

Design and construction of an eco-sustainable house. (June 2021)

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Summary - Currently there are many environmental problems and one of the main causes of this is the waste of plastic bottles, since only in Mexico annually about 200 PET bottles are produced for each Mexican. That is why there is a variety of projects for the reuse of plastics as well as other materials giving it a second use and thus not only being able to take care of the environment but also the health of human beings; therefore the ecological house is a clear example since in the municipality of Tepexi de Rodríguez you can find reused materials such as PET bottles and marble dust that is the waste or the reduction of the marbles, the main economic activity that is located in the community, said house would be built with walls of bottles filled with marble dust supported with a metal structure and the elaborate roof by recycled rubber tiles resulting in a comfortable and accessible place for all inhabitants and at the same time being able to respect the environment both in the process of its construction once finished.

Index of Terms – Ecological house, PET, marble powder.

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I. INTRODUCCION

The present work is developed in order to obtain a well-detailed design of the construction of an eco-sustainable house, based on the NMX-AA-164-SCF1-2013 standard of Building Sustentable. Idea that arises as a result of the need for a space that serves as a practice area for the Industrial Engineering career, applying ergonomics and technological innovation techniques, which impact on development sustainable and the reduction of a loss produced in the marble industries of Tepexi de Rodríguez, known as marble dust.

II. OBJECTIVES

A. General objective.

Design and build an ecological-sustainable house, through the use of reusable materials in the period September 2020 – January 2021, in order to give a second use to the PET material and marble dust as well as having a space to develop practices related to the industrial engineering career.

B. Specific objectives.

Create a space where the students of the INDUSTRIAL ENGINEERING academy can carry out some of their practices.

Give an alternative of materials that could be used in construction.

Use clean energies such as wind and solar.

Mostar a new alternative to build spaces where you can work by recycling different materials.

Conserve and restore the environment.

III. HIPÓTESIS

The increase in the waste of marble dust has had a considerable increase in the community of Tepexi de Rodríguez. by the marble factories that are located in that community and is the main source of income for the inhabitants.

This considerable increase in marble dust may be related to some respiratory diseases and something needs to be done with marble dust.

IV. ANTECEDENES.

Since 1990 in the city of Tepexi de Rodríguez, Puebla, marble stone processing companies have been working under a scheme outside the protection and preservation of the environment, dynamiting farmland, mountains, and damaging aquifers due to the extraction of the stone known as marble, however, it is the only economic source of the region [1]. On the other hand in industrial buildings an enormous amount of marble dust is derived from continuous work and agglomerate in areas that do not contribute to sustainable development, being these amounts in tons of dust not used in any second activity, therefore the design and construction project of the eco-sustainable house is based on taking advantage of this substance to be poured and compacted inside a 600-milliliter PET bottle, and be used as a partition or block.

Steel is used in a large part of the constructions that exist today, and the pedacería that derives from it, is not reused, for example, in housing construction works, public infrastructure, metal waste such as cyclonic fences, electroweossed Maya, all this type of material being used for the construction of the eco-sustainable house.

A. What is an eco-sustainable house?

An eco-sustainable house is one that contributes to the mitigation of environmental impacts and the sustainable use of natural resources, without neglecting the socioeconomic aspects that ensure its viability, habitability and integration into the urban environment and natural [2]. Several requirements are required for its construction; such as the soil, which is a place or free area without any obstacles or impediments, the selection of materials must consider the environmental, social and economic impacts to throughout the entire life cycle of the house, inside it there must be parameters of thermal comfort, with temperatures between 18 and 25 °C favoring bioclimatic solutions on mechanics, in the same way take advantage of solar energy [3].

B. What is it for and what is the operation of an eco-sustainable house?

Man has been polluting the planet and global warming makes us reflect on our planet, so we must take action to have a better place where

root. A good way to support ecology from architecture and as inhabitants, is bio-construction, which tries to relate technology in harmony and get to use the materials of the region

They have a long life.

The orientation of the house should be north-south to make the most of the heat and natural sunlight. The most used rooms should be to the south and have large windows and those that are less frequent, to the north. In this way you can enjoy heating in winter and air conditioning in summer.

C. Characteristics

- Decrease the use of other energy sources due to the orientation of the house, use of light, heat of the day, cool at night.
- Sustainable construction: counting on local materials.
- Form of construction and materials not harmful to the environment [4].

V. JUSTIFICATION.

The lack of a space for the elaboration of practices in the career of industrial engineering respect to industrial automation, study of times and movements, analysis of process control among others, contributing to the reduction of polluting materials for the environment in the Tepexi de Rodríguez region.

This project aims to reduce plastics and also the large amounts of dust waste from the factories in Tepexi de Rodríguez and reducing tires that are discarded in nature, would solve environmental problems and problems in the population (housing), thanks to which are materials that are easily accessible to all.

VI. METHODOLOGY.

For the design and construction of the sustainable house it is necessary to take into account some recommendations that are requirements for the **NMX-AA-164-SCF1-2013 standard of Sustainable Building.**

It is a Mexican voluntary standard approved by the Ministry of Economy with the participation of the Ibero-American University of Mexico City A.C. Department of Architecture, National Autonomous University of Mexico, Technological Institute and Higher Studies (ITESM), School of Engineering and Information Technology, Monterrey National Legacy for Sustainability campus, Mexico City Campus, Association of Companies for Energy Saving in Building A.C. (AEAE), Mexican Association of Companies in the Field of Facilities (AMERIC), General Directorate of Works and Conservation, only for

mention a few, it establishes the minimum environmental criteria and requirements of a sustainable building to contribute to the mitigation of environmental impacts and the sustainable use of resources natural, without neglecting the socioeconomic aspects that ensure its viability, habitability and integration into the urban and natural environment.

In point 4.18 of the DEFINITIONS section, the characteristics of a sustainable building are mentioned: It is the one that throughout its life cycle complies with the specifications established in this standard. In terms of soil, energy, water, materials, waste, environmental quality and social responsibility.

The methodology is based on the hypothetical-deductive scientific method, which is based on empirical knowledge that requires its demonstration, in the context of the project the hypothesis indicates the construction of a prototype example of an eco-sustainable house. Based on practices and tests it is possible to demonstrate the construction of this.

N° Actividad	Inicio	Final	28-nov	04-dic	08-ene	13-ene	15-ene	16-ene	18-ene
Llenado de botellas	28/11/2020	04/12/2020							
Paredes	08/01/2021	13/01/2021							
Techo	08/01/2021	15/01/2021							
Puertas	15/01/2021	16/01/2021							
Ventanas	15/01/2021	16/01/2021							
Revisión de la casa	18/01/2021	18/01/2021							

Fig.1. Letter from Gantt. Source prepared by the project team. In this Gantt letter the chronology of the construction of the ecological house is appreciated, after carrying out some tests we proceed to the determination of the definitive materials for its construction. The filling of the marble powder bottles is done by manually introducing the powder until the PET bottle is completely full, either shaken to be able to compact the most complete powder material, after this it is sealed with the corresponding cap and the process is repeated for each one. The walls are made with a metal structure in which all the bottles are fastened and then covered with a layer of concrete, to obtain more firmness. The roof is made of small pieces of reused rubber. For a better understanding, some of the images are presented in the results section.

An operations diagram is a fairly explanatory representation to exemplify sequentially all the activities that are performed in a process.

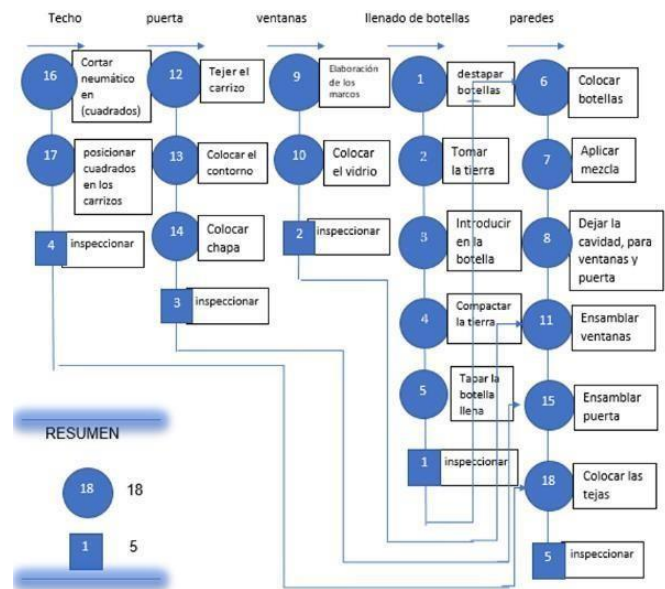


Fig. 2. Operations diagram. Source prepared by Bryant Anselmo Tobón Aranguthy, collaborator of the project [Student of the Industrial Engineering career of the Higher Technological Institute of Tepexi de Rodríguez]. In a generalized way the methodology is exposed in this diagram.

A. Budgets.

Most of the materials are reusable, but purchased materials will also be needed to give aesthetics to the sustainable house these are the budgets of the materials to occupy real:

Cal 5 packages= \$327.5

Arena 3m3= \$285.057

Cement 5 packages=

\$885

Total price per material=1497,557

The budget was quoted in October 2020, in Materiales para construcción el Libramiento, April 2 number 23, San Pedro neighborhood, Tepexi de Rodríguez, Puebla, RCF: CUMM800909EU9, Tel: (224) 4219485, Cel: (224)1111291.

B. Reaches.

According to the day of operations, the activities are carried out sequentially as shown in the following figures to obtain the prototype example.



Fig. 3. The filling and compacting of the marble powder inside the PET bottles is carried out. Source: Photograph taken by the team.



Fig. 6. In the figure you can see the disassembly of the sheer that was placed event to the concrete coating, to obtain a better aesthetics. Source: Photograph taken by the team.



Fig. 4. The PET bottles are attached to the metaclie structure, placing a wooden mold to serve as a molding when pouring the concrete for its coating and better firmness. Source: Photograph taken by the team.



Fig. 6. Ceiling placement. Source: Photograph taken by the team.



Fig. 5. Once all the PET bottles have been placed and once fastened, they are coated by means of concrete. Source: Photograph taken by the team.



Fig. 7. Final phase, painted and finished of the prototype example of the eco-sustainable house. Source: Photograph taken by the team.

VII. CONCLUSION.

- The construction of a prototype example of the eco-sustainable house was carried out.

- Firm walls were obtained.
- There are details with the roof because it is only a prototype.
- The size of the PET bottles was 600 ml.

RECONOCIMIENTO

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