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REHABEND 2024

Euro-American Congress

CONSTRUCTION PATHOLOGY, REHABILITATION TECHNOLOGY AND HERITAGE MANAGEMENT

Gijón (Spain) - May 7th - 10th, 2024

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REHABEND 2024

CONSTRUCTION PATHOLOGY, REHABILITATION TECHNOLOGY AND HERITAGE MANAGEMENT

(10th REHABEND Congress)

Gijón (Spain), May 7th-10th, 2024

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10TH EURO-AMERICAN CONGRESS ON CONSTRUCTION PATHOLOGY, REHABILITATION TECHNOLOGY AND HERITAGE MANAGEMENT

REHABEND 2024

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The **Euro-American Congress REHABEND 2024** on **Construction Pathology, Rehabilitation Technology and Heritage Management** was held in **Gijón (Spain)**, in **May 2024**. The event was co-chaired by the **University of Cantabria** and the **University of Oviedo**.

REHABEND 2024 **continued the series of the nine previous REHABEND international events**, which had been held **since 2006 in different Spanish cities**. The previous one, in **2022**, took place in **Granada, Spain**. In 2022 edition, approximately **280 papers** from around **30 countries** were presented, making it a conference of great interest to those who attended.

Construction Pathology, Rehabilitation Technology and Heritage Management currently hold significant importance in the construction sector. This prompted the organizers to propose a **technical event on these topics in Gijón**. The 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 around **275 technical contributions** coming from professionals, academics and specialists from more than **30 countries**.

Based on previous experiences, the Congress **was once again proposed within 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, would be understood by participants, as evidenced by previous editions of REHABEND.

Under these premises and the success of previous editions, the Congress was sponsored by the **Government of Spain**, the **Regional Government of Asturias**, **the Municipality of Gijón**, **Laboral Ciudad de la Cultura**, **Gijón Convention Bureau**, **Grupo Puma**, **Mapei, Sika, Tecnalia,** the **University of Cantabria** and the **University of Oviedo**. Additionally, several universities, technical and professional associations, institutes, foundations and companies pledged their collaboration to ensure the success of this initiative.

The organizers of REHABEND 2024 extend their gratitude to the **sponsors and collaborating entities**; the **Scientific Committee members** for their diligent review of technical contributions to ensure the required level of quality for an international event, to the **keynote speakers**, to the different s**peakers** for their valuable contributions, and **all attendees** for their confidence in the event. Sincerely, many thanks to all.

Dr. Ignacio Lombillo
Chairman of the REHABEND 2024 Congress
Associate Professor
University of Cantabria

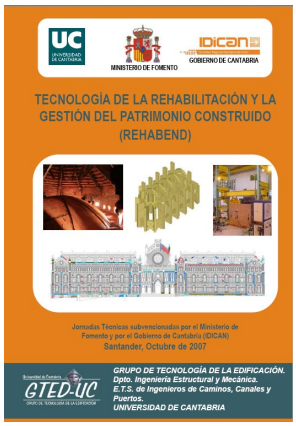
Dr. Alfonso Lozano
Chairman of the REHABEND 2024 Congress
Associate Professor
University of Oviedo

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, Spain, 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 2020 edition was to be held in person in Granada in March 2020, but due to the global health emergency resulting from Covid-19, it had to be held online in September 2020. The 9th edition (REHABEND 2022) took place in Granada, featuring a hybrid format combining in-person presentations with other asynchronous online sessions.

The ability to convene of the nine perfomed editions was prominent, gathering an appreciable number of experts in the topics of the Congress. As a reference, in REHABEND 2022 Congress took part approximately 280 speakers from around 30 countries worldwide.

The covers and ISBN of some the books of papers corresponding to the previous congresses are attached below. The ISSN of the series of REHABEND books is 2386-8198. In addition, since REHABEND 2014, the papers presented at the congress have been indexed in Scopus.



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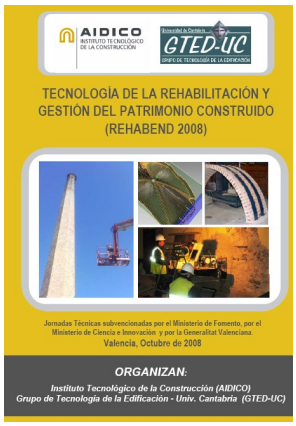

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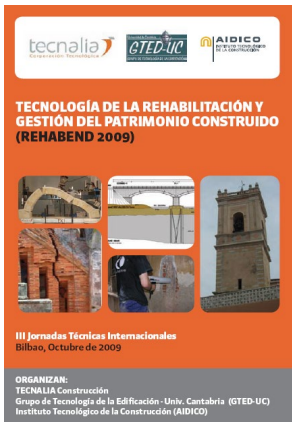

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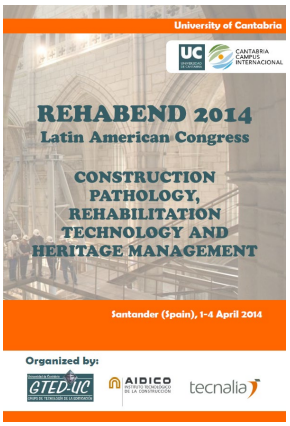

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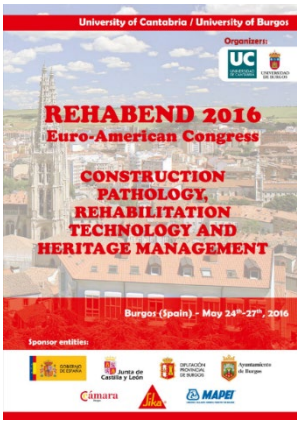

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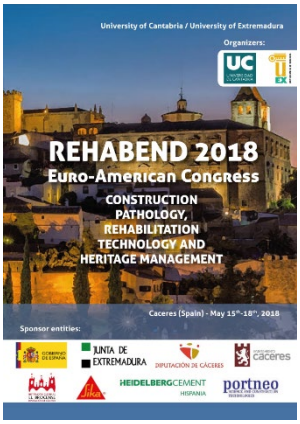

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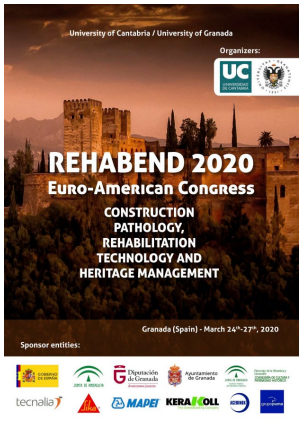

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The Collaborating Entities have been presented grouped in countries, following an alphabetical order. As Collaborating Entities have been considered to all that have contributed at least with two accepted articles in the Congress, or that some of its 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.

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Italy-Università di Bologna

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Italy-Pegaso Telematic University

Italy-Università degli Studi di Palermo

Italy-Università Roma Tre

Italy-Sapienza Università di Roma

Italy-Università degli Studi del Molise

Italy-Università del Salento

Italy-Università degli Studi di Salerno

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Portugal-Universidade de Aveiro

Portugal-Universidade de Coimbra

Portugal-Instituto Politécnico de Viana do Castelo

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

Portugal-Universidade do Minho

Portugal-Universidade da Beira Interior

Portugal-Universidade Nova de Lisboa

Portugal-Instituto Politécnico de Viseu

Portugal-Universidade da Madeira

Portugal-Universidade Lusíada Porto

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Spain-Universidad Politécnica de Valencia

Spain-Universidad de Oviedo

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Spain	Dr. J. Tomás San José	Universidad del Pais Vasco
Spain	Dr. Yosbel Boffill	Universidad de Cantabria
Turkey	Dr. Meltem Vatan	Bahcesehir University
United Kingdom	Dr. Giovanni Pesce	Northumbria University
United Kingdom	Dr. Marco Corradi	Northumbria University
United Kingdom	Dr. Tiago Miguel Ferreira	University of the West of England (UWE Bristol)
United States of America	Dr. Francisco J. de Caso y Basalo	University of Miami
United States of America	Dr. Matthew Dejong	UC Berkeley
United States of America	Dr. Miguel A. Pando	Drexel University
United States of America	Dr. Stephen Kelley	University of Illinois
Uruguay	Dr. Gemma Rodriguez de Sensale	Universidad de la República
Uruguay	Dr. Gonzalo Cetrangolo	Universidad de la República

1.- PREVIOUS STUDIES	1.1.- Multidisciplinary studies (historical, archaeological, etc.). 1.2.- Heritage and territory. 1.3.- Urban regeneration. 1.4.- Economical and financial policies. 1.5.- Social participation processes and socio-cultural aspects in rehabilitation projects. 1.6.- Construction pathology. 1.7.- Diagnostic techniques and structural assessment. 1.8.- Vulnerability studies and risk management. 1.9.- 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. 3.4.- Restoration of artworks. 3.5.- Conservation of industrial heritage. 3.6.- Examples of intervention.
4.- MAINTENANCE	4.1.- Construction maintenance and infrastructures. 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.- Built heritage management.

ABSTRACTS OF THE CONGRESS

KEYNOTE LECTURES

1.- PREVIOUS STUDIES

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

1.2.- Heritage and territory.

1.3.- Urban regeneration.

1.5.- Social participation processes and socio-cultural aspects in rehabilitation projects.

1.6.- Construction pathology.

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

1.8.- Vulnerability studies and risk management.

1.9.- 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.

3.5.- Conservation of industrial heritage.

3.6.- Examples of intervention.

4.- MAINTENANCE

4.1.- Construction maintenance and infrastructures.

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.- Built heritage management.

KEYNOTE LECTURES

KEYNOTE LECTURE 1

SEISMIC BEHAVIOR OF MASONRY WALLS REINFORCED WITH FIBER-REINFORCED MORTAR (TRM)

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KEYWORDS: Masonry walls; Brick; Mortars reinforced with textile fibers; Ductility; Earthquake; Fire; TRM.

ABSTRACT

Reinforced mortars with fiberglass mesh, carbon, or other materials have started to be used to strengthen masonry structures. This work presents experimental results developed to analyse the behaviour of these structures under both cyclic loads in their plane and fire conditions. The tests conducted at the Large Structures Laboratory of the Department of Civil Engineering at the University of Alicante were carried out on 3x2 m walls in collaboration with the Firefighters of the Alicante Provincial Council. The study analysed the evolution of the adhesion of the reinforcing mesh before and after damage, both mechanical and thermal in origin. The conclusions highlight the significant increase in the ductility of these reinforced structures against horizontal action even after being damaged and subsequently reinforced. The findings of this study demonstrate that fire can seriously compromise the integrity of masonry structures; textile-reinforced mortar (TRM) reinforcements can provide effective protection and prevent masonry cracking from fire. However, TRM, even when undamaged, may not be able to adequately reinforce a wall severely damaged by fire.

KEYNOTE LECTURE 2

MASTER PLAN OF THE EL PASATIEMPO PARK

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KEYWORDS: Cultural heritage; Conservation-Restoration; Multidisciplinary studies; Master plan.

ABSTRACT

Crecente Asociados was awarded the tender called in April 2021 by the Galician Ministry of Culture, Education, Vocational Training and Universities of the Xunta de Galicia for the drafting of the Master Plan of the Pasatiempo Park (Betanzos - A Coruña - Galicia - Spain), declared Asset of Cultural Interest in 2020.
El Pasatiempo is a compendium of artistic disciplines with samples of architecture from which we can highlight the systems of caves and ponds. It can be considered a representative work of the creative genius of its promoter, Juan María García Naveira, who provides us with a manifesto of his values. It is a representative example of the Galician philanthropic tradition and, specifically, of that developed by the Indianos after their return from America at the end of the 19th century and beginning of the 20th.
The execution of the Master Plan is the result of a 15-month work of a multidisciplinary team made up of 18 specialists from the fields of architecture, history, hydraulic engineering, restoration, archaeology, botany, landscape, geomatics, tourism and informatics.
After gathering all the available knowledge about the Park, through an intense process of investigation, inventory and analysis of pathologies, supported by tests for the study of materials and construction systems, the Master Plan defines the current state of the monument and develops proposals for its maintenance, conservation, enhancement and use. The intervention program, with a 15-year calendar, is structured into 5 lines of action: restoration and recovery, access and accessibility, gardening and landscape, installations and social, cultural and tourist equipment.

1.- PREVIOUS STUDIES

CODE 16

ARCHITECTURAL AND CONSTRUCTIVE INTERPRETATION THROUGH DOCUMENTARY RESEARCH – THE HEADQUARTERS BUILDING OF SOCIEDADE DA ASSEMBLEIA DE ABRANTES, IN PORTUGAL

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KEYWORDS: 20th Century Portuguese architecture; Architect Raul Lino; Raul Lino's Portuguese house; Cultural and leisure buildings.

ABSTRACT

The design of the Assembleia de Abrantes building was commissioned by the *Sociedade da Assembleia de Abrantes* to the Portuguese architect Raul Lino (1879-1974) in 1923 as part of a program in which he defined a building to be used for leisure and cultural activities. The building, completed in 1924, is located in the urban center of Abrantes, a town in mainland Portugal about 150 km north of Lisbon.
Architect Raul Lino pursued an intense and productive professional activity as a building designer, with his works having been built all over Portugal. Besides the iconic and relatively well-documented *villas* in Lisbon, Sintra and Cascais, where much of his work is concentrated, Lino also presents a considerable architectural output in Abrantes, with various projects developed between 1919 and 1968. The town is dominated by residential buildings (new, rebuilt and extended) but other types of buildings have been identified such as a mausoleum and even a statue plinth.
Although the project of the building under study integrates Raul Lino's architectural collection in the Art Library of the Calouste Gulbenkian Foundation, it was found that the documents were not only scarce in information, but also fragmented. This not only compromises but may make it impossible to adequately interpret and characterize the formal, spatial and features of the building, which contribute to supporting decisions on its use and conservation, to publicizing the cultural object or to promoting local tourism by diversifying related products.
This paper describes the documentary research undertaken as part of an interdisciplinary project in the areas of art and design and engineering, which focuses on the work of Raul Lino built in the municipality of Abrantes, and in which the building of the headquarters of the *Sociedade da Assembleia de Abrantes* is included. The aim of this work is to research, identify, locate and cross-reference scattered sources that contribute to the interpretation of the building and the characterization of materials and architectural and systems.

CODE 17

VIRTUAL REALITY FROM LASER SCANS. AN INTERACTIVE AND IMMERSIVE DIGITAL APPROACH TO ARCHITECTURAL HERITAGE CONSERVATION

Del Blanco García, Federico Luis[1]*; Amengual Menéndez, Cristina[1]; Sánchez Aparicio, Luis Javier[1]; Sanz Arauz, David[1]; González Cruz, Alejandro[1]; Aira Zunzunegui, José Ramón[1]; Palma Crespo, Milagros[1]; García Morales, Soledad[1]

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KEYWORDS: Virtual Reality; Historical Constructions; Point Clouds; Immersive Experience; Diagnostics.

ABSTRACT

The research showcases the outcomes achieved by merging point clouds produced through a terrestrial laser scanner and their use in virtual reality for the visualization and detection of damage in historic buildings. The objectives are: 1) The systematization of a workflow to visualize in real time different types of damage using an interactive model. 2) The post-processing of the information collected in the diagnostic phase, allowing to classify these damages, alternating their visualization in the digital twin for easy analysis. 3) The generation of different damage categories that can be incorporated in the same digital model, being able to isolate or link one to another. The methodology has been carried out by means of a case study, after scanning a medieval Templar church. Different approaches have been evaluated using point clouds, three-dimensional meshes and 360º panoramic images. The information obtained from infrared, thermographic images or manually prepared maps has been incorporated into the digital model. Finally, in order to be able to use the digital models in mobile devices with lower computing power, we have explored different approaches for the reduction of the resolution of the digital models. The combination of point clouds and polygonal meshes have proved to be very efficient for real-time rendering if we want to work with low resolution models that maintain a high level of detail.

CODE 72

ARTS APPLIED TO HERITAGE VALUE ARCHITECTURE IN URUGUAY

Beretta, Ernesto[1]; Hojman, Miriam[2]; Marchese, Valentina[2]; Mussio, Gianella[2]; Novello, Diego[2]; Olivera, Leticia[2]; Rimbaud, Tatiana[2]; Rodriguez, Elina[2]; Romay, Carola[3]; Ulfe, Verónica[2]; Zubeldía, Guillermo[2]

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KEYWORDS: Applied arts; Heritage valued architecture; Craft, techniques and trades; Interdisciplinary research.

ABSTRACT

The architectural heritage of Uruguay is characterized by the incorporation of ornaments executed in diverse materials, which are present in a significant number of properties. These ornaments reflect the tastes and aspirations of society in accordance with the political, economic, and cultural circumstances of each era. Currently, the advanced state of deterioration of many of these properties compromises their preservation and drives the adoption of measures for enhancement and recovery.
Since 2010, the Group of Studies in Applied Arts to Architecture of the University of the Republic of Uruguay has been investigating the local socio-cultural, symbolic and technological roots of ornamental systems in works built between the 18th and 20th centuries, under a holistic approach. Its scope includes components in stained glass, plasterwork, cement mortar, blacksmithing and carpentry. This study has made it possible to establish evaluation criteria, recognize legal instruments of protection, identify the artisanal and productive capacities of the different trades involved and characterize materials, aspects necessary to formulate adjusted restoration guidelines.
The methodology employed involves, first and foremost, the registration and analysis of historical and material aspects. This takes into account the political, economic, and cultural context that defines the social circumstances of each period. Subsequently, they delve into the study of formal aspects and iconographic and iconological analysis in correspondence with prevailing stylistic trends. In parallel, they work on the identification of applied materials and techniques and their state of conservation. To address productive aspects, artisan workshops and manufacturing establishments from the periods under study are surveyed. Additionally, interviews with current stakeholders and analysis of detected materials are conducted. Moreover, they visit ongoing restoration projects and specialized professional studios on the subject.
This article presents the group's trajectory and ongoing research through the comprehensive analysis of two valuable heritage properties with distinct and prominent ornamental systems: the Palacio Santos (Capurro, 1881) and Casa Yriart (Vilamajó, 1927). It provides a comprehensive evaluation with the objective of highlighting the connections between socio-cultural, symbolic, and technological variables and considerations regarding their assessment, protection, and proposed restoration guidelines.

CODE 78

THE WALL OF THE CITY OF ORDUÑA (BIZKAIA): HISTORICAL-CONSTRUCTIVE STUDY FOR ITS HERITAGE ENHANCEMENT

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KEYWORDS: Medieval architecture; Walled enclosures; Previous analysis; Historical-constructive Studies; Heritage enhancement.

ABSTRACT

The wall that surrounds the medieval city of Orduña is one of the most important defensive complexes in Bizkaia (Spain). The total length of the medieval walls at the time of their maximum extension was approximately 1800 metres. One of the most characteristic and best preserved sections of wall is located next to the Church of Santa María, in the north-eastern part of the medieval town. An urban park has been projected on this site, which, among other functions, will serve to enhance the value of the medieval wall.
The aim of this research is to analyse and characterise this part of the medieval wall of Orduña. It is hoped that the results will serve as an axis for the enhancement of this heritage site. The research has been carried out in three complementary tasks: fieldwork, documentary analysis and the historical-constructive study of the architectural elements. This paper presents the results of the work carried out to date, showing the main construction phases of this heritage site.

CODE 94

THERMAL BEHAVIOR OF THE WALLING IN SPACES BUILT IN THE HISTORICAL CENTER OF LOJA-ECUADOR

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KEYWORDS: Tapial; Tapia; Thermal behavior; Heritage Architecture.

ABSTRACT

At present, at the Latin American level, earth through the tapial construction system has gained strength in research. As a renewable resource that maintains optimal environmental conditions inside buildings, it has the capacity for bioclimatic adaptation, reduces the use of mechanical systems to maintain an acceptable thermal comfort, and according to studies, with good maintenance, buildings last over time. In this context, this research is developed to study the thermal behavior of the wall in spaces built in the residential architecture of the historical center of the city of Loja, Ecuador. From the patrimonial inventory, we selected buildings made of adobe that are preserved in good conditions, we carried out an architectural survey to understand the physical-spatial and technical-constructive dynamics and with this, we recorded climatic data of the envelopes inside and outside the houses. All the information is recorded in a simulator to obtain heat maps and to know the thermal behavior. In addition, the perception of the inhabitants (PMV and PMD) of the real estate according to the ASHRAE-55 standard is investigated. The importance of the configurations of the analyzed dwellings is centered on the distribution of modular spaces and contiguous to patios, the use of light, luminous and not very saturated colors, which shows that these factors regulate the interior temperature of the dwellings. Adult users consider the dwellings to be slightly cold despite the fact that the temperature in the interior space is acceptable according to the energy simulation reaching average temperature of 18.61 °C, complying with NEC (2018).

CODE 108

MONTECASSINO ABBEY, DESTRUCTION AND RECONSTRUCTION

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KEYWORDS: Montecassino Abbey; Orazio Torriani; Giovan Battista Contini; Arcangelo Guglielmelli; Giuseppe Breccia Fratadocchi.

ABSTRACT

Focus of this contribution is the Benedictine abbey of Montecassino and its reconstruction after the Second World War destruction. Founded by St Benedict in VI century, Montecassino Abbey is the cradle of Benedictine monastic order and also a center of spiritual, cultural and artistic irradiation for Italy and for whole Europe. Each historical period leaves a trace on the monument. In 11th century (1086) Abbot Desiderius was elected Pope Victor III and started significant transformations onf the Abbey, that became one of the most important architectural complexes of the Middle Age. The great transformations of the sixteenth and seventeenth centuries deeply affected the architectural history of the abbey, transforming it into a great monument of the Renaissance and the Baroque and hiding the medieval structures by Desiderius. During the Second World War, on February 15, 1944, the Abbey was completely destroyed by a ferocious bombing; the following year the reconstruction began and was officially concluded on October 25, 1964 when the abbey basilica was reconsecrated for the fourth time since its foundation. In fact, the Abbey has been destroyed and rebuilt several times as is well described in its motto: Succisa virescit, that is “Once downed, it grows back stronger”. Through the analysis of iconographic and textual sources, we will try to retrace the history of this monument with particular reference to its last reconstruction. Today Montecassino is not only a religious symbol and an important architectural monument, but also a symbol of the barbarism of war.

CODE 112

CHARACTERIZATION OF TRADITIONAL MORTARS USED IN WADDING AND RENDERING ON WALLS OF WATTLE AND DAUB IN PORTUGAL

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KEYWORDS: Wattle and daub; Earth and lime mortars; Characterization; Sustainability.

ABSTRACT

Until the middle of the 20th century, wattle and daud walls were usually found in the historic centres and in Portuguese villages. Most of these walls are deteriorated and need intervention. With the intention to carry out a correct intervention, it is necessary to know in depth this legacy of architectural elements in order to preserve the memory of these wall buildings in Portugal.
To achieve this objective, a campaign was carried out for the analytical and laboratory characterization of the mortars applied to wattle and daub walls in buildings located in Portuguese cities and towns. The characterization of the samples was carried out using tests of granulometric analysis by sieving, porosimetry, water absorption by capillarity, drying index, compressive strength, determination of insoluble in hypochlorite, X-ray fluorescence (FRX) and X-ray diffraction (DRX).
The results obtained made possible to collect information on the composition of mortars, namely regarding the type of binder and aggregates, mineralogical and chemical composition, the behaviour regarding the water absorption by capillarity and drying index, the values of porosity and compressive strength. The samples were collected in building in different states of conservations – in phase of degradation, in the rehabilitation project elaboration phase, or in the remodelling phase. The size of the samples was function of the local conditions encountered. After removing the samples, the joints mortars and the plaster mortars were separated. Then, the tests were carried out according to applicable standards. The samples were collected in buildings in different states of conservation and independently, the results achieved for porosity and mechanical resistance to compression are within the ranges recommended by current standards and literature.

CODE 123

THE RETABLISTIC TROMPE L`OEIL AS A RESOURCE IN MURAL PAINTING: THE SPACE REPRESENTATION ON THE FLAT

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KEYWORDS: Fictive altarpiece; Mural painting; Restauration; Heritage; Trompe-l'oeils.

ABSTRACT

The great architectural ensembles enclose multiple artistic jewels within the context of mural painting, as is the case of the fictive altarpieces. These works arise in parallel to the altarpieces made of wood. They are paintings designed initially with a temporary character, elaborated while waiting for the necessary funds to be able to carry out a work of greater magnitude or quality in gilded and polychrome wood. Later they will become large compositions where geometry and mathematics will allow the viewer to approach an almost three-dimensional work.
The aim of the work is to show the techniques of execution of these trompe l'oeil paintings, from the perspective drawing and its transfer to the wall, to the execution of the polychromy; enhancing the importance of the viewer in the contemplation, with an analysis of the representation systems used through the reproduction of the traces of perspective and the representation of space in the plane, describing the historical context of the specific treatises of the time of its execution. Likewise, a cataloguing of the feigned altarpieces of the Brazilian region of Minas Gerais is carried out due to the technical, aesthetic, and historical similarities that some of them present with the Spanish ones.
Based on the results obtained in the research, it has been possible to configure an interactive map with geolocation of the mural groups linked to a database, creation of QR codes for each group, etc. All this will effectively contribute to the reactivation of the heritage of rural areas, promoting their revitalization and conservation.
The work is part of the research project “Spanish mock altarpiece: Geometry, technique, history and enhancement” (Ref. PID PID2020-114271GB-I00), funded by the Ministry of Science, Innovation and Universities (Spain).

CODE 125

HERITAGE VALUATION IN ARCHITECTURAL REHABILITATION AS A STRATEGY FOR SUSTAINABLE INTERVENTION. THE CASE OF COLÉGIO DA TRINDADE

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KEYWORDS: Sustainable refurbishment; Heritage intervention; World Heritage intervention; Built heritage reuse; Aires Mateus.

ABSTRACT

The occupation of disused heritage buildings is a necessary way of sustainable architectural intervention, and in the current context of economic and environmental crisis it is one of the most viable options for architectural practice. This question is reinforced if we take into account, as a consequence, that in the coming years most of the spaces we will inhabit will be those already built. In this sense, it will be decisive to establish mechanisms to carry out qualified interventions on heritage assets, as they can be considered as sources of positive contamination on nearby or surrounding buildings. In addition to rehabilitating the space itself, the intervention can be transformed into an opportunity to promote a dynamic of urban rehabilitation and regeneration, in accordance with new ways of life and consumption. Within a larger research framework, in which a methodology of dialogue between heritage studies and architectural practices is being developed, the main objective of this research is the introduction of cultural valuation as a resource for the definition of criteria and the justification of decision-making in architectural rehabilitation practices, applied on this occasion to the case study of the Colégio da Trindade in Coimbra, the work of the Aires Mateus brothers.
The spatial and constructional logic of the intervention project thus achieves architectural sustainability through the readaptation of the building's pre-existing spaces, elements and materials: it is sought the permanence of the defining elements of the typology and its materiality - eternal value - which constitute the trace on which the transformation takes place, in which dynamic and changing elements are introduced - ephemeral value - which will be in charge of allowing the building to evolve according to the new uses and needs of the times.

CODE 148

STUDY OF RECURRENT LESIONS IN BUILDINGS OF COSTA RICAN CARIBBEAN ARCHITECTURE AND THEIR RELATIONSHIP WITH ROT FUNGI

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KEYWORDS: Pathology; Wood architecture; City of Limón; Basidiomycetes; Ascomycetes.

ABSTRACT

Costa Rican Caribbean architecture is an example of buildings adapted to the particular context of the province of Limón, Costa Rica. It is characterized using wood as the main construction material, the presence of piles and the implementation of bioclimatic strategies such as ventilated roofs, the use of "petatillos", large eaves to provide protection from rain and sun, among others. In addition, these are buildings with a singular architectural language, unique to the Caribbean coast of the country. Given their characteristics and the conditions of high humidity, temperature and precipitation, these buildings are susceptible to the presence of organic lesions caused by biological attacks, being fungi, some of the main agents of deterioration. The objective of this communication is to determine the recurrent lesions identified in Costa Rican Caribbean architecture and their relationship with rot fungi, taking as a sample four buildings in the city of Limón. The methodology applied required several phases that involved field work, planimetry and laboratory analysis; first, the architectural survey of the buildings was carried out for the preparation of plans. In subsequent visits, the damage to the buildings was recorded and samples of fungal lesions were taken. With the information obtained, lesion maps were drawn up, sampling sites were located, and recurrent lesions were quantified. In the laboratory, wood rot fungi were isolated for identification by sequencing. Finally, the results were compared between the general identification of lesions and the species of fungi present in the properties. As main results of the identification of lesions, it was detected that the most recurrent are of organic origin (biological attacks and rotting) and physical (disintegration and dehydration of material); with respect to the fungi, several species belonging to the basidiomycetes and ascomycetes families were identified, which generate white, brown, and soft rotting in the wood.

CODE 164

STRUCTURAL DAMAGE ANALYSIS AND ARCHEOLOGY OF ARCHITECTURE. AN INTERDISCIPLINARY APPROACH TO THE INTERVENTION

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KEYWORDS: Architectural Archaeology; Stratigraphic analysis; Seismic vulnerability; Archaeoseismology; Interdisciplinary restoration.

ABSTRACT

In the disciplinary field of the restoration of damaged buildings, the preliminary phase of historical-archaeological knowledge aimed at understanding structural damage to support intervention choices is a fundamental theme. Historic buildings are often real "palimpsests" and therefore the result of choices, actions, and tampering until nowadays (which can be reconstructions, additions, architectural changes, extensions, additions, etc.). What is increasingly recognized is how each of these “actions” may have influenced the behavior of the structure, generating “weak” or vulnerable parts more exposed to disruption or pathologies. The buildings themselves give us confirmation about it. Structural damages affect parts that are poorly constructed or, as in many cases, have undergone modifications.
Given this, when approaching the restoration of a building, acquiring information on the stratigraphy of the parts and the material could provide an important contribution.
However, as happened in the past, it still happens today that the detailed study of the events suffered by the structure and its stratigraphic evolution continues to be underestimated; carrying out the consolidations in an almost standardized way, with safety measures considered optimal regardless of the stratigraphic, material and evolutionary characteristics of the damaged portion.
A discipline that allows us to focus on these aspects is “archaeology of architecture”, which applies archaeological methods, such as stratigraphic analysis, typological analysis, and analysis of the ancient construction site, proving very useful for clarifying the evolutionary history of the building, investigating and possibly justifying the presence of specific damage.
Such studies would allow us to have data to understand the state of the architecture, guide consolidation actions and acting in such a way as to prevent the collapse from recurring. Given this attractive topic, we will illustrate the methodologies of the archaeological stratigraphic analysis of historic buildings, to demonstrate their importance by highlighting how, from a concrete interdisciplinary perspective, this study can be integrated into the analysis of structural damage, the evaluation of seismic danger and, therefore, then to the intervention project.

CODE 196

GEOLOGICAL ANALYSIS, STONE RESOURCES AND STATE OF CONSERVATION OF THE CURRENT BUILDING OF SAN FÉLIX DE OCA (BURGOS)

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KEYWORDS: San Félix de Oca; Geological resources; Quarries; Conservation.

ABSTRACT

The church of San Felices or San Félix, located in the vicinity of Villafranca Montes de Oca (Burgos), shares constructive characteristics with a group of temples still preserved in the regions of La Rioja, Alava, Soria and Burgos, all of them dating to the end of the 9th and beginning of the 10th centuries. From the original early medieval church, it is currently only standing the eastern apse, a quadrangular vaulted space with a western arch and walls made of sandstone, limestone, gypsum and tuff, covered with a vault made of tuff stone.

Thanks to the funding of the regional government of Castilla y León (Cultural Heritage Department), an interdisciplinary research was undertaking to better understand this building and its constructions process. An archaeological analysis of its standing structure, along with the geophysical exam of its immediate surroundings, the examination of its documentary record and the geological study of its stones materials were thereby carried out.

The results of the geological research are presented here in detail, relating to the identification and characterisation of the stone materials used in San Félix and their provenance, the latter determined thanks to petrological correlation studies between the samples selected in the building and in the quarries and extractive areas identified thanks to the fieldwork.

The analysis of the state of conservation of the building and its pathologies makes it also possible to obtain a preliminary view of the most significant lesions of the structure and to classify the degree of deterioration of the materials. Results altogether that facilitate to further propose future actions focused on the consolidation and preservation of the architectural remains.

CODE 265

PETROGRAPHIC STUDY OF POTTERY SAMPLES FROM THE HEPING DAO B SITE (HEPING DAO ISLAND, KEELUNG, NORTHERN TAIWAN)

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KEYWORDS: Petrographic study; Pottery samples; Archaeological site; Taiwan.

ABSTRACT

Heping Dao B (HPDB) is an archaeological site located in the small island of Heping Dao, off Keelung, northern coast of Taiwan. The site preserves a very complex and uninterrupted sequence of occupation from the early occupation of Taiwan, in the Neolithic, to the present times. It comprises therefore the prehistory of the island, its transition to the historical period with the European colonization of Taiwan, the Chinese (1668-1895) and Japanese (1895-1945) colonial periods and important remains from WWII, and the postwar colonial occupation by the Kuomintang up to the end of the 20th century. The prehistoric period is particularly complex to unravel due to stratigraphic questions and a traditional focus on ceramic typologies. We aim to overcome these difficulties by providing additional technological information on a sample of ceramics from HPDB.

Optical microscopy is a common method to analyse and characterize the components of pottery. These studies are carried out with thin sections and are able to identify the components and the morphology of the aggregates, and determine the porosity and the different types of clay matrix. Moreover, these studies are useful in order to distinguish the minerals which are formed in paragenesis with the clay from those which were added as temper in order to improve the properties of the pottery.

The assessment of the pottery from Heping Dao B has been carried out by means of eleven thin sections obtained from samples that define specific pottery groups. Every thin section has been studied to identify the components, aggregate size, morphology, voids and textural relationships. According to the initial findings of this study, the predominant component in seven of the analysed samples is quartz, while sandstone is commonly found in three of the thin sections. It is also important to note that sandstone components are remarkably present in three of the seven samples aforementioned. In the remaining sample, other minerals and components, as volcanic stones, feldspars and pyroxenes are present in varying proportions, highlighting the diversity of materials in the studied area. These results provide a valuable insight into the mineralogical composition of the samples and could serve as a starting point for further investigations into their geological origin and possible uses.

CODE 273

PRESERVING HERITAGE AND HISTORY: THE FRAGILE LEGACY OF THE HEAD QUARTER BUILDING OF SOUTH EASTERN RAILWAY, INDIA

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KEYWORDS: Preservation methodology; Railway legacy; Indo saracenic style.

ABSTRACT

The Head quarter building of South Eastern Railway, a historical and architectural landmark (1906-1907) located on the banks of the river Hooghly in Kolkata, India. The building is a testimony to the colonial architecture of the British era. However, due to a lack of proper knowledge and preservation methodology, the maintenance has fallen through some glaring gaps, urgent attention is needed with intervention of trained supervisors, as well as the masons, with proper emphasis on the methodology lest the building may fall into disrepair in the near future.

The building's unique blend of indo saracenic style, is a three storied brick masonry structure with central Dome, surrounded by four domed minarets, an imposing overhanging eaves, pointed arches, marble bifurcated staircase, colonnaded balcony is a precious node to India's past.

This paper presents a comprehensive approach to saving this building, a shining example of indo-saracenic style. Analysis of this building's current condition involves a thorough examination of the structural integrity, material deterioration, and the impact of environmental factors on the buildings. This analysis provides a basis for the development of a restoration plan that addresses the specific needs of each part of the structure. The proposed approach includes a detailed analysis of the building's current condition, identification of the causes of deterioration, and a plan for restoration and conservation.

The restoration plan proposed in this paper includes a range of interventions such as repair of the facades, restoration of the roofs, and strengthening of the foundations. The proposed restoration interventions are designed to preserve the authenticity and integrity of the building's original design. The use of appropriate materials and techniques is also emphasized to ensure that the restored building retain its historical and architectural value, which can serve as a model for the conservation of other heritage buildings of the Indo saracenic style in Kolkata and beyond. The proposed approach provides a model for the conservation of other heritage buildings of the same style and can contribute to the preservation of India's cultural heritage site.

CODE 290

HOTELS IN HAVANA CITY, CUBA. (1850-1958) STYLISTIC AND TYPOLOGICAL EVOLUTION OF AN ARCHITECTURAL HERITAGE WORTH APPRECIATING

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KEYWORDS: Hotels; Havana city; Architectural heritage; Typology; History of the Hotel.

ABSTRACT

Architectural heritage is an indisputable part of historical memory, this being, as a whole, one of the most important cultural heritages that a nation has. The city of Havana, capital of the island of Cuba, the largest of the Antilles, has always been an important center of attraction for travelers; Therefore, throughout history important buildings have been built to accommodate tourists. It is striking that, despite this, when reviewing the specialized bibliography, little Havana hotel architecture has been studied, documented and valued. The objective of this work is to highlight the architectural heritage value of the main hotel buildings located in the City of Havana between 1850-1959, based on an inventory that establishes their location in the city, as well as their stylistic and typological affiliation, determining historical periods. based on its main architectural characteristics. This is qualitative research, which, following a historical-bibliographic and documentary approach, results in a catalog where the Havana hotels belonging to the indicated period are recorded in technical sheets, as well as a map of the city showing the location of said buildings, differentiating the established historical periods. For each period, the representative stylistic and typological characteristics are established. It is important to note that the research is part of a doctoral thesis in development that proposes to show the evolution of the hotel typology in Cuba and the Dominican Republic in the first half of the 20th century, carried out within the framework of the Doctorate program in Caribbean History, Center of Caribbean Studies from the Pontificia Universidad Católica Madre y Maestra.

CODE 43

JESUIT HERITAGE ON THE CAMINO REAL DE TIERRA ADENTRO OF NEW SPAIN. A CASE FOR MANAGEMENT IN TEPOTZOTLÁN AND ARROYO ZARCO BEYOND THE CATALOGUES

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KEYWORDS: Caminos Reales; Heritage management and technology; Jesuit haciendas and infrastructure; Territory of New Spain.

ABSTRACT

The work addresses the study of the Jesuit heritage in the New Spain highlands since the end of the 16th century, with its territorial articulation route, the Camino Real de Tierra Adentro; particularly haciendas and infrastructure for educational activity.
We seek to analyze and contextualize uncatalogued Jesuit assets, for their dissemination, management, and reactivation, in a contemporary Hispanic heritage framework. We consider parallels with the Camino Real al Alto Perú, another route related to evangelization and mining production, the indigenous past, and references to Andalusian territories. We investigate architectural and territorial historiographic documentation with field studies, level, and aerial photogrammetric surveys, considering archaeological and museological studies. We support this work in statistics, planimetry and geographic information systems, with previous academic work.
The Caminos Reales were not totally new, nor unprecedented, but rather they assimilated and hierarchized the indigenous territorial structuring. Partly according to what happened in Andalusia, and as an expansion for evangelization and commerce; activities that, concatenated, were present in the region. As if it had been a religious symbol, the New Spain territorial structure was cruciform; with royal roads from east to west and from south to north. Its condition as an "insular" territory of great wealth, as a geopolitical pivot and Hispanic bridge between Europe and Asia, gave rise to these powerful spinal axes where the Society of Jesus was established. In them, and the Jesuit assets, the religious engine supported by economic prosperity is verified.
The Society of Jesus was key to the Hispanic Monarchy and New Spain; and the Camino Real de Tierra Adentro is the first cultural itinerary worldwide recognized as such. Certain Jesuit assets in Tepotzotlán and Arroyo Zarco, however, are not cataloged, and there are sections of the road not sufficiently managed. A comprehensive long-term reactivation of the Camino Real and its assets calls for a progressive update of regulations, optimizing management instruments with new technologies such as HBIM and GIS, thus consolidating the missing assets.

CODE 47

EVALUATION OF THE URBAN ARCHITECTURAL IMPACT OF CHUQUIRIBAMBA-ECUADOR, AFTER IT'S DECLARATION AS NATIONAL CULTURAL HERITAGE

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KEYWORDS: Heritage; Urban-architectural evaluation; Declaration; Habitability.

ABSTRACT

Chuquiribamba, one of the rural parishes of the city of Loja; for its history, conservation of ancestral knowledge, urban layout and architecture; was declared Cultural Heritage of Ecuador on May 13, 2013. On this date, it was possible to determine 192 houses that are part of this inventory, qualified as vernacular civil architecture in continuous section, of which 128 are in the area of first order, which represents 60% of the total of the properties of the parish head.
The present investigation makes an evaluation of the impact of the declaration, through the resolution of the following research questions: 1. What is the impact of the declaration for the conservation of the property and its surroundings? 2. What are the social and cultural dynamics that have been produced? and finally 3. Is there an improvement in the physical infrastructure, equipment and basic servicies?. The objective of this research is to determine the current degree of conservation of the inventoried houses; for which, in the first instance we proceeded to validate the information of the inventory cards of the Instituto Nacional de Patrimonio Cultural - INPC; towards defining a line of information of the current conditions of the urban-architectural heritage; and subsequently to evaluate the physical conditions and occupation of the inventoried houses. The method applied was the analogical method based on the official document that is the file of the declaration that contains the inventory cards; and the descriptive-exploratory method, applied in the field visits.
The analysis carried out leaves a positive result of the heritage declaration, evidencing 97% of the conservation of architectural characteristics in the inventoried buildings; however, in terms of occupancy, it was possible to determine other types of problems, characterized, among others, by the abandonment and deterioration of several buildings that respond to social circumstances such as: rural-urban migration, longevity of their owners and the deficient valuation of the meaning of this declaration.

CODE 49

CONSERVATION AND ENHANCEMENT OF THE INDUSTRIAL ARCHAEOLOGICAL HERITAGE ON THE MAIELLA MOUNTAIN

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KEYWORDS: Maiella mountain, Industrial Heritage, Bituminous rock, Geotrail, mines.

ABSTRACT

The bituminous rocks of the Maiella have always been the object of exploitation, already in Roman times the bituminous material was used to caulk the hulls of boats, there have been many studies and attempts since the mid-19th century on mineral exploration for the search for hydrocarbons. Only the second oil drilling well in the history of humanity is built in Tocco da Casauria
5 years after the first well drilled in the world in Pennsylvania. Starting from 1841 the northern slope of the mountain began to be the subject of deep tunnel excavations for the extraction of asphaltic rocks, in 1903 a decouville railway was built which entered the mines and descended loaded down to the valley, as many as 7 overhead cable lines with numerous pylons, corner and loading stations will be the means of transport for the mining industry. In total there will be around a hundred mines built for the extraction of the bitumen used for the production of asphalt tiles from the SAMA factory and exported all over the world together with the labor of the workers, the installation was in fact included in the price.
The aim of the work is to highlight the main industrial archeology emergencies, create a path network that leads near the main extraction centers with adequate and inclusive signage, where possible try to make some of the study sites accessible also to the disabled.
The objectives are the valorisation of the mining sites through the CONSERVATION OF THE BUILT HERITAGE with the creation of the Maiella Mining Park in an integrated system between thematic trail network and museum centre.
Following the study of the mines on the Maiella, their distribution and accessibility, the census of the accessory structures (warehouse buildings, canteens, miners' and managers' houses, old tracks, pylons and trolleys), a thematic map was created identifying the main stages of the future Geotrail of the miners and the territory suitable for the creation of a mining museum.
The entire project falls within the territory of the UNESCO Maiella Geopark, and acts as an attraction in the area through the related CULTURAL TOURISM which to date has already led to over xxx presences since its creation.

CODE 55

COLD WAR MILITARY LANDSCAPES: JUPITER MISSILES BASES IN ITALY

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KEYWORDS: Cold War; Modern Architecture; Italian Heritage Construction; Italian Air Force; Military Landscapes.

ABSTRACT

The evolution and progress of the arts of war, as well as of the tools and technologies used in the great world conflicts, led to a transformation of defensive locations and architectures that saw the use of increasingly complex and often inaccessible strategic sites, as well as the use of the most diverse defence systems. In the tense climate of the so-called Cold War, the strong threat from the two superpowers USA and USSR in the use of weapons of mass destruction, involved many European countries including Italy, which, under the incredulous eyes of the population, saw as many as 10 nuclear missile bases deployed in the uncultivated lands of the Murgia, in an area straddling Basilicata and Puglia. The Jupiter bases were characterised by their distinctive triangular shape, arranged in a north-easterly direction, at the apexes of which were the launch pads for intermediate-range missiles (IRBMs), armed with a powerful thermonuclear warhead.
These "invisible" but well-rooted sites, wanted to support NATO represent a large "slice" of the military building heritage that, under the secrecy constraint, is nowadays, in most cases, in a state of abandonment and disuse. In the case of the Jupiter bases, the decommissioning and consequent degradation is linked to an early state of obsolescence that involved these military sites, which were underused for a very short period of time (1960-1963), no longer responded to the needs required by the rapid evolution of military strategy. These particular military landscapes, in which human action is intertwined with uncontaminated nature, today provide numerous cues for redevelopment aimed both at recovering the intangible values of which these sites are bearers and at functional reuse for local communities. The importance of knowledge towards the artefacts of this architectural heritage, as close in time as it is culturally distant from contemporary society, becomes the fundamental fulcrum for actions of protection and valorisation of places of timeless charm that otherwise left in a state of neglect would entail the loss of material and historical evidence.

CODE 96

MORPHOLOGICAL TRANSFORMATION OF THE TERRITORY OF THE FORMER HACIENDA OF SAN FRANCISCO DE CERVERA IN GUANAJUATO, MEXICO

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KEYWORDS: Transformation; Urban morphology; Mineral processing haciendas; Cultural heritage.

ABSTRACT

The "ciudad histórica de Guanajuato y sus minas adyacentes", inscribed in the list of UNESCO (1988) world heritage sites, have relevance due to their origin and mining site. This extractive activity represents an important factor in urban growth, since it has allowed the development of mineral processing haciendas which have been transformed according to the needs of the population. The territory of San Francisco de Cervera, our subject of study, is no exception.

At present, there are few vestiges of the spaces that formed the hacienda, many others have been modified by human action over time. However, there are spaces of permanence, such as the traces of plots or roads that, although they respond to its original layout, they have become the streets and alleys that communicate the houses with the historic center. Among these spaces of permanence, the oldest one is the Temple of San Roque, a landmark of the built cultural heritage.

The main objective of the research was to know the growth and transformation of the spaces to understand and recognize the importance they have, to contribute to their conservation and protection.

The study was based on the morphological, historical, and evolutionary analysis of the hacienda, using photographic records, cartography, cabildo protocols, ephemeris of the city and historical documents as a resource.

The focus of the research was aimed at the historical-evolutionary recognition of the urban morphology of the city, concluding that it is important to know the growth and transformation of spaces in order to understand and recognize their importance, as a tool for planning, protecting and disseminating cultural heritage.

CODE 141

WHERE THERE WAS THE GRASS. RETHINK, UPDATE, REVIVE THE WORKERS' DISTRICTS

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KEYWORDS: Agenda 2030; Urban regeneration; Built heritage; Workers' discrits; INA-Casa.

ABSTRACT

The theme of the house, which found its highest moment of reflection during the Modern Movement, lives again in Italy a second and intense season with the INA Casa plan (1949-1963, 1963-1970) born in response to the housing emergency which - in the years of the economic boom - reached warning levels, both for the need for post-war reconstruction, both to deal with the phenomenon of urbanism and in Turin reaches its peak. It is no coincidence that Turin is defined as the first southern city in Italy. In fact thousands of workers from the south converge in Turin bringing a great variety of traditions and living cultures. From this point of view, Turin can in fact be considered a privileged observatory for experimenting with construction procedures and techniques, even if the city was in a situation of social conflict. It is interesting to note how social transformations and technological experimentation change over time giving life to as many construction models. We move on from the euphoric climate of reconstruction - characterized by building types still strongly linked to tradition, with admirable attention to the insertion into the surrounding greenery - to the dark and asphyxiated climate of the terrorism of the Years of Lead, with the introduction of heavy prefabrication systems for the construction of ghetto neighborhoods marked by a static and non-specific vision of life models.
These settlements, originally isolated from the center and deprived of even minimal but now easily accessible services reached by the public transport network are rediscovered and appreciated by the new residents - sons and grandchildren of first generation immigrants - for the architectural quality and environmental integration. Not at case many of these neighborhoods are signed by the most cultured and up-to-date professionals of the time they have concentrated their best energies on the topic of living.
In the current debate on the future of cities and urban regeneration interventions - also in relation to the implementation of the SDGs of the 2030 Agenda - what to do with this extensive and widespread heritage, with indisputable elements of residual quality, but which requires inevitable updates from the point of view energy and performance, takes on great strategic and cultural value

CODE 149

REVALUATION OF ARCHITECTURE AND THE ANDEAN LANDSCAPE IN THE SONDONDO VALLEY (PERÚ)

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KEYWORDS: Cultural Landscape; World Heritage; Pre-Hispanic Urbanism; Vernacular Architecture; Peruvian Andes.

ABSTRACT

The Sondondo valley is in the Ayacucho region, at the heart of the Andean range, in Peru. In 2019 it was included in the tentative list of the UNESCO World Heritage sites, considering the exceptional values of its ancient cultural landscape. Our research served to support the Ministry of Culture's application submitted to UNESCO.
We describe these values by characterizing several pre-Hispanic landscape units that are part of its territory; among them: colonial Andean towns and their vernacular architecture. They are historically related to the design of spectacular *andenes* (agricultural platforms) and agricultural terraces. These towns are the core of rural life and of their residents' cultural identity. There, housing architecture is integrated -in a singular way- with indoor open spaces, linked to the main landscape.
Vernacular architecture builds, and is built of, several values (material, structural, productive, environmental, eco-friendly, aesthetical, landscape and cultural values) that need to be invigorated vis-à-vis the current devaluation, change and replacement trends, associated to the imposition of global models based on a false perspective of modernity. Revaluating the traditional architecture means also to weigh different local materials and building techniques, as well as the knowledge, arts and crafts used to create it, reestablishing links with nature and the environment. It is also about recovering the traditional look, which is sensitive to its surroundings, and has to do with the particular Andean way to understand the territory, deeply rooted to the environment, and embodied in its architecture.
Considering that Andean towns and vernacular architecture are inseparable from the cultural landscape and their memory, we need to generate alternative proposals to the mainstream trend that aims at replacing traditional architecture with buildings that are completely unrelated to their context, thus eroding their values. Last but not least, we need to promote -through architecture- a better quality of life for town residents, and the sustainable development of their hometowns, based on their sense of being rooted to the place and their projection into the future, within the context of an outstanding living cultural landscape.

CODE 151

COSTA RICAN CARIBBEAN ARCHITECTURE: A COMPARATIVE ANALYSIS OF THE MAIN COASTAL URBAN CENTERS

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KEYWORDS: Vernacular heritage; Wooden architecture; Costa Rica; Puerto Limón; South Caribbean.

ABSTRACT

Costa Rican Caribbean architecture exemplifies how buildings can adapt to the characteristics of the territory. This architecture is the product of the historical and socioeconomic context of the late nineteenth and early twentieth centuries and is now a unique heritage and identity in the Caribbean landscape of Costa Rica. Among its main characteristics are the use of wood, piles, pronounced roofs with galvanized iron sheets, decorations with fretwork, and the application of diverse bioclimatic strategies to respond to the environmental conditions of the surroundings.
This contribution aims to conduct a comparative analysis of the features of Caribbean architecture in various coastal urban centers of the Limón province in Costa Rica (Puerto Limón, Cahuita, Puerto Viejo, and Manzanillo) to verify the existence of a regional architectural style.
The methodology used to identify and quantify the characteristics of the settlements analyzed was based on previous research and fieldwork. In the second stage, we extracted the specific characteristics of the properties in each site based on the provided information. Then, in the third stage, we created a comparative matrix to identify recurring characteristics at the regional level, local adaptations of architectural elements, and the presence of specific features in urban centers.
The study identified a regional architecture that features languages with local adaptations in each of the settlements analyzed. The results also confirmed the accelerated loss of this heritage and emphasized the need to explore alternatives for its conservation and enhancement.

CODE 152

IDENTIFICATION OF THE VERNACULAR ARCHITECTURE OF THE CITY OF PUNTARENAS

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KEYWORDS: Costa Rica; Vernacular heritage; Wooden architecture; Inventory; Geographic Information System.

ABSTRACT

Vernacular architecture is distinguished by its close association with the landscape and cultural heritage of the territory, as evidenced by the use of materials available in the area, adaptation to environmental and social conditions, and the application of traditional knowledge. In Puntarenas, a historic and tourist port in Costa Rica, numerous wooden vernacular buildings from the early 1900s can be found. However, no comprehensive studies have been conducted to document this significant cultural heritage.
The purpose of this paper is to identify the vernacular architecture in this city by conducting architectural characterization, quantifying existing buildings, and conducting a preliminary recognition of their conservation status.
The first stage of the methodology applied was the review of primary and secondary documentary sources to verify existing information and obtain a preliminary profile of architectural characteristics, which was validated through a participatory workshop with the community. The second stage consisted of conducting fieldwork to obtain an initial list that included a photographic registry and geolocation of properties. The third stage consisted of a detailed review of the listed properties in order to verify the profile of characteristics, define architectural typologies, and exclude those buildings that did not correspond to the preliminary profile or that had significant modifications that would affect their architectural legibility. During the fourth stage, an inventory of vernacular architecture was compiled, documenting each property through corresponding files. The data collected on site was entered into standardized inventory cards and a Geographic Information System.
The study resulted in an initial list of 172 wooden buildings in the city of Puntarenas and a geolocalized inventory of 75 buildings of vernacular wooden architecture that still preserve considerable architectural legibility.

CODE 161

HERITAGE AND TERRITORY: THE «MASSAE» IN THE RURAL AREAS OF SOUTHERN ITALY

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KEYWORDS: Historical heritage; Farm buildings; Constructive tradition; Conservation and rehabilitation.

ABSTRACT

The *masserias* (buildings farms) identify those residential-productive-rural constructions typical of Southern Italy, having the characteristics that the Latin etymology of the term contains: “massae”, i.e. block, a set of rural buildings, usually surrounding courtyards or less extensive, each with different intended uses, but constituting a single corporate or legal reality [1]. The term *masseria*, therefore, reveals a precise meaning, better determined over time, as a logistic center of the productive activities of the rural economy, as an autonomous company with a large estate orientation, linked to the cultivation of the field sand/or to the breeding of animals; it will be precisely the prominence of one of the two main activities, the alternation between these two orientations, that will define, in its general lines, the typological structure of the farms and their formal image. Of course, it takes different forms and types also depending on the geographic allocation, morphological, environmental and cultural characteristics of the site, population loads and levels of social and urban organization of the territories. Moreover, in the very long historical evolution of these settlements, other functions, always largely deriving from the political-economic contingencies of the territories they belonged to, have ended up declining their function: from markedly proto-urban residential, in the periods of the city's decline (from the Roman empire to the early Middle Ages), to defensive functions (from medieval 'castra' to the 'fortified' farms of more recent times), to religious ones (abbey sand convents, hermitages and monasteries).
Within this important typological-constructive variety, through a study carried out mainly in the rural area of Matera and its surroundings, it was possible to identify some specific typologies of the geographical areas to which they belong (Murgia; coastal; inland); researches on materials, construction techniques and functional schemes, analysis of failures and pathologies were carried out; interventions of recovering and functional reuse, compatible with the architectural-constructive characteristics of the building and their landscape surroundings, were proposed, aimed at the conservation, use and promotion of important prodromes of the history and heritage of Lucanian constructive tradition.

CODE 204

HISTORICAL AND COSTRUCTIVE ANALYSIS OF THE ROTONDA ROMAN BATHS AT CATANIA (SICILY)

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KEYWORDS: Roman thermal baths; Historical construction techniques; Roman heating system.

ABSTRACT

One of the main icons of the Roman civilization are thermal baths, built as public places for personal hygiene, body and mind relaxation, as well as recreation, social intercourse and sport.
In Sicily, there is evidence of several thermal buildings dating back to the time of the Roman Empire. Among these, the Terme della Rotonda, in the city of Catania, have always attracted strong interest due to their intricate and fascinating architecture. However, at present the dating of the different parts that constitute the complex is still uncertain, while diverse assumptions have been advanced on the function of the main rooms, built in different historical periods, from Roman to Byzantine to late Baroque times. This paper reports the preliminary investigations carried out as part of a multidisciplinary research project that aims at bridging the knowledge gap on the diachronic development of the Terme della Rotonda through accurate investigations. To this end, historical and constructive analyses are here presented, providing new information on the materials and construction techniques adopted.

CODE 339

RECOVERING MORTAR PRODUCTION TECHNIQUES USING OYSTER SHELLS IN COASTAL REGIONS

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KEYWORDS: Lime mortar; Blue circular economy; Oyster shell; Construction techniques.

ABSTRACT

The use of mortar goes back thousands of years, across countries and continents. With the use of oyster shells in its composition, this product became more resistant and could be used in bricks in buildings, making them more durable. Today, society's greatest challenge is to tackle climate change and mitigate environmental impacts. With the history of the use of oyster shell lime mortar and the prospect of global aquaculture production, this paper aims to discuss the recovery of oyster shell mortar production techniques in coastal regions, due to the availability of this local resource. The analysis covers the mapping of existing case studies and the importance of recovering the use of oyster shells in the construction industry. This work is part of the activities to be carried out as part of the Shellter project, which intends to incorporate oyster shells into the production of construction materials in a circular economy model in order to valorise and exploit the potential of shell waste. The study is also part of a master's thesis and a PhD thesis.

CODE 56

DROSSCAPES AND URBAN REGENERATION. BETWEEN ENVIRONMENTAL QUALITY AND CIRCULARITY OF RESOURCES. ROME, "PARCO DELLE CAVE"

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KEYWORDS: Environmental recovery strategies; Urban regeneration; Circularity of resources.

ABSTRACT

To contribute towards the debate over the relationship between urban regeneration, environmental quality, and resource circularity, the illustrated study attempts to understand how the expectation of new, multiscalar, multidimensional, and integrated intervention instruments based on sustainable and resilient strategies can guarantee high levels of urban and environmental quality, as well as quality in terms of energy efficiency and resource circularity, thus countering the effects of climate change, of the deteriorating landscape/environment, and of socioeconomic marginalization. Starting from analysis of the current socio-political framework and from design and regulatory references that integrate into planning a new model for the ecologically-oriented city, the paper identifies, in a study area within the western periphery of Rome (Municipio XII district) strongly marked by decay and by blighted landscape, the opportunity to experiment with new design strategies that, in valorizing drosscapes, find a new design metaphor. The adopted methodology simulates a planning process extended to the entire Municipio XII district by applying an iterative and interscalar logic, and an articulation in levels and phases corresponding to different reading scales and intervention instruments. The design focus concentrates on defining the "Parco delle cave" Masterplan, with the objective of guaranteeing high levels of ecological and environmental quality, the conservation of biodiversity, and improved ecosystem services, as well as of using natural solutions to restore the quality of the air, soil, and water environmental matrices, thus triggering a new urban metabolism. The contribution underscores potentials and limitations of the proposed experimentation relating to the quality and innovation of the design solutions and the possible lines of evolution, as well as to the lack of a clear institutional governance and of sound disciplinary approaches that, in Rome, are limiting these territories' regeneration towards compatible uses integrated into the context of new, circular and sustainable economic and productive cycles.

CODE 68

EVALUATION OF URBAN LANDSCAPE DISTORTION CAUSED BY ENERGY REHABILITATION INTERVENTIONS ON FAÇADES: THE CASE OF SCULPTORIC STONE BUILDINGS IN THE ENSANCHE OF SAN SEBASTIÁN

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KEYWORDS: Energy rehabilitation; Landscape distortion; Environmental Protection; Methodology; Ventilated façade.

ABSTRACT

Public administrations are working to promote the rehabilitation of existing buildings. To this end, Royal Decree 853/2021 has been published, which regulates aid programs regarding residential rehabilitation and social housing. Next Generation EU aid has encouraged the placement of ventilated facades to improve the energy efficiency of existing buildings. However, these interventions modify the composition and materiality of the facades, which alters the urban landscape and can cause the cities to lose their identity. The regulations of the San Sebastián City Council regulate this type of intervention, on facades with some degree of protection. However, some buildings are not protected, which is causing the appearance of interventions that distort the idiosyncrasy of the expansion and lead to a loss of identity. To solve this problem of homogenization in cities, a pilot case has been proposed for the expansion of San Sebastián. A work methodology has been designed that allows unprotected buildings to be characterized, measure their vulnerability and establish intervention criteria. The unprotected buildings in the expansion have been identified and classified into different scenarios. Among the identified scenarios, the stone sculptural buildings stand out, which present a façade with a great wealth of shadows and planes that are difficult to cover without changing their original appearance. The proposed methodology has been applied to a case study located at C/ San Martín, 37. To evaluate the results, a digital twin of the façade has been generated in which different solutions have been tested. The results obtained demonstrate that the ventilated façade solution is not suitable for this type of façades, since it offers standardized solutions that simplify the façades and do not adapt to sculptural buildings.

CODE 90

BIOPHILIA AS AN OPPORTUNITY IN THE REGENERATION OF ANDEAN URBAN ENVIRONMENTS, LOJA - ECUADOR

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KEYWORDS: Biophilic City; Urban Regeneration; Urban Green; Biophilic Indicators.

ABSTRACT

Modern life and the scarcity of spaces for contact with nature affect the health and well-being of the urban population. The COVID - 19 pandemic highlighted the importance and necessity of natural environments in cities and the problems of provision and access to greenery worldwide. To face the challenges of the contemporary city, biophilia represents a path in the provision of urban qualities that promote the well-being and quality of life of the population. Biophilia promotes the creation of regenerative spaces that motivate the population to experience meaningful connections with the natural environment and healthy behaviors. They also contribute to the recovery of the city's history, memory and identity.

The present work seeks to propose diagnostic instruments for urban greenery under biophilia principles and thus provide an alternative approach for urban planning and regeneration. The study focuses on intermediate mountain cities, taking as a case study the city of Loja, located in the south of the inter-andean region of Ecuador. The biophilic situation of the city and its urban parishes is diagnosed based on 7 indicators, which focus on the conditions and infrastructure, biophilic activities and attitudes, as well as government actions for the care and promotion of green spaces. Finally, biophilic regeneration strategies are proposed for the two scales.

It is determined that the city does not present characteristics of a biophilic city despite the strong presence of nature in its surroundings, just as the parishes do not meet optimal biophilic standards. The above strategies allow for the improvement of natural conditions in the urban environment through the application of biophilic design principles. Therefore, biophilia represents an opportunity for the regeneration of urban environments that motivate the reconnection and daily experience with greenery and its benefits.

CODE 95

CONSERVATION OF ENVIRONMENTAL AND CULTURAL HERITAGE OF LASSANCE, (MINAS GERAIS), BRAZIL

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KEYWORDS: Proteção; Patrimônio; Material; Imaterial; Ambiental.

ABSTRACT

Lassance, a town in the north of Minas Gerais state, Brazil, has a rich environmental and cultural heritage. The Cabral mountain range (*Serra do Cabral*) is listed by the Historic and Artistic Heritage Institute of Minas Gerais (IEPHA) due to its special fauna and flora and a set of pre-colonial archaeological sites with rupestrian paintings. In the urban perimeter, Lassance has a valuable heritage comprising material and non-material culture. The regions' expressions and traditions represent the non-material heritage and the historical buildings and urban spaces represent the material heritage.
Lassance also has an architectural complex built by the old Central Railway of Brazil, (*Estrada de Ferro Central do Brasil - EFCB*) and a set of buildings linked to the work of scientist Carlos Chagas in the region. This project aims to recover not only the noble historical buildings, but also the popular ones and also the urban spaces and the ambience of the city from the time when the famous scientist lived in the city. For this purpose, the Environmental and Cultural Protection Area (*Área de Proteção Ambiental e Cultural – APAC*), in Lassance, was created.

CODE 104

THERMO-OPTICAL MAPPING OF URBAN COATING MATERIALS: A GIS BASED SURFACE RENOVATION TOOL FOR PASSIVE COOLING OF CITIES

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KEYWORDS: Thermo-optical properties; Reflectance; Emissivity; Urban renovation; Surface finishes.

ABSTRACT

The coatings of construction materials determine the amount of energy that is reflected, absorbed and emitted in urban areas. Their thermo-optical properties largely determine the Urban Heat Island effect. A promising line of research for climate change adaptation strategies is the substitution of urban finishes for better management of solar radiation in our cities. In previous works, the characteristics of the most common urban finishes in the city of Madrid that are currently in use have been experimentally determined. This work has made it possible to create a catalog of materials that includes their reflectance properties (visible and solar), emissivity and color. The work presented here consists of a methodology for the creation of intelligent maps based on GIS technology, which collect information on surface finishes and their characteristics in neighborhoods of the city of Madrid. Through the exploitation of existing open databases of urban cartography and the realization of in situ inspections and measurements, it is possible to obtain an inventory of the surfaces exposed to the exterior. These maps are useful for the planning of passive cooling strategies for urban spaces, based on the reflection of solar radiation and the emission of infrared radiation. The methodology is applied to the case study of the Picazo neighborhood, as a vulnerable and degraded urban area, which needs investments in renovation and is also affected by a high incidence of urban heat island in summer.

CODE 118

URBAN REGENERATION OF THE TRINIDAD GRUND STREET, MALAGA

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KEYWORDS: SOHO Malaga, Infraestructure, Management, Heritage values, Accessibility.

ABSTRACT

The aim of this article is to show the context, background, characteristics, methodology and results of the design and construction of the urban renewal project of Trinidad Grund Street in Malaga, in the section between *La Marina Square* and *Cordoba Street*, in the traditional *Ensanche Heredia*, now known as *SOHO Malaga*. The action was supported by European Regional Development Funds (ERDF).
The strategy intends to transform a port district degraded in all their social and urban planning terms, into a dynamic area of activities linked to art and cultural tourism, linked to the development of plans for accessibility, mobility, energy efficiency and sustainability. By this way, in recent years *Casas de Campo* and *Tomás Heredia* streets have been pedestrianised, with the purpose of creating meeting spaces between the city centre and the port. And also from the Contemporary Art Centre (CAC) to the *Parque de Málaga* (Malaga Park).
The urban intervention explores an distinct identity within the overall design strategy of the urban expansion. It has been carried out according to classic criteria of intervention in heritage, evaluating the different heritage values and linking them to the building-street binomial. In addition, constructive elements of contemporary architectural rehabilitation have been transferred to the urban space.
In addition, the infrastructure has been modernised, maintaining in service the supplies to the buildings that make up the street. The water supply system (asbestos cement pipes) has been replaced with a cast iron pipe. Also it has been incorporated a separate water drainage network, improving the electrical and gas installation and incorporating a prism for telecommunications linked to the Smart City concept.
Finally, information is provided about the management of the building project within the framework of the public works execution project included in the Public Sector Contracts Law. Particularly, regarding the deadlines, the official papers required and the costs are related to the different circunstances that have taken place during the construction process, such as the discovery of poorly executed service systems in the street, the transport strike or the war in Ukraine.

CODE 201

CULTURAL FACILITIES AND PROJECTS AS ANCHORS OF URBAN REGENERATION IN PORTO. WHAT'S DIFFERENT?

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KEYWORDS: Urban Development; Municipal Politics; Culture; Porto.

ABSTRACT

There is an ongoing rehabilitation strategy in the Eastern Zone of the city of Porto, in the parish of Campanhã, which deserves to be observed within the broader context of the recent urban and cultural policies of the city, considering the emphasis on culture given by the current mayor, the independent Rui Moreira. This context takes into account two preceding political periods, one marked by antagonism and the other by identification.

When the mayor took office at the Porto City Hall (CMP) in 2013, he established culture as one of the strategic pillars of the administration. For the cultural department, he invited Paulo Cunha e Silva, one of the key figures from Porto 2001, the European Capital of Culture, thus establishing a connection with that initiative. After the early death of the councilor in 2015, Rui Moreira took over the cultural department and has remained in this position.

Having inherited a significant cultural infrastructure, due to Porto 2001, such as Casa da Música, the current municipal administration is based on two lines of work that merge into the same purpose: one that focus on strengthening cultural programming, decentralizing cultural offerings across the territory, and the other seeking to fill gaps in cultural infrastructure and programming, such as the rehabilitation of Cinema Batalha.

The conversion of Matadouro de Campanhã into a new cultural and business facility is part of the rehabilitation strategy for that parish, renewing the focus on cultural facilities and projects as anchors for the urban revitalization. Through an unparalleled model, the Municipality grants private entities the exploitation of 60% of the facility. Simultaneously, regarding the public dimension of the facility, it takes responsibility for developing educational, social, and cultural programs in the most depressed region of the city.

CODE 202

ECOSYSTEM SERVICES AND GREEN COVER FOR URBAN REGENERATION

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KEYWORDS: Ecosystem services; Urban renaturalization; Global warming; Urban heat island; Natured based solutions.

ABSTRACT

The upcoming increase in hazards belonging to climatic change, such as droughts and heat waves, is expected to be exacerbated in urban areas due to landscape disturbances, turning it into an Urban Heat Island (UHI). These anthropogenic changes are attributed to the increase of greenhouse gasses (GHG) concentration, surface sealing, and biodiversity loss, which are responsible at last resort of warming and pollution of the atmosphere that directly affect human well-being and health. The vulnerability of different urban areas in front of the UHI, or their potential to ameliorate the microclimate, depends on the present vegetation, either being spontaneous or by the implemented solutions, thanks to the Ecosystem Services (ES) in climate and hydrologic regulation. To assess the vulnerability in the presence of UHI it is important to know all variables in different urban typologies about a quantitative and qualitative values of the present vegetation that, simultaneously, contribute to draw an environment suitable or not for different vegetations species. Assuming thi as a growth factor and in addition of different vegetation phenotypes, it is intended to gather a comprehensive knowledge of all indicators that allow the elaboration of a methodology for urban zones categorization based on their vulnerability and, also, climate amelioration potential by possible Nature Based Solutions (NBS); and assess the climate regulation services potential of those NBS along the established vulnerable urban zones. Thus, a literature review has been carried out about indicators belonging to urban parameters and vegetation properties related, on the one hand, to the ES for climate and hydrologic regulation and, in the other hand, to their adaptation capacity, assessing both for an integral knowledge. Results show a concurrency of parameters related to surface and morphology of both construction materials and the present vegetation.

CODE 223

THE FUNCTIONALITY OF THE CONSTRUCTIONS, BEFORE AND AFTER. THE CASE OF RECYCLING HERITAGE BUILDINGS

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KEYWORDS: Integral evaluation; Traditional building; Design; Heritage architecture; Functionality.

ABSTRACT

This work continues the presentation held at Rehabend 2022, when the evaluation methodology proposed by the team at the Faculty of Architecture, Design and Urban Planning - Udelar was briefly described. The group researches on social housing built in a traditional way or with innovative technologies. It was proposed to transfer the theoretical framework applied in this evaluation to heritage architecture for residential use, guiding decision-making at the project level and its implementation.
Two case studies are presented and the proposal to visit the structural model of the pre-existing constructions to decide on the possible adaptations of the historical buildings, hand in hand with the study of the functionality of the typologies and the entire construction in the historical headquarter of the Ciudad Vieja of Montevideo.
In buildings in which their use is intended for a new destination, the greatest difficulty lies in achieving spaces that are habitable for all users; as well as the adaptation to habitability standards. The study includes the analysis of the functional conditions of the home and the common spaces with other families, including the interior and exterior spaces of the house, from the point of view of its organization; linkages; quality and comfort.

CODE 351

SUSTAINABLE STRATEGIES IN THE REGENERATION OF THE CLODOVEO JARAMILLO NEIGHBORHOOD IN THE CITY OF LOJA-ECUADOR

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KEYWORDS: Urban regeneration; Sustainable neighborhood; Quality of public green space; Indicators; SDG 11.

ABSTRACT

Urban regeneration can solve physical and socioeconomic problems in urban environments, through the planning of public green recreational areas, promoting the recovery of neighborhoods by offering environmental and human welfare benefits. Green areas in a neighborhood fulfill various functions such as social cohesion and recreation, therefore, it is necessary that they are of quality and ensure accessibility, inclusiveness and safety for users. The study focuses on the rehabilitation of the Clodoveo Jaramillo neighborhood in the city of Loja - Ecuador through strategies focused on the environmental, physical and connectivity treatment of the green space. The methodology starts with the identification of the urban problems of the neighborhood in relation to the natural and physical built conditions, the green space is classified, the endowment and permeability levels are measured through indicators and the quality of the spaces is evaluated under the dimensions: accessibility, environment, comfort and safety, use-user, equipment-furniture according to the UN-Habitat methodology of the year 2020. As a result of the analysis, flooding problems caused by the creek that delimits the neighborhood were identified, and gardens and parks were located that favor the design of urban strategies for the recovery of the sector. On the other hand, the neighborhood has a green area per inhabitant of 5.84 m2/inhabitant; a non-optimal value according to the World Health Organization (WHO). As for the quality of green spaces, these do not reach the maximum value of 5 points, with the highest scores for comfort and safety (3.08) and the lowest scores for equipment and furniture (1.79). With the strategies proposed, the levels of endowment, green quality, as well as accessibility, inclusion and safety increased from 45% to 80%, which in addition to improving the current conditions of the neighborhood contributes to goal 11: Sustainable Cities and Communities of the Sustainable Development Goals for 2030.

CODE 391

BROWNFIELD SITE TRANSFORMATION - A CASE STUDY OF 'TOZ PENKALA' FACTORY IN ZAGREB

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KEYWORDS: Urban Area; Land Use Planning; Brownfield; Abandoned Factory; Transformation.

ABSTRACT

Neglected and abandoned brownfield sites in urban areas negatively affect the community's social, economic, and environmental development. They can be transformed into viable options. By transforming unused industrial locations, project teams design new mixed-use districts with housing, retail, office space, and community gardens to fulfil present and future needs. For this reason, the present research explores the concept of the transformation of abandoned manufacturing plants and warehouses and the impact of the new project on the surrounding environment. The paper presents an example of a brownfield transformation scheme that is waiting to be realized on the former pencil factory complex, in the Kustošija district, in the western part of the city of Zagreb. Special attention is given to the history of the well-known former pencil factory 'TOZ Penkala' (Tvornica olovaka Zagreb Penkala) closed in 2015. The research data collection methods include interviews, observations, reviews of existing records, documentation, and SWOT analysis. The paper's objectives are to explore existing site opportunities, address the potential and constraints of the site, and evaluate the potential of the proposed brownfield development. The paper concludes with a look at the future of existing factory buildings in the Zagreb urban area. The brownfield transformation project of the former pencil factory site has experienced many challenges. It faces technical, regulatory, and financial challenges that might result in the site remaining neglected, and unused for many years to come.

CODE 200

COMMUNITY INVOLVEMENT AS A DRIVER OF INCLUSIVE CULTURAL MAPPING AND SUSTAINABLE MANAGEMENT OF THE HISTORIC URBAN LANDSCAPE OF VALE DE MASSARELOS (PORTO, PORTUGAL)

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KEYWORDS: Historic Urban Landscape; Participation; Co-creation; Cultural Mapping; GIS.

ABSTRACT

Community participation and interdisciplinary co-creation represent best practices in inclusive urban management, going beyond top-down approaches and favouring bottom-up strategies that promote sustainable and integrated development. This article discusses the results of participatory strategies involving different groups of people applied in a pilot area in Porto (Portugal), the Vale de Massarelos. The methodology presented in this article is based on a critical analysis of the results obtained through field observation, work by architecture students and various participatory techniques, such as interviews, surveys, blackboards, collaborative murals, perception maps and social network analysis.
These strategies made it possible to identify the most relevant attributes and values of the Historic Urban Landscape of Vale de Massarelos. Based on the analysis of the results, the paper categorises the dimensions of the Historic Urban Landscape in the study area and map them georeferenced using GIS software.
In this way, mapping the attributes and values will contribute to the management the Historic Urban Landscape of the Vale de Massarelos and serve as a methodological basis for application elsewhere.
Finally, the discussion of the proposed analysis will make it possible to identify the strengths and weaknesses of the strategies used and provide guidelines for cultural heritage mapping and inclusive urban management through community participation.

CODE 232

HERITAGE BUILDINGS RECYCLED FOR MUTUAL AID OR PRIOR SAVINGS HOUSING COOPERATIVES IN CIUDAD VIEJA

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KEYWORDS: Heritage; housing cooperatives; recycling; timber.

ABSTRACT

In the 90s, the Municipality of Montevideo carried out pilot experiences of rehabilitation and recycling of deteriorated buildings in slum areas of the Old City, destined for the production of housing under the cooperative system - through mutual aid or prior savings - to reverse the emptying and systematic loss of population of the historic center. The action attempts to demonstrate that it is possible to work with a group of organized neighbors who take on the challenge of building their habitat, advised by a Technical Assistance Institute.
The Mutual Aid Housing Cooperative, COVICIVI II, recycles 11 homes, restores the façade and builds 8 new homes with the contribution of labor from the recipients in the old Lecocq House (1790), maintaining an original volume with mezzanines of palm trunks, stone walls and paneled bricks as a neighborhood cultural center.
In 2004, the Municipality decided to recover the Jaureguiberry building (1911), an urban landmark, located in front of the Port Market, which was occupied and in danger of collapsing. Grants custody of the property to the "El Resorte" Previous Savings Housing Cooperative. The recycling of 16 homes is carried out by a construction company. The construction system responds to the dominant technology in the period 1880-1920, consisting of load-bearing masonry walls, vaulted mezzanines supported by steel profiles and a French-style mansard with a wooden structure and metal tiles. Both properties are listed as Grade 3 in the Inventory of the architectural and urban heritage of Ciudad Vieja, COVICIVI II is also a Historical Monument.
This work shows the guidelines given from the public sphere for recycling, rehabilitation and new construction in heritage buildings, the challenges faced by mutual aid cooperatives and Technical Assistance Institutes when working on very deteriorated properties, in addition to the methodology applied in the diagnosis of wooden structures with non-destructive techniques for their reuse and commissioning.

CODE 27

A COMPREHENSIVE APPROACH TO THE PERFORMANCE-BASED DESIGN OF FAÇADE SOLUTIONS AGAINST RAINWATER PENETRATION

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KEYWORDS: Wind-driven rain; Building façades; Rainwater penetration; Performance-based design; Return period.

ABSTRACT

Rainwater penetration into building façades causes several issues, including material and structural weakening, reduction of energy efficiency and negative health effects on occupants. Currently, the watertightness performance of building envelopes is characterised by means of standardised tests, which recreate water supplies and pressure differences that do not represent the exposure combinations that can occur at each particular façade location and configuration. As a result, the choice of the suitable façade system for each specific situation has a qualitative and imprecise nature, leading to poorly optimised designs. This work enhances a method for the performance-based design of building façades against rainwater penetration anywhere (BPB method). This method determines the recurrence with which will occur, for each façade to be designed, climatic exposures equivalent to those surpassed by the façade system in any watertightness test. This recurrence, characterised as a return period, defines the façade performance at its final operating conditions and depends on the exposure surpassed during the test (the greater its magnitude and duration, the greater the severity and associate return period), on the site climatic conditions, and on the specific façade configuration (height and surroundings). In this study, a comprehensive and functional implementation of this approach is proposed by correcting some methodological deficiencies, which allows to enhance the method reliability as well as reduce calculation effort and reliance on exhaustive weather data. The universal and quantitative nature of this design verification procedure is illustrated with examples of different building façades in two Spanish cities (Pontevedra and Málaga), within the framework of the HUEFAES research project (PID2021-122203OB-I00).

CODE 28

WEST GALLERY STABILITY OF THE PALACE OF THE DUKES OF THE INFANTADO

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KEYWORDS: Palace of the Infantado; Stability; Linking; Alumina cement.

ABSTRACT

The Palace of the Dukes of the Infantado at Guadalajara was built at the request of the second Duke at the end of the 15th century. It is an Elizabethan Gothic building that has been so modified since it was erected. Perhaps the most important interventions were those carried out by the architect D. José Manuel González Valcárcel in the second half of the 20th century. These interventions were carried out to repair the building that was then seriously damaged after a bombing and the subsequent fire at the beginning of the Spanish Civil War.
Within the palace, one of the most unique architectural bodies is the Poniente Gallery. This gallery is formed by an arcade of two levels of arches, open towards a garden of the palace. At the moment the arches develop numerous damages by degradation of the stone and by the tilt of the pilasters.
In the study of the stability of the Gallery, it was observed that the equilibrium was conditioned by the need for the slabs frameworks that supported the two levels of the arches were able to fasten the arcade. When entering to analyse the configuration of that framework in the link with the arcade, the presence of joist made with alumina cement was identified. That kind of concrete joist were relatively usually used at the time of the rehabilitation of that area. We also found remains of different ancient tie-rods embedded in the slabs, since from its construction it was necessary to materialize effective linking mechanisms.

CODE 39

PATHOLOGICAL LESIONS RECURRENCE ANALYSIS IN MEDELLIN CITY´S METRO STATIONS´ PEDESTRIAN BRIDGES´ ACCESS

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KEYWORDS: Building pathology; Recurrence of injuries; Metro transport system; Medellín.

ABSTRACT

The growth of the Medellin Metro transportation system over the last years is evident, with the main objective of mobilizing the majority of citizens, the investment in physical infrastructure for the construction of access stairs, platforms, stations, pedestrian bridges among others is vital for the proper functioning of the system, but it is not the only thing. In the case of pedestrian bridges, the high flow of people, their geospatial location, the impact of weather factors and environmental pollution, lack of preventive and corrective maintenance and construction errors generate damages in their structure that can affect their durability over time. Due to these factors, this article presents the study of the most recurrent pathological lesions in the pedestrian bridges accessing the stations of the Medellin Metro system (Antioquia - Colombia) on line A, north-south direction. According to the methodological strategy applied, it was possible to perform ocular inspections to the pedestrian bridges of the 15 stations, the photographic record of the deteriorations found and the systematic analysis of the results; this allowed a correct classification, quantification and correlation of injuries in each of the structures evaluated with their causes of origin seeking to establish intervention processes both corrective and preventive applicable by those responsible for the maintenance of the transport system.

CODE 44

PATHOLOGICAL MANIFESTATIONS IN BUILDINGS LOCATED ON THE VALENCIAN COAST AFFECTED BY SEVERE CORROSION

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KEYWORDS: Pathology; Durability; Apartment Buildings; Costa Valenciana; Building System.

ABSTRACT

This article presents the pathological manifestations of second-home buildings located on the Valencian coast, exposed for a long period of time to the marine environment, less than 150 meters from the sea line. The opportunity of this work is based on the specific characteristics of this area due to the building typology and the level of growth of the same that has caused the appearance of a high percentage of these buildings that show levels of pathology in all the structural elements, both reinforced and prestressed concrete. The most influential factors in the pathological manifestations of the structures of second-home buildings on the Valencian Coast are analyzed from the point of view of construction systems. The effect of the marine environment is included, taking into account climatic factors and exposure of the buildings studied. Parameters of a social type such as: the massive construction of this type of building, common typological forms of the time and some constructive deficiencies are taken into account.

CODE 45

DYNAMIC IDENTIFICATION OF A RETROFITTED INSTITUTIONAL BRICK MASONRY BUILDING

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KEYWORDS: Brick masonry; Seismic retrofitting; Ambient vibration; System identification; N4SID.

ABSTRACT

Dynamic characteristics of an institutional brick masonry building constructed during the 1970s and retrofitted after the 2015 Gorkha earthquake are reported in this paper. The building had sustained considerable damage due to the earthquake. The building is a brick masonry construction with prefabricated reinforced concrete (RC) beams comprising half brick thick piers and prefabricated slab panels. Ambient vibration testing in operational state after the completion of the retrofitting works in 2019. Using a triaxial accelerometer, vibration records were taken on the top floor for an hour. Considering the two translational components of the time series, modal frequencies and damping ratios are estimated using the Numerical algorithms for subspace state space system identification (N4SID). Results show that the fundamental vibration frequency along the short wall direction is 2.19 Hz and that along the long wall direction is 3.48 Hz, which indicates the dominance of governing vibration by the short wall direction. Similarly, the first mode damping ratio for the building is determined as 5.41%. The dynamically identified vibration frequencies are also compared with the codal recommendations.

CODE 48

CAPILLARY RISE OF SOLUBLE SALTS AND ITS EFFECT ON THE DEGRADATION OF CALCAREOUS MATERIAL USED IN HISTORICAL MONUMENTS

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KEYWORDS: Hygroscopic condensation; Crypto-florescence; Efflorescence; Built heritage.

ABSTRACT

The crystallization of soluble salts is one of the main deterioration mechanisms of the porous building materials of cultural heritage with significant economic implications. The sources of these salts can be geogenic (soil wastewater, sea salt spray, interactions due to incompatibilities of different materials in historical constructions, etc.), or anthropogenic (environmental pollution, organic waste, etc.). The present study focuses on the capillary rise of retained and sustained water in the soil, which is subsequently absorbed by the calcareous rocks of the monuments, causing damage from simple stains and efflorescence to mass losses associated with material disintegration processes. The paper addresses the study of capillary rise and analyzes the typology and origin of the salts that most affect the durability and mechanical resistance of the calcareous rocks used as construction material of historic buildings in Spain.

CODE 66

WALL COATINGS AS A DETERMINING FACTOR FOR MOISTURE MANAGEMENT AND INHIBITION OF MICROBIAL DEVELOPMENT

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KEYWORDS: Wall; Covering; Saltpeter; Moisture.

ABSTRACT

Wall coverings are part of the construction system and as such, they must be understood; for this reason, knowing its characteristics and functions is essential for its design in each type of climate and type of building.
The useful life of the constructions depends to a large extent on the conservation of the coated surfaces, however, little attention is paid to the damages triggered by the binding materials used for this purpose. So, the main objective of this research was to determine how a pair of coatings can have substantial differences in relation to moisture management and microbial development; considering both processes as determinants for the physical-chemical deterioration of the space, the decrease in indoor air quality and consequently, the -eventual- appearance of respiratory diseases in the occupants.
Derived from a sequence of basic experiments, in which the capacity to manage water in sections of conventional-coated wall was monitored and quantified, in addition to an analysis carried out by an accredited laboratory, which consisted of the inoculation of coatings with colonies of aerobic bacteria and molds, it was possible to identify how it is that the walls have a peculiar behavior. Starting -simply- from one variable: the type of cementing material.
The results made it possible to analyze the vulnerability of the walls to the insipient performance of industrialized materials such as cement mortar, while at the same time making evident the efficiency of materials of natural origin, such as hydrated lime.
The conclusion reached was that, regardless of the requirements of each architectural project, it is essential that the coating of the surfaces be adequate to control the effects of the environmental factors prevailing in each region, because temperature and relative humidity will be conditions that, if not properly integrated into the interior of the rooms, can cause serious effects on the structure and, consequently, on the well-being of human beings.

CODE 76

STRATEGIES AIMED AT THE PROTECTION OF TIMBER STRUCTURES AFFECTED BY SUBTERRANEAN TERMITES IN HISTORICAL CENTERS

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KEYWORDS: Historical centers; Timber structures; Subterranean termites; Wood protection.

ABSTRACT

There is no doubt that the main biotic agents that affect cellulose-containing materials in general, and timber structures in particular, are rot fungi and subterranean termites. Indeed, currently, all of the historic centers of the Iberian Peninsula suffer or are susceptible to being affected by some type of degradation associated with these two xylophagous organisms. For this reason, there are already special action plans against subterranean termites in towns such as Azkoitia, Hondarribia, Santurce, Vigo, etc.
On the other hand, for an attack of this type to occur, in both cases it is necessary for the wood to have moisture contents greater than 20%. However, the fact that the termite colonies may be located several tens of meters from the building structure, that termites (with the exception of swarmers) are lucifugal and, therefore, difficult to detect for the human eye, and above all, damages are only perceptible when their magnitude and extension reach important dimensions, survey of timber constructions, located in places where they may be affected by the humidity, require a careful prior inspection.
Furthermore, in those cases in which the visual inspection finds signs of damage by termites, the corresponding refurbishment project should contemplate some basic measures aimed at avoiding the reactivation of the attacks.
The paper presents, first of all, the particular and complex way of living of termites, paying special attention to the symptoms of degradation that are most commonly detected in historic buildings; and then, some of the protective measures that are usually included in rehabilitation projects, developed by specialized professionals, to prevent these social insects from affecting the timber structures.

CODE 107

RESTORATION OF THE FAÇADE OF THE TOBACCO FACTORY IN SEVILLE (SPAIN). STUDY OF ORIGINAL MATERIALS AND DECORATIVE ELEMENTS

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KEYWORDS: Limestone rock; Sulphation; Polychromy; Bronze.

ABSTRACT

The Tobacco Factory of Seville, the current headquarters of the Rectorate of the University of Seville, dates from the 18th century, and its façade is an element of great artistic value in the grandiose building, one of the largest industrial constructions of its time, dated 1757 on a plaque under the tympanum. The façade is the work of Sebastián Van der Borcht, with sculptural elements by Cayetano de Acosta. The materials studied were the different types of stone, the pictorial layer and the metallic materials of the ornamental elements of the Allegory of Glory, the statue that crowns the façade and is the institutional emblem of the United States. Physical property tests and instrumental techniques (mineralogical, chemical, petrographic analysis, etc.) were used to characterise the original materials and pathologies. The results obtained have been fundamental in the development and decision-making for the restoration work to be carried out in 2022.

CODE 119

THE CURRENT STATE OF THE RESEARCH ON BUILDING FAÇADE DURABILITY UNDER THE EFFECTS OF CLIMATE CHANGE

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KEYWORDS: Climate change; Building durability; Building pathology; Facade materials; Extreme weather conditions.

ABSTRACT

Climate change refers to the long-term alteration of the Earth's climate system, typically characterized by changes in global temperature, precipitation patterns, sea levels, and weather events. This changing climate is expected to have a significant impact on the built environment, particularly on the durability of buildings. The question of how the performance of buildings will be within these changing environmental conditions in the future arises in relation. This subject is a complex issue that requires consideration of various building materials, elements and systems, and climate components that are expected to change in a particular region. Accordingly, there have been numerous studies on building durability under the effects of climate change, covering these fields. In these respects, this study aims to provide an overview of the current state of research on building durability under the effects of climate change. The methodology of the study is based on a systematic literature review through two widely used databases (Scopus and Web of Science). In the paper, a brief theoretical background has been provided for climate change and then, the method of the study has been explained in detail. The data obtained from the literature has then been analyzed and discussed concerning the building sub-systems, materials investigated, and the expected change in their performance, climate components, climate projection models, and regions considered. According to the the results of the analysis, the building elements system has been the most commonly studied building sub-system, in comparison to structural and services system, while the façade has been the most studied component under the building elements system. Among the facade materials investigated (concrete, brick, stone, metal, GRSW, waterproofing membranes, porous materials, and retro-reflective materials), wood has been the most frequently studied. Most importantly, it is estimated in the studies that, in regions where temperature and precipitation are expected to increase, the service life of components made of wood will reduce due to decay and mold, and in the case of components made of concrete, brick, stone, and porous materials due to corrosion, carbonation, and salt crystallization.

CODE 145

BIODETERIORATION BY MICROORGANISMS IN THE REAL FORTE PRÍNCIPE DA BEIRA - RONDÔNIA, BRAZIL

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KEYWORDS: Biodeterioration; Microorganisms; Heritage; Fortification; Stone masonry.

ABSTRACT

The Royal Fort Príncipe da Beira, a fortress built on the banks of the Guaporé River on the border between Brazil and Bolivia, located in the municipality of Costa Marques in the Brazilian state of Rondônia, was built in the 18th century by the Portuguese crown to protect and guarantee possession of its territory. Considered to be the largest Portuguese military building erected outside Europe, with a floor area of 24,553m2, it expresses the quality of its design and layout. Belonging to the Patrimony of the Union (Federative Republic of Brazil), this monumental complex, built mostly of stone masonry, solidified with lime, clay and sand mortar, was listed by the National Historical and Artistic Heritage Institute (IPHAN) in 1950 and, currently under the responsibility of the Brazilian Army, is in disuse, with its buildings in a process of ruin. There are several pathologies affecting the monument, mainly: loss of constructive elements, cracks and fissures, water infiltration, loss of cladding and biodeterioration, the subject of this study.
The aim of this paper is to present the results obtained in characterizing the microbiota associated with the biodeterioration process, pointing out the main genera of microorganisms present in the masonry of the fort. The methodology used comprised the following steps: visual diagnosis, environmental monitoring (temperature and humidity), collection and conventional microbiological analysis of four samples of visible surface biofilm. As a result, fungi and cyanobacteria were identified, possibly associated with environmental factors such as temperature, salinity, humidity, and luminosity, which may be responsible for the accentuated biodeterioration process, posing a threat to its materials and structure if the necessary controls are not put in place.
The importance of this work is emphasized, not only for the indication of an effective method for controlling the infestation, to be used in the future restoration of the monument, but also for the preservation of the national built heritage and for the development of Conservation and Restoration Science.

CODE 167

AUTOMATED DETECTION OF BUILDING ENVELOPE DEFECTS - A SYSTEMATIC REVIEW

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KEYWORDS: Defect detection; Machine learning; Building envelope; Building facade.

ABSTRACT

Building envelope serves to protect users and structures, and supply insulation, among other purposes, such as giving an identity to a building. However, due to adverse environmental conditions and physical factors, various deteriorations may occur in the components and materials constituting it. In order for the buildings to have a long service life, it is important to detect the deterioration in the materials and to plan the necessary maintenance and repair. There are various human-based inspection methods, both simple and advanced, for defect detection in a building. However, defect detection through human-based inspection needs expert knowledge in most cases and otherwise might be inaccurate. Additionally, it is usually time-consuming and poses a safety threat in the case of the facades of high-rise buildings. For these reasons, automated defect detection methods are developing to facilitate the process and to improve both the time needed and the objectiveness of the inspection results. Thus, there has been an increasing interest in machine learning-assisted automated detection methods in recent years, mostly concerning image/visual-based methods in addition to other advanced methods.
In this study, to put forth the current state of automated defect detection regarding the inspection of the building envelope and to examine the role of machine learning in this process, a systematic literature review was conducted using data from the Scopus database. In the paper, following a brief background on machine learning and the explanation of the review method, research studies were analyzed and discussed considering the material and defect types studied, accuracies achieved for the defects, and some factors affecting accuracy. Regarding the crack, as the most commonly considered defect type in these studies, the accuracy rate of the model was seen to be higher (i.e. 94-98%) when it was inspected as the sole defect rather than as a defect among other defects. However, when more than two defect types were considered together, the accuracy was seen to be ranging between 40-70%.

CODE 217

ATILIO PAIVA OLIVERA FOOTBALL STADIUM CONSERVATION ASSESSTMENT, RIVERA-URUGUAY

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KEYWORDS: Reinforced concrete; Structural performance; Injuries; Diagnosis.

ABSTRACT

The Atilio Paiva Olivera football stadium is located in the Uruguayan city of Rivera, in the north of the country, on the border with Brazil. The first grandstand dates from 1966 and the remaining three were built between 1994 and 1995. This important intervention allowed the city to become one of the venues for the Copa América held in Uruguay in 1995.
The sports arena is made up of four concrete grandstands and a set of services built in ceramic masonry located under them. At present the old grandstand is painted and the others maintain the exposed concrete without any protection. The stadium has not had frequent use and since the inauguration of the expansion there have been no maintenance tasks.
In 2022, the owner of the property, the Departmental Administration of Rivera (IR), concerned about the finding of injuries, such as humidity due to seepage, fissures and corrosion of steel, agreed with the Faculty of Architecture, Design and Urbanism (FADU) of the University of the Republic the realization of a technical report with the objective of evaluating the state of conservation of the same, attending mainly to its structural performance.
In order to carry out a diagnosis of the situation, FADU formed a team made up of teachers from different specialties and implemented a work methodology for the characterization and performance evaluation of the different reinforced concrete components that make up the structure of the stadium. Among the activities carried out, the collection of background information, execution of tests and experimental techniques in situ and in the laboratory, identification and registration of injuries and structural modeling of some sectors stand out.
It is considered that the study carried out provided the necessary inputs from which the Municipality will be able to define the necessary actions to enable the use of the stadium in safe conditions while prolonging its useful life. This article presents the applied methodology, the main results obtained and the conclusions reached.

CODE 259

A METHOD PROPOSAL FOR SURVEYING THE CONSTRUCTION TECHNIQUES OF TRADITIONAL HOUSES

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KEYWORDS: Building surveying; Traditional construction technique; Traditional house; Hımış.

ABSTRACT

Traditional houses have been built in line with opportunities and limits of easily available materials and developed against earthquakes, floods, fires, and the corrosive effects of external factors. In traditional houses located in Turkey, most of which were constructed during the late-Ottoman period, various typologies specific to different regions were formed.
Traditional construction techniques are one of the most important character-defining features of them, and knowledge about these techniques is essential to their protection and sustainability. While this knowledge has about to be forgotten with the widespread use of modern building materials, even in rural settlements of Turkey, the most reliable source for this information is the buildings themselves. However, in both academic research and conservation practices, they are recorded only by documenting general architectural features without gathering adequate information about construction techniques.
In all works on different scales, knowledge of traditional construction technology should be collected systematically using a common language. Only in this way can all the research and practices feed each other, and this experience is guaranteed not to be lost.
For this aim, an economically sustainable method has been developed to survey construction techniques used in traditional houses. This method includes recording the construction details from the foundation to the upper structure, in accordance with the construction process, at every point where the system section changes, using a simple code system. In addition, a general assessment, including common structural problems and authentic construction errors, is part of this method. This data is enhanced through interviews with local users and builders, if feasible, to determine the quarries and sources of building materials, and acquire knowledge of construction tools and local construction terminology.
By storing this type of information, gathered from various regions with a common language, building up a national-scale geospatial database is suggested. In this paper, the practice of the aforementioned method on traditional Ottoman hımış houses, which is the most common construction type used in the traditional housing stock in Turkey, is presented.

CODE 303

DIAGNOSIS AND INTERVENTION PROPOSAL FOR A STRUCTURAL ISSUE IN MERCADO DE SAN MIGUEL

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KEYWORDS: Heritage; Durability; Cast iron supports.

ABSTRACT

The San Miguel market, declared a BIC (Asset of Cultural Interest), is one of the latest examples of Madrid's so-called iron architecture, characterised using steel trusses that, as in the market, are normally supported by cast iron supports. This architecture developed mainly throughout the XIX century, although it was occasionally used in utilitarian structures such as the one under study in the first quarter of the XX century.

Throughout its more than one hundred years of life, different actions have been carried out on the building, both architectural and structural. In fact, in the intervention carried out at the end of the last century, some structural consolidation actions were made, as some problems of foundation and others of durability in the steel structure had been identified. Similar problems continued to be detected in recent years, although the appearance of some cracks in the cast iron supports of the facade caught the attention of the property.

Through the detailed study of the structure, an initial design problem was identified, which could have been masked over the years by other more striking pathologies (durability problems and foundation movements), without definitive corrective measures being adopted in due time.

This article presents both the diagnosis made and the determining factors that exist for temporary suspension of the building's roof and consolidation. In addition to this factors proper of a building with comprehensive protection, there are also those inherent to a property of special tourist interest for the city of Madrid, as it is a market open every day of the year and with a large number of visitors.

CODE 4

POST-EARTHQUAKE SYSTEM IDENTIFICATION OF A STRENGTHENED COMPOSITE BRICK MASONRY MUSEUM

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KEYWORDS: Heritage structure; Composite masonry; Seismic strengthening; System identification; N4SID.

ABSTRACT

The 2015 Gorkha earthquake in Nepal caused severe damage to heritage and monumental constructions. Among the affected masonry buildings, quite a few were strengthened or renovated. On the other hand, most of the heritage and monumental constructions were in the 'as constructed' state. The lack of periodic maintenance and strengthening was one of the most convincing causes of damage to heritage and monumental buildings. To characterize a strengthened composite brick masonry heritage building, we performed ambient vibration measurements of the Patan Museum located in the Patan Durbar Square world heritage site, Lalitpur, Nepal. The museum building is a brick masonry construction with wooden posts. The building was strengthened before the Gorkha earthquake using steel members to provide additional stiffness and integrity to the wooden components. Using three triaxial accelerometers, vibration records were taken for an hour on each story. Using operational modal analysis, modal frequencies and damping ratios are estimated. We used numerical algorithm for subspace state space system identification (N4SID) to estimate the dynamic characteristics of the complex three-story composite brick masonry building with a courtyard. Results of dynamic identification highlight that the fundamental vibration frequency along the short wall is 3.6 Hz and along the long wall direction is 4.9 Hz. The governing vibration is thus marked along the short wall direction with reference to the entrance. Similarly, first mode damping ratios along the short and long walls are respectively obtained as 6.6% and 7.1%. It is worth noting that the protection of heritage buildings is challenging, especially in high seismic regions. Periodic record taking and operational modal analysis could be insightful to assess the health of complex heritage buildings. The results of this study could provide an important benchmark for future comparison and finite element model calibration/updating.

CODE 60

RECOGNIZING OF TIMBER IN OLD BUILDINGS: DENSITY ESTIMATION BY PENETRATION RESISTANCE TESTING

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KEYWORDS: Timber; Assessment; Density; Penetration Resistance; Properties Correlation.

ABSTRACT

In interventions of old buildings for conservation or rehabilitation, there is a high probability of encountering timber elements in the building system. The species, strength and stiffness of these elements are generally unknown, which makes it difficult to perform safety assessment calculations. This task is made even more difficult by the huge variability of timber properties.
The work presented in this text aimed to find ways to recognize the density of wood elements in service, using non-destructive penetration resistance tests. These tests are an effective way of estimating wood properties since it is not necessary to destroy the elements and their easy handling and execution allows them to be carried out quickly and effectively in situ. The knowledge of the physical-mechanical properties of wood is one of the most reliable bases for the structural evaluation of the element.
The text presents the laboratory work carried out with the aim of estimating the density of wood elements in service. In the laboratory campaign, penetration resistance tests were performed on Pinus sylvestris wood elements collected from old buildings in the Lisbon region. Good correlations were found between penetration resistance tests and density, with coefficients of determination (R2) between 0.71 and 0.74. Subsequently, a campaign of penetration resistance and core extraction tests was carried out on timber elements in service in four Lisbon buildings dating from the 18th to the early 20th century. The density of the cores (real data) was correlated with the density estimated from the penetration resistance readings based on the laboratory conclusions (indirect data), resulting in a good correlation, R2 = 0.77. It is concluded and confirmed by the experimental results obtained that the penetration resistance test is a very reliable and practical means of estimating the density of wood in service.
This work is part of the research activity carried out at Civil Engineering Research and Innovation for Sustainability (CERIS) and has been funded by Fundação para a Ciência e a Tecnologia (FCT) in the framework of project UIDB/04625/2020.

CODE 70

ANALYSIS AND ACHIEVEMENT OF THE STRUCTURAL CLASSIFICATION AND QUALITY PARAMETERS OF MOBILA (SOUTHERN YELLOW PINE) FROM ULTRASOUND TESTS CARRIED OUT ON EXISTING BUILDINGS

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KEYWORDS: Old wood structures; TND non-destructive techniques; Old wood structural classification; Southern yellow pine; Rehabilitation.

ABSTRACT

Wood for structural use is very present in old constructions and buildings of a historical and heritage nature. The presence of structural wood when undertaking rehabilitation represents a handicap, since there are no technical specifications for these elements. Through TND non-destructive techniques, the structural classification of said elements can be determined in order to adapt them to current regulations and their scope of use after their rehabilitation.

The present work focuses on the wood commonly known in the Valencian Community as “Mobila” wood, this species of wood corresponds to the southern yellow pine (Pinus palustris, Pinus taeda, Pinus echinata and Pinus elliottii) from America between the years 1880 and 1930. This species was widely used because it presented very high physical and mechanical performance, such as greater density and resistance, less presence of knots and defects inherent to the wood, greater length, etc. Through this work, the values obtained by emission and reception of ultrasound performed on elements of this species in real analysis cases are analyzed. Specifically, the values obtained in more than 50 real works are studied in which ultrasound emission/reception tests have been carried out on more than 300 elements of different square and length during the period 2021-2023.

The methodology includes the analysis of the possible influence of various variables, both the non-destructive measurement technique itself and the wood (density, squareness, location, year of construction), so that a structural classification scheme can be developed. which groups the different elements studied into classes based on the variables extracted from each of them. in order to know if different parameters give rise to different resistant classes.

The statistical analysis shows that mobila wood presents a high degree of homogeneity both at the element level and at the level of distribution and location, allowing a resistant class to be established for this type of wood.

Finally, a set of conclusions has been formulated that specify the correlation between the variables analyzed and the structural classification obtained by the species.

CODE 89

DYNAMIC PROPERTIES OF A 1950 BUILDING BASED ON ORIGINAL DESIGN PROCEDURES AND MODERN TECHNIQUES

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KEYWORDS: Existing buildings; Structural assessment; Dynamic properties estimation; Ambiental vibration testing.

ABSTRACT

The structural assessment of a 15-storey building built in 1950 in Mexico City is currently in progress. Historical research on the building revealed a publication describing the equivalent lateral load assessment methodology used during the structure's design process. The methodology, which includes the calculation of maximum probable actions and natural vibration periods, is recognised as advanced for its time. Since the estimation of the dynamic properties of structures in seismic zones is a fundamental aspect for any structural assessment, the aim of this paper is to present a comparison between the determination of the building's natural vibration periods by means of classical techniques used during the structure's design process and two modern techniques: ambiental vibration testing and numerical modelling. The comparative study allows to show the evolution of structural dynamic analysis development over the last 70 years. A discussion on the hypotheses assumed during the structure's design process and its differences with those accepted in the practice of structural engineering today is carried out. Numerical modelling is used for reproducing both the ambiental vibration tests and the design results. As a result of the comparison, it has been proved that classical techniques give acceptable results when the hypotheses on which they are based are fulfilled. Nevertheless, important differences between the design and the more recent results have been identified.

CODE 97

PRELIMINARY STUDY OF MODELIZATION OF THE DEGRADATION IN STRUCTURAL TIMBER BY HYLOTRUPES BAJULUS L. USING NON-DESTRUCTIVE TECHNIQUES

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KEYWORDS: Non-destructive techniques; Hylotrupes bajulus; Timber degradation; Ultrasonics; Stress waves.

ABSTRACT

Among the applications of non-destructive techniques applied to timber in historical heritage buildings, it is common to use them to assess the current pathological condition of the wood. However, early-stage degradation in structural wood is difficult to diagnose, which hinders efforts to prevent further damage. One of the most common pathologies in wood used in Spain is infestation by larval-cycle xylophages of the species *Hylotrupes bajulus* L. (large woodworm). This preliminary study aims to identify and quantify the degradation caused by this species in its initial stages. Several samples of pine wood (*Pinus nigra* Arnold) measuring 200 x 80 x 500 mm3, chosen due to its common use in construction, were exposed to woodworm larvae and kept under optimal conditions to facilitate their development and growth on the wood. By conducting successive measurements over a period of over two years using non-destructive wave transmission devices with ultrasound sensors, degradation trends were observed in some of the test specimens. The studied pieces exhibited uneven evolution over time, which could be attributed to variations in larval survival during the initial stages among the samples, as well as differences in the proportion of sapwood and heartwood, with the heartwood being resistant to attack by this species.

CODE 99

DRONIX: AUTOMATED INSPECTION OF INFRASTRUCTURES USING DRONES

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KEYWORDS: Inspección; Infraestructuras; Dron; Digitalización.

ABSTRACT

This project, based on the use of robotic technology, has allowed inspections to be carried out on large civil, energy and industrial infrastructures to obtain updated data on their status and thus improve decision-making for maintenance processes.
The DRONIX project has three main objectives. Firstly, it seeks the development of technology that allows expanding the operational capacity of drones to collect data from inspections. In addition, it is advancing in the creation of processes and algorithms to digitize the information collected and automate its processing. Finally, it launches an intelligent management platform to improve decision-making in the inspection and maintenance processes of the monitored structures.
DRONIX allows you to increase the frequency of inspections and maintenance work, reducing the associated costs and risks. Furthermore, the digitalization and automation of these processes improve productivity significantly, thus having a positive impact on the competitiveness of the industry.

CODE 100

EVALUATION AND MANAGEMENT OF EXISTING INFRASTRUCTURES FROM A DECISION-MAKING PERSPECTIVE

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KEYWORDS: GENIA; Inspection; Evaluation; MIVES; Digitalization.

ABSTRACT

There is a national and international need to make structural inspections in a more efficient, affordable and homogeneous way by the companies that carry them out and also provide them with a global vision, regarding the network or park in which they are located. A good maintenance program is necessary, which supports decisions with adequate and optimized criteria, and increases the useful life of the structures.
An innovative method is therefore introduced to evaluate the condition of different types of infrastructure based on inspections using different digital and technological tools that are increasingly present in society but that are not connected with the digital and functional operational flow that allows companies, managers, not only visualize the results of the inspections, but we cannot evaluate them objectively and consistently and also allow them to collect the necessary information to be able to make decisions that optimize the budgets available for conservation and maintenance tasks.

CODE 147

FAILURES IN THE CONCEPTION, DESIGN AND EXECUTION OF REINFORCED CONCRETE STRUCTURES; CASE STUDY

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KEYWORDS: Reinforced concrete; Structural anomalies; Structural diagnosis; Non-destructive testing; Safety analysis.

ABSTRACT

In recent years, Europe has seen the publication of an extensive and diverse set of standards for design, materials, execution, observation and safety control. Innovative construction technologies have been developed, new products have been created and many powerful design tools are now available. However, it is still possible to witness serious infringements at different stages of the construction process, committed by different players.
This article presents a case of a reinforced concrete building in which serious structural anomalies were identified at the beginning of the finishing phase. The work, carried out by the Construction Studies Centre of the School of Engineering - Polytechnic of Porto, with the aim of identifying the causes of the structure's behaviour and advising possible repair or reinforcement solutions, involved several stages. The main aspects of the visual inspection carried out are presented, as well as the geometric survey and verification of dimensional conformity. The structural diagnostic tests carried out and their main results are described. The reinforced concrete project is analysed and compared with the results of the numerical modelling of the structure, also carried out as part of this study, concluding with the need to reinforce the structure, with the consequent inevitable invasion of the available interior space and the final decision of the Owner of the Building.

CODE 155

DETERIORATION AND STRUCTURAL FAILURE OF THE LAMINATED WOOD ROOF OF A HEATED SWIMMING POOL

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KEYWORDS: Structural Failure; Laminated Wood; Rot, Corrosion; Heated Swimming Pool.

ABSTRACT

The swimming pool in Corrales de Buelna (Cantabria) was demolish in March 2017 due to the loss of mechanical performance of the laminated wood structure caused by deterioration from white rot in the wood and corrosion of the metal connecting elements. The structure had a barrel vault shape with five large three-hinged arches closed on the sides by sloping facades formed by main beams and purlins.
The diagnostic process involved data collection and structural evaluation through an evaluation of load-bearing capacity and serviceability. Data collection took place in December 2015 and included a thermal camera inspection to identify moisture accumulation points, opening of test holes, measurements of wood and environmental hygrothermal conditions, and measurement of cross-sectional losses and deformations of structural elements. Load-bearing capacity assessment was evaluated using matrix structural analysis software, both for the original and deteriorated structure.
The conclusions of the diagnosis indicated that the damage was caused by leaks occurring in the joints of the aluminum composite roof panels and due to the insufficient load-bearing capacity of the structure. The severity of the damage compromised the mechanical strength and stability of the building, leading to an immediate recommendation to cease using the facilities. The extent of deterioration rendered the structure irrecoverable, making it very difficult to apply reinforcement measures, which ultimately led to its demolition to prevent its collapse.

CODE 157

ANALYSIS OF CAUSES OF THE COLLAPSE OF REINFORCED CONCRETE SLAB IN 2020 IN A CAR PARK AT THE "NUEVA MONTAÑA" RESIDENTIAL DEVELOPMENT, SANTANDER

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KEYWORDS: Collapse; Punching shear; Honeycomb; Compression struts; Concrete cracking.

ABSTRACT

The study aims to clarify the possible causes of the structural collapse that occurred between 6:00 and 7:00 am on 13 January 2020 in the car park of the "Nueva Montaña" residential development, C/FRANCISCO TOMÁS Y VALIENTE 13-19 Y LUCIANO MALUMBRES 1-3.
A geometric and topological survey was conducted on the structure, land fills and acting loads, damages and materials and a structural analysis was carried out based on data taken on site and other project information.
A bending and punching shear model of the structure was created, and we analysed how the cracking detected on the upper face of the slabs and faults identified in the concrete —honeycomb formation, disintegration and lack of vibration—affected the structural collapse of the car park.
A structural model was created with SAP2000 software using the Finite Element Method to analyse the effects of honeycomb formation on increased stress in the concrete compression struts at their joint with the columns.
The conclusions justify the most probable hypotheses for the collapse after a thorough study of materials, damage and a structural analysis of the buildings.

CODE 169

EVALUATION OF THE STABILITY OF SEVERAL ALBANIAN CASTLES AFFECTED BY EARTHQUAKES BY COMBINING A SERIES OF "IN SITU" INSPECTIONS AND NON-DESTRUCTIVE TECHNIQUES

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KEYWORDS: Cultural heritage; Finite Element Analysis (FEM); Structural pathology; DinSAR Structural consolidation of walls.

ABSTRACT

Due to their eminently defensive nature, an important part of Albania's castles are located on rocky ridges, where the outer walls of these fortifications are located very close to the edge of the slope. Over the centuries, the action of external agents has given rise to the progressive dismantling of these rocky slopes, compromising the stability of some of the structures they support. On November 26, 2019, an earthquake of intensity 6.4 occurred in the northwest of Albania, which led to the collapse of numerous structures of these castles (e.g.: walls, towers, cisterns) leaving many others damaged and in a metastable state, which require rapid intervention for their conservation. For this reason, the Albanian government has launched a series of intervention projects, the starting point of which has been the identification and prioritisation of those areas of the slope with the highest risk of collapse in order to stabilise them.
In all cases, the first step has been to carry out a geological-geotechnical study of the rocky slopes that support the structures of the castle and the adjacent slopes, as well as the state of conservation of the stone walls themselves. In this work, the methodology followed when identifying and prioritizing the most susceptible areas is presented, as well as the nonlinear numerical analysis (FEM) used for the design of the engineering solutions to be implemented. The methodology developed includes a combination of advanced surveying techniques (LiDAR and aerial photogrammetry), geological, geomorphological and structural mapping, geomechanical analysis, non-destructive testing (electrical tomography and seismic refraction) and remote satellite monitoring techniques (DinSAR).

CODE 216

MECHANICAL PROPERTIES OF HISTORICAL MASONRY WALLS THROUGH FLAT JACK TESTS

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KEYWORDS: Diagnostic techniques; Masonry structures; Flat jack tests.

ABSTRACT

Many Countries in the Mediterranean area are characterized by a wide and ancient masonry building stock, whose preservation and restoration have economic, social and logistic impacts. However, the first step to protect this patrimony, is the characterization of the mechanical behavior of its masonry walls by an in-situ testing campaign. The flat jack tests are the most adopted inspection method, because, even if they require the execution of cuts on the walls, the effects of this procedure are quite limited and, thus, are compatible with the respect of the heritage protection demands. Moreover, this procedure provides valuable data on the vertical stress pattern, and the elastic modulus, that are key parameters in the vulnerability assessment procedure. The paper investigates the results of an experimental campaign performed by means of single and double flat jack tests. In detail, the investigated structures belong to an Italian zone characterized by the use of materials directly extracted on site before the construction of the structure and, thus, the mechanical parameters of these walls can be considered as reference values at local scale as they depend on the strength and stiffness of the extracted material, and on the geometry of the blocks which in many cases have conditioned the laying method and the thickness of the wall.

CODE 221

STRUCTURAL MODELING OF THE STADIUM, RIVERA - URUGUAY. FROM SCHEMA TO REALITY

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KEYWORDS: Reinforced concrete; Modeling; Structural analysis; Theoretical analysis.

ABSTRACT

Based on the request from the Township of Rivera to verify injuries at the Atilio Paiva Olivera Football Stadium, a team of teachers from the Faculty of Architecture, Design and Urban Planning from different specialties to work on it. In order to deepen the analysis of stresses and the design of the sections of the reinforced concrete structure, which would explain the behavior of the building, structural modeling of some sectors was implemented.
This task started from reality to the problem which was abstracted into a diagram. Once simplified, it was quantified based on the information collected from the graphics and memories of the Stadium, or from the rehearsals, and then returned to reality with the structural modeling of six sections under study, facilitating the structural analysis with the visualization of the representation on the computer screen. Deformations, stresses, tensions and theoretical cracks were analyzed to reach a synthetic stage for a complete understanding of the problem, comparing the result of the analysis carried out with the reality surveyed and drawing conclusions that support what was visually surveyed.
The results of this advice constitute a product that can be used at the FADU, whose Architecture degree seeks to familiarize the student in the use of specific computer programmes for calculation and dimensioning of architectural structures.

CODE 228

SEISMIC FAILURE ANALYSIS OF COMPLEX HERITAGE MASONRY STRUCTURES USING ENERGY OUTPUTS OF FINITE ELEMENT ANALYSIS

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KEYWORDS: Failure of masonry structures; Nonlinear finite element analysis; Monumental masonry structures; Concrete damaged plasticity; Energy-based failure criteria.

ABSTRACT

The present work describes how energy outputs from 2- and 3D nonlinear FE analyses can be used to accurately assess failure conditions produced by seismic action on complex masonry heritage structures. This methodology relies on the analogy between plastic strains development and fracture propagation that is inherent to the concrete damaged plasticity (CDP) macro-model used in Abaqus/CAE Explicit to represent the quasi-brittle behavior of masonry material. Under seismic conditions, deterioration of a structure from static integrity to dynamic failure is precipitated by increasing time dependent loading. Once critical conditions are reached, the structure begins to show signs of local failure and internal energy initially stored as elastic strain energy begins to dissipate through fracture propagation. Dissipation in models with CDP materials produces plastic strain distributions that represent fractures. Thus, plastic dissipation energy will rapidly increase with time as regions of plastic strain propagate throughout the model. Approaching failure this growth becomes asymptotic. Accordingly, the instant at which elastic strain energy stored from loading and plastic dissipation energy generated from plastic-strain-represented fractures are equal can be taken as the time of complete structural failure. The successful application of this energy-based approach to the evaluation of the lateral capacity of heritage masonry monuments is illustrated with three case studies: the massive, earthen pyramid at Huaca de la Luna (Trujillo, Peru), the Roman pozzolanic concrete vault of Diocletian's Frigidarium (Rome, Italy), and mixed material triumphal arch of the San Pedro Apóstol Church of Andahuaylillas (Peru), and. The first two cases are analyzed under dynamic conditions using the present methodology and the third case combines the proposed method together with conventional pushover analysis. The method is verified with other quantitative measures of failure.

CODE 233

BETWEEN SAFETY AND CONSERVATION: DIAGNOSTIC INVESTIGATION AND DYNAMIC MONITORING OF THE CAMPANONE

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KEYWORDS: Ambient vibration; Diagnosis; Masonry tower; Monitoring; Structural assessment.

ABSTRACT

The availability of quick and fully non-destructive methods, such as terrestrial laser scanning and dynamic monitoring, allows significant enhancement in the structural assessment of ancient towers. The advances are related to both increasing accuracy and decreasing time of investigation, provided that the overall assessment process maintains the cultural multidimensionality needed to collect and merge information coming from multiple fields (i.e., historical archives, geomatic survey, direct inspections, operational modal analysis, material testing and numerical modelling). On the other hand, continuous dynamic monitoring of towers using a limited number of sensors should be used to decide, in some cases, the need of strengthening interventions through the continuous evaluation of the building dynamic characteristics and the detection of structural anomalies.
The paper is mainly aimed at presenting selected results from the first months of continuous dynamic monitoring of a historical tower, known as *Campanone* and placed in the centre of Pontremoli (Tuscany, Italy). After a concise historic background of the monument and of the geometric and on-site investigations performed to determining the state of conservation of the tower and evaluating the effects of previous interventions, the dynamic characteristics of the tower are presented and discussed. Subsequently, full details are given on the sensing devices installed in the building and the software tools that are employed to process the continuously acquired data. Special attention is paid to the variations of natural frequencies, that is conceivably driven by the environmental variability. Furthermore, clear evidence of the time-invariance of mode shapes is highlighted, within a perspective of Structural Health Monitoring (SHM) and condition-based structural maintenance.

CODE 251

STRUCTURAL ASSESSMENT FOR THE COPANDARO CONVENT IN MICHOACAN, MEXICO

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KEYWORDS: Convent; Pathologies; Numerical Modeling; Ambient Vibration; Seismic Demand.

ABSTRACT

An evaluation of the structural behavior is presented for a 16th century convent building located in the Municipality of Copandaro de Galeana in Michoacan, Mexico. An estimate of the current safety level of the structure as a whole is then obtained, both for vertical permanent actions, which have produced significant supports settlements due to being founded on lake soil, as well as for a seismic demand conformed by real seismic records. The used methodology includes the construction of a linear elastic finite element model, which was calibrated from the results obtained from the measurement of ambient vibrations carried out on the nave of the temple and the cloister, whose experimental dynamic properties were evaluated using Operational Modal Analysis. The calibrated model was subjected to its self-weight, as well as to a set of seismic records obtained in the State of Puebla during the earthquake of September 19, 2017, an event that had its epicenter between the limits of the States of Puebla and Morelos in the so-called Trans-Mexican Volcanic Belt, within which the studied convent is located as well. The results obtained show a strong structural interaction within the bell tower with the nave as well as the latter with the cloister, which produces high traction and compression stresses that exceed the values established as maximum permissible.

CODE 260

EXPERIMENTAL CHARACTERIZATION OF THERMAL COMFORT CONDITIONS IN KINDERGARTENS LOCATED IN THE NORTH OF PORTUGAL

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KEYWORDS: Indoor environmental quality; Thermal comfort; Monitoring, Kindergarten.

ABSTRACT

Suitable school buildings are fundamental to the development of children, young people and teenagers as they must guarantee appropriate conditions for their well-being and health. A healthy and comfortable indoor environment is also fundamental to the performance of students in the learning process.
The aim of this study is to assess the indoor environmental conditions of kindergartens located in the north of Portugal, with a particular focus on thermal comfort and indoor air quality. Thus, five buildings with different construction characteristics were selected and monitored, and temperature and relative humidity measurements over time were carried out in classrooms with different orientations. The outside climate was also monitored during the same period. Thermal comfort was assessed using the adaptive model defined in European standard EN 16798:2019. To assess the ventilation efficiency, continuous monitoring of carbon dioxide concentration was also carried out in three of these buildings.
The results show great heterogeneity between the buildings, with a relevant influence of the construction characteristics on the thermal comfort of the occupants. The effect of orientation and glazing area is particularly noteworthy. There was also a relationship between the maximum daily concentration of carbon dioxide and the outside temperature.

CODE 280

NEW APPROACHES TO DETECT CONCRETE CORROSION FROM GROUND PENETRATING RADAR DATA

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KEYWORDS: Corrosion; Internal damage; GPR; Amplitude-based imaging; Digitization.

ABSTRACT

This work explores new processing techniques of Ground-Penetrating Radar (GPR) data for the detection of internal damages associated to corrosion in concrete. New amplitude-based imaging methods (outliers, amplitude phase, etc.) will be therefore developed to highlight defects such as delamination, voids, etc. The methodology was applied to a precast pedestrian bridge showing superficial distresses due to corrosion. A three-dimensional (3D) GPR survey was conducted using high-resolution antennas of 2.3 GHz. It was demonstrated how the imaging strategies here implemented gave a better definition than conventional GPR images to highlight the existence and definition of such subsurface distresses. A new approach was also developed to digitize the extracted information into a point cloud format, thus improving the possibilities of 3D visualization and contributing to the integration of GPR results into Building Information Modelling (BIM) and Digital Twin (DT) environments. Thus, this provide more suitable understanding of the extent and shape of the detected defects that is crucial for more accurate decision making.

CODE 284

SIMPLIFIED MODELLING STRATEGY FOR EVALUATING FAILURE PROPAGATION IN REINFORCED CONCRETE STRUCTURES

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KEYWORDS: Reinforced concrete; Progressive collapse; Failure propagation; Column removal; Practical modelling strategies; Simulation.

ABSTRACT

The progressive collapse of reinforced concrete (RC) structures involves a series of complex load-resisting mechanisms, including flexural, arching and catenary actions, among others. A detailed model comprised of 3D-solid elements with refined mesh and complex material models is typically adopted to accurately simulate these phenomena in new or existing buildings. However, this approach is computationally expensive and unsuitable for practical applications, especially when dealing with large models of real buildings. This study proposes practical modelling strategies that balance the accuracy of an RC structural response to an initial failure with a practical method of preparing and analysing the models. The proposed modelling approaches include a) the PMM–lumped hinge (based on the FEMA-356 guideline), b) a modification to the FEMA hinge, and c) the fibre–distributed hinge. Several progressive collapse tests from the literature were simulated on RC subassemblies with various boundary conditions and loading scenarios from the literature to systematically validate and compare the different approaches. The results revealed that the PMM-lumped approach cannot accurately simulate the structure's response under large deformation mode (catenary) where plastic hinges (yielding of reinforcement) are typically formed at a more extended region along the member. The present study suggests that the fibre-distributed hinge is the most suitable approach for simulating the progressive collapse of structures. This finding is pertinent (yet also alarming) as some new studies in the progressive collapse field still adopt the traditional PMM-hinge approach, which may eventually lead to invalid conclusions.

CODE 293

SONIC TOMOGRAPHY FOR MONITORING DAMAGE AND STRESS LEVEL EVOLUTION IN HISTORIC MASONRY WALLS

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KEYWORDS: Sonic tomography; Stone masonry; Damage evolution; Non-destructive testing; automatic inspection system.

ABSTRACT

Sonic tomography has been applied in the past as a non-destructive inspection technique for masonry, when aiming to evaluate masonry elements in qualitative terms, e.g., estimating the presence of voids and providing rough approximation of the inner cross-section. However, crack propagation and variation of material properties due to damage can also be detected using acoustic measurements. Inner cracks lead to changes in the sonic wave velocities and frequencies. Therefore, the paper explores and reflects on the possibility of using sonic tomography for long term monitoring of historic masonry structures. Based on a recent laboratory test campaign, the paper aims to show the potential to use sonic tomography to perform time-lapse tomography (4D analysis) on historic masonry walls, measuring damage and stress level of masonry components over time, as a novel monitoring technique.
The laboratory campaign consisted on cyclic uniaxial compression tests on stone irregular masonry walls representative of historic masonry typologies. During the test, a novel automated sonic tomography system was used to inspect the wall under loading cycles of increasing amplitude. The automated system allows to perform tomographic inspections within a few minutes, which led to obtain tomographic images during loading and evaluate the evolution of damage. Tomographic inspections are necessary because historical masonry materials are discontinuous media in which the deformation can localize, so that few measurements of sonic velocity across the sample are not sufficient and may overlook localized damage. Results show that sonic wave propagation is both sensitive to the stress state and damage level. For low stress level, the velocity increases. Towards the end of the analysis, when cracking is widespread, the velocity significantly decreases. The use of sonic tests to evaluate stress level and damage evolution in masonry structures is a novel field of research, but results show a promising potential.

CODE 298

MULTIVARIATE MONITORING APPROACH TO CHARACTERIZE EROSION RATES IN HISTORICAL BUILDINGS: CASE STUDY OF JAMETE'S ARCH IN THE CATHEDRAL OF CUENCA (SPAIN)

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KEYWORDS: Environmental conditions; Stone; Cultural heritage; Lidar; Haloclasticity.

ABSTRACT

Centennial stone monuments and traditional constructions undergo a continuous process of deterioration due to haloclasticity (crystallization of salts in the porous system of the rock). This process is highly sensitive to changes in temperature and relative humidity in the environment and is directly associated with the transfer and circulation of moisture through the walls. The limestone used in the construction of the Arco de Jamete (1546) is a clear example of this process.
It is an unavoidable necessity that these monumental buildings be monitored and sampled to implement effective preventive measures. The main hypothesis of this research is that the very specific type of salts found in the Arco de Jamete can strongly contribute to erosion due to the combination of local temperature and humidity. Therefore, there are three main lines of research: 1) monitoring the microclimate (ambient temperature and relative humidity) of the immediate area around the Arco de Jamete; 2) quantifying the total erosion and the current erosion rate suffered by the materials; and 3) characterizing the material and analyzing the alteration process affecting the stone. A combination of air temperature and humidity sensors, laser scanners, and sample collection has been used to cross-reference data during an innovative year-long monitoring program.
Through these means, specific combinations of environmental parameters to avoid have been detected, and guidelines for monitoring and control, as well as preventive measures, have been proposed, avoiding invasive procedures that can help slow down the erosion process.

CODE 304

LAYOUT DESIGN AND GEOMETRY OF THE SANTA ANA CHURCH IN SEVILLE. IMPACT ON ITS STRUCTURAL BEHAVIOR

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KEYWORDS: Gothic-mudejar; Masonry; Vault geometry; MEF; High definition models.

ABSTRACT

With the reconquest of the cities of Cordoba (1236) and Seville (1248) a new style of Gothic influence was established This style had some aspects of the tradition of Almohad architecture. Perhaps its main representation was developed in the construction of parish churches over the previous Muslim mosques, although it also had an influence on civil architecture. Some rules of proportion were already perceived in the Cordovan parish churches in the layout design of their construction, also they still responded to the original Muslim building. Santa Ana Church in Seville is presented as an unique case study given its strategic location in the City on the outskirts of the walled enclosure. This and the Boats Bridge (1717) and the San Jorge Castle proximity will give it a strong defensive character against the continuous sieges of the conquered settled in Aljarafe, outside the city. These defensive needs would require a passable roof from which to defend theirselves. As a new construction would allow the adaptation of certain rules of proportion in its plan layout design which would affect the geometry of the vaults.
The purpose of this paper is to establish a relationship between how the socio-cultural, military and religious situation of Seville conditions the location of the Church of Santa Ana, allowing the establishment of proportion rules that condition the vaults geometry to let the construction of a passable roof, which will condition its structural behavior. Knowing the rules of proportion and the geometric layout design, and after analyzing the construction systems used, we proceed to define high-definition geometric models for analysis by the MEF. In these numerical models, the high levels of loads due to the roof construction design are analyzed as long as the global structural behavior of the Church.

CODE 305

PRELIMINARY STUDIES TO REALIZE THE STRUCTURAL ASSESMENT OF THE CENTRAL LIBRARY OF THE UNAM-MEXICO, A HERITAGE BUILDING

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KEYWORDS: World Heritage; Ambient vibration; Mechanical properties of the concrete; Periods and modal shapes of vibration.

ABSTRACT

This manuscript presents a brief description and some results of the preliminary studies that have been carried out in the Central Library to carry out its structural evaluation in accordance with current local construction regulations. This building is part of the central campus of the National Autonomous University of Mexico (UNAM), which, in 2007, was declared World Heritage by the United Nations Educational, Scientific and Cultural Organization (UNESCO). These activities have been implemented by UNAM to review the level of structural safety that exists in its main buildings. It is important to mention that there is no evidence that this building has been affected by the action of recent earthquakes, such as the one that occurred on September 19, 2017. The Central Library is the work of the architect and painter Juan O'Gorman. One of its main characteristics is the presence of a mural formed with small stones of natural and artificial colors (glass), which surrounds the entire structure from the second level and is also the work of Juan O'Gorman. Some of the activities that have been carried out are geometric surveys of the current state of its structure, quantification of the acting loads, mechanical characterization of the concrete, identification of the configuration of the rebars of the main reinforced concrete elements using non-destructive and destructive testing, ambient vibration testing to estimate its dynamic properties.

CODE 307

EVALUATION OF THE STRUCTURAL INTEGRITY OF A WOODEN PERGOLATE: PROPAEDEUTICS, DIAGNOSIS AND THERAPEUTICS

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KEYWORDS: Structural integrity; Wood; Non-destructive tests; Propaedeutics; Therapeutic.

ABSTRACT

To perform rehabilitation, restoration, or reinforcement on a wooden structure, an evaluation of its 'health' status must be conducted. This assessment is similar to the Structural Health Assessment (SHA), which applies multidisciplinary techniques and procedures to establish the accumulated damage state and its growth rate. This allows for predicting its residual life and scheduling actions for its extension. Therefore, the objective of this study is a comprehensive investigation of the health of a wooden pergola structure located in Belo Horizonte, MG, Brazil, through SHA evaluation based on propaedeutics, diagnosis, and therapy. For propaedeutics and diagnosis, non-destructive tests were used, namely: acoustic tomography, controlled penetration test (Resistograph), and impact test (Pilodyn). Through macroscopic visual assessment, it was possible to identify the wood species of the pergola, which are Cumaru, Angelim Vermelho, and another unidentified species. The wood resistance class was determined using the Resistograph. Biotic, abiotic, and structurally originated damages were assessed. The evaluation of structural performance, considering the real sections and the adopted physical and mechanical characteristics of the wood, was carried out using the SAP 2000 program. The verification of structural elements and connections was done following the Brazilian standard NBR 7190. The conclusions present constructive, treatment and protection, and structural therapies.

CODE 331

AMBIENT VIBRATION TESTING AND DYNAMIC IDENTIFICATION OF A HISTORICAL BUILDING. RONDA BULLRING (MÁLAGA, SPAIN)

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KEYWORDS: Non-destructive techniques; Operational Modal Analysis; Ronda bullring.

ABSTRACT

The conservation of architectural heritage is a fundamental aspect in the cultural development of modern cities. The preservation of this heritage involves numerous technical analyses to ensure its proper conservation. In this sense, non-destructive techniques are often essential to provide information about the structural behaviour of historical buildings. Consequently, the use of ambient vibration tests and the Operational Modal Analysis (OMA) technique allows to obtain an accurate definition of the dynamic characterization of the building. The OMA technique is consolidated as a non-destructive technique that allows the experimental estimation of the modal parameters of a structure from ambient vibration tests. In recent years, many cases of application of ambient vibration tests can be found in historical buildings, However, this method has never been applied to a building that presents a geometry as singular as that of a bullring.

This paper investigates the dynamic characteristics of the Ronda Bullring (Fig. 1), which dates from the 18th century and is located in Málaga (Spain). After performing several ambient vibration tests, eight modes of vibration were obtained in a frequency range from 0 to 6 hertz. The goodness of the results obtained was evaluated by comparing the differences between the natural frequencies and modal displacements by using different modal identification methods.

CODE 345

CLARIFYING THE MYTH OF DELAMINATION DETECTION IN BRIDGE DECKS USING INFRARED THERMOGRAPHY

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KEYWORDS: Infrared thermography; Image data; Concrete delamination; Numerical simulation; Concrete heat transfer.

ABSTRACT

Infrared based sensing is an important non-destructive evaluation (NDE) approach for detecting substrate defects in many different types of materials, including concrete materials for building and civil infrastructure. Despite infrared thermography (IRT) methods have been explored for more than 40 years in concrete delamination detection, The reliability of its results has been frequently called into questions due to the presence of false positives and false negatives induced by some environmental factors, such as the timing of data collection, presence of water and other foreign materials on the pavement surface or subsurface. Recent studies using unmanned arial vehicle (UAV) based IRT and the state-of-the-art image processing methods made significant progress in overcoming many existing issues in traditional ground vehicle based IRT methods. However, UAV-based IRT did not fully address the reliability issues. This paper reports the results of a systematic investigation of the potential factors surrounding the reliability issues of IRT concrete deck delamination detection and makes suggestions about how to avoid pitfalls in data collection and data analysis. The novel aspect of this study is that it captures the thermal transfer interactions among the multiple delaminated areas, which was rarely reported in the previous studies. The study used both numerical and experimental methods to increase the validity of the conclusions. Based on the results, recommendations are provided to minimize or to eliminate the false detection.

CODE 352

THE USE OF INFRARED THERMOGRAPHY IN INSPECTION AND MONITORING OF CONDITIONS IN HISTORIC CERAMIC BRICK MASONRY CONSTRUCTIONS IN THE STATE OF SÃO PAULO

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KEYWORDS: Infrared thermography; Ceramic masonry; Historical buildings; Cultural heritage; Non-destructive testing

ABSTRACT

Historical buildings constructed with ceramic brick masonry make up a significant part of Brazil's cultural heritage, especially in the state of São Paulo. This growth occurred predominantly from the mid-19th to early 20th centuries, driven by the coffee economy and the development of railway transportation technology, accounting for over eighty percent of this architectural heritage in the state. Due to the specificity of these structures, it is crucial to have a thorough understanding and characterization of their construction systems, constituent materials, and state of preservation to implement appropriate intervention measures for each case. While the use of non-destructive testing (NDT) equipment and methods for inspecting and monitoring equipment and structures in civil engineering is relatively common in Brazil, there is still a significant lack of regulation and standardization at the national level. Consequently, it is not uncommon to find professionals with little or no formal training, relying heavily on empirical methods to address specific problems. When focusing on the use of non destructive techniques and methods in historical earthen constructions, including adobe, rammed earth, or fired clay masonry, this situation becomes even more complex due to the specificities of each building, including regional variations and difference in materials used and their own characteristics. This article aims to present the initial results of an applied research project on the use of NDT equipment and methods, with a focus on infrared thermography for inspecting and monitoring historical brick masonry constructions. It includes field analyses of late 19th-century buildings in the state of São Paulo, as well as laboratory tests using mock-ups to calibrate and adjust equipment and methods.

CODE 358

RESEARCH ON GEORADAR INSPECTION METHODOLOGY FOR DETECTION GFRP BARS

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KEYWORDS: Composite materials; Fiberglass; GFRP; Non-destructive inspection techniques; Ground penetrating radar; Reinforced concrete.

ABSTRACT

Ground Penetrating Radar (GPR) is a non-destructive inspection technique that uses high-frequency electromagnetic waves aimed at detecting the internal characteristics of a given medium. Specifically, it consists of the emission of electromagnetic waves between 10 MHz and 2.6 GHz and the subsequent reception of the reflection of these waves after bouncing off the boundary of two materials with different electromagnetic properties. Originally used for geophysical studies, such as subsurface investigations, it is also an effective technique for the study of building materials, such as concrete, and is increasingly used in the inspection, diagnosis and study of concrete pathologies, as well as in the detection of steel interior reinforcement. Currently, fiberglass reinforced polymer (GFRP) bars are an alternative to steel reinforcement due to its corrosion resistance, lighter lightness, and better durability. It is mainly used in concrete constructions where the risk of corrosion is very high (docks in ports) or where the safety requirements are high (nuclear power plants).
This paper presents an experimental research on the feasibility of the GPR inspection technique for the detection of GFRP bars embedded in concrete elements. For this purpose, two concrete slabs have been manufactured (dimensions: 120 cm x 64 cm x 20 cm). Inside, GFRP and steel bars have been arranged (diameters 6 mm to 32 mm). The inspection is carried out with a portable ground penetrating radar device (model C-THRUE from IDS GeoRadar Srl and Leica Geosystems) due to its ease of use in "on-site" inspections.
The study concluded that, although with a less clear signal than for steel, the inspection with georadar allows the detection of fiberglass bars embedded in concrete. Specifically, most of the longitudinal fiberglass bars with a diameter greater than or equal to 14 mm have been detected when the concrete coating was 25 mm.

CODE 368

RIVER PLATE STADIUM (ARGENTINA) REMAINING LIFE LIME PREDICTION

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KEYWORDS: Stadium; Corrosion rate; Service life; Residual life.

ABSTRACT

Argentina's River Plate stadium (today called "Monumental Más") was built in 1938. Subsequently, extensions and remodeling were carried out in 1958 and 1978; the latter for the World Cup held that year in Argentina.
Towards the end of 2022, taking advantage of the suspension of football events due to the World Cup in Qatar, the club took the opportunity to carry out a series of important remodelling that included the change of a large part of the seats and the increase of its capacity to 84.567 spectators, becoming the largest capacity stadium in South America.
Faced with this investment, directors asked the engineering department to determine the remaining useful life of the structure in general. This is how the construction company conveyed its concern to us, in response to which we proceeded to make a proposal to achieve this objective.
attery tests presented includes: the analysis of the structure and its orientation, the concrete cover of steel bars, the ultrasonic pulse rate, the corrosion rate and the extraction of concrete cores in specific sectors, with their corresponding carbonation depth.
With obtained results, applying the carbonation equation ($x = k \sqrt{t}$) and Tuutti's model [7], the remaining useful life of the structure for each sector was estimated according to their orientation, since it was observed that sunlight is a factor that considerably affects the speed of corrosion of the structure, as well as the probability of this occurring.
Finally, on some specific sectors where concrete detachment and corrosion of steel bars were appreciated, repair proposals were made according to the characteristics of the structure.

CODE 386

NUMERICAL MODELLING OF EXPERIMENTAL UNIAXIAL AND COMPRESSION-SHEAR TESTS ON TRADITIONAL STONE MASONRY SPECIMENS, USING 2D PARTICLE MODELS

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KEYWORDS: Rubble stone masonry; Compression-shear tests; Numerical modelling; 2D Particle Model.

ABSTRACT

Stone masonry walls are the main structural elements of many historic buildings. Their restoration and preservation are a major concern given the increasing interest in the rehabilitation of built historical heritage and the implementation of preventive measures to mitigate seismic risk. The accurate structural assessment of the existing rubble stone masonry is a very complex and difficult task, due its composite and complex nature. The heterogeneity and uncertainty in material properties of its constituents, mortar and stone, the variability of the stone units positioning and geometry, among others, make its experimental characterization and accurate numerical modelling still nowadays a challenging task. In this context, the research presented aims to contribute to a better understanding of the in-plane shear behaviour of unreinforced two leaf rubble stone masonry walls, typical stone masonry of ancient buildings that are representative in Portugal.
Rubble stone masonry specimens, built with traditional Portuguese construction techniques, tested experimentally under monotonic compression-shear loading conditions are here numerically evaluated, adopting a micro-modelling approach using a 2D particle model (2D-PM). In the 2D-PM model the stone and mortar elements are represented as particle assemblies that interact with each other, thus capable of representing their inherent physical and material heterogeneity. The numerical model is generated through a mapping process of the stone units and mortar joints. The experimental campaign conducted on rubble stone masonry wall specimens allowed to collect the data necessary for the calibration of the PM model parameters, namely the stone-stone and mortar-mortar elastic and strength contact properties. The validation of the 2D-PM models of the rubble stone masonry specimens under compression and combined compression-shear loading conditions is performed using the Parmac2D software. The presented results show that 2D-PM models can predict the crack propagation, the final failure modes, the maximum shear strength, and the wall ductility observed experimentally. Parametric studies that allow a better agreement between the numerical predictions and the experimental response, showing the relevance of the stone-mortar interface strength properties in the overall macroscopic behaviour, are also presented.

CODE 389

DETECTION AND RECOGNITION OF DAMAGE IN MOROCCAN HISTORICAL MONUMENTS USING THE YOLO NETWORK

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KEYWORDS: Historical Monuments; Damage detection and recognition; YOLO network.

ABSTRACT

Historical Monuments are vulnerable to harm arising from ecological, cultural, and societal influences, leading to the deterioration of the integrity of these edifices and even jeopardizing their security. Therefore, it is crucial to conduct periodic examinations of these buildings to guarantee their upkeep and conservation. The use of manual vision-based inspection for identifying and evaluating superficial damage in historic buildings proves to be a time-consuming and labor-intensive task. To address these constraints, the present study introduces an innovative deep learning-based approach for automatic detection of damage in Rabat's historical monuments, aiming to expedite investigation and enhance the effectiveness of damage detection. For this research, a dataset comprising images of Rabat's historical monuments was manually collected via a camera Canon 700D. Subsequently, after the annotation procedure, the dataset was employed for training and testing purposes, employing the YOLO object detection technique. The model used in this research demonstrates the ability to detect and categorize distinct damage types found on the outer walls of various historical monuments. These damages comprise of areas with spalling, delamination, crack, partial collapse, rising damp and lichens. Several validation experiments were carried out to evaluate the performance of the model's outcomes. As a result, the study conclusively showcased the significant automation, efficiency, and reliability of the proposed technique in detecting damage in historical buildings. Ultimately, this contribution aids in the management and preservation of historic structures.

CODE 392

EXPERIMENTAL STUDY OF THE MECHANICAL BEHAVIOR OF DRY-STONE STRUCTURES CONTACT

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KEYWORDS: Masonry; Dry stone; Retaining walls; Pseudo-static.

ABSTRACT

Dry-stone structures are traditional constructions that are present everywhere around the world, their stability mostly working by gravity. Their out-of-plane response is very brittle and is fully controlled by the geometry as well as the contact properties between stones. Two main local failure modes of dry-joint contact have been identified that lead to the global failure of the structure: i) sliding and ii) joint opening.
This contribution presents the results of an experimental work aiming at evaluating the effect of sliding and joint opening in a dry-joint at two different scales: i) couplets, ii) structures made of few (up to 5) between stones at different scales: couplet, structures made of few (up to 5) blocks/units or more complete walls. Different stones have been employed to quantify potential differences: i) solid concrete blocks of 250 mm × 125 mm × 100 mm, ii) flat and irregularly shaped sedentary stones from Alt Empordà in the north-eastern part of Catalonia (Spain), and iii) volcanic irregular shaped stones from Garrotxa in northern part of Catalonia (Spain). All the structures have been tested up to their collapse by using a tilting-table to induce out-of-plane actions. Repeatability tests have been conducted to better understand the effect of contact variability.
The results of this study unveil that the heterogeneity of the dry joint contact, as well as the distribution of the blocks/units, affect the global response (both in terms of load capacity and failure mode). They also evidence that the most critical local failure mode is the joint opening.

CODE 395

ROBUST COTS-BASED MONITORING SYSTEM FOR EXTERNALLY POST-TENSIONED RAILWAY BRIDGED

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KEYWORDS: Structural performance monitoring; Continuous monitoring; Vibration-based monitoring; External post-tensioning; Railway bridges.

ABSTRACT

High-speed (HS) railway bridges are key elements for sustainable transport networks. As an example, in Spain, there are more than 1.600 bridges in the HS network. Thus, the development of reliable structural performance monitoring (SPM) systems has been identified by Transport Administrators as a priority line to gradually migrate to a more predictive maintenance. In this sense, this paper describes the development of a scalable, multi-sensor SPM system based on Commercial Off-The-Shelf (COTS) components. The system is conceived for railway continuous concrete bridges with external post-tensioning tendons. These elements have been identified as vulnerable elements and have attracted special attention during the last years due to several reported failure cases (mainly due to accelerated corrosion associated with deficient grouting).
The key features of the proposed COTS monitoring system are: 1) distributed Time Sensitive Networking Ethernet-based DAQ devices are used 2) multi-sensor capability, 3) DC current outputs (i.e., 4-20mA), allowing low background noise and long distance measurements, 4) the system supports three acquisition loops: static (for static measurements such as inclination, displacement, temperature, etc.), dynamic (for accelerometers) and high-speed (for low-frequency acoustic emissions), 5) the system includes security elements such as smart plugging or Uninterrupted Power Supply remote controlled, 6) data are initially saved locally (and early-bird alarms may be launched) and then sent to a NAS station configured in RAID5 to avoid loss of information, 7) every few minutes (10 min in this case) a computer task is launched which involves: the detection of new acquisition files, the analysis of them (inducing modal analysis, calibration of tendon digital twins, tension estimation and bending stiffness assessment, amongst other analyses), the extraction of performance indicators (sensitive to structure anomalies), activations of alarms and publication of main plots in a web.

CODE 396

VIBRATION-BASED NON-DESTRUCTIVE TESTING SYSTEM PROPOSAL FOR POST-TENSIONING EXTERNAL TENDONS

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KEYWORDS: Non-destructive testing; Post-tensioning tendons; Vibration-based monitoring; Operational modal analysis; Tension force estimation.

ABSTRACT

This paper describes the development of a non-destructive testing (NDT) system for the detection of mechanical anomalies in external post-tensioning tendons. The system is based on the dynamic response of the tendons and on the computations of several performance indicators in such a way that decisions regarding the maintenance or substitution can be supported for the use of the proposed NDT. The system carries out two experimental tests: an operational modal analysis using several vertical and lateral accelerometers and Frequency Response Function-based test using an instrumented hammer. For each tendon segment, the extracted performance indicators are: the first four natural frequencies, a symmetry/antisymmetry ratio of modal shapes through the Modal Assurance Criterion between symmetric test point measurements, the damping of the fundamental mode and, through in-line updating of a tendon digital twin, the effective tension force. An immediate tendon assessment report is generated by the system. The prototype is rapid to be applied, economical, scalable (since additional sensors or performance indicators are easy to be added) and portable (since the system is carried by a trolley). The system has been applied to a 12-span continuous concrete railway bridge, testing up to 25 tendons with a total of 202 tendon segments. Several tendons have been classified as anomalous by computing a cumulative damage indicator that has been proposed. Finally, unsupervised K-means clustering algorithm has been applied to create clusters and detect outliers automatically from the performance indicators.

CODE 398

INDOOR AIR QUALITY IN A RESIDENTIAL BUILDING ACCORDING TO BRAZILIAN, PORTUGUESE AND WHO REQUIREMENTS

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KEYWORDS: Indoor air quality; Air pollution; IAQ monitoring; Quality of life.

ABSTRACT

Air pollution inside buildings is an environmental problem that can compromise the health and well-being of people who live or work in closed environments. It can cause poor health symptoms, such as eye, nose and throat irritation, allergies, to serious problems, such as respiratory and cardiovascular diseases, cancer and even death. Therefore, it is important to know the factors and sources of indoor air pollution and adopt prevention and control measures to guarantee air quality and the health of the people who use these spaces.

The objective of this work is to study the indoor air quality (IAQ) of a single-family house in the city of Vila Real, seeking to identify and quantify indoor air pollution. The results obtained in this work were analysed according the criteria adopted for the assessment of IAQ in Brazil (BR), Portugal (PT) and the World Health Organization (WHO).

The assessment was carried out using two Air Assure monitors, which continuously measure indoor air quality (IAQ) in terms of: Carbon dioxide (CO2), Particulate matter (PM2.5/PM10), Barometric pressure, Temperature and Relative humidity. The devices were installed and positioned in four different rooms. These rooms were chosen because they are the most used by the house's occupants and because they have characteristics that can influence IAQ, such as combustion sources, cleaning activities, natural ventilation, among others. The measurements were carried out between 18/06 and the 25/06 and between the 26/06 and the 03/07/2023.

The results show that the highest levels of air pollution were in the kitchen. However, the elements corresponding to the other rooms, although generally complying with BR and PT standards, did not comply with WHO standards.

CODE 400

RELATIONSHIP BETWEEN STATIC AND DYNAMIC MODULUS OF ELASTICITY IN GLULAM ELEMENTS

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KEYWORDS: Glued laminated timber; Glulam; Non-destructive tests; Ultrasonics; Experimental modal analysis.

ABSTRACT

Due to its versatility in engineering and its aesthetic and ecological characteristics, glued laminated timber, or glulam, has become an increasingly used material in current structures. Non-destructive tests (NDT) play a crucial role in assessing the integrity and structural quality of glulam elements. Frequently, the value of the Static Elasticity Module (E_E) is established as a fundamental reference when assessing the structural condition of glued laminated timber. However, EE cannot be determined directly in-situ, and NDT techniques must be employed for its indirect determination. The purpose of this study was to verify the accuracy offered by ultrasonic and modal analysis techniques as NDT tools in assessing the Static Elasticity Module in bending. To achieve this, 41 samples of both glued and sawn timber beams were tested. In the case of ultrasonic techniques, a transmitter and receiver were used to measure the time of flight of acoustic waves, and from this value, the Dynamic Elasticity Module by ultrasound (EUS) was obtained. In the case of modal analysis, the samples were excited with an impact hammer, obtaining natural frequencies and vibration modes as responses, from which the Dynamic Elasticity Module was determined through modal analysis (E_M). The dynamic elasticity modules were compared to the static elasticity modules of the elements obtained through a standardized bending test. The results demonstrate the relationship between the different methods, the accuracy achieved, and their potential to be used as non-destructive testing methods in this type of structures.

CODE 407

UPV TESTING FOR DECAY AND MOISTURE DETECTION IN STONE BUILDING MATERIALS: INSIGHTS FROM LAB MEASUREMENTS

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KEYWORDS: Ultrasonic velocity; Sedimentary rocks; Porous stones; Physical/mechanical properties; Apulian Region.

ABSTRACT

Stone building materials have been widely employed in historical-architectural heritage worldwide, with local peculiarities, construction techniques and surrounding conditions, resulting nowadays in a great variety of decay patterns and pathologies, so that the reliable assessment of their state of conservation and residual performance is paramount in order to address effective and compatible conservation measures. In this regard, Ultrasonic Pulse Velocity (UPV) is acknowledged as a valuable tool for onsite investigation, in terms of overall quality and compactness, evidence of decay phenomena, and effectiveness of consolidation treatments. However, since the availability of laboratory data under controlled conditions is crucial for the interpretation of results from real cases, the paper is focused on a laboratory workflow for UPV testing on different types of sedimentary limestones from the main quarry basins of Apulia Region, South Italy. The main purposes were: (i) acquiring reference data that can support the interpretation of onsite measurements, particularly for detection of cracks, voids and discontinuities, that are expected to lower the velocity compared to undisturbed samples; (ii) identifying reliable relationships between the ultrasonic velocities and some physical/structural properties, including density, porosity and mechanical resistance, enabling the estimation of the expected ultrasonic response for further stone typologies of the same geographic area; (iii) verifying the correlation between the ultrasonic values and the variation in moisture content. The main results included the availability of reliable UPV values for all the eight investigated stone typologies, the identification of very good correlation trend between UPV and density and the good correlation trend between UPV and compression strength, as well as the evidence that the UPV variations from dry to saturated conditions are significantly different for low (UPV decrease) and high (UPV increase) porosity materials. However, the measurements did not lead to meaningful insights on the correlation between UPV velocity, water content, compression strength and porosity. In the light of the above, the paper is meant to offer some useful insights in terms of data availability, as well as of methods and tools to be replicated in future studies, in order to make onsite UPV ultrasonic testing of architectural stone elements – especially monolithic ones, such as columns, pillars, architraves, cornices – more effective and trustworthy.

CODE 59

COMPARING MACROSCOPIC AND MICROSCOPIC APPROACHES FOR OPTIMIZING FLOOD EVACUATIONS IN HISTORIC URBAN BUILT ENVIRONMENTS

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KEYWORDS: Historic Urban Built Environment; Emergency Planning; Flood Evacuation; Evacuation Simulation; Multi-objective Optimization.

ABSTRACT

Worldwide, millions of people are forced to evacuate their homes and areas due to floods. During such dangerous procedures, pedestrians experience difficulties in choosing or applying the right evacuation strategy due to difficult interactions with outdoor environments deeply modified by the floodwater. Flood-prone Historic Urban Built Environments (HUBEs) are of particular interest due to their complex and compact layout, general poor implementation of risk-mitigation strategies, and attractiveness for tourists with a low level of familiarity with spaces. Evacuation planning and management are fundamental to guarantee pedestrians' safety, and can be pursued through macroscopic or microscopic approaches. The formers are less detailed (as they do not consider single pedestrian features) and can be represented as optimization problems. The latter consider each pedestrian singularly in spite of higher computational costs. This work compares the capabilities of a macroscopic and a microscopic assessment approach for flood evacuation strategies optimization. The macroscopic approach consists of an Integer Linear Program (ILP), which computes optimal evacuation paths depending on pedestrians' rules in path choice. The microscopic approach simulates the evacuation paths through a commercial, generic software set up on purpose to reproduce pedestrians' flood-related behaviors and crowd dynamics ignored by the ILP. A Risk Index to jointly consider the urban layout, the human factor, and the event intensity, is then developed and applied to evaluate assessment differences among the approaches, thanks to the application to a typological riverine HUBE in the Italian context, characterized by a narrow streets grid. Hydrodynamic conditions refer to a real-world event with a return time of 100 years, to assess floodwater impacts on pedestrian motion and safety. Results demonstrate a general correspondence between the approaches, although the microscopic one seems to be more conservative in terms of pedestrians who can be hindered by floodwaters during the evacuation. The two tested approaches could be also combined in a single tool for technicians of local authorities, including low-trained ones, to preliminary assess evacuation risks in HUBEs and to propose risk-mitigation strategies, (i.e., architectural integrated solutions, implementation of wayfinding and alert systems).

CODE 67

STUDY OF THE IMPACT OF CLIMATE CHANGE ON THE SEDIMENTATION OF FOUR WATER MILLS ON THE DUERO AND PISUERGA RIVERS

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KEYWORDS: Climatic Risk; Hitorical Heritage; Weir; Watermill; Sedimentation.

ABSTRACT

There is currently increasing interest in the consequences of climate change on built historical heritage, especially in environments close to water, whether in coastal areas or on riverbanks, although the latter with considerably less intensity. This article analyses the singular pathological process of sedimentation in four of the mills complexes of medieval origin located on the Duero and Pisuerga rivers. Among a wide group, at least are seventeen identifiable, the mills located downstream of historical bridges have been selected, situated in the main urban centers like Valladolid and Zamora, or nearby towns, such as Tordesillas or Toro. As the flow of the river is a reflection of its capacity to carry and deposit solid particles, the study analyses the flows collected by the gauging stations closest to each watermill, with comparable data over five decades, as well as the evolution shown in aerial photographs since 1945. Although the flow may be regulated by dams, the gradual decrease in the summer water flow can be associated with an increase in the sedimentation process in the weir and, although less frequent, the great floods of water have been more intense, generating a greater risk of breakage. It should be pointed out that the weir used by the historic watermills has for centuries formed an anthropogenic landscape, currently assumed as natural by the population, which allows the richness of the naturalized flora and fauna to be maintained during the summer periods. For all these reasons, it is advisable to consolidate and maintain the weirs of the historic watermills in order to promote their understanding, preserve the memory of the population and safeguard the environment of the rivers.

CODE 98

SEISMIC PERFORMANCE OF IRREGULAR SHAPE 20TH CENTURY BUILT HERITAGE IN MEXICO CITY

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KEYWORDS: Vulnerability; Damage index; Ductility; roof drift; Irregular shape.

ABSTRACT

The shape of a building has a significant impact on its seismic behavior, and researchers have been studying this since the early 20th century. Various factors, including height, weight distribution, and other parameters, have been investigated. Global seismic regulations emphasize maintaining specific proportions in building shapes to improve seismic resilience and minimize vulnerability.
Between 1920 and 1999, several vertical buildings ranging from 7 to 20 stories were constructed in Mexico City. These buildings are architecturally significant and representative of the construction practices of their time. However, some of them have irregularities in their floor plans that fail to meet contemporary seismic standards.
The objective of this study is to evaluate the vulnerability of such buildings characterized by irregular floor plan geometry and reinforced concrete walls and frames. Building models were created based on structural plans, and the study involved determining their dynamic elastic properties, capacity curves, and accumulated global damage indices. Various seismic analyses were conducted using 52 synthetic seismic records representative of the city's seismic hazard spectrum, including linear, step-by-step, and bidirectional non-linear methods.
The study presents findings from two buildings with irregular geometries and explores variations within each case. Despite the seismic parameters used in their original structural design differing from current standards, these buildings exhibit an acceptable level of vulnerability given the accelerations corresponding to the soil conditions they occupy. However, relocating these buildings and altering the foundation soil type results in varying levels of vulnerability. The extent of vulnerability modification depends on factors such as building height, dimensions of load-bearing elements, and their positioning within the floor plan, particularly in irregular geometries.

CODE 116

NUMERICAL SIMULATION WITH MACRO ELEMENTS OF OUT-OF-PLANE FAILURE IN ADOBE BUILDINGS UNDER SEISMIC LOADS

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KEYWORDS: Seismic resistance; Homogenization; Adobe.

ABSTRACT

Ecuador is located on the eastern rim of the Pacific Ring of Fire, an area known for its seismic activity. One notable city in Ecuador is Cuenca, a historical center of UNESCO World Heritage Trust since 1999, due to its many historic buildings often featuring adobe walls. This paper aims to numerically simulate the out-of-plane failure of three adobe facades representing typical buildings in Cuenca - Ecuador using homogenized properties of adobe to estimate the seismic resistance of these walls. A micro-model approach using a damaged-based model with material properties from experimental tests on units and piers defines the homogenized properties of adobe. The methodology uses numerical analyses of Representative Volume Elements (RVEs) to characterize the complex behavior of adobe and define orthotropic homogenized properties. Further, with the homogenized approach, it is possible to numerically represent the walls and obtain their capacity curves using displacement-based pushover analyses. Finally, the damage is characterized as a function of inter-story drift. The numerical method has been proven accurate and efficient since it uses a mixed implicit-explicit integration scheme. Moreover, it can capture in-plane and out-of-plane tensile, compression, and shear failure modes. This methodology can be extended to characterize complete 3D adobe structures with relatively little complexity. Future research in this area could improve our understanding of the structural behaviour for entire adobe buildings and aid in conserving historic buildings by proposing retrofitting techniques that improve seismic strength.

CODE 144

STUDY FOR THE PROTECTION OF HISTORIC BUILDINGS DUE TO THE CONSTRUCTION OF A TUNNEL THROUGH TBM IN THE CITY OF GUADALAJARA, MEXICO

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KEYWORDS: Tunnel; Risk of settlement; TBM; Cathedral; Historic buildings.

ABSTRACT

During the construction of the tunnel for line 3 of the Guadalajara Light Rail, the situation arose that the tunnel passed 1.5 m from the façade of the Metropolitan Cathedral of Guadalajara and the Metropolitan Sagrario.
Due to the high risk of damage to the building, the evaluation of the possible settlements initially produced by the construction of the protection measures based on Milan-type walls and the subsequent passage of the tunnel boring machine was carried out.
To carry out the analysis of settlements and the effectiveness of the protection measures, the characteristics of the Cathedral were approximately reproduced, such as those of the construction procedures of the tunnel, and the protection measures. For this purpose, three-dimensional numerical models were made using the PLAXIS 3D finite element program, to incorporate the main factors that could affect the structural integrity of the Cathedral and the Tabernacle church.
Finally, the results of the analyzes were consistent with the instrumental measurements and there were no effects on the Cathedral.

CODE 249

DAMAGE AND COLLAPSE OF CORNER BUILDINGS IN MEXICO CITY DURING THE SEPTEMBER 19, 2017 EARTHQUAKE

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KEYWORDS: Corner buildings; Hysteretic energy demands; Torsional eccentricity; Nonlinear dynamic analysis; Performance level.

ABSTRACT

On September 19, 2017, an intraplate earthquake of magnitude Mw=7.1 occurred in Puebla and became one of the most devastating events in Mexico City, mainly affecting the buildings on transition and soft soils. According to damage statistics among the corner buildings, 47% of them were in high risk and 38% collapsed. In this study, three numerical models of reinforced concrete buildings of four, six and eight floors with a flat slab were created. The corner buildings were designed with the regulations of the Federal District of 1976, and the geometry was determined by analyzing the characteristics of the damaged structures during the earthquake action. A nonlinear dynamic analysis was carried out by subjecting the buildings to 36 accelerograms recorded on the most affected areas, and the damage evolution was evaluated. The influence of the hysteretic energy demands of the masonry walls was greater in the early stages of performance, but its relevance decreased as their damage and the number of levels of the building increased. The participation of the ribs of the slab on the dissipation of hysteretic energy depended mainly on the building height and the contribution of other structural elements, became more relevant as the number of floors increased. The columns presented damage concentrations at the final performance levels and little uniformity in the energy dissipation distribution.

CODE 252

SEISMIC VULNERABILITY INDICES OF FAÇADES OF COLONIAL HOUSES IN THE HISTORIC CENTER OF MORELIA

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KEYWORDS: Seismic vulnerability; Facades of masonry buildings; Facades of heritage buildings; Damage scenarios.

ABSTRACT

The seismic vulnerability evaluation of façades of heritage masonry buildings is essential not only for their important historical value but also to evaluate the safety of this type of construction. In this study, a simplified methodology is applied to evaluate the seismic vulnerability of façades of masonry buildings in the historic center of Morelia, Michoacán, Mexico. The historic center of Morelia was declared a World Heritage Site by the UNESCO in 1991. The façades contain ornamentation with sculptural and vegetal decorative elements. The methodology adopted consisted of carrying out visual inspections to identify: location, type of structure, construction materials and the current state of doors, windows, balconies, cornices, ironwork, pediments, niches, sculptures, among other characteristic elements of colonial architecture. Based on the methodology and the compiled database, vulnerability indices were defined for different damage scenarios that buildings may present.

CODE 138

INTEGRATED STRATEGIES FOR REHABILITATION AND MAINTENANCE OF BUILDINGS IN RESPONSE TO THE HOUSING DEFICIT

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KEYWORDS: Construction Information; Building Registration; Rehabilitation Strategies; Maintenance Plans.

ABSTRACT

The shortage of affordable housing has been a growing problem in Portugal and in many other European countries, especially in large urban centers, both in terms of buying and renting. Although the construction of new homes is an important part of the solution, in recent years there has been a greater awareness that the rehabilitation of existing buildings is essential to the creation of a housing stock that allows for a market offering at affordable prices and with quality, comfort, and sustainability levels suited to current standards.
Public policies based on some tax incentives and financial aid, often on a case-by-case basis, have proven to be insufficient. The solution to this complex problem therefore involves the adoption of strategies that materialize an integrated vision of the various plans involved, including effective knowledge of the existing housing stock through the preparation of detailed building records, as well as the study, definition, and development of typified solutions for rehabilitation interventions, and also the implementation of effective maintenance strategies to avoid its progressive degradation and the early need for interventions of great economic impact.
This work explores the importance of information in construction as a structuring element for the implementation of these strategies, and presents methodologies based on the digitalization and standardization of information to facilitate the development of an integrated plan that includes the preparation of detailed records of the building, the study of typified solutions for rehabilitation interventions, and the implementation of effective building maintenance strategies.
By means of a review of literature related to the topic, and analysis of case studies of real buildings, including inspections and interactions with the entities responsible for them, information was collected and subsequently compiled to guide the investigation.
As results, classifications and models for structuring building registration data, BIM-based tools that allow for speeding up studies underlying rehabilitation interventions, and guides for preparing building maintenance manuals are presented.

CODE 341

LIQUID APPLIED ROOF WATERPROOFING KIT WITH AN INNOVATIVE INNER LAYER: TECHNICAL ASSESSMENT FOR CE MARKING

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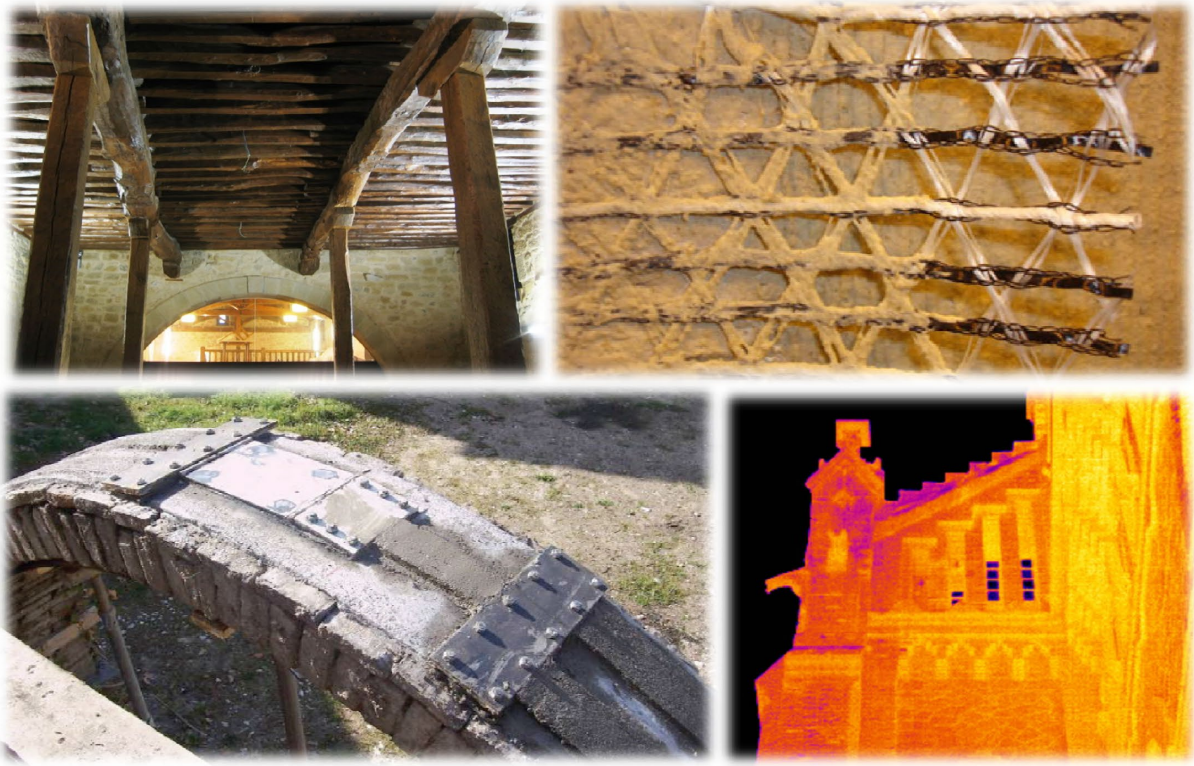
KEYWORDS: CE marking; Waterproofing membranes; ETA; Tests.

ABSTRACT

Over the years, the architectural option for flat roofs has been increasing and showing greater incidence in hot climates. This option poses several challenges to the construction industry, in various areas. This preference poses several challenges for the construction industry, namely: designers, who need to ensure that all unique situations are resolved; manufacturers, who need to offer completely watertight and durable solutions in the face of the expected demands (thermal amplitudes, expansion movements, weathering, resistance to roots, etc.); and he experts responsible for installing the solutions, who must have specialized skills to ensure flawless application.
Today, there is also growing concern about the environmental impact of products. In response to these concerns, the industry is working to develop innovative solutions with less environmental impact, without compromising their physical performance. One example of this effort is the Smart Roofs System project, whose main objective is to develop an advanced waterproofing system using a water-based polymeric material with UV-reflecting additives, reinforced by a textile substrate.
This paper presents the performance of that membrane, evaluated following the standardized procedures proposed in the European Assessment Document (EAD) 030350-00-0402. The performances of this and other water-based membranes available on the market are analysed. The system proved to be watertight and resistant to mechanical stress.
This research was funded by the FCT Portuguese Foundation for Science and Technology (UIDB/04625/2020) from the research unit CERIS.

2.- PROJECT



CODE 239

AN INSIGHT INTO THE ADJUSTMENTS FOR CHANGES IN COSTS FORMULA FOR CONSTRUCTION CONTRACTS ATTENDING REAL PLANNING

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KEYWORDS: Exceptional Regime; Homologous rate of change; Adjustment for changes in cost; Current formulas; Current cost indices; Adjustment multiplier; Construction contracts.

ABSTRACT

The cost management of construction contracts has required increasing rigor, using methodologies that can be adjusted to the diversity of cyclical changes. Price fluctuations, especially price increases in construction materials, due to the unstable market situation, require planning and decision-making that starts with the project. In many cases, planning is done considering only the present, but during the construction works unforeseen events and various external factors arise, which in many cases do not allow for procedural changes at a bureaucratic level, triggering management problems and money losses. The "adjustment for changes in cost" applicable to contracts covers the updating of prices based on updated indices of materials, labour, and equipment, but in certain phases of the construction works they do not compensate for the real and effective increase in prices of some materials. The adjustment for changes in cost is made based on an average of the most significant materials present in the project design, distributed throughout the construction works (contract application).
About a year ago, the exceptional regime applicable to adjustment for changes in cost, as known by "price revision" was created, and its application was extended until December this year, and considered other activities. This change contemplates the possibility for interested parties to present a correction or change in the application of the adjustment for changes in cost regime. This is attended to when the current one is not adjusted to the specificities of the contract or when it is omitted in the specifications. The new regime allows this adjustment, but in the future, this may not be possible, so the design of "adjustment for changes in cost" formulas must take into account some particularities of the construction work and foresee possible constraints, and lessons can be learned from current price inflation.
The paper intends to present formulas present in construction contracts and the proposal of possible solutions, procedures, and adjustments to these formulas, considering the planned planning for them. Their application in the calculation using the formulas meets the materials applied on specific dates, often neglected situations. The establishment of comparisons between the different projects under study allows us to know the financial compensation for contractors in the different situations studied, extending the comparisons with the price increase that occurred in materials.

CODE 245

INTERVENTION ON DIFFUSED ARCHITECTURAL HERITAGE IN SEISMIC AREA: WHICH INVESTIGATIONS FOR WHICH INTERVENTION?

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KEYWORDS: Historic masonry; Intervention; Seismic vulnerability; On-site tests; Diffused architectonic heritage.

ABSTRACT

The structural diagnosis is a key point in the preservation strategies of the historic buildings; it is often aimed at addressing the possible options - cultural and technical - for the preservation and/or repair, assessing the structural and materials conditions, as well as the possibilities and potential vulnerabilities of the building. The processing of the collected information leads to the formulation of projects and use strategies that have, as main priority, the safety of the structure with full compatibility with the building characteristics. The analysis involves research aimed at a) recognizing - and evaluating - the technological and morphological characteristics - or any pathology - through visual inspections, b) collecting data concerning the building evolution, c) surveying the geometry, the cracks and the structural discontinuities, d) the mapping of the surface decay, e) characterizing sampled materials through laboratory tests, f) studying detected problems through on-site tests. Despite the requests of the Italian Code, the knowledge process is often overlooked or carried out only superficially, being often considered a waste of resources. The paper analyses the main problems affecting the architectonic heritage and the suggested diagnostic solutions; the possible risks of un-reliable structural assessments and interventions are underlined.

CODE 295

DIFFERENT METHODOLOGIES FOR EVALUATING THE EQUIVALENT DAMPING RATIO DUE TO CROSS LAMINATED TIMBER ROOF STRUCTURE IN SEISMIC RESTORATION OF AN HISTORICAL CHURCH

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KEYWORDS: Historical churches; Masonry structures; Seismic restoration; Seismic improvement; Equivalent damping ratio; Cross lam roof structure.

ABSTRACT

The paper shows different methods to evaluate the Equivalent Damping Ratio for historical church reinforced by cross laminated timber roof structure. The role of roof in the seismic restoration of historical churches, characterized by one nave configuration and masonry walls, is crucial in order to avoid the out-of-plane rocking mechanisms of the lateral walls and reduce the in-plane shear forces stressing the façade. Wooden based roof structures are preferable for this kind of constructions because they respect the conservation requirements, being compatible to the original materials. Therefore, the roof should be able to dissipate the seismic inertia forces in the nave transversal response, working as a dissipative diaphragm. Some solutions for the roof-diaphragm are here discussed and the relative Equivalent Damping Ratio is evaluated for a case study modelled with finite elements. Equivalent damping ratio is initially estimated by nonlinear static analyses (pushover analyses) based on the Coefficient Method and the Capacity Spectrum Method. Moreover, the equivalent damping ratio is determined also by nonlinear dynamic analyses where the seismic action is represented by seven spectrum-compatible accelerograms. Finally, the equivalent damping ratio values are compared themselves to optimize the wooden based roof structures in terms of strength and stiffness by showing possible configurations for type of wood (hardwood in double planks or industrial technology as Cross Laminated Timber panels) and steel connections.

CODE 325

CONSERVATION-RESTORATION OF STONE MATERIALS: PROTOCOL FOR THE DEVELOPMENT OF PROJECTS BASED ON THE CHARACTERIZATION AND KNOWLEDGE OF THE MATERIALS

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KEYWORDS: Conservation-restoration; Characterization; Intervention; Preventive conservation; Multidisciplinary studies.

ABSTRACT

Although in the design of a conservation-restoration project of stone materials there is a consensus to determine the aspects to be evaluated and analyzed to select in a critical and argued way the most suitable intervention in each case and context, really, there is a great disparity when carrying out these projects, making difficult in many occasions the selection of the most appropriate intervention, its monitoring and future interventions.
The objective of this research is to design a protocol for the development of conservation-restoration projects of stone elements, establishing the work plan to be followed and the regulations and recommendations to be taken into account, establishing the characterization and knowledge of the stone materials as the basis of the interventions.
For this purpose, a review of the criteria, recommendations and current national and international regulations that address the processes of conservation-restoration intervention of stone materials has been carried out, bringing them together in a joint protocol.
The results show that before carrying out any conservation-restoration intervention, in order to select the most appropriate treatment in each case, either by direct treatments or, in order to select the most appropriate preventive conservation actions, 4 correlative quantitative characterization phases must be carried out: Phase 1) Characterization and diagnosis; Phase 2) Intervention proposal; Phase 3) Durability study and Phase 4) Preventive conservation plan. Taking into account the need to carry out each phase, a protocol has been designed for conservation-restoration projects divided into 5 work packages with different tasks: 1) Study of the state of conservation (characterization and diagnosis); 2) Proposal for intervention, dissemination and preventive conservation; 3) Implementation of the designed intervention (realization and documentation); 4) Final report (writing and delivery) and 5) Follow-up of the intervened property (monitoring, control and maintenance). In addition, the results show the need to use non-destructive and portable quantitative analysis techniques and to approach the studies and interventions to be carried out from a multidisciplinary perspective.

CODE 357

MINIMUM INTERVENTION CRITERIA AS A REFERENCE IN THE SPANISH FORTIFICATIONS' CONSERVATION AND VALORISATION

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KEYWORDS: Castles; Fortifications; Spain; Minimum intervention.

ABSTRACT

Spain's cultural heritage includes numerous castles, fortifications and walled cities that mark an extensive territory and which have enjoyed the highest level of heritage protection since the first law on historic-artistic monuments in 1933. The protection, conservation and diffusion of their values are a fundamental issue within the disciplines of cultural heritage, since the interests of all the disciplines involved in the matter, fundamentally history, archaeology and architecture, overlap in these heritage realities.

Conservation interventions on fortifications are approached from very different angles. Based on the situation in which these buildings find themselves, three main currents of intervention can be established. Often the work focuses on recovering large gaps that allow a complete reading of both the monument and the landscape that characterises the territory on which they stand. On other occasions, the interventions are aimed at adapting them to different uses - cultural or otherwise - or at the museumisation of the monument itself. Finally, when the buildings have already lost "the secrecy of form" as Brandi indicated, the interventions are limited to the conservation of the ruin and to facilitating its accessibility to the public.

This paper analyses different interventions in fortifications in Spain in which minimal intervention is the main characteristic of their conservation and valorisation projects, establishing points of convergence between them in the current cultural context. The works of the Catalan architects David Closes - Santa Caterina path - and Carles Enrich - accesses and landscape adaptation of Jorba Castle - , the Balearic architect Marià Castelló - towers of La Gavina and des Pi des Català - , the Extremaduran architects Julián Prieto Fernández, Jorge López and Javier Gómez de la Peña - rehabilitation of the Alcazaba of Badajoz - or the Andalusian Francisco Reina - castle of Jimena de la Frontera - share a vision of maximum respect for the historical fabric which translates into interventions of surgical precision on which this work focuses to extract their fundamental project strategies.

CODE 22

INFLUENCE OF THE RUSTIC CONSTRUCTION TECHNIQUE OF THE BAMBOO ENVELOPE ON THE THERMAL PERFORMANCE OF VERNACULAR HOUSING IN THE ECUADORIAN COASTAL REGION: THE CASE OF EL CARMEN-MANABÍ

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KEYWORDS: Vernacular architecture; Building Technique; Passive ventilation; Thermal behavior.

ABSTRACT

Bamboo has thermal characteristics suitable for construction in hot and humid regions. Guadua angustifolia has found extensive use in the construction sector in Ecuador for over 9,500 years due to its versatility, low thermal conductivity, adherence to architectural tradition, and affordability. The Ecuadorian coastal region has cultivated a series of architectural typologies that employ local materials and resources. Specifically, this applies to "El Carmen", a settlement located in the northwest of Ecuador that experiences a monsoon climate. The attributes of its structure are the walls made of "caña chancada," where the Guadua cane is unrolled through longitudinal cuts and incorporated as an enclosure material in the building. As a result of this practice, the percentage of cracks in the walls increases, which could be attributed to a defect in the construction technique. This publication intends to investigate and assess the influence of openings derived from the bamboo enclosure technique on the passive cooling system of vernacular housing typologies in "El Carmen". Based on the documentation obtained on-site, such as information on construction systems, technical qualities, climatic characteristics of the sector, and passive ventilation strategies, computational models were reconstructed and subjected to CFD simulation and evaluation of the thermal behaviour of the enclosures. Throughout the process, a quantitative assessment is conducted to measure the proportion of openings within the envelope and how they affect internal thermal comfort. These results determine the thermal impact of a vernacular construction system with openings and irregularities in its envelope.

CODE 23

USE OF RECYCLED AGGREGATES FROM DEMOLITION AND CONSTRUCTION WASTE IN THE DEVELOPMENT OF SOIL-BASED MATERIALS

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KEYWORDS: Improvement of soil materials; Construction waste; Recycled clay brick aggregates; Recycled concrete aggregates; Recycled asphalt aggregates.

ABSTRACT

The abundance of construction and building renovations in urban centers results in an increase in the demand for aggregates for construction, and the continuous increase in the amount of construction and demolition waste that is deposited in landfills. The present research, with the purpose of obtaining earth-based materials with good mechanical performance of resistance to compression and durability against humidity, experimented with earth and additions of recycled aggregates such as asphalt (2% and 4%), concrete (20%) and clay bricks (60%). The addition percentages of recycled aggregates were variations defined by the best results from the review of scientific articles. The following aspects of the raw material were studied: granulometry and Atterberg limits of the soil, granulometry of the natural and recycled aggregates, X-ray fluorescence (XRF) of the recycled aggregates. The hardened materials dried for 20 days and 46 days at room temperature and under shade were analyzed through compressive strength, and the physical properties of apparent density, porosity, water absorption by immersion and capillarity. The results showed that recycled aggregates derived from asphalt can be considered as an alternative for the development of soil-based materials with good mechanical characteristics and greater durability against water than materials developed with waste clay bricks, recycled concrete and traditional adobes.

CODE 24

CEMENT SUBSTITUTE BASED ON RECYCLED MARBLE POWDER TO IMPROVE THE STRENGTH AND DURABILITY OF MORTAR

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KEYWORDS: Waste marble powder; Marble recycling; Cement mortars; Physical and mechanical properties.

ABSTRACT

Waste marble dust (WMP) is an inert material derived from the sawing and processing operations of marble stone obtained from tombstone and grave manufacturers, and from waste dumps. The main objective of the work was to investigate the possibility of using WMP as a partial replacement of cement. Different substitutions of cement for WMP (5%, 10%, and 15%) were experimented with. The following aspects of the raw material were analyzed: granulometry of the sand, chemical composition of the cement and the WMP through X-ray fluorescence (XRF) and X-ray diffraction (XRD), mixtures of cement and WMP were also analyzed by XRF. The hardened mortars were studied after 28 days of curing through compression resistance, and the physical properties of apparent density, open porosity, water absorption by immersion and capillarity. In addition, the specimens tested under compression were crushed and studied via XRD. The results showed that the mortars with the incorporation of 15% of WMP increased the compressive strength and decreased the absorption of water by immersion and capillarity, resulting in an ecological material with better mechanical performance and greater durability than the mortars without replacement suitable for general use in various construction segments such as repair or finishing.

CODE 25

ADOBE STABILIZED WITH ASHES FROM THE COMBUSTION OF PRUNING AND GARDENING WASTE

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KEYWORDS: Stabilized adobe; Physical and mechanical properties; Pruning and gardening waste; Ash.

ABSTRACT

The large amount of ash generation is causing waste disposal problems. This article contemplates the study of the effects of ashes from the combustion of pruning and gardening waste on the physical and mechanical properties of adobes. The combusted elements were dry grass residues, small faique trunks and some species of shrubs such as durantas and cucardas. Different substitutions of sand for ash were experimented (2.5%, 5%, 10%, and 15%). The following aspects of the raw material were analyzed: granulometry of the sand, ash and soil, Atterberg limits of the soil, chemical composition of the ash through X-ray diffraction (XRD) and X-ray fluorescence (XRF). The hardened materials dried in the shade for 20 and 28 days were analyzed for compressive strength, and the physical properties of apparent density, porosity, water absorption, immersion and capillarity. The results showed that the adobes with the incorporation of 2.5% of ashes increased the compressive strength and decreased the absorption of water by immersion and capillarity, resulting in an ecological material with better mechanical performance and greater durability than traditional adobes.

CODE 65

IMPLEMENTATION OF COLOMBIAN TRADITIONAL MATERIALS IN CONTEMPORARY ARCHITECTURE - ANALYSIS OF ARCHITECT SIMÓN VÉLEZ' WORKS

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KEYWORDS: Construction system; Traditional materials; Joints; Guadua angustifolia kunth; Wood.

ABSTRACT

This study delves into the works of Simón Vélez, a Colombian architect, focusing on studying the relationship between structure and architectural design. The analysis explores Vélez's use of traditional Colombian materials, such as timber and Guadua angustifolia Kunth, while also examining the evolution of his construction system and identifying common architectural and structural aspects.
Objectives:

- To identify how Simón Vélez incorporates Colombian traditional materials into contemporary architecture in his works.
- To gain a comprehensive understanding of the architect's construction system and some of their key characteristics.
- To deduce the interplay between architecture and structure within the architect's body of work.

This study is based on the methodology developed during a master's thesis to explore the relationship between architecture and structure in finalized construction projects, focusing on the architect's body of work. Several stages were undertaken to accomplish this, including

- Defining the analysis methodology.
- Conducting an in-depth investigation of the case study involving interviews, site visits, architectural plan raising, and reviewing and analyzing various documents, photographs, sketches, and original architectural plans.
- Conducting a retrospective analysis of the selected works, involving systematically organizing acquired information and creating detailed architectural plans.
- Performing a comparative analysis of a subset of the architect's works.

As part of this research, comprehensive matrices were developed to encapsulate all the information necessary for a profound understanding of the construction systems employed in the analyzed works. The study found that the architect initially designed structures with bolted wood but later shifted to *guadua*, a bamboo species with a distinct morphological composition compared to wood. This shift led to the development of a unique system of joints specifically tailored for structures constructed with *guadua*. The comparative analysis unveiled intricate construction details that shed light on how the architect adapted the bolted wood system to *guadua* structures, identified common elements across his works, and demonstrated the symbiotic relationship he achieved between architecture and structure.

CODE 105

EXPERIMENTAL AND NUMERICAL ANALYSIS FOR EARTH STRUCTURES, FROM MATERIAL CONSTITUENTS TO MASONRY WALLS

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KEYWORDS: Stabilised earth block; Earth mortar; Earth masonry; Compressive strength; Homogenization.

ABSTRACT

Earthen construction is a vernacular building technique which adopts locally sourced materials and can provide an overall comfort of living. Despite earth being generally a weak structural material, it can offer an appealing solution for construction in terms of energy consumption and emissions. Reinforcement can be introduced in earthen structures to improve mechanical response of load bearing elements. It is therefore of interest to study its structural behaviour. In this paper a new building approach, developed in Senegal for reinforced earth walls, is presented. It is composed of concrete stabilised compressed earth block (CEB) and earth mortar. The blocks are moulded with hollows which allows a minimum reinforced concrete frame to be cast in them. The aim of this study is to analyse structural performance of constituent materials and contribution of reinforcement to masonry. Experimental tests have been carried out to identify mechanical properties of stabilised CEB and mortar (compressive strength, elastic modulus). Unreinforced and reinforced masonry walls have been tested in compression to investigate the contribution of the reinforcement frame. A homogenised FE model has been adopted to study the linear behaviour of the wall in compression, validated through experimental data.

CODE 109

ANALYSIS OF THE PERFORMANCE OF NATURAL LIGHTING IN TRADITIONAL ARCHITECTURE ON LAND. THE CASE OF THE CITY OF LOJA, ECUADOR

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KEYWORDS: Earthen architecture; Illuminance simulation; Daylighting; Lighting comfort.

ABSTRACT

The effects of poor lighting in buildings have a negative impact on the mood, productivity and general comfort of occupants. In many cases, these shortcomings are due to the limitations of the construction system, which makes it difficult to find solutions that allow the use of natural light and the preservation of traditional building features. The city of Loja preserves examples of traditional adobe architecture in the outskirts of the city, but the lack of habitability of the spaces for current uses and requirements leads to the abrupt modification of facades or the total replacement of the existing constructive typologies. This article presents an evaluation of the lighting comfort in a group of traditional earthen dwellings and the way in which they could be intervened to generate a better natural lighting performance. In order to carry out this study, the forms, spaces and construction technologies were characterised, internal illuminance information was collected in the spaces of traditional earthen dwellings and virtual models were developed to evaluate illuminance levels in different conditions. In addition, minimal modification solutions adapted to the construction technique that might be feasible to achieve indoor lighting comfort were tested. The results show that the traditional typologies respond to minimum illuminance levels that do not comply with current standards, but that with a slight modification of the construction elements it is possible to improve the lighting comfort conditions in the interiors and adapt them to current needs.

CODE 114

COLLABORATIVE WORK PRACTICES IN THE IMPROVEMENT OF TRADITIONAL HOUSING IN BOLIVIA'S CHIQUITANIA REGION

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KEYWORDS: Cultural heritage; Jesuit mission; Traditional chiquitano housing.

ABSTRACT

At the beginning of the 17th century, the Jesuits founded ten missions in the Bolivian Amazon region known as Chiquitanía. In 1990, the United Nations Educational, Scientific and Cultural Organization (UNESCO) declared six of them as Cultural Heritage of Humanity. This missionary heritage is visible in different aspects of the life of the Chiquitano inhabitant, where the new towns that have emerged since the twentieth century and inhabited by indigenous communities repeat features of this model at the urban, architectural and constructive level.
This study presents the experiences of construction practices in the parish of San Francisco Javier, to which eight indigenous peoples belong, all of whom share common architectural typologies and construction technologies. Currently, 80% of its inhabitants live in poverty and overcrowding, so in order to adapt their homes to the new requirements they choose to incorporate materials foreign to their tradition, which causes a loss of architectural identity and construction practices on the one hand; and on the other, abrupt environmental alterations that they must endure inside their homes, due to the suffocating heat during the day and low temperatures at night. The proposed objective was to strengthen the practice of adobe construction in the community, through self-construction systems to improve the habitability and health conditions of rural housing in Chiquitanía. The descriptive and observation methodology allowed us to evaluate the buildings to be intervened, considering aspects such as: feasibility of obtaining materials from the environment, lack and adaptation of required spaces, as well as the availability of appropriate labor. This was complemented with the participatory method in which the residents and project leaders worked together to reach the best solutions by managing the available materials and economic resources of each family.
The collaborative work in the community resulted in the intervention of 17 houses out of the 30 identified; mainly the change and improvement of roofs, repair and reinforcement of walls, and construction of additional dwellings.

CODE 115

ARGAMASA: THE EXPRESSION OF AN INDIGENOUS COMMUNITY FOR THE NOVO HISPANIC BAROQUE OF THE SIERRA GORDA IN QUERETARO, MÉXICO

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KEYWORDS: World Heritage Site; Franciscan Missions; Artistic Syncretism; Argamasa (mortar).

ABSTRACT

The Sierra Gorda, located in the northeast of the State of Querétaro in Mexico, is part of the Sierra Madre Oriental system. Rich in biodiversity due to its multiple microclimates, in the 15th century it became a space of rebellion and resilience for its inhabitants. Walled by nature, its intricate orography allowed nomadic cultural groups called *Chichimecas* to resist the yoke of Tenochtitlán and its allies. The social composition of these small groups, recognized as "warrior peoples", made it easier for them to fight any invader who arrived with a powerful army. After the fall of Tenochtitlan, their resistance continued against the new Spanish hegemony. The viceroyalty armies failed, as did the Mexicas, again and again trying to subject the irrepressible Chichimecas. The attempt of a spiritual conquest trough evangelization also failed. For two centuries, the viceroyalty rule was rejected. Well into the eighteenth century, Fray Junípero Serra achieved what three centuries and two imperial military systems had not: he founded, with the help of the Chichimecas, five sedentary populations that marked the transformation of the life system in the indomitable region, based on an ideological and architectural typology inspired by Thomas More's Utopia: The mission.
Through this article, we will analyze the architectural typology of the five Juniperian missions of the Sierra Gorda: Jalpan, Tancoyol, Concá, Landa and Tilaco. The analysis will focus on the following aspects: functional, distributive and expressive space, based on the graphic study of the architectural floors and elevations plans. The masonry construction system defines the architectural volume and the layout, while, in the expressive aspects, the mortar molded by the local inhabitants interpreting the Western Baroque language, becomes a vehicle of communication for cultural syncretism. Likewise, we will focus on the technical analysis of mortar as a system of expression, its material qualities, as well as maintenance, which have allowed the permanence to date of these five heritage buildings, despite the inclement weather, human intervention and the pass of the centuries.

CODE 117

CONSTRUCTION OF A PREFABRICATED VAULT PROTOTYPE WITH RAW EARTH AND WOOD AS A ROOF FOR BUILDINGS

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KEYWORDS: Raw earth; Bahareque; Quincha; Vault; Roof.

ABSTRACT

Constructions with raw earth are of great importance in various parts of the world due to their numerous advantages and benefits. The material used in the construction is considered ancestral and traditional and is made primarily of raw earth, water, and organic fibers. There are multiple construction techniques, and some are combined with other materials such as wood, bamboo, etc. Based on the bahareque technique that combines multiple materials, the objective of this research was to propose a prefabricated prototype of a vault as a roof for buildings. Being an experimental model, the study was divided into three stages: first, the optimal soil and possible natural and chemical additions that could be part of the material to cover the structural element were selected, second, the shape and construction system were studied, and third The prototype was built and mechanical tests were carried out. As a result, a 1:5 scale prototype was obtained, 0.65 m long, 30 cm wide and 0.14 m high, with a shape approximation to the Catalan vaults, combining wood, natural ropes, raw earth coating, and tensioners, supporting considerable loads in mechanical tests. This experimentation makes us think about the innovation of construction systems with raw earth, this being an alternative for new buildings to be built.

CODE 153

LESSONS FROM VERNACULAR BAMBOO ARCHITECTURE FOR SUSTAINABLE DESIGN IN HOT HUMID AREAS OF COASTAL MANABI

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KEYWORDS: Vernacular architecture; Coastal Ecuadorian houses; Bioclimatic design; Bamboo-building techniques, Project simulation.

ABSTRACT

It is now understood that vernacular architecture essentially embodies the tangible and intangible values of a community that comes to identify itself with what it builds as a result of its engagement and cultural legacy. In the coastal province of Manabí, Ecuador, the vernacular architectural heritage is mestizo, stemming from the intermingling of Spaniard techniques and indigenous craftsmanship that made extensive use of bamboo as the main building material. For centuries, vernacular bamboo houses have adapted to social changes and harsh coastal climatic conditions, displaying the effectiveness of their bioclimatic design with highly sustainable construction methods. However, over the past decades there has been a loss of passive climate control principles, mainly due to the substitution of bamboo in favour of culturally and environmentally foreign processed materials. Scientific literature has further explored the properties that distinguish *Guadua angustifolia kunth* from other bamboo species, placing it as one of the most sustainable and cost-effective materials for human use.
This paper proposes, based on historical analysis, to reveal the bioclimatic strategies bound to the material which could be implemented in a sustainable and comfortable housing design proposal. The aim is twofold: to highlight the bioclimatic nature of traditional architecture when associated with other local materials, such as *cade* and *quinche*, and to demonstrate the versatile performance of bamboo for sustainable constructions. DesignBuilder software is used to model the proposal, which is then evaluated under ASHRAE 55 adaptive comfort parameters. The results show a sustainable and energy efficient annual performance, with more than 98% comfortable annual hours using only bamboo, *quinche* and *cade* architectural and construction strategies. The study also highlights that a high thermal mass of the building, in conjunction with cross ventilation, is a very efficient strategy in hot humid climates, capable of ensuring indoor comfort without resorting to mechanical air-conditioning.

CODE 171

EVALUATION AND CHARACTERIZATION OF THE BUILT RURAL ENVIRONMENT OF THE MONTESINHO NATURAL PARK, PORTUGAL. THE INHAVIT PROJECT

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KEYWORDS: Vernacular architecture; INHAVIT project; Chalkboard roofs; Water mills.

ABSTRACT

In Portugal, in recent decades, there has been an increase in the population and cities located on the coast and, on the contrary, a decrease in inland locations, with greater severity in rural areas. The causes are complex and not consensual, but it is clear that factors such as the lack of investment in the interior, emigration and migration to a coast that is increasingly autistic in its relationship with the rest of the territory, the abandonment of agriculture and aging of the population constitute sufficient ingredients to promote the desertification of some areas of the country.
The abandonment and desertification of villages is not just a problem in Portugal, however. Although Portugal is one of the countries most affected by this problem that affects the entire national territory, it is a European problem that has been increasing since the second half of the 20th century.
Concerned about this fact, which puts at risk the high level of abandonment of villages and places in the interior of Portugal, particularly those located in the northeast of Trás-os-Montes, the InHaVit Project - Sustainable approaches for the rehabilitation and revitalization of the cultural heritage built in the Montesinho Natural Park (PNM), funded by FCT – Fundação de Ciência e Tecnologia, has as its main objective the evaluation and characterization of: (1) the rural built environment of the PNM, at the level of buildings and at the level of villages; and (2) socioeconomic and environmental factors that contribute to the vulnerability of PNM villages and vernacular architecture. In-depth knowledge of these aspects will help to understand the reasons why the villages were progressively abandoned. In the end, the project will propose strategies for risk mitigation, rehabilitation and conservation of built heritage, recognizing that the appreciation and preservation of vernacular architecture is a key element of cultural identity and that it can become a privileged factor for local development.
This article aims to show the work methodology relating to the “in-situ” survey carried out so far, relating to point (1), as well as some very particular aspects of this region, namely the slate roofs and the water mills.

CODE 186

COMPARATIVE STUDY OF CONSTRUCTION OPTIONS BASED ON SUSTAINABILITY ASSUMPTIONS

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KEYWORDS: Sustainability; Rehabilitation; Isolation; Solutions; GGE Reduction.

ABSTRACT

Sustainable development is an approach grounded in the balance among three dimensions, namely environmental, social, and economic, aiming at satisfying current needs without compromising those of future generations. In the construction industry, sustainability seeks to ensure that processes of construction, rehabilitation, and demolition employ strategies that reduce environmental impacts, promote economic viability, and enhance the quality of life for generations to come. With this premise in mind, the study's objective is to conduct a comparative analysis of construction solutions that embody greater sustainability principles and meet minimum requirements for thermal performance. The goal is to identify viable solutions that minimize environmental impact, achieve energy and embodied water reductions and contribute to the reduction of greenhouse gas emissions.
The selected construction options under study were analysed based on collected results from various environmental impact categories, such as GWP, ODP, AP, among others. Bibliographic studies were conducted to support the analysis, in addition to consulting the EPDs used in construction products applied in the different studied solutions. The results are based on a proposed solution for the rehabilitation of a building, suggesting the replacement of conventional processes with sustainable and thermally efficient construction methods that are applicable.

CODE 210

STANDARIZATION FOR THE ENHANCE OF RAMMED EARTH'S MECHANICAL PROPETIES

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KEYWORDS: Unstabilized Rammed Earth (URE); Rammed earth; Suitability criteria; Sustainability; Architectural Heritage.

ABSTRACT

Nowadays, there is a growing interest in earth construction as a solution to the need for reducing the environmental impact of the building sector. Among all earth construction methods, rammed earth stands out not only as an ecological alternative but also as a solution with social benefits due to its cultural roots in diverse regions. Rammed earth structures often do not meet the strength and durability requirements of current construction standards and regulations. Therefore, for its implementation as a sustainable material, various suitability criteria are being studied with the goal of optimizing the use of local materials and analyzing the influence of these criteria on the primary mechanical properties of rammed earth. A systematic review was conducted to analyze the results obtained in previous studies that used various suitability criteria. Some of these criteria were commonly employed in prior research, while others were defined in this study. The results indicated that the primary suitability criteria, such as particle size distribution envelopes, were not conclusive in enhancing the compressive behavior of unstabilized rammed earth.

CODE 230

RE-BUILD UKRAINE, REFLECTIVE RE-CONSTRUCTION OF A BOMBED NEIGHBOURHOOD IN IRPIN

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KEYWORDS: Vernacular wood architecture; Izba; Reversible intervention; X-lam; Steel structure.

ABSTRACT

The paper addresses the issue of reconstruction of cities bombed by war conflicts with the aim of recovering reusable building materials and components in reconstruction and proposing a sustainable reconstruction model. The paper illustrates the reconstruction project of a neighborhood in the city of Irpin, near Kiev (21km in the West), destroyed on March 6, 2022, during the Ukrainian-Russian conflict with numerous casualties and atrocities. The project involves the incorporation of new structures within the solid brick walls of the ruined houses, creating new spaces from the intersection of old and new. The project concept is the izba, the Russian wooden vernacular house with the centrality of the fireplace used to heat the rooms, a symbol of unity and sharing of family home life, chosen as a symbol of the common roots and traditions between Ukrainians and Russians. The main points underpinning the project are inclusion and cohesion, the recovery of common traditions and the spirit of brotherhood, and the use of ecological materials and economical and robust construction technologies that are quick to assemble and reversible. The intended use of the reconstructed complex is a shelter and first aid center for victims of the conflict. The reconstruction project demonstrates how ruins can and should be used into the sustainable reconstruction of bombed cities and how from these ruins of war can be designed places of peace and brotherhood between the Ukrainian people and the Russian people who have the same cultural roots and building traditions.

CODE 243

ADOBE REINFORCED WITH REEDS AS A THERMAL-CONSTRUCTION STRATEGY FOR RURAL HIGH ANDEAN HOUSING IN PERU

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KEYWORDS: Reinforced adobe; Housing; Rural; Andes.

ABSTRACT

This research has a descriptive approach and seeks to explain the processes and strategies developed in the Sumaq Wasi rural housing project ("Beautiful House" in Quechua language) promoted by the Peruvian government to improve the living conditions of the most needy populations in the south. of Peru through the National Rural Housing Program (PNVR).
These housing units are built in rural contexts at high altitudes, on average between 3,500 and 4,000 meters above sea level, very wild and cold areas, where habitability conditions are seriously affected. The analysis of this large-scale project focuses on two strategies: Construction aspect, based on the use of adobe reinforced with reeds as the main material, taking advantage of its low cost and ancestral knowledge of the technique by the population, thus achieving the preservation of the construction heritage. of these geographical areas. A bibliographic review was carried out that demonstrates an acceptable level of resistance compared to other structural systems. Thermal aspect, the problems faced by the typical high Andean home and the thermal comfort strategies used in the intervention at the level of roofs, walls and floors are explained, which allow the temperature to be raised by up to 10°C with respect to the outside. These results would demonstrate the effectiveness of the strategies developed, however, in the present research they propose some alternatives for better thermal-construction performance in this important rural housing program.

CODE 287

EARTH AS A TRADITIONAL BUILDING MATERIAL IN MESETA IBÉRICA

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KEYWORDS: Meseta Ibérica; Earth; Building Materials; Vernacular Construction; Heritage.

ABSTRACT

Research work has been done in Meseta Ibérica to characterize its landscape. Meseta Ibérica (MI) is a biosphere reserve. It includes the territory of Portugal and Spain. Douro River International is a physical border. Due to natural richness, preserving and enriching this region is crucial. Therefore, a detailed survey was performed to get data about the landscape that will guide the managing entities. This team focused on studying the urban areas of Meseta Ibérica from a village-scale perspective. The process was to be manageable, so six villages were chosen as references. These six villages are Atenor, Rio de Onor and Bemposta, from Portugal, and Fariza, Riomanzanas and San Martín de Castañeda, from Spain. Altogether, 767 buildings have been studied so far. A detailed survey has been done to collect data concerning several building aspects concerning the buildings of these villages. This paper intends to highlight the relevance of the application of earth as a traditional building technique in this region. Examples of vernacular rehabilitated buildings are given.

CODE 328

IMPACT OF MOISTURE CONTENT ON THE MECHANICAL PROPERTIES OF SAN CRISTOBAL'S STONE (ANDALUSIA, SPAIN)

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KEYWORDS: Building stone; Mechanical properties; High-porosity sandstone; Static and dynamic elastic modulus; Uniaxial compressive strength.

ABSTRACT

San Cristobal's stone is a high-porosity building sandstone. It was widely used for the construction of numerous iconic historical structures in Andalusia, Spain during the 15th-18th centuries. These structures included religious, military, and civil buildings, such as the Cathedral (1434) and the Monastery of San Jerónimo (1414) in Seville (Spain) and Santiago Church (15th century) and San Dionisio Church (15th century) in Jerez de la Frontera (Cádiz, Spain). To ensure adequate conservation, many of these structures have been evaluated in recent decades due to damage detected in areas affected by moisture. Taking into account that structural assessments of historical buildings require a thorough understanding of the mechanical properties of the materials used, it seems important to comprehend how moisture affects the mechanical behaviour of this sandstone to ensure sufficient safety levels in in the aforementioned structures.
This study aimed to determine the elastic moduli, both static and dynamic, and the uniaxial compressive strength of San Cristóbal's Stone under dry, a moisture content of 40% and saturated conditions in order to examine the influence of moisture on these properties. For this, sixteen cylindrical specimens were extracted by drilling from columns and walls of Santiago Church and were tested in laboratory. The results indicate that moisture content has a direct effect on the deformability of the stone, particularly between dry and 40% moisture content states. The elastic modulus values, both static and dynamic, are reduced with average values of 16.98% and 22.85%, respectively. The loss of uniaxial compressive strength between the dry and saturated states is established with a mean close to 30%.

CODE 332

PHYSICAL-MECHANICAL DEGRADATION OF A CALCARENITE STONE USED AS STRUCTURAL MATERIAL. SAN CRISTOBAL'S STONE (ANDALUSIA, SPAIN)

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KEYWORDS: New-old rock; Apparent density; Porosity; Calcium carbonate; Modulus of elasticity.

ABSTRACT

The calcarenite rock from southern Andalusia, as a construction material, is characterized by its low mechanical performance, such as compressive strength and low-magnitude elasticity modules. Numerous buildings in this region of Spain were constructed with this material between the 15th and 18th centuries.
Recent interventions and structural reinforcements of buildings constructed with this material have prompted this study to determine the differences between the aged rock from these constructions and the unaffected rock from the quarry. The aim is to recognize whether notable differences in their properties have occurred, confirming the existence of a physical-mechanical degradation between the two groups, developed over time as a structural material.
Samples of aged rock from one of these buildings and samples of "new" rock freshly extracted from the historic quarry are available. An extensive campaign has been conducted to characterize their physical, chemical, and mechanical properties.
The results indicate notable differences in porosity and, consequently, in apparent density between the two groups. Chemical variations suggest the same mineralogical composition but in different proportions. These disparities between groups translate into significant changes in their resistance properties, providing insight into the reasons for reinforcing these buildings.

CODE 348

AN EXPERIMENTAL ANALYSIS ON THE THERMAL PERFORMANCE OF RAMMED EARTH WALLS

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KEYWORDS: Sustainability; Earth construction; Rammed earth; Thermal performance.

ABSTRACT

Earth has been used as a building material since the beginning of civilizations and its utilization was widespread to most regions of the world, promoted by the high availability, easy access, and low cost of the material. As result of the generalised use of raw earth as building material, many earthen building techniques were developed through time, where adobe masonry, rammed earth and wattle-and-daub are among the most important. Currently, it is estimated that one quarter of the world's population lives in buildings made of earth. However, during the last century, earthen materials fell into disuse in several developed countries with the popularization of concrete, steel and fire bricks. Nevertheless, earthen architecture has been receiving increasing attention in the last few decades, driven by its green building potential and by other features of earthen materials, which includes, among others, unique aesthetics and hygrothermal regulation capacity.

Several studies have been developed to characterize earthen solutions concerning physical and mechanical properties. However, regarding the thermal behaviour, it is known that the thermal conductivity of rammed earth is a parameter that depends on the characteristics of the soil (particle size distribution, mineralogy, etc.) and moisture content. Thus, given the soils variability, it becomes clear that further investigation should be addressed to characterize the thermal performance of rammed earth solutions, contributing to define more accurate thermal conductivity values for the design of rammed earth buildings. On this regard, this paper presents an experimental study that aims to characterize the thermal behaviour of rammed earth built with different soils and with different thicknesses. A continuous measurement allowed to obtain heat fluxes, inner surface temperatures and the thermal transmission coefficient of the tested rammed earth walls solutions. Values of 0.72 W/mºC and 1.17 W/mºC were obtained for the thermal conductivity, showing the thermal behaviour variability depending on the soil composition. It was also confirmed that thickness significantly influences the earthen solution thermal behaviour, being verified that the thermal transmission coefficient of a 50 cm thick wall is about 30% lower than the one verified for the wall with 35 cm, built with the same soil.

CODE 377

ANALYSIS OF THERMAL COMFORT BETWEEN A LIGHTWEIGHT INDUSTRIALIZED SOLUTION VERSUS THE TRADITIONAL TECHNIQUE OF BUILDING CONSTRUCTION IN THE DOMINICAN REPUBLIC: MONITORING

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KEYWORDS: Lightweight Solutions; Wood; Traditional Construction; Concrete Blocks; Monitoring; Thermal Performance; Tropical Climate.

ABSTRACT

Adapting new buildings to emerging construction techniques requires a phase of learning and demonstration of their environmental, social, and economic benefits, especially in countries where traditional construction solutions predominantly rely on a single option, such as concrete blocks, as is the case in the Dominican Republic. This research proposes a comparative analysis of facade solutions produced in a traditional manner, using concrete blocks covered in mortar, versus a light wooden framework solution with EPS insulation. The proposed methodology includes a mechanical and thermal characterization of the solutions on a laboratory scale, complemented by the real-scale construction of two experiment modules measuring 3.0 x 3.0 x 2.75 m. These modules belong to the Laboratory for the Characterization of Sustainable Construction Solutions at the Pontificia Universidad Católica Madre y Maestra. The modules have been monitored by a series of sensors, both inside and outside, measuring surface temperature, air temperature, relative humidity, CO2, and other climatic variables. The primary objective of the research is to demonstrate the thermal comfort benefits that the lightweight industrialized wooden solution can offer compared to the traditional construction of concrete blocks in the Dominican Republic. Approximately 79% of the buildings in the country have facades constructed with concrete blocks, resulting in a significant impact on the exploitation of non-renewable resources such as aggregates from rivers and mountains.

CODE 378

RUBBERIZED CONCRETE MASONRY UNITS FOR FACADES: MECHANICAL AND THERMAL INFLUENCE OF THE ADDITIONS OF RECYCLED TIRE RUBBER IN THE DOMINICAN REPUBLIC

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KEYWORDS: Environmental sustainability; Tire recycling; Compressive strength; Thermal conductivity; Concrete blocks with rubber.

ABSTRACT

The construction of housing in the Dominican Republic relies predominantly on concrete, creating a significant environmental impact. Most urban areas throughout the country are dominated by concrete block enclosures, in contrast to other nations where a variety of building cladding materials are utilized. Another issue that substantially contributes to local environmental degradation is the waste generated by the ineffective management of used tires. In this context, the potential reuse of crushed tires in concrete production is analyzed. However, it is crucial to understand how this addition affects concrete properties, especially in terms of compressive strength and thermal conductivity. The development of this research was carried out by manufacturing concrete samples for concrete blocks, with different proportions of crushed tires (2.5, 5, and 7.5%) as partial replacement of fine aggregate. The results obtained in this research indicate that the addition of crushed tires in the studied percentages does not adversely affect the mechanical strength of the concrete. Furthermore, a notable decrease in thermal conductivity has been observed in the samples. These findings suggest that concrete modified with crushed tires could be a promising solution in construction and thermal insulation applications. From an environmental perspective, this approach facilitates the reuse of a material that would otherwise be considered as waste and improves the energy efficiency of buildings. This dual advantage results in a significant reduction in energy consumption and costs for users, highlighting the implications of this sustainable and economically viable solution.

CODE 26

MECHANICAL PERFORMANCE OF TERNARY CEMENTS MANUFACTURED WITH SILICA FUME AND LIMESTONE

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KEYWORDS: Ternary cements; Silica fume; limestone; Mechanical strength; Cements properties.

ABSTRACT

Ternary Portland cements manufactured with silica fume (D), limestone (L), and Portland cement (CEM I) present several environmental advantages due to the clinker content lowering in the resulting Portland cements. Blended cements contribute to reduce the clinker factor target, which currently is about 0.78, and is expected to be around 0.60 by 2050. This objective will help Europe to be climate neutral. Ground limestone offers three major outcomes, i.e., dilution (decreases the hydration products content and increases the porosity), filler (refines the microstructure of mortars and concretes), and chemical effects (carboaluminates formation and porosity reduction). On the other hand, silica fume (D) participates in the pozzolanic reaction. Accordingly, compressive strength and durability is improved. This paper deals with the mechanical characteristics and synergetic mechanism of Portland cement-silica fume-limestone ternary cements. Two, seven, 14 and 28 days compressive and flexural strength determined in Portland cement mortar is presented. It was found that silica fume exhibits a lower effect on the nucleation at early ages than ground limestone. Furthermore, nucleation and filler effects are less marked at early ages in coarse and fine ground limestone. The greatest mechanical strength at 28 days was found in the mortars made with 3% of silica fume; whereas Portland cement mortars prepared with a high content of limestone yielded a delay in the rate of gain of compressive strength.

CODE 38

RETROFITTING OF RC COLUMNS CONFINED WITH CFRP JACKETS. EXPERIMENTAL STUDY ON DUCTILITY IMPROVEMENT

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KEYWORDS: Retrofitting; CFRP; Full-scale columns; Ductility enhancement; Axial compression.

ABSTRACT

Confinement with fibre reinforced polymers (FRP) is capable of increasing the strength and ductility of reinforced concrete (RC) columns. However, in situations where ductility is the main concern, e.g. in seismic retrofitting of RC columns, a small amount of FRP confinement may be sufficient in terms of ductility enhancement although it may not be sufficient for a significant improvement in loadbearing capacity. In such a situation, an analysis of the post-peak stress-strain response of FRP confined concrete to study the ductility is interesting to structural engineers.
A few studies have quantified and compared the increase in ductility for RC columns with different cross-section most of them in small-scale tests.
The paper summarises the results of an experimental program in which 6 low-strength reinforced concrete columns were subjected to axial compression to failure. All columns have a height of 2400 mm and three different cross sections: circular, square and rectangular. For each cross-section, one column was reinforced with the carbon FRP jacket and the other one was tested without reinforcement.
Experimental results of three different cross-sections are analysed and compared, quantifying the strength improvement and paying special attention to ductility.

CODE 61

UNDER SLAB VENTILATION STUDIES IN THEIR ABILITY TO REDUCE RADON INGRESS IN BUILDINGS

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KEYWORDS: Radon mitigation; Sub slab ventilation system; Ventilation scenarios; Chamber depressurization; Effectiveness.

ABSTRACT

Radon gas is a pollutant that can be found in living spaces. This natural origin gas, generated in the earth's crust, is capable of moving between the pores of the soil and penetrating the building. Its accumulation in high concentrations constitutes a risk for occupants. The World Health Organization classifies it as a grade 1 carcinogen. WHO and various institutions promote actions to avoid its presence in buildings. These are divided into: a) those that act on the source of radon, such as ground depressurization systems or ventilation under slab or crawl space chambers, b) radon membranes or c) indoor ventilation. Although the existing documentation sets the working guidelines, there is a lack of specific studies to help technicians to design and size mitigation measures. This paper presents a study on one of the strategies in which the air space of a ventilated floor system is used as a gas evacuation mechanism. It is a highly effective measure and suitable as a retrofit system. Different scenarios such as ventilation, pressurization or depressurization of the chamber are considered. Parameters such as the volume of the space, the application surface, the air flow rates or the pressure states generated in the chamber, configure different options of use with different associated effectiveness. It is shown the field experimentation carried out in a real demonstrator and the results of the different configurations, which improve from the unventilated state, through the ventilated state, to the maximum effectiveness in depressurization and pressurization scenarios. The different phases also distinguish the power of the exhaust fans and their location in the building. In parallel, laboratory tests have been carried out to study the airtightness offered by the air chamber of the ventilated floor system, complementing those studied in the demonstrator.

CODE 62

LOW CO_2 FOOTPRINT AND HIGH CIRCULAR CEMENTITIOUS BINDERS FOR BUILDING REHABILITATION BASED ON MINERALIZED RCF AND LF STEEL SLAGS UNDER SYNERGISTIC APPROACH

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KEYWORDS: Mineralization by accelerated carbonation; Alkaline waste; Low CO_2 binders; Binders for building rehabilitation.

ABSTRACT

The CO_2 footprint reduction in conventional Portland cement production constitutes a huge challenge due to the limited availability of low carbon footprint and economic Supplementary Cementitious Materials (SCM) supplies to be employed in clinker substitution. This challenge increases when developing specific binders with a low carbon footprint for building rehabilitation due to the unique properties that these binders must meet, such as durability, compatibility, application flexibility and ease of use. A Carbon Capture and Utilization (CCU) approach based on mineralization by accelerated carbonation of concrete fines (RCF) and ladle furnace (LF) steel slags derived from industrial and urban alkaline waste currents, appears to be a feasible route to reduce sectorial carbon footprint and promote new circular building materials. In this work, a CO_2 sequestration was performed on different conditions to RCF and LF. The amount of CO_2 captured was calculated and the mineralogical transformation monitored by spectral tools (Raman, HSI), for process optimization. Once the lab scale carbonation processes were applied, the effect of mineralization on new binders was assessed through the reactivity and accelerated pozzolanicity analysis. The obtained materials were synergistically employed as SCM in novel cementitious binders for building rehabilitation.

As a result, relevant CO_2 capture (between 50 and 117g eq.CO_2/kg by RCF and LF respectively) and lower clinker content (<30%) by replacement yielded high circular low carbon footprint binders, according to the performed Life Cycle Analysis (LCA). The synergistically use of the obtained mineralized wastes as SCM on new binders' dosages, led to increase on pozzolanic phases generation. Carbonated RCF and LF wastes used as SCM in binders showed to be beneficial to obtain mechanical performance gains (achieving an increase in accelerated pozzolanic activity of 150%.) and lower environmental footprint, as a lower carbon footprint and less use of virgin raw materials (-27% CO_2, -270kg/t of binder) than a commercial binder. This research has been developed under NEUCLICEM project, co-funded by IHOBE, the public environmental management company of the Basque Government (Spain), through the program *"Eco-design, demonstration projects on circular economy and strategic eco-innovation"* (2020), FYM (HeidelbergCement Hispania), and VOLBAS.

CODE 79

GEOPOLYMER CONCRETES DESIGNED FOR ENVIRONMENTAL BIOREMEDIATION: EXPERIMENTAL RESULTS OBTAINED IN THE KEOPS PROJECT

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KEYWORDS: Sustainability in construction; New construction materials; Geopolymer concretes for environmental bioremediation.

ABSTRACT

The R&D&I project "KEOPS: Research into geopolymeric cementitious solutions with comprehensive sustainability and high added value from construction waste", launched in 2020, develops innovative geopolymeric concretes that dispense with Portland cement in their composition due to its high environmental impact. As an alternative to this material, geopolymer products obtained from the combination of electric arc furnace steel slag as precursors, in particular white slag and iron and steel aggregates, with different types of activating solutions, are used. This work presents the main conclusions obtained in the development of geopolymer concretes for environmental remediation, designed within the framework of this project for the capture of heavy metals from road traffic in transport infrastructures. In addition to proposing different experimental dosages and working formulas for non-structural concretes, aspects related to their porosity, workability and consistency, absorption capacity, density and mechanical resistance were investigated. The preliminary results and conclusions of the KEOPS project, which had previously been presented at the REHABEND 2022 congress, have been extended and deepened.

CODE 101

APPLICATION OF BIM METHODOLOGY TO STRUCTURAL INSPECTION OF BRIDGES

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KEYWORDS: BIM; Inspection; Structure; Bridges; Operation and maintenance.

ABSTRACT

During any structure life cycle, it is necessary to stablish the proper maintenance protocols, furthermore if bridge constructions are being considering. These actuations contemplate both periodic and principal inspections. In the mentioned procedures, the preservation status is analyzed. Depending on it, one status index, the relevant improvement recommendations, as well as the deadline to complete the works are assigned.

The BIM methodology, (Building Information Modeling) is applicable to the whole structure life cycle, from the basic design stage to the final demolition of the construction.

In the present investigation, the BIM methodology has been incorporated to the bridges operation and maintenance (O&M) stage, applying specifically to the inspection works.

On the one hand, the bridge model contains geometric information, being a virtual representation of the real structure. On the other hand, the model includes semantic information. In this regard, all the evidences discovered during the inspections, and the existing repairing works done over the structure previously are considered in the BIM model. Additional relevant information is considered as well.

So, the inspection procedure is digitalized and all the relevant information regarding one specific structure is summarized in one unique digital file. This file can be updated in a periodic manner, or once the structure should be inspected and/or repaired.

In this way, it possible to have available one historic documentation, containing all the inspections and allowing to have an idea about the bridge evolution during its life cycle.

Finally, to use the BIM model with different views depending on the inspection and showing the output information from these views using filters or labels, is a great help to the structure owner or manager. The data visualization, structure status analysis and construction behavior is much easy in comparison with the traditional methods, as for example drawings, technical reports, Excel files…etc.

CODE 126

HBIM APPLIED TO THE PBE AND DO FOR THE CONSERVATION WORKS OF THE CLAUSTRO GRANDE DEL MONASTERIO DE STA. MARÍA DE SOBRADO

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KEYWORDS: BIM; HBIM; Built heritage; BEP; Restauration.

ABSTRACT

BIM (Buliding Information Modeling) methodology is based on the generation of models with information. However, its application to heritage, HBIM (Heritage Building Information Modeling), is limited.
Heritage buildings elements' geometry is one of the great obstacles in BIM application, but it is not the only one.
The present study focuses on the development of the Proyecto de Conservación del Claustro Grande del Monasterio de María de Sobrado Dos Monxes (A Coruña), BIC and World Heritage Site, in BIM format.
An execution methodology is proposed through a BEP (Building Execution Plan).
Among the main topics to be discussed are the search for heritage elements categorization, the study of parameters types that best define the pathological processes that affect the monument, nomenclature generation, process automation, etc.
From this experience, problems, opportunities and possible research paths are extracted.

CODE 131

A BIM TOOL FOR THE QUANTIFICATION OF WASTE AND IMPACTS IN HISTORICAL BUILDINGS RENOVATION PROJECTS

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KEYWORDS: BIM; Renovation; Circularity; Waste; Demolition.

ABSTRACT

Building Information Modelling (BIM) is a powerful methodology that is widely used in the design, construction and maintenance of buildings. However, it can also offer significant benefits for renovation planning and waste management, such as enhanced collaboration, accurate waste quantification and improved safety. LiDAR scanning technology can be used to capture the visible surfaces. Digital models based on BIM methodology can include the elements and materials to support quantification and traceability. Nevertheless, both are expensive and time consuming in most renovation projects due to their complex modelling and data integration.

A new software tool called BIM4DW has been developed in the framework of the European project ICEBERG (HORIZON2020, GA869336). This web-based tool can reduce the time required for modelling and inventory. It also eliminates the need of previous complex BIM models. By combining a 2D/3D modelling interface with parametric databases of common building elements, BIM4DW allows architects and restorers to identify and quantify materials quickly and accurately. The tool also supports the definition of refurbishment and partial demolition techniques and quantification of waste streams, as well as calculating the total time, environmental impacts and cost of each intervention.

This paper presents the results of validating BIM4DW in one renovation project of an historical building in Madrid (Spain). The study found that BIM4DW accurately identified and quantified waste, improved control of the renovation tasks. However, there were also areas where the tool could be improved, such as the sketching module and the traditional (non-linear) building elements.

CODE 132

MIXED RECYCLED AGGREGATES CLASSIFICATION USING IMAGING AND DEEP-LEARNING TECHNIQUES FOR EFFECTIVE WASTE MANAGEMENT IN REHABILITATION WORKS

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KEYWORDS: CDW management; Image-based classification; Semantic segmentation; Mixed recycled aggregate fractions; Deep-learning techniques.

ABSTRACT

The rehabilitation and renovation of existing buildings generate significant amounts of construction and demolition waste (CDW) [1]. Proper classification of this waste is crucial for effective waste management and resource recovery. However, identifying and classifying the waste can be a tedious, costly, and error-prone process, which can lead to inadequate treatment and have a significant impact on the environment. This study focuses on the development and laboratory testing of advanced classification methods based on image processing and semantic segmentation to classify mixed recycled aggregate fractions. A comprehensive comparison is made between two different approaches: a semantic segmentation without ground truth, i.e. training the neural network without a reference target, and a semantic segmentation trained after exhaustive labeling of the classes.

A dataset of images of different types of CDW, including pure samples of concrete, ceramics, and plaster, as well as prepared mixtures, was collected, labeled, and segmented. The study applies deep-learning techniques and evaluates the performance of the two methods by quantifying the amount of each component in the image. The first approach involves training a supervised semantic segmentation network to learn the distinctive features of each pure class of material without mixing and assigning semantic labels to pixels. The second approach involves manual labeling of the classes in mixed samples as ground truth for the model. The results reveal that both approaches have distinct advantages and disadvantages. The ground truth- based approach provides an accurate and reliable reference but requires considerable effort in manual labeling. On the other hand, the classifier training approach is more efficient in terms of time and resources but may be subject to classification errors. We further show that fine-tunning the ground truth-free model on few labeled samples outperforms both alternatives and represents a data-efficient trade-off.

In conclusion, this study demonstrates the potential of deep-learning techniques with image analysis for cost-effective CDW classification. The results obtained in this research can serve as a basis for developing more accurate and reliable methods for CDW identification, contributing to sustainable CDW management for rehabilitation and renovation works.

CODE 146

DIATOMACEOUS EARTH AS A PARTIAL REPLACEMENT FOR PORTLAND CEMENT IN MORTARS - A REVIEW

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KEYWORDS: Sustainability; Alternative binders; Diatomaceous earth; Cement mortars.

ABSTRACT

Over the last years, the increase in CO2 emissions into the atmosphere, its impact on climate change, and issues related to the sustainability and environmental impacts generated by the participation of the construction industry in global warming, have led to countless researches, several of them looking to modernize cement production with alternative binders. The most known alternative binders used nowadays in the construction industry are slag obtained in blast furnaces, metakaolin and fly ashes obtained from burning coal in thermoelectric power stations. In the present paper, due to diatomaceous earth's pozzolanic properties, is researched the possibility of the use of diatomaceous earth as an alternative binder. This work shows a review of studies about introduction of raw and calcined diatomaceous earth in cement mortars, and the feasibility of using this material as a binder in cement mortars.

The different studies present that the introduction of different percentages of diatomaceous earth in mortars influences the physical and mechanical characteristics of the manufactured mortars. The tests performed in mortars with introduction of calcined diatomaceous earth show that the mechanical strength improves when compared to mortars manufactured with raw diatomaceous earth. The results of the compressive and flexural strength in mortars with introduction of calcined diatomaceous earth present lower values during the first 28 days, when compared with mortars without diatomaceous earth, however, there is a significant increase in the values of mechanical resistance, surpassing the values of mechanical resistance of mortars without diatomaceous earth at the end of 90 days. The water absorption by immersion tests also reveal that the increased introduction of diatomaceous earth increases the water absorption of the mortars.

CODE 168

HERITAGE-BIM®: CLOUD VIRTUAL PLATTFORM FOR DOCUMENTATION IN BIM ENVIRONMENT OF HISTORICAL HERITAGE RESTORATION PROJECTS

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KEYWORDS: HERITAGE-BIM; Patrimonio histórico; Digitalización; Documentación; Modelos 3D.

ABSTRACT

This article presents a novel, extremely useful and effective tool in the management and documentation of cultural heritage. HERITAGE-BIM is a virtual platform that integrates specific databases in the field of historical heritage conservation into 3D BIM® models. The software developed, as a virtual platform in the cloud, consists of a technological viewer that allows to walk, navigate and interact, create virtual sections and generate filters for graphical and numerical queries of all those elements and associated data that have been incorporated into the resulting 4D model. The tool developed facilitates an efficient management of all information, through comprehensive, selective or combined data visualization or consultation, with instant and simultaneous accessibility through the Internet to a large number of users. This versatility facilitates its implementation in the field of professionals and technicians from different disciplines, involved in the conservation and restoration of heritage, at a national or international level, optimizing and guaranteeing the resources provided by new technologies, with reduced costs.

CODE 173

AI POTENTIAL FOR RENOVATION MEASURES IDENTIFICATION

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KEYWORDS: Artificial Intelligence; Building energy renovation; Decarbonization; ChatGPT; Renovation measures.

ABSTRACT

Building renovation processes always require guidance from different experts or professionals who successfully conduct all the steps starting from the previous studies, project definition, intervention, commissioning, and maintenance. The quality of the results often depended on the professionals' expertise when facing these challenges. This work evaluates whether the new open-access AI can conduct building energy renovation diagnosis effectively.

Traditionally the use of AI was rather limited to some experts and activities. However, in November 2022 one of the first Open-source AI, ChatGPT, became public and is offering a chance to boost human capacities worldwide and for free. This mainstream AI potential raised concerns about human job replacement risk and lack of control. In a few months, the social perception of AI as a far-future issue turned upside-down and made it a very present fact.

When applied to building energy renovation, AI can assist professionals, or even replace them, to identify the best renovation measures for achieving deep renovation. This study tested how responds this AI when asked about the best energy renovation measures in a certain case. To understand if AI can replace renovation experts' diagnoses, the quality of the response is evaluated by experts and according to recent literature solutions. First, the AI is asked without any further preparation. Later, some additional data input is given to the AI to enlarge its preparation. Finally, some secondary questions are raised to enrich the analysis to evaluate the maximum potential of ChatGPT outcome.

The study results prove that open-access AI can provide good responses but can be incomplete without the proper specialized preparation and data input. In general, the AI findings can be trusted but their quality is limited. AI can help and provide a good start to any user and create comprehensive lists of feasible possibilities.

CODE 234

INCLUSION OF BIM METHODOLOGY AND OPEN BIM WORKFLOW IN SMALL ENGINEERING PROJECT OFFICES

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KEYWORDS: Building Information Modeling (BIM); OpenBIM; Interoperability; Projects; Specialty projects.

ABSTRACT

Due to technical demands and the continuous evolution of technologies in the development of engineering specialty projects, Building Information Modeling (BIM) has emerged as a tool with enormous potential for utilization. However, there are still many gaps in the implementation of this methodology, especially in small-scale project offices, where the transition to this "new era" of construction information is not yet fully accessible and facilitated.
It remains a challenge with inherent problems related to the specialization and training of stakeholders in the sector, as well as the initial investment cost. However, these issues can be addressed with long-term planning, in addition to considerations for cost, time, and quality in project development, alongside keeping pace with market demands for new technologies. Even professionals working with BIM face difficulties in adapting to and accommodating conventional two-dimensional models and even paper formats, which are still required by licensing authorities. Just as these entities, which are also not adjusted to the evolution of BIM technology, receive projects without the necessary information in the 3D models.
This article provides a detailed literature review related to the problems and implementation challenges in BIM technology within engineering project offices, more specifically practical knowledge in some engineering offices.
The article aims to demonstrate several alternatives and potential solutions to facilitate the adaptation and implementation of BIM methodology in small-scale project offices, particularly in the field of specialty projects. It also intends to propose a workflow involving designers, project offices, and licensing authorities so that 3D models developed in BIM can be maximized, aiming to reduce resource and information losses while licensing authorities are not updated to analyze projects in BIM format.

CODE 256

DESIGN OF SUSTAINABLE MORTARS FOR USE IN STRUCTURAL REHABILITATION WORKS

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KEYWORDS: Structural rehabilitation; Mechanical properties; Mortar design; Electric Arc Furnace Slag, Ladle Furnace Slag.

ABSTRACT

Sustainable Development Goal number 12, 'Ensure sustainable consumption and production patterns', establishes the objective of sustainable management and efficient use of natural resources by the year 2030 and substantial reductions of waste generation through prevention, reduction, recycling, and reuse. In this context, the recycling of waste from the steel and iron-making industry for use as raw material in the construction industry is addressed in the present work. In doing so, in addition to recycling waste that might otherwise be dumped, the consumption of natural raw materials is reduced. With these aims in sight, several mortars are designed, seeking to achieve different strengths, with the partial substitution of natural components for by-products from the steelmaking industry. Fresh and hardened mortar properties were tested. The main use of the mortars was for structural rehabilitation works, so special attention was placed on the bond between fresh mortars and hardened substrate. Achieving dosages with high bonding strengths figured among the main challenges of this work in which very encouraging results were obtained.

CODE 264

DESIGN AND EXPERIMENTAL EVALUATION OF FULL SCALE GLUED LAMINATED TIMBER FRAMES CONNECTED BY GLUED-IN-RODS AND REINFORCED MICRO-CONCRETE

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KEYWORDS: Timber structures; Moment-resistant connection; Stiffness; Beam-column connection.

ABSTRACT

In this article, design and experimental results for a moment-resistant connection in reinforced concrete for timber frame structure are presented. Beam-column connections in timber structures are often considered as pinned connections due to the challenge posed by the discontinuity of wood grain between the two elements. When moment resistance is essential for structural demands, the polygonal connection with steel bolts is the typical solution, but it does not ensure sufficient stiffness to justify classification as semi-rigid. However, semi-rigid connections can offer advantages such as reducing beam deformation or achieving a more favourable moment distribution. In a previous study conducted by some of the authors of this article, small-scale L-shaped specimens were produced and tested, using wooden elements with a cross-sectional area of 80 mm × 160 mm. The intersection volume was filled with high-strength reinforced micro-concrete, with continuous 10 mm diameter steel bars bonded to the adjacent wooden elements with a structural epoxy resin. As this type of connection proved capable of withstanding bending moments on the order of magnitude of the resistant moment of the section of the connected elements, this preliminary study was expanded with the execution of several new test series with similar topology and setup but with larger cross-sectional areas and reinforcement bars of 12 and 16mm in diameter. Based on the results of these tests, equations were developed for the design of this connection type. This article presents the design and test results of structural-sized frames with glued laminated timber elements of 160 mm × 400 mm cross-section, 5 m span, and 2.2 m height. For comparison purposes, a frame with the same dimensions but with a polygonal beam-column connection was also constructed. Static tests were carried out until failure, to evaluate the structural behaviour. It is concluded that this type of connection can be applied in timber frame structures, offering stiffness and strength superior to that achieved by the typical polygonal bolted connection.

CODE 300

NATURAL FUSE-SEGMENTATION TO ARREST FAILURE PROPAGATION IN PRECAST CONCRETE BUILDINGS

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KEYWORDS: Progressive collapse; Full-scale testing; Precast building.

ABSTRACT

The use of precast concrete structures is rapidly increasing worldwide because of their advantages in terms of quality, safety, sustainability, and speed of construction. In the field of progressive collapse of structures, few experimental studies have been carried out to investigate its structural integrity or robustness when subjected to a local initial failure. Previous work by the authors has shown that sufficient structural robustness can be achieved by properly designing the connection detailing between the structural components to withstand a sudden column removal under the accidental load combination defined in the codes. However, some aspects remain open for scientific discussions, such as: “What would happen if the initial failures were not limited to the failure of a single column?”. In such a scenario (multiple column removals or other large initial disturbances), it has been shown that the probability of local collapse propagating to the rest of the structure is significantly higher. This article presents one of the recent tests carried out by the Building Resilient research group of the Universitat Politècnica de València, where a full-scale precast building of 2 storeys (6m) and 3 x 2 spans (15 x 12 m2) has been tested under removal of three columns. The results indicate that the way in which the detailing was provided to the precast elements allowed the system to arrest the failure propagation and limit the collapse extent to a minimum. It can be argued that precast concrete structures naturally have fused connections that take advantage of continuity for small initial failures yet automatically segment the building into individual parts when failure propagation is inevitable.

CODE 311

MACROENCAPSULATED PHASE CHANGE MATERIALS AS NOVELTY SOLUTION FOR ENERGY RETROFIT OF HERITAGE BUILDINGS

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KEYWORDS: Energy retrofit; Heritage building; Innovative materials; Phase change materials (PCM).

ABSTRACT

Energy retrofitting of heritage buildings is commonly a technical challenge that implies complex and expensive constructive solutions. Typical retrofitting in heritage buildings is usually done on the interior side to maintain the external envelope in its original state. This work aims to analyze an innovative solution for energy retrofitting using macroencapsulated Phase Change Materials (PCMs) whose capacity of absorbing and releasing thermal energy improves the thermal inertia of envelopes with a very thin system. A heritage envelope is numerically studied using Finite Element Methods (FEM). Traditional rehabilitation is compared with innovative solutions using macroencapsulated PCMs. The used PCMs were experimentally characterized by the authors of this work and their thermal response is reliable and proved in previous works. The use of macroencapsulated PCMs significantly reduced the thickness of the enveloped, minimizing the loss of space inside the building and modification of the original building. The results of this work discuss energy efficiency of several solutions for energy retrofitting.

CODE 319

MECHANICAL CHARACTERIZATION OF ECOLOGICAL CLAY BRICKS MADE OF WITH HIGH- SILICEOUS CONTENT AND GLASS WASTE FOR USE IN RESTORATION WORK

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KEYWORDS: High-silica clay; Glass; Mechanical properties of bricks.

ABSTRACT

This research work presents the evaluation of the mechanical properties of bricks made from clays with high- siliceous content and glass obtained from the recycling of containers, with the purpose of reducing the contaminating effects during their production. For the preparation of the mixtures to obtain the semiproducts, the raw materials, clay, sand and glass waste were used by applying the plastic molding method. The semiproducts were sintered in an air atmosphere at a sintering temperature of Tsint = 800 °C. The physicochemical characterization of the raw materials was performed by X-ray diffraction (XRD), X-ray fluorescence (XRF) techniques, for ceramics it was analyzed by field emission scanning electron microscopy (FESEM) technique and EDS microanalysis. The physical properties of the clay were evaluated with the plasticity index using the Atterberg method. The results of X-ray diffraction analysis (XRD), X-ray fluorescence, have shown that the initial samples, clay and sand, its main crystalline phases that predominate are quartz and plagioclase, the structure of the glass is amorphous. According to the results of the mechanical tests on the bricks, the compressive strength properties were higher than those indicated in the construction regulations in force.

CODE 335

BIOCEMENTATION AS CRACK SEALING TECHNIQUE AND ITS INSPECTION USING SfM

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KEYWORDS: Biocementation; Repair; Joint filling; Inspection; Photogrammetry.

ABSTRACT

Biocementation is a technique that has generated great interest in the scientific community in recent years. It consists of using microorganisms to promote the precipitation of calcium carbonate (biocement) that functions as a natural cement, filling voids and discontinuities. It is a green technology in constant development that can be applied in multiple fields such as, for example, erosion prevention or joint sealing. In this sense, this technique has great potential in the field of the restoration of historical and cultural monuments made of stone or masonry. A proper crack filling or even consolidation is fundamental for several repair purposes, and therefore it is important to monitor the amount of biocement precipitated. After a brief state of the art on this topic, this paper discusses how Structure from Motion (SfM) photogrammetry can be used to inspect the surface of a treated rock sample, presenting an example. The potential and limitations of using this technique for this purpose are discussed, as well as future perspectives.

CODE 338

PERFORMANCE EVALUATION OF AN INDUSTRIALIZED AND MODULAR FAÇADE INCORPORATING RENEWABLE TECHNOLOGIES IN AN INTEGRATED CONCEPT

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KEYWORDS: Industrialized façade for renovation; Multifunctional façade; Performance evaluation; Envelope integrated solar technologies; Modular and adaptable envelopes.

ABSTRACT

Current building renovation trends are strongly governed by an energy-efficiency scope although closely linked to comfort, sustainability, accessibility, functionality, or aesthetics. This strategy directly implies upgrading and improving different building components (envelope, insulation, windows…) and services (HVAC, lighting, renewables…). However, there is no universal solution that is usable for all the different and complex renovation cases.

The research presented herein is focused on an innovative industrialized façade for retrofitting residential buildings. The solution is an aluminium modular façade concept, with a high industrialization level that, thanks to its flexibility and versatility, can be configured for different and varied renovation scenarios. Moreover, it also allows to integrate a variety of renewable solar energy technologies (photovoltaic, thermal and hybrid) in the same component.

In this paper the procedure to evaluate this multifunctional façade is described, providing the objectives and target values that the new solution needs to accomplish, as well as the methods to assess them. Based on the results achieved from different simulations, design verifications and, full-scale laboratory tests, the system's design will be validated. The double scope of a building component and an energy generating device defines the differentiative approach adopted compared with regular analysis employed for conventional construction products. The main conclusions of the research presented are the demonstration of usefulness of the evaluation procedure developed, together with its practical application to a product development process where the successful incorporation of solar capturing technologies into a façade system is validated.

CODE 404

RECYCLED FOUNDRY SAND IN SELF-COMPACTING CONCRETE: EFFECTS ON THE WORKABILITY AND MECHANICAL PROPERTIES

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KEYWORDS: Recycled foundry sand; Self-compacting concrete; Workability; Mechanical properties.

ABSTRACT

The construction industry is responsible for more than 50% of the extracted natural resources and produce 39% of CO_2 emissions. Meanwhile, the foundry industry, utilising foundry sand, produces 100 Mt/year of waste. The use of recycled foundry sand (RFS) as a substitute for fine aggregate has been studied in various cement-based materials, however, the higher replacement percentages are up to 50%, so its total use as a replacement is not full exploited nor analysed. This research work analyses the total replacement of RFS as fine aggregate in self-compacting concrete (SCC). To achieve this, a new mixing method was proposed. To evaluate workability, EFNARC guidelines for SCC were followed and mechanical properties were evaluated by means of compressive strength at 7 and 28 days, as well as splitting tensile strength at 28 days. Workability tests results (slump flow, t_{500} and V-funnel) showed an improvement in the slump diameter, t_{500} and V-funnel time when using the RFS compared to the control SCC natural sand. This is due to its lower fines content, reducing the friction between the aggregates and the cement paste. In terms of mechanical properties, RFS was found to improve the strength in all tests, due to an improved workability, having a denser cement matrix. In this work it has been shown that the use of RFS is an alternative for mitigating the exploitation of natural resources and, at the same time, obtaining environmentally friendly concrete.

CODE 406

PRODUCTION OF ARTIFICIAL STONES BETWEEN 1800 AND 1900: A PATENT REVIEW

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KEYWORDS: Artificial Stone; Patents; Performance Failures.

ABSTRACT

The search for formulations of building products to replace cut natural stone materials, in terms of aesthetics, workability and strength, has constantly featured the history of construction. However, in the period between the 19th and 20th century, the practice of artificial stone was at its most widespread, boosted by the availability of novel cement-based conglomerates. Within this framework, the present research analyses the patents filed in Italy between 1870 and 1940 and stored at the Central State Archives in Rome, in order to provide in-depth historical, material and technological knowledge of the artificial stone manufacturing.
The analysis was conducted through diligent reading and classification that allowed the patents to be catalogued according to the time sequence, the countries of production and the main mixtures, with particular reference to the binder. Within each typology, the reported defects/anomalies/failures and the declared causes were also pointed out, along with the proposed improvement strategies for each shortcoming, involving both the formulation of the mixtures and the production techniques and procedures. Nowadays, the results may constitute a useful baseline toward the analysis of alteration and obsolescence forms, as well as the identification of compatible maintenance and repair measures.

CODE 9

DEMAND-SIDE MAPPING TO SUPPORT BUILDINGS' INDUSTRIALISED DEEP RENOVATION THROUGH A STAKEHOLDERS' INVOLVEMENT APPROACH

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KEYWORDS: Industrialised deep renovation; Stakeholder's approach; Demand-side mapping; Industrialised envelope kits; Building stock features.

ABSTRACT

The H2020 INFINITE project aims to achieve a zero-emission and fully decarbonized EU building stock by 2050 through increased renovation rates and depth for poorly performing buildings. Industrialized all-in-one building envelope kits, including passive eco-compatible & green solutions, energy distribution systems, smart windows, and energy generation systems, are being developed under this project. This paper outlines how to support the industrialization of construction processes, a decision-making aid tool was created using the Delphi method with the industrial stakeholders, analysing the building stock features, and assisting in selecting suitable kits for renovation projects. An interactive market potential map was developed to connect demand and supply for the kits, using GIS technology to represent information at different scales. Specific INFINITE archetypes were defined for each kit to provide ideal building characteristics for optimal installation, allowing flexibility in applying the kits in different building renovation projects.

CODE 12

PASSIVE SOLAR SYSTEMS IN BUILDING DESIGN, ENVIRONMENT, AND ENERGY EFFICIENCY IN DIFFERENT AFRICAN COUNTRIES

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KEYWORDS: Climate change; Energy efficiency; Passive solar systems; African Countries.

ABSTRACT

Europe has been a driver of the change in the decarbonization of the built environment and in recognition of the potential for improvement that can be achieved at the level of buildings. This example can be applied in other geographical contexts. About 40% of energy consumption currently results from the need for heating, cooling, or sanitary hot water. The use of construction in accordance with climatic conditions, efficient technical systems, and high-performance equipment can significantly reduce this consumption.

The adoption of passive solar systems in the design of buildings is a fundamental premise for achieving energy efficiency and rationalization, especially in developing countries. To advise these goals, the project must be adapted to the characteristics of the local climate. In that case, it will be possible to minimize energy needs to obtain thermal comfort, minimizing the consumption of resources and the emission of greenhouse gases, thus contributing to sustainable construction and development, a prominent issue, for example, in African Countries.

In the original Portuguese construction implemented in African Countries in the middle of the XX century, it is possible to identify the empirical solutions to date adopted and their impact on reducing the energy consumption of these dwellings, which is now intended to be validated scientifically from the point of view of current knowledge.

First, the geometry, materials, solutions, shading strategies, span-to-area relationship, orientation, etc. were analyzed. In a previous study. In the second moment, based on psychrometric chart analysis using psychrometric charts in the Climate Advisor software, we identified the best design approach for Beira's unique climatic conditions, focusing on strategic allocations for the specific climate of Beira, Mozambique. Passive solar systems are individually constructed. With some simulation or analysis, it is possible to define passive solutions that are most suitable for the local climate and have a greater impact on the thermal performance of the building in terms of energy demand and indoor comfort. In this way, future work will develop strategies to improve the energy efficiency of existing residential buildings in Beira, Mozambique.

CODE 18

BOND DURABILITY OF BASALT FIBER REINFORCED POLYMER (BFRP) REBAR EMBEDDED IN FIBER REINFORCED CONCRETE UNDER SEAWATER EXPOSURE

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KEYWORDS: Bond behaviour; Fatigue loading; Monotonic loading; Basalt fiber reinforced polymer; Fiber reinforced concrete; Recycled steel fiber; Industrial steel fiber.

ABSTRACT

The use of basalt fiber–reinforced polymer (BFRP) as reinforcement in concrete structures is relatively new. Although in general BFRP shows similar mechanical performance to that of glass fiber–reinforced polymer (GFRP), its behaviour when embedded in concrete, especially in harsh environmental conditions, is not fully addressed yet. This study is focussed on the characterization of bond degradation of BFRP bars embedded in fiber reinforced self-compacting concrete (FRSCC) after long term exposure to sea water. The results are part of a research program aimed to develop high corrosion resistant concrete offshore elements. The reinforcing system is composed of fiber–reinforced polymer (FRP) rebars, while hybrid Recycled Tire Steel Fibers (RTSF) and Industrial Steel Fibers (ISF) are used in the concrete matrix. This reinforcing system is expected to suppress the corrosion problems found in steel reinforced concrete structures, while steel stirrups are eliminated due to the use of SFRSCC and steel rebar is replaced by non-corrodible FRP longitudinal reinforcements. Besides, the discrete fibers used in developing the SFRSCC elements collaborate to overcome the shortcomings of FRP reinforcements in plain concrete structures by increasing the strength and stiffness and assuring the desired ductility. In this study, 12 cubic specimens were produced with SFRSCC incorporating 90 kg/m3 of hybrid steel fibers (50% RTF and 50% ISF). In 6 of these specimens GFRP bars were embedded, while in the 6 other specimens BFRP bars were embedded. All specimens were subjected to monotonic and fatigue pull-out tests, after 24 months of exposure to sea water. The long-term behaviour of the bond between SFRSCC and FRP in exposed specimens was further compared to that of similar specimens tested in unexposed conditions in the previous studies. Influence of the type of reinforcement, the environmental condition, and the type of loading on bond stress versus slip behaviour, maximum bond stress, and failure mode are analysed and discussed in this study. The experimental results have shown that the bond strength of concrete-BFRPs decreased by 50% after 24 months of aging in seawater. The outcome of this study is expected to contribute to a better understanding of the for the design of structures reinforced with BFRP rebars.

CODE 30

EVALUATION OF THE BEHAVIOUR OF STRUCTURAL CONCRETE BEARING WASTE WIND-TURBINE BLADE UNDER TENSILE STRESSES

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KEYWORDS: Concrete; Wind-turbine blade; Mechanical properties; Tensile stresses.

ABSTRACT

It is generally acknowledged that it is an urgent task of the concrete industry to find new ways of introducing waste materials in their mixtures in order to increase its sustainability. Wind power industry can play an important role in this challenge, while solving the problem of the recycling of the old wind turbine structures that are reaching the end of their lifecycle, which is currently imperative. Hence, the need for the disposal of Waste Wind-Turbine Blade (WWTB) sets an opportunity to introduce it after crushing as a raw material in concrete, being able to reduce its content of natural aggregates and cement. This research aims to conduct an exhaustive material characterization and analyse the feasibility of adding WWTB in concrete for structural purposes. For this study, five different concrete mixes were produced with variable WWTB volume contents (0.0%, 1.5%, 3.0%, 4.5% and 6.0%). The amount of siliceous aggregate used in all five mixtures remained invariable, as well as the cement content. All the resulting mixtures were characterised in terms of the slump, fresh- and hardened-density tests. Besides, splitting tensile strength and flexural strength allowed evaluating the performance of the concrete mixes under tensile stresses. The results demonstrate that a rise in the WWTB content up to 1.5% can result in a slight increase of the splitting tensile strength, whereas high contents of this waste (6.0%) allow maintaining constant the flexural strength. The values of both properties remain approximately stable when adding WWTB, thus preserving the basic mechanical properties of structural concrete. According to this study, it is feasible to evaluate the addition of WWTB as a method of obtaining structural concrete without compromising any of its tensile-related mechanical properties, simultaneously transform an industry hitherto considered polluting into a more sustainable one.

CODE 31

COMPRESSION-RELATED PERFORMANCE OF AN STRUCTURAL CONCRETE PRODUCED WITH CRUSHED WIND-TURBINE BLADE

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KEYWORDS: Sustainability; Concrete; Wind-turbine blade; Compression-related mechanical Properties.

ABSTRACT

The sustainability of the concrete industry is an important issue worldwide. The need for concrete increases steadily, and the natural-resource exploitation and cement manufacturing are speeding up climate change and global warming, among others. The wind-energy sector is also facing sustainability issues, as some of the first-installed wind-turbine blades are approaching the end of their approximately twenty-year life span and need to be replaced. These two different fields can help each other by adding crushed wind-turbine blade to concrete, so a second life for the crushed wind-turbine blades can be found, thus also reducing the use of cement, which is the concrete´s most polluting raw material. This study aims to find out whether the addition of crushed wind-turbine blade is valid for structural use up to 6% vol., in steps of 1.5% vol. Hence, five different mixtures were made incorporating this alternative material as an addition and maintaining constant the aggregate and cement content. Occluded-air content, compressive strength, modulus of elasticity and Poisson´s coefficient have all been evaluated. This analysis demonstrates that the higher the crushed-blade content, the higher the occluded air, although it did not result in a notable loss of the compression-related mechanical properties when added in small percentages. Nevertheless, when the percentage of crushed wind-turbine blade was increased, these properties decreased their values, yet still largely maintaining their suitability for structural usage. The results yield that the addition of crushed wind-turbine blade to concrete fulfills the requirements for be used in structural applications becoming a plausible solution to the raising sustainability issue of the concrete-manufacturing industry and the wind-farming sector.

CODE 40

ENERGY RETROFIT AND BIOCLIMATIC DESIGN ON A KINDERGARTEN IN NEUQUÉN, ARGENTINA

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KEYWORDS: Energy efficiency; Bioclimatic Design Strategies; Building Simulation; Climate Change.

ABSTRACT

During 2021 and 2022, the Euroclima Project evaluated municipal buildings in Neuquén, Argentina to propose improvements in their energy efficiency (EE). Its conclusions show the potential savings that could be achieved by installing thermal insulation in the roof, walls and floors, and by replacing openings. Improving EE is crucial from an environmental perspective, but it is no the only one. Therefore, the objective of this work is to evaluate the potential for energy savings and increased comfort through the combination of bioclimatic design measures and EE in the Mariano Moreno Kindergarten, located in the Municipality of Neuquén. To achieve this, we analyze the local climate and identify the bioclimatic strategies that best suit the case, including direct solar gain, thermal inertia with night ventilation, and evaporative cooling. The article describes the evaluation of improvements through a dynamic simulation with Design Builder in three scenarios: the current state, with EE improvements, and with bioclimatic interventions. The results indicate a potential annual energy savings of 86% with EE, mainly improving comfort in winter, and 90% with bioclimatic strategies, showing comfort benefits in summer. These energy savings have a positive impact on the economy of the Municipalities, while the improved comfort impacts the productivity of municipal employees. Based on the results of this case study, it is concluded that an effective energy rehabilitation should include both efficiency measures and bioclimatic design.

CODE 41

TEXTILE-REINFORCED-MORTAR STRENGTHENING OF AGEING CONCRETES: SUSTAINABLE APPROACHES AND OPPORTUNITIES

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KEYWORDS: Reinforced Concrete Structures; Electric Arc Furnace Slag (EAFS); Ladle Furnace Slag (LFS); Flexural Strengthening; Tensile Tests.

ABSTRACT

In the mid-nineteenth century, inventive entrepreneurs (among others, Lambot, Wilkinson, and Monier) took the first steps towards the production of Reinforced Concrete (RC) on an industrial scale. Nowadays, RC is used in over 80% (160×106) of buildings within the EU27, 25% of which were built before 1960 (in Bilbao, for example, 80% were built before the 1970s). The situation calls for sustainable and fully compatible strengthening solutions, especially where RC structures (some considered as built heritage) are now decaying and in need of repair. In this paper, novel composite solutions based on inorganic matrixes (i.e., cement mortars, as with RC) reinforced with a technical textile core made of different synthetic fibres (steel, basalt, carbon and glass, respectively) are used. The composite, known as Textile Reinforced Mortar (TRM), was developed around the turn of the century for restoring masonry heritage structures. TRM is tested here for two purposes: material characterization (mortar and textiles) and the strengthening of medium-size RC beams under bending loads. All the experimental results are discussed, in order to balance the opportunities for future applications where the inorganic TRM matrixes (cement and aggregates) could be partially substituted by two kinds of steel-making (EAFS-black and LFS-white) slags, so as to convert them into types of eco-inorganic matrices and co-products of high added value within a circular economy.

CODE 87

IMPLEMENTATION OF SUSTAINABLE CONSTRUCTION STANDARDS IN BUILDINGS IN THE GALAPAGOS ISLANDS ARCHIPELAGO

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KEYWORDS: Sustainable building; Efficient construction; Energy rehabilitation; Comfort; Galapagos Islands; Technology transfer; Living Labs.

ABSTRACT

The Galápagos Islands are a particularly appealing ecosystem for scientists globally. However, aspects related to energy efficiency and sustainability in its building stock have yet to be thoroughly studied. In previous research, the authors developed sustainable performance standards for buildings on the islands in line with the National Energy Efficiency Plan promoted by the Government of Ecuador for the Galapagos Archipelago. The development of these standards made it possible to analyze how different strategies for reducing greenhouse gas emissions impact on the use of resources and their potential savings. The present study aims to facilitate the implementation and replication of these sustainable construction standards, developing a "living laboratory" where different strategies and technological solutions are validated according to the defined standards in three real case studies. In addition, the process of knowledge transfer generated through local training of construction industry and administration stakeholders is described.

CODE 103

COMPARATIVE ANALYSIS OF THE THERMAL TRANSMITTANCE (U-VALUE) OF A MULTILAYER BRICK CLADDED FAÇADE IN HOT AND COLD PERIODS

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KEYWORDS: Energy efficiency; Envelope performance; Subtropical climate; Thermal transmittance; U-value.

ABSTRACT

In recent years, there has been an increasing demand in Europe for energy efficiency standards to limit carbon dioxide emissions from the building sector. Due to the growing concern about global climate change, the energy consumption of buildings is in the spotlight because of the direct relationship between the energy demand for air conditioning and outdoor climatic conditions. The energy consumption of buildings is partly due to energy losses through the building envelope. Therefore, in order to improve the energy efficiency of buildings, it is necessary to evaluate the thermal performance of the building envelope, which depends on the characteristic properties of the material (thickness, density, thermal conductivity and specific heat) and is measured by its thermal transmittance. Thermal transmittance, also known as U-value, provides information on the level of thermal insulation of a façade wall in relation to the percentage of energy passing through it. This paper analyses the thermal performance of a building envelope and the influence of climatic conditions on the measurement of thermal transmittance using the thermometric method (THM), both in hot and cold periods. The experiment was carried out in a Spanish traditionally constructed building located on the university campus of Huelva, city characterized by a subtropical-Mediterranean climate with Atlantic influences (mild, windy winters and hot, dry summers). The results measured in summer showed some variability and uncertainty with respect to the U-values measured in winter due to the strong influence of the outside temperature on the thermal performance of the building envelope.

CODE 128

LIFE CYCLE ASSESSMENT OF INNOVATIVE ECO-CONSTRUCTION SYSTEM: INTERLOCKING MODULAR INSULATION PANELS (IMIP)

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KEYWORDS: Life cycle assessment; Bio-based materials; Circularity; Sustainable construction; Prefabricated construction.

ABSTRACT

The IMIP project is about taking action to achieve the triple bottom line: economic, environmental, and social, both in the life cycle of the materials and processes and in the service life of the building systems developed in the project.
Four panels have been designed to implement a new industrialised and green building system using bio-based materials to improve energy efficiency, assembly, disassembly, reuse and reducing demolition costs and waste materials.
The objective of this paper is to assess the environmental impact of the panels and to compare them to conventional constructive systems.
According to the analysis, the panels have great potential in terms of energy efficiency, circularity, cost, and environmental impact. As they are made from natural bio-based materials and their design is based on assembly and disassembly, the panels sequester CO2 and show excellent sustainability, circularity, and reusability results. The disassembly and recycling capacity of IMIP products are critical to the results of the manufacturing stage, as they can be considered a substitute in further production.
This assessment identifies the main strengths of the proposed panels in terms of sustainability compared to usual market competitors.

CODE 135

THERMAL PERFORMANCE OF SOCIAL HOUSING BUILDINGS IN CURRENT AND FUTURE CLIMATE OF THE IBERIAN PENINSULA

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KEYWORDS: Climate change; Social housing; Thermal performance; Energy poverty; Iberian Peninsula.

ABSTRACT

Climate change represents a current and future challenge in different sectors of society, including the building sector. In residential buildings, the impact of this phenomenon has repercussions, among others, on increased requirements to obtain proper thermal performances. In social housing buildings in the Iberian Peninsula, thermal performance is extremely important given the impact of energy poverty, which limits the use of active systems to correct the existing performances so as to obtain proper indoor conditions. The objective of this paper is to understand the extent of the impact of climate change on the indoor thermal conditions of a social housing dwelling, for different locations in the Iberian Peninsula. A calibrated model was used and a set of dynamic simulations was run using current and future climate databases, in order to obtain indoor temperature results for representative winter and summer periods in each of these locations. The results indicate a worsening of indoor conditions in the summer, and still rigorous winters that make it difficult to obtain proper thermal performances in some inner locations, confirming the need to prepare and adapt the social housing stock of this European region to climate challenges, for both seasons.

CODE 139

MEASURING THE INFLUENCE OF INDUSTRIALISATION IN DEEP ENERGY RENOVATIONS: A THREE-CASE STUDY UTILISING KEY PERFORMANCE INDICATORS (KPIS)

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KEYWORDS: Deep energy renovation; Key performance indicators (KPIs); Performance gap.

ABSTRACT

Buildings in the European Union are responsible for 40% of energy consumption. The European Parliament aims to achieve a reduction between 80% and 95% by 2050, compared to 1990 values. European directives require tripling the rate of annual energy rehabilitation in the next decade to meet these targets. However, the construction industry relies on manual and poorly automated processes, leading to high costs and slow execution times, especially in building rehabilitation. Various methodologies are being developed to address this challenge and encourage the renovation of existing buildings throughout all stages, from design to post-occupancy.

The European research project INPERSO (Industrialised and Personalised Renovation for Sustainable Societies) seeks to create an innovative, industrialised, and personalised method for energy rehabilitation, improving the efficiency of the work and subsequent building usage. To ensure better performance and reduce the gap between theoretical predictions and actual building behaviour, the project has developed a set of indicators or key performance indicators (KPIs), classified as Economy, Energy, Environmental, Social, CO2, and Technological.

Adopting a human-centric approach, these KPIs aim to narrow the performance gap by considering multiple parameters and factors. The methodology revolves around an iterative process that involves consultations with experts from diverse disciplines. The indicators allow the evaluation of rehabilitation performance at any project stage and enable users to provide continuous feedback, influencing their behaviour and ensuring the desired and projected energy savings are accomplished throughout the building's lifespan.

CODE 142

GUIDELINES FOR THE APPLICATION OF THE INCENTIVES FOR IMPROVING THE ENERGY PERFORMANCE OF BUILDINGS IN THE SMALLER HISTORIC CENTERS OF SARDINIA

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KEYWORDS: Historical Architecture; Minor historical centres preservation; Incentives for energy retrofit.

ABSTRACT

Historic buildings can and must contribute to the decarbonisation of the construction sector. In Italy about 15% of the residential building stock was built before 1918 and it represents an important field for the application of policies on buildings retrofit. Improving the performance of the historical heritage is more complex due to the coexistence of the energy consumptions issues with the preservation of architecture and landscape, two non-renewable values, too. Difficulties can be also found in the access to incentives, particularly those from the so-called Superbonus, which in Italy has led to a relevant number of interventions on buildings, but not on historical ones.
The energy requalification of the latter plays a more significant role in smaller towns, which must face the problem of depopulation. The high operating costs and the poor quality of the historical heritage reduces its economic value and accentuate the risk of abandonment. The increase of energy requalification processes could become an important part of those strategies, already underway in Italy, as well as in Europe, aimed at enhancing inland areas and small towns, in an attempt to avoid the loss of the heritage and to counterbalance the demographic densification of urban centres. It is now recognized that reinhabiting inland areas would produce numerous advantages: reduction of land consumption; urban decongestion; health improvement; protection of an important tangible and intangible heritage; safeguarding local identities. The recent health emergency has further highlighted the great potential of rural areas, revealing their greater resilience compared to large cities. On these premises, the Union of Municipalities of Montiferru-Sinis, in the Province of Oristano, on the initiative of the National Association of Cities of Raw Earth, has commissioned to a group composed by university researchers and professionals, the drafting of guidelines for the application of Superbonus incentives to buildings in their historic centres. The work has shown that it is possible to intervene on the historic minor buildings, even taking advantage of tax incentives, in compliance with the constraints of protection. The results in terms of energy performance are of absolute interest, as well as the economic benefits deriving from them.

CODE 143

THE SEISMIC - ENERGETIC REFURBISHMENT OF VERNACULAR ARCHITECTURE: AN APPLICATION TO AEOLIAN ISLANDS (ITALY)

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KEYWORDS: Sustainable refurbishment; Summer School; Filicudi (Sicily).

ABSTRACT

The search for sustainable ways of living and building is a highly topical issue today.
Explicit mention of it can be found in Agenda 2030 (Goal 11) and generally in almost all the policy documents of European states. Some useful lessons can be deduced from the factories of the past, for example, from the dwellings of the Aeolian archipelago in Sicily, which constitute an outstanding case study as ante-litteram sustainable buildings because of the very features of their architecture: the thermal inertia of the masonry, the presence of opposing openings, the light colours of the envelope, and the same generally southern exposure make Aeolian architecture almost passive buildings and therefore characterized by high comfort conditions. The objective to be achieved in this paper is to evaluate integrated reuse proposals that combine the aspects of preservation of these architectures, although in a state of ruins (but perfectly integrated into the Aeolian man-made landscape), with their energetic and seismic regeneration. To achieve the above, an interdisciplinary team of technologists, structural engineers, and technical physicists pooled their expertise and organized a workshop open to young professionals at the island of Filicudi, which, being more isolated than the others, has preserved almost intact the typical features of the local building tradition. The outcomes of the produced elaborations represent a rare example of the conjunction of the safeguard needs, seismic safety and energy efficiency and have been appreciated by local administrators.

CODE 198

ONE-STOP-SHOPS, AND REHABILITATION AND CONSERVATION AREAS. ARE THESE COMPATIBLE FIGURES FOR THE PLANNING AND MANAGEMENT OF RESIDENTIAL ENERGY REHABILITATION?

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KEYWORDS: Residential energy rehabilitation; Rehabilitation financing; Conservation and rehabilitation areas; Residential rehabilitation management.

ABSTRACT

The European built stock is responsible for 36% of GHG emissions and 40% of energy consumption. 35% of the buildings are pre-1970 and almost 75% are energy inefficient. In Spain, 50% is prior to the NBE-CT-79 standard on minimum thermal insulation criteria in homes. For this reason, the European Union promulgated the Energy Performance Building Directive (EPBD) 2002/91/EC on the energy performance of buildings, establishing that Member States must develop energy certification systems and an Energy Performance Certificate for buildings. Subsequently, its 2018 update defined One Stop Shops (OSS) as accessible and transparent advisory tools on EE renewals and financing instruments for consumers. In Europe these have operated with public funds, but when they lost them, they have ceased their activity. In Spain, only four have recently come into operation. For its part, Catalan Law 18/2007, on the right to housing, establishes that municipalities can define Conservation and Rehabilitation Areas (ACRs) for the rehabilitation of homes in vulnerable neighborhoods, including protection measures. The successful experiences of ACR have involved a hard effort on the part of municipalities to inform families and manage projects, works, financing and payments, having to act as OSS. The objective of this work is to evaluate the possible fit of the OSS in the framework of the development of the ACR, as a strategy to formalize the financing of these entities and, in turn, free the municipalities from the management of the actions in the ACR. To develop guidelines for future action, an analysis of the legal framework and the successful cases of OSS and ACR is carried out. Currently, more measures have been introduced to encourage residential energy retrofit, such as building renovation passports. Despite all this, only between 0.4% and 1.2% of the housing stock is rehabilitated, generally due to lack of knowledge and financial, legal, technical and administrative barriers that households face when undertaking renovation works. improvement of residential EE.

CODE 209

SOLAR POTENTIAL ANALYSIS OF BUILDING INTEGRATED PHOTOVOLTAIC PANELS AS RETROFITTING SOLUTION FOR EXISTING INDUSTRIAL BUILDINGS

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KEYWORDS: BIPV; Industrial buildings; Energy retrofitting; Renewable energy.

ABSTRACT

According to the Global Status Report REN21, the building sector has a high impact on global energy consumption and greenhouse emissions. Starting from this consideration, several incentives and regulations have been produced by European Union members State to promote extensive retrofitting initiatives for existing facilities. Such efforts should be moreover read within the perspective of a European free-carbon economy within 2050 and the framework set by United Nations' Sustainable Development Goals (SDGs). Despite the growing interest in the topic, industrial buildings have been often neglected even if production activities and the related processes are highly energy intensive as well. This is also due to the insufficient thermal, energy and environmental performance of the facilities hosting manufacturers companies. Focusing on the Italian context and the Tuscany area specifically, the most of industrial facilities are old and no longer comply with current regulations. Moreover, a large-scale survey highlighted the absence of active systems for energy production from renewables, since no photovoltaic panels were retrieved on over 80% of 2000 industrial buildings. Given the need for both overall requalification for this building stock, the research aims at outlining possible architectural redevelopment solutions including PV panels integrated into rain-screen or ventilated facades to be installed as external recladding, enhancing at the same time thermal, energy and aesthetic standards. Referring to a representative case study facility in Tuscany, the energy production potential of a Building Integrated Photo Voltaic (BIPV) is evaluated by considering parameters such as the building's size and orientation. Considering central Italy conditions, PV panels on facades proved to be particularly suitable for wide and south-oriented wall surfaces to enhance energy production in winter periods (4.30 kWh/m2). On the other hand, N-S-oriented buildings are likely to produce more energy during summer enabling them to cover up to 94% of energy demand for cooling when coupled with heat pump generators. The results suggest a considerable solar potential to be unlocked by adopting PV cladding elements, allowing also to ensure significant yearly surplus energy production to be exploited for lighting, industrial processes or sharing in a renewable energy communities perspective.

CODE 226

THE "GREEN" CHALLENGE OF SMALLER HISTORIC CENTERS: FROM ENERGY SELF-SUFFICIENCY TO ENVIRONMENTAL AND URBAN REGENERATION

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KEYWORDS: Environmental Sustainability; Renewable Energy Communities; Historic Centers.

ABSTRACT

The ecological transition of energy production and related supply systems, as well as the evolution of cities and territories towards new forms of energy self-sufficiency, represent the most interesting project areas for those who intend to face the challenge of sustainable reconversion of Anthropic Communities. A challenge that poses particular requirements for the evaluation, validation and control of expected results especially when the intervention object consists of inland territories and Small Historic Centers. Contexts often characterized by a high landscape, architectural, historical and cultural quality, which determine its environmental value, scientifically recognized. A value with which any transformative intervention must have to confront, in terms of compatibility, protection and conservation of urban and territorial quality.
A value with which any transformative intervention must have to confront, in terms of its compatibility with the protection and conservation of urban and territorial quality.
The opportunities offered by the recent directives, rules and financial instruments on green transition, as the Renewable Energy Communities (RECs) and National Recovery and Resilience Plan (NRRP), glimpse that these places will be subject, in the near future, of significant transformative interventions, linked to the construction of renevable energy production plants and to the renovation of more or less extensive parts of building and/or urban heritage. Actions that needs to be coordinated within a landscape and urban sustainable regeneration program, the only instrument capable of ensuring its valorization, and a consequent tourism and socio-economic relaunch.
This contribution moves from these premises to focus its attention on the experiences developed on the RECs at the EU level, and to take out from these some methodological indications to be applied to a specific case study, a small historical center included among the most beautiful villages in Italy.
Scope of the experimentation was to define, through its practical application, an holistic and multidisciplinary approach, capable of accompany and support local communities in the programming, planning and management phases of interventions.

CODE 231

STRUCTURAL OPTIMIZATION AS A SUSTAINABLE DESIGN STRATEGY: THE CASE STUDY OF CAPO D'ORSO MILITARY COMPLEX IN SARDINIA

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KEYWORDS: Sustainable design approaches; Historical built heritage valorization; Multi-objective optimization; Topological optimization.

ABSTRACT

The aim of the proposal is to explore techniques and methods permitting take into account different requirements in the design process. An integrated approach to design is employed, which considers various questions, strategies, and actions applied to a case study in Sardinia, the abandoned military battery of Capo d'Orso. The refurbishment project highlighted key issues, such as seamless integration of new and existing structures, economic feasibility, and efficient use of resources, minimizing the environmental impact of buildings throughout their entire lifecycle, with the goal of repurposing historical buildings. This paper specifically describes the process of integrating and optimizing the structure of the addition required for the re-functionalization of the area. The volume is located above the underlying pre-existing historic vaults, which are intended to be preserved and protected, given their great testimonial value. The work describes a multi-objective optimization approach that evaluated different design alternatives according to the constraints given by the context and the objectives, in order to optimize the structural members to the greatest extent possible while meeting all requirements: structural efficiency, visual permeability, lightweight, low environmental impact, and the feasibility of assembly in a specific location with challenging accessibility. The study shows methods to compare different technologies, configurations, and materials, starting from three structural schemes enabling significant spans and developing a finite element model for each configuration to assess their structural performance. The study ultimately advocates for the arch system obtained as the most viable design option that can meet environmental, architectural, and structural requirements, analyzing its structural performances, the modular optimization for the site, and the assessment of materials' sustainability. The research delves into the topological analysis that led to the definition of the optimal geometry and cross-section of the arch, derived from specific boundary conditions.

CODE 258

SEISMIC RESPONSE OF THERMAL INSULATION SYSTEMS FOR RC BUILDINGS

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KEYWORDS: Thermal insulation; Earthquake experimental; Extruded sintered polystyrene; Integrated design; Energy retrofitting.

ABSTRACT

The new challenges of reducing the energy consumption and CO2 emissions is pushing the European Community and the associated countries to undertake effective policies to achieve important goals in the next decades. It is worth noting that buildings contribute to the 40% of the energy demand of the EU and 32% at global level. Thus, the reduction of emissions and energy consumption should pass through the building renovation. Many studies pointed out the effectiveness of thermal insulation systems to increase the properties of the building envelop. However, only few studies considered the response of such non-structural components when subjected to earthquake loads or other lateral distortions.
This study focuses on the experimental response of a novel thermal insulation system applicable from the exterior of the building. Experimental tests on a multi-storey infilled reinforced concrete building with and without the insulation system were performed and the results are reported and discussed. The tests were performed by using a pseudo-dynamic testing infrastructure. A focus on the attained damage on the infills and insulation coat under increasing earthquake intensity is made. The lateral response in terms of base-shear versus the imposed top displacement is reported to quantify the contribution of the coat to the lateral behaviour.

CODE 261

EVALUATION OF THE THERMAL PERFORMANCE OF THE VERNACULAR HOUSING OF THE DOMINICAN REPUBLIC

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KEYWORDS: Vernacular Housing; Thermal Performance; Indoor Comfort; Simulation; Dominican Republic.

ABSTRACT

Dominican vernacular architecture, based on the Spanish-influenced indigenous bohío, is built with natural materials. This housing model has remained practically unchanged for five centuries, adequately responding to the tropical Caribbean climate. However, it is necessary to characterize this behavior to verify the internal comfort conditions of this type of housing. Therefore, the aim of this research is to evaluate the thermal behavior of a vernacular house located in Villa Sombrero, Peravia Province, Dominican Republic through a simulation model. For this, a bohío was selected, which has a simple volume with a rectangular plan, with a gabled roof and small eaves that protect the four facades. It has a load-bearing structure of wooden forks, on which rests the thick cover of cana palm leaves (*Sabal Dominguensis*). The walls of the house and the internal divisions are made of planks of royal palm (*Roystonea Hispaniolana*). The hut has a door in the middle of its main façade and four windows, two on each side of the door. On the rear façade facing the courtyard, it also has a door placed in the center and four windows, two on each side of the door. The spatial distribution of the interior consists of a central area divided by two low walls, which define the living and dining areas, and on both sides are the bedrooms, one to the right and two to the left of the hut. The kitchen and latrine are located outside the hut, where there is usually a tree or covered terrace. In this way, to carry out the energy simulations, the Design Builder software was used, considering the passive strategies incorporated in the hut. The results indicate that the indoor ambient temperature of the hut remains within the comfort range throughout the annual cycle, presenting a difference of 1.43°C and 3.44°C with respect to the outdoor temperature in the coldest and warmest months, respectively.

CODE 266

A THEORETICAL APPROACH BETWEEN DFA/DFD DESIGN STRATEGIES AND MODULAR TIMBER TECHNOLOGIES

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KEYWORDS: Prefabrication; Modular timber structures; Adaptability; Disassembly; Flexibility.

ABSTRACT

Prefabrication and modular construction have impacted the global market, and with the increased focus on sustainability, these construction technologies are leaning towards implementing timber systems. Design for Adaptability (DfA) and Design for Disassembly/Deconstruction (DfD) are strategies used to face unpredicted events (such as structural reinforcement, repair needs, or new user demands), assure long-lasting efficiency, and enhance materials sustainably, thus upgrading the building's adaptability. While in the literature, there are projects focused on the functional and environmental challenges of taller timber buildings and the DfA/DfD benefits, little research is available on the application of DfA/DfD of timber buildings, particularly in prefabrication and modular timber construction, owing to the barriers to the implementation and development of these strategies. Consequently, the relationship between adaptability and two critical parameters, flexibility and durability, given their crucial role in the design and construction processes and how they enable DfA/DfD strategies, was first reviewed in this paper. The next step was exploring the combination of DfA/DfD strategies and integrating them with the features of prefabricated construction/ modular timber technologies to describe a theoretical approach for developing adaptable buildings. Finally, the gaps analyzed between the parameters, design strategies, and prefabricated construction/modular technologies in some projects to understand their possibilities and limitations. Thus, the paper aims to describe an initial theoretical approach, identifying knowledge gaps and addressing research needs between parameters, design strategies, and technologies to enhance timber buildings.

CODE 334

ENERGY EFFICIENCY RENOVATION STRATEGIES FOR A HISTORIC RESIDENTIAL BUILDING

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KEYWORDS: Energy Efficiency; Energy Retrofitting; Historic Building; Sustainability; Terraced House.

ABSTRACT

Climate crisis the World is facing requires radical measures by all citizens, companies, and the governments. We all know that we must act at all fronts to limit and decrease the carbon emissions and the increase in global average temperature below pre-industrial levels. This requirement is now more important for the built environment. At this point, energy efficiency and consumption behaviour have an important role in decreasing the energy demand. According to the International Energy Agency, it is important to achieve deep renovation for at least 20% of the existing building stock to meet decarbonisation targets for 2050 [1]. However, as the latest studies show that energy savings from implementation of insulation on retrofitting projects disappear in a few years due to the rebound effect [2]. Therefore, it is crucial to analyse occupants' behaviour towards a more sustainable lifestyle and to understand the key drivers for human comfort as well as improving energy efficiency. This would bring the highest potential to decrease energy consumption from building stock in line with getting closer to the 1.5℃ goal.

In the context, we report study on a historic house as at Fener district of Istanbul as a renovation project. The building is a terraced house with a floor area of 175 sqm. It is in the heritage protection area; therefore, the renovation of the building is challenging due to the restrictions on external touch to the building façade. The project aims to decrease the energy demand by carefully implementing sustainability measures from initial stage to the post occupancy phase. To reach this goal, the key steps are to specify the sustainability strategy, to conduct passive design analysis and occupant behaviour analysis, to achieve high standard and quality during the construction in implementation of energy efficiency features, and finally to finalise the project with soft landing to the occupants. We present a methodology here to show how a challenging project like this one need to be handled to have a lasting impact.

CODE 346

THERMAL INSULATION OF ADOBE WALLS: THE USE OF BIO-BASED MATERIALS

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KEYWORDS: Adobe walls; Organic-based materials; Thermal comfort; Acoustic comfort.

ABSTRACT

Interventions to improve the hygrothermal conditions and energy efficiency of existing buildings are governed by performance criteria offered by the materials applied, namely their thermal resistance, permeability to water and water vapour and, not least, durability. However, to these functional requirements must be added the concern for the efficient use of resources, establishing another dimension in the criteria for choosing materials and defining more sustainable solutions. In this context, the use of natural materials, known as "bio-based" or "nature-based solutions", is an alternative that is already known, but still little explored in intervention in existing buildings, particularly old buildings. On the other hand, earthen construction is very popular worldwide, with earthen buildings in various forms (blocks, rammed earth, etc.) existing in different contexts, often with recognised heritage value. The aim of this work is to characterise a "bio-based" thermal and acoustic insulation solution applied to adobe masonry. To this end, an experimental campaign was carried out centred on the study of adobe walls insulated with a bio-based solution and the respective performance evaluation. The results of this study show that the use of bio-based solutions is not only a more sustainable and compatible alternative from the point of view of conservation, but also an efficient, technically and economically viable alternative with less environmental impact in the context of rehabilitating built heritage.

CODE 347

THE USE OF REMOVABLE WINTER WINDOW TO IMPROVE INDOOR THERMAL CONDITIONS IN EXISTING BUILDINGS

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KEYWORDS: Old building stock; Rehabilitation; Thermal behaviour; Windows.

ABSTRACT

Owners of old buildings who want to improve thermal comfort and energy efficiency during the winter often choose window replacement as a necessary first step. Windows can be a significant source of air leakage and heat loss, yet total replacement is just one of many options that can improve windows' contribution to energy efficiency. In the case of built heritage conservation, practices struggle with the fact that old single-glazed windows with wooden frames (such as sash windows) have architectural value and play an important role in the aesthetics of traditional buildings. However, their poor performance, based on their low thermal resistance, influences the overall thermal resistance of the external envelope that can be surprising. The results of a campaign to monitor the use of a winter window that is installed and removed during the winter are presented and discussed, comparing it with the original undisturbed existing window solution. These results showed the good impact on thermal and acoustic performance and the influence they can have on the decision-making process of designers, contractors, and homeowners when it comes to renovating existing houses without compromising authenticity and architectural significance.

CODE 349

VALUATION OF HERITAGE-INTEREST PROPERTIES: ARCHITECTURAL RESILIENCE, ENERGY PERFORMANCE, AND TRENDS ANALYSIS IN THE FACE OF CLIMATE CHANGE IN "BARRIOS BAJOS" NEIGHBORHOODS OF VALDIVIA, CHILE

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KEYWORDS: Climate Crisis; Sustainable Habitability; Embodied Energy; Just Transition; Heritage Valuation.

ABSTRACT

This work aims to address the critical discussion on the valuation of heritage-interest properties in the current context of climate change. The focus is on a specific case study located in Valdivia, in Southern Chile. This case involves buildings constructed with native wood, with a history of over 50 years, in a neighborhood that was heavily affected by the 1960 earthquake. This example becomes the focal point that allows exploring the need to expand the valuation criteria (DDU 260), currently under the jurisdiction of the Ministry of Housing and Urbanism of Chile (MINVU). This implies incorporating the energy dimension into the evaluation in terms of use, with reference to a sample universe and considering the typological dimension for the selection of unique properties.

The methodology focuses on reviewing the energy dimension as a possible essential element in the valuation of heritage-interest properties, expanding the criteria, and proposing the use of internationally validated indicators. The contribution of the building sector to carbon emissions is taken into account, and criteria of singularity related to the persistence of spatial configurations and identity typologies in local neighborhoods are explored.

This case study stands out as a fundamental component in formulating a just transition in mitigating climate change in the construction sector, both at the national and global levels, aiming towards 2030. The importance of valuing these buildings is emphasized as a critical step towards more sustainable practices.

CODE 365

IDENTIFICATION OF KEY INDICATORS FOR CLIMATE RISK ASSESSMENT IN INDUSTRIAL AREAS: TOWARDS SUSTAINABLE ADAPTATION TO CLIMATE CHANGE

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KEYWORDS: Areas of economic activity; Sustainable adaptation; Mitigation; Climate change; Green infrastructure.

ABSTRACT

Currently, we face significant challenges related to climate change, as heat waves and heavy rains, and it is essential to address them effectively. While industrial areas play a crucial role in the economy, they also contribute to greenhouse gas emissions and environmental degradation that negatively impact climate change. Therefore, it is necessary to find ways to adapt these areas to achieve sustainable social, economic and environmental development.

This research focuses on analysing the economic activity areas in the Basque Country, aiming to study their sustainable adaptation to climate change through the implementation of green infrastructure. The goal is also to identify the potential for rehabilitating these industrial areas and to promote measures for climate change mitigation and adaptation.

To accomplish this objective, a detailed analysis of the economic activity areas in the Basque Country (Spain) will be carried out for their constructive and social characterisation. This will allow identifying potential rehabilitation interventions and climate change adaptation. For this purpose, Geographic Information Systems (GIS) tools will be used.

Secondly, the implementation of green infrastructure is proposed as a key strategy for achieving sustainable adaptation. Green infrastructure includes nature-based solutions like urban parks, vertical gardens, green roofs, and sustainable drainage systems. These solutions not only enhance the environmental surroundings, but also generate economic and social benefits.

The findings of this research are relevant for policymakers, urban planners, and technical professionals, serving as a solid foundation for informed decision-making in the planning and management of economically and environmentally sustainable development in the region.

CODE 366

EVALUATION OF THE ENERGY EFFICIENCY OF MUNICIPAL PALACES IN THE PROVINCE OF BUENOS AIRES. THEIR ENERGY INDICATORS AND IMPROVEMENT PROPOSALS

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KEYWORDS: Municipal buildings; Buenos Aires province; Energy efficiency; Energy audit; Euroclima.

ABSTRACT

The project team in the period from 2020 to 2023 carried out 47 energy audits for the Euroclima+ project called “Energy efficiency of energy-efficient and sustainable municipal buildings” which was coordinated by the UNLP associated with RAMCC and the Copenhagen Center on Energy Efficiency with the economic contribution of the Republic of France.
It covered an extensive territorial space from a very hot humid climate at -27° lat to a very cold mountain range climate at -40° lat, covering 15 municipalities in 6 Argentine provinces. Many of the 47 cases have heritage value for their communities. Of these, results are presented from the municipalities of San Antonio de Areco, San Miguel, Chacabuco, Tapalqué and Rauch that have municipal palaces built in the period from the mid-19th century to the mid-20th century and have protection as architectural cultural heritage. These were audited for their energy efficiency and level of hygrothermal comfort in winter and summer in order to know their environmental energy behavior, develop indicators to subsequently make design recommendations that allow them to improve their level of energy efficiency. The recommendations sought to minimize their formal impact in each case studied by recognizing the parameters valued as heritage. The results with approval of technicians from the Agence Francaise de Developpement were transferred to the municipalities.
The evaluation found that all buildings, as expected, have very poor energy efficiency; but it is possible to be rehabilitated with passive and active measures in order to obtain improvements in their efficiencies between 35 to 75% on average. Contrasted results are presented in relation to the climatic conditions of each municipality, together with the strategies used and the environmental energy model developed for this project.

CODE 384

DESIGN AND MATERIALS OF THE AUTEUR SOCIAL HOUSING: THE CASE STUDY OF SANTA MARÍA MICAELA HOUSING COMPLEX BY SANTIAGO ARTAL RÍOS

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KEYWORDS: Modern movement; Social housing; Architectural design; Duplex housing type; Ceramic cladding.

ABSTRACT

In Spain, although with some delay compared to other countries, social housing has had its own singular evolutionary history with design experiments and technological innovations by famous architects in the construction of important works belonging to the architectural heritage of cities. The paper illustrates the peculiarities and originality of Spanish social housing design through the case study of the Santa María Micaela complex in Valencia designed by Santiago Artal Ríos in the late 1950s. The work highlights the relationships between the formal component, the application of principles of Modern Movement Modernism, and the technical constructive aspects, with particular attention to the use of materials both in terms of formal characterization and contribution to the stratigraphic envelope. Artal Ríos arranges and shapes the three building blocks following the shape of the lot and creates a complete enclosure perceived from the street, also emphasized by the only entrance placed in the low block along S. María Micaela Street, which conceals and guards the large interior common areas. His design skilfully achieves more than one balance between the sub-systems present (technological-constructive, organizational-distributive, environmental-climatic, figurative-formal) and the relationships between them generate other ones between load-bearing building system and aesthetic expression. The structural frame masterfully punctuates the metrics of the elevations. Within the generative mesh, formed by exposed concrete beams and pillars with 45-degree bevelled edges and a pitch of 4.80 m x 4.80 m, fixed elements (yellow exposed brickwork and red under-window panels), movable elements (iron window frames and wooden shutters), and reticular elements (square perforated screens in white concrete) are inserted, creating alternation and constant movement between opacity transparency and colour.

CODE 385

THE ENERGY REQUALIFICATION OF THE AUTEUR ARCHITECTURE FOR SOCIAL HOUSING: THE CASE STUDY OF SANTA MARÍA MICAELA HOUSING COMPLEX BY SANTIAGO ARTAL RÍOS

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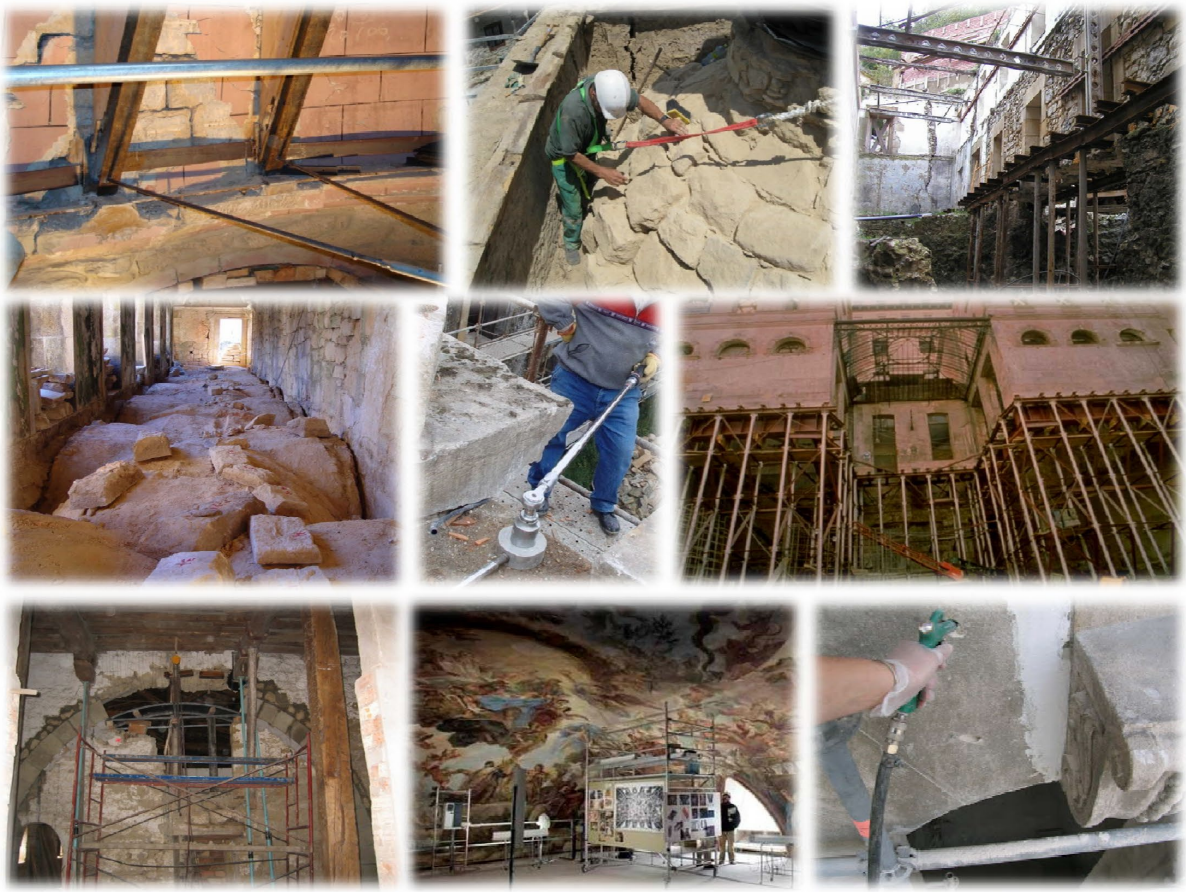
KEYWORDS: Auteur architecture; Social housing; Energy requalification.

ABSTRACT

To meet the new housing demands caused by current environmental policy, many social housing districts, complexes, and buildings must undergo a technical performance update more than 50 years after their construction. The redevelopment strategy must consider various aspects, including the significance of authorship and the social, cultural, and technological merit of a building system that was prevalent during the post-war period; the use of sustainable materials to preserve the expressive and material value of the work; and technical deficiencies to respond strategically to current regulations to the assessors. The paper, examined original design solutions and compared innovative products, comes to propose an energy requalification solution that adhered to current legislative provisions, also considering both the historical and architectural value of the Santa María Micaela housing group designed by Santiago Artal Ríos in Valencia (ES) as a model for methodological experimentation, of which the technical-constructive and energy-performance characteristics have been evaluated, by making a comparison between the Spanish and Italian regulatory approach, carrying out the analyses with two different software. The challenge of this work is finding a balance between the rights to preserve the Modern architecture also the one designed for social housing and even when unrestricted, and the urgent demands of a performance adjustment imposed by the energy requirements but implemented by the residents in an ineffective manner.

3.- BUILDING INTERVENTION



CODE 192

PLAN DEL HORRU. PROGRAM OF ACTIONS FOR THE PROTECTION OF HÓRREOS, PANERAS AND CABAZOS IN THE PRINCIPALITY OF ASTURIAS

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KEYWORDS: Conservation; Architectural Heritag; Raised granaries.

ABSTRACT

The *Plan del Horru*, driven by the *Consejería de Cultura, Política Llingüística y Deporte del Principado de Asturias*, and whose initial document was presented in 2023, is conceived as a set of measures aimed at providing the information and analyses necessary to make strategic decisions regarding the conservation and protection of the *hórreos*, *paneras*, and *cabazos* of Asturias. These elements, of significant architectural, landscape, historical, and cultural value, are in a vulnerable situation due to the complex demographic situation and the social and productive changes in rural areas over the past decades. The Plan proposes a series of Axes: 1. Regulatory and Technical Regulation; 2. Heritage Protection; 3. Conservation and Restoration; 4. Knowledge Transmission and Dissemination. On these axes, a total of 22 specific measures or objectives are proposed, to be implemented from 2023 and in subsequent years with the active participation of various entities, organizations, and professionals from different perspectives (legislation, history, architecture, sociology, engineering, etc.). This work aims not only to present the objectives and general measures of the Plan but also to showcase the progress made in the planned activities during the first development phase (2023-2024), as well as the evolution of its impact, repercussions, and the definition of subsequent steps to be taken.

CODE 302

DEFECT MONITORING AND PREDICTIVE MODELLING: AN ATLANTA CASE STUDY

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KEYWORDS: Cultural heritage; Defect monitoring; Civil rights; UAV; LiDAR.

ABSTRACT

The English Tudor Revival structure of the English Avenue Elementary School (b.1911) is one of the oldest public schools in the city of Atlanta, Georgia and it was listed on the National Register in March 2020. It was originally designed for the white residents of the working-class Western Heights neighborhood, but shifting demographics changed the designation to a 'Black school' in 1950. Following Brown vs. Board of Education 347 U.S. 483 (1954), an early morning bombing at the site in December 1960 demonstrated the ongoing white supremacist presence within the city, eager to express their disapproval of desegregation. The history of the site challenges Atlanta's myth of smooth racial progress in the "city too busy to hate," as coined by Mayor Ivan Van Allen in the 1960s.
As interpretive immersion technologies advance through digital archives, collections, and databases, so do options for layered, interactive models that can advance the potential of heritage BIM (building information modeling). Incorporating these innovative interpretative methodologies for documentation and public outreach, this project explores the alignment of data collection and analysis using archival, Historic American Buildings Survey, and digital documentation methods at the English Avenue Elementary School. At the present time, the site is abandoned and structurally compromised, but plans are underway for the emergency stabilization, restoration, and adaptive use of the structure. Demonstrating the feasibility of melding digital documentation of fragmented sites with archival material to enhance historic interpretation and public outreach, this project enhances and augments sequential point cloud captures for deep climatic and structural data analysis, proposes workflows for non-invasive defect monitoring, and serves as an example of community-grounded field work within the academy.
Throughout its history, this large elementary school has been a community center to uplift its residents. It has witnessed many moments and movements in history including women's suffrage, child labor laws, and the pursuit of racial justice. The building is poised to be preserved, and eventually rehabilitated, but the neighborhood is also poised for gentrification with the immerging presence of two major tech companies and the construction of the Atlanta BeltLine.

CODE 324

SYSTEM FOR THE WRITING OF A MASTER PLAN OF UNDERGROUND MONUMENTS WITH PICTORIAL ELEMENTS. THE CASE OF SANTA EULALIA DE BÓVEDA (LUGO)

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KEYWORDS: Built heritage.

ABSTRACT

During drafting the Plan Director (hereinafter P.D.) del Monumento Romano de S. Eulalia de Bóveda, a systematization of the processes to be executed in the development of a P.D. has been sought.
The lines of research conclude the following process as extrapolable and adaptable to various cases. The P.D. It is divided into 9 groups: monument's general description, historical memory, cataloging of the available information, previous interventions' analytical relationship, materials' characterization, restoration, material pathology's registration, function and diagnosis, proposals for urgent action, use plan and management proposals.
The general description includes fortnightly files' preparation which incorporate architectural and artistic elements' study, archaeological knowledge of the monument's current state description, stonework's study, construction evolution, typological contextualization, description of the environment and landscape and the review of the protection area. In addition, a historical memory is prepared including the different historians' hypotheses and the available information's cataloging. The analytical relationship of the previous interventions involves the creation of files for compiling plans and graphic documentation of the different interventions and the review of documentation related to the environmental conditions of the monument. Materials' characterization contains documentary references on salt content, mapping and identification and wall surfaces' non-destructive analyzes. The registration of pathological processes, function and diagnosis involves biweekly files' preparation, an annual summary report of the controls carried out, psychrometric diagram's study, a study of the cycle of the behavior of salts and biological agents of deterioration, physical, mechanical and chemical processes. and the materials of the structure. Urgent action proposals include those immediate intervention works to ensure the monument's integrity in the immediate future. A use plan is prepared, as well as management proposals that improve the understanding and dissemination of the monument.
Finally, future research work will be specified to complete all the information obtained and from all this conclusions will be extrapolated regarding: climatic conditions, salt contribution, salts' typology and their distribution, biological colonization, the structure and all those topics addressed in the plan.

CODE 63

THE NEW REHABILITATION STRATEGIES OF ARCHITECTURE: THE BUILDING OF THE NEW UNIVERSITY OF MESSINA

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KEYWORDS: New workspaces; Health and wellness; Archival documentation; Architecture of the '900; Architectural survey.

ABSTRACT

The city and its buildings are an expression of the history and the socio-cultural context shaping their forms and interior meanings. The archival documentation allows to walk backwards along the milestones influencing the design process, giving the possibility of understanding all the motivations driving its continuous development. The system of buildings forming the original nucleus of the New University of Messina, built immediately after the 1908 earthquake and, in particular, one of the buildings in question, represents the research object of this contribution. The comparative reading of the original project with the recent surveys has become an opportunity to set up a strategy aiming to improve the level of comfort of its environments by adapting the building to the new standards. Indeed, by applying such exegetical process we will try to investigate the construction methodologies putting them in relation to the needs of main users; the building under investigation had in fact to fulfill the "specialist" function of the headquarter of university institutes integrating among the other functions of laboratory type. After having analyzed the transformations that have occurred over time and the relative adaptation to new uses, the objective of the research is to formulate design hypotheses aimed at the "rehabilitation" of the building through the combined application of the tools of representation (survey, graphic analysis and 3D modeling) which will allow, in the first phase of the work, to formulate hypotheses for the re-functionalization of the environments. Subsequently, the remodulation of the spaces analyzed according to the new comfort needs will be foreseen, applying innovative technologies in the field of environmental improvement, optimization of the dimensions and furnishings in relation to the work activities that take place there. All this invokes the civil role of architecture in response to great contemporary needs, where the redesign of workspaces, through the use of some fundamental steps, allows for the creation of a simple, comfortable, dynamic, multifunctional, technological and compliant workplace and productivity. The perception of the work space, single or shared, is gradually changing also due to a series of dynamics that involve our lives: the advancement of technology, the emergence of more flexible forms of work, growing attention to sustainability and greater interest in the health of users.

CODE 64

SOLAR NOTRÊ REVÊ: FROM HISTORIC PROPERTY DESIGNATION TO NEGLECT

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KEYWORDS: Structural Reinforcement; Restoration; Stability; Historical Heritage.

ABSTRACT

The present work refers to a mansion, built in 1921, in the center of the city of Niterói, in the state of Rio de Janeiro, in Brazil. Known as Solar Notrê Revê or Casa Norival de Freitas, the place is considered a historical heritage and was protected in 1983. However, due to neglect, lack of maintenance and accidents, the building is practically in ruins and with its structure completely unstable. With this, the city hall began a process of restoration and structural reinforcement of the mansion, with the aim of trying to preserve the culture and history of the place. Therefore, this work aims to present the history of the building, pointing out all the structural pathologies detected as well as the solutions that will be required to return the structure of the mansion to its bearing capacity, so that the reinforcement work is carried out in accordance with the restaurant service. As a methodology used to prepare this work, inspection visits were carried out at the site, with analysis by engineers and architects specialized in the area, to detect and survey existing pathologies, in addition to a detailed study of all reinforcement projects prepared, which will be presented here explained. With this, it will be possible to present more modern, effective structural reinforcement techniques that are capable of guaranteeing the architectural originality of a modern building, in addition to providing stability and useful life.

CODE 129

ANALYSIS OF HYDRAULIC BEHAVIOR IN LIME-BASED MORTARS FOR UTILIZATION IN RESTORATION

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KEYWORDS: Mortars; Restoration; Lime; Metakaolin; Hidraulicity.

ABSTRACT

In the field of rehabilitation and restoration, there has been a longstanding debate on the effects of the hydraulicity of mortars in historical buildings. Frequently, simplistic ideas are employed, coupled with the absence of regulations or the use of commercial terms that do not contribute to a crucial topic necessary for the selection of compatible mortars in each intervention, aiming to prevent the development of pathological processes that could compromise their future.
For instance, in rehabilitation and restoration projects, there is significant resistance to the use of Portland cement, with a preference for the use of slaked lime or, in any case, hydraulic limes (especially natural ones), as they are considered less aggressive binders for historical mortars. However, it is a complex issue for which there are no comparative empirical studies analyzing the short- and long-term behavior of the most common mixtures.
This research presents a comparative study of common hydraulic mortars in restoration works, achieved through different combinations: aerial lime-Portland cement, slaked lime-pozzolan, natural hydraulic lime, and, as reference, the two extreme cases of hydraulicity - slaked lime (no hydraulicity) and Portland cement (maximum hydraulicity). To achieve this, mortars were produced with the mentioned binders and different dosages, and various physical and mechanical properties of each were analyzed in an extensive experimental campaign over the short and long term (up to 6 years).
Regarding the results, some behaviors were observed as more or less predictable, such as lime-based mortars being flexible enough to be used as a coating for a substrate, adapting to its movements. On the other hand, Portland cement-based mortars, due to their rigidity, are more prone to cracking issues. It was also observed that mortars with metakaolin significantly improve their permeability performance over time. The most noteworthy aspect of the study is that it has allowed the evaluation, with concrete data, of variations between different combinations.

CODE 156

FROM DECAY TO DURABILITY: A STUDY ON THE ENVIRONMENTAL AND AGING IMPACT ON THE DEGRADATION OF WOOD SPECIES

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KEYWORDS: Wood aging; Weathering; Degradation; Timber rehabilitation.

ABSTRACT

Wood, as one of the oldest building materials, is popular for different types of structures. As a natural resource with hygroscopic behavior, its strength, durability and visual appearance is highly affected by changing climate conditions. Those factors can significantly influence the durability and estimated age of climate exposed buildings and structures. Reversing or stopping degradation of the structures and their mechanical properties is of utmost importance when members or other parts of the structures need to carry loads or serve for overall structural stability. To gain a better understanding of the environmental, aging and degradation impact on climate exposed timber structures a field study on the influence of natural aging and degradation of wood species has been started to serve for determination of prerequisites for strengthening or refurbishing of treated or matured wood in reconstruction. First, a better understanding of the influence of natural hazards like climate and weather exposition or fungi attack on exposed wooden parts in historical buildings is needed to evaluate the degradation level depending on the intensity over time. With this knowledge, a repair technique based on a resistance-enhancing surface treatment shall be developed with an adhesive strengthening system based on permanent coating.
This paper gives an insight to the first part of the field study. The most influencing natural hazards on exposed wooden structures and buildings have been classified and investigations how to measure the impact to the global degradation of wood are described. In this study, artificially accelerated aging serves to simulate the different environmental impacts and lifecycle stages. Substantial changes related to durability, surface properties and the substantial composition of exposed matured wood have been investigated in lab tests on clear and small size specimen samples. This paper presents results of the accelerated aging test series on clear samples and gives assumptions regarding the observed lifetime degradation level for affected material characteristics. The evaluation of the test method and obtained results compared to the natural degradation of structural properties will serve as starting point for the next investigations and development of a permanent coating and protection system for wooden heritage buildings.

CODE 214

VIBRATION RESISTANCE OF TIMBER-CONCRETE COMPOSITE SLABS

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KEYWORDS: Timber-concrete composite; Heritage protection; Strengthening and revaluation; Vibration resistance.

ABSTRACT

Timber-concrete composite (TCC) is a well-approved technology for revaluation or strengthening of existing timber beam ceilings. In this process, shear connectors are assembled at the top of the timber beams and subsequently a concrete slab is casted resulting in a composite member in consequence of hardening of concrete. Normally, the boarding can stay in place and the bottom side of the floor may be unchanged. This fact is a huge benefit in the context of heritage protection and revaluation of old buildings in general. Whereas the load bearing behavior of TCC slabs was investigated in many research projects, the vibration resistance less often was considered. The paper introduces the TCC construction method including its advantages and disadvantages. The authors discuss the requirements to the application of TCC and analyze the request on vibration resistance while applying TCC from the technical and the legal point of view. Based on a parametric study, the paper provides information about influence parameters on vibration resistance and draws conclusions for the appropriate design of TCC slabs. This paper only refers to slabs in residential buildings. For labs in industrial buildings, shopping malls, or sports facilities, other requirements exist.

CODE 246

PERFORMANCE ANALYSIS OF NOPAL (OPUNTIA FICUS-INDICA) AS REINFORCEMENT CORROSION INHIBITOR IN SIMULATED CONCRETE PORE SOLUTION

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KEYWORDS: Mucilage, Nopal; Corrosion; Inhibitor; Electrochemical cells.

ABSTRACT

In recent years, the use of green corrosion inhibitors has been investigated, with plant extracts gaining prominence due to the large presence of phytochemicals that contribute to inhibition. Among them, Opuntia Ficus Indica (Nopal), a cactus plant species, has been studied as an alternative. In this work, exudate nopal mucilage (ENM) was used as reinforcement corrosion inhibitor in electrochemical cells with simulated concrete porous solutions. ENM volumetric concentrations of 0, 2%, 4% and 6% were used for the experiments and three replicate cells were adopted for each experimental condition. Cumulative additions of chlorides were performed along time until reinforcement depassivation was reached. Along this period, potential corrosion and corrosion current density were monitored by using linear polarisation measurements. Results show that the addition of ENM can improve the reinforcement performance in chloride contaminated media, retarding the reinforcement depassivation and increasing the critical chloride content. This behaviour depends on ENM concentration.

CODE 247

ASSESSMENT OF ETICS SYSTEM WITH HIGH REFLECTANCE PIGMENTS: IN SITU PERFORMANCE STUDY AFTER 5 YEARS OF USE

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KEYWORDS: ETICS; Cool pigments; Durability; In situ Experimental Assessment; Functional Performance.

ABSTRACT

A single-family residential building located in Felgueiras, North of Portugal, built in 2018, was thermally insulated using an ETICS solution consisting of a black coating formulated with modified acrylic resins, specific additives and cool pigments on a thermal insulation system based in EPS. The solution applied to date was designed to allow, in combination, the waterproofing of facade walls, the increase in thermal resistance, the reinforcement of performance against climatic actions, and the development of biological agents such as fungi and mold. After 5 years after the original application, the use of a black-coloured finish, more susceptible to the occurrence of color loss and generalized cracking than other finishing colors, determines the need to develop an experimental evaluation study of the in situ performance of the ETICS coating originally applied in 2018.
The in situ performance of the ETICS system is strongly dependent on the characteristics of the finishing coating, which must ensure high resistance to cracking, strong waterproofing, and high permeability to the passage of water vapor, without compromising the aesthetic characteristics. of the system, such as its texture and the color of the finishing material.
In situ experimental evaluation using thermographic inspection, measurement of color stability and surface temperature, and rapid cracking study, made it possible to validate the durability of the originally applied solution, after 5 years of intensive use, thus reducing costs. associated with the coating of the applied ETICS solution.
The application of new generation organic coatings, based on modified acrylic resins, specific additives and cold pigments, known as reflective pigments, based on the analysis of the experimental results of the tested solution, makes it possible to mitigate pathologies related to color loss, and with widespread cracking as a result of the high surface temperature, thus improving the color stability of the coating and its watertightness.

CODE 297

SEISMIC VULNERABILITY OF EXISTING RC MOTORWAY BRIDGES CHARACTERIZED BY FRAMED PIERS

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KEYWORDS: Existing RC bridges; Seismic vulnerability; Corrosion effects; Multi-modal pushover analysis.

ABSTRACT

During last decades, the scientific community has increased its attention on the evaluation of the seismic vulnerability of the existing reinforced concrete structures, also following the damages and collapses occurred during recent strong seismic events. Among the existing structures, the motorway viaducts stand out for their strategic importance. Different types of approaches have been proposed to evaluate the seismic performance of the existing reinforced concrete bridges, especially considering the use of non-linear techniques. Among nonlinear techniques, the pushover analysis is preferably applicable in presence of structures where their dynamic behaviour is characterized by a predominant translational vibration mode, which is not the case of bridges, typically. Another approach commonly used is the non-linear time history analysis that presents different critical aspects as the correct definition of the seismic input and the modelling of strength/stiffness degradation. In recent years, some researchers have extended the use of the multi-modal pushover analysis for the evaluation of the seismic vulnerability of the reinforced concrete existing bridges. This analysis method can take into account the contribution of higher vibration modes, not neglectable in the case of multi-span and long-span viaducts with framed piers and elastomeric bearings. In this paper, the application of the multi-modal pushover analysis is proposed for the evaluation of the seismic behaviour of existing reinforced concrete viaducts located in Italy and built around the 1960's, considering its limited computational effort. The results obtained are defined considering appropriate risk indices expressed in terms of peak ground acceleration (PGA) and related return period (RP), useful for classifying the vulnerability of the considered structures and to define their appropriate maintenance interventions.

CODE 375

ASBESTOS REHABILITATION METHODS

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KEYWORDS: Asbestos; Rehabilitation; Health; Safety.

ABSTRACT

Asbestos is a mineral of natural origin consisting of fibres with excellent properties, which led to its use in many places and products until the end of the 20th century. Despite its low cost, this material has excellent physical and chemical properties, such as: mechanical strength, resistance to high temperatures, good thermal and acoustic insulation, excellent chemical stability. Due to its excellent properties, it was widely used, because until then its harmful effects on public health were not known, and most of the time it can take years, even decades to manifest in the human body.
This study aims to analyse the buildings where there is asbestos, with regard to hygiene, health and safety. In particular, the type of tests that can be done to identify and characterise the type of asbestos fibre present in the samples acquired at the study site.
Finally, examples of rehabilitation solutions for buildings where asbestos is present are presented.

CODE 379

THE DURABILITY OF ADAPTIVE SKINS: AN OPEN ISSUE

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KEYWORDS: Adaptive skins; Differential durability; Maintainability; Adaptive envelope.

ABSTRACT

The aim of the paper is to provide a literature review on the durability of contemporary surfaces known as 'adaptive skins.' These surfaces are constructed with the dual objective of creating dynamic or kinetic, multimedia, communicative, responsive, and energy-controlled surfaces. Adaptive facades usually change shape or texture in response to environmental stimuli. They are built with mechanical components and electronic connections, often incorporating textile or smart components. It seems that they have not lasted long in service, perhaps due to installation in extreme latitudes, harsh climates, or in tall buildings where maintenance is challenging. These facade systems are complex, as they built with sophisticated technologies from industrial fields (mechanical, electronic, etc.), out of building sector. Consequently, the approaches to the maintenance and management of these systems differ significantly from those of traditional building systems, from design through all phases of service and dismissing because can be make gaps, tolerances, and technological incompatibilities.
The research's limitations stem from the unavailability of technical data and post-construction tests of facades over time. For this reason, the study was developed theoretically after analysing the literature and case studies. It is generally recognized that the reliability and longevity of construction systems largely depend on the sophistication of the adopted solution. However, defining durability indicators for these 'skins' is challenging because they are 'adaptive,' constantly changing, particularly in shape and texture. The components used to build them come from industrial sectors where they are highly tested and have high reliability requirements. However, we are not certain that the same requirements hold in the construction sector.
The paper, through literature analysis, describes the complexity of these technological systems throughout different operational phases. The involved factors have been analysed and they have relating the traditionally established concept of 'durability' to these systems that, by their origin, are characterized by variable and ephemeral functionality. In the case of adaptive skins, it seems more important to program the lifespan and maintenance of components within a maximum of 10 years than to use durable materials and solutions. The hypothesis arising from the analysis conducted here will be to propose the extension of the concept of 'differential durability' coined for installations to adaptive skins.

CODE 383

HYGROTHERMAL MODELLING OF MOISTURE ACCUMULATION IN COMPOSITE ROOF DECKS IN HIGH HUMIDITY ENVIRONMENTS

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KEYWORDS: Vapor Retarders; Condensation; High Humidity; Roof Decks, Durability.

ABSTRACT

High humidity and corrosive indoor environments in natatoriums in cold climates pose unique risks and challenges due to moisture condensation in roofs. Without the existence of standards for roof design, based on a simple, steady-state dew-point analysis, the common practice is to employ at least a 0.1 perm vapor retarder on the warm side of the assembly to eliminate the risk of condensation. The use of the vapor retarder in preventing condensation is not well understood. This study investigates the role of a vapor retarder in a roof assembly for natatoriums by hygrothermal modelling in Climate Zone 7 using WUFI. A wood composite roof deck (R-value of > 35 hr.ft2·°F/BTU) that provides acoustics, thermal insulation, and a nailable surface such as oriented stranded board (OSB), with and without a vapor retarder, at different locations in the assembly is used as a roofing candidate for the simulation. The moisture accumulation in the OSB board over the years of exposure is used as an indicator of the roof's performance. In addition, the presence of a dew point to verify the occurrence of condensation in the assembly is monitored.
The simulation results show that even without a vapor retarder: 1) The moisture content in the OSB reaches a dynamic steady state in 3-5 years. 2) Maximum moisture content in the OSB does not exceed more than 11.6% (>20% is considered "risky"). 3) There is no risk of condensation in the assembly at any point in time. 4) With the placement of a vapor retarder on the warm side or close to the OSB, the maximum moisture content is reduced to 11.2%. These observations contradict the simple dew point analysis model that is commonly used to prescribe a vapor retarder for the roof assembly and question the need for one in the roof assemblies.

CODE 390

RESTORATION OF THE FACADES OF THE CATHEDRAL BASILICA OF SAN SALVADOR

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KEYWORDS: Rehabilitation; Heritage; Cathedral; Pathologies; Facades.

ABSTRACT

The Catedral Basílica de São Salvador is a building which is dated to the 17th century. Considered one of the most important sacred buildings of the country, its facades are made of lioz stones, imported from Portugal and the niches under the doors are Saint Ignatius of Loyola, Saint Francis Xavier and Saint Francis Borgia. With the departure of Jesuit from the country the church was abandoned and was used as a military hospital and as the first Brazil's School of Medicine, installed in 1833. Yet in 1938, the church was individually listed by Iphan and the protection also includes all of its pile, which is composed of canvas fr many different authors from the seventeenth century, jacaranda wood furniture and a big sort of gold and silver sacred objects.

The Restoration Project integrates a group of actions accomplished in the Cultural Patrimony of Bahia reaching more than R$ 92 million in sums from the Federal Government via Instituto do Patrimônio Histórico e Artístico Cultural (Iphan).

It was implemented with the support of São Salvador da Bahia Archdiocese, with the Municipal government of Salvador and State Government of Bahia, the restoration work was accomplished by Marosul Engineering Company composed of a multidisciplinary team, with more than 120 professionals, which merged the use of techniques, contemporary and traditional materials. The basilica was subjected to a three years and eight months restoration process. The restoration work permitted the treatment of all existing pathologies in the building. Installation of modern sound system equipment, fire fighting and fire prevention system, patrimony security, implementation of access ramp were provided, making its infra-structure more modern, optimizing space occupation, establishing rules for its use and maintenance, potentializing the cultural vocation of the listed asset.

The lytic elements present on the historic building facades show different pathologies, crusts and biofilms, presence of mortar upon the elements, injuries and material losses which allowed the spread of vegetation.

During the restoration work we applied the chemical cleansing technique, removal of inappropriate interventions, elements desalination, confection of prosthesis in lytic material identical to the ones on the facades which were installed on the parts which showed grand fractures and voids, these parts had their outlines determined from the exact faces of the injuries identified on the facades.

CODE 85

DESIGN OF CONCRETE OVERLAY ACCORDING EUROPEAN STANDARD EOTA TR066

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KEYWORDS: Renovation; Concrete overlay; Shear connectors, Anchors, TR066.

ABSTRACT

The installation of new, retrofitted concrete layers (concrete overlay) is becoming increasingly important due to the growing need for repair and reinforcement of existing structures.
Bridge cross-sections reinforced by a new concrete layer as well as the repair and reinforcement of existing concrete components by a new concrete layer are typical examples of the use of overlay. If the shear stresses in the bonded joint between the concrete layers that were poured at different times are not sufficiently transferred, the structural safety is at risk. In order to achieve a monolithic connection, post-installed shear connectors are usually placed.
The new design concept according to EOTA TR 066 "Connector for strengthening of existing concrete structures by concrete overlay" [1] allows the design and dimensioning of these connections and the interface taking into account all load-bearing components (cohesion/friction, interlocking and dowel action) and other product-specific factors.

CODE 86

DESIGN OF FASTENINGS IN MASONRY WITH METAL INJECTION ANCHORS ACCORDING TO EUROPEAN REGULATION

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KEYWORDS: Masonry; Fastening; On site testing; European Technical Assessment (ETA); European Assessment Document (EAD).

ABSTRACT

The definition of structural anchor solutions in masonry is a recurring problem in projects, both in new construction and renovation.
Since 2014, the European organization EOTA has defined the necessary tests to be able to homologate, at European level, the chemical anchors in this base material. These tests are described in the European Assessment Document EAD 330076-00-0604 "Metal injection anchors for use in masonry". The approval includes the anchor strength values for different types of masonry.
The document Technical Report TR054 "Design methods for anchorages with metal injection Anchors for use in masonry", of April 2016, includes the methodology for calculating chemical anchors in masonry. This methodology is very similar to the calculation of anchors in concrete, where the different failure modes of the anchor are checked for tension, shear and combined load.
The resistance values of masonry anchors vary significantly depending on the type of masonry (hollow, solid), material (clay, light concrete) and the exposure of the masonry over time to climatic agents (hours of sun, humidity, rain, etc.). In renovation works, it is necessary to carry out tensile tests on the anchors in masonry. The document Technical Report TR053 "Recommendations for job-site tests of metal injection anchors for use in masonry", indicates the protocol for on-site tests, as well as the evaluation of the results obtained in order to estimate a design strength to calculate the solution.

CODE 121

AN INNOVATIVE INSULATING SYSTEM FOR DUAL SEISMIC AND THERMAL MITIGATION OF MASONRY STRUCTURES

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KEYWORDS: Masonry infills; Seismic response; Thermal insulation; Retrofit; Experiments.

ABSTRACT

The proposed work presents the results of an experimental investigation aimed at assessing the performances of unreinforced masonry units retrofitted with an innovative insulating system. The system consists of a reinforced mortar applied on an insulating EPS panel, with the double function of thermal insulation and seismic retrofit. The system has been developed by the Italian company Pontarolo Engineering SpA and studied by the research group at CIRI Building and Construction of University of Bologna. The experimental investigation aimed at assessing the improved shear resistance of masonry panels equipped with the system under study. Diagonal compressive tests were carried out on a series of panels realized with hollow masonry bricks. The results provided an improved response under shear action of the retrofitted masonry panels for non-structural infills in RC frames. The investigations proved the effectiveness of the innovative thermal and seismic retrofitting system in improving both shear strength and deformation capacity with respect to the unreinforced traditional masonry units.

CODE 187

PARAMETERS AFFECTING THE FLEXURAL CAPACITY OF FLAT PLATE SECTIONS DURING FIRE EXPOSURE

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KEYWORDS: Reinforced concrete; Flat slab; Fire; Flexural capacity.

ABSTRACT

Engineers have been following prescriptive design criteria to achieve acceptable fire safety, which is restricting their ability to innovate and estimate the actual fire safety of their designs. Performance-based and objective-based designs, which were introduced in North American design standards, can address this problem. Fire-induced elevated temperatures cause a temperature gradient within concrete sections. This gradient leads to the development of internal stresses to maintain the plane section behaviour and thermal and transient strains. The elevated temperatures also cause degradation of the properties of concrete and steel. These effects complicate estimating the flexural capacity of concrete sections during fire incidents. This paper provides engineers with an understanding of the parameters affecting the flexural capacity of flat slabs during fire exposure. The examined parameters are slab thickness, fire duration, surface exposed to fire (top, bottom, or both), steel ratio, and concrete strength.

CODE 250

FRP-STRENGTHENING FOR ENHANCING TORSIONAL CAPACITY IN RC BEAMS: A CASE-STUDY IN AN ITALIAN CHURCH

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KEYWORDS: Case study; FRP system; Structural rehabilitation; Torsional strengthening.

ABSTRACT

This paper concerns the damage analysis and external torsional strengthening of an existing reinforced concrete (RC) church located in Italy. The study was carried out in order to define a suitable structural rehabilitation intervention using a Fibre Reinforced Polymer (FRP) system for the beams of the frames in the longitudinal direction that show damage due to torsion stresses. Several tests were carried out on the existing structure, and the full knowledge level (KL3) was reached according to the Eurocode. The mechanical properties of the materials obtained from the tests were used to carry out the analysis of the actual state of the church. The results showed that the structure has no problems with respect to the bending and shear stresses. However, the structure cannot adequately withstand the torsional stresses that caused the damage to the horizontal beams. Strength verification/design at the Ultimate Limit State (ULS) were carried out according to the Italian Code and the Italian guideline. A variable strut inclination model for RC members was used, and this showed that the ULS for torsion due to inadequate longitudinal reinforcement was not satisfied. However, current codes and guidelines allow torsion strengthening only if collapse occurs due to insufficient transverse reinforcement (stirrups). Therefore, a new model needs to be formulated to calculate the contribution of the external FRP strengthening to the torsional strength due to the existing internal longitudinal steel. This study also showed that when adopting the Ritter-Mörsch model, in which the concrete compression struts are assumed to be 45°inclined to the longitudinal axis of the beam, collapse occurs due to insufficient transverse reinforcement. Based on the latter model, a strengthening intervention for the damaged beams was designed and implemented by applying bi-directional carbon fibres. The fibres were applied continuously using the U-wrapped technique. The proposed structural intervention with the FRP system met the required verifications and achieved the goal by enhancing the torsional capacity of the RC beams of the existing structure.

CODE 263

SHEAR BEHAVIOUR OF REINFORCED CONCRETE BEAMS STRENGTHENED BY TEXTILE-REINFORCED MORTAR COMPOSITE

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KEYWORDS: Textile reinforced mortar (TRM); RC beam; distributed fibre optic sensor (DFOS); shear load; Digital image correlation (DIC).

ABSTRACT

This paper presents an experimental study on the local and global mechanical behaviour of Reinforced Concrete (RC) beams under quasi-static shear load. The aim is to assess the effect of the retrofitting by Textile Reinforced-Mortar composites (TRM).
The TRM reinforcement is constituted of two layers of alkali-resistant (AR) glass textile grid embedded in a self-compacting cementitious matrix. The overall thickness of the applied composite is approximately 1 cm.
The different beams underwent four-point bending tests. TRM reinforcement is applied on the shear zone situated between the application point of the load and the bearing. To control the shear failure, the design of the RC steel bars and stirrups was made accordingly, one of the shear zones was poorly reinforced (only 1/3 of the stirrups was installed).
In order to assess the local behaviour, the TRM was equipped with distributed fibre optic sensor (DFOS) bonded to the upper textile layer. This sensor enables the study of the local internal behaviour of the TRM and helps to deduce the evolution of the load transfer mechanism. Moreover, digital image correlation (DIC) technique is used to assess the evolution of the crack widths in the shear zone. The local/global behaviour and the effect of the retrofitting by TRM are measured, studied, and analysed in this work.

CODE 306

ANALYTICAL FORMULATION FOR THE DESIGN OF STEEL REINFORCED PLASTER

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KEYWORDS: Masonry retrofitting; Analytical model; Steel reinforced plaster.

ABSTRACT

Among the available techniques to improve the performance of existing masonry structures, steel reinforced plaster (SRP) is largely adopted to retrofit common residential masonry buildings. The adoption of the method is mainly due to its simple technology, which recurs to ordinary and cheap materials, associated with its high effectiveness. Even if several technical codes suggest it as a possible retrofitting intervention for existing masonry, satisfactory theoretical models to be used for the practical design are not available in the scientific literature. This paper proposes an analytical method to predict the strength of SRP-retrofitted masonry walls. The aim is to define a general design formulation, which considers the main parameters that affect the performance of the strengthened wall (e.g., thickness and mechanical properties of the plaster, number of connectors), to be used in daily structural engineering practice. The method was developed starting from a database of experimental results of diagonal compression tests conducted on unreinforced and retrofitted masonry specimens. The proposed formulation is able to approximate the experimental values with an acceptable level of accuracy, being on the safe side in most of the cases. It should be noticed that the experimental data used in the assessment process were limited to specific masonry types. For this reason, further experimental results should be acquired to extend the validity of the proposed method to other masonry base materials and confirm the good trend of the prediction model.

CODE 326

THE STRENGTHENING OF FLOOR AND ROOF MASONRY RING BEAMS WITH FIBRE-BASED COMPOSITE MATERIALS: EXPERIMENTAL TESTS

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KEYWORDS: Masonry; Ring beams; Composites; Fibre Reinforced Polymer (FRP).

ABSTRACT

The paper collects the results of some experimental tests carried out to assess the behaviour floor and roof masonry ring beams strengthened with composite materials. Two different techniques are considered. The former consists in the reconstruction of the masonry of the roof ring beam by embedding Glass Fibre Reinforced Polymer (GFRP) preformed meshes in the bed joints; the latter in wrapping the floor/roof ring beam by means of Carbon Fibre Reinforced Polymer (CFRP) strips bonded on the outer surface of the building. The tests are carried out on full-scale masonry beams samples with a span of about 3.0/3.6 m and two different masonry types are considered: solid brick masonry (250 mm thick) and rubble stone masonry (350 mm thick). The samples are subjected to horizontal cyclic bending. The results, collected in terms of applied load varying the net deflection, evidence the effectiveness of both the proposed measures to provide bending resistance to the masonry ring beams also at high levels of deflection, thus proving effectiveness against the out-of-plane failure of masonry walls but also compatibility with the mechanical characteristics of historic masonry.

CODE 340

DEVELOPMENT OF AN ECO-FRIENDLY LIME-BASED MORTAR SUITABLE FOR INTEGRATED RETROFITTING: THERMOPHYSICAL AND MECHANICAL CHARACTERIZATION

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KEYWORDS: Lime mortar; Integrated retrofitting; Textile-reinforced mortar; Sustainable building products; Rice husk.

ABSTRACT

In the last decades, the European building stock has been affected by several seismic events, causing human losses and considerable economic damage. Indeed, many existing constructions exhibit deficient seismic behaviour due to the outdated or total absence of design methods used in the past and/or due to the lack of maintenance over the years. This has promoted an increasing focus on the development of retrofitting strategies aiming to improve seismic safety. Although earthquake action is often the primary parameter considered in the design of retrofitting interventions, other factors should also be considered to achieve integrated solutions that would drastically improve the overall building performance. Among these, energy efficiency is one of the most crucial as it poses a significant impact on the inhabitants' comfort level and the buildings' operational costs. Another critical factor is the sustainability of the materials employed in the intervention since there is an urgent need for reducing the environmental impact in the construction sector.
This paper examines the development of a thermally efficient eco-friendly mortar that can be used as a matrix in Textile Reinforced Mortar (TRM) overlays. The solution considered involves the use of rice husk in the mortar composition as a partial substitute for conventional aggregate. Rice husk is a vegetal material that is not only renewable and widely abundant around the world, but it is also a by-product that can be hardly disposed of in different ways than landfill. Its use as aggregate in mortar mixtures may open interesting perspectives in terms of thermal performance and sustainability of cementitious materials decreasing their embodied carbon as well as the overuse of virgin sand. The development of the rice husk-based mortar matrix is part of an ongoing research effort for the design of a TRM system for the concurrent seismic and energy upgrading of masonry buildings. Starting from a reference mortar previously developed, several dosages of substitution with the new aggregate have been considered, investigating its possible benefits and drawbacks. The assessment of the mechanical and thermal properties of such a product highlights its potential in the field of masonry retrofitting.

CODE 403

STRENGTHENING OF REINFORCED CONCRETE BEAMS WITH EXTERNALLY ATTACHED TITANIUM RODS

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KEYWORDS: Titanium; Reinforced Concrete; Mechanical testing; Retrofit.

ABSTRACT

Aging and deterioration of Reinforced Concrete (RC) structures and infrastructures is an important issue in many countries. In recent years, the steadily increasing average age of concrete infrastructure together with budgetary constraints caused significant dysfunctional problems and put at risk the safety of users and citizens. Climate change accelerated the degradation effects: among the various material degradation mechanisms associated to climate change, excessive rainfalls and high temperatures play a major role in causing rebar oxidation, concrete cracking and carbonation, with significant reductions of load capacity of concrete infrastructures.
In attrition, existing RC structures are often susceptible to freeze-thaw damage since the concrete was not air entrained in the past, and acidic substances in the rain, if exposed, and the surrounding soil and water can cause disintegration of the concrete surface due to a reaction between the acid and the hydrated cement. These RC structures often need to be reinforced, but interventions are expensive, invasive and difficult to carry out. Complete replacement of concrete infrastructures is expensive and unaffordable for many countries. This is also difficult for the need to guarantee the use of vital road and railways infrastructures.
This paper offers the results of an experimental investigation aimed at assessing the structural behavior of RC beams strengthened with externally attached Titanium rods. RC beams were reinforced with high strength Titanium rods in order to add more tensile resistant material, especially when old steel bars are insufficient or degraded, and resist internal tension forces within the cross section. A total of 8 full-size concrete beams were tested in this experimental programme at the laboratory, by conducting bending tests aimed at studying the flexural structural response. Different Titanium retrofit solutions were studied and used to reinforce the beams. It was found that the bending-capacity of the concrete beams reinforced with the Titanium rods greatly increased over that of the control unreinforced specimens. The proposed reinforced method was able to provide some significant additional resisting capacity to the beams in a more effective way than the traditional methods of composite materials.

CODE 15

REHABILITATION OF THE RAW MATERIALS WAREHOUSE IN THE LEMONA CEMENT PLANT

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KEYWORDS : Rehabilitation, industrial building, metal structure, preliminary studies, project, civil works.

ABSTRACT
The raw materials warehouse is located in the plant that CEMENTOS LEMONA has in Lemona (Bizkaia). Originally built in three phases in the years 1962, 1967 and 1973, it reached a total length of 253 meters, alignments 01 to 39. Subsequently, the first six modules on the west side were demolished, thus forming the current situation of the warehouse with 211 meters in length, alignments 06 to 39. The modulation of all the gantries is 7 meters and its span is 20.80 meters between axes of pillars that have a height of 19.5 meters.
The performance in the warehouse comes from the concern, on the part of CEMENTOS LEMONA, for the state of deterioration that the structure of the roof of the warehouse presented. This led to request TECNALIA a study of the real situation of the structure of the warehouse, and the design of a General Action Plan, which would allow it to undertake its rehabilitation in the most appropriate way, taking into account that the service provided by the warehouse to the production process of the factory cannot be stopped.
The compilation and analysis of the existing documentation was carried out, to later undertake the diagnostic and evaluation of the state of the structure, including the characterization of the materials, the inspection for the recognition of geometry, determination of present damages, review of the general state of loads, verification of structural calculations, estimation of the necessary repair or reinforcement actions and their initial economic valuation.
Subsequently, the General Action Plan was defined in the Raw Materials Warehouse of the Lemona plant, making an analysis and study of the necessary actions, defining one by one the specific actions to be executed, their way of developing them, necessary auxiliary means, fit in times and materials to be used. All this taking into account the essential adaptation of the actions to be developed in relation to the activities of the factory in each location of these.
Finally, in these years the execution phases have been defined, and consequently the execution projects have been drafted in each case, carrying out the works in phases in the annual factory stoppage.

CODE 176

THE "PARASITIC" ARCHITECTURE OF THE NEW CULTURAL HUB IN THE EX SUGAR FACTORY OF RIETI. RESILIENT STRATEGIES, REGENERATION AND REFURBISHMENT OF INDUSTRIAL PRE-EXISTENCES

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KEYWORDS: Industrial heritage; Resilient strategies; Regeneration; Refurbishment; Parasitic architecture.

ABSTRACT
Abandoned industrial areas, places of memory par excellence, are "immersed in a temporal suspension that does not make them protagonists of urban life, and oscillate between the loss of values they have possessed in the past and the potential they can offer to the city". Differently placed in interstitial areas, in the face of uncontrolled urban growth, these today represent that condition of marginality capable of generating environmental and social degradation.
The acknowledgment of the testimonial value of abandoned industrial heritages connected to the start of Italy's rapid industrialization process, as well as the subsequent phases, and the need for their conservation and protection transform their condition into that of a "possible marginality" which can be activated through regeneration strategies aimed at defining not only new forms of use of space but also renewed and more inclusive social models. This contribution intends to present, according to a multidisciplinary and multi-scale approach, the design experimentation on the ex Rieti Sugar Factory, a building with a strong identity value for the city, a symbol of the beginning of the industrial development of the area and a cornerstone of the evolution of the settlement tissue today. The urban regeneration project recovers the complex of historic buildings, creating new cultural and service polarities, and reconnects it with the context by outlining new relationships and renewed ties with the city.

CODE 318

EVALUATION OF THE EFFICACY OF SURFACE TREATMENTS FOR THEIR SUBSEQUENT USE IN THE RESTORATION OF FACTORIES WITH HIGH PRESENCE OF SALTS. THE CASE OF LAS ERAS DE LA SAL IN TORREVIEJA (ALICANTE)

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KEYWORDS: Eras de la Sal; Consolidating; Calcarenite; Haloclasty.

ABSTRACT

This work presents the methodology followed and the results obtained in the studies to evaluate the effectiveness of various surface treatments on the Las Eras de la Sal walls in Torrevieja. The objective is to select the best results to apply them in future restorations. Las Eras are an industrial architectural complex from the late 18th century that served as a collection, shipping and loading site for salt located in the center of the city of Torrevieja, on the south coast of the Valencian Community. The stone arches that make up the connections between the threshing floors and the loading docks were made with very porous calcarenite from the coast of Torrevieja. Currently, these stones are extremely degraded, so it has been considered appropriate to evaluate the possible effectiveness of different consolidating treatments to increase their durability over time without generating negative side effects. The salts present in the walls have been analyzed in the case of halite. The petrographic characterization of the stones that make up the arches has been carried out. The extraction quarries have been located, which has allowed the creation of test specimens to which different consolidating treatments have been applied. Subsequently, different studies and tests have been carried out related to the future conditions to which the treatments will be subjected once applied to the Las Eras de la Sal factories. Comparative studies have been carried out between the same untreated specimens and once treated, evaluating color variation, behavior against capillary rise humidity, droplet absorption, resistance to salt crystallization and vapor permeability. The modifications in the microtopography observed by SEM have also been studied. From the analysis of the results it is clear that some treatments have modified the color or surface too much, reducing vapor permeability, which is why they have been considered inappropriate for this use. The resistance to salt crystallization has worked well in most of the treatments with the exception of the consolidant based on ethyl silicates.

CODE 46

EXAMINATION OF INTERVENTIONS ON REINFORCED CONCRETE SYSTEM ON HISTORIC BUILDING - CASE OF TURKEY

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KEYWORDS: Modern period; Reinforced concrete system; Intervention.

ABSTRACT

In the 20th century, after the destruction of World War II, concrete was commonly used in buildings due to its rapid and economic production nature. Concrete buildings from this era reflect the period's characteristics, social, economic, and political changes, and even are important evidence of the developments of concrete as a material, detail design, construction, and production technology. Because of these reasons, the conservation of concrete buildings from the 20th century is of great importance in sustaining their value. Most of them require interventions (e.g., repair, treatment, and maintenance) due to obsolescence originating from intrinsic factors of the material/design/construction itself, exposure to environmental conditions for years, and changing regulations/aesthetic factors, etc. Today, international conservation organizations (e.g., DOCOMOMO, ICOMOS) are playing a leading role in embracing the conservation approaches and principles applied to 20th century cultural heritage. The documentation of them contributes possible assessment in the future within the context of cultural heritage conservation.
In the study, the main objective is a detailed review of intervention to the buildings that have a reinforced concrete structural system. Through this objective, the study consists of two main stages as (i) a comprehensive literature review, and (ii) intervention examples from part of Mimar Sinan Fine Arts University – Fındıklı Campus, Istanbul, Turkey. In the first stage, the intervention factors, obsolescence, principles, methods, process, and measures for the reinforced concrete system are presented. In the second stage, a brief explanation is given about the case building which was constructed in 1860 and was intervened according to modern period characteristics in the 1950s and 1970s. Afterward, interventions were made to reinforced concrete structural system of part of the building (Münire Sultan Palace) between 2020-2023 are explained. As a result, the conservation methods of building are discussed with the earlier interventions to the buildings and information collected from the comprehensive literature review.

CODE 57

ERMITA DE LA SANG IN CASTALLA (ALICANTE, SPAIN): ARCHITECTURAL ACTIONS (2019-2022)

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KEYWORDS: Spain; Cultural Heritage; Gothic churches; Conservation; Restoration.

ABSTRACT

The *Ermita de la Sang*, which was previously known as *Església de Santa Maria*, is a chapel located in the Castalla Castle Heritage Site in the north of the province of Alicante (Spain). It was built at the end of the 13th Century and was extended between the 15th and 19th centuries. Therefore, its historical context belongs to the Christian colonisation process of the ancient Kingdom of Valencia.
From an architectural point of view, it is a single rectangular nave church covered with wood on ogival arches and side chapels. Furthermore, it was one of the most important buildings in medieval Castalla due to its size and civil and religious representativeness.
With some added parts and transformations, the *Ermita de la Sang* became a monument of great historical and heritage value within the current Valencian Community until the early 1960s (20th Century). Nevertheless, a historical restoration process was developed without following any methodology or scientific criteria between 1963 and 1970, which destroyed and modified a large part of those values. This intervention was followed by less important interventions that did not respect the temple in the 1980s and 1990s (20th Century).
Therefore, the purpose of this research is to publish the architectural actions carried out on the western and southern façades of the chapel between 2020 and 2022. To this effect, the analytical methodology was applied on three levels (historical analysis, constructive analysis and pathological analysis) in the temple according to the previous work.
Moreover, the most recommended actions for each façade were designed. In this way, these interventions have increased the historical and constructive knowledge of the temple and have improved its state of conservation with the appropriate materials and techniques under the national and international regulations on cultural heritage.

CODE 134

REHABILITATION OF THE MONUMENT TO THE VIRGEN OF "LA ANTIGUA" IN ORDUÑA (BIZKAIA)

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KEYWORDS: Early concrete; 20th-century heritage; Monier; Rehabilitation; Corrosion.

ABSTRACT

The monument to the Virgin of La Antigua was constructed in 1904 on Mount Txarlazo (Burgos), very close to the town of Orduña (Vizcaya). Its architect and builder, Claudio Duran i Ventosa, owned the Monier patent in Spain. His basic system consisted in constructing an "iron framework" with any grid-shaped geometry, so as to "immerse it in cement" later on, protecting the iron and giving sufficient strength to the whole structure. The technique was partially applied to the monument to construct the irregular surface folds of the Virgin's robes from the crown down to the lower level, below which a tree canopy was formed lower down and branches of reinforced concrete stretching outwards from a tree trunk. A few years after its inauguration, defects began to be detected in the form of spalling and cracking, which intensified despite periodic repair work. The most significant intervention was carried out in 1974, which shaped its present-day appearance. Its closure to the public today is because of the severe damage that is evident due to detachment in its envelope and because of corrosion affecting its metal mesh and reinforcements. The damage is conditioned by the thin concrete cover over the metal mesh and the reinforcements, continuous leakage of rain water inside the monument, and the presence of marine aggregate in some parts of the original construction. Its rehabilitation was planned in view of such extensive deterioration. During the preliminary works, efforts were made to differentiate the materials used for the initial construction from those applied for its repair. Its structural behavior and the condition of the structural strengthens, especially those added in 1974, were assessed. All of which led to the draft project that takes account of the above factors and intervenes to ensure structural stability while maintaining the uniqueness of a monument that is one of a kind in Spain.

CODE 175

IMPLEMENTATION OF TIMBER GRAFTING TECHNIQUE FOR BEAM REPAIR AT ZABALA PALACE IN ORDIZIA

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KEYWORDS: Timber; Rehabilitation; Timber Grafting; Resin; Epoxi.

ABSTRACT

This article presents an application of the timber grafting technique with epoxy resin in the structural reparation of three deteriorated oak beams at Zabala Palace in Ordizia (Gipuzkoa, Spain). It describes the design, calculation and execution process, as well as the experimental studies carried out in laboratory to verify and validate the structural capacity of the repair method.
During the structural assessment of the building, an area of high humidity, rot, and attack by wood-boring insects was detected, affecting the ends of the various beams converging in one of the corners of the uncovered inner courtyard. Given the difficulty involved in removing the original timber elements as they were supporting the external enclosure walls that formed the corner, an in-situ repair intervention was designed. This intervention consisted of cutting and removing the degraded heads of the oak beams, inserting a new piece of sound timber, and connecting both elements with threaded steel rods and epoxy resin on the tension section and fully threaded screws at a 45-degree angle between faces to transmit the shear force.
The proposed solution made it possible to preserve most of the original timber structure which remained in good condition. It also made it possible to significantly reduce the need to shore up the upper floors and to avoid the temporary evacuation of residents during work.

CODE 177

STRUCTURAL REHABILITATION WITH TIMBER-TIMBER COMPOSITE FLOORS IN ITSASO TOWN HALL

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KEYWORDS: Timber; Rehabilitation; Composite floor; Cross-laminated timber; CLT; Oak.

ABSTRACT

This article describes the characterisation, calculation, and on-site execution works carried out during the rehabilitation of the upper wooden floors of the Itsaso Town Hall in Gipuzkoa, Spain.
The chosen structural system consisted of a structural collaboration between the pre-existing timber elements (oak beams and joists) and new timber (softwood glulam beam supplements and cross-laminated timber panels on joists). The structural connection was achieved using fully threaded screws, arranged at a 45º angle to bear the shear forces between timber elements axially. This system made it possible to maintain the structural function of the original beams and joists, increase the load-bearing capacity and serviceability of the floors, and keep the original oak exposed without the need for additional fire protection measures. The use of cross-laminated timber (CLT) significantly reduced the added weight on the structure when compared to a concrete composite type solution.

CODE 235

THE APPLICATION OF LEAN CONSTRUCTION SOLUTIONS IN SITE WORKS OF RESIDENTIAL REFURBISHMENT PROJECTS: AN OVERVIEW

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KEYWORDS: LEAN construction; LEAN solutions; Residential projects; Building refurbishment; Management.

ABSTRACT

The construction industry has long faced challenges of low productivity, high costs, and substantial waste. In recent years, Lean Construction has emerged as a promising solution to address these issues. This scientific article explores the principles of Lean Construction and investigates their application in building refurbishment projects. Specifically focusing on the context of building refurbishment, this article delves into the key concepts and tools of Lean Construction, such as Value Stream Mapping, Pull Planning, Just-in-Time Delivery, Last Planner System, and Visual Management. These tools enable the elimination of waste, improvement of project outcomes, increased productivity, and reduced costs. Moreover, this article presents the results of surveys and interviews conducted within the building refurbishment sector, examining the implementation of Lean Construction practices. The findings illustrate the potential benefits of Lean Construction in enhancing project delivery, reducing costs, and improving overall project outcomes. Based on these insights, practical recommendations are provided for the successful implementation of Lean Construction solutions in building refurbishment projects, including the importance of leadership, stakeholder collaboration, continuous improvement, and the use of data and metrics to measure progress. This article contributes to the knowledge base on Lean Construction, providing guidance for the development of building refurbishment projects and serving as a catalyst for further research in this field.

CODE 272

DESCENT OF UNIDIRECTIONAL FLOOR WITH SYNCHRONIZED HYDRAULIC JACKETS WITHIN A GLOBAL REFURBISHMENT PROJECT

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KEYWORDS: Rehabilitation; Concrete structure; Lifting; Hydraulic jack system.

ABSTRACT

Refurbishment works can include some types of activities to extend the service life of the structure, sometimes adapting it to new regulations or modifying its conditions of use. Within the refurbishment works, it may be considered to change the section of a building (for reasons of accessibility or use), which is usually solved with partial demolition works and rebuilding the affected elements. However, sometimes, the existing structure can be preserved and be placed it in its final situation, provided that the safety conditions of the structure allow it, contributing positively to the sustainability of the refurbishment works and, in many cases, minimizing the economic impact regarding demolition and reconstruction. The construction procedure for the holding of the unidirectional floor, for its descent 600 mm with respect to the original level, is detailed. This activity is part of a global refurbishment project for public use of a flagship building in the AZCA complex, in Madrid. The unidirectional floor area is rectangular and measures 500 m2. It is supported by eight perimeter metal columns. The procedure included a descent system in stages, with a hydraulic power station, in order to guarantee a progressive and homogeneous descent. The main feature of the system is the use of jacks suitable for lowering and lifting, supported by metal structure modules that allow the independent completion of each stage.

CODE 343

THE (RE)CONSTRUCTION OF THE DEBA MASONRY BRIDGE

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KEYWORDS: Masonry bridge; Reconstruction; Heritage; Shoring.

ABSTRACT

The masonry bridge over the Deba River (Guipúzcoa, Spain) suffered a partial collapse of its central pier on July 5, 2018, leaving the structure in a precarious state. As the bridge was classified as a Qualified Cultural Asset of the Camino de Santiago, it was decided to restore it to its before-the-incident configuration. Rebuilding a stone bridge in the 21st century, when the techniques seemed forgotten, was a unique technical challenge, as it was the communication of its heritage values to stimulate the vindication of its social, technical, and cultural values.

The intervention had two phases: the emergency works, to consolidate the bridge after the incident, and the construction project with the following restoration works. Especially in the second phase, the study of ancient treatises on the construction of stone bridges, unknown today by engineers and poorly understood by historians, represented a fundamental resource of knowledge for solutions developed in the past. This, together with the availability of modern means of foundation strengthening, shoring, heavy lifting systems, and new materials compatible with existing ones, led to a sustainable result (90% of the pieces were reused), comprehended, and loved by the people.

This paper presents the technical aspects related to the reconstruction, those linked to the study of the classic construction procedures of this type of bridges, as well as the exposition aspects during the construction phase and in the final permanent phase.

CODE 363

OPPORTUNITIES AND CRITICALITY RELATED TO TAX INCENTIVES FOR BUILDING ENVELOPE ENERGY EFFICIENCY. AN OPERATIONAL PROCEDURE APPLIED TO A RESIDENTIAL BUILDING

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KEYWORDS: Building envelope energy upgrading; Tax incentives; Decree Law No.34/2020; Operational procedure; Insulation materials.

ABSTRACT

The existing building stock accounts for approximately 40% of final energy consumption, due to the high energy requirements, related to heating, cooling, lighting, and domestic hot water production, coupled with limited use of renewable energy sources. In this context, Italian legislation, in compliance with the European Directives on environmental sustainability, has enacted many regulatory measures in order to reduce emissions and incentivize energy efficiency in existing buildings. However, there appears to be a widespread lack of procedural and regulatory guidance regarding construction technologies and materials, especially on non-bonded and non-historic buildings, but nonetheless characterizing the established building fabric of cities. This research focuses attention on the issue of energy upgrading of the opaque envelope of apartment buildings related to the exploitation of tax incentives. Specifically, it addresses strategic choices and material selection, with particular regard to those that comply with the Minimum Environmental Criteria (CAM).
The paper illustrates a case study of a condominium that took advantage of the tax incentives under Decree Law No.34/2020 (commonly known as "Superbonus 110%"). The building underwent a global redevelopment focused on energy efficiency, downstream of an in-depth cognitive process and the subsequent process of compatibility between the different design choices deemed compliant.

CODE 364

BUILDINGS WITH HIGH ARCHITECTURAL VALUE - TWO EXAMPLES OF RESTORATION AND SEISMIC REINFORCEMENT

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KEYWORDS: Seismic Emprovement; Masonry Building; Built Heritage.

ABSTRACT

Two seismic repairing and improvement interventions on buildings of high historical and architectural interest are illustrated here. The first is the Oratory of S. Antonio da Padova, which dates back to the 16th century, contains important wooden works such as the organ case, the choir and the painting on canvas of Saint Anthony and the Madonna in the centre of the ceiling.
In the apse, there is a ceramic frontal as well as widespread plaster decorations. The second is the "Casino delle Delizie Branconio", which dates back to the 17th century and contains frescoes by Monaldi, a disciple of Raffaello. For the restoration and seismic improvement interventions, both traditional and innovative techniques were used. In the first case, chains, stitches and unstitches were applied, in the second case, fiber-reinforced mortar and connections with helical bars were used. The interventions, necessary after the earthquake of 2009, were designed and implemented in such a way as to make collaborate the restoration of the historical and decorative structures with the seismic improvement of the structures.

CODE 381

COMPREHENSIVE REHABILITATION OF THE PUNTA DEL ESTE SHOPPING CENTER AFTER A FIRE INCIDENT

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KEYWORDS: Fire damage; Material properties; Repairs.

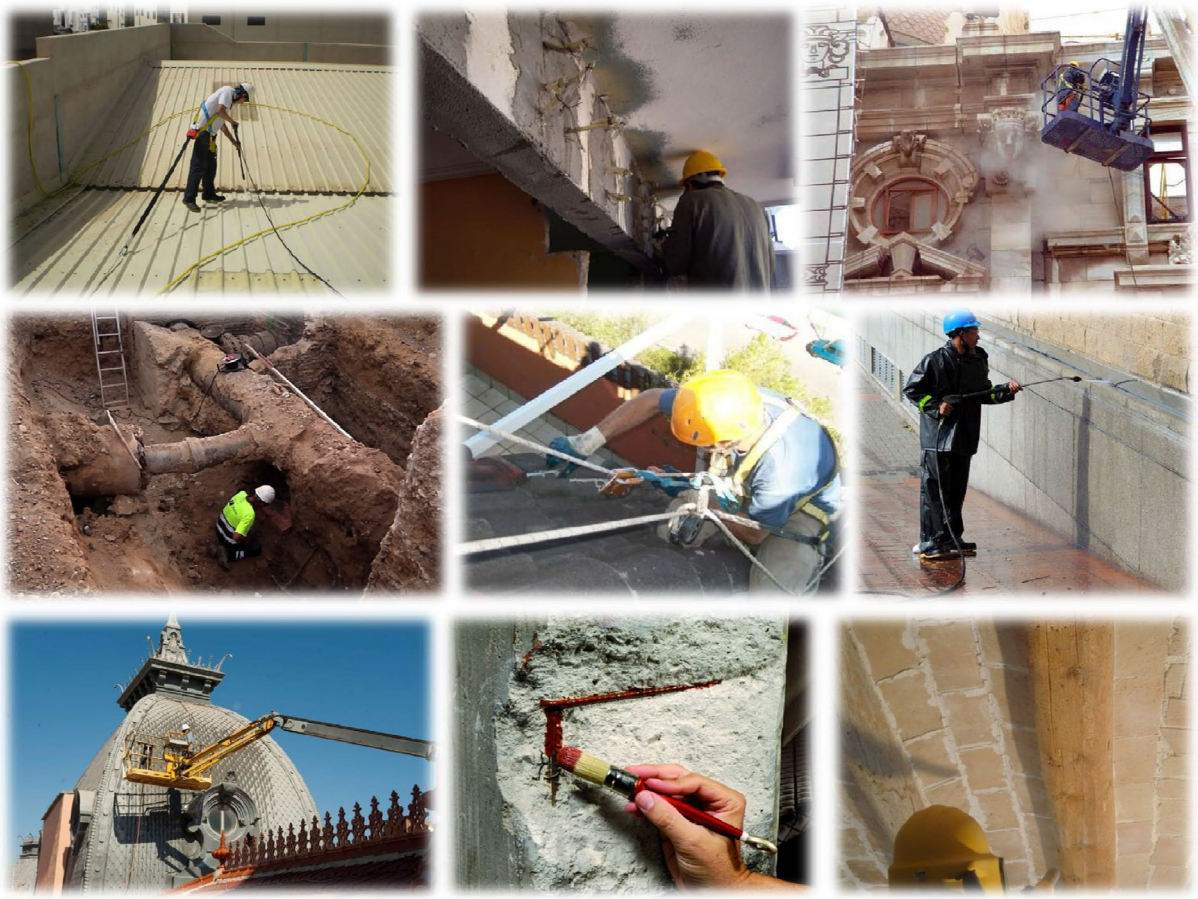
ABSTRACT

On August the 6th 2022, a fire devastated 80% of the surface of the Shopping Center in Punta del Este, Maldonado, Uruguay. Starting in the kitchen of a supermarket, the flames extended through the Shopping Center for 72 hours before they could be controlled.
This article presents the studies carried out to assess the impact of the fire on the structure of the building, the strategies and rehabilitation project for its stability and functionality.
Different areas of damage were identified based on their severity (3 zones). Some areas, comprising 3000 m2, completely collapsed, providing a useful contrast for the analysis of fire behaviour, depending on the different structural solutions of the building (reinforced concrete, prestressed concrete, “in site” built zones and prefabricated zones).
The damaged areas were categorized by the National Fire Department into three zones: red, yellow and green, depending on the deterioration and risk of collapse. Tests of the concrete, reinforcement and foundations were carried out, using destructive and non-destructive tests. A total of 139 concrete cores were collected for analysis and the foundations were studied by indirect methods (pile integrity testing and SPT soil testing) since their details were not available.
The concrete samples were evaluated visually to check their cracking status. Its compressive strength and static modulus of elasticity were determined. The yield and failure limits were determined in steel samples. Based on these analyses, actions were planned for each area, including repairs of structural elements, reinforcements or demolition.
Due to the tight deadline to resume commercial activity, innovative structural solutions were designed to rehabilitate severely damaged large surface areas without demolishing them, modifying the "working" scheme of the structure and incorporating reinforcements.
The demolition and subsequent construction would have required deadlines not compatible with the client's aspirations, while the group of solutions adopted allows the set goals to be met.
At the same time the architectural program introduced multiple improvements to the functionality of the building.
The less damaged areas required multiple repairs for which various methods were used.

4.- MAINTENANCE

4.1.- CONSTRUCTION MAINTENANCE AND INFRASTRUCTURES.

4.2.- PREVENTIVE CONSERVATION OF BUILT HERITAGE.



CODE 35

USE OF DRONES FOR UNDERWATER INSPECTION OF SUBMERGED ELEMENTS IN MASONRY BRIDGES AND OLD CIVIL CONSTRUCTIONS

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KEYWORDS: Drones; Masonry Bridge; Underwater Inspection; Heritage preservation; Old bridges conservation.

ABSTRACT

In previous investigations, drones were used to carry out visual inspections of heritage elements. To complement this information obtained with the common drone, the use of a new drone model, the underwater drone, is proposed here for the particular case of old bridges. It is intended to verify the applicability of underwater drones for the inspection of submerged elements of old bridges of patrimonial value, given the huge number of catastrophes and collapses of bridges linked to failures in their foundations. For this, we have carried out the underwater inspection of the visible submerged elements (submerged, but not buried) of three old bridges, which cross different rivers. The different location of each of these bridges and their different characteristics allows a first conclusion to be drawn. The results obtained in the operations carried out will demonstrate that not only is the use of underwater drones useful for this type of inspection, but that the work is much safer than with the means with which underwater inspections are currently carried out (immersion of divers). In addition, this drone allows the study of certain parameters that can anticipate subsequent foundation problems and that affect the entire bridge, such as the settlement of piers or abutments or the rotation of piers and abutments.

CODE 50

BIM METHODOLOGY APPLICATION IN THE MANAGEMENT OF A MULTIFAMILY AND COMMERCIAL BUILDING

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KEYWORDS: BIM; BIM-FM; Maintenance Sheets; Building Management (FM).

ABSTRACT

Proactive maintenance planning is essential in the building operation phase, with an important impact on costs and sustainability throughout its useful life cycle. The use of the Building Information Modeling (BIM) methodology supports the building manager, allowing an organized detailed information related to the maintenance activity and its sharing with the experts involved. In addition, a link can be established between Facility Management (FM) and BIM systems. The BIM-FM link consists of the use of geometric and non-geometric database of BIM model, of the building under analysis, allowing its manipulation in the context of maintenance operations and management of the building.
In order to illustrate integrated BIM-FM technology implementation, a multifamily and commercial building located in the city of Pato Branco, Paraná, Brazil, was selected as a case study. Initially, a bibliographic research was carried out regarding the maintenance activity (inspection cycle, cleaning periodicity, proactive maintenance plans and estimation of the components useful life), the BIM model of the building was created and a set of maintenance sheets was elaborated for the elements subject to a high level deterioration (equipment, windows, doors, roof and walls). Maintenance data is inserted into the model, be the use of the SheetLink plugin (Autodesk), accessed through Revit (Autodesk). In order to allow direct access to the maintenance sheets, a shared parameter was added to the model, referring to the online repository of the editable sheets.
The application of the integrated BIM-FM methodology to the proactive maintenance of buildings, naturally allows the visualization of the 3D model of the structure, but also allows to consult the model database and its updated in real time, with the information collected through the maintenance sheets, which can be filled out during a technical visit to the site. This methodology is particularly suitable for buildings and companies of small volume, where it is not possible to use Computerized Maintenance Management Systems (CMMS).

CODE 113

REHABILITATION OF THE MAURA WHARF IN SANTANDER (CANTABRIA): MAIN ACTIONS

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KEYWORDS: Structural rehabilitation; Port infrastructure; Maura wharf in Santander.

ABSTRACT

The Maura Wharf is a maritime infrastructure located in the centre of Santander (Cantabria, Spain), which has lost its original port use and has become part of the promenade of the Cantabrian capital, an area open to leisure and public enjoyment. Built in the 1940s, the historic pier was closed to the public in December 2018 due to the risk of collapse of its concrete porticoed structure. This communication presents a summary of the structural rehabilitation works undertaken in 2022 by the construction company Misturas, S.A. on behalf of the City Council and the Port Authority of Santander, entities that assumed the cost of the intervention. It also discusses the main pathologies detected and the action strategies implemented to keep the pier in service in its new use, as part of the valuable built port heritage that makes up the waterfront of the Bay of Santander.

CODE 122

LOW-COST BIM-BASED MODELS FOR BUILDING DIAGNOSIS AND MAINTENANCE

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KEYWORDS: Maintenance; BIM Model; GIS; Process automation.

ABSTRACT

Overall, BIM is a fundamental element in the transformation of the construction sector and in the maintenance of built assets in particular. But it is not widely used, and this article shows how the BIM technology is used to democratize through the automatic generation of the BIM model, in simple and low-cost IFC formats, aimed at conveying static and dynamic information, generated throughout the life cycle. In addition, the associated semantic model can be compatible with CMMS (Computer Aided Maintenance Management) maintenance systems.
Based on available information, for example information from GIS, the cadastre, CAD files, etc., different mechanisms are developed for generating the geometry of BIM models based on simple parametric rules. But this model is made up of Key elements on which provide therapeutic interventions or assign pathology information, corrective actions, etc., and link them with external software. In addition, the standardized structure of BIM objects' parameters allows the connection of the information that happen in the operation phase of the building from diagnostic activities to the maintenance operations.

CODE 136

ENHANCING BUILT ASSET MAINTENANCE MANAGEMENT THROUGH DIGITAL TOOLS (GIS & BIM/HBIM 5D-7D)

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KEYWORDS: HBIM; BIM; GIS; Facility Management; maintenance; CMMS.

ABSTRACT

The management of infrastructure and asset maintenance is referred to as Facility Management. It encompasses a set of coordinated, planned, and developed activities aimed at effectively managing an asset, involving both human and material resources. The emergence of Building Information Modeling / Heritage Building Information Modeling technology, BIM/HBIM, has significantly impacted the field in recent years, leading to a rapid uptake of these technologies alongside digitization and collaborative work practices. This, in turn, has opened up access to numerous applications, including maintenance management.
BIM/HBIM is a valuable tool for decision-making in asset management, enabling the integration of various types of information to generate an updated model that enhances asset management. Unfortunately, many Facility Management technicians still rely on 2D digital tools. Therefore, it is crucial to propose 3D solutions applicable to this field to enhance maintenance operability and optimize the management process. This research integrates several 3D digital tools (GIS & BIM/HBIM) to digitize the building maintenance management process, focusing on a specific case: the maintenance of a classroom building at the University of Cantabria, Spain.

CODE 154

IMPORTANCE OF HERITAGE MAINTENANCE AGAINST FIRE: A CASE STUDY IN A SEISMIC AREA

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KEYWORDS: Maintenance; Fire; Stained glass; Earthquake; Repair.

ABSTRACT

The work questions the management of a heritage building in the city of Mendoza, Argentina after a fire. The Contemporary Art Space is located in a monumental building of French classicism of ceramic masonry built between 1914 and 1918. It is a typical old bank building, whose plant is organized around a large octagonal central space covered by a large dome of 30 m of light with an important central clearance circular with stained glass. For annual maintenance, the waterproofing of the roof was tendered. During the execution of the works, a fire damaged: the central dome generating melting stained glass, enclosure structures, earthquake-resistant support and exhibition paints. The fire in its propagation totally affected the masonry of the ceiling and walls and by the effect of the radiation the electrical wiring. The fire was generated by the misuse of the constructive technique of inappropriate material under unfavorable environmental conditions of wind. The result of this technical-legal-economic evaluation indicates that the damage generated by the fire corresponds to the verification of a concatenation of errors and omissions in the control management.

CODE 191

KNOWLEDGE AS A TOOL FOR MANAGING TRANSFORMATIONS OF CULTURAL HERITAGE. THE MONUMENTAL STAIRCASE OF SANTA MARIA DEL MONTE IN CALTAGIRONE (SICILY)

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KEYWORDS: Heritage values; Conservation and transformation; Knowledge; Caltagirone.

ABSTRACT

The paper focuses on a study carried out by a multidisciplinary team from the University of Catania for the restoration of the staircase of Santa Maria del Monte in the historic heart of Caltagirone, a UNESCO heritage site. The staircase, which nowadays represents the iconic image of the town's ancient ceramic tradition, derives its 'monumentality' primarily from its size (142 steps, about 130m in length, and 50m in height) and then from the relationship with the surrounding historic buildings, the landscape and the town that lies at its base.
Built at the beginning of the 17th century and radically renovated in the mid-19th century, it owes its current single-flight configuration (indifferent to the entrances of the buildings and the surrounding road system) to a general renovation realised in the 1950s. On that occasion, the risers were decorated with majolica tiles, though using industrially made elements instead of handicraft products, some of which were replaced in the 1990s with new ones on lava support.
Nowadays, the staircase suffers from general deterioration and differential subsidence. Previous studies had the primary objective of filling knowledge gaps and identifying the main construction problems; they also helped to consider the effects of the UNESCO brand on tourist promotion of the staircase and to better understand its significance and reception as a cultural object, which rests more on its iconic image than authenticity or architectural quality.
The staircase has undergone considerable changes and proper conservation can hardly preserve it 'as found' and should encompass the sensitive management of transformations. Therefore, the restoration design did not consider it a static inheritance. Regular maintenance would replace the gradually disappearing decoration and support traditional ceramic manufacture. Guidelines for improved fruition and accessibility to and from neighbouring buildings were also provided. Finally, a pilot project would test methodologies and procedures, assessing results in preparation for a full-scale intervention.
A concluding note emphasizes the importance of knowledge in restoration work for recognizing architectural value and identifying deficiencies. In this sense, knowledge is also essential to reconcile the preservation of urban heritage and the need to define the limits of acceptable and appropriate changes.

CODE 262

OUT-OF-PLANE CAPACITY ENHANCEMENT OF MASONRY WALLS WITH INNOVATIVE INORGANIC COMPOSITES

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KEYWORDS: Seismic retrofit; Out-of-plane strengthening; Unreinforced masonry buildings; Fibre reinforced mortars (FRM); Fibre Reinforced Cementitious Matrix (FRCM).

ABSTRACT

Unreinforced masonry buildings (URM) often suffer of local out-of-plane failure mechanisms of the walls during a seismic excitation. This study investigates the effectiveness of two classes of inorganic composite materials, namely Fibre Reinforced Mortars (FRM) and Fibre Reinforced Cementitious Matrix (FRCM), for the out-of-plane strengthening of unreinforced masonry walls. Three experimental tests, part of an enlarged ongoing testing campaign performed by using a novel setup to perform out-of-plane tests on masonry panels, are presented herein. The specimens are solid tuff brick masonry walls subjected to compressive axial load and out-of-plane horizontal actions according to a “four-point bending test” scheme. Two specimens are reinforced before testing with FRM and FRCM in double-side configurations, while the third specimen is tested in the bare configuration. Experimental results are reported and discussed in this paper. The preliminary results attest that both composite systems effective in increasing the out-of-plane capacity of masonry walls and in postponing the activation of the out-of-plane failure mechanism.

CODE 308

INTEGRATED APPROACH FOR THE SAFETY EVALUATION OF MASONRY BRIDGES

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KEYWORDS: Masonry Bridges; Unmanned Aerial Vehicle (UAV); Building Information Model (BIM); Finite Element Model (FEM); Nonlinear Static Analysis.

ABSTRACT

Infrastructure is the backbone for the economic and social development of a territory, influencing its productivity, facilitating trade with other areas and markets, improving economic and social inclusion, and ensuring its environmental and climate sustainability.
Italy has a rich and diverse asset of transport infrastructures. After the collapse of the Viadotto Polcevera in Genoa in 2018, the Italian Ministry of Infrastructure and Transportation enacted an important and extended plan for a united safety management of bridges.
In this scenario, masonry bridges represent a particular type of infrastructure due to their dated design and the employment of heterogenous materials. In this work, it is presented an integrated approach for the safety evaluation of masonry bridges which combines the use of Unmanned Aerial Vehicle (UAV) and testing. The collected data is processed and employed with the Building Information Model (BIM) working methodology to define the digital twin of the bridge. The BIM model is used to organize the collected information and set the finite element model (FEM) of the bridge. Finally, nonlinear static analyses are adopted to evaluate the safety coefficients of the structures under traffic loads.
The approach represents a comprehensive workflow to integrate modern technologies and methodologies as UAV, BIM, and nonlinear analysis to improve the safety evaluation of masonry infrastructures.

CODE 376

BUILDING MAINTENANCE: FIRE SAFETY

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KEYWORDS: Building maintenance; Fire safety; Technical facilities; Equipment and security systems.

ABSTRACT

Older buildings often have fire safety deficits when analysed under current requirements. Additionally, even existing conditions such as technical installations, equipment, and safety systems they may not be properly maintained to ensure their operation throughout the building's lifespan, rendering the initial investment made in fire safety during construction ineffective. To address these issues, a model was proposed to assess the compliance level of technical installations, equipment, and safety systems according to current regulations. The plan also focused on organizing maintenance, particularly preventive, and routine checks. The model was applied to a higher education building completed in 1992, considering the technical facilities, safety equipment and systems installed, excluding the lightning-rod system. The objective was to continuously improve compliance with regulatory and recommended requirements.

CODE 34

USE OF AERIAL THERMOGRAPHY FOR THE INSPECTION OF ARCHITECTURAL HERITAGE AND ANCIENT STRUCTURES

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KEYWORDS Aerial Thermography; Drones; Inspection; Heritage preservation; Joints and Efflorescences.

ABSTRACT

In previous investigations, drones have been used to carry out visual inspections of heritage elements. After this, the use of aerial thermography is proposed here, to complement the information obtained with the common drone, which performs purely visual inspections. Thus, after briefly exposing the contribution of aerial thermography to heritage, the inspection will be carried out on three unique elements of great heritage relevance with a drone with a thermographic camera: the Roman Bridge of Alcántara, the Roman Aqueduct of Segovia and the Roman Bridge of Alconétar . The three monuments were previously visually inspected with a drone with a camera. With these operations, it will be possible to draw conclusions about the applicability of this technology to heritage: the inspections will demonstrate the usefulness of thermography for the diagnosis of lesions on stone that do not occur at a superficial level and that already have an advanced state of development in the interior of the element when they manifest on the surface. Detecting these lesions early can be the key when trying to adopt less aggressive and expensive early therapies, thus avoiding greater punishment for the constituent elements of the monument to be protected.

CODE 91

DIGITIZED EVALUATION FOR THE OPTIMIZATION OF PREVENTIVE MAINTENANCE OF INDUSTRIAL BUILDINGS

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KEYWORDS Preventive maintenance; Multi-criteria analysis; Digitized inspection; Industrial buildings.

ABSTRACT

Industrial buildings are very complex built environments and key elements of the industrial sector. Their capacity to provide this service in safe conditions is essential for the development of the industry, which constitutes an important source of investment to guarantee their correct operation. Furthermore, any incident in them can limit their use, even requiring their shutdown, with the inconvenience and economic losses that this can entail. This is the reason why continuous maintenance is necessary, based on an effective diagnosis of these infrastructures, in order to effectively manage the challenges posed by the aging of the buildings. Maintenance, understood as the process to be applied to an asset to restore its functionalities affected by the passing of time, makes it possible to ensure its integrity and guarantee its activity. The optimal management of the maintenance process requires an objective evaluation of the damage, previously registered and automatically processed, as well as a precise definition of the necessary corrective and preventive actions, depending on the criticality of the damage.
This work presents an innovative method to diagnose damages and to prioritize in an objective and economically sustainable way the actions that allow an advanced, integral and digitized preventive maintenance of industrial buildings. The damage assessment has been carried out starting from the definition of a library of pathologies and their repairs on which the multi-criteria decision making methodology MIVES (Integrated Value Model for Sustainable Evaluation) is applied, which will allow prioritizing the interventions on the pathologies through the so-called intervention urgency index (IdU), also considering economic criteria. This is aimed at increasing objectivity and consistency in the results of inspection and evaluation of the damage observed, by establishing a unique criterion to automatically identify and weigh the relative importance of each damage.

CODE 102

MONITORING OF THE SURFACE EVOLUTION OF THE 16TH CENTURY FACADE OF THE RECTOR'S OFFICE OF THE UNIVERSITY OF ALCALÁ DE HENARES

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KEYWORDS: Historic facade; Durability; Preventive maintenance; Optical characterization; Chemical characterization.

ABSTRACT

The façade of the current rector's office of the University of Alcalá was built on the original adobe and wood façade between 1537 and 1553. Limestone extracted from the lands owned by Cardinal Cisneros in the Madrid town of El Vellón was used. The façade was declared a historical-artistic monument in 1914 and during the following years various restorations were undertaken. A limestone from the region of Novelda (Alicante) was used, which turned out to be more fragile than the original against climatic attacks. More recently, in 2017, a new cleaning and conservation intervention was carried out on the façade and some damaged elements were restored. Immediately after this intervention, an analysis of the surface was carried out with portable equipment in which data on colour, reflectance in the UV-VIS-NIR range, emittance and chemical composition through Raman spectroscopy were taken. Three elements were analysed at street level that are expected to be most affected by urban pollution and that include ashlars of the two types of stone present in the façade. In addition, two accessible elements were analysed in the upper area of the façade, less exposed to urban aggression and more affected by environmental and meteorological conditions. A year later, a second analysis was carried out with the same techniques and in the same areas, which confirmed the reliability of the methodology used to determine the evolution of the surface characteristics of the façade. After another five years, the analysis was repeated under the same conditions and a preliminary analysis of the exhalation of radon gas through the stone wall was also included. The results indicate stable surface properties in the upper area, slight variations in colour and surface chemical composition at street level, a slightly different evolution between different stone elements and a behaviour of radon exhalation consistent with that obtained in other historic buildings. The observed trends must be confirmed by future monitoring of the façade with the same methodology for the early detection of deterioration processes in the materials.

CODE 163

TOWARDS BEST RESTORATION PRACTICES: THE RESTORATION BY RISING DAMP OF SAN BASILIO'S CASTLE OF PISTICCI (ITALY)

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KEYWORDS: Restoration process; Best practices; Thermographic analysis; Gravimetric analysis; Charge Neutralization Technology.

ABSTRACT

Founded in the 7th century by the Basilian monks, the fortified farm of San Basilio of Pisticci in the province of Matera (Italy), also known as San Basilio's castle, had a central role over the centuries both as grange and as coastal watchtower in Basilicata's fertile Ionian coastline. Since 1989, the San Basilio's castle has been listed as an architectural asset of cultural interest. Today it hosts social events and houses an important collection of artworks and installations of contemporary art. This latter one dates back to the 1960s when the Berlingieri marquises, patrons and lovers of contemporary art, reused some spaces of this ancient and unique building to house the family's important collection of paintings, photographs, sculptures and installations.
The entire building complex, characterized by several construction phases, was affected by significant deterioration over the time, due to environmental and construction factors and capillary rising damp. Therefore, various restoration and renovation works have been carried out to preserve the construction itself and the inside collection of artworks.
In 2015, six CNT-Domodry devices based on the so-called "Charge Neutralization Technology" were installed to stop rising damp. Nonetheless, despite the stopping of rising damp assured by this effective and not-invasive technology, many rooms, including the exhibition hall areas, are still affected by an advanced state of deterioration due to efflorescence and sub-efflorescence.
For this reason and because of its historical importance in the panorama of fortified farms in the Mediterranean, San Basilio's Castle was chosen as case study of the research activity that aims to critically analyze restoration work, in all the phases that have taken place over the years, with particular attention to the interventions carried out to remove the phenomenon of capillary rising and its effects. The preliminary results obtained allow us to understand the reliability of thermographic analysis as a strategic diagnostic tool to verify effectiveness and durability of restoration interventions and to define good practices aimed at minimum intervention and preventive and predictive maintenance.

CODE 182

RECOVERY AND CONSERVATION OF HISTORIC CENTRES: ANALYSIS AND RESTORATION OF PALAZZO DE CARO IN PIANELLA

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KEYWORDS: Restoration; Cultural heritage; Preventive conservation; Method of intervention.

ABSTRACT

Italy's inland areas, particularly in the present case study, those in the Pescara area, are presented as territories in which we find a strong tendency toward depopulation of historical centers, with a propensity for population displacement to the suburbs or to areas close to major cities. In this perspective, the municipality of Pianella, in the province of Pescara, has taken several steps in recent years aimed at redeveloping buildings, squares and traces of the ancient city, outlining the rebirth of the historic center. Specifically, this paper aims to propose the analysis of an approach aimed at preventive conservation and applied in the restoration project of one of Pianella's seventeenth-century palaces: the de Caro Palace. Each era has an architecture connoted by values of different depth and importance, claiming a certain autonomy from all those particular phenomena that constitute its most superficial aspect. Precisely, the key component that guided this intervention was the creation of a circular internet of connections between public agency, universities, planners, individuals and citizens, creating a network of information, resulting from in-depth historiographical and archival research, laying the foundation from which to start for future reflection and research. At the same time, the various acquisitions of the building were obtained, including the laser scanner survey, endoscopic investigations, and observations of the masonry samples and construction systems; from the aforementioned analyses it is possible to extrapolate essential information in order to elaborate an effective restoration project both from the point of view of direct conservation, as an intervention related to the monument, and with respect to preventive conservation, as a result of an in-depth study of the dynamics that affected the environment in which the artifact is located. The restoration project of the de Caro palace is identified as the recovery of a fragment of the city, which, however, is deeply connected to its surroundings and pours its influence on it. The intention emerges, with reference to future research, to study a methodology aimed at preventive conservation, starting from the study of restoration projects developed from the 1980s to the present, having as the main objective the transmission of cultural heritage to future generations.

CODE 188

VERNACULAR ARCHITECTURE OF THE COFFEE CULTURAL LANDSCAPE. PREVENTIVE MAINTENANCE MANUAL

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KEYWORDS: Landscape; vernacular; Preventive Maintenance; Traditional materials and techniques.

ABSTRACT

The Coffee Cultural Landscape is a region of Colombia, located in the central west of the country, inscribed on the UNESCO World Heritage List due to having become an outstanding example of traditional human habitat and land use and that represents the culture of this town. The cultivation, processing and trade of coffee at the end of the 19th century and beginning of the 20th century enriched the region and became the country's main export product. This economic boom produced an architecture inspired by European historicist eclecticism with hints of the peasant architecture that preceded it.
In order to provide a tool for its identification and conservation, a group of architect professors carried out this work, which resulted in a manual, aimed at the owners as a contribution to knowing what this architecture is like in its materiality and how to intervene with it. look at its conservation.
To do this we based ourselves on field work, we toured the region visiting different towns in their urban and rural areas, we made inventory sheets of real estate, we carried out surveys of typical properties, we interviewed both owners and bricklayers and construction workers. We detect how these houses are built, what are the materials and construction techniques used, as well as the main deteriorations they present and the appropriate way for their intervention.
Finally, we design the manual, with its production process, and present it to the different communities in workshops that we carry out at each site.

CODE 206

THE STABILIZATION OF A HELLENISTIC SQUARE AT NİĞDE KINIK HÖYÜK, TURKEY

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KEYWORDS: Hellenistic Plaza; Cobblestone floor; Consolidation; Eco-pozzolan.

ABSTRACT

In recent years at Niğde Kınık Höyük in Turkey, a plaza located in the town's acropolis was discovered. Context and spatial finds indicate that this stone-paved plaza dates to the Hellenistic era. It is made of a large cobblestone masonry made of local amorphous units that were fixed only with compacted earth. The conservation plan concentrated on enclosing the unbound free edges by using new pavement and a retaining wall to stop the ongoing decay because the plaza had already lost its integrity before the discovery. To distinguish between the original application and modern interventions, the new cladding was designed and installed to be lower than the ancient pavement level and by using smaller stones. Additionally, a retaining wall was planned and built to be plastered to achieve a plain surface, where the pavement's texture created contrast and highlighted neat craftsmanship. For this consolidation application, a hydraulic lime-based binder was combined with local earth to have compatibility with the older application. The application's suitability and durability were demonstrated after it was observed for a few years while being subjected to atmospheric impacts without any protection.

CODE 207

PROTECTIVE ELEMENTS OF HERITAGE BUILDING FAÇADES AGAINST DIRECTIONAL HYDROMETEOROLOGICAL EVENTS

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KEYWORDS: Architectural heritage; Façade; Preventive conservation; Anisotropic deterioration.

ABSTRACT

Monumental architecture shows different protective solutions for the preventive conservation of ornamental elements that are vulnerable to atmospheric phenomena.
These protection or shielding systems are specially designed to mitigate the effects of directional hydrometeorological agents that act on architectural elements of high heritage value, altering and eroding them. Examples of these directional hydrometeorological agents are high intensity wind gusts, precipitation (fog, rain, hail and snow) directed by wind action, or direct sunshine, as well as its absence, which can favour an anisotropic frost regime.
Over time, these constructive solutions have proved necessary for the conservation of both materials and the ornamentation of the architecture. While older solutions allow their effectiveness to be assessed by observing the conservation state of the materials they protect, modern systems try to meet this need for preservation.
The objective of this study is to establish a classification of the types of protection or shielding (ancient or modern) that the monumental façades of historic buildings have against the action of directional hydrometeorological agents.
A compilation of old and modern cases of protective and preventive elements on façades of heritage buildings in Spain has been carried out. Each case has been analyzed in terms of the formal and material characteristics of the solutions adopted and the corresponding terminology has been reviewed. Finally, a typological classification of preventive measures for the protection of façades and openings has been proposed.
As a result of this study, the different types of preventive façade solutions and protective levels are presented. Its classification is offered as a useful tool that allows us to know the old and modern constructive solutions (many times reinterpretation of the old ones). In the future, it will be possible to assess the effectiveness of these elements through the evolution of the conservation state of the materials protected from the effect of directional hydrometeorological agents.

CODE 211

PREVENTIVE PRESERVATION OF RAMMED EARTH HISTORICAL HERITAGE THROUGH CONTINUOUS MONITORING, ARCHITECTURAL INSPECTIONS AND DATA FUSION

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KEYWORDS: Model updating; Modal analysis; Heritage structures; Data-fusion; Rammed earth.

ABSTRACT

Historical architectural heritage is a strategic resource of great value for societies from a cultural, social and economic point of view. In particular, rammed earth buildings represent a widespread typology, about which knowledge on structural conservation is quite limited. Condition-based maintenance schemes are particularly appropriate for this kind of buildings, where structural conservation must be harmonized with the respect for their artistic and architectural value. In contrast to classical periodic inspection techniques, these schemes advocate for the use of permanent non-destructive monitoring systems to identify the appearance of pathologies. Particularly, damage identification algorithms based on structural models can offer a complete identification of the existing pathology (detection, localization and quantification), although their application to large-scale assets represents a formidable challenge. On the one hand, the models of these structures are often computationally very heavy, making it difficult to calibrate through iterative optimization methods. On the other hand, the optimization problem is often ill-conditioned, resulting in high uncertainty in inference.

In order to make compatible the inverse calibration of the models with the continuous monitoring schemes and to minimize the uncertainty in the inference, this work proposes a conservation scheme combining the use of metamodels and data fusion, where the finite element numerical model is replaced by a metamodel compatible with a quasi-real-time calibration. The efficiency of the proposed methodology is illustrated with a real historic structure built in rammed earth, the Tower of Mohammed on the Alhambra, in Granada. As a first step, the regions potentially sensitive to structural damage are identified by finite elements numerical analysis, on which a computationally efficient metamodel is built. Then, the model is updated using results from continuous modal identification of the tower through the analysis of ambient vibrations, with the aim of obtaining a digital twin that allows the evaluation of its structural integrity and the planning of conservation interventions.

CODE 229

CHECKING THE INDOOR MICROCLIMATE AFTER RETROFIT WORKS: THE CASE STUDY OF THE S. SILVESTRO CHURCH IN L'AQUILA, ITALY

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KEYWORDS: Retrofit Works; Church Microclimate; Indoor Comfort; Monitoring Data; Values protection.

ABSTRACT

Religious buildings of the architectural heritage, due to the specificity of places, construction type and fruition modes, has microclimatic characteristics that must be monitored and evaluated in order to ensure the correct conservation and protection of both materials and values involved. A timely diagnosis guarantees timely interventions if problems such as humidity, mold and degradation arise. During surveys and analysis design phases, often carried out through non-destructive techniques, the human factor and the impact that the type of fruition of these environments has on the internal microclimate is not adequately considered; in the same way, the wholesomeness of the indoor conditions in terms of both comfort and healthiness is neglected. This work illustrates the early results of an internal microclimatic survey of a XIII century church in L'Aquila which has the peculiarity of being internally frescoed and recently restored. Data acquisition of the case study relate to the air temperature, the radiant temperature, the humidity ratio, the air velocity and the CO_2 parameters. In the unusual setting of a post-earthquake deep renovation, the main scope of the survey is to register the internal microclimatic condition corresponding to the peak heat of the 2023 summer season: the results are useful for evaluating both the problem of preserving the artistic values of the church and the comfort of users.

CODE 269

IMPACT OF ARCHITECTURAL FORM AND CONSTRUCTION DETAILS ON THE STATE OF CONSERVATION OF A FLAT ROOF

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KEYWORDS: Conservation; Maintenance; Performance; Building Inspection; Water-tightness.

ABSTRACT

The headquarters of the Center for Sustainable Development at the University of Brasília is one of the modernist-style buildings that make up the built environment of the Darcy Ribeiro Campus. The architectural form, design solutions, and construction details used for rainwater drainage prompt an investigation into the condition of the mechanically protected waterproofing system. The architectural project documentation reveals a set of details designed to address the edges of the slabs that receive rainwater and project it in free fall to the ground, as well as recommendations for the execution of regularizations and mechanical protections unique to the circular concept adopted. The research seeks to identify how the details designed by the architecture were executed during construction, investigating the impact of form and construction procedures on the state of conservation of the building's flat roof. This article is based on documentary survey and project analysis, as well as procedures for building inspection. Image capture using a drone aided in the identification, mapping, and categorization of damage to the roof. The results point to the need for the correct sizing of expansion joints in the mechanical protection layer to absorb the stresses resulting from structural movement and the hygrothermal variation of different segments that make up the curvature of the building. The performance of the construction detailing proposed for the edge of the flat slab is discussed, as the executed solution differs from the one designed. Building inspection, not only for diagnosing and monitoring existing damage but also for planning preventive and corrective maintenance actions on flat roofs of modernist buildings, is a necessary approach when deciding on the type of repair to be adopted in interventions.

CODE 292

A STUDY ON THE DISPLACEMENT OF COLUMNS OF KOREAN WOODEN BUILDING HERITAGE ACCORDING TO SEASONAL CLIMATE CHANGE

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KEYWORDS: Heritage Management; Korean Wooden Building; Seasonal Climate; Seasonal Displacement.

ABSTRACT

Since 2005, the Safety and Disaster Prevention Research Division of the National Research Institute of Cultural Heritage (NRICH) has overseen the monitoring of national architectural heritage that needs to be managed. Most traditional buildings in Korea are built using wood, and wood is a material that is more sensitive to climate change than other materials. Since Korea has significant seasonal climate change, the seasonal climate significantly impacts architectural heritage. This study examines the seasonal displacement in the columns of traditional wooden buildings in Korea based on the monitoring results of the Sungnyemun Gate by NRICH.

As a result of observing the structural displacement of Sungnyemun Gate from 2013 to 2022, it was possible to identify the transformation quantitatively according to the seasonal climate. Depending on the stabilization process of the structure, seasonal climate and geographic influence, the building tends to lean toward the south, and the Girder and Hip Rafter show a downward movement. These results will be used as primary data to manage the structural risks of wooden architectural heritage in the future.

Korea has traditionally built buildings with wooden structures. Thus, the Korean government has designated and managed 834 wooden architectural heritages. Naturally, architectural heritage exposed to the outdoors is transformed and damaged over time. Therefore, exceptional management is required to prevent irreversible damage and pass it on to future generations. It is hoped that this study will be helpful for the management of architectural heritage in Korea and other countries that share the wooden construction tradition.

CODE 329

FOUNDATIONAL MONOLITHS OF LA CAROLINA (JAÉN). CHARACTERIZACTION AND ORIGIN OF STONE MATERIALS, REALIZATION OF BAS-RELIEF REPLICAS FOR THEIR CONSERVATION

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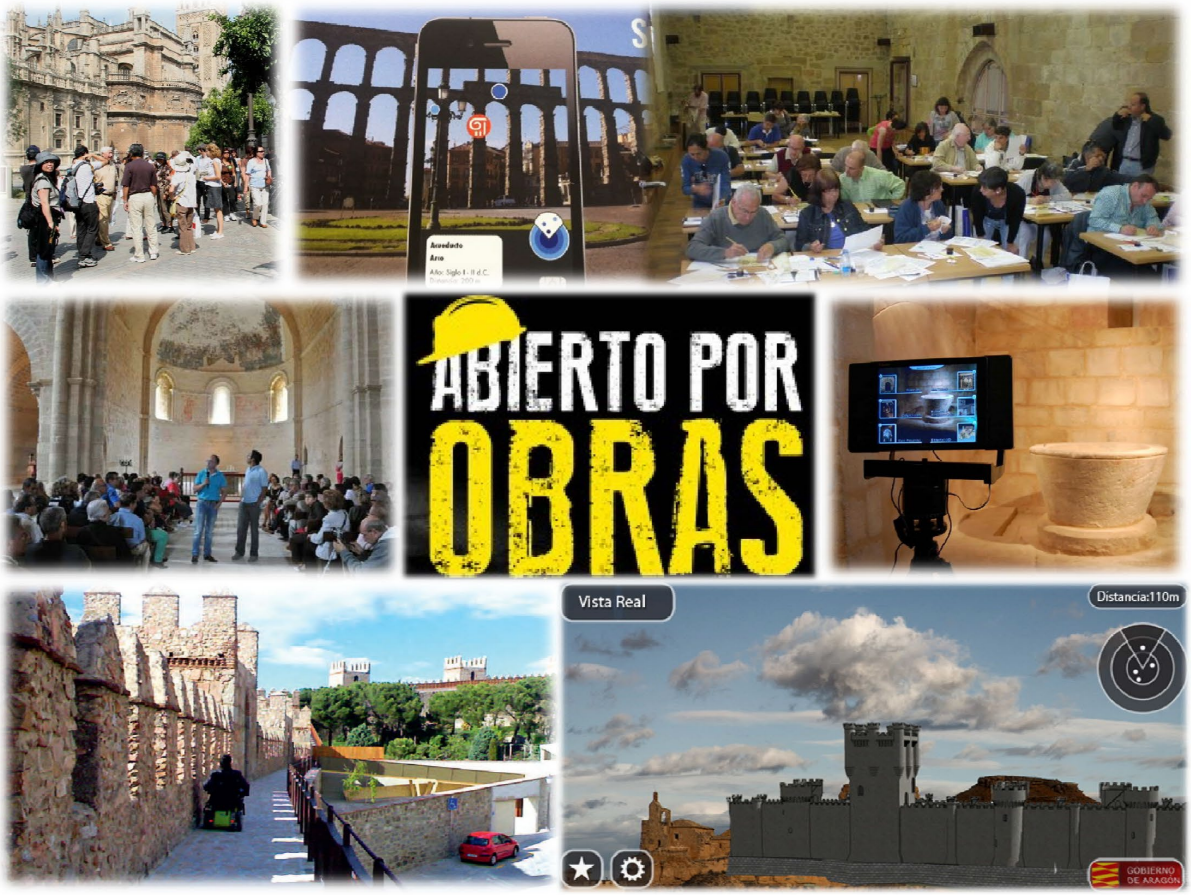
KEYWORDS: Bas-reliefs; Replicas; Conservation; Stone materials; Quarries.

ABSTRACT

The Monoliths of the Foundation of La Carolina (Jaén) were built in the 18th century to commemorate the foundation of the town and in honour of its founder, King Carlos III. Built in calcarenite, the monument has two square monoliths with bas-reliefs depicting scenes of work and life in the colonies.
In the project "Inventory of quarries associated with the construction of the architectural heritage of Andalusia" (CN IGME-CSIC, Junta de Andalucía), work was carried out on the characterisation of the stone materials used in its construction and the location of the quarries. The rocks used as structural elements correspond to calcareous sandstones from nearby quarries, within a radius of 5 km, where historical marks of exploitation can be identified.
The stones used in the bas-reliefs are selected specifically for the creation of these bas-reliefs, and this material has also been characterised.
The monoliths have a high degree of exposure to degradation, and the CN IGME-CSIC, in collaboration with the Town Council and the Museum of La Carolina, carried out actions for their conservation. A study of the main lesions was carried out and replicas of the bas-reliefs were made.

5.- DIFFUSION AND PROMOTION



CODE 88

TIDE MILLS IN FARO, PORTUGAL PROPOSAL OF A PEDESTRIAN ROUTE

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KEYWORDS: Vernacular heritage; Cultural tourism; Heritage preservation; Collective memory; Algarve.

ABSTRACT

With the Algarve having a predominantly Mediterranean climate, the invitation to make pedestrian walks is something with which Nature itself collaborates. Proposing new pedestrian paths in the city of Faro, based on cultural heritage, is something that is obviously part of this territory.
The reasons for writing this paper relate to the issue of valuing vernacular heritage that is not yet recognized as cultural heritage by most people and its preservation for future memory.
The research was based on bibliographical, webgraphic and field surveys and the framework of this proposal is pedestrian cultural tourism, which is a sustainable way of doing tourism and knowing the cities.
The purpose of this paper is to draw attention to a heritage that goes unnoticed by most people and that has a tourist potential that can be very important, especially in the Algarve region (southern Portugal), of which the city of Faro is the capital, as it is a highly touristic region.
During the development of the research was identified the location of several tide mills in the city of Faro, although most are in ruins. However, these places and ruins are part of the collective memory and deserve to be disclosed and valued, showing tourist potential.
The novelty of this work are the objects of study: the tide mills of the city of Faro. In this city, the vast majority of this vernacular heritage goes completely unnoticed, especially for those who do not live in the city. Drawing attention to these elements, the competent authorities are expected to be more committed to their preservation and enhancement.

CODE 165

UNPACKING THE EFFECTS OF CULTURAL TOURISM IN HISTORIC CENTERS: A LITERATURE REVIEW OF HISTORIC EUROPEAN CITIES

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KEYWORDS: Cultural tourism; Historic center; Impact; Negative effects.

ABSTRACT

Cultural tourism plays a vital role in the global travel market, and Europe's historic cities stand out as favored destinations among travelers worldwide. Nevertheless, the significant growth of this industry has a profound impact on historic centers, raising concerns about the negative effects of unregulated tourism and policies prioritizing visitor numbers over sustainable development and resident well-being. This paper presents a comprehensive literature review aiming to address two key research question: (1) What factors make historic centers vulnerable to the adverse effects of cultural tourism? and (2) What are the effects resulting from the growth of cultural tourism in historic European cities?
In order to identify the challenges faced by urban centers in Europe and address the research questions, a review of the existing literature in the Scopus database is conducted. The findings indicate that while cultural tourism has been extensively studied at a general geographical level, there is a notable gap in the literature regarding its impact on historic cities, especially in vulnerable contexts such as historic centers. By providing fresh insights, the paper highlights the importance of further investigation into the study of cultural tourism's impact on historic centers, aiming to achieve a sustainable balance between tourism growth and the preservation of the local community's quality of life.

CODE 179

RESIGNIFYING SOCIAL HISTORY IN THE PUBLIC SPACE: HERITAGE CEMETERY

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KEYWORDS: Heritage management; Social situated history; Tourism in cemeteries; Cemetery museum.

ABSTRACT

It is necessary to give validity to the past, recover the collective memory and make present what defines the society's identity. A comprehensive understanding of cemetery-museums requires knowledge of the culture and history of the cities and countries where they are located; which they may stand out for their architecture, the notorious personalities they host or the historical interest they hold. The proposal is an alternative for heritage management, to give meaning to social history by placing it in a public space, taking as a study case the General Cemetery of La Apacheta (Arequipa-Peru), considered a Historical Monument. La Apacheta, is a testimony of the contemporary and republican history of the city, the proposal is to revalue the memory (to make it known to the local population and visitors) the social history it tells, its historical, cultural and architectural value, focused on three axes: the space itself, funerary architectural styles and prominent figures. The objective is to establish cultural tours supported by digital technologies, based on the premise of placing history in the public space; that is, social and cultural events together with their protagonists. To achieve this goal, we proceed in two stages. The first stage involves reviewing related literature to identify what was made in similar contexts and then searching and consolidating historical data. This information is used to design routes of recovering memory for strengthen cultural identity. In the second stage, with the support of digital technology, it will be possible to locate the history in space, through the development and validation of an application that has geolocation and access to transmedia information that will serve as a motivating agent that will arouse interest for access, under a different conception, the place. The application implemented for this purpose may result in a regional tourism enterprise that would allow the protection, restoration, and conservation of the monument as a living testimony of history. It is concluded that a future would be proposed for this place which useful life is near its end and the city's past would be made known in a different way.

CODE 184

PREDICTION OF CULTURAL VISITORS' ATTENDANCE IN MUSEUMS AND CITIES

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KEYWORDS: Tourism; Prediction; Machine Learning; Culture; Heritage.

ABSTRACT

The tourism sector is one of the fundamental pillars of the Spanish economy, mainly due to its contribution to GDP and the employment it generates, causing an impact on other sectors. The innumerable data collection contrasts with the scarce use in the treatment of the same, opening the door to the need for a digital transformation of the sector so that it can promote a sustainable and personalized tourism to the tourist.

In pursuit of this purpose, UPintelligence seeks to improve the tourist experience, as well as the management and planning of tourist destinations and museums, in order to promote and preserve cultural heritage. In this study, a prediction of the future influx of tourists is made, in order to foresee a future scenario and, by means of Artificial Intelligence algorithms, the type of tourist is characterized according to the cultural events demanded. The destinations Castropol and Peñafiel, located in Asturias and Valladolid respectively, were used as case studies. Initially, data analysis was carried out using data mining techniques, which made it possible to identify correlation patterns and characterize the destinations and their cultural facilities as well as the tourists who visit these points of interest. In a second phase, Machine Learning algorithms were applied to try to predict and perform the necessary classification to obtain the tourist characterization. Among the algorithms studied for the prediction of affluence and tourist characterization, it was observed that the use of Gradient Boosting stood out with 81% accuracy in Castropol and 86% accuracy in Peñafiel.

The use of artificial intelligence algorithms based on traffic prediction and tourist characterization allows for better management of available resources, as well as proposing more personalized services to tourists and improving their experience.

CODE 190

REVALUATION OF CABAÑAS DE TEITO IN THE SUSTAINABILITY PLAN OF SOMIEDO (ASTURIAS). PILOT REHABILITATION PROJECT FOR EXPERIENCE TOURISM

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KEYWORDS: Rehabilitation; Experience Tourism; Cabanas de Teito.

ABSTRACT

The *Tourism Sustainability* Plan (TSP) in Somiedo has three main objectives: to protect the natural and heritage resources of the municipality, to consolidate the sustainable tourism model for providing the best ecotourism experience, and to strengthen the management of the tourist destination. Within this action plan, the proposal is to give new functionalities to the *cabanas de teito*, a highly significant architectural, ethnographic, and cultural element of the region, through an experiential ecotourism project. This pilot project will unfold in two phases: the selection of a cabin located in the Braña de la Pornacal (Somiedo, Asturias) for structural inspection and subsequent rehabilitation, and secondly, the interior adaptation with the aim of transforming it into an experiential ecotourism facility. The structural inspection involves the application of non-destructive sonic technologies to estimate the conservation status of wood and its mechanical properties, three-dimensional surveying using terrestrial laser scanning (TLS), and verification through structural calculation. The interior adaptation consists of installing chestnut wood elements combined with metal grid platforms. These platforms support wooden living spaces for rest and create a central common space and another double-height space above the original uneven stone floor. A staircase, which also provides storage space, provides access to a third platform located above the *treme*, intended for observing the roof structure, the *teito*. On the ground floor, a resting area is set up with two modules on either side of the cabin entrance, each with three separate compartments, accommodating a total of six people. The ultimate goal of the project is to provide a welcoming space for an ecotourism experience and serve as an example to demonstrate that it is possible to reconcile sustainable tourism with the conservation of ethnographic and cultural heritage.

CODE 193

CODIFIED CITY: BETWEEN CULTURAL HERITAGE AND URBAN AREA

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KEYWORDS: Cultural Heritage; Cartography; Tourism; Évora; Seville.

ABSTRACT

In the context of the patrimonialization of urban centers, policies have been implemented as entrepreneurial strategies, aiming to construct a spectacularized image. In the dynamics of the coded city, especially within the city-museum framework, cultural assets are commercialized through simplified signs and codes for consumption, resulting in an urbanal and themed city, shaped by a specialized market logic. In this perspective, the idea of a programmed route for partial and reduced visitation arises. However, this approach renders subjects, narratives, identities, and memories invisible, reducing the experience of space and place. In light of these considerations, this work presents, as a methodology, the production of critical cartography whose objective is to identify patrimonialization processes related to the spectacularization of urban cultural territory. The critical production of cartographies aims to counter narratives that guide the rapid and coded consumption of cultural territories and reveals contradictions and limitations of these practices. To achieve this, areas directly related to heritage preservation actions were delimited, employing key readings focused on the consumption of patrimonialized cultural goods. The goal was to unveil determined discourses and practices about the territory they belong to, particularly concerning cultural tourism and the programmed consumption of the city. This field study was conducted in two European historic centers: Évora, Portugal, and Seville, Spain. In Évora, the study analyzes patrimonialization processes from the protected area classified as a world heritage site, while in Seville, the study focused on the manifestation of symbolic elements of Flamenco and its relationship with the cultural territory of the city. The recognition of processes of cultural commodification in urban contexts reveals the urgent need to rethink preservation policies and the specific consequences of urban entrepreneurship. The spectacularization of the city, centered on constructing a superficial and simplified image to attract visitors, often obscures the richness and complexity of the stories, identities, and memories that truly constitute a place.

CODE 208

THE BUILDING STONES OF PIENZA (TUSCANY, ITALY)

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KEYWORDS: Geoheritage; Building material; Quarry; Decay.

ABSTRACT

Pienza, a fifteenth-century town in Tuscany, Italy, is renowned as a prime example of Renaissance urbanism. Constructed by Pope Pius II, the town was designed by the esteemed architect Bernardo Rossellino to embody an ideal city centered around a grand square, Piazza Pio II. This study focuses on identifying and characterizing the stones used in Pienza's main buildings and understanding their decay forms. Through XRF and XRD analyses, the chemical and mineralogical characteristics of the main identified litologies (Pienza sandstones and Bioclastic calcirudites) have been determined. Microscopic observations aided in studying thin sections, while physical and mechanical properties of the stones were also assessed. The findings have led to the proposal of an geo-lithological itinerary to showcase the building stones of the most remarkable monuments and palaces of the Pienza center, and highlight the locations of their quarrying areas. This research aims to contribute to the knowledge and valorization of Pienza's architectural heritage.

CODE 219

INTEGRATED EVALUATION OF THE HOTEL ARCHITECTURE IN THE HERITAGE CITIES OF OURO PRETO AND PARATY - BRAZIL

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KEYWORDS: World Cultural Heritage in Brazil; Colonial Brazilian Architecture; Tourism and Accommodation Facilities; Ouro Preto (MG); Paraty (RJ).

ABSTRACT

In the locations of Ouro Preto (MG) and Paraty (RJ), UNESCO's World Heritage Sites, the main urban and architectural features are associated with Luso-Brazilian constructions from the colonial gold-bearing period. These are cities that carried throughout the centuries, the core foundations of national architecture and within them monuments and buildings primarily from the 18th century can still be found. They encompass works recognized by their baroque and rococo artistic styles perceived in churches and institutional buildings. Due to the scope of these constructions, they can range from distinguished mansions to humble houses. To further contextualize the sites and their landscapes, the adding formation of clusters with these diverse civil, institutional and religious edifices, among the various urban apparatus enriching their urban and historical sceneries. These places facilitated connections between people, products and basically the gold flow, primarily through a route known as Caminho Velho which today is part of the Estrada Real touristic route. An old road established by royal folks in Brazil's Gold Route. The inherited location of these sites and architecture combined with the touristic destination demands of both places. Currently their sustainable infrastructure caters to the high demand of national and international visiting while attending to the cultural and historical preservation interests. This study aims to characterize recycled colonial houses as contemporary means of accommodations. To this end, the present work undertakes qualitative exploratory research, employing comprehensive analysis that considers the subjective characteristics of those variables, the temporality of the subject matter and its originality. After bibliographical review that supports the theoretical foundation to the study, documented research has been applied to the investigation procedures where the analysis of photography, video and text descriptions of multiple sources *online* have been made. The results indicate relevant and enduring aspects in regards to the recycling of the works, allowing for the understanding of common necessity programs to the lodging of those colonial houses, while links between patrimony, tourism and the architecture are made.

CODE 225

THE HISTORICAL HERITAGE OF SANTA TEREZA AND ITS TOURISTIC ATTRACTION PROFILE

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KEYWORDS: Built heritage; Immigration; Cultural tourism; Santa Tereza; IPHAN.

ABSTRACT

Santa Tereza is a small city located in the extreme south of Brazil, whose urban downtown área is legally protected since 2012 by Instituto do Patrimônio Histórico e Artístico Nacional – IPHAN, (National Historical and Artistic Heritage Institute). The listing of the urban center, consisting of 57 wooden and brickhouses, was due to the integrity of the assets, which maintain the original characteristics of its layout almost intact and, above all, due to the great value of the cultural landscape, which is representative of the immigration period in southern Brazil (19th and 20th centuries). This study aims to highlight the characteristics of the listed heritage as a potential tourist attraction and its preservation and conservation relation. To this end, exploratory qualitative research is carried out, based on a comprehensive analysis of local characteristics and the preservation and maintenance conditions of the listed heritage landscape. The end considerations presents the relation between the different local touristic activity agents, their convergences and divergences.

CODE 255

INTERNAL RURAL AREAS: FROM PROBLEM TO RESOURCE. PROSPECTS OF URBAN-TERRITORIAL REGENERATION FOR ALTA IRPINIA (IT)

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KEYWORDS: Rural areas; Resilience; GIS; AHP (Analytic Hierarchy Process).

ABSTRACT

The National Strategy for Internal Areas (SNAI) is an Italian policy for promoting territorial cohesion and development with the goal of reducing marginalisation and demographic ageing in internal areas. It aims to provide clear objectives and a coordinated set of actions to address economic, social and environmental challenges faced by people living in those areas. In doing so, it facilitates job creation, enhances quality of life, and supports the preservation of cultural heritage. To reverse the present tendency of depopulation within these areas, their services related to education, healthcare, and transport need improving, and developing projects aimed at promoting local production chains, enhancing cultural and natural heritage, and preserving ecosystems and biodiversity within the green economy are a necessity.
This research concentrates on Alta Irpinia, the pilot area of the internal areas of the Campania Region (IT). Based on the analysis of the 26 local councils in the inland region, it is imperative to provide direction to the community and managers towards a collaborative approach to inclusive and proactive development in political decision-making and execution.
After selecting four municipalities in the region (Caposele, Carife, Montemarano, Villamaina) and conducting a GIS analysis, a detailed study of social, environmental and economic issues was undertaken. The resulting analysis has provided guidance on implementing integrated socio-economic transitions.
The findings of this spatial analysis suggest that by prioritising the distinctive characteristics of rural landscapes shaped over centuries, it is feasible to establish a renewed economy for these areas, counteracting trends of abandonment.

CODE 278

HERITAGE SUSTAINABILITY IN TOURIST ATTRACTIONS: A CASE STUDY OF THE CHAPEL OF SANTO ANTÔNIO DE CASTRO IN CARLOS BARBOSA, BRAZIL

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KEYWORDS: Cultural Heritage; Italian Immigration; Rural Tourism; Santo Antônio de Castro.

ABSTRACT

This work addresses the restoration of the century-old Capela de Santo Antônio de Castro, in the interior of the municipality of Carlos Barbosa – southern Brazil – and the strengthening of its attractiveness for rural tourism. Located in a region historically identified as Serra Gaúcha, in the state of Rio Grande do Sul, it is characterized by intense colonization by European immigrants at the end of the 19th century, predominantly Italians, a fact that still marks the culture of local communities today. Its historical aspects qualify the architectural typology characteristic of this regional colonization, in the Capela. Opened in 1916, it has an important collection of frescoes by an unknown author, which highlights the artistic and cultural merit, as well as the beauty and simplicity involved in a space that strengthens faith, adored by the community's residents. In 2003, these values were recognized through its classification at municipal level as Historic Heritage of Carlos Barbosa. Twelve years later, a new rural tourism itinerary called L'Amore Di Colônia was created in the community of Santo Antônio de Castro, with the aim of introducing visitors to the rural experiences lived on a day-to-day basis by the descendants of immigrates. In it, although in need of restoration, the Chapel has always been one of the main cultural attractions. In October 2022, work on its restoration will begin and, after going through all the stages of the civil work, it is in the restoration stage of the mural paintings, assets integrated into the historic building. Its reopening is scheduled for February 2024. The objective of this study is to analyze the social and economic sustainability of the heritage asset based on its status as a tourist attraction, the perception of local residents regarding the appreciation of their own culture and the process of conservation and restoration of the built heritage as a driver of the rural tourism itinerary. To this end, exploratory qualitative research was carried out through comprehensive analysis, justified by the subjective characteristics of the work, the temporality imprinted on the restoration stages and the potential of this asset for heritage sustainability. The results obtained establish relationships between the heritage, its community and the sustainable restoration of the tourist-cultural attraction in rural areas.

CODE 372

BALANCING TOURISM AND CULTURAL HERITAGE CONSERVATION IN SVALBARD: CHALLENGES AND SUSTAINABLE PRACTICES

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KEYWORDS: Sustainability; Vulnerability; Svalbard; Cultural heritage sites; Tourism.

ABSTRACT

The High-Arctic Archipelago of Svalbard is a unique region that attracts tourists from around the world due to the combination of cultural heritage sites and stunning natural landscapes. However, the increasing tourism activities, coupled with the effects of climate change, pose challenges to the preservation of these vulnerable heritage sites. This paper is based on an ongoing study of sustainable tourism on Svalbard. The paper seeks to understand the perspectives of various stakeholders and assess the impact of tourism on cultural heritage and the environment. A mixed-methods approach was employed, including interviews with tourists, guides, and experts, and observations at ten selected sites across Svalbard. The results reveal that the environmental aims for preserving for nature and cultural heritage are Impressively high, although difficult to balance with tourism as a desired industry. The fragile nature of the cultural heritage sites, coupled with the effects of climate change, require careful management and conservation efforts. Both observations and interviews with tourists revealed divergencies between their attitudes and behaviour. The paper identifies several key objectives for sustainable tourism on Svalbard. These include minimizing the ecological footprint of tourists, promoting responsible behaviour through education and guidelines, implementing visitor management strategies, and developing protective measures at the most vulnerable sites. Collaboration between stakeholders is crucial for a sustainable management of Svalbard's cultural heritage in a unique natural environment. The findings underscore the importance of balancing tourism activities with protecting cultural heritage and natural environments on Svalbard. By highlighting the challenges and opportunities associated with tourism and cultural heritage sites, the paper provides valuable insights for a variety of stakeholders. Sustainable tourism practices combined with active protection measures, can ensure a continued appreciation and learning from the rich cultural heritage and awe-inspiring landscapes of Svalbard for future generations.

CODE 373

IDENTIFICATION AND CATEGORIZATION OF CULTURAL ASSETS WITH TOURISTIC POTENTIAL IN VERANÓPOLIS AND VILA FLORES - BRAZIL

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KEYWORDS: Architectural Heritage; Regional Development; Tourism.

ABSTRACT

This study involves the survey and categorization of cultural assets with potential for touristic appropriation in Veranópolis and Vila Flores, locations situated in the Serra Gaúcha, southern Brazil. Initially, the regions are characterized as a spatial framework for the analysis of the objects. The research questions the values embodied in properties resulting from Italian immigration processes, a decisive event in the late 19th century. Thus, architectural elements that endow the relevant buildings with distinctive value and recognition from a perspective that transcends the common issues of Western Architectural Theory are identified. In this analysis, the goal is to pinpoint the positioning of the research objects as tourist offerings and to develop complementary proposals tied to the value of memory. The research defines the regions in which the assets are located, portraying their economic formations and variations, justifying the touristic vocation of the surroundings. This confrontation stands as a methodological procedure and values that distinguish it as a case study for object characterization. The study portrays the research objects through theoretical and bibliographic comparisons. Therefore, the objective is to identify the assets and understand their spatial distribution, as well as their local and regional contexts. This process results in a locational study of their cultural assets and their possibilities for touristic appropriation. It confronts the local characteristics of the surroundings, presenting the region as part of a concrete whole that can be understood by social and spatial factors external to it, acknowledging its inherent contradictions. However, it should not be considered either as a logical totality or as a harmonious whole. The study's completion is expected to assist in the development of new public policies related to tourist routes, filling gaps and contributing to the formulation and qualification of administration guidelines suitable to local characteristics, enriching the understanding of the region, and reinforcing the economy in the sector.

CODE 81

MODELLING MASONRY PROCESS ACTIVITIES TO EVALUATE ON-SITE PRODUCTIVITY

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KEYWORDS: Masonry process; Worker 4.0; Civil Construction; Performance; Motion Productivity.

ABSTRACT

Improving on-site productivity and increasing the mechanisation of tasks is one of the construction industry's main challenges. A craft-workforce motion productivity framework was conceptualised and established nine processes to map and measure on-site performance, being composed of: i) Free-hand performing, ii) Auxiliary tools, iii) Manual tools, iv) Electric/Electronic tools, v) Machines operation, vi) Robotic automation, vii) Do not operating value, viii) Walking, ix) Carrying. An experiment was conducted to model masonry activity in residential and commercial sites. A work sampling methodology was conducted to collect data and test the proposed framework's feasibility. Through human observation, randomly performed, the sample was stratified according to the pre-established framework.
The activities include laying individual masonry units (expanded clay blocks 400x190x200mm) with horizontal and vertical joints in mortar. Only the brickwork was analysed (without coatings). For the observed five working days in the residential building worksite, 198 square meters of masonry were carried out, undertaking 145 labour-hours, achieving a rating of 0.73 labour-hours/m2. In the same period, conducting the work sampling methodology, 3,484 observation points were made about the crew performance. Also, for the commercial building worksite, at five working days, 242 square meters of masonry, undertaking 158 labour-hours, achieving a rate of 0.65 labour-hours/m2. With a total of 3,606 observations made about the processes. Resulting of the masonry processes modelled for each site indicate that most activities performed concern manual tools and free-hand performing. Finally, the comparative analysis between different worksites regarding masonry tasks allows the evaluation of the processes. It identifies characteristics that can be better adapted to enhance production and increase mechanisation levels. Modelling process methods can lead to measures to standardise the crew's activities and improve productivity.

CODE 353

TRAINING AND QUALIFICATION FOR THE USE OF NON-DESTRUCTIVE TESTING EQUIPMENT IN ARCHITECTURE AND ENGINEERING SCHOOLS IN BRAZIL

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KEYWORDS: Teaching and training; Civil works inspection; Non-destructive testing; Drones; Thermography.

ABSTRACT

Civil works, whether heritage-listed or not, need to be regularly inspected to detect possible changes in their initial technical characteristics. The knowledge and skills required for these inspections are directly related to the technical knowledge and experience of the professionals, which are not widely taught in the education of engineering and architecture students in Brazil. Furthermore, traditional inspection methods have limitations for areas that are difficult to access, as well as safety issues associated with industrial climbing, for example. These and other issues can be addressed by using new technologies such as drones, thermal cameras, tomography, 3D scanning, among others. Although these technologies are already being used in the Brazilian job market, there are still no well-defined procedures for their use. Therefore, an interdisciplinary group of researchers from the Faculty of Architecture and Urbanism and the School of Engineering of Mackenzie Presbyterian University, in collaboration with equipment manufacturers such as Faro and Proceq, and companies and institutions providing services in the sector, such as the Brazilian Association of Non-Destructive Testing and Inspection (ABENDI), has been conducting research to analyze traditional inspection methods, define methodologies for the use of innovative technologies to replace or complement traditional methods, and provide teaching and training to students in these areas, aiming to fill a gap in the university environment. This article aims to present the results of the actions taken over the past 3 years and discuss proposals for their further development.

CODE 7

THE CENTRAL SQUARE OF LOJA - ECUADOR A HISTORICAL, PATRIMONIAL AND DIGITAL VISION

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KEYWORDS: Virtual tour; Heritage; Loja; Public space; Documentation.

ABSTRACT

The objective of this paper is to analyze the central square of the city of Loja located in Ecuador from the recognition of its historical and documentary importance through the use of reconstruction and 3D virtual tours, and certain necessary processes prior to the use of this technology. It should be noted that the city of Loja has been characterized by having unique heritages, among these stand out the public spaces such as squares that have a great historical, cultural and architectural value that have witnessed abrupt changes, losing their original attributes. Knowing these heritages through time is essential for the identity and roots of locals and strangers, therefore, virtual tours are digital tools that allow to preserve and disseminate them to people not specialized in the subject. For this reason, an analysis was carried out applying the design principles of Louis Kahn, being convenient to analyze them in the central square of Loja in terms of historical principles, space, server and served, to learn about its transformation, not only as an independent element but as a landmark of foundational reference, in addition, the function and distribution of Latin American squares was studied to understand its importance among other points. Finally, the tour was evaluated in order to improve it and use it as a free digital tool, educational and available to society in general.

CODE 10

NEW TECHNOLOGIES AS TOOLS FOR DOCUMENTATION AND DISSEMINATION OF HERITAGE HOMES, LOJA - ECUADOR

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KEYWORDS: Heritage housing; Software; Loja; Ecuador; Documentation.

ABSTRACT

The focus of this article is mainly based on documenting and disseminating, through the new architectural software, the technical and historical characteristics of the patrimonial house of Mrs. Beatriz Valdivieso and Patricia Valdivieso, located in the city of Loja, Ecuador. This house dates back to 1840, that is, the beginning of the republican era in the country, so it is almost 200 years old; however, due to the existing deficit in Ecuador, with respect to the conservation of heritage properties, this house has been affected by various abrupt and inconceivable interventions that have greatly affected its integrity as cultural heritage. On the other hand, the lack of processes to maintain a clear and accurate record, both technical and historical, of these elements, has led to both ignorance and loss of information, generating an "unnoticed ignorance" within society. As a result of this problem, and through a methodology based on consecutive phases of research, digitization and virtual dissemination, we sought to adequately record the various changes that the work has undergone from its conception date to the present, thus carrying out a technical and functional analysis that allowed us to reconstruct the work to its original state in a hypothetical way. Similarly, once documented all the changes and historical processes through which the building has gone through, through a virtual, interactive and immersive tour, we were able to disseminate the final result to local and international citizens, if the case of interest, in addition, through this research we were able to digitize all the information corresponding to the heritage house, a fact that will serve in the future as a permanent and updateable database that can be used in processes of study, maintenance, restoration and intervention in the property.

CODE 73

METODOLOGY TO DEVELOP A 3D-GIS HERITAGE CITY MODEL TO SUPPORT THE MONITORING OF BUILDINGS´ STATE OF CONSERVATION: CASE STUDY OF LEIRIA DOWNTOWN HISTORICAL CENTRE

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KEYWORDS: 3D-GIS; Three-Dimensional Modelling; Shape Grammar; State of Conservation.

ABSTRACT

One of the huge challenges faced by the scientific community is related with the identification of solutions that allow the preservation of the tangible and intangible heritage historical city centres. Another issue is related with the management of architectural heritage information which faces significant challenges since architectural objects require an integrated representation of various types of information in order to develop appropriate conservation strategies.
In the present paper, the author present results of the application of a 3D model developed for the Historic Centre of Leiria City (HCL) in Portugal, to contribute both to the conservation of the heritage buildings and to the dissemination of tangible and intangible heritage of the historical city centre. The methodology applied included the integration of a 3D BIM model in a 3D-GIS environment to obtain an interactive system for the management, integration and presentation of historical urban geoinformation. For more than 0.40 km2 of the city, 3D GIS building geometry and thematic information have been processed. The model was enhanced with the application of textures and patterns and also with information about the non-structural pathologies associated to each building to support the municipality decisions related with the conservation of the historical city centre.

CODE 77

DISSEMINATION OF THE ARCHITECTURAL HISTORICAL HERITAGE THROUGH THE COMIC

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KEYWORDS: Digital comics; Dissemination; Cultural heritage; Historical heritage.

ABSTRACT

The preservation of cultural heritage heavily relies on its recognition and appreciation within society. Effective communication, particularly through public outreach, plays a crucial role in achieving this goal. Combining digital media with comics offers an exciting avenue for exploration, where elements like editing, interaction, popular culture, and graphic appeal intersect. The educational potential of comics to evoke monuments, places, cultures, and civilizations has yet to receive the thorough examination it deserves.

This article aims to explore the potential and opportunities that comics offer as a medium for communicating and promoting architectural heritage appreciation. By leveraging modern distribution platforms, comics can be adapted into an interactive format, broadening their appeal and extending their outreach.

The study begins by examining a segment of the extensive collection of comics focused on their role in reviving the past. These comics can be categorized into two main types: those that feature stories set in historical contexts, such as cities, places, or buildings, and those that use the medium to convey experiences that deepen our appreciation of cultural heritage.

Our observations indicate that comics are a potent communicative tool, significantly shaping our perceptions of historical and cultural heritage, influencing the collective imagination. Their use in promoting architectural heritage, though impactful, has primarily shaped localized perceptions compared to narrative comics, where they serve as contextual elements for storytelling.

CODE 80

SABATINI IN MADRID. DRAWING OF THE PAST AND SYSTEMS OF REPRESENTATION: NEW GRAPHIC APPROACHES FOR THE DISSEMINATION OF HISTORICAL ARCHITECTURE AND CITIES

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KEYWORDS: Architectural drawing; Heritage drawing; Representation systems; Sabatini.

ABSTRACT

The large monographic exhibition on Francisco Sabatini held in Madrid in 1993 provided a panoramic view of all his projects. Almost 30 years later, in 2021, the exhibition *El Madrid de Sabatini. The construction of a European capital (1760-1797)*, achieved a complete review of his work in Madrid from another point of view. Focusing the relationship between architecture and the city, it took advantage of new technologies applied to study lost heritage. In addition to the historical and scientific advances, the main novelty of this exhibition was its visual approach, implemented through the *ex-professo* production of architectural and city drawings. In this context, not a single representation system was chosen, but rather a combination of several of them in order to explore the most suitable one for each specific discourse.

This communication addresses the expressive capacities of each type of drawing depending on the aim of the information that wants to be produced. From a common starting point, a rigorous historical reconstructive planimetry in CAD format, three-dimensional models of the buildings and urban areas were produced serving as a basis for graphic research, building formal hypotheses of the different elements studied. With the aim of enabling an easy understanding of the results by the general public, the most appropriate variables and representation systems in each case were selected and the final drawings and animations were edited. General plans and elevations of the city, axonometries, sectioned perspectives of specific buildings, urban views of unbuilt projects, oblique elevations... were incorporated into a double space-time reading of the city that allowed the understanding of the visitors of certain architectural concepts that turned more readable the original documentation, not always easy to read by all types of public, while showing the architect's interventions in the city and the consequences that these had on its subsequent development.

CODE 137

A VIRTUAL EXHIBITION FOR CINEMA HALLS. A DIGITAL DOCUMENTATION PROJECT FOR THE CITY OF MESSINA IN THE 50S

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KEYWORDS: Messina (Italy); Cinema; Modern Architecture; GIS (Geographic Information System).

ABSTRACT

Theatre, cinema and television contributed to the cultural education of entire generations that have approached these forms of "art". Each has benefited from specific spaces: from the sumptuous theatres of the 19th century to the dynamic cinema halls of the 20th century to first public and then private places holding up television sets. All spaces have undergone transformations to adapt to social changes and more flexible uses. Cinemas have been hit by the worst fates everywhere in the world: abandonment or incongruous renovations have mostly changed their meaning. The subject has been deepened for Messina (Italy), a context that is as peripheral as representative of a widespread reality and where authoritative exponents of Italian Rationalism - Filippo Rovigo, Vincenzo Pantano, Aldo Indelicato, MAC - operated in the second half of the 20th century. Applying a synthesis of architecture, art and craftsmanship of great quality in spatial, cognitive, performance and aesthetic terms, innovative architectures were conceived according to great urban, functional and technical criteria, seeking a symbiosis between architectural container and spectacular content.
Only a few cinema halls built after the Second World War continue to preserve their original use, although supplemented by new ones. Some have undergone heavy changes to accommodate commercial or catering activities; of others there is no longer any trace.
The study, which is replicable and experiential, intends to address the issues of knowledge and conservation in the spirit promoted by the association DOCOMOMO International and by the General Directorate for Contemporary Creativity of the Italian Ministry of Culture, but also looking at the best European practices of reinterpreting obsolete places to be returned to the community. Therefore, with reference to the most representative examples present in the city, the results of a cataloguing project conducted according to standardised criteria have been illustrated, using digital technologies in GIS environment to archive the construction history and the cultural significance of the cinema halls. The aim has been to virtualise contents preparatory to a conservative reinterpretation and to a promotion congruent with their values, drawing on the most advanced concepts of social, economic and environmental sustainability.

CODE 185

AUGMENTED REALITY SYSTEM FOR THE DISSEMINATION OF THE EVOLUTIONARY STUDY OF THE ROYAL PALACE OF VALLADOLID

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KEYWORDS: Augmented Reality; Cultural Heritage; Artificial Vision; Virtual Assistant; 3D.

ABSTRACT

Palacio Real is a project carried out by UPintelligence that recreates historical destinations as they were hundreds of years ago through Augmented Reality (AR). The aim of the project is to immerse the tourist visitor in an ancient era through the use of cutting-edge technologies. The project is based on the integration of a mobile application, with georeferenced signal processing (GPS), internal accelerometers and gyroscopes of the mobile device and artificial vision. Through the mobile application, the tourist can operate the camera and focus on the actual facade of the historic destination points. Through artificial vision techniques, the facade is processed in real time and through AR, the visitor can see how that destination was in the past. In addition, taking into account the internal sensors of the mobile device and its GPS position, the tourist can see himself integrated among historical characters modeled in 3D shown through AR.
The use of cutting-edge technologies and innovation allows, through software tools, the preservation of cultural heritage.

CODE 212

A COMPENDIUM OF HISTORICAL-ARCHITECTURAL STRATIFICATION IN MESSINA IN THE AREA OF LARGO SAN GIACOMO: FROM ARCHAEOLOGICAL REMAINS TO ELEVATIONS ON THE BLOCKS IN TWENTIETH CENTURY

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KEYWORDS: Historical Stratification; Messina; Urban Identity; Multimedia Processing; Digitisation.

ABSTRACT

The city of Messina boasts a history that spans a millennium, with origins predating the arrival of the Greeks in the eighth century BC. Its development has been a gradual process shaped by numerous historical and environmental events, including devastating natural disasters. Throughout this progression, previous stages have been at times completely or partially concealed, without the adequate attention and protective measures they deserved.
Along Via Garibaldi, a significant thoroughfare that has existed since the Hellenistic era (as Via Dromo) until the 19th century (as Via Ferdinanda), Largo San Giacomo is located precisely in the apsidal area of the Cathedral of the Peloritan city. Here, there is substantial archaeological evidence neglected, alongside residential buildings dating back to the 20th century. In numerous of these cases, the final phase of historical and architectural layering comprises the elevation projects conducted during the latter part of the 20th century. While the proportions and aesthetics of the original buildings have been negatively altered in many instances, it is important to highlight that some of these designs are of high quality and noteworthy to the community.
To restore some of Messina's identifiable construction characteristics, the initial methodological step was to select and outline the section of Via Garibaldi that best explains the stratification processes that have occurred from ancient times to the present day.
Bibliographic and archival research is a natural progression towards gaining insight into what has survived, alongside what has been lost or overlooked. This led to the consideration of the city's identity features, including those that currently exist, such as archaeological remains, and potential ones, such as the floor addition of valuable post-earthquake buildings.
Finally, research has been oriented towards the valorization of Messina's stratified heritage through digital guides containing files and original documents to enhance citizen knowledge and cultural tourism. The employment of multimedia processing alongside basic QR codes placed at architectural observation points showcases the capacity for both the procedure and ultimate outcome to be effortlessly duplicated and exported.

CODE 277

A BIRD'S EYE VIEW OF A HANDCRAFTED JEWEL IN ARCHITECTURE. THE ROCCHETTA MATTEI IN ITALY

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KEYWORDS: Eclecticism; Castles of invention; Drone; Structure from motion; Photomodelling.

ABSTRACT

This study aims to examine a place with very suggestive characteristics: Rocchetta Mattei. Rocchetta Mattei is a Castle located in Riola, municipality of Grizzana Morandi, in the province of Bologna. It owes its name to Count Cesare Mattei (1809-1896) and was built between 1850 and 1858, on top of the ruins of a more ancient building, which dates back to the 13th century, the castrum of Savignano. Today it is considered a unique and suggestive building, made up of mazes of towers, monumental stairways, reception halls and private rooms all designed in different styles. It's an architectural complex composite, eclectic, built at several different points in time, with oriental references, where neo-Medieval, Moorish, neo-Renaissance, Egyptian and liberty architectures blend. Due to its unique architectural form, it is impossible to capture its beauty and uniqueness from a singular perspective. For this reason, we believe that a drone gaze can best convey its outstanding and unique characteristics, as well as tell the story of this handcrafted jewel. Rocchetta Mattei has a complex history, which finds its roots in the eclecticism of invented castles and is defined by magical and mysterious features that only a drone gaze can represent in the best way possible.

CODE 397

PHOTOGRAMMETRIC OPTIMIZATION FOR THE CREATION OF THE VIRTUAL MUSEUM OF THE CATHEDRAL OF SANTIAGO DE COMPOSTELA

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KEYWORDS: Photogrammetry; Virtual Museum; 3D Modelling; Unreal Engine 5; Video Games.

ABSTRACT

After the pandemic in 2020, some museums found themselves in the need to close. Faced with this new reality, institutions had to seek alternatives, choosing to utilize a new technologies to continue reaching different sectors of the population, from a presence on social media to the use of three-dimensional (3D) technology or virtual reality.
This article suggests the use of 3D models for the creation of virtual museums, as well as the optimization of photogrammetric pieces for their integration into a graphic engine. This article focuses on the generation of a virtual object, known as a "digital twin", which has been used to represent the piece "Santiago Seated and Crowned" from the Cathedral Museum of Santiago de Compostela. Furthermore, the use of Unreal Engine 5 is proposed as the graphic engine for the integration of all elements.

CODE 402

DECAY ASSESSMENT IN HISTORIC BUILDINGS WITH TEXTURE-BASED CLASSIFICATION TECHNIQUES: FROM DIGITAL SURVEY TO HBIM

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KEYWORDS: Cultural Heritage; Automatic Decay Segmentation; Supervised Machine Learning; 3D Models; Virtual Environment.

ABSTRACT

This research work focuses on innovative classification strategies for the diagnosis of degradation in the field of Cultural Heritage. From the analysis of recent literature, the vital role that digital technologies, such as photogrammetry and laser scanning, play in the preservation process of historical buildings emerges. These methods enable the collection of accurate 2D and 3D data to assess buildings and their structural elements. Additionally, Virtual Reality offers cost-effective alternatives to traditional documentation methods. The research aims at leveraging photogrammetric techniques in the digital survey phase to acquire geometric and colorimetric data of heritage objects and panoramic views for virtual representation. Digital models derived from this data include spherical photos, point clouds, meshes and textures, which are then used to evaluate the degradation of the surrounding environment. The methodology is based on semi-automatic classification techniques to semantically segment and evaluate these degradation phenomena. The field of automatic classification of cultural heritage lacks specialized approaches, unlike other fields where it is highly developed. The research highlights the absence of standardized procedures for the acquisition, reconstruction and analysis of 2D/3D data in the evaluation of heritage artefacts, hence the need for streamlined, accessible and rapid methodologies to evaluate heritage conditions. To address these challenges, the research introduces preliminary results that aim to develop algorithms for monitoring the surfaces of historic buildings. This systematic workflow uses cost-effective, intuitive tools and machine learning algorithms to automatically recognize various types of decay in images, photos and textures resulting from monitoring and diagnostic activities. Finally, the paper emphasizes the potential of Historic Building Information Modeling to integrate and share different data sources, supporting restoration and analysis efforts while providing a valuable tool for project stakeholders and users. The proposed methodology is presented through an application in a case study.

CODE 172

ACCESSIBILITY TO CULTURAL HERITAGE: THE CASE STUDY OF THE KINDERGARTEN AND THE MIDDLE SCHOOL USING THE MATRIX OF AUTHENTICITY AND ACCESSIBILITY

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KEYWORDS: Accessibility to cultural heritage; Authenticity; Cultural significance; Matrix of authenticity and accessibility.

ABSTRACT

As part of the strategy for cultural heritage diffusion and promotion, it is important to consider that the access to cultural heritage is a duty and a right of all. Cultural heritage conservation requires capability to face challenges and implementation of actions to avoid authenticity lost that could happen at adaptation work execution for accessibility, for example. Cultural heritage buildings and sites must be accessible as possible but preserving the heritage values. Considering that accessibility legal requirements and heritage buildings and sites particularities sometimes may be in conflict, the Matrix of authenticity and accessibility has been an important method to investigate what is necessary to adapt and the risks and opportunities to cultural heritage. This method has been applied in many case studies in the last twelve years in different types of heritage buildings and sites and in 2021 it was improved as consequence of Brazilian rules revision. This paper describes the application of the matrix to two Brazilian modern heritage buildings: the kindergarten designed by Stellio Rodolpho Bastos Seabra, built in the sixties, and the Middle School designed by Oscar Niemeyer, built in 1959, both buildings in the 308 south superblock in Brasília, inserted in the Neighborhood Unit designed by Lucio Costa as a way of living for the new capital of Brazil. The main results show that there are many possibilities of adaptation to provide accessibility, respecting the heritage values, such as adjustments to existing sidewalks and ramps, insertion of tactile floors, handrails and railings, widening of doorways and corridors, installation of supporting bars and accessories in toilets, installation of drinking fountains, service and information counters and sidewalks refurbishment. The Matrix was able to identify the adaptation necessities, the restrictions and the possible changes, providing the necessary subsidies for guiding design and adaptation work, contributing for cultural heritage promotion and diffusion, recognizing the importance of accessibility to physical, social, economic and cultural means, to enable persons with disabilities to fully enjoy all human rights and fundamental freedoms, as set out in the Convention on the Rights of Persons with Disabilities, adopted on 2007 by the United Nations.

CODE 195

PROJECTS FOR A "DISCONNECTED" HERITAGE. A NEW IDENTITY FOR ARCHAEOLOGICAL LANDSCAPES SYSTEM OF MARMILLA

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KEYWORDS: Heritage; Archeological landscape; Conservation; Requalification; Accessibility.

ABSTRACT

This paper is part of a broader research framework that aims to develop strategies for knowledge and intervention on the huge prehistoric and protohistoric archaeological heritage of Sardinia, focusing on the historical region of Marmilla. The method is based on the analysis of the relationships between the site and the rural landscape and the systematization of archaeologies with existing multi-layered settlement networks. Specifically, this paper triggers a process that aims to bring attention back to the places of the archaic, proposing services and routes that can promote their visibility and, consequently, make them known and appreciated, activating a virtuous mechanism of valorization. The objectives of the work are reconstructing the identity of the places and preserving this unique heritage. Through the reinterpretation of existing features, a current and contemporary response is proposed to interpret the sites' needs in relation to accessibility in the broadest sense of the term. Some sites already appear to be partially equipped with accommodation and reception facilities, but these are often oversized or poorly functioning. Architectural and landscape design then becomes a necessary tool for fruition and enhancement, through actions that are focused on the maintenance and updating of existing buildings of proximity, the insertion of new minimal devices, paths, and coverings in archaeological areas, but also on the issue of the management of excavated material and processes related to the needs of the archaeological site. At the same time, however, the project is also a tool for general consideration, verification and fine-tuning of possible approaches and paradigms. The principles of intervention invoke the concepts of enclosure, by redefining access thresholds and limits, land and soil manipulation, and excavation, as a means through which to bring out the materiality and massiveness of the built environment and to provoke deep relationships between the present landscape and archaeology. The case studies are part of a network of archaeological sites from the Nuragic period (1700-800 B.C.) that are strongly interconnected and are located in Marmilla, a historical region of central Sardinia. We find Sa Scaba 'e Cresia in Morgongiori, Nuraghe Cuccurada in Mogoro, Sa Domu 'e S'Orcu in the jara of Siddi, Nuragic Villagio Brunk 'e s'Omu in Villaverde, Nuraghe Su Mulinu in Villanovafranca, Nuraghe Santu Miali in Pompu and the Sacred Well of Sant'Anastasia in Sardara.

CODE 301

ACCESSIBILITY AND HERITAGE. MEASURE OF CONNECTIVITY OF THE HISTORIC WALLED CENTER OF CARTAGENA DE INDIAS

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KEYWORDS: Accessibility; Heritage; Cartagena; Mobility; Historic Center.

ABSTRACT

Preserving and promoting heritage today is closely linked to the ease of access for both tourists and residents. Considering a high level of interest from the population indicates a higher level of importance and, consequently, greater ease of intervention by government entities. Thus, it becomes extremely necessary to assess connectivity and accessibility conditions in historical areas, from residential environments to major tourist reception points (terminals). This aims to identify potential areas lacking access from both a social and mobility perspective.

In this context, the present research aims to analyze the geographical accessibility conditions to the walled historic center within the urban environment of Cartagena de Indias, Colombia. This will be achieved by applying geo-statistical models using digital GIS tools, based on available transportation infrastructure and the location of tourist arrival points (Transport Terminal, Airport). This analysis will be complemented by sociodemographic coverage.

The main outcome reveals limited accessibility to Cartagena's historic center for the majority of the population. This is due to the historical center being located on the western side, while the city's urban expansion occurs towards the eastern side due to its limiting coastal condition. Furthermore, the primary conclusion drawn is that assessing accessibility enables decision-making interventions for heritage preservation, thereby creating a greater impact from both mobility and social inclusion perspectives.

CODE 333

ACCESSIBILITY OF CULTURAL HERITAGE - BY REMOVING BARRIERS, COMPENSATING AND ASSISTING TECHNOLOGIES

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KEYWORDS: Accessibility of cultural heritage; monuments; Wawel Royal Castle; Pieskowa Skała Castle; compensatory and assistive technologies.

ABSTRACT

Efficiently ensuring accessibility of cultural heritage resources to individuals with specific needs, including seniors, while considering their diverse range, serves to open up heritage to new user groups and offers opportunities for innovation, creativity, and increased market attractiveness of heritage. However, this occurs only when accessibility becomes an integral component. The aim of the article is to analyse accessibility and evaluate architectural, urbanistic, and technological solutions implemented with the consideration of audiences with special needs, using cultural heritage resources in Poland as an example. The analysis was conducted on the basis of case studies involving some of the most frequently visited sites, and on-site research was carried out in a few of them (Wawel Royal Castle, Pieskowa Skała Castle). Universal access to cultural heritage and its surroundings is undoubtedly a global and ongoing issue, as a significant number of historic sites are not fully accessible to all individuals. Equal participation with other people necessitates the rational introduction of improvements in many historic sites and spaces, enabling fuller and more independent participation, regardless of physical, perceptual, or intellectual capabilities. However, in practice, implementing accessibility often means inclusion of individuals with special needs only into selected, specific places or events. Therefore, it is obligatory to employ additional measures to overcome various barriers, including the utilization of compensatory and assistive technologies. The results of the conducted analyses proved to be highly inspiring. They demonstrated that accessibility is not merely a technical process but also a creative one that should be monitored in collaboration with individuals with special needs, starting with the most obvious and achievable changes. Apart from adapting the offerings and resources, this process requires above all openness to change, mutual inspiration, and staff competence.

CODE 8

3D SIMULATION OF CLASSROOM BUILDING USAGE MANAGEMENT THROUGH INTEGRATED GIS AND BIM MODELS

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KEYWORDS: BIM; GIS; Digital Twin; CMMS; GMAO.

ABSTRACT

3D virtual visualization is one of the tools being rapidly implemented. The construction sector is undergoing a revolution due to technological changes taking place. This, coupled with collaborative work, contributes to optimal management for all stakeholders. In this context, this research aims to contribute to the 3D digitalization process of cities, buildings, and asset management processes with 3D tools. To achieve this, a process of integrating GIS-3D & BIM models with links to Computerized Maintenance Management Software (CMMS) is proposed for application in building usage management. The results obtained demonstrate that it is possible to integrate GIS & BIM digital models with simple linking mechanisms that do not compromise efficiency in the synchronization and management of information contained in both models.

CODE 32

GENESIS: A WEB-BASED PLATFORM FOR MANAGING THE SEISMIC RISK OF HISTORIC CENTRES OF SOUTHERN ITALY

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KEYWORDS: Multi-scale risk analysis; Web-platform; Historic built environment; Structural rehabilitation; Energy efficiency.

ABSTRACT

The seismic risk analysis at different scales and the use of modern data acquisition processes are of fundamental importance to define targeted interventions at different scales, from the urban to the single building levels. Yet, integrated digital-based methodologies and tools to assess multi-scale risk, damage scenarios and the impact of interventions are still missing. The aim of this paper is to present the initial stage of the development of an open-source computational web-based platform, "GENESIS", designed to support the effective management and conscious use of built cultural heritage by prioritizing cost-effective interventions and wise allocation of resources for long-term heritage protection. To this purpose, GENESIS includes informed multi-scale risk analysis combined with energy efficiency upgrades of the historic built environment, suggesting interventions to address not only structural rehabilitation but also to reduce energy consumption while respecting the cultural value of heritage assets. Input data are processed at different levels of increasing accuracy, enabling analysis from the territorial/urban level (historic centre) to the individual building level. Though the case studies will focus on towns in Southern Italy in their current condition state, the platform is applicable to any historic centre, and it is updatable over time and space.

CODE 178

MANAGEMENT PROTOCOL IN THE BUILDING RECONSTRUCTION PROCESS: THE CASE STUDY OF THE 16TH CENTURY CASTLE IN L'AQUILA

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KEYWORDS: Quality control; Digital site management; Construction process; Heritage.

ABSTRACT

In recent years, the construction industry has witnessed a substantial re-evaluation of the way in which all phases of the building process are managed and controlled, particularly the executive phase, thanks in part to the development of innovative technological and computerised tools, in response to the needs of increasingly demanding clients, both public and private, and to the rapid evolution of regulations, which are linked to increasingly evolved concepts of comfort and safety in buildings. This has an impact on the need for designers and contractors to innovate their modus operandi, through better organisation of the work carried out and the adoption of procedures to ensure the quality of the services provided, where there is less and less chance of making mistakes, which would entail losses of an economic and time-related nature.
In the case of the construction process, since the construction site is a unicum in terms of both production and organisation, which escapes any simplistic standardisation, the operational control of management, understood as production efficiency, organisation and management of the construction site, can be validly conducted in parallel with the implementation of BIM methodologies and tools to support Construction Management. These concepts find concrete application in the post-earthquake consolidation and restoration site of a portion of the 16th-century castle in L'Aquila, for which the planning and control process in the digital environment was developed in parallel with the actual execution of the work, since the site was started in the traditional way, with the aim of verifying the deviations between the ideal and actual construction process.

CODE 313

OPTIMIZATION OF BUILT HERITAGE DIGITALIZATION AND MANAGEMENT OF HISTORICAL TEMPLES IN TAMIL NADU, INDIA USING AR &VR -A CONCEPTUAL STUDY

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KEYWORDS: Augmented Reality; Built Heritage; Digital Technologies; Heritage Management; Virtual Reality.

ABSTRACT

Historical temples of India are renowned for their architectural significance and standing examples of architectural traditions dating back to the early centuries. Pilgrims and tourists regularly visit the temples to perform rituals and prayers. Indeed, temples are forced to accommodate more population and required to adopt some interventions in the name of infrastructure development. In most cases, proper conservation is neglected, and slowly the magnificent architecture of the temples is fading its significance. Development of technologies like Virtual Reality (VR) and Augmented Reality (AR) provides solutions to manage the built heritage. However, the cost of those technologies is not affordable to preserve all the built heritage in developing countries like India.

The optimization of the built heritage digitalization and management is needed at this crucial time. Thus, this study reviews the concept of AR &VR to create the hologram of existing temple and suggests digital documentation of historical temples in Tamil Nadu, India. With that, the user can have the virtual experience of historic built heritage and the same can be archived for future studies. So, we can control the population of pilgrims which would be significant to preserving the architecture of the temples for future and further studies.

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