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OBTAINING AND CHARACTERIZING A POLYESTER RESIN COMPOUND WITH FIBERGLASS AND PET

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Abstract. *Currently the concept of reducing, reusing and recycling wastes that have been discarded, giving them a new purpose is not only an option but a necessity. Each year the amount of waste generated increases, and with this there is a need to allocate them correctly. The use of waste in construction is already a reality, as well as in the manufacture of rustic furniture, among others. Detaching from waste and giving it a use for what was previously considered waste is of great value in many areas, as it reduces environmental impact, generates added value, jobs, profits and increases in the economy. In this context, the objective of the work was to make and characterize the mechanical properties of a PET and fiberglass composite with polyester resin. Traction tests showed that the mechanical strength of the composite was lower compared to the pure thermoplastic polymer, which is due to the presence of discontinuities in the composite caused by the artisanal confection process.*

Keywords: *fiberglass, mechanical properties, composities.*

1. INTRODUCTION

The PET polymer is a thermoplastic, being one of the most recycled plastics in the whole world, due to thatextensive amount of applications: textile fibbers, mats, carpets, nonwovens, packaging, films, tapes, ropes, compounds, among others. The reuse of this material significantly reduces the environmental impact caused in dumping, since it can take centuries to fully degrade itself. The recycling can be done with the purpose of generate raw material, composites or energetic means (Santos Jr, *et al.*, 2012).

In energetic recycling, the PET has a superior calorific value to coal, but this practice results in the emission of carbon dioxide, worsening the greenhouse effect (Guelbert, *et al.*, 2007).

Santos Junior *et al.* (2012) performed studies about the use of PET bottles in the manufacture of bricks. The bottles were collected and clean for the removal of impurities, the cleaning was done in water and the drying was done in free air during a period of 12 hours. After the cleaning the material was crushed to ease the fusion process. The material was molten and mixed with coconut fibber to add better mechanical resistance. The proportion of coconut fibber was 30% used in 3 to 10 cm long. The PET mix with coconut fibber was heated in a metallic vessel until meltdown; the material was then dumped still hot in a wood mold. The mechanical tests revealed lost of integrity in the bricks with a compressive load of 100 kgf, however this loss of mechanical resistance was assigned to internal porosities of the composite.

Canellas (2015) performed a study about the replacement of parto f the sand used in concrete for PET bottles particulates. Were realized replacements in the proportions of 10, 30 and 50%, being noted that the Best possibility of percentage use was 30%, due to not presenting significant losses in plasticity and compression resistance. It was possible to conclude that the obtained composite has potential to be used in the manufacturing of concrete artefacts, without much structural responsibility.

Mulinari *et al.* (2014) proposed a composite with the base in merging sisal fibber and castor oil based polyurethane resin, the results of the traction test showed a tensile strength limit of 8,6 MPa, with a standard deviation of 0,8 MPa.

Oliveira, Guimarães and Botelho (2009) performed studies in thermoplastic composites of PEI matrix (Polyetherimide) reinforced with fibreglass. Was noticed that traction resistance, shear and fatigue of the laminated PEI/fibreglass were superior to the epoxy/fibreglass laminated.

On this context, the present work had the objective to manufacture and evaluate the mechanical properties of a polyester resin with fibreglass and PET.

2. MATERIALS AND METHODS

For a better adhesion of the cold cure polyester resin with catalyst, the PET bottles were sanded to ease the bind. Right after they were cut in strips about 5 mm wide, and braided forming a blanket of PET that served as base for the samples.

Was applied the polyester resin along with catalyst in the fibreglass blanket so all the stripes could be glued. After two blankets of PET were binded using resin and catalyst. The first and second PET blankets were prepared forming a 45º angle. After being glued, it was used another resin layer, then, another fibreglass blanket, and at last, resin. The samples were made according to the ASTM D 638 (2014) standard for traction tests.

Right after the samples were pressed using metallic plates binded by screws for a better pressing of the materials, for further testing.

The tests of the samples were performed in a universal test machine of TIME GROUP brand, available at Instituto Federal de Educação, Ciência e Tecnologia do Espírito Santos (IFES), Campus São Mateus, with test speed of 5 mm/min. Was used an strain gauge of 50 mm with 0,001 mm precision. All data was saved in a computer, along with Stress – Strain curves generated by the data acquisition software that follows the equipment itself.

All the fabrication sequence of the composites is shown in Fig. 1a-f.

Figure 1. (a) PET Blanket interlaced; (b) Cutting the fiberglass; (c) Application of the resin in the fiberglass; (d) PET, resin and PET at a 45 ° angle; (e) Samples; (f) Samples after tensile test.

3. RESULTS AND DISCUSSIONS

Due to the manufacturing of the samples being artisanal, there was the emergence of porosities between the PET blankets and fibreglass. Those porosities give place to stress concentrations in the samples, which will act reducing the final mechanical resistance of the composite.

The modulus of elasticity is related with the binding force between atoms and provides an indication of the material hardness. Was calculated the modulus of elasticity based on the stress-strain curves by using linear regression methods using the Microsoft Excel program, in the appendix the curves referring to the test of each sample are shown.

The breaking stress determines the end of the test, in fragile materials, this stress evens the maximum stress, since these materials don't present plastic deformation zone. In the case of the fibreglass and PET bottles composite a fragile behaviour was noticed.

Table 1 shows the mediums and standard deviations for the breaking point and flow for each sample.

Table 1. Modulus of elasticity and resistance limit.

Sample	E (GPa)	σ.res (MPa)
1	3,04	36,50
2	3,44	28,60
3	3,61	28,20
4	3,00	20,70
5	2,80	32,40
6	3,54	32,80
Medium	3,24	30,50
Standard deviation	0,33	5,43

According to Callister (2006), the resistance limit for PET is between 48,3 and 72,4 MPa, therefore, the fibreglass and PET composite presented lower values than expected for the pure PET, this fact is explained due to the composite being manufactured by artisanal method, presenting discontinuities that acted reducing the material resistance. Even a visual analysis showed several discontinuities.

In the study of Mulinari *et al.* (2014) were obtained a resistance limit of 8,6 MPa for the sisal fibber and castor oil base polyurethane merge, compared to the obtained result for the composite it was about 22,0 MPa higher.

Figure 2 shows the results obtained on the traction test. The behaviour of the composite was similar to a fragile material, not showing a considerable plastic deformation.

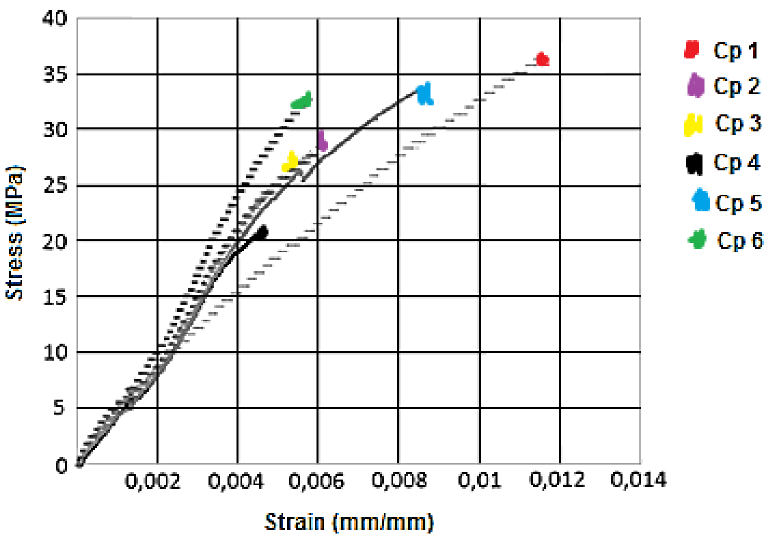

Figure 2. Traction test results for the manufactured composite.

From Fig. 3 to 8 is showed the results from traction test. It is observed that quality of the linear adjustment was superior than 0,9 in all of the samples.

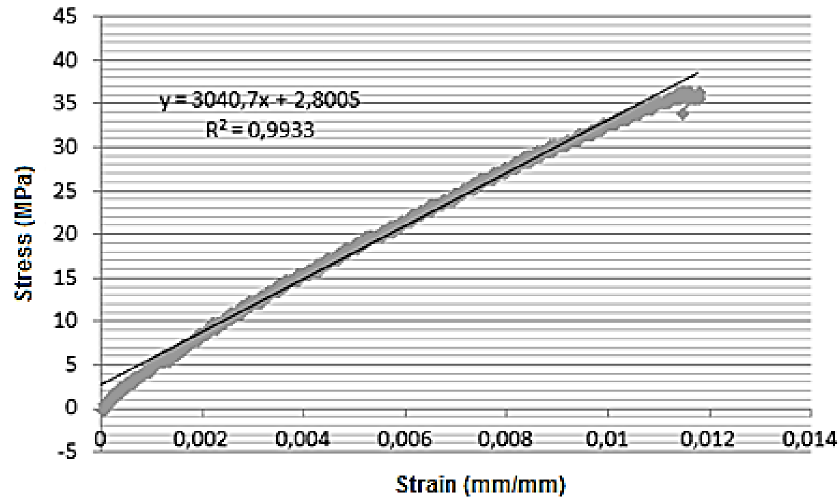

Figure 3. Traction test for sample 1.

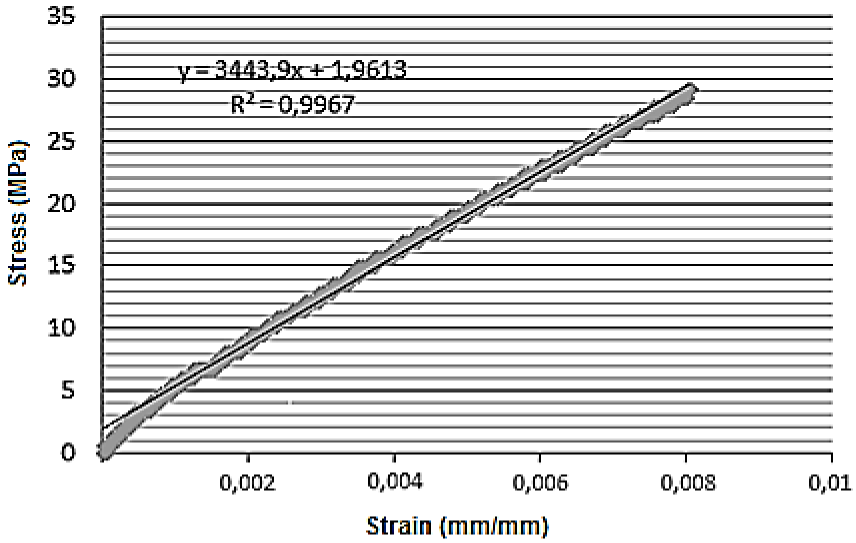

Figure 4. Traction test for sample 2.

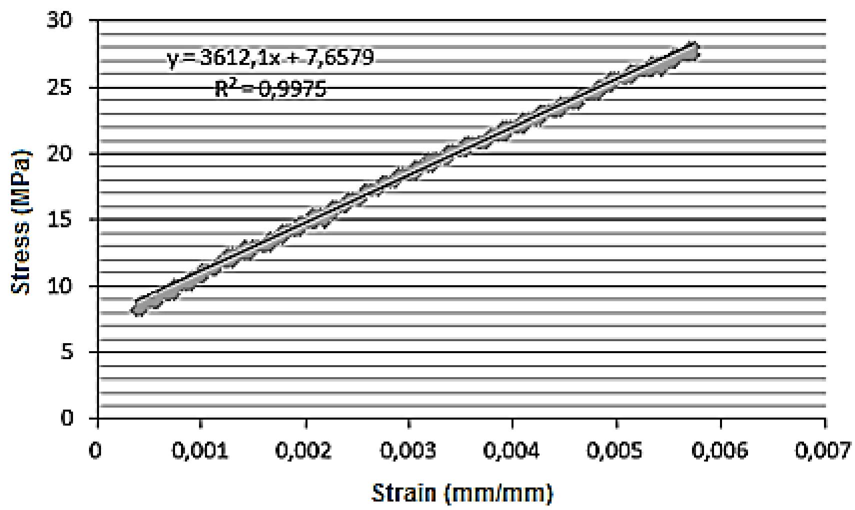

Figure 5. Traction test for sample 3.

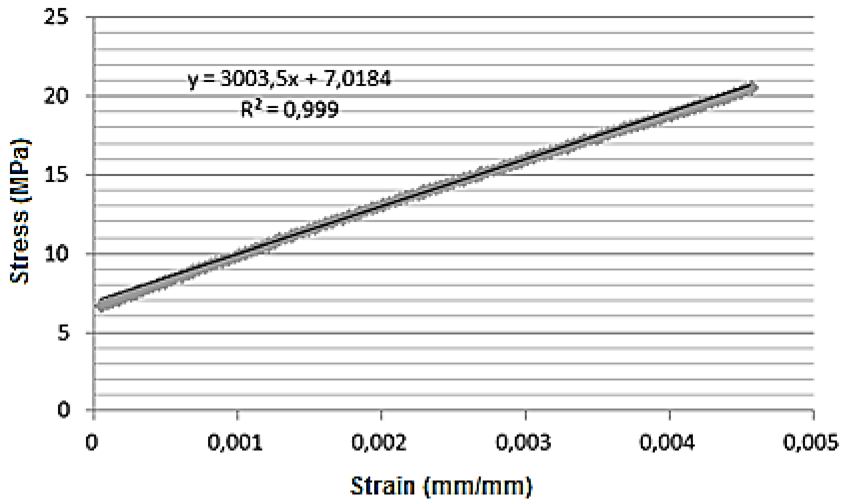

Figure 6. Traction test for sample 4.

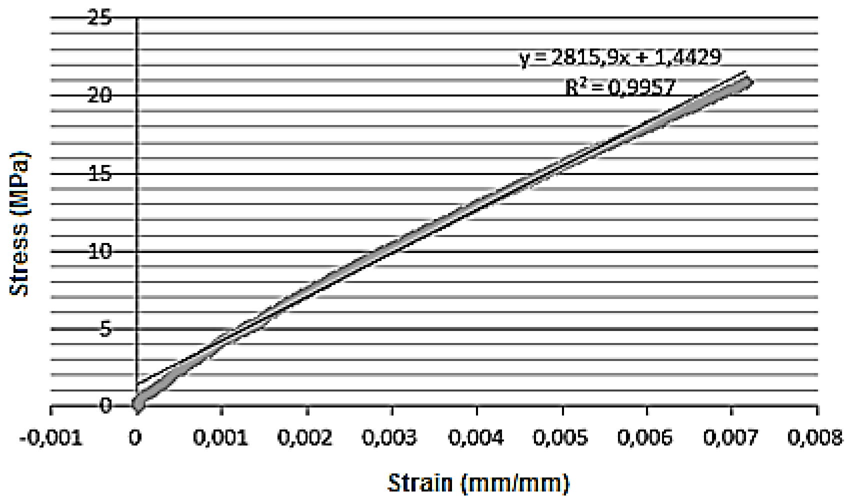

Figure 7. Traction test for sample 5.

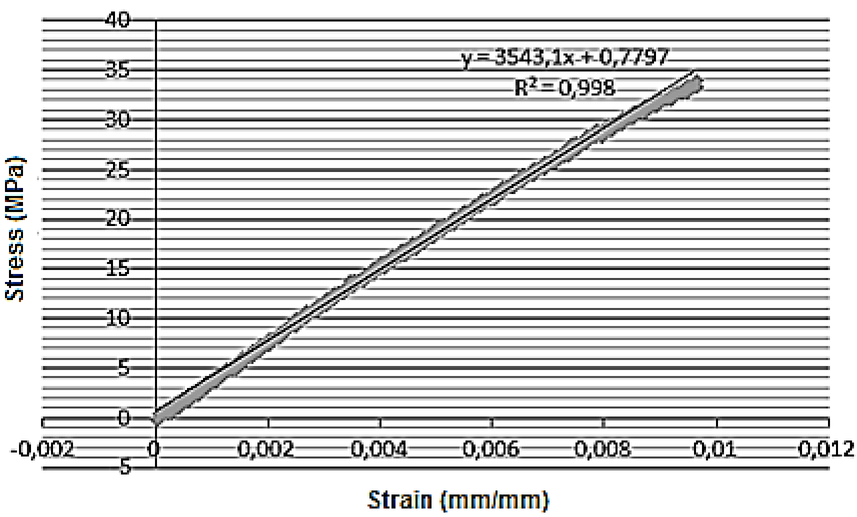

Figure 8. Traction test for sample 6.

4. CONCLUSION

The results obtained in the traction test showed that the mechanical resistance of the composite is lower than the obtained by the pure PET. This result is explained due to the presence of imperfections present in the artisanal manufacturing of the material.

The manufactured composite have as advantage the saving in the use of fibreglass, because part is replaced by the PET blanket which helps in the recycling of the bottles. The material can be used in the construction in general, since it doesn't have a high mechanical resistance as requirement.

It is recommended for future works that further tests are realized in a composite containing only PET blankets and polyester resin. Proposing a pressing way that reduces the discontinuities and imperfections inside the material and perform a microscopic analysis of the fractured samples.

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6. RESPONSIBILITY NOTICE

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