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Responsible changes in the brick industry: clay bricks and PET blocks

Cambios responsables en la industria ladrillera: ladrillos de arcilla y bloques de PET

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Abstract

The brick industry needs carbonization processes to produce its products. This has resulted in it becoming one of the actors that generate the most polluting emissions and impacts climate change quickly. Therefore, the industry must take action in favor of sustainable options. The following work carries out a comparative work of conventional bricks and blocks made with PET to explore their effectiveness.

Bricks, Clay, Contaminants, PET

Resumen

La industria ladrillera necesita de los procesos de carbonización para la producción de sus productos. Esto ha resultado en que se convierta en uno de los actores que más emisiones contaminantes genera e impacte en el cambio climático rápidamente. Por lo que es de prima importancia que la industria accione a favor de opciones sustentables. El siguiente trabajo realiza un trabajo comparativo de ladrillos convencionales y bloques hechos con PET con el objetivo de explorar la efectividad del uso de estos.

Ladrillos, Arcilla, Contaminantes, PET

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Introduction

Urban planning has been overtaken by the crisis spread by climate change. Cities have become vulnerable to the damaging natural disasters that are striking with increasing frequency. This directly affects buildings and infrastructure which, in most cases, are not yet prepared for such disturbances.

In 2006, it was estimated that the construction industry was responsible for 30% of the world's solid waste and has been actively involved in the emission of greenhouse gases (UN, Environment program, 2021). It is worth mentioning that, despite a substantial increase in investments to reduce energy consumption in this sector, CO2 emissions increased in 2021.

Furthermore, the brick industry, located in the core of the construction industry, is responsible for a large part of the emissions of polluting gases that accelerate the consequences of the greenhouse effect and have direct repercussions on cardiorespiratory diseases. In 2020 alone, annual global production was 1,500 billion bricks (Berumen-Rodríguez, Pérez-Vázquez, Díaz-Barriga, Márquez-Mireles, & Flores-Ramírez, 2021).

The manufacture of conventional bricks requires excessive energy use and some of the polluting gases are carbon monoxide (CO), volatile organic compounds (VOC), nitrogen dioxide (NO2), sulphur dioxide (SO2), heavy metals, carbon dioxide (CO2), polycyclic aromatic hydrocarbons (PAH), polychlorinated biphenyls (PCB), dioxins, among others (Berumen-Rodríguez, Pérez-Vázquez, Díaz-Barriga, Márquez-Mireles, & Flores-Ramírez, 2021).

The following work will take conventional bricks, such as clay bricks, as the object of study and compare them with bricks made from PET (polyethylene terephthalate) plastic. The objective will be to compare and explore the existing renewable options, in order to make the construction industry, more specifically the brick industry, a space in which sustainability and resilience to the effects of global warming are taken into account.

Methodology

The following research is a mixed approach, as it aims to carry out a comparative analysis from both qualitative and quantitative approaches. A search for university research, official articles and experimental studies was carried out. These were found in databases such as Google Scholar and Redalyc, as well as in the websites of governmental institutions and non-governmental organizations.

Information was limited to conventional brick manufacturing processes, basic characteristics and socio-environmental repercussions. Similarly, literature was sought on the production of bricks with PET plastic and its characteristics. With this in mind, the comparative method was used in order to draw strong conclusions about the efficiency in both cases.

Results

Manufacturing processes

In the case of the conventional brick, the raw material required for its production is essentially clay, sand and water. The mixture is prepared to a plastic ceramic mass, poured into moulds to obtain the raw brick and left to dry. The pre-dried brick is then taken to the firing kilns, where the chemical changes take place (Pontifica Universidad Católica del Perú, 2019).

In the kiln, the combustion process must be based on the adaptability of temperature control and the effect of each fuel on the material to be heated. Among the most commonly used fuels are wood, charcoal, coal, mineral coal, natural gas, propane, fuel oil, among others (Figueroa Parra & Martinez Delgado, 2000). Although firing processes may vary depending on the fuel, specific brick materials and the kiln design itself, combustion processes are one of the main air pollution processes.

For the manufacture of a PET block, it is important to first determine that it is an optimal raw material for the production of the block. As it has high thermal and mechanical strength, good creep coefficient and high chemical resistance, it is considered as a good substitute for traditional elements (Campos, Gómez, Montero, Pantoja, & Pasco, 2020).

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For example, the study by Maaze and Shrivastava (2023) shows how fly ash geopolymers are a sustainable substitute for raw clay brick; another material is plastic powder, supplanting the 7.5% mass of clay, which is reported to make bricks that are lightweight, with greater durability to water absorption and volumetric stability (Idrees, Akbar, Saeed, Gull, & Eldin, 2023). It is important to mention that, of the 770 tonnes per day of solid waste, 7.7% is plastic, of which only about 30% is collected for reuse (UN Environment programme, 2021).

Although only a small percentage of the waste chain is reused, 21 tonnes are still available for reuse. PET elements are cut out and used for the mixing of the blocks. Sometimes it is melted before being added to the mix, but in this case the plastic loses some of its properties. Once poured into the mould, it is left to cool for a few hours or a day until it hardens (Maure, Candanedo, Madrid, Bolobosky, & Marín, 2018).

Brick properties

The processed bricks themselves should be homogeneous and compact, they should be well fired and sufficiently porous without any excess (Barranzuela Lescano, 2014). Also, clay bricks have the capacity to withstand compression. They have properties such as hardness, shrinkage and sonority. According to the regulations of the Mexican Ministry of Communication and Transport (SCT, 2022) they must be suitable for severe climates with frost and high rainfall. One advantage of clay bricks is that, as they are available in different types, the selection can be varied among those available on the market.

In the case of PET blocks, the choice is equally optimal if the above characteristics are considered. This is due to the fact that they comply with resistance and impermeability. The PET partition can reach five times more resistance than traditional brick, 14% thermal efficiency and good moisture resistance (González-Velandia, Sánchez-Bernal, Pita-Castañeda, & Pérez-Navar, 2019; Viveros-López & Gonzalez-Léon, 2018). Another characteristic of polyethylene terephthalate blocks is that they are lighter than traditional bricks, making them easier to handle, and they show better water absorption performance at 4% (Wahane, Dwivedi, & Bajaj, 2023).

The analysis offered by El-Metwally et al. (2023) concludes that the larger the grain size, the higher the compressive strength and the lower the thermal conductivity, regardless of the type of plastic used; in addition, most studies consider a maximum of 5% clay mass substitution for load-bearing constructions, increasing if it is for non-load-bearing walls (Wahane, Dwivedi, & Bajaj, 2023); Another interesting observation is the consideration of including plastic fibres in the mortar to improve thermo-mechanical properties, tensile strength and thermal insulation, as well as the reduction of micro-cracks.

Generally, the addition of an additive to conventional bricks has been more concerned with improving physical or chemical properties on an almost selective basis. For example, additives against freezing and thawing or to accelerate setting time. That is, according to the variability and needs of the batch (Di Marco Morales & León Tellez, 2017). However, if we follow the logic of resilience in the construction sector, it is imperative to take advantage of the resources available for the manufacture of bricks and blocks.

Socio-environmental impact

The construction industry is undoubtedly one of the main generators of solid waste and emitters of polluting gases. Brick making as mentioned above is inevitably functional with carbonisation methods. According to the UN Environment Programme in its 2022 report, there is no prognosis to ensure a decrease in CO2 emissions by 2050 in the building sector. However, the use of one of the most common wastes brings only long-term benefits (UN, Environment programme, 2022).

If the demand for PET blocks were to increase, collection organisations would look for ways to increase their reach in the search for waste. In this way they would be suppliers of a raw material that could be substantial in the brick industry. In Mexico alone, this industry generates 52,315 jobs (Berumen-Rodríguez, Pérez-Vázquez, Díaz-Barriga, Márquez-Mireles, & Flores-Ramírez, 2021).

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Conclusions

The costs of inaction in the face of climate change will be reflected in reduced construction activity and could result in sub-optimal living and working spaces. The damage caused by natural disasters over the last 20 years has resulted in the loss of $2 trillion dollars according to the World Bank (Word Green Building Council, 2022). Starting to produce materials and products that are efficient for construction but also responsible for natural changes will create the necessary basis for trust in trade.

Although it is not the only robust solution to the problem the world is facing, it is one of the fronts to be addressed for resilience in building and housing development. Moreover, PET blocks have so far demonstrated that they can be of better quality for practical purposes. While there is still a long way to go to meet the commercial demand for building materials, PET blocks are an option that in the long term can lead to more sustainable practices in the construction industry.

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