

Feasibility Study of Scrap Tires in Civil Construction

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Abstract — This article describes the research carried out, aiming to give an appropriate destination through recycling for the large number of discarded tires. In Brazil, most of the waste tires are reused in different ways, however, there is still a portion that is discarded in an irregular way, therefore, a tire roof was proposed, aiming to lessen the environmental impacts by the disordered disposal and to propose a solution sustainable and more economical than conventional building roofs. The eco-tile presents itself as a technologically viable project, with the greatest obstacle to cultural aspects that are still decisive for the market to adopt this type of solution with recycling of waste tires that are discarded every year. The methodology used was through bibliographic verification in several scientific sources. Based on this, a study was developed with data collected from the company Reciclanip, which reveals the normative responsibilities of the national environment council, highlighting the importance of recycling. Finally, an alternative method was considered to recycle waste tires, using them to create a sustainable eco roof, comparing it with conventional roofs in price, resistance, and durability, highlighting the innovation.

Keywords — Roof. Tire. Useless. Recycling.

I. INTRODUCTION

Today, recycling is becoming more and more necessary and even a good business alternative. Waste, whether solid or liquid when disposed of in nature, usually causes damage and in extreme cases, irreversible. The development of new products in the recycling area has been stimulated as an important means for sustainable development and productive competitiveness.

Tenório & Espinosa (2010), point out that man is the only agent that generates waste caused by the consumption patterns of today's society. It is estimated that each year, approximately sixty million tons of waste are produced on Brazilian soil. Part of this waste is collected

and reused by cooperatives and large recycling and infrastructure companies. Another part, thrown into the environment, becomes a supplication for needy communities, who live near dumps and landfills. Within this context, the difficulty in disposing of tires at the end of their useful life becomes a humanitarian issue. The improper disposal of waste tires has great impacts on nature, in addition to harming human health.

In Brazil, there are laws that require tire manufacturers and importers to be obliged to collect and dispose of waste tires in an environmentally appropriate manner, this measure demonstrates the danger of indiscriminate disposal of this waste. Due to their difficult

compaction, collection and disposal, the tires take up a lot of physical space. The large deposits occupy extensive areas and are subject to accidental or provoked burning, causing losses in the air quality, due to the release of smoke containing a high content of sulfur dioxide among other toxic substances. (CAMILO, 2010) The construction of the tire is basically done with a mixture of natural rubber and elastomers, also called 'synthetic rubbers', adding carbon black, giving the rubber properties of mechanical resistance and the action of ultraviolet rays, durability and performance, this composition favors the creation of tiles, mainly due to its characteristics of mechanical resistance and the action of ultraviolet rays. The roof of scrap tires can be included among the material options available for civil construction, with the consequence of attracting investments, creating demand for new products, generating jobs and development. (NAIME & SILVA, 2010)

To develop a tile from waste generated by unused tires, it is necessary to evaluate the tile manufacturing processes, their environmental impacts, and the application of a construction process in a more economical and sustainable way in residential buildings. According to Naime & Silva (2010), the use of waste tire rubber in several construction stages, allows a way to increase the life cycle of this material and provide architectural, aesthetic, constructive, environmental, and financial qualities. Therefore, the proposal is to apply tire rubber in the construction of an ecological roof, aiming through the tire tiles to minimize environmental problems, collaborate with sustainable development and benefit the community with a quality and low-cost product. This project proposes to analyze the feasibility of recycling waste tires, with the purpose of designing and building a new type of roof that meets the needs of comfort, structural and thermal insulation of a residence. For this, extensive bibliographic research was carried out to clarify the current state of tire recycling in Brazil and to establish technical and constructive parameters that favor its use in the country.

II. LITERATURE REVIEW

2.1. Scrap tires

The environment has become the focus of society's concerns on a global scale, the future depends on current global actions. Sustainable development is a process of change in which the exploitation of resources, an investment orientation, the directions of environmental development and an institutional change must consider the needs of the next presentations. (SOUZA & DELPUPO 2012). The National Association of the Pneumatic Industry, an ANIP was created in 1960 and represents a tire

and inner tube industry installed in Brazil, comprising 12 companies and 20 factories around the country. In 2007, ANIP created or Recycled which has the function of collecting and disposing of waste tires in a country, being one of the main initiatives in the post-consumption area of the Brazilian industry, having 1053 collection points around Brazil. In 1999, the national tire collection and disposal program started with a collection of manufacturers, more than 5.3 million tons of waste tires that were collected (that is, equivalent to 1.04 billion passenger tires) and used until the end of 2019. (ANIP, 2020).

According to Gomes et al. (2010), waste tires left to the environment are very harmful, as they not only contaminate the air, soil and groundwater in tropical countries like Brazil, they increase the spread of fatal diseases like dengue, Zika and Chikungunya. A 2003 study carried out by the Ministry of Health revealed that in 1140 municipalities surveyed, tires were in 25% of them the main focus of the mosquito (284 municipalities), and the second in 43% (491 municipalities) and the third in 41% (465 municipalities).

The accumulation of tires is one of the most serious environmental problems due to the difficulty of collection and the high production of it. The tires can be easily turned into tiles, using cutting instruments and a wooden structure, where the tires will be fastened with nails according to figure 1. The industry already produces a large quantity and its useful life is short after the use, it can be easily adapted for this purpose, thus being a cheap and lasting alternative, taking into account the way in which they are manufactured.

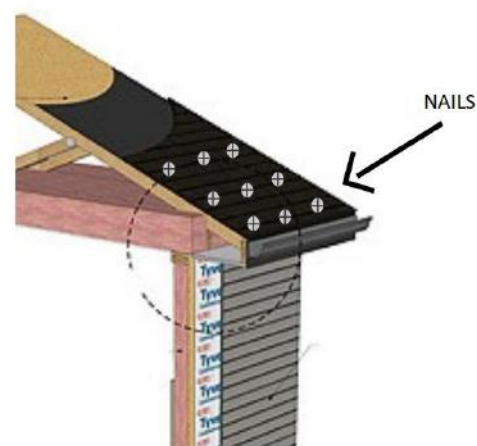


Fig.1: Timber and roof fixing

Source: EuroShield Roofing, adapted (2020).

2.2. Conventional proposals for the solution of the problem

The business commitment to recycling, Cempre, is a non-profit association, dedicated to encouraging recycling within the concept of integrated waste management. Founded in 1992, it is maintained by private companies from different sectors and its function is to raise awareness among the population about the importance of reducing, reusing, and recycling waste through seminars, research, and databases. (Cempre, 2020).

Also according to Cempre, (2020), waste tires can be ground and applied to the asphalt composition of greater elasticity and durability, contribute to soil compaction, create other rubber products such as soles, tubes, carpets, floors or even fuel - thanks to its calorific value that surpasses the burning of fuel oil and coal. In Brazil, the tire retreading rate is high, thus prolonging its useful life, especially that for buses and trucks, which is refurbished about twice, however, part of them ends up in landfills and along rivers and roads.

It is possible to generate energy by burning old tires in controlled, whole, or perforated furnaces. Each tire contains the energy of 9.4 liters of oil. In Brazil, the use as fuel, between 1999 and 2004, destroyed 150 thousand tons of tires, about 30 million used car tires, providing savings of 720 thousand tons of oil. Petrobras' plant in São Mateus do Sul in Paraná incorporates crushed tires in the bituminous shale extraction process, which guarantee lower viscosity to the mineral and an optimization of the process. (SEBRAE, 2017). In civil engineering, rubber from tires can be decomposed into grains that are used in the construction of materials for building bridges, viaducts, and rainwater retention basins so that they are lighter than using common materials. The drainage, anti-mold, anti-vibration, thermal insulation properties and the low weight of the materials derived from tire recycling, make its use increasingly advantageous in these applications. (FLORIOS, 2015).

2. 3. An alternative method: tire roof

Thinking about the environmental issue and the appropriate destination for this material, aiming to reduce even more the impacts that are caused in nature, a tire roof can be used as another means of taking advantage of useless tires, so that its use, due to its properties physical and chemical properties, are very valid in the construction of roofs, given its thermal and acoustic insulation capacity, as well as the ease of its execution, as it is a lightweight material and does not require some resources commonly used in conventional roofs, Figure 2 demonstrates a roof composed of 70% tire, finished and in use.



Fig.2: Composite roof of 70% tire.

Source: Euro Shield Roofing (2020).

For Dias (2018), this type of tile can replace ceramic, fiber-cement, metallic tiles, among others. Each tire produces three tiles of approximately 53 cm. each and takes advantage of the tread with the sides, excluding the beads, being the tool used for cutting, the chainsaw or cutting machines. Figure 3 illustrates the composition of a tire.

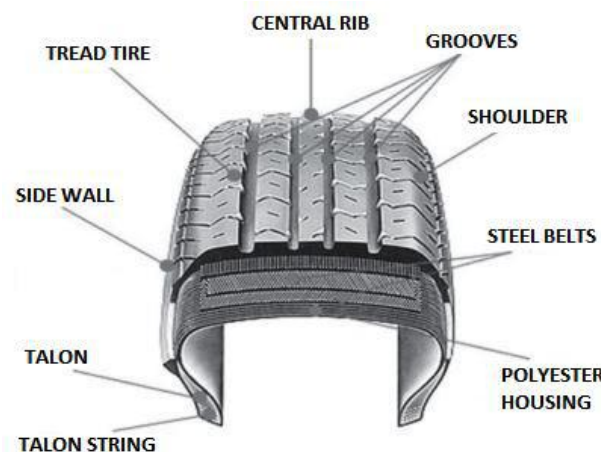


Fig.3: Composition of a tire

Source: Brazil Tires (2009) Apud Brazilian Association for the Prevention of Traffic Accidents (2013), adapted.

The wooden structure of the roof is the same as that used in ceramic tiles, however the tire tiles are fixed with nails. Rubber is a thermal insulator, which guarantees a good temperature inside the residence.

The manufacture of tire tiles allows buildings to be built in locations with trees that produce large fruit. With the characteristic of absorbing the tension due to the collision of the fruit with the roof, preventing it from coming to rupture. The tiles are extremely easy to transport, favoring the construction and maintenance of the roof.

The appearance of leaks is minimized due to its fixation by means of nails. The unit price of these tiles is relatively low when compared to more conventional tiles

because it is a material that has already been discarded for its original use. When comparing the cost of tiles and woodwork per square meter of ceramic, fiber-cement, and metal roofs, we have a significant reduction in the total value for the roof construction.

III. METHODOLOGY

First Stage: a bibliographic survey was made on several sources of research - periodical books and reliable sites regarding environmental preservation; sustainable development, generation and disposal of solid waste - in particular waste tires and the absorption of this issue by society and companies, the initiatives that have been adopted regarding recycling and reuse of waste tires.

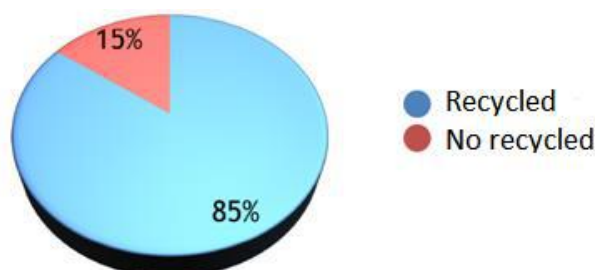
Second Stage: a study was carried out using data from the company Reciclanip, constituted by the National Association of the Pneumatic Industry (ANIP), based on the responsibilities imposed by Resolution No. 416, on September 30, 2009 at CONAMA - Conselho Nacional de Meio Environment, showing its importance for the environment.

Third stage: considerations were made regarding an alternative method for recycling tires with the creation of an ecological roof, surveying the recycling index in Brazil, comparing prices between the most common types of tiles and finally, collecting data from tensile test, to check the resistance.

IV. RESULTS AND DISCUSSIONS

In 2014 the tire recycling index in Brazil was 85% as shown in Graph 1, referring to the most recent survey carried out by Cempre, we have that 15% of all waste tires are still improperly disposed of in Brazil, having the roof use this space to contribute to the recycling of this material, seeking to further reduce environmental impacts.

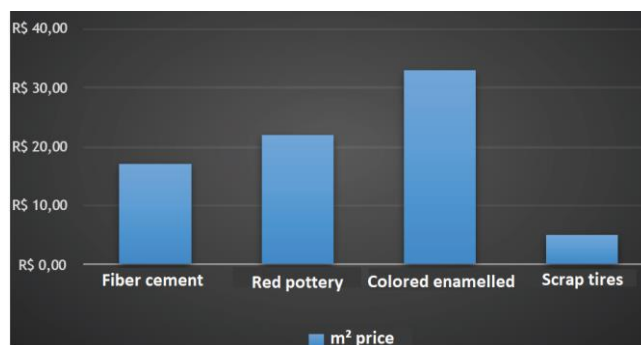
Graph 1: Tire recycling index in Brazil



Source: Cempre (2014), adapted.

As for the question of price in the use of waste tires in residential building roofs, we have a great differential according to Graph 2, as it is observed that the other types of tiles have expenses with lumber, transport and the price of the tile itself, which in the tire tile, we would only have the price of the cut and its transport and wood, that is to say also saving in the total value, since the tiles are made of a material that has already been discarded.

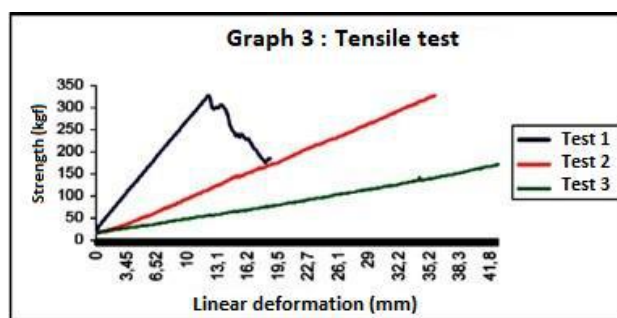
Graph 2: Types of tiles and their price differences.



Source: authors.

According to Graph 3, we have the minimum load that a tire tile can withstand is 122.5 kg. With this data, this product can easily withstand an average human load of 80kg. In test number 1, a maximum load was used until the specimen collapse was determined and the linear deformation obtained at rupture was measured. In the second and third tests, the parts were forced with applications of different magnitudes and measured the deformations of the part, making it clear that when the rupture does not reach, the deformations are quite close, regardless of the applied loads.

Graph 3: Tensile test



Source: Naime & Silva (2010), adapted.

The main purpose of the development of this tile is to further reduce environmental impacts and revolutionize the tile production market, generating jobs and a new material option, since the research that has been done, shows their superiority over other materials. as for costs,

lightness, and resistance, having a possible barrier to its implementation, cultural issues, because in Brazil new construction methods tend to be resisted by builders and customers.

V. CONCLUSIONS

According to research carried out in the construction process, it is concluded that tires have different uses, in addition, there are projects and organizations that are geared towards the reuse of this material. The reinsertion of waste tires as cover for residential buildings is ecologically, socially, and economically viable. The main reason for choosing this element is the cost, as an expressive inferiority was observed when compared to the other more usual materials, which can consolidate this innovative and quality technique for roofing. However, one of the obstacles encountered is the lack of knowledge about the technique in Brazil, as well as prejudice against reused materials, both in relation to the contractor and to the end users of the product. It is evident, therefore, that the use of the tire to create roofs of high durability and totally recyclable, is feasible, thus creating a cheaper and easier to be manufactured product, being also a great commercial competitor, adding to the set of materials for building roofs existing residential properties.

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