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Reuse of expanded Polystyrene for waterproofing production and Application in Civil Construction

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***Abstract*— *The expanded polystyrene known commercially as proportional, is very present in our daily lives, showing great uses, in this way, it has become a very popular element. Because it has high volumetric features due to its composition of 98% air and only 2% polystyrene, the recycling becomes unattractive to disrupt the environmental effects caused by its misuse. Currently, the use of technologies in conjunction with alternative inputs, such as styrofoam, are considered major innovations for the civil engineering market, with a tendency to provide cheaper construction, achieving excellent results. This work aims to reuse expanded polystyrene for the production of waterproofing using solvents and vegetable oil. The present work has shown positive results capable of protecting the building elements and components against harmful water actions.*

***Keywords*— Expanded polystyrene, Styrofoam, EPS, recycling.**

I. INTRODUCTION

Currently, planet Earth has been suffering from changes caused by a series of human activities, as well as burning, use of fossil fuels, deforestation, and improper waste disposal. This environmental problem is also related to a growing product, known commercially as Isopor®, the expanded polystyrene (EPS), considered by NBR 10004: 2004 a non-hazardous waste belonging to class II, but this product becomes a villain of nature for having a long decomposition time. According to Coelho, Manzanares, Menedez,(2014), despite the EPS being a recyclable material, companies and people end up improperly disposing, because they find its recycling impracticable, since it is a material composed of 98% air and 2% polystyrene, having a large volume for low mass. Taking this issue into account, this work aimed to reduce the extraction of raw material and as a measure to combat the impacts caused by the waste, reusing EPS in the manufacture of a new waterproofing material, initially intended for civil construction, as according to BORGE, GONÇALVES, MOURA. (2008). The main cause of pathologies in structures and finishes is due to some action that water causes. The polymers are composed of long wires being linear or branched, their structure influences according to the temperature causing a rearrangement of atoms, (SOUZA, 2019). Thus being able to regroup to form a new material. Polymers due to their size are recognized by macromolecules, they have materials that are easy to process, in addition to being light, resistant and of good performance in thermal and electrical insulation, it has low investment value, so it became viable to develop the areas of electronics, appliances, even civil engineering (SPINACÉ; PAOLI, 2004).

EPS exhibits very peculiar properties and characteristics, making it a very advantageous material for civil construction, presenting attributes capable of providing thermal and acoustic insulation, in addition to showing a material with good mechanical resistance despite being very light, it is not a hygroscopic material providing good resistance to water and moisture (MEDEIROS et al.,2011).

According to NBR 9575/2010 Waterproofing - Selection and design, states that waterproofing is a constructive technique, consisting of one or 15 more layers in order to protect the building elements and components, against the harmful action of fluids and moisture. The waterproofing materials have two classifications, rigid (waterproof and polymeric mortar), used more in static structures because it does not support movements, and flexible (based on acrylic membranes, thermoplastics, among others), capable of adapting according to the requirements of the structure VOTORANTIM, (2017).

Therefore, this work has developed a flexible waterproofing product, resulting from the recycling of EPS and the addition of solvents, fibers and oils in order to protect from water actions, contribute significantly to the mechanical and abrasive resistance of the surface to be applied.

II. METHODOLOGY

The research is of an experimental and exploratory character, through experiment and field test.

The present study was carried out in the laboratories of Instituto Presidente Antônio Carlos (ITPAC) and in the Federal Institute of Science and Technology Education of Tocantins (IFTO) in the municipality of Porto Nacional - TO, located 60 km from the state capital, Palmas as shown in figure 1.

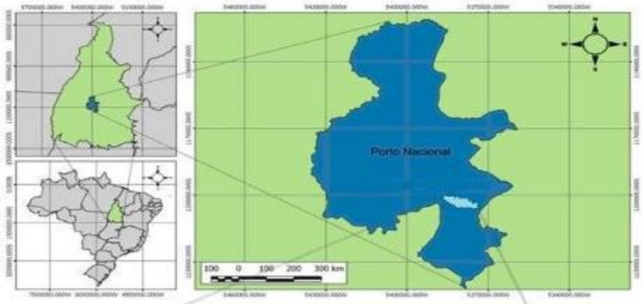

Fig. 1: Location of the municipality of Porto Nacional. Source: (BALDUINO et al., 2018).

Parts of isopores were improperly discarded to the environment, this collected material went through a process of cleaning with water and liquid soap, this act is extremely important because the contaminated material can compromise the results affecting color and uniformity.

For the dilution of the expanded polystyrene, some solvents were used, such as station alcohol, thinner and kerosene. In addition to Styrofoam as a solute, the addition of PVA glue and fiberglass were tested, to acquire plasticity, soy oil was used.

After collecting the material, using a loofah, rub gently with liquid soap, removing all existing impurities. Then 4 types of mixture were made.

Mixture 01 - In a 600 ml beaker, 100 ml of thinner, 30 grams of expanded polystyrene were added, constantly stirring until all the material was diluted.

Mixture 02 - In a 600 ml beaker, 100 ml of thinner, 30 grams of expanded polystyrene, 5 ml of soybean oil and 15 ml of PVA glue were added in constant agitation until all the material was diluted.

Mixture 03 - In a 600 ml beaker, 100 ml of thinner, 30 grams of expanded polystyrene and 30 ml of kerosene were added in constant agitation until all the material was diluted.

Mixture 04 - In a 600 ml beaker, 100 ml of thinner, 30 grams of expanded polystyrene and glass fiber were added in constant agitation until all the material was diluted.

Mixture 04 - In a 600 ml beaker, 100 ml of thinner, 30 grams of expanded polystyrene and glass fiber were added in constant agitation until all the material was diluted.

III. RESULTS AND DISCUSSIONS

First, several solvents were tested to analyze which one has the best performance in dissolving the expanded polystyrene. Dissolution using hydrated ethanol and kerosene did not have a desired effect on EPS, kerosene behaved like an oily solution, being applied together with the thinner performing a binder function.

The cleaning process proved to be necessary because the poor execution of this step generated unwanted results in its coloring.

Samples were applied to fabrics to analyze mobility, strength and measure permeability, as well as tiles and plastered walls.

Solution 1 proved to be a robust material, making it difficult to apply it homogeneously on the surface, a plasticizer material where the thicker layers were opaque and the thinner transparent as shown in figures 2, 3 and 4.

Fig2. Thinner and Styrofoam on fabric.

Fig 3. Thinner and Styrofoam on tile.

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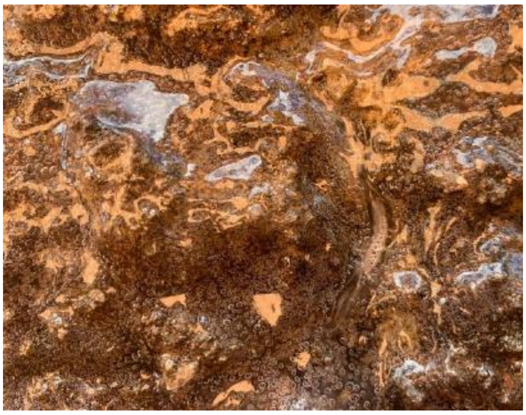

Fig 4. Thinner and styrofoam on the wall.

In solution 2, the substances were not homogeneous, highlighting more particles of expanded polystyrene in the middle of PVA glue according to figures 5, 6 and 7.

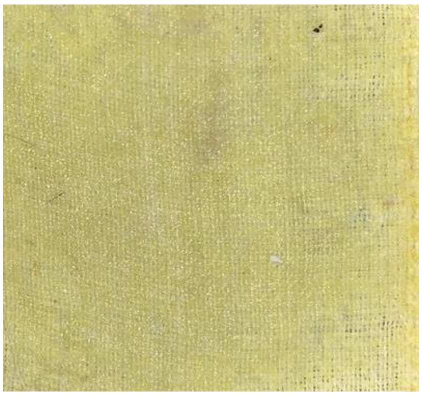

Fig 5. Thinner + Styrofoam + PVA Glue + Oil on Fabric.

Fig 6. Thinner + Styrofoam + PVA glue Oil on the tile.

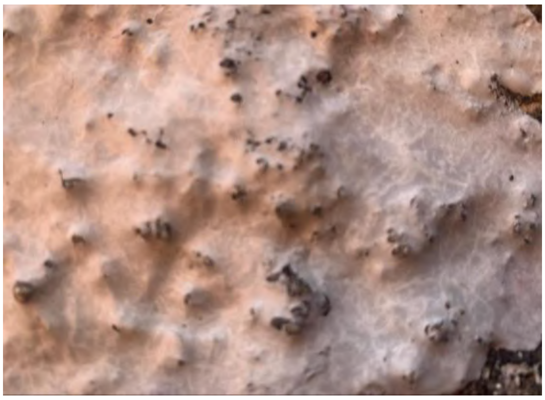

Fig 7. Tiner + Styrofoam + PVA Glue + Oil

Solution 3 proved to be more moldable with the presence of kerosene, facilitating uniform application, with transparent and shiny coloring according to figures 8, 9 and 10.

Fig 8. Thinner + Styrofoam + Kerosene in the fabric

Fig 9. Thinner + Styrofoam + Kerosene on the tile

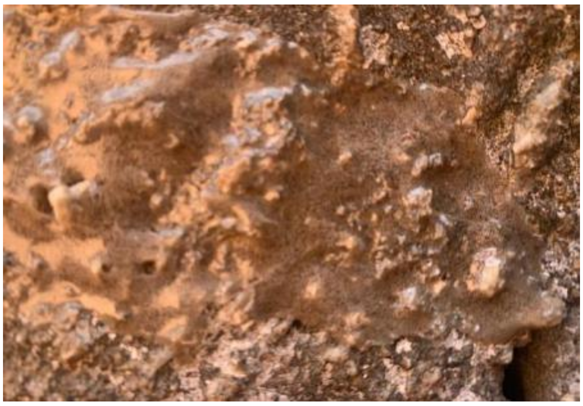

Fig 10. Thinner + Styrofoam + Kerosene on the wall

Substance 4 showed to be a firmer material, gaining mechanical resistance properties after drying, according to figures 10,11 and 12.

Fig 11. Thinner + Styrofoam + Fiberglass on fabric

Fig 12. Thinner + Styrofoam + Fiberglass on the tile

Fig 13. Thinner + Styrofoam + Fiberglass on the wall

Table 1. Characteristics of mixtures.

PROPERTIES	MIX 1	MIX 2	MIX 3	MIX 4
TOUGHNESS	Hard	Moldable	Hard	Very hard
COLORING	Colorless	opaque	Colorless	Partly opaque
WATERPROOFIN G ABILITY	Great	Good	Great	Great

IV. CONCLUSION

All the tests carried out with the different mixtures showed characteristics according to their composition, regardless of that any of the substances presented satisfactory results before the humidity. However, the use of PVA glue and oil influenced both the color and the water resistance, among the four mixtures it was the one that presented less resistance forming a white layer, an unwanted characteristic for waterproofing, another negative point in the mixtures was the immediate application of the product. which formed some bubbles, requiring the complete evaporation of the gases present in the substances. Substances 03 and 04 were the ones that had the best results, mixture 03 showed a transparent coloring with excellent resistance to humidity, whereas mixture 04, in addition to these characteristics, showed a resistance gain due to the presence of fiber, leaving opaque only in the areas that have fibers.

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