its passive thermal efficiency.

Looking under the lens of thermal sustainability the building solutions of the MoMo legacy, our study aims to foster further progress in improving the resilience to climate change in design practices devoted to both: the conservation of the MoMo architecture and renovation of the 20th-century building stock.

CODE 268

THE HISTORICAL STUDY IN THE BENIGNO MALO SCHOOL, ITS INCIDENCE IN THE RESTORATION PROJECT AND CONTEMPORARY ARCHITECTURE

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KEYWORDS: Historical study; restoration; contemporary architecture; Benigno Malo School; Cuenca - Ecuador.

ABSTRACT

There is a long experience developed by the architectural culture in the intervention of monuments of the twentieth century that gives history a decisive role in the process of understanding heritage assets. However, in everyday practice and in the city of Cuenca - Ecuador, the history of monuments, far from establishing a dialectical relationship with other aspects of heritage (aesthetic, social, scientific, etc ...) has been understood as a Complementary issue, as a task required to meet requirements, neglecting the role that it can and should fulfill in the reflection around the monument, as well as its influence on the life of society and the subsequent project decision making.

Within the framework of the problem described above, this article focuses on the analysis of the importance of the historical study, carried out in the restoration project of the Benigno Malo College (World Heritage Site since 1999) in Cuenca, showing an effort to achieve a comprehensive proposal that respects the history and important events for the city, as well as for society and community rooted in the existence of the property. In addition, the historical study was accompanied by a participatory process with actors directly and indirectly related to the good, obtaining relevant historical episodes of the monument and its immediate surroundings, as well as the value that the good possesses for society, also being considered as a topic Priority conservation of the historical use of the property.

Finally, the proposal based on the historical study allowed to generate a cultural continuity with identity, which is possible, through the legibility of the parties (old-new) and the relationship between them, without renouncing that the current culture is expressed with Strength and freedom

CODE 285

SPATIAL ANALYSIS OF FINNISH ARCHITECT JUHA LEIVISKÄ'S CHURCHES AND THEIR LINK WITH DE STIJL DUTCH GROUP

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KEYWORDS: Natural lighting; european architectural heritage; styles hybridization; hinged space; planar architecture.

ABSTRACT

The continuity of European Heritage, from late German Baroque to the avant-garde, shows episodes which are difficult to explain with the sole vision of Modern Architecture historians. In these circumstances, buildings such as the church of the Three Crosses of Alvar Aalto in Vuoksenniska or several works of Finnish architect Juha Leiviskä seem to be expressive innovations out of context. The concept of 'interpenetration of volumes' -applicable to different intertwined spaces- allows us to reveal such continuity in these architectures, which Leiviskä develops from the notion of 'intermediate space', to establish links between the structural solution, the lighting of the building and Late Baroque spatial ambiguities, together with the assumption of ideas from the De Stijl group and the first designs by Mies van der Rohe.
Relationships with the transparent constructions by Van Doesburg are then presented in order to understand Juha Leiviskä's architecture. It is known that the Neoplasticists aspired to dissolve the physical boundaries. That is why their painting lines suggested a thrust beyond the margins of the canvas or the abolition between the interior and the exterior in their architecture, by fragmenting walls -a plastic matter later elaborated by John Hejduk and Steven Holl, lasting until today-. Leiviskä's architectural spaces, defined by free parallel planes, form areas without closing them, contrary to what would happen in a conventional rectangular parallelepipedic volume. Several of his churches and public centres present a light and sensorial vibration. He transcended the designer's role, assuming that of a critic, aware of the values of historical architecture, and becoming a communicator of new ideas where heritage issues and the overcoming of avant-garde coexist.
The article focuses on the study of several churches of the Finnish architect that exemplify this fact, emphasizing the value of the published graphic material (plans, models and photographs) connected to statements by Leiviskä himself, as reliable sources and knowledge tool.

CODE 287

URBAN-BUILDINGS PERMANENCES IN POST-FRENCH SEVILLE (XIX-XX CENTURY): PLANIMETRIC RECOMPOSITION AND SEQUENTIAL HYPOTHESIS

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KEYWORDS: Urban historiography; conventual cartography; Haussmanian principles; urban renewal.

ABSTRACT

This communication aims to show the latest findings on urban and architectural transfers in Seville in the context of the collation of Santa María, the founding nucleus of the city. In the nineteenth century, the successive confiscations of the conventual fabric gave way to a network of public spaces that, following the Illustrated laws, sought to modernize and sanitize the Islamic permanences of the plot. In this case, we present one of the most significant examples, consisting of the demolition of the extinct convent of St. Francis and the subsequent construction of a rational and neoclassical public space, now Plaza Nueva. The symbolism and importance of the Franciscan Order and of the convent complex itself led to it being chosen by the French troops to be converted, in the first instance, into a military barracks. When the plundering of the church's goods became a government interest, the Convent was demolished in search of the creation of leisure space for the bourgeoisie. The absence of exhaustive planimetry of the old convent allows deepening in the field of the hypothetical cartographic representation based on the theory of the urban permanences. The application of a methodology elaborated expressly for the case has allowed to conclude how the final project of the square, work of the architect Balbino Marrón, uses the urban traces generated by the convent as a design strategy, having verified the reuse of materials of the convent for the construction of the new farmhouse. Despite the almost total loss of the monastic heritage, two recognizable milestones have been maintained: the access arch to the entrance court (currently attached to the Town Hall) and the chapel of San Onofre. The geometric radicality introduced by the square does not prevent both elements from being integrated into the civic scenario, living side by side with the design of the extinct convent.

CODE 288

SEGOVIAN SHEEP SHEARING BUILDINGS DURING XVII AND XVIII CENTURIES. REDISCOVERING LOST TRANSHUMANCE HERITAGE, THROUGH GRAPHIC RECONSTRUCTION OF ITS BUILDINGS

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KEYWORDS: Sheep shearing buildings; Segovia; transhumance; Cañada Real Soriana Occidental; industrial heritage.

ABSTRACT

Segovian sheep shearing buildings are a fascinating and barely known example of industrial architecture linked to livestock transhumance. During the XVII and XVIII centuries, the increase in wool exports forced its owners to transform and improve the associated processes to the management of the big Merino sheep sheds, and, as a consequence, the construction of big complexes to extract the wool in a systematic and chained way; main fruit of the transhumance and endless source of castilian wealth.
These buildings, known as *esquileos*, were implemented by the main transhumant farmers (nobility, monastries and wealthy people) in the Segovian hillside of the Sierra de Guadarrama. This would constitute a unique phenomenon at the time, associated with the Cañada Real Soriana Occidental: a large industrialized corridor specialized in the treatment and extraction of wool before being exported to other European countries. However, after the abandonment of the activity during the XIX century, the buildings would be doomed to uncontrolled abandonment and plundering and, consequently, to systematic demolition and ruin.
The development of ongoing research seeks to reveal the importance and magnitude of these complexes from the point of view of architecture, thanks to meticulous documentation and fieldwork, which has so far been nonexistent. The importance of recovering and resizing this phenomenon is based on the understanding of the own *esquileos* typology; self-sufficient cores that during the period in which the tasks were developed (20 days per year) could lodge more than 600 people among workers and concurrents. Likewise, in attention to their dimension and scope, it has been possible to document complexes with an approximate 8.500 m² of constructed surface.
The aim is to provide and establish a solid and updated basis for research, documentation and understanding of this cultural, environmental and heritage phenomenon, which has now mostly disappeared, and to constitute a model for its future conservation and safeguarding.

CODE 291

THE IRONWORK, TOOL FOR THE ANALYSIS OF HISTORIC URBAN LANDSCAPE IN LARBI BEN M'HIDI STREET IN ALGIERS (ALGERIA)

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KEYWORDS: Historic urban landscape; morphologic components; ironwork.

ABSTRACT

The historic urban landscape of the 19th century in Algiers has been treated as an artwork. Therefore, it presents decorative, ornamental and technical richness that must be preserved as a source of knowledge. The resulting urban order was first determined through a codification linked to plans of alignment and embellishment, then to other planimetric and tridimensional morphological components. The shape of the balcony's ironwork : continuous or punctual, highly contribute as architectural components in the physical, visual and spatial quality of the urban landscape. It is often expressed through the concepts of harmony, coherence and homogeneity.

The aim of this research work is to analyze the quality of historic urban landscape through its morphological components and define the role of the ironwork ornemental component in the composition of the urban and architectural facades. The method used combines the systemic and the morphological approach. The analysis was conducted through the use of mathematical tools.

The results of the 60 facades analysis from Larbi Ben M'hidi street revealed morphological regularities in its historic urban landscapes and correlations between urban and architectural variables. It also highlighted the relationship between its bonds.This allowed us to verify and objectify an observed homogeneity.

The use of the facades as units of decomposition, firstly analyzed independently from one another then in groups classifed according to the ironwork component and including their interrelations, have demonstrated in our research the efficiency of the analysis protocole to understand the complexity of the historic urban system.

CODE 324

PROTOCOLS AND SAMPLING OF ANALYSIS OF MATERIALS FOR THE CHRONOLOGICAL STUDY AND INTERVENTION TECHNIQUES: TORRE PIMENTEL OF TORREMOLINOS, MÁLAGA

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KEYWORDS: Heritage; tower; samples; mortar; wood.

ABSTRACT

The material analysis of the walls of a building through the reading of its constituent materials presents historical and scientific interest. The application of techniques of archaeometric type allows to establish a chronology, when determining the relationship between the material and the time of construction. In addition, knowledge of their physical and chemical properties provides a guide in the decision-making process regarding the proposed intervention techniques to be applied for their recovery.
The Tower of Pimentel or the Mills, located in the town of Torremolinos (Malaga) was part of the defensive chain that the Nasrid kingdom of Granada erected along the coast, linked to its system of farmhouses. This article exposes the methodology and protocol followed in order to characterize and identify the materials used in its construction, as well as the coatings of different chronology that are superimposed on its walls, with the purpose of placing in their historical-archaeological context the different interventions. The criteria for the extraction of these samples of materials, belonging to the cultural heritage, goes through the elaboration of an adequate record of the taking of samples and of a obtaining procedure that minimizes the damage to the cultural property.
Thus, in a first phase a specific protocol has been developed for the taking and analysis of samples. In this, the main role is adopted by a series of cards that are designed to collect the necessary information for the investigation, such as the type of material, number of samples, as well as its geolocation. In addition, the analysis and characterization techniques to be used in the analysis of historical mortars, as well as in the biological material found, such as wood, are collected. Secondly, the procedure for the extraction and sampling of these woods and mortars has been specified, since this depends on the type of material to be sampled, as well as on the chemical-mineralogical, petrographic and physical properties that are to be determined. As a conclusion, the results obtained in the analyzes carried out are exposed.

CODE 325

THE ROLE OF ITALIAN IN ARCHITECTURAL CONSERVATION MOVEMENT IN IRAN

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KEYWORDS: Ismeo; Italy; Iran; architectural Conservation

ABSTRACT

The Italian Institute for the Middle and the Far East (ISMEO), was founded in 1933, had the purpose of promoting and developing cultural relations between Italy and the countries of the Middle and the Far East.
Preservative and conservative operations in Iran are always grateful of Italian conservatives especially when some professional members of ISMEO have come to Iran since 1959.
Some activities of ISMEO in Iran are:- Foundation of Restoration Institute at Teheran National University
- Start restoration activities on some remarkable monuments In Isfahan, …
- They have set up a sample for the restoration and preservation of historical monuments in Iran
- Clarify some of the little-known aspects in the history of Iranian architecture
Because of the revolution in 1979 and then the war between Iran and Iraq, they could not complete all the restoration activities, but in fact, they started a very important movement towards conservation and preservation monuments in Iran.
In this paper, I want to study the process of conservation and restoration by the Italian expert in Iran to determine the effects that they have on preserving the Iranian monuments. In this case, I have to collect existing documents in Italy and Iran.
Research methods include information and data collected through the archive, books, and documents, edited in Iran and Italy, site observations and inspections, interviewing with architects who have been an active part of the restoration process, with Iranian and Italian specialists; in order to gather information, data and impressions related to the subject.

CODE 331

CONSERVATION OF THE FORTIFIED WALLS OF THE ALHAMBRA: PRELIMINARY RESULTS ON THE ORIGINAL AND REPAIR MATERIALS OF THE TOWER OF THE HEADS

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KEYWORDS: Alhambra; materials characterisation; earthen materials; rendering mortars; deterioration.

ABSTRACT

This work shows the preliminary results of the characterisation of earthen materials, rendering mortars and patinas of the Tower of the Heads, belonging to the fortified walls of the Alhambra (Granada, Spain). This work provides a scientifical-technical study of the original and repair building materials of the tower, so as to understand the building techniques used and the causes of deterioration. The tower, indeed, shows severe volume losses and salt deterioration that are badly endangering its conservation.
More than thirty samples collected at different heights from the external and internal southern wall and from the external eastern wall of the tower were studied by means of X-ray diffraction (XRD), X-ray fluorescence (XRF), optical microscope observation (OM), high-resolution scanning electron microscopy (HRSEM-EDX) and visual granulometric study (VGS).
Cement has been detected in almost all the rendering mortar samples as well as high amounts of gypsum and singenite (K2Ca(SO4)2·H2O). The latter was likely originated as secondary phase from the high-alkaline cement used as binder in the repair mortars. In some original mortars (especially those collected from the interior of the tower) lime and gypsum were found as binders. The great amount of gypsum found in mortars (as both binder and cement additive) explains most of the deterioration processes affecting the tower. It is also worth highlighting that the repair mortars applied for rendering present dolomite as aggregate, which can be deleterious due to the possible formation of Mg-based soluble salts. Finally, the original earthen materials collected from the most inner layers of the wall are composed of high amount of aggregates, mainly quartz and calcite, with lower amounts of phyllosilicates and gypsum.
The following step of this research will be linking these results with archaeological and architectural studies on the tower, so as to be able to correctly determine the original building techniques and all the possible interventions carried out on the tower in the past, with the final aim to define a correct intervention strategy that can be used as a model for the rest of towers belonging to the fortified walls of the Alhambra.

CODE 360

THE POWER BEHIND ARCHITECTURE. MODERN BUILDINGS USED AS STRATEGY TO EXPRESS A POLITICAL IDEOLOGY IN THE CARIBBEAN

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KEYWORDS: Modern buildings; power-space; Caribbean architecture.

ABSTRACT

This enquiry studies the relationships between power, space and architecture; highlighting the role of architecture as a strategy to transmit a political ideology, through a series of modern buildings built by the dictator Rafael Leónidas Trujillo in 1955, in Santo Domingo, in the framework of an International Exhibition, called International Fair of Peace and Brotherhood of the Free World, in complex historical, political and cultural circumstances. The Fair had a double denotation: The celebration of the Dictator's 25 years of power, which fulfilled and demonstrated to the world the economic achievements, prosperity and peace which supposedly subsisted in the country, deviating the international awareness from the human rights violations that were actually present at that time. The architect used spatial monumentality accompanied by an iconographic program of powerful sculptural elements and murals, which represented the progress and prosperity of the citizens. He designed a new urban layout, built 12 large buildings, three hotels and several dozens of small pavilions. The arrangement deranged the traditional urban configuration, it framed within the stylistic current movement of the moment with new compositional forms and new materials such as reinforced concrete. The entire design process was directed of the Dominican architect Guillermo González Sánchez, a graduate of Yale University, assisted by young Dominican architects. Its construction was done in a record time of just over a year. The fair was inaugurated in the presence of the diplomatic officials accredited in the country, high army commanders, ecclesiastical dignitaries, important figures of the Dominican society of that time and coincided with the participation of forty-two nations. Currently, the urban layout is maintained and many physical structures of the building have survived. Undoubtedly, this urban-architectural arrangement forms a unique scenery in the Caribbean, which has been exceeded by Brasilia, six years later. Still today, the whole evokes the economic power, the strength of the regime, the advance of the national industry; self-sufficiency, control and economic stability

CODE 366

SHELL CONCRETE STRUCTURES IN VALENCIAN REGION (SPAIN) CATALOGUE

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KEYWORDS: Catalogue; shell; concrete; rehabilitation; Valencia.

ABSTRACT

Shell concrete structures mainly use their shape as stand up mechanism. They are extremely efficient and beautiful structures. The development of this type of structures begins around the 20s of the 20th century reaching its quantitative and qualitative splendor around the 50s and 60s and its decline in the following decade, mainly for economic reasons.
This study aim is the location and historical, constructive and structural characterization of the shell concrete structures in Valencian Region (Spain). For this purpose, a previous work of location and documentation of 17 structures has been carried out for its complete cataloging.
Protection of this unique architectural heritage is necessary and urgent because issues related to durability of reinforced concrete. The purpose of this study is the dissemination and enhancement of this structural typology in the Valencian Region with the hope that administrations and owners will undertake actions for its conservation, rehabilitation and protection.

CODE 383

THE TECHNIQUE OF THE ARABAN QANAT IN THE LOW BASIN OF THE HENARES RIVER, AN HIDDEN HERITAGE

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KEYWORDS: Foggara; viajes de agua; mina de agua.

ABSTRACT

Until now, there were only brief and imprecise references on the use of the ancient technique of the Arab qanat, in the lower basin of the Henares River. It is not strange this circumstance because the Arabic voice qanat, refers to a gallery, which is used to capture the waters of an underground aquifer and transport them to their place of use. It is its underground layout that makes these infrastructures, true wonders of hydraulic engineering, so important in their time, remain hidden and forgotten. This technique is behind many of the famous desert oases. On the contrary, the transcendental relevance of the use of this water collection technique in the city of Madrid is well known. This importance made the current Law of Historical Heritage of the Community of Madrid, declared Assets of Patrimonial Interest. The investigations that originate this article have also served to document the existence of these infrastructures, acting as supply systems, in the main cities of the Henares river basin, the cases of Guadalajara and Alcalá de Henares. The work carried out to locate these galleries has been based: in the historical study of the data obtained in the primary sources, of the archives, in the hydrogeological study of the area and of the historical and current photography and cartography. On the other hand, modern topographic and graphic survey techniques have been used to carry out the survey and cataloging of its characteristics and its layout. The research has served to locate these galleries, document them, catalog them and represent them graphically, so that they can be shown, since their underground layout makes this essential for their dissemination, study and knowledge. The physical-chemical analyzes have allowed to know the quality of the waters and confirm the uses to which they were destined. It has also been noted, the important role they have played in the historical development of these urban centers, in the lives of their inhabitants, institutions and religious communities.

CODE 410

CHARACTERIZATION OF THE BUILDING STOCK HERITAGE ORIENTED TO STUDIES OF SEISMIC VULNERABILITY AT URBAN SCALE: CASE STUDY HISTORIC CENTRE OF CUENCA, ECUADOR

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KEYWORDS: Historic Centre; heritage buildings; unreinforced masonry; characterization; seismic vulnerability.

ABSTRACT

Cuenca is a city located in southern Ecuador (the third in importance), whose Spanish foundation dates back to 1557. Declared, in 1999, a World Cultural Heritage city by UNESCO, largely due to the valuation of its Historic Centre. The city is categorized as high seismic threat, with PGA: 0.25g, according to the Ecuadorian Construction Standard (NEC, acronym in Spanish). The Austro Seismic Network, a research center attached to the University of Cuenca, carried out, in the late 2000s, the first (and only) seismic vulnerability study of the city. The damage scenarios obtained showed that the Historic Centre of Cuenca (CHC, acronym in Spanish), where the oldest non-reinforced masonry (MNR, acronym in Spanish) buildings in the city are concentrated, is the most vulnerable area. This study was based on a simulation of seismic behavior at territorial scale with simple 1D models. With this background, within the framework of a seismic vulnerability project for the CHC whose objective is the establishment of more reliable damage scenarios, this work considered the characterization of its building stock, in typological and geometric terms. The characterization was oriented towards the estimation of the damage by means of static non-linear pushover analysis on 3D models, assuming as a strategy the condensation of the typicality of the existing buildings in a family of buildings-prototypes (EPs, acronym in Spanish). Focused on two of the three existing sub-typologies: adobe and brick MNR buildings, the characterization strategy was developed in three sections: 1) chronological study of construction practices and technologies of construction materials, 2) identification of predominant uses, and 3) study of geometric and architectural features. As a synthesis of such studies, a catalog of six buildings-prototypes was obtained, three for each sub-typology.

CODE 420

RESULTS IN GRANADA OF THE METROLOGICAL INTERPRETATION OF HERITAGE BUILT BY ANTHROPOMETRIC RULES

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KEYWORDS: Architecture; archeology; dating; proportion; diagonal.

ABSTRACT

The absolute dating of the historical period of construction of a work of the past from the analysis of its measures has always been a logical possibility, because before the adoption of the Meter each town used its own references, such as the Roman foot or the Castilian yard. Now that option could be viable using anthropometric techniques based on a rule of harmonic proportions that linearly combines sides and diagonals of the same square pattern. Under this premise, techniques and tools have been developed to anthropometrically analyse numerous architectural samples from all times and places, always reaching positive results in terms of determining their modulation and metrics. Several examples of interpretation of the measures of works of the historical site of Granada are presented on this occasion. In the first place it has been proven that, together with the Castilian measure that was imposed after the conquest of the city, the old Toledo yard was also used in the construction of the Palace of Carlos V and other contemporary works. In addition, a change in the reference measure has been detected in the works of the Nasrid period that differentiates what was done in the first reigns of the thirteenth century from that executed or added from Ismail I, since the beginning of the fourteenth century. Although much scarcer, another series of works that would respond to previous historical measures have also been located. The capacity for detailed analysis offered by the developed anthropometric rules makes it possible to discern practically in real-time between the original parts of a building and those added with different metrics. Thus, a large number of works and parts considered of the Modern or Contemporary Age are being detected, which by anthropometric dating are Nasrid or earlier.

CODE 511

GEOLOGICAL AND GEOMORPHOLOGICAL STUDY OF EL PENDO CAVE (CANTABRIA, NORTHERN SPAIN)

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KEYWORDS: Geological and geomorphological studies; cave protection; geomorphological mapping; El Pendo Cave; Spain.

ABSTRACT

El Pendo Cave is located in North Spain, near Escobedo de Camargo Village in Cantabria Province. The cave was excavated by Marcelino Sanz de Sautuola in 1878 and since then has been considered one of the most important sites of Palaeolithic rock art in the region, mainly with the discovering of the painting panel in 1997 and its inclusion in the list of Human Heritage in 2008. Nowdays The Cantabria International Institute for Prehistoric Research has resumed the study of the archaeological deposit.
Geological and geomorphological studies are excellent tools in order to preserve and protect caves because permit to outline the interaction between the different areas of the karstic system. Here we discuss the results of the information depicted by the geological and geomorphological mapping carried out inside and outside the cave. The external characterization points out four main geological units dated from Lower Cretaceous which consist of clays, silts, marl and limestones. The bottom of the sequence is defined by siliciclastic materials overlaid by marls and limestones in which the cave is formed. The cave entrance is formed in limestones that with a more fragile behaviour are prone to undergo rock falls and make this zone the largest of the cave. The internal area is formed into the marly geological unit that shows a lower fragility causing a reduction of the rock falls and the cave turns narrower.
The geomorphological mapping into the cave permits to deduce a strong relation between the large deposits of sand, silt and clay that cover the internal area of the cave and the flooding events caused by the Pendo Stream. The stream drains into the endokarstic system through a sinkhole located in the northern zone of the blind valley just below the cave entrance. These flooding events as well as the uprising of the water table are currently active processes of big interest in order to depict protection areas surrounding the cave. Samples of these detritic material have been study in order to obtain a petrographic description and dating.

CODE 526

PROPOSAL OF A SIMPLIFIED APPROACH FOR ASSESSING AND MAPPING FLOOD VULNERABILITY IN HISTORIC SITES: APPLICATION TO THE HISTORIC CITY CENTRE OF GUIMARÃES

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KEYWORDS: Flood vulnerability assessment; historic city centres; built heritage; GIS; Historic centre of Guimarães.

ABSTRACT

Over the past few decades there has been a considerable increase of the frequency, the duration and the negative impacts of flooding events in urban areas. Several reasons can be pointed out to explain this, namely the combined effect of disorderly human activities, such as extended urbanization or changes in the land use patterns, with environmental and physical factors, such as those related to climate change. In consequence of that, the analysis of flood risk, the evaluation of their consequences and the adoption of adequate mitigation and preparedness measures, are presently a fundamental societal challenge. This study aims at contributing to this discussion by presenting a simplified flood vulnerability assessment approach for historic sites. The historic city centre of Guimarães, Portugal, is used in this work as a pilot case study to apply and discusses the preliminary version of the approach. Field acquired data is processed and mapped using a free GIS package, allowing for the spatial evaluation, analysis and interpretation of the results over the study area

CODE 95

EMPLOYERS AND EMPLOYEES: EACH ONE IN HOME THE TUNA FISHERMEN AND THE COMPANY'S OWNERS

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KEYWORDS: Tuna fishing dwellings; company's owner house; Faro; Algarve; Portugal.

ABSTRACT

This article describes, in a general way, the provisional housing in the arraial of Faro's beach, Algarve, Portugal, where fishermen lived during the fishing season of the tuna (50s and 60s) and already disappeared, and the existing houses in the city of Faro, where the owners of the fishing companies lived. The transition from thatched roof houses to the wooden pavilions on the beach, which housed fishermen and their families during the tuna fishing season, from March to June, and the houses owned by the employers, are described. One of the main objectives to be achieved is the dissemination of this heritage, part of which disappeared and the population's awareness, especially the local population, about the danger of its total disappearance. This research was based on documentary, photographic and bibliographical analysis and also on interviews with people involved in this activity, and who are now with about 90 years old, which constitutes, beyond the scarce information that exists, an important limitation to the development of this work. That is why it is urgent to register and disclosure of this heritage, given the advanced age of those who witnessed in the first person all this experience and art. Being a heritage that characterizes this region, it must be valued and transmitted to the generations to come. Otherwise, there exist a great risk of disappearing completely, both physically and from the collective memory of the community. The originality of this paper is the taken approach: based on the tuna fishery in Faro, perform a characterization of the fishermen's dwellings, located on the beach, and those of the employers, located in the city.

CODE 121

TERRITORY AND DRYSTONE WALLS. COMPARATIVE OF CASE STUDIES IN CENTRAL AND SOUTHERN PORTUGAL

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KEYWORDS: Drystone walls; territory; vernacular heritage; Barrocal; Cernache do Bonjardim; Portugal.

ABSTRACT

Since becoming settled, Man had the need to shape the territory in his benefit, gaining ground for agricultural activity. Drystone walls were the way found to overcome sharp slopes. The way these walls are arranged in the territory is not random, as it may seem at first glance: they are disposed in the best way to facilitate agricultural activity, taking into account the natural factors of the territory where they are located, such as orography, climate or geology. Taking as study cases two regions in Portugal under slightly different climate regimes, one located in the Algarvian Barrocal and the other located in the Center, we intend to compare and advance with explanations as to the way drystone walls are disposed and their relation to the territory. To achieve the objectives bibliographical, photographic, interviews with the inhabitants of these areas, cartographic and field surveys were carried out. Whereas the purpose, materials and construction characteristics were achieved by the previous, their disposition and relationship with the orography were carried out by the latest. Particularly, field surveys were made by digital stereo-photogrammetry applied to several overlapping nadiral photographic images from different perspectives acquired by an unmanned aerial vehicle along its flying pathways that allowed for very high-resolution geographic data. Where such surveys were not made, cartographic data were used instead. Through the dissemination of such vernacular heritage, it becomes valued and known. In this way, people will attribute cultural and patrimonial value, protecting it, especially the local population that tends not to attribute any value to this “minor” heritage, contributing to its disappearance. There are still not much works about this subject in the areas analyzed here, so this paper has an added value, in order to disseminate and create added value to these kind of heritage.

CODE 129

CLIMATE CHANGE AND ADAPTATION ON CULTURAL HERITAGE IN THE FACE OF SEA LEVEL RISE. A PERSPECTIVE FROM INSULARITY

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KEYWORDS: Climate change adaptation; sea level rise; fortified heritage; Canary Islands; cultural heritage.

ABSTRACT

Climate change is being recognized as one of the phenomena with the greatest impact on Spanish cultural heritage. From the point of view of spatial management, integrated planning on the coastline is presented as the most appropriate response to climate change in the shoreline. One of the direct vectors in the vulnerability of historical heritage located close to the coast is sea level rise. A review of the assets of historical and cultural heritage in areas of marine intrusion implies to take awareness of possible impacts on which they will be subjected in the coming decades. In the specific case of the Canary Islands, there are innumerable elements of historical and cultural heritage in coastal areas that may be affected by sea level rise. Archaeological sites, historical urban centres, fortresses of the Modern Era, saltworks and other productive infrastructures of great cultural values are being altered by the action of high tides and other extreme phenomena associated with climate change.
A system of assessment of impacts on the heritage located on the coast is proposed, which makes possible to prioritize decision making as the first mechanism to manage this huge problem. Once the patrimonial assets at risk have been identified, the necessary adaptation strategies can be established preventatively. A planning of adaptation actions should be coordinated equally with changes in the definition of land uses. This implies a change in the planning model that encompasses both territorial management and urban planning. It is, in short, the need to implement a response that encompasses integrated planning strategies, beyond the recurrent sectoral vision of heritage protection.

CODE 132

NEITHER BOUNDARIES NOR BARRIERS. INTERNATIONAL INTERACTIONS BETWEEN THE CITIES OF SANTANA DO LIVRAMENTO (BRAZIL) AND RIVERA (URUGUAY)

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KEYWORDS: Border; heritage; territorial relationship; Brazil; Uruguay.

ABSTRACT

Starting from the premise of encouraging a better management of the historical heritage in the south of Brazil, this work aims to disclose a social situation that unites two countries and two cultures, mixing them together and integrating the residents of Santana do Livramento and Rivera. These cities are located alongside in the borders of Brazil and Uruguay, without physical or natural division, only boundary landmarks. In this assignment it will be brought attention to the beginning of territorial discussions until the newest decrees of the evolution of political discussions about the separating line and the way it changed the population, so they would become one. Plenty of documental and online research, such as legislative decrees, maps, reports and local history books, went through analysis for the construction of this study, with the main objective of bringing recognition to a territorial arrangement that resulted in a unique interaction between two countries. The situation of the unusual case is the main characteristic of the historical heritage, transcending from the history of how this territory came together and how the population became one, bounding cultures and changing the ways of living. It is of great importance the revealing of this border so that the appropriation of the own residents with their past and heritage is increased, hoping to bring bigger investments and a more careful look to the visual of both cities, so that it could prosper as it should. Taking this subject into consideration, it is noteworthy that the visibility of southern Brazilian and Uruguayan heritage must be explored in a way that it brings more value to this territory, instead of only being outgrown by the profit, immediate gain of big corporations and buying power, so that this population can have opportunities to grow and prosper.

CODE 139

SALT: THE WHITE GOLD OF ALGARVE

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KEYWORDS: Salinas; patrimony; Castro Marim; Algarve; Portugal.

ABSTRACT

One of the riches of the municipality of Castro Marim, in Portugal, are its traditional salinas. In this article it is proposed to make known the patrimonial aspect of this activity, as much from the point of view of the cultural heritage, as of the natural one. For the development of this article, bibliographical research, iconographic, audiovisual, photographic and field surveys were carried out, but one of the fundamental parts was the interaction with the local population dedicated to this task. One of the objectives of this work is the dissemination and appreciation of the natural heritage, but also of the vernacular heritage connected with the exploitation of salt in Castro Marim. In this way, it is intended to influence decision-makers, industry associations and the community in general to be an active part in the valorisation of a product of excellence that is sea salt and salt flower, which play a fundamental role for the socio-economic development of this territory. As the research evolved, it was clear the territorial, cultural and economic importance that this activity has for this municipality, which is why it is urgent to disclose these assets. The lack of well-defined and structured programs, in partnership with the other environmental and scientific institutions, makes it impossible to implement sustainable projects for the valorization and enrichment of the salt areas and increase the distance of the community from these environments, making it difficult to raise awareness of the value they possess . Traditional salinas should be made known and valued so as to create empathy and a sense of belonging in the community. All should play a key role in the protection, maintenance and enhancement of these marine environments. In this sense, this work is important because of the approach adopted and because it is one more way of disseminating this kind of heritage that is disappearing and deserves to be maintained.

CODE 181

ARCHAEOLOGICAL SITES IN MEXICO AND THEIR RELATION WITH INMEDIATE HUMAN SETTLEMENTS: DECONSTRUCTIVE IDENTITY

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KEYWORDS: Territory; landscape; urban expansion; archeological sites; acropolis.

ABSTRACT

The acropolis draws its silhouettes in the landscape; the imposing walls define the edges of the hill from where it is displaced. Even today, the surrounding villagers rise on specific dates, to celebrate ancestral rituals. The site is built over time, pyramidal silhouettes and platforms, dialogue with each other, with the landscape and with the universe. The stars, hills and temples obey the same idea, distributed in different scales. Macros and microcosm become a single inseparable organism. Below, the reticular trace of the village speaks of the inhabitants. Even through a cultural over position and syncretization, there seems to be a harmony between one horizon and the other.

We continue to look from the tip of one of the pyramidal basement. Something is starting to distort the experience. The defined plots of the peasants begin to give ground. The village trace expands and degrade. The territory deals with other rules, with other interests. Industrial warehouses, large wineries, low-cost serial houses... They are neither city nor suburb. It is the deconstruction of the territory under a line of thought that, despite all the questions with which it has been confronted, it is still the current pattern of land occupation today. In this context, the heritage disarticulates from its environment, becomes another spatter of the system, disjointed and exploitable only from a tourist industry perspective. Is it possible to propose an alternative? Can the territory be arise from the still existing, although increasingly dissolved ancestral traditions of the inhabitants and its link with its monuments and heritage pre-existences?

In this article, we will develop the concepts mentioned from the analysis of four heritage archaeological sites, which are related by a territorial axis: Calixtlahuaca, Teotenango, Malinalco and Xochicalco. Each in its peculiarity as acropolis that dominates a territory, and its relationship with a landscape preserved or degraded as the case may be.

CODE 231

MUELLE DE LEVANTE MASTER PLAN IN HUELVA PORT. PLANNING THE REHABILITATION OF THE PORTUARY INDUSTRIAL HERITAGE TO THE REALITY OF PORT-CITY INTEGRATION

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KEYWORDS: Responsible architecture; sustainable urban planning; port-city; industrial portuary heritage; energy efficiency.

ABSTRACT

The city of Huelva, its port and its estuary have been deeply interrelated throughout the centuries. For years, the last navigable section of the Odiel estuary has been linked mainly to mining and industrial uses, its use being marginal for the enjoyment of citizenship. The advances that are taking place in different administrations policies in urban and territorial planning are making compatible the transformation of their socio-economic activity and putting in value *Muelle de Levante* for the citizens.

Since the expansion of the Port of Huelva and the transfer of its main focus of activity to the outer port, the weight of the inner port in all its activities has been greatly reduced, coinciding with a strong citizen demand to recover the contact of the city of Huelva with its estuary. To achieve it and make it sustainable in the medium and long term it is necessary to incorporate new uses this urban sector that provide value for citizen enjoyment and make possible the implementation of compatible non-industrial activities in *Muelle de Levante*.

Port-city actions undertaken in recent years Huelva Port Authority as the *Paseo de la Ría* have shown how it is possible to rehabilitate port areas, facilitating the meeting of the city of Huelva with its estuary by organizing a common place for citizen leisure and compatible portuary uses.

The master plan presented in this work allows the orderly development of fishing, industrial, portuary, commercial and recreational activities, generating synergies between them. It also highlights the important industrial port heritage of more than a kilometer of historic quay that has been the origin of the city of Huelva and currently an opportunity for port-city integration. We are referring, in short, to the transformation of an important border-boundary of the city of Huelva historic center into a unique both portuary and citizen space.

CODE 251

THE FARMS IN THE WEST AREA OF PÁRAMOS DEL ESGUEVA. THE CASE STUDY OF THE COUNTRY HOUSE-WINERY OF THE ROYAL MONASTERY OF SAN QUIRCE Y SANTA JULIA

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KEYWORDS: Territorial heritage; landscape; rural architecture; farms; country houses.

ABSTRACT

As the territory of Páramos del Esgueva became consolidated after the peninsular repopulation in Spain, and with the rise of the city of Valladolid, large landowners look for a better use of natural resources and an improvement of agricultural production. Therefore, they spread in the west zone a number of facilities for control and management of those resources. The progressive decrease of transhumant activity since the end of XVIII century, in favor of an economic development model focused on the agricultural exploitation of the Esgueva Valley, enables the understanding of the distribution of country buildings as a system at the service of rural societies. This article summarizes the territorial analysis of the settlements, and applies the functional, formal, material and constructive study to the country house and winery founded by the Royal Monastery of San Quirce and Santa Julita, in order to recognize this type of architecture, in risk of loss.

CODE 263

PREVIOUS STUDIES FOR INTERVENTIONS IN THE CULTURAL HERITAGE BUILT ON THE COSTA LAMBAYECANA: RAINFALL INTENSITY FOR STORM DRAIN DESIGN

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KEYWORDS: Precipitation intensity; storm drainage; heritage conservation.

ABSTRACT

Over time on the coast of Peru and particularly in the north, meteorological events, such as the El Niño Phenomenon, with heavy periodic rains, have affected the deterioration of old buildings built predominantly as a base material earth.
Indeed, the rains affect the heritage building by the persistent precipitation that moistens roofs and walls; also its bases, by the recharge of the underground aquifer that causes the ground water level to be closer to the surface of the terrain; causing all this situation to affect the stability of the buildings.
In view of this, any conservation intervention must take care of a good design of the storm drainage as an indispensable factor, and this depends on certain factors inherent in the building, but especially those related to its geographical location, the same that has an on the intensities of the precipitation, which in the case of the Lambayeque territory because it has altitudes relative to sea level exceeding 3000 meters above sea level, this is different, as shown in the research.
This study provides for these purposes information on precipitation intensity throughout the Lambayeque region, following the assessment and processing of data from the various weather stations in the area, corresponding to information rainfall at the maximum rainfall level in 24 hours.
Its importance lies, in the need for this information to assess the real irrigation of the monumental buildings and then for the proper design of the storm drain. Although the rainfall information is scarce, using formulas, maps and graphs have been developed that allow to determine for Lambayeque Region, the value of the intensity for a certain period of return and concentration time.

CODE 350

THE CURRENT STATUS OF LEVANTINE ARCHITECTURAL HERITAGE IN THE CITY OF MERSIN

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KEYWORDS: Mersin; mediterranean; port cities; levantine heritage; conservation

ABSTRACT

Mersin, which is one of the Eastern Mediterranean port cities, is also located in the ancient Cilician Region. Although there is less information about this city, which was known as Zephriuma (Zefirium) in ancient times, then surrounding ares, archaeological studies show that the city was in contact with Anatolian and Mesopotamian cultures. The city, which lost its importance during the Middle Ages, was known as a fishing village where the Turkmen tribes lived in the beginning of the 19th century, and it re-gained its value in the middle of the 19th century. During this period, the port of Tarsus lost its importance due the silting up of the Tarsus river and the Mersin port had started to grow. It is not possible to evaluate the development of Mersin and its transformation into a residential area independently from the port and port trade. The most distinctive feature of the Eastern Mediterranean Port cities, is a multicultural society and the presence of European merchants called "levantine". In this century, apart from the Levantines, there was an also Maronites coming from the vicinity of Aleppo, Arabs, Greeks and Armenians, as well as Jews, Chaldeans, Syrians and other non-Muslim communities.
Within the scope of this study, the current status of Levantine architectural heritage in Mersin city center and the preservation problems of them will be investigated. The aim of the study is to contribute to the preservation, introduction and transfer of the cultural heritage to the future. Literature review and on-site examinations are envisioned as the working method. Then, the obtained data will be evaluated and presented.

CODE 454

BUILD IN TILES WITHOUT WOODEN TILES. A CONTEMPORARY LOOK

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KEYWORDS: Local architectures; shingle; cultural identity; architecture.

ABSTRACT

The local architecture is the material sparkle of certain elements that put in evidence different cultural practices, which confers identity to communities and villages. In that way, the communities see their memories reflected at the occupations that sustain these traditional practices. In the south of Chile, the work related to hardwood associated to architecture is raised in a dialogue between the material and who shapes it; a contextual expression materialized in different objects, volumes, and ensembles that deliver techniques, occupations, and different manners of inhabit that constitute an architectural and contextual patrimony.
The following work, develops an integrated perspective, from an architectural view, about shingles in the locally of Aysén. Here, it is defined as an input that tributes interdisciplinary the project with a multidisciplinary approach in relation to the Intangible Cultural Heritage (ICH) documentation obtained between the Austral University and the State of Chile.
The methodological purpose, that the hypothesis displays, considers, to give meaning to shingles as a component of an architectural system that, fundamentally, contributes to build a cultural identity that is associated to different manners of inhabiting. The preliminary results, show that the patrimonial context comprehend is only possible if shingles are analysed in a material, iconic, and architectural perspective. These perspectives are proposed as thickness of value and sense of these local architecture, like singular elements, and also as intangible and tangible context of the analytical territory.

CODE 465

VERNACULAR HERITAGE OF NORTHWEST PORTUGAL: THE VALLEY AND THE MOUNTAIN RANGE FARMHOUSE

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KEYWORDS: Vernacular heritage; heritage preservation and rehabilitation; authenticity and identity; masonry; farmhouse; farmstead.

ABSTRACT

Vernacular farmhouses are one of the most notorious and authentic elements of the European rural cultural landscape. For centuries, such structures proved their resilience and adaptability to social and economic changes and are part of rural populations cultural identity. Nonetheless, they are a slowly fading heritage, due to the progressive loss of traditional ways of life and the industrialization of agrarian production methods. Being heritage authenticity and identity features identification a key element to any heritage preservation methodology, this research was set in motion to identify such features regarding Northwest Portuguese farmhouses. The goals were to create a database on vernacular farmhouses context and their role in the construction of the rural landscape, but also to identify representative morphologies and typologies, construction features and durability issues.
Taking into consideration the strong loss of authenticity or the severe state of ruin of the majority of most existent examples, the research methodology was based on: i) deep literature review to set the methodologic framework; ii) guided exploratory visits to representative areas of the studied region, to assess in-situ heritage's main features and state of preservation; iii) selection and analysis of representative case studies of buildings and rural landscapes; iv) assessment and identification of vernacular heritage main design and construction principles; v) guidelines for heritage farmhouses preservation and rehabilitation. Being and ongoing research, the three first steps revelled the existence of a strong regional identity, shaped into two more specific local identities. Agrarian strategies, adaptation to geography and to natural building resources were identified as directly responsible for buildings design, construction principles and specific identity elements. This paper presents the preliminary results of the research and contributes to enlighten researchers to the deep cultural value and importance of preserving this European endangered vernacular heritage.

CODE 28

PROTECTION OF POST-WAR HOUSING ESTATES

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KEYWORDS: Post-war; housing; estates; preservation.

ABSTRACT

World War II greatly influenced the history of contemporary European architecture. Due to military operations, city centers, industrial facilities, and housing estates perished. The resulting shortage of housing created the demand for industrialized prefabricated construction which had no match in terms of efficiency, speed, simplicity of manufacture and assembly. Le Corbusier's ideas of housing complexes equipped with all essential functions such as commerce and services were a great inspiration. Their thoughtful, functional, pro-social and egalitarian urban planning created the living conditions for several generations of Europeans, e.g. the ones from the so-called Eastern Bloc. Similar socio-economic and political conditions in those countries resulted in the emergence of characteristic, suburban housing estates. A similar type of development also appeared on the outskirts of many cities outside Europe.
Prefabricated housing complexes in Poland were built basing on the assumptions as well as urban and architectural plans that met the best criteria and standards in the field. Their authors were teams of well-educated and dedicated architects. Their concepts followed the guidelines and principles of the time. As for the technology itself, the prefabricated structures can survive for another several decades as studies show the steel joints and concrete shells to be mostly in good condition. However, the biggest drawbacks of this kind of housing seem to be the layout of the interiors and their small size as nowadays people expect more space and comfort. Moreover, urban infill becomes increasingly popular on this kind of housing estates. What used to be public space is now being rededicated to new functions. Residents protest but deficient legal regulations result in degradation of those housing complexes. This poses a serious threat to their old character unless they receive protection as conservation areas.
The goal of that paper is to made the society aware of the values that were created by previous generations of architects, urban planners, authors of post-war realizations, most of which have still great aesthetic, cultural and historic significance. The point is also that the principles of protecting mentioned urban and architectural complexes should be redefined and their institutional protection should be established.

CODE 38

HOW TO BRING PEOPLE BACK INTO HISTORIC CITY CENTRES: A COMPARISON OF STRATEGIES PROPOSED IN QUITO, ECUADOR TO OTHER INTERNATIONAL CASE STUDIES

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KEYWORDS: Urban regeneration; historic city centre; urban planning.

ABSTRACT

This paper sets out to compare the Urban Plans of four UNESCO World Heritage Historical Centres: Quito, Cuenca, Lima (in Latin America) and Santiago de Compostela (in Spain).
The evolution of every city has been defined for development periods which show their urban, social, political and economic transformation. The historic centres represent a clear differentiation between the new and colonial city. Latin American cities colonized by Spaniards have in an urban layout and pattern in common, which following independence starts to transform into a city-scape with its own characteristics. Since 1960, in Latin American cities, degradation processes have been observed in the different historical centres caused by the lack of study of the impact of the interventions carried out on them.
On the one hand, the declaration of being a UNESCO World Heritage Site gave the historical centres a new impetus to conserve their architectural and urban heritage. On the other hand however, it promoted a shift in the historical centres to solely cater for the tourism industry, suffering from a common problem of depopulation and subsequent degradation of buildings. Against this background, recent urban plans have sought to amend this factor, attempting to entice people to move into the historic city centres. It remains to be seen if these are to be successful in the coming years.

CODE 198

MASTER PLAN FOR THE CENTER OF SAN JOSÉ, COSTA RICA: CHALLENGES OF THE INTEGRATED APPROACH AND PLAN IMPLEMENTATION

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KEYWORDS: Urban regeneration; inclusive repopulation; local economic development; integrated approach; governance; master plan; San José; Costa Rica.

ABSTRACT

Urban regeneration of existing cities faces significant challenges, given the complexity of acting in consolidated and inhabited environments. The need to apply an integrated and multidimensional approach, as well as the difficulty of implementing the plans that are designed, are some of the most important challenges. This article analyzes these challenges through the study of the development process of the Master Plan for Urban Regeneration and Local Economic Development of the Four Central Districts of San José, Costa Rica, with the objective of providing keys to overcome these challenges. The urban center of San José, which in recent decades has undergone a marked process of depopulation and degradation, faces important challenges for its future, such as the shortage of residential demand, a deficient mobility system, poor water management infrastructure, high vulnerability to climate change, lack of integration of the urban fabric and an obsolete productive model. Since the 1990s, the Municipality of San José, in collaboration with other institutions, has tried to address these challenges by developing plans and implementing specific action projects. Despite the efforts, progress has been scarce, mainly due to the absence of a common vision and a road map for the integral urban regeneration of the city center. In response to this problem, and with the support of the Inter-American Development Bank, the aforementioned Master Plan has been developed between 2018 and 2019. This article features the main challenges identified during the development process of said Plan: the approach from an integrated perspective to the challenges of urban regeneration, and the barriers to an effective implementation of the proposals. For this, in the first case, the existing complex problems and the possible synergies in the actions in the different urban dimensions are identified; and in the second, the barriers to inter-institutional coordination and the lack of adequate management and financing instruments, providing keys to overcome these barriers.

CODE 217

3D-GIS MODELS TO SUPPORT THE CO-CREATION OF ENERGY EFFICIENT STRATEGIES FOR HISTORIC URBAN ENVIRONMENTS

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KEYWORDS: Energy rehabilitation; 3D models; rehabilitation strategies; CityGML; historic urban environments.

ABSTRACT

Urban models can be powerful tools for energy assessment of urban environments and dissemination of results. ENERPAT project has tested an approach where 3D-GIS support the co-creation of innovative eco-renovation strategies for traditional energy conservation measures from a life cycle perspective, as a way to work with local produced solutions linked with new local business models. Three living labs have been created in Porto, Vitoria and Cahors as demonstration buildings and long-term thinking frameworks including stakeholders of the whole value chain. The solutions based on local materials that are being monitored have been decided by co-creation strategies using multicriteria methodologies. A multiscale characterization, evaluation and monitoring methodology has been defined in order to extrapolate the results of the selected solutions to the whole urban environments. The methodology is based in a 3D -GIS model that interrelates three scales (building, historical centers and city) through a multiscale and multi-thematic set of common key indicators. The assessment identifies the current status and estimates the impact of the selected strategies in terms of the impact on the heritage; sustainability and energy efficiency; and improvement of the quality of life (comfort, air quality, reduction of energy poverty). Three urban models of the historical centers of Cahors, Vitoria and Porto have been created using CityGML standard format and are adapted to support the specifications for energy rehabilitation processes in historic centers. In order to do that, 3 application domain extensions (energy efficiency, heritage and indicators) has been generated. The resulting CityGML models will be made persistent by storing the information in one place in an XML-based format and in a geospatial data format through the 3DCityDB extension of PostGIS. As a result, the models allow the upscaling of the impact of the monitored strategies at city scale facilitating an agile and fast first estimation of the impact.

CODE 386

THE REGENERATION OF INDUSTRIAL WATERWAYS AS AN EXTENSION OF THE URBAN OPEN SPACE SYSTEM. LONDON-MILANO-ZARAGOZA

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KEYWORDS: Urban canals; regeneration; open spaces system; connectivity.

ABSTRACT

Since the early 1990s, important urban regeneration projects have been carried out, many of them on neglected areas like the sea or river fronts of post-industrial cities. Despite the great diversity of situations and different strategies, similar trends are observed, such as environmentally-led regeneration based on the open spaces connectivity, heritage-led regeneration or events-led regeneration. In all of them, the pedestrianisation, the development of cycling networks and the improvement of public transport are used as strategies to achieve more sustainable cities.
From these points of view, old industrial canals, as water corridors, are also important structural and connection elements between the urban and regional scales. This article includes three examples of urban canals: the Canal Imperial de Aragón (Zaragoza), the Naviglio Grande (Milan) and the Regent´s Canal (London), which are part of the Green and Blue System. The aim of this paper is to explore how the canals, despite their small scale, are acquired new uses and values, beyond their original main function as a means of goods transport. These emerging values are leading to improve environmental and landscape conditions, pedestrian and public connectivity; in summary, a quality of life enhancement. In the case of the Regent´s Canal, the important regeneration process currently underway, reflects its new urban role, not only as an environmental corridor, but also as a heritage, recreational and landscape urban element. In this process, the canal opens to the city through the towpath as a pedestrian promenade and the water itself as an identity component along its course.

CODE 402

TOWARDS EFFICIENT ENERGY RETROFITTING OF RESIDENTIAL BUILDINGS. COMPARING A NEIGHBORHOOD IN PAMPLONA (SPAIN) AND THE NEIGHBORHOOD OF CLINTON HILL, BROOKLYN, NY (USA)

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KEYWORDS: Renovation buildings; standardization of energy retrofitting; energy renovation policies; CO_2 emissions; thermal envelopes.

ABSTRACT

There is global consensus that CO_2 emissions need to be reduced in order to keep the global temperature from rising more than 2ºC by 2050 (Paris Agreement, 2015).
On one side of the Atlantic, 40% of the total energy consumed across the EU is used in buildings and 29% of this percentage corresponds to the residential sector. Europe is making great efforts to ensure that all its buildings are 'nearly-zero Energy Buildings' (NZEB), in order to reduce the consumption of energy and CO_2 emissions. These targets aim to place the EU on the pathway to a transformation towards a low-carbon economy by 2050 (Commission of the European Communities, 2008).
On the other side of the Atlantic, New York City has a plan called New York City's Roadmap 80x50 whose objective is to reduce greenhouse gas emissions by 80 percent by 2050. Under this approach, 5,000 buildings will have to be rehabilitated every year in New York City.
The aim of this paper is to describe Why and How should we renovate old residential buildings at a neighborhood level. The focus of the study will be the comparison between the rehabilitation of two neighborhoods with similar size and characteristics: Chantrea, a housing district in Pamplona, Spain, and Clinton Hill, a neighborhood in the borough of Brooklyn, NY. Is it possible to apply a common methodology to different neighborhoods in different countries?. Can energy retrofitting be standardized?.
This study will start by looking at the current regulations in place in relation to the reduction of energy consumption and the difference in context between both cities. Secondly, the identification of typologies of residential buildings and construction aspects; thirdly, different measures of thermal envelope rehabilitation are applied to achieve the objectives of almost zero consumption buildings. Finally, the study will compare the impact that could have in one neighborhood and another.

CODE 550

THE REHABILITATION, A FUNDAMENTAL MEASURE FOR THE RECOVERY OF THE HISTORICAL CENTER OF GUADALAJARA

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KEYWORDS: Rehabilitation; center; heritage.

ABSTRACT

As in many other Spanish cities, in Guadalajara there is an almost exact correspondence between what was the city until the middle of the 20th century and its current Historical Center. The city presents a great vitality although its center has been losing its functions, which has determined its progressive deterioration.
Its still rich architectural heritage and its interesting urban plot continue to confer identity traits that differentiate it from other areas or cities, signs that must be preserved.
At present there is a greater concern for the protection of the architectural heritage, but nevertheless, despite the actions that are being carried out, it continues to deteriorate. The same can be said about its urban fabric, in which certain actions, paradoxically undertaken to revitalize it, have modified it significantly. The recovery of the Historical Center must necessarily go through the recovery of its functions, especially that of centrality and residence.
As a result of the deterioration produced, the center has been abandoned, which has made its main activities are the tertiary, although with low economic activity, and that their current population is of advanced age and sometimes marginal. On the other hand, the city facilities, those that have been occupying the main buildings of the center, are increasingly being moved to other neighborhoods.
It is necessary to reverse this trend, avoiding that it continues to depopulate, attract new inhabitants and also recover its administrative, cultural and leisure centrality.
For this, it is necessary to carry out a rehabilitation of the hull proposed as an integral operation in it, in which not only its most notable buildings are recovered, but also its traditional buildings and its urban layout.

CODE 554

HISTORICAL CENTER OF LIMA. URBAN RENEWAL AND THE IMPLICATION OF URBAN LAW. CASES: CASA DE LAS COLUMNAS, CONJUNTO HABITACIONAL LA MURALLA AND PROYECTO PILOTO MARTINETE

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KEYWORDS: Historic center; urban renewal; urban law.

ABSTRACT

Currently the Historic Center of Lima shows signs of physical, socio-economic and functional deterioration. Faced with this problem, urban renewal processes act as surgery for the recovery and reintegration of deteriorated central areas into the functioning of the current city. Recovery actions are based on various modes of intervention on the physical structures and human component of the deteriorated area. On the other hand, understanding that every city is based on political-administrative fundamentals and systems that regulate actions that are carried out on urban soil, and that mainly actions on deteriorated central areas with historical value they have specific national and international regulatory supports that define and support the promotion, development and implementation of urban renewal projects.
This research proposes the case-by-case study of urban renewal projects in collective housing implemented in the urban center of the Historic Center of Lima in the corresponding period 2000-2010; Casa de las Columnas, Conjunto Habitacional la Muralla and Proyecto Piloto Martinete, and the relationship and implication of the legal-urbanistic order, which includes the analysis of the management, execution and control of the process of transformation of the urban renewal project, in order to identify the practical effect of the rules on the project development of urban renewal.

CODE 576

THE PROJECT OF WIDENING FOR THE CITY OF JAÉN IN 1927

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KEYWORDS: Project; widening; urban regeneration; Jaén.

ABSTRACT

The Project of widening for Jaén in 1927 constituted the first and only urban reform carried out in the city from the Middle Ages to the second half of the twentieth century, when the first General Plan of Urban Planning was elaborated in the year 1951.
The document sought to respond to problems of various types that affected the population applying a modern vision of planning and promoting the urban growth outside the walls, towards the North.
This article intends to publicize the Project of widening of the architect Luis Berges Martínez (1891-1939), which was an urban regeneration model of exceptional importance in Jaén, since it conditioned the subsequent development of the city forever.
During the preparation of this article we have conducted an exhaustive search of general and bibliographic information at all levels. Subsequently we have selected the one of interest, analysed the results and drafted the final conclusions based on previous studies carried out by the authors.

CODE 478

COST-BENEFIT ANALYSIS APPLIED TO THE REHABILITATION OF PUBLIC SCHOOL BUILDINGS

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KEYWORDS: Cost-benefit analysis; decision support; rehabilitation; public school buildings.

ABSTRACT

Cost-Benefit Analysis (CBA) is a method for assessing the net economic impact of a public investment project and can be used to support decision making in a variety of interventions. CBA-based methodologies applied to rehabilitation projects can be powerful and highly functional tools, supporting the decision-making process on the rehabilitation of one or more buildings or other infrastructures, and comparing the effectiveness of different strategies in terms of the cost-benefit ratio for the system concerned. Additionally, the CBA allows the determination, for each case studied, if the future benefits of the rehabilitation strategies considered are sufficient to justify the current costs of the rehabilitation project.
This paper presents a methodology for a financial analysis of existing public school building rehabilitation projects based on the Cost-Benefit Analysis, which integrates the evolution of Community policies and financial instruments and aims to provide technical support and contribute to the reflection on the modulation of co-financing rates. The case study comprises a set of Portuguese public school buildings, with rehabilitation interventions carried out between 2007 and 2011, to which the Cost-Benefit Analysis methodology is applied in order to validate its applicability to real situations.

CODE 18

THE URBAN TRANSFORMATION AS A COLLECTIVE CREATION: BOTTOM-UP AND PARTICIPATIVE TOOLS TAXONOMY FOR URBANISTS AND ARCHITECTS

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KEYWORDS: Urbanism; architectural representation; participation; bottom-up; sustainable urbanism; urban tools; right to the city; ecology thinking; social transformation; participation tools.

ABSTRACT

Some of the emerging issues related with European cities, such as gentrification, degradation of patrimony, social tensions, mass tourism and exclusion, are partially related to the way we have planned cities during the last century. Making our cities more and more attractive, through ambitious urban plans of transformation and renovation - such as the famous "Barcelona model" - should now evolve into a more inclusive and participative model. Since the 1970s, the claim for the city has accelerated the processes of participation that are now re-emerging in the urban and architectural processes in cities worldwide. Sustainable urban regeneration means collaborating with the inhabitants when transforming cities. It also means a change in the role of the architect and urban planner, which is within his or her reach, for a methodology of participation to work transversally with other specialists. Thus, new creative mechanisms of solidarity are required when regenerating our urban environment. This research* proposes to create a methodology for participatory action with new strategies (information and communication technology, mapping, big data cartographies and ludic tools such as urban sketching, tactic planning, opinion polls, collaborative webs, etc.), through classification via taxonomy of participation tools. It entails analysis of the present in several case studies in which the real actors of urban planning—its users—co-design the project. At the same time, some of the strategies are being experimented in collaborations between our students and the local community. The use of these methods is meant to listen to the voice of the inhabitants, involve them as actors and hold them responsible to induce changes in habits and mindsets.

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CODE 24

THE OLD BRIDGE OF BROTO: LONGING OF A PEOPLE

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KEYWORDS: Medieval bridge; social participation; heritage; rehabilitation; association.

ABSTRACT

The medieval bridge of Broto (Huesca, Spain), built in 1532, as it appears in an arch stone of the key of the only arch that remains, consisted of three arches of half point, of 12.40, 14.70 and 16.20 meters of span approximately. From an oblique trace to the river current, it had two piles with their corresponding cutwaters and two half piles as stirrups. In total, 56 meters in length and about 43 meters of linear drainage for the passage of the waters of the Ara River. The main arch rose 9 meters above the low water sheet.
The bridge had an upward configuration from the right bank of the Ara River, until it flowed next to the now called "Torre de la Cárcel". The bridge carriageway was cobbled with boulders and was 3.80 meters wide. For the construction of the bridge, limestone slabs were used, abundant in the area. The stones were roughed and swirled to make the arch stones of the arches, large, and less worked for the rest of the construction.
This solid construction, maintained for four centuries, was blown up as a result of the Civil War in April 1938.
Continuing the activities of the "Association of Friends of Broto and its Valley", work has begun to ensure the recovery of the bridge, which, while possibly may not be in its original configuration, can be in one that allows to maintain the memory of what existed.
The article shows the steps taken to do this, previous studies of reconstruction, hydrological study, management with the CHE, Ebro Hydrographic Confederation, contest of ideas open to all neighbours to provide possible solutions, description of the two awarded options and a campaign of popular surveys to take the pulse of the ideas of the people of the village and those who visit it.

CODE 84

CULTURAL LANDSCAPE CHARACTERIZATION BASED ON THE PERCEPTION OF ITS INHABITANTS: ALGORTA'S OLD FISHING PORT

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KEYWORDS: Cultural Landscape; historic site; local perception; identity values.

ABSTRACT

Algorta´S Old Fishing Port is a key identity and historical element in the urban and natural landscape of the Abra port area of Bilbao. Even though the main functional activities as a fishing port and related activities were lost long time ago, its importance as a distinctive landscape in the area is still very relevant. The need for further protection, wider than the current Listed Area (Conjunto Monumental) level, that only deals with the protection of the buildings has been acknowledged.
Algorta´S Old Fishing Port therefore requires a new level of protection such as the Historic Urban Landscape that would guard its social, environmental, historical and cultural relevance. The Basque Cultural Heritage Law categorises the figure of Cultural Landscape as an element to be protected, "a natural, rural, urban or peri-urban area which character is the result of an historic stratification of values and natural and cultural features". To help achieving this aim, a study has been carried out to identify the extend of the landscape area to be protected and the buffer area to ensure this protection, together with a research approach to recognise the intrinsic values to be preserved.
This study combines legal and documental review with a participation process, aimed at learning and discovering local perception with a combination of research techniques. The study is complemented with analysis of images posted in social media in order to include perception from tourism and occasional visitors.
The study results will allow the local authority to determine not only the geographical limits of the cultural landscape area, but also will provide with relevant information to identify sub-areas for specific analysis, identifying materials and immaterial elements and their specific landscape values. Additionally, some intangible features of the Cultural Landscape highlighted by the local population during the participation process are identified as relevant for local identity and meaningful enough to be protected.

CODE 213

GROUNDED THEORY AS A RESEARCH BASE FOR INTERVENTION IN MODEST HERITAGE BUILDINGS

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KEYWORDS: Modest heritage; forms of intervention; grounded theory; intervention protocols.

ABSTRACT

It is essential for the intervention of heritage buildings to find the identity relationship between the inhabitants of a place and the building that is intended to have a restoration or an architecture intervention. Through a series of previous investigations we have defined research protocols that are based on grounded theory, as defined by Glaser and Strauss, based on interaction with the inhabitants of the areas of influence of the heritage asset, under the social constructivist approach that Charmaz built, according to Delgado (2012), in which the classical methods of grounded theory such as theoretical sensitivity, constant comparison and saturation of conceptual categories are used.
The main objective of this research is to contribute to the architects and other actors involved in heritage building transformation with a methodology that derives in intervention protocols in heritage buildings in modest contexts.
The methodology used, grounded theory, in the case of modest heritage, under the constructivist paradigm, is applied to study the actions of social actors and the meaning they attribute to buildings, which are part of the same co-constructed reality. For this reason, one of the theoretical currents that are applied derives from symbolic interactionism, in which interpretation and context play a fundamental role.
Systematic design seeks to provide methodical guidelines for data processing, to ensure the contribution to the construction of concepts. It starts from the questions asked and is done under the coding of the data under the paradigm of Charmaz (Esper, 2011). Based on this methodology, assessment and analysis forms can be obtained that give the designer clear methodological guidelines to determine the forms of intervention.

CODE 226

TOWARDS THE SAFEGUARDING OF CONTEXTUAL DWELLINGS: INDICATORS OF PATRIMONIAL SUSTAINABILITY. MAR DEL PLATA, ARGENTINA

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KEYWORDS: Preservation; sustainability; indicators; housing; Mar del Plata.

ABSTRACT

Safeguarding the characteristic housing of each territory, with mainly contextual values is a current challenge. Even when framed in heritage areas, the preservation of dwellings oscillates among multiple problems. In an urban setting, the European and Latin American experiences coincide in pointing out the importance of the awareness of each local community, with emphasis on the users in order to achieve active protection in the longer term. In parallel, in recent decades, the meetings of experts have encouraged, through letters and documents, the construction and application of indicators of patrimonial sustainability to systematize, evaluate and monitor the values and state of conservation of assets.
In this sense, through sociomaterial research focused on a selection of coastal and mediterranean intermediate cities of southeastern Buenos Aires Province (Argentina), the development of indicators of patrimonial sustainability was pursued through the joint analysis of characteristic housing typologies, the conditions of government protection and the state of consciousness of their inhabitants. This analysis is presented in this paper, with focus in the advances investigated in Mar del Plata, a complex coastal city with a relevant national historical-tourist significance. From a mainly qualitative methodology, the main domestic legacy conformed by the "Mar del Plata style" chalets, the state of consciousness of their inhabitants and the state framework for their protection were studied. For this study, in situ building surveys, planimetric, bibliographic and photographic analyses, interviews with key informants and household assessments were carried out.
In this way, it is hoped to contribute to the progress of renewed processes of residential approach together with a greater development of thematic indicators suitable for each local reality, in the process of optimizing reflections and preservationist actions.

CODE 405

A CRITICAL STUDY OF TRANSIT ORIENTED DEVELOPMENT (TOD) IN THE HISTORICAL CENTRE OF QUITO, ECUADOR

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KEYWORDS: Transit oriented development; UNESCO world heritage site; development; social participation; mobility; urban planning.

ABSTRACT

The research presents a critical study of Transit Oriented Development (TOD) in the historical centre of Quito, Ecuador, which is a place of residence, commerce and tourism in a world heritage site. The paper draws on data gathered through a participatory study carried out with residents of Quito's historic centre by the Municipal Institute of Heritage (IMP) from March to December 2018. A deeper understanding of the results related to urban form, transport and social equity were then gained through a semi-structured interview with the IMP project leader in January 2019 for the purpose of this paper. As a UNESCO World Heritage Site, the historic centre is isolated from the TOD legislation of the city. As such, the objective of the IMP study was to determine grassroots' perceptions and needs, which then became the overarching concept for the development of a new Integral Urban Development Plan for the historic centre. The results from the participatory study and semi-structured interview were used in this paper to examine a) what people expressed their core needs were, vs b) the requirements established by the TOD model. The historic centre of Quito is an interesting case for a critical examination of the TOD model. It is within the area of influence of one of the new underground metro stations and contains one of Quito's main bus/BRT transport hubs. Additionally, the resident population reflects different identities, visions and needs for the area, which became highly visible in the qualitative research carried out by the IMP. For example, as a world heritage site there is a constant flux of tourists, on which the commercial sector relies on. However, the needs of the tourist and commercial sector are often at loggerheads with residents who have lived in the area for generations. Finally, a large sector of the population is characterised as low-income immigrants (from rural areas or abroad), who have entirely different needs. The results show the limitations of the TOD model when applied to the historic centre, and give an indication of the People Oriented Development (POD) approach that needs to be adopted instead.

CODE 452

TRADITIONAL DOVECOTES RESTORATION AND REUSE IN CASTILLA- LEÓN. SPAIN

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KEYWORDS: Bioconstruction; depopulation; adobe; rammed earth; squab.

ABSTRACT

The breeding of pigeons is a traditional activity in Spanish lands at least from the time of the Roman occupation. Dovecotes have been built using traditional techniques such as rammed earth, adobe and wood that characterize the Castilian landscape posing a substantial part of the peninsular cultural heritage and its vernacular architecture and landscape. As the consequence of the current social dynamics, the progressive depopulation of the rural world means the abandonment of its aged dovecotes leading to its gradual degradation and ruin.

Among the many initiatives that are being carried out to avoid this situation, is the activity of the Rehabitar Tierra de Campos Foundation, an entity that aims to rehabilitate the abandoned dovecotes through traditional techniques and also through the enhancement of the rural population, using these to market the squabs and selling the bird droppings as fertilizer.

The pigeon houses restoration, on one hand, is associated as traditional activities in risk of extinction such as the recovery of the earth walls, the proper manufacturing and use of rammed earth and adobe and the reconstruction of clay tiles roofing supported on wooden structure. On the other hand, the precise heritage cataloguing and exhaustive documentation of the restored pigeon houses will later allow their treatment in archives and data base for their diffusion.

Within its strategic plan, the Rehabitar Tierra de Campos Foundation addresses the recovery of traditional dovecotes and their associated economic activities, respecting the original construction materials and techniques adapted to the current building technology for coming into service of the reconstructed dovecote. This study demonstrates that the exploitation of traditional dovecotes of Tierra de Campos can be profitable by creating a micro-enterprise that manages a set of 10 to 12 dovecotes.

CODE 8

LIFTING OF THE MAIN PATHOLOGICAL MANIFESTATIONS IDENTIFIED THROUGH PREDIAL INSPECTIONS IN FORTALEZA-BRAZIL

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KEYWORDS: Pathological manifestations; building inspection; constructive systems; case study.

ABSTRACT

At the end of a building inspection process, a large number of pathological manifestations and failures due to low conservation conditions and lack of adequate maintenance for the building are identified. On the other hand, the significant number is related to the scope of the building inspection, since it involves all building construction systems. Several studies address the main pathological manifestations occurring in a given building system, usually in structures, masonry and cladding. However, there are gaps in the survey of anomalies in other building systems such as electrical, plumbing and gas, fire fighting, providing a systemic approach involving all building systems. This study presents a survey of the pathological manifestations in vertical buildings for residential use in the city of Fortaleza, through building inspection reports, through a systemic view, involving the various building systems. As a contribution, the study raised 4,016 pathological manifestations through 16 building systems, showing the correlation between the increase in the number of pathological manifestations according to the aging of the buildings, as well as identifying the most recurrent ones, their origin, cause and severity, providing a overview of the status of buildings, serving as a basis for corrections of the production process of the building, as well as providing light to maintenance failures, allowing a reflection of the status of preventive maintenance of buildings.

CODE 17

PHYSICO-CHEMICAL ANALYSIS OF HISTORIC CONCRETE STRUCTURES IN THE CARIBBEAN

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KEYWORDS: Characterization; concrete; mercury porosimetry; petrography; SEM; X-ray Diffraction.

ABSTRACT

The aim of this research is to analyze the physical and chemical characteristics of historical concrete structures with differing destination of use and in age (between 1917-1955) in the Dominican Republic, as well to compare the material characteristics. The study was doing in buildings built by American and Dominican engineers that represents a whole generation of construction history. Also, provide information on the composition of concrete used in that constructive period. The techniques using was: X-ray Diffraction (XRD), X-ray Fluorescence (XRF), Mercury Intrusion Porosimetry (MIP), petrographic examination, Scanning Electron Microscope with an Energy-Dispersive X-ray Spectroscopy (SEM-EDS), and Visual Testing (VT). The results indicate that the composition of the concrete change through the time. The major oxides in the composition of the samples are CaO, SiO_2, CO_2 and Al_2O_3. The porosity in the samples change to 5,48% to 16,73%. It was observed that all the samples showed the characteristic peaks of the crystalline phases: quartz, albite and calcite, in different proportions, except one that presents peaks corresponding to the portlandite phase.

CODE 56

GLOBAL INSPECTION, DIAGNOSIS AND REPAIR SYSTEM FOR BUILDINGS: HOMOGENISING THE CLASSIFICATION OF DIAGNOSIS METHODS

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KEYWORDS: Building pathology; degradation; maintenance; inspection systems; diagnosis methods.

ABSTRACT

A global inspection, diagnosis and repair system for buildings intends to aggregate disperse information on degradation mechanisms of several building elements and materials in a single tool, standardising the surveyor's inspection process. Such a system includes classification lists, which define the relevant defects, causes, diagnosis methods and repair techniques and their standardised nomenclatures. In this research, a methodology to homogenise different classification lists of diagnosis methods, as they are integrated in a global inspection system, is proposed. Defining that methodology allows developing a broad and consistent global inspection system, without disperse and repeated information. In individual expert systems, classification lists are adapted to the building element the systems refer to, detailing or omitting specific pathological processes, diagnosis methods or repair techniques. For the process of unification of classification lists, objective criteria must be used to guide the methodological approach. For instance, in the case of diagnosis methods, conciseness is important, but having a comprehensive list is more important. Additionally, the technology associated with the test procedure conditions the organisation of methods within the list of diagnosis methods. The proposed list of diagnosis methods includes ten groups, such as "assisted sensory analysis", "electrical methods" and "mechanical methods". In the validation process of expert inspection systems, fieldwork data were collected. They show the varying importance of diagnosis methods in different types of building elements. In painted façades, measuring the environmental or superficial temperature or humidity is advised 1.38 times for each detected defect, while, in wood floorings, the same method is advised only for 1% of defects. In external thermal insulation composite systems, the measurement of temperature and moisture is also a highly recommended diagnosis method (33% of defects). When managing the maintenance of a building, or set of buildings, being aware of the most common diagnosis methods, or those most important for a specific material present in these buildings, may help decision-makers to agree on acquiring the means to perform those tests and training labour to implement them.

CODE 65

THREE EXAMPLES OF DECISION MAKING IN THE STRUCTURAL INTERVENTION IN HERITAGE

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KEYWORDS: Architectural heritage; pathology of structures; reinforcement of structures; masonry structures.

ABSTRACT

One of the main problems that the technician must face when dealing with a problem of structural pathology in something as sensitive as Architectural Heritage is the correct evaluation of the decision and the scope of the intervention. It is necessary to analyze carefully, both the risk of intervening, and the risk of not intervening, since sometimes the possible intervention can be extremely aggressive. And in the case of not intervening, the risk is that it is not possible to control the pathology and its evolution causes irreversible damage to the building. In addition, sometimes an obvious pathology may not imply significant risks and, on the contrary, little perceptible damage may pose a much greater risk.
All this means that the decision to intervene and the correct evaluation of its scope, is one of the essential problems in rehabilitation. At the present time the technician has computer programs with great power and that can respond to the most complex calculations. On the contrary, the growing faith in these media and the gradual abandonment of structural intuition, which has served us so well throughout history, is becoming increasingly frequent. Therefore, it is of the most importance to analyze all the previous phases with the greatest care, before placing oneself in the hands of the computer.
In the paper three cases of relevant buildings in Galicia will be studied. Two of them are buildings belonging to the architectural heritage, the churches of La Trinidad de Ourense and Perpetuo Socorro in Ferrol. The third is the small hermitage of Armeses in Maside (Ourense), which is a building that does not belong to the heritage, but instead is very relevant in the sociological aspect, being the nucleus of a great popular pilgrimage. In all of them, several lesions were detected, but the degree of intervention required has been very different. The paper will present the analysis carried out and the justification of the proposed lines of action.

CODE 76

MICROCEMENT: STANDARDIZATION AND CONSTRUCTIVE PATHOLOGY

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KEYWORDS: Microcement; standardization; pathology; case study.

ABSTRACT

When new materials appear on the market, the lack of normalization or their difficult way to apply, can originate pathologies. This is the case of microcement, which is a cementitious based material with a lower grain size than ordinary cement. In commercial terms, the microcement designation applies to a multi-layer system of materials, where polymer-modified mortars are part and which, at the end of application, constitute a single continuous coating. It has a very thin total thickness and is gaining market, mainly in the execution of floor coverings, walls and interior ceilings. Its use also occurs in exterior elements including coverings of urban furniture and walls of swimming pools. Based on a case study on the application of a microcement coating, we describe the main constructive anomalies observed and identify the probable causes. A brief study of the products marketed in Portugal was carried out, as well as a review of the applicable standardization and the specific bibliography. In the analysis carried out, it was verified that much of this material is marketed in Portugal without complying with the requirements of Portuguese and European legislation. In addition, the technical information that most manufacturers and traders provided was insufficient. Therefore, a more assertive inspection activity is suggested to the entities that control the commercialization of building materials, in order to contribute to the withdrawal from the market of non-certified products. For products certified by the producers, the content of the technical information about this material has been found to be flawed. A specific training for applicators is also considered essential. The absence or non-fulfillment of certain requirements in some building materials and their applicators may lead to a greater occurrence of pathologies, which, in addition to the aesthetic aspects, will affect the functionality, durability of the solutions, and the buildings' sustainability.

CODE 81

ANALYSIS OF FACADES PATHOLOGIES REGISTERED IN A SET OF HERITAGE BUILDINGS IN THE CITY OF UBERLÂNDIA

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KEYWORDS: Buildings listed as historical patrimony; pathologies of facades; recovery of heritage buildings.

ABSTRACT

The present work has as its objective the investigation, identification and characterization of the pathologies present on the exterior facades of buildings of more historical importance, which are listed and / or inventoried as heritage site, located in a previously determined area of the City of Uberlândia.
Therefore, to elaborate a correlation diagram in order to propose a practical model of evaluation methodology. This model encompasses the identification and recurrence of facade anomalies, the generic diagnosis of possible triggering causes and degrading processes, and the respective recommendations for actions to future recoveries of the building. In this way, it serves as a subsidy for future recovery interventions, whether private or public order.
Through the case studies, it was evidenced that the origin of these identified injuries is mostly associated with the use of inappropriate materials, subsequently, the mistakes made during the design and execution phases. Another major cause of pathological manifestations is the irregular, unplanned or even non-existent maintenance system. It is quite common for pathologies to develop due to the association of two or more of these factors, in fact it is rare for a single factor to trigger the entire degrading process.
Finally, the study proposes to bring those responsible for the demand for rehabilitation of these properties to the scientific milieu with the purpose of reducing costs by providing a greater durability of the recuperative works. In addition, it serves as an important tool for knowledge due to the records made, characterization and correlation of anomalies.

CODE 106

DAMAGE CAUSED BY THE COLLAPSE OF GYPSIFEROUS ROCK MASSES. CALLOSA D'EN SARRIÀ (SE SPAIN) CASE STUDY

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KEYWORDS: Damage; collapse; karst; gypsiferous rock masses.

ABSTRACT

When a building or a civil infrastructure is built on a gypsiferous area affected by karstification processes, dissolution can continue under certain conditions during the lifetime of the construction. Currently, the meaning of the word "karst" refers to the processes and phenomena related to the dissolution of rocks by water flows. Such dissolution can result in underground caves systems. As the internal rock mass dissolution progresses, underground galleries generated by the action of groundwater can collapse. The overlying rock mass will fall into the void space causing subsidence at the soil surface and affecting the buildings located in the nearby area. The level of damage caused to the constructions depends on their structural quality, the magnitude of the collapse and the interaction of the karstic system and the constructions. This work presents the results of the study developed in the village of Callosa d'Ensarrià (SE Spain) in order to determine the origin of the damage in a farmhouse and a local road located on gypsum materials of Keuper facies. The gypsum solubility and the hydrogeological conditions of the area allow concluding that, since the construction was built (about 100 years ago), the preexisting cavities could have been enlarged up to one meter, considering a dissolution rate of 10 mm/year. This fact, together with the low geomechanical quality of the gypsum rock mass, results in a poor geotechnical behaviour when caverns are formed, or preexisting ones enlarge, causing the collapses commonly observed in the studied area.

CODE 126

STUDY OF DAMPNESS IN LARGE RESIDENTIAL ESTATES IN THE METROPOLITAN AREA OF BARCELONA: THE CASE OF LA VERNEDA, SUD-OEST DEL BESÒS AND CIUTAT MERIDIANA

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KEYWORDS: Large residential estates; pathological processes; dampness; humidity; health.

ABSTRACT

The results of several previous studies carried out in the buildings of large residential estates built between the 50s and the 70s in the Metropolitan Area of Barcelona, in collaboration with the Barcelona Council, verify how the presence of humidity of different nature is one of the principal causes of actual pathological processes. This problem is especially significant in the area near the Besòs River and the sea front. The research presented here aims to describe this problematic through the analysis of a sample of buildings in relation to their construction systems at different scales. Various on-site inspection campaigns present data and results regarding the assessment and quantification of the detected damages, providing information on the existing processes regarding the durability and effectiveness of the construction systems and facilities, as well as the implications for the health within the blocks affected by the studied damages. Finally, this research concludes providing project guidelines for the repair and rehabilitation of existing dampness damages taking into account the causes and compatibility of constructive systems and materials, the compliance of current regulations, the opportunities to contribute to meet energy efficiency criteria as well as implementation feasibility on the analysed sites in relation to their economic reality.

CODE 130

INTERNAL DETERIORATION MECHANISMS OF COLUSA SANDSTONE AND THE DRAWBACKS OF PROTECTIVE COATINGS

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KEYWORDS: Sandstone; pyrite; weathering; coatings; exfoliation.

ABSTRACT

Colusa Sandstone has occupied the attention of preservation architects in California due to its wide use and susceptibility to exfoliation and spalling. The deterioration of Colusa Sandstone is known to be promoted by water infiltration. In response, some conservation efforts have focused on preventing the ingress of water into the stone by applying protective coatings. This study summarizes an investigation into the impact of existing protective coatings on the deterioration of Colusa Sandstone based on a coordinated program of field inspection and laboratory analysis.

At one landmark in San Francisco, California, coatings were previously applied to vertical and horizontal stone surfaces to improve the building's appearance and prevent ongoing deterioration of the façade. However, over time the coatings exhibited mixed results: some vertical surfaces remained intact and in good condition, while others such as water tables and surfaces near mortar joints experienced repeated delamination and spalling. The inconsistent performance of the coatings raised questions about the overall efficacy of the coatings for protecting the sandstone façade; it was unclear whether the coatings were protecting or contributing to the sandstone deterioration by trapping moisture. Building maintenance personnel were understandably concerned about the reapplication of coatings for repairs and maintenance.

Previous studies suggested that the deterioration mechanism of Colusa Sandstone is driven by the formation of gypsum at the surface, as the result of dissolution of calcite in the matrix by dilute sulfuric acid derived from atmospheric pollution. Although our laboratory analysis confirmed that the formation of gypsum contributes to deterioration of the stone, we determined that the source of the sulfuric acid responsible for the gypsum is within the matrix of the stone, in the form of extremely fine inclusions of pyrite. The oxidation of these pyrite inclusions in the presence of moisture produces sulfuric acid in the stone that both dissolves calcium-bearing components and serves as a source of sulfate. Water vapor transmission testing revealed that the existing coatings reduced the permeance of the stone. At this building, impermeable coatings that trapped moisture in the stone promoted rather than mitigated deterioration. Flashings with breathable coatings are a better design solution.

CODE 137

DEVELOPMENT OF A TOOL FOR TECHNICAL DAMAGE AND RISK ASSESSMENT IN CONSTRUCTION

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KEYWORDS: Building pathologies; technical damages; sustainable methodology; risk management.

ABSTRACT

The Spanish building construction and rehabilitation sector is regulated by the Law on Building Ordinance (Ley de Ordenación de la Edificación –LOE-) and the Building Technical Code (Código Técnico de la Edificación -CTE-). The former was enacted to protect users interests and it establishes the obligations of the agents that participate in the building process so that their responsibilities and guaranties are specified. The latter, translates the basic requirements of the LOE into technical objectives, defining the requirements to be fulfilled by buildings. With the entry into force of the LOE, the ten-year warranty is the only one that has been materialized through the hiring of a ten-year insurance. Since 2016, various meetings have taken place among the different agents involved in the construction sector, the Ministry of Development (Area of architecture, housing and soil), and representatives of political parties from the parliament, in order to study the opportunity of the compulsory subscription of three-year guarantees. Nevertheless, it still has not had a specific answer from insurers mainly due to the lack of definition of the extension of "damage" and uncertainty in the quantification of the risk.
This paper presents the development of a tool that will allow to assess technical damages along the building process and manage technical risks by the implementation of a sustainable and continuous improvement to ensure adequate response (technically and economically) of the building agents to end users, in line with the guarantees required by law. The methodology identifies existing constructive typologies for every building components and their common pathologies, establishing their origin and the corresponding law compliance breaches. Then, an objective criterion to identify, assess and manage existing risk is presented.

CODE 157

ALTERNATIVES TO ANALYSE LOW COMPRESSIVE STRENGTH IN PRESTRESSED CONCRETE JOISTS MANUFACTURED WITH HIGH ALUMINA CEMENT

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KEYWORDS: High alumina cement; calcium aluminates; crystalline conversion; low compressive strength; prestressed concrete joists.

ABSTRACT

Almost 50 years have passed since the prohibition in Spain to use high alumina cement in structural elements, and buildings with this problem are still being analysed year after year, of the real estate park built prior to that prohibition.
Although the degradation of this kind of cement ends up occurring, to a greater or lesser extent, in almost all cases, it's in those places where the temperature and humidity conditions are most unfavourable where fortunately the problem is revealed at earlier ages. The problem occurs in buildings where these conditions are not so unfavourable, without manifesting outwardly durability problems, and yet the remarkable low compressive strength has occurred, having a great impact on the safety conditions of the joists.
INTEMAC has had the opportunity to study, throughout its professional career, more than 300 buildings affected by the use of high alumina cement, always having to assess the impact on durability and safety conditions. It's in this last case where study techniques become more complex and more invasive, so different analysis techniques have been tested, some qualitative and others quantitative, in order to analyse the true impact of the degradation of this cement on joist's strength.
The most frequent problem detected is that many users only face the problem and its corresponding solution from the point of view of durability, frequently intervening in areas damaged by corrosion and using repair techniques that in some cases can be counterproductive (due to incompatibility in occasions between repair mortar and cement). In this way the problem is just approached in one way, the durability, leaving the other (strength's decrease) unanalysed, this being the hidden danger. Remember that shear failure of joists is fragile and with very little warning signs.
Different methods of analysis of low compressive strength in joists are analysed, from real-scale laboratory tests to those obtained by microcores drilled in concrete, and their practical application to real cases.

CODE 170

MOISTURE DETECTION USING NDE OF DIESTE'S CHURCH OF CHRIST THE WORKER

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KEYWORDS: Reinforced brick masonry; moisture; infrared thermography; ground penetrating radar.

ABSTRACT

Engineer Eladio Dieste was one of the most renowned innovators in the reinforced brick masonry field. Among Dieste's legacy, we can find the outstanding Church of Christ the Worker (1958-1960) in Atlantida Uruguay. At that time, this type of construction was an economical way to cover large areas, with large spans without intermediate pillars or columns. Even though the structure has been maintained by the local community, it has begun to show signs of aging. This article presents the inspection of some of the main problems that affect the church, moisture presence in the areas of contact with the terrain. The inspection of Dieste's church, by means of visual inspection and non-destructive evaluation (NDE), performed under this program, revealed the pathologies present in the structure. Several NDE techniques - such as infrared thermography and ground penetrating radar were used. The visual inspection and NDE yielded results associated with various symptoms of initiated deterioration mechanisms: presence of moisture, corrosion of some steel bars and degradation of mortars. Despite these pathologies that are commonly present in aged reinforced brick masonry structures, the church is in a good state of preservation. This fact reveals the impressive care with which it was designed and built.

CODE 177

SULFATE RESISTANCE OF COAL ASH PORTLAND CEMENT MORTARS

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KEYWORDS: Mortars; sulfate resistance; durability; coal ash; portland cement.

ABSTRACT

Coal Combustion Products (CCPs) are residues produced in thermo-electrical power stations as result of the coal combustion. In particular, coal ashes are the main CCPs and also, some characteristics of the coal fly ash (CFA) are comparable with those of the coal bottom ash (CBA). This fact is attributed to their origin, i.e., they are originated together in the same boiler. Nevertheless, coal bottom ash size is larger than coal fly ash one. Consequently, it was found that it is necessary to grind the coal bottom ash (CBA) to reach a similar size to that one of the CFA. The aim of this paper is to evaluate the performance of Portland cement mortars made with coal fly ash (CFA), coal bottom ash (CBA) or mixes (CFA+CBA), with regard to the sulfate resistance. It was determined by the expansion of slender bars submerged in a sodium sulfate solution (5%) according to the ASTM C-1012/C1012-13 standard. Mortars elaborated with CEM I 42.5 N (without ashes) presented the largest expansion (0.09%) after a testing period of 330 days. Mortars made with CEM II/A-V exhibited lower expansion (0.03%). Summing up, it can be established that mortar expansion decreases when the coal ash amount increases, independently of the type of coal ash employed.

CODE 190

THE IMPACT OF WATER SUPPLY SYSTEMS TRANSFORMATION ON THE SANITARY STATE AND THE OLD BUILT ENVIRONMENT DETERIORATION OF THE ALGIERS OTTOMAN HOUSES

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KEYWORDS: Ottoman houses in Algiers; pathological diagnosis; water supply system; *djeb* (cistern)*;* sceptic tank.

ABSTRACT

Water as a vital element considered the generator of ancient cities. On an architectural scale, it became the focus of constructive knowhow. For example, the water supply systems in the ancient Ottoman houses in Algiers, primarily geared to rainwater harvesting or groundwater abstraction, show a highly technical performance through both the logic of their installations and their functional integration within the house.

Today, one of the reasons for the healthy deterioration of these old Ottoman houses in Algiers is the degradation of the water supply systems. In fact, the transformations made to these systems, coupled with the new use of theirs elements, have been the cause of many of the adverse effects found in the houses. When, for example, the *djeb*, that originally a rainwater cistern, is transformed into a sceptic tank or bathroom, it is the whole water supply system that is compromised, adversely affecting both the sanitary and structural conditions of the ancient Ottoman house.

The aim of this study is to highlight all the different forms of degradation that are related to the transformation of these old water systems. It includes the pathology for different types of material and relates them to specific structural damage.

Using a methodology based on the examination of archival documents, bibliographic review, on site observation and diagnosis, we were able to identify, in more than 100 buildings, both houses and palaces, the transformations made to their original water supply systems.

As a result, we have been able to conclude that the greatest threat to the old Ottoman houses in Algiers is that posed by the transformations of their original water systems.

CODE 241

TREE RELATED SUBSIDENCE IN ENGLAND: EFFECTS OF CLIMATE CHANGE ON THE BUILT ENVIRONMENT

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KEYWORDS: Subsidence; tree; local authorities.

ABSTRACT

This paper investigates whether it is possible to improve the process of solving tree-related subsidence problems in England when they are caused by a local authority owned or protected tree. The paper provide an overview of the problem applying to both, historic and new buildings as well as the possible solutions that can be used to solve tree-related subsidence. The paper also describes a number of industry solutions to the problem and provides suggestion on whether surveying companies can improve their procedures to improve the successful rate and reduce the time of application for tree removal. An assessment of case law surrounding the topic's reported before discussing the results of primary data collection. Our research studied data from a surveying company on the costs and time taken to solve subsidence cases. The study finds that the main improvements surveying companies could make to the processes of solving tree-related subsidence is to make changes to its communication strategy and to obtain higher quality evidence about the cause of the subsidence sooner in the process. The findings should help surveying companies to improve their processes in the future, thereby reducing the costs involved, and the length of time it takes to solve subsidence cases.

CODE 298

ANALYSIS OF PATOLOGICAL INJURIES FROM VISUAL INSPECTION OF THE QUALITY SCHOOLS IN THE CITY OF MEDELLIN (COLOMBIA), BUILT BETWEEN 2004 AND 2007

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KEYWORDS: Quality schools; public infrastructure; pathological manifestations; City of Medellin.

ABSTRACT

We analized the pathological condition in the buildings of the 10 Quality Schools of the city of Medellín in Antioquia-Colombia, built in between 2004 and 2007. The physical, mechanical, chemical and constructive errors present in each of the buildings were studied. The study was developed in 4 phases: recognition of the problem, pre-diagnosis, pathological study and diagnosis. It was found that the most frequent physical alterations are dirtiness with 17.39% and detachments with 16.15%, out of a total of 322 alterations analyzed. In addition, it was determined that the building with the highest number of pathological lesions corresponds to the Héctor Abad Gómez school and the building with the least number of injuries belongs to Benedikta Zur Nieden school. As a conclusion to this investigation it was determined that the presence of injuries in the institutions is constant and its most probable cause corresponds to the lack of preventive and corrective actions.

CODE 305

HOUSING PATHOLOGY; TOWARDS A HOLISTIC PATHOLOGICAL APPROACH OF RESIDENTIAL BUILDINGS

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KEYWORDS: Building pathology; housing quality; housing management; life cycle management; sustainability.

ABSTRACT

Housing pathology is the holistic approach to identify, investigate and diagnose housing deficiencies, specify preventive measures and remedial interventions and evaluate their effects. In analogy with health as the core condition for the quality of human life, the health of housing accommodations stands for housing quality, being the ability of residential buildings to fulfil adequate shelter for specified groups of residents.
The relevance of housing and building pathology as a relative new knowledge field lies in the paradigm shift from new construction to maintenance and adaptation of the existing housing stock that occurs in most western countries, but also in the fast growing urban areas in developing countries. To maintain the fast ageing housing stock in developed countries as well as to shelter the growing population in emerging economies in a durable and sustainable way, the service life span has to be optimally extended. The impending assignment to reduce the ecological footprint and CO_2 and N_2 emissions of the construction and housing sector – also a major paradigm shift - requires major adaptations of homes and services as well as of the mindset and behaviour of builders, managers and residents. For the implementation of the Paris Climate Action Agreement, knowledge based sustainable stock management and adaptation will be indispensable.
Though it is the combination and interference of technical, social, spatial and economical processes that is determining for the health and life span of housing stocks, they are hardly interdisciplinary studied nor integrated in practical knowledge, let alone in a pathological context. The existent theoretical and applied knowledge about the different fields of housing stock management – in particular life span, life cycle and quality condition management is up to now too limited and segmented to successfully fulfil the new assignments. Rearrangement in a comprehensive pathological domain appears as an obvious solution.
This paper defines and explores the knowledge the knowledge required for the coming assignment, overlooks the available knowledge and shortcomings, the field of application, the main diagnostic tools and instruments and the practice in housing management. The paper concludes with the necessity of better holistic, building type and behaviour directed pathological knowledge and further international interdisciplinary research cooperation.

CODE 328

CERAMIC TILE SYSTEM, PATHOLOGIES AND PERFORMANCE EVALUATION

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KEYWORDS: Ceramic tile; pathologies; performance.

ABSTRACT

The paper considers the most common pathological problems on ceramic tiling in facades, referenced in different case studies in single story houses, residential and commercial buildings. The examined construction systems are infilled frame with non-structural masonry and structural masonry. To discuss the possible causes and ways of preventing these pathologies, the design recommendations that must be followed in the detailing of these rendering are related to the execution care to increase the durability. These recommendations are based on some current standards in Brazil and research work already done in this area. The minimum performance criteria in order to ensure that these ceramic tiling meet the Brazilian standardization are related with types of tests that can be carried out on site, or in the laboratory, to evaluate the different performance parameters of the ceramic tile system. As a result, a check list considers the main criteria to be considered in order to minimize these pathologies, that are becoming more important today, and the large number of studies already performed.

CODE 361

UNMANNED AERIAL VEHICLES (UAV) AS A TOOL FOR VISUAL INSPECTION OF BUILDINGS FACADES

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KEYWORDS: UAV; building inspection; visual inspection; monitoring; aerial photos.

ABSTRACT

The demand for technological insertion in industrial processes, notably due to the need for optimization of time is a challenge to the world revolution. In particular, Unmanned Aerial Vehicles (UAV's) are assuming increasing relevance as a new mechanism, more agile and secure. This research sought to accomplish the exploratory study of the UAVs use as a visual tool for pathological manifestations inspection in facades. The research strategy considers three steps: the exploratory analysis, the experimental procedure and, finally, the data processing, in order to verify the inspection feasibility. The steps of the inspection procedure were determined and a comparative analysis of the performance of the 3 types of visual assets generated (digital photographs, 3D model and orthomosaic) was performed to detect pathological manifestations. As a contribution, there is evidence of the convenience of using UAVs particularly where access is difficult, such airborne vehicles can reduce time, costs and generate greater security and data efficiently.

CODE 387

CONSTRUCTIVE ANALYSIS OF TWENTY RESIDENCIAL BUILDINGS BELONGING TO THE CULTURAL HERITAGE IN HERNANI (BASQUE COUNTRY): PATHOLOGIES AND CAUSES

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KEYWORDS: Cultural heritage; construction history; structural analysis; pathological analysis.

ABSTRACT

Whenever a rehabilitation project for a historic building is being carried out, information is required on its structure in the stages prior to the interventions, as well as about any alterations suffered and their effects, the phenomena that have affected it and on its current condition. The Old Town of the town of Hernani (Gipuzkoa, Basque Country) corresponds to its formation as a town, has maintained its original configuration, based on the medieval land from the 14th century and is classified as a Monumental Site. This area also has abundant examples of residential architecture corresponding to different historical periods, which have aroused the interest of the present study. We have consulted several documents about constructive history of twenty buildings with unique historical-architectural-artistic value in Hernani's Old Town and we have analyzed the structural elements, roofs, walls and installations, assessing the main interventions carried on them and identifying the pathologies and their causes.

CODE 457

METHODOLOGY OF RISK ANALYSIS IN REPORTS OF BUILT HERITAGE - THE CASE OF THE MUNICIPAL MUSEUM AGOSTINHO MARTHA

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KEYWORDS: Cultural heritage; estrutural analysis; archtetural heritage.

ABSTRACT

The architectural ensemble of the Municipal Historical Archive and the Agostinho Martha Municipal Museum has a great architectural and cultural relevance for the city of Gravataí and for the region. However, the buildings present a series of pathologies that have worsened over time.
Based on all the data collected, accumulated with the available technical knowledge, it is possible to concluded that the building is already in a high degree of deterioration, and that part is already bordering the collapse. The tendency is that, due to lack of maintenance, the building will irreversibly jeopardize its entire structure.
This study proposes the adoption of a methodology of risk analysis associated with the conditions of the building analyzed, in order to allow a evaluation of the general state and the existing risk. The proposed risk classification matrix considers the probability of an event occurring and its possible consequence, assigning a specific weight according to the degree of impairment of the building.

CODE 474

SALVO PALACE. STATE OF CONSERVATION OF THE SÍMIL PIEDRA FAÇADES RENDERS

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KEYWORDS: Heritage; facades; símil piedra; damages.

ABSTRACT

The Salvo Palace is one of the most emblematic constructions in the city of Montevideo (Uruguay). By the beginning of the 20th century, with its 100 meters high, it was the tallest building in the country and South America. Product of an ambitious private undertaking carried out by Salvo brothers; it was inaugurated in 1928. It was designed by the Italian architect Mario Palanti, it has been throughout its life a controversial building: praised by some and reviled by contemporary modern avant-garde. In 1996, it was declared a National Historical Monument, the highest legal figure of patrimonial protection at the national level.

Apart from of the ground floor, the facades have as a finishing material a continuous binder render called "Símil piedra". This material was widely used in Uruguay from the end of the 19th century until the first decades of the 20th century.

At the age of 90, the facades show obvious signs of deterioration to the point that there is a perimeter fence to protect passers-by from frequent detachment. For this reason, the owners have requested to the Faculty of Architecture, Design and Urbanism (FADU) to prepare a diagnosis for the rehabilitation of their facades. The work team, coordinated by the FADU Construction Institute, was composed of specialists from different disciplines, all of them lecturers/researchers from the University of the Republic.

In this article, the methodology carried out to achieve the objective will be described and the results that allowed to characterize the material and identify the main damages that affect it will be presented.

Likewise, a qualitative and quantitative analysis of the state of conservation of the facades will be exposed.

Finally, we will analyze aspects that were considered to propose technical recommendations allowing a reversal of pathological processes, while preserving heritage values of the Salvo Palace's facades.

CODE 533

THE EVOLUTION OF THE 18TH CENTURY SLAVONIAN PALACE OF GENERAL COMMAND OSIJEK, CROATIA - CAN WE RETRIEVE THE AUTHENTIC BUILDING DESIGN?

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KEYWORDS: Cultural heritage; 18th century building; design evolution; earthquake resistance verification.

ABSTRACT

The definition of the place derived from the theory of phenomenology of architecture as a combination of space and character, provides the theoretical structure for dealing with a concept of research and management of heritage buildings - HBIM (Historical Building Information Modelling). This concept is appropriate for the buildings of which significance and influence goes beyond local scope. If the building is marked with genius loci, the concept of HBIM can be structured according to the scopes of quantity and quality. Space is supported by information about geometry, material information (quantitative), and other quantification attributes (stability, resilience, etc.), while the character can be linked to the elements that add the meaning of the whole building, qualitative ratings, value evaluations (style, design, authenticity, etc.). The baroque service early 18th century building Palace of Slavonian General command in the baroque Fortress of Osijek, eastern Croatia, of which genius loci is confirmed in value resilience, despite changes of purpose, geometry, symbol transition, is a topic of research of the potential reconstruction in its most integral phase. The paper presents the results of spatial and qualitative analysis of the architectural values and the earthquake resistance verification of the building through geometry study of the atrium construction – vaults of the atrium that was deconstructed and changed during the first part of the 20th century. The numerical results are integrated in the HBIM with the use of object parameters. The paper presents the possibility of using the modelling process for the reconstruction and analysis of the non-existing parts of the building.

CODE 541

PATHOLOGY IN CRUDE EARTH, RESEARCH ON CONSTRUCTIONS IN THE ECUADORIAN ANDEAN AREA

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KEYWORDS: Earth construction; constructive pathology; sustainable vernicle architecture.

ABSTRACT

The dynamism of the construction on land in the Ecuadorian Andean area is reflected in the richness of its discrete formal configuration, site materiality and adaptability to a primary rural landscape, where such construction has been affected by the passage of time, atmospheric agents and periodic lack of maintenance.
The investigation tries to catalog some of the constructive pathologies product of the construction on raw earth in the Ecuadorian Andean area, since the land is the constructive element of easy access and employment, its reduced cost of execution and adaptability allows the construction on raw earth to develop in our geography.
The methodology was based on the application of the SVE method (Systematic Visual Evaluation), together with the systematization of the building diagnosis supported by the site visit, technical sheet, graphic schemes and photographs, where the pathologic status of the real state is described with the particularities of the constructive system applied be this adobe, tapial or bahareque; fifty cases of construction located in rural areas of five provinces of the central highlands of Ecuador where studied.
The results allowed to elaborate a pathological pattern of the building, finding causes and effects as a common factor that allowed to generate common typologies and thus elaborate the guidelines for a better intervention as well as the characteristic of the mixture that allows to delay the damages of the buildings.

CODE 580

VIOLIN-JOIST CERAMICS SLABS. EVALUATION AND WORK PROPOSAL WITH DUPLEX-TYPR STAINLESS STEEL

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KEYWORDS: Violin joist; oxidation; stainless; corrosion.

ABSTRACT

According to a study carried out by the WCO (World Corrosion Organization), worldwide expenditure on repair work for elements affected by corrosion amounts to approximately 2.5 billion dollars a year. Moreover, according to a study conducted by CONREPNET [1] (Performance-based approach to the remediation of reinforced concrete structures: Achieving durable repaired concrete structures), approximately 50% of repairs on elements affected by reinforcement corrosion show symptoms of defects within the first 5 years.

The case of a building located on the first line of the beach built in the 1950s, whose structural elements have been affected by corrosion of their reinforcements, is presented. Independently of other elements of the building, it is proposed to study the situation of the basement floor slab formed by a type of ceramic joists known as VIOLIN JOIST [2].

These structural elements were repaired approximately 12 years ago due to the corrosion of their reinforcements. The high humidity and chloride ion contamination led to significant corrosion activity in the reinforcement of these elements, causing cracking in the coating concrete and even detachment of the latter.

Due to the shape of the ceramic piece which receives the joist reinforcement, it is physically unviable to clean and repair the steel bars over their entire contours; this is probably the cause of the failure of the previous repairs. Therefore, the work necessarily involves replacing the steel elements with other suitable ones that comply with the necessary mechanical and corrosion resistance requirements.

For this kind of situation, a repair and reinforcement system has been developed with a special low nickel duplex stainless steel, capable of meeting today's new requirements for mechanical strength (without loss of free height), fire resistance, and chloride corrosion resistance, with a viable economic investment.

CODE 1

INVESTIGATION ON EXPERIMENTAL TECHNIQUES FOR THE MECHANICAL CHARACTERIZATION OF BRICK MASONRY

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KEYWORDS: Historical masonry structure; Minor Destructive Test (MDT); laboratory test; cylindrical core sample; pin penetration test.

ABSTRACT

One of the main difficulties found in the assessment and verification of masonry historical structures lays in the characterization of the main mechanical properties of the material components (units and mortar) and masonry as composite material. In an attempt to provide possible approaches for mechanical characterization, the paper presents and discusses different Minor Destructive Tests (MDTs) oriented to the measurement of the compressive strength of mortar bed joints and masonry composite samples extracted from existing brick masonries. The MDTs discussed for mortar characterization are the Double Punch Test (DPT), the Windsor Pin Penetration Test (PPT) and the Helix Screw Pull-Out Test (HPT). The method presented for the characterization of masonry as composite encompasses laboratory tests on cylindrical core samples. Different types of cylindrical samples, corresponding to alternative sizes and geometrical joint configurations, are investigated based on-purpose built laboratory walls and from a set of real case studies. The proposed MDTs are appraised with regard to their reliability and real applicability.

CODE 23

PREVIOUS STUDIES IN A SINGULAR BRIDGE: BRIDGE OF ALMARAIL IN SORIA

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KEYWORDS: Bridges; concrete; prestressed; diagnostic; material analysis.

ABSTRACT

It presents a work developed by TECNALIA about a road bridge, built in the fifties of the last century, in which a detailed work of characterization of its constituent materials has been developed.
The Almarail Bridge, over the Douro River, is located in the municipality of Cubo de la Solana in the province of Soria. Promoted its construction by the Douro Hydrographic Confederation, it dates its final project of the year 1951, and was carried out its construction between 1950 and 1955. It is a structure of three bays, of 20-30-20 meters of length, with a total of 70 meters in length. Its structural conception is somewhat peculiar, and was a pioneer in its time, as it was one of the first ones in which concrete was post tensioned.
The bridge was designed by the distinguished engineers Eduardo Torroja and Alfredo Páez. In the words of the latter: "Almarail is where for the first time special national steels are used for the technique of prestressed concrete, and constitutes an interesting feature of this true experimental bridge"
The bridge is protected by its historical-artistic values in the Municipal Urbanistic Standards of Cubo de la Solana.
The article includes the scope of the work carried out, the description of the structure, the approach and the conduct of the tests for the characterization of the materials and the uniqueness of the results obtained, in order to finally provide some general conclusions about this type of work, which are essential for the rehabilitation work of these structures.

CODE 35

NON-DESTRUCTIVE TECHNIQUES APPLIED TO HISTORIC BUILDING FOR MEASURING MOISTURE CONTENT IN BRICK VAULT

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KEYWORDS: Infrared thermography; electrical resistance measuring; non-destructive technique; historic building, Dominican Republic.

ABSTRACT

The aim of this research is to analyze and monitor the presence of moisture in brick vaults of historic building applying non-destructive techniques (NDT). The building studied was in the "Atarazanas Reales" (Royal Warehouse) of Santo Domingo in the Dominican Republic and was built during the first half of the XVI century. This building is the oldest of its type still standing in America and is a rectangle plan with three naves. The south and central vaults were first built, leaving the northern one to be added later in 1972. To carry out this research, Infrared Thermography (IRT) and Electrical Resistance Measuring (ERM) were used. In addition, climatic conditions were measured and a visual inspection was performed. Two in situ measurement inspections were carried out. The IRT and the ERM establishes that the moisture observed during the first inspection was solved with the application of waterproofing sealant as solution. Using a combination of visual inspection, IRT, ERM and environmental condition data, we can determine the condition of a brick in a vault in a historic building or in any other construction element.

CODE 45

VIBRATION ASSESSMENT ON THE HISTORICAL STRUCTURES INDUCED BY TECHNICAL SEISMICITY

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KEYWORDS: Vibration of historical buildings; dynamic response analysis; traffic vibrations; technical seismicity.

ABSTRACT

The recognition of the actual condition of the historical structure (diagnosis) is however not only achieved by determining the reason for an already detected defect. It is necessary also to determine the effect of any impact, and also during decision-making, whether at all, or how long the older structure could be in further safety. Long-term dynamic loads represent a serious factor which compromise the safety and durability of historical buildings. Continued exposure to these types of loads contributes to the degradation of materials and joints, causing the initiation of cracks or the growth of existing ones, such that they may endanger the structure. Loads, which an undamaged structure could securely resist, can be critical if repeated numerous times. This risk is present in various types of historical buildings, and is influenced by changes in vibration magnitude, by the distance from their source, and by the quality of the building's maintenance. Good maintenance, which includes regular inspections, affords early detection of any emerging damage and its subsequent repair. This article describes the methods and results of the measurement of dynamic response to road traffic and other types of technical seismicity in two historic buildings.
One of the negative aspects of the technological progress is the threat to historical heritage by the impacts of expanding production, transport, mining or blasting. The goal of the paper is the analysis and evaluation of the effect of such human induced vibrations on historical buildings and monuments.

CODE 48

VIBRATION MONITORING IN HISTORICAL CITY CENTERS: EFFECT OF TRAM SPEED ON THE VIBRATION INTENSITY INDUCED TO THE TEMPLE OF MINERVA MEDICA, ROME

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KEYWORDS: Vibration monitoring; historical city centers; structural safety; urban traffic; cultural heritage.

ABSTRACT

The structural safety of monuments may be endangered by the presence of remarkable vibrations that can be induced by natural (mainly earthquakes) and anthropic (e.g. urban excavation/construction works, intensive transportation traffic etc.) sources. In historic areas where scattered archaeological sites must coexist with modern urban activities, the exposure of cultural heritage assets must be monitored to assure that vibration levels are compatible with their integrity in the long term. Even if in terms of urban sustainability of modern transport systems tramways are considered very appreciable solutions, their proximity to vulnerable structures might represent a relevant issue, since trams passages may induce remarkable vibrations levels, as proved by several studies in the recent literature. The vibration intensity that is induced to the adjacent structures depends on the geometrical configuration of the problem (e.g. the source-structure distance), the propagation properties of vibration path (e.g. road, soil and foundations) and the dynamic properties of the structure itself. Moreover, different kinds of vehicles (e.g. vehicle type, weight, length, wheels imperfections etc.) have different effects, but also the passage conditions, especially in terms of vehicle speed, may change dramatically the vibration intensity level, which makes the problem become even more complex. The present paper illustrates an experimental study about the measurement of trams vibrations at the so-called Temple of Minerva Medica located in Rome, Italy. Tramways are situated very close to its southwest side. Vibration data were acquired by digital recorders equipped with triaxial velocimeters positioned at several measurement points on the ground, while time of tram passages were also noted. The different times of vibration peak occurrences in the three monitoring stations on the southwest side of the monument were compared with tram passage times, allowing to estimate the trams speed and to relate it to the vibration intensity levels induced at the various monitored positions of the structure. Data were collected during the morning, on several days in different seasons (February, April and July) to provide more representative conditions.

CODE 63

DAMPING CHARACTERISTICS OF DRY SANDY SOILS UNDER IMPACT

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KEYWORDS: Dry sand; impact; soil damping; force-time history.

ABSTRACT

There exist several problems in civil engineering that deal with stress waves through soil due to dynamic load, such as earthquake excitation, vibration of foundation due to piling or demolition, ...etc. For the design of such systems, it is important to investigate the dynamic soil properties especially, shear modulus and the damping ratio.

Damping is the energy dissipation through a system such as soil in which only a few techniques are available for damping evaluation of soil such as “resonant column” and “cyclic simple shear tests”. No reliable field testing method is currently available as an established technique.

An experimental study is carried out on dry sandy soil “loose, medium and dense” under the action of a single impulse caused by a falling weight from different heights conducted using the falling weight deflectometer (FWD) to provide the pulse energy. Different parameters were taken into consideration such as footing embedment, footing diameter, soil density, and the applied energy. Accordingly, the damping characteristics were evaluated based on a proposed expression taking into account the energy dissipated in a single degree of freedom system.

The results show soil damping is found to be a function of embedment ratio (D/B) where the damping ratio increases by 50-150% when the embedment ratio increases from 0 to 2. Damping was found to be affected by the soil density and the magnitude of the applied energy of the dynamic impulse.

CODE 66

PROTOCOL FOR THE MONITORING OF ENVIRONMENTAL VARIABLES THAT AFFECT THE DEFENSIVE HERITAGE OF TAPIAL: A CASE STUDY OF THE WALL OF THE ALCAZABA CADIMA. GRANADA, SPAIN

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KEYWORDS: Environmental and surface test protocol; diagnostic monitoring; efficient preventive action.

ABSTRACT

The extent of deterioration of built heritage largely depends on the degree to which it is exposed to the climatic and environmental conditions in its immediate environment. Structured knowledge regarding these conditions demands that diagnostic protocols are designed on the basis of monitoring, thus enabling an assessment of how the asset´s state of conservation is affected by the environmental conditions.

This paper presents an environmental and surface test protocol (Temperature and Humidity) applied to different sections of the Zirí Wall located in the city of Granada. The main objective is to identify, analyse and characterise the relationship between changes to the cultural asset´s state of preservation and the environmental variables in its immediate microclimate. To do this, a methodology has been designed which uses a network of sensors distributed according to the following factors: orientation, construction system, degree of deterioration, degree of exposure and altitude. In order to specifically locate them, processes which impede changes to the dynamic environmental variables affected by direct solar radiation have also been taken into account. It is important to note that the technique employed to obtain the environmental temperature is that of generating a continuous movement of air by natural convection.

The underlying structure of this model, on the basis of differential equations, allows us to predict the behaviour of structures over time. By so doing, effective and efficient preventive action measures can be adopted, which are additionally more sustainable when considering the heritage values of the cultural asset. We propose that this proven strategy, which takes the specific microclimate into account, could be extrapolated to other affected cases.

CODE 116

DAMAGE OBSERVED IN ANCIENT CHURCHES DUE TO THE EARTHQUAKES OF SEPTEMBER 7TH AND 19TH, 2017 IN MEXICO

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KEYWORDS: Ancient churches; earthquakes; seismic behavior; damages patterns; masonry.

ABSTRACT

The earthquakes have been one of the main causes of destruction of the architectural heritage buildings. The careful seismic assessment of the architectural heritage affected by severe earthquakes is one of the most effective techniques to understand the structural weaknesses of those constructions. It is also necessary for assess the interventions made in the past, in order to establish which have had successful behaviour and must continue to be used and which not. Due to the earthquakes of September 7th (Mw 8.2) and 19th (Mw 7.1), 2017 happened in Mexico, in different locations. More than 2000 historic buildings were damaged in localities near to the epicenter area. Due to this, the Instituto de Ingeniería by UNAM organized different campaigns of reconnaissance to observe damages in old churches and convents in some locations affected. A total of 58 temples, distributed in four states of the center of the country, were visited: 16 in Oaxaca and 11 in Puebla, both in the Mixteca region, 15 in Morelos, in the so-called “Ruta de los Conventos” and 10 in Mexico City. Different levels of damage were observed (light, moderate and severe), even in temples of the same area. Damage was observed in different structural elements, such as towers, roofs, abutments, walls and arches. In some cases, the level of damage was very serious and collapses, both partial and total, of some of these elements were observed. In this paper, a summary of the damage and behaviour observed in old churches is presented.

CODE 131

SEISMIC BEHAVIOUR OF NAVES COVERED WITH POINTED VAULTS

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KEYWORDS: Pointed nave; masonry; rigid element method; seismic behaviour; barrel vault.

ABSTRACT

Hundreds of masonry churches were built in Mexico during the Colony; these vary in size and architectural characteristics. Arches and vaults were built following certain rules in order to achieve certain element geometries and dimensions. Although different geometries may be found, most churches are covered by barrel vaults. Plenty of churches were damaged throughout the country in the earthquake of September 19, 2017. The churches of Pilcaya and Ixcamilpa, in the State of Puebla, are covered with pointed vaults, which is rather uncommon in the country's colonial constructions. Originally, these churches were covered with barrel vaults, but they were modify at the first half of the past century. In order to understand the seismic behaviour and the observed damage of these vaults, a non-linear dynamic analysis by using the Rigid Element Method was carried out. This method is based on a semi-discrete model of rigid bodies and springs. Walls and buttresses are made with stone masonry, while arches and vaults are built with brick masonry. In order to study the seismic behaviour, the response was compared with a nave with the same characteristic covered with a barrel vault. Real earthquake records of the event of September 19, 2017 were considered. The results show that geometry is an important factor for the seismic response and the damage mechanism of this kind of constructions.

CODE 133

SIMPLIFIED SEISMIC VULNERABILITY ASSESSMENT OF WOOD HERITAGE BUILDNGS, IN SOUTH CHILE. NUEVA IMPERIAL

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KEYWORDS: Seismic vulnerability; heritage; timber; buildings; South Chile.

ABSTRACT

Currently, there is a growing need to develop comprehensive and coherent strategies to manage and preserve the built heritage of our cities and especially in those areas that are extremely susceptible to natural hazards, as in the case of southern Chile. In this sense, this work focuses on assessing the condition of seismic risk of wooden heritage buildings, incorporating the assessment of the architectural cost and threat in the evaluation. In a simple way in order to obtain a preliminary evaluation in real estate properties. The methodology used is based on the application of vulnerability index, and considers a total of 26 input variables related to heritage attributes, physical vulnerability of buildings and external hazards to which they are subjected. In this way, an index of heritage seismic vulnerability is generated, which focuses on a more multidisciplinary view of the problem in question, as a support tool for the systematic management of the built cultural heritage. This information is really useful to expand the existing knowledge on the preservation of the built heritage and on the decision-making process in the management of its maintenance and preservation over time. It process allows objectively quantify the condition of vulnerability from a perspective of the heritage and incorporating the architectural variable, beyond the traditional evaluations that focus on quantifying physical or structural parameters, and adding the existing threat conditions. For the evaluation, eight historical wooden buildings located in the city of Nueva Imperial, Araucanía region, in southern Chile are considered as case studies. This area is characterized by being in an area of very high seismic threat, and scene of strong earthquakes in the past. The knowledge collected in this study is particularly relevant for professionals, users, researchers and, without a doubt, the stakeholders responsible for defining and implementing preventive maintenance programs in heritage buildings in cities in South America. This research work contributes to a good strategy to carry out diagnosis of properties of heritage interest.

CODE 140

CONDITION MONITORING OF BUILDING ENVELOPE - TECHNICAL INSPECTION USING DRONE TECHNOLOGY

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KEYWORDS: Building envelope; technical inspection; drone.

ABSTRACT

Among the building surveying techniques, visual inspection is often used, since it may play a relevant role on a fast evaluation of construction defects, helping to define a more appropriate way of intervention. Particularly in what building envelope is concerning, this procedure can be an essential prerequisite at ensuring that integrity and safety will be guaranteed. However, when resource is made to this simple practice, unexpected difficulties may arise, especially when sites to be inspected are hard to access, safety risks may also exist for the inspector or scaffolding assembly is expensive and economically unviable, etc. Therefore, it is important to rely on alternative support methodologies to technical inspection, aimed at overcoming such setbacks and from which substantial benefits can still result. It is in this context that relevant potentials may derive from the use of drones. Recently, great focus has been put on this kind of small aircraft as an emerging technology in the Construction Industry (IC).

As a case study, this paper presents a condition monitoring assessment using drone, getting as target the envelope of a recent building of University of Beira Interior (UBI), in Portugal. The objectives are to demonstrate the advantages of using drones, framing it in two hypothetical analysis perspectives: (i) using the inspection results at presuming the necessity of building (or elements) rehabilitation - this examination is carried out mainly on the scoping of some methodologies already developed to rating the condition status; (ii) using the inspection results in the scope of building maintenance management, in order to accomplish the characterization of the reference state of the elements - this is made by filling of inspection event sheets, aiding thus later maintenance plans achievement.

Through this study, the adaptability and versatility of using drones were scrutinized, since it may come a promising alternative methodology to support the technical inspection in the process of condition monitoring of building envelope. In fact, drones seem to be a worthwhile tool for supporting certain civil engineering activities - particularly when displaying a multirotor configuration, loading high-definition (HD) cameras, for both photography and video.

CODE 143

SEISMIC PERFORMANCE ASSESSMENT OF HISTORICAL CULTURAL HERITAGE MASONRY BUILDINGS: COCCHI SERRISTORI PALACE IN FLORENCE, ITALY

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KEYWORDS: Historical buildings; cultural heritage; seismic assessment of masonry buildings; existing buildings

ABSTRACT

In Italy, historical cities have been built over the centuries through different interventions and remaking. Starting from Romans foundation, cityscapes have been modified and transformed, damaged by conflicts, renovated in buildings and the urban design. Cultural Heritage buildings, even if apparently congruent in façade motifs, have been subjected to the same type of changes and improvements. Because of their monumentality, prominence and central position, nowadays these buildings are usually involved in relevant uses, such as museums, representative palaces, schools. Cocchi Serristori Palace, located in Florence in piazza Santa Croce has been built during the Medieval period and renovated by Giuliano da Sangallo in the Renaissance. Following the latest interventions of XIII and XIX centuries, today the building represents the District Headquarter of the Historical Centre of Florence. In this paper the seismic performance assessment of the Palace has been made. The procedure has followed the Italian Guidelines for the seismic assessment of Cultural Heritage and it defined three different levels of evaluation. In particular, the latest two levels LV2 and LV3 allowed to estimate both local and global behaviour of the building due to seismic actions. The assessment has been checked trough kinematic analysis, dynamic modal analysis and non-linear static analysis. The results, expressed by the ratio between capacity and the corresponding demand, mark out the seismic performance of Cocchi Serristori Palace.

CODE 144

MULTIDISCIPLINARY APPROACH TO THE STUDY OF THE STRUCTURAL EVOLUTION OF PALAZZO VECCHIO FLORENCE (ITALY)

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KEYWORDS: Cultural heritage; seismic behavior; structural evolution; site survey campaign.

ABSTRACT

Historic buildings are elements of great complexity, shaped by history. They are the result of long evolutionary processes and not of a single construction phase, because of their characteristics, they require particular attention in the reconstruction of their architectural and structural evolution.
The urban area of Palazzo Vecchio, Florence Italy, is a site of extraordinary historical importance, built in Roman times, late antiquity, early and late medieval, Renaissance and modern. The Palagio dei Priori, designed by Arnolfo di Cambio, in 1299, constituted the first core of the Palace, which has always been the seat of the city government. The administrative needs of the Florentine Republic, before, and later for the Lordship, Grand Duchy and in the XIX century for Florence Capital of Italy and now as City Hall, required the palace to expand until it occupied the whole block.
The final objective of the research program, the definition of the seismic behaviour of Palazzo Vecchio, needs to know construction phases in order to define homogeneous structural blocks on which to direct the survey campaigns on the consistency of the materials of the walls and on the dynamic behaviour of the structure. The knowledge of the building cannot be separated from the historical analysis of the functional evolution of the building and its structural articulations, and in the case of Palazzo Vecchio particular attention must be paid to the fact that it was erected onto Roman and Early Medieval ruins and not directed rooted in the subsoil. In order to evaluate the seismic vulnerability of a building, a full knowledge of the structure is required, also obtained through on-site survey campaign, which terms for buildings of cultural heritage is defined by the Ministery for Cultural Heritage guidelines (MiBACT 2011 rule).
This on-site survey campaign must not to be too invasive and harmful and asks for techniques based on a multidisciplinary research approach for defining the knowledge of the structural evolution and of the characteristics of the materials. Therefore, only architectural survey, historical research and non-destructive investigations (NDT), as Georadar, thermic, microendoscopy, sonic, ultrasonic and local small unplaster can be performed.

CODE 155

THE KNOWLEDGE PATH FOR THE DEFINITION OF STRUCTURAL SAFETY: COCCHI SERRISTORI PALACE IN FLORENCE, ITALY

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KEYWORDS: Cultural heritage; in situ survey; non-destructive tests; buildings masonry; historical buildings.

ABSTRACT

The issues related to the security of cultural heritage are closely linked to the knowledge path reached, where the assessment of structural performance is the last step. This path is very important to limit the uncertainties concerning the evaluation of the building. In recent decades, many national and international codes have incorporated the definition of cognitive path, in particular for the historical-architectural heritage. In this context, the Guidelines developed by the MIBACT in 2011 trace a clear path of what information must be acquired to reach different knowledge levels that are flanked by evaluation levels. In this work, the knowledge path conducted on a historical monumental building located in the historic centre of Florence will be analysed and illustrated. The object of the evaluation is Cocchi Serristori Palace, partially founded on pre-existing Roman buildings. The knowledge process conducted on this building has involved many different disciplines, in order to acquire the information required for understanding the construction techniques and the relationships between the various structural parts. The research comprehended investigations on the subsoil, on the historical asset of the building over the centuries, and geometric surveys. Then a diagnostic investigation campaign was carried out, with semi-destructive methodologies, aimed to identify the different masonry typologies used over the centuries and their characterization. The knowledge path carried out allowed to obtain all the necessary information for the next phase of structural performance evaluation.

CODE 163

DETECTION OF FILLING DEFECTS IN A SLIDING CONCRETE SILO USING NON-DESTRUCTIVE TECHNIQUES

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KEYWORD: Concrete; sliding formwork; impact-echo; pulse-echo.

ABSTRACT

Reinforced concrete silos are usually manufactured using the slip-form technique. This technique, more economical and quicker to execute in silos over 15 m in height, consists of pouring the concrete into a mobile formwork, which moves vertically without waiting for the concrete to finish completely set. To ensure a good quality of the hardened concrete, one of the main requirements is to adopt an adequate lifting speed. This must allow the supporting concrete to gain sufficient strength, but avoid the generation of cold joints and the creep of the material. The objetive of this work is to present the experimental methods used to evaluate the wall of a reinforced concrete silo built with slip formwork. During its construction, part of the wall of the silo suffered drag of the material, which generated cavities inside the wall. After its repair, it was of interest to know the state of repair and the existence of hidden cavities in areas without repair. The evaluation was carried out using three non-destructive testing techniques: ultrasound in pulse-echo mode, passive infrared thermography and impact-echo. The ultrasound results were inconclusive due to the impossibility of obtaining clear signals in areas of sound, good quality concrete. The main hypothesis that would explain the obtaining of noisy signals is the heterogeneity of the material, product of the constructive technique applied. Passive thermography was also affected by this heterogeneity. The impact-echo technique was the most sensitive for detecting defects inside the concrete. The analysis of signals in the frequency domain is a very powerful tool for the detection of delaminations and cavities, even in concretes more heterogeneous than those usually used in construction.

CODE 168

VISUAL PROGRAMMING FOR THE STRUCTURAL ASSESSMENT OF HISTORIC MASONRY STRUCTURES

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KEYWORDS: Upper bound limit analysis; genetic algorithms; visual Programming.

ABSTRACT

The objective of this work is to formulate a new methodology the assessment of masonry structures that is using a fully digital procedure to automatically build up a reliable structural model, limiting expensive destructive tests. Data arising from laser scanning surveys and digital photogrammetry techniques are employed to generate a detailed 3D model that can be automatically imported in a Finite Element (FE) software environment. This is used to perform a non-linear static analysis aiming at investigating on possible collapse modes of the structure. As the focus is not on the actual structural capacity of the structure, such results are not strongly dependent on material parameters employed, which are set based on engineering judgement only. This preliminary structural analysis is employed to generate a possible configuration of failure surfaces through the Control Surface Method (CSM), which is here proposed for the first time. These are associated to the 3D models and implemented into a visual coding which embeds an upper bound limit analysis of the problem assuming a no-tension material hypothesis. Based on such failure surfaces, Genetic Algorithms are used to generate other possible collapse mechanism and search for the actual failure mode corresponding to the minimum value of the loads multiplier.
The work-flow is all integrated into a computational tool implemented in the visual programming environment offered by Grasshopper and Rhino3D. The procedure is validated by the analysis of one benchmark case, whose results are presented and discussed.

CODE 176

EVALUATION OF VEHICLE TRAFFIC VIBRATION IN ANCIENT BUILDINGS IN SALVADOR HISTORIC CENTER

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KEYWORDS: Vibrations; accelerometers; heritage; historic center of Salvador; conservation.

ABSTRACT

Salvador, the first capital of Brazil, was founded in 1549 and since then has a vast historical, artistic and cultural heritage composed of buildings, such as houses, churches, monuments, among others. The architectural, landscape and urban complex located in the Historic Center is one of the most relevant examples of Portuguese overseas urbanism. Despite their great importance, some constructions present structural degradation due to the action of time, modern impositions and lack of maintenance. The present work aims to measure vibrations in terms of speeds resulting from the traffic of automotive vehicles in buildings located in the Historical Center of Salvador, and asses whether these values are within limits set by international regulations. It is known that vibrations can cause and, mainly, potentiate existing damages, taking the building to the risk of collapse. In order to obtain the results, an experimental program was carried out, which included measurements of vibrations through the installation of accelerometers on floors and walls of old buildings. The methodological procedures included a wide bibliographic review on the subject, execution of tests and a comparative analysis of results with the provisions of international literature. Because this is an unpublished study, it is expected that this will contribute to the expansion of the technological knowledge on the subject, and thus for the development of the Science of Conservation and Restoration and for the preservation of the vast built national heritage.

CODE 186

SEISMIC DAMAGES OF THE SEPTEMBER 19, 2017 EARTHQUAKE IN MEXICO AND RETROFIT ALTERNATIVES FOR EXISTING BUILDINGS

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KEYWORDS: Seismic damages; passive control devices; soft story buildings; seismic vulnerability.

ABSTRACT

The Mexican Republic is located in a highly seismic zone. There are intraplate and interplate seismic sources in the country. In the southwest zone there is a large subduction zone and into the continent there are local faults and normal faults of intermediate and large depth. In the northwest there is a transformation fault that continues to the United States of America. On September 19, 2017, an intraplate earthquake occurred (Mw = 7.1), with an epicenter in the State of Morelos, 120 km away from Mexico City. More than 300 buildings had serious damage and the most common structural deficiencies were identified with torsion and soft story buildings. Both types of structures were severely damaged or collapsed. Visual inspections carried out after the earthquake allowed to collect information on the typologies of damaged buildings and also to obtain an important number of seismic records near the most damaged sites. This study describes the most frequently building damages and analyzes the seismic demand and capacity of typical buildings with flexible ground floor. The buildings were subjected to a family of real accelerograms recorded in this area during the occurrence of the earthquake. To improve the seismic capacity of these structures, and to reduce their seismic vulnerability, several retrofit techniques to mitigate damage in the future are analyzed. The results show that the seismic vulnerability of structures with flexible ground floor can be drastically reduced if an adequate reinforcement system is adopted.

CODE 202

STRUCTURAL ANALYSIS MODELS FOR THE ASSESSMENT OF SEISMIC VULNERABILITY OF A MASONRY SCHOOL BUILDING UNDER NEW ITALIAN RULES (NTC 2018 AND CIRCULAR 2019)

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KEYWORDS: School buildings; masonry structures; seismic vulnerability assessment; methods of structural analysis; Italian standards.

ABSTRACT

As part of the "2nd program of seismic vulnerability assessments of Italian school buildings", the Carducci elementary school in Terni was audited. The school, completed in 1956, designed according to the regulations in force in 1954 and therefore not in an anti-seismic way, has an elongated rectangular plan, arranged transversely to a slight slope, with foundations on two levels, a partially basement floor and two floors outside land plus an attic. The school has a load-bearing masonry structure and has few, modest changes compared to the original project. In this work the procedure of the operations carried out for the evaluation of the seismic vulnerability is presented first: from the survey of the existing to the geotechnical characterization tests of the site, to the 3D modeling of the structure and design of the consolidation interventions. The first seismic vulnerability assessment was performed with reference to the Italian standards of 2008 and the 2009 explanatory circular. The results obtained, following a dynamic modal analysis with structural factor q, indicated the need to proceed with seismic consolidation operations that in the vulnerability assessment phase they were mainly proposed in the increase of the resistant capacity of the masonry walls. Subsequently, the executive project of the consolidation work was tendered out and today (2019), having completed the tender procedure, the consolidation work is in the start-up phase. After the entry into force of the new technical standards for construction (NTC2018) and the relative application Circular (February 2019) the impact of the innovations introduced in the field of existing masonry structures and in particular in the non-linear calculation was presented, both for the assessment of seismic vulnerability and for the planning of consolidation works. We then proceeded to a recalculation of the three-dimensional model of the entire building by comparing the results of linear static analysis, linear dynamic analysis and non-linear static analysis, also in relation to the planned interventions of consolidation. Finally, the economic effort of consolidation interventions is also presented.

CODE 221

NON-DESTRUCTIVE TESTING OF CONCRETE: ANALYSIS OF EXPERIMENTAL RESULTS

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KEYWORDS: Concrete characterization; non-destructive testing; laboratory tests; in situ tests.

ABSTRACT

The advantages of using structural concrete are well recognized. The value of the solutions, their strength and durability, as well as the ease of placement in work have made concrete the most widely used material in construction in the last century.
In Portugal, the first constructions that deserve special mention are the Moagem de Trigo do Caramujo Building, built in 1898, and the Luiz Bandeira Bridge in Sejães over the Vouga River, built in 1907; while the first national regulation only appeared in 1918.
More than 100 years after the beginning of the use of structural concrete in Portugal, the concern of the maintenance of a large built stock, under safe and economical conditions, is increasingly relevant. Moreover, the current functional and comfort demands on the constructions often lead to the need for strengthening and structural rehabilitation interventions. It is in this context that the evaluation of the strength and deformation properties of the existing concrete assumes special importance.
Procedures for conducting non-destructive testing for characterizing concrete in existing structures are well known and many of them are in European standards. However, some gaps persist in the interpretation of results, as is the case in situations where other phenomena occur in parallel, such as the concrete degradation, cracking, among others. On the other hand, the possibility of using experimental design results according to the standards is very demanding and difficult to apply.
This paper is dedicated to the in situ assessment of the strength and deformation properties of concrete. From a laboratory campaign, which focused on models made with different concrete classes, the results of non-destructive tests that have been most commonly used in situ are analyzed and validated to appraise mechanical properties of concrete. For this purpose, the results of the non-destructive tests, obtained in the small scale specimens under different test conditions, are compared with the corresponding reference values, obtained also in laboratory.

CODE 237

AN INTEGRATED APPROACH OF NON-DESTRUCTIVE METHODS FOR INSPECTION AND CHARACTERIZATION OF CULTURAL HERITAGE: CASE STUDY OF MONASTERY OF BATALHA, PORTUGAL

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KEYWORDS: BIM; Non-destructive Inspection; Cultural Heritage; Building pathologies.

ABSTRACT

In the present paper, the authors present a new approach that merges in a Building Information Modelling (BIM) environment geospatial data obtained by a set of non-destructive technologies, namely terrestrial laser scanning, ground penetrating radar, and unmanned aerial systems, as well as the results of the classification of the observed anomalies. This approach was applied to the inspection and characterization of the main façade of the Monastery of Santa Maria da Vitória in Leiria, Portugal, also known by Monastery of Batalha, which is inscribed on the UNESCO World Heritage List. Its main styles are Gothic and Manueline, a Portuguese late gothic.
By applying this approach to the monastery, the spatial data required to produce a high-fidelity 3D model was obtained. Ground-penetrating radar (GPR) was employed to assist in the characterization of the internal structure of the walls and piers and to spot different building materials, which is helpful for the investigation of some of the detected pathologies.
The data acquisition technologies were also analysed with emphasis being given to their most relevant limitations and to strategies for optimization of the surveys.

CODE 286

MACRO MODELLING IN THE SEISMIC VULNERABILITY ASSESSMENT OF SCHOOL ARCHITECTURE IN ALGERIA

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KEYWORDS: Macro modelling; masonry; seismic vulnerability; school architecture; Algeria.

ABSTRACT

19th and early of 20th-century Algerian schools comprise a rich architectural and know-how heritage, apart from being places of education and learning. Their vulnerability to earthquake endangers generations attending all-day facilities. Their construction in masonry, before the advent of concrete and seismic code, increase their exposure to earthquake hazards; let alone Algeria's geographical location well-known as a strongly active seismic zone. The valuation of seismic vulnerability will contribute to anticipating potential risks at a structural level. Additionally, it is important to study the risk prevention and management plans as well as resolutions adoption of foreseeable natural hazards. This study will in the first place identify and locate the buildings, select a sample, of commonly spread architectural models; in accordance with their forms, building techniques, used materials and construction know-how. After that, there will be a modelling by macro elements using specialised software (S.T.A data Tremuri) in the calculation of masonry structuresExpected results will then be summarized in the form of a guide with recommendations in the perspective of protection or rehabilitation.

CODE 315

SEISMIC VULNERABILITY ASSESSMENT OF PERUVIAN COLONIAL CHURCHES USING THE COLLAPSE MECHANISMS METHODOLOGY, CASE STUDY: PUNO CATHEDRAL - PERU

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KEYWORDS: Historical structures; seismic vulnerability; collapse mechanisms; kinematic analysis.

ABSTRACT

During a strong earthquake, many historical structures usually collapse, sometimes even with regrettable life loss. Therefore, a quick study of the current situation of buildings, as churches, is necessary to know their seismic vulnerability.
For this reason, this study uses the collapse mechanism methodology described in the Italian code, which allows evaluating the overturning of some mechanisms, previously identified in a structure, and the acceleration and displacement levels that could generate the collapse of the structure.
This methodology is applied to Puno's cathedral, a stone structure located in southern of Peru. The cathedral is a stone masonry building from the XVII century. The plant is similar to a Latin cross constituted by one nave, transept, presbytery, apse, two towers and a dome. The nave is covered by a barrel vault with stone lunettes supported by masonry columns connected by arches. For Puno, a maximum horizontal acceleration of 0.35g is expected to occur over a rigid soil, with a 10 percent probability of being exceeded in 50 years.
The methodology specifies 28 possible collapse mechanisms. However, for Puno's cathedral, only 23 mechanisms were identified. In addition, global and local vulnerability indexes were computed for each mechanism, to identify the most probable mechanisms. Then, a linear kinematic analysis was done to calculate the maximum acceleration that could activate each mechanism. Finally, a nonlinear kinematic analysis was done, which involves a comparison between the displacement capacity vs the displacement demand.
The results indicate that the mechanisms with the highest probability of occurrence is the facade, nave, transept, apse and towers, which could be activated with accelerations lower than one specified in the Peruvian code. Therefore, the need for seismic protection in this type of historical structures is adverted.

CODE 317

COMPARATIVE EVALUATION BETWEEN DIFFERENT FORMULATIONS OF PHYSICAL DEGRADATION IN EXISTING STRUCTURES OF RC

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KEYWORDS: CEB method; GDE method; concrete structure; diagnosis.

ABSTRACT

This article will present comparative valuation studies regarding physical degradations in reinforced concrete structures. It is evident that the concrete structure is intended to provide to the user secure conditions when utilizing a building. Therefore, it is necessary the realization of periodic inspections, to establish the security level. The objective of this work is to analyze the results generated by applying the building inspections methods created by the Comite Internacional du Beton bulletin 243 [5] ang by the parametrized GDE methodology [12], employed in a residential building that present project and execution flaws. With the methodology, were used, for the building inspection, photographic records, project valuation and the Standard Penetration Test (SPT). Once data was gathered, systemizing and matching were made to generate the critical level and the deterioration degree of the structure. As expected, results it aims to identify and diagnose the criticality levels of the building, as well as identify the differences between the methodologies used and, finally, if any of them prove to be more effective for identifying urgent interventions in the structures.

CODE 338

BRICK MASONRY COMPRESSIVE STRENGTH EVALUATION: COMPARISON BETWEEN PREDICTIVE MODELS

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KEYWORDS: Brick masonry; compressive strength; predictive models; double flat-jack test.

ABSTRACT

The evaluation of the safety of existing masonry constructions is a crucial and current issue, especially for countries characterized by the presence of a large number of old and ancient buildings. Within the vulnerability assessment procedures, one of the most important phases is the evaluation of the material mechanical properties. Several investigation techniques can be adopted, classified as non-destructive, minor-destructive and destructive according to their invasiveness on the construction. To determine the compressive strength of existing masonries, tests on the masonry components, bricks and mortar, can be performed. Predictive models or empiric formulations can then be used to evaluate the masonry compressive strength, starting from the mechanical properties of the constituents. The objective of the present research is to determine the capability of predictive models to effectively capture the masonry compressive strength. For this purpose, a database of experimental tests conducted on existing masonry buildings was collected, together with data from the literature. In particular, the masonry compressive strength and the strength of bricks and mortar were experimentally evaluated or derived from previous researches. The predictive models chosen were applied, using the brick and mortar properties, and the results were correlated with the masonry compressive strength, considered as a reference. The investigated masonries were classified according to their strength and different ranges were considered to better evaluate the reliability of the formulations adopted. Critical analyses about the suitability of each predictive model will be presented, with a particular focus about the determination of the compressive strength for poor-quality masonries, for which a modified analytical formulation was calibrated.

CODE 343

ANALYSIS OF THE EFFECTS OF TEMPERATURE ON CONTINUOUS MONITORING OF STRESSES IN MASONRY STRUCTURES

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KEYWORDS: Structural and environmental health monitoring; temperature effects; correlations; stress device; masonry structures.

ABSTRACT

Historic heritage provides a representation of cultural diversity, hence the need for its preservation and conservation. Structural health monitoring systems and non-minor destructive techniques are valuable alternatives for structural characterization and safety management. It is noteworthy the close relationship between the structural behaviour and the variation in environmental properties (e.g. temperature and humidity), hence the importance of assessing their incidence. In this sense, this article focuses on the study of the temperature effect in the behaviour of the fluid contained in a device for continuous monitoring of stresses. For this, the environmental conditions are taken into account, as well as their influence on the sensor records. In this way, first of all, two possible fluids, capable of being used in stress devices, are studied. Their behaviour concerning to thermal variations are analysed, and one of them is selected to be used in the proposed stress sensor. Then, the characteristics of the aforementioned stress device and the variables of control are analysed. Next, its laboratory implementation in a masonry structural element and the results of 10 months of continuous monitoring are presented. Finally, the results are correlated with the temperature variations, demonstrating the significant influence of the environmental conditions.

CODE 347

A DISCUSSION ABOUT THE APPLICATIONS OF INFRARED THERMOGRAPHY FOR BUILDINGS DIAGNOSIS

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KEYWORDS: Infrared thermography; qualitative analyses; quantitative analyses; buildings diagnosis.

ABSTRACT

Infrared thermography (IRT) is a non-destructive and non-contact testing technique that measures surface temperatures that are displayed as 2D images. IRT is used to assess the energy performance of buildings but also as a diagnosis tool.
In spite of all its advantages, IRT is mainly used to perform a qualitative and superficial evaluation, in which only the thermal patterns are observed to identify a possible anomaly. However, there has been several attempts to implement different quantitative methodologies to interpret the results, which ensure higher reliability and provide greater amount of data about the anomaly under study.
In this paper, some examples of the use of IRT to assess the buildings behaviour are presented. Information about the test procedures and about the analyses of the results is also provided. The case studies are: detection of moisture in walls, assessment of radiant floors, identification of thermal bridges, air leakage in building elements and water leakage in underfloor heating pipes and observation of hidden details in walls.

CODE 349

AN AUTOMATIC DISCRETE MACRO-ELEMENT METHOD BASED ROCEDURE FOR THE STRUCTURAL ASSESSMENT OF RAILWAY MASONRY ARCH BRIDGES

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KEYWORDS: Nonlinear analysis; discrete macro-element method (DMEM); HiStrA software; masonry arch bridges; railway bridges.

ABSTRACT

Railway masonry arch bridges belong to our cultural heritage structures that have to be safeguarded and still represent a high percentage of the railway infrastructures of many countries, particularly in Europe. These structures are difficult to characterise in terms of real structural geometry and material mechanical characteristics and in many cases have been subjected to structural retrofitting or modifications that are not sufficiently documented. The continuous upgrading of the railway network implies the need to provide a structural assessment of each existing masonry bridge under static and dynamic loading conditions. A reliable structural assessment of old masonry arch bridges is, however, a very complex task. Spatial geometric consistency, assignment of proper mechanical properties and the need to consider several load combinations, associated to all possible positions of train loading, are important requirements for performing a reliable numerical model. The use of 'General purpose' three-dimensional nonlinear Finite Element (FEM) software, although accurate, is extremely time consuming in terms of model implementation and computational effort and requires expert judgement. In this paper a Discrete Macro-Element Method (DMEM) approach, previously applied to model the behaviour of different masonry structural typologies, is applied for the structural assessment of a masonry bridge. The computational cost of the proposed numerical approach is greatly reduced in comparison to that involved in nonlinear FEM simulations or Discrete Element Method (DEM) strategies based on a meso-scale discretisation. The discrete DMEM approach is applied for the structural assessment of a particular masonry arch bridge characterised by larger central span about twice the size of the other identical arches. The results show how the proposed DMEM can be successfully used for performing the structural assessment of masonry bridge with a reduced computational burden, compared to the nonlinear finite element simulations, and an easy and straightforward interpretation of the numerical results.

CODE 369

SEISMIC BEHAVIOR OF A MASONRY BELL-TOWER WITH VERTICALITY DEFECT

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KEYWORDS: Masonry; seismic; bell-tower; FEM; analysis.

ABSTRACT

The seismic behaviour of slender structures, such as masonry towers, is dominated by bending which may lead to overturning. Since the geometrical survey of towers is hard to compute due to the prevalent longitudinal development of the structure, the shape inputted in the FEM-habitat (Finite Element Method) is commonly regularised (e.g. in cross-section, openings, global shape, etc.). This assumption may make the computation significantly more time-saving together with the increase of the model robustness. At the same time it may compromise the accuracy of the theoretical prediction. The present study is aimed to report and discuss a seismic vulnerability analysis of a Heritage masonry bell-tower, dated back to the 14th century, placed in the south-east of Italy. The geometry of the structure was assessed by using a drone flying around the building and taking a series of photo afterwards computer-elaborated. The orientation of the photos, associated with the relative position of the drone in the 3D-space, allowed to assess a cloud of points belonging to the bell-tower, leading to an accurate geometrical survey. This process evidenced a verticality defect of the structure. After different investigations aimed to assess the mechanical properties of the masonry and the structural details, a FEM-analysis was achieved in order to compute the capacity under horizontal forces. Linear (modal) and non-linear (push-over) analyses were performed. Moreover, a nonlinear kinematic analysis was able to individuate the weakest rigid-body mechanism. The main results are presented and discussed in the paper, by evidencing that the lack of verticality produces an unsatisfactory seismic vulnerability index. In fact, the first failure mode consisted in the diagonal cracking at the middle height of the tower and the consequent overturning of the top-body, under the seismic acceleration at ultimate limit state (according to the Italian Technical Code).

CODE 400

THE RESPONSE OF GAZI HASAN PAÇA MOSQUE (KOS ISLAND, GREECE) TO 2017 MW 6,6 EARTHQUAKE

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KEYWORDS: Masonry; earthquake; mosque; seismic response; FEM analysis.

ABSTRACT

After an earthquake of Mw=6,6 with epicenter near the Gazi Hasan paşa mosque built in 1786 in Greek island Kos, this ostensibly vulnerable structure did not develop the expected damage. The structure is 23m x17m in plan and of total height 10,48m (excluding the timber roof) with many wide windows and piers of a small length. In this paper, the structure is analyzed using the response spectrum from the nearby recorded ground motion and its behavior is assessed with performance-based criteria. The ratio of relative drifts of both the walls and the piers in- and out-of-plane are considered, and the demanded seismic ones are compared with the drift capacities of the masonry elements. Performance-based methods on masonry structures have limited application due to the uncertainties of the non-linear behavior and the degradation of their stiffness after cracking and of their capacity caused to their non-monolithic structure and the ability to be deformed throughout the numerous contact areas between masonry units and the mortar. From the analyses, it was proven that in fact the mosque, thanks to strengthening measures taken after damage due to 1933 earthquake withstood the relative drifts caused by the earthquake but it would have been damaged without these. The critical intervention was the construction of a reinforced concrete tie-beam at the crest of the load-bearing walls. The tie-beam reduced the critical out of plane deformations by about 30% on the average and the mosque has undergone the developed ones without damage.

CODE 404

REHABILITATING OLD TIMBER IN PORTUGUESE 'POMBALINO' BUILDINGS

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KEYWORDS: Timber; pombalino buildings; conservation; rehabilitation.

ABSTRACT

Old buildings carry to the present messages from the past about the often centuries-old materials and techniques used by previous generations. This text presents the construction techniques of wood in buildings as transmitted by their stakeholders. This transmission is verified either by written records and published books or by the visible testimony of the buildings still existing. The text focuses on the construction techniques that began to be implemented after the great Lisbon earthquake in 1755 highlighting the central role that wood played in the complex structural systems, forming a set with high earthquake resistance which was named by "gaiola pombalina". Emphasis is placed on the use of wood in the walls and how it interconnects with pavements and with stone masonry and aerial lime, promoting energy dissipation and the protection of inhabitants during an earthquake.

Nowadays the growing interest in heritage rehabilitation has not only contributed to a more balanced view of the importance of wood in construction but has also brought with further development of the technologies associated with it. This text reflects on the techniques that may be applied to works with low intrusion, maintaining the old structural elements, reinforcing or rehabilitating them only to the extent strictly necessary, or by replacing them with wooden ones with similar or improved characteristics.

The reflection that is presented is developed, not only in the light of proven scientific principles and international conventions, but also in cases where they were applied. These cases, which not only demonstrate the feasibility of the solutions, but also their virtuosity. Solutions are presented, either for the reinforcement or rehabilitation of wood structures, or for the replacement of degraded wood with sound wood, which were applied in the works of Pombaline housing buildings in Lisbon.

CODE 415

MULTI-RUN OPERATIONAL MODAL ANALYSIS OF A MASONRY HISTORICAL CHURCH: THE CASE STUDY OF SAN GIOVANNI IN MACERATA

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KEYWORDS: Historical Masonry; structural health monitoring; ambient vibration test; multi-run operational modal analysis; onsite testing.

ABSTRACT

On-site testing has a fundamental role in construction assessment; however, often the results of localized tests do not provide satisfactory information to clearly evaluate the building behaviour. Structural health monitoring, and the Ambient Vibration Test (AVT) in particular, provides global information on the overall dynamic characteristics.
This paper, through the case study of San Giovanni's church in Macerata, aims to propose an experimental procedure to identify the global behaviour of a large masonry building by merging local measurements and optimizing the position of a reasonable number of sensors.
The case study of San Giovanni is particularly interesting: first for the features of the building – the construction consists of the characteristic Latin cross, the central circular dome, the tower bell, the annex convent and the oratory, and second for the state of the building – San Giovanni was condemned after seismic events in 1999 and it has yet to reopen following the central Italy earthquake in 2016. However, in the next future, the church will finally return to the community thanks to local and European funds.
PRiSMa Lab (Proof and Research in Structures and Materials of Roma Tre University) carried out an extensive in-situ testing campaign – including a geometric survey, video endoscopy, flat-jack tests, sonic tomography and an ambient vibrations test – to investigate the state of the building. Operational Modal Analysis (OMA) was used to assess the dynamic behaviour of the church. Five different ambient vibration measurements were recorded in the most relevant parts of the building, the extracted modes were then merged and finally the dynamic global behaviour was identified.

CODE 421

THE STRUCTURAL CAPACITY EVALUATION: THE IMPORTANCE OF NON-DESTRUCTIVE TESTS

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KEYWORDS: Structural safety assessment; Non-destructive test; Existing reinforced concrete buildings.

ABSTRACT

In the structural safety assessment process of existing structures, the knowledge of mechanical material properties is a key point. In fact, different experimental activities carried out on materials extracted from existing reinforced concrete buildings show a high strength variability, especially for concrete. In the past, the lack of standardized material controls and manual techniques of workmanship, determined not always uniform and homogeneous flows of concrete, with consequent very different values of strength within the same structure, but also in the same structural element. The most accurate and reliable experimental techniques are direct tests on the material, but these are very expensive and invasive. Alternatively, indirect methods estimate the material strength by correlating very different physical quantities; however, the non-destructive methods have a lower cost, they are easily executable and finally they cause no damage to the structural elements. In this work, a complete experimental activity, concerning destructive and non-destructive tests, was conducted on some elements (four portions of column and a beam portion) extracted from an Italian school building built in 1940. This building, demolished in 2003 due to a negative evaluation of the structural capacity, represents an interesting case study, especially for the important functionality. Destructive and non-destructive methods have been compared and appropriate correlation laws have been developed in order to predict the main mechanical properties of the material. Concrete compressive strength has been correlated to the ultrasonic pulse velocities and the pull-out test, moreover, the static and dynamic elastic modulus have been compared. Finally, a specific SonReb formulation has been performed on the base of available data.

CODE 427

INFLUENCE OF MOISTURE CYCLES AND DIFFERENT IMMERSION MEDIA IN ULTRASONIC VELOCITY IN WOOD

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KEYWORDS: Ultrasounds; wood; moisture cycles; immersion media.

ABSTRACT

Wood could be considering as last, current and future material due to particular properties that permit it to be a candidate for structural applications. Nevertheless, it is important to know the service degradation phenomenon since wood is a hygroscopic material due to its inherent structure, with several internal and external defects that could lead to a change of properties on service. This fact depends on a lot of variables: type of wood, allocation, type of soil, dynamic environment conditions changes, etc. The goal of this paper is study the influence of moisture cycles in the results of nondestructive tests by ultrasounds carried out in several types of wood (*Quercus robur* and *Pinus pinaster*), mainly used for civil and naval applications, after immersion in natural waters, rain and sea waters, for two months. The investigation has permitted to define a relationship between the water absorbed by wood and ultrasound wave velocity.

CODE 443

STUDY OF THE MORTAR-SUPPORT INTERFACE BY ADVANCED CHARACTERIZATION TECHNIQUES

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KEYWORDS: Mortar; substrate; interface; testing techniques; microstructural analysis.

ABSTRACT

The objective of this work is to discuss a methodology of microstructural analysis used to characterize the interface substrate-mortar. The microstructural characteristics, including compositional analysis, of the mortars applied on different substrates and during the curing process are analyzed. The study presents the results of the first experimental program within IF Mortar project, related to the application of a cement-based mortar applied on a ceramic substrate and moulded in the laboratory (for comparison purposes). The observations were carried out at hardened state, after 7, 14 and 28 days of curing. Physical and chemical tests were also performed. X-ray computerized microtomography (MicroCT), X-ray diffraction and scanning electron microscope with EDS were used. The relevance of this study is to provide a deeper three-dimensional analysis of the region near the interface mortar+substrate, and thus contribute to a better understanding of the mechanisms involved in the formation and in the evolution of the microstructures.
The different observation scales and the integration of the various analysis techniques, allowed to create a tool that will help future qualitative and/or quantitative comparisons of interfaces.
The study of a larger number of substrates and mortars may contribute to the improvement the knowledge of the adhesion mechanisms, performance and or the formulation of mortars more compatible with the substrate.

CODE 458

WALL THICKNESS AND WATER CONTENT CONTRIBUTION TO THE OUT-OF-PLANE INSTABILITY OF ADOBE WALLS

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KEYWORDS: Adobe masonry; finite element model; out-of-plane stability; water content; slenderness ratio.

ABSTRACT

This paper presents the results of a finite element numerical study to assess the effect of wall thickness and a moist region along the wall base on the out-of-plane lateral stability of adobe walls. The models consisted of cantilever unreinforced adobe walls with thickness of 25 cm, 30 cm, and 40 cm. Analyses were performed for four lengths (L) of the moist region and for dry walls. The moist region was modelled with material characteristics corresponding to partially saturated and nearly saturated adobe. The results showed the detrimental effect of moisture along the lower portion of the wall on the out-of-plane lateral strength. The out-of-plane lateral strength reduction ratio dropped significantly as L increased. The results provided insight on the role of wall thickness on the stability against overturning. High slenderness ratio was found to be critical for cantilever adobe walls when L extended beyond half of the wall length.

CODE 462

SEISMIC VULNERABILITY ASSESSMENT OF A MONUMENTAL MASONRY BUILDING

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KEYWORDS: Masonry building; cultural heritage; seismic assessment; FE models.

ABSTRACT

Recent seismic events that hit the Centre Italy have highlighted again the high vulnerability of the historical and architectonical heritage of Italy and the importance of preserve it. However the seismic assessment of monumental building is particularly complex because each historical construction is a singular case realized by specific techniques. Therefore the knowledge of the building is a difficult and indispensable process. In the present paper the seismic behaviour of an important nineteenth century astronomical observatory, constructed between 1816 and 1819, is investigated. The building, located in Naples, the southern part of Italy classified by the Italian code as an area of medium seismic hazard, is analysed in the elastic and inelastic range under seismic actions. In this study the results of two different models are proposed and critically compared. The first one is implemented by shell elements for walls and vaults developing a dynamic linear analysis, while the second one simulates the building through “equivalent frames” applying a non linear static analysis.

CODE 492

SEISMIC VULNERABILITY ASSESSMENT OF THE HISTORICAL CENTRE OF CUSCO, PERU

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KEYWORDS: UNESCO sites; seismic vulnerability; historic centers; Cusco; adobe.

ABSTRACT

This paper deals with the seismic vulnerability assessment of dwellings in the historic center of Cusco (Peru), one of the most important UNESCO sites in the world. This activity is framed within a cooperation agreement between the University of Chieti-Pescara (Italy), the Andina University del Cusco (Peru) and the Cusco Municipality (Peru), and also with the participation of the Pontificia Universidad Católica del Perú, which aims at the evaluation of the seismic risk of the whole historic center.
After a discussion concerning the development of the historic center and the main construction typologies, the paper presents the main outcomes of an extensive in-situ survey for collecting information about the main structural features of the buildings. Stats about this information are given through a GIS (Geographic Information System) environment.
Then, the collected data are used in order to implement an empirical model for the prediction of the seismic vulnerability extended to the whole historic center. The model is derived by a methodology already proposed by the authors for Italian historic centers, but proper assumptions are made in order to account for the peculiarities of the studied structural typologies (adobe, stone, RC).
Finally, fragility curves are given as a predictive tool for evaluating seismic scenarios provoked by earthquakes of different intensities.

CODE 529

UNCERTAINTIES IN THE EQUIVALENT-FRAME MODELING OF THE SEISMIC BEHAVIOR OF EXISTING MASONRY BUILDINGS

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KEYWORDS: Seismic vulnerability; masonry buildings; equivalent-frame; parameters uncertainty; masonry spandrels.

ABSTRACT

Unreinforced masonry (URM) buildings represent a large part of the existing dwellings in Italy and in other countries. They were often built without structural calculations, with the aim to carry vertical loads only, in sites that instead are now recognized to be earthquake-prone. The assessment of their seismic vulnerability is therefore a very relevant issue.
The reliability of equivalent frame models (EFM) for URM buildings has been discussed by several Authors, with particular attention to the case of irregular walls of existing buildings and to the role of alternative numerical formulations. Less attention has been so far devoted to the diagnostic phase, when the on-site investigation on existing buildings provide geometrical and mechanical parameters that are crucial in the definition of mechanical models and are usually affected by significant uncertainties.
By means of non-linear static analyses, this paper deals with some of these uncertainties (i.e. flexural behaviour of spandrels and load distribution), and shows their effects on the structural capacity. This highlights the role of the diagnostic investigation on the implementation and calibration of reliable mechanical models for URM existing buildings.

CODE 535

INSPECTION, DIAGNOSTIC ANALYSIS AND SEISMIC IMPROVEMENT OF BUILDINGS DAMAGED BY SEISMIC EVENTS: S. MARIA ASSUNTA CHURCH AT FABBRICO (ITALY)

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KEYWORDS: Non-destructive testing; numerical modelling; damage reparation; seismic improvement.

ABSTRACT

Structural diagnosis can be usefully employed for the protection of existing buildings from the effects of earthquakes and is a useful device for risk prevention, assessment of the usability of buildings damaged by seismic events and for the planning of reparation and improvement interventions.
Each of these applications involves the use of specific methods and techniques that have to be known and standardized as far as possible.
In 2012, the Emilia region in Italy was affected by an earthquake of medium intensity, that therefore caused very extensive damage particularly to the historical and monumental heritage, due to the great sensitivity of its constructive typology to seismic loads. The paper aims to describe the overall approach to the intervention of damage reparation and seismic improvement with reference to the case history of the parish church of S. Maria Assunta at Fabbrico (RE).
The proper planning was based on the results of a careful diagnostic campaign aimed at identifying the damage kinematics activated by the earthquake and at achieving the structural identification of the building and the mechanical characterization of the masonry.
The building site set up that followed, meant the building could be observed with the finest detail in very systematic way, so confirming the results provided by the preliminary diagnostics. This was fundamental for the definition of the constructive details of the intervention, which had to be designed and implemented with great precision and operative attention. In particular, the very significant damage that affected the vaults of the church were shown to be mainly caused by the action of a heavy reinforced concrete beam built in recent years at the extrados of the vaults, evidently with the aim of providing a provisional reinforcement, that, in fact, proved to be harmful. Its removal through a very delicate operation, was therefore necessary.

CODE 564

LABORATORY / IN SITU ASSESSMENT OF PREDICTION MODELS FOR MECHANICAL BEHAVIOUR OF ANCIENT BRICKWORK UNDER COMPRESSION

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KEYWORDS: Prediction models; ancient brickwork, compressive strength; experimental data.

ABSTRACT

Knowledge of the mechanical properties of masonry structures is essential in all intervention processes. Their characterization is one of the major concerns in the field of heritage, and their analysis brings important challenges. Nowadays, there is still a need to extend research related to the complex task of mechanical characterization of ancient masonry structural elements. In this context, this study focuses on the analysis of the mechanical behaviour of ancient brickwork under compression. For this, in a first phase, the degree of approximation of some existing empirical equations in the scientific-technical literature from experimental results and analytical calculation was verified, proposing new coefficients to improve the predictions' accuracy of the compression mechanical behaviour of existing brickwork. Moreover, in a second phase, the investigation considered the on-site structural assessment of ancient constructions using the proposed empirical equation. The methodology was applied to a masonry building from the XIX century under in-depth refurbishment. The analysis of its behaviour was carried out through in situ / laboratory tests, in order to obtain the properties of the component materials and the masonry as a whole. The experimental results were contrasted with those achieved through the empirical equations commonly referenced in the literature and the obtained in the present study, the latter presenting the best approximation. The results achieved allowed to assess the structural safety of the historic construction previously to the intervention process.

CODE 568

STRUCTURAL DIAGNOSIS OF THE ARCHITECTURAL HERITAGE: THE KEY ROLE OF HISTORICAL RESEARCH

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KEYWORDS: Diagnosis; structural assessment; historic research; archive documentation; masonry.

ABSTRACT

A reliable conservation strategy of a historic structure involves the collection of information about the building characteristics, building technology and state of preservation. The processing of such information leads to conservation projects and re-use programs having as priority the safety of the structure, the compatibility with the structure characteristic and actual re-use possibility, the respect of the pre-existence and of the historical, cultural, documentary values according to the main Recommendations for the Analysis and Restoration of Architectural Heritage. Within this approach, the diagnosis and the monitoring of the structure are key factors. The most advanced international procedures concerning the structural assessment of the historical heritage define this item as a complex and multidisciplinary activity; it requires the collection of information from several disciplines, despite the lack of clear merging procedures. If the use of technical data from geometrical survey or on site tests seems widely accepted, the use of historical information within the structural assessment is often not clear. The paper aims to explore the role of the information resulting from a deep historical research. In fact, the resulting notes are not limited to the main dates of the building but data should be processed to reconstruct the history of the past aggressive events, the history of the occurred damage and the related repair intervention. The continuous direct comparison with the building and the stratigraphic survey highlights the localization of the masonry changes, helping the reconstruction of the building steps.
The history of the building re-use could add information and explain other building transformation, sas well as the upgrade to past codes, standards and prescription, or the past computational methods. For instance, the requirements of the XX century codes, particularly of the seismic code, could be very invasive for historic masonry construction, often suggesting the strengthening by r.c.; this produced the hybridizing of the structural behavior, difficulty to predict by traditional analytical procedures.
In general, the historical analysis allows the reconstruction of the building evolution, recognizing changes of the building technology, as well structural discontinuity and eventual weaknesses to take into account in the structural assessment.

CODE 569

INVESTIGATION STRATEGY FOR THE STRUCTURAL ASSESSMENT OF HISTORIC TOWERS

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KEYWORDS: Diagnosis; towers; assessment; dynamic testing; monitoring.

ABSTRACT

Thinking about the country and urban skyline, towers often represent a distinguishable but harmonized diffused entity in landscapes with a deep historic and symbolic significance; they embody the distinctive characteristics of the construction methods of the past, mainly related to masonry. The towers, defensive, religious or civic ones, are, at the same time, architectonic heritage and frequently challenging structures of their time. In most case, these structures were the top of the technology, engineering and architecture of the time and region, showing the builders deep knowledge of the materials locally available and of technological solutions.
Despite the frequent high quality of the past constructions, literature documents several unexpected damage during earthquakes or even sudden collapses without an evident direct action; the analysis of the case-studies shows some common problems, like the absence of a continue use and/or controls.
Due to the height, the structural survey of the towers could be difficult requiring a direct inspection of the wall surface. Extended and deep experimental investigation are difficultly to propose due to the large number of towers, particularly in historic centers.
The Authours have developed addressed procedures to study historic towers with different level of complexity and aimed at defining a baseline for the future monitoring of the structure.
The combination of direct survey of geometry, materials and damage, the collection of historic information and the dynamic testing define an effective minimal procedure to analyse the structural behaviour of historic towers. Dynamic monitoring complements the strategy, allowing the early warning of any structural change with a fully agreement between the safety requirements and the Conservation principle.
The paper describe the procedures through some case studies recently investigated by the Authours. Furthermore, the manuscript focuses the advantages of each investigation and experimental step, stressing the type and the importance of each collected information as well as the following data merging and result comparison.

CODE 582

AUTOMATIC DETECTION OF DAMPNESS PHENOMENA ON ARCHITECTURAL ELEMENTS BY POINT CLOUD SEGMENTATION

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KEYWORDS: Cultural Heritage; diagnostic analysis; reverse engineering; digital image processing; point cloud segmentation.

ABSTRACT

In conservation analysis, a fundamental goal is the detection of decay patterns on architectural elements in the Cultural Heritage domain. The current research aims at supporting and facilitating the identification of dampness phenomena, through the creation of specific routines for the automatic segmentation and computation of dense point clouds, based on representative colour ranges. The remote decay survey via reality capture and data processing enables cost-effective non-invasive and contactless methods. The proposed pipeline provides a geometric and spatial distribution of moisture evidences, without loosing information about the three-dimensional configuration.
In reverse engineering, dense point clouds are representations of virtual 3D models, composed by huge quantities of data points, which enclose geometrical, colour and texture information. They are the results of 3D scans of real objects, carried out using techniques such as digital photogrammetry.
The historical convent of “San Leonardo” (XVI century, Monopoli, Bari, Italy) was selected as test case for the experimentation and validation of the proposed procedure, which highlighted the presence of dampness phenomena consistently affecting the intrados of masonry cross vaults.

CODE 583

INFLUENCE OF THE BACKFILL PARAMETERS IN DISTINCT ELEMENT MODELING (DEM) OF A BACKFILL MASONRY ARCH BRIDGE THROUGH THE PFC2D SOFTWARE

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KEYWORDS: Discrete element method; backfill masonry bridge; PFC2D; geomechanical modelling; soil-structure interaction.

ABSTRACT

This paper presents an investigation on how to model a backfill masonry arch bridge using the discrete element method (DEM). The calculations that geotechnical engineers use the most today are elastic calculations, which use an elastic modulus "E", or plastic analysis that check the equilibrium limit, through a cohesion "c" and a friction angle "Φ". There is an important problem here in determining these parameters. Soils are not homogeneous materials, but have a great variability. The micromechanics of particles arises here to solve these difficulties

PFC2D software is used for this purpose. A certain backfill masonry arch bridge is modelled, with different types of fill, mortar and voussoir materials. Contact bonds and parallel bonds are installed to create the arch at a first stage, positioning balls by their center and radius. Secondly the fill is introduced in several layers and finally the arch is loaded until its collapse in three different load cases. A biaxial test has been programmed using 'FISH' code to obtain the micro-parameters used in the model so that they match the macro-parameters obtained from a real biaxial test. Also, a macro within a spreadsheet has been created to simplify the process of introducing the geometry of the arch.

Further discussion on the influence of the DEM backfill parameters is presented as well as a sensitivity analysis for the arch bridge, specially with backfill parameters and load position. Advantages, disadvantages and limitations of this method of analysis are identified in relation to other frequently used methods.

CODE 587

CONTRIBUTION OF CHEMICAL ANALYSIS ON BULDING SURVEYS

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KEYWORDS: Building assessment; adobe walls; chemical analysis; thenardite; mirabilite.

ABSTRACT

The Civil Architecture of the 19th and of the beginning of 20th centuries represents an important period of change in architecture and construction. In the central region of Portugal, this period, the use of traditional materials such as, adobe walls, lime mortars were well disseminated in all types of buildings. The main scope of the present research, at the University of Aveiro (Portugal), is to characterize this historical phase of building construction and to identify patterns of decay involving combined methods of assessment. One of the most widespread problems is the effect of rising damp in the base of the walls. The main purpose of this paper is to present the importance of chemical analyses during the process of building assessment, which can led to more credible results in the characterization of the problems, the identification of salts, their impact and progression, which can be very helpful in the proposal of preventive measures of conservation. The analyses of the crystalline phases present in the studied adobe blocks and salts were done by powder X-ray diffraction (XRD). The spectra were compared with ICDD (International Centre for Diffraction Data) database, supported by hygrothermal monitoring. From those analysis it could be concluded that the adobe breakdown by sodium sulfate can be explained by the fast change from thenardite (Na_2SO_4) to mirabilite ($Na_2SO_4 \cdot 10H_2O$) in presence of water or high levels of environmental humidity (R. H. >81.5 %) as a result from the difference in their molar volume. The presence (or the contact with wet environments) of water should be avoided and interior hygrothermal conditions should be controlled.
The results show the contribution of chemical analysis to the understand the progression and pattern of decay, as well as in supporting future recommendations for building conservation.

CODE 69

REGULATORY FRAMEWORK ON PRODUCTIVE URBAN LANDSCAPES. WINE URBAN LANDSCAPE OF "EL PUERTO DE SANTA MARIA" CASE STUDY

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KEYWORDS: Historical landscape; industrial heritage; productive landscape; sherry wine, winery.

ABSTRACT

The sherry wine landscape is the focus of the urban reality of the populations included in its territorial denomination area: Marco del Jerez. Taking as a case study El Puerto de Santa Maria, we intend to analyze and define its characteristics, highlight its repercussions on the historical landscape of the city, and know the patrimonial protection strategies proposed by the administration.
El Puerto de Santa Maria presents a singular urban historical landscape which is characterized by the presence of the architecture and urbanism of the wine industry. This urban production landscape develops from the end of the 18th century until the middle of the 20th century, coexisting with the historic city, from its beginnings as an urban edge up to the present as part of the historical center. At present, the architectures of the wine represent, approximately, 23% of the area declared as historical sector.
This landscape in which we are working through our doctoral thesis (The urban landscape of wine of El Puerto de Santa Maria) presents different problems: the relationship of the architecture of production with the historic city and the current city, the ownership of the wineries, the lack of recognition of the urban landscape of wine by the administration, the crisis of the sector that led to the abandonment and conversion of the wineries, the deterioration of the buildings, the lack of strategies and urban planning...
Through this communication we intend to show the strategies and regulations raised by the administration at its different scales (local, regional and national) to protect the urban historical landscape of wine. To do this, we will structure our communication in the following sections: 1) Introduction, 2) The urban landscape of wine in "El Puerto de Santa María", 3) Regulations on the historical landscapes of the production of wine, 4) Conclusions and future lines.

CODE 272

MANAGEMENT OF THE DIFFERENT PHASES OF AN IRRIGATION DAM CONSTRUCTION PROJECT: CASE STUDY

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KEYWORDS: Management; project phases; project design; irrigation dam; stakeholders.

ABSTRACT

This article develops the procedural basis of documentary management of projects in different phases of development of a project, using an exhaustive bibliographic review, denoting some differences and particularities among countries and even among authors, especially in organization procedures.
A case study was conducted comparing the regulatory assumptions and bibliography on the subject, with the real management of a construction project of an irrigation dam. At first, it was undertaken a consultation of the various documents that constitute the dam design project along the different phases of its development. Subsequently, in order to complement the gathered information during the investigation, as well as to respond to other omissions research questions even after the documentary consultation, an interview supported by a questionnaire with the dam designer was conducted.
The main results of the research allow the convergence of scattered and unclear information about which documents are mandatory in each phase of the project, being this unclearly specified in the regulations.
The case study of a real construction project of a dam irrigation allows to analyse beyond the required documents at each phase of the development project. And also, the case study contributes to understanding the role of the different stakeholders throughout the process, and the criteria that supports their decisions to move forward to the next phases of a project.

2.- PROJECT

CODE 33

FRONTON CARMELO BALDA OF SAN SEBASTIAN (1969-1973): DECLINE AND INTERVENTION IN BRUTALIST ARCHITECTURE

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KEYWORDS: Heritage; architecture; brutalism; pathology; intervention.

ABSTRACT

During the fifties, after Le Corbusier announced the Unité d'Habitation project in Marseille, a new way of conceiving and materializing architecture emerged through the so-called “raw concrete” or “béton brut”. This new style, based on the simplicity and honesty in the material’s use, spread throughout the world in the sixties and seventies. In the Basque Country, there were also buildings that followed the precepts of this new way of designing architecture. One such example is the Carmelo Balda pelota court or *Fronton*, located in San Sebastian and designed in 1969 by the architect Luis Jesus Arizmendi Amiel. Over the years, many of these buildings have deteriorated. The conception of the architectural object itself dismissed the durability of the exposed concrete and nowadays several pathologies are easily visible. Even if many of these buildings are listed as heritage**,** many others do not have any kind of protection. That is the case of the Fronton Carmelo Balda. Fifty years after the beginning of its construction, and taking into account the progressive deterioration it shows, the designation as historic building seems necessary to guarantee its survival. The debate about what the best way to intervene should be is still open, considering that this example of brutalism has architectural and constructive values that make it worthy of its conservation. The peculiarities of these buildings, in which structure and facade not only form a single element but are a fundamental part of their architecture, make it difficult and expensive to intervene in.
The aim of this paper is to highlight the lesser-known buildings of Brutalism, such as the Fronton Carmelo Balda, and to analyze what should the best way to intervene in them be respecting their heritage value. Extending the building’s life without losing its architectural simplicity and constructive honesty should be the main aim in a future intervention.

CODE 127

CONTEMPORARY ARCHITECTURE IN PLACES OF MEMORY

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KEYWORDS: Pre-existences; memory; historical patrimony; intervention.

ABSTRACT

This article seeks to understand the processes employed in Brazil for the approval of projects in preserved heritage that ignore the exceptionality and identity of the buildings. This loss of interpretative reference and the historicist rigidity end up reflected in project decisions, as it disregards each building as unique. Within this discourse, one can notice the difficulty in accepting freedom of interpretation when projecting within preexistences, adding contemporaneity. Consequently, the search for projects in which standardization is possible is favored, both by those who design them and by those who approve them. The city must be understood as a living construction, in constant change, revealing its identity through the maintenance and respect for each historical layer. This is, perhaps, a way to understand how we could face our architectural past in contemporary times. Familiar places, which are references from the past, provide psychological and mental support for people. However, if the space of the city is the space of history, as Giulio Carlos Argan said, it is necessary to have a history in order for a city to exist. But how will there be history if there is no memory? Would it not be one of the functions of architecture to preserve our memories and the experience of continuity, culture, and life? Documents, monuments and cities' landmarks rebuild a most often discontinuous image of the past. As I begin this process of reflection, I find that the interpretation of the past presents gaps. The reconstruction of a place based on the analysis of preexistences, ruins and historical heritage is a memory that is shaped and built in the present. The number of places of patrimonial value that are empty and degraded, coupled with the considerable changes in Brazilian history, make the interpretation of several works by architects and historians challenging.

CODE 146

MASSERIA CAPPELLI IN THE VALLE DEL CHIARINO, L'AQUILA. REFURBISHMENT STRATEGIES AND REUSE MODELS

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KEYWORDS: Refurbishment; rural heritage; active conservation strategies; ecomuseum.

ABSTRACT

The complex of the buildings, proposed as a case study, located in the Valle del Chiarino, in Abruzzo, are part of an extensive territorial system of farms that the Cappelli, an emerging family of entrepreneurs in the livestock breeding sector, realize, between Eighteenth and nineteenth centuries, in their possessions that actually occupy all the grazing extensions of the south-west area of the Gran Sasso.
The farm consists of three separate buildings called: the "casone" intended for storage, the mill, used for the production of oil obtained from the seeds of beech, and the small church of San Martino, all built between 1781 and 1899 .
The close relationship that links the settlement of the farm to a territory with strong environmental and naturalistic values, is taken as a guiding criterion in the refurbishment project that chooses, as a new use, the ecomuseum that is configured as a new form of museum, which comes out of a closed place and regains the territory with which it re-establishes a bond.
Depending on the different types of buildings and their state of conservation, the refurbishment project adopts different intervention strategies: in the "casone", which maintains its original volume and is destined to host services for welcome and hospitality of the ecomuseum, it chooses, according to the criterion "of the house in the house", the insertion of a wooden box that proposes its internal spatiality, functionally redefined, on the contrary, by freely arranged specialized blocks; in the mill, which houses the ecomuseum rooms and laboratories, it chooses, according to the criterion of addition, the creation of a volume which, placed above the pre-existing wall box, extends towards the river reachable by means of a treetop walkway, both characterized by use of corten.
The purpose of this paper is to demonstrate how, in the refurbishment project, the objective of defining a suitable new use destination is connected to the definition of coherent operating strategies and compatible technical options.

CODE 175

THEORETICAL APPROACH TO THE RESTORATION AND NEW ARCHITECTURAL DESIGN OF THE BENIGNO MALO HIGH SCHOOL OF CUENCA, ECUADOR

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KEYWORDS: Theoretical approach; restauration; contemporary architecture; Benigno Malo high school; Cuenca - Ecuador.

ABSTRACT

There is a recurring challenge when it comes to intervening in heritage buildings, and this is how to do it. The application of charters and conservation or restoration theories, while greatly contributing to establishing broad principles of consensus when it comes to managing, restoring and reusing built heritage, have been tools that show their limits in the face of the great diversity of cases in different regions and cultures. The inclusion of contemporary uses has been broadened to include new architectural elements that are designed to share, dialogue or contrast with the fundamental monument, which implies more complex and complete processes of reflection on the coexistence of the modern in the ancient.
In the years 2018-19 a proposal has been developed to restore, complement and construct new architecture in the monumental building of the Benigno Malo National School, which is located in the UNESCO area of the historical centre of Cuenca-Ecuador, inscribed in 1999 in the World Heritage List. The process of restoration and design of new buildings has been conducted through an exercise in which theoretical concepts have been put into dialogue with social elements and intense identity, thanks to interdisciplinary and inclusive participatory processes, from the social point of view. The result of this exercise is a proposal in which the processes of design and theoretical and social reflection are almost as evident as the project itself.
The proposed article reflects on the approach to architectural design and the restoration of this cultural asset, the way of achieving sensitivity to the echoes of the past, without renouncing contemporaneity, the way of being (socially) inclusive and (technically) interdisciplinary, without renouncing the role of the architect as a fundamental figure in decision-making, in order to achieve the ultimate goal that is concretised in the project.

CODE 222

ADAPTIVE RE-USE OF THE BUILT HERITAGE: A PROPOSAL FOR THE TOWN OF LEONFORTE (ITALY)

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KEYWORDS: Monumental stable; conservation; social centre; sustainability.

ABSTRACT

Italy has a territory dotted with a built heritage of exceptional value. Value that is declined from a cultural, social, environmental and economic point of view.
Several sites are not recognized as architectural emergencies by local institutions or international associations (UNESCO, Europa Nostra, etc.) and are no longer used or have lost their original function. Their presence is however an element of considerable interest for the local communities that identify themselves with them.
It is therefore necessary to imagine virtuous processes of adaptive reuse that guarantee the conservation of ancient matter and, at the same time, propose socially useful functions, in respect of the collective memory. Adaptive reuse is in fact recognized as a conservation strategy for the built heritage, as recently specified by the Leeuwarden Declaration (2018).
In this paper we want to propose a methodology that respects the superior premises: it has been applied to the proposal for the reuse of the monumental stable of the Branciforti Princes in Leonforte (Enna, Italy). The monumental fabric, now partially abandoned, has been studied in its historical, material and constructive aspects. The voice of the local community was heard in proposing its redevelopment for social aims: a multipurpose center for all age groups of citizenship.

CODE 227

THE EXISTING AS STARTING POINT. CONTEMPORARY DESIGN STRATEGIES FOR THE REUSE OF ABANDONED HERITAGE

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KEYWORDS: Reutilization; minimal intervention; as found; reutilization strategies; unfinished; overwriting processes.

ABSTRACT

The processes of intervention on the pre-existing architecture have left marks through its history. Current buildings and places are only understood as the sum of everything that happened before. However, there is a growing number of authors who take over rehabilitation projects in a different way. Not to erase, not to hide the history of the building. An approach which can reforce the character of a place while its useful life is extended.
This new perspective is partly the heritage of Peter and Alison Smithson. They found a virgin field in London ravaged in World War II to experience a new way of looking at the ruin: As Found, The discovery of the ordinary. The Smithson's, influenced by contemporary artists such as Nigel Henderson or the sculptor Jannis Kounellis, raised subjectivity above reason as an architectural project tool. An example of this approach was the Solar Pavillion. A small rural house where the discovery of pre-existence became the main design tool for the project. The final work transcends beyond the ruin itself, creating a modern intervention that dialogues with the memory of the place. The objective of the article will be to analyze how this subjective way of looking at and understanding the preexistence has influenced contemporary rehabilitation.
We will refer to those types of projects that enhance the intrinsic qualities of the inherited and are not limited to keeping it. Temporary processes are shown in the bareness of the walls, increasing the confrontation between the added and the existing. The new and old identities converge leaving the inherent history of the building in sight. The ability to interpret preexistence becomes the main project tool.
Several case study are proposed: Llauna Factory (Miralles + Pinós), Oficina Theater (Bo Bardi), Studio House (Caruso St John), Quay Arts Center (Fretton), Nave 8b (Franco), PC Caritas (architecten de Vylder Vinck Taillieu) and Tokyo palace (Laccaton + Vassal).

CODE 264

STRENGTHENING DEVICES AS ELEMENT OF EXPRESSIVE AND FUNCTIONAL AUTHENTICITY FOR HISTORIC STRUCTURES

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KEYWORDS: Retrofit; strengthening; authenticity; aesthetics; interdisciplinary approach.

ABSTRACT

In the recent architectural panorama, the relationship between covering and structure attracted particular interest. With the introduction of new building materials, architects wonders about the formal correctness of hiding the structure behind a covering. On one side, this opportunity allows new ways of expression but, on the other side, it entails depriving the architecture of its substance, creating a simple appearance. Shifting the same theme into the restoration field, it addresses the relationship between strengthening and preservation. The reinforcement interventions, even if indispensable for the survival of the building itself, have always been considered as an anonymous and invisible tool, without any expressive capacity, whose purpose is only to allow the stability of the structure over time. The cases in which the strengthening devices are not hidden, taking on not only the technical issue of reinforcing the building but also the aesthetic issue of representing the contemporary architectural language, are rare. From these considerations, a research has been carried out in order to overcome the belief that the concept of valorization is not applicable to the strengthening intervention, underling that these reinforcement tools can enrich the structure of an added value. In order to reach this purpose, the study has developed strengthening devices relating their technical requirements to added functions that influenced their aesthetic. Furthermore, such an approach entails interdisciplinarity, first of all between engineering and architecture, in order to reach effective compromises of technical, functional and aesthetic issues.

CODE 265

ROMANIAN CASE STUDY: CHALLENGES IN THE APPLICABILITY OF THE LEEUWARDEN DECLARATION ON LOCAL BUILDINGS HERITAGE

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KEYWORDS: Study case; local heritage; accessibility; Leeuwarden Declaration.

ABSTRACT

This case study is the preliminary design stage for an upgrade intervention to one interwar heritage building, the Academic College from Cluj-Napoca, Romania. The design theme provided as public bidding was not as a part of one restoration work for the entire heritage building, after the proper practice requirements. There was asked only the intervention on a particular public space from the heritage building for achieving "design for all' accessibility and the upgrade of the interior after the XXIth century trends, technical and aesthetical.
The theoretical research touches the vision of the restoration of the building heritage before Leeuwarden Declaration, the time of the concept of the design. To preserve the untouched heritage versus upgrading a fashionable design that answers to a theme expressed by a society with his changing needs.
There are three design versions with rendering images analysed with a similar SWOT method and argued with practical issues, like esthetical and technical from an architectural and historical point of view and defined by the general trends from the restoration area:

- The first design version, non-interventional one, according to ICOMOS' authenticity charter applied in the international legislation and agreed by experts from the Zonal Commission of Historical Monuments;
- The second design version, the answer to the contemporary design theme requirement but according to ICOMOS' reversibility principle;
- The last one, a creative restoration with the authenticity after Francoise Choay, in some points similar to principles from Leeuwarden Declaration.

Will also be remembered some philosophical notions linked to these three versions: about the falses after Umberto Eco or the revealing hidden truth after Martin Heidegger. Martin Heidegger details that when Technology achieves the Newness is just an answer to a "very insistent asking for delivery". The asking for delivery can also be the theme to upgrade a heritage building to answer to the new needs of the society. The option for the first version was primordial justified by the local preservation of the heritage of the crafts or the professional skills that might be an essential difference in choosing a design following ICOMOS' principles.

CODE 398

ALOIS RIEGL'S AGE VALUE THEORY: SHIFTING IDEOLOGIES AND METHODS IN PRESERVATION PRACTICES

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KEYWORDS: Alois Riegl; cultural heritage; conservation theory; venice charter; Akershus Castle.

ABSTRACT

The essay "Der moderne Denkmalkultus, sein Wesen und seine Entstehung" by the Austrian art historian, lawyer and museum curator Alois Riegl is an important contribution to our understanding of the fundamental changes that took place in the treatment of artefacts and historic buildings around 1900. The essay, which was published in 1903, was a theoretical introduction to a draft for a law on historic preservation. When Riegl's collected essays were published in 1929, the volume included only the introduction. It is this version that was translated into English, entitled "The Modern Cult of Monuments: Its character and Origin", and published in the journal *Oppositions* in 1982. In conjunction with the 50th Anniversary of the Venice Charter in 2014, the tendency to separate the introductory, theoretical preamble from the legislative provisions that followed was pointed out. This has resulted in an ever-expanding definition of what constitutes a "monument", without serious discussion of the principles that should guide its treatment.

The head of the Norwegian Directorate for Cultural Heritage, Harry Fett, refers to Riegl's "Der moderne Denkmalkultus" when he writes in his memoirs (1943) that what characterizes the twentieth century's restoration practice is an ever-increasing emphasis on age values. In his analysis, Riegl introduces the concept of "age value" as a testimony to the passage of time and to the marks of usage. He emphasizes that the rise of age value in the late nineteenth century generated opposition and conflicts, which were apparent wherever monuments were to be preserved. Riegl refers to the nineteenth century as the age of historical value, and the twentieth century as that of age value. According to him, the turn of the century was a period of transition, but also one of struggle.

The aim of this paper is to elucidate the shifting ideologies and methods of preservation practices using the restoration of Akershus Castle in Oslo, the plans for which have been protested against and revised continuously from the late 1890s onwards, as a case study.

CODE 407

ENERGY PERFORMANCE AND COMFORT IN SERVICE CONDITIONS OF SOCIAL HOUSING IN HISTORIC CENTRES: TRADITIONAL SOLUTIONS VS PASSIVE HOUSE

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KEYWORDS: Rehabilitation; social housing; energy efficiency; comfort; passive house.

ABSTRACT

The rehabilitation of residential buildings in historic city centres requires an approach that addresses the preservation of the pre-existence, the outdoor climate and the patterns of use. On the other hand, the energy efficiency concerns cannot be dissociated from the comfort conditions in service, which are a function of the economic reality of families and their cultural habits.
The energy certificate and the associated energy consumption label do not reflect the actual consumption in Portugal, mainly because in practice intermittent heating strategies are used due to energy poverty.
It is of great relevance to evaluate the real energy consumption and its distribution, as well as the comfort/discomfort in situations of intermittent heating of rehabilitated historic buildings.
This paper presents a reflection on the measurement of energy consumption, energy poverty, support programs for energy rehabilitation, quantification of discomfort and describes a case study in which two similar buildings were rehabilitated in Porto with two different strategies: traditional rehabilitation vs. passive house. The rehabilitation solutions are presented according to the envelope treatment and technical systems, taking into account the specificity of social housing and historic city centres.

CODE 466

APPLICATION OF A MEDITERRANEAN METHODOLOGY IN THE ANALYSIS OF REHABILITATION OF A RESIDENTIAL BUILDING DECLARED HERITAGE MONUMENT OF THE HISTORICAL CENTER OF LIMA - PERU

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KEYWORDS: Rehabilitation; heritage; traditional construction.

ABSTRACT

The Historic Center of Lima is a place where there are buildings of great cultural value, the vast majority are buildings of the colonial and republican era. Some retain their originality and some others show a combination of styles. There is a governmental concern to adapt a regulatory plan aimed at regulating the commercial use of residential buildings in order to transform the historic center of Lima into tourist, cultural and commercial spaces.
The study building is a building of "residential typology" located in the Historic Center of Lima; this building has been declared a Heritage Monument, and currently more than 50% of the building is in disuse and in another part of the building there are some shops and offices.
The details of the architectural condition of the building, such as location, general characteristics of the form, materials; They are registered as part of a preliminary characterization based on observation and field inspection applied to the building as it is a temporary summary of the integral transformation of the work in the Historic Center of Lima, so the objective of the study is apply various operative tools for the analysis, evaluation, proposal and execution of this type of Rehabilitation, allowing to develop and implement the RehabiMed Method, which defines methodological guidelines that allow analyzing and determining complementary fields of study, such as the characterization of the materials, the prediction of scenarios, and the orientation of the corrective and preventive conservation policies, all consisting of reinforcing the rehabilitation and maintenance of the traditional architecture as a factor of sustainable development and that affects the improvement of the conditions of life of its inhabitants and preserve the historical and cultural identity of the Historic Center of Lima.

CODE 479

TECTONICS IN URBAN INTERVENTIONS IN NORMAN FOSTER'S PROJECTS

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KEYWORDS: Tectonic; urban intervention; norman foster; sustainability.

ABSTRACT

This paper presents a theoretical-practical research based on the tectonics of Norman Foster + Partners' work focused on intervention projects, applied both in the context of the building and in the urban context. The focus of the paper is to discuss and point out which tools and theoretical criteria were taken into account for an intervention project strategy, in order to verify if these are based on the tectonic theory. According to this focus, examples have been selected in the European context and are within the contemporaneity of the last two decades. Through a qualitative and exploratory research methodology, it will be possible to identify design tools that provide support and answers to contemporary demands such as cultural anchoring, identity creation, use of new materials and new technologies, as well as the precepts of sustainability. The main purpose is to reflect the paths that our cities and buildings are taking in the contemporary world in relation to the management of the built heritage and the relation of the same with the constant need for adjustments and interventions of our cities in a globalized world. As a result, we seek to establish the relationships of the project that draw the guidelines between resources, building life cycle, correct use of materials and technologies, in order to find out if the theoretical concept of tectonics in the projects of Norman Foster + Partners can be confronted in a qualitative and respectful scale regarding the pre-existing conditions and needs of the contemporary world.

CODE 496

WORK PERFORMANCE AS PART OF A DETERMINED SYSTEM OF A CONSTRUCTION PROJECT

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KEYWORDS: Determined system; construction project; uncertainties; work performance.

ABSTRACT

Every construction project is a system. It is determined with time, work quality and price. If one of these factor breaks, the investor suffers damage that affects the other system (for example sales, people who bought these buildings or flats, bank loans, and so on). Between the start (entry into the system) and the finish point (exit from the system) of the construction project are several solutions available. They are reflected in the economic, technical or time performance of the project. For the successful operation of the system, uncertainties must first be identified. Uncertainties arise from the non-systematic treatment of the project. It is necessary to eliminate them and ensure that the project is as determined as possible. Due to the structure of the project, we expect that the entire construction project is treated as a determined system (determined by the price, deadline, and quality of performed works). However, in the reconstruction of historical objects, we encounter other factors that influence the determination of the system and change it. It is influenced by the factors that the determined system changes into a stochastic system. The causes of the stochastic behavior of the system are when on a determined system involve external factors of a stochastic character or internal mechanisms, which are assumed as a stochastic and change in the system from unknown reasons. In this paper, we analyze the internal factors of work performance, which are important for construction quality, price, and deadline.

CODE 500

CONSERVATION AND REHABILITATION TO MUSEUM OF LAURINI PALACE IN TITO, POTENZA, ITALY

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KEYWORDS: 18th Century building systems; wall and floor anti-seismic reinforcement; energy performance and sustainability improvement.

ABSTRACT

The Palace owned by the Laurini family is an important building located in the historic center of the ancient city of Tito, a few kilometers from Potenza, in the heart of Southern Italy, built between the end of the 18th century and the end of the 19th century. It was built in three phases and three factory bodies joined together at different levels (up to five), with a very irregular volume both in plan and in section and a large sloping garden with a surface of over 3,800 m^2. Thanks to the attention and care of the property, the building has fully conserved its original construction, and today appears as a living manual of the architecture of its time. This also and above all because the owners refused to apply the simplistic and invasive recipes practiced after the 1980 earthquake, which led to the almost complete destruction of the historical heritage of Campania and Basilicata. The Palace preserves untidy stone wall; the vaults in stone, barrel and cross-shaped (one also lathwork type, on the top floor); the original stairs; the floors in chestnut wood, the roofs with Palladian trusses and bent tiles; the frames of doors and windows, some very ornate, and the original wooden fixtures; railings and gratins in molded cast iron and wrought iron; the pavements in colored and decorated cement grit stones; the original plasters and colorings. The Notary Laurini intends to dedicate the building to the enhancement of the thought and work of Lorenzo Ostuni, personality of Tito internationally known, artist and scholar of symbols, who died a few years ago. And to this end it has set up a Foundation to which it has given the Palace, to make it become the seat of a Museum of Symbols and related study activities. The research carried out has determined the methods through which, in respect of the historic-artistic characteristics of the building, it reaches its anti-seismic adaptation, its re-functionalization, the elimination of humidity pathologies, also achieving a marked improvement in its energy performance and sustainability.

CODE 43

INFLUENCE OF WATER SATURATION ON MECHANICAL PROPERTIES OF POROUS BUILDING STONES

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KEYWORDS: Building stones; mechanical properties; water saturation; strength.

ABSTRACT

Currently, rock materials are principally used in the construction of emblematic buildings, ornamental elements, retaining systems or as replacement material of architectural monuments. Nevertheless, despite most these constructions are commonly in moist environments or in direct contact with water, standard tests determine rock mechanical properties under dry conditions, after removing water content in an oven. Furthermore, it is well known that moisture is a key ingredient in the strength of some rocks. These points mean that there is a need to study in more detail the effect of water content on mechanical properties of building stones. The objective of this research was to quantify the effect of water saturation on strength and deformability of porous calcareous building stones from the province of Alicante. To this aim, cylindrical specimens of three biocalcarenite varieties were prepared and the bulk and real densities, open and total porosities, water absorption and P and S wave velocity were determined according to UNE Spanish standards. Subsequently, for each variety of building stone, half of the samples were dried in an oven at 105 ^{0}C for 48 h and the other half were soaked in water for 48 h in a vacuum chamber to fully saturate them. Finally, all samples were tested in laboratory in order to determine the mechanical properties under dry and saturated conditions. The results showed a very significant reduction of unconfined compressive strength, Young modulus and point load strength, so it is necessary to consider the saturation effect when these stones are exposed to water during its lifetime.

CODE 71

THE REINFORCED CONCRETE DOUBLE SLABS FROM THE BEGINNING OF THE 20TH CENTURY. THE FIRST STEPS OF PREFABRICATION IN CONCRETE STRUCTURES

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KEYWORDS: Concrete; precast; lost formwork; slab; Twentieth century.

ABSTRACT

Although the industrial production of standardised prefabricated reinforced concrete pieces dates back to mid-20th century, patents from the very first years of that century already described the workshop construction mechanisms of some pieces. Some double reinforced concrete slab floors have been located during the restoration of the Bilbao Alhondiga or in the Punta Begoña Galleries, giving rise, in both cases, to the question of how they were executed. A comprehensive diagnosis of the state of preservation, and of the deterioration of the constructive and ornamental pieces of these buildings is essential to enhance their value. Further, the constructive characterisation of the structure is crucial to be able to estimate its stability. Studying patents of this type of double slab floors has helped to clarify their construction process, and has shown the need to prefabricate some of the pieces used in their execution. Several patent records have been consulted in order to study these double slab floors. Eight patents, registered in different countries over the first decade of the 20th century, have been selected for analysis and comparison. These eight patents were further reduced, selecting those in which no permanent formwork was used, and which contained some parts made of prefabricated concrete, to perform a more in-depth analysis. This final study has enabled us to infer the constructive processes used in their execution. These processes entailed complex constructive mechanisms with some workshop prefabricated parts. Based on the mechanism described in these patents, we have been able to infer how it was possible to construct these singular slab floors.

CODE 85

FAILURES OF THE CAST-IRON COLUMNS OF HISTORIC BUILDINGS CASE STUDIES

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KEYWORDS: Cast-iron; column; load carrying capacity; imperfections; brittleness.

ABSTRACT

In the paper selected technical problems related to the adaptation of cast-iron columns in structures from the turn of the 19th and 20th century, which are currently subject of revitalization, were discussed. A short history of development of cast-iron elements and examples of adaptation of existing buildings and structures to contemporary needs were presented. Lack of contemporary standard regulations related to design of cast-iron structures is a significant problem in the design works. For this reason, the results of experimental investigations on cast-iron columns are also needed. The authors presented results of the tests concerning principal properties of cast-iron – strength and deformability, affecting the specificity of designing cast-iron structures. The course of destructive test of a cast-iron column was also described. The results of measurements carried out during the tests were included. The historical design principles in the light of the result of experimental investigations were discussed. It was stated the actual load carrying capacities of cast-iron columns may exceed several times the values resulting from the 20th century design rules. The conservatism of the design principles resulted, however, from the material uncertainties – lack of homogeneity and hidden defects of the cast-iron. The failure mode which is rapid, non-signalized and brittle should also be taken into account by assessing the load capacity of the existing cast-iron columns.
Selected examples of failures of cast-iron columns from 19th-century structures: post-industrial buildings and engineering structures were discussed. They resulted from errors made during adaptation works. The considered methods of repairing the structures and the reasons of failures were presented.

CODE 100

ASSUMPTIONS FOR THE STRUCTURAL AND CONSTRUCTIVE REHABILITATION OF THE TRADITIONAL HOUSING IN THE HISTORICAL CENTER OF GUIMARÃES

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KEYWORDS: Traditional house; rehabilitation; historic city center; Guimarães; UNESCO.

ABSTRACT

It is understood that the housing construction arose because of the Human need to seek protection and shelter, but from the time when the city of Guimarães was still divided into two villages, there are few records on how living was, making it difficult to determine the origin or influences systems and techniques that evolved to the current model. The house considered typically "*Vimaranense*" results from a process of several transformations since the first fixations in the territory and the economic, social and constructive changes that were conditioning the architecture and the city itself. In general, they are characterized by a narrow plot of land, which results from the pre-existing medieval parcelling, present only two fronts, defined directly by the interior function and form irregular streets. In order to respond to new social requirements while maintaining the same constructive techniques, this article presents the evolution model of the city of Guimarães from its Historic City Center classified as World Heritage by UNESCO and analyses the structural and material questions that are presented as relevant for the practical development of a proposal for the rehabilitation of a traditional house in the said Historic City Center.

CODE 108

CAPILLARY ABSORPTION COEFFICIENT OF CERAMIC BLOCKS WHEN IN CONTACT WITH MORTAR

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KEYWORDS: Capillary absorption; hydraulic contact; mortar; knee point; ceramic bricks.

ABSTRACT

Intervening in old buildings requires extensive and objective knowledge. The multifaceted aspects of the work carried out on these buildings tend to include a growing number of disciplines, with a marked emphasis on those allowing for a greater understanding of the causes involved with the problems that affect them, as well as how to appropriately handle these causes.
The analysis of moisture migration in building materials and elements is crucial for knowledge of its behaviour. This behaviour involves durability, waterproofing, degradation and thermal performance of building wall. Generally, the wall consists of multiple layers, and thus the investigation of the moisture transfer implies knowledge of the continuity between layers. There are several interface types but the most common one is the hydraulic continuity - when there is interpenetration of both layers porous structure.
An experimental study was carried out with specimens of two different ceramic bricks with cement mortar and lime mortar interface. The samples were produced by placing mortar in the fresh state. The results showed significant differences in capillary absorption coefficient between monolithic samples and samples with hydraulic contact, before reach the interface. The changing of porosity in mortar near the brick-mortar transition zone can be attributed to the flow of water from fresh brick during the bonding process. In the beginning, small binder particles can be transported to the mortar-brick interface and the plaster becomes more compact in the interface (enriched in the binder agent).
For hydraulic contact interface, cement and lime mortar, it was possible to observe the existence of two points of change in the water absorption curve profile (Knee points), i.e, the transition between brick/mortar and mortar/brick. A detailed analysis was done based on the comparison of the average moisture content over the sample thickness before (bottom) and after (upper) the interface, and at the beginning and at the end of the experimental test.

CODE 124

MECHANICAL BEHAVIOUR AND REABILITY OF ANCIENT CLAY BRICKS FROM ZAMORA (SPAIN) UNDER THREE POINT BENDING TEST

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KEYWORDS: Flexural strength; flexural modulus; weibull statistics; three-point bending; ancient clay bricks.

ABSTRACT

Ancient clay brick masonry rely on the brick units properties, so their analysis are important on interventions in historic buildings. This study evaluates the mechanical behaviour of specimens extracted from clay bricks of buildings built between the late nineteenth and early twentieth centuries in the province of Zamora (Spain) under three point bending tests. Clay bricks with very different characteristics and manufacturing processes are analysed. The results of flexural strength and flexural modulus are analysed and related with compressive strength and physical properties obtained in a previous study. A reliability analysis is performed using Weibull statistics, giving the Weibull modulus as indicator for the reliability and reproducibility. Experimental mechanical properties show high variation not only between different clay bricks but also in-between specimens extracted from the same brick. According to the reliability analysis it can be concluded that the ancient clay bricks of the study are unreliable with respect to their mechanical characteristics under bending.

CODE 161

THE EFFECTS OF TRADITIONAL HOT-LIME TECHNOLOGY ON THE CHARACTERISTICS OF LIME

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KEYWORDS: Traditional mortars; hot-mixed mortar; hot-lime; steam slaking; portlandite.

ABSTRACT

This paper aims to provide some fundamental scientific knowledge on the characteristics of the mortars produced with the hot-lime technology. This technique entails the direct mixing of quicklime with sand and other additives to produce the mortar. In this way, the quicklime is slaked by the water absorbed on the sand grain surfaces and by water added to reach the correct workability of the mix. According to practitioners, the mortars produced with such method show improved performance in terms of durability and workability. Despite this, very few scientific knowledge is currently available on this process.
This contribution aims at introducing the basic principles of the hot-lime technology based on the literature currently available and on initial experimental results highlighting the effects of the slaking method on the reaction products, using chemical and microscopic analyses and geochemical models.
Results suggest that the slaking conditions affect the crystal size and shape of the binder which may be the reason of the improved performance of the mortar. Our models show that the chemical composition of the pore solution in 'hot-mixed' mortars is different from that of mortars produced with slaked lime.
Understanding how a traditional technology, such as hot-lime, affects the properties of lime in a mortar is key to producing compatible repair mortars for historic masonries and is therefore a fundamental task for the conservation of the built heritage.

CODE 187

DAMAGES PRODUCED BY THE SEPTEMBER 19, 2017 EARTHQUAKE ON THE TEMPLE OF THE SAINT MATTHEW'S EX CONVENT IN ATLATLAHUCAN, MEXICO

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KEYWORDS: Convent; earthquake; vault; damage; temple.

ABSTRACT

On September 19, 2017 an Mw 7.1 earthquake occurred with an epicenter near the city of Jojutla, Morelos. Due to this intraplate seismic event more than 2800 historic buildings were damaged in the states of Morelos, Puebla, Tlaxcala and Mexico City, which cases experienced significant damages and in several cases different parts of the buildings collapsed. In the present work, the damages observed in the temple of the Old Convent of San Mateo, in Atlatlahucan, in the State of Morelos, Mexico, which dates from the 16th century and was built by the Augustinian religious order, are presented. The different damages produced on the main nave of the temple, on the closing wall over the triumphal arch, as well as severe damage at the base of the battlements located on the longitudinal nave walls are shown, some of which rotate and fell down the building. Finally, the damages presented on the clock masonry box located on the main facade are analyzed, as well as the damages produced on the bell tower. The incidence of spectral amplitudes in the response of the building is qualitatively discussed and possible actions are proposed to mitigate future seismic events.

CODE 189

MECHANICAL CHARACTERIZATION OF MASONRY SAMPLES EXTRACTED OF MEXICAN CONVENT CHURCHES FROM SIXTEENTH CENTURY

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KEYWORDS: Mechanical properties; mexican convent temples; compression axial testing; stone masonry.

ABSTRACT

The earthquake on September 19, 2017 caused severe damage in part of the Architectural Heritage of the central area of Mexico. Particularly, in the state of Morelos, some conventual temples of the 16th century suffered damage to their structure and even in some cases there were partial collapses of vaults, arches, bell towers and cloisters. Also, there were cases, where the total collapse of their domes was presented. Due to this event, the Institute of Engineering by UNAM carried out various campaigns to recognize damages in these kind of structures in the affected areas. On the other hand, due to the large amount of debris generated by the partial collapse of some structural elements of these temples, the IINAH Center in Morelos was requested to obtain masonry samples to be tested in the laboratory for the purpose of obtaining their basic mechanical properties This paper presents the results of 33 specimens obtained from 28 samples collected.

CODE 206

ANALYSIS AND CONSERVATION STRATEGIES OF TRADITIONAL TIMBER ROOF STRUCTURES IN NORTHERN MOROCCO

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KEYWORDS: Timber roofs; Morocco; traditional building techniques; structural behavior; conservation strategies.

ABSTRACT

This paper describes the results of the investigations carried out on the construction techniques and the mechanical behavior of the timber roof structures, which characterize the traditional architecture of Northern Morocco. The identified construction systems are two: the Berber and the Andalusian roof structures. The morphological, constructive and structural investigations, aimed at assessing the vulnerability level of the constructive systems, highlighted performances and criticalities. The mechanical behavior of these roof structures was investigated by performing numerical modeling through the finite element software Straus7. Results were compared to the actual cracking pattern surveyed on the masonry walls where they are positioned and to the real deflections of the timber members, and they match very well. Finally, due to the state of conservation and the deflection of the timber members observed during surveys, two strengthening systems, one for each structural type, have been devised to prevent the risk of a possible collapse and, therefore, to preserve them.

CODE 269

MATERIALS AND CONSTRUCTION TECHNIQUES AS A TOOL FOR THE RESTITUTION OF MEDRACENS' BUILDING PROCESS

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KEYWORDS: Masonry structure; materials; construction techniques; funerary constructional cultures.

ABSTRACT

Ancient masonry structures, considered as our ancestral built heritage, require humanities and scientific based approaches for their study and conservation. Therefore, a detailed knowledge of their history, materials, geometry and their construction process must be the first step before any intervention on this common heritage.
Medracen, known as the Royal Mausoleum of Numidia, is built between the 4th and the 3rd centuries B.C. It is located in Batna in the eastern region of Algeria. This very typical and monumental structure has undergone different deterioration due to its particular construction techniques and lack of knowledge of the inner structure's characteristics during the restoration campaigns led in the 20th century.
The mausoleum is built with two different materials. Its architectural cladding is made of layers of sandstone blocks linked with lead-coated wooden clamps. The inner core is made of small limestone slabs set in an irregular masonry stone-setting. The use of these two construction materials, and consequently two different construction techniques, reveal the construction process and chronology of Medracen. Thus, it becomes possible to establish correlations between construction methods and the construction cultures in the ancient North Africa.
Within this presentation, we will discuss the genesis of the inner structure of Medracen and a review of its construction process through the study of its materials and construction techniques. Such an approach will not only lead to a more accurate structural study of Medracen for its conservation but would also enlighten the relationship between construction features (structure and materials) and their cultural and historical significance.

CODE 281

RELATIONSHIP OF THE PRISMA ELASTICITY MODULES OF CERAMIC BLOCKS WITH EMPLOYED MORTARS

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KEYWORDS: Ceramic blocks; ceramic masonry units, structural masonry; prism testing, modulus of elasticity, mortar type

ABSTRACT

In the design of structural elements, specifically in this case for residential buildings, one of the premises employed is the control of the deformations that occur when the loads related to the structure's own weight, use, wind and so on. Therefore, it is essential to know the Elasticity Module of the materials used in the execution of this structure, so that the deformations are kept within a range compatible with the characteristics of these materials. The cost and time required to construct, cure and test the ceramic block prisms, an alternative to the Brazilian standard for determining the characteristic design resistance, as well as the waiting time to start construction, make this prism test model expensive and time consuming. The alternative to these traditional methods is to establish the Masonry Elasticity Module from the Masonry Unit Elasticity Modules (ceramic block) and the type of mortar specified by the engineer. The objective of this work is to relate the ungrouted ceramic block prism Elasticity Module with the Mortar Elasticity Module employed. The results of a comprehensive test program with ceramic blocks with a nominal compressive strength of 7 MPa, representing more than 90% of the works performed in Structural Masonry (AE) in southern Brazil, were used statistically. 4, 5, and 8MPa mortar prisms were tested. The results of the tests, although showing an increase in the modulus of elasticity of the prisms with the increase of the modulus of elasticity of mortars do not present proportionality with these values. For the 4Mpa nominal strength mortar, the Prism Elasticity Module had a value 2.97 times higher than the Mortar Elasticity Module. For the 5MPa mortars the ratio was 3.21 times. Already the mortar of 8MPa had a ratio of 3.69 times higher. The test results reported here for the relationship between the prism elastic modulus and the mortar elastic modulus, always with 7MPa ceramic blocks, were consistent with the results reported by other researchers.

CODE 297

HISTORICAL MORTAR COATING CHARACTERIZATION FOR RECORDING AND RESTORATION PROPOSAL

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KEYWORDS: Historical mortar; physicochemical characterization; paint layers; UFRGS Radio building.

ABSTRACT

The Federal University of Rio Grande do Sul (UFRGS), located in Porto Alegre - Brazil, has several protected historical edifications. The Radio building, object of this study, was built in 1921. This work aims to characterize the coating mortar of this historic building for registration purposes and as a subsidy for future interventions. In this way, technically analysis from laboratory tests were done. Proportion binder:aggregate, particle size composition, morphological analysis through the stereoscopic microscope, paint prospecting and characterization of soluble salts were performed. Proportion binder:aggregate indicated values between 1:1.91 and 1:3.48 (binder: aggregate, by mass), with siliceous aggregate, probably by river origin. The maximum average dimension of the aggregates was 4.8mm and the average fineness modulus, 2.85. Chloride and sulfate salts were found at a site of visible coating desegregation. The analyzes allowed to obtain relevant information to register the general characteristics of the mortars. Although restricted to formal aspects (stereoscopic microscope analysis) and proportioning aspects in the composition of mortars, they are important contributions to the indication of materials with similar characteristics, allowing greater chances of compatibilization, when the insertion of new materials is necessary. The verification of soluble salts presents in the sample indicates the need for attention with stretches vulnerable to moisture ingress, which allow the solubilization and crystallization of salts, which may result in loss of adhesion and integrity. The identification of the paint layers, through prospecting, helped to understand the building's history, showing that the edifice had an original color similar to the one currently verified.

CODE 370

ACOUSTIC ANALYSIS OF ANCIENT CLAY BRICKS FROM ZAMORA (SPAIN) TO DETERMINE ITS CONTRIBUTION IN REDUCTION OF ENVIRONMENTAL NOISE

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KEYWORDS: Acoustic impedance; ancient clay bricks; Zamora (Spain); acoustic absorption coefficient.

ABSTRACT

In large cities, there are not only modern constructions that comply with existing acoustic normative, but also older constructions with brick facades that, due to their historical and heritage value, must be maintained and cared. However, determine the degree of acoustic damping that this type of construction elements possesses, the ancient bricks, is interesting. This work focuses on the determination of the acoustic absorption coefficient using Kundt tube (or acoustic impedance with two microphones), of different series of masonry bricks, manufactured between the end of the 19th century and the beginning of the 20th century, belonging to different buildings from the province of Zamora (Spain). For this, brick pieces were chosen from different locations in the province (Toro, El Perdigón and Otero de Bodas), constituting 15 series that were compared with the current brick building results. The data obtained were related to the density and interconnected porosity, as well as macroscopic observations of the pieces tested. These bricks have a greater acoustic absorption than conventional brick due to the heterogeneities present in their manufacture at frequencies between 800 and 1800 Hz.

CODE 388

"LOST WOODEN STRUCTURE" THE CHURCH OF SANTIAGO APÓSTOL OF MANJIRÓN (MADRID)

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KEYWORDS: Laceria; carpintería de lo blanco; Cartabón; Albanécar; Manjirón.

ABSTRACT

This communication shows the results of the investigation on "lost wooden structure" the Church of Santiago Apóstol of Manjirón (Madrid). A detailed study of this structure and of the technological environment where it is located is presented.

Throughout the second third of the twentieth century, due to undocumented causes, the bow-tie structure of the Church of Santiago Apóstol of Manjirón was in Madrid. There is only one photography kept of this structure, of which a copy was facilitated by Mr. Enrique Nuere Matauco in 2016.

As professors of the "Taller de Carpintería y Sistemas de Entramado de Madera" of the MUCTEH (Master of Construction and Technology of Historic Buildings) of the Construction Department of the Polytechnic University of Madrid, it is appropriate to include this study and its development in the academic activities of the Master program.

As a result of this research, and under our direction, a Master thesis was done in 2016. Later, a scale prototype was produced by the students of the subject workshop, during the course 2017/2018.

The first master thesis served as a constructive hypothesis that allowed to undertake the physical construction at scale of the structure. This structure has allowed us to describe in detail the constructive particularities of the wood structure and locate it technically and historically.

CODE 422

ALTERNATIVE MATERIALS AND TECHNOLOGICAL SOLUTIONS FOR LOW-INCOME HOUSING IN TROPICAL AFRICA

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KEYWORDS: Low-income housing; tropical climate; indoor thermal comfort; traditional and modern materials.

ABSTRACT

Low-income housing in tropical Africa is currently built with modern technologies that often deny local traditions, producing negative environmental impacts and poor thermal comfort. As regards Uganda, there is a gradual shift, both in rural and urban areas, from traditional and environmentally friendly materials (adobe and thatch) towards modern ones, such as cement concrete, burned bricks and iron roofing sheets. These materials generally increase hygiene and durability, but they also entail a relevant amount of greenhouse gas emissions and may generate indoor discomfort. In particular, the handmade manufacture of the local burned bricks has a negative impact in terms of air pollution, deforestation and waste production, while iron sheet roofs increase the risk of overheating, with consequent indoor thermal discomfort. This study aims to identify alternative materials and technical solutions to improve the performance of low-income houses in terms of durability, environmental sustainability and indoor thermal comfort, while respecting local traditions and limited budgets. To this purpose, six different single-family houses in the Ugandan district of Nakaseke have been parametrically designed and modelled. Dynamic thermal simulations have been conducted on the models to evaluate the effects of different walling and roofing solutions. Results indicate that the proposed solutions significantly improve the indoor thermal comfort.

CODE 447

REINTERPRETATION OF FLAT SCULPTING OF AREQUIPA'S IGNIMBRITE CULTURAL HERITAGE

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KEYWORDS: Flat sculpting; ignimbrite; front façade; ashlar; restoration.

ABSTRACT

The architectural heritage of the historic center of Arequipa (Peru) has been built taking advantage of the volcanic flows of the ignimbrite itself that give it beauty and uniqueness. The docile stonework favored the Baroque decoration of the front façades of the religious buildings and stately homes and the flat sculptural work that is called *"textile architecture"*. It is exposed that the carving is flat because it is conditioned by the masonry rather than by the sculptural design. It is done on the face of the ashlars, which originates a variety of dimensions of the head and edge, also increasing the thickness to contribute to the drawing of the carving and assembly of the pieces, thereby altering the height of the masonry rows. The limitations of the low mechanical strength of the stone with presence of hard intrusions and vacuoles contribute to planiform carving. In addition, the continuous earthquakes, particularly after the earthquake of 1868 in the post-colonial phase, reduced the proyecting of corbels and moldings in subsequent reconstructions.

CODE 502

SUSTAINABILITY AND RESOURCE CONSERVATION IN BUILDING INNOVATIONS AND THEIR IMPACT ON SERVICE LIFE EXTENSION OF CONCRETE STRUCTURES

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KEYWORDS: Sustainability; material innovations; service life extension; concrete durability; historic architecture and buildings; building standards.

ABSTRACT

The growing number of deteriorating concrete structures not only affects the productivity of the society, but also has a great impact on our resources, environment and safety. Service life of a structure depends on many variables, some of which are environmental and, as a result, beyond the control of the designers and owners. While several unreinforced concrete structures more than 2000 years old are still in excellent condition and functional, many modern, reinforced concrete buildings built in the 20th century have deteriorated within 10-20 years, resulting in complete replacement or expensive repairs. It raises questions on what accounts for this discrepancy in durability and resilience, and what could be learnt from ancient technologies.
Recent sustainability concerns and the need to conserve depleting resources have resulted in the objective of demanding concrete structures be designed for a service life of more than the assumed service life by the design codes. In this context, the resource conservation approach represents reduction and optimization of the use of resources, use of renewable resources, and re-use/recycling of building parts, components and materials, and waste reduction. In addition, antiqua-inspired structural designs applying reverse-engineering offer a new concept to develop novel, more sustainable and durable materials based on ancient practices and techniques.
Today, 100-year service life of concrete structures can be achieved with relative ease on paper, but accomplishing it requires an integrated approach. One of the realistic possibilities how to make better use of the limited resources is by applying historic principles to new construction and making historic building structures fully operational. Current standards promote some synthetic building products as green alternatives to traditional materials, but the green standards fail to award points for historic buildings already equipped with high quality and resilient materials and construction. This resilience is possibly the “greenest” quality of buildings; therefore, the building standards should acknowledge the value of traditional materials & construction. KAREG Consulting Engineers´ work reflects the respect for historic structures and the work of the architects, masons and craftsmen to preserve their legacy by following the established restoration procedures critical to heritage conservation.

CODE 531

THE BUILDING OF FALSE VAULTS IN THE MAYA REGION FROM THE EARLY CLASSIC TO THE LATE POSTCLASSIC PERIOD (Cents. III TO XV D.C.); CONDITIONS OF STRUCTURAL STABILITY, BUILDING FORMS AND REGIONAL VARIATIONS

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KEYWORDS: False vaults; limestone; Maya architecture.

ABSTRACT

The False Vault, also known, somewhat erroneously, as “Maya”, has unique structural properties that differentiate it from from other forms of vaults produced in other latitudes of the planet, including the “Half-Point” or Barrel Vault, the Ogee or Gothic, or the more modern Ruled Surfaces, in that the weight loads tend to concentrate towards the interior of the built space, instead of outwards, as in the case of the latter. This is intimately related with the materials regionally extant for the one part, and for the other due to the unique conformation of the built spaces, both interior and exterior, that conform the constructions that characterize the Maya Culture, with variations, as produced in different periods and regions.

CODE 571

ECOLOGICAL RESTORATION MORTARS AND PLASTERS DESIGNED WITH RAW MATERIAL FROM THE ISLAND OF GAVDOS

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KEYWORDS: Restoration mortars; calcined clays; Luxan method; thermal analysis; pozzolanic activity.

ABSTRACT

Gavdos, is an island of ca. 34 km2 located to the south of Crete, Greece, that marks the southernmost European territory en route to Africa. Systematic archaeological survey conducted by the University of Crete with the KE' Ephorate revealed that the island was inhabited with consistency since the Palaeolithic and Mesolithic period. The local landscape is rich in clay material of great diversity located in the flysch of Pindos Zone and in neogene sediments which occupy the vast majority of the island. The use of clay since the Neolithic Age is confirmed from the dense surface pottery of excellent quality and traces of pottery kilns. The limited natural and human-made resources are persistently recycled forming the built structures of the island and determining the island's sustainable local tradition. In the framework of this research, areas with clay soil were identified using studies of geological survey and taking into account testimonies of local inhabitants. The earthen samples were characterized with physicochemical analyses and the most appropriate were selected for thermal treatment in order their pozzolanic properties to be investigated. Aim of the research is the use of this local clay material, in raw or fired state, as a pigment and pozzolanic additive, respectively, in restoration mortars. The output of the project will be the design of mortars and plasters that will be economic, easy to be produced and applied, energy efficient and compatible with the existing substrate of local structures and the vernacular heritage of the island of Gavdos. The characterization of 13 clay samples revealed that the majority can be used as additives in external lime plasters providing colour surfaces in perfect line to the ancient Polygnotus coloured scale. Two types of clays exhibited exceptional pozzolanic properties upon low temperature firing, due to their high kaolinite and low calcite content.

CODE 41

PROPOSAL OF AN INNOVATIVE SOLUTION FOR VENTILATED FAÇADE: DESIGN CONSIDERATIONS AND RELEVANCE IN BUILDING-REFURBISHMENT

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KEYWORDS: Ventilated façade; system implementation; building-refurbishment; constructive adaptability.

ABSTRACT

There is an increasing need today for alternative construction technologies that allow, among others, reducing execution time, wastes and energy consumption during the buildings' construction and even after, alongside whole building lifespan. Focusing on architectural façades, the continuous increase in performance required to achieve greater comfort in buildings has led to a growing industrialization process, which has allowed configuring the common layers-solutions currently used. In this context, the present paper shows the results of a research which main goal was to develop an innovative solution for ventilated façades. The proposed solution is based on ceramic tiles, but considering the ceramic material from a technically-advanced perspective.
The system has been designed and evaluated based on the industrializing the on-site execution process premise as much as possible, quitting traditional wet execution in favor of prefabricated products connected by auxiliary elements. In this paper, details of the design process of the ventilated façade system and construction technology are provided.
The designed façade is composed of two differentiated materials, ceramic as the main element providing a great variety of surface finishes and metallic auxiliary elements, responsible for supporting the whole system load. From the results obtained, it is possible to conclude that the solution fulfils all the requirements of structural stability adequate for this type of wall. Furthermore, in terms of thermal performance, the proposed solution presents very good behavior, being an adequate solution for construction and refurbishment of buildings processes both for its aesthetic versatility and for the ease of execution and the improvement of energy efficiency of the buildings in which the system was implemented.

CODE 49

NEW MATERIALS TO INCREASE THE THERMAL MASS OF EXISTING BUILDINGS FOR ITS ENERGY REHABILITATION

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KEYWORDS: Thermal activation; PCM; Concrete; Cement; Thermal mass.

ABSTRACT

Experience has shown that thermal inertia is a property of buildings that permits reducing the energy demand while improving thermal comfort. In fact, inertial systems such as radiant floors or thermally activated structures are standing out from other solutions.
However, in building rehabilitation, the use of such solutions is not considered due to three technological challenges that are not yet solved. On the one hand, the slabs, generally designed to be light, with concrete joists and ceramic blocks, have no thermal mass that can be used to improve the thermal performance of the building. On the other hand, old structures are designed to withstand lower loads than the current ones, so that any width increment of the floor becomes a serious structural problem. Finally, the height between floors cannot be shortened.
For these reasons, thermal activation of floors is not considered as a feasible solution in rehabilitation works, although it has been used in specific cases.
The development of new cement-based mortars with phase change materials (PCMs) embedded in the matrix of the material could permit the implementation of new solution with high thermal storage capacity in reduced volumes, which would allow its activation and a higher market share of renewable energies.
The results of the INPHASE project in this field are promising, although there are still barriers to be solved such as fire resistance or economic competitiveness.

CODE 82

ACOUSTIC STUDIES OF CONCRETES CONTAINING INDUSTRIAL CO-PRODUCTS: NEW EXPERIMENTAL APPROACHES

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KEYWORDS: Aggregates; building; noise insulation; concrete; acoustic chambers; damping

ABSTRACT

The present study contributes to knowledge of building acoustics and, particularly, the damping effects of concretes pumpable and self-compacting (produced with two cement types: CEM I 52.5 R y CEM II 42.5 R) that employ two industrial co-products as aggregates. Firstly, electric arc furnace slags (EAFS), from the steel-making industry, in partial substitution of sand and coarse natural aggregates. Secondly, sawdust (sawing of Radiata pinewood), from the lumber industry, was used in 20% of partial substitution of limestone sand (0-4 mm) for concrete masonry units. Test results on different types of concrete were that the partial substitution of both coarse and fine aggregates by steel-making slags and sawdust showed no improvement over the acoustic performance of concrete made with natural aggregates. Nevertheless, it will be of some value, in so far as all those concretes met current regulations on noise insulation and will therefore, in all likelihood, be compliant with future standards. In addition, a novelty and proper acoustic facility has been designed and built that comprised a set of two mobile chambers, of small-to-medium size, suitable for testing 450×650×25 mm specimens that would replicate slab components with 160 mm of thicknesses. This is explained based on the reduced internal damping from EAFS, because of the higher porosity of EAFS; an effect that is not compensated by the heavier density of EAFS rather than natural aggregates.

CODE 94

DESIGN OF HEMP AGGREGATE CONCRETES FOR REHABILITATION AND RETROFIT WORKS OF VERNACULAR ARCHITECTURE. VALORISATION OF HEMP WASTE

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KEYWORDS: Vernacular architecture; hemp concrete; agricultural waste; wet preserved hemp.

ABSTRACT

The present investigation is carried out as part of the rehabilitative action needed by the architectural heritage of a social nucleus, inhabited in the main by Senhaja Srair Berbers (Central Rif, Morocco) focussing on a positive impact on the environment, improved habitability and cultural valorisation of the same. Mortars and concretes found in several locations of this vernacular architecture (walls, coatings, floor and roof slabs) require attention due to their poor state of maintenance. According to this challenge, it is proposed a design of plant aggregate concretes for the needed interventions, that envision the incorporation of natural binders existing in the region and aggregates from local hemp, giving way to green concretes which include a light weight and insulation value by recycling of material, actually considered agricultural waste. Through the characteristics of the local hemp straw and the regions meteorology this study focuses on the use of chopped, whole stem materials and highlights the advantages of a wet preservation process of the same. Formulations with hemp aggregates and sieved soil are tested in their performances with sodium water glass as additive compared to lime, found in previous formulations. Samples were characterized compositionally, chemically (DRX, FRX, SEM) and physically tested and evaluated in their compressive and flexural strength, thermal conductivity, specific heat, open porosity and water vapor permeability. The proposed hemp concretes perform between insulation and construction materials and confirm their aptitude in retrofit interventions being their mechanical strength in the range of wall, slab and plaster applications and their thermal properties suitable for inside and outside coatings in Mediterranean climate conditions. Positive results are more evident in formulations with siliceous additive, whose properties overcome mortars with lime addition especially in their mechanical performance and resistance to water absorption without suffering undesired disabilities in their water vapor permeability. The proposed solutions minimize the use of commercial binders with negative environmental impact or incompatible properties for restoration works of natural structures, manage the use of local resources of rural surroundings with difficult access, allow better comfort conditions and promote integral socio-economic rural development.

CODE 109

MECHANICAL PROPERTIES OF SCRAP TYRE DERIVED AGGREGATES: STANDARD AND MODIFIED PROCTOR TESTS

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KEYWORDS: Scrap tyre derived aggregates (TDA); standard and modified proctor; elastic recovery; compaction energy.

ABSTRACT

Scrap tyre derived aggregates (TDA) have generally great advantages in civil engineering applications, due to their low specific weight, high permeability and greater resistance to degradation in comparison with conventional materials. In all cases, it is necessary to carry out activities of compaction of the material in order to decrease the rate of pores and increase the strength characteristics of soils, due to its elastic recovery.
This paper explores the mechanical properties related to TDA's dry density (less than 12mm size [ASTM D 6270-17]) analyzing the impact of particle size and water content in order to reach the optimal humidity. The fractions studied include the following samples, A: RE-G1 (0.6 - 2 mm), B: RMD - G1 (0.6 - 2 mm), C: RE -G2 (2.00 - 4.00mm), D: RMD - G2 (2.00 - 7.00 mm). Results show dry density values for Sample A: 595 kg/m3, with 10% humidity and D: 648 kg/m3 with 25% moisture, meaning that the water content has no significant impact on the final values.
In the following test campaign, different mixture proportions were made, such as B (50%) + D (50%), which resulted in a dry density of 654 kg / m3, and the mixture B (10%) + D performed (90%) of 600 kg / m3, both for 10% moisture. These trials show the little variability of results for the tested fractions of grain-size.
The methodology used is based on the assumptions of standard Proctor (6.1 kg cm / cm3) and modified Proctor (27.53 kg cm /cm3), analyzing the influence of compaction energy exerted on the final results. For compaction energy modified proctor in sample B (10%) + D (90%) mixture, values of 624 kg/m3 were obtained for 10% moisture, whereas the 25% showed a slight increase to 647 kg/m3. This research aims to revalue the TDA beyond its main market, which is currently the energy recovery.

CODE 110

SUSTAINABLE MASONRY MORTARS BASED ON LADLE FURNACE SLAGS FROM THE STEEL-MAKING INDUSTRY

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KEYWORDS: Cement; Partial substitution; High in Alumina; Active Addition; Aggregate.

ABSTRACT

Masonry mortars are applied to concrete and brickwork to form structural bonds. Partial substitution of their natural raw materials by waste products from the steel industry represents a sustainable approach towards the ecological management of those materials in Spain, where iron and steelmaking is a highly developed heavy industrial sector. Additionally, a somewhat more traditional industrial sector, the building industry, also consumes large amounts of natural resources and energy, likewise resulting in high CO_2 emission levels. The present research is focused on solid waste from the steelmaking industry and its addition in significant amounts to masonry mortars. Labelled as “white” slag, the waste (saturated in alumina) is commonly known as ladle furnace slag. To do so, several lab tests are presented, which investigate the partial substitution of fillers and hydraulic binders in regular masonry mortars. Firstly, the study of ladle furnace slag and its overall properties and, secondly, studying the feasibility of producing Ladle Furnace Slag mortars, yielded interesting and positive results.

CODE 113

DURABILITY OF ETICS INCORPORATING HIGH REFLECTANCE PIGMENTS IN FINISHING COATINGS

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KEYWORDS: Durability; ETICS; high reflectance pigments; solar absorptance; dark colours.

ABSTRACT

The increase of the durability of building materials and components presents great importance since it contributes to a more sustainable environment by increasing their service life. The development of new building materials and technologies with improved thermal characteristics, such as ETICS with high reflectance coatings, contributes to meet the thermal requirements defined by the European regulation. However, the importance of the durability assessment of new solutions cannot be understated as it plays a key role in the prevention of future early degradation. This paper has the objective of assessing the durability of ETICS incorporating high reflectance pigments in organic coatings. The solar reflectance can be increased through optimised material formulations with the inclusion of nanoparticles in coatings. If the near-infrared (NIR) solar absorption is reduced, the referred benefits can be achieved even in darker colours. One of the main concerns is the durability of the entire system, but the stability of the darker colours must also be taken into account. As such, relevant parameters – solar absorptance, surface temperature and colour – were measured in a long-term "in-situ" experimental campaign, in ETICS specimens with distinct coatings. The effect of the thermal insulation layer, in the referred parameters, was also evaluated, by comparing the performance of the same coatings in samples with traditional substrates. The solar absorptance was measured with a pyranometer with an adapted methodology based on the ASTM E1918 standard. The surface temperature of the samples was continuously monitored for an extended period, enabling a comparison of the benefits under different climatic conditions. The colour was determined by the CIELAB colour space measuring the L*A*B parameters. The results showed that the incorporation of high reflectance pigments leads to a decrease in the solar absorptance and surface temperature even in darker colours. The pigments also influenced the lightness of the coating by increasing the L parameter.
The potential benefits of these finishing coatings result in the combination of enhanced thermal performance, higher durability and higher diversity of aesthetic features.

CODE 136

SELF-COMPACTING CONCRETE MANUFACTURED WITH RECYCLED CONCRETE AGGREGATE

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KEYWORDS: Self-compacting concrete; recycled concrete aggregate; dosage design; flowability in fresh-state; compressive strength.

ABSTRACT

In recent years, it has been common to use recycled aggregates as substitute of natural aggregates in different engineering applications in order to decrease the consumption of natural resources and thus, reduce the environmental impact generated by building and civil engineering sector.
In this research, an exhaustive characterization of aggregate from Construction and Demolition Waste (CDW) is described, as well as its later use in the manufacturing of Self-Compacting Concrete. It is showed that it is possible to obtain a self-compacting concrete with a high compressive strength, suitable for structural use, with a high percentage of recycled concrete aggregate, in this case 100% in the coarse fraction and 50% in the fine fraction. The dosage design is explained through 10 preliminary dosages, in which its flowability in fresh-state was evaluated (slump flow, viscosity in V-funnel test and passing ability in L-box test) until obtaining the optimum dosage regarding self-compactability. In addition, variations in compressive strength related to the changes in the dosage are also analysed, which shows that the fresh-state design of a self-compacting concrete must also take into account the desired behaviour in hardened state.

CODE 224

DEVELOPMENT AND CHARACTERIZATION OF EXPANSIVE GROUTS FOR CRACK SEALING

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KEYWORDS: Expansive grouts; sealing efficacy; performance; permeability test.

ABSTRACT

The present paper deals with one of the main problems related to concrete structural elements, the tendency to crack as a consequence of its low tensile strength. This cracking limits the performance and durability of the concrete. Previous works by the authors showed the feasibility of using innovative expansive grouts in order to avoid or limit this cracking. These expansive grouts are based on the use of inorganic expansive agents promoting the increase of certain hydrates content. Two different agents were considered: type K (based on calcium sulfoaluminate) and type G (based on calcium oxide). The developed expansive grouts presented high penetration ability in the crack in order to prevent the ingress of aggressive agents and regain (totally or partially) the initial uncracked concrete mechanical properties. One of the difficulties encountered has been finding an adequate test method to evaluate the effecitiveness of the repairing.

The influence of including expansive agents on the mechanical properties of the grouts was evaluated, as well as their expansive performance under uniaxial restraining conditions. The influence in the compressive strength depends on the used expansive agent type as well as the expansion performance, this last behavior strongly dependent on the expansive agent dosage considered. According to the obtained results, expansive grouts with 5% in weight cement content of expansive agent were used to evaluate their crack sealing efficacy.

In order to overcome the difficulties encountered in previous works, the sealing efficacy of the grouts was evaluated by ad-hoc methods developed by the authors, in special cylindrical specimens of 150x300 mm where simulated cracks were made at the cross section center of the samples during the casting process. These cracks were sealed with the expansive grouts at 28 days of curing and, after that, the sealed samples were subjected to drying conditions during six months. After this exposure period, the efficacy of the sealing was evaluated by means of water permeability tests. The sealing efficacy of the expansive grouts was compared with that of a conventional grout. Both the mean and maximum water penetration depths were significantly reduced (≈80% of reduction) when using expansive grouts.

CODE 242

CONSOLIDATION OF LIME MORTARS WITH $Ca(OH)_2$ NANOPARTICLES AND TRADITIONAL COATINGS

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KEYWORDS: Heritage preservation; surface consolitation; durability; non-destructive tests.

ABSTRACT

Lime, $Ca(OH)_2$, has been used for centuries in the composition of both mortars and coatings. Consequently, it is found in many historial building and heritage constructions. For this reason, it is necessary to study the most appropriate conservation techniques to be applied in lime mortars restoration. This research addresses a comparison between new and traditional consolidants using physical tests. Firstly, lime mortar specimens were prepared using 1:6 v/v (lime/sand) doses and cured under laboratory conditions for 28 days. The mortars were analysed by optical microscopy, capillary water absorption and permeability tests using Karsten tubes. The shape and size of the nanoparticles of $Ca(OH)_2$ and the ethyl silicate coatings were observed with TEM. Next diluted alcoholic suspensions (5 g/L) of pure $Ca(OH)_2$ NPs were applied on the surfaces. Furthermore, ethyl silicate and sodium silicate were sprayed to compare the different treatments. Finally, the same tests were repeated on the treated materials to compare the effectiveness of the consolidants. The results provided useful information on the consolidation performance of $Ca(OH)_2$ NPs, ethyl silicate and sodium silicate in lime-based mortars.

CODE 300

USE OF BUILDING INFORMATION MODELING IN BUILDING MANAGEMENT RETROFITTING PROJECTS: CASE STUDIES

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KEYWORDS: BIM; building information modeling; building retrofitting; construction management; SWOT.

ABSTRACT

The retrofitting works of buildings is a different practice of the new construction works, involving the previous characterization of the existing elements and their conservation conditions. All existing data collection, project analysis and project management might be in a dimension where non-digital handling is a difficulty factor for the project. That could contribute losing important data related to technical support and for stakeholder's decision. The Building Information Modelling (BIM) technologies are known to be an excellent choice handling information for new projects. However, its usage and potential in retrofitting works may remain unknown or not utilized for several reasons.
The main goal of this research is to determine, using SWOT analysis tool, for the various phases of building retrofitting projects connected to the potential of BIM. In addition, it is expected to determine whether this technology is a feasible solution for these cases and what constraints are involved. Through data collection in design phase and interviews after the research and BIM analysis, three different retrofitting works case studies were analysed. At the same time of the BIM analysis, SWOT methodology was applied aiming to understand the reasoning, constraints and to identify opportunities. The BIM methodology was applied to three design projects studied in 3D and 4D spheres. The 3D analysis aimed to detect incompatibilities among the various disciplines of the projects and information related to the existing elements. The 4D analysis consisted in associating all the building elements with the construction-scheduling plan in order to analyse the activities sequencing behaviour.
The use of BIM prove the existence of several flaws and incompatibilities between the different projects disciplines of each building studied, which being difficult to detect them without this uses. These failures generate problems in the construction phase, whose interviews expect demystify. On the other hand, BIM application at an early stage of the project leads to the resolution of some of these problems that arise posteriorly.

CODE 336

DESIGN OF NEW MATERIALS FOR THE PROTECTION OF CONSTRUCTION UNITS OF RESIDENTIAL BUILDINGS AGAINST FIRE ACTION

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KEYWORDS: Plaster mortar; gypsum mortar; Electric Arc Furnace Slags-EAFS; fire resistance.

ABSTRACT

This work shows the experimental process followed for the design of mortars with a fire-resistant plaster-based mortar, dosed with black slag residues from EAF Electric Arc Furnace (Electric Arc Furnace), generated in the manufacturing process of steel in the Primary Metallurgy phase. EAF black slag residues are valued as mineral filler by joining the mixtures. Although it is necessary to strengthen the final results with a deeper study, the results obtained in this first phase of characterization indicate that the use of black slag EAF in plaster mortars as a mineral load could be a technically viable option for the design of conglomerate materials destined to form prefabricated pieces for the protection of areas of buildings with potential fire load risk. In this way, in addition to obtaining plaster conglomerates with good technical performance, we managed to take advantage of an industrial waste without a defined use, valuing it as a construction material . Mortars have been characterized, both fresh and hardened, following the standards of the European Regulations. Subsequently, the mortars have undergone a non-combustibility test to determine their behavior against fire.
The results show that gypsum plaster and plaster mortars dosed with EAF steel slag mineral filler have good technical performance, both fresh and hardened. Similarly, a good behavior against fire is observed, not only because of the nature of the gypsum binder, but also because of the EAF black slag mineral load dosed in the mixtures.

CODE 367

DEVELOPMENT OF SUSTAINABLE MORTARS THROUGH THE VALORIZATION OF CUPOLA SLAG

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KEYWORDS: Cupola slag; mortar; sustainability; waste recovery; mechanical properties.

ABSTRACT

Obtaining new materials able to meet the requirements demanded by society motivates the search for new solutions capable of satisfying both: respect for the environment and obtaining more durable and resistant materials. Cupola slag is a by-product generated in the process of obtaining ductile iron. When the slag undergoes a rapid cooling, its vitrification is favored, leaving the silica in amorphous form and thus susceptible to reacting. With the help of activators, the slag can develop cementing properties and partially replace the cement, taking advantage of a waste and reducing the costs of the hydraulic binder. In the present study, the physical and chemical properties of the cupola slag are analyzed, as well as the recovery processes used for the manufacture of mortars. Mortars incorporating traditional additions (fly ash and limestone filler) have been manufactured and consistency and mechanical properties have been compared with mortars that incorporate cupola slag addition. It has also been produced mortars with normalized sand and Portland cement replacements of 0, 10, 20 and 30% by weight with cupola slag. Both the compressive and flexural strength of the mortars produced with the different replacements have been determined at curing ages of 7, 28, 60 and 90 days. The obtained results show the suitability of the cupola slag addition with respect to the traditional additions and how both, the values of the compressive strength and the flexural strength, tend to converge for all replacement levels characterized, for ages close to 90 days of age.

CODE 382

TECHNICAL AND ECONOMIC EVALUATION OF A DARK ETICS COATING FORMULATED WITH CONVENTIONAL PIGMENTS VERSUS COOL PIGMENTS

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KEYWORDS: ETICS; intense coulours; pathologies; cool pigments.

ABSTRACT

Facades, as an integral part of the exterior envelope, actively contribute to meeting the aesthetic and functional requirements of buildings.
Among many different possibilities of façade cladding, ETICS has become one of the most popular solutions in Portugal. Despite its solidity, ETICS is expected to present pathologies during its operating life. Accelerated aging, colour loss, biological colonization and system cracking are frequently reported as major pathologies, compromising both the aesthetic and the functional performance of the system.
The research carried out aims to evaluate the performance of ETICS coloured coatings, by trying to compare technically and economically the conventional organic coatings with the new generation organic coatings, based on modified acrylic resins, specific additives and cool pigments, also known as high reflectance pigments. The laboratory tests led to very positive results in the mitigation of the pathologies related to the use of the conventional coatings. In order to validate lab tests, some in situ essays were also implemented, based on non-destructive thermography and colour stability tests. The results allow to conclude that colour intensity directly influences the durability of the coatings, revealing to be more severe for high values of solar radiation absorption coefficient, under conditions of strong sun exposure in South and West facades. Under these circumstances, degradation is evident, with colour loss and widespread cracking. In case of need for repair, the costs of maintenance and repair are usually higher, depending on the extension of the intervention required.
The overall costs of applying a conventional coating are about 15% lower than those compared with the use of an improved cool pigment coating, however maintenance costs when assessed at 5 and 10 years can stay between 41% to 120% of the cost of the system application. For an improved product, a longer maintenance plan - from 10 years of age - is estimated and can represent up to 43% of the initial application cost, so it is in facto more beneficial than a conventional one over the life cycle.

CODE 390

AN INNOVATIVE DUCTILE MORTAR TO IMPROVE THE SEISMIC RESPONSE OF MASONRY STRUCTURES

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KEYWORDS: Masonry; seismic response; retrofit; ductile masonry; experiments.

ABSTRACT

The proposed work presents the results of an experimental campaign aimed at assessing the performances of unreinforced masonry units realized with an innovative mortar characterized by an enhanced ductile behaviour. The improved mechanical properties of the innovative mortar leads to a significant improvement in the performances of masonry panels subjected to shear actions, therefore resulting in seismic improved responses. The experimental campaign described in the paper is part of a wide research project Zero Environmental Risks in Our buildings (ZERO), funded within the Emilia Romagna PORFESR 2014-2020 Call whose final objective is to introduce in the market of the Construction Industry a new class of construction materials and decorative products characterized by high environmental compatibility (VOC-free and ADR-free) and superior performances in terms of both chemical properties and mechanical properties.
One of the research line of ZERO was devoted to improve the ductility of unreinforced masonry. For this purpose, an experimental campaign has been conducted at CIRI Building and Constructions of University of Bologna between 2017 and 2018. The experimental tests were conducted to characterize the new mortar and masonry specimens made of different clay units. The mortar specimens have been tested under flexural and compressive loads, and the performances compared with those of traditional mortar. The results show an improved tensile strength and large values of ductility leading to larger deformation capabilities with respect to the traditional mortar. The masonry specimens have been realized both with structural clay units (to realize structural walls in unreinforced masonry buildings) and with non-structural clay units characterized by improved thermal properties and typically utilized for infill walls in RC frame buildings. Direct shear tests on small specimens (referred to as “triplets”) and compressive diagonal tests on square panels have been performed, and the results compared with specimens realized with traditional mortar. The experimental tests show the effectiveness of the innovative ductile mortar in improving both the shear strength and the shear deformation capacity with respect to the traditional masonry system.

CODE 419

PRECAST CONCRETE MODULE FOR STRUCTURAL AND ENERGY REHABILITATION OF REINFORCED CONCRETE BUILDINGS

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KEYWORDS: Existing buildings; structural rehabilitation; energy retrofitting; precast concrete module.

ABSTRACT

Concrete structures built throughout the 20th century show performance deficiencies that lead to undergo seismic and energy comfort consequences. In particular, independent reinforced concrete (RC) structures do not comply with European energy efficiency standards due to the absence or insufficient insulation, or the existence of significant thermal bridges. Moreover, they were built with obsoleted construction methodologies that, being incompatible with actual structural canons, make them vulnerable to earthquakes.
The current prefabricated technologies, used for the refurbishment of buildings, are focused on energy retrofitting, leaving the field of structural reinforcement unexplored.
The challenge of this research is to improve and monitor the mechanical characteristics of RC buildings as well as their energy performance through precast concrete modules.
In this paper, preliminary design strategies of the innovative panel is presented. It connects the existing façades, stiffening the pillar-beam nodes in order to obtain a box-like effect. Integration with real-time detection sensors ensures monitoring of energy and structural performance.

CODE 490

USE OF BIM METHODOLOGY TO SUPPORT THE FUNCTIONAL REHABILITATION OF A BUILDING

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KEYWORDS: Functional rehabilitation; BIM; laser scan; digital model.

ABSTRACT

The recent situation in Portugal has promoted real estate rehabilitation opposing to new construction, and actions of this nature have technical specificities that must be studied by the design, construction and maintenance stakeholders. Rehabilitation often involves functional aspects related to a "new use" of space, including also aspects such as lighting, electricity and communication networks, water facilities, building thermic, energy systems, fire safety and acoustics. The Architecture, Engineering, Construction and Operations (AECO) sector has been innovating in the methods of design and construction using new technologies, especially the Building Information Modelling (BIM) methodology. However, it remains to be seen how this methodology can be applied to rehabilitation. BIM has as its main advantage the possibility of an accurate geometric representation of the elements, integrating information about them in several dimensions. The use of digital models is very important, since it allows optimizing the visualization and detail of these elements and their constructive processes, being a collaborative methodology.
The present work intends to focus the BIM methodology in the rehabilitation of buildings, namely regarding interventions in functional alterations, being developed a study in which this methodology is applied to the conversion of a storage space of a commercial building into a last generation movie theater. The BIM model was developed from drawings, made available by the installation manager, in addition to the existing survey, using Laser Scan technology. The digital model developed allowed the verification of dimensional differences between drawings and reality, as well as the integration of all pertinent information, which through traditional means would imply the realization of differentiated designs. The results obtained make possible to demonstrate the usefulness of this methodology in the support to eventual interventions of functional rehabilitation.

CODE 553

ACCEPTANCE OF BUILDING INTEGRATED PHOTOVOLTAIC (BIPV) IN HERITAGE BUILDINGS AND LANDSCAPES: POTENTIALS, BARRIERS AND ASSESTMENT CRITERIA

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KEYWORDS: BIPV; photovoltaics systems; historic buildings; historic towns; heritage landscape.

ABSTRACT

The paper refers to the application of Building Integrated Photovoltaic (BIPV) systems for the renovation of heritage buildings and urban landscapes, preserving their historic, material, aesthetic and natural values as well as lowering energy bills, increasing comfort, and improving their technical quality in terms of economic and environmental sustainability. Several criteria for the compatible use of BIPV systems in heritage context are proposed, also taking into account the perspective of architectural preservation, legislative framework, research projects, and the scientific literature. The research is structured in the following steps: (i) examination of existing criteria for acceptable use of BIPV on heritage sites; (ii) examination of the theory of architectural preservation and restoration; (iii) identification of a set of criteria for compatible insertion of BIPV; and (iv) assessment of these criteria on case studies. The study shows new opportunities of inserting new and emerging solar products in these contexts, especially thanks to the advanced customization possibilities to preserve their values by resembling other known building materials.

CODE 36

FACING CLIMATE CHANGE OVERHEATING IN CITIES THROUGH MULTIPLE THERMOREGULATORY COURTYARD POTENTIAL CASE STUDIES APPRAISAL

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KEYWORDS: Climate change; courtyard; aspect ratio; diurnal temperature range; maximum outdoor temperature; climate zoning; courtyards monitoring.

ABSTRACT

Global warming is an imperative concern at present, therefore all disciplines, including architecture, must consider climatic factors in order to help contributing the climate change effects minimization. Courtyards as thermal tempering elements are becoming increasingly significant in a world with gradually higher temperatures. In this framework, temperatures control through passive strategies such as courtyard design, can suppose an important energy-saving device. Furthermore, considering the climate change influence on of the main energy sources, the adequate thermal comfort must be achievable with lower energy consumption, managing to reduce the average temperature of the cities, thus softening the heat island effect.

The thermal behaviour inside courtyards is influenced by different factors to be considered such as geometry, aspect ratio, orientation, vegetation, shading or albedo, but the outdoor temperature is the main reason determining courtyard thermal tempering potential. A benchmarking analysis of all these parameters is crucial to understand the thermoregulatory courtyard behaviour. To perform it, the thermal gap between outdoor and courtyard temperatures were developed in multiple courtyard case studies located in cities in southern Spain.

The present research main goal was to investigate the thermoregulatory courtyard potential in terms of different variables such as geometry, local thermal amplitude and maximum outdoor temperature. The results of the study reveal a feedback correlation between these parameters. This knowledge can help to a courtyard better design in hot areas of the planet.

CODE 74

ACTIVE RENOVATION STRATEGIES WITH BUILDING-INTEGRATED PHOTOVOLTAICS (BIPV). APPLICATION ON AN EARLY 20TH CENTURY MULTI-FAMILY BUILDING

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KEYWORDS: Renovation; multi-criteria assessment; life-cycle assessment; low-carbon buildings; building-integrated photovoltaics.

ABSTRACT

Tomorrow's cities are already largely built, as much of the existing building stock – with a low level of energy performance – will still be standing in 2050. Urban renewal processes therefore play an essential role towards the sustainable transition of European cities. In this context, building-integrated photovoltaic (BIPV) systems can potentially provide a crucial response to achieve current energy and mid- to long-term carbon targets. Functioning both as envelope material and electricity generator, BIPV systems can simultaneously reduce the use of fossil fuels and greenhouse gas (GHG) emissions, while providing savings in materials and electricity costs. These are precisely the objectives of most European energy directives, from zero- to positive-energy buildings. However, despite continuous technological progress and increasingly favourable economic conditions, the significant assets of BIPV remain broadly undervalued in the current practice.
Focusing on the architectural design, this paper presents the results of a multi-criteria evaluation in terms of Life-Cycle Assessment (LCA) and Cost (LCC) of different renovation and energy-use scenarios, showing which strategies can allow to achieve the ambitious targets for the 2050 horizon by integrating into the design process: (1) Passive strategies, to improve the envelope through low-embodied energy materials and construction systems; (2) BIPV strategies, using innovative photovoltaic products as a new construction material for façades and roofs, and by selecting the BIPV surfaces in order to synchronize on-site generation with the building consumption profile; (3) Active strategies, adapting the HVAC system to improve its efficiency and maximize PV self-consumption, thus reducing the dependence on feed-in-tariffs to ensure the profitability of investments.
The research methodology, presented in this paper through the comparison of different renovation scenarios applied on a 1900's archetype building in Neuchâtel (Switzerland), proposes a new way to address rehabilitation projects of existing buildings in urban environments towards Low Carbon Buildings. The main outcome provides - to architects and engineers - advanced BIPV renovation strategies depending on the building typology, the architectural design goals, and the level of intervention.

CODE 88

MID-TWENTIETH CENTURY HERITAGE HOUSING´S THERMAL ENVELOPE ASSESSMENT: EL CARMEN NEIGHBOURHOOD CASE STUDY

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KEYWORDS: Social housing; 20th century heritage; constructive assessment; thermal envelope.

ABSTRACT

El Carmen neighbourhood project by the architect Luis Recasens Méndez-Queipo de Llano (Seville 1955), takes place in a context signified by a very recent Spanish normative framework involving social housing and new constructive technology climate focused on the constructive systems quality standardization and the housing comfort conditions improvement.
In the economic environment leading the national scene in the Spanish mid-twentieth century, a series of regulatory factors at the national level influences the constructive definition of social housing. Among others the new regulation *Ley de Vivienda de Limitada* (1954), its regulatory application (1955), and the technical regulations and constructive norms approved on 16th July (1955) for limited-income housing carried out by the *Obra Sindical del Hogar* (OSH) under the *Plan Sindical de la Vivienda* (PSV) of the *Instituro Nacional de la Vivienda* (INV).
The present case study is one of the first to be built under this national housing plan. It should be noted that the date of signing the report of the Recasens project is September 1955, barely three months after the new national regulation and only two after the publication of the extended technical regulations.
This research has been developed within the REHABITAR project led by the Andalusian Institute of Historical Heritage. The present work main goal has been to establish a thermal envelope constructive assessment hypothesis analysed in light of the aforementioned up-to-date social housing regulation. To perform the analysis, three parallel research lines have been carried out: The regulations and records examination, the field monitoring campaigns and the detailed inspection of the thermal envelope as a whole.

CODE 91

SOCIAL HOUSING RETROFIT IN BEIRA INTERIOR FOR PRESENT AND FUTURE CLIMATE SCENARIOS

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KEYWORDS: Building retrofit; social housing; thermal comfort; climate.

ABSTRACT

An important part of the Portuguese social housing building stock was constructed prior to the 90's, when the first thermal national building regulation was introduced. Therefore, most of these buildings are characterized by poor thermal performances, and hence unappropriated regarding the resident's comfort requirements, so that refurbishment is often seen as an opportunity to improve those performances. The transposition of the European Directive on Energy Performance of Buildings - 2010/31/EU - into the Portuguese national regulation provides a framework that identifies improvement measures, according to a methodology for calculating energy needs and the minimal requirements assuming permanent heating/cooling habits. However, this methodology does not account for specific and realistic heating/cooling habits in southern European countries. Portugal has a high index of energy poverty, with intermittent heating and insignificant cooling practices. This scenario will be aggravated by the impact of global warming and climate change in buildings, which were not designed considering the potential future climate conditions. In southern Europe, projections indicate high probability of significant increase in daily average temperatures. Summer seasons are expected to become more aggressive, with the occurrence of heat waves becoming more significant, while winter seasons are expected to maintain a rigorous profile. The above mentioned situation is to be considered in the region of Beira Interior, considered as one of Portugal's most vulnerable regions. It has a low economic prosperity, making it particularly fragile to the energy poverty phenomenon. Thus, it presents one of the most rigorous climatic situations of the Portuguese continental territory during winter and summer seasons, which is expected to become more demanding in the future climate scenario. The present article presents an approach for the accomplishment of a constructive retrofit guide so as to adapt social housing buildings in Beira Interior to its actual and future climate scenarios, aiming at improving its thermal and comfort performances according to realistic heating/cooling habits. It consists in a work still in progress, therefore a preliminary formulation of intentions and its methodology are presented, and results are expected to be obtained at a later stage.

CODE 103

ENERGY REHABILITATION OF SCHOOLS IN SPAIN. ENERGY STRATEGIES FOR NEARLY ZERO ENERGY BUILDING IN DIFFERENT CLIMATE ZONES

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KEYWORDS: Energy rehabilitation; school; energy efficiency; payback; environmental impact.

ABSTRACT

This article explains the different energy rehabilitation strategies proposed in schools in northern Spain with the aim of adapting them to the directive 2010/31/EU. The objective of the communication is to demonstrate that schools built in the 70s can be buildings that are equated in energy efficiency, comfort and sustainability to new schools. The article presents conclusions obtained through the doctoral thesis carried out by the author on the processes of energy rehabilitation in school architecture. The majority of schools in the autonomous community of Galicia (Spain) were built using type projects that repeated the same architectural solution in different climatic zones of the region. This peculiarity has allowed studying energy rehabilitation strategies on a sample of 21 case studies, of which many of them are identical schools but located in different climates and orientations. The energy pathologies detected in the buildings (air infiltrations, temperature asymmetries, thermal bridges ...) and their current energy consumption are first exposed to determine in which parts of the building it is necessary to act. Secondly, it is established that actions are more effective in each part of the thermal envelope (facade, roof, gaps ...) and what is its optimum insulation thickness to establish a rehabilitation strategy that allows to reach a nZEB rehabilitated school. Finally, the viability of the strategies from an energy efficiency, investment recovery and environmental impact point of view is analyzed. The results obtained allow us to establish that an energy rehabilitation process is totally feasible in school buildings with a useful life of over 40 years. Reductions in heating demand of between 55% and 65% are obtained according to climatic zones with an average real value in demand of less than 33kWh / m^2year and of non-renewable primary energy consumption of 85kWh/m^2year. In addition, the period of recovery of the investment is less than 20 years with a reduction in CO_2 emissions compared to the state of 55%.

CODE 141

A MULTI-LEVEL STRATEGY FOR THE SUSTAINABLE RECOVERY OF HISTORIC CENTRES

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KEYWORDS: Sustainability; environment; recovery; guidelines.

ABSTRACT

The design process for the revitalization of historical city centers nowdays has to follow sustainable criteria and comfort objectives in order to rise the liveability and the opportunity of use of the built heritage. The study we propose illustrates a methodology for achiving the energy efficiency from a multilevel perspective, identifying three different dimensions -the territory, the urban context and the building-. For each dimension we move from a cognitive framework to a phase of plannnig, providing a series of operative indications. Case study of the present research is Arquata del Tronto, affected by the seismic activity starting in 2016. For research purposes we assume for Arquata a recovery of the original volumetric features. The territorial survey aims to evaluate the climatic and environmental conditions of the several districts of Arquata, scattered on both flat and mountainous areas. This leds to simplify the complexity of the territory and, by identifying similar conditions, to classify all the districts in five climatic zones. Deepening the research for each climatic zone, we outline areas with critical conditions of discomfort by analysing the facades shading and by performing a fluid-dynamic analysis of the urban fabric; we also provide the corresponding mitigation strategies at the urban level. The following step aims to improve the energy efficiency of the historical centers by working on the single buildings, in accordance to the guidelines provided by the Italian Ministry of Culture. As further deepening, the current study presents an estimation of the energy needs of the urban fabric and a corresponding hypothesis of supply from renewable sources.
In conclusion, the project provides a multi-scale guideline text usable for supporting the reconstruction process and, in general, the recovery of the built heritage, orienting the design activities towards the sustainability requirements.

CODE 169

NOVEL METHODOLOGY TOWARDS A DEEP RETROFIT IN MEDITERRANEAN SCHOOLS

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KEYWORDS: Energy retrofit in buildings; Mediterranean schools; energy certification.

ABSTRACT

As a consequence of the need for the public administration to lead the activation of the energy rehabilitation of the building park, in order to give visibility to exemplifying actions in the framework of buildings with nearly zero energy consumption (nZEB buildings), the Department d'Educació of the Generalitat de Catalunya has activated an energy retrofit study in its institutes. In this framework, 8 institutes with the highest potential for replicability, have been chosen from the point of view of the (1) year of its construction, prior the Spanish thermal regulation coming into force, and (2) the climatic zone of severe weather conditions in winter.
Predefined retrofit strategies have been defined and with the support of the official HULC, Spanish energy certification program, the buildings have been evaluated through an optimization system with the aim of improving, by at least two letters, the energy level rating of CO2 emissions, focusing the action methodology on the nZEB concept and on the of cost-optimality levels established by Directive 2010/31 / EU.
Some of the most noteworthy conclusions are linked to passive strategies: (1) the reduction of the heating demand could involve the need to introduce a cooling system to satisfy the summer comfort of the users; (2) the orientation of the windows and the use of the building is key in defining the energy transmittance and the solar protection value of the glass and the whole of the window; (3) as a consequence of reducing by half the thermal demand of the building, the energy consumption is led by the lighting system, accounting for 70% of the total; (4) night cooling is a key strategy to dissipate the heat in educational buildings, even in summer time. On the other hand, as a consequence of the minimization of the energy demand, the final value of CO2 emissions is similar both in buildings that update the heat production equipment by a biomass and condensation gas boiler. Finally, a photovoltaic system of 40kWp of energy production contributes to reducing the energy certification by one letter.

CODE 195

NZEB SCHOOLS IN ITALY: DEFINITION AND OPTIMIZATION OF SYSTEM USING PHOTOVOLTAIC TECHNOLOGY

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KEYWORDS: Sustainable schools; nZEB schools; energy consumption; renewable energy; PV panels.

ABSTRACT

The realization of a Nearly Zero Energy Building (nZEB) school cannot ignore the proper design of the building distinguishing features (shape, orientation and distribution of functional bands and units, window-to-wall ratio – WWR, structure, technological solution for the external envelope, solar shadings etc.) already during the preliminary phase of the design process in order to minimize the energy needs according to the climate zone of construction. At the same time it is necessary to identify the appropriate relationship between building and plant and consequently the share of energy ensures by renewables. In Italy, since 1st January 2017, for new buildings the 50% of energy needs for service hot water, heating and cooling must be guarantee by renewable energy. This is strictly related to the demands of "2050 low-carbon economy" (2018) that requires a decrease in greenhouse gas emissions equal to 80% by 2050. The paper concerns with the three new typological models for kindergartens, defined in a previous stage of the research, to design Nzeb schools in the Mediterranean area: one with compact shape with internal courtyard and two with a predominant linear shape respectively with three and six classrooms. In this case an electric heat pump (air-water) for heating, ventilation and air conditioning (HVAC) and service hot water powered by an integrated photovoltaic system in the building and lighting systems, plackloads and auxiliary system related to HVAC with high energy efficiency were used. The study aims at investiganting the influence on energy produced by photovoltaic panels of the shape and the geometry of the roof and the orientation of the building, considering three cities belonging to different Italian climate zones. The modeling of the system and the energy simulation in dynamic regime with hourly time step were carried out with Design Builder. To estimate the energy production of photovoltaic panels PVGIS software was used considering the system extendend to the available area of the roof. The goal is to define and to optimize the system in term of electricity production, in order to obtain a positive electricity balance and make the system able to share energy with other users.

CODE 196

INDOOR ENVIRONMENTAL QUALITY OF DWELLINGS IN THE HISTORICAL CITY CENTER OF VISEU (PORTUGAL)

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KEYWORDS: Rehabilitation; thermal comfort; temperature; relative humidity.

ABSTRACT

Ensuring adequate health conditions inside the buildings should be considered as a basic requirement, enhancing the habitability conditions and, consequently, the quality of life of the users. Regarding thermal comfort, air temperature is commonly seen as the most relevant parameter, nevertheless relative humidity also plays a decisive role, especially in the context of old building stock.
This paper aims to contribute to the characterization of the hygrothermal conditions of residential buildings located in the historical city centre of Viseu, establishing a starting point for a broad reflection and the definition of strategies, preferably passive, for the improvement of their indoor environment.
In this sense, collecting in-situ monitoring data on the hygrothermal conditions of these buildings is the first step towards a successful intervention. To this end, six buildings were selected, including original buildings (two) and recently rehabilitated buildings (four). In each building two portable sensors were placed to monitor air temperature and relative humidity, one in the bedroom and the other in the living room. The monitoring campaign was carried out from February to June 2018.
The results showed a clear agreement between indoor and outdoor temperature conditions, both in rehabilitated and non-rehabilitated buildings. Through the application of thermal comfort models, namely the ASHRAE 55 graphical model, significant periods of discomfort were found, even in the recently rehabilitated buildings.

CODE 199

INCOMING STRATEGIES FOR ENERGY PERFORMANCE REQUIREMENTS AT GREEN BUILDING RATING SYSTEMS

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KEYWORDS: Energy efficiency; sustainable design; green building certifications; BREEAM, LEED; uhuMEB.

ABSTRACT

Increasing problems about pollution and climate change have been long demonstrated by scientific evidences by The General Assembly of the United Nations in the approved 2030 Agenda for Sustainable Development. It's a matter of major importance to reduce construction industry emissions.
Buildings carbon emissions are directly related with building's energy reduction which relies not only in project and construction stages but the full life's cycle of the building. This include design, construction and operation. To help on reducing these emissions, several green building rating systems have been appearing during the last years, some of them providing multicriteria analysis, others are just single criteria focused on energy and emissions. Considering the most world spread green building rating systems (i.e. LEED and BREEAM) and others emerged in recent years, this paper aims to focus on the investigation of how they proceed with energy performance assessments, describing how energy category is weighted to obtain a global score, and how other single criteria building rating system proceed. Furthermore, this paper deeps in if these certificates are valid after building's close out and during it operation stage.

CODE 201

EVALUATION OF THERMAL BEHAVIOR IN AN EARLY 20TH CENTURY VALLADOLID BRICK FACADE, ACCORDING TO ITS WATER CONTENT

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KEYWORDS: Brick; moisture; heat flow; restoration; non-destructive test.

ABSTRACT

Nowadays, the environment and energy waste are among the main concerns of developed societies. The building is a sector of enormous influence on the evolutions of energy consumption and CO2 emissions. It is necessary to take into account that, in Spain, residential buildings and those in the tertiary sector represent 26% of final energy consumption, with 17% and 9%, respectively. In addition to this, the rehabilitation of our built-up park plays a very important role in this context. Many of the rehabilitated buildings were built with brick facades, mainly between the last decades of the 19th century and early 20th century. For this reason, it is very important to analyze the real behavior of these centennial enclosures by a detailed study of the energy flows through them, in transitory regime; since, as evidenced in recent studies, as well as in some regulations such as UNE-EN ISO 13786, the usually calculated parameter of thermal transmittance at steady state may not be the most significant. Also, these historical facades enclosures usually have a high hygroscopicity and, therefore, a high capacity to absorb water. This circumstance generates a humidity that can significantly alter the energy flows that cross the facades. Against this background, the purpose of this communication is to show the research that is being carried out to quantify the influence that humidity has on energy flows that cross these brick walls of historical buildings.

CODE 208

REUSE OF CERAMIC AND PLASTIC WASTE AS AGGREGATE IN MORTARS FOR THE MANUFACTURE OF PREFABRICATED BEAM-FILLING PIECES IN STRUCTURAL FLOORS

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KEYWORDS: Cement mortars; ceramic waste; plastic waste; beam-filling pieces; rehabilitation.

ABSTRACT

Currently, there is growing concern about the large amount of waste generated each year on the planet. In this sense, each sector must give answers in order to solve this problem.
This work describes the procedure for manufacturing a beam-filling piece for the construction and/or rehabilitation of traditional timber-beam floor structures. Pieces are made of cement mortars with two different types of aggregates: mixed polypropylene plastic (PP) waste from urban waste collection plants and ceramic residues from construction and demolition waste (CDW).
Before the piece was manufactured, the mortars were characterized in both fresh and hardened state by analysing their physical and mechanical properties, using different percentages and types of waste. The results helped determine the best dosage for achieving the levels of resistance required by law for infill pieces.
After that, the pieces were developed, obtaining their mechanical behaviour. Finally, a comparison between both types of waste was made, trying to find the most efficient solution.

CODE 215

AN ARCHITECTURAL APPROACH FOR THE DESIGN, CONSTRUCTION, AND MANAGEMENT OF MINIMUM ENERGY BUILDINGS RETROFITTED IN SUBTROPICAL CLIMATES

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KEYWORDS: Energy efficiency; sustainable design; energy retrofit; passive architecture; measurements; U-value.

ABSTRACT

Although construction sector is responsable of nearly the 40% of green house gases production in the European Union (EU), the new building industry is just a little part of the whole operating building sector. Specially in EU during the 50's, the 60's and the early 70's -the period including the big reconstruction after the second world war and before the first petrol crisis in the middle 70's- most of the new periphery of big cities were built up with social neighbours without taking care of the minimal energy performance of the building. In case of they need, the inhabitants of those social houses could use households for heating or cooling their houses, because electricity in that period used to be affordable and easy available. Cose owners have had no money enough to retrofit and improving the quality of the materials used in the original construction, most buildings have remained in the same state as they were built, becoming obsolescent and converting social neighbours in energy sinks, cause of big energy waste and even energy poverty for those who can't afford the cost of the electricity they need to use to maintain their homes in healthy conditions.
Same authors settled a new methodology for the design, construction and management of Minimum Energy Buildings (uhuMEB) in subtropical climate. A MEB is a building that demands very low energy and, depending on the level of exigency and resources available, can produce renewable energy on site to attend some part of it demand (nZEB), it whole demand (ZEB) or even produce more that it needs (+ZEB). This methodology was specifically oriented to new buildings and include the whole process from negotiation with the client, passing throw the project design, the construction works and finally the operation phase of the building.
In this paper, we open this new uhuMEB methodology for retrofitting proposes (named it as uhuMEBr), according to the general principles settled, but including new specifications truly adapted for existing buildings.

CODE 220

REGENERATION STRATEGIES ON SOCIAL HOUSING IN CHILE: FROM DEMOLITION TO TRANSFORMATION BETWEEN PAST, PRESENT AND FUTURE

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KEYWORDS: Energy efficiency; social housing regeneration; building envelope Retrofit; building energy simulation.

ABSTRACT

Recent housing policies in Chile have promoted a massive housing model to reduce its deficit while minimizing construction costs. This model has resulted in the deterioration of their inhabitants' living standards, the buildings and the urban context. The crisis originated by the Type C Blocks led the government to question the current housing policy and to promote new policies to regenerate existing housing. The "Regeneración de Conjuntos Habitacionales" program has established the urgency to reduce these buildings' qualitative deficit using regeneration strategies. The case study is a group of 16 housing blocks at the Marta Brunet complex in Santiago where a prototype proposal will be built to verify the effectiveness of the intervention on a larger scale. The research here presented developed an analysis of the current situation based on literature review, energy performance simulations, field observation and interviews with key informants. Results show existing buildings present low building standards, poor energy performance and living conditions, in some occasions even hazardous for their residents. However, demolition is not the prerogative of the inhabitants, who mainly would prefer to improve living conditions of existing buildings. From the structural point of view, the existing structure is not at risk of collapse, but is incapable to resist any additions or expansions. Based on the results, a regeneration proposal was developed based on an independent structure and a new layout according to users' needs. The proposed building envelope considers an improved energy performance that has been evaluated through dynamic calculations in order to quantify its relevance. Finally, the benefits of the proposal are discussed with emphasis on energy performance, showing the advantages of the rehabilitation approach and its further possibilities.

CODE 223

TEMPERATURE VALIDATION OF AN ADVANCED HYGROTHERMAL MODEL: STATISTICAL ANALYSIS

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KEYWORDS: School buildings; prototype; experimental measurement; numerical simulation; validation.

ABSTRACT

Portuguese school buildings are generally characterized by an in-service thermal discomfort, due to the poor envelope thermal properties and the lack of resources for paying energy consumption. Portuguese schools are free-running buildings in a Mediterranean temperate climate, with a natural ventilation strategy.
The constructive records of the past describe the existence of typified projects for school buildings replicated throughout the country, without the necessary adaptations to the particular climatic situation. Likewise, the replication of solutions in rehabilitation projects, without taking into account the climatic reality, will have repercussions on the hygrothermal environment inside the classrooms.
This work studies the Portuguese *Brandão* basic schools (from the '70s). About 100 non-refurbished *Brandão* schools will require some interventions in the near future. A prototype classroom was prepared in a *Brandão* school, in Porto. With this prototype, some studies were carried out regarding the thermal behavior before and after a refurbishment process, by experimental monitoring. The in situ experimental campaign consisted of temperature, relative humidity, CO_2 concentration and energy consumption measurements.
This extended experimental campaign (three academic years) was a crucial tool to validate an advanced dynamic hygrothermal model of Heat, Air and Moisture transfer – Wufi Plus. The calibration process consisted of comparing and minoring differences between experimental and numerical results of temperature. Given the duration of an experimental campaign like this and also the cost of the prototype, it was important to dominate and improve the numerical model that replies the *in situ* conditions and allows the studying of the other Portuguese *Brandão* buildings.
This paper presents the temperature validation of this model in three distinct situations: (1) before refurbishment without heating, (2) after refurbishment without heating and (3) after refurbishment with heating. The main inputs were climatic data, building envelope, inner gains, solar gains, ventilation and heating strategies and the main output was the temperature.

CODE 225

THE INFLUENCE OF INSULATION ON THE PASSIVE DISCOMFORT INDEX OF DWELLINGS LOCATED IN HISTORICAL BUILDINGS WITH INTERMITTENT HEATING PATTERNS

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KEYWORDS: Historical buildings; dwellings; intermittent heating; southern Europe; comfort assessment.

ABSTRACT

There is a great potential for comfort improvement and energy refurbishment in residential built heritage. Those dwellings present sometimes very poor thermal comfort conditions, with direct consequences in its habitant's health. The Energy Certification Schemes (ECS) represents the most powerful tool to improve the energy efficiency of the European building stock, specially designed for permanent heating habits and for new buildings. Although, some studies show that the introduction of traditional improvement measures indicated on Energy Certificates (EC), as high insulation thicknesses, may not always have the high expected benefit, concerning Mediterranean climates, where the most common practice is intermittent heating on winter. Also, energy poverty phenomena explain low heating habits in these countries, which is different from the regulation assumption of permanent heating in space and time.
A sensitivity study was carried out for two climates of southern Europe, using a historical building, previously validated in a monitoring campaign. The consequences of placing insulation in facades were evaluated in terms of discomfort hours and energy consumption, for a low intermittent heating scenario and free-floating temperatures, for different orientations. The results confirm the need to reflect if the ECS is the best approach to evaluate the thermal performance of these type of buildings, in a moderate climate with low heating consumptions.

CODE 266

EXPERIMENTS IN HYGROTHERMAL AND FREEZE/THAW EFFECTS OF INSULATING MASS MASONRY WALLS

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KEYWORDS: Masonry; insulation; energy improvements; freeze/thaw.

ABSTRACT

Much of the current literature and thinking concerning insulating mass masonry walls cautions that adding insulation significantly increases the potential for freeze/thaw damage to the masonry and other moisture-related issues. This literature asserts that adding this insulation should be done with caution and only after testing the existing masonry's hygric and strength properties and performing hygrothermal modeling of the wall assembly both with and without interior insulation and air barriers (often costly exercises). However, we have not yet found a documented case of adding interior insulation to a mass masonry wall causing damage without additional detrimental factors, such as bulk water leakage into the wall at the roof or windows. Also, previous research on freeze/thaw durability and the conditions necessary to cause freeze/thaw damage seems to indicate that masonry generally must experience far greater stresses that insulation typically imposes on the masonry for such damage to occur.

After reviewing this previous research on freeze/thaw damage to masonry, this paper presents in-progress research specifically on the effect that interior insulation has on the capillary suction of historic brick samples and on what would be realistic moisture content and temperature cycling of brick units, based on hygrothermal modeling results from several previous projects. Previous research has shown that both significant water content and rapid temperature cycling typically are necessary to cause freeze/thaw damage. The hypothesis for this testing is that brick masonry units in general will have much lower moisture content and experience far more gradual temperature cycling after adding interior insulation in real-world applications than is necessary to cause freeze/thaw damage.

CODE 283

GREEN DESIGN OF ECO-CEM SYSTEMS AS A PROPOSAL FOR SUSTAINABLE REHABILITATION OF HISTORICAL CEMETERIES. CASE STUDY: LA APACHETA GENERAL CEMETERY - AREQUIPA

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KEYWORDS: Sustainable rehabilitation; green design, Eco-Cem, La Apacheta General Cemetery.

ABSTRACT

This research presents a special case study on the application of green design of Eco-Cem systems. Arequipa, a peruvian populous city with one million inhabitants or more has a few urban green spaces so that, according local newspaper reference in present year, this appreciation is maintained and even increased demonstrating that green systems incorporated in metropolitan area are needed ; however, in the historic zone exists architectonic infrastructure declared as historical and cultural heritage; among them and perhaps the oldest is La Apacheta General Cemetery (LACG) which has been operating since 1833, so its infrastructure, constructions and distribution are considered non-functional and obsolete since it has not received potential technological inputs useful throughout its life period becoming an asynchronous system with human population growth since it has been located in downtown of the city and without considering any harmonious tourist and environmental factors. The results obtained in this research declares LACG as a dysfunctional system considering the described pathology and developed a technological innovative design of rehabilitation based on three stages of management (diagnosis, harmonization of green areas and traditional infrastructure and design for the application and use of sustainable photovoltaic energy) for its transition programmed and final transformation to a hybrid functional system called Eco-Cem (contraction of eco-park and cemetery technical terms) proposing in applied methodology like a re-engineering of the system and the efficient management of its resources using mass and energy closed cycles for the self-generation of photovoltaic electric energy that guarantees eco-sustainability to consume the water resources of its green areas, efficient treatment of their residual flower waste for the organic production of bio-fertilizers and, specifically, the conservation of its native vegetation and the expansion of arboreal green spaces within the sacred field.

CODE 337

DESIGN AND STUDY OF PREFABRICATED MATERIALS FOR USE IN THE INTERIOR CONSTRUCTION AND ENERGY REHABILITATION OF THE BUILT HERITAGE

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KEYWORDS: Energy efficiency; polyurethane foam waste; recycling; plaster mortar.

ABSTRACT

The research developed studies the design of gypsum mortars dosed with valued polyurethane (PU) foam residues, with the aim of obtaining environmentally friendly building materials with improved thermal properties. Based on previous laboratory studies, suitable dosages of plaster-based mortars have been designed, using A1 (E-35) and B1 (yg) plaster as a binder, together with polyurethane (PU) foam and water residues. The corresponding characterization tests have been carried out, both in the fresh and hardened state, following the standards determined by the European Regulation of application. The results show that plaster-based mortars have good technical performance, similar to those of standard reference mortars. On the other hand, some thermal properties of mortars designed to know their behavior as insulating material have been studied. The Coefficients of Thermal Conductivity, Thermal Effusivity and Thermal Diffusivity have been studied. The results obtained allow us to affirm that the designed gypsum-based conglomerates show a good thermal behavior, retain heat and emit it to the environment slowly, which allows obtaining more efficient walls from the point of view of thermal comfort and the habitability conditions of buildings. Although more specific complementary studies have to be done, the first results show that the use of polyurethane (PU) foam residues in the design of plaster mortars can be a competitive advantage as an environmentally efficient construction material.

CODE 372

ENERGY RENOVATION OF THE BUILT HERITAGE HOUSING BASED ON THE LIVING BUILDING CHALLENGE CERTIFICATION. CASE STUDY IN BRESCA (SPAIN)

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KEYWORDS: Heritage; retrofit; sustainable architecture; energy simulation; living building challenge certification.

ABSTRACT

In light of increasing sustainability requirements, one of the challenges related to the heritage building stock consists in finding a balance between preserving the existing architectural character and improving energy efficiency. The project presented in this article has been carried out through a collaborative design process, involving experts from different disciplines (e.g. construction, energy, low-carbon materials, etc.), through a simulation-driven approach integrating both architectural and energy-performance evaluation aspects from the early-design phases of the project. In order to go as far as possible in terms of sustainability, the Living Building Challenge (LBC) label has been taken as a guide, providing a design framework to create regenerative spaces where people connect to daylighting, air, food, nature and community. It aims to obtain self-sufficient buildings from a holistic point of view (e.g. positive-energy building approach, treatment of the used-water onsite, prioritizing low-impact materials to obtain healthy living spaces).
The project consists of the complete renovation of a rural home located in the medieval urban fabric of a small village called Bresca in the north of Spain. The initial construction date is unknown, but the house underwent a first basic renovation in 2007. The building consists of a typical farmhouse, well oriented regarding solar exposure, with poorly insulated massive walls and no heating system. The renovation project includes both passive and active strategies, improving thermal insulation of the building envelope and integrating a sunspace that helps to reduce heating and lighting demand, in addition to a photovoltaics (PV) installation with storage system that feeds a high-performance heat pump. This paper focuses on the energy aspects, comparing design results and post-occupancy evaluation in terms of energy consumption/production (energy performance gap). We highlight the high energy performance achieved while surmounting the architectural challenges related to the heritage constraints of the existing building. Results show that between February and March 2019, the house produced 858 and consumed 508 kWh, demonstrating that it is possible to achieve high levels of annual PV coverage ratio while respecting and valuing traditional architecture.

CODE 409

HOSPITAL LIGHTING: FROM VISUAL FUNCTION ASSISTANCE TO THE WELCOMING AND HUMANIZATION TOOL

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KEYWORDS: Hospital lighting; quantity and quality; reception and humanization; light and color.

ABSTRACT

Hospital lighting has often been relegated to the background within the concerns surrounding these environments. In general, management is given more importance due to the complexity of the hospital structure. However, regarding the health and comfort of the main hospital users – namely the set of professionals who work there and the patients – proper lighting can positively influence. This paper deals with hospital lighting. It addresses the Brazilian standards governing hospital projects and the standardization used in the lighting of these environments. It analyzes quantitative aspects of hospital illumination, regarding the observance of minimum illuminances established by the norms, and those regarding visual quality. In addition to these requirements, which serve the visual function strictly, it discusses lighting as a tool to improve hospital environments, in order to make them more welcoming and humanized, providing better conditions of care, safety and comfort to users. This perspective implies reflecting on the use of color. Combined, light and color can enhance this process, giving a special character to hospital spaces.

CODE 423

DESIGN OF SUSTAINABLE SOLUTIONS FOR CONCRETE BLOCK WALLS

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KEYWORDS: Recovery filler; recycled concrete; grout; masonry concrete blocks.

ABSTRACT

This work focuses on the use of recovery filler obtained from hot-mix asphalt concrete plants joined to recycled aggregate to produce grouts to be used in masonry concrete blocks. The works has been developed in the framework of ALFILLER research project. This project is supported by FEDER funds throughout the Axencia Galega de Innovación (GAIN) in the CONECTA –PEME 2018 call. The partnership is integrated by the following companies: EXTRACO, GALAICONTROL, PREFHORVISA y RENGA.

Ten grout mixes, divided into two different series, were designed: one without the incorporation of recycled aggregate and the other adding a 20% of this material, replacing the conventional sand. In both series a commercial limestone filler was used and then replaced by recovery filler using different replacement rates: 0%, 25%, 50%, 75% y 100%.

All grouts were characterized in fresh and hardened state. It was concluded that all of them fulfilled the compressive strength minimum requirements of this kind of material.

Finally, a sustainable building solution was designed using grouted masonry concrete blocks. Compressive strength tests were developed in two different concrete blocks: a conventional concrete block (40x40x20cm dimensions) and a sustainable concrete block that incorporates bottom ashes from carbon thermal plants replacing the conventional aggregate (with the same dimensions). Both blocks were grouted with the control grout (without any of the wastes) and the grout that incorporates 100% recovery filler and 20% recycled sand. Results showed that grouted block with the wastes presented the best behaviour in terms of compressive strength due the deformation compatibility.

CODE 431

A DESIGNING METHODOLOGY FOR OPTIMAL SIZING OF PHOTOVOLTAIC AND ELECTRICAL STORAGE SYSTEMS FOR TERTIARY BUILDINGS

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KEYWORDS: Self-consumption; photovoltaic energy; electrical storage; multiobjective optimization; sequential quadratic programming.

ABSTRACT

This article presents a novel methodology to define the optimal design of photovoltaic installations and electrical storage systems focused on both new installations and retrofit buildings of the tertiary sector. The proposed methodology consists of using a multiobjective optimization algorithm based on sequential quadratic programming, which evaluates several economic and energy impacts of different sizing strategies (for photovoltaic generation and electrical storage) and determines the optimal one, based on the building´s characteristics and conditions, as well as in the design criteria established by the user. The proposed methodology integrates photovoltaic models that permit to calculate the potential of energy produced in the installation, in terms of the cell technology and the climatic conditions, as well as the restrictions of the available surface. Moreover, it includes models of electrochemical batteries to calculate the storage capacity and efficiency for different cell size configurations. In both models, the algorithm considers the performance losses of the technologies due to the energy conversion as well as the losses related to their aging throughout their use. Finally, based on the demand profiles of the building and its climatic conditions, the developed algorithm calculates the energy flow in the installation, in terms of energy exchange with the grid (supply and export), storage and self-consumption, and evaluates the resulting energy and economic impacts for different sizing configurations. In terms of optimization criteria, it permits to establish or minimize the investment and operating costs of the installation, to maximize the self-consumption ratio of the building and to minimize the return of investment ratio. The proposed methodology (and algorithm) has been developed and validated in the research project ELDE, in the framework of the European program for Research and Innovation Strategies for Smart Specialisation call (RIS3).

CODE 435

A THERMAL COMFORT ASSESSMENT IN A REHABILITATED RESIDENTIAL BUILDING OF THE CITY CENTER OF TEGUCIGALPA, HONDURAS

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KEYWORDS: Rehabilitation; city center; dwellings; thermal comfort; overheating risk.

ABSTRACT

This study develops an assessment of indoor thermal comfort conditions in five apartment-type dwellings of a rehabilitated building, previously abandoned, now intended for residential use, which is in the city of Tegucigalpa, Honduras, with a tropical hot climate. For the development of the study, a monitoring of indoor temperatures was developed for 41 days during the hottest and driest season of the year. Since this unprecedented pilot project seeks to promote new housing projects in the historic center of Tegucigalpa, the objective of this study was to measure whether the rehabilitation was effective in terms of thermal habitability conditions. The rehabilitation was assessed by identifying the hours of exceedance where indoor operative temperature exceeds the maximum acceptable temperature, following the adaptive thermal comfort approach of ASHRAE Standard 55. The study demonstrates that the preservation of passive measures of the original design (sun protection in the facade and the inner courtyard) help to provide comfortable indoor temperatures during the hottest period of the year, with the exception of some dwellings that experienced hours of exceedance during the afternoon and evening hours. Among the factors that influenced dwellings to experience hours of exceedances, is the lack of natural ventilation, orientation and level in the building. Rehabilitation projects can achieve the double objective of preserving the identity of the building and the city center, and in turn provide healthy thermal conditions for the occupants.

CODE 461

ECO-REHABILITATION OF COURTYARD HOUSE

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KEYWORDS: Heritage; courtyard house; climate comfort; eco-rehabilitation.

ABSTRACT

At the moment, the balance between comfort and ecology has become the equation to be solved for any new Project [1]. This balance must also be maintained during rehabilitation projects, and if possible with more enthusiasm when it comes to heritage. Evolving this approach is a vast subject that has yet to be explored.
Therefore, our research work is part of a rehabilitation perspective of the patio house. At the end of the identification of the different constructive typologies of our case study "Dar Meziane" in Constantine. Measurements were made in situ, followed by a numerical simulation for the evaluation of climatic comfort inside the house, in order to integrate this environmental dimension into the rehabilitation operation of Constantine's patio houses, such an approach ensures the sustainability of this heritage.

CODE 484

APPLICATION OF THE BIM METHODOLOGY IN THE ENERGETIC REHABILITATION OF PUBLIC BUILDINGS

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KEYWORDS: Energetic rehabilitation; BIM methodology; public buildings.

ABSTRACT

The rehabilitation of buildings has been growing in recent years and is currently one of the areas with the highest investment, both by the public sector and the private sector. In fact, when it comes to the rehabilitation of a building, the main objective is to increase its life cycle, allowing greater adaptability to new functionalities, increasing quality standards and consuming less material and energy, compared to the new construction. In this sense, it is understood that the rehabilitation of buildings is evidenced as an area where one of the guiding principles should be the sustainability. The energy rehabilitation has a high potential of savings at different levels, allowing optimizing the energy consumption of the inhabitants with solutions that correct the low constructive quality and the functional inadequacy. As such, sustainable building techniques should become an integral part of rehabilitation strategies, in order to safeguard resources for future generations.
The present work intends to approach how the use of digital tools allows a more efficient approach in the search of energy rehabilitation solutions of a public building, using an approach supported in BIM methodology. The different analyzes performed from the energy performance point of view of the building are presented, testing different constructive solutions and analyzing each of them. That allows to see which is the most effective solution and the advantage of using BIM in an initial design phase. The application of BIM in energy rehabilitation allows a joint study of the different performance types of alternative solutions to be carried out. The main conclusions are presented and the future developments of the work are considered.

CODE 501

CONSERVATION AND RENOVATION TO NZEB OF SILVIO SPAVENTA FILIPPI ELEMENTARY SCHOOL IN AVIGLIANO, POTENZA, ITALY

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KEYWORDS: Conservation; renovation; energy consumption reduction; nZEB building.

ABSTRACT

In Italy, a large part of the public service functions (administrative, educational, health, social services, religious) is carried out in buildings that also represent an important part of the cultural and historical heritage. In terms of sustainability, the preservation of their constitutive and formal characteristics is as important as their renovation, so that they can perform the tasks entrusted to them efficiently and with the lowest consumption of non-renewable energy. The kindergarten and elementary school "Silvio Spaventa Filippi" in Avigliano, an ancient city of about 5,800 inhabitants a few kilometers from Potenza, in the center of southern Italy, is a large and monumental building (2,480 m^2 of covered area, above of a lot of 4,680 m^2). It has three floors, with a symmetrical pentagonal plan and a central courtyard. Built in the years 1930-35 in classicist style, it was seriously affected by the earthquake of 1980 and, in the following years, it was the object of partial demolition and reconstruction interventions. In present days, the building is in use as an essential part of municipal school services, but needs to be upgraded in terms of fireproofing and functionality, especially from the acoustic perspective. Furthermore, it is very energy-intensive, with annual consumption ranging between 474.70 kWh/m^2 and 652.71 kWh/m^2, because of the two heating systems of which it is provided. The aim of the research was to verify the following points: 1 – that the analysis had been carried on the stability of the slope on which the school stands; 2 – that all parts of the building were resistant to the earthquake; 3 - that the fire regulations, the acoustics, lighting and those relating to the accessibility were respected. The necessary corrective actions were designed following the results of the analyzes. Furthermore, the requirements of the most recent school regulations regarding the enhancement of activities have been introduced. Finally, intervention have been designed to make the building energy efficient, so that it can be classified as nZEB, nearly Zero Energy Building, according to the Directive 2010/31/EU. Its energy consumption has thus been reduced by 93-94%, bringing them to 32.37-40.76 kW/m^2 per year. All this, while renewing its appearance and respecting its formal characteristics, as an important part of the monumental heritage of the city.

CODE 522

NEW FUNCTIONAL ROLES AND ENERGY EFFICIENCY IMPLEMENTATION IN THE RECOVERY OF MINOR HISTORICAL CENTRES

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KEYWORDS: Energetic rehabilitation; minor centre; new functional roles; systems upgrade.

ABSTRACT

The importance of spontaneous architecture is internationally acknowledged and many authors have dedicated studies to this topic. In Italy the architecture of the minor historical centres characterizes the internal territory of the regions and it is very important as it is the result of local knowledge. In fact, it includes many case-studies and a large amount of information, some of which still needs to be decoded. The central theme of the problem lies in the need to give back a function to historical centres and repopulation would also allow the physical recovery of these places. The possibility of recovering minor buildings would not only save land use for the new construction, but would also involve an environmental advantage, with the possibility of defining design methods to bring the existing built heritage back to life. A viable way is the active conservation, through a controlled transformation. This approach restores the centrality of the project and allows the preservation of the formal, typological, architectural, technical-constructive features on the one hand, the technological and functional updating of the historical building on the other one. This paper shows a case study of a rehabilitation project of a building aggregate locates in the hinterland of Abruzzo, in which a mix of compatible strategies is used to promote functional recovery and performance upgrading, in full compliance with the historical, architectural and construction values.

CODE 537

SUSTAINABLE CONSTRUCTION AS A FUTURE HERITAGE: TECHNIQUE, ROOT AND NATURAL CONTRACT

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KEYWORDS: Future heritage; energy and water efficiency; sustainable construction; root.

ABSTRACT

Heritage is understood as built, the old, however, it was once "present", even "future", in the sense that it went through the stage of the idea, and then derive in project and materialized piece. Obviously characteristics such as beauty, relevance to the social and environmental context, and durability make the building pieces heritage. But at present, due to a linear or little reflexive model of the construction activity, where the economic exercise prevails, repetitive projects are being generated that do not know the characteristics of the territory to be intervened. That is why this work reveals how sustainable construction claims knowledge and interpretation of the context to conceive a work that “dresses in place”, using materials with low environmental impact, affordable cost and optimal performance. Rescued construction techniques such as tapia, bahareque and adobe (cement floor block), are resigned and begin to be part of the collection of modern solutions that, given their uniqueness and cultural roots, may result in architectural and cultural heritage.
The experiences developed by the research group allow us to obtain buildings with architectural designs consistent with the socio-environmental context; savings of up to 80% and 100% of energy and water consumption; ventilated and naturally lit spaces, without mechanical air conditioning assistance; and, very important, with a high conceptual assessment by the communities, which allows consolidating a future *patrimonialization* of the project.

CODE 543

SUSTAINABILITY THROUGH RECYCLING FOR BUILDING SELF- CONSUMPTION

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KEYWORDS: Landfills; self-consumption; wind turbine; emissions.

ABSTRACT

Currently, in underdeveloped countries, the lack of electricity supply enables the use of other generation systems that are less efficient and have more environmental impact.
In developed countries, the reduction of the useful life of some technologies leads to the replacement of certain equipment that still have different features and possibilities.
Controlled recycling of the diverse material found in landfills located in underdeveloped countries can help the social, economic and environmental sustainable development of these regions.
This article discusses some possibilities of recycling, developing a technical-economic study on the reuse of materials for the self-consumption of the building of the regions and their possible extrapolation to cooperation between regions. An economic analysis of recycling for self-consumption is described for the user and for the region involved, then the benefits and possibilities are indicated.

CODE 549

THE THERMAL COMFORT IN BUILDINGS OF VERNACULAR ARCHITECTURE OF THE CITY OF LOJA AND MALACATOS - ECUADOR

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KEYWORDS: Thermal comfort; vernacular architecture; sustainable material.

ABSTRACT

The objective of this study is to determine the influence of the sustainable characteristics of the vernacular architecture on the thermal comfort of its occupants in two bioclimatic scenarios in the cities of Loja and Malacatos. The case studies are eight vernacular dwellings; and a reference house of common practice. Experimental measurements were made in situ for a period of 50 days (11/20/2015 - 06/27/2016). Adaptive methods of the ASHRAE-55 standard were used to evaluate the occupants; the graphic method of the aforementioned standard for the thermal performance of homes; and Givoni's psychometric diagram for passive strategies. The results obtained in the thermal performance show that, the traditional materials in houses present a great potential for their use in contemporary constructions.

CODE 552

DISSEMINATION OF BEST-PRACTICE IN ENERGY RETROFIT OF HISTORIC BUILDINGS. RAINHOF, A CASE STUDY IN THE ITALIAN ALPS

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KEYWORDS: Historic buildings; case study; energy retrofit; best-practice; database.

ABSTRACT

Energy retrofit will be key in achieving the comfort and energy standards that are needed to ensure the continued use of historic buildings and consequently their conservation. Dissemination of best-practices is a powerful tool to engage building owners in the adoption of low-carbon measures and increase the renovation rate of buildings (currently below 1% per year).
This paper presents an exemplary case study of a building renovation in the Alpine region of South Tyrol, Italy. The documentation follows the structure developed within the research projects IEA-SHC Task59 and Interreg Alpine Space ATLAS for the elaboration of a best-practice database (available at www.hiberatlas.com). The structure of this database allows the case study to be presented in a way that the information is targeted to the end-users responding to their different needs and requirements. This database will offer owners, architects and developers the possibility to find the inspiration and information needed to pursue their own renovation projects and profit from already existing knowledge.
The building presented here, a listed farmhouse built around the 16th century at 1,500 m above sea level, presents many traditional features such as solid wood construction with decorated balconies, windows with deep reveals and painted frames, or vaulted ceilings. The renovation included insulation of walls, roof and ground floor, replacement of windows and heating system, and the installation of renewable energy sources. The intervention reached low levels of energy demand that are fully covered by renewable sources produced on-site. The open dialogue and support among owners, architect and the local heritage authority ensured the quality of the retrofit towards high standards of efficiency and comfort in the building while preserving its cultural integrity.

CODE 573

IS INFORMATION SYMMETRY SUFFICIENT IN THE PROMOTION OF ENERGY EFFICIENT HOUSING? MAIN RESULTS OF THE ENERVALOR PROJECTS

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KEYWORDS: Energy efficiency; EnerValor; stated; observed preferences; housing.

ABSTRACT

The regulatory requirements related to energy efficiency in housing in Europe date from the late 1970s, that is, they are subsequent to both post-war residential reconstruction and the stages of maximum urban growth due to rural-urban migration. In this way the deficiencies of the existing stock are very relevant with enormous repercussions on energy consumption, CO^2 emissions and energy poverty of the most vulnerable households. For this reason, the EC universalized, in 2010, the EPC energy efficiency certificates, trusting that information transparency would activate, through informed decisions, an efficient building and rehabilitation circle. This article reports the results of the EnerValor project focused on knowing to what extent the EPC scheme, implemented in Spain by RD 235/2013, has foster efficient housing. This project is based on qualitative methods based on in-depth interviews with the key agents of residential production and on quantitative methods aimed at knowing the impact of the EPC energy classes on real estate prices, the level of understanding of households in relation to the energy efficiency and its relevance in residential choice. The results suggest that, although the energy rankings have a positive correlation with residential prices, it is not clear that this responds to greater energy efficiency, but to a concomitant constructive quality. In fact, experts interviewed believe that households, in general, do not give importance to the energy benefits of housing and, therefore, the offer does not premium them. In addition, they point out important shortcomings in the Spanish implementation of the scheme in terms of communication, argumentation, supervision and calculation. However, according to our choice experiments, if households are informed in a simple way what is energy efficiency and also on the repercussions on their family budget and the environment, then this attribute becomes relevant in residential prioritization, even declaring a greater willingness to pay for the most efficient housing. Together, it poses important challenges for the energy and housing policy and the energetic rehabilitation of buildings trough out its market depreciation.

3.- BUILDING INTERVENTION

CODE 22

RETHINKING HOUSES FOR WILDLAND FIRE PROTECTION

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KEYWORDS: Wildland fire; house protection; construction methods; fire resistant materials; fire bunker.

ABSTRACT

In recent years, fires had a major impact on the forest areas in Portugal (2017 fires of "Pedrógão Grande" and "October 15"), mostly due to high combustibility of the wildland and some climate change. These spread to the wildland-urban interface, due to wind effects and poor urban forest area management, causing severe lasting damage or even the destruction of dwellings. It was subsequently observed that the dwellings were rebuilt with similar characteristics to the original ones, disregarding interventions with new techniques in order to protect them. This paper presents a research on solutions for new houses ("fireproof houses") using current building materials but with characteristics to maintain the overall structure for a longer time during a fire exposure. Reference is also made to protect existing houses located in highly endangered wildland fire areas and to the situation of isolated villages surrounded by vegetation.

CODE 70

THE DIRECTOR PLAN FOR THE RECOVERY OF THE LORCA CULTURAL HERITAGE AFTER THE SISM OF 2011. COMPARATIVE ANALYSIS IN THE INTERNATIONAL CONTEXT

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KEYWORDS: Director plan; Lorca; earthquake; cultural heritage.

ABSTRACT

The Director Plan for the recovery of the Cultural Heritage of Lorca was promoted by the Ministry of Culture after the earthquake of May 11, 2011, as a coordination tool between the Institute of Cultural Heritage IPCE, the General Directorate of Cultural Assets of the Region of Murcia, the City Council of Lorca and the Bishopric of Cartagena. It was drafted in June 2011 and approved by the Council of Ministers on October 28, 2011.
It is a document that reflects the degree of affection of cultural property through individualized records, quantifies the necessary investments, reflects a program of action for its recovery and establishes the criteria for restoration, prioritizing rehabilitation according to its degree of cataloging and its impact on the Lorca society. For the development of the Plan, a Control and Monitoring Commission was created that has coordinated the investments for the recovery of cultural heritage.
The management of the Director Plan is analyzed in the time it has been in effect since its approval, showing the intervention times for real estate and the quantification of economic resources through timetables, indicating the evolution of the investment made and the administrative procedure of recovery actions.
This management has had international repercussion, being the 2011 earthquake in Lorca a natural catastrophe in a context where the earthquake of L, Aquila 2009 was an immediate precedent in the management of restoration of cultural property in the European Union. Mexico's 2017 earthquakes have also provided another management model in a country with devastating seismic events in its history. From the comparative analysis, conclusions are obtained for future management actions for the recovery of cultural heritage after an earthquake.

CODE 185

MULTI-SCALAR ANALYSIS SYSTEM FOR THE PRIORITIZATION OF INTERVENTIONS IN ARCHITECTURAL HISTORICAL HERITAGE: THE CASE OF SAN AGUSTÍN NEIGHBORHOOD IN PUEBLA CITY, MEXICO

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KEYWORDS: Risk Analysis; architectural heritage; GIS; MASPI; indicators system.

ABSTRACT

The aim of this article is to show the state of evolution in the development of the MASPI system (Multi-Scalar Analysis System for the Prioritization of Interventions in the Architectural Historical Heritage) through which it seeks to prioritize the interventions made in the architectural historical heritage of Latin American historic centers, supporting decision-making through the acquisition and interpretation of different indicators that can be incorporated gradually according to the needs of the system. In this exercise, risk is taken into consideration as a fundamental factor to understand and prevent some phenomena that affect the architectural heritage; through the review of the state of the art regarding this topic, a simplified risk analysis matrix is proposed, which is applied to four types of architecture representative of the main phenomena to be analyzed, taking as study area the San Agustín Neighborhood, in the city of Puebla, Mexico. With the objective of optimizing and facilitating the management and interpretation of the acquired information, the methodology was integrated to the use of a GIS software (Geographic Information Systems) of free license, which resulted in a significant improvement in the effectiveness of the system as an auxiliary means for decision making concerning the intervention of the built heritage.

CODE 488

MULTICRITERIA ANALYSIS TO SUPPORT DECISION IN PUBLIC BUILDINGS REHABILITATION INTERVENTIONS

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KEYWORDS: Multicriteria analysis; decision support; rehabilitation; inspection sheets; public buildings.

ABSTRACT

The rehabilitation of buildings emerges as an opportunity for the construction sector to readapt, betting on the requalification of the existing patrimony, improving, if possible, its quality based on principles of sustainability. In this sense, when it is intended to carry out some type of intervention in public buildings, in addition to the fact that these interventions are financed through public funds, several opinions emerge from the various stakeholders in this theme that should help to support the decision on which intervention rehabilitation. In order to minimize the complexity of the decision making process, it is sometimes necessary to use methodologies and / or support tools, such as models based on Multicriteria Analysis. The structuring of multicriteria models allows the support of public decision-making in complex and low-definition problems that usually involve multiple points of view. This process helps the decision-maker in defining which priority interventions to implement, minimizing their impact, while reducing expenditure and maximizing the investment of public funds.
The work developed includes the description of the building studied, the inspection and diagnosis of anomalies, the presentation of specific intervention solutions and the development of a multicriteria analysis to support decision making. This analysis will use the choice functionalities contained in the MACBETH model, which allows the decision agent to define the priority intervention solutions to be taken. The results obtained, and duly justified, aim to demonstrate that this usefulness methodology is very promising in the support of decision making on possible rehabilitation interventions in public buildings.

CODE 489

MULTICRITERIA ANALYSIS APPLIED TO PUBLIC REHABILITATION INVESTMENTS

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KEYWORDS: Multicriteria analysis; decision support; rehabilitation; railway infrastructure; port infrastructures; public buildings.

ABSTRACT

Multicriteria Analysis is a decision-support tool and is applied in the comparison of alternative projects, allowing to consider several criteria simultaneously. Its purpose is to structure and combine the different alternatives considered in the decision-making process. This process should be based on multiple choices, and the treatment given to each of the choices leads to the final decision. It is usually used to synthesize expressed opinions, to determine priorities, to analyze conflict situations, to formulate recommendations, or to provide operational guidance. This technique can be applied in the decision process related to projects in the Architecture, Engineering, Construction and Operation (AECO) sector. Through a Multicriteria Analysis, different options can be integrated into the actions to be taken by the decision makers, reflecting the opinions or interests of different actors involved. In this analysis, several objectives related to the rehabilitation project and / or intervention in question are simultaneously considered. In the assessment of public investment, the objectives or interests that have not been integrated into Financial Analysis or Economic Analysis can now be considered.
The present paper intends to frame the multicriteria analysis with the objective of optimizing several investment projects in the rehabilitation of railway infrastructures, port facilities and public buildings. In this sense, its importance and potential will be evidenced for several stakeholders in the decision-making process and some conclusions of the developed studies are presented and discussed.

CODE 584

CLASSIFICATION OF ROOF TYPES IN EXISTING RESIDENTIAL BUILDINGS IN MADRID. DATA FOR AN ENERGY REHABILITATION STRATEGY

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KEYWORDS: Spatial model; roof type; energy refurbishment; roof slope.

ABSTRACT

The roof is the part of the building envelope with the worst exposure to atmospheric agents. From the energy point of view, different ways to take advantage of this element of the envelope are found, such as the incorporation of thermal insulation to improve its passive energy performance, the installation of renewable solar energy facilities as an active contribution, or the incorporation of Nature Based Solutions to limit the heat island effect.
At an urban scale, no detailed information about the existing building stock, or the construction systems used in the roofs, exists nowadays. The development of this information will allow us to establish a strategy of action at the municipal level.
This paper presents a classification of the type of roofs found in Madrid, analysing its slope, year of construction and building typology. The data is obtained and analysed from detailed geographic information published by the IGN, aerial orthophotography, point cloud data with airborne LIDAR sensors, and cadastral data. The analysis of the different parameters allows to define intervention strategies for energy improvement.

CODE 67

CORROSION PROTECTION FOR STEEL TENDONS UNDER ANCHOR HEAD OF EXISTING GROUND ANCHORS

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KEYWORDS: Ground anchors; corrosion; protection measures.

ABSTRACT

Due to the combined effects of weather and geological conditions as well as the systematic problem of anchor design and construction in the past, corrosion had been a long lasting problem for the service anchors in Taiwan. Often, ground anchor corrosion was blamed for several major anchored slope failures in Taiwan. However, the corrosion issue was not seriously dealt with by the ground anchor industry nor by the government until a catastrophic anchored slope failure occurred in one of the National Freeways in 2010.

This accident triggered an extensive investigation on hundreds of anchored slopes along the major highways and railways in Taiwan. The investigation results confirmed that corrosion on the anchor head and the steel tendons right under the anchor head was a clear and common problem for the existing anchors. Such problems had been fed back to the design and construction of new anchors. In the meantime, remedial measures were also taken to mitigate the corrosion problem of existing anchors, such as back-filling the voids in ground anchors with cement grout and/or enhancing the corrosion protection on anchor head. In general, such remedial measures served their purposes well. However, it was found that groundwater was still leaking out from some of the mitigated anchors about 5 years later. To completely stop groundwater leaking from ground anchor, water reactive resin grout was tried to fill the voids and water paths under the anchor head of the existing anchors. So far, the resin grout managed to prevent further water leaking from the ground anchors.

CODE 191

SEISMIC ASSESSMENT AND RETROFITTING OF AN OLD MASONRY BARRACK

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KEYWORDS: Masonry structures; old barrack; seismic vulnerability; pushover analysis; seismic retrofitting.

ABSTRACT

The evaluation of the seismic vulnerability of an abandoned masonry barrack, in its former and retrofitted configuration, is here presented. Preliminarily, a geometric survey of the building was made to determine the actual geometry of the building. Flat-jack and shove tests on masonry walls were performed to characterize material properties. Both geometric and material information were integrated in a 3D BIM model of the barrack, for further exportation into a FEM software.
The barrack is composed of three independent buildings and, due to its symmetry, only two FEM models were implemented. For linear analysis, two 3D FEM models adopting plate elements, to represent the walls, and beam elements, to model columns and wood roof elements, were created. To analyze the non-linear behavior of the structure, other two equivalent frame models with concentrated plastic hinges were implemented to obtain the capacity curves of the buildings before and after the retrofitting interventions. The analyses results have been compared in terms of risk indices to evaluate the effectiveness of the proposed interventions.

CODE 204

REHABILITATION OF TWO MASONRY BRIDGES IN CUEVA (BURGOS, SPAIN)

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KEYWORDS: Rehabilitation; extension; masonry bridges.

ABSTRACT

The start point was two masonry bridges on the road BU-V-5626, near the little village of Cueva de Sotoscueva, in the north of Burgos (Spain). The bridges were very different, on their age, their span, and, also with the quality of the masonry. The ancient one had a span of 5,92 meters, and the other a span of 3,80 meters. However, the main problem was the with of the road over the bridges with a mínimum value of 3,10 meters, in a road with normaly two lines, and, also, the bridges were located in a place near the important karstic place of Ojo Guareña, with a high landscape value. The paper shows the project of extensión the with of both bridges up to 7 meters. Concepts as extension dismounting and mounting the parapets, or with new parapets with new ashlars, or vaults on masonry or concrete are analysed. Finally, it is described the ending solution with two parallel vaults in each bridge, where the ancient one is beside the new one, which is made on reinforced concrete, exactly with the same shape, and with the parapets made with new ashlars. At the same time, different solutions to improve their capacity of support higher loads were applied. In the pape,r all the posibilites considered are analysed, with the advantages and disadvantages. Another problem was that, because of the place where the bridges were located, it was impossible to change their capacity of drain, despite of the circumstance that the level of the river is many times a year, some few meters over the road. This situation is provoked by the sink of Ojo Guareña.

CODE 212

CONCRETE SURFACE APPLIED CORROSION INHIBITORS: ON SITE EVALUATION BY NON-DESTRUCTIVE ELECTROCHEMICAL TECHNIQUES

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KEYWORDS: Concrete; migration inhibitors; electrochemical techniques; on site efficiency.

ABSTRACT

Corrosion of steel reinforcement can be initiated when chlorides in enough quantity or the carbonation front reach the bar surface. This corrosion is known to be the cause of structural damages and its prevention or reduction is of primary importance. Several methods can be used to delay the onset corrosion or to try to stop its development among which corrosion inhibitors are the method studied in present work.
Corrosion inhibitors can be added during mixing of concrete, or as made more recently, can be applied on the concrete surface in order to try to penetrate through the concrete pores and reach the bar surface. Both situations require different conditions.
Concerning migratory corrosion inhibitors, more recently suggested to be applied in existing corroding structures. Even thought manufacturing companies assure that these products show their ability to migrate to embedded reinforcement, form a protective film, and mitigate corrosión, and some laboratory test (provided by the manofacturers) present a reduction of one order of magnitude in quantitative corrosion rate values, increasing the service life expectancy by more than 15-20 years, a lot of doubts about these products and its inhibition mechanism are still unsolved.
In the present paper, different structures repaired by patching and then treated with a surface applied inhibitor has been studied before and after being repaired. The inhibitor efficiency has been evaluated during 10 years in service. Non-destructive electrochemical techniques have been used to monitor not only corrosion parameters such as corrosion rate or corrosion potential, but also concrete resistivity to know how it is affected by the inhibitor treatment.

CODE 230

NUMERICAL INVESTIGATION OF THE STRUCTURAL PERFORMANCE OF AGED RC BRIDGE COLUMNS SUBJECTED TO CORROSION AND SERVICE LOADS

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KEYWORDS: RC columns; eccentric load; reinforcement corrosion; finite element analysis; lateral displacement.

ABSTRACT

Deterioration of reinforced concrete (RC) bridge columns due to reinforcement corrosion is a significant problem for aging infrastructure exposed to cold weather conditions, such as those found in Canadian winters. Corrosion-induced damage in aging bridge columns subjected to service loads can lead to significant reduction in their structural capacity and premature failure. This research presents a 3D numerical model using ABAQUS software to evaluate the structural response of large-scale RC columns subjected to eccentric load and reinforcement corrosion. The 3D numerical model evaluates and predicts RC structural behaviour for two different patterns of corrosion exposure: (i) corrosion of two ties at the mid-section of the column with cover stiffness reduction, (ii) corrosion in the compression rebar and cover stiffness reduction. The numerical model is validated with experimental work conducted on small-scale RC columns at the University of China. Results of the models are analyzed in terms of concrete and reinforcement response in addition to the lateral displacement at the mid-section of the column.

CODE 232

STRUCTURAL RESTORATION OF THE BUILT HERITAGE: CASE STUDY OF TAZI PALACE HOTEL

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KEYWORDS: Structural rehabilitation; existing building; pathology; diagnosis; FRP.

ABSTRACT

The rehabilitation process is very complex; as each building is a special case, with features and unique pathologies, the detailed inspection of the building and the assessment of its conservation status allows to develop solutions to existing problems, according to the original features of the building and lead to compatible solutions.
The historical structure that is the focus of this study is the Tazi Palace Hotel in Tangier-Morocco that was constructed at the beginning of the 20th century, the particularity of this building is that it has never been inhabited.
After an archival research, an investigation campaign is conducted on the building, it includes different on site structural destructives and non-destructives tests (determining the amount and position of reinforcement, testing compressive strength of existing concrete and stone masonry...)
This paper presents a structural analysis of the existing building, in order to guarantee the structural safety under seismic forces, actual loads (self-weight and wind) and future ones. Structural retrofitting was developed using composite materials, these reinforcements comprised the use of Carbon Fibre Reinforced Polymer (FRP) system to strengthen existing concrete slabs and also adding concrete wall and vertical anchors inside the existing masonry walls, these elements allows to reinforce the existing structure regarding both static and seismic actions.

CODE 333

EVOLUTION OF PHYSICAL AND MECHANICAL PROPERTIES OF BRICKS TREATED WITH DIFFERENT CONSERVATION PRODUCTS APPLICABLE IN THE REPLACEMENT OF EXPOSED BRICKS IN HERITAGE BUILDINGS

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KEYWORDS: Heritage; exposed bricks; protection products; evolution study.

ABSTRACT

The conservation of exposed brick facades, especially in the case of heritage buildings, often leads to the application of protection procedures whose fundamental objective is to minimize the entry of water and soluble products capable of causing alterations in the material. The effectiveness of these procedures, can be evaluated by studying the physical characteristics of the material related to water permeability, absorption, capillary suction; and especially the color variations.
This article expose the progress achieved in relation to the monitoring over time, of different types of ceramic bricks available in Uruguay to use as a exposed brick and that can be used as restitution pieces in heritage buildings. The work has been carried out following the recommendations of the technical standards developed by the Cultural Heritage Conservation Committee. The present monitoring includes the study of three types of bricks treated with different products, exposed to two different conditions: outdoor direct solar radiation and accelerated exposure to UV radiation in simulation chamber. The study is complemented by results obtained from the evaluation of superficial hardness, resistance to penetration and compressive strength at the end of the exposure period, compared to previous reference determinations.
The results show the differences in the behaviour of the different bricks against the applied products, identifying in a preliminary way that one of the treatments seems to have the most favorable effects on the different analyzed properties. In the same way, these results allow to infer that it is possible to complement the information provided by the different methods and that the non-destructive techniques applied are appropriate for the characterization of the pieces in situ.

CODE 429

QUANTIFICATION OF WATER TRANSPORT IN FACADES WITH THE USE OF HYGROTHERMAL SIMULATION

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KEYWORDS: Directed rain; facades; degradation; hygrothermal simulation.

ABSTRACT

The facade is the building element most exposed to external degradation agents, where the climate factors act strongly, among which can be highlighted the action of directed rain. The study of directed rain becomes essential considering that water is the main degradation agent, besides acting as a great adjuvant, providing favorable conditions for the development of pathologies such as efflorescence, corrosion and cracking. In this context, this work aims to evaluate the water transport in the external vertical fence system of buildings when subjected to the incidence of directed rain. For this purpose, the WUFI® Pro 5.3 hygrothermal simulation software is used as a tool to quantify the agent under study, thus allowing the analysis of the effect of directed rain on the facade layers. A detailed analysis of the rain episodes is performed for each facade, considering two coating systems (ceramic and mortar coating) over a period of one year, where the studied parameter is the moisture content of each facade layer. This investigation resulted in the elaboration of an index called Impact Factor that is the result of the rain action in the specific system analyzed. Through the analysis of this index, we observed the distinct behavior of the cladding systems and found a significant relationship between Impact Factor and rainfall for the mortar facades.

CODE 532

REHABILITATION PRACTICES IN THE TRÁS DOS MONTES E ALTO DOURO REGION: CASE STUDY VILA REAL HISTORIC CENTRE

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KEYWORDS: Housing buildings; rehabilitation; quality; historic centre.

ABSTRACT

The late twentieth century was a period when Portugal saw a disproportionate growth in construction, resulting in many buildings with inadequate quality. Moreover, historic centres are increasingly suffering from heritage degradation, either by natural factors, abandonment, or simply by not fulfilling today's requirements. The city of Vila Real is no exception, since it has experienced in the past a huge expansion in real estate, resulting in many poorly planned buildings, with pathological manifestations, that may affect the welfare of the users. Therefore, rehabilitation emerges as a way to solve such deficiencies, considering sustainable development and current concerns. It aims at a better performance of the built heritage, adds value to real estate and brings benefits to their functionality and aesthetics. Added to that, the emergence of financing programs has turned the population more aware of the importance of rehabilitation. In this context, and within the scope of the Construction Observatory of Trás-os-Montes and Alto Douro (TMAD), work is has been carried out with the main objective of identifying the residential buildings rehabilitated in the last 10 years in this city and to analyse their state of conservation, the techniques and the construction methods used and to verify if they were properly rehabilitated. Thus, technical visits were made to the Historic Centre of Vila Real and data provided by the City Council was analysed. This led to the conclusion that the interventions performed do not meet the requirements to be considered rehabilitation. Therefore, the work presented in this paper seeks to contribute to raise awareness among the population on buildings' rehabilitation measures and on the need to improve the quality of these interventions.

CODE 538

PROMPT QUALITY ASSESSMENT METHODS FOR REHABILITATION PROJECTS: THE METHOD 'MIMAQ'

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KEYWORDS: Rehabilitation; quality; prompt quality assessment methods.

ABSTRACT

Rehabilitation processes in Portuguese buildings are often unsuccessful due to a wide range of circumstances, mainly those related with the severe degradation state of the older building scope, the insufficient knowledge regarding rehabilitation practices and the lack of methods that allow prompt quality assessment of the design phase.
Taking into consideration the scarcity of methodologies for the area of rehabilitation comparing with the significant amount of similar processes already developed regarding new constructions, the aim of this work is to present and assess the effectiveness of a recently developed Portuguese methodology that proposes a tool for minimizing the risk of low quality interventions in rehabilitation actions- the 'MiMaQ'. This method was developed by Instituto Pedro Nunes as a contribution to a public policy to minimize the poor quality of building rehabilitation projects. The method is based on the use of automatically formulated quality assessment sheets with a warning algorithm for non-quality risks.
This paper presents the method and its application to a case study, analysing its effectiveness and ease of application, identifying system strengths and opportunities for improvement. In addition to the analysis of the method, there is also a sensitivity analysis in relation to the variables that allow their customization in specific contexts. This work, carried out in the context of a Master's thesis, aims to conclude by the interest and potentiality of the method, including opportunities for evolution, but also by the need for a reformulation of the organization of rehabilitation projects, in view of the ease and effectiveness of its formal scrutiny.

CODE 548

EXPERIMENTAL TESTS OF SCHIST MASONRY WALLS STRENGTHENED WITH GROUTS

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KEYWORDS: Schist masonry; grouts; injection; walls.

ABSTRACT

Grouting is a well-known technique for conservation and strengthening of historic masonry buildings which can be durable and mechanically efficient, whilst preserving the historic value. The selection of a grout for repair is based on the physical and chemical properties of the existing masonry. Compatibility between the existing and the injection material is a major factor in the success of the intervention. The effect of ternary grouts and hydraulic lime-based grouts on the compressive and shear strength of three-leaf stone masonry has been widely investigated [1-4]. However, few studies have been done on walls with one or two leafs.
Subsequently, in the present research an experimental campaign addressing the behaviour of masonry walls of schist stone with one or two leafs, when subject to injection grouting, was performed. The analysis of the mechanical behaviour of masonry walls of schist, very common in old buildings in the northeast or Portugal and also in the north of Spain, was carried out based on experimental results of uniaxial compression tests. The influence of strengthening by injection grouting was analysed considering two types of grouts (one commercially available and another prescribed). A comparative mechanical analysis was performed between the walls tested and also the bond strength capacity was tested between the grouts and schist. The interior of walls were inspected, after dismantling, in order to check the amount of voids filled after the intervention. The results obtained showed that these strengthening techniques were successful in increasing the compressive strength of the walls and in improving their behaviour under compressive loads.

CODE 581

THE RISKS OF THE CURRENT CONCRETE REPAIR SYSTEM. NEW APPROACHES WITH STAINLESS REINFORCING BAR STELL

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KEYWORDS: Risks; reinforced concrete; repair; stainless.

ABSTRACT

In 2006, CONREPNET announced in its publication the failure of the reinforced concrete repairs that have been carried out as a consequence of reinforcement oxidation. The published results were alarming. They established a list of causes for the faulty repairs that have been carried out. 3 of the 5 exposed cases were directly related to the technical prescribers, who are the ones who eventually answer before the court with their Civil Liability Insurance:
When a technician has to draft a project for repairing concrete elements affected by corrosion, he faces a very heterogeneous built reality, where the extent of the repairs is diffuse, even within the same element, the intensity of corrosion changes without following a clear pattern.
As a result of this situation, the uncertainty of the extent and the intensity of its repair is inherent to the prescription phase; the only possible thing to do is to define how to proceed depending on the findings. During work, the parameters that indicate how to proceed in each case depend on the degree of oxidation; loss of steel cross-section, existing coatings, exposure, humidity, chloride contamination, etc. Therefore, everything is eventually decided on site, and as project management cannot be present at all times, most of these decisions depend on the operator's interpretation criteria.
The article analyzes the risks and their location, while proposing an alternative repair system that guarantees the sustainability of repairs at a cost equivalent to that of traditional repair.

CODE 14

ADOBE MASONRY WALLS REINFORCED WITH WEAVING WASTE

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KEYWORDS: Adobe; reinforced masonry; ourelas; waste weaving; waste.

ABSTRACT

The paper presents two proposals for reinforcement for masonry using fibers and yarns from textile industry waste, such as "ourelas", edge yarns in the length of the fabric are cut, removed and discarded at the end of the weaving process. The first type of reinforcement was inserted in the joints, horizontal and vertical. The continuous ribbons of "ourelas" were arranged in the joints of the masonry of adobe so as to create a mesh with alternating rows and crossed in all the joints. The second reinforcement was made with "seams", executed with the insertion of continuous ribbons of pretensioned ourelas in the connections between walls and in places where it is predicted the occurrence of tensions in the walls. Simple compression and diagonal compression tests were performed on small adobe walls, without reinforcement and with the two types of reinforcement. The results showed a significant improvement in the performance of the adobe masonry with both reinforcements. It is hoped to promote and seek the use of techniques and materials of low cost, easy access and easy application, be it in rehabilitation, repair, reinforcement or even in new constructions.

CODE 54

EVALUATION OF BOND BETWEEN REINFORCEMENT BARS AND REACTIVE POWDER CONCRETE

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KEYWORDS: RPC; bond; pull out test.

ABSTRACT

The reactive powders concrete (RPC) is a concrete that has no coarse aggregate in its composition. By reducing the internal voids, more resistance, durability and homogeneity is gained. The RPC can achieve high tensile strength, but although not commonly used with reinforcing steel bars, its behavior bond steel-concrete is still little known. Standards were created with respect to the bond stresses for conventional concretes, but this study is necessary for special concretes. Tests pull out, where the size of concrete cover is 5 times the diameter of the bar, are widely used. But, recent results presented in the literature show that the size of concrete cover should be reduced to high strength concretes, under the risk of not reaching the maximum tension limit. Thus, the objective of this work is to evaluate the bond steel-concrete in reactive powders concrete with less cement (35% replaced by blast furnace slag). At ages 28 and 56 days, mechanical tests were performed on 12 specimens for analysis of compressive strength and tensile strength and pull out tests on 6 cylindrical specimens (100mm diameter and 100mm height) with 10 mm diameter bars and a length of concrete cover of 2 times the bar diameter. In some tests, with a length of 5 times the diameter of the bar, the sample presented low bond stress, with cracking. With shorter length, although the samples cracked, there was slippage of the bar and with good strengths. The compressive strength of this more sustainable RPC without thermal cure was 108,01 MPa at 28 days, with an increase of 14,06% at 56 days. At behavior bond steel-concrete there was a reduction in strengths from 28 to 56 days by 15,27%, reaching 59,47 MPa at 28 days. Experimental bond studies steel-RPC are required to design structures with proper anchor length.

CODE 117

REINFORCED INJECTION AS A UNDERPINNING TECHNIQUE CAREFUL WITH ARCHEOLOGY AND ARCHITECTURAL HERITAGE

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KEYWORDS: Archaeology; underpinning; ground treatments; architectural heritage; reinforced grouting.

ABSTRACT

Archaeological excavations, and buildings considered Architectural Heritage, when it is necessary to intervene in its foundation, have the common characteristic of being a matter of great delicacy. It is the support of a set of elements built with a high degree of conditioners, and a high risk of loss of great value in case of a wrong decision, so there is no room for experiments.
It is necessary to properly select intervention techniques. Also use systems that guarantee the preservation of their integrity. Not only that they guarantee their structural stability with reduced occupancy, but that they do not alter their relationship with the soil. That respects the materials themselves without altering them, and that guarantees to maintain the original behaviour of the constructive elements. As specialized technicians, it is mandatory to investigate and know the spectrum of the different application techniques, seen from the eyes of the experts in heritage (by having specific problems and requirements). Even looking beyond the aspects of the field of basic engineering of these techniques.
The University of Alcalá has a great concern about intervention in Heritage (not surprisingly, it has been a World Heritage Site since 1998). Within this, one of its missions is focused on research (currently and from the Department of Architecture), on various application techniques in interventions in the Architectural Heritage. The analysis of the results of a research project in continuous development on this field will be presented in the communication by the UAH Research Group "Intervention in Heritage and Sustainable Architecture", on the application of a specific technique, that of the reinforced grouting of great versatility and validity. The analysed experiences will be shown as effective results of their application.

CODE 158

OPEN ISSUE FOR CONFINEMENT OF MASONRY COLUMNS WITH FRCM-SYSTEM: THEORETICAL AND EXPERIMENTAL INVESTIGATION

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KEYWORDS: Masonry; confinement; PBO-FRCM; testing; theoretical model.

ABSTRACT

The Fabric Reinforced Cementitious Matrices (FRCMs) are promising solution for the confinement of masonry column because they demonstrated strengthening effectiveness and, at the same time, compatibility with historical substrates. Nevertheless, the matrix is responsible for the stress-transfer from the structural element to the fabric-reinforcement. So, in case of poor-quality mortar, the effectiveness of the strengthening can be limited or even compromised. For this reason, few studies have been targeted to this aspect in the recent past; while theoretical studies are still limited. The present paper refers to the results of an experimental and analytical investigation on FRCM confined clay brick masonry. A series of small-scale masonry columns were tested under monotonic concentric compression load until collapse. The varied parameters were: the number of confining layers (i.e. 1, 2 and 3) and the confinement configuration (i.e. continuous and discontinuous).
The aim of the research consists of strengthening the knowledge in the field of FRCM-confinement in order to provide a contribution in developing accurate analytical design-oriented formulas. At this scope, some analytical models, available in the technical literature and proposed for national Guidelines, were also adopted for predicting the herein reported experimental results. The outcomes evidenced that the number of FRCM-layers is a crucial parameter for the accuracy of the forecasts.

CODE 379

EXECUTION AND REPAIR OF MASONRY STRUCTURES USING MORTAR REINFORCED WITH NATURAL FIBERS IN A CEMENTITIOUS MATRIX

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KEYWORDS: Masonry panels; reinforced mortar; natural fibers; diagonal compression tests.

ABSTRACT

Masonry structures that are built in Ecuador use a cementitious mortar, either in the joints of the blocks or in the plaster, and the mortar is made of water, sand and cement only, on a ratio of 3 to 1.
Such mortar has a good compression behavior but a poor tension behavior of the elastic-fragile type. Therefore, under seismic forces the masonry walls suffer different types of collapse, either of the panels or of the plaster.
This construction typology using mortar with the addition of natural fibers from the bamboo plant (guadua angustifolia) gives to the masonry an increment of the tensile strength with some ductility avoiding the collapse of the explosive type.
A theoretical and experimental research on the fiber reinforced mortar was carried out in order to verify its real behavior. The natural fibers obtained from the bamboo plant have also a good durability, due to the inherent properties of these species, and therefore are acceptable with reference to the life expectancy of the structure.
In order to define the characteristics of the mechanical behavior, many diagonal compression tests were conducted in masonry panels of 120 x 120 cm, using clay blocks and mortar reinforced with short and long fibers of the bamboo plant (guadua angustifolia).
Such tests were confronted with similar tests of previous research in which carbon and basalt fibers were used under the form of a mesh reinforcing the plaster.
The results can be considered positive also under the cost-benefit aspect, and therefore this type of reinforcement is recommended for the execution of new masonry structures or for the repair of the masonry damaged by seismic events.

CODE 385

REPARATION AND STRUCTURAL STRENGTHENING IN MASONRY STRUCTURES WITH INNOAVTIVE SYSTEMS OF LOW THICKNESS, SRG AND FRCM

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KEYWORDS: Masonry; structural strengthening; hydraulic natural lime mortars; steel fibers; basalt fibers.

ABSTRACT

Traditional reinforcement and consolidation of masonry structures and buildings has usually been done through interventions that provide the integration of structural elements with significant sectional growths, by using the classical technic of mortar jacketing on masonry structures. This approach, on the one hand, ensures a static mechanical performance improvement of the structural element. On the other hand, it is not beneficial enough, because to the existing static actions we should add a dynamical one, related to, for example, a natural event as an earthquake or a settlement.
The modern approach to consolidation and structural strengthening places the strength and the necessity of acquire and quantify the ductility of the reinforced element as key factors. It has shown the generalized necessity of adapting the existing structures to the new parameters of strengthening and ductility, in order to improve their static and dynamic behaviour, through the appliance of effective reinforcements while respecting the architectural, historical and structural identity of the building,
The combination of the natural hydraulic lime matrix GeoCalce F Antisismico on masonry structures with steel fiber fabrics (GeoSteel Hardwire ™) and basalt fiber (GeoSteel Grid), forms and innovative system of low thickness structural reinforcement developed by Kerakoll, offering as advantages its technical and application simplicity. These strengthening systems assure an improvement of resistance performance, elastic modulus and strength, compared with other common systems composed by carbon – glass – aramid fibers and epoxy resins.
The project purpose is to expound the main characteristics of the solutions composed by steel fiber (GeoSteel Hardwire ™) and basalt fiber (GeoSteel Grid) fabrics with the hydraulic natural lime mortar GeoCalce F Antisismico. Besides, to present different real cases in Spain and Italy where these systems have been applied, throughout the study and execution phases, referring to the calculus of structural reinforcements in masonry sites, their simple application and their safeness once installed.

CODE 439

EXPERIMENTAL STUDY OF IN-PLANE SHEAR BEHAVIOUR OF BRICK MASONRY RETROFITTED WITH BASALT AND STEEL REINFORCED MORTAR

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KEYWORDS: Masonry; TRM; near surface mounted; seismic retrofit; shear strength

ABSTRACT

This paper focuses on the application of composite materials to improve the in-plane shear strength of existing brick masonry walls. The experimental program involved the construction of walls composed of handmade solid clay brick and hydraulic lime mortar joints, a recurrent typology for historical buildings in the Mediterranean countries. The walls were tested under both unreinforced and reinforced configurations, being the latter obtained by either externally bonded textile reinforced mortar (TRM) or structural repointing with near surface mounted (NSM) rebars into the bed joints. Both TRM and NSM compounds were embedded in hydraulic lime mortar. The diagonal compression tests on retrofitted specimens considered different double-sided TRM configurations. One of them consisted in a novel asymmetric layout based on basalt TRM on one face, and NSM steel reinforcing bars on the other face. The experimental results illustrate the suitability of the proposed TRM and NSM solutions for seismic retrofit and post-earthquake repair of existing masonry buildings. The research outcomes highlight the effectiveness of the investigated systems in increasing the resistance and ductility of unreinforced brick masonry.

CODE 505

U-SHAPED FRCM FOR STRENGTH AND DEFORMATION ENHANCEMENT OF REINFORCED CONCRETE BEAMS

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KEYWORDS: Reinforced concrete; strengthening; FRCM; flexure; U-wrap.

ABSTRACT

The strength and deformation performances of fabric-reinforced cementitious matrix (FRCM U-wrapped reinforced concrete (RC) beams has been studied in this work. Nine RC beams were used to assess this strengthening technique, three of which were unstrengthened while the other six were strengthened using two different types of fabrics; namely carbon- and polyparaphenylene benzobisoxazole, PBO-FRCM. The specimens were four-point loaded in flexure until failure. The original reinforcement ratio of the beam was a parameter of which effect was assessed. All beams were strengthened using a single ply of the fabric used in the FRCM system. Test results indicated that the strength gain was higher for lower reinforcement ratios. The proposed strengthening method provided sufficient FRCM/concrete substrate bond that limited debonding and led to an increase in the strength of an average of 75%. The deformational characteristics were also significantly improved.

CODE 512

COMPARATIVE ANALYSIS OF THE EXISTING CALCULATION RECOMMENDATIONS FOR STRENGTHENING WITH COMPOSITE MATERIALS OF RC COLUMNS OF RECTANGULAR SECTION

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KEYWORDS: Confinement; axial compression; theoretical-experimental comparison; square and rectangular columns.

ABSTRACT

The use of advanced composite materials of the FRP type (fibre-reinforced polymers) is becoming increasingly common in the strengthening of concrete structures. One of the most widespread applications is the strengthening by confinement of reinforced concrete columns in existing structures such as bridges or buildings.
Numerous researches have shown that confinement with FRP can considerably increase the strength of concrete. Different theoretical models are also being proposed, generally of an empirical nature. Most of the experimental programmes have been carried out in circular sections. Tests on square or rectangular specimens show that confinement is less effective. As far as the theoretical analysis is concerned, it is generally a question of using the models developed for cylindrical specimens, in which reducing coefficients are introduced, for which different proposals have also been made.
Despite the fact that there are currently multitudes of applications, there are still significant uncertainties in the calculation of reinforcements, especially in the case of rectangular section columns. A key parameter in the prediction of the models is the estimation of the ultimate deformation of the FRP. Some models introduce a deformation efficiency coefficient of approximately 0.6, based on the average value obtained in tests on small circular specimens, which are the most numerous, but the dispersion of the results is enormous. This work presents an analysis of the calculation formulations proposed in the main published international guidelines and they are compared with experimental results of larger square and rectangular section specimens (intermediate size and real size).

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CODE 513

STRENGTHENING OF LOW-STRENGTH CONCRETE COLUMNS WITH FIBRE REINFORCED POLYMERS. FULL-SCALE TESTS

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KEYWORDS: Strengthening; columns; FRP; tests.

ABSTRACT

Composite materials, also known as fibre reinforced polymers (FRP), are being increasingly used in rehabilitation of concrete structures due to their good corrosion resistance and high strength and stiffness in relation to their weight. Confinement of columns with externally bonded FRP sheets is an easy and effective way of enhancing the load carrying capacity and ductility of reinforced concrete columns.
Many experimental studies have been conducted on cylindrical small-scale unreinforced concrete specimens externally confined with FRP. It is widely accepted that confinement of square or rectangular columns is less efficient than the confinement of circular columns. The theoretical models for rectangular sections are mostly based on approaches created for circular columns modified by a shape factor, but the different models do not give similar results.
This paper presents an experimental program on large-scale square and rectangular RC columns externally strengthened with carbon FRP sheets and subjected to pure axial load. Large-scale tests on FRP confined columns are very limited by high cost and unavailability of the necessary equipment in many laboratories. The variables in the experimental program are the aspect ratio of the cross-section, the radius of curvature of the corners and the amount of FRP reinforcement. The tests results show that the FRP confinement can increase the strength and ductility of rectangular concrete columns with low strength concrete. The hoop ultimate strain of the FRP jacket is much lower than the material ultimate tensile strain obtained from flat coupon tests and the strain efficiency factor achieved on the tests is smaller than the value usually recommended by design guides.
This work is part of the project BIA2016-80310-P (AEI/FEDER, UE) and PIE201460E049, funded by CSIC. The authors acknowledge SIKA S.A.U. and Betazul S.A. for providing testing materials and performing the strengthening work. V. J. Castro acknowledge Spanish MICINN and European Social Fund the financial support (FPI grant BES-2017-080647).

CODE 525

TRANSFORMING THE CONSTRUCTION IN COASTAL ZONES: IMPLEMENTING GFRP REINFORCING BARS IN CONCRETE STRUCTURES

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KEYWORDS: GFRP reinforcement; durability; coastal structures; corrosion; development; infrastructure.

ABSTRACT

The extension of the service life and the reduction of the high and continuous costs of maintenance are two of the most critical needs for the state and local agencies, especially in coastal areas, where the chlorides of the seawater accelerate the corrosion of steel reinforced concrete structures. This is especially important in marine environments due to: i) salt water in direct contact with concrete structures, through foundations or by air and ii) the need to increase the infrastructure's future resilience and sustainability to sustain the numerous effects related to climate change. These critical needs may no longer be of concern with the use of GFRP bars (Glass Fiber Reinforced Polymer); which are made of glass fibers integrated in a resin matrix, and therefore are non-corrosive.
This document details the properties of the GFRP bars, describing existing standards and specifications, as well as exemplifying their use through existing practical construction projects around the world. The purpose of this article is to establish a frame of reference to transform of the construction in coastal areas by implementing the use of GFRP rebars in reinforced concrete structures.

CODE 527

CASE STUDY OF FRP APPLICATION: THE HALLS RIVER BRIDGE

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KEYWORDS: FRP-RC/PC bridge construction; FRP-RC/PC constructability; sustainable construction; Halls River Bridge; bridge replacement.

ABSTRACT

A special and innovative vehicular bridge is under construction in Homosassa, Florida. The FDOT District 7 Structures Design group designed this Bridge utilizing innovative Fiber Reinforced Polymer (FRP) materials with the support of the FHWA Every Day Counts and FDOT Invitation to Innovation programs. This Bridge Replacement project is a demonstration project and is like no other bridge in Florida.
The 186-foot (56.7-m) bridge features special Glass Fiber Reinforced Polymer (GFRP) bars and Carbon Fiber Reinforced Polymer (CFRP) prestressing strands. By using CFRP-PC Bearing Piles, CFRP-PC/GFRP-RC Sheet Piles, hybrid GFRP-RC sheet piles, Hybrid Composite girders, GFRP-RC bent caps, GFRP-RC bulkhead caps, GFRP-RC deck, GFRP-RC Traffic Railings and Approach slabs and a 66-foot long GFRP-RC gravity wall, the Department was able to virtually eliminate regular carbon-steel reinforcement on the bridge.
This FDOT bridge replacement project is crucial as the corrosion of the steel reinforcement in the existing bridge has severely impacted the future reliability and safety of the bridge. The chloride-attack that has occurred over that last 63 years has resulted in loss of effective reinforcing steel, especially in the substructure. Having a bridge made in composite materials prevents this problem in the future. After carefully considering all options, FDOT opted for composites primarily because of the high costs of maintaining traditional steel-reinforced bridge elements in the state's saltwater and wetland environments.

CODE 560

NSE/EB-FRCM TECHNIQUE FOR STRENGTHENING OF RC BEAMS IN SHEAR

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KEYWORDS: Strengthening; shear; hybrid NSE/EB; fabric-reinforced cementitious matrix (FRCM).

ABSTRACT

This paper presents experimental results on strengthening of reinforced concrete (RC) beams using "hybrid near surface embedded/externally bonded" NSE/EB technique for fabric reinforced cementitious matrix (FRCM). Six RC beams have been constructed, strengthened in shear using the NSE/EB-FRCM system and tested in addition to one control beam without strengthening. Three types of FRCM composites were utilized in the NSE/EB-FRCM strengthening system including carbon FCM, glass FRCM, and polyparaphenylene benzobisoxazole (PBO) FRCM. Two test parameters were investigated; namely, the type of FRCM composite and strengthening configuration (full configuration versus intermittent FRCM strips). From the experimental results, it was concluded that the load carrying capacity of RC beams could be significantly increased using NSE/EB-FRCM strengthening system. An average of 84.5% gain in the ultimate load carrying capacity of the strengthened beams relative to the control beam have been observed. The strengthening system has also enhanced the ductility behaviour and deformational characteristics of the beams. With regard to the FRCM type, carbon FRCM was the most effective of all. Moreover, full strengthening configuration performed better than intermittent configuration, which confirmed the significance of the amount and continuity of the FRCM system in the shear span.

CODE 566

EFFICACY OF NSM HYBRID FRP STRIPS FOR SHEAR STRENGTHENING OF RC DEEP BEAMS

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KEYWORDS: Reinforced concrete; deep beams; shear; strengthening; near-surface mounted; hybrid carbon/glass FRP.

ABSTRACT

This paper presents an experimental study on the efficacy of near-surface mounted (NSM) hybrid carbon/glass fiber reinforced polymer (FRP) strips for the strengthening of shear-critical reinforced concrete (RC) deep beams. For this purpose, the experimental investigation was carried out on four medium-scaled RC deep beams. Three beams were strengthened with hybrid NSM-FRP strips, while one beam was kept unstrengthened to act as a reference. All beams were tested as a simply supported system under displacement controlled three-point loading test. The test variable includes the geometric reinforcement ratio of the FRP system. The test results revealed that the NSM-FRP strengthening system is effective in increasing the shear strength of deep beams, up to 55.8% increase in the shear strength was observed. In addition, the results showed that the NSM-FRP had the potential to mitigate the premature debonding between the concrete and the strengthening material, which is commonly observed in the conventional externally bonded technique. The strengthening system has also enhanced the deformational characteristics of the strengthened deep beams.

CODE 578

STRENGTHENING OF A MASONRY WALL IN SEISMIC PRONE AREA WITH THE CAM SYSTEM: EXPERIMENTAL AND NUMERICAL RESULTS

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KEYWORDS: Masonry wall; stainless steel ribbon; CAM; Reinforcement technologies; modelling.

ABSTRACT

In this work, experimental and numerical results of a research project on the structural behaviour of seismically strengthened unreinforced masonry are presented and discussed. The topic of the research is to investigate the in-plane shear behaviour of an old masonry wall with an opening in the arch form, reinforced with a pioneering system of three-dimensional pre-tensioned stainless steel ribbons. The masonry wall was in-plane loaded until first cracking appeared, then it was reinforced and re-loaded until collapse. The results of the experiments carried out have highlighted the benefits in using the reinforcing method for masonry structures, specially its capacity to provide a large increasing in terms of strength and ductility. Analytical modelling of the wall behaviour was accomplished by applying non-linear finite element methods generally used for reinforced concrete elements.

CODE 585

SHEAR STRENGTHENING OF RC BEAMS WITH STEEL REINFORCED GROUT (SRG)

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KEYWORDS: Rehabilitation; strengthening; steel reinforced grout (SRG); beam; shear.

ABSTRACT

Steel reinforced grout (SRG) has shown to be an efficient and cost-effective strengthening solution for reinforced concrete (RC) structures. With regard to RC beams, the experimental studies to date have focused mainly on the application of SRG for flexural strengthening of RC beams, however, the study on its application for the strengthening of shear-critical RC beams is scarce. Thus, the present study focuses on the application of SRG for the strengthening of RC beams in shear. Five T-beams were constructed and tested under three-point bending. The effects of steel fabric density and bond schemes on the shear strengthening efficacy of SRG system have been studied. The experimental test results showed that SRG is effective in strengthening of shear-deficient RC beams with the efficacy that varies with the test parameters. The increase in the shear capacity of the strengthened beams varied between 42% to 71%. In addition, the strengthening system has significantly increased the deformational characteristics of the strengthened beams.

CODE 586

EXTERNALLY BONDED HYBRID CARBON/GLASS FRP STRIPS FOR SHEAR STRENGTHENING OF RC DEEP BEAMS

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KEYWORDS: Reinforced concrete; deep beams; shear; strengthening; externally bonded; hybrid carbon/glass FRP.

ABSTRACT

The experimental study on the shear strengthening the efficacy of a recently introduced hybrid carbon/glass fiber reinforced polymer (FRP) for reinforced concrete (RC) deep beams has been presented in this study. The hybrid carbon/glass FRP combined the benefits of the constituent materials, specifically, strength and ductility properties provided by carbon and glass FRP, respectively. A total of four deep RC beams with shear span-to-effective depth ratio (*a/d*) of 1.6 were constructed and tested under three-point bending considering the amount of FRP reinforcement ratio as a test variable. One unstrengthened beam was used as a reference, while three beams were strengthened with different reinforcement ratios of externally bonded (EB) hybrid carbon/glass FRP. The test results revealed the successful application of the EB hybrid carbon/glass FRP for strengthening of RC deep beams critical in shear. The increase in the load-carrying capacity of up to 17.9% was obtained. Moreover, the strengthening system has enhanced the deformational characteristics of the strengthened deep RC beams.

CODE 588

OPTIMISATION OF STAINLESS STEEL REBARS TO REPAIR MASONRY STRUCTURES

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KEYWORDS: Masonry repair; walls transversally tied; stainless steel rebar; bonding; minimum grout cover.

ABSTRACT

Andalusia (Spain) is a rich area when speaking about architectural heritage. Historical religious or civil buildings, as well as poorer dwellings composes mainly the important and huge set of buildings that deserves being maintained and repair.
Most part of the heritage alluded previously is supported by structural walls of masonry. Masonry walls are frequently composed by external leaves of soft and porous stone blocks infilled with rubble masonry, resulting in three-leaf walls that are easily affected by rising damp and other degradation effects. In this context, the development of repairing techniques to repair, reinforce and consolidate masonry walls is compulsory for the current scientific community. These techniques must solve effectively and economically the problems linked with degradation, always following the guidelines given by the Charters about the reversibility, among other characteristics.
The use of steel to transversally tie columns and walls, as well as to structurally repoint joints is a widespread methodology that has given good results. Currently, the use of fibbers has displaced stainless steel to this end, even being more expensive than steel, mainly due to the smaller sections that are necessary and to the variability of the shapes that can be found. Recently, a research project entitled PGC2018-098185-A-I00, supported by the Spanish Government (Ministerio de Ciencia, Innovación y Universidades), began in order to optimise the shape of stainless steel rebars of small diametre to be used for repair masonry structural elements and make it a competitive material. This project is mainly targeted to improve the geometry of stainless steel rebars to maximise bonding when they are in this special situation. The description of the research project, as well as the first conclusions obtained, are the main target of this paper.

CODE 591

EFFECT OF USING MULTIPLE FABRIC PLIES ON THE TENSILE BEHAVIOUR OF CARBON TEXTILE REINFORCED MORTAR

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KEYWORDS: Textile composites; fabric reinforced cementitious matrix; textile reinforced mortar; tensile characterization.

ABSTRACT

Recently, textile reinforced mortar (TRM) has emerged as a viable strengthening material for reinforced concrete (RC) and masonry structures. Understanding the TRM tensile behaviour is important to achieve an accurate design for TRM strengthening systems. This paper investigates the tensile properties of carbon-TRM composite with multiple fabric plies. Twenty TRM specimens (410 × 50 mm), which varied in the number of fabric plies (one/two/three/four), were prepared and tested in accordance with AC 434 provisions (clevis-grip mechanism). The results revealed a significance of the number of fabric plies on the tensile capacity as well as the failure behaviour of the TRM composite. The failure mode had changed from ductile fabric slippage (associated with up to 3 fabric plies) to brittle fabric delamination in carbon-TRM specimens when using 4 layers of fabric. As expected, the TRM tensile capacity had proportionally increased with the number of fabric plies. The effect of the number of fabric plies was less significant (within 20%), though, on the ultimate tensile stresses of the impregnated fabric. The results verified the established bilinear trend for TRM tensile stress–strain relationship that indicates two sequential phases, namely, non-cracked/stiff and cracked-section phases. However, the TRM cracked tensile modulus had somewhat increased with an increase in the number of fabric plies.

CODE 152

EVALUATION OF THE PHYSICAL AND PATHOLOGICAL STATE USING THE LASER SCANNER TECHNIQUE OF THE MURAL FACES OF THE CITY BY THE ARTIST RAMÓN VÁSQUEZ, AT THE SENA DE PEDREGAL FACILITIES IN THE CITY OF MEDELLÍN - COLOMBIA

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KEYWORDS: Murals; pathology; conservation; heritage; scanner.

ABSTRACT

There is a sound need for an evaluation of the current state of the mural *Rostros de Ciudad* painted by the Colombian painter Ramón Vásquez, this analysis is based in need for the preservation of mural painting, the characterization of the physical state of these kinds of pictorial works, and with the aim of strengthening the protection of heritage in the city of Medellín-Colombia. The mural is ¿ located at the headquarters of the SENA of Pedregal. The study was carried out through the classification of pathological alterations of the work using different inspection techniques. The mural has a pathological analysis carried out through visual inspection and photographic records in 2015 (Cañola, Pérez, & Builes, 2016). For this new study, methodologies based on photographic analysis and laser scanning was used, which were compared in order to establish problems, differences and coincidences between the two methodologies and to define a mural diagnostic protocol supported by both techniques. The research also sought to evaluate the deterioration progress in the murals for the 2016-2019 period. In this way we were able to propose intervention and protection measures that promote the conservation and care of the mural heritage in the city.

CODE 39

DURABILITY OF THE OLD PREFABRICATED CONCRETE NAVES OF ENSIDESA, AVILÉS (SPAIN)

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KEYWORDS: Prefabricated concrete; huge industrial naves; aggressive environment; durability.

ABSTRACT

During the decade of 1950 the steel company “Empresa Nacional de Siderurgia, S.A. (Ensidesa)”, built in Avilés (Asturias-Spain) a huge industrial plant of eleven kilometers long and 191,000 m2, that employed more than 21.000 workers. The area, located very close to the sea, included seven naves with 1 km long and a very high design technology, all built in prefabricated concrete.
Unfortunately, after many years of continuous operation, problems related to conversions, privatizations and company fusions, in 1998 its production stopped definitely. That fact supposed the abandonment of these unique naves, the biggest prefabricated structure ever built in Spain, and the beginning of their ruin.
In 2006 “Mittal Steel”, now known as “Arcelor-Mittal”, bought the industrial area, but decided not to use the naves any more.
The paper describes the current state of the constructions and the survey carried out three years ago on their concrete structure, just before a different company analyzed the possibility of rent two of these naves, after more than fifty years of exposure in a very aggressive environment and with an obvious lack of maintenance..

CODE 142

THE SELECTED ISSUES OF ADAPTATION OF 19TH AND 20TH CENTURY POST-INDUSTRIAL BUILDINGS IN ŁÓDŹ

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KEYWORDS: Revitalization; post-industrial buildings; cast-iron; girders; experimental investigations.

ABSTRACT

The paper deals with selected technical problems related to the adaptation of the structures of existing post-industrial buildings from the turn of the 19th and 20th centuries. According to the definition of the term revitalization, all activities aimed at conferring new functions should proceed with the maximum respect of composition and architectural form as well as the building structure. A significant difficulty is the fact that the strength and geometric properties of cast-iron and steel elements often differ significantly from the values characterizing contemporary materials. Due to uncertainty regarding the load carrying capacity of historical structures, in many cases there is a need to carry out destructive tests of elements taken from the buildings. This was also in case of the revitalization of the 19th century factory complex Manufaktura in Łódź. The paper presents the results of experimental investigations on cast-iron girders, which were the elements of the main structural system of the former I. Poznański's spinning mill.
The destructive tests showed that the existing girders were characterized by sufficient load carrying capacity and could be preserved as elements of the main bearing structure of the modernized building. On the basis of the accompanying material tests, the characteristics of the cast-iron were determined – tensile and compressive strength. Due to the high brittleness of the material, the failure of the girders was violent and not signaled by a visible increase in deflections.

CODE 180

ANALYSIS OF THE PLANNED WORKER HABITAT IN THE UPPER & MEDIUM BASIN OF SIL RIVER (LEÓN, SPAIN)

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KEYWORDS: Company towns; industrial architecture; post-mining territories; urban landscape; worker housing.

ABSTRACT

Through several case studies, the constructive features and frequent pathologies of the industrial settlements in El Bierzo and Laciana counties (Castilla y León, Spain) are featured. This communication is the result of an exhaustive review, including research in libraries and archives, combined with fieldwork. It aims to analyze the state of conservation of these heritage buildings of the industrial legacy. These counties concentrated, from the 20s to the 60s, an important production of the workers habitat devised in the form of company towns and "Tenements", driven by the business and state agents involved in the industrial transformation of the Sil river basin. Mining, hydraulic, railroad and agricultural settlements offered a delayed housing response, whose architectural value and scope have been scarcely studied. These settlements were the subject of major criticism in the 1970s for their rigidity in facing improvements in habitability. They faced several issues because of their frequent peripheral location, the poor quality of the materials used in the buildings, miscalculations for weather adverse conditions, or differential settlements caused by the surrounding mining activity. The low maintenance was driven by the lack of interest of the owning companies and the financial constraints of their residents. Nowadays, some of them have been the subject of rehabilitation and reconstructions efforts thanks to private enterprises or improvement programs under the aid of Restructuring of Coal Mining Policies.

CODE 192

NORMATIVE, TECHNICAL AND EXECUTION CONDITIONERS FOR THE INTERVENTION IN TWO 19TH CENTURY BRICK CHIMNEYS

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KEYWORDS: Industrial heritage; chimneys; brick chimneys reinforcement; earthquake.

ABSTRACT

The need of a structural reinforcement intervention in a factory that has existed for over 100 years is associated with a series of regulatory, technical and procedural constraints.
Firstly, when addressing the study of two brick chimneys that presented multiple defects, the need to face the inherent passage of time arises: to confront the current reality of the existing constructions with the current regulations, which evidences the disparity of the considerations and planning of actions according to the standards to adhere to.
On the other hand, the drafting of the project for the elimination of risks and rectification of damages presented some technical peculiarities typical of this type of construction and the procedure of action for the works: very slender brick structures with damages and degradation due to the passage of time and the scourge of inclement weather, areas with a unique geometry to be restored, space constraints etc.; characteristics that must be updated to a state that guarantees resistance and stability against the planned actions (dead loads and wind action fundamentally), including other accidental actions not contemplated in its original design, that should not be ignored (such as earthquakes and security against the impact of lightning).
Once the technical and regulatory constraints are established, different possibilities of action are proposed, exposing the main particularities of each one: placement of scaffolding, partial demolition of the structure, etc. In this case, the difficulties in the execution of the works lead to the most appropriate solution, although this means having to propose a temporary auxiliary structure, with its associated cost, to make the work viable.
Finally, the technical solution chosen for the structural intervention is presented, describing the regulatory requirements to which it responds, as well as the technical solutions to be developed.

CODE 249

CONSTRUCTION OF IRON CARBONATE CALCINATION FURNACES AT THE CATALINA MINE IN SOPUERTA, BISCAY

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KEYWORDS: Biscay; mining; iron; furnace; calcination.

ABSTRACT

In the second half of the 19th century, the iron ore mining industry started to become extremely prominent in the Basque Country. Conversely, towards the end of the century, the most valued iron ores started to deplete causing concern for iron mining in Biscay. As a solution, in 1882, the mining companies invested in constructing trial calcination furnaces in order to increase the quality of the iron carbonates and to permit the use of these ores in the blast furnaces. The construction of these mining structures in Biscay continued for decades, allowing their form, size and material to be adapted to the technological resources and to optimize the calcination process.
Nowadays, several calcination furnaces that have been built with different construction systems throughout the 19th and 20th centuries subsist in Biscay. The furnaces constructed at the end of the 19th century were composed of a cubic structure of stone masonry. During the 20th century, the formation of the furnaces transitioned to being created with a truncated cone structure of brick masonry. Finally, by the end of the 20th century, the composition shifted to a metallic cylindrical structure. However, these surviving calcination furnaces are in danger of disappearing.
The Catalina Mine calcination furnaces, in Sopuerta, were built between 1956 and 1961. The state of conservation of these furnaces are more adequate in comparison to other surviving furnaces in Biscay. The form and materials that were used to build these mining structures were utilized during the final construction period of the calcination furnaces in Biscay. Subsequently, decades of technological and industrial developments in the Basque mining industry have been made, and the furnaces have obtained an incalculable patrimonial, historical and structural value.

CODE 254

OBSOLESCENCE AND RECONVERSION OF AN HISTORICAL MONUMENT IN SOUTHERN CHILE. THE CASE OF THE RAILWAY BRIDGE OVER THE CHOL CHOL RIVER, LA ARAUCANÍA REGION

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KEYWORDS: Industrial heritage; railway; obsolescence; urban dynamics.

ABSTRACT

Industrial heritage existing in cities offers appropriate cases for devising rehabilitation projects by assigning new roles, pondering the historical-cultural contexts that led to its presence. In the late 19th century, Chile experienced a systematic opening up of trade, both nationally and internationally. This was consolidated in part, among other factors, by the strengthening of a rail network due to a growing demand for services associated with mining, port operations, agriculture, forestry and passenger transport, attaining a total extension of 7,658 km in 1913. This development prompted the construction of an infrastructure suitable for such purposes (e.g. roads, viaducts, bridges, stations, among others). Some of these structures were noteworthy for their architectural and engineering aesthetics, others for their ability to brilliantly overcome the challenges offered by topography.
Despite this, after almost eight decades of clear and vigorous activity, the Military Dictatorship (1973-1990) introduced a neoliberal economic system which, since 1978, neglected the Empresa Ferrocarriles del Estado's (EFE) budget and the incentives for its operation. This progressive abandonment entailed the obsolescence of emblematic segments of the system, making it difficult to return to its initial layout. Despite this obsolescence of use – estimated by the diminution of serviceability, material deterioration and the absence of preventive conservation –, a significant number of them have been recognized by state heritage protection instruments, placing the contemporary discussion of their use and renewal in the sphere of the principles of Industrial Heritage.
This article displays the methodological steps taken towards the characterization of the attributes of a railway bridge in Southern Chile and its applicability in an intervention project, following the UNESCO-ICOMOS Charters. Both actions have permitted a reflection on the enhancement of the railway infrastructure's value and its programmatic reconversion within the public space, enabling material heritage revitalization through its reintegration into the communities urban dynamics.

CODE 339

LIFE CYCLE ANALYSES APPLIED TO HISTORIC BUILDINGS: INTRODUCING SOCIO-CULTURAL VALUES IN THE CALCULUS OF SUSTAINABILITY

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KEYWORDS: Green transition; sustainability; cultural heritage; societal value; life cycle assessment.

ABSTRACT

Historic buildings often get the unprecedented characteristic of being enemies of the environment, due to the energy consumption in use, adding to the challenges of protecting such buildings and building environments. Currently, assessment of existing buildings mainly evaluates greenhouse gas emissions from the operation phase. There are few systematic methods available to prove how old materials and whole historic buildings are more sustainable than building new, and how technical, historic, and aesthetic values can be maintained to carry forward cultural values also in the future. Methods to assess and consider socio-cultural resources hardly exists. Such methods will enable the assessment of the holistic sustainability in historic buildings and urban settings for establishing the total green footprint.
This paper reports a state-of-the-art, mapping to what extent sustainable societal values has been included and implemented for evaluating the sustainability in historic buildings. The overall aim is to pursue a more holistic picture of the total footprint of existing buildings, by including historic, architectural and aesthetic arguments when establishing the value. Based on the literature review we have discussed how to expand the concepts of Life Cycle Assessments (LCA) and Environmental Product Declaration (EPD) by implementing historic, architectural and aesthetic values. This paper upholds that the existing building stock may contribute to a climate friendly, diverse urbanity. It is emphasizing that a holistic approach, taking soft values and social factors into consideration, will gain the society and increase the awareness and understanding. Further, that sustainable resources in the form of soft values embedded in the historic building stock can contribute to and encourage the development of a future sustainable society.

CODE 374

HYDRAULIC ENGINEERING OF THE XVI CENTURY IN THE HISPANIOLA ISLAND. THE SAN CRISTOBAL SUGAR MILL OF DIEGO CABALLERO

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KEYWORDS: Sugar mills; hydraulic engineering; Española Island; Diego Caballero; San Cristóbal sugar mill.

ABSTRACT

Hydraulic engineering in the sugar industry was used from the 10th century on the Iberian Peninsula, taken to the Canary Islands at the end of the 15th century and from there to the New World in the 16th century. In America, the cultivation of sugarcane (Saccharum Officinarum) began on Hispaniola Island where the first trapiche moved by animals was installed in the town of Azua de Compostela and then the first mill by means of a hydraulic system, in the village of the Concepcion de la Vega. Between 1526 and 1530, Diego Caballero, first secretary of the Royal Audience of Santo Domingo, built a new sugar mill with a hydraulic system, called San Cristóbal, which was moved by a vertical hydraulic wheel with a system of water channels along a league (about 5 kilometers) from the mill. This technological innovation contributed to the success of sugar production, making this sugar mill the most important and productive of the moment. For this reason, the aim of this research is to analyze the hydraulic system installed at the San Cristóbal mill, its spatial organization and contribution to the development of sugar production in the Antilles.

CODE 473

APPLICATION OF COST-BENEFIT ANALYSIS TO INTERVENTIONS IN INDUSTRIAL HERITAGE REHABILITATION

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KEYWORDS: Cost-benefit analysis; decision support; rehabilitation; industrial heritage.

ABSTRACT

The Cost Benefit Analysis (CBA) of investment projects is explicitly required by the EU regulations governing the Structural Funds, the Cohesion Fund and the Instrument for Structural Policies for Pre-Accession in the case of projects whose budgets exceed, respectively, 50, 10 and 5 million euros. CBA allows determining whether the future benefits of rehabilitation strategies will be considered sufficient to justify the current costs of the project, laying the conversion to monetary values of all costs and benefits, and respective corrections, even when they are of intangible character. The decision to rehabilitate Industrial Heritage is complex, similarly to what happens to other types of buildings, since the associated costs require different levels of assessment, given the relevance to stakeholders in decision-making, and in most cases are not easily quantifiable.
The present paper aims to propose a CBA based approach, being identified the methodology phases for socio-economic evaluation of Industrial Heritage rehabilitation projects, providing a useful tool for support to key stakeholders in decision-making and clarify all stakeholders. The proposed methodology is in development at LNEC, in the scope of a scientific research project, and can be implemented by managers and by the designers of different specialties in Industrial Heritage rehabilitation interventions.

CODE 503

INDUSTRIAL HERITAGE FOR HOUSING IN LISBON: CONSTRUCTIVE SOLUTIONS AND REHABILITATION INTERVENTIONS

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KEYWORDS: Industrial heritage; rehabilitation; constructive solutions.

ABSTRACT

The development of housing issues accompanied a series of technological, economic, social and political transformations, inseparable from the process of industrialization in Europe during the 19th century. In Portugal the phenomenon of the Industrial Revolution happened after other European experiences, for example, in Lisbon the great transition to an industrialized society took place in 1850. However, although it is a time of great changes and evolutions, industrial progress was unable to provide a rapid and effective response to the problem of the lack of housing, and the workers were obliged to settle in vacant spaces in the urban network: i) existing palaces and convents abandoned by religious orders following ordered expropriations by the scheme; ii) workers' courtyards; iii) workers' villas. The workers' courtyards have formal and functional characteristics that correspond to an exterior space resulting from the construction of a house around it and whose construction extends from the 16th century until the mid-20th century. The workers' villas arise as a result of the morphological evolution of the courtyards.
In the present paper, the aim is to classify the subject, describe the types of industrial construction for housing, and survey the heritage with architectural interest, present its location and forms of insertion in the urban design. In the following phase, we intend to identify the different constructive solutions that are evident in the workers' courtyards and villas of the city of Lisbon. Finally some examples of rehabilitation interventions performed in this type of construction are presented.

CODE 579

SMART APPROACHES FOR INDUSTRIES CONVERSION THROUGH ADAPTIVE REUSE MODELS: THE INDUSTRIAL AREA OF BARI-MODUGNO

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KEYWORDS: Building adaptation; building recovery; built environment; adaptive reuse; design criteria system.

ABSTRACT

The transformation of abandoned industrial areas guarantees new living standards in the urban suburbs. The theme of urban regeneration plays an important role for building recovery in derelict peripheral areas. The uncontrolled urban sprawl decreases the possibilities for urban development and increases the interventions for the conversion of existing structures. Adaptive reuse strategies refurbish existing unused buildings into contemporary spaces, giving them new functional purpose. In this paper, considering the industrial area of Bari-Modugno, a detailed analysis of the typological characteristics of industrial constructions is shown. These empty volumes are classified according to the construction period and their intrinsic features. The proposed Design Criteria System (DCS) manages the factors that most affect the building regeneration process. It analyses the seven main categories, predicted in the S. Conejos adaptSTAR Model, with the insertion of macro and micro-scopes. The methodological approach considers a first classification of abandoned industrial buildings, trying to evaluate their potentials and weaknesses through multicriteria decision-making methods. The use of performance matrix allows to compare the status of decay, the predicted functions and the figures involved in the conversion process, evaluating possible solution to simplify the choices selection from the DCS. The model, under implementation, can assist the stakeholders decision-making processes for factory reuse, considering sustainable practices and outcomes. In addition, the DCS provides to identify the smart refurbishment actions of obsolete structure to highlight the flexibility of adaptive reuse interventions. This research illustrates that the hypothesized model is a good alternative to adopt adaptive reuse strategies on abandoned warehouses and recommends future uses by government authorities to simplify the transformation processes, minimizing times and costs of intervention and amplifying benefits for society.

CODE 29

HIGHER EDUCATION INSTITUTIONS IN HISTORIC BUILDINGS

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KEYWORDS: Historical; monument; repurposing; tertiary; education; institution.

ABSTRACT

Institutions of tertiary education often occupy historic objects which have been adapted to serve this purpose. The aim of the paper is to present problems related to the repurposing of historic buildings for use as tertiary education institutions and to show that it is possible. The problem has been analyzed using three selected objects as examples, namely Cracow University of Technology, Higher College of Trade in Krakow and Major Seminary of the Pauline Fathers in Krakow. They were chosen so as to represent diversity in terms of size, ownership and teaching profile. The main campus of the Cracow University of Technology is located in Warszawska Street. The history of its construction dates back to the nineteenth century. Cracow University of Technology was founded in 1945. In 1948, the university took over part of the barracks from the army, and currently owns the entire complex. For over 70 years the historic buildings have been in use and have been permanently adapted to meet the new needs of the university, but some problems still remain unsolved.
In Poland after 1990 there were more opportunities to establish non-state colleges. The result often was the repurposing of historic buildings to serve new functions. A case in point is the Higher College of Trade in Krakow. The building which houses the school is a palace in the historic city center. After World War II, the interior of the palace was converted into multi-family housing, which resulted in its division into small rooms. In the early 1990s, the new owner of the building decided to adapt it for the function of a private university. As a result, the original form was restored.
Another object is the Pauline Fathers' Seminary. In 1949, the building was taken away from the Order of St. Paul and transformed into a secondary school. In 1991 the order regained the building and then it was decided that it would house a major seminary. The task of the conservation project was to combine the modern function with the original spatial arrangement. It was important to create new values for the object so as to respect the tradition and preserve what was the unique cultural value of the site. The object has been restored to its original shape and serves the same, though modified function.

CODE 47

EXAMINING THE RELATIONSHIP BETWEEN NEW FUNCTION AND BUILDING SUB-SYSTEM INTERVENTIONS OF REUSED INDUSTRIAL BUILDINGS-CASE OF TURKEY

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KEYWORDS: Industrial buildings; adaptive reuse; building elements; intervention types.

ABSTRACT

Developments in production and introduction of new power sources other than manpower have created need for specific production places such as mills, impellers and silos. Especially by the industrial revolution in 19th century, the number of industrial buildings increased parallel with mechanization, but in time, these buildings and/or equipment became dysfunctional. In the world after 1950s, these kinds of industrial buildings, which remain idle but historically important as they reflect their period's characteristics have become a subject of concern. In Turkey, starting from Ottoman era numerous industrial buildings were also constructed; especially between the late 1800s and early 1900s. Like the case in the world, idle industrial buildings, became a concern in Turkey as well, and different functions were selected, when adaptive reuse strategy was preferred.

Within the context of a master study, interventions on building structural system and building elements that were made for implementing new function to existing industrial buildings, are being investigated to reveal their relationship with selected function. In this regard, comparative analyses on case buildings are being performed on survey, restitution and restoration projects to determine and discuss the type, magnitude and reason of interventions, (i.e. either to restore the original or to adapt to new function's requirements). In this context, in the paper, comparative analyses performed on four historically listed industrial facilities are presented. The facilities were selected considering the commonality of their original and new functions among reuse cases in Turkey. All facilities were originally for food, beverage and/or tobacco production, and two of them were converted into cultural centre, while the remaining ones were adapted as education building.

Analyses showed that most remarkable changes made for adaptive reuse were in the circulation system and internal walls, almost regardless of new function. Moreover besides others, in cultural centres, most interior space functions were observed to be not requiring intervention much, since they needed large spaces too, while in education buildings, especially the classes and instructor rooms were two major reasons of interventions, showing that education buildings might have much more spatial requirements that affect the magnitude of interventions.

CODE 77

MODERN FAÇADE CLADDINGS REFURBISHMENT: METHODOLOGY AND APPLICATION TO A SIGNIFICANT CASE STUDY

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KEYWORDS: Façade; cladding system; FEM analysis; laboratory test; thermography.

ABSTRACT

The modern cladding systems have shown not infrequently inconsistencies or mechanical deficiencies, such as to compromise their own safety. In this regard, the paper shows how the study of the structural aspects of façade claddings through proper numerical modelling and laboratory and in situ test, is today fundamental. The goal of the research activities has been the definition of a systematic methodology for the evaluation of the structural aspects of façade claddings, that can be used in case of already realized façade systems, but can be extended to the design of new cladding solutions as well. The methodology is here presented through the analysis of a significant case study, that is a residential building with a shell thermal insulated envelope with a clinker strips finishing, where the weight and the forces acting on the insulating panel caused a cyclic stress state and led to the thermal insulating panels breaking and to the collapse of the cladding system. The paper describes in detail the study of the façade cladding structural aspects, outlining the characteristic and the procedure of the specific refurbishment intervention.

CODE 99

TRACES OF TIME: SECOND STAGE OF THE RESTORATION PROJECT ON QUINTA TORRE ARIAS'S CLOSURE WALL, MADRID

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KEYWORDS: Historical heritage; protection plans; closure wall; collapses; rammed earth with lime.

ABSTRACT

5'5 km northeast away from downtown Madrid, today still remains one of the most famous aristocratic estates of the past centuries, called "Quinta Torre Arias". It is a 400 years old outstanding example of the Old Regime agricultural exploitation, that spreads out for around 180.000 sqm. It belonged to the nobility until the beginning of the 21st century, when it was given for free to Madrid City Council by its last owners, the Earls of Torre Arias.

After taking over the "Quinta", a "Historical Heritage Protection Plan" was approved by the City Council in order to carry out its restoration. As a part of this Protection Plan, a multidisciplinary study of the "Quinta" closure wall has been carried out in three stages: data collection, analysis and diagnosis of the current situation; study of solutions and design draft; Consolidation and Restoration Project.

The work carried out has concluded that the closure wall has a very heterogeneous composition due to successive extensions, repairs and reconstructions. Twenty-nine different types of closure wall has been identified, belonging to four main construction periods: original or Earl of Villamor (1580-1602), Earl of Frigiliana (late S.XVII -S.XVIII), Marquisate of Bedmar (1850-1877) and final period or Earl of Torre Arias (S.XX). The state of conservation of the closure wall is deficient, mainly due to the materials it is made of (old clay bricks, rough stones, rammed earth and lime mortars), to inadequate maintenance works and to external factors (poor foundations, earth pressure, later constructions leaning on the wall, etc.). All of them have caused some stability issues and some collapses in the wall.

The proposals developed in the Restoration Project, will ensure the stability and durability of the closure wall by removing inadequate and later items, and rebuilding the original ones. It is interesting to highlight the use of one special kind of rammed earth in the original construction period, called "calicastrada": layers of rammed earth alternating with layers of lime mortar extended through the internal faces of the formwork.

CODE 123

ASSESMENT OF BUILDINGS OF HISTORICAL PATRIMONIAL VALUE. STUDY CASE: MANOR "EL LEONCITO", SAN JUAN, ARGETINA

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KEYWORDS: Crude earth construction; dynamic behavior; structural reinforcement; heritage buildings.

ABSTRACT

This work presents the tools for the identification of pathologies and the technological measures designed to take part in the rehabilitation and reinforcement of a rural house called "El Leoncito". The main building was built with crude earth (adobes) and has had over time different functions, even hosting a small school.
The province of San Juan is included in zones 3 and 4, defined by Norm INPRES - CIRSOC 103 as high and very high seismic hazard respectively. In the last century it has been hit by three major earthquakes that left a high toll of victims, deaths and material damage, particularly in those constructions made with elements whose dynamic behavior is fragile type, such as adobe.
Within this context, even today there are several constructions considered with patrimonial value, among them: archeological structures such as "Village of Angualasto", the historical Church and Jáchal Flour Mills built during the XVIII Century, the set of rural chapels, or the old farmhouse of El Leoncito, case study of the present work. It is precisely this scarcity of historical constructions that gives them a substantive importance since they constitute the few works that survived the conditions imposed locally.
A series of preventive, corrective and reversible actions are proposed to stop some processes of deterioration until the "Protocol of Intervention" of this resource is defined, and that on the other hand guarantees the physical conservation of the cultural resources of the historical period. At the same time it seeks to revalue earthen architecture as a socio-cultural practice traditionally shared.
The work capitalizes on previous research carried out by the authors, linked to the identification of the degrees of seismic vulnerability of constructions executed with elements outside of regulations (adobes, rammed earth walls, quincha) and the applicable technological solutions to mitigate the risks of collapse in the face of moderate and high intensity earthquakes.

CODE 145

CRACKING OF A EXTERIOR DOUBLE WALL OF A HIGHER EDUCATION SCHOOL

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KEYWORDS: Double wall; cracking of walls; poor support of the outer layer; wall rehabilitation.

ABSTRACT

This work presents the diagnosis and solution to rehabilitate the cracking and (partial) collapse of a circular double exterior wall of the library building of an institution of higher education designed and built in the 1990s.
The wall consists of a 0.11 m thick hollowed brick outer layer (supported only about 0.07 m) and a 0.20 m thick inner layer of reinforced concrete. The outer layer is poorly anchored (to the inner layer) and does not have reinforced concrete columns (to control the expansion of the bricks).
In general, the causes that are at the origin of the cracking of the masonry walls can be grouped into the following main types:

- movements of the building's foundations;
- deformations of the masonry of the support elements;
- the action of moisture;
- thermal action.

In this case, it is accepted that the cracking of the external walls results mainly from the behaviour of the hollowed brick outer layer, due to the action of temperature, humidity and the actual process of execution (in particular due to insufficient support and absence of control of the expansion of the bricks).
The recommended rehabilitation involves one of the following solutions:
a) Outer layer stabilization:

- anchoring the outer layer using connectors (5 connectors / m²). In view of the instability of the 1st row of some areas, the density of connectors in the 1st and 2nd row should be reinforced in a timely manner;
- treatment of the most significant cracks;
- final and integral coating of walls with polymer-based plaster, preferably textured ("grain") and in a colour identical to that of the existing buildings.

b) Demolition of outer layer and execution of ETICS:

- global demolition of the hollowed ceramic brick outer layer;
- execution of ETICS solution with 18 cm insulation thickness, in order to respect the dimensions of the existing elements (eg protrusion of the sills). On the outer face of the short consoles the insulation thickness will be smaller (4 cm).

CODE 214

EXTENSION OF THE ROAD BRIDGE PLATFORM OF THE XIX CENTURY

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KEYWORDS: Intervetion; enlargement; bridges; repair; reinforcement; environment.

ABSTRACT

The purpose of this article is to develop the history, as well as the latest actions carried out on the N-621 road, as it passes through the Hermida Gorge, in Spain, and specifically on four bridges dating from the 19th century, in order to provide these with traffic conditions within acceptable margins of road safety, allowing the crossing of vehicles without interrupting traffic, and at the same time defining an action compatible with the environmental wealth existing in the whole area, SCI areas, SPA, National Park, with minimum quality of service in line with current demand, substantially improving current conditions, and at a cost largely offset by the functionality to be achieved.
The bridges form part of the route of the then called Road in the 19th century, at the beginning of the decade of 1860 the road crossed the river Deva by means of wooden bridges, and it was waiting to have sufficient resources to build a definitive bridge, which consists of a masonry and ashlar factory bridge, with a straight ground plan and ground level, and some cases oblique to the watercourse.
The heritage interest of these structures is high and has been analysed not only from a historical point of view, but also from an aesthetic, functional, symbolic and even scientific point of view, thus justifying the need to develop an updating project that respects its natural and heritage environment.
From the constructive point of view carried out in 2018, in order to enlarge the platform, it is identical in the four bridges, with the deck being built in a parallel situation to the definitive one downstream and then being rippled. This avoids affecting the traffic of the road and these bridges continue to be preserved.

CODE 243

PRESERVING THE DESIGN INTENT WITH MODERN TECHNOLOGY

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KEYWORDS: Preservation; modern technology; design intent.

ABSTRACT

Preservation in practice should be applied to both physical materials as well as the intangible design concepts that are manifest in the materials. In the situation where original physical materials no longer remain, that should not diminish the value in preserving and potentially restoring the design intent of a lost structure, artifact, or building element. This presentation reviews a case study where the storefront of an historic building had been demolished more than a half century earlier and the practical and financial realities of present day dictated that a full recreation of the original storefront would not be feasible. Instead, the design team set out to reimagine the original design intent using modern technology and materials.

Guided by the remnants of the original storefront drawings, the team integrated readily available cast iron ornaments with a stainless-steel brake formed shell and laser cut metals to bring the design intent back to life. The sandwich composite provided visual depth of field, the weightiness of the original cast iron, and the tactile finish that would be consistent with original materials. The composite also reduced the structural load, enabling a revised support system.

Integration of new technology does not proceed without challenges. The presentation will conclude with lessons learned from the project, bureaucratic hurdles to consider in obtaining necessary agency approvals, and suggestions for further use of modern technology in the restoration of design concepts.

CODE 294

THE INTERVENTION PROJECT OF THE "BANCO PELOTENSE DO VALE DO CAÍ"

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KEYWORDS: Cultural heritage; restauration; architectural; immigration.

ABSTRACT

Located in the city of São Sebastião do Caí, in South Brazil, the Pelotense Bank building was officially registered by the municipal government in 2009, "due to its cultural value for the Caiense community, as an example of the neoclassical architecture in the late 19th century and because it represents one of the most important historical monuments in the "Cais do Porto" region." The intended uses refer to the material and immaterial historical heritage of the city, the region and the State of Rio Grande do Sul, regarding aspects of immigration, history of the economy, European cultural influences, the scourge of prisons, commercial and port activity , as explained below.

The property was built in 1890 for residential and commercial use by the German Friedrich Arnold Engel, which makes it a landmark of Vale do Caí immigration and its cultural influences transmitted to the present. In the late 19th century it was acquired by Banco Pelotense, the main financial institution of the state, and for more than 30 years was the financial centre of the region, fomenting economic activity and guardian of the wealth produced by immigrants. With the bank's bankruptcy, the building was incorporated into the State's Heritage in 1931 and began to host government agencies until the late 60's. Between 1970 and 1980, it was a local prison. In 2005 was finally donated by the State to the municipality of São Sebastião do Caí.

The property consists of a masonry house with approximately 390m² of built area, installed on land 407.20 m². The architectural design of intervention assures the restoration of originals, present essentially in the facades and the reconstruction of the interior of the building in independent metallic structure. With the restoration and availability to the public as a cultural equipment, it will be a center of memory capable of expanding the notion of belonging and cultural significance of society, especially the riverside population of the old harbor docks.

CODE 302

SAN FRANCISCO RAMADA: RELIGIOUS VICE REGAL ARCHITECTURE IN LAMBAYEQUE - PERU

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KEYWORDS: Religious vice regal architecture; ramadas; enhancement, Lambayeque; Peru.

ABSTRACT

This research is focused on the study of one of the main examples of religious heritage architecture in Lambayeque city, which once was a colonial indians village during the viceroyalty in Peru. San Francisco Ramada is a chapel which is part of the monumental complex of San Pedro, composed by four smaller churches and a main church. The most salient feature of this building is the harmonious architectural expression of its structural and construction system, which consists mainly of horcon columns and carob tree beams, walls made of adobe and bricks.
The study includes the outcomes of the historical and construction research as well as the presentation of the restoration process carried on given the extreme deterioration found caused by inadequate interventions and the climatologic effects specially related with El Niño.
The methodology for the studies previous to the restoration is centered in the inventory and registration of the field and documental information as well as the architectural and construction analysis. The restoration process partly answered to the previous information about this building and to the special design of its enhancement, considering returning to the intrinsic use of the building as a catholic temple.

CODE 310

FEASIBILITY STUDY AND CONTROL OF THE CONSTRUCTION IN THE REHABILITATION OF TRADITIONAL DWELLINGS: REHABILITATION OF MANOR HOUSE IN ARDANAZ DE EGÜÉS (NAVARRA)

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KEYWORDS: Rehabilitation; housing; popular architecture; traditional construction.

ABSTRACT

The survival of a good part of the traditional heritage built in rural areas, and especially of those buildings with housing use, depends on the way in which adequate rehabilitation projects are carried out that allow the improvement of the conditions of the buildings without threatening the architectural, significant and documentary characteristics and values that define this architecture.
Nowadays, it is essential to determine the degree of satisfaction of the increasing mandatory requirements, in relationship with other values to be promoted in the building, and the technical, economic and operational feasibility of the project.
The case study presented is a residential building located in the centre of the urban nucleus of Ardanáz (Egües) in Navarra, Spain. It is a traditional building with the main façade of ashlar masonry and a Baroque coat of arms from the 18th century. The building is catalogued with a degree of integral protection in the municipal planning. However, several technical reports carried out for the valuation of the building and even the catalogue file itself, condemned it to disappear, due to the supposed bad state of the structure and the compulsory demolition of a part of the building erroneously considered added.
It explains the process followed in the project, from the first preliminary studies that encouraged the implementation of the project to the final result achieved, emphasizing the methodology, criteria, and parameters used to define the feasibility of the project, as well as the mechanisms for monitoring and control during the works to meet the aims.

CODE 313

METHODOLOGICAL PROCESS FOR THE INTERVENTION IN THE PATRIMONIAL BUILDINGS OF THE NEIGHBORHOOD EL VERGEL, "LAS HERRERÍAS" STREET, CUENCA - ECUADOR

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KEYWORDS: Intervention methodology; participatory processes; consecutive cycles; control methodology.

ABSTRACT

The intervention area known as "Las Herrerías" street was historically one of the ways in and out of the city. Now it is one of the connecting axes with the Historic Center of Cuenca, included in the list of World Heritage of UNESCO.
Historic centres are generally under pressure today as a result of urban growth and globalisation. Attentive to these realities, a clear lack of maintenance of the buildings with and without patrimonial value in the street of Las Herrerias is perceived; mainly affections have been identified caused by exogenous agents or modifications carried out to solve needs that many times structurally affect the good. Factors such as, the economic situation of the people or inadequate interventions that affect the deterioration of the built heritage of the neighbourhood.
With this background, the World Heritage City Project of the University of Cuenca has the initiative to implement a maintenance campaign that executes its plan of intervention in 22 buildings of "Las Herrerías" street. The maintenance campaign was carried out with the objective of recovering the tangible and intangible heritage of the place, developing a participatory process, where the inhabitants are considered as one of the main actors in all stages of the campaign.
The intervention took place between May and July 2018, had a previous intense process of planning and administration, resulting in an integral diagnosis of the neighborhood and its buildings, concluding in specific intervention plans for each. The intervention plans show a process to follow, considering: different alterations levels, limited time for the execution of the works, the economic situation of the owners, unforeseen events at the time of starting the works, as well as the technical and theoretical criteria of the restoration.
The results of the research conclude in a methodology that will contain guidelines to be considered during the interventions in contexts similar to the historical center of the city of Cuenca, where the recovery of the heritage should include cyclical processes focused on preventive conservation and mainly with citizen participation as a determining factor.

CODE 408

COMMISSIONING OF AIR-CONDITIONING AND VENTILATION SYSTEMS IN A PUBLIC MUSEUM STORING HISTORICAL CULTURAL PROPERTIES

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KEYWORDS: Museum; commissioning; storing environment; hygrothermal; air-conditioning.

ABSTRACT

In museums, a suitable and controllable indoor environment that considers energy-saving efforts is required. However, a lack of experts and inappropriate building systems are commonplace, and present situations in museums must be understood to solve these problems. In this paper, a public museum in Kyoto (Japan) was surveyed, with a focus on the storage rooms, which are composed of double-layered walls with an air layer. These storage rooms are installed with central air-conditioning (AC) systems or a room air-conditioner (room AC) and ventilation system. In the central AC systems, the conditioned air supplied to the ceiling flows to the underfloor space. The temperature and humidity around the storage rooms were measured. In one storage room (hereafter SR1), no negligible temperature difference between the room and the underfloor AC sensor was found. Meanwhile, in the other storage room (hereafter SR2), the humidity remained higher than 70 %RH during summer, although the room AC was operating in dehumidification mode; and condensation and heat loss occurred at the cooling/heating ducts. A dehumidifier for domestic use was introduced to lower the humidity in SR2. The effects of several factors were checked, including air tightness, operation of the exhaust fan in the toilets, and air tightness of the windows. The relative humidity in SR2 quickly reduced by 15% to 20%, indicating that even a small dehumidifier can lower the relative humidity such that it is suitable for the conservation of metallic properties. The air flow from the room to the corridor was suppressed by tightening the windows and ceasing toilet fan operation. To maintain a suitable hygrothermal condition for cultural properties, introduction of a detailed monitoring and control system is required, in addition to thermal insulation and airtightness of the room and an improved AC system.

CODE 414

ANOMALIES IN THE PARTITION WALLS OF A PUBLIC BUILDING: ANALISYS OF POSSIBLE CAUSES AND REPARING STRATEGY

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KEYWORDS: Partition walls; anomalies; inspections; simulations; repair strategy.

ABSTRACT

The partition walls of a large public building are affected by cracks and spalling with different levels of intensity. These anomalies occur in general way in all partitions walls, however being more severe in the longer walls that define the main corridors of the building, which are the focus of this paper (corridor partitions).
The building is made with a framed concrete structure (flat/waffle slabs and columns) having spans of 6.5 to 7.5m. The corridor partitions have 3.6m high and 30 to 40m of length, 10 to 20% of door openings. These partitions are made with double leaf clay masonry walls (hollow units of 11cm of thickness) and coated with traditional mortar render and stone slabs, forming a double wall of 73 cm of apparent thickness. The main purpose of this thickness was to hide several installations/pipes. Excluding the concrete lintels constructed at the door openings, these walls do not have reinforcement elements nor movement joints.
In order to study the causes and to define a suitable repair strategy, an “in situ” thorough survey of the anomalies, inspections and numerical simulations were performed. The shape and intensity (crack width and spalling area) was registered and some small/local demolitions were performed to acknowledge some constructive aspects of the walls. To establish some possible causes for the anomalies observed in the corridor partitions, numerical simulations were performed. A 3D detailed model of a corridor partition affected by the structural movements of the concrete slabs, including long term effects of the concrete (shrinkage and creep) and clay masonry (moisture expansion) were simulated using a FEM model.
The main results of the survey/inspections and simulations performed are presented and discussed and a repair strategy is proposed.

CODE 417

EVALUATION OF CONSERVATION STATE AND STRUCTURAL SAFETY OF A WOOD STRUCTURE AND PROPOSAL OF INTERVENTION MEASURES

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KEYWORDS: Wood; conservation state; structural safety; diagnostics; repairing works.

ABSTRACT

Wood structures are very sensitive to temperature and humidity variations. It is necessary to design these structures according to the "on site" exposure conditions (e.g. suitable safety levels and construction measures), as well as to perform periodic inspections and preventive maintenance to ensure a proper durability throughout its useful life. Neglecting these aspects may result in early deterioration of the structural wood pieces and/or their connections, impairing the resistant performance and structural stability of wood constructions.
This paper describes a case study regarding an evaluation of the conservation state and structural safety of a large sculpture made with a wooden structure. This sculpture is located at Vila do Conde City, in the north of Portugal, and is totally exposed to the river/sea climate conditions, and it presents some signs of anomalies/deterioration. This evaluation was performed through "in situ" inspections and numerical simulations in order to evaluate the structural safety.
In general, the structure of the sculpture has an acceptable global level of conservation. However, it presents some low/medium gravity anomalies that may compromise its conservation and structural safety in the near future. On the other hand, the numerical simulations revealed that the steel-to-timber connections of the sculpture are the critical sections, since they have substantially lower resistance levels than the current wood sections, being very close to the safety limits defined by Eurocode 5, especially for wind loads.
Considering the conservation and safety levels obtained, repairing and preventive measures were proposed to ensure a proper structural functionality and durability throughout its useful life. The repairing works have begun in February 2019 and they will be finished until mid-summer in 2019. This paper presents both the diagnosis and design procedures and considerations regarding the on-going repairing works.

CODE 430

XIX CENTURY BRIDGE REPAIR, IN DEBA, NORTH OF SPAIN DUE TO THE VERTICAL SUBSIDENCE OF ONE OF ITS PIERS

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KEYWORDS: Rehabilitation; bridges; heritage; repair; strengthening.

ABSTRACT

Opened in 1866, the 67m-long Deba Bridge is an historical arch bridge considered as the most representative example of its type and time in the region. It is located in the town of Deba, a seaside town around 40km west of San Sebastián in northern Spain. The crossing consists of four arches, three with a similar span of around 15m and one at 9m.
On July 2018, sudden and significant subsidence occurred on the main pier of the bridge, which also twisted along its longitudinal axis. The pier subsided by 0,90 m on the downstream side and 0,70 m on the upstream. There were no warning signs detected by pedestrians on the days leading to the incident. Miraculously, the structure did not collapse.
However, the ensuing extensive damage included, among others, cracking above the central arches, the loss of some keystones/stone quoins, twisted sections, loss of a large section in the downstream parapet, and loss of deck alignment over the affected arches
The proposed repair works were divided into two phases. The first, classed as the emergency intervention and described in this document, aimed both to stabilise the arches that were at serious risk of collapse and to ensure the safety of the whole structure. This phase also included the second objective of re-establishing pedestrian access across the river, which was urgently needed by the local community. Once structural integrity had been secured and a new footbridge installed, phase two would then begin, namely the return of the bridge to its original geometry, as required for a structure of such national cultural importance.
Works falling under the first phase were contracted to Freyssinet with two principal requirements; that they be carried out quickly and safely, given the risk of imminent collapse of the arches. Any operation that could put personnel at risk was forbidden, in particular the carrying out of works under the arches, including walking on the deck above them.

CODE 433

TECHNOLOGICAL ANALYSIS, TYPOLOGICAL FEATURES AND SEISMIC VULNERABILITIES OF POST-WORLD WAR II ITALIAN SCHOOL BUILDINGS

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KEYWORDS: Typical/specific seismic vulnerability; existing RC buildings; seismic risk reduction intervention.

ABSTRACT

Many Italian school buildings, built just after the post-World War II, share similar geometrical and spatial characteristics. Some of these features may negatively affect the building seismic response, generating typical seismic vulnerabilities. In order to mitigate them, and then to foster an effective transition towards a safer and more sustainable society, it is important to provide exemplary cases on how to proceed correctly. For this reason, in this paper typical vulnerabilities of Italian post-World War II RC school buildings are individuated and discussed. For one of the most representative case study an in situ experimental campaign has been carried out in order to identify the specific seismic vulnerabilities related to specific geometrical aspects or material properties. Results of structural assessment have evidenced that some typological vulnerabilities such as wide atriums, eccentric stairs and tall windows, along with irregularity in plan configuration, strongly affect the global seismic behavior of the school buildings. Finally, a structural intervention aimed to improve the performance against seismic actions has been proposed and described for the case study. The intervention concerned RC jacketing of the columns, shear strengthening of beams through Carbon Fiber Reinforced Polymers (CFRP) sheets and strengthening of the beam-columns joints. The strengthening efficiency has been evaluated by means of pushover analysis. The proposed intervention can improve the seismic resistance of the building.

CODE 436

OPTIMIZATION OF AN ACTIVE DEPRESSURIZATION SYSTEM, FOR RADON MITIGATION IN AN EXISTING BUILDING IN MADRID

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KEYWORDS: Radon mitigation; active depressurization system; indoor air quality; optimization.

ABSTRACT

Sub slab active depressurization systems have proven highly effective as a technique for reducing radon concentrations inside buildings. In order to optimize these systems and designs, it is useful to know some parameters of the building and the substrate, such as the permeability of the soil, cracks or joints in the slab, or the foundation barriers that may constitute obstacles in the pressure field propagation in the soil. This paper presents a case study of real application where several configurations of this type of techniques have been tested.
The results obtained from the different tests performed in the diagnosis, have allowed us to propose a phase methodology for the design. The effectiveness of the different combinations and configurations, as well as extraction powers, have been analyzed. Finally, an optimal configuration has been proposed, for the specific case of study, as the final design of the system operation with better effectiveness.

CODE 441

RIONE FOSSI AND THE DUCAL PALACE OF ACCADIA: RECOVERY CRITERIA, SEISMIC RETROFITTING AND REHABILITATION

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KEYWORDS: Recovery; rehabilitation; seismic retrofitting.

ABSTRACT

The study carried out is based on the most appropriate criteria and intervention philosophies to be implemented in the recovery of damaged or abandoned building artefacts within historic villages. In detail, the object of study was the historic village of the municipality of Accadia (FG); especially the Rione Fossi which today is in a state of complete abandonment and degradation. The constructions present common problems: the collapses of horizontal partitions and the damage to the roofs; the fewer are the cases in which the buildings have collapsed at the vertical partitions. The types of intervention identified are suitable for the damage cases encountered, also allowing the reclamation, the re-functioning and the redevelopment of the entire village, based also on the directives of the National and Local Tourism Strategic Plans. Starting from the structural and architectural analysis of the case study of the Ducal Palace, it was decided to use light and reversible timber construction systems, which are suitable to fulfill a dual task: structural reinforcement and seismic retrofitting together with the support for the functional recovery of spaces, guaranteeing the preservation and identification of the urban and environmental skyline and landscape.

CODE 455

LOCAL HERITAGE ENFORCEMENT METHODOLOGY: A GLOBAL PROCESS OF IDENTITY REVIVAL. STUDY CASE OF THE TOWER OF THE CHURCH OF THE ASSUMPTION (GUADALCANAL, SEVILLA)

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KEYWORDS: Built heritage; local identity; refurbishment methodology; sustainability.

ABSTRACT

We hereby present the case study of the Restoration of the Tower of the Church of Santa María de la Asunción, in Guadalcanal, Seville. The project and execution of the work were set as objectives to undertake the repair of the damages of the building. Likewise, the intervention halted the process of accelerated deterioration of this property. Additionally, the Tower is a true urban landmark. Its height, image and volumetric power are values assumed by the town as their own and as common identity features that needed to be recovered in order to rebuild the relationship between the local population and its main symbol. Despite being a property with the highest level of heritage protection in Spain, there was a total lack of information about it, its history and its materiality. For this reason, it was necessary to design a global research process encompassing various disciplines that would allow reconstructing the common past of the Tower and the town and project the necessary intervention based on the main conclusions of this study. The result of the research and the recovery of the constructive systems and of the image of the Tower is laid out in this contribution. The initiative of the Catholic Church, as the owner of the property, is to undertake in the present case of study a model process of private intervention aimed at the global, symbolic and material recovery of the religious heritage with the final objective of its reintegration into the community.

CODE 485

COSTS AND TECHNOLOGIES IN SCHOOL BUILDINGS REHABILITATION WORKS

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KEYWORDS: Rehabilitation costs; rehabilitation levels; rehabilitation techniques; school buildings; economic indicators.

ABSTRACT

Nowadays, school buildings represent the place where young people spend much of their day-to-day life. However, not all buildings have the ideal conditions of use for the school community. Therefore, it is necessary to carry out interventions that give them the necessary characteristics of performance, as functional, structural and constructive safety.
The work carried out is based on the survey of technologies and costs associated with the rehabilitation of school buildings. Its main objective is to determine the economic indicators for the rehabilitation of school buildings, in order to prospect and control future interventions. The study begins with a brief framework on rehabilitation, followed by the identification of some current pathologies, as well as their rehabilitation solutions, for the structural elements, primary elements, secondary elements, coatings / finishes and for technical installations. In order to achieve the proposed objectives, various cost structures were adopted, and the different costs involved in the rehabilitation of various school buildings were analyzed, through the bill of quantities and budgets for each project. For the work it was used ProNIC platform, where the technical and investment information's of the works in question are stored. After collecting all the relevant information, this was worked out to determine different economic indicators, the main rehabilitation guidelines and respective unit costs, among others, according to different identified cost structures. Finally, the results obtained and their conclusions will be presented, as well as proposals for future development of complementary works.

CODE 499

REHABILITATION OF THE ROOF STRUCTURE OF THE MULTIUSE ROOM OF THE "ALVES MARTINS" SECONDARY SCHOOL, VISEU, PORTUGAL

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KEYWORDS: Timber structures; rehabilitation; strengthening; construction process; prosthesis.

ABSTRACT

The "Alves Martins" Secondary School, former Central Viseu Lyceum, was built in 1948, within the frame of an extensive governmental scholar constructions program. It includes a 2-floor open space pavilion, the upper floor being taken by a Multiuse Room. The roof structure consists of a series of parallel double timber trusses, partially concealed above a polyhedral wooden plank-made ceiling. In September 2017, the support of one of the trusses collapsed and another one has been assessed as in a pre-collapse condition. Spurious load-redistribution provided by secondary elements and the prompt shore of the structure prevented the generalised failure of the trusses. The subsequent inspection and assessment of the structure led to the conclusion that the primary cause of the collapse was the failure perpendicular to the grain of the solid timber elements inserted between the double rafters and tie-beams, which finally bring the gravity load to the supports. In the follow-up, two possible repair solution were considered and compared, one consisting of the full replacement of the existing structure by a steel lattice structure, and the other preserving the existing wooden trusses, through localised repair and reinforcement of the collapsed supports and reinforcement of all the others. Considering the intrinsic quality of the original trusses and their generally good condition, the latter solution was adopted, with the additional advantages of being cheaper and faster to execute than the alternative. The whole process is detailed in this paper, starting from the inspection and diagnosis stage up to the repair works, with special emphasis on the structural aspects, of utmost importance to a successful intervention.

CODE 555

PATRIMONIAL STUDY OF THE REAL FELIPE FORTRESS OF CALLAO-PERU

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KEYWORDS: Restoration; put in value; intervention; military architecture.

ABSTRACT

The Real Felipe fortress was one of the most important strongholds of the Spanish Monarchy and the scenario of major historical events. This key stronghold controlled the Callao port, entry point to Lima. The fortress is one of the greatest examples of Spanish military architecture in the 18th century. It suffered different interventions and changes in usage over time. However, only in the 20th century increased the awareness of its heritage value; hence, it was restored several times, taking different approaches and achieving different results.
It is worth noting that no heritage research has been made. For this reason, this paper aims to acknowledge the interventions and restorations the fortress has suffered and to provide evidence of the restoration practices in Peru over time. For this I have unpublished information provided by the architect Víctor Pimentel and the support of the military authorities that administer the fortress.

CODE 570

ALMALLUTX: A RENOVATION PROPOSAL IN A VERNACULAR ARCHITECTURE EXAMPLE IN SIERRA DE TRAMUNTANA (MALLORCA)

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KEYWORDS: Rehabilitation; vernacular architecture; architectural heritage.

ABSTRACT

The importance of the Built Vernacular Heritage is unquestionable as well as its uniqueness, due to the different techniques and materials used to adapt it to the site conditions. Because of its historical, social and cultural conditions, it is about protected goods whose conservation is a need understood by society and its institutions.
This Thesis focuses on a renovation proposal in a vernacucular architectural example of a traditional Mallorcan architecture, studying a house located in the Sierra de Tramuntana, next to the Gorg Blau reservoir and known as the Finca de Almallutx.
Initially, the traditional architecture of the area is analyzed to understand how it originally was and to identify the changes supported. This study is completed with the characterization of the current materials and systems.
Taking into account all the above information, a renovation project is drawn up combining different needs: respect for traditional architecture, current technical solutions to the endemic problems of their original systems, the necessary adaptation to their current use and respect for the natural environment that surrounds it, which was awarded as World Heritage Site.

4.- MAINTENANCE

4.1.- CONSTRUCTION MAINTENANCE.
4.2.- PREVENTIVE CONSERVATION OF BUILT HERITAGE.

CODE 50

DIRECTIVES FOR THE EVALUATION OF THE CONDITIONS OF THE ENVELOPE OF CURRENT BUILDINGS IN CONDOMINIUM REGIME

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KEYWORDS: Management of condominiums; characterization of buildings; pathologies of buildings; conditions of the envelope of buildings.

ABSTRACT

The influence of management of condominiums and their annual budgets in the decision process on maintenance actions, both preventive and reactive is well known. Therefore, it is pertinent to elaborate tools, some of which help to record the pathologies / anomalies and their correlation with the building, and some others that can consolidate the technical support, comprising the importance of maintenance, quality and durability of buildings.
In this context, the most important contribution of this article is the proposal of directives for the evaluation of the conditions of the envelope of current buildings in condominium regime.
The present article, which reflects the work within a Doctoral curricular unit, is aimed at the accomplishment of several guidance instructions for technicians hired by condominium administrations to perform reports of anomalies / pathologies existing in the building.
It has particular emphasis in this work the development of methodologies and tools for the assessment of the envelope of current buildings, with the differentiation between a preliminary evaluation and a detailed evaluation, complemented with the presentation of a case study.

CODE 83

GENIA: INSPECTION, EVALUATION AND BRIDGE MANAGEMENT TOOL

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KEYWORDS: MIVES; value-based analysis; maintenance and conservation; GENIA; condition index; main bridge inspections; bridge management.

ABSTRACT

Bridges are key elements in the road network and constitute an important source of investment for different administrations. Over time, the bridges deteriorate if the necessary maintenance and conservation measures are not taken. Likewise, because they are designed to provide a passage, any mishap in them can limit or interrupt them, with the inconveniences that this entails and the economic losses that may result.
This is why a better and more continuous assessment of the condition of bridges is required in order to better face the challenges presented by aging. The main inspections, which should be carried out every 5 years on highway bridges, are understood as the technical actions carried out in an organized manner that provide all the necessary data to evaluate, at one specific point time, the state of conservation of a bridge (functional and resistant state), being the basis to define the maintenance tasks.
This paper presents an innovative method to evaluate the condition of bridges based on the main inspection. The method has been developed following the MIVES methodology, a multiple criteria model for decision making that evaluates alternatives to solve a generic problem defined through a value index. This method increases objectivity and consistency in the evaluation of bridges by establishing general criteria to identify damages and automatically quantify their relative importance. The evaluation method has been implemented in a web application called GENIA that provides a global condition index of the bridge and improves the inspection system.

CODE 203

METHODOLOGY FOR THE STUDY OF PATHOLOGIES IN POST-TENSIONED SLAB BRIDGES. AN APPROACH TO MONITORING AND CONTROL

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KEYWORDS: Bridges; post-tensioned slabs; aggregate-alkali reaction; dynamic tests.

ABSTRACT

In recent times, damage has been shown in bridges of solid reinforced concrete post-tensioned slabs associated with a degradation of the concrete itself due to chemical reactions between some of its aggregates and the alkaline of the cement.
This type of aggregate-alkali reaction is a problem of hydraulic works in which, if there are reactive aggregates, the humidity necessary for the development of the reaction and the massiveness of the affected elements favours the development of the phenomenon.
However, despite the fact that several of the identified bridges are not found in particularly humid environments, this type of damage has been developed in a very characteristic way as a consequence of the added stresses induced by the longitudinal post-tensioning of the board.
The structural significance of this attack, apart from the reduction of the durability of the structure, lies in the reduction of mechanical performance of the concrete itself as well as in the loss of rigidity associated with intense cracking.
Quantifying this structural transfer is very complex, not so much because of the reduction of mechanical properties of the concrete, but also because of the aforementioned effect of cracking in the rigidity of the board and therefore in the distribution of stresses.
One way to approach the problem, and to analyze the evolution of the pathology, is to perform dynamic tests on the board so that the dynamic characteristics (own frequencies, modal shapes and damping) can be determined and the measured global response can be compared with what would be expected according to models of finite elements in which the effect of the degradation of the material is discounted. This work, thus raised, has been carried out on several of the affected bridges. In this way, a tool is obtained that allows control of the monitoring and evolution of structural behavior that can facilitate decision-making for the patrimonial management of this type of construction.

CODE 468

THE COMMON MISTAKES DURING THE INTERVENTION IN EARTHEN VERNACULAR ARCHITECTURE

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KEYWORDS: Vernacular heritage; earthen architecture; preventive conservation; maintenance.

ABSTRACT

The interest in protecting vernacular architecture can be considered one of the most recent concerns in the heritage field. Although consensus about the notion of vernacular architecture has not yet been achieved, it has often been linked to a spontaneous process of construction which responds to the continuous socio, cultural, economic and environmental changes. On this never closed process of creation, acquired empirical-knowledge is transmitted from one generation to the next one in permanent adaptation, prioritizing the use of local materials and local knowledge. In the case of the historic city centre of Cuenca, Ecuador, vernacular architecture mainly corresponds to earthen architecture, such as adobe and bahareque, inhered from the colonial and republican period. Quantitatively this group represents more than 80% of the total of heritage buildings placed in this World Heritage Site. Unfortunately, the current stay of decay of those structures is evident, compromising its physical conservation and the transmission to future generations of the cultural values embodied. In this line, the present research aims to study the anthropological causes as one of the important factors of deterioration, revealing some common mistakes during intervention over this type of architecture. Based on previous research carried out in the last decade, a sample of 36 heritage buildings located within the historic city centre of Cuenca is analyzed using no-destructive analysis (visual) and expressed in quantitative and qualitative data. As part of the main results, the link between physical deterioration and anthropological causes was revealed, and a set of common bad practices of intervention on vernacular earthen architecture were evidenced. This research concludes indicating corrective and preventive recommendations to favor the proper conservation of that important cultural legacy.

CODE 518

AIR POLLUTION IMPACTS ON TRADITIONAL BUILDING MATERIALS: FROM SAMPLE EXPOSURE TESTING TO AN URBAN SCALE ASSESSMENT

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KEYWORDS: Historic buildings; air pollution; soiling; corrosion; treatment costs.

ABSTRACT

Several international programmes have been carried out in the past to study the effects of air pollution on exposed metals and stones. Research programmes such as the ICP-Materials and MULTI-ASSESS have performed material sample exposure tests, in order to determine the impacts of suspended particles on the blackening of limestones and the impacts of acidic pollutants on the corrosion of traditional metals. The present work summarizes the experimental framework developed in the historic centre of Coimbra regarding the exposure of limestones and metals, that allowed the validation of existing dose-response functions used to estimate soiling and corrosion effects in this city centre. An urban scale assessment was then carried out through the modelling of air pollution dispersion in the centre of Coimbra and an estimation of the exposed surface area of selected materials in the old town's building stock, in order to estimate long-term treatment costs associated to air pollution in this historic centre and raise municipal awareness regarding air quality.

CODE 55

RISK ANALYSIS METHODOLOGY APPLIED TO EARTHEN FORTIFICATIONS. THE TORRE DE RIJANA: A CASE STUDY

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KEYWORDS: Risks; preventive conservation; earthen defensive architecture.

ABSTRACT

The state of conservation of the remains of defensive earthen architectural heritage is often compromised by a variety of natural or man-made hazards that, if sustained over time, can aggravate these sites deterioration until the consequences become irreversible. This has led to the creation of management tools which, using the defensive earthen architecture of the southeast Iberian Peninsula as their reference and adopting the guidelines set out in the various National Plans, contribute to a more thorough study with regards to its preventive conservation.
The study presents findings from the development of an innovative risk assessment protocol founded on sustainability criteria and which is designed to facilitate decisions on protection, conservation and appraisal by the corresponding administration and agencies involved in protecting these sites. The model is logical and operational, sufficient to determine the real risk to these structures, and integrates information regarding their vulnerability and hazardous conditions at the sites where they are located. The determination of risk is made via an assessment of the different, aggregated risk factors present in a specific geographical area.
This methodology is applied in the Torre de Rijana case study, which examines a watchtower located on the Granada province coast in Spain and which is protected by Spanish Historical Heritage legislation, with the highest available generic award, as a consequence of its significant heritage value. The protocol allows for a multidisciplinary analysis of its heritage characteristics, an analysis of the risk factors, assesses to what extent it is vulnerable to them, takes into account the area where it is located, as well as its derived state of conservation. It also allows for the creation of preventive measures Action Maps from specific Risk Maps, whilst simultaneously establishes how to prioritise actions, thus promoting sustainable conservation with minimum economic investment and creating an efficient maintenance programme.

CODE 96

MICROCLIMATIC ANALYSIS IN THE LIBRARY OF THE FACULTY OF HUMANITIES AND EDUCATION SCIENCES, UNIVERSITY OF LA PLATA, ARGENTINA: A CASE-STUDY

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KEYWORDS: Preventive conservation; climate; library; monitoring; hygrothermal.

ABSTRACT

Temperature and relative humidity can influence the conservation of organic materials like paper, books and other materials that lay in library deposits. Surveillance and control of this variables is recommended to alert on harmful values, but is also useful to organize collections according to their frailty and the most fitted zones for conservation. This paper presents an evaluation of temperature and relative humidity implemented at a deposit in the Library of the Faculty of Humanities and Education Sciences, in the National University of La Plata (UNLP), Argentina, in order to verify the climate of the collection and determine the most fitted zones for conservation according to the location of the deposit into the building. We performed an annual monitoring campaign in five spots of a naturally ventilated deposit, contrasting with external reference data provided by the UNLP Observatory weather station. Results show that climate conditions are satisfactory, the study provides the delimitation of a range of admissibility according to the climatic oscillations occurred during the monitored period, and a numerical evaluation of each spot. The shelves located in the center of the deposit and on the northeast side show better performance than the southwest side of the room.

CODE 178

VULNERABILITY AND IDENTIFICATION OF EVACUATION ROUTES FOR HAZARDS IN THE HISTORIC ENVIRONMENT OF THE LOWER ALBAYCÍN

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KEYWORDS: Evacuation routes; emergency plan; Hazard scenario; lower albaycín; Granada.

ABSTRACT

This research assesses building vulnerability, capacity and fragility in the urban environment which is a basic tool for the prevention of future seismic scenarios. Identifying hazard-prone vulnerable buildings become essential for designing emergency plans and self-protection measures in order to minimize material and human damage.
Due to the uncertainty of the magnitude and depth of earthquakes regarding seismic hazard and risk prevention and management, it is necessary to be aware of the building response capacity based on its vulnerability index and fragility curves, and also to plan resources aimed to mitigate potential damages on people, assets and the environment. A succesful and urgent intervention largely depends on the response capacity of emergency services given a suitable accessibility and mobility plan in a historical environment.
Based on the results obtained after implementing the methodological guidelines developed by the Risk-UE Project, we propose a data collection protocol in the lower Albaycín neighborhood to facilitate a list of buildings that may affect evacuation routes for future emergency plans.

CODE 234

CULTURAL HERITAGE MAINTENANCE CAMPAIGNS AS TRIGGERS OF PARTICIPATORY PROCESSES IN THE CITY OF CUENCA (ECUADOR)

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KEYWORDS: Sustainable conservation; modest heritage; participatory processes; actors networks; maintenance campaigns.

ABSTRACT

Within the built cultural heritage conservation, innovative initiatives called "Maintenance Campaigns" have been designed and implemented in the last decade from southern Ecuador. That campaigns emerged in a rural area inspired by the strong social organization and ancestral indigenous practices such as the "minga" which are currently in use. Indeed, maintenance campaigns foster a system of collaborative work which links different resources and different actors (public, private, academic and community), to implement maintenance actions in a set of heritage buildings, considered not monumental. Progressively, these initiatives have been adjusted and transferred to urban areas, implicating new challenges for their implementation. Precisely, this article aims to reveal some of the critical variables, lessons learned and challenges for the sustainability of those initiatives in urban areas. To this end, the comparative analysis of the maintenance campaigns carried out within the urban area is presented, based on the preliminary results of the evaluation process of two maintenance campaigns developed in two traditional neighborhoods of the World Heritage City of Cuenca: San Roque (2013-2014) and El Vergel (2017-2018). Despite the different methodologies adopted to these evaluations - a quantitative and qualitative approach in the first case and participatory approach in the second case- the preliminary results on each case agree that these initiatives go far beyond the physical improvement of buildings that affects the level of habitability of users and their contribution to the awareness of heritage care, to reveal its potential as an instrument of (re)activation of networks of actors, those who influence the values of cultural heritage built and its possible transmission to future generations. Finally, the comparative analysis revealed the design and implementation processes of the campaigns are continuously nourished. Those contribute to the improvement in the quality of life in each territory based on a more participatory approach in the conservation of the built heritage.

CODE 236

WHOLE HISTORICAL STUDIES OF FIFTY BRIDGES OF THE SPANISH ROAD AND RAIL NETWORKS

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KEYWORDS: Heritage of public works; history of bridges; road and railway bridges.

ABSTRACT

A study has been carried out on fifty road and railway heritage bridges in Spain. The objective sought has been to characterize them to enhancing their value since the selected bridges, although they are not declared as buildings of Cultural Interest, they are relevant because of their period, the technology used in their construction, for the historical relevance of the road they serve, or because of the reputation of the technicians who built them.
The studies of these bridges have been approached with a multidisciplinary focus: a historical study of the context of the work has been carried out, its current structural state has been analysed, the materials used in its construction have been mechanically characterized, and the environment has been studied of the site from the geotechnical and hydrological-hydraulic point of view.
Given that the analysed bridges are quite representative of the Spanish bridges fleet that are in service in the country, the approach followed has allowed us to have an approximate vision of the state in which our road network is located. From the structural point of view, in general the bridges did not present serious anomalies since their pathologies were not the criteria by which they were selected. The damages that they presented were generally associated with the degradation of their materials and the lack of sufficiently efficient maintenance. However, in a timely manner some bridges unexpectedly presented greater severity structural damages, and even in one of the cases it was necessary to put the bridge out of use after the inspection.

CODE 248

CASE STUDY ON SEISMIC VULNERABILITY ASSESSMENT OF MASONRY BUILDINGS BY USING CARTIS DATABASE

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KEYWORDS: Masonry buildings; seismic vulnerability assessment; pushover analysis; CARTIS-ReLUIS project.

ABSTRACT

The seismic assessment of the building heritage represents the first step in seismic prevention, especially in southern Italy, which is one of the most seismic-prone areas in the Mediterranean. For these reasons, several research centers have developed multiple building analysis tools over the years. CARTIS (CARatterizzazione TIpologia Strutturale) is one of these attempts, implemented by the interuniversity consortium ReLUIS (Rete Laboratori Universitari Ingegneria Sismica) together with the Italian DPC (Dipartimento Protezione Civile). This project is based on the development of a systematic methodology for assessing the exposure of seismic risk on a territorial scale for ordinary buildings. The evaluation occurs through the compilation of two kinds of survey forms: “compartments” on a municipal level, and “buildings” for the single structure.
This work aims to represent the results of the CARTIS survey campaign carried out on a case study in southern Italy: the municipality of Mendicino in the province of Cosenza. Based on the typological-structural features of the buildings highlighted in the compilation of the forms, the territorial survey led to the identification of two town compartments: “old town” and “expansion area”. By focusing attention on masonry buildings only, the identification of the most common building typology within the “old town” sector is performed to highlight the elements of greatest vulnerability.
In particular, for the “tower-house” typology, these elements are as follows: the plan shape (square, rectangular and irregular), the story height, the number of floors, the type of masonry, the slab stiffness, and the percentage of openings. These elements are combined in a calculation model, and pushover analyses are carried out to detect the safety index – expressed as the ratio between displacement capacity and seismic demand – for each structural configuration.. An intervention priority scale might be deduced from the index comparison, and the most vulnerable buildings are defined qualitatively.

CODE 278

MAINTENANCE BOOKLETS FOR BUILT HERITAGE, APPLIED IN THE HISTORICAL CENTER OF CUENCA - ECUADOR

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KEYWORDS: Owners; control; tools; preventive conservation.

ABSTRACT

The Latin-American cities declared by UNESCO World Cultural Heritage have a widespread problem due to the lack of maintenance of its vernacular architecture, which has caused and could continue to cause irreversible losses of their heritage buildings. In this context, the World Heritage City project (CPM) of the University of Cuenca is developing a set of tools, that enable among others a continuous monitoring and maintenance of built heritage.

Among these tools are the so-called maintenance booklets, developed by the CPM project through its research in urban and rural settings, which are easy to understand educational instruments, designed to support and encourage the informed participation of owners and property managers in the continuous monitoring and maintenance of their heritage buildings.

The booklets are made up of friendly and didactic illustrations with everyday language, in which solutions are offered to common damages in different elements that make up the local architecture, such as for example: roofs, adobe and bahareque walls, plasters, paint, etc. They are intended to propose appropriate treatments to material elements of the buildings.

These tools are a fundamental support within the practical experiences of preventive conservation of the so-called “Maintenance Campaigns” carried out by the World Heritage City project of the University of Cuenca. In the methodological process of the preventive conservation phases as proposed by ICOMOS (2003) - Anamnesis, Diagnosis, Therapy and Control -, they are primarily being applied in the last phase: Control.

The booklets have been used in the “San Roque” (2014) and “Las Herrerias” (2018) maintenance campaigns, which are important historical sites that belong to the UNESCO area of the city of Cuenca. In the Las Herrerias neighborhood the use of the booklets is part of a Comprehensive Preventive Conservation Plan. Furthermore, the booklets have been awarded an Honorary National Mention by the “XXI Pan-American Biennial of Architecture in Quito, 2018”.

CODE 396

METHODOLOGIES FOR EVALUATING THE IMPACT OF CLIMATE ASPECTS ON HERITAGE CONSTRUCTIONS: A DELPHI METHOD APPLICATION

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KEYWORDS: Heritage; buildings; conservation; fuzzy logic; climate change.

ABSTRACT

In the Latin American context, specifically in the Chilean case, interest in climatic conditions and natural hazards has increased because of the possibility that extreme conditions can occur. For this reason and given the uncertainty of future climate behaviour, different climate change scenarios have been proposed. In this study, a Delphi study has been conducted to explore, in particular, the variables of rainfall and temperature and their impact on the conservation of heritage buildings. The objective is not only to identify the most damaging atmospheric factors in the preservation of historical constructions but also to determine the personal attributes of a group of experts that can influence the process of preservation. The sample of case studies focused on a set of 25 heritage buildings declared as historic conservation buildings as per property identification regulations of the Ministry of Housing and Urban Planning of the Chilean government. An analysis of the Delphi methodology was conducted using a panel of 17 experts from different areas of construction and architecture in southern Europe and Latin America. The results on the use of the Delphi methodology are expected to yield a consensus from the panel of experts on the climate indicators to be assigned in new methodologies that focus on prioritising interventions for heritage buildings in Chile. The findings of this research provide new approaches to study the influence of climate indicators, which can be used to more accurately predict the degradation of heritage properties in climate change situations.

CODE 460

RISK ASSESSMENT AND ACTIONS FOR MAINTENANCE OF PUBLIC BUILDINGS - CASE OF THE MUSEU NACIONAL/RJ

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KEYWORDS: Maintenance; risks; museu nacional.

ABSTRACT

This article aims to address the maintenance actions recommended in the context of public buildings in Brazil, taking into account the potential risks observed in the case of Museu Nacional, Rio de Janeiro. First, a bibliographical review was carried out on the topics related to building maintenance and risk analysis and, thus, the history of the building and its peculiarities was prepared, from its construction to the fire occurred in September 2018. Then, the research was conducted by means of document review, using the post-fire expert report, identifying the importance of maintenance in public organizations and creating a link with the incident occurred. Based on this relation, a risk analysis tool - fault tree was used to evaluate the possible causes of the fire in Museu Nacional, thus tracing the recommended actions to serve as a model in the prevention of this type of case.

5.- DIFFUSION AND PROMOTION

CODE 42

NUBIAN AUTHENTIC CULTURE NOW, BETWEEN COMMODIFICATION AND ENDURANCE

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KEYWORDS: Culture-heritage tourism; Nubian culture; cultural authenticity preservation.

ABSTRACT

Nubia is the homeland of Africa's earliest black culture which can be traced from 3100 BC onward based on written records from Egypt and Rome. Hence, the Nubians are believed to be the first human race on earth, and most of their customs and traditions were adopted by the ancient Egyptians. The unique characteristic of Nubian is shown in their culture (dress, dances, traditions, houses and music).
The land of Nubia used to be an 800 kilometers desert stretch loosely defined between southern Egypt and northern Sudan, before the dramatic changes their communities went through in the past decades. In the 1960s, more than 50,000 Nubians were forced to vacate their lands and offered a place in desert settlements during the construction of Aswan High Dam. When the project was launched, UNESCO was approached by Egypt to help saving the endangered sites and monuments, and in 1960, it made its first appeal for the International Campaign to save the monuments of Nubia. However, and while this campaign was considered as one of the greatest achievements by UNESCO, not much attention was paid to the fate of Nubians and to their cultural heritage which was strongly connected through history to their original homeland.
While Cultural Tourism offers a strong motivation to preserve heritage and foster economic development, its sustainability depends on how much local community is involved and how much "authenticity" is valued. Taking into account that a tourism-related approaches cannot always be considered as a panacea to the cultural and socio-economic problems of Nubians, the tourism industry has been rapidly growing during the past two decades, and the expansion will probably continue well into the future; but at what expense? commodification may result in the loss of original meaning and loss of authenticity and cultural identity of Nubian people.
This paper offers an overview on the value and traces of the Nubian authentic culture, and raises an important issue related to the recent trends in cultural tourism in Nubia and the response of the Nubian people to the commodification of their culture.

CODE 211

CULTURAL TOURISM AROUND NON-MONUMENTAL HERITAGE: THE CASE OF THE PUREPECHA EMPIRE

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KEYWORDS: Cultural tourism; Purepecha empire; non-monumental heritage; cultural landscape; pueblos magicos.

ABSTRACT

It is at the end of the 19th century when in Mexico the first "leisure visitors" register emerges, attracted by the culture and imagination of a little known territory. Since then, the heritage that is conserved in the archeological zones and in the colonial cities has occupied a prominent place in the tourist offer of the country, and therefore we can talk about a historical relationship between tourism and heritage, which became cultural tourism today.
This communication focuses on the Lake Patzcuaro region, a territory located in the interior of the country, in the State of Michoacan. In this region of remarkable cultural and landscape value, the capitals of the Purepecha Empire are established and subsequently the colonial transformations and processes linked to later stages are superimposed, gathering all this a cultural stratification of great value.
In 2001, the Mexican government established a cultural tourism program under the "Pueblos Magicos" seal, increasing the visibility of this heritage. However, the story has been limited to showing peoples in isolation. This research raises a patrimonial characterization at territorial level that can pick up its complexity, transcending the urban scale of each town.
From an interdisciplinary methodology, and through the use of geographic information systems (GIS) the graphic construction of a database is approached, considering for this analysis historical, cultural and morphological layers that frame the historical periods where this territory has been anthropized. Subsequently, it was sought to characterize the evolution of the occupation of what was the Purepecha political core, recognizing that as they were transformed, in parallel new urban centers were consolidated, causing the loss of recognition of the existing heritage beyond the urban scale.
With the evolution of cultural tourism in this region, we identify that, taking advantage of the wealth existing outside these urban centers, it is the genetics of the territory that offers the opportunity to forge development and protection mechanisms in the territory, at local and regional levels.

CODE 253

CULTURAL TOURISM IN EUROPE. DISCOVERING HERITAGE CREATED BY WOMEN ARCHITECTS AND DESIGNERS

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KEYWORDS: Cultural-tourist itineraries; women in architecture and design; MoMoWo Guidebook; EU Creative Europe project; architectural heritage; active involvement in the promotion.

ABSTRACT

This paper presents an original experience of cultural-tourist itineraries devoted to the discovery of architectural heritage and legacy designed by women in Europe. This experience originated in the frame of the European cultural project MoMoWo – Women's creativity since the Modern Movement (headed by Politecnico di Torino) and it has produced the first guidebook focused on women's works: Women – Architecture & Design itineraries across Europe (2016). This pilot publication combines cultural and tourist contents for technical and informative purposes, and it mainly addresses a broader audience, tourists, and local visitors, families and young people, students and professionals.
An innovative and interactive research approach was applied 'up-stream' through the active involvement of women architects and designers in suggesting works for the itineraries. A call was launched via the architects and engineers associations to receive works from women professionals. The call asked for the author's favourite work and not necessarily the most popular one thus generating active participation in the process.
Considering that architectural heritage designed by women is rarely included in tourist or architectural guidebooks of major European cities, the MoMoMo guidebook appears as a first step toward the recognition of women's achievements in building and restoring European heritage.

CODE 276

CANNING PORTIMÃO. PROPOSAL OF A PEDESTRIAN ROUTE IN PORTIMÃO

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KEYWORDS: Canning industry; industrial heritage; tourism; portimão; Portugal.

ABSTRACT

The city of Portimão, located in the region of Algarve, southern Portugal, is poor in its touristic offer of thematic cultural routes. Being tourism the main driver of the region's economy, the touristic proposal presented here, based on the canning industrial heritage, is original and topical. This proposal is composed by places, buildings and neighbourhoods of the city linked to the theme of the canning industry, and stem from these locations, it was intended to make known this heritage. The proposal of a pedestrian path, aims to provide a visit to the city of Portimão from another point of view and to be a promoter of hiking and, simultaneously, be another offer of cultural tourism in this city. On the other hand, being an urban route, it can be carried out by several age groups and all year round. It is possible to reach a more in-depth knowledge of the industrial history, political, social and economic past of Portimão, and simultaneously, of the country itself, through the history of canned fish and of the canning industry, reason why there is a great tourist potential for the proposal of a circuit under this topic. Stem from this knowledge, it is intended to sensitize the local community and tourists to the richness of the existing heritage in Portimão, positively influencing their social responsibility, while valuing the city and showing its history. The development of this paper was based on bibliographical research, photographic surveys and visits to the sites related to the subject, to obtain relevant information. However, there were found some contradictions in the bibliographical sources consulted and the disappearance of some records, along with the closure and/or demolition of the existing canneries, made the development of this work difficult.

CODE 335

BUCHAREST IN BETWEEN RECOGNIZING AND MANAGING HERITAGE BUILDINGS

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KEYWORDS: Heritage buildings; culture; architecture; 3D models; reconstructing.

ABSTRACT

The relationship between man and his environment is to be addressed through the project of architecture, materializing through the accomplishment of a complex series of places. This series will ultimately be validated by the local community as far as it manages to identify, find itself or evolve through the project.
The iterations of living is necessary to truly realize the architecture, representing a phenomenological understanding of some special places of urban culture, born from the living experience of our predecessors. Their understanding is based on dreams, aspirations, intellectual training and the happenings through which their owners have passed, and the way they are all represented in the domestic reality of places can be a very useful teaching tool.
The majority of these places must be returned to the urban community in which they were founded and to which they belong. In this sense, a strategy of activating the patrimony should be considered in the long term, in which the predominant policy must be the preservation of identity.
At present, at the level of Bucharest Municipality, for example, despite the identification of some areas of interest in this sense and their approval as Protected Built Zones, as well as classification in the List of Historical Monuments of some buildings considered to be significant from the architectural point of view, as well as urban, memorial or symbolic; the issue of integrating these cultural goods in the urban daily life cycle persist, without a built heritage management plan. The present paper aims at reserch on how the tools and methodology identified in the study through witch the Protected Built Zones were established and declared, can be used to optimise the management of Heritage Buildings and sites and to identify key issues of HBs social engagement thet will trigger a new aspect of the heritage and cultural tourism in the 3rd Macro-region of Romania.

CODE 376

THE EXPERIENCE OF ITÁLICA GREENWAY. CULTURAL AND ETHNOLOGICAL HERITAGE IN AN AGRICULTURAL ENVIRONMENT IN THE ALJARAFE, SEVILLE, SPAIN

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KEYWORDS: Ethnological heritage; cultural and nature tourism; landscape; greenway.

ABSTRACT

The Roman city of Itálica, located in Santiponce in Seville, can be contemplated from multiple places, given its strategic position high compared to the height of the modern urban core. One of the most beautiful places to observe its profile and intuit its extension is the Itálica Greenway, a recreational place for the poncinos (the name of its inhabitants) and visitors to the area who come to the place with ludic and sporting reasons. The road passes very close to the Traianeum, the temple of Trajano, to the major baths, and next to the Castellum Aquae, the cistern that was supplied with water by the aqueduct that ran through the fields through which the greenway goes through.
The territory in the north-western side of Itálica is very remarkable. The fields planted, the bridges that cross streams, creeks and rivers, the architectural elements of agricultural activity, and the archaeological remains related to water, mining, and defensive infrastructures, are plenty of arguments that invite to the experience of the route. It is an opportunity as an itinerary of interior, cultural and nature tourism, which can be used and made available to all, with an efficient management that respects its landscape values, guarantees its accessibility, and the provision of sufficient elements that favour its safety and comfort.
This study is developed within the research project of the 2013-2016 National Research Plan-Challenges, called Smarch-Smart Architectural and Archeological Heritage, whose objective is the development of Instruments and Strategies of Innovation for the Integration of Patrimonial, Tourist and Landscape Management. It´s main goal is the highlighting of the qualities of the western environment of Itálica through the analysis of the elements of the territory and its ethnological heritage, by means of a historical, cultural, and aesthetic interpretation, putting in value the attributes that make the experience of its journey unique, and offering specific intervention proposals.

CODE 572

ADAPTING HERITAGE SITES COMPRISING AN ARCHITECTURAL HERITAGE TRAIL FOR THE PURPOSES OF TOURISM. PROTECTING THE VALUES OF THE CULTURAL LANDSCAPE

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KEYWORDS: Adaptation; cultural landscape; cultural tourism; cultural routes; Poland.

ABSTRACT

The article features information about studies of the adaptive reuse of heritage sites for the purposes of stimulating tourist traffic in a specific region. The author discusses the problems associated with establishing architectural heritage trails in Poland. As practice has shown, employing a method of increasing their attractiveness neither provides tourists with proper access to it, nor does it generate any active engagement of the local population in its protection. Despite the fact that such trails have been operating in Poland for quite some time, they do not generate the expected socio-economic improvement in the region. There is a lack of measures oriented towards changes in the presentation of the values of this landscape that are being interpreted and that are so essential to the modern philosophy of heritage protection. The author is hopeful that the appropriate renovation of the entire trail, with a stronger orientation towards emotionally tying the tourist with the values of cultural and natural heritage, can change this state of affairs. The problem has been discussed primarily on the example of the Timber Architecture Trail in Lesser Poland. Some elements of this trail have been placed on the UNESCO World Heritage Sites List. The valorisation of this heritage space is being performed by different specialists. However, their goals diverge sometimes. An interdisciplinary researches gave the opportunity to formulate a conciliatory model of the monumental values presentation of heritage sites that comprise a cultural trail and give people better understanding and emotional connection with its values.

CODE 238

LUDIC LEARNING AS A TOOL TO VALUE THE IDENTITY AND CULTURAL HERITAGE IN EL SALVADOR WITH UNIVERSITY STUDENTS

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KEYWORDS: Ludic learning; cultural heritage; heritage conservation; higher education; El Salvador.

ABSTRACT

One of the greatest challenges facing developing countries in terms of the conservation of cultural heritage, particularly El Salvador, is their recognition and appreciation by society as a whole, where pressing problems such as low levels of schooling population, little access to quality health services and crime, have put in the sunset the recognition of heritage as an educational resource that can contribute to strengthen identity and social cohesion.

At the same time, it must be recognized that cultural heritage preservation must be achieved through the interaction and deep commitment of the various actors involved, including society, users, owners, technicians or restoration specialists, as well as universities, on this last aspect Fernando Carrión (2000) expresses that: “For the preservation and development [of historical centers, but for heritage in general], must be done by sensitize universities to form committed professionals and connoisseurs of the heritage, so that they become proactive assets. This involves designing a training and education system that has a presence at all levels of action”.

That is why, from the Restoration and Rehabilitation of Heritage university class, an effort is made to discuss the subject "identity, culture and heritage" with a ludic teaching didactic, which addresses these fundamental theoretical issues for the restoration discipline, through board games, which students created together with the teacher as an educational resource that helps to promote the study and knowledge of the cultural heritage of El Salvador.

This educational resource is used as an innovative strategy to internalize the aforementioned contents and above all to sensitize students or future professionals in architecture and restoration, that they play an important role within society, to articulate processes that lead to interventions on Salvadoran cultural heritage that will contribute to the strengthening of identity.

CODE 271

THE CITY AS A LABORATORY: TEACHING PRACTICE IN THE FIELD OF HERITAGE CONSERVATION. THE CASE OF CUENCA-ECUADOR

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KEYWORDS: Built cultural heritage; participatory research; theoretical-practical training; collective learning.

ABSTRACT

One of the most recurrent questions that arise when intervening in the built cultural heritage is *for what is it restored or is it intervened?*, even more when it is known that, in general, the intervention in the built heritage is expensive and demanding. The existence of certain buildings that are considered legacies of the past is not always assessed for what it really is: the privilege to own buildings that preserve fundamental lessons, especially for current architects and builders, which must be deciphered and properly understood. The Faculty of Architecture of the University of Cuenca-Ecuador (FAUC) in the last 10 years, has made the decision to transfer its teaching spaces to the territory in which the daily life networks move. During a year of theoretical-practical training, students dabble and assume responsibilities in research, study, society participation, execution and monitoring of interventions that are planned and fulfilled simultaneously, on several fronts or in several constructions, in periods of approximately 2 months, after 10 months of investigation. The integration of multiple actors in these experiences in which the owners and neighbors of the community and the professional technicians of the public institutions, private company and academy come together, has allowed to elucidate new aspects in the field of heritage, which - beyond aesthetic and historical values - emerge strongly, thanks to the construction of close and stable links between the different actors. This allows to formulate and execute a collective project in which everyone learns: students, neighbors, technicians, politicians, and of course, the teachers who, with these type of experiences, enrich their chairs. The proposed article shows the experience executed in Las Herrerías street - El Vergel neigborhood in Cuenca, in the period between September 2017 and August 2018, emphasizing the teaching exercise and the defined methodological approach which is under construction.

CODE 565

USE THE FLIP TEACHING METHODOLOGY TO ENHANCE THE TEACHING-LEARNING PROCESS IN UNIVERSITY EDUCATION

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KEYWORDS: Flip teaching; flipped classroom; flipped learning; collaborative work, TIC.

ABSTRACT

Nowadays, we are witnessing a profound change in the teaching and learning process. Gone is the educational system in which the teacher had to provide the student with all the subject matter to be learnt. More and more, international commitment is made to the use of active methodologies; which allow a greater participation of the student in his academic training. Within the different existing active methodologies, the so-called Flip Teaching - also known as Flipped Classroom, Reverse Classroom, Inverted Class - changes the basic sequence of education, because with this methodology the lesson is carried out at home by the student and the tasks in the classroom... Under this new sequence and using, among other resources, short good quality videos, we have piloted this methodology in the Building structures subject with undergraduates studying for the Degree of Technical Architecture in our university. As a result, we have had greater student involvement as well as a good rating on the use of such active methodology.

CODE 11

VIRTUAL REBUILDING OF THE OLD DEMOLISHED DRAWBRIDGE OF PIRAN

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KEYWORDS: Digital modelling; virtual rebuilding; mixed reality; stone drawbridge; demolished heritage.

ABSTRACT

A stone drawbridge once connected the banks of the mouth of the inner port of Piran, but was demolished after the port bay has been filled up. Although little documentation remained, it became evident that the bridge had some very unique characteristics, which awakened the motivation to explore the details and develop a digital model of the drawbridge. The first step of the methodology includes the process of discovering the geometry of the bridge, the building technology and the lifting mechanism. A plan of measures was drawn using reverse projection on two remaining photographs. The material was determined on the basis of photographs and knowledge of the construction methods of that time and the surrounding geology. The unique lifting mechanism was of specific interest. Its operation was determined on the basis of photographs and experimental physical models.

For the digital modelling of the bridge we decided to use a generic 3D modeller, where the components of the building can be easily designed using basic geometric primitives and methods. SketchUp seemed most appropriate for the task as it supports all required functionality, including hierarchical segmentation, thematic layers and dynamic components. The latter were used to simulate the lifting mechanism operations. Since we could satisfactorily determine the dimensions of the visible stones, we could model each stone block as an individual component with specific location and size. As for the foundations, we could only assume about the depth of the water, the approximate size of the stones and that they were made of sandstone. So we decided not to model each stone individually, but to define a component that represents a horizontal row of stones.

To demonstrate the position of the bridge in the real environment, we have put the model onto its original position using mixed reality technology. For this purpose we applied SketchUp Viewer for Mobile with the AR/VR extension.

Since the bridge is still hiding a few secrets we plan to further investigate them and refine the digital model. Furthermore we plan to extend the application of the model, as for example enabling on-site collaborative MR sessions.

CODE 58

3D RECONSTRUCTION OF THE MARINIDS SITE LOCATED AT THE CHELLAH ARCHAEOLOGICAL AREA

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KEYWORDS: Heritage; archaeological remains; 3D reconstruction; photogrammetry; rehabilitation.

ABSTRACT

During the last few years, the preservation and protection of archaeological heritage have become increasingly digital, through the use of 3D technologies for the recognition and documentation of cultural and historical sites and monuments. In this study, we developed an archetype of the deteriorated Islamic Marinid site (a dynasty between the 13th and 15th centuries), located at the Chellah archaeological site in the city of Rabat (Capital of Morocco), this site being the mixing of several civilizations that have played a prominent role since antiquity (7th-6th century BC). However, the recognition of the importance of this Islamic site, both in terms of the evolution of Moroccan Islamic art, requires the combination of large-scale scanning capability of unmanned aerial vehicles (UAVs), and the photorealistic rendering of 3D, as well as an exhaustive research on the history of this cultural site. The collection of these tools and information has been materialized in a 3D virtual reconstruction of this Marinid monument, which will allow archaeologists, architects, and cultural heritage experts to explore this site remotely, compare it easily and carry out architectural analyses essential to the restoration and rehabilitation of this area.

CODE 60

SEQUENTIAL VISUALIZATION OF THE INFORMATION GENERATED IN A REFURBISHMENT PROJECT THROUGH HBIM 7D

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KEYWORDS: HBIM; HBIM 7D; families parameterization; mass generation.

ABSTRACT

BIM (Building Information Modeling) applied to new buildings are quite functional due to the wide variety of family libraries or existing building elements. In the case of refurbishment works appear several difficulties related to the complex and costly processes of data capture for the generation of the models, and the unavailability of libraries referring to traditional construction elements, because their characteristics are strongly affected by the building local practice. Through HBIM (Historic Building Information Modeling), considering HBIM 7D (Building Management and Maintenance) approach, a digital library of historical elements is made that, in addition to visual and inventory tools, allows to study and compare the evolution of the building from its original state to its current state (refurbished building).
The HBIM process begins with the generation of the geometric model. Next, families are created and parameterized in 3D software. This parameterization is associated with the technical data obtained in previous studies carried out in the building, in its original state. This allows to configure each construction element. Subsequently, special elements (non-standard families) are created by mass generation, which allows to recreate, virtually, construction elements unavailable in the usual digital libraries. Finally, several time periods are created in the same 3D model: the original state, the refurbished building according to the project and, finally, the “as built” time period. This allows to display and analyze the changes generated in the building during the refurbishment works.
This paper is devoted to the application of the referred methodology in the Riva-Herrera Palace, the oldest non-religious building in Santander, Spain. First of all, the existing 3D model (building in ruins) is generated. After that, the model is fed with data referring to geotechnical campaign, characterization of materials, non-minor destructive tests (N-MDT), and existing pathological processes. Subsequently, another time period, according to the refurbishment project of the building, is created in the same model. Then, the comparison of the “original state” and the “refurbished building according to the project” is carried out. Currently, the production of the “as built” time period in the model is under development.

CODE 122

SILVES BRIDGE GEOMETRIC MODEL VIA STRUCTURE-FROM-MOTION: TOOL FOR HERITAGE DIGITAL CATALOGS

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KEYWORDS: Silves bridge; structure-from-motion; geometric point-cloud; digital model.

ABSTRACT

The old bridge in Silves, Portugal, has five perfectly formed arches extending over the Arade river with about 76 meters long built of local materials. In the 14th century this structure was rebuilt on the location of a previous structure built when Silves was the Moorish capital between the 8th and 13th centuries occupation of the Algarve. Though a Roman road might have crossed this area, there is no medieval descriptions mentioning a bridge in Silves, still it is also known as the Roman bridge. After interventions in the 14th, 17th, 18th and 20th centuries, the bridge was classified as monument of public interest and became pedestrian-only and frequently evaluated for its risk of collapse.
Stereo-photogrammetry is a recognized surface reconstruction tool applied for almost one century, where from several overlapping images of the surface a 3D model can be obtained. Contrasting with classical stereo-photogrammetry, Structure-from-Motion (SfM) is a nearly automated compilation of digital imagery processing strategies that solve for camera position and surface geometry using matching features identified in several images from diverse perspectives and preferably with high degree of overlap. Together with ongoing increase in computer power, SfM allowed digital stereo-photogrammetry to be operative for close-range, high-resolution and non-metric overlapping digital images, and cost-effective. Applying these nearly automated strategies to digital images of the old bridge in Silves taken from the surrounding grounds, a dense point-cloud was computed providing its complete digital model allowing accurate measurements and materials visual identification, key elements for heritage digital catalogs and historical building information models.

CODE 151

AUGMENTED REALITY SYSTEM FOR TOURISM AND CULTURAL HERITAGE MANAGEMENT

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KEYWORDS: City museum; artificial intelligence; prediction; tourism; cultural heritage; intelligent panels; 3D.

ABSTRACT

City - Museum is a system developed by the company UPINTELLIGENCE that allows the management of tourism interested in the cultural heritage of a city. The system allows, through augmented reality, cultural exhibitions and virtual musealizations around the city. Gijón City-Museum is a project that integrates a system of intelligent 3D panels with a certain degree of accessibility, linked by communication through the cloud (IoT) with the augmented reality part, being able to show the stored information to the user. As a more original part it serves as a tool for predicting the influx of people to events through automatic learning (Machine Learning), in a way that improves the management of tourism and cultural heritage of the city.

CODE 252

CONCEPTUAL DEVELOPMENT OF AN INFORMATION SYSTEM FOR THE MANAGEMENT OF THE DOCUMENTATION GENERATED IN THE PREVENTIVE CONSERVATION PROCESS. CASE STUDY: CUENCA-ECUADOR

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KEYWORDS: Heritage; preventive conservation; information system; open source; multiuser.

ABSTRACT

Heritage documentation is a superlative task in the acquisition of knowledge that facilitates decision-making aimed at the conservation of heritage assets. The innumerable availability of documentary techniques contrasts with the limited use of the enormous amount of data generated by these techniques, which makes the consequent amount of knowledge and skills difficult for efficient management of stakeholders interested in preserving heritage. Therefore, it is essential to develop tools that encourage the participation of these actors through constant feedback of information, thus achieving effective and sustainable monitoring that promotes an adequate preventive conservation process. With the intention of avoiding the loss of value of a traditional neighborhood of Cuenca-Ecuador, World Heritage City, a preventive conservation plan has been implemented that adopts the phases proposed by ICOMOS (2003): analysis, diagnosis, therapy and control. Three phases have been concluded leaving as a result an innumerable quantity and quality of data.

For the control, the fourth phase currently implemented, it is necessary to ensure that the actions taken to prevent damage are based on useful and quality information. For this purpose, the conceptual processes applied in the development of an information system that facilitates the management of the entire set of data collected, are described. This includes first of all the evaluation of the existing data that defines the quality parameters, the conversion of the data to open source universal formats for the exchange between multiple digital platforms and the possibility of integration in virtual environments that facilitate the experience of different types of users. In this way, it seeks to facilitate the use, recovery and exchange of information between different users and support the implementation of monitoring and control strategies in this phase of preventive conservation.

CODE 255

MULTI-TEMPORAL ANALYSIS OF VERNACULAR FARM BUILDINGS AND RURAL LANDSCAPE THROUGH HISTORICAL CARTOGRAPHY AND 3-D GIS

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KEYWORDS: Vernacular heritage; Farm buildings; rural landscape; geographical information systems; historical cartography.

ABSTRACT

Farm buildings, designed over the centuries in order to fulfil their primary agricultural goal, now often constitute a widespread heritage of vernacular constructions, endowed with an unreplaceable architectural value. Together with the concurrent action of natural events, human interventions and changes in natural cycles, they play indeed a central role in shaping the rural landscape.
In this paper, thanks to the use of a Geographic Information System in which historical cartography, aerial photos and other ancillary dataset have been implemented, the land use of the area of "Monte Vulture and Monticchio lakes" and its environmental components have been investigated through a 3-D modelling of the relevant rural landscape and its main features. This area, located in the Basilicata Region (southern Italy), is one territory with a great scenic interest, having been recognized as a landscape heritage thanks to some specific cultural and historical elements. This rural landscape also includes – similar as many other Italian rural landscapes - some vernacular constructions having a high historical and architectural value, that have contributed to create this traditional rural landscape. The analysis has involved a multi-temporal comparison of the vernacular constructions located in the study area, so as to evaluate the built heritage evolution in the framework of its rural landscape, as well as its interactions with the surrounding territory. With this aim, the historical reconstruction of the landscape before and after the year 1900 has been conducted through implementing digital terrain models enriched by draping land cover pictures over them.
The results which have been obtained enabled an evaluation in a scenic way of the morphological and vegetation variations during time of the rural landscape, allowing a virtual "time jump" back to periods when digital aerial photography was not yet existing. Thanks to these new technologies, able to exploit information included into old cartographic supports, some suitable tools have been then developed, skilled to support the sustainable planning and management of rural built heritage, enabling an analysis of their possible valorisation for cultural tourism purposes as well.

CODE 46

THE ADDITION OF NEW ELEVATORS IN BUILDINGS OF MODERN HOUSING ESTATES OF THE METROPOLITAN AREA OF BARCELONA

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KEYWORDS: Building refurbishment; building accessibility; addition of elevator; large housing estates.

ABSTRACT

The improvement of accessibility conditions in residential buildings has become a common practice promoted by public administrations for some years. Among these actions, the improvements in vertical accessibility deserve special mention for its daily importance in the living conditions. A common practice is the provision of new elevators in buildings with more than two stories, thus correcting situations derived from less demanding former regulations. The present investigation provides a systematic study of the different forms of insertion of new elevators in buildings of the modern residential groups built during the decades of the 50s and 60s of the last century in the Metropolitan Area of Barcelona. Likewise, a complete typology of this type of intervention has been generated, which provides the keys that have guided the decisions adopted regarding the choice of materials, their construction techniques, the relationship between the added volume and the pre-existing building or possible additional functional improvements compatible with the actual use of the elevator. In conclusion, the research provides an extensive overview on this issue that can be useful in the legislative area or more directly concerning the design of future improvement actions.

CODE 153

MOBILITY INFRASTRUCTURE PROPOSALS FOR PROTECTION PURPOSES OF THE HISTORICAL CENTER OF MANIZALES (COLOMBIA) FROM AN URBAN TERRITORIAL ACCESSIBILITY ANALYSIS

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KEYWORDS: Coverage; cultural heritage; mobility; tourism; transportation; urban accessibility.

ABSTRACT

In this investigation an analysis of urban territorial accessibility of the Historical Center in the city of Manizales, Colombia is carried out. In 1990, the first scientific inventory of real estate assets of patrimonial interest located in this sector was made, approximately 350. Currently, this sector is declared as National Monument (Decree 2178/96, Ministry of National Education), given its Neo-classical, Neo-Gothic and Neo-Renaissance style architecture, which highlights the republican period. The historical centers of the cities tend to disappear, given the conditions of general degradation to which they are being subjected; however, Manizales became the second city in Colombia, after Cartagena, which obtains certification as a sustainable tourist destination for its historic center. This will promote the awareness of cultural heritage, will allow directing the city as a region highly respectful of the environment, its visitors and its residents and regulating tourism activity, among other aspects. The research target is to know the characteristics of urban accessibility that are currently achieved in the area corresponding to the historic center. The methodology of the accessibility analysis is based on the application of geostatistical techniques that allow identifying which sectors of the city of Manizales are better connected with the historical center, which allows to clearly define the necessary infrastructural interventions, or those operative interventions in relation to the different modes of transport. The analyzes allow to know, for example, how the coverage of the population is presented according to its socioeconomic stratum from the sector in question, which will allow to identify the mode(s) of transport that possibly should be object of improvement or impulse to mitigue or diminish to the maximum the effects that these appear in the sectors surrounding it. The results shows that from any point in the city it is possible to reach the historic center in an average travel time of up to 20 minutes; likewise, it is corroborated that the intervention proposals on the transport network are beneficial in relation to limiting the use of the private vehicle and promoting the use of sustainable modes of transport, without detracting from the current accessibility conditions.

CODE 182

THE CONVENT OF SAN FRANCISCO IN OLINDA: THE AUTHENTICITY AS A GUIDE FOR THE ADAPTATION OF BRAZILIAN CULTURAL HERITAGE SITES TO UNIVERSAL ACCESSIBILITY

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KEYWORDS: Cultural heritage; authenticity; accessibility; franciscan convent.

ABSTRACT

The Convent of San Francisco in Olinda is the birthplace of the Franciscan order in Brazil, and part of the set was listed as Brazilian heritage site in 1938, which includes the church, the chapel, the house of prayer, the forecourt, the high cross and the monastic fence. The construction occurred around 1585, when the Franciscans arrived in Olinda and the chapel was received as a donation. In 1631 the convent was set on fire during the Dutch invasion in Brazil, and only in the second half of the 17th century its reconstruction began. Other additions have been done during the 18th and 19th centuries, when it became one of the most beautiful and noble architectonic sets of premises of the Franciscan order built in the country. The forecourt, the stone standing cross and the convent form an integrated and harmonious urban-architectural complex that was part of ancient via Crucis which was held in the city, as part of the catholic religious ritual. Nowadays the Franciscan convent, in addition to its religious use, is also used for tourist, festive and educational purposes. Cultural changes happened in the last decades that demanded the adaptation of buildings and urban spaces to the needs of people with disabilities. Cultural heritage, buildings and sites, must also be as accessible and inclusive as possible, but their cultural significance must also be preserved. So, the implementation of adaptations for accessibility requires respect to values of the heritage. Based on the need for adaptation and on the restrictions for the preservation of cultural heritage, a methodological tool, called the Matrix of Authenticity and Accessibility, was developed in 2011 from studies applied in buildings of the Brazilian historical cultural heritage. In 2018 the forecourt adaptation work was finished, based on studies about accessibility. This paper describes the application of the matrix to the Franciscan Convent. The main results showed that there are restrictions, but are many possibilities of adaptation, and the tool can provide the necessary subsidies for guiding the project design and intervention work, assisting the diffusion and promotion of cultural heritage.

CODE 318

THE MATTER OF THE SMALL HISTORIC VILLAGES IN ABRUZZO. ACCESSIBILITY AND ENHANCEMENT AS STRATEGIES FOR CONSERVATION

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KEYWORDS: Historical and cultural heritage; environment; enhancement; accessibility; public space.

ABSTRACT

In Abruzzo, the state of isolation and several other factors have caused the marginalisation of many settlements. Thus, an increasing process of degradation and abandonment has begun turning some centres into open-air museums where traces of a rural past and a traditional way of living are still present. A scenario of extraordinary interest linked to geo-morphological and cultural panoramas is evident: individual architectural elements are concealed in favour of an obvious homogeneous organism for constructive and typological solutions, but largely complex for the transformations occurred during the last centuries. Thanks to their number and great testimonial value, this is the ideal set to develop a network of specific interests aimed at the knowledge and enhancement of the historical and cultural heritage in the Abruzzo area.
In this sense, the topic of accessibility is a necessary instrument to revisit the public space, open to the transformation and regeneration of the urban fabric and able to reactivate the connections between inhabitant and environment, extending its recognition in a general program of territorial promotion. Thus, accessibility becomes expression of quality for the built environment because it allows its use and guarantees its survival. In the last years, various territorial policies are implemented to reintegrate small villages into a systemic network that responds to the unique and unrepeatable characteristics of the context in which they are located. Through several revitalization experiences, the research does not lead to univocal solutions but identifies possible strategies to make accessible the spaces of the ancient villages, even in terms of availability.

CODE 456

HABITABLE. ACCESSIBILITY TO HERITAGE BY APPLYING A FUZZY MULTI-CRITERIA ANALYSIS

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KEYWORDS: Accessibility; diagnosis; fuzzy multi-criteria analysis; reasonable accommodation.

ABSTRACT

The tool “habitable” arises from the continuous evolution of different research projects on accessibility in buildings, its authors' line of work.
The first approach came from PATRAC, Accessible Heritage: R+D+i for a culture without barriers (Mineco-Feder, 2007-2010). The line of research continued with another R+D+I VIVable (Public Works Agency of the Regional Government of Andalusia-FEDER, 2013-2015) and became operational in 2019.
The objectives of habitABLE are three:
1.-To have an application capable of managing in a rigorous way the numerous information that is needed in the evaluation of the accessibility of a building, providing an accurate diagnosis of the situation.
2.-Facilitate the development of proposals for action to improve accessibility.
3.-Provide a tool for analysis proposals to assist in decision making, through a fuzzy multi-criteria analysis. The tool characterizes interventions and determines what the intervention that can be considered “reasonable accommodation”.
habitABLE is an effective tool to work on the commitment to enable people with disabilities and older people to “inhabit our heritage” with better conditions of autonomy, comfort and security.
It is an open source application under a creative commons license and has an AA level of web accessibility.

CODE 120

NEED FOR INTEGRAL MANAGEMENT STRATEGIES IN THE ARCHITECTURAL CULTURAL HERITAGE

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KEYWORDS: Service coordination; planning; resource optimization.

ABSTRACT

The particular situation of our country, with its wealth of assets, and current real estate situation, forces the establishment of work models and methods adapted to our reality and to Spanish and European legislation. They become a strategic need that could become a priority and as a source of resources and employment.
The role of the Integral Manager in the operation of the Historical Architectural Heritage is considered as a great professional opportunity, although it is to recognize the need for training that allows the ability to manage any Heritage property in an innovative way, and offer a proposal for operation that allows the whole to be valued so that its exploitation is feasible with an offer of services, that allows to show the successful potential of the proposal for the proper implementation and exploitation of the Good, so as to allow the development of the necessary investment for it.
It is about going beyond mere control of maintenance, or facilities. It is the incorporation of many more aspects to be implemented in the process: Preventive conservation as a philosophy, Risk assessment, Emergency management, resource efficiency, dissemination processes, social integration, heritage education, optimization of uses and exploitation, the inclusion of the scope of sustainability (and not only as energy efficiency), knowing the risks, the control measures, knowing what to look at and how to measure it. And even, in some cases, incorporate aspects of local development in the environment of the population where the Good is located.
The communication will present various ways to implement these models, where the integrated global conception becomes the main tool, it is not about studying the loose and independent aspects, but about doing so, from its initial approach in a global, interrelated way, that is, integral management. Applying these new concepts is a very positive real experience, and several examples will be presented, which imply a change of concept, and the generation of a new paradigm, a qualitative leap in the criteria and in the decision-making processes.

CODE 371

HERITAGE AS A RESOURCE OF DEVELOPMENT: PROPOSAL FOR INTERVENTION FOR THE "ANTIGUA HACIENDA DE LLAVIUCU," CAJAS NATIONAL PARK - ECUADOR

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ABSTRACT

Through a restoration proposal, as well as the approach of a program and projects, within a good that has particular characteristics (cultural asset - natural context), it aims to show new approaches to the recovery of heritage, which should be preserved for future generations, making it a sustainable development resource.
The importance of conserving these sites is due to the fact that they have social, cultural, environmental, social and scientific values, among others, commonly recognized by society; that is where heritage truly maintains its spirit.
The development of this research clarifies the notion of heritage as a development resource, and adopts a methodology to carry out an intervention that aims to turn good into a source of self-sustainable development. For this purpose, good practices and experiences in the use of heritage as a development resource are reviewed, but before arriving at the proposal, it was necessary to carry out the diagnosis of the "Antigua hacienda de Llaviucu", (located in the Cajas National Park - Ecuador) that presented high levels of deterioration, through its assessment, pathological analysis, the problem it faces, as well as the analysis of the legal and institutional framework where it is inserted.
Finally, the proposal suggests an intervention that can be considered as a methodological example, which demonstrates a form of integral action, where through the development of various projects, the recovery of both material and intangible value of heritage is discussed with argument, while continuing side strategies for its operation and sustainability.

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