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Production of Non-Structural Concrete with Addition of Polyethylene Terephthalate Fiber (PET) in Porto Nacional - TO

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***Abstract*— Concrete is one of the most used materials in construction, due to its great versatility and high workability and can be molded in any way besides having high compressive strength, on the other hand the resources used for its manufacture are not from renewable sources. In order to search for new materials and to help the environment, as the number of improperly discarded PET bottles is huge, non-structure concrete was produced with the addition of polyethylene terephthalate (PET) fibers in order to improve its mechanical characteristics. Due to the widespread use of concrete in the world and the improper disposal of the PET bottle polluting the environment and causing various environmental problems. From these circumstances, fiber added to the concrete was produced in the following proportions (2%, 4% and 6%) instead of Portland cement, obtaining a 7 mm Slump Test. The specimens were submitted to a curing process (3, 7, 14, 21 and 28 days) in which an improvement in the resistance can be observed during the curing process. how many for resistance gain.**

***Keywords*— Concrete, Concrete Fibers, Environment, Fibers and PET Bottle.**

I. INTRODUCTION

In Brazil and worldwide, when it comes to material used in construction, concrete is the most used, although not as strong as steel, this is due to its popularity created by factors such as: versatility (because concrete is a substance plastic being thus moldable, besides having easy production and handling.), durability, economy (being very cheap and commonly used worldwide) and high water resistance (MENESES, 2011).

The use of fibers in cement mixtures promotes significant improvements in their composition, which makes their mechanical characteristics improve. According to Metha and Monteiro (2008) the use of fibers industries, due to its versatility, high mechanical (impact) and chemical resistance.

Regarding sustainability, the use of materials such asactive silica tailings and PET bottles in the manufacture of new materials presents a good alternative, if we consider that the improper disposal of Polyethylene Terephthalate (PET), presents a huge damage to nature, besides de represents 20% of the volume of waste disposed of in landfills (SILVEIRA, 2018). The production of concrete with the addition of this polymer would establish a new way of recycling this product and contribute to its reduction in nature.

occurs due to some limitations that conventional concrete has, such as low tensile strength which makes it susceptible to cracking, to minimize these limitations the fibers are used.

According to Metha and Monteiro (2008) the fibers are classified as short and long, while the short ones areused in mortar, reducing the cracks in a composite under load, while the long fibers are used in concrete to reduce cracks, their use reduces the workability. more increases its tensile strength. According to Cardoso, Liboni and Honda (2016) Polyethylene Terephthalate (PET), it is a polymer widely used in plastic bottle.

The work is characterized by the production of a non-structural concrete with the addition of polyethylene terephthalate (PET) fiber, for analysis of its mechanical characteristics, workability, and homogenization among others. In order to reduce the number of improperly disposed PET bottles in the Porto Nacional - TO region, a study experiment was carried out to evaluate the influence of partial addition (2%, 4% and 6%) of Polyethylene Terephthalate fibers (PET) on mechanical properties of concrete, aiming to evaluate and analyze their influence on the resistance to the uniaxial compression test, in order to verify their real feasibility of use in civil construction.

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II. METHODOLOGY

In order to produce non-structural concrete and reduce the number of PET bottles in the environment, a joint effort was made where the collection bottles were used to produce Polyethylene Terephthalate (PET) fibers, these bottles were collected by colleagues and friends in the municipality of. Porto Nacional -TO, after washing and drying it in the open, the horizontal cuts were made zmanually using scissors and rulers for measurements, the fibers were manufactured in a 10 cm length by 5 mm width as shown. FIG. 1.

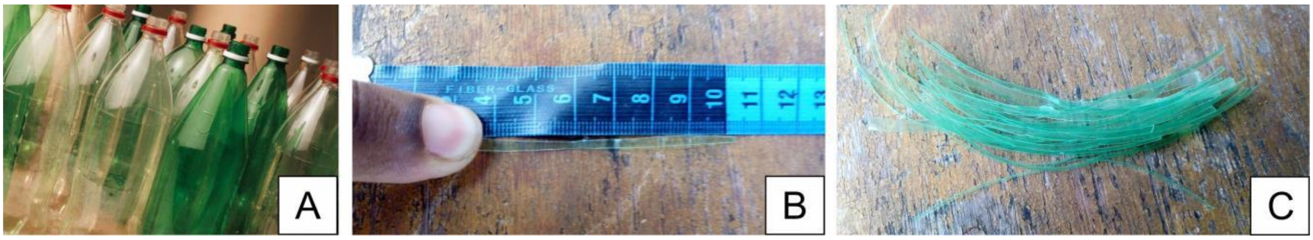

Fig.1: (A) PETS bottles used in fiber manufacture, (B) manual fiber measurement, (C) fibers already cut and ready for use.

The use of fibers in cementitious mixtures (concrete and mortar) has promoted an exponential improvement in the mechanical characteristics of these mixtures, with improved flexural toughness and impact fatigue strength (SALVADOR AND FIGUEIREDO, 2013). Observing Nunes (2006), it is said that the main function of fibers is to increase energy absorption through cracks because the current transfer bridged fibers reduce their propagation and expansion.

Another very important factor to take into account when using PET bottle fibers is that it does not absorb water, so you do not have to worry about water loss due to the absorption that natural fibers like bamboo have in the curing process. concrete (GERALDO, 2017).

The production of concrete consists of the composition of cement, aggregates and properly dosed water (RIBEIRO, 2013). For this study, the following materials were used:

– Small aggregate (Coarse Sand);
– Large aggregate (Gravel 1);
– Portland cement composed with slag CPII F 32 TO;
– Water supplied by the supply company;
– Polyethylene Terephthalate fibers (PET).

The natural aggregate was collected on the Tocantins river, near the city of Palmas, Tocantins State, Brazil, and sorted by similarity of size ABNT NBR NM 7211:2005. Portland cement CPII F 32 TO was used as a binder to obtain the concrete, according to ABNT NBR 5736: 1991 specifications. All raw materials used in the manufacture of the bodies of evidence, were weighed using a digital balance. The table 1 and 2 shows the proportions of materials consumed for each type of concrete studied and the levels of additions of dashes represented in percentage.

For the concrete trace, the following formulation was used: 1: 1.68 (cement: sand), 1: 2.68 (cement: crushed stone) and 1: 0.482 (cement: water) (ANTONIO et al., 2019), as there was a slight change from the amount of water (± 600 ml). The table 2 shows the compositions characteristics of determination of trace of concrete with and without the addition of Polyethylene Terephthalate fibers (PET). Note - if the only change that occurred was between the cement and the addition of fibers.

Table.1: proportions of consumable materials for each type of concrete

Concrete	Cement (g)	Sand (g)	Gravel (g)	Water (ml)	Fiber (g)
0%	18000	30240	48240	8676	0
2%	17640	30240	48240	8676	360
4%	17280	30240	48240	8676	720
6%	16920	30240	48240	8676	1080

Table.2: Composition characteristics of determination of trace on the concrete

Betonadas	Dash (Kg)	Rupture
0% (Fiber)	18.00:30.24:48.24: 8.676	28 days
2% (Fiber) PET	17.64:30.24:48.24: 8.676	28 days
4% (Fiber) PET	17.28:30.24:48.24: 8.676	28 days
6% (Fiber) PET	16.92:30.24:48.24: 8.676	28 days

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The concrete dosed to obtain the compressive strength of 20MPa fck, established by ABNT NBR 6118: 2003 at 28 days, using CPII F 32 cement, without the use of additive. After weighing and characterization' of the materials, the concrete was fabricated with the help of a stationary concrete mixer. After the preparation of the molds, the traces were made using PET bottle fibers with replacement content of 0% (conventional concrete), 2%, 4% and 6%. in the binder (cement CPII F 32). Concrete production follows the specifications of ABNT NBR 7215: 1996, in a dry place the materials were mixed in the order of coarse aggregate, fine aggregate and cement, then water was added, PET fibers were the last components to be added to mixture to form a consistent and homogeneous paste.

The concrete consistency of each composition was evaluated by the Slump test according to ABNT NBR NM 67: 1998. The concrete mixture was placed in the trunk of the three-layer cone metal mold, each layer also distributed received 25 blows. With the help of a legislator, the mold was slowly removed in the vertical direction to verify the final reduction of the concrete (difference between the height of the mold and the height of the concrete mix). After the Slump test was a test to verify the workability of concrete in which 10 beats were given around the mixture in order to verify its characteristic in order to avoid porosity, was still verified in the test of the spoon again the consistency of the concrete, as shown in following figure.

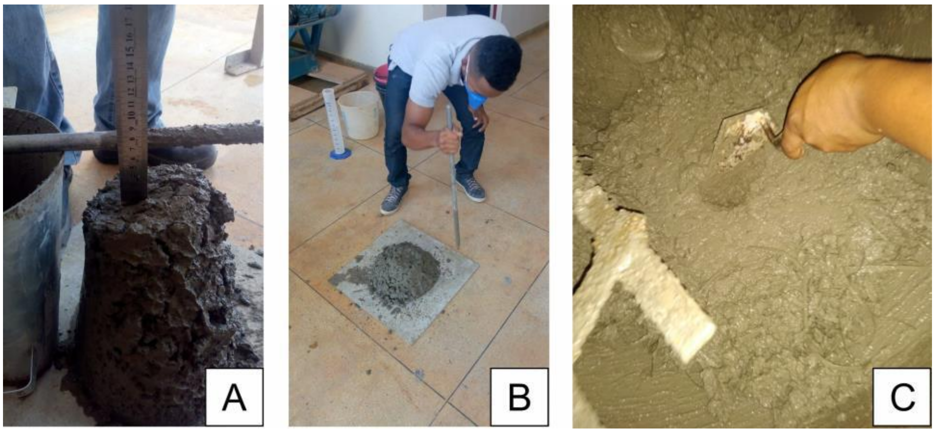

Fig.2: mixture characterization procedures, (A) Slump test performed on the trace, (B) workability verification test, (C) consistency test.

After performing the tests and once the proper consistency has been achieved, the specimens are molded. The concrete was placed in the molds with the help of a spatula and concrete compactor (AF 46 mm), to eliminate the voids of the dough, establishing its uniformity. For each composition 25 cylindrical samples were made in the dimensions of Φ10x20cm. After approximately 24 hours, the samples were removed from the cylinders and placed in a saturated water tank (hydration process) until they reached ages (3, 7, 14, 21 and 28) days of cure, ABNT NBR 5738: 2015, as shown in fig. 3.

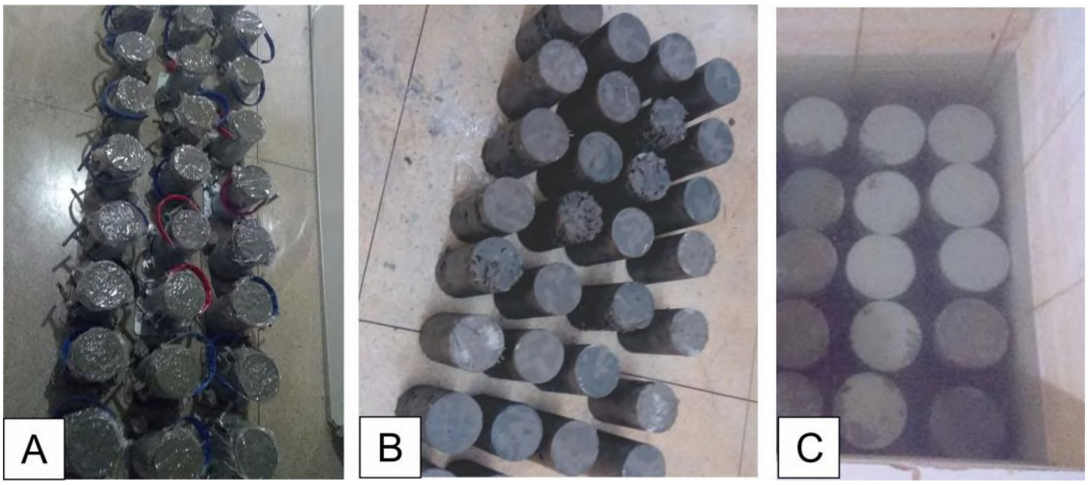

Fig.3: PC molding and demolding process (A) formation of evidence bodies, (B) removal of evidence bodies, (C) hydration and cure of bodies of evidence.

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Samples of each composition with and without fiber addition were evaluated by the uniaxial compression test to determine their compressive strength. The uniaxial compression test consists of determining the maximum value of rupture load supported by each specimen. The uniaxial compressive strength of concrete was determined by the compression test according to ABNT NBR 7215: 1996 specifications. Thus each sample was tested for each fiber portion (2%, 4% and 6%) and age (3 , 7, 14, 21 and 28) days of cure, having a total of one hundred (100) evidence bodies, subsequently allocated to each, strictly centralized mechanical bottom plate hydraulic press (EMIC DL 3000), illustrated in Fig. 4, Breakage and strength determination were performed automatically.

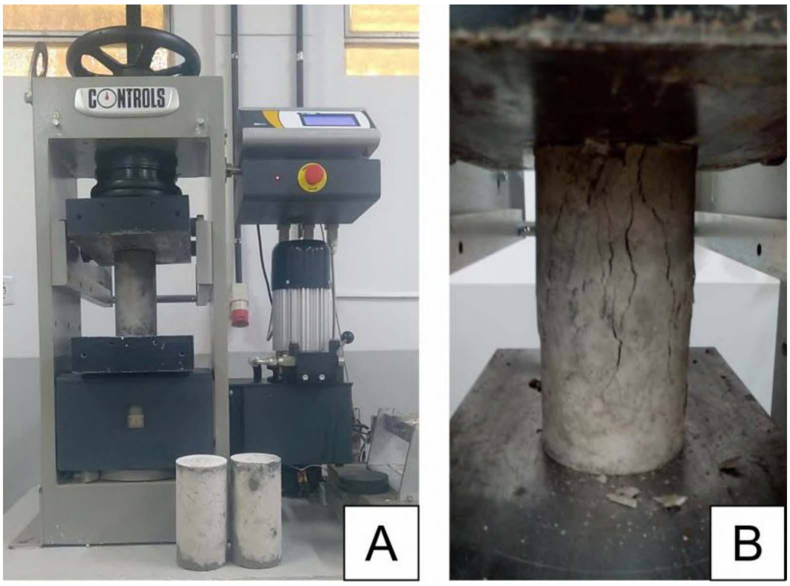

Fig.4: (A) Test of resistance to compression, (B) Uniaxial compression

III. RESULTS AND DISCURSSIONS

In the reproduction of concrete using the trait 1: 1.68 (cement: sand), 1: 2.68 (cement: broken stone) and 1: 0.482 (cement: water) (ANTONIO et al., 2019), found that the Traces with 2% and 4% fiber addition had a satisfaction when compared to the conventional 70 mm and 60 mm, respectively, without drop test, having a good workability already in samples with 6% fiber having a yield test. Unsatisfactory fall of 40 mm with its very difficult use, there was no water loss, since, as the fibers are not absorbed in water, as in the last sample shown porosity in some evidence bodies when drawing. Figure 5 shows the strength obtained in the uniaxial compression test.

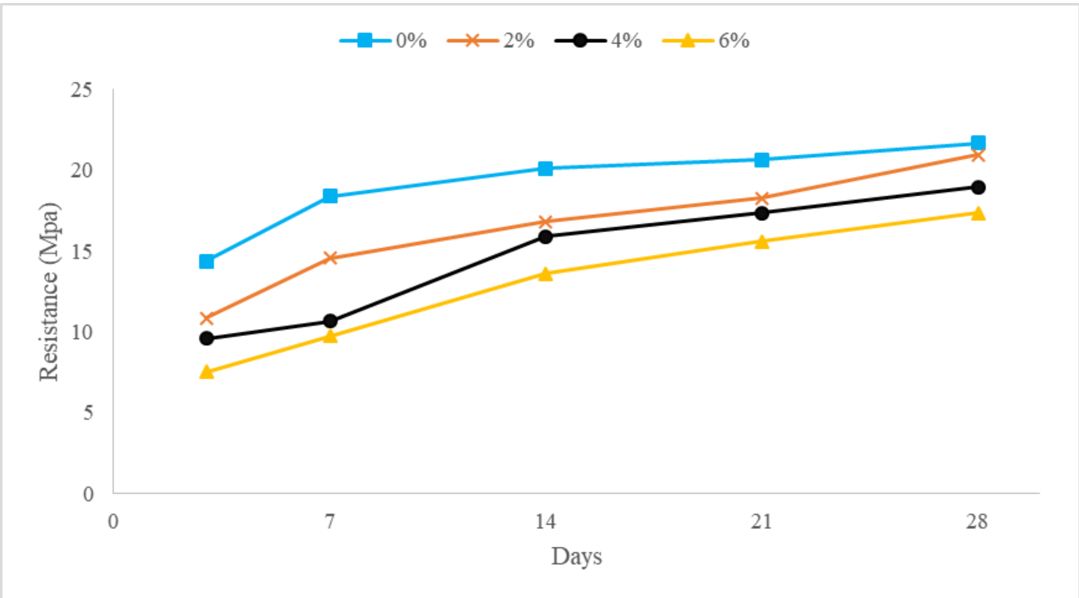

Figure 5: Graph of compressive strength gains after 3, 7, 14, 21 and 28 days with addition of 5 cm bamboo fiber concentration.

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Fig. 5 shows the compression forces achieved (3 to 28) days, respectively, to determine uniaxial compressive strength. It can be verified that the lowest value of compressive strength occurred in the composition of 6% of PET fibers at 28 days and the highest value occurred in the concrete with the addition of 2% of PET fibers. With lower percentage of fibers the workability is much better than with higher percentage which gives a better distribution of fibers and filling of the evidence bodies.Figure 5: Graph of compressive strength gains after 3, 7, 14, 21 and 28 days with fiber addition of PET bottles. In Figure 6 it was observed that there is a significant decrease in the compressive strength of both ages, in contrast to the conventional concrete (0% fiber addition) and the composition of 2% of fiber replacing the cement that came closest to compressive strength at 3 days of hydration and cure, yet far from the strength of conventional concrete.

Fig. 7 and 8, shows that there was a greater compressive strength gain in fiber compositions than in conventional concrete, with the sample with 2% PET fibers reaching the target of 20 Mpa, the 28 days of cure, and even Other compositions in achieving this goal their resistance gain was very satisfactory.

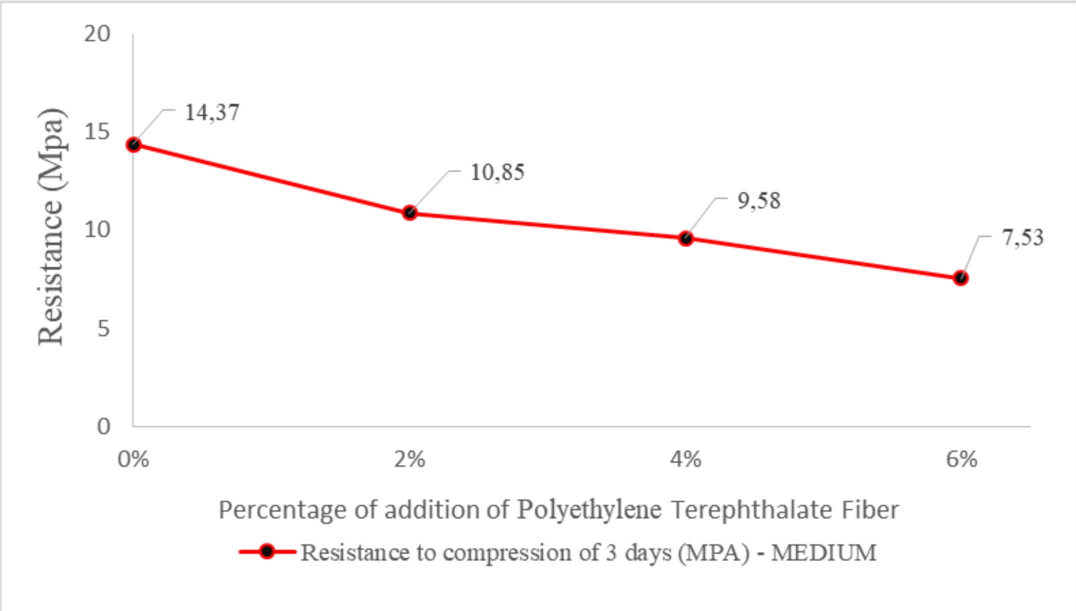

Fig.6: Graph of resistance to compression for 3 days.

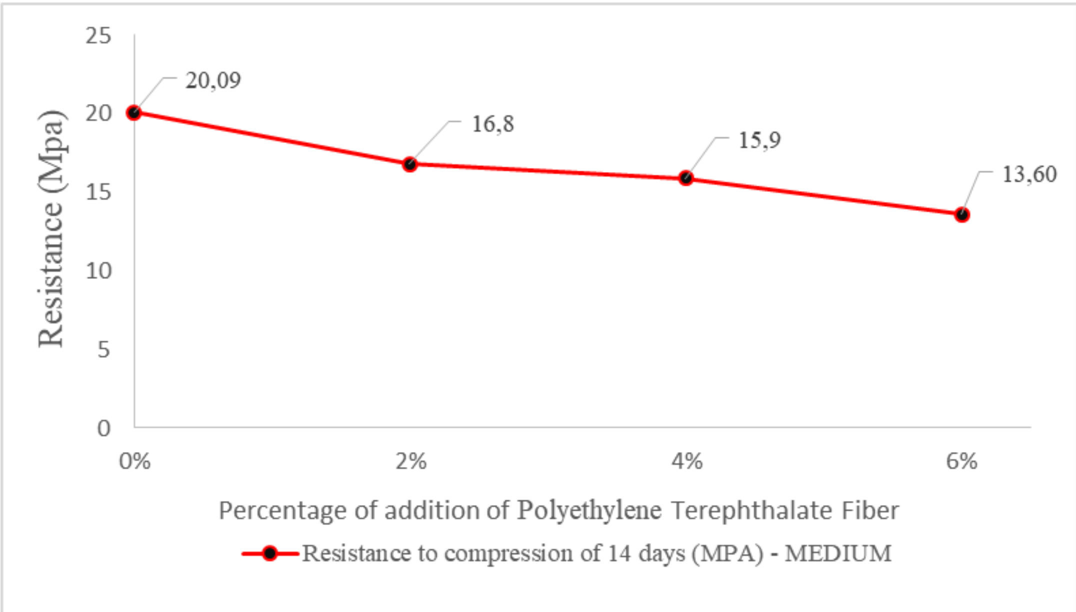

Fig.7: Graph of resistance to compression for 14 days.

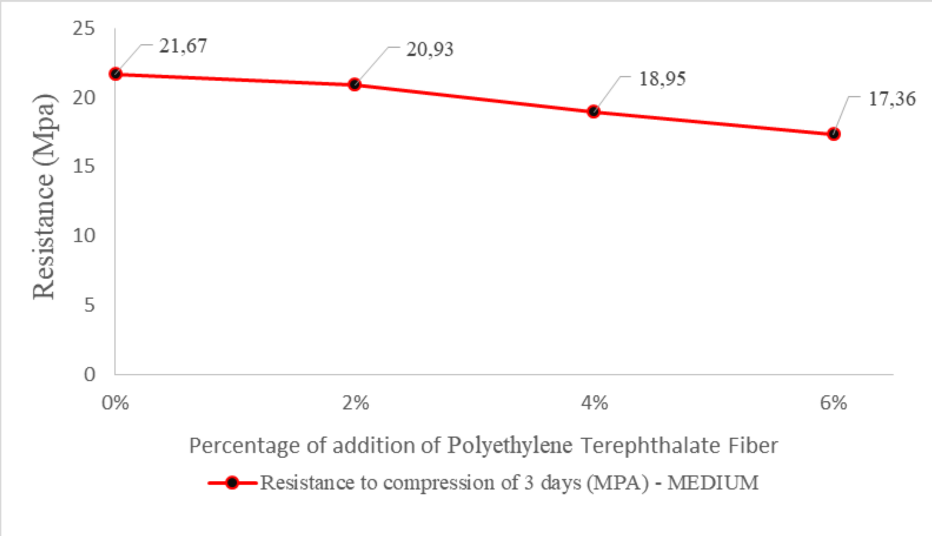

Fig.8: Graph of resistance to compression for 21 days.

After the analysis observed that the concrete with 2% of fibers in substitution to the cement obtained satisfactory resistance and being the concrete with 4% slightly below the target and 6% much below, according to ABNT NBR 6118: 2003, this make the use of PET fibers in concretes feasible.

IV. CONCLUSION

Concrete is the most used material after steel in construction because of its high compressive strength, the conventional concrete (0% fibers) manufactured for this project obtained a compressive strength of 21.67 Mpa at 28 days. curing, with the concrete with 4% and 6% content not reaching the desired resistance of 20 Mpa, being with 18.95 Mpa and 17.36 Mpa respectively, in view of this and the proximity to the resistance and the likely addition of some additive would help to achieve this resistance, and the composition of 2% for having a better workability than the other samples reached 20.93 Mpa at 28 days of cure. Therefore through the obtained results, it is possible to use Polyethylene Terephthalate (PET) fibers in concrete in order to improve sustainability in the construction industry.

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