

Viability of Production and Application of Concrete with Addition of Fibers of Polyethylene Terephthalate (PET) Bottles for Construction

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1 Introduction

In the ongoing search for more cost-effective and environmentally friendly building materials, the basis for effective sustainability for the construction industry, it is necessary to review the feasibility of certain academically acclaimed solutions, in particular those already unanimously considered sustainable from the standpoint of purely ecological, ensuring that the scientific solution can be industrialized and easily applied in the production and logistics processes of construction industry to create buildings and structures. This work aims to present an analysis on the sources of the recycling of PET (Polyethylene Terephthalate) to determine the possibilities for the production and availability of PET fibers that are appropriate for the concrete mixture of Portland cement, minimizing the use of sand in the civil construction industry; to review the physical mechanical behavior of the concrete with the addition of PET bottle fibers; and verify the best application of this concrete in the construction of buildings, aiming at reducing costs and ensuring the sustainability of the sector while maintaining the necessary quality. The methodology used has included laboratory tests with the molding, curing, grinding and rupture of specimens to verify the behavior of the concrete with PET fibers in relation to its axial compression strength and diametral compression tensile strength, when compared to the fiber-free concrete. The fresh concrete test has showed the slump of the concrete cone specimen come was 90 mm for concrete without the addition of PET fibers, characterizing a rich concrete, while for the trait with 2% PET fiber, the slump was 20 mm indicating a poor concrete of very low workability. The axial compressive strength test has demonstrated that the mixture with addition of PET fibers (2% content) showed a small reduction in axial compressive strength in relation to concrete without fiber addition at the age of 28 (3.27% reduction). In contrast to what be observed at the age of 7 days, when fiber-reinforced concrete showed higher axial compressive strength results than fiber-free concrete (an increase of 1.18%). In the diametral compression tensile strength test, we observed an increase in tensile strength by diametral compression with increasing control age (7 to 28 days), as expected. On the order hand, the results for axial compressive strength, PET fiber-reinforced concretes showed a 18.38% increase in diametral tensile strength in relation to non-PET-reinforced concrete at both ages. From the analyzed aspects, the use of recycled PET fibers in concrete provided considerable changes in the physical properties of the material. a) regarding

workability, the conventional concrete was workable and cohesive. It was noted a loss of rebate in the trait with 2% content of PET (20 mm rebate), proving to be very consistent, a fact that, however, did not compromise the casting of the concrete; b) regarding the axial compression strength, concrete with the addition of PET fibers at 7 days of age had a strength gain of 6.59% and a loss of 5.54% at 28 days of age. Regarding the mechanical test for axial compression at 28 days of age, there was no significant difference for fiber-reinforced concrete compared to non-fiber concrete; and c) a significant increase in the results of tensile by diametral compression to 2% PET fiber concrete was obtained with increasing control age (from 7 to 28 days), as expected. The result of increasing tensile strength was then successfully achieved. Thus, contrary to what has been observed in the axial strength results, the concrete with addition of PET fiber presented a 18.38% increase in tensile strength compared to concrete with no fiber addition. The results allow us to conclude that there is possibility of production and availability of PET fibers that are suitable for mixing in concrete, since the results of the mechanical physical behavior of the concrete were satisfactory for the mixing condition used. It is noteworthy that further studies are necessary to prove its applicability in structural use, aiming at a future revision of NBR 8953 (2015). Thus, even though it has been well demonstrated academically that the tensile strength property of this technology proves superior to conventional concrete, the viability of its use at the industrial level will only occur with more government support and incentives through an infrastructure that can guarantee the stability of the production of PET fibers, establishing the necessary logistics to guarantee its offer for the civil construction, allowing construction companies to use this material for the preservation of our planet. As mentioned in the beginning of this study, the waste from PET bottles generates a major environmental problem, and any appropriate end we can find for this waste returns a great benefit to nature.

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Referencies

- Pelisser, F. (2002). *Avaliação do Desempenho de Concreto Reforçado com Fibras de Polietileno Tereftalato (PET)*. 2002. 127 f. Dissertação (Mestrado) - Programa de Pós-graduação em Engenharia Civil, Universidade Federal de Santa Catarina, Florianópolis.
- Hendriks, C. F. and Pietersen, H. S. (1998). *Concrete: durable, but also sustainable?* In: DHIR, R. K.; HENDERSON, N. A.; LIMBACHIYA, M. C. (Eds.). *Sustainable Construction: Use of Recycled Concrete Aggregate*. London: Thomas Telford Pub., pp. 1-18.