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The Possibility of Making a Composite Material from Waste Plastic

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Abstract

The plastic is the most used man-made material in the world through their specific characteristics such as easy manufacturing and shaping, cheaper cost and low density. It is very useful in in different areas such as medicine, architecture, construction and transport. Unfortunately after the use are thrown in nature. Their accumulation poses an environmental problem. Due to the non-biodegradable. The utilization of waste plastic in manufactory of another materiel is a partial solution environmental that will reduce the proportion of waste plastic incineration or landfill.

This work focuses on the Possibility of Making a Composite Material from à sand dune (A natural source abounds) and recycled height density polythene (HDPEr) by mixing the amount. The composite has been designated as roof tile. An experimental test program was conducted on the polymer roof tile containing different percentages (30%, 40%, 50%, 60%, 70% and 80%) of recycled (HDPEr) from the weight of the mixture. Experimental tests were conducted on density, the breaking load by flexural and impermeability test. In this present study, the density of polymer roof tile varies from 1.379 to 1.873 g/ cm3. . The breaking strength by flexural of all polymer roof tile mix were below the resistance of Clay roof tile. A good impermeability gives compared to the control roof tile.

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Keywords: Dune sand, Plastic waste, Possibility, Valorization ; roof tiles

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1. Introduction:

Although plastic is an essential material in our life. It is used in automotive, electronics, buildings and other industries. This production of this material increased in recent years, which has led to a big environmental problem. The plastic waste is not a biodegradable material. Recycling of plastic waste to produce new materials is one of the solution for getting rid of the mountains of trash. A vast work has been done on the use of various plastic waste as aggregates or fillers or fibres in concrete such as height, polytelene terephthalate (pet) [1-4], polystyrene (PS) [5], expanded polystyrene [6], polyvinylchloride (pvc) [7], low density polythene (LDPE) [8], height density polythene (HDPE) [9], E-plastic waste [10], in mortars (pet) [11-13]. The researchers indicated that the waste plastic could be reused as partial substitutes for sand [14], [2, 7, 14] or coarse aggregate [10].

The research revealed that the incorporation of any types or form or size of plastic waste as aggregates generally decreases the dry density [2, 5, 10, 15].

[15] proposed the use of waste plastic with 10, 15, and 20 % plastic aggregates as replacement of fine aggregates in concrete. The results show that the compressive strength and the flexural strength decrease with increasing the waste plastic ratio. [10] studied the utilization of E-plastic waste as fine and coarse aggregate in concrete with percentage replacement ranging from 0%, 10%, 20 and 30%, the study show also that the mechanical properties of concrete contain the E-plastic waste are lower than the concrete without E-plastic waste.

The use of plastics waste in the concrete give a good advantage to reducing the unit weight of it. But gives lower compressive strength and tensile strength.[1, 2, 7, 11, 12, 16]

A review on the use of the plastic waste in manufacturing of concrete or mortar are available[16] however in this paper based to find a new method to valorized the recycled height density polythene and used a natural source abounds

The recycled height density polythene (HDPEr) melted and mixed with the sand dune (SD) to produce new material used as roof tile. An experimental test program is conducted on composite containing different percentages of HDPEr.

2. Experimental program:

The experimental program is:

- Showed that the composite can be made with different percentage.
- Studied the characteristic of this new material.
- Compared the results obtained with a clay roof tile flat (without plastic) and with the standard.

2.1. Materials:

2.1.1. Sand:

The dune sand used in this work was taken form Ain el Beida of Ouargla (Northern Algerian Sahara) (Fig. 1). The characterization tests were performed at the LTP-South. The results are present in the following table:

Table 1. Properties of Dune sand (SD).

Properties	Dune sand (*SD*)
Apparent density	1475 kg/m3
Specific density	2500 kg/ m3

2.1.2. Plastic waste:

Plastic waste used is High density polyethylene recycled (Fig. 1) derived from crates used for transporting. It is in the form of granulate.

The characteristics were performed in the laboratory of Polymed Company – Sonatrach- Skikda. (Fig. 2).

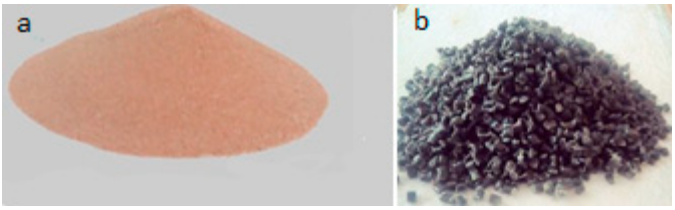

Fig. 1. (a) Sand dune (SD); (b) recycled high density polyethylene.

The results are present in the following table 2:

Table 2. Physical and mechanical properties of recycled high density polyethylene.

Properties	Test Method	Value	Unit
General:			
Melt flow index(2.16kg, 190°C)	ASTM D1238 [17]	0.9	g/10min
Density (23°C)	ASTM D1505 [18]	0.943	g/cm^3
hardness, Shore D	ASTM D2240 [19]	54	
Mechanical:			
Tensile Strength at Break	ASTM D882 [20]	12.71	Mpa
Elongation at break	ASTM D882 [20]	327	%
IZOD impact (23°C)	ASTM D256 [21]	24.33	j/m

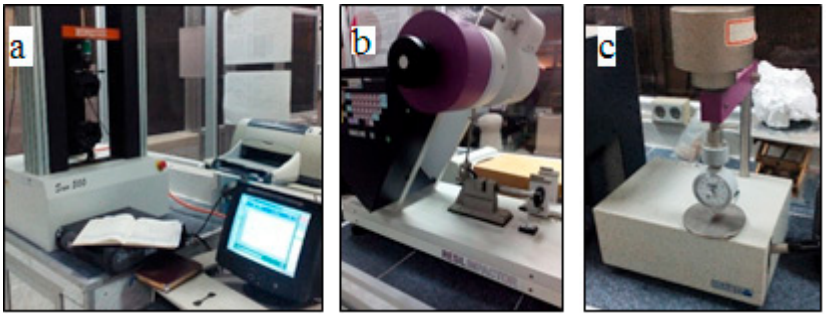

Fig. 2. (a) tensile strength at break & Elongation at break; (b) IZOD impact; (c) hardness, Shore D.

2.2. Mixtures preparation:

2.2.1. Materials needed

To facilitate the manufacture the roof tile we used mold size (100 x 100) mm. a mixer, Oven, Machine compression.

In this research, a control clay roof tile and six mixes were studied. The compositions of polymer roof tiles are characterized by their proportion in 30, 40, 50, 60, 70, and 80% in weight. The compositions of the six proportions of roof tile presented in the table 3. The polymer roof tiles are fabricated according to the process described below:

- Weigh the required quantity of sand dune (SD) and HDPEr.
- Mix and melt the HDPEr with the sand dune (SD) in the Mixer for few minutes.
- Place the mixture in the oven for 10 minutes than remove it
- Put the composite in the mold and apply the load using a press.
- Unmold after cooling the mixture to air.

Table 3. Compositions of the tiles to study.

Components	Proportion 01 (30)	Proportion 02 (40)	Proportion 03 (50)	Proportion 04 (60)	Proportion 05 (70)	Proportion 06 (80)
HDPEr (%)	30	40	50	60	70	80
HDPEr (g)	0.023	0.030	0.038	0.045	0.053	0.060
Dune sand (%)	70	60	50	40	30	20
Dune sand (g)	0.14	0.12	0.10	0.08	0.06	0.04

After the manufacture of the roof tile tow proportion were eliminated:

Pro 01 (30% HDPEr of with 70% SD) because haven't the enough amount of plastic necessary to bond and get a completely tile.

Pro 06 (80% of HDPEr with 20% SD) because it are deformed.

3. Results and discussion:

3.1. Density:

The test of density was carried out according to NF P 18-554 [22]. The density of a composite polymer roof tile are presented in Fig. 3. The results indicated that the density tends to decrease with the increasing the plastic waste ratio in each roof tile mixture.

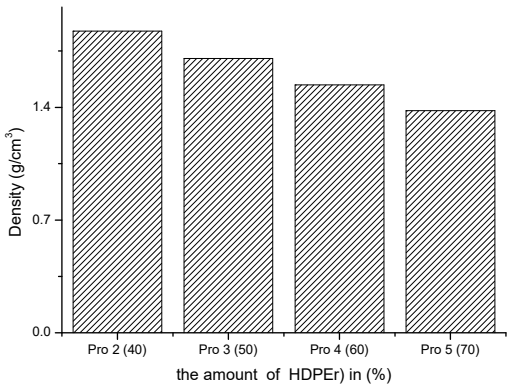

Fig. 3. The density of polymer roof tile.

3.2. The breaking load by flexural:

The test of breaking load by flexural was carried out according to NF EN 538 [23].

The results of the breaking load by flexural tests for the polymer roof tile mixtures pro (0), pro (40), pro (50), pro (60), pro (70) are illustrated in Fig. 4. The results show that the breaking load values of all polymer roof tile mix tend to increase below the values of the roof tile reference and the standard with increasing of amount of HDPEr. This is logical. When the ratio of HDPEr (The binder) increased that gives the material enough bond strength which that led to increase the breaking load.

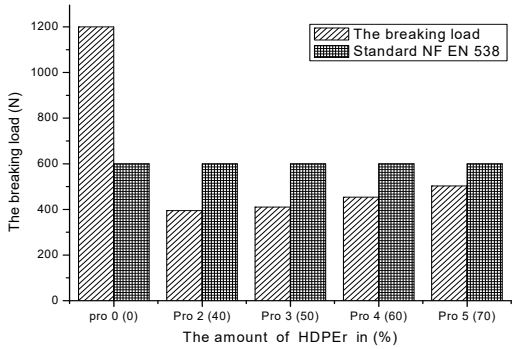

Fig. 4. The breaking load of polymer roof tile

3.3. The Impermeability:

The impermeability were measured according to NF EN 539-1 [24]. The test based on cutting the roof tile to pieces of 45 x 45 mm. Place the tube on the specimen surface sealing the gap between the two with a molten paraffin. Pour the water to reach a height of 10cm. weighing the whole. Then reweigh after 48 h. The difference in weight between the first and the second weighing is the volume of evaporated water (v1) Refer the same procedure by replacing the sample with a glass plate (v2). The impermeability is calculated as follows:

$$IF = \frac{(V1 - V2)}{A \cdot 2} \tag{1}$$

Where V1: Volume of water passing in 48 hours, in cubic centimeter; V2: Volume of water evaporated in 48 hours, in cubic centimeters; A: Projected area of the test piece, in square centimeters

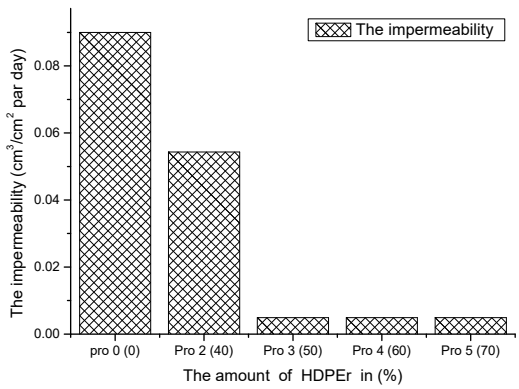

Fig. 5. Variation of average of impermeability in relation to the amount of HDPE.

Similarly to the breaking load, the Fig. 5 shows results of the impermeability coefficient. Irrespective of the amount of HDPEr added in mix, the average value of the impermeability coefficient of the test pieces after the test is below than the standard values 0.5 cm^3 / cm^2. The average value of the impermeability coefficient of polymer roof

tile mix tend to increase with the increasing the ratio of HDPEr below the values of the reference roof tile reference (Clay roof tile).

Table 4. Average values of impermeability.

Components	Impermeability factor cm^3 / cm^2 per day
Pro (0)	< 0.09
Pro (40)	0.0543
Pro (50)	0.0049
Pro (60)	0.0049
Pro (70	0.0049

4. Conclusions

In our study we have successfully demonstrated that it is possible to manufactured roof tile from recycled HDPEr and sand dune. This is one of the most effective methods that can be applied to get rid and save the world form the environmental pollutants. However two mixes are suspended because the pro6 (80) gives a very deformable tile and the second pro1 (30) does not have enough resin (binder) so that the mixture adhere. It is noticeable that the density decreases with the increase of the HDPEr ratio that gives the polymer tile to a light weight.

And also the polymer roof tile containing 70% HDPEr with 30% sand dune gives the best quality. Further all polymer roof tile mix gives a good results in the permeability coefficient according the standard. As a mechanical result the breaking load of all polymer roof tile mix was lower than the clay roof tile reference as well as the standard. According the results this polymer roof tile has potential to be used as Clay roof tile.

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