Waste valorization for the concrete block production: a sustainable solution

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Civil construction is one of the most important activities in the development of the economy, however it generates a large amount of waste and is responsible for the consumption of a large part of natural aggregates, contributing to their serious crisis (ZHAO et al., 2020; KUMAR; SHRIVASTAVA; GUPTA, 2020). The growing concern with environmental issues related to the extraction of non-renewable natural raw materials and the irregular disposal of waste caused by the sector, has led society to seek to maintain components and materials at maximum utility value at all times, being one of the alternatives for reducing the Environmental impact called circular economy (ZHAO, et al., 2020; ARAÚJO, 2020). The recycling of civil construction waste seeks to transform it into useful by-products, such as the production of concrete blocks, enabling the generation of savings in natural resources, cost reduction, energy savings and reduction of landfill volumes (HEMALATHA, 2019) . Their production process consists of a mixture produced in the factory, using a dry mixing method with pressing, and they have several application options, including concrete paving blocks, dividing blocks and floor blocks (MENG; LING; MO, 2018). Concrete blocks offer a resource of great value to the market, including their structural capacity, durability, skidding resistance, pavement drainage, in addition to allowing for a diversity of colors, shapes, thicknesses and densities (HEMALATHA, 2019). However, according to their application, the blocks must have functional properties, including flexion, compression, water absorption, among others (MENG; LING; MO, 2018). Therefore, the present study was carried out with the objective of evaluating the performance of concrete blocks for paving with the addition of civil construction waste – Concrete and plaster.

Firstly, the materials characterization used was realized, as well as the traces determination for the production of proof bodies. For the production of the concrete blocks were used: high resistence Portland cement CP V, with a density of 3,150 g/cm³, basic polysaccharide plasticizer additive, water, fine aggregates with a particle size of less than 4, 8mm, coarse aggregates less than 152mm and civil construction waste. The civil construction waste used are from the sidewalks demolition with high traffic of people and the plaster obtained from the disposal of the material used for the construction of drywall. In this work, the material classified as thin (4.8-0.004mm) was used. According to laboratory tests, the specific mass of concrete and plaster was calculated, 2.45 kg/m³ and 1,400 kg/m³, respectively. The proof bodies were prepared with: 20 kg of cement, 6L of water, 150 ml of plasticizer and 27,450 kg of sand, the materials (trace) concrete, stone dust and residue are specified in Table 1.

Table 1: Materials composition for the production of 65 proof bodies (10x20x6).

Trace	Stone Dust	**Residue**
Reference	66,120kg	-
Concrete 30% (fig.1 a)	46,284kg	19,836kg
Concrete 40% (fig.1 a)	39,672kg	26,448kg
Plaster 30% (fig.1 b)	46,284kg	19,836kg
Plaster 40% (fig.1 b)	39,672kg	26,448kg

For sample preparation, was performed mixing for 5 min, and then sent to the vibro-press to be molded (50 sec). After molding, the blocks, at room temperature. To determine the mechanical resistance to compression and traction in bending, an electrohydraulic press was used. Samples were taken in triplicate and curing times (with ages) 7, 14 and 28 days. The average results of resistance compression and flexion the different ages of the 5 compositions evaluated are shown in Figure 1 (c and d). Note that cement blocks with waste additions have relatively lower mechanical strength than conventional concrete (Ref. blocks) produced with noble raw materials. Similar results were observed in the studies by Namarak et al., (2018) and Kumar, Gupta and Shrivastava (2021), who state that the division of waste used as fine and coarse aggregates for the concrete blocks production must consider the strength considerably, when used in large proportion. This result was attributed due to the porosity of the material.

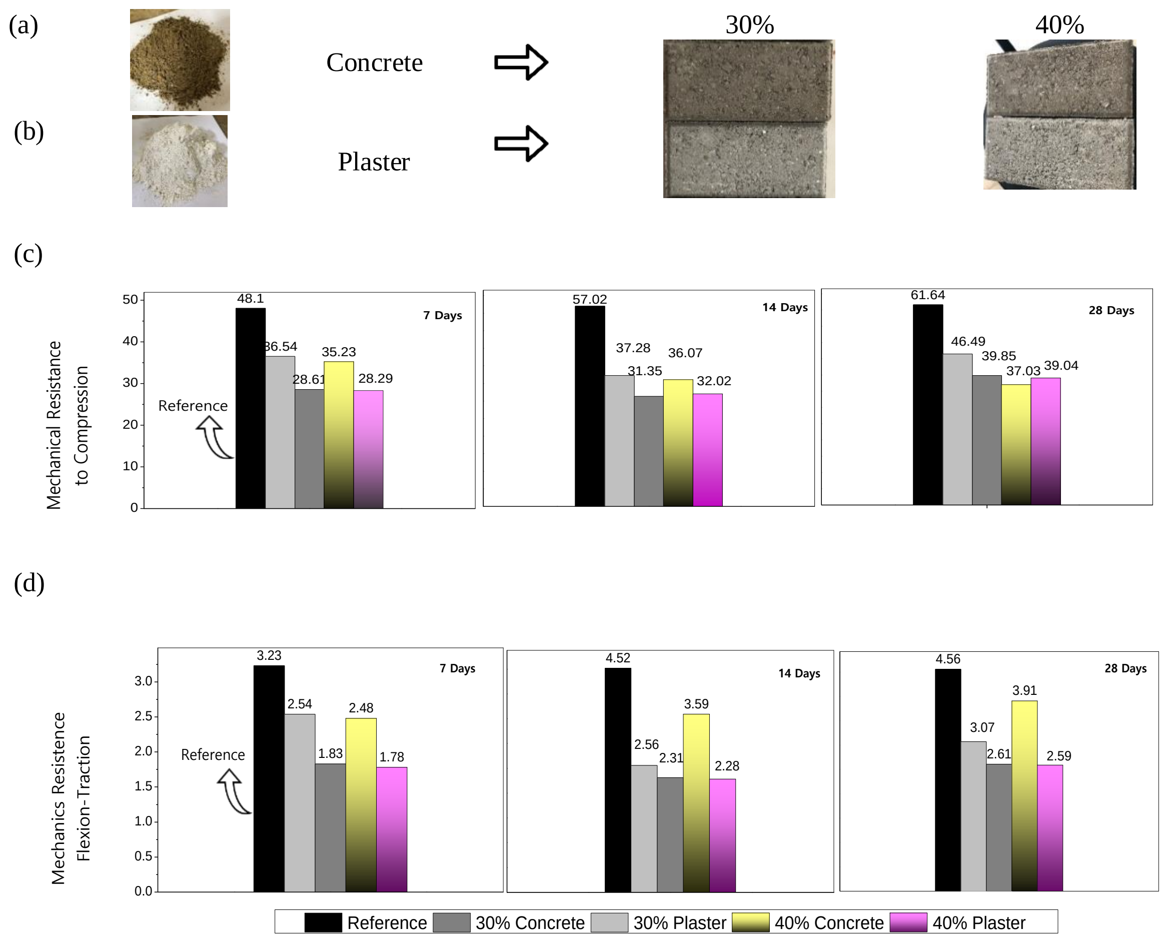

Figure 1. Results mechanical resistance (c) compression and (d) flexion-traction.

Figure 1 (c and d), indicated variations between the studied compositions, and the reference trace presented ideal results for the tests. According to the results, it was found that the mixtures with the proportion highest of residues used showed loss of compressive resistence of the blocks, and this factor is essential for performance evaluation. In this sense, blocks containing plaster can be better applied for paving after 28 days of curing the concrete, whereas blocks with concrete residues can be used after 7 days. However, even with relatively low resistance values up to 28 days the produced blocks with plaster, they can still be applied for paving sidewalks and floors with low traffic, such as squares and sidewalks. On the other hand, the resistance the flexion-traction is treated as a secondary characteristic of concrete, as it does not have good strength (LEITE, 2001). It is noted that all blocks had resistance gains at all ages, being more pronounced in the reference blocks and blocks with 40% of concrete residue. Regulations in some coutries establish minimum values, as is the case of the SANS 1058/2009 standard in South Africa, which requires a value of 2.2MPa for light traffic and 2.8 MPa for heavy traffic. Therefore, all samples evaluated showed satisfactory results after 14 days of cure.

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