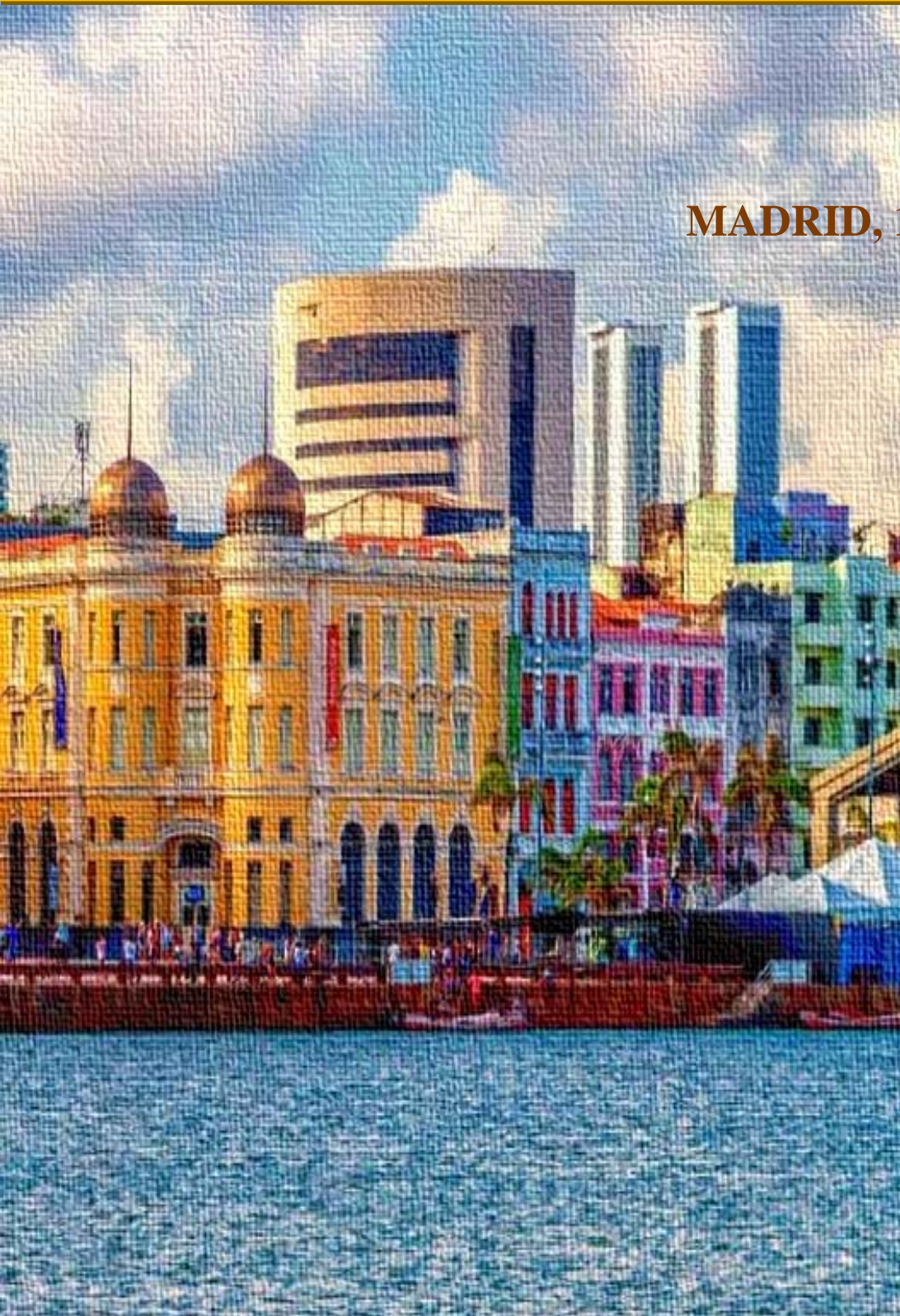


**4<sup>th</sup> BUILDING AND MANAGEMENT INTERNATIONAL CONFERENCE**  
**4º CONGRESO INTERNACIONAL DE GESTIÓN EN EDIFICACIÓN**

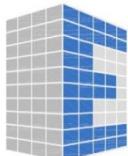


BUILDING & MANAGEMENT  
**BIMIC**  
INTERNATIONAL CONFERENCE

**MADRID, 16-18 November**

**2022**

**PROCEEDINGS**

ETS  M

UNIVERSIDAD POLITÉCNICA DE MADRID

**Escuela Técnica Superior de Edificación**  
**Universidad Politécnica de Madrid**

Avda. Juan de Herrera, nº 6 - 28040 - Madrid

Colabora el Instituto Federal de Pernambuco (Recife, Brasil)



**4<sup>th</sup> BUILDING AND MANAGEMENT INTERNATIONAL  
CONFERENCE**  
**4º CONGRESO INTERNACIONAL DE GESTIÓN EN  
EDIFICACIÓN**



ESCUELA TÉCNICA SUPERIOR DE EDIFICACIÓN  
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## PRESENTACIÓN

### CONGRESO INTERNACIONAL DE GESTIÓN EN EDIFICACIÓN (BIMIC 2022)

16, 17 y 18 de noviembre de 2022

**BIMIC** nace con el **objetivo** de servir de plataforma a la difusión de los avances en el ámbito de la Gestión en la Edificación.

Este año la Conferencia está organizada por la ETS de Edificación junto al Instituto Federal de Pernambuco, por lo que se celebra de manera simultánea en dos sedes, en **Madrid (España)** y en **Recife (Brasil)**.

Los temas de interés incluyen todos los avances teóricos, metodológicos y prácticos en la gestión de edificios dentro de cualquier fase de su vida: proyecto, construcción, uso, mantenimiento y fin de vida.

El **programa BIMIC 2022** está estructurado en conferencias invitadas, mesas redondas, comunicaciones orales, posters y talleres sobre la base de diferentes áreas temáticas, tales como Gestión de Accesibilidad, Gestión y Seguridad en la Construcción, Gestión de Evaluación de Riesgos, Rehabilitación, Patología y Mantenimiento de Edificios, Eficiencia Energética, Innovación en la Construcción, Gestión de Planificación Urbana, Gestión de la Construcción de Edificios.

Finalmente agradecer la siempre inestimable colaboración de la Cátedra-Empresa Proiescón y a la empresa INACOM Ingeniería Aplicada.

El Comité Organizador

## INTRODUCTION

### BUILDING AND MANAGEMENT INTERNATIONAL CONFERENCE (BIMIC 2022)

**November 16th, 17th and 18th, 2022**

**BIMIC** was born with the **aim** of serving as a platform for the dissemination of advances in the field of Building Management.

This year the Conference is organized by the ETS de Edificación together with the Federal Institute of Pernambuco, so it is held simultaneously in two venues, in **Madrid (Spain)** and in **Recife (Brazil)**.

Topics of interest include all theoretical, methodological and practical advances in building management within any phase of their life: design, construction, use, maintenance and end of life.

The **BIMIC 2022 program** is structured in invited lectures, round tables, oral communications, posters and workshops based on different thematic areas, such as Accessibility Management, Construction Management and Safety, Risk Assessment Management, Rehabilitation, Pathology and Building Maintenance, Energy Efficiency, Construction Innovation, Urban Planning Management, Building Construction Management.

Finally, we would like to thank the always invaluable collaboration of the Proiescón Chair-Company and the company INACOM Ingeniería Aplicada.

The Organizing Committee

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**FACILITIES AND BUILDING SERVICES MANAGEMENT**

## PROPOSAL FOR IMPROVING THE TEMPORARY MANAGEMENT OF SOCIAL ACCOMMODATION FOR REFUGEES IN QUITO, ECUADOR

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**Keywords:** *refugee, social relations, receptivity, architectural prototype, shelter.*

### Abstract

Throughout human history, migration has been an essential phenomenon that has indirectly affected social development and has remarked freedom importance. Since 2008, according to statistical data from HIAS (Refugee Protection Organization), Ecuador has become the primary option for thousands of refugees from South America when looking for a place to live or they're transiting to another country [1].

However, the main idea of this proposal is the creation of essential spaces that attend the ever changing necessities of the refugees.

Quito, the capital of Ecuador, has one of the highest rates of refugees. Hence, it is the perfect location for the proposed prototype, that consists on the creation of an urban network for the implementation of shelters located on the main public transport routes of the city. The exact locations of the proposed scheme for the refugees is considered to not to be important at this stage.

In contrast to the traditional shelters, this prototype designs and recommends essential spaces for the non-permanent residents seeking for social inclusion. Historically, the refectory or dining room played a very important role to create friendships and bonds. For instance, in the 16th century, those spaces were meeting places where monks could interact, besides eating.

Architecturally, they were large spaces with long tables that encouraged the user to engage into conversation. Starting from this concept, one of the key elements are the kitchen and dining room, which are considered as the "heart" on the scheme of the refuge given that they encourage social interactions and food markets, making the project profitable. Additionally, there will be educational workshops in which the students will be able to learn new skills aiming to increase the chances of an insertion to the professional world.

This type of building seeks to be a neighborhood landmark that encourages new social relationships making the user to be part of the city and promoting the importance of refugees to the local population.

### References

[1] P. A. Larrea "prototype for a temporary stay shelter of refugees in Quito", Larrea, Universidad Central del Ecuador, Quito, Ecuador, 2018.

## A NEW METHOD FOR REINFORCE AND DESIGN OF 3D CONCRETE PRINTING (3DCP): CONSIDERING STRUCTURAL FRAMES

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**Keywords:** 3D concrete printing, 3DCP, 3DCP reinforcement, Shape memory alloy, SMA, Nitinol, 3DCP design.

### Abstract

Each part in construction industry is going to be automated, which can increase and reduce the accuracy and time of construction process, respectively. 3D Concrete printing (3DCP) which is known as additive manufacturing, too, is the future generation of construction industry with respect to the mentioned benefits. To extend 3DCP construction method from laboratory scale to practical scale, it is needed to define rules and standards for designing these types of structures. In this study, a new method for reinforcement and design of 3DCP structures was proposed. The new method is based on considering structural frames, columns and beams, like conventional structures, for 3DCP structures. To evaluate effect of the proposed reinforcement method, a numerical simulation was done in Abaqus finite-element (FE) software. Three groups of samples were modelled with different geometric and reinforcement materials. Gravitational and lateral loads were applied to the considered structural frames and results in terms of method of failure, flexibility and the maximum lateral load which frames recorded before failure were evaluated and compared.

## USE OF LNG DURING THE SUMMER SEASON

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**Keywords:** LNG, Logistic, Satellite plants, Exploitation, Managment.

### Abstract

Over the last forty years, the Spanish state has been increasing its use and dependence on natural gas. The use for many of the daily activities has meant that our country has had to create a wide, modern and safe infrastructure which can guarantee the development of this technology and the supply to all points of the national orography.

This network carries the gas coming from the pipelines, which are fed from the south by Algeria and Morocco, from the north by France and finally from different sea ports where the gas arrives in methane tankers; which unload the natural gas that comes liquefied, and there it is regasified to inject it into the system.

But not all points have a connection system, there are points where the natural gas does not arrive and taking it would be too expensive. Therefore, the solution created was the construction of satellite plants that would be supplied by tanker trucks that would carry the liquefied gas, and in which the regasification and distribution to homes and industries in the area would take place.

The problem of these plants is found in the summer months or in the less cold ones, since the plants are practically in disuse, causing the tanks containing the Liquefied Natural Gas, hereinafter LNG, to be pressurized, taking the plants to extremes that would pose a danger to the installation and the environment.

Therefore, this article aims to avoid the so-called venting and to take advantage of these facilities to produce energy in the summer months, or to create underground collection systems where the excess pressure is derived, and so store the gas without having to release it into the environment.

## POTENTIAL FOR THE THERMAL USE OF WASTEWATER FOR THE AIR CONDITIONING OF BUILDINGS

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**Keywords:** *thermal energy recovery, wastewater, wastewater treatment system, energy efficiency.*

### Abstract

The main objective of this research is to analyze the thermal energy potential of wastewater around the building, as a function of temperature and power parameters in a hybrid HVAC system. Through the qualitative and quantitative study for one year, of a case study located in the city of Madrid, it was confirmed the energy contribution of wastewater in a hybrid HVAC system, consisting of heat pumps, geothermal probes, and heat exchanger circuit (installed in the groundwater and rainwater collection tank). It was identified that there is a greater energy contribution in the summer seasonal period, up to 4%; in addition to the fact that the temperatures of the wastewater and geothermal energy at this time are favourable from the point of view of the use of cooling energy. Finally, it is observed that the temperature fluctuations of these two sources follow a line of solvency with the outside temperature. There is a wide scientific literature that supports the recovery of thermal energy from wastewater, however it is still a technology in continuous research and of limited diffusion, both at scientific, technical, and commercial level. This work is a reference for the implementation of this resource within the energy efficiency alternatives, which together with passive and active strategies in the building is one of the alternatives for a sustainable and equitable energy development.

## VISUAL MODELLING OF THE ON-SITE LOGISTICAL SUPPLY OF SOLAR ENERGY EQUIPMENT WITH FLEXSIM

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**Keywords:** *FlexSim; Logistics; Solar power; Modelization; Simulation.*

### Abstract

It would be true to say that among all the existing technological sectors, the construction sector is probably one of the most "classic" or "conservative" in terms of the operations and procedures that are usually followed. Among these procedures, it could be said that the management and logistical planning of the supply of materials and equipment on site is one of the activities in which there is most room for innovation. This article modestly attempts to shed some light in this sense, by rescuing a programme that is clearly linked to Industrial Organisation Engineering, so that it can be used in the Building sector: FlexSim. In fact, this application is part of what is known as 3D modelling and simulation software for systems or processes. Thanks to FlexSim, it is possible to transform existing input data into precise predictions whose dynamic and visual simulation can be carried out with the utmost flexibility in order to make the best decisions. In addition, the short and precise learning curve, the intuitive parameterisation of the logistic model to be studied, and the possibility of graphically customising any equipment, provide users with a smoother, satisfactory experience before validating any operation in the real world.

How can FlexSim be applied in an environment such as the procurement of materials and equipment for the building sector, specifically to plan the on-site logistics of solar thermal and photovoltaic energy equipment? The response to this question is by building a simulation that allows conceptualising the delivery process of materials and equipment corresponding to the aforementioned technologies (collectors, tanks and pumps or panels, batteries and regulators, for instance). Specifically, these materials will be unloaded from the supply trucks and transported to an initial unloading area using forklift trucks. These materials will be processed in an intermediate palletising area and will be handled by spherical coordinate robots. From this location the final installation areas of equipment (two single-family houses in this case) will be reached. Equipment will be separated according to both technologies and also unloaded by a force of operators together with forklift trucks. For reasons beyond both the scope of this article and the legal and free version of the software application (restricted to 30 items), it is not feasible to simulate the actual equipment installation process.

Furthermore, it is feasible (extremely interesting, one might add) to measure in real time practically all the relevant concepts of the logistics process: unloaded equipment and parameters of the unloading means (forklifts, robots, and operators) such as percentages of occupied trips, empty trips and unproductive time... All this is in order to optimise the allocation of human and technical resources to this process from the point of view of measuring organisational efficiency. That is, under the criterion of a correct balancing of the workload of the operators and the investment in equipment for this task.



**INNOVATION IN BUILDING ENGINEERING**

## ANALYSIS OF THE IMPROVEMENT OF ADOBE BRICKS WITH ADDITION OF COCOS NUCIFERAS L. FIBERS: MOLDING OF THE BLOCKS AND TESTS

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**Keywords:** *Civil construction, coconut, vegetal fiber, sustainability, raw earth.*

### Abstract

An anthropic activity that causes the most impact on the environment is civil construction, since its damage ranges from raw material to energy expenditure to its transformation.

One of the alternatives to mitigate these environmental problems is the use of raw land. Within the buildings there is the adobe technique, characterized by being a brick that does not go through the supply process, offering benefits, such as no energy expenditure and does not require specialized labor. Disadvantages such as low mechanical strength, which requires the use of materials to improve their properties. Thus, this work should be analyzed as improvements of the study bricks with the addition of fibers from *cocos nucifera* L. as a stabilization process. For testing and production of adobe bricks, families F0, F1, F2, F3 and F4 were used, which correspond to 0% (reference), 10%; 20%; 30% and 30% of fiber addition in relation to the volume used for each percentage, respectively, total coconuts used in the coconut ration. The deOMIC test was performed in a 200kN servo controlled press. Visually, the F0 family showed a large number of cracks, reaching up to 1.8 mm. Families that had thicknesses included may have greater quantity and thickness in relation to the degree of comparison.

The F2 (20%) have a greater visual. It is concluded that there were positive results in the adobe substance with this significant. The test results of resistance to the family with which there was a 20% increase. Families with percentages of 30% and 40% showed reduced resistance. It was concluded that, in addition, it seems that the larger fibers are higher strength percent, weight loss percentages when compared to bricks with lower strengths.

## REPLACEMENT OF THE AGGREGATE BY MARICULTURE WASTE IN THE PRODUCTION OF NON-STRUCTURAL CONCRETE

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**Keywords** : *Seafood, Non-structural concrete, Waste, Sustainability.*

### Abstract

The civil construction market has great potential regarding the reuse of environmental resources, which at first could be discarded, opening the possibility of several possibilities for the use of different materials. This research studies the use of mollusc shells (*Anomalocardia brasiliensis*) from artisanal seafood and incorrect disposal causes the accumulation causing serious damage to the environment, especially on the coast of Pernambuco, making it essential to analyze the management of these residues. Thus, the objective of this study is to analyze the application of shell residues, as coarse aggregate in its natural shell form and fine aggregate in crushed form, for the preparation of non-structural concrete. Thus, numerous tests were carried out with the concrete both in the fresh state and in the specimens of concrete in the hardened state. It can be concluded that it is possible to make use of mollusc shells as fine and large aggregates in the production of non-structural concrete, making this material useful for the composition of protective layers, layer fillers, base of blocks, ballasts, against floors and parts. low-demand precast.

## MIX DESIGN METHOD LIGHTWEIGHT CONCRETE

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**Keywords:** *lightweight concrete; EPS; mix design concrete.*

### Abstract

There are several methodologies for Portland cement concrete dosage, among these, the method recommended by the Technological Research Institute of the State of São Paulo - IPTUSP, which is widespread in Brazil. Although it does not present dosage factors for lightweight concrete, this paper proposes a dosage method based on the IPT method for lightweight concrete with EPS. The concrete was dosed with CPV ARI cement, sand and EPS, and two volumes of aggregates (m) were made, thus making a rich and a poor trace, for this, two aggregate contents (m) were executed, thus making a rich and a poor mix, being them: 1:1, 1:2 (aggregates mix in real volume (L) per kg of cement), respectively. Then, each mix (1:m) was dosed with three different levels of EPS (25, 50 and 75%, to each "m"). The properties of the concretes were evaluated in the fresh state, through the slump test [1] and specific mass through the known volume method, and, in the hardened state, by the specific mass test [2] and compressive strength [3]. With the results obtained from this study, it was possible to elaborate a dosage diagram for each "m" analyzed, obtaining the values of the EPS content, projection of compressive and slump resistance, indicated in a dosage abacus made from the test results, these parameters are essential for the determination of the concrete mix.

## PRODUCTION OF NON-STRUCTURAL CONCRETE APARTI FROM THE REUSE OF COCONUT ENDOCARP AS LARGE AGGREGATE

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**Keywords:** *Non-Structural Concrete, Endocarp, Sustainability, Reuse.*

### Abstract

The scarcity of natural resources has changed the environmental dynamics as a whole, it is observed that the action of man causes a greater amount of waste every day, which interference negatively and directly impact the environment. Considering this context, Civil Construction seeks to create sustainable actions, creating strategies for the destination of numerous types of tailings, thus, this study is based on the use of dry coconut endocarp residue (RECS) in the production of non-structural concrete, knowing that in the northeast region, coconut cultivation is currently expressive. The objective of this research is to present the application of coconut endocarp as a coarse aggregate for the production of non-structural concrete. The methodology applied consists of making 3 (three) families of non-structural concrete, adhering as a reference trace 1:2:3:0.6 (cement, fine aggregate, coarse aggregate and water/cement ratio), and other families varying the proportions of the coarse aggregate (stone/endocarp). Several laboratory tests were carried out in the fresh and hardened state, to understand the workability, specific mass, compressive strength, tensile strength by diametrical compression, modulus of elasticity and absorption. The results conclude that gravel can be replaced by coconut endocarp in the production of non-structural concrete, being acceptable for this purpose.

## USO DE FIBRA DE COCO VERDE EN BLOQUE DE YESO PARA SELLADO VERTICAL

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**Keywords:** *Fibra de coco verde, construcción civil, medio ambiente, bloques de yeso, sellado vertical interno.*

### Abstract

El Nordeste es un importante productor de coco, pero sólo la parte interna del mismo es utilizada, resultando en la disposición de miles de toneladas mensuales desde el exterior, la más abandonados en la naturaleza, lo que representa un gran desperdicio de recursos naturales, además de la contaminación ambiental. El uso de fibra representa beneficios económicos, ecológicos y sociales, ya que, aunque el material está siendo correctamente destinados a vertederos, son emisores potenciales de gases de efecto invernadero (metano) y contribuyen a la que la vida útil de estos depósitos se reduce, proliferando focos de vectores transmisores enfermedades, malos olores y posible contaminación de suelos y cuerpos de agua, además de la destrucción de paisaje urbano. El objetivo de este trabajo es evaluar el comportamiento de la fibra de coco verde añadida a la fabricación de bloques de yeso utilizados en el sellado vertical interno de edificios para su uso en construcción civil con 5% y 10% de fibra a través de medios observacionales comparativos. Se creó un prototipo de bloque de yeso. Los resultados después de la rotura fueron 7,5 Mpa sin adición de fibra, 6,9 Mpa con adición de 5% y fibra y 6,2 Mpa con adición de 10%. Se concluye que la resistencia del bloque adicionado con fibras de coco verde estuvo dentro de las normas y cercano a la resistencia sin adiciones de fibras, no presentó oscilación significativa, posibilitando su uso y aplicaciones en la construcción civil y edificación. La investigación tiene como objetivo general Evaluar el desempeño de la fibra de coco verde añadida a la fabricación de bloques yeso utilizado en el sellado vertical interno de edificios para su uso en la construcción civil. La metodología de investigación todo el procedimiento para la obtención de las fibras se llevó a cabo en tres pasos: 1 – Inmersión en agua: Una unidad de coco verde en agua natural del grifo durante un período de siete días. 2 - Extracción y secado de la fibra: Obtenido por maceración y posterior secado de forma casera, expuesta a la luz solar y al calor natural del ambiente en un periodo de 15 días. 3 – Corte: Las fibras ya secas fueron cortadas manualmente con tijera en un tamaño estándar de 5 cm. Ensayo de resistencia a la compresión axial Tras la rotura de las probetas, los resultados fueron los siguientes: La rotura de CP sin adición de fibra alcanzó 7,5 Mpa, la

rotura de CP con la adición del 5% alcanzó los 6,9 MPa y la CP con la adición del 10% de fibra de coco alcanzó los 6,2 MPa.

## MECHANICAL AND CHEMICAL CHARACTERIZATION OF AUTOMOTIVE WASTE-BASED GYPSUMS

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### Abstract

The improving economic, social, and environmental indicators of sustainable development are drawing attention to the construction sector, which is a globally emerging sector, and a highly active industry in both developed and developing countries.

It is confirmed that construction activities have major impacts on the social, environmental, and economic aspects of sustainability [1]. Many harmful wastes from industrial products cannot be disposed of by any means. At present, this waste is either buried deep in the soil or incinerated [1]. Each of these methods leads to the spread of pollution in soil, groundwater, and air. Worldwide automotive waste is growing rapidly every year and its impacts are considered to be an important environmental problem.

In this sense, the main objective of this research is to investigate the feasibility and the effects of the use of automotive waste (a mixture of polyurethane foam, cardboard, and fiberglass (PCF) through different particle size scales) in a gypsum matrix to characterize new gypsum-based materials that incorporate waste from the automotive sector.

To this several gypsums, specimens were prepared to incorporate different percentages of non-treatment waste (2.5%, 6%, and 11%) based on the weight of the gypsum (0.5, 0.6, and 0.7). Reference samples were also produced (without additions) to compare the results obtained.

All samples were tested in the laboratory and the following physical and mechanical characteristics were determined: density, superficial hardness, flexural strength, compressive strength and bonding strength. Chemical tests were also performed in order to characterize the gypsum and waste. A comparative analysis showed that the traditional characteristics are improved. From the various tests carried out, it emerged that the incorporation of polyurethane foam, cardboard, and fiberglass improved the behavior of the traditional gypsum and was applied in various construction applications.

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[2] Jay et al., 2007; Ortolano and Sheperd, 1995; Toro et al., 2010; Wathern, 1994; Wood, 1993

## DESIGN APPLICATIONS IN PARTITIONED COVERS TO TEACHING IN ARCHITECTURE

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**Keywords:** *partitioned vault, traditional technique, geometric, constructive.*

### Abstract

The recovery of the use of the partitioned technique has historical, practical and experimental interest. This research is developed in a first phase, which consists of the analysis of the construction system of the partitioned vault, with the aim of promoting and promoting this type of construction technique in the area, thanks to the advantages it offers us, such as: its high resistance, the variety of forms that can be generated, the great lights offered by these harmonious structures, minority in environmental impact, exceptional finishes, aesthetics superior to that of a common flat roof, etc. Its geometric and constructive technique will be demonstrated, in order to generate an alternative that can be affordable, thanks to its low cost, ease and speed of construction.

The experimental activity to be developed will be carried out in Poza Rica, Veracruz, Mexico, this being the northern area of the state where it is proposed to reactivate this wonderful traditional construction technique, the supply of primary and secondary material were the same area, the development and the results obtained from this experimental practice, in addition to the conclusions reached and what is planned to be developed in a second phase of the investigation.

## SHORING STUDY: ANOTHER WAY TO DESIGN AND EXECUTE CONCRETE STRUCTURES

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**Keywords:** *Shoring, construction process, load transmission, formwork.*

### Abstract

The Structural Code RD 470/2021, determines that the designer must define the construction process foreseen in the design of the structure and that the builder is responsible for submitting a detailed shoring study, where it is justified that the construction process defined in the project will be executed on site. To date, there is a great lack of knowledge about these specifications and a different dynamic to the one referred to in the standard is followed, which needs to be changed.

The research carried out to technically justify the shoring studies, estimating the load transmission between props and slabs, when executing successive floors in height, is explained. The main results are collected to help to design and execute the structure in accordance with the current regulations.

On the one hand, the three types of construction processes are specified, and a comparative analysis is made between them, highlighting that each building, according to its design load, requires a concrete and specific solution. On the other hand, the content of a shoring study and who it affects is specified, highlighting that it goes far beyond a mere justification of the props.

At the same time, structural typologies are changing, from lightened slabs to solid slabs, while maintaining the same design loads as always, and the construction processes currently used are becoming critical. If we want to adapt to current construction rhythms and deadlines, it is necessary to review the calculation criteria we use to ensure that the safety coefficients established by the standard can be met.

## CONCRETE CARBONATION IN URBAN INFRASTRUCTURES. PROGRESS SIMULATION IN URBAN TUNNELS

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**Keywords:** carbonation; concrete; numerical model; carbon dioxide; urban infrastructure.

### Abstract

Concrete carbonation occurs when atmospheric CO<sub>2</sub> is absorbed by the material and reacts with the dissolved calcium which is present in the pore solution generating calcium carbonate. This phenomenon is especially harmful when handling reinforced concrete, as the consumption of the calcium coming from the hydration compounds of the cement can lead to a pH reduction from 12,6 (sound concrete) to the surroundings of 8. Taking into account that reinforcement depassivation takes place when pH drops to a value of 9 or below, the carbonation progress may compromise the durability of the reinforcement steel.

The aim of the present work, currently under development, is to analyse, simulate and predict the progress of the concrete damage when exposed to high CO<sub>2</sub> concentrations in urban tunnels. For this purpose, an existing numerical model, developed by Phung, is being adapted to fit the particular conditions existing in urban tunnels. Also, an experimental campaign is being developed in order to obtain the required parameters to calibrate the numerical model. This campaign is divided into two phases: the first one, using concrete and mortar samples produced in the laboratory; and the other one, performing gas measurement concentration and extraction of concrete samples in a ventilation gallery of the Madrid Calle 30 tunnels. This model, still counting with some simplifications, allows to reasonably reproduce the results obtained in the laboratory and the ones published by other authors.

## MECHANICAL PROPERTIES IN SPECIMENS OF CEMENT MORTARS REINFORCED WITH POLYPROPYLENE FIBERS SUBJECTED TO VARIOUS TEMPERATURES UNDER DIFFERENT COOLING REGIMES

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**Keywords:** mortar, cement, fiber, polypropylene, temperature.

### Abstract

Know the behavior of the mechanical properties of elements such as steel, concrete and mortar is very important when evaluating a construction solution. In the present study, the variations of the mechanical properties such as resistance to bending, compression, as well as the loss of mass of cement mortar specimens reinforced with polypropylene fibers subjected to high temperatures and cooled in different regimes were analyzed. The mortar was made with CEM II/B-L 32.5 R cement, monofilament polypropylene fiber, fine aggregate and drinking water, using a dosage in proportions of 1:3:0.6 for all mixtures. Specimens containing 0, 2, 3 and 4 Kg/m<sup>3</sup> of polypropylene fibers, in volume, were made, these mortars were exposed to temperatures of 20, 50, 100, 200, 300, 400 and 500 ° C and cooled to a temperature 20±3 °C in air and in water. The specimens reinforced with 2 kg/m<sup>3</sup> of polypropylene fiber had the best behavior of their mechanical properties up to 300°, regardless of the cooling regime. It was found that at higher temperature.

## SANDWICH PANEL WITH BEARING CAPACITY TO SUPPORT A ROOF FLOOR WITH THE ADDITION OF RECYCLED POLYETHYLENE FIBERS ADAPTED TO THE BIOCLIMATIC CONDITIONS OF PANAMA

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**Keywords:** *Circular economy; sustainability; precast concrete; aggregate recycles.*

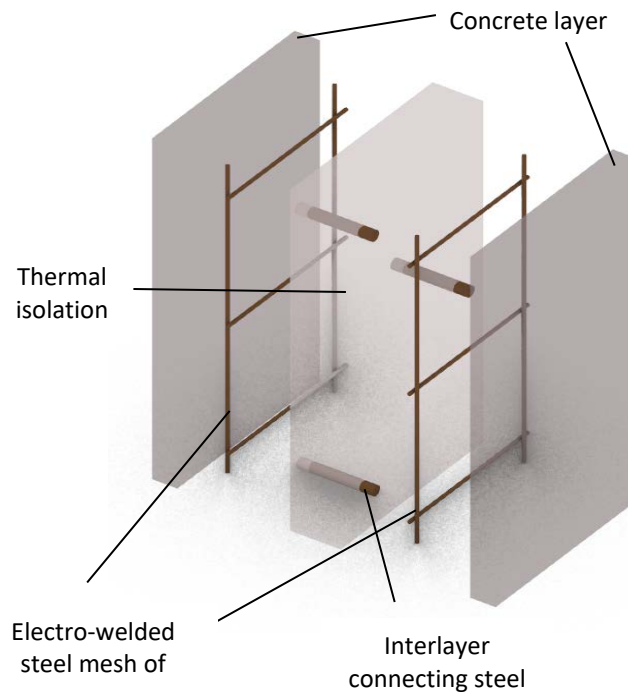
### Abstract

This research is focused on a prefabricated concrete sandwich panel, with the highest possible thermal insulation capacity and the lowest concrete thickness for Panama's overall climate. This will be evaluated with the addition of fibers from recycled plastic that is initially polyethylene and polypropylene for commercial use that allow to increase the resistance of concrete and reduce the use of corrugated steel, thus granting greater durability over time against corrosion by sodium chloride in the environment [1].

Sandwich panels bring benefits to the environment because they reduce the energy absorbed by buildings, reducing the consumption of active systems for heating and / or cooling. The idea is produced in order to improve a construction system, capable of supporting loads in extreme climates, close to the sea, where humidity is higher than in other areas [2]. It also reduces the environmental impact that these plastic-derived materials produce on the planet due to their low capacity for self-destruction.

To this end, a campaign of experimental tests have been carried out, to determine the characteristics of the material, its thermal insulation and its resistance, comparing the results obtained in the different panels. Polypropylene and recycled polyethylene fibers have managed to benefit in the strength results of these concrete panels, allowing to reduce the amount of used concrete and thus its thickness up to about 25mm.

The results reflected improvements in the compressive strength of the panels that had addition of recycled polyethylene fibers up to 21.25 N/mm<sup>2</sup> and bending improvements of the panels that had addition of polypropylene fibers reaching 4.35 N/mm<sup>2</sup> [3].



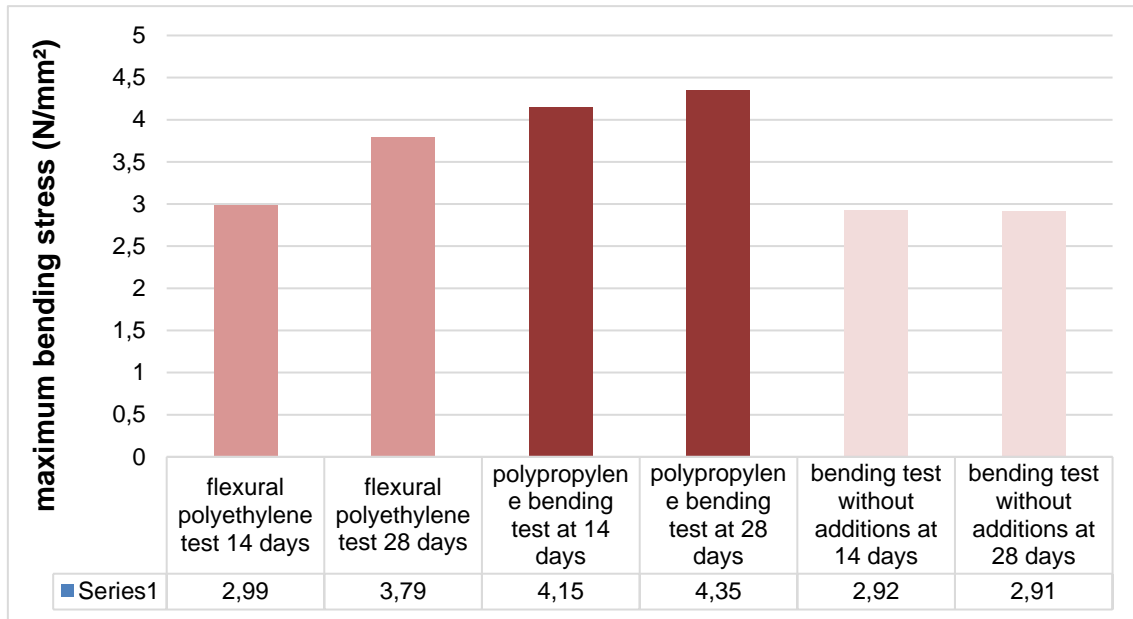
**Figure 1:** Prototype design to study

Several prototypes of prefabricated panel will be made with a measure of  $40 \times 20 \times 10 \text{ cm}^3$  in order to evaluate their results and compare them:

- Prototypes 1 to 12 will have two layers of  $28 \text{ N/mm}^2$  concrete mixed with recycled polyethylene fibers 2.5cm thick and a 5cm thick insulation layer and these will be subjected to local structural compression and bending tests.
- Prototypes 13 to 24 will have two layers of  $28 \text{ N/mm}^2$  concrete mixed with commercial polypropylene fibers 2.5cm thick and a 5cm thick insulation layer and these will be subjected to local structural compression and bending tests.
- Prototypes 25 to 36 will have two layers of concrete  $28 \text{ N/mm}^2$  thick 2.5cm and an insulation layer 5cm thick as seen in (Figure 3.1) and these will be subjected to local structural tests of compression and bending [4].

Breaks of each test will be made at 14 and 28 days to verify that they preserve their resistance.

Additionally, 6 cylindrical samples of the pattern concrete will be taken to measure its compressive strength without additions. So you can check that the concrete mixture meets its strength. These samples will fail after 3.7 and 28 days as is done in the measurements in Panama to verify that they preserve their resistance.



**Figure 2:** Graph of maximum bending stress (N/mm<sup>2</sup>) of test averages at 14 and 28 days, with the addition of recycled polyethylene fiber, polypropylene fiber and without additions.

The results obtained in the bending tests carried out according to the procedures explained in Chapter 3 were analyzed. The tests were carried out on the prototypes with the addition of 5Kg/m<sup>3</sup> of recycled polyethylene fibre and with the addition of 5Kg/m<sup>3</sup> of polypropylene fibre and without additions. Below, you can see in Figure 2, the comparison of the averages obtained in the bending tests of the 18 prototypes, at 14 and 28 days. It is observed that prototypes with the addition of polypropylene fibers are those with the highest load capacity and that between 14 and 28 days their load capacity is quite similar. The prototypes without additions obtain a resistance similar to 14 as at 28 days and is the lowest of the prototypes studied. Prototypes with the addition of recycled polypropylene fiber have a difference between 14 and 28 days, which indicates that they take longer to acquire their greater load capacity.

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[4] CONCRETE, Sampling Fresh. ASTM C 172, except modified for slump to comply with ASTM C 94. a. Slump: ASTM C, vol. 143, no 1.



## PROPOSALS FOR FOLDING ROOFS FOR THE RESCUE OF URBAN SPACES

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**Keywords:** *Transformable Architecture, Folding Roofs, Prototype Design, Construction Details.*

### Abstract

The following research work was developed through the generated diagrams of folding systems by Dr. Félix Scrig, which provided the basis for generating prototypes that can be built and placed more quickly on site, therefore different covers that could be proposed were developed. In different public spaces in the city of Poza Rica, Veracruz, helping the community to have a space where they can integrate into recreational and social activities.

The development of each prototype generated a more efficient geometric methodology to elaborate this type of structures and thus apply them to architectural projects, the transfer of knowledge to architecture students was vital so that several of the research projects presented here could be concluded, most of them concluding in 1:20, 1:10, 1:5 and 1:1 scale models, in thesis and linking projects, in conclusion the development left a catalog of architectural models that can be applied to different urban points of the city.

## RECYCLING OF POLYPROPYLENE WASTE AS PARTIAL REPLACEMENT OF BINDER MATRIX TO PRODUCE ECO-FRIENDLY GYPSUM COMPOSITES

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**Keywords:** *Polypropylene waste; gypsum plaster; mechanical performance; water-resistance properties; sustainable material.*

### Abstract

The current research evaluates the viability of using polypropylene (PP) waste sourced from disposable coffee capsules (CCD), as partial replacement of gypsum matrix to manufacture new eco-friendly gypsum composites. Considering the growing consumption trend that CCD have showing over the last few years, its proportional environmental impact should not be neglected. So, although discarded plastic CCD represent a low percentage of the total plastic pollution in comparison with the large amount of undifferentiated plastic waste, this residue was selected to be representative of a real waste material rather than using pure and uncontaminated PP. To this purpose, four replacement levels of plastic waste were studied - 2.5%, 5%, 7.5% and 10% by weight of gypsum. The experimental campaign developed consisted of two stages. In the first step physico-mechanical properties (density, flexural and compressive strength) of gypsum composites were analysed, while the water performance of new composites (water absorption by capillary action and water resistance by subjecting them to several wetting-drying cycles) was evaluated in the second stage. As a result, a slight improvement of gypsum composites' compressive strength (up to ~9% with 2.5% of PP waste content when compared to the control material) was observed, most likely due to the enhanced compactness from the optimal particle size distribution. Furthermore, the higher the level of plastic waste replacement was, the lower water absorption capacity and water retention of PP waste-containing composites was achieved. New gypsum composites presented a decrease of water absorption capacity in comparison with reference gypsum (up to ~37% decrease with 10% of PP waste content). Therefore, it could be inferred that PP waste can be accepted as viable partial substitute to the commercial gypsum to produce sustainable building products.

## THE EFFECT OF ELECTRIC ARC FURNACE DUST (EAFD) ON IMPROVING CHARACTERISTICS OF CONVENTIONAL CONCRETE

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**Keywords:** *Electric Arc Furnace Dust, Conventional Concrete, Compressive Strength, Water absorption, Chloride Ion Penetration.*

### Abstract

The steel industry is one of the key industries and its use is inevitable in many industries including construction. In addition to steel, this industry produces large amounts of electric arc furnace dust (EAFD) that's classified as hazardous waste. Using this material as an admixture can improve the characteristics of concrete, neutralize its hazard and be beneficial to the circular economy. In the present study samples from 11 different sources of EAFD in Khuzestan Steel Company (KSC) were collected, and classified into 3 groups (Fine, Coarse, and MH) based on their physical and chemical characteristics, then some conventional concrete samples have made by replacing 0 (control), 2, 5 and 8% of EAFD with cement and compressive strength test in 7, 28 and 90 days, Depth of water penetration under pressure test and Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration was done. The result shows that, replacing 2% of MH caused the most improvement in compressive strength of 7 days' concrete, but negative effect on water penetration while Coarse replacing has had a negative effect in almost all tests except chloride ion penetration. The best results caused by replacing 2% of Fine with cement, the results show improvement in all tests and in addition to the upward trend of increasing compressive strength over time.

## DIFFUSION OF CHLORIDES INTO CONCRETE MADE WITH TERNARY PORTLAND CEMENTS MADE WITH GRANULATED BLAST FURNACE SLAG AND SILICEOUS COAL FLY ASH

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**Keywords:** Ternary cements; chloride diffusion; coal fly ash; granulated blast-furnace slag; properties of cementitious materials.

### Abstract

The use of ternary Portland cements with a high additions content has a number of important climate change-related benefits due to the reduction of Portland cement clinker content in the final product. This will contribute to the reduction of greenhouse gases (GHG) emissions to a level very close to zero by 2050. These cements can contain different amounts of siliceous fly ash, granulated blast furnace slag and clinker. Cements made with both additions are pozzolanic. Therefore, they would improve both compressive strength and durability. In this work, the compressive strength of concretes and the resistance to chloride ion penetration were studied by means of non-stationary chloride migration (NT BUILD 492) and natural chloride diffusion (NT BUILD 443) tests. The results of the experimental study of chloride penetration into concrete show that there is a clear dependence between the concrete dosage and the chloride diffusion coefficient. Ternary cements made with siliceous coal fly ash or ground granulated blast furnace slag showed better resistance to chloride diffusion than concretes made with CEM I cements. On the other hand, the strength gain of concretes made with ternary cements is slower than concretes made with CEM I. This information could be useful for architects and building technicians in the design of sustainable concretes made with ternary cements made with siliceous coal fly ash or ground granulated blast furnace slag.



## IMPACTS OF BIM METHODOLOGY IN PLANNING AND MANAGEMENT OF ENTERPRISES

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**Keywords:** BIM. Building Information Modeling. Data management. Architecture, Engineering and Construction. Collaborative automation.

### Abstract

Building Information Modeling (BIM) is a methodology that employs data management in a collaborative manner in the architecture, engineering and construction sector, providing greater agility and reliability in the planning, operation and maintenance phases of projects. The use of processes based only on 2D technology, however, slows down the application of more efficient methods of modeling and data management in this industry, since it hinders the agile production of reliable content, often generating disagreement between agents involved in the planning and execution of works. Therefore, this study evaluates, through a bibliographic review, the evolution of BIM and the impacts brought to the planning and management of works through this methodology. For this, an analysis of its historical application and characteristics was made, its standardization in Brazil was evaluated through the current legislation, in addition to its influence on the future of the construction sector. For analysis of the literature, books, articles and dissertations on the theme were selected, taking the most cited authors as the criterion of choice. It was observed that among the main consequences of the application of BIM, are: reduction of rework, increase of precision in planning and reduction of global costs of the projects. However, for a smart and effective implementation of companies, large investments of time and capital are required. The regular creation of standards, decrees and guides demonstrates that there is a worldwide trend of incentives for professionals to seek qualification and adopt BIM principles in their work, as the methodology applies automation principles to the construction sector, adding quality to its products.

## BIM MODELLING IN BLENDER: AUTOMATION OF THE MODELLING OF AN ARCH BRIDGE TYPE STRUCTURE FREQUENTLY USED IN CIVIL ENGINEERING

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**Keywords:** BIM, Civil Infrastructures, Open Source, Blender, Python, Automation.

### Abstract

Building Information Modelling (BIM) is a collaborative working methodology that allows the creation of parametric digital models of an infrastructure or building. These models contain the geometry and data necessary to support design, construction and maintenance operations.

There is currently a large set of tools that enable the application of BIM methodology, but they are mostly Closed Source commercial tools. This makes it difficult to reuse the data and automate it in the different phases of the asset lifecycle.

In contrast to the above, there are Open Source tools with the necessary potential for developing BIM models. This is the case of Blender, a 3D design tool. Its Open Source nature allows the creation of different extensions (known as add-ons) in order to solve problems or add new functionalities to the program. These extensions are developed by people with programming skills external to the project.

This work approaches the automation, using the Python programming language, of the BIM modelling in Blender of an arch bridge type structure, frequently used in civil engineering. For this purpose, an add-on composed of four Python scripts has been developed, which reads a set of input data from an external file in CSV format and transforms it into a geometry represented through a graphical interface.

The menu of the extension created allows the selection of the files containing the coordinates of the arch axis, the piers and the bridge deck, as well as indicating the type of section that these elements will have, which can vary between rectangular, square or circular, depending on the case. Once the bridge components have been modelled, it is

also possible to extract the reports of concrete volume and formwork area necessary for the execution of the infrastructure.

This proposal provides a simplification of the processes necessary to perform the modelling of a structure such as the one presented in this case study. Future lines of work intend to address the incorporation of geometric processing of different types of structures through Blender in other areas, such as structural optimisation.



**SUSTAINABILITY, ENVIRONMENT AND ACCESIBILITY**

## DEVELOPMENT AND CONSTRUCTION OF TENSEGRITY SYSTEMS WITH ALTERNATIVE MATERIALS

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**Keywords:** *tensegrity structures, design methodology, construction detail manufacturing.*

### Abstract

In this work, a light cover model generated in a tensegrity network will be developed. This proposal will be based on the theories of arch. Snelson. This character has created a series of premises that allow new dimensions to be incorporated into a compressed network based on tractions. , based on this principle of poles and cable-stayed networks, we will verify if their lightness and the weight of the construction can reduce the construction time in light roofs to cover large spans.

A design model generated from an experimental prototype will be executed and studied, which will be able to determine what types of joints can be manufactured in this structural system, this was simulated by the robot analysis structural and solid work software, so this dissertation focused on the study of a design methodology to generate structural construction models, suitable for making tensegrity roofs, for which a methodology was developed to build these systems and make them easier to design, with them we generated examples of application and use of this type of structural systems, so some academic cases are presented that were developed in the design workshops of the architecture career and the type of modeled roofs that can generate a practical use.

Therefore, a tensegrity system was built, which led to generating experimentations in the form, so that the experimental construction plays a special role in this dissertation, consequently, an experimental module will be generated at a 1:1 scale to demonstrate manufacturing capacity and constructive stability, giving a proposal for covering large spans or urban implementation for social or recreational areas.

## SERiation AS A BUILDING STRATEGY IN ANDALUSIAN SCHOOLS

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**Keywords:** *primary schools, energy rehabilitation, building characterisation, repeatability.*

### Abstract

Buildings are large energy consumers, requiring a third of the total energy consumed on the planet. In the specific case of Andalusian schools, it is estimated that 43% of their buildings were built prior to the appearance of some type of regulation that established requirements regarding the thermal behavior of the envelopes. In addition, many of these centres share identical buildings, without taking into account key aspects such as their location, climatic zone or orientation. These aspects, together with the rise in average temperatures in autumn, spring and summer, coinciding with the school year, mean that the quality and effectiveness of the teaching process may be affected and, on occasion, may have repercussions on health and performance of the different members of the educational community.

In this line, this work aims to analyse one of the most repeated school typologies throughout the national territory, and especially in the Andalusian autonomous community. Thus, its main objective is to highlight the serial reproduction that has been carried out, in the 1980s, of said building typology, without taking into account fundamental aspects such as the location of the school (climatic zone of the locality where locates) or the orientation of the building. Likewise, it is intended to demonstrate the urgent need to carry out energy improvement actions in these buildings, due to the significant energy and comfort deficiencies that they currently present.

By way of conclusion, it is shown how the same constructive solution of the envelope cannot be used indistinctly for an educational centre located in Huelva (zone A4) as in another located in Jaén (zone D3). The authorities are thus urged to propose intervention strategies that contribute to the improvement of this serious social problem.

**BUILDING CONSTRUCTION MANAGMENT**

## THE IMPORTANCE OF COMMUNICATION WITH THE CLIENT OF PROJECTS UNDER CONSTRUCTION

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**Keywords:** *communication, customer, management gives construction civil, development*

### Abstract

The present work has as objective the analysis of the Communication with the Consumer Customer of Real Estate under Construction. Therefore, the importance of communication with the client is a great managerial and commercial tool in the area of works under construction. The communication techniques used by civil construction in the sale and purchase of real estate are still very selective and distant from the final buyer, so when an effective and new communication channel is opened, making the buyer the best analyzer of the quality of each stage of the work, the dialogue becomes richer and more reliable. "Network is the key to business today", and in civil construction, development is possible with the aim of forming a new, more human concept about the interaction of projects under construction to guarantee a successful final work. in a methodology capable of assuring the reach of the objectives outlined and previously defined in order to: Analyse, Identify and Understand it is possible, when end of the investigation, to verify and to conclude that the communication with the client can represent an excellent managerial and commercial tool, and, act continuous, represents a powerful strategy to conquer and retain the customer in the real estate market, since this instrument has the potential to generate security, as it allows the client to information updated gives evolution physical and financial of enterprise, credibility, confidence, in addition in a permanent channel for exchange of information, clarifications and suggestions.

## VIABILIDADE ECONÔMICA, AMBIENTAL E SOCIAL DE UMA USINA DE REPROCESSAMENTO DE RESÍDUOS DE CONSTRUÇÕES PARA VILHENA-RO

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**Keywords:** Reuse. Environmental impact, Construction, Growth, Rubble.

### Abstract

This article analyzes factors that demonstrate positive and negative aspects of waste recycling in civil construction, in order to mitigate environmental damage. As for these aspects, it brings with it the ills of the impacts on nature, whether due to the need to use natural resources, raw material for inputs, or the disposal of unserviceable materials and packaging, most of which are discarded incorrectly with the aim of result in environmental imbalance. In order to contribute to the reduction of consumption of natural resources and the possibility of reuse/recycling of construction debris, the feasibility of implementing a plant in this sector in Vilhena - RO was evaluated. The study was developed through the survey of bibliographic data regarding the companies of reprocessing of residues of the civil production, to obtain new products, for the same market and data collection with the companies of transport of disposal (in the city universe of this research), known as “buckets”. Regulations such as Resolution 307/2002-CONAMA and the National Solid Waste Policy Law - PNPRS (02/08/2010) were also taken as the theoretical basis of the research. Considering that for the maintenance of a construction waste reprocessing plant it is necessary to have the real possibility of economic gains, we indicate here factors regarding the product generated by the company, such as the acceptability by professionals and end consumers of this market, quality research and durability, amount of waste needed for production, cost and sales value, to finally list the potentials and challenges that this enterprise has.

## ANALYSIS OF THE TREND OF PRICES OF BUILDING MATERIALS POST-PANDEMIC

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**Keywords:** *energy, inflation, building materials, price increases.*

### Abstract

Construction materials prices have experienced significant generalised rises in the period 2020-2021, directly or indirectly influenced by the Covid-19 crisis. These increases have consequences for companies executing construction contracts for works that have been agreed upon in a context before and outside of this situation. In order to mitigate these consequences, it is necessary to take into consideration the legal framework for price revision. This framework is mandatory for contracts with the Spanish Public Administration and optional for private contracts. This research aims to analyse the rise in prices of building materials, construction and energy over the last five years. Thus, based on data provided by the National Statistics Institute (INE), variations of the general materials price index are analysed and compared with different relevant indices of the economy, industry and construction. For this purpose, both the average price increase and the result of the standard formula for general building works from RD 1359/2011 are used, based on the same criteria. It was concluded that the prices of materials had experienced an average increase of 21.93% since the beginning of the pandemic in 2020, reaching a minimum for explosive materials (-6.67%) and a maximum for energy (63.23%) until December 2021. Similarly, the average price rise after the start of the pandemic has been similar to the import price index (IPRIM) and the industrial price index (IPRI).

## BRIDGE MANAGEMENT. THE ECONOMICAL PERSPECTIVE CONSIDERING THE GREENHOUSE GASES EMISSION

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**Keywords:** *Bridge management; deterioration; life cycle costing; greenhouse gases.*

### Abstract

In the actual society, and worldwide, the sustainable mobility is one of the main challenges that humanity is facing. The economic growth is connected to high levels of motorization. The greenhouse gases that result, from the human activity, and especially from the vehicle emissions, resulting from freight and passenger transport, are a concern for the wellbeing of the earth and a concern for the next generations. Volatile organic compounds, emissions from gasoline vehicles, and nitrogen oxides, emissions from diesel vehicles, are the main components of vehicle pollutant emissions. Nowadays, the society is facing great mobility challenges. To be successful, it's mandatory to carry out traffic flow optimization on congested roads and work zones. The strategies must be defined in early design stages. In this paper, it will be demonstrated that it's possible to quantify, and optimize, the total costs and, at the same time, quantify the vehicle emissions for different concrete bridge solutions. This methodology will be applied in a real bridge of the Portuguese Highway A25, that connects Aveiro to Vilar Formoso located in the Portuguese-Spanish frontier. In this case study different construction materials are modelled quantifying the deterioration rate and lifetime along with the related economic and environmental impacts, supporting the decision making.



## KAIZEN EVENTS FOR THE LEARNING OF MAINTENANCE PROFESSIONALS OF LARGE INFRASTRUCTURES

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**Keywords:** *Maintenance engineering, Kaizen events, Reliability, Energy efficiency, Maintenance.*

### Abstract

Large infrastructures and industrial constructions, buildings in the tertiary sector, etc., depend to a large extent on the adequate availability of their physical assets that result in their productivity or the service they provide. The personnel dedicated to the maintenance of these large infrastructures (industrial constructions, activities of the tertiary sector, etc.) require technical knowledge based on their experience for years and with a high component of tacit knowledge. This paper shows the possibilities of carrying out Kaizen events in environments where there are large infrastructures and high maintenance teams, as a way of learning and transmitting the knowledge of the technical operational staff in their activities in the environment that implies a continuous improvement and efficiency of the service provided. The results indicate that there is an improvement in the reliability of the facilities, a reduction in the execution times of maintenance activities, as well as other non-tangible benefits obtained in the equipment such as improvement in group work processes, greater involvement and motivation of operators, awareness of the actions and importance of energy efficiency, and greater sense of safety in the face of non-cyclical decisions and actions by maintenance operators.

## IMPLEMENTATION OF THE KANO PREFERENTIAL MODEL TO ENHANCE PROJECT-BASED LEARNING IN THE FIELD OF BUILDING PROJECT MANAGEMENT

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**Keywords:** *Kano model, Project Based Learning (PBL), Building Projects, Project Management (PM), Education innovation.*

### Abstract

Project-based learning (PBL) is a dynamic process that has the capacity to facilitate students' learning and understanding of essential content at the highest level, while taking an active part in their learning. Moreover, within the framework of active learning, PBL is conceived as one of the most appropriate means of achieving effective competence-based education that integrates self-learning, knowledge, problem-solving competences and creativity. However, it presents a number of key challenges in applying the methodology to the field of project management. In order to successfully manage these challenges, a pilot experience was designed to synergistically apply Project Based Learning (PBL) and the Kano preferential model in the Integrated Project Management subjects taught at the School of Industrial Engineering of the University of Extremadura (Spain). To this end, the students involved were divided into teams of three to four members and were assigned a personalised building project. During the execution of the project, theoretical knowledge was reinforced with practical experience. It was concluded that the synergetic methodological combination proposed in this research favoured and enhanced the development and execution of successful projects. It allowed the development, reinforcement and/or enhancement of different project management skills and competences (quality, stakeholders, project design, negotiation, power and interest, etc.) in both students and teachers.

## INCLUSION OF LIFE CYCLE ANALYSIS IMPACT INDICATORS IN CRADLE-TO-GRAVE BUILDING MANAGEMENT

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**Keywords:** *Environment, industrialisation, Life Cycle Assessment (LCA), Environmental Product Declaration (EPD).*

### Abstract

The Life Cycle Assessment methodology has proven to be an effective tool for assessing the environmental impacts of products, processes or services throughout their life cycle. Building products are no stranger to this reality and participate in this assessment through the so-called Environmental Product Declarations (EPD). Currently, assessment tools are available at building level, some of them based on standards using BIM and drawing on EPD data. However, they are limited to the assessment of the building without taking into account installation, maintenance or end-of-life.

The industrialisation of construction is presented as an alternative to traditional construction, using innovative processes and techniques both in production and on site. This process optimisation achieves greater quality control, increasing productivity, reducing work-related accidents and controlling the cost and consumption of materials. Making industrialised construction a sustainable alternative to traditional methods.

This paper presents the gaps that exist in the calculation of the environmental impacts of products under current rules and proposes how to fill the information gaps so that the LCA can be a tool to assist in process management and decision-making, especially in industrialised buildings.

## THE STANDARDIZATION OF WORK PROCEDURES IN BUILDINGS

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**Keywords:** *Building, Process, Procedures, Tasks, Risk Assessment, Method.*

### Abstract

The composition of the following document has as its starting point the interpretation, from a technical framework, of those work processes carried out in building works that have been subjected to an analysis as a result of the risk levels that they presented during their stages and phases of execution. By their nature, these processes show common patterns of execution, so they can be the subject of a standardization procedure.

Therefore, it is proposed to carry out a study methodology, in which the design to be used is configured in two work blocks in which to assign the different sections that will shape a common index for those object work units. The first block, field work, will include the preliminary analysis of the work unit, the extraction of information by the staff, to finally conclude with the taking of photographs of the current situation in which we began our work with the object unit. The second block, office work, will collect and analyze the data, through the field documentation obtained, which will allow us to define the work procedure, the risk assessments and the proposal for the adoption of preventive measures to improve the execution.

The purpose of standardization is to achieve a useful tool in which, through the redesign of processes, and with the identification and evaluation of existing risks, an improvement in the reduction and /or elimination of occupational accidents within the sector of the construction is achieved.

## OPTIMIZATION OF PLANIFICATION PROBLEMS ON NETWORKS

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**Keywords:** *Project planning, critical path, network optimization, simulated annealing, resource optimization.*

### Abstract

In building processes, carrying out a project involves hundreds of complex, interdependent activities, for which project programming is crucial to estimate the overall execution time span of the project. As of today, there are many computational techniques able to optimize process programming, such as the Critical Path Method. This method implies that the calculation of the optimal path is done using computational packages, but the planification design has to be established by the user in advance, which will vary the final outcome as a result of the abilities, experience, and previous knowledge of the user that defines the planification problem to solve using those computational packages.

In large projects where some groups of activities are interchangeable without affecting the final planning, the overall duration of the project will depend on the experience of the team of programmers that organizes those sets of activities, as well as on the distribution of project resources. Based on the interchange of activities, as long as they are truly interchangeable and depend on manpower availability, in this contribution I propose to apply a classical optimization method (Simulated Annealing), which performs a heuristic exploration of the space of orderings of activities, aimed at finding their optimal distribution, leading to a minimal project duration. I will apply this methodology to different examples, varying the number of activities to complete, and the number of resources available for completing them. I find that the overall duration outperforms that of the initial planification, and an optimal number of resources that minimizes the overall project cost arises.

## THE PARTICIPATION OF WORKERS IN THE IMPROVEMENT PROCESSES OF CONSTRUCTION WORKS

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**Keywords:** *construction works; participation; quality management; Quality Circles.*

### Abstract

Significant expenditures of time, money, and resources, both human and material, are wasted each year as a result of inefficient or non-existent quality management procedures [1].

On the other hand, motivation is the driving force within individuals that drive them physiologically and psychologically to pursue one or more goals to fulfil their needs or expectations [2]. This motivation can be achieved by paying special attention and respect to the worker, who must be made a participant in the production improvement processes. For this, it is essential to establish good communication channels to attend to the needs of the workers, which creates an environment of trust that makes them feel more motivated in achieving greater productivity (Fig.1).



**Figure 1:** *Worker communication*

With the impetus of the ISO 9000 Series of Standards, the question about how to involve workers with organizational objectives, beyond salary, was taking shape to set up a field of knowledge, power in the social, economic, and business sciences related to work management. From this configuration, new theories, disciplines, and techniques emerged and were developed that began to address the relationship between productivity and subjectivity, such as human capital, human resources, job skills, coaching, etc...

One way to get workers to participate in improvement processes is Quality Circles. These were created for quality control but have become a good tool for improving production

processes. These circles address very different issues, from quality, safety, costs, etc., which is why they are called Productivity Circles. They are based on self-control by the operator of the work that he develops, for which mechanisms are needed to detect and prevent these defects automatically. On the other hand, they also carry out a series of visual controls that help to check the progress of production. Of course, the participation of workers in improving production on construction sites is a great challenge that requires, above all, a change in mentality.

It can consider that by implementing a proposal for improvement and conflict resolution, better terms can be established in the reciprocity of the workforce. For this reason, a strategic planning guide is proposed for application by each worker that provides the actions and topics to be developed within the company in an ascending manner. It is recommended that the measures adopted in this guide be public knowledge and be associated with the company's objectives and aspirations.

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## THE USE OF PROCESS DATABASES FOR THE DEVELOPMENT OF WORK SCHEDULES

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**Keywords:** Databases, Work Schedule, Procedures, Standardization

### Abstract

Due to the large size that the programming of a residential construction work can reach, it is essential to seek standardization associated with the processes that occur in it. This standardization will bring countless advantages to future works in which these models can be applied repeatedly. In order to compose the global process of a given work, it is essential to choose, in the Database that we establish, those processes that emanate from the project document (Fig. 1). There are many processes that are carried out during a residential building project and multiple conditions that we can find, that is why it is essential to have good management of the construction work as well as strict control and methodical planning based on standardized processes.



**Figure 1:** Advantages of the use of data bases

The construction industry has significant opportunities to improve its productivity from the application of database management systems, which can provide an alternative to monitor the progress of work in digital format under a graphic environment that facilitates management. visualization of its content, allowing shared access to information from anywhere and among multiple users [1].



The construction industry maintains a manual character (Fig. 2), in which the predictions of the duration of the execution of isolated subsystems are difficult, but there is great historical experience in the aggregate execution times of the work as a whole. Therefore, the simplest and most realistic way to estimate the duration of the execution of a construction work consists of:

- Create a database on real durations of past works.
- Identify relevant parameters.
- To develop a statistical model.



*Figure 2: Structure phase in construction work (Madrid).*

In conclusion, the databases must be organized according to the work breakdown structure of the work in question and must be subject to continuous improvement processes that allow their updating and improvement. The main advantages that its use will bring will be the saving of time for the elaboration of the programming, greater quality in the work programs, avoiding omissions or duplications of activities and the possible continuous improvement of the processes.

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## USE OF CONSUMER ELECTRONIC DEVICES FOR THE GRAPHIC DATA COLLECTION OF EXISTING BUILDINGS

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**Keywords:** 3D Graphic data collection, LiDAR, iPad Pro, 3D Laser Scanner.

### Abstract

The implementation of technologies such as LiDAR -Light Detection and Ranging or Laser Imaging Detection and Ranging- in consumer computing devices such as the Apple's iPad Pro raise interesting questions about their possible professional applications within the world of architecture and construction.

Although the professional market offers solutions as powerful/versatile as point clouds generated by 3D laser scanners for surveying existing buildings, it is worth asking if more affordable equipment can compete with them, at least in less demanding scenarios. And this seems to be just the beginning, since the development of the hardware/software binomial promises much more compact and powerful solutions with possibilities that we cannot even imagine and that may end up being essential for the technical profiles of architects and engineers.

After a comparison in several common cases, the results obtained show that, and despite the abysmal difference in performance with respect to professional equipment, in some cases consumer computing devices that incorporate technologies such as LiDAR offer more than sufficient solutions and with advantages very interesting especially if we compare them with traditional methods.

It would be possible to integrate these devices/technologies in the professional workflow avoiding resorting to large investments that require more equipment.

## SYSTEMS THINKING IN THE STRATEGIC MANAGEMENT OF THE "SUSTAINABLE BUILDING" BUSINESS MODEL

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**Keywords:** *Systems thinking, sustainable building, strategic management, business model.*

### Abstract

In 2015, UNESCO established 17 Sustainable Development Goals that reflect the concern for a sustainable, peaceful, prosperous and just world set out in the 2030 Agenda. With respect to strategic management and building, it refers to achieving resilient, inclusive and sustainable cities and infrastructures and promoting sustainable economic growth. The objective of this paper is to propose a strategic management model for sustainable construction based on systems thinking.

The building business sector is driving sustainable construction in designs, materials, technologies and construction techniques motivated by environmental challenges and regulations such as the European one. Added to this are the problems of procurement and operational energy use in buildings and the failure to meet performance targets in project design. Therefore, we need a multidisciplinary vision (financial, institutional, operational and socio-cultural), thanks to systems thinking, which facilitates improvement in the design and construction of building businesses.

The methodology employed is the consideration of the three bases of systems thinking: reinforcing feedback, compensating feedback and delay. Subsequently, the two archetypes that emerge from the three bases are determined: growth limits and load shifting. All this, contextualized for sustainable construction and its adaptation to the current complex and changing context.

The conclusions corroborate that systems thinking helps to propose strategic management models adapted to the current complexity in the construction of sustainable and energy efficient buildings, by considering the reinforcing and compensating feedbacks and the delay during the design, planning and construction process. It also drives the structure, implementation, evaluation and its dynamic effect with the sustainable building project.

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**GENERAL ISSUES**

## IMPACTS OF SELF-BUILDING IN BRAZIL

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**Keywords:** *Self-construction, Architecture, Materials, Labor and security.*

### Abstract

Self-construction is a recurrent practice in Brazilian culture, which consists of the construction of buildings without the accompaniment of a qualified technician (architects, civil engineers or building technicians), with the work being carried out by the resident, relatives, friends, neighbors or even a paid professional who makes use of empirical or popular knowledge. This practice is common mainly in Latin American countries, as is the case of Brazil, where a good part of the population does not have enough financial conditions to pay for the hiring of a qualified professional, which causes problems not only in the building, but that it also reaches larger scales, even harming society. Thus, the objective of this work is to inform and contribute to the dissemination of problems related to this practice, making correlations between self-construction and architectural design, self-construction and construction materials, self-construction and labor and, finally, self-construction and job security.

## MANIFESTACIONES PATOLÓGICAS EN PUENTES Y VIADUCTOS DE CONCRETO EN LA CIUDAD DE JABOATÃO DOS GUARARAPES - PE

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**Keywords:** *Patologías en puentes y viaductos; Principales problemas estructurales en puentes y viaductos; Mantenimiento de puentes y viaductos.*

### Abstract

Desde la antigüedad, los puentes y viaductos destacan por su importancia en la sociedad, en infraestructuras viarias, ferroviarias y urbanas. Utilizados para acortar distancias y superar obstáculos, se crean en las más diversas formas y modernas técnicas de construcción. No solo importantes en áreas urbanas, los puentes juegan un papel importante en la conexión de ciudades en áreas rurales, facilitando el acceso a grandes centros. A pesar de su importancia, no es común realizar inspecciones, pruebas de resistencia y mantenimiento periódico a estas estructuras, para evitar patologías que puedan presentarse con el tiempo. La idea que alguna vez se tuvo fue que el hormigón tendría una vida útil indefinida, hoy con las diversas investigaciones es seguro que esto es un gran error. Dado lo anterior, este trabajo busca evaluar el estado de conservación de puentes y viaductos en la ciudad de Jaboatão dos Guararapes - (PE) y diagnosticar las posibles causas de las patologías encontradas. En total, se inspeccionaron doce puentes y cuatro viaductos. La gran mayoría demostró estar en buen estado, sin embargo, algunos presentaban patologías, en algunos casos bastante graves. El estudio demuestra que la investigación constante del estado de conservación de estas estructuras es vital para mantener la seguridad y movilidad de toda la población.

## A WORTHY HOUSE FOR EVERY BRAZILIAN: ARCHITECTURAL DESIGN FOR SELF-CONSTRUCTION

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**Keywords:** *Architectural project. Low-cost housing. Self-construction. Dignity.*

### Abstract

Self-construction is directly related to the way Brazilian cities are produced, which is responsible for almost all housing built throughout Brazil. However, this endless number of dwellings – essentially low-cost ones – are built without any support from a technical person. Therefore, as an objective, we sought to understand self-construction and its main factors, so that it can connect this executive environment to architecture, with the elaboration of a local project. From this, aspects such as materials and techniques already applied, instruments of bioclimatic architecture and other real solutions of executed projects were analysed, which will condition criteria during the future design stage, obtaining a project for low-cost housing, having as public target directed self-construction. This work reinvigorates the role of architecture in society, seeking to incorporate yet another housing solution, built under economy, comfort, aesthetics, accessibility and executed under self-construction.



## REINFORCEMENT APPLICATION IN AN OLD BUILDING of steel USING THE PRESTRESS METHOD

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**Keywords:** *Structural reinforcement, pre-reinforcement, structural steel, rehabilitation, old structures.*

### Abstract

The objective of this work is to develop a structural reinforcement application to the building of the Institute of Dairy Products and Fat Derivatives of the PJC in Arganda, which is configured by metal frame frames, applying a solution analyzed with the prestressing method.

A structural analysis of the building was carried out to know its current behavior. With the data obtained, the case of eliminating a pillar on the ground floor was considered, leaving a span twice as long, because it is a critical situation. Under these conditions, a new analysis was carried out to determine the new way of working in the building. This resulted in elements that did not meet the structural safety conditions, so a reinforcement design was proposed. For this, the analysis was carried out by means of a matrix calculation and once its effectiveness was verified, the elements that make up the reinforcement were designed.

With the results obtained, it is intended to promote the use of prestressing as a reinforcement solution in cases of metal structure buildings and to verify that the proposed method is applicable and presents a feasible solution.

## CALIBRATION OF SITE EFFECT PARAMETERS AND ATTENUATION COEFFICIENTS IN THE GMPM BSSA 14 FOR THE REGION OF SPAIN

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**Keywords:** *GMPE, GMPM, BSSA 14, Response spectrum, Anelastic attenuation coefficient.*

### Abstract

There are several types of analysis that allow us to involve seismic phenomena that cause strong requirements for structures that are designed by society, one of them is a probabilistic analysis which works from prediction equations that have been created based on collected seismic metadata. in different regions. These equations form models that are used to describe the response of the 5% damped pseudospectra for the different zones considering some easily known input parameters. The biggest problem for the creation of these models requires data with great robust statistics that support the results and there are several places where this type of information is not available, so the use of alternative methodologies helps to achieve adjustments to different models of seismic prediction. Using these residual methodologies and using the seismic data provided by the National Geographic Institute of Spain, it has been possible to calibrate the BSSA 14 seismic prediction model proposed by Boore for the region of Spain, which improves the seismic response of the response spectrum. for the different periods analysed, having the best efficiency results for periods greater than 3 seconds.

## FOTOGRAMETRÍA SFM EMPLEANDO IMÁGENES DE TELÉFONO MÓVIL PARA LA DOCUMENTACIÓN DE ELEMENTOS SINGULARES DE FACHADAS DE INMUEBLES CATALOGADOS

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**Keywords:** *photogrammetry, heritage, architecture, urban planning, 3D modelling.*

### Abstract

Advances in photogrammetry programs allow us to obtain highly accurate three-dimensional models with photographic texture. We observe that mobile phone cameras are getting better and better, inserted in increasingly thin and manageable devices, producing high-resolution images. The sum of these aspects, together with the duties of the public administrations of the Canary Islands towards the existing built heritage, leads us to investigate the possibilities that SfM (Structure from Motion) photogrammetry would entail for the documentation and protection of singular elements of facades of buildings using images captured with a cell phone.

With this objective, we have tried to analyze, following a proposed workflow, some of the possible uses linked to the protection and/or dissemination work of the elements obtained from photogrammetric surveys and apply it to four case studies of singular elements of facades belonging to protected buildings in the city of San Cristóbal de la Laguna.

## PROPOSAL FOR IMPROVING THE TEMPORARY MANAGEMENT OF SOCIAL ACCOMMODATION FOR REFUGEES IN QUITO, ECUADOR

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**Keywords:** *refugee, social relations, receptivity, architectural prototype, shelter.*

### Abstract

Throughout human history, migration has been an essential phenomenon that has indirectly affected social development and has remarked freedom importance. Since 2008, according to statistical data from HIAS (Refugee Protection Organization), Ecuador has become the primary option for thousands of refugees from South America when looking for a place to live or they're transiting to another country [1].

However, the main idea of this proposal is the creation of essential spaces that attend the ever changing necessities of the refugees.

Quito, the capital of Ecuador, has one of the highest rates of refugees. Hence, it is the perfect location for the proposed prototype, that consists on the creation of an urban network for the implementation of shelters located on the main public transport routes of the city. The exact locations of the proposed scheme for the refugees is considered to not to be important at this stage.

In contrast to the traditional shelters, this prototype designs and recommends essential spaces for the non-permanent residents seeking for social inclusion. Historically, the refectory or dining room played a very important role to create friendships and bonds. For instance, in the 16th century, those spaces were meeting places where monks could interact, besides eating.

Architecturally, they were large spaces with long tables that encouraged the user to engage into conversation. Starting from this concept, one of the key elements are the kitchen and dining room, which are considered as the "heart" on the scheme of the refuge given that they encourage social interactions and food markets, making the project profitable. Additionally, there will be educational workshops in which the students will be able to learn new skills aiming to increase the chances of an insertion to the professional world.

This type of building seeks to be a neighborhood landmark that encourages new social relationships making the user to be part of the city and promoting the importance of refugees to the local population.

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## RESTAURATION OF THE DRESSING ROOM OF THE “VIRGIN OF ATOCHA”

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**Keywords:** *gypsum, X-ray diffraction, scanning electron microscopy*

### Abstract

The basilica of Atocha has had transformations since its beginnings when it was still a convent, and later transformed into a dominicos convent by Calos I in 1523. It was remodeled in the 16th and 17th centuries, and used as a barracks during the French invasion. In the Civil War the Church and the Convent were set on fire. For the years 1946-1951 it was rebuilt.

The image of Nuestra Señora de Atocha is a sculpture of small size, in wood without polychrome, of late Romanesque style. The base on which the sculpture is placed seems to be a sort of plaster, with gray enamel and a gilded finish on the edges. The vertical wall presents material losses in some areas as well as in the painting and in some edge finishes.

Another part of the sculpture, it is the vertical wall of support. It is composed of the same material as the base and at first glance shows similar damage.

This paper is dedicated to the previous study for characterize the materials that is composed the sculpture for making decisions and choosing the right materials for your restoration.

## PROPOSALS FOR THE PRESERVATION AND PROTECTION OF CAVE HOUSES IN CUEVAS DE ALMANZORA (ALMERÍA)

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**Keywords:** *cave house, legalization, habitability conditions, preservation.*

### Abstract

In different areas of Spain, especially in territories where the soil is predominantly sedimentary, typologies of excavated or underground constructions known as cave-houses are concentrated. Not only in Andalusia (especially in Almería and Granada), but also in provinces such as Alicante, Valencia, Albacete, Murcia, Toledo, Madrid, Guadalajara, even in areas of Aragón, La Rioja and Navarra. Also in many areas of the Mediterranean (Italy, Turkey, Tunisia, Greece, among others).

However, in almost all these areas there is a common denominator: the legalization of a “cave-house” as a “housing” [1].



Until now, only the Community of the Canary Islands, is one of those that has provided the most means to provide concrete solutions to the legalization of different types of cave-houses as housing, publishing, in 2006, Decree 117/2006 [2], of August 1, which regulates the habitability conditions of homes and the procedure for obtaining the certificate of habitability. Example of actions, we can see them in Guadix (figure 1) and nearby towns, in Granada, and in Terque in Almería (figure 2).

**Figure 1:** Example of cadastral regulation of cave houses in Guadix (Granada).

The current situation of many of them has caused their disappearance, not to mention the urban speculation that many towns have suffered in their historic centers and suburbs. In addition, the excess of rain and the erosion of the land around it or the

increase in drought sometimes cause a lack of stability and security, making it necessary to establish architectural strategies for its conservation and maintenance.

Despite the lack of regulation, recently in Andalusia, some regional decrees [3] have been published with the aim of preventing their demolition, especially in Andalusia, allowing their use as rural tourism apartments [4].

Law 7/2021 [5], of December 1, promoting the sustainability of the Andalusian territory, has recently been published, which in its 3rd section on Detailed urban planning instruments, establishes that the Special Plans may have one or more of the following objectives:

a) Establish complementary determinations to conserve, protect and improve the situation of the historical, cultural, urban and architectural heritage, the environment and the landscape, as well as to implement measures against climate change in defined areas on any type of soil.

h) Delimit, where appropriate, and establish the preservation and protection measures in the traditional areas of cave-houses when they require urban planning.



And in its Title VIII, on Measures of environmental and territorial adequacy of the irregular buildings, in its article 173, section 5 it indicates that, "the minimum safety and health conditions of the cave-dwellings in their traditional areas will be established by regulation".

The objective of this study is to make proposals for the preservation and protection of cave-houses, indicating the minimum conditions, especially health and safety, to provide them to the town hall of Cuevas del Almanzora in Almería, where the Doctoral Thesis that I am developing is focused.

**Figure 2:** Example of adaptation of cave houses in Terque (Almería).

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