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Development of Composite Sheets for Emergency Shelters using waste Plastics

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Abstract:
Roofing materials are one of the most essential construction materials. Roofing materials have been changed from low life span renewable roofing material to longer life roofing materials when changing from traditional environmental friendly roofing materials to modern day roofing materials, environmental impacts also raise due to extensive processing requirements to enhance the durability and performance etc. It has been revealed that some common type of roofing materials such as cement asbestos fiber reinforced and coated metal sheets etc. have significant environmental impacts not only during manufacturing but also usage and disposal phases. Conversely, there are many waste material generated from different processes. The quantum of plastic waste generation in India is estimated to be over 20,000Tones per day Hence there is a huge need to reduce, recycle and reuse the waste plastics in order to maintain the eco balance and to avoid the effects of plastic waste hazards to the environment. The aim of this project is to involve plastic wastes in an effective manner to manufacture light weight water proof plastic fabric tents for emergency shelters.

Keywords ***:****Emergencyshelter,Epoxyresin,Plasticfiber, Plastic wastes, Recycle, Roofing sheets.*

I. INTRODUCTION

An emergency shelter is a place for people to live

temporarily when they cannot live in their previous residence, similar to homelessshelters. Sustainable design is often employed in response to global environmental crises, the rapid growth of economic activity and human population, depletion of natural resources, damage to ecosystems, and loss of biodiversity.This project aims in developing sustainable emergency shelters.

A. Problems with Existing Products

There are currently many alternatives to the conventional concrete, stone and cement like materials available in the market. These are usually used for temporary and emergency sheltering mechanisms, with varied purposes catering to a variety of fields. Some of them are mentioned below;

- Tensile fabric
- Tarpaulin
- FRP sheets
- Bitumen sheets
- Shamiyana (in India)

But these materials do come with their own shortcomings.

- Necessity of Extra support structures
- Uneconomical
- Erection is time consuming
- Not sturdy and less stability
- Consumption of new resources

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B. Objectives

The main objectives of the project are as follows,

1. To develop an eco–friendly light-weight, waterproof plastic composite for emergency shelters
2. To manage plastic wastes effectively by shredding and reusing it
3. To ensure that the shelters provided by using plastic wastes are aesthetic, sustainable and easily handleable
4. To further develop the current idea to entertain the use of plastic wastes ahead of conventional construction materials
5. To provide a cheaper alternative material , affordable to all

II. LITERATURE REVIEW

Hao Wang et al. (2019)discussed the Thermoplasticroofing membranes, especially those membranes engineered to cover flat or low - sloped roofs. Many of these membranes are engineered to meet the industry standards defined in ASTM D 790.

RadimSmolkaandJindrichSobotka1(2018) describes andverifies the possibility of applyingsecondary plastic materials to construction details such as flat roofs.

Thong m.Phamet.al(2017) investigated the effects offabrication technique on the tensile properties of fiber reinforcedpolymer (FRP) flat coupon tests.

III. METHODOLOGYDESCRIPTION

The waste plastics are collected and cleaned, then it is shredded into desired sizes and shapes using shredder machine.Shredded plastic may be in the form of fibers, granules or pellets depending upon the quality of the product neede and they are then blended with the resins (epoxy resin, synthetic polymer resin) and poured into thick sheets. These sheets are cured until it sets initially. Once the sheet is set into shape, it is rolled into thin sheets using mechanical rollers.

The sheets are tested according to the standards. Different samples are tried to meet the objectives. The end product is a light weight tensile sheet that can be used for emergency shelters.

A. General

The basic materials used are recycled waste plastic and resin. There is an ever-growing concern for management of plastic wastes all over the world. This situation is attributed to the cause of aggressive usage of plastics, especially that of single-use.

B. Materials Used

The Following materials were used for the preparation of Roofing sheet samples.

1. Plastic Wastes

There is an ever-growing concern for management of plastic wastes all over the world. This situation is attributed to the cause of aggressive usage of plastics, especially that of single-use. Plastic wastes, in general, can be classified into the following types based on their Resin Identification Code:

- Polyethylene Terephthalate (PET)
- High-Density Polyethylene (HDPE)
- Polyvinyl Chloride (PVC)
- Low-Density Polyethylene (HDPE)
- Polypropylene (PP)
- Polystyrene (PS)
- Others, including polycarbonates (PC), bioplastics, etc.

2. Synthetic Resins

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- Epoxy resin
- Polyvinyl Adhesive (PVA)

D. General Procedure

STEP 1: Clean the equipment and all the materials, free ofdust and dirt

STEP 2: Measure various quantities of materials requiredfor sampling

STEP 3: Mix all the components thoroughly to get an evenpaste/matrix

STEP 4: Pour the paste into a plastic tray and spreadevenly

STEP 5: Aluminum foil is placed over the mix to enableproper rolling

STEP 6: Roll over the mix using a roller pin to get uniformthickness

STEP 7: Let the sample dry thoroughly on both sides

STEP 8: Test the samples for tensile and flexure strength

STEP 9: Compare the results with existing material values

STEP 10: Finally, prepare the report for the work donewith all details

E. Development of Samples

Fig.1 Weight Batching of Raw Materials

SAMPLE 1:

Fig.2Fibers with Silicone

Components used

- Silicone Paste
- Plastic Fibres

Casting

- Casted into thin sheets

Drawbacks

- **No proper adhesion**
- **Casting** is a problem

SAMPLE 2:

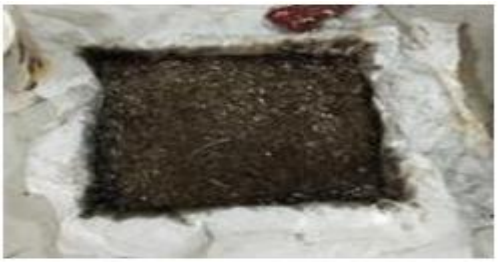

Figure 3:Fibers with Epoxy Resin

Components used

- Epoxy resin : 100gms
- Harderner :10gms
- Plastic fibres : 50 gms
- Casting

- Thick Sheets
- Properties
- Hardenes within 30 mins
- Cures within an hour
- Extremely hard and rigid

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SAMPLE 3:

Fig.4Fibers with Epoxy Resin

Components used

- Epoxy resin : 100gms
- Harderner :10gms

- Plastic fibres : 50 gms

Casting

- Thin Sheets

Properties

- Flexible for nearly 2 weeks
- Can be cast into any shape desired
- Hardens gradually and becomes brittle at the end of curing
- Can be used for cladding purposes, décor applications etc.

SAMPLE 4:

Fig.5:Fibers with Epoxy Resin (Less Hardener)

Components used

- Epoxy resin : 100gms
- Harderner :5gms
- Plastic fibres : 20 gms

Casting

- Thin Sheets

Properties

- Takes approximately one week for complete curing
- Flexible and can be molded into any shape desired within the curing period

SAMPLE 5:

Casting

- Thin Sheet

Properties

- Takes 2- 3 days to dry completely
- Extremely flexible
- Good bonding

IV. RESULTS AND DISCUSSION

Sample 5 and Sample 6 attained the desired objectives and hence testing was carried out for only those samples. Tensile and Flexural strength tests were carried out. The results given by the laboratory is also attached.

The properties of the final samples are as listed below:

B. Physical Properties

Table – I: Physical properties of the Sample

Properties	Sample 5	Sample 6
Color	White	White
Thickness	2.74 mm	4.64 mm
Weight of sample (200mm x 25mm)	8.5 g	9 g
Density	0.62 g/cc	0.39g/cc

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C. Mechanical Properties

Fig.6:Fibers with Synthetic Adhesive (1:2)

Components used

- Plastic Fibers : 40 gms
- Resin : 100 gms

Casting

- Thin Sheet

Properties

- Takes 2- 3 days to dry completely
- Extremely flexible
- Good bonding

SAMPLE 6:

Fig.7:Fibers with Synthetic Adhesive (1:2.5)

Components used

- Plastic Fibers : 50 gms
- Resin : 100 gms

The obtained test results are as follows:-

1. Tensile Test
2. Flexural Test

1. Tensile Strength Test

The tensile strength test was conducted on all Samples and the following two samples were found to be effective

Table - II: Tensile Strength of the Sample

Test Parameters	Observed Values	
	Sample 5	**Sample 6**
Gauge Width (mm)	26.84	27.65
Gauge Thickness (mm)	2.74	4.64
Original Cross Sectional Area(mm^2)	73.54	128.30
Ultimate Tensile Load (kN)	0.05	0.06
Ultimate Tensile Strength (N/mm^2 or Mpa)	0.75	0.47

2. Flexural Strength Test

Similarly flexural strength test was conducted on all Samples and the following two samples were found

Table –III: Flexural Strength of the Sample

Test Parameters	Observed Values	
	Sample 5	**Sample6**
Flexural Strength (N/mm^2 or MPa)	2.00	1.00

D. ANALYSIS

From the above results it is found that, the two different samples made with different proportions of Bulbond resin and recycled

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waste plastic fibers are done with various tests and the obtained results are compared with the presently available market products like tarpaulin.Sample 1 with standard size attained the tensile strength of 0.75N/mm^2 and the flexural strength of 2N/mm^2, which is 10% of the strength of the tarpaulin sheets. Similarly, Sample 2 attained the strength of 0.47N/mm^2 and 1N/mm^2 respectively, which is 9% of the strength of the tarpaulin sheets.

Table –IV: Strength of plastic composites

Tensile strength in plain sheet at state of origin	
SAMPLE 5:- 100gms of Bulbond 40gms of plastic fibers	Minimum 0.75N/mm^2 , which is 10% of the tensile strength of the tarpaulin sheet
SAMPLE 6:- 100gms of Bulbond 50gms of plastic fibers	Minimum 0.47N/mm^2, which is 9% of the tensile strength of the tarpaulin sheet

Table -V: Test Results of Mechanical Properties

Flexural strength in plain sheet at state of origin	
SAMPLE 5:- 100gms ofBulbond 40gms of plastic fibers	Minimum 2N/mm^2 , which is 10% of the tensile strength of the tarpaulin sheet
SAMPLE 6:- 100gms of Bulbond 50gms of plastic fibers	Minimum 1N/mm^2, which is 9% of the tensile strength of the tarpaulin sheet

VI. CONCLUSION

- A flexible roofing sheet was developed using recycled waste plastics. The materials were subjected to various tests such as tensile and flexure. The result obtained was 10 – 12% of the existing roofing sheets.
- Roofing Sheet Material from recycled plastic is very competitive to all the other commercial Roofing sheets available in the market.
- Theirproperties put them in compositions where traditional heat insulation materials are used.
- Using a product in a lower thickness for a structure, makes it flexible, lighter in weight and easy to handle while the requirements of technological standards are met.
- Cost of the Roofing sheet Material from recycled plastic is also economical
- flexible roofing sheet was developed using
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recycled waste plastics. The materials were subjected to various tests such as tensile and flexure. The result obtained was 10 – 12% of the existing roofing sheets

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