CITE 2019

DEPARTAMENTO DE TECNOLOGÍA DE LA EDIFICACIÓN

6TH, 7TH and 8TH of March 2019

ESCUELA TÉCNICA SUPERIOR DE EDIFICACIÓN
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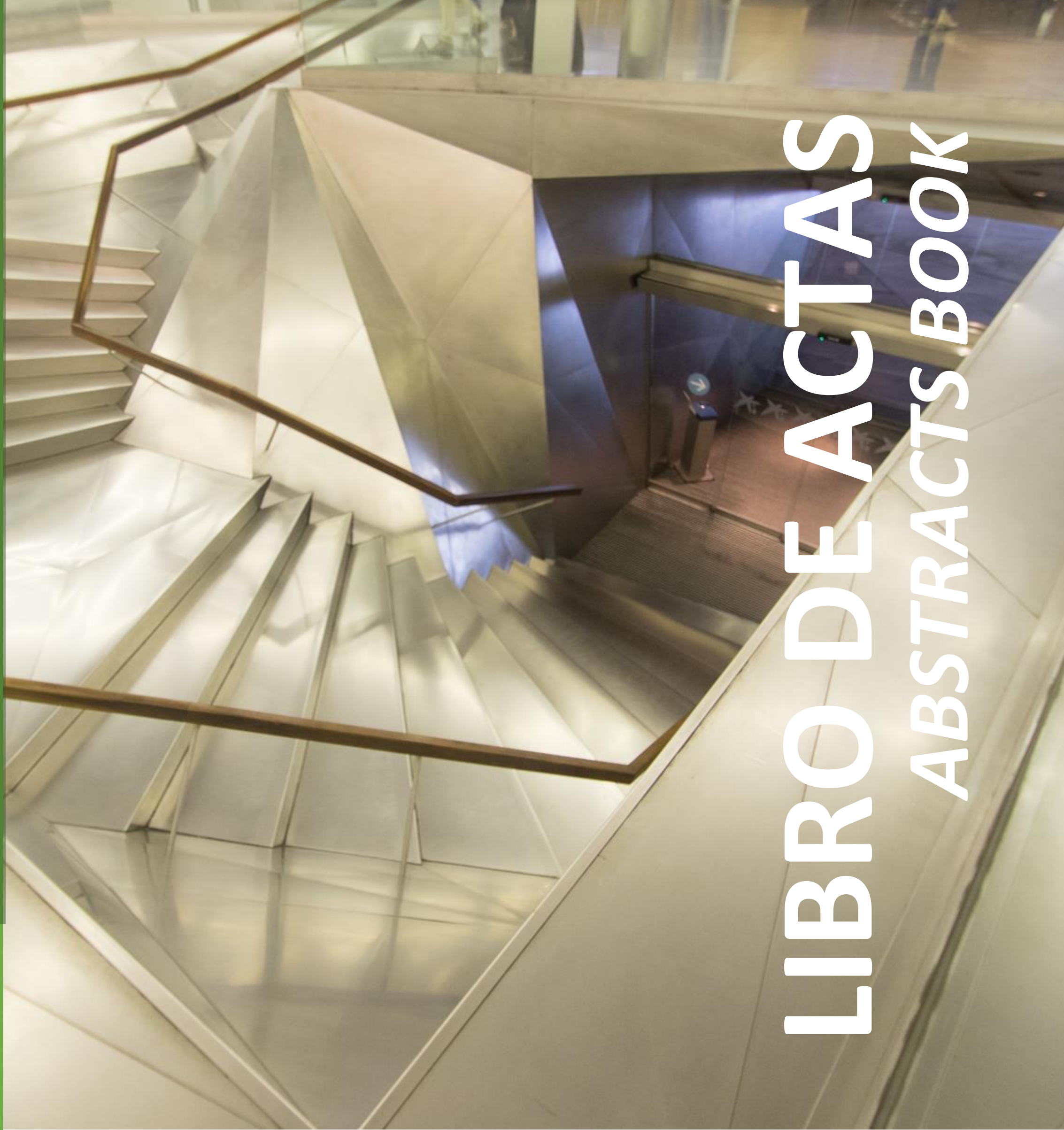

LIBRO DE ACTAS

ABSTRACTS BOOK

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Congreso Internacional de Innovación Tecnológica en Edificación

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ANALES de Edificación

DEPARTAMENTO DE TECNOLOGÍA DE LA EDIFICACIÓN

IV INTERNATIONAL CONFERENCE ON TECHNOLOGICAL INNOVATION IN BUILDING
CITE 2019

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Avenida Juan de Herrera, 6. 28040 – Madrid

Tel. 91 336 75 95 Fax: 91 336 76 44

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GREETINGS

IV INTERNATIONAL CONFERENCE ON TECHNOLOGICAL INNOVATION IN BUILDING (CITE 2019)

6, 7 and 8 March 2019

CITE was born in 2016 with the aim of promoting the transfer of knowledge about learning, innovation and competitiveness between productive and training areas, as well as to publicize best practices on innovation in training and learning in the building sector. Likewise, the conference has acted as a meeting point between different social agents related to training, in order to encourage cooperation among its participants and extend it to other areas related to learning, innovation and competitiveness in that sector. This new edition of the CITE, the fourth, aims to lay the foundations for the development of joint projects and produce relevant results in the field of technological innovations.

Program organization CITE 2019 contains different activities within technological innovation, oral communications, posters and virtual exhibitions of different subject areas such as construction materials and systems, health and safety energy efficiency, automation, rehabilitation, maintenance and pathology building, experiences in technological innovation in building.

In this fourth conference it is important to note the quality and involvement of all participants, which involved the presentation of a large number of papers that bring together more than 400 speakers from different places through different types of presentations.

Also appreciate the invaluable collaboration of the company Placo-Sain Gobain, Chair-Company Proiescón and of the Consejo General de la Arquitectura Técnica de España.

The Organizing Committee

SUMMARY INDEX

CITE 2019 PROGRAM

ABSTRACTS

CONCRETE PERMEABILITY AS A KEY DURABILITY INDICATOR

[1]Miguel Ángel Sanjuán

[2]Cristina Argiz

[1]Department of Science and Technology of Building Materials, Civil Engineering School. Technical University of Madrid (UPM), 28040 Madrid, Spain, ma.sanjuan@upm.es
[2] Department of Science and Technology of Building Materials, Civil Engineering School. Technical University of Madrid (UPM), 28040 Madrid, Spain, cg.argiz@upm.es

Keywords: *Air permeability, testing methods, concrete, durability.*

Reinforced concrete durability is a great issue in modern buildings designers because durability is related to sustainability. The longer the service life of the concrete structures, the lower wastes are produced, and the higher savings are generated. Transport of liquids and gases thorough the concrete make up a durability indicator known as permeability [1]. Concrete carbonation, chloride ion steel corrosion, alkali-silica reaction, freezing and thawing resistance, among others, depends on the specific permeability given by the porosity and connectivity [2-4]. In particular, the pore size distribution plays a significant role in this property. Also, the water content in the pores affects the transport of liquids and gases thorough the concrete. Six slabs of 200 x 1000 x 1000 mm^3 were made with concrete (405 kg/m^3 of cement, water/cement ratio of 0.37). They were tested for twenty years to determine the concrete air permeability over time. It is believed that initially the concrete pores are filled with a liquid which is being drying out from the pores over time. Such liquid reduces the gas concrete permeability, but on the other hand enhances the ion transport thorough the concrete. Air permeability testing pressure has a clear impact on the experimental procedure. In any case, it is believed that concrete air permeability is a key durability indicator.

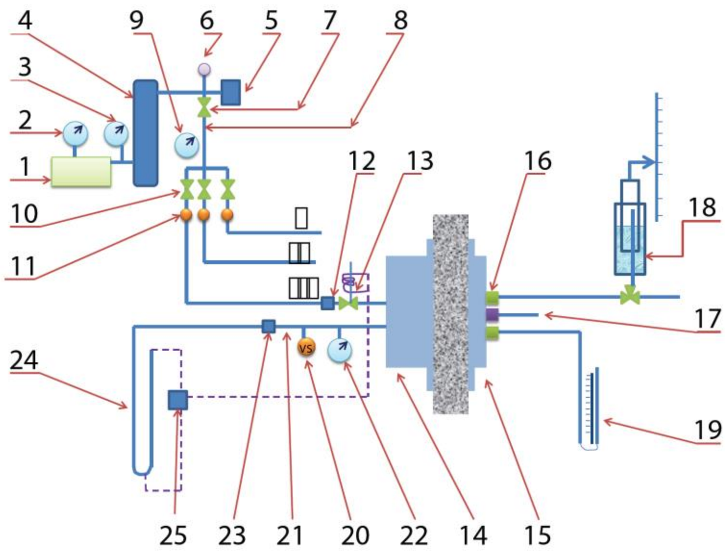

Figure 1. Testing equipment to determine the air permeability coefficient

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IRON SILICATE USE AS LAND FILLING AGGREGATE IN BUILDING AND CIVIL WORKS

[1]Miguel Ángel Sanjuán

[2]Pedro Mora

[3]Juan Antonio Suárez

[1]Department of Science and Technology of Building Materials, Civil Engineering School. Technical University of Madrid (UPM), 28040 Madrid, Spain,
ma.sanjuan@upm.es
[2] ETSI Minas y Energía UPM, C/ Ríos Rosas, 21, 28003 Madrid,
pedro.mora@upm.es
[3]Atlantic Copper, S.L.U., Avenida Francisco Montenegro, s/n, 21001 Huelva,
jsuarezc@fmi.com

Keywords: *Iron silicate, abrasive, land filling copper melting, portland clinker, durability*

Iron silicate is formed in the electrical furnace during the copper production process. More precisely, it is the metallurgical slag as result of the silica addition as flux to separate the iron. This chemical product is quite stable and may be used in several applications. One of them is its use as a potential aggregate in building and civil works. Within the circular economy context [1-4], its reuse has been promoted extensively. Given that, the scope of this paper is tocharacterizethe iron silicate and assessing its viability to be used as a land-filling aggregate in building and civil works. Chemical characterization was performed by XRF and by analysis defined in EN 196-2. A granulometric study was developed according to the European standard EN 933-1. The main conclusion is that the use of iron silicate as land filling has a positive environmental impact and may replace natural aggregates typically used in this application.

Figure 1. Iron silicate

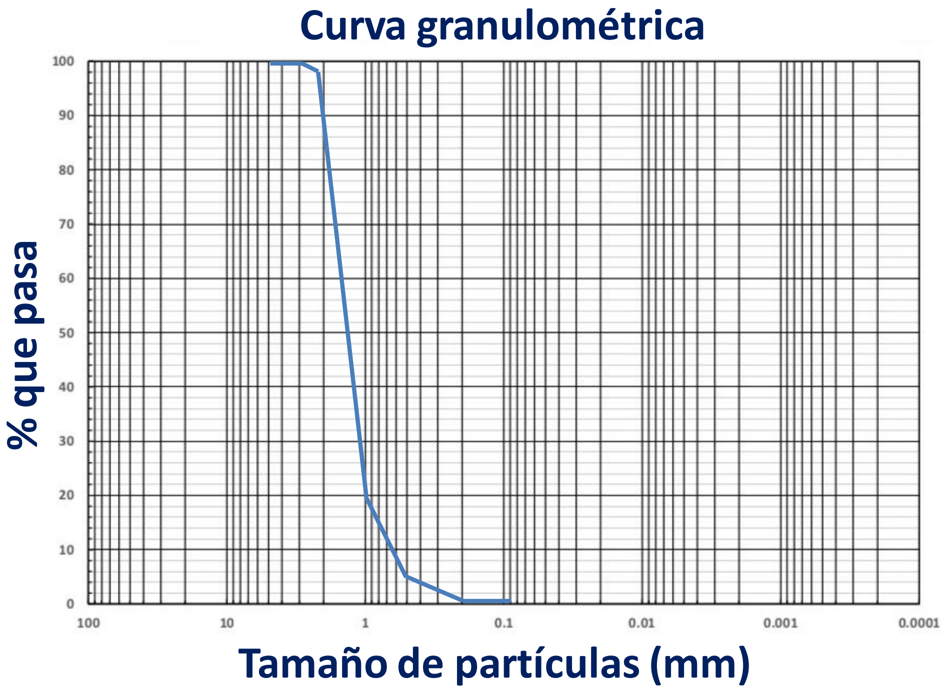

Figure 2. Iron silicate size distribution. (UNE-EN 933-1)

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DURABILITY REQUIREMENTS FOR REINFORCED CONCRETE USED IN BUILDINGS EXPOSED TO COASTAL MARINE ENVIRONMENT (IIIA)

[1]Miguel Ángel Sanjuán

[2]Antonio Núñez

[3]José Antonio Hurtado

[1]Department of Science and Technology of Building Materials, Civil Engineering School. Technical University of Madrid (UPM), 28040 Madrid, Spain, ma.sanjuan@upm.es
[2]Asistencia técnica y prescripción sur. HeidelbergCement Hispania. Carretera de Almería km.8. 29720 Málaga a.nunez@fym.es
[3]Director Innovación, Asistencia Técnica y Prescripción. HeidelbergCement Hispania. j.hurtado@fym.es

Keywords: *Marine environment, reinforced concrete, buildings, durability.*

The Structural Concrete Spanish Code (EHE-08) set up the basis to select the most appropriate materials and concrete composition for structural purposes. Given that, the material designers have a really good tool to achieve the designing of strong and safe structures over time [1]. Therefore, the projected service life would be guaranteed by using such Code. In particular, a series of specifications are provided for the cement, aggregates, water, additives and so on, to produce strong and durable concrete. The EHE-08 also contains a series of requirements specifically concerning the building materials, exposition environment, calculation methodology, and materials characterization. It is the inadequacy of Annex 9th of the Structural Concrete Spanish Code (EHE-08) in technical terms that has been increasingly debated and criticized (Figure 1). The aim of this paper is to assess the application of Annex 9th in some coastal buildings (Figure 2).

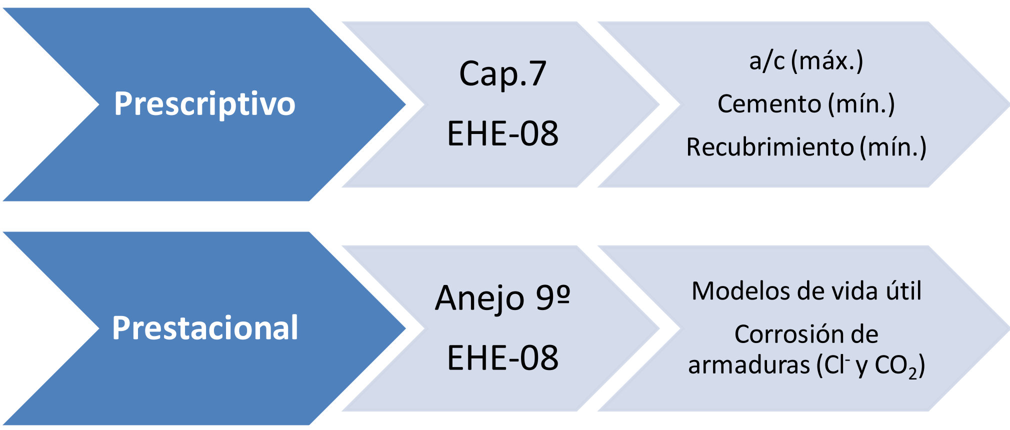

Figure 1. Service life assessment methods for reinforced concrete structures

Figure 2. Pathologies observed in buildings located in the Mediterranean coast: Inadequate cement type and low concrete cover

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REFLECTIONS ON THE SCOPE OF THE CONTENTS IN BASIC SECURITY AND HEALTH STUDIES AND STUDIES IN RD 1627/1997

[1]Miguel Ángel Zapata Lobo

[2]Antonio Ros Serrano

[3]Pilar Cristina Izquierdo Gracia

[1]Escuela Técnica Superior de Edificación. Universidad Politécnica de Madrid; ma.zapata@alumnos.upm.es
[1]Dirección de Infraestructura de la Armada. Ministerio de Defensa; mzaplob@fn.mde.es
[2]Construcciones arquitectónicas y su control, Escuela Técnica Superior de Edificación. Universidad Politécnica de Madrid; antonio.ross@upm.es
[3]Construcciones arquitectónicas y su control, Escuela Técnica Superior de Edificación. Universidad Politécnica de Madrid; pilarcristina.izquierdo@upm.es

Key words: *Contents, Health and safety study, RD 1627/1997.*

The ambiguity in the rules, the result of its lack of definition, only generates uncertainty at the time of being applied, and RD 1627/1997 [1] is a clear example of this.

With these premises, the editor of the Basic Health and Safety Study (EBSS) and the Health and Safety Study (ESS), is sometimes forced to formulate imprecise generic references, more designed to safeguard their responsibilities, due to insecurity legal situation in which it finds itself, that to achieve positive preventive effects.

As a consequence of this situation, some reflections arise about the suitability of certain interpretations when developing the contents of the EBSS and ESS, which 20 years after the appearance of the said RD do not seem to have been normalized.

These reflections are based on the analysis carried out to elaborate the research "Most common noncompliance shared by the studies and basic studies of safety and health in the construction works of the Navy, with respect to the requirements of Royal Decree 1627/1997." [2]

At the same time, the content of the aforementioned RD 1627/1997 is analyzed, in terms of the preparation of the EBSS and ESS. The joint study of the aforementioned research and of the normative analysis, allows us to extract a series of conjectures that raise the validity of this model at present.

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WEB-BASED TOOL FOR CONSTRUCTION AND DEMOLITION WASTE

[1] Paola Villoria Sáez

[2]Marina Álvarez Alonso

[3]Álvaro Sagarruy de la Rosa

[1] Universidad Politécnica de Madrid. Escuela Técnica Superior de Edificación. Grupo de Investigación TEMA. Avenida Juan de Herrera, 6 28040 Madrid; paola.villoria@upm.es
[2] Universidad Politécnica de Madrid. Escuela Técnica Superior de Ingenieros Informáticos; marina.alvarez@upm.es
[3] Universidad Politécnica de Madrid. Escuela Técnica Superior de Ingenieros Informáticos. Email; a.sdelarosa@alumnos.upm.es

Keywords: *Construction and demolition waste; management; traceability; web-based; tool; software*

Since 2008, Spain has incorporated several regulations to manage construction and demolition waste (CDW), such as the Royal Decree 105/2008, which currently regulates the production and management of CDW and various National Waste Management Plans [1], [2]. These regulations establish several measures to promote waste recycling and minimization in construction and demolition projects. For example, they oblige to develop a CDW Report and Plan during the design and construction phase of the project as well to stablish an economic fee deposit that will be returned at the end of the project, once the client present all the documents certifying the correct management of the CDW generated.

Despite the legislative advances in CDW management, there are still many difficulties for its application in the construction projects, such us: the difficulty of estimating CDW generation, the difficulty of CDW onsite segregation and the difficulty of managing and controlling the waste generated [3]. In addition, there are many agents involved in the management of CDW, which makes it difficult to trace CDW management throughout the entire building process [4].

For this reason, it is essential that the construction sector, as well as the Local Councils, establish measures to ensure a proper CDW traceability, as happens in other industrial sectors, such as food industry.

Thus, this work develops a web-based application, which allows tracing the amount of CDW generated in a construction project, assuring the correct management and control of the waste.

The web-based tool developed will connect –in real time- the different agents involved in the management of CDW, and will collect the documents and additional information that prove the traceability of CDW generated from the construction site to its final deposit. Besides carrying out the management in real time, the system will store a detailed record of dates of each construction activity, which will remain once the project is completed.

This work aims to modernize the CDW management system currently used, making it a more convenient, faster, safer and more efficient process. Consequently, this tool will help construction practitioners, including clients, construction companies and Local Councils. Clients will benefit when presenting the necessary proofs for the return of the economic deposit. Construction companies will have a record of the amount of CDW generated in each of their projects and the amount of waste generated per construction activity. Finally, Local Councils and officials in charge of controlling CDW management, will be able to know more accurately the responsibility of illegal dumping or even incidents caused by toxic waste.

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COMPARATIVE STUDY-BIM TECHNOLOGIES IN BUILDING: SUSTAINABLE ARCHITECTURE.

[1] Esperanza M.G. de la Llave Zarzuela.

[2] Julián Arco Díaz.

[3] David Hidalgo García.

[1] Graduate in Building in ETS. Building Engineering, University of Granada.
[2] PhD ETS. Building Engineering,University of Granada. Department of Architectural and Engineering Graphic Expression.
[3] PhD ETS. Building Engineering,University of Granada. Department of Architectural and Engineering Graphic Expression; dhidalgo@ugr.es

Keywords: *Architecture, BIM, efficiency, sustainability and technology.*

It can be stated that the drawing never had a beginning and will never end, since the human being has always had the need to express and communicate through a non-verbal language [1]. Added to this evolution to a continuous and unstoppable progress of the different graphic methods that the human being has been adopting throughout history, we must focus on the confluence that is taking place between the objectives of both types of drawing: artistic and technical [2].

It is at this moment when a takeoff to virtual reality in 3D occurs without apparent purpose. Thus, from the appearance of the first computer-aided design software until the birth of the Building Information Modeling concept (BIM) [3]. This, so unknown to many, is bringing a new vision of work in the field of architecture and building causing some professionals to act reluctantly. Not only with this new work system, but with the applications and tools it offers, such as those focused on the analysis of the energy consumption of a building [4]. That is why this study arises from the need for certainty about the capabilities of the different programs offered by the market related to BIM technologies applied to the field of construction, given the multitude of existing possibilities at global level the uncertainty at the time of decision to use one or the other [5], [6].

It is a dissection of the capacity, potential and reliability of the different BIM construction information modeling software focused on the tools that each of them possess for the energy analysis of a building. It includes an individual study of two of the BIM alternatives that currently exist in the global market (Revit and ArchiCAD), from a confrontation of the data obtained through the various tools focused on the energy efficiency of each of the software that is going to analyze, for a later conclusion about which is the most complete in this field according to the parameters in which we are interested in deepen and whose data are of proven reliability. This research work has a great weight in the field of building, since, although there are comparative studies between both programs, there is none that focuses on the application of the same to energy efficiency [7], [8].

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STUDY OF THE "ISLAND OF HEAT URBAN" PHENOMENON ON GRAN VÍA OF GRANADA STREET.

[1] Oscar M. Jimenez Ferrer.

[2] Julian Arco Díaz.

[3] David Hidalgo García.

[1] Graduate in Building in ETS. Building Engineering, University of Granada.
[2] PhD ETS. Building Engineering, University of Granada. Department of Architectural and Engineering Graphic Expression.
[3] PhD ETS. Building Engineering, University of Granada. Department of Architectural and Engineering Graphic Expression; dhidalgo@ugr.es

Keywords: *City, pollution, island of heat, temperatures and urbanism.*

In a few decades, climate change has gone from being a theory proposed by a series of experts to a real and evident fact. Weather modification is here and it's here to stay. The industry has increased the emission of gases to the atmosphere by 30% and according to the latest data, the concentration of CO_2 in the atmosphere reaches a record value of 418 ppm [1]. This figure has not stopped growing even after the implementation of control and reduction measures established by the European Union and Governments. The emissions produce the so-called "greenhouse effect" that is modifying all the meteorological parameters, not only of the rural environment, but also of the urban environment. Cities are one of the main sources of pollution and consumption of natural resources. In them, an effect known as "Island of urban heat" is being produced as a consequence of a series of factors: growth, pollution, scarcity of green areas and increase of paved areas [2], [3]. This effect is defined as the difference in temperature between the city and the bordering rural areas.

In the city of Granada the factors indicated for the production of this phenomenon are developed, converting it together with Madrid, Barcelona, Valencia and an area of the Canary Islands as the only areas of Spain where the maximum annual limits of nitrogen dioxide in the air are exceeded. [Four. Five]. This circumstance is increased by the proximity to the Natural Park of Sierra Nevada with altitudes of around 3.200 meters. This circumstance, together with the scarcity of winds in the area and the daily contrast in temperatures (up to 20ºC a day) [6], causes the effect known as "thermal inversion" to occur, in such a way that pollution is pocketed in the city [7], [8].

The Gran Vía de Granada is located in the center of the city and is possibly one of the busiest streets, both vehicles and pedestrians [9]. The investigation of the thermal differences in this central street has been carried out by means of the mobile transect method with Data logger between the months of April, May and June of 2018. A series of snapshots have also been made by thermographic camera to different parts of the street [10], [11], [12], [13], [14]. In total, 15 field measurements whose result has allowed us to identify thermal differences in the different control points of the street between 1 and 2ºC and differences with the meteorological station of the Spanish Meteorological Agency, located at the Granada Airport, between 3 and 5ºC.

The method used has determined a hot and a cold sector in Gran Vía de Granada Street. The latter coincides with a zone of lower altitude and where the prevailing winds flow.

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COMPARATIVE STUDY TRADITIONAL HOUSING - HOUSE DOMO.

[1] Juan Garzón Segura.

[2] David Hidalgo García.

[3] Julián Arco Díaz.

[1] Graduate in Building in ETS. Building Engineering, University of Granada.
[2] PhD ETS. Building Engineering,University of Granada. Department of Architectural and Engineering Graphic Expression; dhidalgo@ugr.es
[3] PhD ETS. Building Engineering,University of Granada. Department of Architectural and Engineering Graphic Expression.

Keywords: *Architecture, house dome, efficiency, sustainability and technology.*

With the entry into force of the European Directive 2010/31 [1], [2] opens an important field for the improvement of the energy efficiency of existing buildings and new buildings [3]. In Spain, most of the energy produced is through coal and oil, very polluting fuels and generators of the known "climate change" [4]. It is necessary to modify these approaches and change to more efficient construction systems that allow the use of "sustainable or renewable" energy sources.The situation caused by the economic crisis that has affected the construction sector must be taken advantage of to evaluate another new path of sustainable development within the building sector [5].

In this direction, the construction of Domo housing is located. These are ecological houses that began to be built thousands of years ago using techniques and primitive materials lacking chemical transformations. Its vaulted form has remained with the passage of time but not its constructive system that currently takes advantage of technological advances and new materials [6].

The objective of this paper is to carry out a comparative study between this type of housing and the traditional one. For this, we will rely on the inductive method of investigation, studying a series of factors for its general implementation: the land, the construction systems, the cost of execution and above all the profitability for the owner.

As an initial conclusion, it can be anticipated that, analyzing the construction systems, the cost of execution and the impact it makes on the environment is a type of sustainable and ecological architecture. In this way, and compared to a traditional home, they considerably reduce energy consumption, construction cost and environmental impact [7], [8].

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STUDY OF THE BEHAVIOUR OF REINFORCED CONCRETE WITH FIBRES

[1] **Simone Feroldi**

[1] ***Escuela técnica superior de edificación de Madrid, Universidad Politécnica de Madrid; six94.ferol@gmail.com***

Keywords: *Concrete, reinforcement with fibers, high temperature, resistance to bending*

Concrete, the material most used in our building engineering work, is a compendium of virtues but with great flaws [1-4]; it is heavy, it has a very low relation between its resistance to traction and compression; its weight-resistance ratio is excessively high; Its volume stability leaves much to be desired, and its instability is the source of important pathological problems [5-7]. Its ability to absorb energy before it breaks is low, its durability is very sensitive to its design and execution, etc. However, when thinking about these drawbacks, the concrete has so many advantages and so many arguments in its favor that it can be considered without a doubt, the king of building materials [8-9]. The addition of fibers to the cement matrix, giving rise to fiber reinforced concretes, aims to improve the mechanical characteristics of the concrete. In this article, we compare several scientific articles, all of which contain a common theme: the study of the flexural behavior of cement, reinforced with different types of fibers, in different conditions. In particular we have 4 articles that talk about bending reinforced concrete with different fibers and environmental conditions [10]. As a result of this comparison it is observed that the fiber that improves more flex is the carbon, for the reinforcement to compression it is better to use the alone fiber of polipropileno that polipropileno and steel together, and the steel fibers work well both to compression that bending if you use alone and in limited quantity.

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RISK MANAGEMENT, ONE SOLUTION TO REAL ESTATE ASSET MANAGEMENT

[1]Désirée Sandoica París;

[2]Manuel Soler Severino

[1]Departamento Construcción y Tecnología Arquitectónicas, ETSAM, Escuela Técnica Superior de Arquitectura de Madrid, Universidad Politécnica de Madrid.
desiree.sandoica@emasd2.com

[2]Departamento Construcción y Tecnología Arquitectónicas, ETSAM, Escuela Técnica Superior de Arquitectura de Madrid, Universidad Politécnica de Madrid.
manueljose.soler@upm.es

Keywords: *Risk Management, Real Estate, asset management, property, facility manager*

The cycle of cost growth, price competition, tighter margins and the need for greater profits challenge Real Estate Asset Managers to innovate to safeguard sustainable benefits.

In addition, global Real Estate Asset Managers are willing to expand, but in order to overcome the problem of the fragmentation of regulations (municipal, regional, federal, etc.), Asset Managers need to manage more complexities than ever before.

Innovation among Asset Managers is becoming increasingly complex and, often, this innovation is driven by specialized entrants from Anglo-Saxon countries.

Risk management and effective risk mitigation were considered a vital source of differentiation and / or a convincing route for direct entry into a market. Thanks to Risk Management, Asset Managers that were being impacted by a large number of regulations with different effects (some significant and others contradictory) can enter new markets. In addition, Risk Management provides them with adequate governance, integrated procedures and an effective use of a risk management framework.

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STUDY OF THE DURABILITY OF CONCRETES AND MORTARS REINFORCED BY INDUSTRIAL WASTE (METALLIC FIBERS)

[1]Souad Kherbache

[2]Abdelkader Tahakourt

[3]Karim Moussaceb

[4]Nedjima Bouzidi

[1]Laboratoire de Génie de la Construction et Architecture, Faculté de Technologie, Université de Bejaia, Algeria, souad_kherbache@yahoo.fr
[2]Laboratoire de Génie de la Construction et Architecture, Faculté de Technologie, Université de Bejaia, Algeria, htahakourt@gmail.com
[3]Laboratoire de Technologie des matériaux et Génie des Procédés, Faculté de Technologie, Université de Bejaia, Algeria, karimmoussaceb@yahoo.fr
[4]Laboratoire de Technologie des matériaux et Génie des Procédés, Faculté de Technologie, Université de Bejaia, Algeria, nedjmabouzidi@yahoo.fr

Keywords: *Industrial waste, metallic fibers, valorization, durability, concretes and mortars*

For a long time, waste has fuelled several value chains. Faced with this problematic, value chains in civil engineering have been sought. This recovery operation brings together an economic advantage and an environmental issue [1-5]. The process of valorization in the field of building and construction makes it possible to answer to multiple problems, such as: the preservation of the natural reserves of aggregates by the valuation of the materials of substitution for the works of civil engineering, and the reduction of the transport and CO2 emissions. Solid waste management is one of the main environmental concerns in the world [6-12]. With the shrinking of spaces for landfilling and because of its high cost, the use of waste has become an attractive alternative made available for various applications. On the other hand, sustainability is a quality goal for the engineer. The durability of the concrete material in its environment is considered a major concern in the building sector [13-17]. The mechanism of chemical degradation of this material is its gradual decalcification over time in contact with an aggressive environment. This degradation causes changes in the physicochemical and mechanical properties of the concrete [18-20]. To experimentally evaluate the durability of concrete, one must study its behaviour in relation to a number of mechanisms that could degrade it. The issue can be treated as the durability of concrete in aggressive environments. In this study, we investigated the effect of the addition of industrial waste (metallic fibers) on the durability of concretes and mortars containing 10% of fibers in substitution of cement. The results presented concern those obtained with the following tests: Wetting-Drying Test, Monolith Leaching Test, Chemical Attack and Evaluation of Compression Resistance by Sonic Auscultation Test.

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EVALUATION OF THE FPSICO METHOD SUITABILITY FOR THE DETECTION OF PSYCHOSOCIAL RISKS IN CONSTRUCTION COMPANIES

[1] Miriam Zamora Calleja

[2] Mercedes del Río Merino

[3] José Luis Llorca Rubio

[1] Doctoranda de la Universidad Politécnica de Madrid y Técnico de Prevención de Riesgos Laborales en Arpada S.A.; miriam.zamorac@alumnos.upm.es
[2] Universidad Politécnica de Madrid; mercedes.delrio@upm.es
[3]Universitat Politécnica de València; llorca_josrub@gva.es

Keywords: *Psychosocial risks; applied psychology; prevention; Fpsico*

Social psychology pursues to study the relationships, real or imaginary between persons, within a social frame, affecting people involved in this situation [1]. Furthermore, the applied psychology [2] is a preventive discipline in the field of labour risks prevention related to organization and work realization factors that can affect the health of working population as the development of the organization itself.

Applied psychology emerges with the contributions of the psychology together with sociology, their interrelation and necessity to create new ways to tackle and improve the health and work wellbeing levels [3].

The psychosocial origin problems are not as evident, close or urgent, in the majority of the cases, as the problems from physic conditions. However, a special feature of these problems is the frequency, impact and time that a person is exposed to them (work hours), which causes consequences in the worker health as well as in the organization and society.

Applied psychology regarding to labour risks prevention is an academic subject, which applies the occupational health psychology knowledge, for the evaluation, prevention and treatment of the psychosocial risk at work and their consequences. [4] Although, it has been widely applied in a wide range of sectors, but not in construction companies, probably because construction companies have a diverse personal, such as crane drivers, security team, technicians and directives. Therefore, there are persons who carry out tasks with really different risks, making difficult to determine these risks.

Hence, this paper introduces the results of a study, which aims to analyse the psychosocial risk in construction companies using the FPSICO method [5], from the Instituto Nacional de Seguridad y Salud en el Trabajo, since is a valid and reliable instrument. In general terms, this tool contributes to the diagnosis of the psychosocial risks in a construction company or in partial areas of them, from individual questionnaires (quantitative data).

In addition, after gathering the responses submitted in the report of the questionnaires, generated by FPSICO, a series of workers have been selected randomly to perform personal interviews (qualitative data).

The quantitative and qualitative results obtained have been analysed, to defined preventive measures, agreed with the companies' direction, prioritizing its action, aiming to obtain an improvement in the company and progress to the excellence.

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PREDICTIVE MAINTENANCE OF HVAC HOSPITAL FACILITIES TO IMPROVE ENERGY EFFICIENCY

[1] Gonzalo Sánchez-Barroso

[2] Miguel Gómez-Chaparro

[3] Manuel J. Carretero-Ayuso

[4] Justo García Sanz-Calcedo

[1] University of Extremadura; gsanchezbmoreno@gmail.com
[2] HM Hospitals; mgomezchaparro@hmhospitales.com
[3] University of Extremadura; carreteroayuso@yahoo.es
[4] University of Extremadura; jgsanz@unex.es

Keywords: *Maintenance, HVAC facilities, weibull, healthcare engineering.*

In hospital buildings cohabit multitude of people with very variable health status. Certain pathologies require specific environmental needs in order to favour their improvement and/or avoid their contagion to medical personnel and other patients. Hospital air conditioning facilities are an effective tool in the fight against nosocomial infections [1], so providing adequate indoor environmental conditions in hospitals is intimately related to people's health.

The maintenance of these facilities and their equipment is of particular economic and environmental importance, due to its relationship with energy efficiency, and for people's health. In addition, the Spanish Regulation on Thermal Installations of Buildings (RITE) requires the design of specific maintenance programmes in order to continue with the expected performance of the installation [2].

Reliability-based maintenance (RCM), also called preventive maintenance, is the widest application for energy production equipment [3]. It is based on the use of statistical techniques for the future detection of faults based on historical results [4]. In this way, a maintenance action can be performed without maximizing the useful life of the replaced part. Condition-based maintenance (CBM), known as predictive maintenance, monitors variables of interest to empirically determine the percentage of service life consumed (and, consequently, the remaining one) [5]. The maintenance strategy implemented influences the satisfaction of the end user of the facilities [6].

Weibull Distribution is one of the most widespread models used to describe failure time in component reliability analysis in complex systems [7]. By modifying the value of the shape coefficient, it accurately describes the model of faults that will occur in the different phases of the life of the components and allows them to be related to the bath curve [8].

This paper evaluates the factors related to a change from the current RCM (preventive maintenance) model to a CBM (predictive maintenance) approach that maximizes the useful life of the components of hospital facilities, optimizes the consumption of energy and economic resources and provides indoor environmental conditions appropriate to people's health.

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ANALYSIS OF MAINTENANCE EFFICIENCY IN A HOSPITAL IN MADRID (SPAIN)

[1] Miguel Gómez-Chaparro

[2] Gonzalo Sánchez-Barroso

[3] Manuel J. Carretero-Ayuso

[4] Justo García Sanz-Calcedo

[1] ***HM Hospitals; mgomezchaparro@hmhospitales.com***
[2] ***University of Extremadura; gsanchezbmoreno@gmail.com***
[3] ***University of Extremadura; carreteroayuso@yahoo.es***
[4] ***University of Extremadura; jgsanz@unex.es***

Keywords: *healthcare engineering, hospital maintenance, facilities management*

Hospitals are equipped with complex and expensive facilities and equipment, the correct usage of which conditions the quality of the services provided [1]. The state and regularity of use of these resources depends fundamentally on adequate design of the facilities and equipment, on the quality of the construction and on efficient maintenance [2]. Taking into account that once built, the first two aspects are unalterable, the importance of maintenance is obvious [3-4].

Proper maintenance management will have an impact on the increase in healthcare activity, due to the greater availability of facilities and equipment. Another favorable result is the reduction of energy and water consumption [5]. It will also be crucial to avoid the premature aging of equipment and installations.

The aim of this work is to analyze the efficiency of maintenance in a hospital located in the province of Madrid (Spain). It has a 198 beds and a floor area of 23,300 m^2. The construction was finished in 2007.

For this, the following installations were studied: air-conditioning, domestic hot water, industrial cooling, low voltage systems, plumbing, sanitation, medicinal gas, compressed air, fire safety and lifting devices.

Currently, 2 maintenance strategies are mainly used: preventive and corrective. The increase in operations of preventive maintenance may led to a lesser demand for corrective maintenance and quality perceived by the users and workers [6].

The results showed that the maintenance plan is the basic tool for organizing maintenance operations, and that it must meet the following objectives: ensure the completion of operations with the proper periodicity, optimize the organization of operations by similar teams and distribute evenly the workload to optimize the use of available human resources and therefore lower costs. It must also include legally mandatory periodic inspections, to increase the safety of the facilities.

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FREQUENT FLAWS IN THE INSTALLATION OF WATERPROOFING LAYERS IN ROOF TERRACES

[1] **Manuel J. Carretero-Ayuso**

[2] **Gonzalo Sánchez-Barroso**

[3] **Miguel Gómez-Chaparro**

[4] **Justo García Sanz-Calcedo**

[1] ***University of Extremadura; carreteroayuso@yahoo.es***
[2] ***University of Extremadura; gsanchezbmoreno@gmail.com***
[3] ***HM Hospitals; mgomezchaparro@hmhospitales.com***
[4] ***University of Extremadura; jgsanz@unex.es***

Keywords: *Failures, building, roofs, maintenance,*

The roof is one of the most vulnerable parts of a building, as it is continuously exposed to external climatic actions. In addition, it has a constant aggression due to rain, snow, wind, temperature, biological agents and solar radiation. Due to its great exposure to all these factors, the failures that may exist on a roof are, in most situations, more serious than elsewhere, due to the speed of advance they have, and their impact on habitability [1].

An investigation carried out in Victoria (Australia) determined that roofs are the second construction element most affected by the number of faults [2]. In Spain, roofs are also the second most affected by construction faults, and if it is analyzed by building element, flat roofs are the number one [3].

In order to find out what irregularities and constructive malpractice are committed during the execution, especially filtrations and dampness [4-5], the most frequent faults in the on-site installation of the waterproofing were analyzed.

During execution process, it was necessary to have recourse to written sources that could contain this information. The construction enterprises In Spain, except in very exceptional cases, do not keep a written record of problems and non-compliance with regulations [6]. Therefore, the notes made by the building facultative team in the 'book of orders and visits' were studied.

This research was carried out on residential building works in the province of Badajoz (Spain) between 2012 and 2018. The most frequent building failures were studied. In addition, a comparative study was carried out between that were single-family dwellings and block dwellings.

It was found that there were 10 types of failures that occurred in more than 30% of the cases studied. Particularly noteworthy are the faults known as 'The crown height of the waterproofing is lower than that indicated by the Spanish regulations' and 'the level of the threshold is below the level of protection of the roof' which was observed in more than 75% of the cases studied.

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WATER ABSORPTION IN SELF-COMPACTING CONCRETE

DONE WITH RECYCLED AGGREGATE

FROM CONCRETE ELEMENTS

[1]A. Zurita Diaz

[2]E. Sereno Minuesa

[1]Estudiante, Escuela Técnica Superior de Edificación, UPM;
a.zuritad@alumnos.upm.es
[2]Estudiante, Escuela Técnica Superior de Edificación, UPM

Keywords: *Self-compacting concrete, recycled aggregate, water absorption, durability*

This study pretends to verify the statement on EHE-08 (Spanish Instruction for Structural Concrete) regarding the greater water absorption of Recycled Concrete, which is considered very relevant due to it makes its durability decrease, since corrosion of the structural elements occurs by the carbonation of the steel beams due to the penetration of water in environments with sufficient oxygen.

However, the use of these concretes with recycled aggregate is considered very important for environmental reasons because the aggregate usually supposes between the 60 and the 75% of the volume of the concrete and between the 70 and the 85% of its weight. Apart from economic reasons.

The concretes analysed are made with aggregate from the crushing of concrete waste, both from demolitions and remains of kneading plants and the prefabrication industry. Not taking into consideration their mechanical and physical characteristics; if fact the compression resistance in the analyzed mixtures does not describe a homogeneous behavior given the different provenances and characteristics of the aggregates.

Specifically, the study is focused on the case of the realisation of Self-compacting Concrete, since these have to have certain characteristics, such as fluidity and viscosity. Among the conclusions of the study it was found that the use of recycled aggregate in them does not suppose the exceeding of the established limits of those characteristics.

It is also intended to find what are the causes of this increase in the permeability of Self-Compacting Concrete made with recycled aggregate. Among them it is found that in fresh state the fluidity decreases and the viscosity increases, which produces more cavities. On one hand, due to its worse compaction, given the angular shape and the rougher surface of the crushed aggregate. And on the other hand, recycled concrete aggregates absorb more water because they are more porous, mainly due to their content of mortar. In addition, these aggregates are less clean and more friable.

In the same way, the researh aims to propose what could be the measures to compensate this greater water absorption. These are: Carry out an appropriate design of the mixture, increase the cement content or reduce the water/cement ratio, use cements with fly ash, moist the aggregates before kneading and control the time of kneading and transport (to avoid the breakage of the aggregate). Atending directly to the durability, increases of the dimensions of the reinforcement coating might be done.

PROPOSAL TO REUSE RECYCLED FINE AGGREGATE AND INSULATING MATERIALS WASTE IN THE MANUFACTURE OF MORTARS

[1] Katarzyna Kalinowska-Wichrowska

[2] Carolina Piña Ramírez

[3] Alejandra Vidales Barriguete

[1] Bialystok University of Technology, Faculty of Civil and Environmental Engineering, ul. Wiejska 45E, 15-351 Bialystok, Poland; k.kalinowska@pb.edu.pl
[2] Universidad Politécnica de Madrid, Escuela Técnica Superior de Edificación, Departamento de Construcciones Arquitectónicas y su Control; Avda. Juan de Herrera, 6,28040 Madrid, España; carolina.pina@upm.es
[3] Universidad Politécnica de Madrid, Escuela Técnica Superior de Edificación, Departamento de Tecnología de la Edificación, Avda. Juan de Herrera, 6, 28040 Madrid, España; alejandra.vidales@upm.es

Keywords: *Construction and demolition waste, recycled filler, insulating waste, concrete rubble, modified sand lime products.*

Widespread use of cement based compounds as a construction material causes that it is used on a mass scale. This causes 510 million tons of construction waste in Europe, about 325 million tons in the USA and about 77 million tonsin Japan [1]. Consequently, the issue of cement based compounds recycling is widely described by many researchers, which proves that the subject is up-to-date and the need to improve the treatments and processes that enable the most efficient use of secondary products. On the other hand, the use of mineral fiber insulation is also currently booming due to its excellent properties that make them essential for the fulfillment of the thermal and acoustic requirements marked by the increasingly demanding construction regulations. This progression of the use of insulating materials has caused an alarming growth of mineral wool residues, since it is the most used insulation in the European Union [2], so it is essential to recycle or reuse it. For a few years, there have been conducted research in the world to use also small recycling fractions for the production of cement composites [3], [4], [5]. In addition, in recent times the study on the use of mineral fiber waste in cement mortars is increasing [6], [7]. The paper presents the results of own research confirming the possibility of reusing a waste materials: fine fraction from cement based compounds recycling as a filler in sand lime products and residues of insulating materials (rockwool and fiberglass) and recycled sand using as insulating materials. The compressive strength, bending, water absorption, surface hardness and structural research were carried out. The results show that the all of describing materials could be acceptable solution to reduce natural resources - natural sand (for example) or be a filler. Reuse of waste materials to new composites is expected in these world because of lack of natural resources.

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ANALYSIS AND DIAGNOSIS OF THE FORMAL ASPECT OF THE PREVENTIVE DOCUMENT KNOWN AS HEALTH AND SAFETY PLAN IN SPAIN

[1]A. Romero Barriuso

[1]B.M. Villena Escribano

[2]M.N. González García

[3]M. Segarra Cañamares

[4]A. Rodríguez Sáiz

[1] Universidad Politécnica de Madrid; alvaro.romero.barriuso@alumnos.upm.es; bm.villena@alumnos.upm.es
[2] Universidad Politécnica de Madrid; mariadelasnieves.gonzalez@upm.es
[3] Universidad de Castilla-La Mancha; maria.segarra@uclm.es
[4] Universidad de Burgos; arsaizmc@ubu.es

Keywords: *Health and safety plan; occupational risk-prevention; construction sector; case study; regulations on ORP.*

This research work analyzes some of the aspects related to the formal compliance of the preventive document used in construction sites in Spain, the Health and Safety Plan [1]. Always from the point of view of the formal compliance of the current regulations and from the prism of the correct use on site of the preventive instruments available to firms and workers of the Construction Sector in Spain [2].

To do that, a prospective analysis is carried out by using the on-site consultation technique of the preventive instrument par excellence, the Safety and Health Plan (HSP). This preventive tool is explicitly included in the 7th article of the Royal Decree 1627/1997 [3], and its obligation is set in the 19th article of the aforementioned regulation, which establishes that "*the opening communication of the work center to the competent labor authority must include the Safety and Health Plan…*"

In order to make the research relevant and extrapolated, and at the same time competent, a sample is formed with 3,600 Health and Safety Plans consulted for the period of time between the years 2008 to 2016 (both included), and for the five Labor Authority sites that compose the Regional Government of Castile-La Mancha. The collection of information, carried out by using quantitative techniques, through the compliance of a questionnaire or a pre-prepared checklist, of a dichotomous type, with regard to the most relevant items that directly affect this research and that set up the content of the Health and Safety Plans.

For the present research work, the analysis is focused on several points related to the formal aspect of the document [4]. The extracted results show on the one hand the scarce preventive planning that the work is done, hence its scarce validity at a preventive level, finding that only 10.64% of the analyzed Health and Safety Plans have a chronogram or organization chart of the different phases of the work. On the other hand, it is observed that it is a generic document, without specific guidelines or preventive procedures for the work to which they refer, finding for example that only 2.72% of the Health and Safety Plans consulted have graphic material related to the work or the machinery to be used in it, or that only 9.58% of the Health and Safety Plans integrate action guidelines in case of serious and imminent risk.

That is the reason why it is of imperative necessity to create a living tool that updates the state of the work and that is accessible to all the agents involved in the constructive-preventive processes, whether they belong to the public or private entity. This tool must therefore integrate the constructive-preventive processes of the work.

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FIRE RESISTANCE OF CEMENT MORTARS REINFORCED WITH MINERAL FIBERS FROM CWD

[1] **Carolina Piña Ramírez**

[2] **Alejandra Vidales Barriguete**

[3] **Rubén Serrano Somolinos**

[4] **Mercedes del Río Merino**

[5] **Evangelina Atanes Sánchez**

[1,4] Universidad Politécnica de Madrid, Escuela Técnica Superior de Edificación, Departamento de Construcciones Arquitectónicas y su Control, Avda. Juan de Herrera, 6,28040 Madrid, España; carolina.pina@upm.es; mercedes.delrio@upm.es
[2] Universidad Politécnica de Madrid, Escuela Técnica Superior de Edificación, Departamento de Tecnología de la Edificación, Avda. Juan de Herrera, 6, 28040 Madrid, España; alejandra.vidales@upm.es
[3] Universidad Politécnica de Madrid, Escuela Técnica Superior de Edificación, Avda. Juan de Herrera, 6, 28040 Madrid, España; somoli83@hotmail.com
[5] Universidad Politécnica de Madrid, Escuela Técnica Superior de Ingeniería y Diseño Industrial, Departamento de Ingeniería Mecánica, Química y Diseño Industrial, Calle Ronda de Valencia, 3, 28012 Madrid, España; evangelina.atanes@upm.es

Keywords: *Cement mortars, mineral fibres, recycling, fire resistance, construction and demolition waste*

This study is part of a research that analyses the viability of the mineral wool from the construction and demolition waste (CDW) as reinforcement of cement matrices. The objective is to analyse the fire behaviour of a material composed of a cement mortar matrix to which the aforementioned waste is incorporated. For this purpose, an experimental plan is made in which cement mortar specimens are made with 50% of different types of mineral wool waste, on which Shore D surface hardness, flexural and compressive strength and thermal conductivity tests are carried out before and after the fire test, to evaluate their viability as a reinforcement material [1].

It has been determined the behaviour to fire of the mortars made in the facilities of the Service of Prevention and Extinction of fires of the Community of Madrid, according to the indications described in the standards UNE-EN 1363-1: 2012, UNE-EN 1363-2: 2000 and UNE-EN 1365-4: 2000. Prismatic specimens of 40x40x160 mm are manufactured and after 28 days their resistance to direct fire is tested. The test was carried out in accordance with the ISO R-834 standard that considers a calorific potential of 40 kg of wood per square meter (kg/m^2), equivalent to the average value of the calorific potential in the formation of fires [2].

To perform the test pieces were placed horizontally supported on a steel grid of 1m^2 of surface, leaving all the sides in direct contact with the fire. The fire was made by spraying pine wood with gasoline to cause the start of combustion [3]. The test lasted 1 hour, measuring the surface temperature of the samples every 5 minutes, using a compact model infrared thermometer "Testo 845".

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BEST STRATEGIES TO REDUCE CO2 EMISSIONS IN THE EXECUTION PHASE OF A BUILDING BY MEANS OF CONSTRUCTION WASTE RECYCLING ON SITE. A CASE STUDY IN NAYARIT MEXICO

[1] **Ulises Mercado**

[2] **Paola Villoria Sáez**

[3] **Francisco Javier Hernández Ayón**

[1] ***Universidad Autónoma de Nayarit, arqumb@gmail.com***

[2] ***Universidad Politécnica de Madrid, Escuela Técnica Superior de Edificación, Grupo de investigación TEMA, paola.villoria@upm.es***

[3] ***Universidad Autónoma de Nayarit, Unidad Académica de Administración y Contaduria, franjha@gmail.com***

Keywords: *Climate change; minimization; best practices; construction and demolition waste; recycling*

At present, one of the biggest problems on a global scale that the human being faces is the climate change, product of the high concentrations of greenhouse gases in the atmosphere, mainly carbon dioxide (CO_2) [1]. In this sense, the construction industry is one of the sectors causing the greatest environmental impact and contributes to global warming, as it consumes large quantities of raw materials and energy from non-renewable sources [2] and it is responsible for generating of millions of tons of construction and demolition waste (CDW). Only in Europe the construction industry is responsible of 36% of the total waste generated [3]. The recent regulations approved are encouraging the change of adopting practices based on sustainable strategies instead of traditional practices [4]. However, these practices have not been effective enough to substantially reduce CO_2 emissions in order to comply with the provisions of the Paris Agreement, which sets to keep the global average temperature below 2 ºC compared to Pre-industrial levels. Therefore, the construction industry requires alternative solutions with greater efforts [5], such as the prevention and collection of waste for reuse at the construction site [6].

The objective of this study is to reduce the CO_2 emissions and thus the impact to climate change caused by the building construction sector, by implementing CDW management strategies during the execution of the construction site. For this, a case study comprising a single-family housing located in the state of Nayarit was selected and further analized to investigate the relationship between CO_2 emissions and CDW management in order to offer lessons for CO_2 minimization strategies. To establish the strategies, the following steps were carried out: 1) the carbon footprint of the mayor raw materials consumed in the case study, which arose from the NOP Methodology [7], 2) the use of the materials at the construction site was determined, 3) the different waste streams generated at the construction site were identified and those able to substitute the main raw materials consumed were highlighted, 4) potential CDW recycling strategies to avoid the use of the major raw materials consumption are proposed, and 5) one of the strategies proposed is the further analysed in terms of CO_2 minimization.

The results of the CO_2 footprint show that natural aggregates are the materials generating the greater amount of emissions to the atmosphere due to the consumption of fuel required for the transportation to the construction site. On the other hand, concrete and bricks are the main CDW generated and can be used to replace natural aggregates as for example: in bases and subbases of buildings or water tanks, finishings of flat roofs and filler of drainage. By replacing 67% of natural aggregates by recycled aggregates, CO_2 emissions are reduced by 53%, resulting in a reduction in the impact on climate change. Finally, these results can help to promote the opening of new companies dedicated to the recycling of CDW in Nayarit and thereby contribute to the sum of practices related to sustainability in the building construction sector.

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CURRENT STATUS OF SUSTANIBLE CONSTRUCTION IN EUROPE

[1] Paola Villoria Sáez; [2] Mercedes del Río Merino; [3] Blerta Vula Rizvanolli;

[4] Odysseas Kontovourkis; [5] Themistoklis Tsalkatidis; [6] Giulia Peretti;

[7] Aranzazu Galán; [8] Daniel Friedrich

[1] Universidad Politécnica de Madrid. Escuela Técnica Superior de Edificación. Grupo de investigación TEMA. paola.villoria@upm.es
[2] Universidad Politécnica de Madrid. Escuela Técnica Superior de Edificación. Grupo de investigación TEMA. mercedes.delrio@upm.es
[3] University for Business and Technology. Department of Architecture. blerta.vula@ubt-uni.net
[4] University of Cyprus. Department of Architecture. kontovourkis.odysseas@ucy.ac.cy
[5] Norwegian University of Life Sciences. Faculty of Science and Technology. themistoklis.tsalkatidis@nmbu.no
[6] WSGreenTechnologies GmbH, Stuttgart Germany. giulia.peretti@wersobek.com
[7] Université Libre de Bruxelles. Building, Architecture and Town Planning Department (BATir). aranzazu.Galan.Gonzalez@ulb.ac.be
[8] Baden-Württemberg Cooperative State University, Faculty of Civil Engineering, Mosbach, Germany. d.friedrich@lehre.mosbach.dhbw.de

Keywords: *Construction, sustainability, regenerative, environment, Europe*

At present, the construction sector is one of the industries generating the greatest environmental impact and therefore it increases pollution and thus natural disasters occurring due to climate change [1, 2]. For this reason, the sector must encourage sustainable development, which is currently aimed – primarily- at achieving zero environmental impact [3].

However, at present, the concept of sustainability is not solving the environmental problems caused by the sector and requires an immediate change [4]. In addition, the level of sustainable implementation in Europe varies substantially from one country to another. In some countries, a movement wanting to go further has been formed; shifting from implementing degenerative or "less bad" strategies to other strategies aiming a positive net environmental impact, by means of regenerative sustainability criteria. Regenerative sustainability promotes buildings that not only achieve zero environmental impact, but their impact is positive, meaning that buildings are able to "regenerate" their users and the environment [5, 6]. In this sense, the COST Action "RESTORE" (REthinking Sustainability TOwards to Regenerative Economy) was developed, aiming to transform the sector and promote this new way of understanding sustainability.

This work presents the first results obtained in the RESTORE Action and particularly in Working Group 3 that deals with Sustainable Building Construction, regarding the level of implementation of sustainability in the different countries of Europe. For this, a short survey was developed, focusing on three main construction aspects: materials, technology and tools. The survey was sent to more than 150 professionals and 62 responses were received. Results show that, in general, there is a lack of regenerative sustainability criteria in Europe, especially in the southern countries. Most countries rely on traditional materials and technologies rather than advanced and emerging materials and techniques. Finally, the results obtained help to understand the current situation of sustainability and to identify the challenges and difficulties of implementing Sustainable Construction in the Europe.

Acknowledgements

This work is based on research activities of COST Action CA16114 “REthinking Sustainability TOwards a Regenerative Economy” (RESTORE) project, funded by COST (European Cooperation in Science and Technology).

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COMPARATION OF STUDIES ABOUT THE APPLICATION OF GLASS FIBRE MESH TO ESTRUCTURAL STRENGHTEN OF MASONRY WALLS

[1] **Francesca Vinciguerra**

[1] ***Student of Ingegneria dei Sistemi Edilizi, Scuola di Architettura, Urbanistica e Ingegneria delle Costruzioni, Politecnico di Milano, in Erasmus Exchange at the Escuela Tecnica Superior de Ingenieria de Edificaciòn, Universidad Politécnica de Madrid;***
francesca.vinciguerra@mail.polimi.it
francesca.vinciguerra@alumnos.upm.es

Keywords: *GFRP reinforcement, masonry, diagonal-compression test, stress-strain*

The aim of this article is to compare different studies about the reinforcement of masonry wall with glass fibre mesh. This technique of reinforcement is one of the most utilized today because of his great results about resistance, ductility and elastic modulus. The efficiency of this reinforcement system is tested on different type of specimens: some are built in laboratory from new materials [1], [2], [3] and others are taken from historical buildings, so the last materials have the same age of them [4]. The most of these specimens are composed of bricks, mortar and glass fibre mesh with epoxydic resin and a specific mortar, but there is masonry composed of stone blocks [4] and autoclaved aerated concrete (AAC) blocks too [1]. All the analysed specimens were tested with the diagonal compression test that consist in apply a load in the diagonal direction till the failure of the masonry. During this test are measured the load and the displacement that permit to calculate and compare the shear strength and the angular strain. This article compares the results of shear stress-shear angular strain of the different type of masonry [1], [2], [3], [4]. This analysis gives us different results between brick masonry specimens because of the differences of the materials about age and dimensions. Moreover, the values of the AAC blocks specimens and stone masonry specimens results more different compared to the bricks ones because of the different nature and behaviour of the blocks.

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ASSESSING OF RAMMED EARTH WITH STEEL REINFORCEMENT AND ADDITIVES

[1] Argelia Tobias Nieto

[1] Estudiante de Máster en Innovación Tecnológica en Edificación, E.T.S. de Edificación, Universidad Politécnica de Madrid

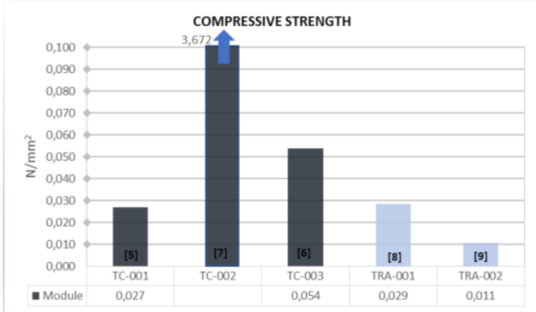

Fig. 1: Compressive strength results.

Keywords: *Rammed Earth, Reinforcement with Steel, Additives, Moisture, Mechanical behaviour.*

Earthen materials and Rammed Earth in particular have been practiced since immemorial time by different civilizations and is still present, for instance currently a 1,7 billion of people live in constructions made with these technics [1]. The increasing interest of the sustainability Rammed Earth properties, beside the low cost and comfort values are making of this method a viable construction [2]. The Rammed Earth innovations implies the use of additives, in order to improve the earth qualities providing a higher stability values and prevent the atmospheric agents [3]. Therefore the use of natural additive such as starch or artificial materials like cement will be analysed. In addition, the structural improvement by using steel reinforcements has been a significant advantage for the Rammed Earth mechanical behaviour [4]. The moisture content in the Rammed Earth is a key factor that can be controlled according to the Relative Humidity, soil content, drying place and additives addition. Taking into consideration that the Rammed Earth is a traditional method, the regulation for these constructions has not a standard worldwide, instead of this it´s use locals or regionals regulations.

The aim of this study is to analyse the traditional Rammed Earth (TC) in comparison with a Rammed Earth with steel reinforcement (TRA), including the use of additives (natural and artificial) in the soil mixture. The Rice Starch from the plant Oryza sativa (GOVA) was selected as a natural additive while the artificial additive is the Portland cement. Therefore it was selected five different samples [5] [6] [7] [8] [9] and evaluated base Sample Module of 200cm^3 created for this study, due to all the samples has different study conditions e.g. shapes or sizes.

Sample	Picture	Steel Reinforcement (mm)	Additives (%)
TC-001 [5]		NA*	NA*
TC-002 [7]		NA*	15% Rice Starch plant Oryza sativa (GOVA)
TC-003 [6]		NA*	NA*
TRA-001 [8]		6mm & 8mm	10% Cement
TRA-002 [9]		3 mm	10% Cement

NA= Not Applies.*

Tab. 1: Selected samples and methodology.

The Figure 1 shows the compressive strength values of the Rammed Earth TC and TRA samples where TC-002 has the higher value 3,672 N/mm^2 while the rest of the samples have an average value between 0,010 N/mm^2 a 0,060 N/mm^2. Regarding the additives, the GOVA benefits the compressive strength in a better value than the cement Portland with a difference of 3,643 N/mm2. The use of steel reinforcement of 6mm & 8mm shows a better behaviour than the 3mm.

Is well known that the use of steel reinforcement can improve the Rammed Earth mechanical behaviour adding stability however the advantage of the additives in this case shows a better scenario. For instance the use of natural additives increase exponentially the compressive strength overcoming the values of the cement. In addition, the percentage of the moisture content in the Rammed Earth in exterior conditions shows unstable values compares to the laboratory samples, in addition the optimal condition of Relative Humidity is 50% [6] with an average of 24% moisture content in the soil.

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OPTIMIZED INFILL IN ADDITIVE MANUFACTURING OF CERAMIC BUILDING COMPONENTS

[1] Luis Borunda

[2]Manuel Ladrón de Guevara

[3] **Pavel Aguilar**

[4] **Jesús Anaya**

[1] ***lborunda.eco@etsav.cat***
[2] ***manuelr@andrew.cmu.edu***
[3] ***pavel.aguilar@upc.edu***
[4] ***jesus.anaya@upm.es***

Keywords: *Topology Optimization, ceramic additive manufacturing, fused deposition modelling (FDM), finite element analysis (FEA)*

Fused Deposition Modelling is an additive manufacturing process based on the principle of stacking layers of a given plastic through a numerically controlled nozzle mainly used for product prototyping in which the object is geometrically approximated by deposition of solid layers in the outer perimeters of a given mesh design and infilled with a constant interior geometrical pattern (infill). One of the principal affordances of Additive Manufacturing to design disciplines is that it enables cost efficient production of highly complex geometries and thus a greater freedom of design [1-5].

Recent studies of architecture and large scale production of structural components exhibit the time required for fabrication and the correct simulation of anisotropic mechanical properties among the main challenges for future development of the technique. This research assesses methods for introducing computational workflows that incorporate Finite Element Analysis and Topology Optimization in the design of functional components by locally differentiating the deposition of material specifically tailored for given application to increase the opportunities for optimization of the mechanical properties of an element (strength, stiffness and mass), which leads to improved performance while potentially reducing, fabrication time, material use, and therefore, environmental impact [6-10].

The proposed method uses results attained from finite element analysis (FEA) to engineer anisotropic ceramic building components by discretely determining infill geometries. In order to produce bespoke infill patterns, a computational method of data processing based on structures such as voxel, OcTree and Unstructured Mesh Grid geometrical rationalization is required [11-14].

We take variable resolution color sampling from contours, slices and thresholds from unstructured data sources in isovolumes and isosurfaces in order to locally differentiate the composition of ceramic tokens (density, mechanical properties and fidelity) based on different analyses such as associated stress values. Thus, examining design and fabrication methodologies of engineered anisotropy ceramic building components [15-17].

Respectively, the contribution of this research lies in the creation and corroboration of a method for the optimization of the infill structure of fused deposition modelled components for the fabrication of digitally designed complex surfaces assembled through discrete ceramic components.

This paper presents and discusses the proposed method, and validates the generalizability, manufacturability and potential of automation of the methods through its ability to handle the manufacturing process constraints of intricate geometries at specific load conditions. The paper validates the method through testing FEA to FDM processed tokens and standard infill designs at different loading scenarios.

Optimization processes that meet manufacturing constraints lead to further design democratization by automation enabled by human-machine collaboration practices.

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MONITORING OF A SELF-SUSTAINNING GREEN ROOF

[1]Argelia Tobías Nieto

[1]Francesca Vinciguerra

[1]Carlos Morón Fernández

[1]Daniel Ferrández Vega

[1]Alejandro Payán de Tejada

Escuela Técnica Superior de Edificación de Madrid, ETSEM. Universidad Politécnica de Madrid. Avenida Juan de Herrera, 28040, Madrid.

Keywords: *Green roof, arduino, sensors, photovoltaic solar panel, sustainability*

The innovation of the urban infrastructure implies the use of green roof as tools to minimize the effect of the Island of Heat, reaching a reduction of 31% in the heat gain on summer days [1-2]. The use of a photovoltaic panel to feed the irrigation system for a vegetation cover is a sustainable solution to reduce energy consumption and CO_2 emissions. In addition, in economic terms an irrigation system powered by photovoltaic modules reduces the cost from 2 to 4 times compared to a system powered by diesel [3-4].

In the same way, the integration of a monitoring system in the vegetation roofs as the use of commercial sensors or ARDUINO free access platforms allows the analysis of data (temperature and relative humidity) in relation to the base of the AEMET weather station in order to evaluate the effectiveness of the vegetation cover. The data is measured during two periods, the first is before the growth of the vegetation and the second period covers after the growth of the vegetation, for which the commercial sensors and the system based on ARDUINO are programmed to record data every hour (Commercial Sensor) and every 20 minutes (ARDUINO) and then make the graphs presented in this document.

Once analysed the data obtained, it has been possible to infer that the temperature registered by the commercial sensor and the ARDUINO-based system presents a similar behaviour for a specific area of the green roof, in addition to comparing this information with the data of the AEMET, they identify an attenuation of the temperature thanks to the presence of the vegetable substrate. On the other hand, the values of the relative humidity register similar tendencies among all the measurement equipment used in this study, however, there is a difference of values of 10% between the commercial sensors and ARDUINO in the habitable space of the green roof.

Thus, the execution of this work aims to create valuable information related to monitoring systems and construction of roofs in addition to the development of a sustainable irrigation system through the use of photovoltaic solar panels.

a b c d

Figure 1. Images of the equipment implemented for the automated irrigation system.

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USE OF BIM METHODOLOGY FOR THE REMODELING OF AN EXISTING BRIDGE

[1] Rafael Blanco; [2]Jorge Martínez; [3]Borja Mozas; [4] Marcos García Alberti; [5] Antonio A. Arcos Álvarez

[1] MSc. Civil Engineer, E.T.S.I. Caminos, Canales y Puertos de Madrid (UPM), rafael.blanco.ravena@alumnos.upm.es

[2] MSc. Civil Engineer, E.T.S.I. Caminos, Canales y Puertos de Madrid (UPM), **jorge.martinezgar@alumnos.upm.es**

[3] MSc. Civil Engineer, E.T.S.I. Caminos, Canales y Puertos de Madrid (UPM), b.mozas@alumnos.upm.es

[4] Departamento de Ingeniería Civil: Construcción, E.T.S.I. Caminos, Canales y Puertos de Madrid (UPM), marcos.garcia@upm.es

[5] Departamento de Ingeniería y Morfología del Terreno, E.T.S.I. Caminos, Canales y Puertos de Madrid (UPM), antonio.arcos@upm.es

Keywords: *BIM, infrastructure projects, software, arch bridge design.*

The incorporation of Building Information Modelling (BIM) methodology to the construction system is a consequence of the new possibilities and advantages that the emergence of new technologies offers [1]. BIM allows the reduction of design errors, incompatibilities, overruns, and increases the value of the project [2]. Its use in building construction projects is already very common and it is also expected to be mandatory in all the projects promoted by the public administrations in Spain by 2019. However, the situation in the field of civil engineering still entails significant uncertainties. Thus, the level of implementation of this technology in infrastructure projects is limited. Nevertheless, BIM will also be compulsory in Spain on these type of projects by July 2019.

The aim of this study was to address the implementation of BIM in road and bridge design in order to highlight the problems that need to be faced with the existing technology. In particular, it encompassed the modelling of an existing arch bridge project in Logroño, including the modelling of the topography and the access roads, the arch bridge, a beam bridge, as well as the creation of an overall model which allowed to perform clash detections and quantifications. Moreover, the software that has been used comprises Google Drive, Revit, Civil 3D, Navisworks, and Infraworks.

The significance of this research lies on the assessment of BIM possibilities in civil engineering projects. This study found that the state of the art nowadays presents difficulties as the software is not adapted yet to this field. For instance, one of the most used BIM software, Autodesk Revit, still lacks of specific utilities related with civil engineering. That is to say, tools or toolkits for bridge design, the possibility of introducing inclined levels or the difficulties in modelling complex shapes would remarkably expand the applicability of the existing BIM software to civil engineering projects.

In conclusion, this study encompasses an innovative approach to the use of BIM in civil engineering projects, showing its advantages and existing limitations for its implementation in real construction of bridges.

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CONCRETE REINFORCED WITH FIBRES

Ramiro Aranda Lincango
John Sebastián Corrales Ospina
Katherine Gaona Aguaisa

Roberth Alexander Pillajo Guachamín
Eva María Villafranca Peña

Tecnología de la Edificación, E.T.S. Edificación de Madrid

Keywords: *concret, reforce, fibres,steel, resistance*

It´s intend to do an study based on the comparison between the different properties of conventional concretes and concretes reinforced with steel fibres, keeping in mind their different shapes and kind of test tubes.

To this we must identify the advantages in construction, economy and tecniques of the differents kinds of steel fibres (Dramix and Sika Fiber CHO),also the results obtained in their comparative analysis and finally the conclusions derived from the study.

The first type of concrete reinforce is Dramix with the next advantages: greater load capacity and resistance to fatigue and the impact, easy and fast execution,effective control of cracking.

Fig. 1: Dramix Steel Fibre

The second type is called Sika Fiber CHO with the some advantages like greater resistance to crack and impact, better ductility, less craking by retraction, high efficiency.

During the study of the comparisons, has been analized comparisons between dosages related with his compression resistance, comparisons of effects of the slenderness related with his traction resistance and lastly has compared the behaviour according to the fiber´s length related with his traction resistance.

Fig. 2: Sika Fibre Reinforce

In conclusion, we can observe that concretes reinforced with fibres get similar or better mechanics resistances than concretes armed, coming to be applied more and more and replacing the traditional armed.

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GOOD PRACTICES (GP) FOR THE EXECUTION OF CONCRETE GROUND SLABS, TO AVOID THE FISSURES AND CRACKS.

[1] Manuel Ramos Arias

[2] Santiago Álvarez Arribas

[3] Mercedes del Río Merino

[1] Departamento de calidad y medioambiente de Arpada S.A. calidadymediambiente@arpada.net
[2] Departamento de producción de Arpada S.A. salvarez@arpada.net
[3] Escuela Técnica Superior de Edificación (UPM) mercedes.delrio@upm.es

Keywords: *Concrete ground slabs; fissures; cracks; pathology; joints in slabs.*

Concrete ground slabs are non-structural elements designed to provide a horizontal firm in certain areas of buildings, either as a final finish or as a base to receive other types of flooring [1].

Non-structural elements as the ground slabs, are often executed by workers without a specialization in work with concrete, so they usually ignore important good practices (GP) that must be taken into account, leading to a pathology, with recurring injuries such as: fissures or cracks and humidity.

Specifying in the fissures or cracks, different types are distinguished: fissures of retraction or contraction of the concrete; cracks due to the absence of separation joints or insulation with constructive elements; cracks due to the lack of compaction of the support base, or due to changes in soil moisture conditions and cracks due to the different support conditions between the ground and the foundations [1-4].

Cracks problems in ground slabs usually have their causes in the different phases of the construction process: design, execution and maintenance [1].
These cracks are tried to solve prescribing in the project three different strategies: using concrete that incorporate fiber additions; placing a distribution armature, or prescribing an adequate separation of joints (considering the thickness of the screed) and obviously through the combination of these strategies.

This paper presents a summary of a research project carried out by Arpada company, about the causes of cracking in concrete ground slabs, based on the first two phases of the construction process: design and execution.
The research has been developed in three stages with different methodologies.
In the first stage, a literature and documentary search was carried out about the most recurrent pathology in concrete ground slabs, taking into account the composition of the ground slabs.

In the second stage, it have been studied "in situ" eleven ground slabs built by Arpada over the past two years, confirming that the execution of the ground slabs coincided with the composition and prescription defined in the projects, as well as if there was any difficulty during the execution of them. Also an inventory of the pathology presented by each slab has been made, with special interest in the fissures and cracks, trying to determine the possible causes that have produced them and in the phase of the construction process that have happened.

Finally, in the third stage, the results obtained in each group of similar ground slabs have been compared, and good practices have been defined to be carried out and considered in the execution project of this work unit.

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STUDY ABOUT THE UTILISATION OF POLYPROPYLENE FIBERS IN ORDINARY CONCRETE AND IN GEOPOLYMER CONCRETE

[1]Silvia Longo

[1]Máster en Innovación Tecnológica en Edificación, Escuela Técnica Superior de Edificación, Universidad Politécnica de Madrid, silvia.longo@alumnos.upm.es

Keywords: *Concrete, fibers, polypropylene*

Different kind of fibers have been used since many years as a reinforcement material in the concrete's mix design. Among them, one of the most used fiber, in both civil and construction field, is surely the synthetic polypropylene fiber [1-3]. Accordingly, the purpose of this article is studying the residual flexural strength of ordinary concrete reinforced with polypropylene fibers of different length and different concentration when it is subjected to four bending tests. The results are then compared with the ones obtained from samples of geopolymer concrete reinforced with the same kind of fiber and subjected to the same test [4-5].

To better understand the benefits of using a geopolymer concrete, in the second part of the article the compression, tension and flexural behaviour are analysed at 7 and 28 days both in samples without fibers and samples with synthetic reinforcement. This comparison also permits understand the relation between fiber concentration and mechanical properties and understand until which limit is convenient adding fibers to improve the mechanical behaviour of geopolymer concrete.

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CONCREMOTE, THE CONCRETE UNDERSTANDERS

[1] **Pablo Alvarez de Anta**

[1] ***Doka - Building engineer pablo.alvarez@doka.com***

Keywords: *Concrete, technology, intelligence, monitoring*

Concremote is the real time monitoring system that allow us to know when is the concrete ready for stripping [1-2].

Concremote reliably delivers data in real time on the temperature- and strength-development of the fresh concrete on site (concrete maturity) [3-4]. It´s main benefits are:

- savings of time and money by definition of the correct moment to strip formwork or to end curing measures
- safety by documentation of concrete works on site
- safety by verification of the correct concrete strength for pre-stressing of concrete members or lifting of climbing formwork to the next suspension point

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CASE STUDY FOR THE IMPLEMENTATION OF BIM METHODOLOGY ON CIVIL ENGINEERING PROJECTS

[1] Pastor Moreno, David; [2] Sastre Furones, Isabel; [3] Eyre Rodríguez, Ana; [4] García Alberti, Marcos; [5] Arcos Álvarez, Antonio A.

[1] MSc. Civil Engineer, E.T.S.I. Caminos, Canales y Puertos de Madrid (UPM), École Nationale des Ponts et Chaussées – david.pastor.moreno@alumnos.upm.es

[2] MSc. Civil Engineer, E.T.S.I. Caminos, Canales y Puertos de Madrid (UPM), École Nationale des Ponts et Chaussées – isabel.sastref@alumnos.upm.es

[3] MSc. Civil Engineer, E.T.S.I. Caminos, Canales y Puertos de Madrid (UPM) – a.eyre@alumnos.upm.es

[4] Departamento de Ingeniería Civil: Construcción, E.T.S.I. Caminos, Canales y Puertos de Madrid (UPM) – marcos.garcia@upm.es

[5] Departamento de Ingeniería y Morfología del Terreno, E.T.S.I. Caminos, Canales y Puertos de Madrid (UPM) – antonio.arcos@upm.es

Keywords: *BIM, infrastructure, connected workflows, bridge modelling, software interoperability*

Building Information Modelling (BIM) methodology represents a new work method that has changed the way architectural projects are developed and managed through their life cycle. BIM approach aims to create and use coordinated and coherent computable information about construction projects, expanding the possibilities of exchange and analysis of information. This tool entails the design and documentation of the construction project as well as its planning, manufacturing, construction, installation and subsequent maintenance [1]. BIM has shown its advantages in building structures although new research is needed in order to adapt BIM to the characteristics of civil engineering projects [2].

This report presents a case study on the arch bridge over the Deba river, located in Mutriku (Basque Country, Spain). The structure is divided in two zones according to their structural typologies: a 85 m long access viaduct, located in the marsh area, and a 110 m span lower deck metal arch bridge, over the Deba estuary. However, the projected design seeks to give formal and geometric continuity to both structures. Regarding the geometry of their elements, it is worth mentioning their complexity, in the three piles and stirrups and in the ribs and boxes that make up the mixed deck. Both the arch and the deck are connected by means of a network system for hangers.

The BIM workflows shown in Figure 1 were followed, in which the results extracted from each phase can also be observed.

A preliminary design phase was carried out with Autodesk Infraworks and a detailed model was designed with Autodesk Revit by creating specific families for each element of the bridge and integrating the terrain 3D model by AutoCAD Civil 3D. The construction was planned by Navisworks.

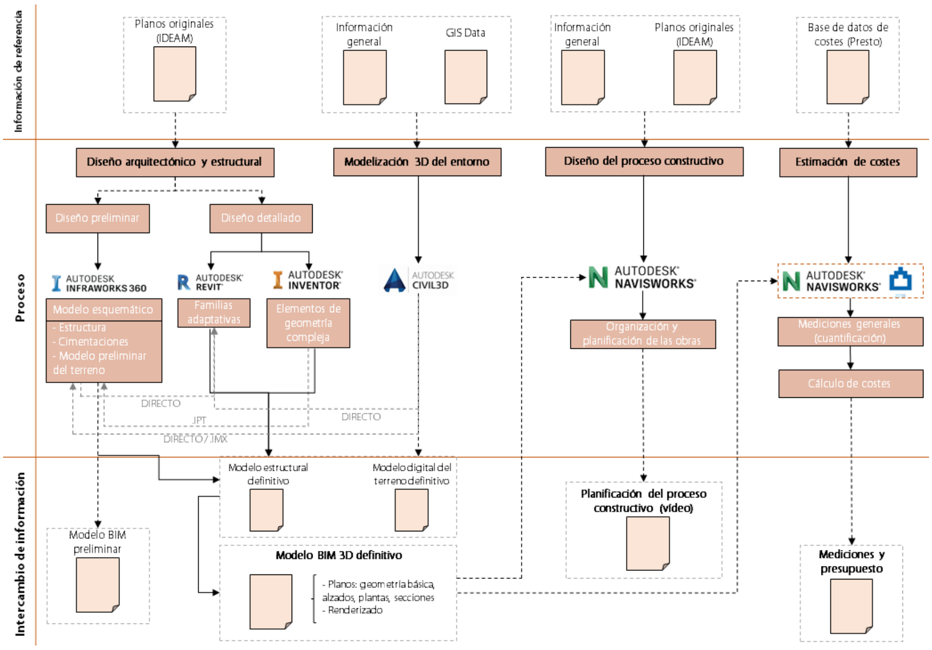

Figure 1. BIM workflows

The model, shown in Figure 2, permitted both cost estimation and the planning of the construction works. It is important to highlight that these results are obtained from a single model, following a connected workflow and maintaining an instantaneous and constant feedback between the different agents participating in the project.

Figure 2. Final BIM model

Given that for the moment BIM methodology for infrastructure projects is still in the initial phases of development, it is important to deepen into it in order to achieve greater applicability, in the appropriate level, for an adequate achievement and management of civil engineering projects.

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POTENTIAL OF IMMERSIVE TECHNOLOGIES IN THE BUILDING LIFE CYCLE ANALYSIS

[1] Jaime Arriagada

[2]Mercedes Valiente

[1] Escuela de Obras Civiles y Construcción, Universidad Central de Chile
jarriagadaa@ucentral.cl
[2] Escuela Técnica Superior de Edificación de Madrid, Universidad Politécnica de Madrid
mercedes.valiente@upm.es

Keywords: *Virtual Reality, mixed reality, augmented reality, life cycle analysis, building sustainability*

The current work of the Engineer - in his different specialties - is constantly confronted with elements of difficult geometrical understanding [1] that later it must execute or manage; the skills associated with that interpretation is also relevant in pre- and post-implementation, such as design, supply, operation and demolition phases, thus incorporating this technology can have an impact on all workers of the so-called Construction Industry by influencing this visualization ability [2]. The incorporation of technology in the Construction Industry has been strengthened due to the incorporation of the BIM (Building Information Modelling), which has had a strong impact in the pre-construction, construction and operation / maintenance phases [3] and that is strongly related to immersive technologies because the three-dimensional modeling of the building forms the basis that will later be the scenario of Virtual Reality to interact [4].

The cost associated with the addition of Virtual Reality, Mixed and Augmented is an item to be evaluated in the industry because it also should be considered computer equipment and programming activity therefore.

This proposal establishes the potential of the incorporation of immersive technologies focused on 3 tools: Virtual, Mixed and Augmented Reality in the Analysis of the Life Cycle of Buildings, two trends that have been strongly incorporated in the Industry during the last decade [5–8]. The investment in this technology has an initial cost in equipment that ranges between 199 and 4995 USD and have different approaches and degrees of immersion; On the other hand, building projects are classified into different phases, seeking to establish the energy demand and greenhouse gas emissions in each one of them

According to the previous, the objective of the study is to determine the potential immersive technological tools that can be used, in relevant phases of the life cycle of a project.

Corresponds to an exploratory type study, since it addresses aspects that have not been previously related, such as the incidence of immersive technology in the analysis of the life cycle of projects. It is classified within the bibliographic review category since it collects existing information from various sources in order to establish the correlation between the aspects studied.

The main results of the experience are related to that the technology of Virtual Reality and visualization (Matterport, NavVis, Oculus and HTC) takes relevance in the design stage; in the intermediate stages - from manufacturing to construction - the potential is given by the tools associated with Augmented Reality (Hololens and Daqri) and finally, several of the tools studied have the potential to be incorporated in the last phases of operation calls and demolition or recycling. On the other hand, that will be basic information for the pre-modeled scenarios that virtual reality requires, it is important to note that dot cloud technology offers disparate results around precision [9] of the scanned enclosure, but that are tolerable for Virtual Reality experiences - not so in mixed reality - since a high level of precision is needed.

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REDUCTION IN GYPSUM COMPOUNDS STIFFNESS WITH THE INCORPORATION OF END-OF-LIFE RUBBER TYRES. ANALYSIS AND RESULTS.

[1] López-Zaldívar, Óscar

[1]Lozano-Diez, Rafael Vicente

[1] Herrero del Cura, Sofia

[1] Mayor Lobo, Pablo Luis

[2] Hernández Olivares, Francisco

[1] Departamento de Tecnología de la Edificación. ETS de Edificación. Universidad Politécnica de Madrid; oscar.lopezz@upm.es

[2] Departamento de Construcción y Tecnología Arquitectónicas. ETS de Arquitectura. Universidad Politécnica de Madrid

Keywords: *Hydraulic binders with aggregates, elasticity, modulus of elasticity, gypsum, end-of-life rubber tyres*

The stiffness of hydraulic binders has negative aspects that are reflected in some of their properties such as the poor thermal and acoustic insulation or the lower impact resistance and therefore they have less ability to prevent cracks. The incorporation of rubber has been used as a procedure to reduce the stiffness of this type of material.

In this paper, the values obtained by calculating the static and dynamic modulus of elasticity in plaster specimens with the addition of various volumetric rubber fractions are analysed. Three different granulometries of rubber particles are obtained from the mechanical crushing of end-of-life car tyres.

As a result of previous research, the values of density, bending and compressive strength and thermal conductivity were obtained. The internal structure of the material had also been analysed in this research [1-3].

The dynamic modulus of elasticity is obtained by determining the ultrasonic transmission rate along the analysed samples [4].

In order to obtain the static modulus of elasticity, the unit deformation produced when the samples are subjected to bending stresses is related to the applied force.

With the data obtained, conclusions are drawn about the structure of the material and its behaviour, and a relationship is established between the two values.

Both modulus of elasticity decrease dramatically, especially in fine granulometry. This shows the great difference in stiffness of the analysed series in relation to the reference one, and the impact that grain size has on the elastic behaviour of the material.

The rubber grains, especially in the coarse crushing act as discontinuities of the material. This results in unreliable values of the dynamic modulus of elasticity because it would no longer be an isotropic and homogeneous material.

They also influence the stress-strain curves in such a way that in the elastic branch the behaviour characteristics of the material are given by the plaster matrix. It has to be assumed that the rubber grains are defects in the structure of the material that lead to decreases in resistance. On the other hand, after overcoming the last resistance, the rubber collaborates with the gypsum producing a gradual break and increasing the capacity of energy absorption by deformation.

It is confirmed that the addition of rubber reduces stiffness. It also modifies its vibratory behaviour which favours its use in certain applications requiring better acoustic behaviour or resistance to impact or cracking and cracking. That is to say, the addition of rubber improves the ability to dissipate and absorb energy.

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IMPLEMENTATION OF RULES FOR STANDARDIZATION IN MEASURING SURFACES IN BUILDING

[1]Jose Antonio López Medina

[2]Carlos Pérez Zapata

[1,2] Universidad Politécnica de Madrid, Escuela Técnica Superior de Edificación, Departamento de Tecnología de la Edificación, Avda. Juan de Herrera, 6, 28040 Madrid, España; joseantonio.lopez.medina@upm.es carlos.pzapata@upm.es

Keywords: *Cadastre, property, surface, standardization, measurement*

Measurement of surfaces and areas in the field of construction and their use in operations related with the traffic real estate in Spain is full of deficiencies. The main it is the absence of regulations which it approves and standardize the measurement of surfaces and the areas that usually are represented and used in the technical vocabulary used by professionals.

Thus, it is normal that when a professional refers to concepts such as surface useful, built-up area, floor area, surface util or habitable, land surface, etc are concepts that do not present a single interpretation, surfaces that do not are homogenized and have no rules or correct nor unique in this Spain, approval and which are moreover not defined by any technical standard that unifies them [1].

This work fits in finding a technical solution and the adaptation of European and international, defined regulations through studies of joint work between international committees and under European directives, with a common objective: define common to the whole international community rules, which are applicable to all buildings, both existing and in project, and is also applied in all stages of construction, from initial data collection existing in that plot you will be built, hasta the completion of all construction work.

The objective is the creation of a quality process, which is cross-border throughout the European Union by surveyors responsible for measurements or all professionals involved, as well as all parties concerned and in all professional fields [2].

Since the process of data collection, design, implementation, construction, sale, transmission of properties, rental, sale tax calculation or any other process that is inherent to the building [3].

In Europe have already begun more than 10 years ago the first movements for these tasks of standardization through the IPMS and ILMS regulations, as well as Measurement Code for the Floor Area of Buildings, developed by European experts from of the European Commission [4].

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ADDING PLASTIC WASTE TO PLASTERS TO IMPROVE THEIR PROPERTIES IN CONTACT WITH WATER

[1] Alejandra Vidales Barriguete

[2] Carolina Piña Ramírez

[3] Mercedes del Río Merino

[4] Evangelina Atanes Sánchez

[1] Universidad Politécnica de Madrid, Escuela Técnica Superior de Edificación, Departamento de Tecnología de la Edificación, Avda. Juan de Herrera, 6, 28040 Madrid, España; alejandra.vidales@upm.es
[2,3] Universidad Politécnica de Madrid, Escuela Técnica Superior de Edificación, Departamento de Construcciones Arquitectónicas y su Control, Avda. Juan de Herrera, 6,28040 Madrid, España; carolina.pina@upm.es; mercedes.delrio@upm.es
[4] Universidad Politécnica de Madrid, Escuela Técnica Superior de Ingeniería y Diseño Industrial, Departamento de Ingeniería Mecánica, Química y Diseño Industrial, Calle Ronda de Valencia, 3, 28012 Madrid, España; evangelina.atanes@upm.es

Keywords: *Impermeability, recycled plastics, gypsum, plastic waste, added plasters*

It is evident that dampness inside buildings favors the emergence of diverse pathologies and can end up causing health problems in their occupants [1]. Dampness is not due to a single cause but *"has different origins and different forms of appearance"* [2]: capillarity, excessive water in construction, condensation, rain, escapes, leaks, etc.

The use of impervious materials is presented as one of the solutions to the problem. Gypsum, one of the most commonly used traditional materials in construction [3], is known for its avidity for water and the negative effects water causes in it; On the contrary, plastic materials are water-resistant. That is why in this study, the improvement of the properties of gypsum compared to water is analyzed through the incorporation of plastic waste in its matrix.

In the experimental process, plaster specimens were made with a mass ratio of water / plaster 0.8. Plastic residue from the recycling cable process with a maximum particle size of 3 mm was added to these plaster specimens in proportions of 50% -60% -70% on the mass of the plaster. To observe their performance in contact with water they were subjected to the following tests: water absorption by capillarity [4], water vapor permeability [5], damp chamber [6], water-stove cycles [6] and total absorption of water. [7]. In all cases, the capacity to retain and absorb water decreased significantly, maintaining the hygrothermal properties of gypsum at acceptable levels according to EN ISO 13788: 2016 [8] for residential buildings. Therefore, it is considered a good solution to minimize the emergence of dampness in buildings without affecting the regulation of relative dampness in rooms.

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A CASE STUDY ON THERMAL INSULATION AS A COMFORT FACTOR IN WARM-HUMID WEATHER HOUSING

[1]Guillermo De Ignacio Vicens

[2]Silvia Soutullo Castro

[3]*Oscar López-Zaldívar

[3]Rafael Vicente Lozano-Díez

[1] Profesor Emérito, Universidad Politécnica de Madrid.
[2] División de Energías Renovables, CIEMAT. Av. Complutense, 40, 28040 Madrid.
[3] Departamento Tecnología de la Edificación. ETS de Edificación. Avenida Juan de Herrera, 6. (28040 – Madrid). Tel.: 91 336 75 99. Universidad Politécnica de Madrid;
oscar.lopezz@upm.es

Keywords: *Environmental conditioning of buildings, insulation, comfort temperature, warm-humid climate.*

This research is developed within the framework of the environmental conditioning of houses in warm-humid climate and the obtaining of optimal thermal comfort conditions by passive means. The study of the thermal insulation of the dwelling is considered as an influencing factor in the achievement of the best habitability levels.

The study focuses on a representative typology of dwelling in Havana (Cuba). Its geographical location makes this city one of the reference locations for the warm-humid climate. [1, 2, 3]. The effects and the influence of the additional insulation to the enclosure are analysed here.

In order to achieve the targets proposed, the hourly evolution of the indoor air temperature under different environmental situations has been analysed using the dynamic simulation software: *Transient Energy System Simulation Tool (TRNSYS 16.1)*. This is a modular and flexible software, that allows complex systems to be designed and the input variables and the contour conditions to be modified at each step time.

Early results give a slight hint of the thermal behaviour of the dwelling under perimeter insulation conditions. In fact, these results justify a priori the quite widespread perception in the bibliography consulted, of the irrelevance in the use of insulation (if not of its inconvenience). Then, it seems pertinent to make a new study on the thermal conditions throughout the 24 hours of a specific day, in the case of the implementation of insulation in the external enclosures. The 17th of January was selected as a representative day in winter conditions, and the 23rd of July as a representative of summer. Both das are characterized by the regular oscillation of the external temperature in them [4, 5].

Among the main conclusions of the research carried out can be highlighted:

- When the perimeter insulation of the external enclosures is considered, the maximum temperatures are up to 6ºC below the maximum external temperature. As the damping of the internal thermal wave is high and the amplitudes are very low, there is a very important stability of the internal temperature of the dwelling when this insulation is implemented.

- From the analysis carried out it can be deduced that the typical thickness of the insulation is 4 cm, in correspondence with the specifications of the Cuban Standard NC 220-1: 2009 for the insulation of roofs.
- The perimeter insulation together with a possible shading of the openings provides in winter an indoor temperature almost constant throughout the 24 hours of the day at around 22ºC. Which represents a clear improvement compared to the absence of insulation. In such a case a normal ventilation level is enough.
- In the summer, with perimeter insulation and possible shading of the openings, the minimum indoor temperature is only 2ºC higher than the minimum outdoor temperature. This provides an average indoor temperature close to 26ºC, in a clearly a comfortable situation. In this case, a medium-high ventilation level is preferable, although not crucial.
- As a main conclusion it can be stated that a solution with the implementation of 4 cm of perimeter insulation combined with solar protection of the external hollows confers the dwelling a very good level of comfort to the warm-humid climate, both in winter and in summer. Being not necessary but appropriate an additional level of ventilation.

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A CASE STUDY ON VENTILATION AND SHADING AS COMFORT FACTORS IN WARM-HUMID WEATHER HOUSING

[1]Guillermo De Ignacio Vicens

[2]Silvia Soutullo Castro

[3]*Oscar López-Zaldívar

[3]Rafael Vicente Lozano-Díez

[1] Profesor Emérito, Universidad Politécnica de Madrid.
[2] División de Energías Renovables, CIEMAT. Av. Complutense, 40, 28040 Madrid.
[3] Departamento Tecnología de la Edificación. ETS de Edificación. Avenida Juan de Herrera, 6. (28040 – Madrid). Tel.: 91 336 75 99. Universidad Politécnica de Madrid;
oscar.lopezz@upm.es

Keywords: *Environmental conditioning of buildings, ventilation, shading, comfort temperature, warm-humid climate.*

The choice of design strategies is a crucial task in hot and humid climates. In general, thermal comfort is favoured by isolated constructions without influencing whether they are massive or light, that is to say: thermal inertia would not be a determining factor. In this cases, ventilation is an important fact and the external openings need to be well oriented and shaded, being more suitable those places affected by air currents. This research is developed within the framework of the environmental conditioning of houses in warm-humid climate and the obtaining of optimal thermal comfort conditions. The study of the ventilation and shading of the dwelling is considered as an influencing factor in the achievement of the best habitability levels.

The study focuses on a representative typology of dwelling in Havana (Cuba). Its geographical location makes this city one of the reference locations for the warm-humid climate [1, 2, 3]. The effects of different natural ventilation scenarios and shading strategies are analysed here. The natural cooling strategy generally focuses on the following aspects: Protecting building openings, minimising internal inputs, dissipating internal heat.

In order to achieve the targets proposed, the hourly evolution of the indoor air temperature under different environmental situations has been analysed using the dynamic simulation software: *Transient Energy System Simulation Tool (TRNSYS 16.1)*. This is a modular and flexible software, that allows complex systems to be designed and the input variables and the contour conditions to be modified at each step time.

In order to analyse what happens throughout the 24 hours of a day, two days have been selected which are characterised by the regular oscillation of the external temperature. The 17th of January was selected as a representative day in winter conditions, and the 23rd of July as a representative of summer. Both das are characterized by the regular oscillation of the external temperature in them [4, 5]. The study carried out for these two days allows us to see the hour by hour temperature differences reached between the outside and the inside, as well as the inside temperature difference between the cases analysed.

Among the main conclusions of the research carried out can be highlighted:

- Assuming a natural health ventilation of 0.63 ACH, normal and medium-high ventilation levels are applicable. Higher ventilation values are not significant and would otherwise be annoying for users.
- In a starting situation of free time exposure to the sun of the enclosures a medium-high level of ventilation is necessary to achieve minimally comfortable indoor temperature values, especially in summer, but also in winter. Given the climatic conditions in Cuba, this level could only be reached by mechanical means.
- The shading of the openings during the day is decisive for achieving a minimum level of indoor comfort. This causes a significant drop in the value of the maximum outside temperature, both in winter and, above all, in summer.
- When the openings are shaded during the day, the level of ventilation in winter can be considered not significant.
- With shaded openings there is a significant reduction in the amplitude of the indoor thermal wave with respect to the outdoor, so that the temperature inside the dwelling is noticeably constant throughout the 24 hours a day. Indoor temperature is stable at around 23ºC with a level of comfort that can be considered acceptable.
- In summer, shading the openings during the day with medium-high ventilation, makes indoor temperature to remain very stable 24 hours a day (below 28ºC). This can be relatively comfortable during the day, but by no means at night.
- As a main conclusion it can be stated that a solution with solar protection of the external hollows combined with an appropriate level of ventilation confers the dwelling a good level of comfort to the warm-humid climate, both in winter and in summer. Being not necessary but appropriate in summer the use of some mechanical ventilation.

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THE INFLUENCE OF ARCHITECTURAL DESIGN ON NATIONAL SECURITY

[1] Inmaculada Sanz Ortega

[2] Montserrat Castellanos

[1] Technical architect, Doctoral student: Department of Construction and Architectural Technology (DCTA), Technical University of Architecture of Madrid (ETSAM), Polytechnic University of Madrid (UPM), Spain. University Master's Degree in Real Estate, Asset management Facility Management. University Master's Degree in Safety, Health at Work and Prevention of Occupational Risks; inmasanzortega@gmail.com
[2] PhD in Architecture, External Collaborating Professor of Postgraduate Studies: European University of Madrid (UEM), Spain; castellanos.mcm@gmail.com

Keywords: *Security, architectural design, national security, architecture*

Security is the basis of the development of a balanced society. Maintaining freedom, stability and ensuring the proper functioning of their institutions must be the priority objective of any State [1].

As identified by the Department of National Security (DSN), National Security is defined as "*the action of the State aimed at protecting the freedom and well-being of its citizens, at guaranteeing the defense of Spain and its constitutional principles and values, as well as at to contribute together with our partners and allies to international security in the fulfillment of the assumed commitments*". This concept must be broad and dynamic, and it has evolved with global transformations and will adapt to face the challenges that the world in which we live presents.

Currently in Europe we work for a coordinated urban and architectural design between the States. The European Urban Charter of 1992 [2], already identified as a basic right of citizens to have "*a safe and portected city, free, as far as possible, of crime, crime and aggression*".

In the Final Declaration of the International Conference of the European Council of February 1997 [3], it identifies the importance of fostering collaboration between the Security Forces and the professionals of Architecture and Urbanism. So much for the achievement of safer spaces, so that the agents of the law receive a specific training that relates the built environment and crime. And more in favor, the National Security Strategy promotes working for global security [4].

We are from 2015 in level 4 out of 5 (high risk) threat of terrorist attack. Since this classification of threat of attack risk exists, the level has not stopped increasing until reaching the current.

Within this scenario, with a global and multidisciplinary approach to National Security, and the non-transitory social situation we are going through, it is necessary to develop a regulation that requires designing, building and maintaining buildings that comply with a minimum of physical security conditions, and not only as up to now the Technical Building Code (CTE) [5], structural safety, fire, utilization, accessibility, noise and health.

This study identifies architectural design parameters that increase the physical security of real estate and therefore, the safety of the people who inhabit it, use it, or relate to it, the elements that compose it and the information found in it. its interior.

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ANALYSIS OF THE DOMESTIC HOT WATER (DHW) INDICATOR IN THE ENERGY CERTIFICATION OF BUILDINGS

[1]Juan López-Asiain

[2]María de la Nieves González

[1]Carlos Morón

[1]Alejandro Payán de Tejada

[1] Departamento de Tecnología de la Edificación. E.T.S. de Edificación de Madrid. Universidad Politécnica de Madrid; juan.lopezasiain@upm.es

[2] Departamento de Construcciones Arquitectónicas y su Control. E.T.S. de Edificación de Madrid. Universidad Politécnica de Madrid

Keywords: *Energy certification, domestic hot water, DHW, consumption, demand.*

It is an European Union aim, and of its member States, to reduce significantly their energy consumption and their dependency on fossil fuels. According to Directive 2010/31/UE of the European Parlament [1], about 40% of the energy consumption comes from buildings, so the reduction of that consumption in buildings must be an important part of the necessary steps to reduce that energy dependency and greenhouse gas emissions.

In order to improve the energy efficiency, energy certification plays an essential role allowing us to evaluate and compare buildings and their features related to demand, consumption and emissions. Energy certification, regulated by Royal Ordinance 235/2013 [2], could be only done using recognised documents by both Ministry of Public Works and Transports, and Ministry of Industry, Energy and Tourism.

As it can be observed in the study of Gangolells et al [3], in which data of more than 129.000 energy certifications from existing buildings are assessed, the energy consumption from heating is been significantly reduced due to new regulation which increase the requirements reducing the demand and consumption energy of this systems. This makes that energy consumption from domestic hot water (DHW) increased its relative importance in residential buildings.

That increasing importance justify the aim of this work, which is to analyse the methodology used by current regulation to estimate the energy consumption from DHW systems and its subsequent energy rating.

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DEVELOPMENT OF SUSTAINABLE TECHNOLOGIES IN CONSTRUCTION. NFUS APPLICATION

[1]Catalina Mondragón-Enguidanos

[2]Amparo Verdú-Vázquez

[3]Tomás Gil-Lopez

[4]Daniel Garcia de Frutos

[1]PhD, Escuela Técnica Superior de Edificación, UPM.
[2, 3] Dpto. Building Technologies, Escuela Técnica Superior Edificación, UPM;
amparo.verdu@upm.es
[4] Dpto. Escuela Politécnica Superior, UAX.

Keywords: *Sustainability, environment, circular economy, recycled rubber*

Over the last decade, the European Union in general, and Spain in particular, has subjected the provision of tyre used in landfills to an increasingly strict regulation. This demonstrates the considerable environmental problem and the associated damages in accumulation of this landfill waste. Therefore, the main objective is the use of this waste in the work itself, as a filling of an embankment core[1] [2] [3] [4].

In order to have a better knowledge of the behavior of the embankment and consequently a better quality of it in its future evolution, we proceeded to follow up with the following objectives:

a) Deformability control of the layers inside the embankment.

b) Control of the evolution of the filing temperature.

c) Influence of landfill in the quality of groundwater (leaching).

After the monitoring performed, it can be said that the vertical pressure produced in the foundation of the embankment due to the use of tires out of use in the filling, is approximately 70% lower compared to that obtained in a conventional landfill, considering the filling of tyres a suitable material for foundations with low capacity.

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STUDY OF THE THERMAL BEHAVIOR OF CEMENT MORTARS REINFORCED WITH WASTE MINERAL FIBERS THROUGH NUMERICAL SIMULATION

[1] **Carolina Piña Ramírez**

[2] **Carmen Viñas Arrebola**

[3] **Alejandra Vidales Barriguete**

[4] **Patricia Aguilera Benito**

[5] **Sheila Varela Luján**

[1,2,5] Universidad Politécnica de Madrid, Escuela Técnica Superior de Edificación, Departamento de Construcciones Arquitectónicas y su Control; Avda. Juan de Herrera, 6,28040 Madrid, España; carolina.pina@upm.es; carmen.vinas@upm.es; sheila.varela.lujan@alumnos.upm.es
[3,4] Universidad Politécnica de Madrid, Escuela Técnica Superior de Edificación, Departamento de Tecnología de la Edificación, Avda. Juan de Herrera, 6, 28040 Madrid, España; alejandra.vidales@upm.es; patricia.aguilera@upm.es

Keywords: *Cement mortars, mineral fibres, CFD simulation, energy efficiency, construction and demolition waste*

This study is part of a research that analyses the viability of the mineral wool from the construction and demolition waste (CDW) as reinforcement of cement matrices. The objective is to analyse the thermal behavior of the new material of cement mortar with waste mineral fibers, as applied in mortar blocks for facades, is analyzed by numerical simulation in comparison with a block façade made of traditional mortar [1].

To perform this numerical simulation, a Computational Fluid Dynamics (CFD) program (Computational Fluid Dynamics) was used, specifically the STAR_CCM + software [2].

Through this heat transfer simulation is evaluated in a constructive traditional facade system. The enclosure is composed of a cement mortar block of 20 cm thickness, a plastering of 1.5 cm, an air chamber of 4 cm, a thermal insulation of 5 cm, a double hollow brick walling of 7 cm and a coating 1.5 cm thick.

A reference model is defined on which the scenario of replacing the block of cement mortar without fibers with the block of cement additive with fiber residues is defined [3].

The decrease in energy flow per W / m² and the temperature difference between the outer and inner face of the wall are analyzed on each model, assuming a winter scenario.

Tests indicate an improvement in the thermal behavior of the compounds, that reduces significantly its thermal conductivity, so it is suggested as material for construction applications requiring energy improvement of the building.

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OPTIMIZATION OF BIM PROCESSES FOR THE OPERATIONAL MAINTENANCE OF REMARKABLE STRUCTURES: BIM PARAMETRIC MODELS BASED ON STRUCTURAL PATHOLOGIES AND INSTRUMENTATION

[1] Jaime Santamarta Martínez

[2] Jaime Santa Cruz Astorqui

[1] MSc Civil Engineer, PhD Student "Technological Innovation in Building", Escuela Técnica Superior de Edificación, Universidad Politécnica de Madrid; jaime.santamarta.martinez@alumnos.upm.es
[2] PhD. Architect, Professor & Thesis Director, Escuela Técnica Superior de Edificación, Universidad Politécnica de Madrid; jaime.santacruz@upm.es

Keywords: *BIM, parameter, pathology, instrumentation, model*

BIM 7D dimension fundamental is based on integrating the asset management processes of an infrastructure within the use of a BIM model. This means that, through a three-dimensional visualization interface and using an electronic document management system (EDMS) as support, all the as-built documentation, as well as the related to maintenance and operation of the infrastructure will be integrated.

To achieve this, it will initially be necessary to determine, on the one hand, the elements of the model or assets that must be managed, and on the other hand, the attributes or parameters that shall be assigned to those elements. The definition of these parameters will depend on the ultimate purpose of the asset management itself, not only by responding to what it is intended to be managed, but also how it is going to be managed and for what purpose.

In the case of the optimization of BIM processes in the field of the operation and maintenance of remarkable structures, the main goal is to create a digital asset management environment where data from the instrumentation of structures is recorded, so that a system of predictive and preventive alerts is generated based on structural behaviour in quasi-real time.

Therefore, it will be essential to ensure a proper mapping of the data collected by the instrumentation system and its correlation with a predictive analysis of potential pathologies that may arise in the structure under maintenance. Some of the most commonly detected pathologies in concrete structures can be classified according to their origin. For example, mechanical origin (failures due to bending stress, transverse cracking due to tensile stresses, longitudinal cracking due to compression forces, shear failure, excessive deformation) or others such as thermal, chemical or hydraulic retraction origin.

The instrumental system installed, will be based on the placement of sensors connected to transmitting nodes, and the implementation of a data acquisition system that may be wired or remote. Displacement sensors (LVDT linear variable differential transformer), vibration sensors (accelerometers), spin sensors (clinometers), tension sensors (extensometers) or meteorological register sensors (thermometers, hygrometers or anemometers) may be used.

Taking as an experimental device a cable-stayed roof, first of all, a three-dimensional digital BIM model is developed, and secondly, a permanent monitoring of the cables is carried out in situ, placing accelerometers in each of them. Thus, using the vibrating string test principle, the vibrations naturally excited by the wind are recorded continuously to obtain the real axial loads, creating the data base.

The link between the model elements (cables) and both the sensor, the data collected (real readings), the prediction of the potential pathology, and its preventive measure, is achieved using a coherent and effective parametric data and codification system. Consequently, the elements are adequately identified according to alphanumeric coding criteria, and also structured according to a tree of constituent parts within the model.

As a conclusion, this parametric model, based on structural pathologies and instrumentation, will enable to operate under an automatic computer maintenance management system integrated with BIM seventh dimension.

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OPTIMIZATION OF BIM PROCESSES FOR THE OPERATIONAL MAINTENANCE OF REMARKABLE STRUCTURES: INTEROPERABILITY BETWEEN 3D MODELS AND ANALYTIC MODELS

[1] Jaime Santamarta Martínez

[2] Jaime Santa Cruz Astorqui

[1] MSc Civil Engineer, PhD Student "Technological Innovation in Building", Escuela Técnica Superior de Edificación, Universidad Politécnica de Madrid; jaime.santamarta.martinez@alumnos.upm.es
[2] PhD. Architect, Professor & Thesis Director, Escuela Técnica Superior de Edificación, Universidad Politécnica de Madrid; jaime.santacruz@upm.es

Keywords: *BIM, Analytical, Structures, Interoperability, Model*

The optimization of BIM processes in the field of the operation and maintenance of remarkable structures requires the assurance of the interoperability between the different computer platforms used. Moreover, as the main goal is to create a digital asset management environment where data from the instrumentation of structures is recorded, the link with the analytical model will generate a system of predictive and preventive alerts based on the structural behaviour in quasi-real time.

Therefore, even though the essence of BIM methodology aims to build a three-dimensional model where each of the elements designed is depicted and compiled with information, the association of an analytical model to structural elements becomes fundamental when the main objective is to ensure interoperability between both.

The analytical model, consist of a set of nodes, bars or finite elements that represent a real element containing information of its mechanical properties. These properties are in the end, the input data necessary to carry out the analysis of the structural elements under the application of certain loads and boundary conditions. It must therefore be regarded as critical the consideration of the use of specific families of elements when modelling, so that the generation of the analytical model is effective.

Once this model has been generated, in order to achieve a systematic and optimized analysis process, it is essential to define which structural calculation software is the most appropriate in each case. Consequently, a thorough understanding of the interoperability between modelling software and analysis software, will lead to a higher productivity in the maintenance of existing remarkable structures.

Therefore, the first step will be to set out which software exists, and build up an interoperability map. Once this is done, taking into account which of them are more commonly used worldwide, two of them will be selected. In this sense, Revit has been chosen as the graphic modelling software, and Etabs as the analysis software.

Taking a concrete structure as the experimental device, it is analyzed how graphic modelling must be developed, and which are the problems that usually arise in relation with: material properties, frame sections generation, levels identification or elements definition (walls, columns, slabs and beams).

The process of importing the analytical model from Revit is generally done by generating files that allow the exchange of data in a bidirectional way. Once the structural checks have been carried out, interoperability allows comparison between the analytic values and the ones recorded in the database that come from the instrumentation installed, generating a machine learning ecosystem capable of predicting possible pathologies or poor structural behaviour.

The results of the research reveal not only good practice rules to be taken into account when BIM methodology is applied in the analysis of structures, but also, as a contribution to knowledge, specific methodological procedures based on the creation of flowcharts and computer routines are established. Reaching this point, the links between models will eventually allow updates, and therefore, BIM structural process will be optimized.

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ADVANCES IN FPR ANCHORING SYSTEMS FOR EXTERNALLY BONDED CARBON FIBRE REINFORCEMENTS

[1] Adriana Cortez Flores

[2]Jaime Fernández Gómez

[3]Paula Villanueva

[1]Departamento de Ingeniería Civil: Construcción. E.T.S de Ingenieros de Caminos. Canales y Puertos. Universidad Politécnica de Madrid. C / Profesor Aranguren. s/n. 28040. Madrid.
ilsenadriana.cortez.flores@alumnos.upm.es

Keywords: *Carbon fibre, debonding, spike anchors*

The use of fibre-reinforce polymers (FRPs) to strengthen and repair existing reinforced concrete structures has notably increased in recent years thanks to the great advantages of these materials. One of the limitation of this technology though is its premature delamination from the substrate. Different existing codes for designing FRP reinforcements have considered this limitation and usually express it in terms of either the maximum deformation or maximum adhesion strength, which depends on different parameters including the substrate strength, the reinforcement width and thickness, and the fibre type. Several anchorage techniques have been developed to prevent or delay debonding failure, among which anchors made from fibre ropes or rolled sheets (known as FRP or spike anchors) have demonstrated to considerably enhance the joint strength ([1], [2]). To date, different existing guidelines for FRP reinforcements point to the improvement that can be achieved with such anchoring systems; however, their use in rehabilitation projects is still subject to tests that demonstrate their proper functioning as there is a lack of knowledge regarding the parameters involved in their behaviour. In order to characterise the anchor behaviour numerous experimental studies that include pull-out tests on isolates connectors ([3], [4]) shear tests on isolated anchors [5], and chiefly, shear tests on anchored joints ([5], [6], [7], [8], [9], [10], [11]) have been carried out. Most experimental studies to date have been conducted with hand-made anchors from rolled fibre sheets. With respect to manufacturing and installation, it is possible to distinguish between wet installed and pre-cured anchors. The main difference between these systems is the moment at which the portion of sheet that is going to be embedded is impregnated with respect to the moment of anchor insertion. Pre-cured anchors have been used by authors such as Ozdemir [3], and Eshwar [4], while Orton [14], Niemitz [15], McGuirk and Breña [16] used fresh installation technique. The results of the tests realized on isolated connectors allowed the identification of the most critical parameters that affect the strength of the anchors themselves which include the embedded length, angle dowel and bending radius. As shear tests represent the maximum stresses for the adherent mechanism of the FRP-support interface, their results allow the study of the support-laminate interaction. The conclusions drawn by the authors mentioned defined that the geometry of the perforation as well as that of the anchor itself are decisive in the anchored joint behaviour. Regarding the embedded region of the anchor, the main variables are the anchor diameter, the embedded depth, drilling diameter and dowel angle. Parameters related with the anchor-to-reinforcement connection like the fan angle, the bonded length and the anchor position with respect to the loaded end have also been proved to influence the behaviour of the anchored joint. This document collects recent advances in FRP anchoring systems. It also presents the configuration of an optimized connector manufactured from carbon fibre ropes based on the results of a previous investigation that serves as the basis for the experimental campaign that the authors are currently carrying out.

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EXPERIMENTAL ASSESSMENT OF THERMAL CONDUCTIVITY IN A NON STANDART GYPSUM PLASTER SAMPLE

[1] Manzano Herrero, Alberto Pedro

[2]Lozano Díez, Rafael Vicente

[2]López Zaldívar, Óscar

[3]Hernández Olivares, Francisco

[1] Facultad de Ciencias Físicas. Universidad Complutense de Madrid; almanzan@ucm.es
[2]Departamento de Tecnología de la Edificación. ETS de Edificación. Universidad Politécnica de Madrid
[3] Departamento de Construcción y Tecnología Arquitectónica. ETS de Arquitectura. Universidad Politécnica de Madrid.

Keywords: *Gypsum plaster, thermal conductivity, heat disipation.*

Most studies regarding to material properties within the scope of architecture rely on the validity of lineal approximation [1]. The simplicity, low computability costs and the capability to represent a large amount of experiments are foremost the reasons why this models are preferred rather than more complex ones [2]. The goal of the present article is to explore the behaviour of the thermal standard model in a non-standart sample (Fig 1).

The standart model for temperature proposed just follows Laplace's time dependent equation adding a term to the model heat

Fig. 1: Box for experimental test.

dissipation according to Newton's law.

In this experiment, heat from a stable source of temperature is applied in both ends of a rectangular piece of gypsum [3]. The piece is insolated mainly to avoid dispation caused by air convection. Mathematicaly this problem is represented by a differential one with fixe boundaries [4]. To enrich the model, thermal fluctuations in the source are also taken into account.

For the shake of simplicity this study is done in the stationary case. Under this regime the only unknown parameter is the disipation (Fig 2) in the lateral faces. Other variables such as conductivity are unknown, but under this simplification they do not affect the final state of the sample.

The main

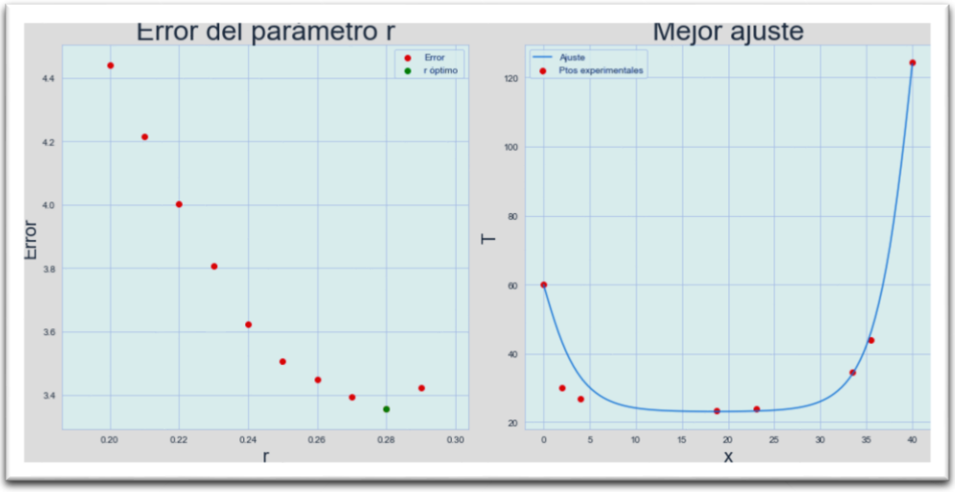

Fig. 2: Best fit under constant approximation

advantage of this description is that, it is possible to enclose the material's response in this unknown parameter as its dependence on the controlled variables is suggested ad hoc. This procedure allows to virtually model almost every situation needed.

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PROVISIONAL TIMBER STRUCTURE FOR EMERGENCY SITUATIONS

[1] Pablo Martín Gallego

[1] Bachelor's Degree in Building Engineering, Máster in Building Technological Innovation, Escuela Técnica Superior de Edificación de Madrid, Universidad Politécnica de Madrid; p.marting@alumnos.upm.es

Keywords: *Structure, timber, provisional, emergency*

Every time more and more building aspects are being modularized, leading to save time and money when manufacturing and installing. From structural elements (pillars and slabs), to prefab façade panels and gypsum plasterboards partitions. With modularity as foundation, this paper states a modular system for building timber provisional structures to adapt to different situations, depending on the required area, showing a better stability and versatility over existing provisional building systems, such as aluminium tubular- structure marquees.

Starting from controlled dimensions to ease structure's fast assembling, basic calculations are used to design the different elements that would compound the initial module, which can be replicated in order to scale up the building according to the necessities. These calculations are based on *Estructuras de Madera.* Bases de cálculo [1] and *Código Técnico de la Edificación, Documento Básico: Acciones en la Edificación* [2]. The structure has been designed to be manufactured with C14 conifer timber, because of being commonly found and less resistant, but also more lightweight than others.

The main gantry is compound of a 6-meter main beam, divided in two pieces which rest one on each other by means of a scissor joint fastened by two clips, and which rest on two pillars that stand the whole load and transmit it to a continuous timber- pieces foundation, working as well as lower bracing, and being modular, so as they can be assembled as many as gantries are needed.

The joint between the main beam and the pillars will be tongue and groove, being fastened by a swing top system. Gantries are braced between them by a top piece and two lateral ones, joining to the main beams by dovetail grooves. In order to get more stability steel braces in St. Andrew's cross- shape will be installed, being tightened by tensors in both of their ends.

This structure will be closed by a 7% slope roof sandwich panel. Lateral envelope will depend on weather conditions.

With this system we can achieve a main structure that can be extended and used from warehouse to field hospital.

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A METHODOLOGY FOR THE CALCULATION OF THE FOUNDATION OF A ROTARY MACHINE SUPPORTING DYNAMIC LOADS INCLUDING THE TRANSIENTE STARTING

[1] Juan Luis Terrádez Marco

[2]Antonio Hospitaler Pérez

[1,2] Departamento de Ingeniería de la Construcción y Proyectos de Ingeniería Civil, Universitat Politécnica de Valencia, Camino de Vera s/n, 46.022 Valencia Spain;
jlterrad@doctor.upv.es; ahospitaler@cst.upv.es

Keywords: *Dynamic loads, foundations, machines, transient, vibration*

Often engineers solve problems in relationship with structures and foundations from the point of view of structural statics. Nothing so far of the reality when finally, on the structure or the foundation, is installed a machine.

Loads produced by machines change with time and will not be constant. The parts that made a machine are usually moving and they transmit to the structure dynamics loads which change with time.

Thinking in dynamics loads means consider the variable “time” to calculate a foundation or a structure. A part of the energy wasted by the machine is transformed in radiation from the vibration of the machine and transmitted to the ground [8].

During the transient to get the nominal speed of the machine, the system can cross its “natural frequency” and collapse by an excess of amplitude of vibration [8] [2] [4].

D’Alambert differential equations based in the Lysmer’s analogy [5] were applied in the time domain to study the vertical movement, sliding and rocking [3] of the ensemble foundation – inertial block – machine. Equations differentials were integrated with a time-step scheme [4], the Newmark’s β method [7], getting the amplitude of vibration, speed, acceleration and strength in the transient and in the permanent operation.

Methodology were applied to a rotary machine working at 3.000 r.pm. with an inertial block and a block foundation, a 3-mass problem with 37 variables. The ground, its parameters and impedance are calculated applying the Norma ACI 351.3R-04.

Dynamic loads were calculated in agreement with ACI Norm 351.3R-04 [1], API Norms Standard 613 [2] and ISO Norm 1940/1.

A MATLAB program was developed to solve the D’Alambert differential equations and get the amplitude of vibration, speed, acceleration and strength changing the speed of the machine during the first 3000 seconds since 0 to 3.000 seconds with different starting functions [9].

Random solutions of the 37 variables were generated by the program. The program allowed to fix constraints to the solution calculated. A set of rules were applied to the transient and the permanent operation mode of the machine [9]. Limits, extracted from the ISO Norm, of the amplitude of vibration, speed, acceleration and strength in the transient and in the permanent operation mode were applied to get the right solution.

Cost of the foundation was calculated for each set of variables. So, a function “cost” depending of the 37 variables was obtained. To study the “cost function”·was used the methodology of a Random Walk of 2.000 solutions [6].

- This methodology permits to design and calculate any foundation supporting dynamics loads in the time domain fixing the limits of the amplitude of vibration, speed, acceleration and strength in the transient and in the permanent operation mode.
- The analysis of the “natural frequency” of the foundation is not necessary because the amplitude of vibration is fixed in the constrains to get the random solution.
- The transient period operation mode is analysed and fixed the limits of amplitude of vibration
- Less cost solution is obtained with the methodology of Random Walk.
- Finally, this methodology permits to applied metaheuristics to optimize the cost of the foundation.

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CHANGES IN THE ARCHITECTURAL DESIGN PARADIGM, THANKS TO CLEAR CODE ARCHITECTURE®

[1] **Blanca Fernández Contreras**

[2] **Maximià Torruella Castell**

[1,2] ***PMMT Architecture; blanca.f@pmmtarq.com; maximia@pmmtarq.com***

Keywords: *Inclusive thinking, universal accessibility, inclusive environments, diversity*

At PMMT Arquitectura, our main concern is to design for people, specifically for those who are over 60, for the future mothers, for those who perceive the world with less senses, for wheelchair users and for those who understand the world in their own way. Our architecture addresses not only these people, but also everyone who is part of our society. Guaranteeing universal accessibility in our projects means questioning the current parameters on which conventional architectural design is based. The aim is to push forward the obsolete concept of "accessibility" to a new one: the "universal accessibility" approach.

Nowadays, 15% of the world population has some kind of functional diversity [1] and over 25% has some type of limitation in the use of built environment. Furthermore, in 2050, more than 2 billion people will be over 60s [2] Given figures like those, it is worth asking if the design basis on which we normally rely on in relation to the social reality of this century are the suitable ones for this century.

As a result of this serious concern, a 3 year research project emerged from our R&D department, being today a living organism that continues to evolve, adapt and incorporate new knowledge. It is the Clear Code Architecture® method (henceforth, CCA®), the first methodology that allows us to ensure universal accessibility. It is an analytical, measurement and implementation method of the universal accessibility level of any built environment.

When checking that there was no unified global universal accessibility knowledge, we studied more than 200 manuals, websites and regulations from around the world. The goal was to collect all the existing material related to universal accessibility applied to our field of action, architecture.

In order to ensure that all people, with or without some kind of disability, were taken into account in our method, we have studied the World Health Organization official diseases list. After that, we conducted a symptoms-based synthesis caused by these illnesses, reducing into 13 groups. These groups include, not only any person with some functional diversity needs, but also those who may suffer a chronic or temporary limitation in the use of the built environment.

After this phase, we study the needs of each group for each space within each building type or outdoor areas. Setting out the requirements that these spaces had to fulfil, both those common to any typology and those specific to each one of them, we made the actions checklists that ensure universal accessibility, for every CCA® group in every CCA® space. Each action has a score, enables us to evaluate the universal accessibility level of any built environment. Scoring not only allows us to know the accessibility level of an area, but also to recognize the improvement actions that should be made in order to increase the universal accessibility level. Nowadays, CCA® has turned into a computer software tool that makes the analysis process easier, objective and more efficient. Thanks to the CCA® innovative method, we have evolved our way of conceiving architecture. An architecture that places itself at the service of everyone.

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CHARACTERIZATION OF HIGH ISOLATION GYPSUM

[1]Manuel Álvarez Dorado

[1]Simone Feroldi

[1]Master in Technological Innovation in Building Student, Polytechnical University of Madrid;
manuel.alvarezd@alumnos.upm.es; simone.feroldi@alumnos.upm.es

Keywords: *Isolation, gypsum, fibers, comparaison*

In the extensive world of construction materials, plaster is one of the most present in day-to-day construction. Due to its low cost of obtaining - it is obtained directly from nature and does not need hardly any treatment - its aesthetic finish and its handling and putting into work, it becomes one of the most used resources as interior finishes, linings and partitions in building.

In a historical moment in which both properties, thermal comfort and the sustainability in terms of the use of materials and resources begin to be important, it is essential to think of new constructive solutions that respond to these needs.

Research is beginning to be observed to verify the mechanical characteristics of recycled building plasters, with the intention of being able to reuse these materials with high reliability and thus reduce the energy expenditure produced in obtaining this material [1].

Another branch of the investigation is the addition of fibers to these mortars. The addition of fibers, both natural and artificial, to construction elements such as concrete or plaster to alter their qualities and improve any of them is a constant object of study. In this way, Iucolano [2], have already experimented with the addition of fibers, specifically with hemp, to improve the mechanical properties of the plaster. In turn, they discovered that thermal properties were also improved with the addition of these fibers.

In addition to natural fibers, the addition of porous materials to the plaster makes it improve its acoustic and thermal insulation, thus allowing it to be used in sites with specific requirements [3].

It is in these lines that there is research on the plasters, which are trying to improve by adding these fibers or even chemical elements.

This research has been carried out based on the UNE-EN 13279-2 standard and using the E-35 plaster material, to which different natural fibers (straw and wood) and artificial fibers were added (polypropylene, fiberglass and basalt) in order to improve the thermal capabilities of this material.

To do this, 6 molds of 3 samples of 4x4x16cm, a reference without additives and a mold with each additive were made. Each of these molds with two different water / gypsum ratios, namely, 0.6 and 0.8. The quantities of additives can be seen in the Fig. 1.

	E-35	Paja	Madera	FV	FB	FPP
g Adición	-	7	7	2,5	2,5	2,5

Fig. 1: characterization of Additions and quantities(g)

Once the specimens were obtained, mechanical tests were carried out to define their resistance to traction, compression and humidity by capillarity. In addition to these specimens, an adhesion test was also made according to regulations.

Finally, and to finish characterizing these 5 types of additives, a test of thermal resistance in thermal box and acoustic test in impedance tube were made.

The results obtained in the investigation have been the following:

The first thing that was measured were the hardness of the specimens, in which it was concluded that while the 0.6 ratio had an average hardness of 71, those of 0.8 had an average hardness of 45.5.

Regarding the mechanical characteristics, the gypsum reinforced with fiberglass was the one that more resistance to flexion and to compression obtained, while the reinforced with fibers of straw was the one that worse result obtained. The difference with respect to the reference values was significant, assuming an increase of 13% in the proportion of 0.6 (Fig. 2).

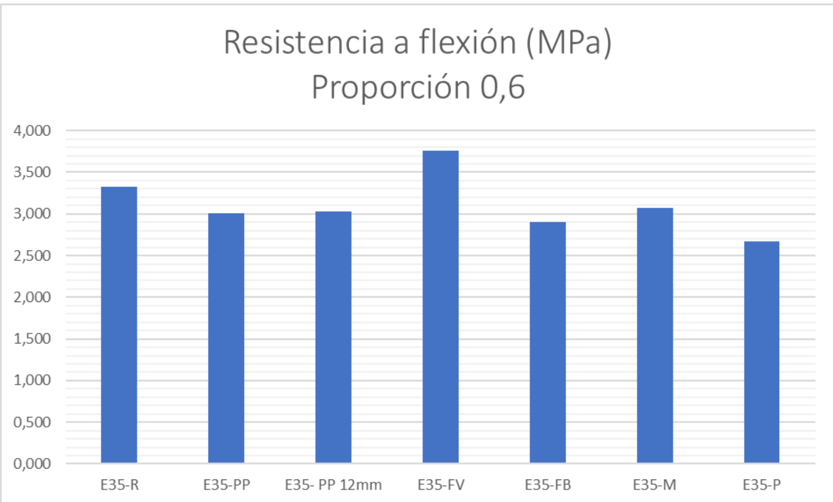

Fig. 2: Flexion resistance (Prop. 0,6)

It is observed that natural fibers have better results with respect to the reference specimen and artificial additives in terms of thermal resistance. The proportion Water / gypsum that has obtained better results in all the tests carried out is 0.6. The addition of natural fibers does not improve the mechanical strength, although it provides a considerable improvement in thermal insulation.

The artificial fibers of glass and basalt are more resistant than those of polypropylene in terms of mechanical characteristics.

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DIY SYSTEM FOR MONITORING AVERAGE ILLUMINANCE IN RESIDENTIAL INDOOR SPACES

[1] Alejandro Payan de Tejada Alonso; [1]Juan López-Asiain Martínez

[1]Carlos Morón Fernández; [2]Pablo Sáiz Martínez

[1] Dpto. Tecnologia de la Edificación, UPM
[2] Dpto. Economía Financiera, contabilidad e Idioma Moderno, URJC
alejandro.payandetejada@gmail.com; juanlopezasiain@gmail.com; carlos.moron@upm.es; pablo.saiz@urjc.es

Keywords: *Building Monitoring System; DIY; lighting; illuminance; arduino*

In building sector, a deep change in users is happening. Users is not asking a house only to stay anymore, but they are asking for more and more requirements related to their comfort, beyond those that are written in the current regulation. One of these requirements is visual comfort. This is widely regulated by international laws, ISO 8995-1:2002 [1] and national such as UNE EN 12464-1:2012 [2] y UNE EN 12464-2:2016 [3] in which the minimum light requirements are stablished divided in different spaces classified by use (offices, libraries, hospitals, sports facilities…) but it is not the case for areas indoors in residential buildings. These are specifically excluded from the Spanish Technical Building Code, in its Basic Document DB HE 3 [4], and it does not exist any other regulation.

However, the activities the users perform inside their houses are similar to the activities that are performed in workplaces such as work in a Data Visualization Display or reading areas among others. In that spaces a recommended level of illuminance has to be achieved according to the stablished standards for not damage the user's health and get good visual comfort. This fact is aggravated by the lack of knowledge of that indoor conditions because the user has not any verification system.

Due to this, in this work it is given to the user a Do It Yourself (DIY) solution to measure one of the more relevant parameters to achieve this visual comfort, the average illuminance of the space. So, it will be explained the development and implementation of a monitoring system for illuminance in an indoor space, based in Arduino platform, marked by its simplicity and suitable and priceless sensors. This system allow the user to know the illuminance levels in real time for taking right decisions.

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FINITE ELEMENTS METHODS

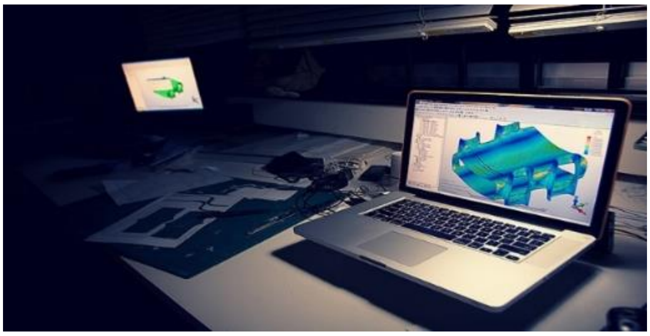
[1]Neda Salsabili

[2]Maria Isabel Prieto Barrio

[3]Joaquín Santiago López

[1] PhD candidate, Universidad Politécnica de Madrid, n.salsabili@gmail.com;n.salsabili@alumnos.upm.es
[2] Universidad Politécnica de Madrid, mariaisabel.prieto@upm.es
[3] Universidad Politécnica de Madrid, joaquin.santiago@upm.es

Keywords: *Finite Element, modelling, validation*



Picture 1: Finite element method

Finite element analysis (FEA) or the finite element method (FEM) (Picture 1) is the product of the digital age in the 1950s by the promotion of digital computers. It is a numerical way [1] and a computer-based tool that uses mathematical calculations [2] in a virtual environment [3] to simulate and analyze products and systems [4] by engineers and scientists in a different range of industries [3]. This article describes the ways to develop the finite element of each structure by validating its data step by step for doing further studying and modeling.

According to different research sources in finite elements methods until the end of January 2019, the finite element method involves modeling the structure by using meshing process [2], different range of properties, verified data [3–5], and different software according to its purposes [2]. Moreover, the most important step after modeling is a validation of the model by testing decompression and stabilization procedures [6] thereby comparing with experimentally validated data.

The modeling method introduced in this study can be used for future analysis and modeling in a wide range of industries, biomechanics, and buildings since it benefits from handling any mathematical or physical problem [4, 7], optimizing performance, designs and cost, reducing the development time, testing [4], the number of physical prototypes [8] , and material usage [3], improving safety, information [4] and quality [7], having freedom to select the elements, its functions [9] and different materials [3], and making complex geometrical calculations [7]. The adoption of this method makes it easy to predict the product performance and reliability, determine the role of material properties and behavior [10–12] and perform parametric analysis of loadings [10, 11, 13].

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STUDY OF RETRACTIONS AND CHARACTERIZATION OF AGGREGATES IN CEMENT MORTARS WITH ADDED CONSTRUCTION AND DEMOLITION RESIDUES

[1] **Alberto Lage Sánchez**

[1] ***Master´s degree in building technological innovation, UPM (Universidad Politécnica de Madrid), ETSEM (Escuela Técnica Superior de Edificación de Madrid);***
alberto.lage.sanchez@alumnos.upm.es

Keywords: *Cement, retraction, recycle, granulometry*

The following document analyzes cement mortars with different types of recycled aggregates. Test pieces are elaborated to measure the retraction of the materials [1-3].

A CEM IV / B (V) 32.5 N will be used. As an aggregate, standardized river sand will be used for the reference. For the ceramic and concrete recycled samples]will be used waste from construction / demolition processes [4-7].

In the first phase of the project, retraction tests are carried out on mortars made from cement, water, additive and either river sand, recycled concrete aggregate or recycled ceramic aggregate. The preparation of test pieces with those residues in arid-cement proportions 1: 3 and 1: 3,63 is initially considered, maintaining in both the amount of water added to the mixture. Once the specimens have been prepared, the retraction they suffer with the passage of time must be monitored in order to characterize the behavior of said mortars [8-9].

During the process of preparation of the test pieces there are problems of water absorption by recycled aggregates, both defective and excess, which does not allow to maintain the proportions of aggregate or water amounts, reaching the point where it is decided to change the proportion. The failures found range from mixtures with harmful workability to fluid mixtures that result in very fragile pieces, even breaking with great ease at the moment of unmolding.

Retraction measurements are made from those that were developed and were not problematic. The recycled sands that have been used in the study come from La Palentina and El Molar, integral treatment plants for construction and demolition waste both located in Madrid. In another project carried out in the same center, aggregate was used from the same plants and proportions have been used that had good results, but this time the behavior is different. As a result of this circumstance, a granulometric analysis of the recycled materials is carried out in order to choose the most suitable proportion of fine and coarse aggregate to be finally used for the test pieces.

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THE EFFECTIVENESS OF THE USE OF FIBERS AND OTHER METHODS AS REINFORCEMENT IN THE REPAIR OF WOOD BEAMS OF VARIOUS ARBOREAL ORIGINS.

[1]**Alfredo Tuya Anyosa**

[2]**Maria Isabel Prieto Barrio**

[1]Master's student in technological innovation in the building, Technical School of Building of the Polytechnic University of Madrid (Spain).

[2]Teacher Member Pathology Research Group of structures, collective protections and auxiliary means of building. Technical School of Building of the Polytechnic University of Madrid (Spain); mariaisabel.prieto@upm.es

Keywords: *Beam, wood, fiber, reinforcements*

This paper describes and compares results between articles, for this, 4 relevant topics were selected in reinforcements to wood beams of different types and tree origin [1, 2, 3, and 4], found in the literature or status of the Art.

On the samples of the literature to be compared, it was considered for the choice that the selected articles have similar approaches and have similar mechanical tests as: tensile strength, resistance to the average flexion, elasticity module analysis, however, a limitation of the work is the fact that the obtained values cannot be bought in an absolute way since the authors and selected referents apply their research on various configurations of wood beams or different species such as Pine, Beech, Alamo and Fir or even the technique and type of fibre to be used in the reinforcement of such fibres as glass, polymer, bamboo, GFRP, and others made from steel, suggesting a percentage comparison of the improvement or efficiency achieved by the applied methods.

Concerning the methodological plan it is noted that the selected samples do not use the same units, this is bought according to relative values or percentage of variation according to the type of test, in which a comparison is made with the control sample (beam without backup) and a reinforced or repaired selected beam (which was selected according to the best achieved or as a sample in which the reinforcement is not invasive).

The comparison between work referents concludes that these constructive solutions (repair and reinforcement) provide benefits or contributions to the mechanical characteristics of structural elements of wood, shaping an attractive concept for the development of applications in the field of building and civil construction, as:

The variation of the elasticity Module, when using a method of repair / reinforcement with organic fibres (the case of Bamboo) is negative [1].
The highest contributions or percentage increases in the elasticity Module and the breakage

Module are obtained when synthetic materials are used, for the matter, the GFRP fibre (F. glass + polymer) and the GFRP bar respectively [2 and 3].

The lowest results in the variation of the breakage Module are obtained by using a repair method / reinforcement with glass fibres [6], however, when using reinforcement with glass materials plus bar polymers, this reaches the highest value on the MOR [2].

The wood beam (Abeto laminate) reinforced with steel bars [4] represents the highest result of bending resistance.

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BEHAVIOR OF THE NATURAL AND ARTIFICIAL LUMINANCE AND ILUMINANCE IN AN INTERIOR SPACE OF THE ACADEMIC PROJECT DISTRITO U-COWORK

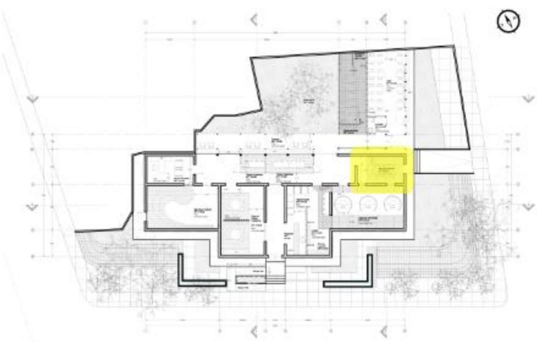
[1]Andrea Sancho; [2]Ana Gabriela Herrera; [3]Melissa Jiménez;

[4]Minor Sancho; [5]Fabiola Arrieta; [6]Roger Hernández; [7]Lucia Flores

[1]Professor and Researcher at the Tropical Architecture Laboratory; Architecture School, Universidad de Costa Rica; andrea.sancho_s@ucr.ac.cr
[2,3,4,5,6,7]Architecture Student, Universidad de Costa Rica

Keywords: *Luminance, illuminance, glare, visual comfort*

This project consists of an exploration and evaluation of the lighting performance of an internal space using digital simulation tools and measurements in a scale model. The evaluated space is part of a project carried out by last year students, belonging to the Design Workshop of Tropical Architecture, where a disused heritage building was taken as a starting point, with the purpose of adapting the use of the space and transforming it into a collaborative work site called "Distrito U Cowork", in the city of Montes de Oca, San José, Costa Rica [1-2].



the heritage ... ork site that ... the analysis. Executed by the student Melissa Jiménez.

The main goal of this exercise is to analyze the behavior of natural and artificial light, taking into consideration the type of lamps, the materials of the surfaces and the original design of the openings. Subsequently, the necessary modifications were made to optimize the behavior of the light in the internal space [3-4].The analysis was carried out through a parallel process of construction of digital models with two free softwares for light evaluation, VELUX and DIALux evo. In addition, a scale model was made with materials as similar as possible to the real ones used on the building, to make measurements with a lamp and natural light.

In the study of natural light, the model worked as a tool that allowed free experimentation and easy visualization. On the other hand, the simulation in VELUX offers the possibility of quantifying the different levels of lighting that reach the space in specific days and hours.

With the use of both strategies, it was possible to make specific modifications that allowed improving the internal lighting of the project, without producing important changes in the design and respecting the heritage building to the maximum.

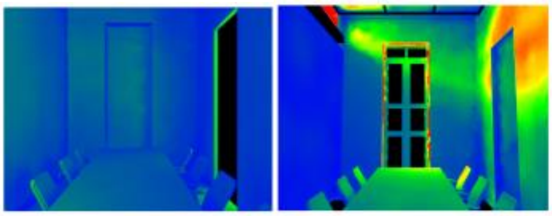


Fig. 2: Behavior of natural light before and after modifications in the internal space. Made with VELUX, by the student Lucía Flores.

Due to the original conditions of low lighting inside the project, it was necessary to make openings in different facades, as well as modifications of structure, materiality and color tests, to guarantee the entry of indirect natural light during most of the year and avoid glare in the work area.

To carry out the analysis of artificial light, the DIALux evo simulation software was used. Through these simulations, it was demonstrate that the height and distribution of the luminaires could be decisive to achieve an optimal management of both, the lighting levels and the quality of the lighting, necessary for the task within the space. In the exercise, it was noticed that, when increasing height, the amount of luxes on the work plane decreases and uniformity increases. In the opposite case, the closer the luminaires were the glare is increased.

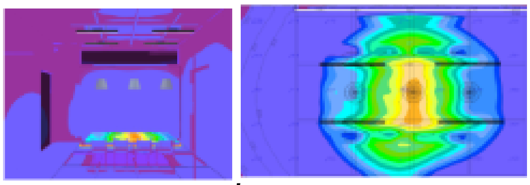


Fig. 3: Simulation of artificial light and operation of the selected luminaires. Made with DIALux evo, by the student Melissa Jiménez.

The use of tools for the evaluation of architectural projects becomes an increasingly latent need, especially in the context of a space rehabilitation project. It is necessary to be able to predict and confirm the behavior of architectural proposals to determine necessary modifications that allow a better performance of the building and energy efficiency.

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ARCHITECTURE ADAPTATION TO CLIMATE CHANGE: DATA PROJECTION AND ENERGY SIMULATION OF TWO SCENARIOS.

[1]Andrea Sancho Salas; [2]Daniel Buitrago Carazo; [3]Andrés Chacón Redondo

[4]Luis Miguel Chaves Chaves; [5]Ana Cristina Lezama Solano;

[6]Rebeca Pérez Castañeda; [7]Luis Quirós Núñez

[1]Professor and Researcher at the Tropical Architecture Laboratory, Architecture School, Universidad de Costa Rica; andrea.sancho_s@ucr.ac.cr

[2-3-4-5-6-7]Graduate. Architecture School, Universidad de Costa Rica; danielbuitragocarazo@gmail.com; andreschaconredondo@gmail.com; ccluism@gmail.com; crilezama@gmail.com; rebe.kcr@gmail.com; luchogn@gmail.com

Keywords: *Bioclimatic architecture, climate change, adaptation, simulation, projection.*

Climate change is a real phenomenon with proven evidence, it represents the biggest challenge humanity is facing [1]. In light of this issue, architecture should be able to adapt in order to guarantee hygrothermal comfort of people inside buildings, in the context of an increasingly warmer planet. If the climate changes, architecture should too.

This investigation´s overall purpose is to achieve hygrothermal comfort of people in the context of climate change in Costa Rica, by adapting selected buildings to two different scenarios, using projected data and simulation software. This project is based on the thesis of Arch. Andrea Sancho [2] which is about performance based design.

Climate change will affect the national territory entirely. However, it's necessary to identify the most vulnerable study zone by doing a three-layer analysis: ecological [3], demographic [4] and economic [5] [6]. After the definition of the study zone, possible buildings to study are listed and selected through a series of evaluation criteria such as: location, type, useful life, etc.

A bioclimatic analysis was done for every zone and building selected. In the macro scale, annual weather data as well as geographical data are analyzed, with the purpose of determining the different comfort ranges for each region. In the meso scale, a building analysis is done, taking into consideration its immediate environment; Also, an hourly weather data file is created for each region using data provided by the National Weather Institute of Costa Rica (IMN) in order to do a first simulation. In the micro scale, a comparison between the inside and the outside temperature is done, to evaluate the performance of the envelope through long term measurements.

Two case studies are selected for simulation, by doing a comparative analysis between the performance of the building in the present and in the 2080 scenario. An hourly weather data file for 2080 is created, using data from IMN and project data from The Center of Geophysical Research of the University of Costa Rica (CIGEFI), provided by Dr. Hugo Hidalgo [7] [8]. A 3D model for each building is created using DesignBuilder simulation software, each model is calibrated and thermic zones are defined.

Two proposals are developed for each building, one consists of a moderate intervention and the other is a new design from scratch. The performance of both proposals are evaluated through simulations in the software. When simulations are done the variables that modify the thermic performance on each case are defined and recommendations are proposed through guidelines and design strategies to apply with its results.

This research project pretends to address the issue of climate change through an interdisciplinary approach, where architecture crosses its traditional boundaries and interact with other academic fields. To adapt buildings and analyze its performance in the future, architects need to get involved with climate change scenarios using observed and projected data to create weather data files, with real and trustworthy scientific information.

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ADAPTATION OF THE FARNSWORTH HOUSE PORTO NACIONAL’S (BRASIL) CLIMATE

[1] Andrea Sancho Salas

[2]Julián García Muñoz

[1] Laboratorio de Arquitectura Tropical, Escuela de Arquitectura. Universidad de Costa Rica. andrea.sancho_s@ucr.ac.cr
[2] Departamento de Construcciones Arquitectónicas y su Control. Universidad Politécnica de Madrid. julian.garciam@upm.es

Keywords: *Climate, adaptation, passive strategies, dry tropics*

As part of a research project in the Máster en Innovación Tecnológica en Edificación (UPM), an adaption of a simple building to a new location was carried out, coherently using advanced passive systems. The case study was the Farnsworth House, designed by L. Mies van der Rohe and built between 1945 and 1951. The building is a volume of pure forms, with a steel structure closed with a glass façade, without natural ventilation except for the main door. Despite being an icon of the international movement, the Farnsworth House is a problematic building in what comes to its relationship with climate.

The location proposed is a plot 234 meters above sea level, in the municipality of Porto Nacional, Tocantins, Brazil. The type of climate in this area is Tropical Dry, according to the Köppen classification. [1] [2] The site is relatively flat; It is located east of the Tocantins River, with an important plant mass on its west side. This condition generates high levels of humidity despite being a theoretically "dry" site. All these conditions, as well as the annual climatic data, are decisive for the design and adaptation to the new location.

Once the climate was studied it could be noted that ventilation allowed counteracting both the high temperatures and the humidity of the area, providing a greater integral feeling of well-being. In addition, a strategy to guarantee that high external temperatures did not reach the interior of the building seemed necessary, requiring shadow elements to avoid thermal gains -but still provide indirect natural lighting. At the same time, it seemed important to use materials with high thermal inertia and to modify the roofs, since the site is one with a large rainy season.

Simulations with the Star CCM+ software were performed to evaluate the building, both in its current state and under the proposed design. A drastic improvement in air movement could be verified, proving the suitability of the strategies implemented for adequate natural ventilation. In addition, the solar path was simulated, verifying the operation of the designed eaves and the direct incidence of sunlight inside the building.

This research shows that architecture must adapt to a specific latitude and to a particular site, with its topography, vegetation and water masses, its materials and its surroundings. Simple designs are not easily adaptable to any environment, so architects must take into account all the aspects around them. Several digital tools exist nowadays that allow verifying the adequacy of every environmental adaptation, making it possible to determine, before construction, if the proposed constructive solution really solves the identified problem.

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THE LEVEL OF PREVENTIVE ACTION ASSESSMENT PARAMETERS FOR CONSTRUCTION WORKS: THE CHARACTERISTIC VALUE AND ITS INCIDENCE IN THE RISK DEGREE EVALUATION.

[1] Antonio José Carpio de los Pinos

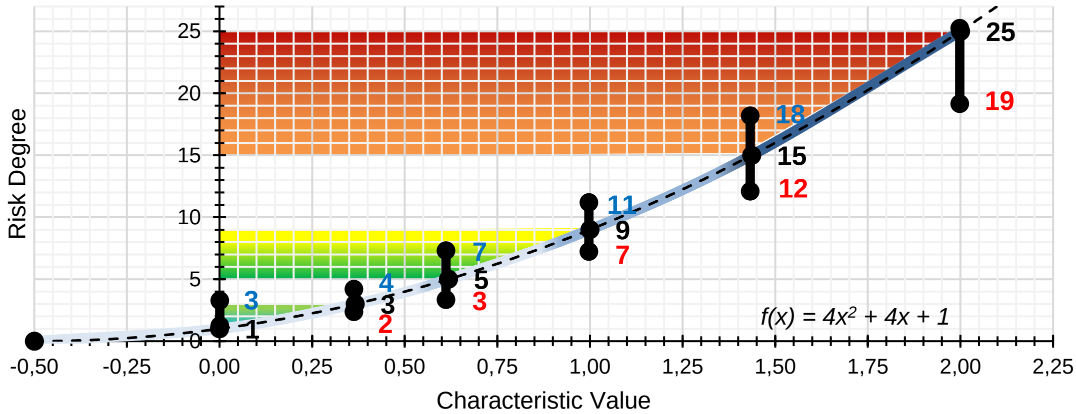
[2] María de las Nieves González García

[1] Universidad de Castilla La Mancha, antoniojose.carpio@uclm.es
[2] Universidad Politécnica de Madrid, mariadelasnieves.gonzalez@upm.es

Keywords: *Health and safety, risks assessment, building, emotional states*

The Level of Preventive Action (*Lpac*) is a methodology for assessing occupational hazards adapted to building works [1]. Its implementation is based on a mathematical formulation developed from the method of William T. Fine [2]. *Lpac* parameters observe the reality of building work in environments of the building process: initial, documentary, constructive and social; encompassing four of the techniques of fight against risk: Safety at Work, Industrial Hygiene, Ergonomics and Psychosociology. This observation determines, quantitatively, the levels of risk that correspond to the complexity of the work units, their location in the work and their interdependence [3] (in the documentary environment) [4]. Likewise, it determines, quantitatively, the levels of risk according to the characteristics of the constructive systems and preventive systems [5] (in the constructive environment) [6]. Finally, it determines, quantitatively, the levels of risk based on the perception of the environment and the emotional states of the workers [7] (in the social environment) [8]. The *Lpac* is developed in five phases from technical analysis, observation and a psychosocial survey on site. The first phase of the protocol defines an inherent characteristic value to the actual situation of the work seen in the documentary, constructive and social environments; and it is applied to each one of the parameters of the Level of Preventive Action formula. The second phase determines the incidence of the characteristic value to each of the risks that are evaluated. The third phase indicates bases prevention control with the *Lpac* value obtained relative to absolute risk, as initial deviation preventive action. The fourth phase indicates the recommendation actions. And in the fifth phase the preventive action improvement during the construction process is verified.

The characteristic value is associated with the real characteristics presented by the work unit in execution [9] on which it is going to proceed to evaluate and on each one of the parameters of the Lpac, based on the criteria of: complexity of the work unit [10], the position of the work unit, degree of risk exposure, organizational procedure, participatory interest and congruence of risk perception [11]. The characteristic value positions, with the integer values 1, 3, 5, 9, 15 and 25, the degree of risk. This characteristic value will be the minimum value of the risk associated with the real conditions of the work. Subsequently, the incidence of this characteristic value is evaluated in each of the risks to be evaluated [12] and the result may be higher or lower.



The corrected value is based on its incidence on the evaluated risk gives us a value (risk degree) that is transferred to the Lpac formula. The results determine, with quantitative criteria, the percentage or amount of preventive action that is required. Therefore, the Level of Preventive Action method is more flexible in its applicability and more sensitive to detect risks in all situations in the construction process.

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STUDY OF THE BEHAVIOR OF BASTARD MORTARS PREPARED WITH RECYCLED AERIAL AND REINFORCED WITH FIBRES

[1] Tiare García Pavón

[1] Alfredo Tuya Anyosa

[2] Pablo Saiz Martínez

[1] Carlos Morón Fernández

[1] Escuela Técnica Superior de Edificación de Madrid, ETSEM. Universidad Politécnica de Madrid. Avenida Juan de Herrera, 28040, Madrid.

[2] Departamento de Economía Financiera, Contabilidad e Idioma Moderno, Universidad Rey Juan Carlos, 28032, Madrid, España.

Keywords: *Cement, lime, recycled aggregate, fibres, bastard mortars*

The building sector is one of the largest producers of waste on the planet, however, the growing depletion of natural resources and the exponential increase in greenhouse gas emissions in industrial sectors, is having an impact on the search for new solutions constructive more respectful with the environment. There are many processes in the construction sector that are being influenced by awareness and responsibility, in the interest of greater sustainability and less environmental impact on the planet [1].

Based on this sustainability in the construction, many studies have deepened the recycling and reuse of demolition construction waste. This is the case of recycled aggregates, which have been incorporated into the manufacture of mortars by partially or completely replacing the natural aggregate, showing good results and demonstrating that it is possible to incorporate them into the sector [2] [3].

The present study studies the viability of incorporating recycled aggregates in the elaboration of bastard mortars made with two types of binders in equal parts, cement and lime. For this, the complete replacement of the natural aggregate by ceramic recycled aggregate has been carried out, with and without the addition of fibres. Two types of dosages have been carried out in 1: 3 and 1: 4 proportions, as well as, reference test pieces, adding to the mortars made with recycled aggregate five types of fibres, performing retraction, tensile, compression and hardness tests according to the brand name. current regulations. So far, the results show that the addition of fibres represents a significant improvement in bastard mortars of 1: 3 ratio, while in the 1: 4 dosage they show a negative efficiency. In addition, the incorporation of lime in the mortars has a positive effect, decreasing the retraction in the samples, an effect that is even better with the addition of fibre.

Figure 1. Tools and equipment of the Construction Materials Laboratory located in the School of Building Technology.

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THEORETICAL STUDY ABOUT THE APPLICATION OF DRONES FOR THE THERMAL INSPECTION OF BUILDINGS

[1] **Celia García González**

[2] **Pablo Martín Gallego**

[1,2] Departamento de Tecnología de la Edificación, Universidad Politécnica de Madrid, Spain; celia.garciag@alumnos.upm.es; p.marting@alumnos.upm.es

Keywords: *thermography, drone, inspection, flight pattern*

Building's world is progressing faster than other sciences with the purpose of improving the comfort of homes and energy efficiency. That is the reason why new technologies are being applied, such as BIM analysis in buildings, building monitoring, thermographic cameras or even drone applications for the monitoring and control of buildings. As for the latter, research is increasingly focusing on two aspects; first, the control of work and reduction of execution times of these. Secondly, the thermographic analysis not only of isolated facades of buildings but even the general thermal analysis of cities, reaching thermal maps of conflictive zones in large cities.

This study focuses on the last point, having as objective not only the theoretical study of the necessary technology to be able to perform the thermographic analysis of facades, but also, developing the study of the necessary characteristics to be able to perform the analysis of a facade concrete The main façade of Escuela Técnica Superior de Edificación de Madrid of the Universidad Politécnica de Madrid, located on Avenida Juan de Herrera, number 6 and whose coordinates are: 40 ° 26'20 "N 3 ° 43'55" W.

To begin this study, an analysis of the state of art was carried out, which reflected the results as that most of the energetic loss of the buildings is from the envelope [1]. Going a step further in the research, there are studies that not only focus on the external analysis of the building, also reflect that a thermographic map of the interior of the building is also necessary to carry out a good analysis of the energy losses of this as concluded by Beatriz M. Marino [2].

Carrying out this theoretical analysis, it is decided that the most appropriate technology is the use of infrared thermal imaging cameras, since it is a technology that not only allows measuring the heat loss of the building but also allows locating thermal anomalies, leaks of air or even humid areas. It is for these qualities that it is postulated as an important instrument for the diagnosis of buildings in order to improve the efficiency of these, and therefore it is a great instrument to achieve compliance with energy efficiency European Union's policies, recently published by the European Commission [3].

Therefore, in order to carry out a subsequent analysis of the material execution of the building by means of a drone, it has been concluded that hardware and software capable of supporting all the data analysis that this process entails is required. Within the physical characteristics of the drone include the pieces belonging to a surveillance drone, since they can move as lightly as possible while they are capable of carrying cameras with high weights and great definition.

This drone can be controlled by a PC or by an Android application depending on how you want to work with the connection to Arduino. As for the camera that can be attached, can support up to 100gr so it has been used as a reference model infrared camera is *Flir Boson 320x256 40mK lens 4º 55mm*. And for the control of the drone using the flight maps, the *Mission Planner* software has been used to make these maps in a very intuitive way.

In conclusion, the application of these technologies is feasible in terms of the thermal analysis of the envelope provided that high-powered professional equipment and qualified personnel are used for the handling of these materials. With this technology, you can get to analyze entire neighborhoods of large capitals and not just isolated buildings.

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THE GEOMETRIC DATA COLLECTION WITH 3D LASER SCANNER IN EXCAVATED ARCHITECTURE: EXAMPLE OF CAVE HOUSE IN THE PROVINCE OF ALMERIA.

[1] Luis Jiménez López

[2]Inmaculada Martínez Pérez

[1] Doctorando en Innovación Tecnológica de Edificación; l.jimenezl@alumnos.upm.es
[2] Departamento de Construcciones Arquitectónicas y su Control, Escuela Técnica Superior de Edificación de Madrid. UPM; i.martinez@upm.es

Keywords: *3D laser scanner, point cloud, educational software, cave house, excavated architecture.*

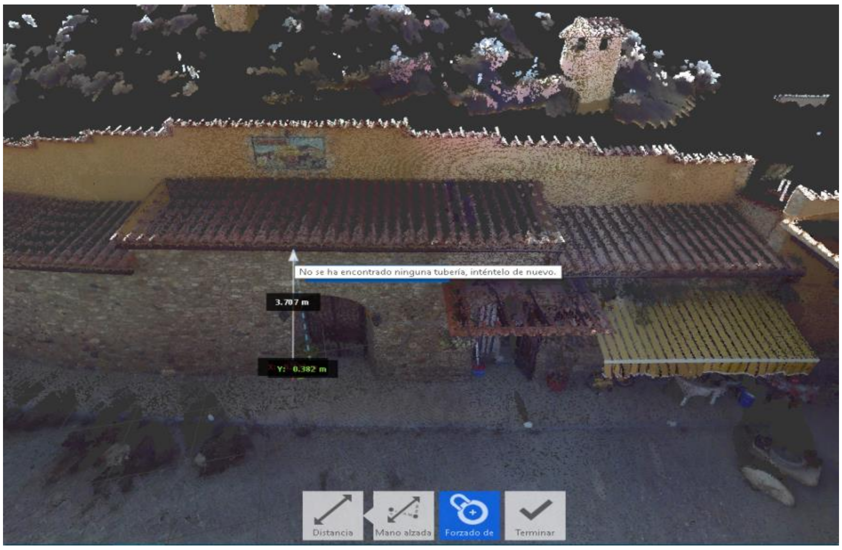
An abundance of recent research have been performed in the study of the indoor behavior on cave houses, especially in Cuevas del Almanzora (Almería), but also in different areas of Spain. Not only can be found some studies of cave houses in other areas of Almeria (Terque, Gador), but also in the high plateau of Granada (Guadix, Huescar, Galera), Alicante (Crevillente) and Valencia (Paterna), Albacete (Chinchilla de Montearagón, Alcalá del Jucar), Murcia (Puerto Lumbreras, Águilas), Toledo (Villacañas), Madrid (Tielmes, Titulcia, Perales and Morata de Tajuña), Guadalajara (Hita, Almogera); even in areas of Aragon (Calatayud) and Navarra (Agreda, Valtierra). Especially in the Canary Islands (Barranco de Guayadeque) are the one that have invested in giving concrete solutions to the legalization of different types of cave houses as housing.

Most of these areas correspond to the sedimentary Spain, easily excavated material, where unfortunately (or fortunately), were the only way out of many families to live.

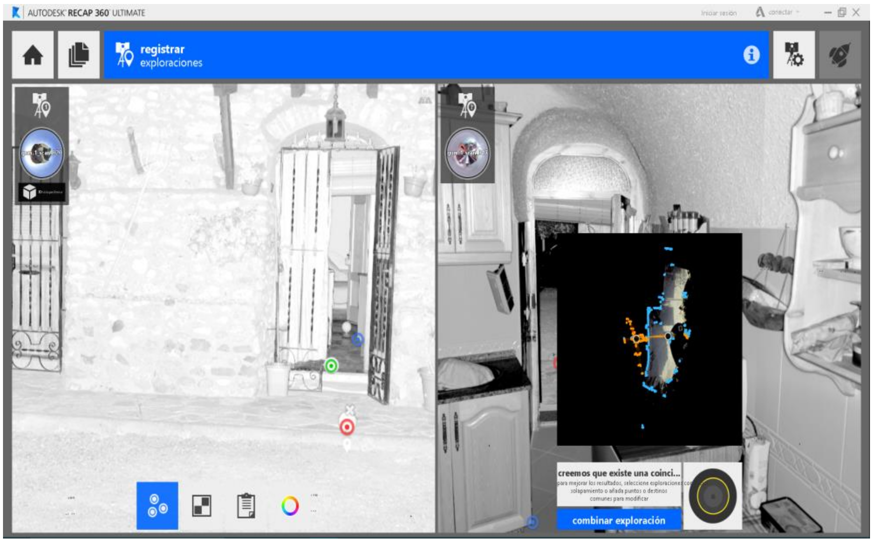
Not only this kind of constructive solution or *vernacular architecture* exists in Spain, but also in many places in the Mediterranean, such as Greece (Santorini), Tunisia (Matmata) or Turkey (Goreme valley). Furthermore, we may find other places in the Asian Continent as China (Loes) or Nepal (the caves of the cliffs in Mustang).

Many of them proceeded from medieval times, although different typologies of cave houses from Neolithic have been found excavated horizontally, even in inaccessible areas. As a result, underground cave houses have been discovered as the example of the silos of Villacañas. In brief, *it is a rich historical heritage that deserves to be preserved.*

The difficulty of data collection, ones due to being in inaccessible areas while others the need to obtain 3D models[1] for the study of the behavior, has made it required to use new technologies in the data collection, such as the use of data 3D laser scanner.



With the technique of three-dimensional digitalization, it can be obtained a 3D model of point cloud [2]. Later, with an appropriate educational software [3], we may get linear 3D models (models in BIM), necessary to simulate their behavior, such as quality of air (ventilation). Although mainly these are used to demonstrate that the necessary habitability requirements have been achieved in any type of housing and to compare them with the on-site data collection, it can be useful for other applications and studies too.



The purpose of this study is to verify the obtained results with 3D laser scanner [4] in a case of study located in the town of Cuevas de Almanzora (Almeria), both outside and inside, in order to obtain a linear model in 3D. To this effect, we have analyzed the results and we have considered possible difficulties in the use of this data collection technology.

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STUDY OF THE MECHANICAL BEHAVIOR OF PLASTER WITH LOADS OF SEPIOLITE ADDICTION AND THE PREPARATION OF PREFABRICATED PANELS

[1]Alfredo Tuya Anyosa

[2]Celia García González

[3]Engerst Yedra Álvarez

[4]Mercedes del Río Merino

[1,2,3]Master en Innovación Tecnológica de la Edificación, E.T.S. de Edificación, Universidad Politécnica de Madrid, Madrid, España
[4]Profesora: Master en Innovación Tecnológica de la Edificación, E.T.S. de Edificación, Universidad Politécnica de Madrid, Madrid, España; mercedes.delrio@upm.es

Keywords: *sepiolite, gypsum, plaster, absortion, formaldehydes*

At present, building is considered one of the most polluting activities [1], however, the sector is becoming aware and taking responsibility for the impact it generates throughout the life cycle of buildings [2].

In the development of the idea of sustainability in the construction, it has been investigated in studies related to the improvement of the conditions of comfort and improvement of the quality of life of the people. In this sense, there are many studies found that intend to incorporate sepiolite for its properties in various materials for the absorption of formaldehydes [3][4][5]. Therefore and in view of the results obtained by other authors, the design of a prefabricated panel for indoor false ceiling is proposed.

The base material of this panel will be a plaster with sepiolite load in its composition to get it to help improve the indoor air quality of the homes in which it is installed.

To achieve the objective, an experimental plan has been developed, divided into three phases:

In the first phase, gypsum and plaster were used, following the technical prescriptions of Norma UNE-EN-13279: Yesos de construcción y conglomerantes a base de yeso para la construcción [6]. Said norm, specifies the requirements that this type of material must comply with in terms of hardness, bending and compression, which are the parameters taken into account for this study.

In the second phase, the study of the behavior of prismatic specimens (4x4x16cm) of both gypsum and plaster with an A/Y = 0’8 ratio (reference specimens) was carried out. Once these specimens were analyzed, the gypsum/plaster composite material was analyzed with different percentages of addition of sepiolite (5%, 10% and 15%). Surface hardness (Shore C), bending and compression tests have been carried out on these specimens, according to current regulations [6].

Subsequently, the specimens were selected, which, in compliance with the norm, had a greater proportion of sepiolite and water, characterizing them again.

In the last phase an element for false ceiling has been designed.

The main conclusions obtained after the analysis of the results have been:

i. Sepiolite does not significantly affect the capabilities of gypsum or plaster.
ii. It can be added both to the gypsum and to the plaster in order to improve its qualities in terms of absorption of harmful substances in the air.

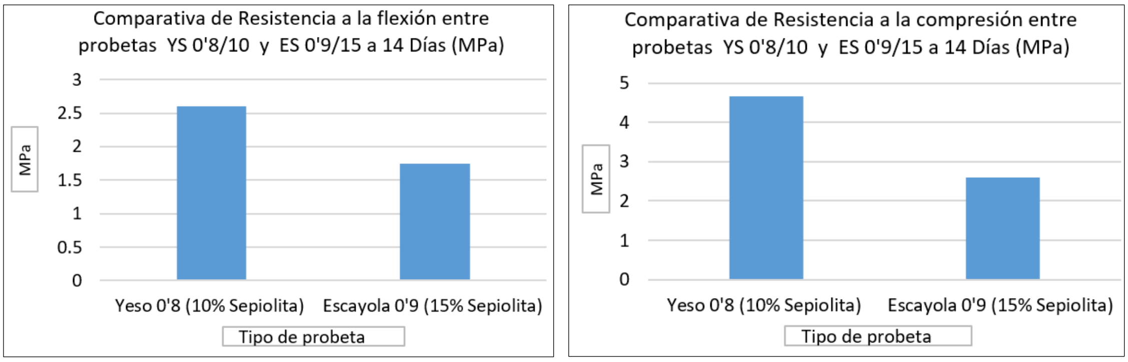

Fig.1. Comparative graphs between Gypsum 0'8 (10% of Sepiolite) and Plaster 0'9 (15% of Sepiolite)

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INNOVACIÓN EN ESTRUCTURAS DE MADERA

Tiare Garcia Pavon

[1] ***Universidad Politecnica de Madrid, tiare_30gp@hotmail.com***

Keywords: *wood, structure, innovation and construction.*

Abstract

One of the important challenges when approaching architecture and construction projects, is the choice of the materiality of the structure **[1].** It is a process that involves defining the characteristics of resistance and parameters of mechanical properties, such as elasticity, linearity of behaviour and plastic ranges, among other factors, which allow the proper development of the project and proper construction performance **[4]**.

In this context of increasingly diverse options, wood is presented as a traditional material with enormous potential, derived from a series of structural factors and, from architecture, by its appreciated aesthetic and perceptual qualities **[3].**

Despite the remarkable development of the wood industry, there are still some pending issues when addressing larger structural and architectural challenges **[2].** In this article, 4 case studies are presented, which show a step further regarding the theme of innovation in wooden structures, showing favourable results to the use of wood as a structural theme, concluding that the challenge it presents for architecture The development of wood structures is to incorporate the optimum proportion of this material in their projects, thus enhancing their formal and aesthetic expression.

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SIMULATION OF THE ENERGY DEMAND ON THE REAL ESTATE UNIT LOCATED IN VILLAVERDE (MADRID)

[1] **Pablo Martin Gallego**

[2]**Alfredo Tuya Anyosa**

[1,2]***Máster en Innovación Tecnológica en Edificación, Escuela Técnica Superior de Edificación, Universidad Politécnica de Madrid (Madrid, España);***
p.marting@alumnos.upm.es

Keywords: *Energy demand, passive design, renewable energy*

The passive design represents a solution to the energy issue in dwellings. We should highlight the existence of several elements that take belong to the field of passive design. This work aims to study de relation between the implementation of a passive design plus an active- passive design (use of renewable energy) to apply on a dwelling and the resulting energy saving. The object of study is a 100 sq. meter dwelling placed in the top floor of a seven story building in Villaverde (Madrid).

To begin Design Builder software [1] was used, that reaches just up to energy consumption issues. In order to know the contributions about energy saving, a comparative analysis between both (original and modified) Design Builder models.

3D models in Revit and SketchUp were done in order to make a preliminary analysis. Then a passive and an active- passive designs were chosen and keeping in mind the features of the base dwelling, using Design Builder software, for a first approach and analysis of the original model and the proposed one.

At the calculation phase original model's energy requirements were observed in order to be later compared to those of the modified model.

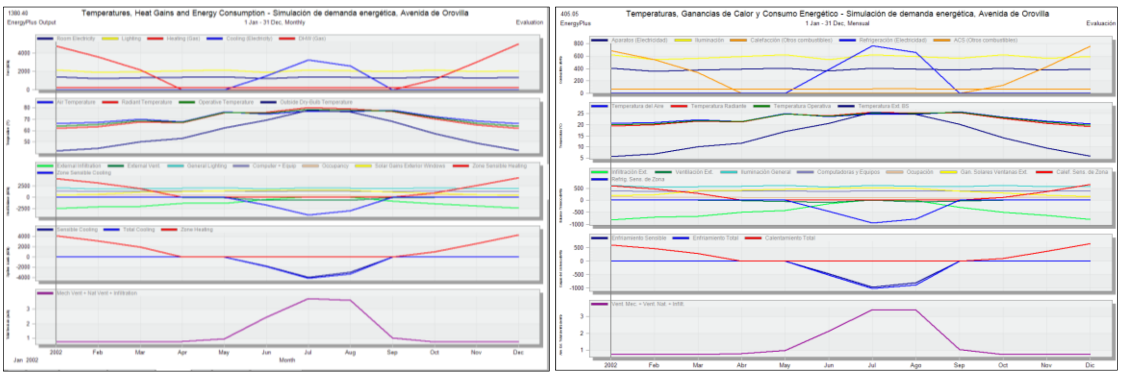

Fig.1. Simulation of the total energy demand of both original and modified models

Comparing the graphics of both situations obtained we can see a drastic reduction over energy consumption, especially in refrigeration (20%) and heating (50%). We cannot see any consumption variation in the rest of the systems because no specific measures were taken in order to reduce them (e.g. artificial lighting's energy consumption).

Heating timetables could not be reduced. Here is where active- passive design Will be indispensable, changing the fossil fuel (gas) to a renewable resource (biomass boiler), leading to a cost reduction.

In both previous systems the envelope's improvement contributes to a better inner comfort using less energy resources, decreasing electricity and biomass consumption, and leading to a bigger efficiency.

Regarding to lighting, skylights' installation would increase natural light income in the inner rooms, reducing the need of artificial light use, and leading to an energy saving.

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INFRARED THERMOGRAPHY APPLIED TO THE ANALYSIS OF THE FACADE OPENINGS

[1] Tomás Gómez Prieto

[1] Daniel Ferrández Vega

[1] Carlos Morón Fernández

[2] Jorge Pablo Díaz Velilla

[1] Escuela Técnica Superior de Edificación de Madrid, ETSEM. Avenida Juan de Herrera, 28040, Madrid.
[2] Institución Profesional Salesiana, Salesianos de Carabanchel. Ronda Don Bosco, 3, 28044 Madrid.

Key words: *Infrared thermography, facade openings, thermal bridges, metrology*

Energy efficiency has become one of the most important challenges facing the construction sector. The envelope of the building, considering as such: facades, roofs, holes, walls against terrain and slabs, is the object of study in multiple investigations that try to find the most efficient constructive solutions that allow to reduce the energy expenditure and CO_2 emissions [1].

Among all the elements described above, the facades occupy the most important position, since if we manage to reduce the transmittance through them, the demand of the building decreases as well. The facades must be designed with the intention of isolating as much as possible our buildings from outside and complying with the requirements of the Technical Building Code.

Infrared thermography has been increasingly used as an inspection technique to identify and map façade defects and their severity. The use of hygrothermal simulation to understand the dynamics of heat flow allows us to observe significant references that can help in the interpretation of thermograms under different heating or cooling conditions [2]. The detection of thermal bridges and the quantification in real time of the heat flow lost through them becomes crucial when proposing solutions that allow improving the efficiency of the building. There are many studies that address these measurement techniques, some have even tried to compare the effectiveness of current fluid dynamics simulation programs with real measurements taken with thermal imaging cameras, in order to validate the solutions proposed in the studies comparing them with measurements in situ [3].

The field of thermographic analysis has progressed rapidly in recent decades, the higher resolution of the images captured, the training of technicians in the field of energy efficiency, the new automated visual inspection drones and the simulation programs, among others, have helped to improve the solutions proposed by the technicians in order to comply with the requirements of the regulations [4-5].

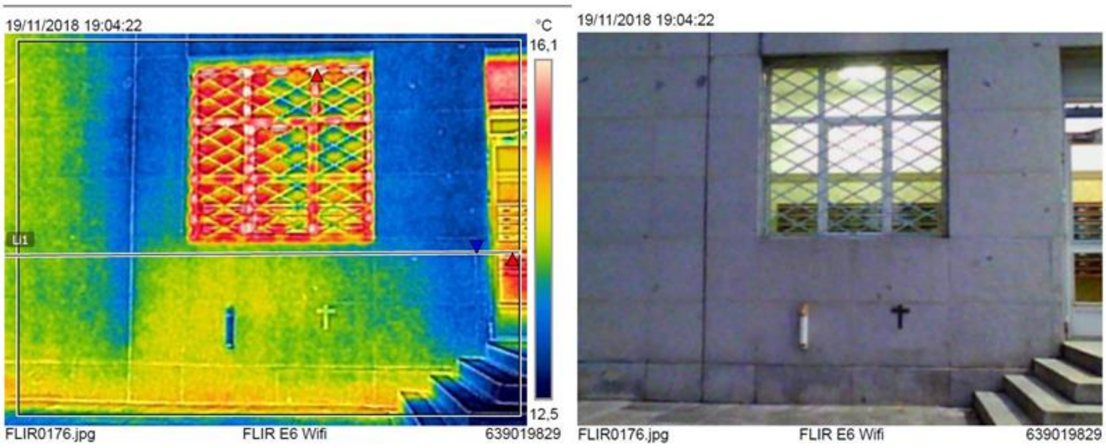

Figure 1. Image taken from an opening in the west facade of the ETSEM.

The objective of this study is to carry out a thermographic analysis of the west façade of the Superior Technical Building School. In addition, to carry out a comparative study with a thermal simulation model, using the *Design Builder* software. A *FLIR E6 Wifi* thermographic camera was used for the study. The data showed that although the wall is thick, the behaviour does not always show the desired efficiency. Since, the heat emitted from the interior comes out without too much opposition, being able to observe from the outside the zones where the radiators are. Regarding the CTE, the enclosure does not comply with current legal regulations and the simulation behaves in a better way than the field data.

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THE STUDY OF HISTORICAL CITY CENTRES WITH GEOGRAPHIC INFORMATION SYSTEMS. THE CASE OF STUDY OF THE JESUS CEMETERY OF MURCIA, SPAIN

[1] José Marín-Nicolás

[2]Mª Paz Sáez-Pérez

[1] PhD student. Program in History and Arts (Territory, Heritage and Environment), University of Granada, Spain; jomarni2@correo.ugr.es
[2] University Lecturer. Phd, Department of Architectural Constructions. Advanced Technical School of Building Engineering, University of Granada; mpsaez@ugr.es

Keywords: *Architectural heritage, geographic information system, cemetery, pantheons*

Preservation of non-monumental architectural heritage is a challenge for today's society, whose first step is the study of its characteristics, conditions and relationships. The study of large sets of samples, such as the historical city centres, raises the problem of managing a high volume of information, which should not be analysed individually in each building, but as a whole, understanding the environment as a unit.

The geographic information systems (GIS) are tool that allows managing large amounts of data related to each other and linked to their location, allowing to view successive layers of information both analytically and graphically, enabling a rational and dynamic analysis of the information.

The aim of this paper is to show the usefulness of the geographic information systems for the study of the historical city centres. For this purpose, the cemetery of Jesus of Murcia is used as an experimental laboratory, whose characteristics are similar to those of a fragment of urban area of buildings whose typological, constructive and material characteristics are similar to those of a city centre.

The methodology proposed is divided into three stages: the first stage comprises the previous documentation and creation of the data collection model, the second one includes the field work, which allows the collection of information; the third stage corresponds to the dump of the information and its processing to obtain results.

The study has allowed the obtaining of a large amount of chronological, typological, material and pathological information of the pantheons of the cemetery, which has been mapped, obtaining the relations between parameters such as the situation of the cemeteries, their antiquity, their typology or its materiality.

STRUCTURAL CHARACTERISATION AND NUMERICAL ASSESSMENT OF SEISMIC DAMAGE OF THE *CORTIJO DEL FRAILE* FARMHOUSE IN NÍJAR (ALMERÍA, SPAIN)

[1] Luisa Mª García-Ruiz

[2]Mª Paz Sáez-Pérez

[1] PhD student. Program in History and Arts (Territory, Heritage and Environment), University of Granada, Spain. lumagr@correo.ugr.es
[2] University Lecturer. Phd, Department of Architectural Constructions. Advanced Technical School of Building Engineering, University of Granada, mpsaez@ugr.es

Keywords: *Structural assessment, digital methodology, heritage*

The need to recover our built heritage and the interest in performing fully guaranteed interventions requires today the use of new technologies which allow ensuring a correct assessment and the structural validation in its new use. The present investigation focuses on the Cortijo del Fraile farmhouse, catalogued as a Bien de Interés Cultural because of its architectonic, historical and social value. It is located at the municipality of Níjar (Almería, Spain), a geografic location with high seismic risk.

Structurally, the buiding is composed by a masonry walls system of limestone and lime mortar, almost totally developed in one floor. The most of the construction was built between the 18th and 19th centuries, besides lower interventions during the 20th century until its abandonment in the sixties, what has tiggered a progressive deterioration [1] [2].

This study analyses two main aspects in the conception of any structure, done in a systematic way. On the one hand, the knowledge of its gravitational loads and, relying on that, if a stability failure is produced and where will happened. On the other hand, the structural behaviour with the adittion or real loads and and hypothetical seismic ones, just as the geometrical safety margin before the structural failure because of stability problems.

The complexity of perform this kind of analyisis on historic masonry builidings makes neccesary the use of a methodology based on digital tools. To this end, a tridimensional model of the actual status of the cortijo is done. Next, a static analysis and a dynamic analysis are made to the model by the Finite Elements Method, using the software “Abaqus” (version 2018), which allow managing a big amount of variations quickly and obtaining the results of different hypothesis.

The procedure uses a multiscale model that firstly works with an ideal piece of wall, that distinguishes the two materials that define the masonry. With it, the properties of an ideal homogeneus material with similar mechanic behaviour is defined. This one is applied to the Finite Elements model.

The results of both analysis allows determining the most sensitive areas of the structure to suffer mechanical failure by excessive strain concentration, reaching a near value to its tensile strenght and excessive desplacement or deformation.

In conclusion, the use of digital tools (specific software) accept the possibility of adopting a computer model and, despite its simplifications, knowing the resistant behaviour, its stability and the areas where executing the intervention.

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PORTAL FRAME NODES UNDER HORIZONTAL LOADS

[1] **Luis Carrillo Alonso**

[1] ***PhD. Ingeniero de Caminos Canales y Puertos. Prof. Asociado UPM.***
luis.alonso@upm.es

Keywords: *Portal frame, concrete, struts and ties model, frame beam, frame column*

Nowadays, more common building structures are formed by means of a sequence of rigid concrete portal frames, with several floor levels and spans.

Usually, in conventional buildings, the structural behaviour is governed by vertical loads. Only in case of large height towers horizontal forces are the main concern in the design [1-2].

This is not the case of structures in seismic areas, where the horizontal inertial forces generated by the ground motion cause very large bending moments and shear forces. Thus, in this type of structures the design is governed by their seismic behavior [3].

Although the best way to withstand very large horizontal seismic forces is to design structures with restrained horizontal displacement (in order to have as much as possible little displacements by means of shear walls or cross frames), there could be special designs without this capability. So, horizontal stiffness mainly could be concentrated in the columns of the portal frames [4].

Portal frames withstand horizontal forces due to rigid connection between beams and columns. In case of concrete rigid frames, the amount, the shape and the dimensions of the reinforcement need to be design with special care at nodes that connects beams and columns in order to guarantee an adequate behavior [5].

Related to previous comments, an analysis has been carried out in this paper for different types of portal frame geometries under horizontal forces. This study has been focused on developing structural models that could led to a better understanding of the structural scheme and so an specific reinforcement could be stated on each case studied.

Finit element models and strut and ties model has been proposed for each case studied. So based on those structural models reinforcement to be placed on the connection area has been calculated.

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STUDY OF THE RETRACTION OF CEMENT MORTARS PREPARED WITH ARIDES FROM CONSTRUCTION-DEMOLITION WASTE

[1] **Alberto Lage**

[2] **Pablo Saiz Martínez**

[1] **Carlos Morón Fernández**

[1] **Daniel Ferrández Vega**

[1] ***Escuela Técnica Superior de Edificación de Madrid, ETSEM. Universidad Politécnica de Madrid. Avenida Juan de Herrera, 28040, Madrid.***

[2] ***Departamento de Economía Financiera, Contabilidad e Idioma Moderno, Universidad Rey Juan Carlos, 28032, Madrid, España.***

Keywords: *Shrinkage, recycled aggregate, cement mortars*

The massive construction of buildings in recent decades and the gradual aging of the Spanish building park has led to the demolition and restoration of many buildings, so that the management of waste produced has become a challenge for sustainability in the construction sector [1].

On the other hand, the rapid depletion of natural resources and high consumption of these by the construction industry, especially in developed countries, has led researchers to study the possibility of incorporating demolition construction waste (RCD) as a substitute. of other raw materials, due to its easy availability and economy [2-3].

In this work we propose the incorporation of recycled aggregates from different waste for the complete replacement of natural aggregate in cement mortars. For this purpose, cement type CEM IV / B (V) 32.5 N was used and sands from ceramic, concrete and natural recycled materials were used for the reference specimens.

In the first phase of the project retraction tests are carried out on mortars made from cement, water, additive (if necessary) and either river sand, recycled concrete aggregate or recycled ceramic aggregate. Initially, the preparation of test pieces with said residues in arid-cement proportions 1: 3 and 1: 3.6 is proposed, maintaining in both the amount of water to be added to the mixture. The test requires specimens of very small section and high length, which makes it difficult to manipulate the specimens since it facilitates their bending. On the other hand, RILEM standardized test pieces of 4 x 4 x 16 cm were also made for bending and compression tests according to the current regulations. In addition, steel fibres were used as reinforcement of these to study their influence within the most relevant properties of masonry mortars.

Figure 1: Retraction pieces.

The results show that it is possible to carry out a complete substitution of natural aggregate by recycled aggregates in the manufacture of mortars, although it is true that the mechanical resistances are somewhat lower, and the retraction levels increase due to the greater absorption of water by part of the recycled aggregates. The steel fibre samples showed better results in all the tests.

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ARDUINO APPLICATION TO MEASURE THE MOISTURE CONTENT IN CEMENT MORTARS

[1] **Engerst Yedra Álvarez**

[1] **Daniel Ferrández Vega**

[2] **Pablo Saiz Martínez**

[1] **Carlos Morón Fernández**

[1] ***Escuela Técnica Superior de Edificación de Madrid, ETSEM. Universidad Politécnica de Madrid. Avenida Juan de Herrera, 28040, Madrid.***

[2] ***Departamento de Economía Financiera, Contabilidad e Idioma Moderno, Universidad Rey Juan Carlos, 28032, Madrid, España.***

Palabras clave: *Cement mortars, moisture sensors, natural agreement, absorption*

The way of measuring moisture in construction materials has evolved gradually. However, the study of moisture in building materials continues to have a problem in construction. The use of alternative sources for natural aggregates is becoming increasingly important [1]. More recently, sensors are increasingly being used to measure and characterize physical parameters such as temperature, relative humidity, moisture, among others. They have appeared as a promising way to monitor the behavior of the materials in building structures.

This paper suggests the Arduino as a platform to manage the information from the sensors, in order to use that information to evaluate the behavior of the physical parameters and predict any issue in structures of buildings. After appraising the results can be defined prevention plans or in other case correctional plans but with enough time to act and maintain or repair any damage on the structures.

Arduino is an open-source hardware and software company, project and user community that designs and manufactures single-board microcontrollers and microcontroller kits for building digital devices and interactive objects that can sense and control objects in the physical and digital world.

The boards are equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards or breadboards and other circuits. The boards feature serial communications interfaces, including Universal Serial Bus (USB) on some models, which are also used for loading programs from personal computers. The microcontrollers are typically programmed using a dialect of features from the programming languages C and C++. The Arduino project started in 2003 as a program for students at the Interaction Design Institute Ivrea, Ivrea, Italy aiming to provide a low-cost and easy way for novices and professionals to create devices that interact with their environment using sensors and actuators [4].

Nowadays are many researchers studying about this subject, i.e. the combination between Arduino boards and sensors, to monitor the behavior of physical parameters. For example, Juca SC, Rabelo SL, Gonçalves DL, Silva VF, Pereira RI, da Silva SA, 2018 [7], in the paper is proposed a solution to measure soil moisture, temperature and relative humidity, and implement automatic irritation, i.e. watering plants. The data is monitored with no cables, i.e. wireless, using ESP8266. This device is connected to the Arduino allowing the possibility of communication to a web server and get data remotely. The sensor used to monitor soil moisture is the Moisture Soil Sensor HL-69, and the temperature and relative humidity is used the sensor DHT-22. Another example founded, is Aizebeokhai AP, Ekumatalor IO, Oyeyemi KD, Obafemi NL [8], in this paper is proposed a similar solution monitoring just the temperature and relative humidity using also DHT-22. This system is successfully implemented in several zones of the University where the researchers are teachers or collaborators such as Chapel, Physics Laboratory, Basket Ball Court, Lecture Theater, and Cafeteria.

The objective of this work is to design an efficient system, by programming Arduino, connecting to it: sensors; through which it is possible to monitor and get the data of the optimum content in mixing water for different types of existing mortars. For this purpose, this work has been studied the evolution of water loss from cement mortars since its preparation for a specific water/cement ratio. Evaluate the system and verify if the measurements are taken reliably and quantify the loss of water that occurs inside these mortars since its preparation is also the subject of this investigation. The main objective of this work is design a system to measure the content of water in cement mortars using the Arduino platform. But before that is necessary to study the devices to use in the system, characterizing and comparing their main properties, in order to choose the proper ones and reach a viable solution and obtain the measure and quantify the loss of water that occurs inside these mortars since its preparation.

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PRACTICAL DEVELOPMENT OF A CONCEPTUAL EVAPORATIVE CLIMATIZER PROTOTYPE

[1] Jorge Pablo Díaz Velilla

[2] Daniel Ferrández Vega

[2] Carlos Morón Fernández

[3] Pablo Saiz Martínez

[1,2] Institución Profesional Salesiana, Salesianos de Carabanchel. Ronda Don Bosco, 3, 28044 Madrid, jdiaz@salesianoscarabanchel.com
[2] Escuela Técnica Superior de Edificación de Madrid, ETSEM. Universidad Politécnica de Madrid. Avenida Juan de Herrera, 28040, Madrid.
[3] Departamento de Economía Financiera, Contabilidad e Idioma Moderno, Universidad Rey Juan Carlos, 28032, Madrid.

Keywords: *Evaporative air conditioner, arduino, flowchart, programming, simulation*

There is a wise phrase that says: "what you hear, you forget, what you see, you remember, what you do, you learn". Being consistent with this reflection, this article shows the guidelines to take a project from its purely theoretical conceptual origin, to its construction and practical execution, from a pedagogical point of view and with didactic purposes so that students can use the contained in it presented. We understand that it is the best way to assimilate and fix a knowledge in a pleasant and lasting way: to learn not only with intelligence, but also with the senses.

The technology chosen to try to achieve the above objective is evaporative cooling, widely used in the building sector in industrial environments and large tertiary type buildings. This technology is the optimal response to combine efficiency in the objective sought in terms of thermal comfort (reducing high room temperatures) and the reduction of energy consumption (energy efficiency) [1-2]. You could say that it is the same principle of cooling that our body uses when moisture (sweat) evaporates and refreshes our skin. In addition, in order to promote sustainable development and increase the energy efficiency of the air conditioning equipment in the building as future legislation will indicate, it will encourage its integration with renewable energies (such as photovoltaic solar energy).

The practical format to approach this technique, focusing on the associated regulation and control maneuvers, is to fully develop an operational prototype of evaporative air conditioner. To the object besides not incurring in very high costs of investment in equipment, sensors and computer hardware, it is going to resort to low cost devices such as automatons of the firm Arduino [3], all its ecosystem of sensors and actuators, rechargeable batteries connected to small photovoltaic solar panels, recycled PC fans and plastic housing for domestic use. From the point of view of the software, it will be opted for free software that can be installed locally or in online versions. The stages that will be followed sequentially are the following:

1. Conceptualization of the manoeuvres to be performed by the automaton that regulates said air conditioner, through the use of control flow charts materialized with the *PSeInt* program.
2. Programming of these manoeuvres in a visual environment of generation of code by blocks, through the freeware *Facilino*, whose foundations are based on the platforms of *Visualino* and *Scratch*. Its name makes unequivocal allusion to its ease of use, but it does not have a less powerful processor: on the contrary, the extensive library of preprogramed manoeuvres, make it a tool of undoubted utility.
3. Dynamic simulation of the programmed manoeuvres and *CAD* tracing of the precise wiring for the power supply of the equipment and interconnection of installed sensors, thanks to the *TinkerCAD Circuits* website.
4. Construction of the complete prototype according to the theoretical criteria previously shown and submission to a battery of real tests (calibration, operation, sensitivity analysis, infrared thermography) to corroborate its proper functioning.

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MEASUREMENT OF BENDING IN CONSTRUCTION BEAMS- FRP REINFORCED CONCRETE BEAMS

[1] Jun Deng

[1] Carlos Morón Fernández

[2] Pablo Saiz Martínez

[1] Alberto Morón Barrios

[1] Escuela Técnica Superior de Edificación de Madrid, ETSEM. Universidad Politécnica de Madrid. Avenida Juan de Herrera, 28040, Madrid.

[2] Departamento de Economía Financiera, Contabilidad e Idioma Moderno, Universidad Rey Juan Carlos, 28032, Madrid, España.

Keywords: *FRP reinforced concrete beams, cathode-ray oscilloscope (CRO), lissajous curve*

The FRP reinforcing bar, which is a structural reinforcing bar made form filaments or fibers held in a polymeric resin matrix binder. The FRP bar can be made from various types of fibers such as glass (GFRP) or carbon (CFRP). FRP bars have a surface treatment that facilitates a bond between the finished bar and the structural element into which they are placed. FRP Bars are intended for use as concrete reinforcing in areas where steel reinforcing has a limited life span due to the effects of corrosion. They are also used in situations where electrical or magnetic transparency is needed. In addition to reinforcing for new concrete construction, FRP bars are used to structurally strengthen existing masonry, concrete or wood members [1].

FRP bars are a new type of structural material for the civil engineering community. The basic constituent materials for reinforced concrete design have changed very little in the past 100 years. Traditionally, composite materials have been used extensively in aerospace and consumer sporting goods where their high strength to weight characteristics were first exploited. Corrosion of steel reinforcement in concrete structures causes deterioration of concrete resulting in costly maintenance, repairs and shortening of the service life of structures. Government agencies throughout the world have recognized the potential benefits to society if our infrastructure can last longer and are thus funding significant amounts of research in the field of FRP's [2] [3].

In this paper, the bending resistance of FRP reinforced concrete beams is measured by the bending moment effect using tools such as Cathode-ray oscilloscope (CRO) and using a parallel plate capacitor to detect small displacements of the beam under pressure. CRO cathode ray oscilloscopes are used to measure small deformations of beams at different pressures. And parallel plate capacitors can detect changes in capacitance by different metal electrode spacing. The frequency is measured by the oscilloscope's Lissajous curve and compared to its theoretical frequency. In addition, according to the stress test results of the beam, the finite element analysis was performed using the constitutive material model of ordinary concrete to simulate the bending behavior of these beams. The simulation results are then used to determine the accuracy of the constitutive model used to predict the performance of FRP reinforced concrete beams.

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PLASTER REINFORCED WITH FIBERS FOR THE PREPARATION OF PREFABRICATED PANELS

[1] Manuel Álvarez Dorado

[1] Daniel Ferrández Vega

[1] Carlos Morón Fernández

[1, 2] Jorge Pablo Díaz Velilla

[1] Escuela Técnica Superior de Edificación de Madrid, ETSEM. Universidad Politécnica de Madrid. Avenida Juan de Herrera, 28040, Madrid.
[2] Institución Profesional Salesiana, Salesianos de Carabanchel. Ronda Don Bosco, 3, 28044 Madrid.

Keywords: *Plaster, natural fibers, synthetic fibers, prefabricated panels*

Within the construction materials, gypsum and plaster occupy a privileged place, since it is difficult to conceive a building without the presence of one of these two elements. Due to its low cost of obtaining, since they are extracted directly from nature (algez stone) and almost does not need previous treatment unlike cement, it is a material of quick application, easy to handle and aesthetically well considered, characteristics that they become one of the most used resources for the execution of interior finishes, coatings and partitions [1].

For several years now, the behaviour of plasters has been studied by adding fibres, both natural and synthetic, with the aim of improving the mechanical performance that this material offers and mainly for the execution of prefabricated. While until now the use of artificial fibres of polypropylene, glass, etc ... was the most common, due to its good performance and price [2-3], more and more natural fibres are experimented with to improve properties of this type of materials and be more respectful with the environment environment.

Natural fibres are the best option for its easy and renewable production. They are materials whose production is not exclusive of the building, but all the parts of the plant are used for different applications. But natural fibres are just one of the different additives that we can find. Regarding the addition of fibres, some authors showed that treated hemp fibre basically achieved mechanical results very similar to plasters with addition of plastic fibres such as polypropylene, which is a clear indication that there are possible and sustainable alternatives to improve the quality of life without harming us in other areas [4]. Other fibres such as coconut, nut husks or similar, have also been used by various authors [5], which after several thermo-mechanical tests, have been able to clarify that its good adhesion to the plaster matrix improves its tenacity and insulation thermal.

Therefore, it is interesting to make a comparison between the types of fibres most used in the market today, and establish a relationship between the results obtained according to the origin of the fibre used.

The following work shows the results obtained from the characterization of E35 plasters reinforced with fibres and tested according to the current regulations. For this, both natural fibres (straw and wood) and artificial fibres (glass, polypropylene and basalt) have been used, with two different water / binder ratios: 0.6 and 0.8. Mechanical characterization tests have been carried out such as flexion, compression, humidity by capillarity and hardness. In addition to these tests, they were also subjected to thermal and acoustic tests. Natural fibres obtained a better result in terms of thermal resistance, while fiberglass and basalt obtained the best results in terms of mechanical strength.

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AN IMPROVEMENT IN CONSTRUCTION PLANNING: LAST PLANNER SYSTEM ®

[1]Miguel Ángel Álvarez Pérez

[2]Manuel Soler Severino

[3]Eugenio Pellicer

[1]Ms. Architect, PhD. Candidate DCTA, Escuela Técnica Superior de Arquitectura, Universidad Politécnica de Madrid. miguelangel.alvarez.perez@alumnos.upm.es
[2]Dr. Architect, Associate Professor DCTA, Escuela Técnica Superior de Arquitectura, Universidad Politécnica de Madrid.
[3]Dr. Civil Engineer, Professor and Director of the Escuela Técnica Superior de Ingenieros de Caminos, Canales y Puertos,Universitat Politècnica de València.

Key Words*: Planning, last planner system ®, lean construction.*

For approximately five years, the Last Planner System ® has been used more and more in Spain, due to the improvement that its use produces in the productivity of construction, reaching better results in the achievement of the objectives: Cost, time and quality of the projects.

It was Professors Glenn Ballard and Greg Howell of the Berkeley University in California, United States, who in the early 90s of the Last Century investigated a form of work planning within the Lean Construction philosophy, which were more appropriate with the special characteristics of the construction process.

In 2.000, Professor Glenn Ballard presented his Ph. Doctoral Thesis at the University of Birmingham (United Kingdom), entitled: "The Last Planner System of Production Control", where he gives definitive form to the methodology [1].

In 2.011, the authors: Rodriguez Fernández, A.D.; Alarcón Cárdenas, L.F .; and Pellicer Armiñana, E.; published an article in the Revista de Obras Públicas, Órgano Profesional de los Ingenieros de Caminos, Canales y Puertos de España, on the subject, entitled: "La gestión de la obra desde la perspectiva del último planificador"(http://hdl.handle.net/10251/29189) [2].

Lean Construction contributes with numerous associate techniques to improve the constructive process, and one of them is Last Planner System ®.

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THE ARCHITECTURAL EXPERT PROOF REPORT ON LEGAL ACTION FOR CONSTRUCTIVE DEFECTS. THE SYNCRETIC METHOD VERSUS THE ANALYTICAL METHOD

[1]Ignacio de Luis Otero

[1]Lawyer. Associate Procedural Law Professor at the UCM; igluis@ucm.es

Keywords: **expert proof report, syncretic, analytical method**

Keywords: *Expert proof report, syncretic, analytical method*

When exercising legal action on liability for construction defects, it is possible to exercise the ten-year liability action or for housing ruin, in accordance to the provisions of article 1591 of the Civil code as well as the Building Management Act, directed against the builder and/or promoter as well as against the surveyor and the architect [1].

In our civil process the general rule of the principle device applies by which the parties are responsible for the task of pleading, setting and proving the facts that support their respective claims.

To certify the alleged claims, the plaintiff and the defendants (constructor, promoter, technical architect and architects planner and/or auxiliary director), even though optional, however, for reasons of obvious procedural strategy they tend to turn to the expert test by architects and technical architects in order to obtain a technical opinion on the existence or scope, where appropriate, of such deficiencies, and solutions, with the assessment of the costs concerned.

However, does every expert method turn out to be conclusive?

Subsequently, a question arises regarding the expert method to be used in the case of Super-communities, associated or big urban developments, where it is possible to presume that the shortcomings recur in the different properties.

There are several options [2]. Firstly, the empirical-analytical method, that requires the observation and verification of the shortcomings and, in some cases, their statistical analysis. Thus, the empirical data es drawn from the tests and their results, the own experience.

One might also bring the realization of the pathology by the inductive method, from particular to general.

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PELLET OPTIMIZATION IN BLAST FURNACE TO OBTAIN CONSTRUCTION STEEL

[1] Alberto Morón Barrios

[1] Carlos Morón Fernández

[1] Daniel Ferrández Vega

[2] Pablo Saiz Martínez

[1] Escuela Técnica Superior de Edificación de Madrid, ETSEM. Universidad Politécnica de Madrid. Avenida Juan de Herrera, 28040, Madrid.
[2] Departamento de Economía Financiera, Contabilidad e Idioma Moderno, Universidad Rey Juan Carlos, 28032, Madrid.

Key words: *Infrared thermography, facade gaps, thermal bridges, metrology*

An increase in green pellet plasticity leads to a decrease in bed permeability in the drying zones. Therefore, green ball properties such as the elastic-plastic deformation during compression needs to be studied the behaviour as well varying their content of bentonite, water or the use of different ore [1-4]. This work describes a method to determine simply the plastic deformation of green pellets and the examine the effect of moisture, bentonite content and ground ore size distribution on the green ball mechanical strength curve.

The current method of measuring pellet elasticity is using the d100 parameter, which simply returns the deformation experienced on a pellet at 1 N. This doesn't truly determine the elastic to plastic transition. The aim of this study is to examine the mechanical resistance of green iron ore pellets to compression and to characterize better the elastic to plastic transition of different pellets batches as well as the study of pellet properties. Consequently, a 5 kg lab scale installation, will be used to perform series of tests to study the above mentioned topics. These series will include mixtures produced with ores with very different PSDs i.e. ores meant for production of pellets versus ores meant for production of sinter. The results will be evaluated in terms of green ball properties as well as final pellet cold strength and quality [5-7]. To minimise the variability in the pellets and the amount of material used, the pellets are made using a small balling disc along with an ore vibratory feeder.

This work established two more reliable evaluation models, which can describe the green pellet plasticity. Also, a new measuring device for the characterization of green pellet viscodamage was built and a new measuring method for green pellet plasticity was developed.

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THE PRESTRESSED IN BUILDING. EVOLUTION AND ADVANTAGES AGAINST REINFORCED CONCRETE

[1]Alfonso Blasco Gutiérrez

[1]Arquitecto Técnico. Escuela Técnica Superior de Edificación

Key words: *Concrete; Prestressed; Wire; Residual stress*

he prestressing of concrete using pre-stressed reinforcement is one of the most widespread techniques in the prefabricated concrete industry. This technique consists in tightening the reinforcement before to the concreting of the structural element, proceeding to the unstressing once the concrete has reached a certain resistance. By means of the unstressing operation, the prestressing force introduced into the reinforcements is transferred, by adhesion, to the concrete.[1]

The prestressing presents its disadvantages. In order to make the armature tensioning, special and expensive installations are needed, so the system is only used in certain industrial applications. Another disadvantage is that the armatures, of small diameter and very tight, are more sensitive to corrosion.[2]

Sometimes it cannot be established which is the most suitable structural concrete technique for its application in a certain structure, since it depends on several factors.[3]

This paper shows the advantages of using this technique with respect to other more conventional techniques such as reinforced concrete, and gives a vision of where it can and should evolve to settle permanently in the world of building.

Figura 1: Colocación de piezas prefabricadas en la Estación marítima de Le Havre. Primer triunfo del pretensado.

It shows how the prestressing technique is being combined with new innovative types of concrete, such as lightweight high performance concrete, or ultra high performance concrete, or seeking sustainability in the use of concrete, demonstrating that prestressed concrete It is a clear commitment to the future of structures.

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LATER ACTION TO THE DOCTORAL THESIS "EXPERIMENTAL MECHANICAL CHARACTERIZATION OF A STRUCTURAL LIGHTWEIGHT CONCRETE"

[1]Dr. Fernando Israel Olmedo Zazo

[1]Universidad Politécnica de Madrid

Keywords: *Patent, lightweight concrete, formwork*

The publishing of a Doctoral Thesis [1] has two main goals. In the one hand, administrative qualification to have access to specific universitary educational places. In the other hand, to research about a specific side of scientific interest. The resaults are spread by scientific journal [2, 3, 4] or the presence to scientific divulgation [5, 6]. According to the specific results of the research, theses could lead to the formulation of a scientific Theory, an action protocol, even a patent.

The obtained result during the experimental phase enable see the behaviour of different types of multilayer beam, and the strength of the concrete layer which form them. In addiction, the behaviour of same types of beams according to the way they were pouring was studied. The main conclusion of all it is that multilayer beams with 5 cm of regular concrete at the external layers, poured one layer continuous to the previous layer, lead to the best results. In the same way, the strength of the internal layer has hardly influence in the beam behaviour.

All this leads to the necessity of developing a low strength concrete to form the internal layer, and a formwork system which allow a continuous pouring.

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OPTIMIZING THE THERMOMETRIC METHOD TO ASSESS THE THERMAL TRANSMITTANCE OF FAÇADES IN ENERGY AUDITS

[1] David Bienvenido-Huertas

[2]Carlos E. Rodríguez-Jiménez

[3] David Marín

[4]Juan Moyano

[1] University of Seville, TEP 970, jbienvenido@us.es
[2] University of Seville, TEP 970, ceugenio@us.es
[3] University of Seville, TEP 970, damar@us.es
[4] University of Seville, TEP 970, jmoyano@us.es

Keywords: *Thermal transmittance, thermometric method, façades*

Greenhouse gases emitted to the atmosphere due to the high energy consumption have contributed to climate change and the degradation of the ecosystem. Under these circumstances, the European Union has established a series of objectives to obtain a low-carbon economy [1]. In this context, building sector plays a fundamental role. The energy consumption related to such sector is among the highest because it is responsible for the 40% total energy consumption at a global level [2]. Likewise, such consumption generates 38% of greenhouse gas emissions [3]. For these reasons, the European Union has established that the existing buildings are needed to reduce their emissions by 90% [1].

This is due to the deficient behaviour of the existing buildings' envelope because its thermophysical properties significantly influence the energy consumption [4–6]. From the different elements of the envelope, the façade is where the buildings suffer greater energy losses, since façades are the element of major surface having heat transfer with the external air [7], whereas thermal transmittance is among those thermophysical properties with the highest impact on the energy demand [8,9] because it allows heat losses with the external air to be reduced [10,11]. Thus, determining the thermal transmittance correctly is essential to suggest adequate energy conservation measures, thus reducing the energy consumption and greenhouse gas emissions. To determine the U-value, there are many methods, both theoretical and experimental. One of the most used experimental methods by professionals is the thermometric method [12]. Such method consists of determining the U-value of an element by measuring external and internal ambient temperatures, as well as the internal surface temperature of the element. To do this, the equation of the average method from ISO 9869-1 is adapted by applying the Newton's Law of Convective Cooling, obtaining therefore the equation for the thermometric method. There were no research studies developing such method, but its potential and limitations have been highlighted in the last year [12–14]. However, despite the progress of this method in the research field, there is disparity concerning the type of analysis used. This study analyses the feasibility of using different theoretical approaches for the method by analysing 20 case studies. To do this, 9 formulations were suggested by using various approaches for the internal convective heat transfer coefficient. Moreover, two approaches of data analysis (arithmetic mean of the instantaneous measures and mean of the sum of the numerator and denominator) and the data filtrate required to be applied were assessed. The results determined the most acceptable analysis configuration to apply the method.

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EXPERIMENTAL STUDY ON RUBBER AS CARBON FIBER REINFORCED BEAM REPAIRING MATERIAL (AGGREGATE REPLACEMENT)

[1]Jun Deng

[1] Student of Master, School of Building Engineering.
Polytechnic University of Madrid, Av. Juan de Herrera, 6, 28040, Madrid,
jundeng6@outlook.com

Keywords: *Rubber concert, recycled material, compressive strength, rehabilitation*

With the development of the automobile industry, the "black pollution" of used tires has become an increasingly serious environmental problem. The application of rubber particles in concrete building materials is of great value in researching the utilization of used tires, conserving resources and improving the performance of cement concrete building materials. In order to improve the adhesion of the interface between the rubber particles and the cement colloid, the rubber replaces the fine aggregate in the concrete beam material. In this paper, the rubber is used as a fine aggregate to be incorporated into concrete building materials for beam repair [1-2].

At the same time, the effects of different proportions and different particle size of waste tire rubber particles as fine aggregates on the performance of cement concrete were studied. According to the change of its performance, determine the optimum rubber content and the optimum particle size. On the basis of the optimum rubber content and the optimum particle size, the comparative analysis of the pressure resistance to see the permeability [3-5].

The results of interface modification show that the surface treatment of rubber particles with NaOH solution and silane coupling agent is sensitive to the particle size of the rubber and the concentration and amount of the solution. The water-washing rubber particles are simple in operation and low in cost, and can still greatly improve the compressive strength of the cement mortar, so it can be determined that the water washing method is the best rubber interface treatment method.

Therefore, it is determined that the water washing method is the best rubber treatment method. The results of mechanical properties of rubber concrete show that the compressive strength of concrete decreases with the increase of rubber content. The flexural strength did not change significantly at the 10% rubber content. However, after the mechanical properties are greater than 10%, the decrease is quickly. The toughness of rubber concrete increased during the test. However, the flexural modulus of rubber concrete decreases and the drop is particularly pronounced at 10%. A decrease in modulus will result in a decrease in temperature and load bearing stress. Its impermeability increased at 10%, and then decreased.

Therefore, according to the trend of the performance of the concrete with the amount of the change, it is determined that the 10% rubber content is the optimum amount. The difference in rubber particle size has different effects on the mechanical properties of rubber concrete. With the decrease of rubber particle size, the compressive and flexural strength of rubber concrete has decreased to varying degrees, and the bending modulus is improved. Therefore, for cement concrete pavement, rubber particles with an average particle size of 3 mm should be used. Under the optimal rubber content and optimum particle size, the rubber particle cement concrete mix ratio design is carried out. Compared with ordinary unfilled concrete, the rubber reinforced concrete has less change in flexural strength and a large decrease in flexural modulus. Fatigue and anti-vibration performance are improved, and rubber has little effect on the wear resistance of the concrete surface.

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DIRECT TENSILE STRENGTH OF POLYOLEFIN FIBER REINFORCED CONCRETE

[1]Álvaro Picazo, [2]Raquel Pérez, [2]Marcos G. Alberti,

[2]Alejandro Enfedaque, [2]Jaime C. Gálvez

[1]Departamento de Tecnología de la Edificación, E.T.S de Edificación, Universidad Politécnica de Madrid. Av. Juan de Herrera, 6, 28040, Madrid.
a.picazo@upm.es
[2]Departamento de Ingeniería Civil: Construcción, E.T.S de Ingenieros de Caminos, Canales y Puertos, Universidad Politécnica de Madrid. C/ Profesor Aranguren, s/n, 28040, Madrid.
r.perezd@alumnos.upm.es; marcos.garcia@upm.es
alejandro.enfedaque@upm.es; jaime.galvez@upm.es

Keywords: *Reinforced concrete, polyolefin fibres, direct tensile strength test, digital image correlation.*

Concrete is a construction material that boasts great versatility in the shapes that it can adopt. Its early stages of development might be dated back to Romans [1]. Regarding its mechanical properties, concrete is known by its remarkable compression strength although it has a reduced ductility and tensile strength [2]. Traditionally, such lower properties have been improved using steel bars forming reinforced concrete (RC). More recently, randomly distributed short fibres have been added to concrete while mixing creating fibre reinforced concrete (FRC). By any of the previously mentioned options, the merger of the concrete properties together with the ones provided by the localized reinforcement of RC or by the continuous reinforcement of fibres of FRC have created a material suitable for a wide range of structures.

The fibres added to concrete can be manufactured with several materials such as steel, natural substances or even polymeric compounds [3]. Depending on the fibre type and dosage, fibres might not only improve the concrete behaviour when subjected to fire or prevent shrinkage cracking [4] but also might be considered in the structural design. This last option can be carried out only if certain requirements set on standards and recommendations are met [5-6].

The requirements established in the standards refer to the material behaviour obtained by means of laboratory tests of concrete subjected to flexural tensile stress states. Nevertheless, the relation between the flexural and tensile behaviour of a FRC is a matter that is still not fully understood. Furthermore, the influence of the distribution and orientation of the fibres within the concrete matrix is a matter that deserves being studied [7]. It is important to relate the design parameters and the production conditions with the mechanical behaviour of concrete [8].

With the aim of relating the flexural and tensile behaviour of FRC an experimental campaign performed in polyolefin fibre reinforced concrete has been carried out by using the setup that can be seen in Figure 1. Three types of concrete were studied, two with fibres of 60mm length, one vibrated and other self-compacting, and the third type with long polyolefin fibres. In all cases, the volumetric fraction was 0.66 (6kg/m^3). The setup was complemented with a digital image correlation analysis that permitted to study the surge and coalescence of cracks during the tests.

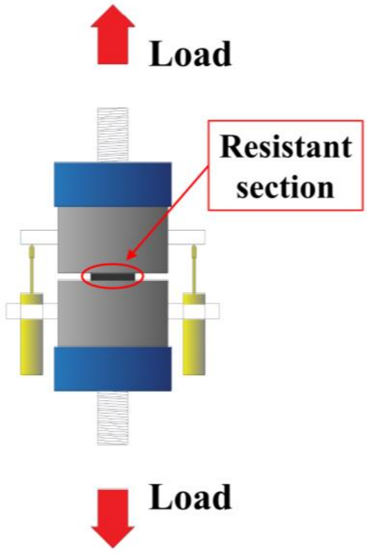

Figure. 1: Direct tensile test outline.

The results showed that the addition of fibres were capable of bearing the stresses borne by the concrete matrix avoiding the collapse of the specimen. In addition, the relation of the experimental results and the distribution and orientation of fibres was determined. Regarding the image analysis it could be proved that such technique was suitable for obtaining reliable results.

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CRITERIA FOR THE EVALUATION OF THE SUSTAINABILITY IN CONSTRUCTION COMPANIES

[1] **Martín Alejandro Campos González**

[1] ***Universidad Politécnica de Madrid; mcamposgzz@gmail.com***

Keywords: *Building, standards, methodology, parameters, sustainability*

This research presents some of the most prevailing methodologies used by enterprises to measure their operative sustainability level. These methods were extracted from the analysis performed to establish the indicators, plus the quality and quantity measurements frequently applied, as the degree of intervention and corporation responsibility on the sustainable terms [1-3].

The analysis is based upon a study realized into Spanish construction companies; whose involvement goes from building, management, funding, development and real state, to participation on service, engineering and technological areas [4-6].

The first aim of this study resides on answering the question of "How does a company performing in the building scope can become sustainable?"; while on the other hand, due to the great number of standards and indicators, establishing the general parameters that consider the three features to acquire a sustainable development: economic, social and environmental.

These parameters are set up as a guideline for building organizations, from an administrative perspective, by providing them the minimal aspects necessary to evaluate the involvement of its activities in sustainability.

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DIGITAL DESIGN AND FABRICATION OF CLUSTERS OF COMPLEX, EFFICIENT AND CONTINUOUS ARCHITECTURAL SURFACES

[1] Andrés Miguel Rodríguez

[2] Jesús Anaya

[1] Architect, MSc. Phd Candidate. ETSAM. Department of Construction and Architectural Technology. Universidad Politécnica de Madrid.
andresmiguel.rodriguezr@alumnos.upm.es
[2] PhD. Architect. Prof.UPM. ETSAM. Department of Construction and Architectural Technology. Universidad Politécnica de Madrid.
jesus.anaya@upm.es

Keywords: *Morphology, digital design and fabrication, complex surfaces, membrane structures.*

The emergence of digital design and edition tools in architectural production has allowed the development of typologies and forms that were extremely complicated to draw and represent previously. They are based on surfaces with high degree of formal indetermination and complexity, in which the geometry is a fundamental analytic and support tool for their accomplishment and understanding. All this, in conjunction with the implementation of digital manufacture technics, has enabled that architect and engineers can materialize elements with great formal and programmatic complexity and efficient structural behaviour.

The application to architectural production of the principles that are present in the morphogenesis and epigenesis of minimal surfaces with crystalline structure [1], triply periodic minimal surfaces [2], especially those that contain straight lines, is of interest to the digital design, edition and manufacture of new architectural solutions based on continuous, complex and efficient surfaces with high prefabrication degree. These surfaces emerge from a simple hyperbolic patch when the operations of the associated crystallographic group related to Bravais lattices are applied to it, and produces a tiling of Euclidean three-dimensional space. This patch is an n-sided skew polygon, whose borders can correspond to those straight lines previously mentioned, and in many cases, these patches could even be identified with doubly ruled surfaces, with the advantages that this implies.

Different authors have investigated these surfaces since nineteenth century and they have presented different construction methods and varieties of surfaces. Schwarz [3], Neovius, Schoen [4], Fischer and Koch [5], Karcher and Polthier [6], Lord and Mackay [7], Weber and Fujimori [8] stand out among all of them. In twentieth century, many architects have made different architectural research and proposals related to these surfaces or similar surfaces. This could be observed in the works of Haussermann, Chanéac, Michael Burt [9], Peter J.

Pearce [10], Haresh Lalvani, Ami Korren [11], Toyo Ito, Vlad Tenu, Leeser Architecture, Vincent Callebaut, UNStudio and Studio RAP.

The research present how can be obtained and fabricated a great variety of new modular architectural typologies, that even can constitute complex and porous clusters, with advanced digital design and manufacture methods, as the additive 3D printing. They will be formed by complex, continuous efficient surfaces with high replicability level through the application of the principles that are present in the construction of triply periodic minimal surfaces, especially those that contain straight lines and whose patch can be assimilated in some cases with doubly ruled surfaces. Likewise, conclusions that connect their geometry and their adaptive deformation capability with the digital fabrication method and its limits will be investigated.

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PROYECTOS DE GENERACIÓN ELÉCTRICA DE ORIGEN GEOTÉRMICO EN ALEMANIA: ANÁLISIS ECONÓMICO DE UN CASO DE ESTUDIO APLICANDO EL MÉTODO DE LAS OPCIONES REALES

[1] José Balibrea Iniesta

[2]Yilsy M. Núñez Guerrero

[3]Carlos Rodríguez Monroy

[1] Universidad Politécnica de Madrid e-mail: jose.balibrea@upm.es
[2] Universidad Politécnica de Madrid e-mail: ym.nunez@upm.es
[3] Universidad Politécnica de Madrid e-mail: crmonroy@etsii.upm.es

Keywords: *Energías Renovables, Valoración de Proyectos, Opciones Reales; Sostenibilidad*

No es novedad que las energías renovables estén siendo la fuente energética hacia donde se están apuntando los esfuerzos por parte de los diferentes países para mitigar el impacto ambiental negativo que han generado años de uso de energías provenientes de fuente fósiles. En este sentido el gobierno alemán ha desarrollado un marco regulatorio para el desarrollo de los proyectos de generación eléctrica de origen geotérmico. Esta Ley de Energías Renovables (Renewable Energy Sources Act EEG) entró en vigor el 01 de abril de 2000. En junio de 2011 el Bundestag aprobó una modificación a esta ley que entró en vigor el 01 de enero de 2012 (Renewable Energy Sources Act EEG 2012) [1]. Esta investigación analiza este marco normativo y se enfoca en las opciones que se les presentan a los promotores que son susceptibles de valoración aplicando la metodología de las opciones reales. En particular, el trabajo se analiza la influencia que dicho marco regulatorio tiene sobre la valoración de la energía de origen geotérmico. Dadas las opciones que incorpora esta regulación, se ha creído oportuno incorporar a la valoración de proyectos el efecto de dichas opciones reales. Dentro del ámbito de las opciones reales, los proyectos de inversión pueden ser medidos como un conjunto de opciones de compra (CALL) y de venta (PUT), que representan los diferentes tipos de oportunidades u opciones que existen en el proyecto [2]. El punto fundamental en la evaluación de proyectos mediante opciones reales es identificar las opciones que se presentan en el horizonte de la vida del proyecto [3]. Hasta ahora, las pocas contribuciones que abordan el papel del regulador en la generación de valor de las inversiones mediante opciones reales se centran en aspectos generales de corte medioambiental [4] o en la valoración de fuentes renovables genéricas [5]. En este sentido, Balibrea et,al. [6], [7] evalúan proyectos de inversión en energía eólica marina en Dinamarca y de eólica terrestre en Alemania y España respectivamente con opciones reales existentes en el marco regulatorio. Como resultado, se han detectado dos opciones reales regulatorias. La incorporación de estas dos opciones tiene un valor muy positivo para el promotor del proyecto. El enfoque utilizado en este estudio sobre la utilización de opciones reales regulatorias puede proporcionar soporte a las decisiones que deben tomar los promotores privados. Adicionalmente, esta herramienta es muy útil para los responsables políticos porque les puede ayudar en el diseño de políticas eficientes de apoyo a las energías renovables. La elección del esquema de apoyo público a la energía renovable tiene gran impacto en el valor del proyecto. Como recomendación de carácter político, sugerimos la inclusión de las Opciones Reales Regulatorias en la medición del impacto de cualquier iniciativa de la Administración para apoyar proyectos de generación eléctrica renovable.

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CONSTRUCTION WITH COMPRESSED EARTH BLOCKS IN MARS, BASED ON CONSTRUCTIVE SOLUTIONS OF THE PRECLASSIC PERIOD

[1]Carlos González Puchol

[1]Student, Escuela Técnica Superior de Edificación de Madrid y Escuela Técnica Superior de Arquitectura de Madrid, Universidad Politécnica de Madrid

Keywords: *Compressed earth block, mars, barrel vault, automated, robotized*

Due to the high cost of bringing materials to space, any construction on another planet would require the least possible material from outside. Thus, it is essential to study the feasibility of a structure made of the most abundant material on the surface of the planet Mars: the terrain itself.

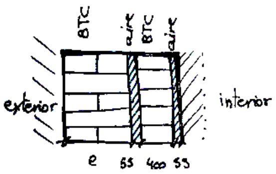
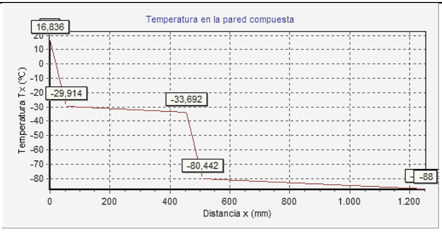
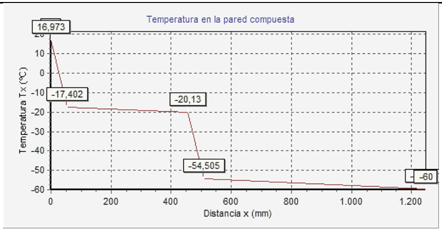
The simplicity of some structures from Ancient Egypt is perfect for a fast execution in an autonomous way, so in this study we will consider the possibility of creating structures based on Martian compacted earth blocks based on radial barrel vault.

1. Amount of material necessary to counteract the adversities of the Martian atmosphere. The thicknesses of a supposed wall of BTC with air chambers will be theoretically found. The variables used are the temperatures registered on Gale Crater: between -88ºC and -60ºC [1].

2. Type of structure and if it is viable with the available material.

3. Construction method and the compatibility with other solutions already designed.

Taking into account the theoretical air conductivity coefficients of the Martian atmosphere [2] and the **Mars-1a JSC** terrain simulator [3], the theoretical results of these two charts have been obtained using **AISLAM**.

	Case 1	Case 2
	Minimum temperature: -88ºC Heat flow: 8.5 W/m2 Thermal conductivity of terrestrial air: 0.01 W / mºC BTC thermal conductivity: 0.9 W / mºC	Minimum temperature: -60ºC Heat flow: 7.5 W/m2 Thermal conductivity of terrestrial air: 0.012 W/mºC BTC thermal conductivity: 1.1 W/mºC
		
resulting exterior thickness:	0,8m	0,8m
Total thickness:	1.31m	1.31m

The density of compacted earth is 1500Kg/m^3 [4]. One block of 0.4x0.2x0.1m^3 would weigh about 12kg, but the gravity on Mars is 3.711 m/s^2 while on Earth it is 9.807 m/s^2: a structure on Mars can support 2.64 times the same load as on Earth.

Therefore, a barrel-vaulted structure with compacted earth blocks disposed radially would be remarkably viable.

An efficient way to collect the material is to make a small ditch-shaped excavation about 4m wide and about 0.4m deep, compacting the material in BTC as the excavation progresses and collecting it in the side of the trench.

Once the trench is completed, a formwork is necessary to hold the pieces as they are placed. A bag of a resistant material and relative flexibility can be used: when filled with air, can keep the pieces stable and deflate until they take contact with each other.

The thickness of the wall has viable dimensions, due to the insulation of the chambers of air rich in CO_2.

The simplicity of the barrel vault, that compresses the blocks, and the low gravity make possible the autonomous construction.

The BTC barrel vault could be a good solution to connect other structures with low loss of energy.

Therefore, with a good design and execution it is theoretically possible to make a BTC structure on the planet Mars.

ACKNOWLEDGEMENTS

I would like to thank: organizers of the congress, Escuela Técnica Superior de Edificación, and María Isabel Prieto Barrio for guiding me with this project.

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POTENTIAL FOR ENERGY USE OF UNDERGROUND URBAN INFRASTUCTURES

[1]Luis de Pereda Fernández; [2] Inmaculada Pérez Fernández; [2] María de las Nieves González García

[1]Doctorando Innovación Tecnológica de Edificación. ETS Edificación. Universidad Politécnica de Madrid. ENERES Sistemas Energéticos Sostenibles. Instituto Europeo de Innovación, IEI.España
[2] Departamento Construcciones Arquitectónicas y su Control. ETS de Edificación. Universidad Politécnica de Madrid. España

Keywords: *energy, recovery, efficiency, management.*

The different systems, and urban subsystems, are not isolated, although today they are managed as such, but integrated into a multidimensional reality where energy flows occur not only within each plane, but between them and in all directions. This integrated reality is an energetic ecosystem, to which we aim to provide balance and sustainability. Once understood this, it is also easy to understand that the mechanisms of rebalancing go through the transfer of the energy resources that are left over in one part of the ecosystem to another part of it where energy is demanded, by the capacity of change of the energy configuration of all the Ecosystem, by the correction of the imbalances and by the symbiotic action between the different systems and subsystems [1].

If we look at the context for opportunities, we see that the two determinants of global development in the coming years are demographic growth and climate change. There is a link between population growth and urbanization in the world in the coming decades, the exponential development of urban areas and the phenomenon of emergence of new megalopolises. The harmonious development of cities is linked to a balance between its density and its complexity [2].

On the other hand, the progressive recovery of urban space for its civic use raises a need to orientate the field of development of the network of infrastructures, services and endowments, towards the underground space. The field of opportunities emerging from integrated management [3] of underground resources includes the use of subsoil Energy resources for energy capture, exchange and storage. Geothermal exchange allows the inertial use of ground and the built mass buildings and infrastructures, for the accumulation of large quantities of thermal energy with low power and moderate temperature bands, is therefore a Means to accumulate the generated thermal energy and often considered residual, by industrial systems and urban infrastructures and to propitiate its reuse with very low costs, and very long life cycle. The accumulation of thermal energy in the field can also be applied to integrated and distributed systems of solar thermal capture, and solar photovoltaic [4].

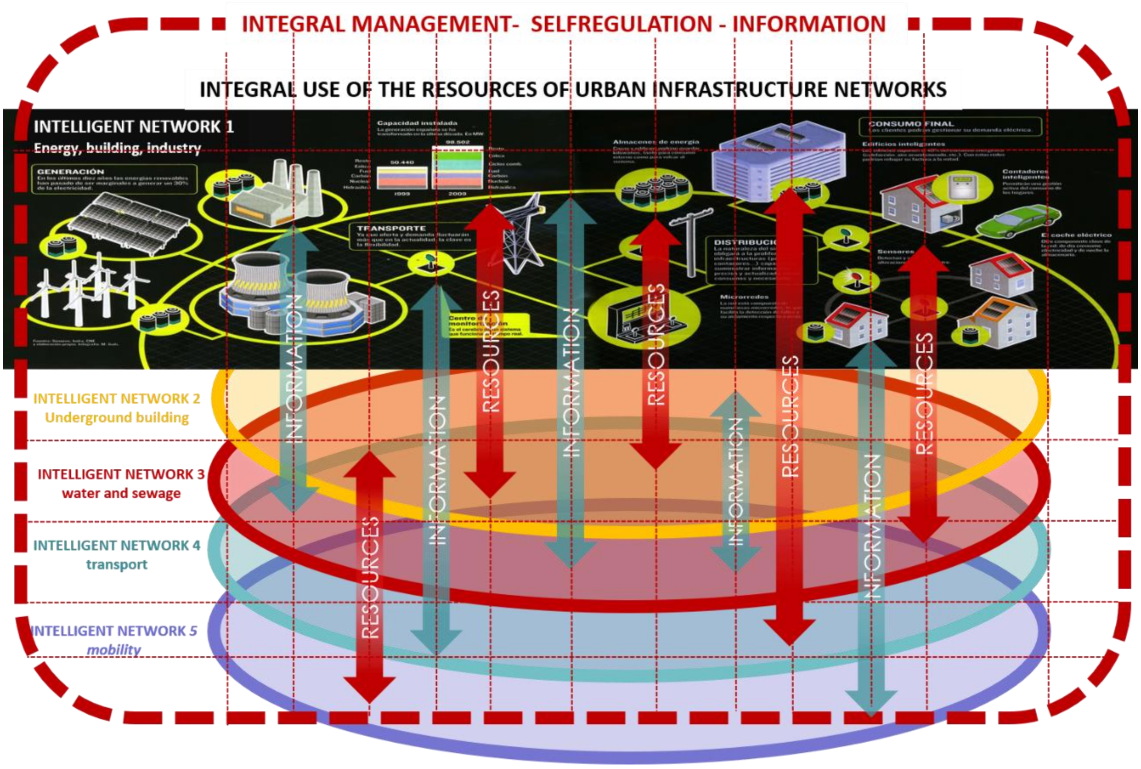

Fig. 1. Underground urban infrastructures integrated in the Energy Networks act as distributed generation, storage and consumption systems, interacting with other systems of the network. [5]

Our cities have numerous and extensive networks and infrastructure systems that interact with the environment generating, capturing and channeling energy fields of different types. The thermodynamic interaction between the three elements that come into play in this context, the ground, the air and the water, [6] is an inexhaustible source of possibilities for the exchange, the extraction, the injection, the storage and the use of the energy [7].

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RESTORATION MORTARS FOR RAMMED EARTH WALLS WITH GYPSUM MASONRY REINFORCEMENTS

[1] **Eva Mejías Romero**

[2]**Francisco Javier Castilla Pascual**

[3] **David Sanz Martínez**

[1] ***Building Engineer, UCLM. Escuela Politécnica de Cuenca;***
eva.mejias@alu.uclm.es
[2] ***Dept. of Civil Engineering, UCLM. Escuela Politécnica de Cuenca;***
Fcojavier.castilla@uclm.es
[3] ***Dept. of Geological and Mining Engineering , UCLM; Escuela Politécnica de Cuenca; david.sanz@uclm.es***

Keywords: *Rammed earth, gypsum, mortar, restoration, building*

Earth walls with gypsum reinforcements are a traditional building system in many regions, and particularly in the north of Toledo and south of Madrid provinces. As many other earth constructions, erosion of uncovered walls occurs due to water runoff and a lack of maintenance, causing a loss of material in the outer surfaces [1-2]. Thickness of the wall is reduced and collapse of some sections occurs. This restoration and replacement of lost material have been done traditionally applying cement mortars, despite being well known that is not a compatible material with the earth constructions [3]. The research tries to give a solution to the problem by studying different restoration mortars, based on the local materials that were used originally to build these walls in the village of Tembleque, were somw representative constructions can be found [4-5]. Mixes were improved with new materials, easy to find today, to make the compositions of the different mortars, with the aim of obtaining a mortar that resists the passage of time and does not detach from the earth surface of the wall. Mortars used for this work were composed of a mix of hydraulic lime with sand, gypsum, local soil from the surroundings, glass fibers and casein, in different proportions. Different tests were carried out with the restoration mortars, among them, capillary test, freeze / thaw test, accelerated erosion test and compression test. After carrying out these tests, results were analysed to select the most effective mixes. Mortars selected were tested in prototypes, on a real scale, built near an historical building previously rehabilitated, whose walls are affected by this type of erosion. Test walls surfaces were eroded manually, and plasters were applied in two coats, to fill a medium eroded depth of 7cm. First infill coat was made of different mixes of local soil with lime and/or gypsum and for renderings fibers and casein were added. Test walls have been left exposed to passage of time, and some preliminary results have been obtained. After the first month, mortars containing glass fibers and casein resulted have proved to reduce significantly the cracking and all of them present well bonding with the infill coat. This solution could be optimized after exposure to the weather in long periods of time. The final objective

of this study is to contrast the result, allowing the time to evaluate the suitability for a future intervention in the buildings that still conserve this constructive system.

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METHODOLOGY FOR THE IMPLEMENTATION OF SOCIAL INNMÓTIC TO IMPROVE PUBLIC BUILDINGS (PROJECT EFIPUBLIC)

[1] **Beatriz Montalbán Pozas**

[2]**Irene Amigo Gamero**

[3]**Agustín Sánchez Domínguez**

[1-2-3] ***Extremadura University; bmpozas@unex.es; ireneag@unex.es; agustin.robolab@gmail.com***

Keywords: *Sensorization, inefficiency, inmotic, public building, usage habits*

Inefficiency of many of the public buildings built, currently in operation, is a worrying reality. Among other consequences, there is waste of energy resources, situations of great discomfort, inefficiency of HVAC systems, wasted space, or inappropriate uses and habits [1], [2], [3]. The in-depth study of a large teaching building: School of Technology in Cáceres (Extremadura University), through Efipublic project (Social Inmotic for the improvement of public buildings 2017-2020), is enabling the design and placement of sensorization and control devices, as well as the open and public data monitoring and its subsequent analysis. The collected data are analysed later, and therefore the deficiencies detected are analysed, and improvement actions are proposed according to them. Water, electricity, and gas consumption, air quality, thermal comfort, occupation, energy provided by renewable sources, equipment turned on during off hours... were some of the variables sensored and analysed. In this way Efipublic project is allowing to implement reforms in the building, awareness campaigns, changes in use, etc. [5], [6]. Working together with the teaching staff: students and teachers, as well as administration and service staff, or with the building management and maintenance team [7],, can guarantee the continuity of the progress made over time. In this paper the designed methodology, currently under experimentation, is developed. First of all, the realization of an inventory of construction systems, equipments and HVAC, as well as consumption ratios through invoices. Then an analysis and experimentation with the ICTs media available as sensors, data storage or visualization systems, and communications [8], [9]. Thirdly, data tracking is developed. Fourthly and finally, solutions are design to address the detected problems. In this case it is being demonstrated that the detailed work with the building and its users through social inmotic allows to generate solutions that address the improvement of the constructed buildings [10].

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GEOMETRIES WOVEN WITH BAMBOO FOR THEIR MATERIALIZATION AS STRUCTURES IN EQUILIBRIUM

[1] Eugenia Muscio

[2] Byron-Sebastián Almeida-Chicaiza

[3] Jesús Anaya Díaz

[1] Architect, MSc., PHD student at the Construction and Architectural Technology Department, Universidad Politécnica de Madrid, eugenia.muscio@alumnos.upm.es
[2] Architect, MSc. Teacher-Researcher. Architecture and Urbanism School, Universidad de Guayaquil. PHD student at the Construction and Architectural Technology Department, Universidad Politécnica de Madrid, byron.almeidac@ug.edu.ec
[3] Doctor Architect, Professor. Construction and Architectural Technology Department, Universidad Politécnica de Madrid, jesus.anaya@upm.es

Keywords: *Bamboo, geometry, weaving, cuts, interlacing knots*

The conformation of geometries from interlaced bamboo to be used as constructive elements is a practice that was carried out throughout all times. From woven basketwork and cordage[1] weaving, this historical method of joint was also used to configure construction elements such as gabions [2], "quinchas", cables and architecture.

For the materialization of a concrete geometry that conforms a resistant structure, in spite of the scale, different parameters that constitute a whole are related in a dependent way, such as: the characteristics of the species of bamboo and the cutting of the bamboo cane, the geometry that defines the lattice, the knot of interlacing and its degree of friction, as well as the geometry itself and its generatrixes [3]. The cut of the bamboo cane defines the resistance of the strip obtained [4] and is intrinsically linked to the patterns of framing [5] that by friction and/or knot density stabilize the crosses that can form light and very rigid single-layer spatial structures. The geometric shape of the whole contributes, in turn, to establishing a system in equilibrium.

Currently, the knowledge of natural materials, as well as the study of traditional construction techniques and structural analysis allow us to innovate with freer spatial surfaces and give rise to the practice of new geometries that put constructiveness to the test [6].

In this paper the analysis of the different parts that overlap to compose a single woven geometry is proposed and the relations between them are established that allow clarifying and quantifying the existing possibilities in the constitution of bamboo fiber frameworks susceptible of being used in architecture.

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THERMOMECHANICAL BEHAVIOUR OF THERMOACTIVE PILES

[1]Kenzo Jorge Hosokawa

[1]Alfonso Cobo

[1]María Isabel Prieto

[1]Inmaculada Martinez Pérez

[1] Tecnología de la Edificación. Escuela Técnica Superior de Edificación. (Universidad Politécnica de Madrid)

Keywords: *Thermoactive piles, energy geostructures, energy pile*

Thermoactive piles are a recent technology for the heating and cooling system of a building that integrates the structural bases of buildings with closed circuits of tubes that form vertical heat exchangers. Compared to conventional deep geothermal exchanger systems, thermoactive piles are more economical than boreholes, since the depth is lower and the existing structure is used to avoid drilling more holes in the ground. In addition, the thermal conductivity of concrete piles is twice that of the benthonic mortar used in the boreholes. Thermoactive piles exchange heat with the ground by using the ground as a heat source in winter or a heat sink in summer. The soil has a relatively constant temperature of approximately 10 to 15 °C at a depth of 10 to 20 m in most European countries (i.e. surface geothermal energy) [1].

The investigations that have been carried out so far, related to the topic of thermoactive piles, can be classified into three main categories, such as experimental studies [2, 3, 4, 5, 6], numerical models that try to predict the real behavior [7, 8, 9] and finally laboratory tests implemented to investigate the behavior of soils around geothermal piles [10, 11].

Despite the great variety of works related to thermoactive structures, the design of these structures is not incorporated in any European or national regulations, making it very difficult for quality control companies to validate them. Up to now, in the structural dimensioning process, the thermomechanical behaviour has been neglected as there are no pathologies that can be observed at present.

The aim of this work is to study the influence of different parameters on the thermomechanical behaviour of thermoactive piles. For this purpose, the modified transfer load model developed by Poudyal [6] will be reproduced, and once calibrated with its own experimental field study on a real scale, different parameters such as the diameter of the pile, the variation of the differential temperature and the increase in load will be modified, thus verifying the interrelation of these parameters with the thermomechanical behaviour.

The results obtained show that the cooling and heating cycles of the piles modify the interaction between the pile and the ground, even obtaining differential seats, although it is true that the maximum deformation values observed are within the safety parameters. However, it is suggested that the thermal load be incorporated into the pile dimensioning.

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STUDY BASED ON HISTORICAL DATA OF NINE PUBLIC AFFORDABLE HOUSING PROJECTS

[1] Juan Pedro Ruiz-Fernández

[2] Nelia Valverde-Gascueña

[3] Miguel Ángel López-Guerrero

[4] Joaquín Fuentes-del-Burgo

[1] Departamento de Ingeniería Civil y de la Edificación, Escuela Politécnica de Cuenca (Universidad de Castilla-La Mancha) juanpedro.ruiz@uclm.es
[2] Departamento de Ingeniería Civil y de la Edificación, Escuela Politécnica de Cuenca (Universidad de Castilla-La Mancha) nelia.valverde@uclm.es
[3] Departamento de Matemáticas, E. Politécnica de Cuenca (Universidad de Castilla-La Mancha) mangel.lopez@uclm.es
[4] Departamento de Ingeniería Civil y de la Edificación, Escuela Politécnica de Cuenca (Universidad de Castilla-La Mancha) joaquin.fuentes@uclm.es

Keywords: *Deviations time and cost, percentage distribution of chapters, production curves*

Can we learn from experience? An empiricist would tell that all human knowledge derives from it. This paper analyzes the confidence level of the predictions that we can make about housing construction, based on similar promotions [1], [2].

The historical data of nine public affordable housing projects were used, whose design and project management was carried out by the same technical team. These nine affordable housing projects, part of the state social security programme, have similar formal and quality functional characteristics. Furthermore, the constructive characteristics of the nine projects are also comparable: foundation and reinforced concrete structure, traditional walls, flat roofs, facilities and similar finishing materials. In all cases, the award procedure was by open competition. The material execution budget was calculated according to a structure of almost identical chapters for the nine promotions, and the control of times and costs was carried out according to the procedures regulated in the “Código de Contratos del Sector Público” [3].

The study consists of calculating the average deviations in both costs and deadlines contracted [4], [5], followed by a statistical study of the percentage of the chapters on both the project budget and the liquidation budget. Finally, the best-fits curve to the production values are analysed through a polynomial regression.

The confidence levels obtained regarding costs, deadlines and percentages of chapters offer high deviations that reveal little reliability in the predictions. On the contrary, the deviations in the production values at origin from the best-fits standard curve have been much smaller.

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THERMO-HYGROMETRIC STUDY OF A WINE CELLAR IN THE NORTH OF SPAIN

[1] Maria Giulia Gagliardini, [2] César Porras Amores, [2] Carmen Viñas Arrebola, [3] Fernando R. Mazarrón and [3] Ignacio Cañas Guerrero.

[1] Student at the Politecnico di Torino, on Erasmus at the E.T.S. de Edificación
[2] TEMA Research Group at the ETSEM. Universidad Politécnica de Madrid (tema.edificacion@upm.es)
[3] PADOC Research Group at the ETSEM. Universidad Politécnica de Madrid

Keywords: *wine cellars, relative humidity, temperature, energy efficiency*

Spain is the third largest producer of wine worldwide. This field represents a very important branch for the country on the environmental, social and economic level, nationally and internationally. At the same time, the environmental conditions of our planet nowadays require an exceptional attention to the construction field in terms of CO_2 emissions. It is becoming more and more spread the concept of a Zero Energy Building, namely the construction of buildings that require a meagre or null additional intake of energy.

This work takes into account these two vital concepts with the aim of improving the energy efficiency of wine cellars in terms of air-conditioning, for the monitorization of relative humidity and temperature, whose value is essential that remains constant for a proper wine aging [1]. The research shows part of the results of the BIA2014-54291 research project which is focused on analyzing the indoor hygrothermal conditions in aging rooms of several wineries in Spain in order to establish guidelines and design recommendation to improve them. Specifically, this article focuses on analyzing the hygrothermal behaviour in the aging room of a winery located in the D.O. Ribera del Duero which is one of the country's quality regions of the production of wine.

The first analysis required in the development of this study would be the examination of four sensors, arranged in a vertical row in the middle of the cellar, which detects the relative humidity and the temperature of the environment. The placement of these sensors - which at the beginning of this study had already provided measurements for one year - were located in such position in order to draw attention to the thermal stratification of air, which, as previous studies show, [2] increases in the summer period for the warming of the roof, fact that will require a significant awareness during the next steps of the study. The experimental results will be of great help in order to set up the HVAC and the ventilation systems which are essentials in wine cellars to achieve optimal hygrothermal conditions for wine aging and to avoid the risk of accumulation of gases or toxics agents. [3]

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STUDY OF MECHANICAL CHARACTERISTICS OF BAMBOO FOR ITS USE IN THE CONSTRUCTION FIELD

[1] Maria Giulia Gagliardini

[1] Student at the Politecnico di Torino, on Erasmus at the E.T.S. de Edificación in Madrid (mariagiulia.gagliardini@alumnos.upm.es)

Keywords: *Bamboo, traction, compression, elastic modulus*

The construction field is the most influent entity on the energy expenditure of our planet, not only in the process of construction materials production, but also in their entire life.

Therefore, the investigation on the construction field could and should contribute profusely in the improvement of the planet's health conditions as well as humans' wellbeing [1].

In this perspective, bamboo is a natural material which armonizes excelents mechanical characteristics with plain sustainability [2].

Thus, this work concerns the study of some mechanical characteristcs of this natural material that is bamboo, which, as many think, could be implemented in the construction field, as it has already occurred in the past, since milleniums, in different parts of the world, like south America or south-east Asia [3].

The work begun with the selection of some articles concerning the study of this material on the mechanical level. The first step was to understand what type of data each article contained, in order to choose the ones that had the most in common, so to realize a well examined work.

Later on, each article was deeply studied and the data coming from the different sources have been compared.

Nevertheless, in many cases the experimental results have appeared to be quite different from each other, even though they lay in the same order of magnitude.

This could depend of the fact that the material studied is a natural one, found in nature at its raw state, thus, it hasn't gone under any process and it has grown in a natural environment, which turns out to be quite different in each case (south America, Italy, and so on).

Proof of this is that we could observe that the values of the Young's modulus, or elastic modulus, stay quite constant in every reference. Therefore, this means that the stress-strain behaviour stays more or less constant in the three, or two, tests, respectively.

Table 1: Results of the tests, listed for article and mechanical characteristics

Articulo de referencia	Titulo del articulo	Tracción paralela a la fibra [MPa]	Modulo de elasticidad del bambù sottopuesto a tracción [GPa]	Compresión paralela a la fibra [MPa]	Modulo de elasticidad del bambù sottopuesto a compresión [GPa]	Corte paralelo a la fibra [MPa]
[1]	Il Bambù Italiano	214,93	16,93	71,37	18,3	2,54
[2]	Laminados de Bambú	132	17,47	48	19,13	9,4
[3]	El Bambú como Elemento Estructural	179,12	-	29,43	-	4,28
[4]	Esfuerzo de Tensiòn y la Influencia de la Humedad	175,35	17,69	-	-	-

Analyzing these results, it pops out that bamboo has pretty good traction characteristics, largely overcoming concrete, and as well compression characteristics, closening to steel and equalling wood.

The only lack is the shear strength, which nevertheless, quadruplicates in the laminated blocks.

Therefore, we could say that bamboo could and should be implemented in the construction field. However, a meticulous study is essential in order to get to the redaction of norms concerning the use of this material in the construction world.

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STUDY AND SIMULATION OF HOUSING ENERGY USING DYNAMIC SIMULATION SOFTWARE

[1] Miguel Cornelio Diego

[2] Daniel Ramírez Burgueño

[1]Universidad Politécnica de Madrid; miguel.cdiego@alumnos.upm.es
[2]Universidad Politécnica de Madrid; d.rburgueno@alumnos.upm.es

Keywords: *Energy efficiency, passive design, building, simulation, energy plus*

The work consists of performing an energy simulation of a prototype house located in the city of Seville. The study of the house was carried out through the thermal simulation software "Design Builder" [1], with which the thermal, energetic and environmental behaviour of the building can be analysed. In the first instance, the geometry of the building will be defined, as well as the real composition of its constructive systems, walls, roof, carpentry, installations, among others. Climate data of the region were obtained and imported into the analysis program. Once the system is configured, a series of simulations will be executed to obtain the data referring to energy consumption, operating and environmental temperatures, thermal comfort and CO2 emissions [2].

After the simulations to obtain the actual situation for reference values, a series of improvements will be included that will allow optimizing its thermal and energy performance [3][4]. The use of passive design system will be preferred for their low initial investment [5]. The actual installation also will be review in its performance to improve their energy efficiency and improve the overall comfort of the building. With the data generated from the simulation of the base building and improved one, there will be a comparison, verifying the increase in energy benefits throughout the year.

Finally, a cost-benefit analysis has been developed obtaining cost of implementation [6], savings in energy to be expect and the time of the initial investment to be pay back by the savings, which will allow us to define the choice of improvement with greater impact and more convenient [7].

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INFLUENCE OF LOCAL CONDITIONS AND IN SITU MEASURED VALUES IN ENERGY DEMAND ESTIMATION OF TRADITIONAL BUILDINGS

[1] Miguel Ángel Mellado Mascaraque

[2]Francisco Javier Castilla Pascual

[1] Dept. of Civil Engineering, UCLM. Miguelangel.mellado@alu.uclm.es
[2] Dept. of Civil Engineering, UCLM. Fcojavier.castilla@uclm.es

Keywords: *Energy demand, energy simulation, thermal values, U-value, rammed earth*

The work here described is part of the PhD thesis that is being developed with the goal of studying the hygrothermal behavior and energy performance of several dwellings in the Dry-Mediterranean Climate. In this phase, after an annual campaign of in situ experimental tests, research now focuses on the assessment and quantification of the influence of local climate conditions and thermal values of rammed earth walls on energy demands of common traditional buildings in La Mancha.

To achieve it, energy simulations have been performed on two buildings, with three goals. 1) Evaluation of construction systems which include walls with a high thermal inertia in comparison with contemporary systems. 2) Study the influence of theoretical values of walls and user activity taken from nominal data in the Catalogue of Building Components (CEC), that can be found in the Technical Building Code (CTE), and compare it with the use of actual in situ data and surveys; 3) Contrast between using standard and actual climate data recorded with a private weather station placed in the same location as the studied buildings. Research like [1], [2], [3] also execute energy simulations of rammed earth buildings and components but in a different climate, while other papers like [4], [5], [6], [7] also compare in situ values with nominal data but the main material of the studied buildings is not rammed earth.

In conclusion, results show that: 1) Energy demands of spaces where the theoretical transmittance value (or U-value) has been used are 52-55% higher in winter and 9-15% higher in summer than those where the in situ value has been used. 2) The use of theoretical information against the use of actual surveys about user activity can generate 12-26% difference in energy demands. 3) On the contrary, the use of available climate data measured at nearby locations would produce lower energy demands than using values recorded in the same location as the buildings, being up to 64% lower in winter months and up to 100% lower in summer months.

Future research should be performed using combined heat and moisture models (HAMT in Energy Plus), as several studies have demonstrated that there is and important relation between thermal values and water content of the material [8] [9].

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PARAMETRIC STUDY OF SUPERADOBE DOME MECHANICAL BEHAVIOR

[1] Marco Aurelio López Gómez

[2]Maria de las Nieves González García

[1] Escuela Técnica Superior de Edificación. Universidad Politécnica de Madrid
marcoaurelio.lopez.gomez@alumnos.upm.es
[2] Escuela Técnica Superior de Edificación. Universidad Politécnica de Madrid
mariadelasnieves.gonzalez@upm.es

Keywords: *Superadobe, earthbag, eco-friendly, parametric, Ansys Workbench*

Superadobe Technology consists on filling long circular polypropylene sacks with a moist mixture of stabilized earth; placing and compacting one ring on top of another thus describing double curvature monolith. An ecofriendly and economical self-construction method: although practical experience has shown good performance of these buildings upon natural events such as extreme temperatures, high winds and earthquakes [1], the mechanical behavior of a Superadobe dome has not been sufficiently characterized theoretically and documented, and this is needed in order for the technology to be regarded as a valid construction method in countries where it is unknown. Among the magnitudes which describe the mechanical behavior of a Superadobe dome we find [2]:

- Maximum value of wind load that it can withstand until slipping or turn-over
- Maximum weight in relation with base soil resistance
- Risk of buckling between rings
- Maximum modulus of vertical and shear stresses on the set of rings surfaces
- Maximum hoop compression and tension stress on the set of individual continuous rings
- Maximum bending moment stress on the most exterior point of contact between ring and ring

The behavior of Superadobe structures (above magnitudes), depend upon various parameters, such as the radius of curvature of the arch which describes the roof (length of the outer compass), the radius of the base of the building (length of the central compass), sack width and height, mechanical properties of the mixture such as elastic modulus, Poisson's ratio, density, cohesion and friction (static) coefficient between rows, etc.

An iterative algorithm written in python calculates such magnitudes (Superadobe behavior) from varying inputs (parametric study), storing the results in a local data base, from which initial design thresholds and patterns are being found to form a design criteria for safe Superadobe buildings. The predicted behavior of some

Superadobe models as calculated by the algorithm is contrasted with finite element simulations done in Ansys Workbench 19.1.

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A PROPOSAL ON TECHNIFICATION OF A MONUMENTAS A LIVING ARCHIVE OF ITSELF

[1] **José Carlos Sánchez Romero**

[1] ***Department of Architectural Technology and Construction, E.T.S. Polytechnic University of Madrid. Spain; josecarlossr@gmail.com***

Keywords: *Museum, technification, virtual reality, restoration, archive*

The complexity of the restoration process of a monument consumes a huge exertion from a cross-discipline team that gathers big data throughout a long period of time. This process brings together data from prospection across historical documents in searching for relevant facts, knowledge arising from the archaeological excavation as well as from the artistic and technical architectural assessment to make appropriate decisions for restoration works. This large amount of data can easily end up dispersed in diverse files and formats, depending on the concerned speciality, the restoration timeline or the working process and so, the shortage in involved activities synergy often compromises the final result [1]. In addition, for cultural heritage, most of the previous information is scattered in different historical private and public archives which could make matter information arduous to understand due to the lack of physical connection with the real object.

Built heritage constitutes one of the most important cultural assets in society. It describes the sediment of our past to explain what we are made of, nourishing feelings of belonging to a place and a community. Context is so relevant that the monument is no longer considered alone [2]. Protecting and understanding heritage is invaluable for community and its comprehension can be broadly improved by using the physical monument as a digital repository of information related to itself as well. This information that can be extracted in real time when visiting the place.

It is a matter of structuring provided data according to interest or curiosity of those who request for them, ensuring a variety of levels of information on demand, turning the monument into a living archive of itself. Hosting a database that can grow up in a sequential or additive process, entering data starting from relevant historical and artistic assets, followed by different types of information that can be increasingly added in layers or digital strata when available or depending on their interest for scientific, technical or cultural purposes.

The goal is to discuss a simple and basic methodology to make cultural, technical or scientific information available on site. Different layers of information concerning cultural and historical values can be merged [3]. Structured data can subsequently be superposed coming from archaeological or restoration data files, from the physical properties of documented materials or the building evolution analysis. By adding real-time data provided by sensors strategically located inside/outside the monument we could have accessible information on heritage or historical values and we could better understand how the building works itself, its pathologies or tectonic evolution. We could use stored structured data or compute and simulate in real time physical processes to dive in what it could be defined as a living organism in terms of chemical, biological or physical interaction with the environment. To know about historical data, temperature and humidity for artwork conservation, air movement or pollutants, construction techniques, artistic values or historical facts.

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WORKPLACE METRICS BASED ON WIFI TRACKING SYSTEMS TO UNDERSTAND SPACE OCCUPATION AND USER EXPERIENCE

[1]*Alicia Regodón Puyalto*

[2]*Alfonso García Santos*

[1]*Escuela Técnica Superior de Arquitectura de Madrid*
aliciaregodon@gmail.com
[2]*Escuela Técnica Superior de Arquitectura de Madrid,*
alfonso.garciasantos@upm.es

Keywords: *Workplace, smart dynamics, user experience, occupation patterns, KPI*

The workplace is undergoing a dramatic transformation in its transition from industrial age towards knowledge age [2]. The need to anticipate and predict change is crucial to make the most of the transition and remain sustainable [6]. Traditional planning methods are nowadays limited to understand new work styles, patterns and locations that will ensure organisations to stay effective in the long-term [6].

Innovation and new technology enable a faster and more accurate understanding of the occupation and interaction with space. Today new ways of monitoring and data analysis can provide almost real-time feedback [3]. The workplace is not an exception; current studies incorporate new technology to understand smart dynamics, workplace optimisation and user patterns. Occupancy information and prediction can help architects to improve space efficiency and workplace design [1].

Traditional analogical space-planning and occupation studies are not functional anymore due to new dynamics of flexibility and collaboration of the users [2] Because of increased mobility in their day-to-day work, collaborative workers today interact in a wide variety of working environments [2]. Location tracking systems such as sensors, wifi or facial recognition are currently used to understand space dynamics [8].

The choice of Wi-Fi (wireless local area network) to provide location tracking information relies on its affordability, already installed infrastructure, precision for indoor spaces and seamless features. The access points are proposed as a proxy to represent the virtual dimension and to integrate both virtual and physical dimensions [5].

The generation of a combination of KPIs is essential to provide manageable data to understand and monitor decision-making processes for architects, space planners and other experts. The different KPIs enable spatial design improvements aligned to the user choices. Overall optimisation of the use of space and comfort and spatial sustainability.

The article studies the generation of the KPI “Vivid Office” that assesses office well-functioning and the sustainability of space through spatial use understanding based on individuals free choice [4]. The KPI is a combination of wifi-tracking fingerprints over time that reveal user activity [7], with calendar events and communication from the user to gain more insights on the activities developed. It enables the analyst to understand not only the occupation of the space but also the user dynamics.

KPIs like “Vivid Office” will change dramatically the way we understand space design and space planning. Workplace designers will now design spaces that better fit their user needs in terms of space, comfort, infrastructure, furniture, technology. It will also optimize the use of spaces and become predictive to anticipate the needs of both users and design experts.

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THIN-WALLED STRUCTURES. PRE-INDUSTRIALIZED CONSTRUCTIVE SYSTEM OF EASY ASSEMBLY, LIGHT, DIGITIZABLE AND ENERGETICALLY SUSTAINABLE.

[1] Susana Palacios Rodríguez

[2] Jesús Anaya Díaz

[1] Universidad Politécnica de Madrid, ETSAM, Departamento de construcción y tecnología arquitectónicas. Avda. Juan de Herrera, 4, 28040 Madrid (España)
susanapalaciosrodriguez@gmail.com
[2] Universidad Politécnica de Madrid, ETSAM, Departamento de construcción y tecnología arquitectónicas. Madrid (España); jesus.anaya@upm.es

Keywords: *Thin-walled structures, digitalizable, energetically sustainable, customization.*

The emergence of new materials and applications of them, and the digitalization of these in the constructive processes allow to optimize the pre industrialization [1].

The parameterization and customization demand a great request at the present time to obtain systems of easy assembling, light, digitizable and energetically sustainable [2].

This research allows to implement with advanced and innovative technologies of energy improvements, obtaining constructive solutions that direct us towards a pre industrialization with energy consumed null [3]. The industrialization of the process from the outset with a horizontal transfer of technology from other sectors, such as the automobile or aeronautics, allow the development of advanced interactive tools to be able to give a new look to the management of the Construction works [4].

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STUDY OF PLASTER WITH RICE HUSK RESIDUES MECHANICAL AND THERMAL PROPERTIES

[1]Tiare García Pavón

[2]**Alberto Lage Sánchez**

[3] **Pablo Martín Gallego**

[4] **Mercedes del Río Merino**

[1-2-3]Máster en Innovación Tecnológica en Edificación, Escuela Técnica Superior de Edificación de Madrid, tiare.gpavon@alumnos.upm.es; alberto.lage.sanchez@alumnos.upm.es; p.marting@alumnos.upm.es
[4]Departamento de Construcciones Arquitectónicas y su Control, Escuela Técnica Superior de Edificación de Madrid, mercedes.delrio@upm.es

Keywords: *Rice, recycling, plaster, circular economy*

In the last years, there has been an increase in studies related to environmentalism and sustainability, starting with recycling, followed by energy saving in homes and reaching the use of renewable energy or even the hybridization and electrification of vehicles. These studies include those that deal with the incorporation of waste from the agricultural industry into building materials.

Continuing the research of María José Leiva Aguilera, who analyzes in her doctoral thesis *Escayola aditivada con residuos de cáscara de arroz* [1] the mechanical and thermal properties of the plaster with incorporations of rice husk in different states and proportions, this line of research studies gypsum with rice husk in order to improve its thermal properties, since gypsum is a much more widely used material internationally and easier to find in the market than plaster.

Based on the results obtained, the future development and design of a thermal insulation applicable to buildings is considered.

The process starts with the preparation of test pieces with dimensions 4x4x16 cm with rice husk in different proportions, followed by its test to flexion and compression to verify the compliance of the CTE as a construction material and finally thermally tested to verify its feasibility as an insulating material, produced with recycled materials and reaching circular economy criteria.

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MECHANICAL BEHAVIOR OF CONCRETE WITH ADDED PLASTIC FILM WASTE

[1] **Cristina Pavón**; [2] **María Isabel Prieto**

[3] **Jorge García-Barrasa**; [4] **José Luis Moreno**

[1] Alumno del Master en Innovación Tecnológica en edificación.
Universidad Politécnica de Madrid. cristina.pavonr@alumnos.upm.es
[2] Universidad Politécnica de Madrid, mariaisabel.prieto@upm.es
[3] Ecoembes, j.garcia@ecoembes.com
[4] Ecoembes, j.moreno@ecoembes.com

Palabras Clave: *Concrete, plastic film waste, compression, impact*

In favor of the circular economy, the European 2020 Strategy aims to advance towards 80% of the recycled containers by the year 2020. Currently, in Spain, 66.5% of plastics are recycled [1]. The problem is the existence of different types of plastics, what makes difficult to recycle them, due to they are often not compatible because they are not a homogeneous material [2].

The objective of the research is to study the mechanical behavior of micro-concrete, with the addition of film chippings as a partial substitute for gravel, in order to obtain a lighter and more sustainable concrete.

To make this possible, a campaign of experimental tests has been carried out, which allows us to determine the mechanical properties of the material and its density. Six cylindrical specimens of ϕ100 and 200 mm height were made for compression tests and six prismatic specimens of 520x100x30 mm^3, for impact tests, which were tested after 28 days.

The results obtained have been compared with concretes without additions, to determine the goodness of the compression and impact material. The results obtained show that the incorporation of film chippings produces a good workability in the concrete, decreases its density by approximately 10% and improves the impact resistance results, although its compression resistance decreases.

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OPTIMIZED INFILL IN ADDITIVE MANUFACTURING OF BUILDING COMPONENTS

[1]Luis Borunda; [2]Manuel Ladrón de Guevara; [3]Pavel Aguilar;

[4]Gianluca Pugliese; [5]Rafael Claramunt; [6]Marta Muñoz;

[7]Jesús Anaya;

[1]Universidad Politécnica de Madrid: Escuela Técnica Superior de Arquitectura de Madrid, lborunda.eco@etsav.cat
[2]Carnegie Mellon University: School of Architecture, manuelr@andrew.cmu.edu
[3]Universidad Politécnica de Cataluña: Escuela Técnica Superior de Arquitectura de Barcelona, pavel.aguilar@upc.edu
[4]Wasp Iberia 3D Printing Services, madrid@wasp3d.es
[5-6]Universidad Politécnica de Madrid: Departamento de Ingeniería Mecánica, Escuela Técnica Superior de Ingenieros Industriales, rclaramunt@etsii.upm.es; marta.munoz@etsii.upm.es
[7]Universidad Politécnica de Madrid: Departamento de Construcción y Tecnología Arquitectónicas, Escuela Técnica Superior de Arquitectura de Madrid, jesus.anaya@upm.es

Keywords: *Topology optimization, additive manufacturing, fused deposition modelling (FDM), finite element analysis (FEA), shell structures*

Initially intended for Rapid Prototyping, Additive Manufacturing technologies are increasingly being adapted to functional component production [1]. Its application in architecture has been quickly growing [2], [3] since the public release of patents the most popular AM technique, Fused Deposition Modelling (FDM) [4], and since the development of several large-scale automated production techniques [5], [6].

The process of FDM is based on the principle of stacking increasingly in height layer upon layer of a given fluid material, typically thermoplastic, deposited through a numerically controlled mechanism. Following a complex toolpath is easily achieved through the numerically controlled system, so that a non-standard virtual model can be cost-efficiently produced by approximating and depositing material in the perimeter. Translating the virtual model into a stacked set of toolpaths called “slicing” where, for purpose of rigidity, the interior of the model is infilled with a constant geometrical pattern.

Recent studies in architecture and large scale production of structural components exhibit among the main challenges for future development the time required for fabrication [7], adaptation of large scale systems of extrusion and numerical control for materials susceptible of deposition such as thermoplastics and semi-liquid pastes [8], [9], and topological optimization [10] with correct simulation of anisotropic mechanical properties [11]. The Finite Element Analysis influenced infill design and the optimization aspects of slicing has been significantly overlooked, represents an area of opportunity to reduce production time, reduce waste and better control the mechanical behavior of final product [12], [13]. The optimization of infill geometries is critical to harness the potential of AM architectural production. This research assesses computational workflows based on the structuring data in isostatic clouds [14] that incorporate simulation feedback loops in the design of functional components by internally differentiating [15] the geometry and material composition specifically tailoring a piece for a given application [10]. This leads to improved performance while potentially reducing, fabrication time, material use, and therefore, environmental impact [16].

The proposed method uses results attained from Finite Element Analysis (FEA) to engineer anisotropic building components by discretely determining infill geometries. In order to produce bespoke patterns, an algorithm for structuring FEM data is required. The processing of results in structured indexes linked to the digital element [17], [18] allows to internally engineer the composition and architectural behavior of functional pieces (density, stiffness, strength, fidelity, energy absorption) [19] based on the simulation values [10], [14].

The mechanical properties of large scale components are significantly determined by form, the case studies particularly focus on augmenting the stiffness of infills of given models, therefore maintain form fidelity, by re-distributing material in such way that displacement is reduced according to tension-displacement vectors on FEM analysis. The contribution of this research lies in the creation and corroboration of a computational workflow tested on ceramic and thermoplastic FDM components to assess the generalizability of the design method of engineering infill structures, the identification of several geometrical constraints due to limitations in deposition techniques and to present different case studies of AM based design and production automation.

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ANALYSIS OF BEHAVIOR OF CONCRETE WITH HYBRIDIZATION OF POLYPROPYLENE FIBERS AND CARBON NANOFIBERS (CNFs)

[1] Rubén Serrano; [2] María Isabel Prieto

[3] Alfonso Cobo; [4] Kenzo Jorge Hosokawa

[1]Universidad Politécnica de Madrid, ruben.serrano.somolinos@alumnos.upm.es
[2] Universidad Politécnica de Madrid, mariaisabel.prieto@upm.es
[3] Universidad Politécnica de Madrid, alfonso.cobo@upm.es
[4] Universidad Politécnica de Madrid, k.hosokawa@upm.es

Keywords: *Hybridizacion; carbon nanofibers, CNFs; concrete; polypropylene fibers*

It is clear, the great impact that the latest advances in the field of nanomaterials is having in the scientific community The possibilities of graphene and its derivatives are endless, since it has qualities never found before in another material, such as better electrical conductivity that of copper, and a resistance and flexibility between 100 and 300 times greater than steel [1].

Although carbon nanofibers (CNFs) are used mainly in the field of technology, research is beginning to study the behavior of concretes with CNFs and that they show a better resistance to flexion, an increase in ductility, a better control of microcracks. and an improvement in compression resistance at early ages [2, 3], while the incorporation of polypropylene fibers into concrete is a well-known result.

The objective of the present investigation is to study the mechanical compression behavior in concrete with hybridization of fibers and compare it with traditional concretes. For this, cylindrical concrete specimens were made with hybridization of carbon nanofibers (CNFs) and polypropylene fibers, with 1% by weight of cement of each type of addition and cylindrical concrete specimens without additions, according to the results obtained it can be seen that the hybridization of the fibers does not represent a great advantage in the compression strength of the concrete, but it implies an improvement in the ductility of the same.

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COMPARATIVE ANALYSIS OF EIGHT DIFFERENT GREEN ROOFS SOLUTIONS UNDER MEDITERRANEAN CLIMATE CONDITIONS

[1] Julià Coma, [1] Ana Lacasta

[2] Inma Cantalapiedra, [1] Montserrat Bosch

[1]Departament de Tecnologia de l'Arquitectura, Universitat Politècnica de Catalunya, Av. Dr. Marañón 44-50. 08028 Barcelona, Spain. e-mail: julia.coma@upc.edu
[2]Departament de Física, Universitat Politècnica de Catalunya, C. Jordi Girona 1-3. 08034 Barcelona, Spain.

Keywords: *Extensive green roofs; thermal assessment; thermal inertia; passive systems; thermal lag*

The building sector accounts for more than 40% of the total energy consumption in Europe and approximately 36% of the overall CO_2 emissions [1]. With the aim to reduce the energy demand of buildings, and consequently decrease the environmental impacts in this sector, more sustainable building solutions have to be implemented. From all the construction systems available in the building sector, the building envelope/skin has the major role in reducing the energy demand. Its improvement can reduce the energy used in buildings between 20% and 60% [2]. Besides providing large passive energy savings, building envelopes also have potential to improve other necessary ecosystem services, especially when combined with green infrastructures, such as green roofs or vertical greenery systems [3-6]. Green infrastructures not only improve the aesthetics of buildings but also improve the water runoff quality, the mitigation of the CO_2 emissions, the protection of internal layers of the building, the thermal inertia, etc. Within this context, the present study, which was developed in collaboration with Universitat Pompeu Fabra, Universitat Politècnica de Catalunya, and Eixverd company, provides a comparative analysis of the thermal performance of eight different commercial extensive green roofs trays installed on Mercè Rodorerda building, Barcelona (Spain) [7]. Data collection was conducted from April to August of 2016. The overall thickness of green roofs ranged between 130 mm and 551 mm. Table 1 shows the main properties of all systems.

Table 1. Main properties of the evaluated green roofs

	M1	M2	M3	M4	M5	M6	M7	M8
Vegetation thickness [mm]	20-40	20-150	20-40	20-40	50	200	40-50	200
Type of vegetation	Sedum	Sedum and flowers	Sedum blanket	Sedum blanket	Sedum blanket	True grass	Sedum	Semi-intensive true grass
Substrate thickness [mm]	100	150	60	30	100	200	100	150
Overall thickness [mm]	130	180	134.5	140	180.6	495.6	150	551

Specific weight [Kg/m^2]	90	160	166.3	80.1	120	145	140	220

To evaluate the thermal evolution of each sample, four different temperature points were registered across the section (Figure 1). **D**: ambient temperature of the vegetation; **C**: surface temperature of the substrate; **B**: temperature below the substrate layer; **A**: temperature below the overall section of the green roof solution. Additionally, each sample has 8 cm of insulation (XPS) below the point A to isolate the samples from the indoor temperature fluctuations.

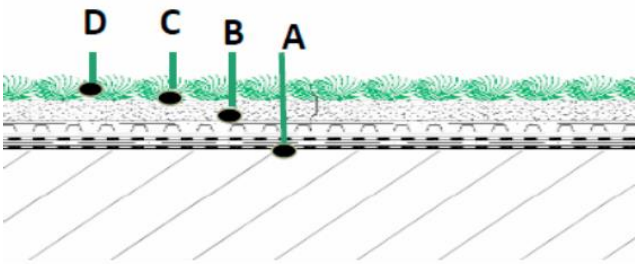

Figure 1. Scheme of the distribution of the four thermocouples installed in each green roof sample

The results showed that systems with larger thickness, especially those with thicker substrate, (M8 and M6) provided higher thermal stability and temperature reductions during the hottest period of summer, as expected. On the contrary, sample M4, which has the thinnest substrate (30 mm), showed the highest thermal sensibility with a difference of 6 ºC between minimum and maximum temperatures. Despite these previous results, other important factors, such as the typology of the vegetation, can develop important roles in reducing the surface temperatures of the substrate. E.g. samples M2 and M8, with thicker plants, registered the lowest average temperatures, and the lowest peak temperatures in point C during the same period in summer. Finally, the higher thermal lag was provided by samples M2 (12 h), followed by M6 (7.5 h), and M8 (5 h).

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ANALYSIS OF THE APPLICABILITY OF CONSTRUCION AND DEMOLITION WASTE IN THE CONSTRUCTION ACTIVITY

[1]Claudia Bin

[1] *DISEG, Politécnico de Turín, claudia.bin@studenti.polito.it*

Key words: *Construction and demolition waste, recycled aggregates, circular economy*

The issue addressed in this work refers to the recovery and the improvement of those materials that until a few years ago were considered waste, a burden for the company destined to be disposed of in landfills. We are talking about the so-called construction and demolition waste, also known as C&DW.

In fact, concrete is one of the most widely used materials in the construction of infrastructure works, but it is also the generator of large volumes associated with the processes of demolition and waste. Climate change and environmental pollution have caused countries to initiate policies whose approach is to reduce these volumes of waste by reusing them or looking for another alternative [4].

Studies conducted in the European Union have been able to establish that the production of construction waste amounts between 221 and 334 million tons/year [1]. Likewise, investigations have been able to determine the feasibility of reusing concrete from the construction as a granular material, demonstrating that if natural aggregate is replaced by recycled material in the correct percentages, concrete can be manufactured without losing its mechanical properties.

In general, this work has been developed in three stages: the first consisting of identifying and obtaining the raw material, which will come from the demolition of the work; the second, where this raw material is processed, thus obtaining the aggregate that will be used in the manufacture of concrete; finally, the third stage will consist in designing concrete mixtures to determine the mechanical properties of the concrete in order to establish the viability of its use from its resistances [1][3][4].

A matrix of variants for the elaboration of the mixtures will be generated, which will allow us to clearly define the behaviour of the concrete in its natural or composite state.

The objective of the experimental phase was to determine the minimum quality of the recycled coarse aggregate and the optimum percentage of substitution of the natural coarse aggregate, in such a way that the concretes made with the recycled aggregates fulfilled the requirements established by the regulations, using one or several relation natural/recycled aggregate, depending on the study.

In this phase, concrete samples with different amounts and types of additives inside were analysed. The properties studied are: resistance to compression and water absorption [2][5].

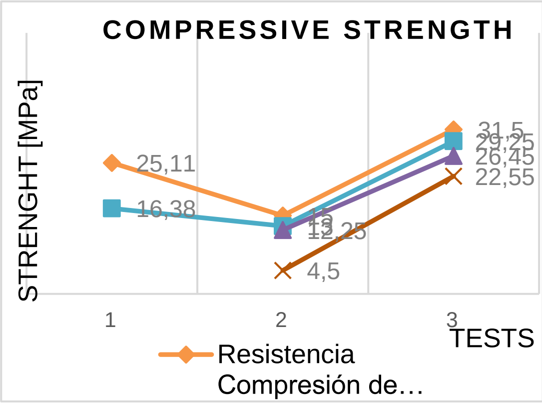

Fig. 1: Compressive strength esistencia a compresión with different percentages of recycled concrete

According to the experimental results it was demonstrated that it is feasible to obtain a material of good performance, such as to be used in resistant structures, with the replacement of a high percentage of natural aggregate by recycled aggregate, collaborating with environmental problems and the generation of waste; this happens above all with the addition of aggregates to the mixture. But it is important to continue researching and be able to determine if this type of concrete can have the same or very similar characteristics to the natural one [5].

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TECHNOLOGICAL CHANGE FOR CONSTRUCTION OF HOUSING IN COLOMBIA

[1] Mónica Andrea Rodríguez

[2] Carlos Rodríguez Monroy

[1] Universidad Politécnica de Madrid, monica.rnino@alumnos.upm.es
[2] Universidad Politécnica de Madrid, crmonroy@etsii.upm.es

Keywords: *Construction industry, housing, Colombia, industry 4.0*

Industry 4.0 is currently presented as an alternative to the different economic sectors of each country with new technological and digital developments. According to the research carried out, the construction industry will grow 4.2% per year between 2018 and 2023 in terms of market value, with opportunities for expansion in residential, non-residential and infrastructure projects [1]. In addition, each year about $ 10 billion is related to construction spending worldwide, which is equivalent to 13 percent of world GDP [2]. In contrast, the diagnosis of the construction sector in labor productivity is discouraging compared to that of the manufacturing industry in general and other economic sectors.

The approach of an intelligent factory that makes industry 4.0 and new technologies is an important alternative for construction in Colombia that, together with the application of good practices with stakeholders, is presented as an exit to take a leap positive in productivity. In Colombia, Social Housing (VIS) appears as one of the sub-sectors susceptible to begin to implement the change to an industrialized system, because there is a favorable projection of volume in the market in the coming years, it requires a little design, focused on covering specific needs, and with low cost.

This paper proposes a strategy of change in two phases for a construction company. The first one has as main objective to generate value to the current chain and find points of synergy between primary activities and support activities to lower costs and prepare technologically for a second phase. This first part constitutes an internal technological transformation with the integration of the current information systems: BIM, CRM, and ERP and Procurement. The second phase proposes a change in the execution of the work, previously evaluating the possibility of migrating to an industrialized system as far as possible. That is, it may not apply to segments other than VIS, but depending on the projects that have already been planned for the next few years, they could study the feasibility of making changes based on systems already executed, such as Katerra or Barcelona Housing Systems, which they have migrated to standardize, prefabricate, assemble and customize in situ.

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EFFICIENCY AND EFFECT OF CONSOLIDATION AND WATER REPELENT TREATMENTS ON STONE MATERIALS. CASE STUDY: BUILDING RESTORATION AT ALMUDENA CEMETERY.

[1] **Esther Moreno Fernández**

[2] **Francisco González Yunta**

[3] **Alberto Sepulcre Aguilar**

[1,3] ***Escuela Técnica Superior de Edificación. UPM***
esther.moreno@upm.es; alberto.sepulcre@upm.es
[2] ***Escuela Técnica Superior de Arquitectura.UPM***
francisco.gonzalez.yunta@upm.es

Keywords: *Consolidants, water repellents, stone materials, architectural heritage, restoration.*

Since a long time ago, some products have been used in order to preserve and protect natural stone monuments as well as bricks and mortars and thus achieve greater resistance to deterioration processes. At first, natural resins of animal and vegetable origin were used but, in the last decades, synthetic polymers have been commercialized to cover the capillary pores of the material, lowering its water suction capacity, coating the material and isolating it from the aggressive environment [1-4].

Regarding to its effect, two main types of products are distinguished: consolidants and water repellents. First ones are substances that --penetrating inside the stone or ceramic material porous network-- improve their internal cohesion and therefore their mechanical behavior. They work attempting to achieve the adhesion between the surface --generally more weathered-- and the unaltered inner base. A water repellent is a product with a behavior that prevents the penetration of water in its liquid state but allows moisture vapor transmission. It can be applied on the surface of the already altered material or under weathering process. These products act in a double way, both narrowing pore radius and thus avoiding liquid water penetration into the pore network on one side, and repelling water due to a chemical hydrophobic behavior on the other side [5].

In recent years, numerous commercial products have emerged in the market for restoration and conservation of architectural and monumental heritage stone materials. It has generated a great confusion among professionals of the sector because of a lack of knowledge of its long-term performance. Therefore, the evaluation of these products is necessary before their use on the materials surfaces [6-10].

Due to different stone and ceramic materials properties, the behavior of these products has not always been optimal and their use has caused irreversible damage to monuments. Therefore, recently, its use has been limited to strictly necessary cases and the need to perform laboratory tests to confirm its suitability is prescribed.

At the present work, an experimental study of the efficacy and effects of different consolidating products based on ethyl silicate and siloxane has been carried out. They have been applied on a limestone and ceramic bricks belonging to a façade of a building from Almudena Cemetery in Madrid where restoration works are being carried out. The aim is to determine the suitable product to use for each material. Conservation treatment selection has been made based on results discussion of the laboratory tests, attending to their effectiveness, suitability and compatibility with existing materials. Penetration depth, interfaces formation, possible aesthetic alteration and water penetrability, have been also studied.

As conclusion, the need to carry out pre-tests prior to the application of any product is emphasized and not applying any product before checking long-term behavior is recommended.

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RENEWAL OF THE TRADITION

[1]Jie Chen

[1] *Universidad Politécnica de Madrid.* jie.chen77@alumnos.upm.es

Keywords: *Renewable housing, ecological resources, air and water pollution*

The main idea is to realize a high-performance renewable housing through ecological resources. The content will be to modernize a two-story building with an Asian-style wooden structure where the system is simple and fast, adding the use of prefabricated wood both in the structure and in the finishes finally giving it a modernized finish on the facade and on the deck.

As we all know, in today's world, the most severe problem is air and water pollution; caused by the smoke of the chimneys of the fabrications, by the smoke of the exhaust pipes of the cars or by forest fires. In the field of construction, due to the great demand for new construction, the manufacture of building materials such as brick, glass, steel, cement, polystyrene, rubber, silicone etc increases; most of these materials need to go through a decoction process per kiln, which leaves a lot of solid, liquid and gaseous waste; which can cause toxic reactions such as carbon monoxide and hydrogen, sulfur dioxide, nitrogen oxides, benzenes, lead compounds; apart from leaving a lot of black water. All this also means a long life cycle and greater energy consumption.

However, wood is a much more ecological and efficient material, it can be considered as a coal pit that absorbs all the CO2 around it; it is a renewable resource, especially if the forests are conserved (in Europe it increases every 500,000 hectares per year), the work of acquiring the raw material involves a much lower risk compared to concrete or steel. The wood also has very thermal behavior (0.04-0.12W / mK) compared to brick (0.6-0.15 W / mK) and concrete (0.8 W / mK), it is able to retain both heat and freshness, which is a great advantage in energy efficiency during its useful life (in case of a good conservation it can be reused, otherwise it can be converted into fiber or wood derivative and have a new life).

The residence consists of two floors, a ground floor of 10 * 8m2 with a hall of 2m wide covered by a corridor. The second floor of 6 * 4m2. The slab would be foundations of dimension 11 * 9m2 made with reinforced concrete.

The structure of the building will be wooden tongue and groove trying to avoid the use of metallic element as a screw. The roof structures do not rest directly on the pillars, they are joined by dong gong, a traditional anti-seismic system. Trus Joist joists (TJI) made of solid wood will be incorporated, a very light and resistant structure that can support up to 5kN / m3 of overload for each piece, apart from facilitating the placement of the pipes of the facilities.

The exterior enclosure will be made with waterproof laminated gypsum board and the interior finish will be made with Oriented Strand Board (OSB-3) whose significant advantages are considerable resistance to the humid environment and its thermal character, great resistance to rupture and torsion, an absence of knots, is not usually attacked by insects. Leave a 7.5cm of the air chamber to fill with thermal insulation (Rigid ISOVER rock wool panel, non-hydrophilic, without coating). A fire barrier is added to increase the time of excavation in case of fire.

The roof, finished with OSB board of 250 * 150 * 1cm3 and on it an asphalt roof to improve the sealing, finally covered with slate tile. The interior flooring is finished with solid flooring on oak flooring.

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STRATEGY FOR QUALITY CONSTRUCTION THROUGH PERSONALISED HOUSINGS

[1]Alejandra Vidales Barriguete

[2]Roberto Vidales Barriguete

[3]Victoria Santiago Rasilla

[1]Universidad Politécnica de Madrid,EscuelaTécnica Superior de Edificación,Departamento de Tecnología de la Edificación, Avda. Juan de Herrera, 6, 28040 Madrid,España; alejandra.vidales@upm.es
[2,3]AunaArquitectos, Francisco Alonso, 2, 28660Boadilla del Monte (Madrid),España;rvidales@aunaarquitectos.com; vsantiago@aunaarquitectos.com

Keywords: *Quality, industrialization of construction, work management, project management, project personalization*

All definitions of quality, belonging or not to the construction sector, are connected somehow to customer satisfaction as the most important thing to consider in the process of obtaining quality [1]. Therefore, and focusing the interest on it, offering a product that has been personalized for the customer seems to be the best option to achieve it.

As García Meseguer indicated in his Decalogue, [2] one of the peculiarities that the construction sector has is that it produces non-mass produced and unique products to which work on the assembly line cannot be applied. Contrarily, its main characteristic is centralised production, with different phases where the responsibilities of the different participants in the process turn out to be vague and ill-defined.

Fig. 1: Promotion in Moralzarzal. Source: Auna Arquitectos, S.L.

Fig. 2: Promotion in Valdemoro. Source: Auna Arquitectos, S.L.

Bearing in mind these premises, two promotions of several attached single-family housings have been proposed in Moralzarzal and Valdemoro (Madrid) (Figure 1-2), the distinctive feature of which is the personalisation of each housing by the final user. This can be done through living projects that are modified to meet each customer needs, but with a resulting delay in this phase of the process. Consequently, there is a time reduction in the construction process to compensate for the project phase bearing in mind the strategy of “constructing well from the beginning” [3], in order to deliver the housing to the buyer in 10 and 6 months respectively from the beginning of work.

This way, these housing developments begin with very precise projects, semi-industrialized construction with the choice of systems that guarantee quality, a correct work planning and a very exhaustive quality control. Its success lies in decreasing contradictions, minimising faults and final errors, completing work in the agreed time and satisfying the final customer.

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QUALITY IN BUILDING THROUGH THE *PASSIVHAUS* STANDARD

[1]Alejandra Vidales Barriguete

[2]Roberto Vidales Barriguete

[3]Victoria Santiago Rasilla

[1]Universidad Politécnica de Madrid,EscuelaTécnica Superior de Edificación,Departamento de Tecnología de la Edificación, Avda. Juan de Herrera, 6, 28040 Madrid,España; alejandra.vidales@upm.es
[2,3]AunaArquitectos, Francisco Alonso, 2, 28660Boadilla del Monte (Madrid),España;rvidales@aunaarquitectos.com; vsantiago@aunaarquitectos.com

Keywords: *Design quality, manufacture quality, client quality, Passivhaus*

The reality is that, in building, quality is not just a hallmark in the market, but also a requirable feature. Therefore, different strategic approaches are needed to achieve it during the whole constructive process [1].

That is the case of constructions following the PassivHaus standard which, trying to obtain zero net energy consumption, becomes an example of the concept of quality according to UNE-EN ISO 9000: 2015 [2], fulfilling the basic requirements for buildings established in the Building Regulations Act 38/1999 [3].

In this context, Penélope house (Figure 1), in Ciempozuelos (Madrid) was designed and planned subject to the limitations of the PassivHaus standards, location restrictions, the contractor's quality policy, etc. In the process, all the different participants were aware of the importance of every decision made [4].

During the work, thorough testing was carried out to achieve thermal comfort and the inner air quality required in the above mentioned standard, through exhaustive leaktightness tests, an excellent thermal insulation installation, thermal bridge breakage allowing for greater thermal insulation and the installation of ventilation systems with heat recovery that guarantes indoor ventilation. This way, it became possible to reach a heating demand of 12 kWh/m2 · year, below 15kWh/m2·year necessary for fulfilling the standard, with primary energy demand of 62 kWh / m2 · year below 120 kWh / m2·year for heating, hot water and electricity in the standard and, an airtightness of 0.26 air renewals per hour (with pressure differential of 50 Pa), below 0.6 air renewals per hour maxims indicated in the standard [5].

Fig. 1: Penélope house certified with standard PassivHaus.Source: Auna Arquitectos, S.L.

With this way of construction, not only design quality is reached by means of adequacy to the use and comfort expected by the client. Also, production and construction quality is achieved due to high performance requirements of the products and installation processes; and, finally, the quality wished by the client arises from the two previous circumstances [1]. Therefore, the quality in this constructive system is clear from two extents: that of the client, who demonstrates satisfaction with the ordered product and that of the company contractor, whose non-compliance costs decrease as its external expenses caused by claims significantly diminish.

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A DIMENSIONAL ANALYSIS METHOD APPROACH: IT'S APPLICATION IN SOCIAL INTEREST HOUSING OF GUAYAQUIL

[1] Byron Sebastián Almeida Chicaiza

[2]Jesús Anaya Díaz

[3]Eugenia Muscio

[1]Universidad Politécnica de Madrid – Universidad de Guayaquil, byron.almeidac@ug.edu.ec
[2]Universidad Politécnica de Madrid – jesus.anaya@upm.es
[3]Universidad Politécnica de Madrid – eugenia.muscio@gmail.com

Keywords: *Social interest housing, dimensional analysis, Guayaquil, graphic comparison*

This paper presents a method of graphical and mathematical analysis as an optimization of a previous proposal [1] that aims to facilitate the comparison and characterization of the dimensions of the spaces of different social housing construction models.

The proposed method has been applied to 71 building models that represent the housing solutions of social interest in where approximately 41.3%[1] of the population of Guayaquil live [2] [3] [4]; 50 of those models are from public promotion and NGOs and 21 were self-built or with a guided construction.

For this work, the most representative housing projects in Guayaquil have been documented, determining the number of solutions per project, dimensions of each space that is part of the architectural program.

The graphical method consists of the superposition of the polygons that define the architectural spaces, within a cartesian plane, always aligning the side of greater length (D_{major}) with the axis of the abscissas and highlighting its diagonal. As a result, the D_{major} / D_{minor} ratio will never be greater than the unit (1.00), making it easier to obtain the angle formed by the diagonal with the abscissa axis which allows a graphical-mathematical comparison and establishing relationships between the dimensions and the ratio used in the studied models.

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STUDY OF A HOUSE WITH DESIGN BUILDER

[1] María Jiménez del Moral, [1] Marina Rodríguez de Paz,

[2] Julián García Muñoz, [2] César Porras Amores,

[2] Carmen Viñas Arrebola

[1] Master student at MUEE. Universidad Politécnica de Madrid
[2] TEMA Research Group at the ETSEM. Universidad Politécnica de Madrid
tema.edificacion@upm.es

Keywords: *building simulation, energy consumption, house, energy efficiency*

The present work estimates the energy consumption and indoor comfort of a dwelling located in the province of Granada. According to the data provided by the State Meteorological Agency (AEMET, Spanish acronym) the latitude is 37º 9' 58'' North and 484m of latitude. Regarding the climate zone, it corresponds to the C3 area according the indications given in the Technical Spanish Code [1]. The dwelling has been modeled through a building energy simulation software "Design Builder" [2]. The results reveal in detail the behavior of the house from different points of view, such as: thermal, humidity, energy gains or losses, indoor comfort according to Fanger index [3], energy consumption, etc.

Once the behavior of the dwelling was known, the points and aspects that could be improved were detected. After that, some passive (thermal transmittance of materials, eave overhangs and blinds) and active (photovoltaic panels) strategies were implemented in the simulation model of the dwelling in order to evaluate their potential of improvement. So another set of simulations were done. The results obtained in the simulations indicate that both, the electricity consumption for lighting and electrical appliances, and the water consumption are identical in both cases (before and after implementation of passive-active strategies), since they are parameters that are not affected by the improvements introduced.

On the other hand, there is a considerable reduction in energy consumption for refrigeration in the dwelling with active-passive strategies. Although in the heating season there is a slight increase of energy consumption. This situation could be due to the installation of blinds and new glasses with lower thermal transmittance which favors the reduction of solar gains in the warm month, but also in the cold, which means higher heating energy needs. It should be noted that the thermal transmittance of the glass of the windows, as well as those of the roof are smaller, so that, in the same way, the losses (and therefore, gains) produced in both cases should be reduced.

The work carried out has allowed to learn the operation of the Design Builder software as well as its potential to evaluate the effectiveness of implementing active and passive systems in dwellings. Definitely, it is considered an excellent design tool for architects and engineers in the building sector.

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THE DAYLIGHT FACTOR IN NON-RESIDENTIAL BUILDING: CASE STUDY OF THE CLASSROOM OF AN EDUCATIONAL CENTER

[1] Claudia Bin, [2] Carmen Viñas Arrebola

[2] César Porras Amores, [3] Rubén Felices Puertolas

[2] Paola Villoria Sáez

[1] Student at the Politecnico di Torino, on Erasmus at the E.T.S. de Edificación
[2] TEMA Research Group at the ETSEM. Universidad Politécnica de Madrid
tema.edificacion@upm.es
[3] Universidad Politécnica de Madrid

Key words: *Daylighting, visual comfort, energy savings, energy efficiency, classroom*

The present study is designed to analyse natural lighting in a classroom of the Environmental Education Building of Pozuelo de Alarcón (CREAS). This building was chosen due to the commitment that the Municipality of Pozuelo has with the environment and the leading design in terms of sustainability and energy efficiency [1]. The work began with the monitoring campaign included between February 24 and March 6, 2017. Ten luxometers, connected to OPUS 200 and 08, were first strategically located inside the classroom, in accordance with standard UNE-EN ISO / IEC 17025: 2017 and UNE-EN 12464-1: 2012; they were set up to do a continuous data recording [3][4].

The results obtained is classified according to three scenarios [2]: 1) days with clear skies; 2) days with partially covered skies; 3) days with covered skies. For these three possible situations, the Daylight Factor (DF) was calculated, for each luxometers, for different hours. This new database with the use of Surfer, an interpolation software, has allowed us to know the lighting horizontal distribution on the working plane of the classroom.In parallel, through the VELUX Light Simulation program, with the same conditions of experimental modelling, we simulated the classroom's DF to obtain the distribution of lighting in the classroom work plane.

The results show a consistency between experimental modelling and simulation modelling, mainly on the clear days. The moderate dispersion on the partially cloudy days that can be attributed to the rank of magnitude m with which VELUX program works. This work shows [4] that areas with large windows, such as the classroom under study, present heterogeneous lighting and therefore it is necessary to check the performance of the incorporation of different passive designs to obtain a more homogeneous DF, by guaranteeing lighting comfort for users.

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URBAN GREEN INFRASTRUCTURE: GREEN ROOFS AND VERTICAL GREENING SYSTEMS PROVIDING MULTIPLE ECO-SYSTEM SERVICES IN THE BUILT ENVIRONMENT

[1] Gabriel Pérez Luque

[2] Julià Coma Arpon

[1] Department of Computer Science and Industrial Engineering, Universitat de Lleida, C/Jaume II 69, 25001 Lleida, Spain. gperez@diei.udl.cat
[2] Department of Architectural Technology, Universitat Politècnica de Catalunya, Av. Dr. Marañón 44-50, Barcelona, Spain. julia.coma@upc.edu

Keywords: *Sustainable construction, urban green infrastructure, green roofs, vertical greening systems, ecosystem services*

In recent decades, the global increase on environmental consciousness has led towards the inclusion of sustainability criteria in the urban systems and buildings designs.

Sustainable development requires the consideration of a whole host of interconnected elements, such as the reduction of energy demand and water consumption, minimizing waste and pollution, and providing efficient public transport. Under that “sustainable construction” approach, the closing of materials and water cycles as well as the reduction of energy consumption are the main objectives in the building sector.

In this context, the concept of Urban Green Infrastructure (UGI) has been defined as a set of man-made, but nature-based, construction systems, such as green roofs and vertical greening systems [1]. UGI provides several eco-services into the urban environment, such as the reduction of surface runoff in large cities, reduction of heat island effect, support to biodiversity, waterproofing membranes durability improvement, and building energy savings, among others. [2-12].

However, there are also a number of barriers related to GI deployment that must be overcome, such as the costs related to the maintenance, difficulty to quantify some of the provided benefits, potential damage for the building, and the fact that their design is sometimes still based on conventional materials with high embodied energy (polypropylene or polyester geotextiles membranes, polyethylene or polystyrene panels, expanded clay, natural pozzolana, and bitumen or PVC membranes).

During the last decade a series of research actions have been carried out at the University of Lleida in order to study these construction systems, to quantify their benefits, and to improve their design.

From these studies, several interesting conclusions have been drawn:

- An extensive green roof without insulation can offer similar thermal properties than a conventional insulated flat roof [2, 3].

- The replacement of pozzolana by recycled rubber as drainage material in extensive green roof systems allows obtaining a more sustainable solution without losses on the thermal and hydraulic properties [4-6].
- Vertical greening systems provide good performance during cooling periods with promising energy consumption reductions due to the integrate effect of shadow, evapotranspiration and wind barrier [7-9].
- Instead of general belief, during heating period vertical greening systems showed a good performance, with slight contribution to thermal insulation and energy savings in the case of the tested green wall [10].
- The contribution of vertical greening systems to the noise reduction and acoustic insulation was confirmed, measured and characterized. The strategies to improve this ecosystem service will imply the foliage-substrate mass increment and applying improvements on sound penetrability and structural insulation to avoid vibrations [11, 12].

Future research will be focused on improving all these urban green infrastructure systems in order to optimize the provision of the abovementioned ecosystem services, to overcome the current barriers, and to shift the design to a more sustainable approach, considering the materials, energy and water cycles.

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DYNAMIC THERMAL BEHAVIOUR OF TABS IN BUILDING ENERGY RETROFITTING

[1] Rossana Laera; [2]Inmaculada Martínez Pérez; [2]Ricardo Tendero Caballero;

[3]Luis de Pereda Fernández; [3]Rafael Tejedor Lopez; [4]Francesco Iannone

[1]PhD Innovación Tecnológica de Edificación. E.T.S. de Edificación de Madrid. Universidad Politécnica de Madrid. ENERES Sistemas Energéticos Sostenibles.
[2]Departamento de Construcciones Arquitectónicas y su Control. E.T.S. de Edificación de Madrid. Universidad Politécnica de Madrid.
[3]ENERES. Sistemas Energéticos Sostenibles.
[4]DICATECh. Politecnico di Bari.

Keywords: *Energy efficiency, thermo-active building systems (TABS), thermal mass, building energy retrofitting.*

In Mediterranean climate, Thermo-Active Building Systems (TABS) play a major role in building envelope integration, in terms of dynamic adaptation and thermal energy storage. In the case of building energy retrofitting and recovery of existing technologies, the integration of TABS compels the designers to assess their performance, by considering the variation of temperature distribution within the different materials over the time, thermal properties and boundary conditions. The designers shall also take into account the role of occupants, that constitute the final determining factor in terms of thermal comfort and utilizability of any building system, including thermal mass [1].

In literature, TABS have not yet been extensively studied in the extent of the heterogeneity of materials, in terms of performance and management arrangements. Therefore, modeling and experimental validation of a dedicated monitoring system is needed in the interest of energy efficiency and control of these systems [2]. This requires the identification of sensitive parameters which affect heterogeneous thermal mass performance.

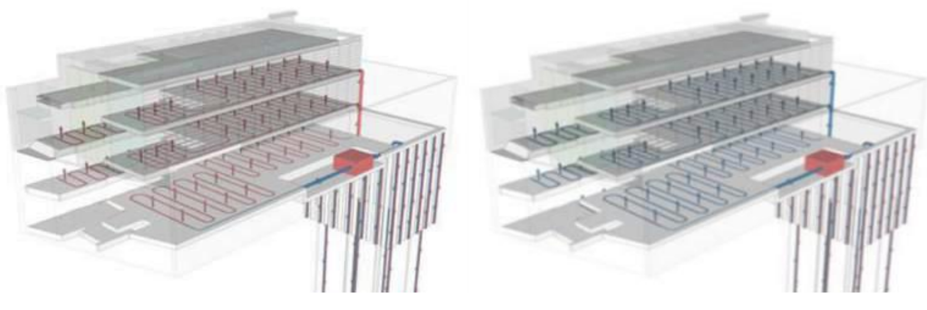

Fig. 1: Apolonio Morales 29, Madrid. Thermo-active Building System.
Source: IEI Instituto Europeo de Innovación.

The case study is an office building, located at Calle Apolonio Morales, 29 (Madrid). The original horizontal structure was thermoactivated [3] with an additional concrete mass of 7 cm. Floors perform like radiant elements during the working hours, like accumulators during the night. This allows to reduce consumption costs (night-time rate) and avoid load peaks during the morning. In winter, during the night, geothermal heat pumps work to pre-heat floors. In summer, free circulation of water and geothermal heat pumps work to pre-cool floors during the night. This strategy takes advantage of the structural mass inertia of the building. The control system monitors supply water temperature in the collectors and adjusts room temperature according to the set points. It acts on servo-powered valves, associated with the collectors, according to the signals received from air and pipe temperature sensors [4]. Concrete slabs temperature is measured by two sensors per floor, connected to the control system: they provide limited information that refers to a few specific points of the slabs.

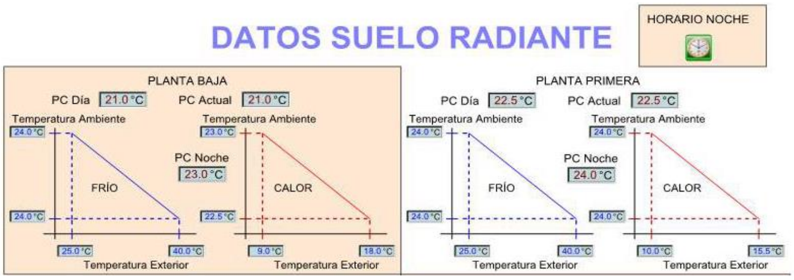

Fig. 2: Apolonio Morales 29, Madrid. Control System interface. Radiant floor Setpoint Manager. Source: Apolonio Morales 29, Madrid, Control System.

A thermographic investigation enabled to realize a map of temperature variation on the interim floor surface during a typical winter working day. This analysis allowed taking awareness of the heterogeneity of materials: position of tubing affect heat transfer, including in relation to the proximity to collectors and the glazed façade, where the distance between tubes is concentrated to increase thermal emissions and to take advantage of solar gains [4]. The variation of relation between bricks and joists is supposed to change thermal mass and thermal stability of the floors, that increase proportionally with the presence of joists.

Future developments deal with the validation of a heat transfer model for heterogeneous radiant floors, along with the definition of dedicated operation strategies. A proper monitoring campaign is being prepared, by integrating the control system with a number of new sensors installed in well-studied locations. The sensitive parameters identified should be taken into account both in the design and the exploitation phases, including for the design of Building Management Systems, with the aim to take full advantage of thermal inertial properties and storage capability.

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COMPARATIVE RESEARCH BETWEEN TWO AIR CONDITIONING SYSTEMS, HYDRONIC FED BY GEOTERMIC ENERGY AND AN AIR-AIR SYSTEM, FOR THE SAME BUILDING CONSIDERING ENVIRONMENTAL IMPACT

[1]Javier Hermoso Gil; [2]Amparo Verdú Vázquez

[3]Inmaculada Martínez Pérez; [4]Luis de Pereda Fernández

[1]PhD, Escuela Técnica Superior de Edificación, UPM.
[2]Dpto. Tecnología de la Edificación, Escuela Técnica Superior Edificación, UPM.
[3]Dpto. Construcciones Arquitectónicas y su Control, Escuela Técnica Superior Edificación, UPM; amparo.verdu@upm.es
[4]ENERES Sistemas Energéticos Sostenibles. Instituto Europeo de Innovación IEI. España.

Keywords: *LCA, geothermic, environmental impact, heat pump, thermoactive slabs*

In the following research, a comparative analysis between two air conditioning systems will be made. [1] One is going to overview an air-air conditioning system and the other one an hydronic system fed by geothermic energy [fig.1].

For this research a protected building has been chosen, placed in the centre of Madrid. It is the old military building Daoiz y Velarde, refurbished into a children´s theatre and cultural space. The choice made for this building has been made due to the fact that working in a safe building makes it easier to draw comparative analyzes. The structure and the frontage can´t be modified, therefore the research should start from the conditions found from the beginning.

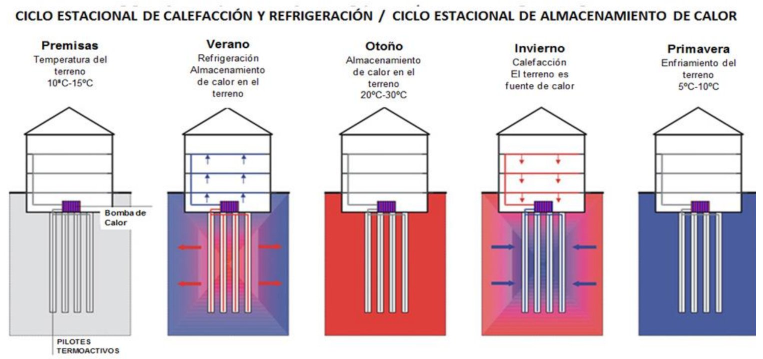


Fig.1: Schematic of the principle of operation of the air conditioning system with geothermal exchange in the primary circuit, geothermal heat pump and thermoactive slabs as an inertial air conditioning system

Finally, it has to be adapted to the C.T of the building, taking in consideration some of the specific requirements for cultural and children´s spaces.

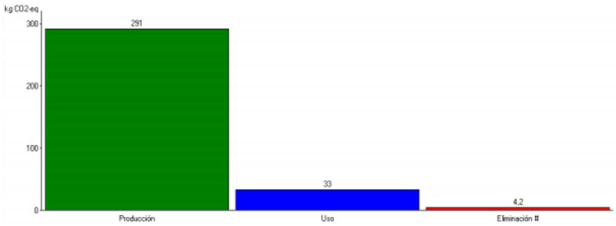
For those analyses, we have to take in account the optimal conditions that a building requires in choosing the most appropriate air conditioning system for the environment (e.g. temperature, humidity and different parameters depending on the user).

An informatic tool for the analysis of life cycle, materials, energies, waste etc., should be used for both air conditioning systems. The aim of this research is to find out and demonstrate which of the systems has lower pollution, a global view of the whole Life cycle, extraction of raw materials, construction and earthworks, use and also to consider waste.

Ultimately, in this research we want to gain a global vision of the whole life cycle, called for the cradle to the grave [2]. This includes, from the production of the raw materials which makes up the machinery, to the transport of equipment. The energetical consumption during the installation, energetic consumption during using face and the last elimination of waste will also be taken into account.

Using the software we can collect data and make the graphics more coherent [Graphic 1.] when comparing both systems and measuring them with the same criteria and scale [3].

Graphic 1: Schematic representation of an example of life cycle analysis with production, use and phase of waste on the abscissa axis and quantification in the ordinate.



This graphic will be represented with the same measurement and we will then be able to see which of the both systems has a higher environmental benefit. Finally, we will then draw out conclusions from the comparative research.

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SUSTAINABLE TECHNOLOGIES TECHNOLOGY BASED ON RAW EARTH

[1]Marta Revuelta Aramburu

[2]Silvia Cenzano Gutiérrez

[3]Amparo Verdú Vázquez

[1]Departamento de Ingeniería Mecánica. Escuela Técnica Superior de Ingeniería ICAI.
[2]Departamento de Tecnología de la Edificación. Escuela Politécnica Superior. UAX.
[3]Departamento de Tecnología de la Edificación, E.T.S de Edificación. Universidad Politécnica de Madrid; amparu.verdu@upm.es

Keywords: *Sustainable construction, ground, adobe, tapial*

Given the current situation of ecological overreach characterized by aspects such as climate destabilization, over-consumption of resources and the disappearance of animal and plant diversity [1], it is considered necessary to study and compare constructive technologies that respond to the housing needs of low environmental impact, with low economic impact and socially respectful. Assuming the consequences of such a situation is especially complex. For this it is necessary to consider the environment as a system affected by human action. As a consequence of this we can understand that local actions affect globally. Another approach to consider in such a situation is whether highly technical solutions are proportionate and assumable [2]. This criterion determines the choice and approach of construction systems of technification and complexity defined for greater viability and for real sustainability.

The construction systems selected are those that use the earth as the main material, as it is the one that best meets these requirements for the Iberian Peninsula at present. The following figures show examples of land-based constructions from traditional models such as tapial to modern technologies such as the superadobe.

Fig. 1: Example of wall as loading wall: La Alhambra, Granada.
Source: https://es.wikiarquitectura.com/edificio/la-alhambra/

Currently earth serves as construction material in many different technologies. Most of them come from traditional methods, some are still made the same or with slight variations. For example, adobe has reduced its size in order to lighten the weight of the pieces and facilitate their handling. The systems of construction with earth most used in sustainable self-construction are the following: adobe, cob, BTC (blocks of compacted earth), tapial, braided partition, lightened mud, plasters and superadobe.

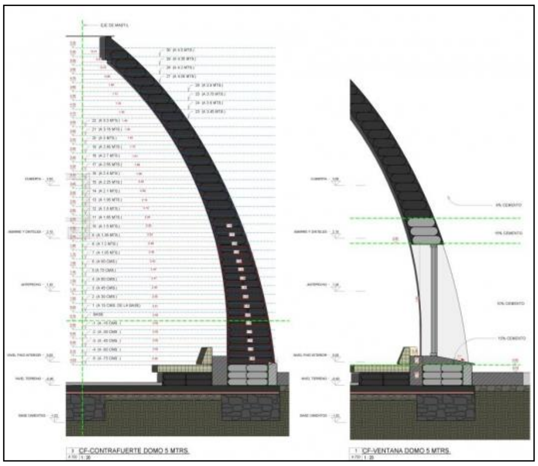

Fig. 2: Example of building detail with superdaobe.
Source: http://www.a57.org/articulos/proyecto/En-proceso-Casa-Vergara-Superadobe

Superadobe was developed in the eighties. It consists of lifting walls and vaults by means of continuous tubular sacks filled with stabilized earth. It can be stabilized with lime or cement, in which case many of the advantages of material sustainability are lost.

The COB technique consists of making monolithic walls from a mass of very moist clay with abundant fiber that is applied and molded by hand.

Lightened Mud designates the walls of great insulating capacity composed of a mixture of diluted mud with other lightening materials that are placed in formwork, are compacted by hand, allowed to harden and are stripped.

The system of braided partitions, basketed or interlaced, consists of a supporting structure of wood as a frame, joined to lattice frameworks of interwoven rods with a mud and straw filling.

The earth coatings are mortars that are applied as a continuous finish for the exterior or interior coating of the walls, in one or more layers, with a protective and aesthetic character.

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METHODOLOGICAL PROPOSAL FOR THE DISTRIBUTION OF SUBJECTS ACCORDING TO EXISTING LIGHTING LEVELS AND LIGHT REQUIREMENTS BY TASK: FACULTY OF ARCHITECTURE AND URBANISM, UNIVERSITY OF GUAYAQUIL.

[1] Pamela Bermeo Rodríguez

[2]Sebastián Almeida Chicaiza

[3]Jesús Rafael Hechavarría Hernández

[4]Maikel Leyva Vázquez

[1]Universidad de Guayaquil – pamela.bermeor@ug.edu.ec Guayaquil,
[2]Universidad Politécnica de Madrid – Universidad de Guayaquil
byron.almeidac@ug.edu.ec
[3]Universidad de Guayaquil – jesus.hechavarriah@ug.edu.ec
[4]Universidad de Guayaquil – mleyvaz@gmail.com

Keywords: *Lighting levels, lighting technology, visual comfort, quality of education, visual task*

This study analyzes the level of illumination with which students and teachers currently work in the classrooms of the Faculty of Architecture and Urbanism of the University of Guayaquil (Ecuador).

The objective is to establish a methodology that characterizes the classrooms according to their lighting levels to determine which subjects should be developed in each of them according to the type of tasks that are performed during the class and their respective minimum lighting requirements according to technical standards, seeking to reduce the visual effort of users.

Due to the economic and financial reality of the university, the study seeks to present a realistic alternative that does not imply a redistribution of luminaries, much less a change of technology; for this reason, it has been considered to work with the same quantity and quality of current lighting, but generating a change in level of lighting comfort [1] by reallocating classrooms according to the demands of the tasks performed [2] ; collaborating in this way to the academic performance of the students [3]; seeking to comply with the requirements established by the CEAACES (Council for the Evaluation, Accreditation and Quality Assurance of Higher Education), the national body that determines the accredited universities in Ecuador [4].

The work carries out an analysis of the existing spaces, their spatial characterization, specification of the lighting technology used, the existing lighting levels per workplace; In addition, categories have been established to classify the subjects according to the level of requirement of the tasks performed.

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NEW LOW TEMPERATURE GLASS COMPOSITES FROM GLASSES RECYCLING, APPLIED FOR ARCHITECTURAL CONSERVATION.

[1] Mª Paz Sáez-Pérez

[2]Alberto Martínez-Ramírez

[3]Mª Ángeles Villegas-Broncano

[4]Jorge A. Durán-Suárez

[1] University Lecturer. Phd, Construction Architectural Department. Advanced Technical School of Building Engineering, University of Granada, mpsaez@ugr.es
[2] Becario de iniciación a la investigación. Conservation and Restoration Degree. University of Granada albertomr@correo.ugr.es
[3] Phd, History Institute. CCHS, CSIC, Madrid, mariangeles.villegas@cchs.csic.es
[4] University Lecturer. Phd, Sculpture Department, University of Granada, giorgio@ugr.es

Keywords: *New composite, glass, shards, geopolymer, low temperature*

By using silicate inorganic binders and glass waste (colourless or coloured) it is possible to mould technical and artistic elements, which later can be hardened by means of high temperature processing. This procedure is controlled by both the glass transition temperature of binder and of glass waste used as aggregate.

To produce new glasses in these cases have been designed a new compound made of liquid binder (sodium silicate) and ground glass as aggregate from common glass bottles (sodium calcium) colored or not colored. This compound is based on the production of geopolymers [1, 2, 3].

"Water glass", catalysed with sodium hydroxide was used as a binder of glass shards from common industrial bottles, classified to a grain size distribution below 2 mm.

Chemical analysis shows similarity of silica content between binder and aggregates of recycled glass, establishing as main differences in the percentages of chromophore oxides. In addition dilatometry curves of the two materials show close glass transition temperature values (575 and 598ºC, respectively), fact that facilitates sintering between binder and aggregates.

The non-heat-treated samples present good compactness and mechanical resistance values, improved with heat-treatment at 700ºC. The high compactness of heated samples, showing rounded aggregate grains and softening of binder could let a good way for obtaining well-consolidated technical elements, made of recycled glass.

From this test, it would be possible to use thermal ranges between 550 and 600°C, as well as shorter exposure times for a proper hardening.

These materials constitute a true substitute for expensive processes, such as the preparation of hot glass. These new products improve technical properties and ease of use that are organic polymers (e. g. epoxy or polyester). The products mechanically finished with this technique can be completed through further compaction with heating to temperatures close to 500 ° C.

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COMPARISON OF DIFFERENT MODELS OF CALCULATION TO EVALUATE THE RESISTANCE TO COMPRESSION OF THE CONCRETE CONFINED WITH CARBON FIBER TISSUES

[1] José Ángel Piñero Díaz

[2]Daniela Brizuela Valenzuela

[3]María de Nieves González García

[4]María Isabel Prieto Barrio

[1] Universidad Politécnica de Madrid; josepinsan@gmail.com
[2] Universidad Central de Chile; daniela.brizuela@ucentral.cl
[3] Universidad Politécnica de Madrid; maríadelasnieves.gonzalez@upm.es
[4] Universidad Politécnica de Madrid; mariaisabel.prieto@upm.es

Keywords: *Confined; concrete; CFRP, ACI, FIB*

The resistance of concrete to compression can be increased very importantly by its confinement. The confinement of the concrete by means of the external gluing of high resistance fiber fabrics is a technique that has been known for decades and is increasingly used in reinforcement works of structural elements subjected to compression. Carbon fiber fabrics are commonly used, due to their high strength and high modulus of elasticity. The break of the elements occurs when the tensile fiber fails (figure 1).

Fig. 1: Break shape of confined concrete.

There are different models to predict the compressive strength of concrete confined with this type of fabric. In America, the model proposed by the ACI [1] is usually used, while in Europe, the one proposed by the FIB is used [2].

In both models, the strength of the confined concrete is obtained from the geometry and strength of the unconfined concrete and the geometric and mechanical characteristics of the fabric that confines the concrete. However, the expressions used are conceptually different. Table 1 shows the expressions contributed by both associations for circular section elements.

Table 1: Expressions used by ACI and FIB for confined concrete

ACI440-17	**FIB**
$f_{cc} = f_c + \varphi_f \cdot 3{,}3 \cdot f_l$	$f_{cc} = f_c\left(2{,}254\sqrt{1 + 7{,}94\frac{f_l}{f_c}}\text{-}2\frac{f_l}{f_c}\text{-}1{,}254\right)$
$f_l = \frac{2E_f \cdot n \cdot t_f \cdot \varepsilon_{fl}}{D}$	$f_l = \frac{2E_f \cdot n \cdot t_f \cdot \varepsilon_{fu}}{D}$
$\varepsilon_{fl} = k_e \cdot \varepsilon_{fu} = 0{,}55 \cdot \varepsilon_{fu}$	
$\varphi_f = 0{,}95$	
$0{,}55\varepsilon_{fu}$	ε_{fu}

Where f_{cc} is the strength of the confined concrete; f_c is the strength of the unconfined concrete; φ_f is a coefficient of value 0,95; f_l is the confinement stress; E_f is the modulus of elasticity of the confinement material; n is the number of layers of the fabric; t_f is the thickness of the fabric; ε_{fl} is the unitary longitudinal deformation that the fabric can reach when it confines the concrete; D is the diameter of the piece to be reinforced; k_e is a coefficient of value0,55; ε_{fu} is the ultimate deformation of the fabric tested under tension.

The comparison between the two expressions reveals two fundamental differences.

First, for ACI the increased strength of the confined concrete is independent of the strength of the unconfined concrete.

Secondly, ACI decreases the maximum deformation at which the fabric can work (and therefore its resistance) to a value close to half of the ultimate deformation of the fabric tested to pure traction, as a result of multiplying by the coefficients φ_f y k_e, while FIB does not specify this point clearly.

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CALIBRATION OF CALCULATION MODELS FOR CONFINED CONCRETE WITH CFRP

[1]José Ángel Piñero Díaz

[2]María de las Nieves González García

[3] Daniela Brizuela Valenzuela

[1]María Isabel Prieto Barrio

[1] Universidad Politécnica de Madrid; josepinsan@gmail.com
[2] Universidad Politécnica de Madrid; maríadelasnieves.gonzalez@upm.es
[3] Universidad Central de Chile; daniela.brizuela@ucentral.cl
[4] Universidad Politécnica de Madrid; mariaisabel.prieto@upm.es

Keywords: *confined; concrete; CFRP, ACI, FIB*

A procedure to increase the compressive strength of concrete consists of its confinement by carbon fiber fabrics bonded externally with epoxy resins. In this way, a structural system is obtained that increases in a very remarkable way its resistance and ductility with respect to the base material.

There are different models to estimate the compressive strength of confined concrete [1-3]. All these models have been experimentally calibrated and in them the characteristics of the confinement material intervene. However, they are not able to predict in a solvent way the effect of the confinement when the concrete moves in a fork of important resistances. Figure 1 shows the experimental results obtained for confined concretes of medium and low resistances and the values estimated by different regulations. It can be verified how the values obtained experimentally (EXP) differ significantly from those estimated by different standards.

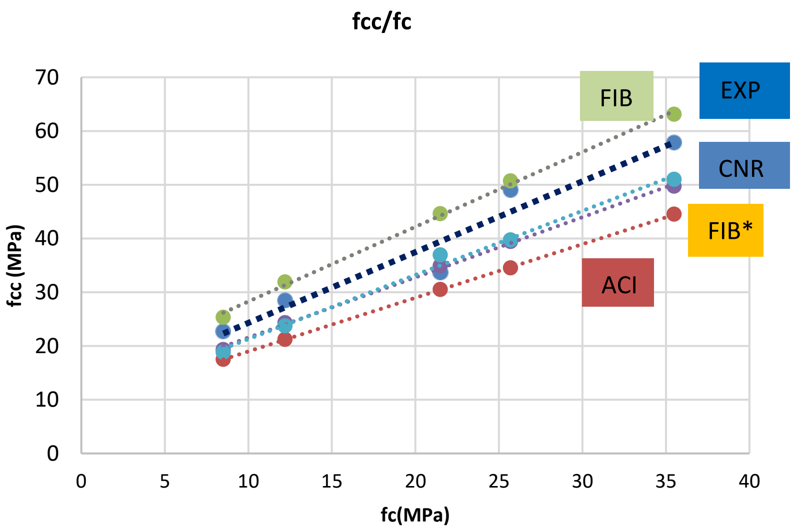

Fig. 1: Evolution of the strength of the confined concrete.

In this work, the compression resistance of concrete of low and medium resistances confined with carbon fiber fabrics has been evaluated experimentally. Different existing models have been analyzed to predict the strength of confined concretes and the experimental results obtained have been compared with the values estimated by the models of these documents. The analysis of the results allows to identify the models that best fit the experimental values obtained.

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SHEAR REINFORCEMENT OF REINFORCED CONCRETE WITH STEEL FIBERS BEAMS ACORDING TO ACI 318-08 and ACI 318-14

[1] José Luis Sánchez Pérez

[2]María de las Nieves González García

[3]Fernando Israel Olmedo Zazo

[4]Nuria Llauradó Pérez

[1]Universidad Politécnica de Madrid; joseluis.sanchezp@upm.es
[2]Universidad Politécnica de Madrid mariadelasnieves.gonzalez@upm.es
[3]Universidad Politécnica de Madrid fiolmedoz@gmail.com
[4]Universidad Politécnica de Madrid nuria.llaurado@upm.es

Keywords: *SFRC; shear; concrete; ACI 318*

The code ACI 318 has allowed the replacement of the fences or stirrups as shear reinforcement in concrete beams reinforced with steel fibers (SFRC) when a number of conditions were fulfilled. The edition of the Year 2014, ACI 318-14 [1], has assumed a conceptual change regarding the edition of 2008, ACI 318-08 [2] which is analyzed below.

In both editions the conditions are set at two levels, at the material level and at the structure level.

At the material level, the edition of 2008 specified that in order to be able to admit the SFRC as a shear resisting material, the following three conditions should be fulfilled simultaneously:

1. The dosage of steel fibers must be equal to or greater than 60kg of fibers per cubic metre of concrete

2. The residual resistance obtained in the flexion test performed according to ASTM C1609M when the dflection reaches 1/300 of the length must be greater than or equal to 90% of the first peak of resistance obtained in the test and 90% of the resistance to flexural , fr, obtained according to the expression $\mathrm{f_r} = 0.62\sqrt{\mathrm{f_c'}}$

3. The residual resistance obtained in the flexion test performed according to ASTM C1609M when the deflection reaches 1/150 of the length must be greater than or equal to 75% of the first peak of resistance obtained in the test and 75% of the resistance to flexural fr, obtained according to the above expression.

The edition of 2014 maintains the three previous conditions but also requires that the fibers used i) must be corrugated and comply with ASTM A820M, ii) must have a slenderness between 50 and 100 and III) must comply with ASTM C1116M

At the level of structure, the edition of 2008 allowed the total substitution of the strrups when it was beams with concrete of normal weight reinforced with steel fibers with a resistance specified to compression no higher than 40MPa, a cross section no greater than 600 mm and in which It complies with the following relation $V_u \leq 0.17\text{Ø}\sqrt{f_c'}b_w d$ Being V_u the shear request increased, Ø the resistance reduction factor, f_c' The specified resistance of the concrete to compression, b_w the width of the beam and d the cross section.

The 2014 edition specifies that the total replacement is possible when $V_u \leq \emptyset \cdot V_c$ otherwise it is necessary to place a minimum reinforcement area in the form of an reinforcement. In any case, in order to be able to give this total or partial substitution, the structural conditions specified by the edition of 2008 must be fulfilled.

The above criteria are based on experimental results in which it has been found that the beams reinforced with steel fibers with conformed ends and in quantities higher than 60 kg/m3 of concrete reach a shear resistance values Superior to $0.29\sqrt{f_c'}b_w d$ [3]. The criteria of ASTM C1609M are based on the tests of Chen [4] made with SFRC with contents and fibers similar to the tests used in the beams of Parra-Montesinos [3].

The previous analysis makes it possible to conclude that the latest edition of the ACI 318 represents a more conservative turn in the treatment of shear sizing in beams with SFRC, both in the requirements at the material level and at the structure level.

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DUCTILITY AND REDISTRIBUTION OF LOADS FOR REINFORCED CONCRETE STRUCTURES WITH STEEL FIBERS

[1] José Luis Sánchez Pérez

[2]Enrique Gómez de la Peña

[3]María Isabel Prieto Barrio

[4]María de las Nieves González García

[1]Universidad Politécnica de Madrid joseluis.sanchezp@upm.es
[2]Universidad Politécnica de Madrid enrique.arquitectura@gmail.com
[3]Universidad Politécnica de Madrid mariaisabel.prieto@upm.es
[4]Universidad Politécnica de Madrid mariadelasnieves.gonzalez@upm.es

Keywords: *SFRC; ductility, redistribution, concrete; EHE*

This paper analyzes the possibility of redistributing stresses in reinforced concrete structures with steel fibers (SFRC) in comparison with conventional concrete structures (CC).

Instruction EHE 08 [1] allows during the structural analysis to perform a limited redistribution of the loads calculated in elastic and linear regime that satisfies the equilibrium conditions and always linked to ductility conditions of the critical sections that guarantee the necessary deformations for the laws of solicitations adopted after redistribution [1].

The level of redistribution allowed by Instruction EHE 08 depends on the relationship between the depth of the neutral fiber and the useful edge of the section. This magnitude is closely related to the plastic turning capacity of the section.

In a CC the plastic turning capacity is conditioned by the ultimate deformation of the concrete, 3.5 ‰, or by the ultimate deformation of the steel 10 ‰. In the vast majority of occasions the ultimate deformation of the concrete is the one that fixes the plastic turning capacity, since the deformation of the steel is reached before that of the concrete for relations $x/d \leq 0.29$, a value that is rarely reached in the practice.

In SFRC the ultimate deformation of the concrete is much higher than 3.5 ‰, so the turning capacity is also. This means that with the same depth of neutral fiber, the turning capacity of an EHRFA is higher than that of an CC.

The redistribution capacity of a CC armed with a B500SD steel is given by the following expression of EHE 08:

$$\delta \geq 0.4+1.25\, x/d$$

Always limited to δ ≥ 0.7. This value is reached when x=0.21d. As an example, with a neutral fiber depth of 0.45d, the redistribution capacity would be 4% and the ductility of the section, obtained as the quotient between the plastic rotation and the elastic rotation would be:

$$D = \frac{\varphi_{pl}}{\varphi_{el}} = \frac{\varepsilon_{cu} + \varepsilon_s}{\varepsilon_c + \varepsilon_y} = \frac{3.5 + 4.28}{2.04 + 2.5} = 1.71$$

In the case of a SFRC assuming for the concrete a final deformation of 6 ‰, the steel could reach with a neutral fiber depth of 0.45d a deformation of 7.33 ‰ and the ductility of the structure would be 2.94, 72% higher.

In the figure 1 shows the relationship between the ductility of a section and the relative depth of its neutral fiber.

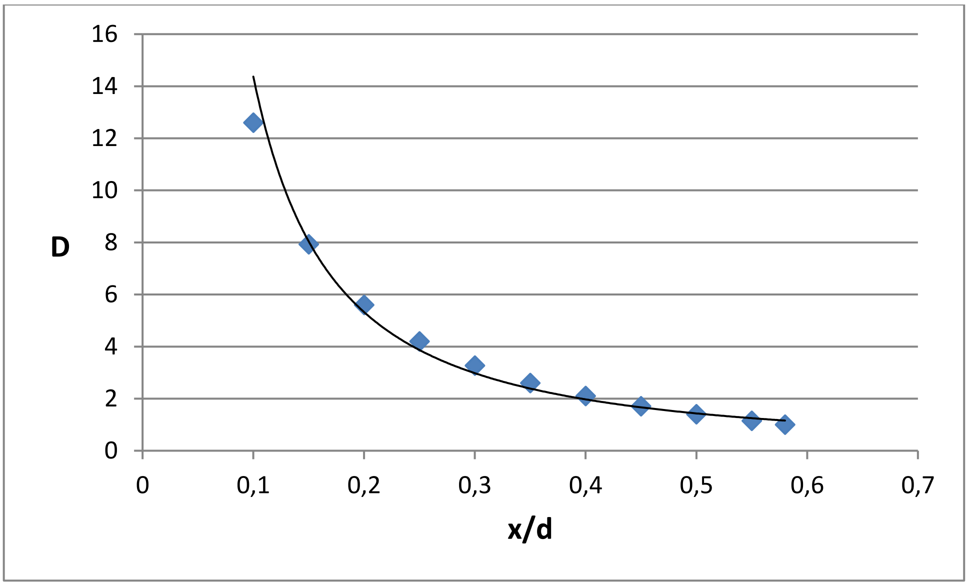

Fig. 1. Relationship between the ductility of a section and the relative depth of its neutral fiber

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EXPERIMENTAL RHEOLOGICAL STUDY OF A SELF-COMPACTING CONCRETE REINFORCED WITH STEEL FIBERS.

[1] José Luis Sánchez Pérez

[2]María de las Nieves González García

[3]María Isabel Prieto Barrio

[4]Gregorio García López de la Osa

[1]Universidad Politécnica de Madrid; joseluis.sanchezp@upm.es
[2] Universidad Politécnica de Madrid; mariadelasnieves.gonzalez@upm.es
[3] Universidad Politécnica de Madrid; mariaisabel.prieto@upm.es
[4] Universidad Politécnica de Madrid; g.garcia.lopezosa@upm.es

Keywords: *SFRC, rheology, concrete, self-compacting.*

In this work, the conditions of self compactability of a self-compacting concrete reinforced with steel fibers have been experimentally evaluated.

The concrete has been manufactured by LAFARGEHOLCIM, for its elaboration it has been used CEM II/A-M (P-V) 42.5 R cement manufactured by Lafarge, with a content of 350 Kg/m3 and a water cement ratio of 0.56. Plasticizers (1.9) and super plasticizers (5.8) have been added as additives. As reinforcement, cold drawn steel fibers of 50 mm length and 0.62 mm diameter (slenderness 80.6) have been used, with a dosage of 10 kg/m3, supplied by the company Bekaert with the commercial name Dramix.

To guarantee that the studied concrete has the necessary characteristics to be able to catalogue it as self-compacting, we have carried out the tests of runoff, funnel in V, box in L and runoff with ring J according to the instruction EHE-08 [1]. Figure 1 shows the performance of the runoff test.

Figure 1. Performing the runoff test

Table 1 shows the results obtained and their comparison with the limits set by annex 17 of the instruction EHE-08 [1] where the conditions required to consider a concrete as self-compacting are indicated.

Table 1. Set of data obtained for checking the characteristics of self-compacting concrete

TEST	**PARAMETER**	**VALUE**	**RANGE EHE**
Runoff text (UNE 83361:2007)	d_f (mm)	700	550 – 850
	T_{50} (s)	6.37	$T_{50} \leq 8$ s
Runoff test with "anillo Japonés" (UNE 83362:2007)	d_{jf} (mm)	695	$\geq d_f$ -50mm
	T_{j50} (s)	2,63	
	H_1 (cm)	6,5	
	H_2 (cm)	8,5	
	C_{bE}	131	
Method of L box (UNE 83363:2007)	T_{60} (s)	4,03	
	H_1 (cm)	12	
	H_2 (cm)	9,2	
	C_{bL}	0,77	0,75 - 1,00
V Funnel test (UNE 83364:2007)	T_v (s)	4,56	4 s – 20 s

It has also obtained the density in fresh state obtaining a value of 2,358 g/L and the percentage of air occluded that has been of 2.4%.

The data in table 1 make it possible to verify that, despite the fiber content of the concrete, which contributes to significantly diminish the characteristics of self-compaction, the concrete can be defined as self-compacting with the requirements of the Instruction EHE 08.

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THE INFLUENCE OF THE URBAN FORM ON THERMAL COMFORT IN PUBLIC AREAS: THE CASE OF SOCIO VIVIENDA II.

[1] Virginia Ricaurte Romero

[2]Byron Sebastián Almeida Chicaiza

[3]Jesús Rafael Echavarría Hernández

[4]Boris Forero Fuentes

[1]Universidad de Guayaquil, maria.ricaurter@ug.edu.ec
[2]Universidad Politécnica de Madrid – Universidad de Guayaquil, byron.almeidac@ug.edu.ec
[3]Universidad de Guayaquil – jesus.hechavarriah@ug.edu.ec
[4]Universidad de Guayaquil – boris.forerof@ug.edu.ec

Keywords: *Social Housing, low-incoming, thermal comfort, microclimate, habitability*

This article analyzes the influence of the urban morphology on the external microclimatic conditions[1][2][3] and the thermal comfort level in Socio Vivienda II, one of the most important low-income housing settlements in Guayaquil, Ecuador.

Four stages of this urbanization were morphologically characterized to be able to develop the virtual model of the physical environment of the urbanization, which was carried out through dynamic simulation programs in order to obtain microclimatic data at different times of the year and hours of the day.

This data have been calibrated with real measurements of the site, such as temperature, relative humidity, wind direction and skyfactor, during the most unfavorable weather conditions for warm weather.

Among the parameters used for this study we have: solar orientation, roads sections, distances between buildings, building heights, sunlight, landscape coefficient, the size of the plots and their relations with open spaces, among others. The comfort conditions of the thermal environment were quantified in terms of the PET bioclimatic index calculated through the Rayman model where the most effective strategies could be selected to achieve comfortable environments and to evaluate the impact of the design and planning of the urban configuration.

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ASSESSMENT OF GREEN NETWORKS IN PERI-URBAN AREAS OF SOUTH-WEST MADRID

[1]Eva Fernández-Pablos, [2]Amparo Verdú-Vázquez

[2]Óscar López-Zaldívar, [2]Rafael Vicente Lozano-Díez

[1] Aula Medioambiental. Ayuntamiento de Boadilla del Monte (Madrid)
[2] Departamento Tecnología de la Edificación. ETS de Edificación. Avenida Juan de Herrera, 6. (28040 – Madrid). Universidad Politécnica de Madrid
oscar.lopezz@upm.es

Keywords: *Peri-urban green spaces, peri-urban parks, green infrastructures, sustainability, evaluation tool*

According to the United Nations 2030 Agenda for Sustainable Development [1], citizens must have universal access to green areas and the connection between urban and peri-urban areas must be encouraged. This investigation shows the important contribution of peri-urban green zones for the fulfilment of this double objective since environmental, social and economic values converge in them and also supra-territorial strategies can be defined from them [2, 3, 4]. In this way, one of the essential principles of Urban Ecology, connectivity as a foundation of resilience, is fostered.

In the case of large peri-urban green areas, this study shows that their location and size are strategic in the definition of the urban ecotones, in the conservation of ecological corridors in urban environments and in the definition of strategies to improve biodiversity. These are places designed to host a strong pressure for public use, so it is increasingly urgent to educate society in the need to value the Mediterranean landscape and ecological designs as the only sustainable model not only for the future, but from the present. These solutions are beginning to be applied in urban green areas on an ad hoc basis, but a great effort and support is needed in their dissemination and knowledge, as well as joint work with research bodies as it is an arduous job.

The difficulties of joint management between local administrations in the management of these green areas result in incoherent situations that condition the adequate achievement of projects with common objectives and their landscape integration. Establishing good governance practices is essential when carrying out projects that, although local in nature, are framed at territorial scales. The commitment to ecological planning in the city implies supporting this work from a supra-municipal perspective in relation to the social, natural and political environment. This requires an effort by all the actors involved: designers, administration, politicians and citizens, in a change of vision and an alternative for innovation. In this way, the weaknesses identified and issues associated with maintaining peri-urban green areas evaluated make them spaces offering great laboratory potential for launching programs featuring dynamic designs and ecological maintenance, and citizen participation that helps to define a program of public use in line with its conservation or aimed at the incorporation of green entrepreneurship initiatives.

Despite the deficiencies observed in the green areas assessed in the study, their role in the Open Spaces Strategy is essential due to their social link and roots, their large size, their location among large urban areas and due to their connection with ecological corridors. In each case, their multifunctional value gives them a key role not only in the Sustainable Strategic Planning of the cities in which they are located but also at a supra-municipal level.

This research puts into practice an overall evaluation tool to analyse the aforementioned areas [5], starting with the incorporation of new criteria in the Technical Specifications of public tenders for both the design phase and subsequent management and maintenance phases. From the point of view of landscape structures, the findings of this study makes it possible to understand the need to create networks, to integrate the peri-urban spaces into the city and to attend to and understand the needs of all actors and sectors involved, providing them a common vision that improves the future of these spaces. This results can be extrapolated and applied to large cities whose urban areas are adjoined and where peri-urban parks can be the starting point for designing supra-municipal strategies for open spaces

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RELATIONSHIP BETWEEN THE COMPRESSIVE STRENGTH AND THE MICROSTRUCTURE OF ULTRA-HIGH PERFORMANCE CONCRETE

[1]Julio A. Paredes, [1]Marcos G. Alberti

[1]Jaime C. Gálvez, [1]Alejandro Enfedaque

[1] Departamento de Ingeniería Civil: Construcción, E.T.S de Ingenieros de Caminos, Canales y Puertos, Universidad Politécnica de Madrid, C/Profesor Aranguren, s/n, 28040 Madrid, Spain.
ja.paredes@alumnos.upm.es; marcos.garcia@upm.es; jaime.galvez@upm.es; alejandro.enfedaque@upm.es

Keywords: *UHPC, compressive strength, durability, nanosilica*

Research developed in the last decades has allowed significant advances in concrete technology, achieving remarkable improvements in the performance of concrete mainly related to the microstructure of the concrete matrix. In the early 1990s, Pierre Richard, former scientific director of the Bouygues company, introduced the term "reactive power concrete" (RPC) to refer to a type of concrete with low water-to-cement ratio and reduced porosity that reached high compressive strength without the use of coarse aggregate and adding smaller particles such as silica fume [1]. In the same decade, De Larrard used the term ultra-high performance concrete (UHPC) to describe a type of concrete with analogous characteristics to that described by Richard, but also including the concept of high-packing density [2,3]. At present, there is an almost general consensus to such an acronym, UHPC, referring to concrete types that reach compressive strengths around 150 MPa and that also have other improved features, among which durability stands out.

In order to relate the behaviour under compressive stresses of UHPC and its microstructure, an experimental campaign was developed with specimens of dimensions 160x40x40 mm^3. A control mixture without additions and a series of mix designs with substitutions of silica fume, metakaolin and two types of nanosilica in different proportions were produced. In all cases, the specimens were manufactured using 1100 kg of binder per m^3 and a water-to-binder ratio of 0.20. Silica sand with 98% of SiO_2 content and a maximum particle size of 0.7 mm was used. The limited water-to-binder ratio entailed the use of a superplasticizer based on modified polycarboxylates, which improved the workability of the mixtures. The specimens were subjected to compressive strength tests at 2, 7 and 28 days, electric resistivity tests, mercury intrusion porosimetry tests (MIP) and differential thermal-thermogravimetric analysis (DTA-TG).

The results of the tests showed that the increase in compressive strength with the use of additions was directly related to the reduction in total porosity and the increase in the proportion of total CSH gel / total portlandite, shown by the MIP and DTA-TG tests, respectively. Mixtures with additions showed reductions of the porosity by up to 33.4% compared with the control mixture, while increasing the proportion of CSH gel/ total portlandite by up to 17.6%. The use of additions, especially nanosilica, significantly increased the electric resistivity of UHPC specimens as evidenced in Figure 1. This is explained by the reduction in the percentage of large capillary pores and the increase of small capillaries, which could enhance the durability of the concrete element.

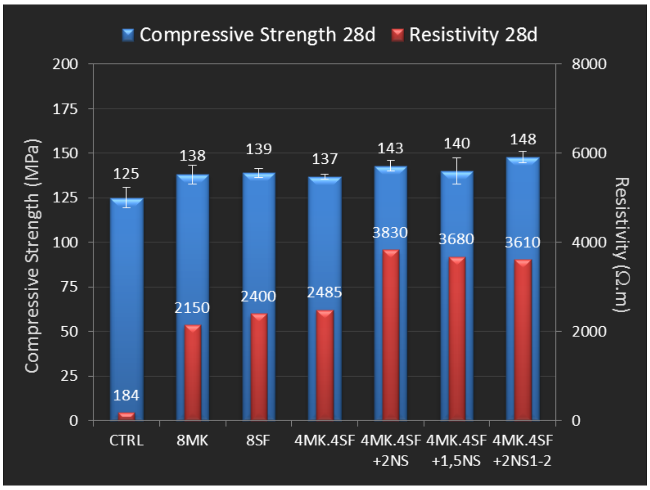

Figure 3. Compressive strength and resistivity at 28 days.

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"MACHINE LEARNING" TECHNOLOGIES APPLIED IN BUILDING

[1] **Alberto P. Manzano Herrero**

[2] **Francisco Gil Carrillo**

[3] **Alfonso García García**

[1] ***Graduated in Physics. Facultad de CC. Físicas – UCM. almanzan@ucm.es***
[2] ***PhD in Architecture. ETSEM – UPM. f.gil@upm.es***
[3] ***PhD in Physics. ETSEM – UPM. alfonso.garciag@upm.es***

Keywords: *Artificial intelligence, machine learning, supervised learning, building, population density*

In order to improve experiments there are only two possibilities, enhance experimental precision through the implementation of new technology or propose new statistics to analyze data. In this case the second option is explored [1-2].

Machine Learning, better known in Spain as 'aprendizaje automático' or 'aprendizaje máquina', was born in the early 60s as an ambitious idea within the framework of Artificial Intelligence (AI). More precisely, it was a sub discipline of AI [3-5].

To give a brief overview, ML is Statistical Learning, its essence relys on, instead of programing a computer to solve a certain task, design the algorithm in such a way that it can face multiple problems. Instead of solving a certain problem, the machine is feeded, and by itself, produces an algorithm. Its current popularity is in part due to the flexibility of the theory which can be used in a large range of fields, from medicine to engineering [6-7].

At first it was used in tasks such as email filtering, but nowadays it is used practically in all fields when there is enough data to make statistic predictions about it. Some of the applications are:

- DNA sequence classification
- Economic predictions related to market fluctuations
- 3D modeling
- Fraud detection
- Medical diagnosis
- Search engines
- Voice recognition
- Digital marketing

This field has become so big that it is possible to differentiate three categories:

Supervised Learning: the data is given as parameters and labels. The program outputs an algorithm that, with some probability, is able to predict labels given the parameters.

Unsupervised Learning: its main goal is to classify data, in this case no labels are provided. For example cluster information based on similarity.

Reinforcement Learning: is highly relate to Game Theory, in contrast with the other two this kind of algorithms tries to design strategies based on a award-punishment system.

In this study some of these techniques would be applied to edification, more accurately the influence of climate variables on the structure of the density population in Spain will be studied. For this purpose one of the Supervised Learning's algorithms will be applied.

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INFLUENCE OF THE ROOFS ENDING ON THE BUILDING VENTILATIONS

[1] **Francisco Gil Carrillo**

[2] **Mercedes González Redondo**

[3] **Alfonso García García**

[1] ***PhD in Architecture. ETSEM – UPM. f.gil@upm.es***
[2] ***PhD in Physics. ETSAM – UPM. mer.gonzalez@upm.es***
[3] ***PhD in Physics. ETSEM – UPM. alfonso.garciag@upm.es***

Keywords: *Ventilation, comfort, building, roof facilities*

There are many works in which various aspects associated with natural or forced ventilation in buildings are studied. Currently, and due to the growing importance that energy efficiency (and the control of CO2 emissions) is acquiring in buildings, these studies are mainly focused on obtaining relations between one or other type of ventilation and the energy consumption of the building [1 -3]. The authors are trying to find more efficient ventilation methodologies as well as adapting existing ones in order to reduce energy losses either by thermal conditioning or by the need to use electric lighting.

Some authors focus their work on comparing the use and comfort of natural and mechanical ventilation, and their influence on the indoor air quality of buildings [4-6]. Some of them analyze, even, the noise produced by mechanical ventilation. Logically, these studies are conditioned by the climatology of the place where they are carried out and by the season of the year. The results show that in the seasons and hot climates, natural ventilation prevails and in the cold or rainy seasons and cold climates the preference for mechanical ventilation prevails.

There are also studies about the influence on health of ventilation in buildings [7] and even works has been done to detect pollution agents inside buildings [8], by using sensors for the detection of various gases (electronic noses) . The results of these studies usually obtain optimal ventilation conditions that are radically opposed to energy efficiency studies.

Todo lo anterior indica que se debe afrontar el estudio de la ventilación en edificios de una forma más global y teniendo en cuenta un aspecto poco contemplado en los anteriores estudios: la influencia de la ventilación de los edificios en el confort de los ocupantes de estos.

All of the above indicates that the study of ventilation in buildings must be approached in a more global way, taking into account an aspect that has not been contemplated in the previous studies: the influence of the buildings ventilation on the comfort of their occupants.

This work presents a study, carried out in two twin buildings, with identical systems of forced ventilation, located in the town of Alcalá de Henares (Madrid). In one of them the efficiency of the ventilation system has been seriously affected by the installation of photovoltaic panels on the roof. This installation may keep the regular movement of air, because its generate an additional output load in the ventilation circuit causing both the air flow and the exit velocity of the same to be reduced, causing a loss of comfort in the occupants of the building due to the existence of bad odors, due to lack of ventilation in various rooms of the houses.

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THE BONDING OF WALLS IN HISTORICAL BUILDINGS AS A STRUCTURAL AND FORMAL ELEMENT OF ARCHITECTURAL HERITAGE

[1] Vinicio Velásquez Zambrano

[1] Gabriela Mejía Gómez

[1] Álvaro Guzmán Rodríguez

[2] Ramiro Rosón Mesa

[1] Pontifical Catholic University of Ecuador
[2] CICOP Ecuador Foundation

Keywords: *bonding of walls, structures, architectural heritage, internal forces, external forces.*

This research is aimed to carry out a detailed identification of the external forces (natural and human factors of deterioration) and internal forces (building materials) which affect the bonding of walls in historical buildings. From this point of view, the structure of a building can be defined as a stable combination of elements which are conceived as a unit, in order to bear and transmit the corresponding loads to the ground safely and without exceeding the resistance limits of each one of these elements [1].

According to this approach, relations between external and internal forces will be studied, considering that internal forces have the mission of counteracting external forces in order to maintain the structural equilibrium of a building. The correct comprehension of these relations will allow to develop a methodological approximation for operating on the bonding of walls in historical buildings, with respect to their authenticity as structural and formal elements of architectural heritage. In this sense, respect to authenticity can only be achieved researching about the building techniques and materials used in the period which a specific building belongs to, and this facilitates that the process of restoring and restructuring architectural heritage is carried out preserving its historical and artistic value.

Given the fact that structure distinguishes architecture from the other arts, any operation on architectural heritage must part from the idea that structural elements accomplish a practical function, contributing in a decisive way to maintain a building through the years, but they can be also assigned an aesthetic function, expressing with them the artistic values of the period which they belong to. This idea has been reflected in history of architecture from the classical Greece, in a way that structural elements of each period have become symbols of its architecture [2]. In the development of this activity, a problem can be solved in different ways which are equally valid, because the attention and the effort which are dedicated to formal details, beyond the requirements of structural calculus, exceed the purely technical field and provide an artistic value on an intentional or fortuitous basis [3].

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COMPARISON OF THE PHYSICAL PROPERTIES OF EARTH CONSTRUCTION UNITS: ADOBE, TAPIAL AND CHAMPA THE IMPORTANCE OF ITS USE IN THE PERUVIAN HIGHLANDS

[1]Andrea Gamio Felipa; [2]Mª Nieves Gonzalez Garcia; [3]Amparo Verdú Vázquez

[1]PhD, Escuela Técnica Superior de Edificación, UPM
[2]Dpto. Construcciones Arquitectónicas y su Control
[3]Dpto. Tecnología de la Edificación
E.T.S. Edificación de Madrid, Universidad Politécnica de Madrid

Keywords: *construction in earth, adobe, vernacular and ch'ampas*

Between 30% to 40% of constructions in Peru are on earth, in this percentage must include the archaeological monuments. Among the areas with highest percentage of building systems on earth is in the Peruvian Highlands. This is because knowledge inherited from generation to generation, location and socio-economic level [1-3].

This document is intended to compare 3 construction units: adobe, rammed earth, and champa, which are commonly used in areas of higher altitude. Adobe, is a block composed of sand or earth, water, clay and straw, forming a mixture that is poured into molds. The tapial, has the same mixture that is adobe, but the process block, in the area of construction by pouring the mixture into a drawer. The champa, therefore, is a fully extracted soil material, does not have any additive or additional material. These materials are based on vernacular of the Peru building systems, which are cultural heritage [4-6].

The raw material of these materials comes directly from nature, shown in the following table (Table 01).

MATERIALES	ADOBE [1]	TAPIAL [2]	CH'AMPA
Arena	40-50%	40-80%	**5-9%**
Limo	20-35%	0-20%	**61-63%**
Arcilla	15-25%	5 - 35%	**19-22%**
Paja / Chiji/ quemello	opcional	opcional	**9,5%**

Table 01: Earth materials or system construction

The dimensions of these materials are varied, but always have the appropriate proportionality for the correct construction (Table 02).

CH'AMPA[3]	ADOBE[2]
50x40x12.5 cm	30x15X7.5cm
70x50x12.5 cm	40X20X10cm

Table 02: Dimension of materials and earth panel

It has collected from various research data of the physical characteristics of these materials and how this constructive system responds (Table 03).

Table 03: Data retrieved of others research

Description	Adobe [1]	Tapial [2]	Champa[6]
Thermal conductivity	0,82 W/m·K	0,60 W/m·K	**0,25W/m·K**
Thermal resistance	1,22 K·m/W	1,72 K·m/W	**4,0 K·m/W**

It can be concluded with the previously exposed data that 3 construction units are quite favorable for thermal resistance values. But in this specific case, it champa it has pretty impressive data, gets 0, 25W/m· K thermal conductivity as a material with high thermal resistance of 4.0 K·m/W. It is for this reason that, this document aims to demonstrate that although construction of ground units possess physical characteristics optimal, and thus is shown, because in the Peruvian highlands is not more used construction unit the champa.

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MODELING AND IMPROVEMENT OF A FLAT IN CUATRO CAMINOS, MADRID

[1] Asier Fernández Egido, [1] Álvaro Sotorrío Fernández-Mijares

[2] Julián García Muñoz, [2] César Porras Amores and [2] Carmen Viñas Arrebola

[1] Master student at MUEE. Universidad Politécnica de Madrid
[2] TEMA Research Group at the ETSEM. Universidad Politécnica de Madrid
(tema.edificacion@upm.es)

Keywords: *Building simulation, indoor comfort, dwelling, energy efficiency*

The present work estimates the energy consumption and indoor comfort of a dwelling, located in Madrid. According to the indications given in the Technical Spanish Code (CTE, Spanish acronym) [1],the climate zone corresponds to the C3 area. The building was built in 1900 and has about 70 m^2. The dwelling has been modeled through a building energy simulation software “Design Builder” [2]. The results reveal in detail the behavior of the house from different points of view, such as: thermal, humidity, energy gains or losses, indoor comfort according to Fanger index [3], energy consumption, CO_2 emission, etc.

Once the behavior of the dwelling was known, the points and aspects that could be improved were detected. After that, those aspects were implemented in the dwelling and a new set of simulations were done. Firstly, the thermal transmittance of the walls and floors were improved according to CTE. In addition other improvements made were: 1) conventional boiler of natural gas was replace by a biomass boiler,2) original 3/13/3 gasses were replaced by 6/12(Argon)/6 glasses,3) a refrigeration system was included for the summer season.

The simulated results show the effectiveness of the improvement implemented in the dwelling. Among the improvements reach, the solar gains of the dwelling are reduced, the indoor thermal comfort for the tenants increase and the CO_2 emissions decrease in the winter season. There is an increase in the energy consumption due to the refrigeration system but it is essential to achieve indoor thermal comfort in the summer season. Finally, since the window surface of the dwelling is small, the solar gains are low, so therefore it is not considered necessary to replace the air chamber of the window by an argon chamber.

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EXECUTION OF A RIGGING WITH PRINTED THERMOPLASTIC MODULAR PIECES

[1]Sandra Moyano Sanz

[1]Mercedes Valiente López

[1]Mª Carmen Sanz Contreras

[1]Department of Building Technology. Superior Technical School of Building. Polytechnic University of Madrid (Spain)

sandra.moyano.sanz @ alumnos.upm.es; mercedes.valiente@upm.es, mariacarmen.sanz@upm.es.

Keywords: *Rigging, modular pieces, building innovation, new technologies, 3D printing*

At present, we see the great advances that occur at the technological level, in all areas of daily life, and instead, as far as building is concerned, the construction methods and materials used are, practically, the same since generations. This leads us to think that, although these methods of execution work perfectly, we can adapt the technological advances that surround us to the constructive processes [1-2].

One of the great discoveries of recent times is 3D printing, which offers us the possibility of imagining any object, designing and printing it, and in this way, solving some building problems that, until now, were more complex [3-4].

In Eastern countries, there is the possibility of printing whole houses in less than 24 hours with the help of this technique, but a different design is needed for each urbanization project.

From this idea, are born, printed thermoplastic modular pieces, hereinafter PTMP parts, which are designed for all types of projects, and thanks to the characteristics of 3d printing, we can manufacture in situ, those pieces that, by morphology, are not clip art so far.

The material chosen for the realization of this project is plastic, which in addition to providing the intrinsic advantages of this material, we contribute to recycling, sustainability and the ecological model. As for the design, the geometrical measurements are comparable to those of a traditional brick, 24 * 12 * 7, and the systems of union, allow to eliminate the contribution of any other material to the departure of work.

In this study, we will see, the types of printers that exist, the materials used, the problems that we find when it comes to printing, the pieces P.T.M.P. and all its variants for the realization of a rig.

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CITE 2019 PROGRAM

ORAL COMMUNICATIONS

Wednesday, 6th March 2019/ Morning conferences

ENTRANCE HALL	
9:30 – 14:30	**Registration / Documentation reception**

MEETING ROOM	
10:00 - 10:15	**Opening session: Dr. Alfonso Cobo Escamilla** *Dean of ETSEM- UPM*
10:15 - 10:35	**Inaugural Conference: Dr. Marta Kosior-Kazberuk** *Vice-Rector for Education and International Cooperation. Politechnika Białostocka (Poland)* **Innovative FRP reinforcement for durable structures**
10:35 - 10:55	**PLACO Conference: Dª. Penélope González de la Peña** *Directora Técnica de Placo-Saint Gobain*
10:55 - 11:15	**CGATE Conference: D. Juan López-Asiaín Martínez** *Consejo General de la Arquitectura Técnica de España*

11:30-12:30	**POSTER SESSION 1 + COFFEE BREAK**

MEETING ROOM	
Conferences	**SESSION 1: MATERIALS AND CONSTRUCTIVE SYSTEMS** **Chair: Dr. Paz Sáez Pérez**
12:30-12:45	**080. DIRECT TENSILE STRENGTH OF POLYOLEFIN FIBER REINFORCED CONCRETE** Álvaro Picazo, Raquel Pérez, Marcos G. Alberti, Alejandro Enfedaque and Jaime C. Gálvez.
12:45-13:00	**098. THIN-WALLED STRUCTURES. PRE-INDUSTRIALIZED CONSTRUCTIVE SYSTEM OF EASY ASSEMBLY, LIGHT, DIGITIZABLE AND ENERGETICALLY SUSTAINABLE** Susana Palacios Rodríguez and Jesús Anaya Díaz.
13:00-13:15	**068. STUDY OF THE RETRACTION OF CEMENT MORTARS PREPARED WITH ARIDES FROM CONSTRUCTION-DEMOLITION WASTE** Alberto Lage, Pablo Saiz Martínez, Carlos Morón Fernández and Daniel Ferrández Vega.
13:15-13:30	**024. OPTIMIZED INFILL IN ADDITIVE MANUFACTURING OF CERAMIC BUILDING COMPONENTS** Luis Borunda, Manuel Ladrón de Guevara, Pavel Aguilar and Jesús Anaya.
13:30-13:45	**050. DIY SYSTEM FOR MONITORING AVERAGE ILLUMINANCE IN RESIDENTIAL INDOOR SPACES** Alejandro Payán de Tejada, Juan López-Asiain, Pablo Sáiz Martínez and Carlos Morón.

ROOM C	
Conferences	SESSION 2: ENERGY EFFICIENCE, SUSTAINABILITY AND ENVIROMENT Chair: Dr. Guillermo de Ignacio Vicens
12:30-12:45	**039. ANALYSIS OF THE DOMESTIC HOT WATER (DHW) INDICATOR IN THE ENERGY CERTIFICATION OF BUILDINGS** Juan López-Asiain, María de la Nieves González, Carlos Morón and Alejandro Payán de Tejada.
12:45-13:00	**114. DYNAMIC THERMAL BEHAVIOUR OF TABS IN BUILDING ENERGY RETROFITTING** Rossana Laera, Inmaculada Martínez Pérez, Ricardo Tendero Caballero, Luis de Pereda Fernández and Francesco Iannone.
13:00-13:15	**083. PROYECTOS DE GENERACIÓN ELÉCTRICA DE ORIGEN GEOTÉRMICO EN ALEMANIA: ANÁLISIS ECONÓMICO DE UN CASO DE ESTUDIO APLICANDO EL MÉTODO DE LAS OPCIONES REALES** José Balibrea Iniesta, Yilsy M. Núñez Guerrero and Carlos Rodríguez Monroy.
13:15-13:30	**093. STUDY AND SIMULATION OF HOUSING ENERGY USING DYNAMIC SIMULATION SOFTWARE** Miguel Cornelio Diego and Daniel Ramírez Burgueño.
13:30-13:45	**085. POTENTIAL FOR ENERGY USE OF UNDERGROUND URBAN INFRASTUCTURES** Luis de Pereda Fernández, Inmaculada Pérez Fernández and María de las Nieves González García.
13:45-14:00	**103. COMPARATIVE ANALYSIS OF EIGHT DIFFERENT GREEN ROOFS SOLUTIONS UNDER MEDITERRANEAN CLIMATE CONDITIONS** Julià Coma, Ana Lacasta, Inma Cantalapiedra and Montserrat Bosch.

Wednesday, 6th March 2019/ Afternoon conferences	
MEETING ROOM	
Conferences	SESSION 3: MANAGEMENT AND SECURITY IN BUILDING Chair: Dr. Daniel Ferrández Vega
16:00-16:15	**004. REFLECTIONS ON THE SCOPE OF THE CONTENTS IN BASIC SECURITY AND HEALTH STUDIES AND STUDIES IN RD 1627/1997** Miguel Ángel Zapata Lobo, Antonio Ros Serrano and Pilar Cristina Izquierdo Gracia.
16:15-16:30	**073. AN IMPROVEMENT IN CONSTRUCTION PLANNING: LAST PLANNER SYSTEM ®** Miguel Ángel Álvarez Pérez, Manuel Soler Severino and Eugenio Pellicer.
16:30-16:45	**010. RISK MANAGEMENT, ONE SOLUTION TO REAL ESTATE ASSET MANAGEMENT** Désirée Sandoica París and Manuel Soler Severino.
16:45-17:00	**113. URBAN GREEN INFRASTRUCTURE: GREEN ROOFS AND VERTICAL GREENING SYSTEMS PROVIDING MULTIPLE ECO-SYSTEM SERVICES IN THE BUILT ENVIRONMENT** Gabriel Pérez Luque and Julià Coma Arpon.
17:00-17:15	**055. ARCHITECTURE ADAPTATION TO CLIMATE CHANGE: DATA PROJECTION AND ENERGY SIMULATION OF TWO SCENARIOS** Andrea Sancho Salas, Daniel Buitrago Carazo, Andrés Chacón Redondo, Luis Miguel Chaves Chaves, Ana Cristina Lezama Solano, Rebeca Pérez Castañeda and Luis Quirós Núñez.
17:15-17:30	**081. CRITERIOS PARA LA EVALUACIÓN DE LA SOSTENIBILIDAD EN EMPRESAS CONSTRUCTORAS** Martín Campos.
17:30-17:45	**054. BEHAVIOR OF THE NATURAL AND ARTIFICIAL LUMINANCE AND ILUMINANCE IN AN INTERIOR SPACE OF THE ACADEMIC PROJECT DISTRITO U-COWORK** Andrea Sancho Salas, Ana Gabriela Herrera, Melissa Jiménez, Minor Sancho, Fabiola Arrieta, Roger Hernández and Lucia Flores.

ROOM C	
Conferences	**SESSION 4: INNOVATION IN BUILDING & DOMOTIC AND SMART CITIES** **Chair: Dr. Pablo Saiz Martínez**
16:00-16:15	**038. THE INFLUENCE OF ARCHITECTURAL DESIGN ON NATIONAL SECURITY** Inmaculada Sanz Ortega and Montserrat Castellanos.
16:15-16:30	**048. CHANGES IN THE ARCHITECTURAL DESIGN PARADIGM, THANKS TO CLEAR CODE ARCHITECTURE®** Blanca Fernández Contreras and Maximià Torruella Castell.
16:30-16:45	**109. QUALITY IN BUILDING THROUGH THE PASSIVHAUS STANDARD** Alejandra Vidales Barriguete, Roberto Vidales Barriguete and Victoria Santiago Rasilla.
16:45-17:00	**035. ADDING PLASTIC WASTE TO PLASTERS TO IMPROVE THEIR PROPERTIES IN CONTACT WITH WATER** Alejandra Vidales Barriguete, Carolina Piña Ramírez, Mercedes del Río Merino and Evangelina Atanes Sánchez
17:00-17:15	**067. ANALISIS DE NUDOS DE PORTICOS SOMETIDOS A ACCIONES HORIZONTALES** Luis Carrillo Alonso.
17:15-17:30	**087. METODOLOGÍA PARA LA IMPLANTACIÓN DE INNMÓTICA SOCIAL PARA LA MEJORA DE LOS EDIFICIOS PÚBLICOS (PROYECTO EFIPUBLIC)** Beatriz Montalbán Pozas, Irene Amigo Gamero and Agustín Sánchez Domínguez.
17:30-17:45	**097. WORKPLACE METRICS BASED ON WIFI TRACKING SYSTEMS TO UNDERSTAND SPACE OCCUPATION AND USER EXPERIENCE** Alicia Regodón Puyalto and Alfonso García Santos.
17:45-18:00	**127. "MACHINE LEARNING" TECHNOLOGIES APPLIED IN BUILDING** Alberto P. Manzano Herrero, Francisco Gil Carrillo and Alfonso García García.
18:00-18:15	**060. THE GEOMETRIC DATA COLLECTION WITH 3D LASER SCANNER IN EXCAVATED ARCHITECTURE: EXAMPLE OF CAVE HOUSE IN THE PROVINCE OF ALMERIA** Luis Jiménez López and Inmaculada Martínez Pérez.

Thursday, 7th March 2019/ Morning conferences

MEETING ROOM	
9:30 - 10:00	**Plenary Conference: Dr. Miguel Mellado Espinoza** *Universidad de Santiago de Chile*

MEETING ROOM

Conferences	**SESSION 5: MATERIALS AND CONSTRUCTIVE SYSTEMS** **Chair: Dr. Rafael Vicente Lozano Díez**
10:00 - 10:15	**019. FIRE RESISTANCE OF CEMENT MORTARS REINFORCED WITH MINERAL FIBERS FROM CWD** Carolina Piña Ramírez, Alejandra Vidales Barriguete, Rubén Serrano Somolinos, Mercedes del Río Merino and Evangelina Atanes Sánchez.
10:15 - 10:30	**074. THE ARCHITECTURAL EXPERT PROOF REPORT ON LEGAL ACTION FOR CONSTRUCTIVE DEFECTS. THE SYNCRETIC METHOD VERSUS THE ANALYTICAL METHOD** Ignacio de Luis Otero.
10:30 - 10:45	**034. IMPLEMENTATION OF RULES FOR STANDARDIZATION IN MEASURING SURFACES IN BUILDING** José Antonio López Medina and Carlos Pérez Zapata
10:45 - 11:00	**130. COMPARISON OF THE PHYSICAL PROPERTIES OF EARTHCONSTRUCTION UNITS: ADOBE, TAPIAL AND CHAMPA THE IMPORTANCE OF ITS USE IN THE PERUVIAN HIGHLANDS** Andrea Gamio Felipa, María de las Nieves González García and Amparo Verdú Vázquez
11:00-11:15	**001. CONCRETE PERMEABILITY AS A KEY DURABILITY INDICATOR** Miguel Ángel Sanjuan Barbudo and Cristina Argiz Lucio.
11:15-11:30	**002. IRON SILICATE USE AS LAND FILLING AGGREGATE IN BUILDING AND CIVIL WORKS** Miguel Ángel Sanjuan Barbudo, Pedro Mora Peris and Juan Antonio Suárez Cabezas.

ROOM C

Conferences	**SESSION 6: STRUCTURES & REHABILITATION, PATHOLOGY AND BUILDING MAINTENANCE** **Chair: Dr. Guillermo de Ignacio Vicens**
10:00 - 10:15	**051. MODEL DEVELOPMENT BY FINITE ELEMENT METHOD** Neda Salsabili, Maria Isabel Prieto Barrio and Joaquín Santiago López.
10:15 - 10:30	**044. ADVANCES IN FPR ANCHORING SYSTEMS FOR EXTERNALLY BONDED CARBON FIBRE REINFORCEMENTS** Adriana Cortez Flores, Jaime Fernández Gómez and Paula Villanueva.
10:30 - 10:45	**070. PRACTICAL DEVELOPMENT OF A CONCEPTUAL EVAPORATIVE CLIMATIZER PROTOTYPE** Jorge Pablo Díaz Velilla, Daniel Ferrández Vega, Carlos Morón Fernández and Pablo Saiz Martínez.
10:45 - 11:00	**032. POTENTIAL OF IMMERSIVE TECHNOLOGIES IN THE BUILDING LIFE CYCLE ANALYSIS** Jaime Arriagada and Mercedes Valiente.
11:00-11:15	**106. EFFICIENCY AND EFFECT OF CONSOLIDATION AND WATER REPELENT TREATMENTS ON STONE MATERIALS. CASE STUDY: BUILDING RESTORATION AT ALMUDENA CEMETERY** Esther Moreno Fernández, Francisco González Yunta and Alberto Sepulcre Aguilar.
11:15-11:30	**027. CONCRETE REINFORCED WITH FIBRES** Ramiro Aranda Lincango, John Sebastián Corrales Ospina, Katherine Gaona Aguaisa, Roberth Alexander Pillajo Guachamín and Eva María Villafranca Peña.

11:30-12:30	POSTER SESSION 2 + COFFEE BREAK

MEETING ROOM	
Conferences	**SESSION 7: MATERIALS AND CONSTRUCTIVE SYSTEMS** **Chair: Dr. Alejandro Payán de Tejada**
12:30-12:45	**003. DURABILITY REQUIREMENTS FOR REINFORCED CONCRETE USED IN BUILDINGS EXPOSED TO COASTAL MARINE ENVIRONMENT (IIIA)** Miguel Ángel Sanjuan Barbudo, Antonio Núñez Padilla and José Antonio Hurtado Hurtado.
12:45-13:00	**016. WATER ABSORPTION IN SELF-COMPACTING CONCRETE DONE WITH RECYCLED AGGREGATE FROM CONCRETE ELEMENTS** Aitor Zurita Díaz, E. Sereno Minuesa, B.W. Vargas Díaz, F. González Planells and J. González Vivero.
13:00-13:15	**101. OPTIMIZED INFILL IN ADDITIVE MANUFACTURING OF BUILDING COMPONENTS** Luis Borunda, Manuel Ladrón de Guevara, Pavel Aguilar, Gianluca Pugliese, Rafael Claramunt, Marta Muñoz and Jesús Anaya.
13:15-13:30	**084. CONSTRUCTION WITH COMPRESSED EARTH BLOCKS IN MARS, BASED ON CONSTRUCTIVE SOLUTIONS OF THE PRECLASSIC PERIOD** Carlos González Puchol.
13:30-13:45	**088. GEOMETRIES WOVEN WITH BAMBOO FOR THEIR MATERIALIZATION AS STRUCTURES IN EQUILIBRIUM** Eugenia Muscio, Byron-Sebastián Almeida-Chicaiza and Jesús Anaya Díaz.
13:45-14:00	**120. CALIBRATION OF CALCULATION MODELS FOR CONFINED CONCRETE WITH CFRP** José Ángel Piñero Díaz, María de Nieves González García, Daniela Brizuela Valenzuela and María Isabel Prieto Barrio

ROOM C	
Conferences	**SESSION 8: INNOVATION IN BUILDING** **Chair: Álvaro Picazo Iranzo**
12:30-12:45	**026. USE OF BIM METHODOLOGY FOR THE REMODELING OF AN EXISTING BRIDGE** Rafael Blanco, Jorge Martínez, Borja Mozas, Marcos García Alberti and Antonio A. Arcos Álvarez.
12:45-13:00	**031. CASE STUDY FOR THE IMPLEMENTATION OF BIM METHODOLOGY ON CIVIL ENGINEERING PROJECTS** David Pastor Moreno, Isabel Sastre Furones, Ana Eyre Rodríguez, Marcos García Alberti, Antonio A. Arcos Álvarez.
13:00-13:15	**042. OPTIMIZATION OF BIM PROCESSES FOR THE OPERATIONAL MAINTENANCE OF REMARKABLE STRUCTURES: BIM PARAMETRIC MODELS BASED ON STRUCTURAL PATHOLOGIES AND INSTRUMENTATION** Jaime Santamarta Martínez and Jaime Santa Cruz Astorqui.
13:15-13:30	**043. OPTIMIZATION OF BIM PROCESSES FOR THE OPERATIONAL MAINTENANCE OF REMARKABLE STRUCTURES: INTEROPERABILITY BETWEEN 3D MODELS AND ANALYTIC MODELS** Jaime Santamarta Martínez and Jaime Santa Cruz Astorqui.
13:30-13:45	**069. ARDUINO APPLICATION TO MEASURE THE MOISTURE CONTENT IN CEMENT MORTARS** Engerst Yedra Álvarez, Daniel Ferrández Vega, Pablo Saiz Martínez and Carlos Morón Fernández.
13:45-14:00	**082. DIGITAL DESIGN AND FABRICATION OF CLUSTERS OF COMPLEX, EFFICIENT AND CONTINUOUS ARCHITECTURAL SURFACES** Andrés Miguel Rodríguez and Jesús Anaya.

Thursday, 7th March 2019/ Afternoon conferences	
MEETING ROOM	
16:00 - 17:00	DOKA Conference: D. Pablo Álvarez de Anta *Engineer at Doka Germany*

MEETING ROOM	
Conferences	**SESSION 9: VIRTUAL SESSION** **Chair: Álvaro Picazo Iranzo**
17:00-17:15	**V007. STUDY OF THE "ISLAND OF HEAT URBAN" PHENOMENON ON GRAN VÍA OF GRANADA STREET.** Óscar Jiménez Ferrer, Julián Arco Díaz and David Hidalgo García.
17:15-17:30	**V006. COMPARATIVE STUDY-BIM TECHNOLOGIES IN BUILDING: SUSTAINABLE ARCHITECTURE** Esperanza García de la Llave Zarzuela, Julián Arco Díaz and David Hidalgo García
17:30-17:45	**V013. PREDICTIVE MAINTENANCE OF HVAC HOSPITAL FACILITIES TO IMPROVE ENERGY EFFICIENCY** Gonzalo Sánchez-Barroso, Miguel Gómez-Chaparro, Manuel J. Carretero-Ayuso and Justo García Sanz-Calcedo.
17:45-18:00	**V117. METHODOLOGICAL PROPOSAL FOR THE DISTRIBUTION OF SUBJECTS ACCORDING TO EXISTING LIGHTING LEVELS AND LIGHT REQUIREMENTS BY TASK: FACULTY OF ARCHITECTURE AND URBANISM, UNIVERSITY OF GUAYAQUIL** Pamela Bermeo Rodríguez, Sebastián Almeida Chicaiza, Jesús Rafael Hechavarría Hernández and Maikel Leyva Vázquez.
18:00-18:15	**V056. ADAPTACIÓN DE LA CASA FARNSWORTH AL CLIMA DE PORTO NACIONAL, BRASIL** Andrea Sancho Salas and Julián García Muñoz.
18:15-18:30	**V014. ANALYSIS OF MAINTENANCE EFFICIENCY IN A HOSPITAL IN MADRID (SPAIN)** Miguel Gómez-Chaparro, Gonzalo Sánchez-Barroso, Manuel J. Carretero-Ayuso and Justo García Sanz-Calcedo.
18:30-18:45	**V086. RESTORATION MORTARS FOR RAMMED EARTH WALLS WITH GYPSUM MASONRY REINFORCEMENTS** Eva Mejías Romero, Francisco Javier Castilla Pascual and David Sanz Martínez.

ROOM C	
Conferences	**SESSION 10: VIRTUAL SESSION** **Chair: Alejandra Vidales Barriguete**
17:00-17:15	**V015. FREQUENT FLAWS IN THE INSTALLATION OF WATERPROOFING LAYERS IN ROOF TERRACES** Manuel J. Carretero-Ayuso, Gonzalo Sánchez-Barroso, Miguel Gómez-Chaparro and Justo García Sanz-Calcedo.
17:15-17:30	**V124. THE INFLUENCE OF THE URBAN FORM ON THERMAL COMFORT IN PUBLIC AREAS: THE CASE OF SOCIO VIVIENDA II** Virginia Ricaurte Romero, Byron Sebastián Almeida Chicaiza, Jesús Rafael Hechavarría Hernández and Boris Forero Fuentes.
17:30-17:45	**V047. A METHODOLOGY FOR THE CALCULATION OF THE FOUNDATION OF A ROTARY MACHINE SUPPORTING DYNAMIC LOADS INCLUDING THE TRANSIENTE STARTING** Juan Luis Terrádez Marco and Antonio Hospitaler Pérez.
17:45-18:00	**V110. A DIMENSIONAL ANALYSIS METHOD APPROACH: IT'S APPLICATION IN SOCIAL INTEREST HOUSING OF GUAYAQUIL** Byron Sebastián Almeida Chicaiza, Jesús Anaya Díaz and Eugenia Muscio.
18:00-18:15	**V096. A PROPOSAL ON TECHNIFICATION OF A MONUMENTAS A LIVING ARCHIVE OF ITSELF** José Carlos Sánchez Romero.
18:15-18:30	**V078. OPTIMIZING THE THERMOMETRIC METHOD TO ASSESS THE THERMAL TRANSMITTANCE OF FAÇADES IN ENERGY AUDITS** David Bienvenido-Huertas, Carlos E. Rodríguez-Jiménez, David Marín and Juan Moyano.
18:30-18:45	**V129. THE BONDING OF WALLS IN HISTORICAL BUILDINGS AS A STRUCTURAL AND FORMAL ELEMENT OF ARCHITECTURAL HERITAGE** Vinicio Velásquez Zambrano, Gabriela Mejía Gómez, Álvaro Guzmán Rodríguez and Ramiro Rosón Mesa.

Friday, 8th March 2019/ Morning conferences

MEETING ROOM	
Conferences	**SESSION 11: MATERIALS AND CONSTRUCTIVE SYSTEMS & REHABILITATION, PATHOLOGY AND BUILDING MAINTENANCE** **Chair: Dr. Óscar López Zaldívar**
10:00 - 10:15	**072. PLASTER REINFORCED WITH FIBERS FOR THE PREPARATION OF PREFABRICATED PANELS** Manuel Álvarez Dorado, Daniel Ferrández Vega, Carlos Morón Fernández and Jorge Pablo Díaz Velilla.
10:15 - 10:30	**119. COMPARISON OF DIFFERENT MODELS OF CALCULATION TO EVALUATE THE RESISTANCE TO COMPRESSION OF THE CONCRETE CONFINED WITH CARBON FIBER TISSUES** José Ángel Piñero Díaz, Daniela Brizuela Valenzuela, María de Nieves González García and María Isabel Prieto Barrio
10:30 - 10:45	**126. RELATIONSHIP BETWEEN THE COMPRESSIVE STRENGTH AND THE MICROSTRUCTURE OF ULTRA-HIGH PERFORMANCE CONCRETE** Julio A. Paredes, Marcos G. Alberti, Jaime C. Gálvez and Alejandro Enfedaque.
10:45 - 11:00	**100. MECHANICAL BEHAVIOR OF CONCRETE WITH ADDED PLASTIC FILM WASTE** Cristina Pavón, María Isabel Prieto, Jorge García-Barrasa and José Luis Moreno.
11:00-11:15	**102. ANALYSIS OF BEHAVIOR OF CONCRETE WITH HYBRIDIZATION OF POLYPROPYLENE FIBERS AND CARBON NANOFIBERS (CNFs)** Rubén Serrano, María Isabel Prieto, Alfonso Cobo and Kenzo Jorge Hosokawa.

ROOM C	
Conferences	**SESSION 12: HEALTH AND SAFETY IN BUILDING** **Chair: Rafael Pérez González**
10:00 - 10:15	**018. ANALYSIS AND DIAGNOSIS OF THE FORMAL ASPECT OF THE PREVENTIVE DOCUMENT KNOWN AS HEALTH AND SAFETY PLAN IN SPAIN** Álvaro Romero Barriuso, Blasa María Villena Escribano, María de las Nieves González García, María Segarra Cañamares and Ángel Rodríguez Sáiz.
10:15 - 10:30	**012. EVALUATION OF THE FPSICO METHOD SUITABILITY FOR THE DETECTION OF PSYCHOSOCIAL RISKS IN CONSTRUCTION COMPANIES** Miriam Zamora Calleja, Mercedes del Rio Merino and José Luis Llorca Rubio.
10:30 - 10:45	**105. TECHNOLOGICAL CHANGE FOR CONSTRUCTION OF HOUSING IN COLOMBIA** Mónica Andrea Rodríguez and Carlos Rodríguez Monroy.
10:45 - 11:00	**057. THE LEVEL OF PREVENTIVE ACTION ASSESSMENT PARAMETERS FOR CONSTRUCTION WORKS: THE CHARACTERISTIC VALUE AND ITS INCIDENCE IN THE RISK DEGREE EVALUATION** Antonio José Carpio de los Pinos and María de las Nieves González García.
11:00-11:15	**077. LATER ACTION TO THE DOCTORAL THESIS "EXPERIMENTAL MECHANICAL CHARACTERIZATION OF A STRUCTURAL LIGHTWEIGHT CONCRETE"** Fernando Israel Olmedo Zazo.
11:15-11:30	**033. REDUCTION IN GYPSUM COMPOUNDS STIFFNESS WITH THE INCORPORATION OF END-OF-LIFE RUBBER TYRES. ANALYSIS AND RESULTS.** Óscar López-Zaldívar, Rafael Vicente Lozano-Díez, Sofía Herrero del Cura, Pablo Luis Mayor Lobo, Francisco Hernández Olivares

11:30-12:30	POSTER SESSION 3 + COFFEE BREAK

MEETING ROOM	
12:30 - 13:00	**Closing plenary conference: Dr. Miguel Ángel Sanjuan Barbudo**
13:00 - 13:15	**Conference summary and farewell: Dr. Carlos Morón Fernández.** *Director of the Department of Building Technology. Universidad Politécnica de Madrid*

Wednesday, 6th March 2019 · POSTER SESSION I	
ENTRANCE HALL	
PSI.1	***005. WEB-BASED TOOL FOR CONSTRUCTION AND DEMOLITION WASTE*** Paola Villoria Sáez, Marina Álvarez Alonso, Álvaro Sagarruy de la Rosa
PSI.2	***009. STUDY OF THE BEHAVIOUR OF REINFORCED CONCRETE WITH FIBRES*** Simone Feroldi
PSI.3	***011. STUDY OF THE DURABILITY OF CONCRETES AND MORTARS REINFORCED BY INDUSTRIAL WASTE (METALLIC FIBERS)*** Souad Kherbache, Abdelkader Tahakourt, Karim Moussaceb, Nedjima Bouzidi
PSI.4	***017. PROPOSAL TO REUSE RECYCLED FINE AGGREGATE AND INSULATING MATERIALS WASTE IN THE MANUFACTURE OF MORTARS*** Katarzyna Kalinowska-Wichrowska, Carolina Piña Ramírez, Alejandra Vidales Barriguete
PSI.5	***020. BEST STRATEGIES TO REDUCE CO2 EMISSIONS IN THE EXECUTION PHASE OF A BUILDING BY MEANS OF CONSTRUCTION WASTE RECYCLING ON SITE. A CASE STUDY IN NAYARIT MEXICO.*** Ulises Mercado, Paola Villoria Sáez, Francisco Javier Hernández Ayón
PSI.6	***021. CURRENT STATUS OF SUSTANIBLE CONSTRUCTION IN EUROPE*** Paola Villoria Sáez, Mercedes del Rio Merino, Blerta Vula Rizvanolli, Odysseas Kontovourkis, Themistoklis Tsalkatidis,Giulia Peretti, Aranzazu Galán, Daniel Friedrich
PSI.7	***022. COMPARATION OF STUDIES ABOUT THE APPLICATION OF GLASS FIBRE MESH TO ESTRUCTURAL STRENGHTEN OF MASONRY WALLS*** Francesca Vinciguerra
PSI.8	***023. ASSESSING OF RAMMED EARTH WITH STEEL REINFORCEMENT AND ADDITIVES*** Argelia Tobias Nieto
PSI.9	***025. MONITORING OF A SELF-SUSTAINING GREEN ROOF*** Argelia Tobias Nieto, Francesca Vinciguerra
PSI.10	***028. GOOD PRACTICES (GP) FOR THE EXECUTION OF CONCRETE GROUND SLABS, TO AVOID THE FISSURES AND CRACKS*** Manuel Ramos Arias, Santiago Álvarez Arribas, Mercedes del Río Merino
PSI.11	***029. STUDY ABOUT THE UTILISATION OF POLYPROPYLENE FIBERS IN ORDINARY CONCRETE AND IN GEOPOLYMER CONCRETE*** Silvia Longo
PSI.12	***064. THERMOGRAPHIC ANALYSIS OF THE FACADE HOLES OF THE WEST FACADE OF THE HIGHER EDUCATIONAL TECHNICAL SCHOOL, MADRID.*** Tomás Gómez Prieto, Daniel Ferrández Vega, Carlos Morón Fernández and Jorge Pablo Díaz Velilla
PSI.13	***036. A CASE STUDY ON THERMAL INSULATION AS A COMFORT FACTOR IN WARM-HUMID WEATHER HOUSING*** Guillermo De Ignacio Vicens, Silvia Soutullo Castro, Oscar López-Zaldívar, Rafael Vicente Lozano-Díez
PSI.14	***037. A CASE STUDY ON VENTILATION AND SHADING AS COMFORT FACTORS IN WARM-HUMID WEATHER HOUSING*** Guillermo De Ignacio Vicens, Silvia Soutullo Castro, Oscar López-Zaldívar, Rafael Vicente Lozano-Díez
PSI.15	***040. DEVELOPMENT OF SUSTAINABLE TECHNOLOGIES IN CONSTRUCTION.NFUS APPLICATION*** Catalina Mondragón-Enguidanos, Amparo Verdú-Vázquez, Tomás Gil-López, Daniel García de Frutos
PSI.16	***041. STUDY OF THE THERMAL BEHAVIOR OF CEMENT MORTARS REINFORCED WITH WASTE MINERAL FIBERS THROUGH NUMERICAL SIMULATION.*** Carolina Piña Ramírez, Carmen Viñas Arrebola, Alejandra Vidales Barriguete, Patricia Aguilera Benito, Sheila Varela Luján
PSI.17	***045. EXPERIMENTAL ASSESSMENT OF THERMAL CONDUCTIVITY IN A NON STANDART GYPSUM PLASTER SAMPLE*** Alberto Pedro Manzano Herrero, Rafael Vicente Lozano-Díez, Oscar López-Zaldívar, Francisco Hernández Olivares
PSI.18	***090. STUDY BASED ON HISTORICAL DATA OF NINE PUBLIC AFFORDABLE HOUSING PROJECTS*** Juan Pedro Ruiz-Fernández, Nelia Valverde-Gascueña, Miguel Ángel López-Guerrero, Joaquín Fuentes-del-Burgo

Thursday, 7th March 2019 · POSTER SESSION II	
ENTRANCE HALL	
PSII.1	***046. PROVISIONAL TIMBER STRUCTURE FOR EMERGENCY SITUATIONS*** Pablo Martín Gallego
PSII.2	***049. CHARACTERIZATION OF HIGH ISOLATION GYPSUM*** Manuel Álvarez Dorado, Simone Feroldi
PSII.3	***052. STUDY OF RETRACTIONS AND CHARACTERIZATION OF AGGREGATES IN CEMENT MORTARS WITH ADDED CONSTRUCTION AND DEMOLITION RESIDUES*** Alberto Lage Sánchez
PSII.4	***053. THE EFFECTIVENESS OF THE USE OF FIBERS AND OTHER METHODS AS REINFORCEMENT IN THE REPAIR OF WOOD BEAMS OF VARIOUS ARBOREAL ORIGINS*** Alfredo Tuya Anyosa, María Isabel Prieto Barrio
PSII.5	***058. STUDY OF THE BEHAVIOR OF BASTARD MORTARS WITH FIBERS*** Tiare Garcia Pavón, Alfredo Tuya Anyosa, Carlos Morón Fernández
PSII.6	***059. THEORETICAL STUDY ABOUT THE APPLICATION OF DRONES FOR THE THERMAL INSPECTION OF BUILDINGS*** Celia García González, Pablo Martín Gallego
PSII.7	***061. STUDY OF THE MECHANICAL BEHAVIOR OF PLASTER WITH LOADS OF SEPIOLITE ADDICTION AND THE PREPARATION OF PREFABRICATED PANELS*** Alfredo Tuya Anyosa, Celia García González, Engerst Yedra Álvarez, Mercedes del Río Merino
PSII.8	***062. INNOVATION IN TIMBER BUILDING STRUCTURES*** Tiare Garcia Pavón
PSII.9	***063. SIMULATION OF THE ENERGY DEMAND ON THE REAL ESTATE UNIT LOCATED IN VILLAVERDE (MADRID)*** Pablo Martin Gallego, Alfredo Tuya Anyosa
PSII.10	***064. THERMOGRAPHIC ANALYSIS OF THE FACADE HOLES OF THE WEST FACADE OF THE HIGHER EDUCATIONAL TECHNICAL SCHOOL, MADRID*** Tomás Gómez Prieto
PSII.11	***065. THE STUDY OF HISTORICAL CITY CENTRES WITH GEOGRAPHIC INFORMATION SYSTEMS. THE CASE OF STUDY OF THE JESUS CEMETERY OF MURCIA, SPAIN*** José Marín-Nicolás, Mª Paz Sáez-Pérez
PSII.12	***066. STRUCTURAL CHARACTERISATION AND NUMERICAL ASSESSMENT OF SEISMIC DAMAGE OF THE CORTIJO DEL FRAILE FARMHOUSE IN NÍJAR (ALMERÍA, SPAIN).*** Luisa Mª García-Ruiz, Mª Paz Sáez-Pérez
PSII.13	***075. PELLET OPTIMIZATION IN BLAST FURNACE TO OBTAIN CONSTRUCTION STEEL*** Alberto Morón Barrios, Carlos Morón Fernández, Daniel Ferrández Vega, Pablo Saiz Martínez
PSII.14	***076. THE PRESTRESSED IN BUILDING. EVOLUTION AND ADVANTAGES AGAINST REINFORCED CONCRETE*** Alfonso Blasco Gutiérrez
PSII.15	***079. EXPERIMENTAL STUDY ON RUBBER AS CARBON FIBER REINFORCED CONCRETE BEAM REPAIRING MATERIAL (AGGREGATE REPLACEMENT)*** Jun Deng
PSII.16	***089. THERMOMECHANICAL BEHAVIOUR OF THERMOACTIVE PILES*** Kenzo Jorge Hosokawa, Alfonso Cobo, María Isabel Prieto, Inmaculada Martínez Pérez
PSII.17	***071. MEASUREMENT OF BENDING IN CONSTRUCTION BEAMS- FRP REINFORCED CONCRETE BEAMS*** Jun Deng, Carlos Morón Fernández, Pablo Saiz Martínez and Alberto Morón Barrios.
PSII.18	***131. MODELING AND IMPROVEMENT OF A FLAT IN CUATRO CAMINOS, MADRID*** Asier Fernández Egido, Álvaro Sotorrío Fernández-Mijares, Julián García Muñoz, César Porras Amores and Carmen Viñas Arrebola.

Friday, 8th March 2019 · POSTER SESSION III	
ENTRANCE HALL	
PSIII.1	***091. THERMO-HYGROMETRIC STUDY OF A WINE CELLAR IN THE NORTH OF SPAIN*** Maria Giulia Gagliardini, César Porras Amores, Carmen Viñas Arrebola, Fernando R. Mazarrón, Ignacio Cañas Guerrero
PSIII.2	***092. STUDY OF THE MECHANICAL CHARACTERISTICS OF BAMBOO FOR ITS USE IN THE CONSTRUCTION FIELD*** Maria Giulia Gagliardini
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