Chapter 1 Latticework based on epoxy resin and recycled clothing

Capítulo 1 Celosias a base de resina epoxica y ropa reciclada

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Abstract

This innovation project within the construction industry introduces a captivating and eco-friendly concept: the development of lattices using recycled materials, specifically recycled clothing. The aim of this initiative is to provide a sustainable and responsible solution to the current challenges faced in construction, with a particular focus on mitigating the industry's ecological footprint.

In the 21st century, the construction sector grapples with a pivotal challenge: to achieve sustainable and responsible production, while adhering to society's quality standards and demands, all the while minimizing environmental impact. Crucial to this endeavor is the integration of material recycling and the promotion of responsible construction practices that not only benefit the environment but also the local communities.

The primary value added by this proposal lies in its innovative and eco-conscious approach. By harnessing the potential of recycled clothing for the fabrication of lattices and ceiling lights, an environmentally sustainable alternative is presented, reducing reliance on finite natural resources, and curbing the accumulation of textile waste in landfills.

Among the noteworthy features of this project is its utilization of recycled materials in the manufacturing of construction elements. Additionally, it emphasizes the optimal use and efficiency of lattices and ceiling lights, ensuring long-lasting and durable performance.

Overall, this project highlights a promising avenue for the construction industry, offering an eco-friendly solution in the form of lattices made from recycled clothing. The significance of this proposal lies in its commitment to sustainability, addressing the pressing need to reduce environmental impact and championing a responsible approach to construction practices.

Textiles, Epoxy Resin, Innovation, Experimentation, Constructive Elements

Resumen

Este proyecto de innovación dentro de la industria de la construcción introduce un concepto cautivador y ecológico: el desarrollo de celosías utilizando materiales reciclados, específicamente ropa reciclada. El objetivo de esta iniciativa es proporcionar una solución sostenible y responsable a los desafíos actuales que enfrenta la construcción, con un enfoque en mitigar la huella ecológica de la industria.

En el siglo XXI, el sector de la construcción se enfrenta a un desafío fundamental: lograr una producción sostenible y responsable, al tiempo que se adhiere a los estándares y demandas de calidad de la sociedad, al tiempo que minimiza el impacto ambiental. Crucial para este esfuerzo es la integración del reciclaje de materiales y la promoción de prácticas de construcción responsables que no solo beneficien al medio ambiente sino también a las comunidades locales.

El principal valor añadido de esta propuesta reside en su enfoque innovador y respetuoso con el medio ambiente. Al aprovechar el potencial de la ropa reciclada para la fabricación de celosías y luces de techo, se presenta una alternativa ambientalmente sostenible, reduciendo la dependencia de recursos naturales finitos y frenando la acumulación de residuos textiles en vertederos.

Entre las características destacables de este proyecto destaca su utilización de materiales reciclados en la fabricación de elementos constructivos. Además, enfatiza el uso óptimo y la eficiencia de las celosías y las luces de techo, asegurando un rendimiento duradero y duradero.

En general, este proyecto destaca una vía prometedora para la industria de la construcción, ofreciendo una solución ecológica en forma de celosías hechas de ropa reciclada. La importancia de esta propuesta radica en su compromiso con la sostenibilidad, abordando la necesidad apremiante de reducir el impacto ambiental y defendiendo un enfoque responsable de las prácticas de construcción.

Textiles, Resina Epoxi, Innovación, Experimentación, Elementos Constructivos

1. Introduction

In this innovation project in the construction industry, a fascinating and eco-friendly proposal is addressed: the development of lattices and ceiling lights made from recycled materials, specifically, recycled clothing. This initiative seeks to offer a sustainable and responsible solution to current construction challenges, focusing on reducing the ecological footprint that this industry generates.

The construction industry faces a crucial challenge in the 21st century: to produce in a sustainable and responsible manner, complying with the quality standards and demands of society, while minimizing environmental impact. It is essential that buildings and infrastructures are built considering the recycling of materials and promoting responsible construction practices that benefit the environment and the community.

The added value of this proposal lies in its innovative and environmentally conscious approach. By taking advantage of recycled clothing to manufacture lattices, a sustainable alternative to conventional materials is offered, reducing dependence on natural resources, and reducing the amount of textile waste that ends up in landfills.

Among the key characteristics of this proposal, the use of recycled materials for the preparation of the construction elements stands out. In addition, it focuses on the correct use and operation of the lattices, guaranteeing their efficiency and durability.

The problem to be solved is the high pollution generated by the construction industry by producing the traditional materials used in lattices and the textile industry. By adopting more sustainable construction practices, such as textile recycling, it seeks to mitigate this negative impact and move towards a more environmentally responsible industry.

The central hypothesis of this project is that, using recycled materials in the manufacture of lattices, it will be possible to significantly reduce the ecological footprint of the construction industry, thus contributing to the development of a more sustainable and respectful environment with the environment.

In summary, this innovative project proposes a promising solution for the construction industry, by offering lattices made from recycled clothing. The importance of this proposal lies in its sustainable approach, which seeks to reduce pollution and preserve the economic, social, and environmental values of the environment. By focusing on the recycling of materials and the reduction of the ecological footprint, this initiative represents a significant step towards a more conscious and responsible construction with the planet.

2. Development

Today, the reuse of clothing stands out to contribute to the environment by taking advantage of products with a longer useful life. Fashion, being a major industry, often wastes clothes that could meet people's needs. The textile industry, in constant growth, can generate income and recognition in the international market, being essential to consider options that promote care for the environment. Unfortunately, SEMARNAT (Ministry of the Environment and Natural Resources) indicated that in Mexico about 3.7 billion tons of textile waste are discarded per year and of that amount, only 1% is recycled. (See Fig.1)

Figure 1. Thousands of tons of textile waste

Reference Source: (Martell, 2022)

The textile industry has been identified by organizations such as the UN and Greenpeace as one of the main sources of environmental pollution, due to its high consumption of water, carbon emissions and generation of microplastics that affect the oceans and marine life. The incineration and accumulation of clothing in landfills aggravate soil and air pollution, accentuating environmental problems.

Faced with this problem, circular fashion has gained relevance, promoting giving a second, third and even fourth life to clothing to maximize its usefulness and reduce the mass consumption of textiles. (UN, 2022)

The promotion of alternatives to give garments a second use and support innovation projects that encourage reuse and sustainability in the construction industry is of the utmost importance today. The problem of textile waste and its environmental impact requires joint action by all social actors, including manufacturers, consumers, and the educational system.

The purpose of this article is to promote a deep reflection on the topic addressed, while presenting an innovative research project developed in the academic context of the degree in Architecture.

The research project focuses on the conception and creation of a Lattice made from textile waste, such as garments and fabrics.

The main objective of this proposal is to take optimal advantage of textile waste, investigating and evaluating its suitability as constructive elements. It seeks to verify their effectiveness and feasibility, with the intention of considering them as a friendly alternative to the environment and the process of recycling textiles in the field of construction.

The initiative is based on a scientific and rigorous approach, carried out from university classrooms, where research principles and analytical methods are applied to evaluate the feasibility and potential benefits of the Textile Lattice in the field of sustainable architecture.

By using terms from the scientific field, we proceed to the detailed characterization of the selected textile materials, analyzing their physical and mechanical properties, as well as their behavior in various environmental conditions. Likewise, the feasibility of integrating these textile elements in the construction process is examined, considering criteria of structural resistance, durability, and compatibility with other architectural components.

The approach is based on the premise of promoting eco-sustainable practices in the field of construction and explores how the use of these textile lattices could reduce waste generation and reduce the environmental footprint associated with the textile industry and traditional construction.

It is relevant to highlight that the project not only seeks to provide an environmentally friendly constructive alternative, but also to contribute to the promotion of the circular economy, promoting the reuse and recycling of textiles, which could have a positive impact on the textile industry and on waste management.

This research aims to provide a solid scientific and academic analysis that supports the use of textile trusses as a viable and efficient option in the field of sustainable construction. In this way, it seeks to encourage the adoption of architectural practices that are respectful of the environment and contribute to the development of a more conscious and responsible built environment.

Concepts

Lattice

It is an openwork decorative architectural element, which partially protects the views of lighting and ventilation where we usually place the windows or windows, but also, they work to give the project a style, this can be made of stucco, wood, stone, iron, clay, or any other material.

"Enclosure door, perforated, made of wood or iron, formed by a frame in which horizontal slats fit, spaced and inclined, in such a way that they allow one to look from the inside to the outside of an apartment without being able to see it from the outside." (Lajo and Surroca, 1997).

"Openwork board (wood or other material) that placed on a door or window makes it difficult to see inside a room" (Caballero, 2020).

Figure 2 Clay, metal, and wood lattices

Reference Source: (Ceramicaamanoalzada.com, Terrazacym.comConsumer.es, 2023)

Textile material

It is a solid and flexible material composed of filaments known as fibers, which are found vertically and horizontally intertwining with each other, which can be natural or synthetic, being the raw material for the manufacture of products (Warshaw, 2006).

“A flat structure, flexible enough to be able to be transformed into garments and textiles for domestic use, as well as for industrial uses where some flexibility is required (Hollen & Saddler, 2006)

Rextile waste

They are fragments, scraps or pieces of fabric that are left over after the creation of a product in this case of design, and a large part of these are discarded, and another quantity is destined for sale.

“Those leftovers are more than just a physical manifestation of a chain of development and a segmented pattern cutting method” (Fletcher and Grose, 2012).

Resin

Also called liquid glass, it is a viscous substance, with a high density and solubility, with an intense odor and that reacts to the effect of heat. It is naturally obtained from the secretion of certain species of coniferous plants. (definicion.com, 2023).

Eco-friendly

Respectful of the environment (Neoma, 2023).

Eco-design

“It is a philosophy that seeks to design sustainable products and services that minimize the environmental impact throughout the product's life cycle from its design itself to production, use and withdrawal. To do this, environmental criteria are added to the conventional criteria of any design process (cost, utility, manufacturability, safety, etc.).

Eco-design then tries to identify the possible environmental aspects and impacts of a product/service based on the process of continuous improvement, which allows decisions to be made aimed at minimizing its impact on the environment” (Cámara de Comercio de España, 2023).

3. Methodology

The methodological approach of this research is based on a quasi-experimental design that is characterized by the management of non-randomized experimental variables in a controlled environment. This experimental approach involves the participation of students to foster research, creativity, and innovation, as well as promote awareness of important issues such as sustainability.

It is proposed to structure this research in three stages in the short, medium, and long term, to ensure the continuity of both the research work and the participation of the students throughout these periods. This phased approach will make it possible to progressively address the proposed objectives and will facilitate the collection of data over time for a more robust and conclusive analysis.

In addition, during the development of the study, relatively controlled conditions will be established to ensure the internal validity of the results obtained. This implies the implementation of measures to minimize possible confounding factors and ensure that the differences observed in the variables are attributable to the experimental treatment and not to other external influences.

The purpose of this research is to carry out a feasibility analysis of the module or construction component, which is based on an existing Lattice, incorporating Textile fibers and Epoxy Resin. To achieve this, various fundamental physical tests will be carried out to identify and demonstrate the physical properties of these elements. In addition, they will be compared with similar elements to detect possible advantages or deficiencies in the component. Likewise, new forms of construction will be explored to assess their potential in terms of efficiency, functionality, and sustainability, in line with lattice standards.

The study will focus on the evaluation of the physical properties resulting from the incorporation of Textile fibers and Epoxy Resin in the pre-existing Lattice. Scientific techniques and methods will be used to carry out the necessary tests and measurements. In addition, comparative analyzes will be applied between the modified module and similar elements to establish significant differences and determine their implications.

The focus of this research lies in the search for innovative and sustainable construction solutions, with the potential to improve the performance and functionality of trusses. It is expected that the results of this study will contribute to a better understanding of the properties and characteristics of the proposed module and allow the identification of opportunities for its practical application in the field of construction.

Within the research strategies, three phases have been outlined with specific objectives that will be carried out in the short, medium, and long term.

In the short-term phase:

- Documentary and field research will be carried out to collect relevant information, both bibliographic and obtained in situ.
- The nature of existing and/or commercial prototypes related to the subject of study will be analyzed and characterized.

In the medium-term phase:

- The textile materials that will be used in the investigation will be selected.
- The selection of the epoxy resin to be used in the project will also be carried out.
- The experimentation of the selected materials will be carried out, defining the samples and the appropriate proportions in the mixture of textiles and epoxy resin.
- The materials and the constructive element (prototype) will be subjected to non-specialized conventional tests.
- An exhaustive analysis of the results obtained in the tests will be carried out.

In the long-term phase:

- The construction processes necessary to produce the final element will be determined.
- Prototypes will be made on a real scale, following the guidelines established in the previous stages.
- The prototypes will undergo specialized laboratory tests, focusing on their strength and compression.
- A comparison will be made of the costs of the product in the current market with respect to other existing alternatives.
- A comprehensive analysis of the function, resistance and durability of the prototypes will be carried out.
- The benefits derived from the manufacture of ecological latticework, such as cost reduction and its functional advantages, will be identified, and quantified.
- The integration of the ecological Lattice in the construction market will be sought, with the aim of achieving national recognition of the product.
- With this methodological approach and planning for different terms, it is intended to obtain solid and well-founded results that allow a potential successful implementation of the ecological lattice in the construction sector, thus contributing to its sustainable development and its large-scale adoption.

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– As mentioned by Abdel & Abo (2023), it is also of utmost importance to consider the objective of savings in construction costs and affordability without leaving behind the main objective, which is structural performance and environmental benefits.

4. Results and discussion

Below are some of the research strategies that will be implemented in the medium-term stage, in the context of the prototyping process:

– Selection of Textile Materials and Epoxy Resin:

At this stage, a rigorous selection process will be carried out for the textile materials and the Epoxy Resin that will be used in the creation of the prototype. Different options available on the market will be evaluated and their physical, mechanical, and chemical properties will be considered to ensure that they are suitable for the prototype.

– Raw Material Elaboration Process:

Once the materials have been selected, the raw material will be prepared. This process may involve the preparation and conditioning of the textiles and the mixing of the epoxy resin with the appropriate components to obtain the desired characteristics in the prototype.

– Experimentation of Materials and Definition of Samples and Proportions:

At this stage, experiments and tests will be carried out to assess the properties of the selected materials and their behavior when combined in different proportions. The appropriate samples and mixtures will be defined to achieve the technical and functional specifications required in the prototype.

Materials

The prototype elaboration process will imply the use of textile materials and epoxy resin specifically selected for the project, scientific and technical criteria will be applied in the selection of these materials, considering their suitability for the prototype, and ensuring the quality and coherence of the results obtained.

It should be noted that this is only part of the research strategies, and it will be carried out in the medium-term phase. The research seeks to obtain substantiated and scientifically based results for the successful development of the prototype and its subsequent application in the corresponding field.

Recycled clothing

Reuse or reprocessing of used clothing, fibrous material, and clothing remains from the manufacturing process, this material is characterized according to its origin, whether natural or chemical, among the natural ones we have cotton, wool, silk, linen, leather, hemp, jute and chemicals rayon, cellophane, polyester, nylon, lycra (elastane), liocel, fleece, etc. (Hollen N. & Saddler, A. 2006).

Epoxy resin

It is a good thermal insulator, resists humidity, has adhesive properties, and resists high temperatures. Commercial brands of epoxy resin are made from a chemical reaction between two products: epichlorohydrin and bisphenol-a. The epoxy resin can react with catalytic homopolymerization (that is, with itself) or using co-reactives, such as acids, alcohols, phenols, thiols, and acid anhydrides. (Navarro, 2013)

Catalyst or peroxide

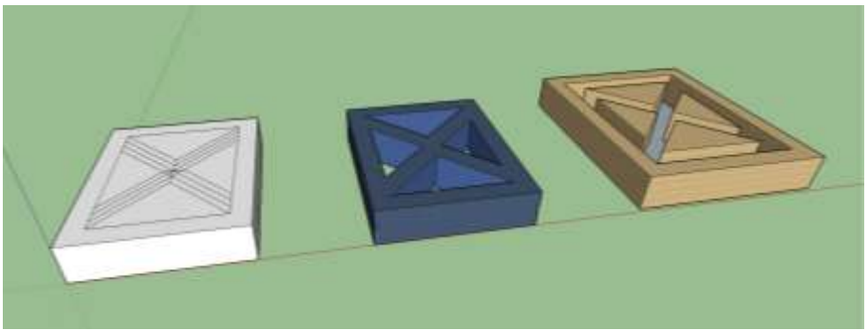
A resin catalyst is an organic peroxide in charge of making the reaction to harden the resin. (Navarro, 2013)

Experimental part

Mold for lattice

a. Lattice design, dimensions 200 mm. x 250mm. x 50mm. A simple and conventional design was chosen for the element, so that it does not present problems when making the mold, but that it complies with the lattice concept, that partially protects the views from lighting and ventilation, hence the holes.

Figure 3 Lattice design



Reference Source: (Author's Own, 2023)

b. Elaboration of the mold, based on waste Wood.

Figure 4 Wooden mold.

Reference Source: (Author's Own, 2023)

Process of elaboration of the raw material

a. Collection of textile waste or used clothing, it must be sought that the material is free of impurities or dirt.

Figure 5 Collection of clothes

Reference Source: (Own Photo, 2023)

b. Classification of Clothing or Textile Waste, the classification was carried out in denim, cotton, and synthetic clothing.

Figure 6 Clothing Classification

Reference Source: (Own Photo, 2023)

c. Removal of buttons, zippers, or any metallic element to obtain a homogeneous material clean of dirt that may affect the preparation of the base material.

Figure 7 Removal of metal parts

Reference Source: (Own Photo, 2023)

d. Reduction of the size of the material obtained by chopping or cutting through manual means where small pieces will be obtained, to improve its compaction.

Figure 8 Material size reduction

Reference Source: (Own Photo, 2023)

e. Selection of epoxy resin

Epoxy resin floors ecopoxy epclk11 transparent and catalyst

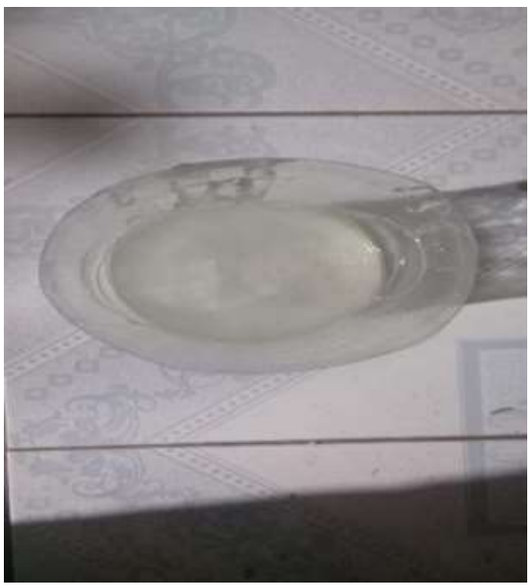
Figure 9 Bio-resina ecológica epclk11

Reference Source: (Ecopoxy.com, 2023)

f. The ecological Bio-Resin from EcoPoxy was chosen for its qualities such as transparency, non-yellowing, durability, and chemical resistance. low odor, low volatile organic compound content, non-toxic. 100% waterproof long term, excellent chemical resistance and toughness, high adhesion, self-priming on most surfaces, resists cracking, peeling, and chipping, dries in 48 hours, fills rough areas, low spots, and cracks, creates a uniform surface. (Ecopoxy.com, 2023)

Inside a container, the epoxy resin is prepared with the catalyst.

Figure 10 Resin preparation



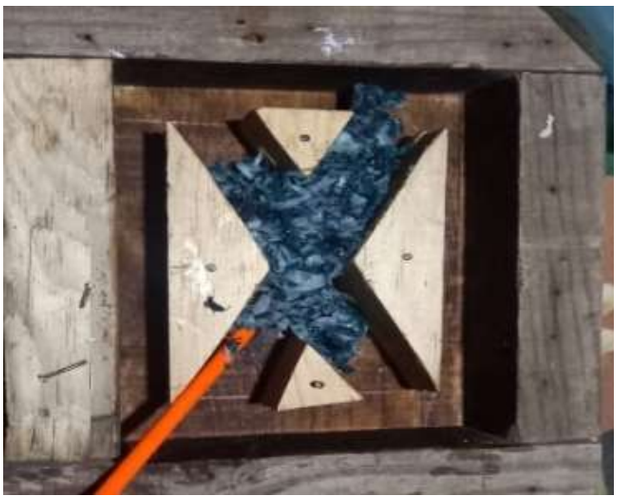
Reference Source: (Own Photo, 2023)

g. The mold is cleaned, and release agent (polyvinyl alcohol) is applied.

h. Gradually add the pieces of fabric mixing vigorously so that the entire fabric is impregnated with the binder.

i. Add the mixture into the mold.

Figure 11 Add the mixture to the mold



Reference Source: (Own by the author, 2023)

j. It is applied under pressure inside the mold.

Figure 12 Pressure is applied to the entire mixture

Reference Source: (Own by the author, 2023)

k. The mold is opened

Figure 13 Unmolded

Reference Source: (Own by the author, 2023)

l. Air dried for the mixture to harden.

Figure 14 Weather drying

Reference Source: (Own by the author, 2023)

Preparation of mixtures

The experimentation of the first mixtures was carried out to analyze the behavior of the materials among themselves and a 250 x 200 x 50 mm mold built with plywood and strips of wood was taken as a base, for the casting of the mixtures.

Which were the following:

Table 1 Mixture dosages

Materiales	Unidades	Mezcla 1	Mezcla 2	Mezcla 3
textiles	grams	2000	2500	3000
epoxy resin	milliliters	500	500	500
catalyst	milliliters	100	125	250

(Own by the author, 2023)

Table 2 Drying time

Materiales	Mezcla 1	Mezcla 2	Mezcla 3
Hours	1080	720	552
Days	45	30	23

(Own by the author, 2023)

Mixture 1

A mix was made with 2000 grams of Textiles, 500 milliliters of epoxy resin, and 100 mm of catalyst. These materials were vigorously mixed in a single container and poured into the mold, according to the procedure described above. (See table1&2).

When carrying out this test, it was observed that the proportion of Textiles and epoxy resin was not adequate because the textiles absorb the resin quickly, the resin, when in contact with the textiles, begins to form a viscous mixture without achieving the proper accommodation of the material. Inside the mold, even applying pressure, the drying time is very slow during the process, and it takes 45 days for a semi-dry drying since the prototype, although it already has the hardness, to date still presents a sticky texture to the touch.

Mixture 2

A mixture of 2500 grams of Textiles, 500 milliliters of epoxy resin, and 125 milliliters of catalyst was made, this test showed that by increasing textile waste, epoxy resin is more manageable, although the mixture also took on a viscous consistency when mixed with the textiles however, it begins to have more stability achieving a better accommodation of the material inside the mold, the drying time outdoors took 30 days to have the pertinent hardness however the texture to the touch is still a bit sticky.

Mixture 3

A mix was made with 3000 grams of Textiles, 500 milliliters of epoxy resin, and 250 milliliters of catalyst. Analyzing this test, it was observed that by increasing the proportion of textile waste, and more catalyst to the resin, as the textiles were better, the resin was insufficient, leaving an uneven mixture also having more catalyst, the mixture began to harden more quickly inside the mixing container and wanting to incorporate it into the textiles is therefore the result of the little uniformity of the mix. The drying time outdoors took fewer days than the previous mixtures, which were 23 days though, an inhomogeneous prototype remained, and it continues to present that sticky consistency to the touch.

5. Thanks

To the Tecnológico de Estudios Superiores de Jocotitlán for the support received, for the realization of this investigation and experimentation of the prototype.

6. Conclusions

According to the test tests of the mixtures and the process of elaboration of the materials and methods, it is concluded that mixture 2 is the most viable for the elaboration of the prototype "lattice of recycled clothing and epoxy resin".

However, it was noted that the amount of resin and catalyst depends a lot on their proportions for the malleability of the mix and adhesion. The drying time is very susceptible to climate changes; however, a favorable result was obtained since the materials reacted adequately.

The lattice based on aggregates of textile waste and bio-resins can become a solution to current problems of contamination with textile waste, since it is considered, according to the UN, as the 4th most polluting worldwide and the environmental impact it causes is damage. irreversible to the lives of all living beings on the planet. The inclusion of the textile residue, with the bio-resin in the lattice was finally an alternative with viable results in the composition of the lattice as confirmed in the general objective.

It was verified that the project can be a sustainable construction element that can be an option to the existing lattices in the market to raise awareness about caring for the environment and reduce pollution from the construction industry.

The importance of this proposal lies in its sustainable approach, which seeks to reduce pollution and preserve the economic, social, and environmental values of the environment. By focusing on the recycling of materials and the reduction of the ecological footprint, this initiative represents a significant step towards a more conscious and responsible construction with the planet.

Knowing the properties of each material used will allow us to investigate more about the results that we could get, since each characteristic positively contributed to the lattice with benefits of stability, hardness, and aesthetics.

Because there are no specific standards for this type of material, such as construction elements based on textile waste, it will be based on the NMX-C-036-ONNCCE-2013 standard. This Mexican Standard establishes the test method for determining the compressive strength, which is applicable to blocks, partitions or bricks, partitions, lattices, and paving stones of national and imported manufacture, which are marketed in national territory.

Based on said standard, tests will be carried out to observe the behavior of the material during its process, it is important to mention that resistance, humidity, and fire tests will be carried out in accordance with the standards to specify the operation, test methods carried out for the lattice in which said samples will be tested according to the following standards:

NMX-C-441-ONNCCE-2005 Construction industry - Blocks, partitions or bricks and partitions for non-structural use - Specifications.

NMX-R-060-SCFI-2013.- "This Mexican standard establishes the properties of windows, doors and enclosures in order to guarantee users the quality and safety of these products in national territory."

“Applies to windows, enclosures, and doors in general, including roof windows, balcony doors and emergency pedestrian doors, which operate manually and/or motorized, with or without blinds, shutters and/or fixed and adjustable lattices, fixed and folding mosquito nets. or roll-up, regardless of the type of materials, including all the necessary fittings for its manufacture and installation”.

This lattice is a product with radical innovation since there are only latticework made of conventional materials such as ceramic, plaster, wood, PVC, etc. without the use of textile waste or any other type of waste that allows recycling. The materials that were used in the lattice of this research make it a viable product, in addition to seeing the recycling of textile waste as the best alternative to reduce environmental impact.

It is important to mention that education plays a fundamental role in this task, since it is from the classrooms where environmental awareness can be formed and sensitize the new generations about the importance of adopting sustainable practices. By incorporating technological innovation proposals that involve constructive products from recycled clothing in the teaching-learning process, students are given the opportunity to understand how reuse can contribute to caring for the planet and building a more sustainable future.

Only through a coordinated and committed effort from all sectors of society, including education, will it be possible to face the challenge of textile pollution and move towards a more environmentally friendly fashion and construction industry. The adoption of these practices will not only contribute to reducing the environmental impact but will also foster a culture of responsible and sustainable consumption, thus benefiting present and future generations.

These research projects within educational institutions make it possible to generate new knowledge and propose solutions to problems that can be related to multiple aspects, which, in the medium and long term, can mean economic growth, improved productivity and the social development of a nation.

Architecture has direct effects on the living space, which is why it has taken this reality into account and is in constant search for innovation in other ways of building while adhering to sustainability.

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