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FABRICATION AND HARDNESS EXAMINATION OF RECYCLED PLASTIC COMPOSITE WITH GLASS FIBRE

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Abstract - *Plastics are used widely throughout the world due to its variety of uses. Though plastics are used in various purposes, it cannot be degraded. Hence it may lead to increase in pollution rates. Plastics can be recycled again to use effectively. It can also be used for the fabrication of railway sleepers. Timber is the most widely used railway sleepers. Due to increasing the rate of deforestation, timber sleepers are to be replaced by various sleepers such as steel and concrete sleepers. To evolve the eco-green revolution, the recycled plastics can also be used in case of timber sleepers. This project work aims on the production of composite railway sleepers using recycled plastics for effective replacement of timber sleepers.*

Key Words: Plastics, Recycle, Railway Sleepers, Injection Moulding, Strength

1.INTRODUCTION

Due to the increased pollution, many harmful effects are caused to the environment. By promoting the eco green evolution and decreasing the pollution, innovative measures should be taken. Various measures have been taken around the world and one of the main hindrances to the environment is the usage of Plastics. Plastics cannot be decayed easily. The only way is by recycling it to a useful product. Our project aims in the usage of these used plastics for the production of the railway sleepers, thereby replacing the commercial wooden sleepers which would also promote the deforestation. The need for the alternatives for the railway sleepers and established that the fibre composites support the development of lightweight, high strength and more durable sleepers for replacing timber sleepers [01]. Several researches and developments on fibre composite sleepers have shown that thisalternative material has physical and mechanical properties comparable or Even better than that of timber sleepers. Composite materials are enhanced nowadays for various purposes. The main advantage of using a composite material is due to its tensile strength and rigidity. It is also available at low cost. The strength of composite material is depended on its composition. Anshuman Sahay et.al showed the usage of HDPE in composite sleepers strengthening and also highlighted the gaps in the current research and the employed model in the railway networks across subcontinent. Hoo Tien Kuan et.al evaluated the mechanical properties of composite materials based on two types of Self-Reinforced Polypropylene (SRPP) and a glass fibre reinforced polypropylene are investigated under quasi-static and dynamic loading conditions. By using a specific amount of composition the relative properties can be varied. In case of plastics while recycling, the plastic particles are shredded in a recycler and it is extracted and the shredded particles are heated at high temperature which could be solidified and used for various purposes. Polymer composites with stitched sandwich structure improved the mechanical properties with increasing the number of stitching yarns [Geon-Woong Lee et.al]. The fracture resistance was significantly higher in the injection moulded, fibre-reinforced composites than in the injection-moulded composites, and the fracture resistance was significantly higher in the microwave moulded, fibre-reinforced composites, than in the microwave-moulded composites [IH Tacir et.al]. From the above literature survey, the need for composite sleepers implementing to railways [1]&[2] is established and the composite material made of High Density Polyethylene (HDPE) [02], Polypropylene (PP) [03], epoxy resin, stitched glass fibre [4], plays an important role to improve its mechanical properties, and the injection moulding process [05] can be used to fabricate the composite materials for the best results, the produced sample can be used for determination of the alternative for the timber sleepers. Hardness of metallic and non-metallic materials will influence more on other properties[12].

2. AIM AND PURPOSE OF PRESENT WORK

Timber sleepers have good mechanical properties over Concrete and steel sleepers. The flexural crack for a concrete sleeper is low. Similarly, steel sleepers should not be mixed with timber sleepers because of the differential settlement. The shape and size of steel sleepers results in a tendency to settle more quickly than timber sleepers. This problem can only be overcome by replacing woody sleepers in a rail track with concrete or steel sleepers even but this practice is more expensive. Another concern is that manufacturing concrete and steel sleepers requires more energy and is one of the largest producers of polluting the environment. However, the main problem with timber sleepers is their tendency to rot, particularly near the points where they are fastened to the rails. Similarly, replacement of timber sleepers are now being

cut from less desirable species due to the declining availability of quality hardwoods. An alternative material for sleeper replacement having minimum cost to overcome problems come across using timber sleepers is therefore provided by composite sleepers with its vast mechanical properties and its life. The comparisons of existing materials for railway sleepers presented in table 1.

Table -1: Comparisons of existing materials of Railway Sleepers

Properties	Timeber	Concrete	Steel
Availability	Hing	High	High
Adaptability	Difficult	Difficult	Difficult
Workability	Easy	Difficult	Difficult
Handling	Easy	Difficult	Difficult
Durability	Low	High	Low
Maintenance	High	Low	High
Replacement	Easy	Difficult	Difficult
Impact	High	Low	Medium

To improve the usability of recycled plastics in railway sleepers, reduce the usage of timbers in sleepers are the important objectives of this work.

3. EXPERIMENTAL PROCEDURE

As the plastic granules cannot be degraded, recycling procedure is in use for preparing the new materials. Since plastics are prepared from the petroleum, the plastics cannot be burned to recycled. High-density polyethylene (HDPE) or polyethylene high-density (PEHD) is a polyethylene thermoplastic made from petroleum. The figure 3.1 presents the typical recycled polymers and die-set.

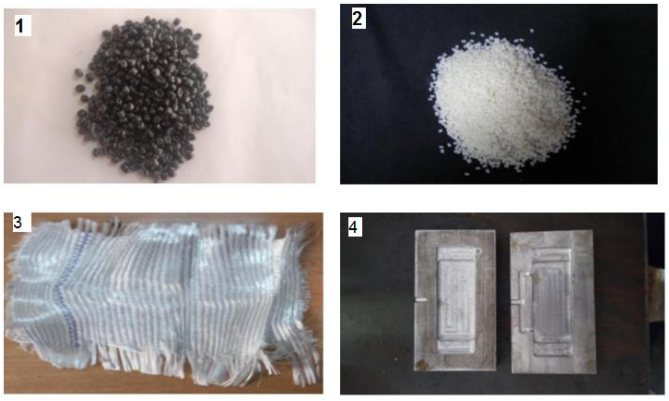

Fig -1: High-density polyethylene (HDPE), 2. Polypropylene (PP), 3. Glass Fiber, 4. Die-sets

Poly Propylene has good mechanical and physical properties which could be used in making the composite materials. The Polypropylene is recyclable and it is ranked no.5 in the plastic identification code. The recycled polypropylene is made to granules and used for the experimentation. Glass is the most common fibre used in polymer matrix composites. The most commonly used glass fibres are E-glass, S-glass, M-glass, C-glass and D-glass fibres. Various designations of glass are tabulated along with its properties. The injection moulding process, in which hot molten plastic is injected under high pressure into a thin cold mould. The injection moulding process is done in an injection moulding machine. The machine we are using here is a vertical plunger type injection moulding machine. It has a heating capacity of about 270°C and has the capacity of holding granules up to 120 grams. Die is an apparatus used to collect the molten plastics and shape it to its mould. Die should be prepared in accordance with the injection moulding machine and mould should be prepared with our sample dimensions. We designed our die as per our sample which is having test dimensions as per ASTM standards D638, D735 and A370. The largest dimensions of all combined three standards are taken and the die is designed for the sample. The Die is prepared in the automated CNC machine. The Die is provided with ejector pins to eject the solidified sample. Fabrication includes the preparation of the glass fibre reinforced plastic composite material sample. As for a composite material constitution, a composite material should have the matrix and reinforcements. Here the Epoxy resin acts as matrix while the recycled plastic granules and triaxial glass fibres act as reinforcements. The fabrication of the composite sample is done by following steps 1. Preparation of Inserts, 2. Fixing inserts to die 3. Injection moulding Process 3. Ejection and 4.Finishing. Preparation of insert includes the mixing of the matrix and reinforcement material. First the triaxial glass fibres are taken and are cut into the ASTM standard sample sizes which should be able to withhold into die. The triaxial fibres can only be able to cut by the tailor scissors as it is like a woven fabric. The glass fibres cut to the sample size where soaked in the epoxy resin mixture. The epoxy resin mixture consists of resin and hardener; which in turn mixes with each other to form a perfect adhesive. The soaked glass fibres are dried for about 3-4 hours, till the material is hardened. When it is hardened, the size of the insert is measured and the additional materials are cut using a hand cutter. The insert for the exact sample is then produced by finishing the edges using a grinding machine. The inserts thus prepared are placed inside the die perfectly. If there is any elongation of the insert in the outside, it will block the runner and the mould will not be in a good shape. Hence the insert fixed to the die should be more accurate. When the insert is fixed to the die, it is closed and placed in the table of the injection moulding machine.

After the die being placed in the injection moulding machine, it is ready for preparation of the mould. The recycled plastic granules are poured into the hopper funnel from which the granules are passed to the heater. The temperature is set in the control panel for the corresponding plastic material. When the plastic granules reach its melting point inside the heater, the plastic materials melts and form into a molten liquid. The plunger is pushed down to give sufficient pressure for pouring the molten plastics to the die. Figure 2 shows the typical arrangement of die inserts and injection moulding process.

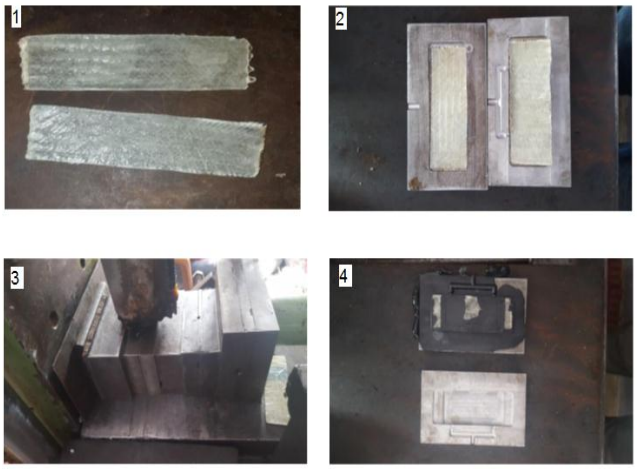

Fig -2: Fiber inserts, 2. Fiber inserts in Die, 3. Injection Moulding Process and 4. Solidification

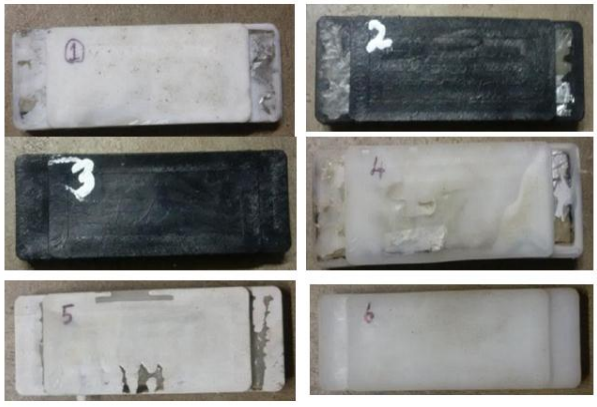

Fig -3: Sample

The molten plastic is passed out through the nozzle of the machine to the mouth of the die. The molten plastic sent through the mouth pass through the runners and surrounds the insert and gets solidified. Thus the composite sample is prepared in the mould. By the above fabrication process various samples are prepared with different composition of matrix and reinforcements. Each of the samples is displayed below. Table 2 presents the sample composition.

Table -2: Sample Composition

Samples	Resin	Reinforcements	Moulding Temperature
Sample 1	Epoxy	Virgin HDPE, GF	200 °C
Sample 2	Epoxy	Recycled HDPE, GF	160 °C
Sample 3	-	Recycled HDPE	160 °C
Sample 4	Epoxy	Virgin PP, GF	210 °C
Sample 5	Epoxy	Recycled PP, GF	190 °C
Sample 6	-	Recycled PP	190 °C

4. RESULTS AND DISCUSSION

The samples prepared by injection moulding process are allowed to evaluate their mechanical properties. Table 3 presents the hardness of each sample.The table shows the result of the hardness test for various samples. The result of the samples 2, 3, 5 and 6 are taken for the further discussion as it is made from the recycled plastics, meanwhile the test results of the sample 1 and 4 are also noted for the enhanced hardness. The Brinell hardness number of the timber ranges from 4 to 7. As the result shows the hardness number of all samples exceeding 7, the samples can be allowed as an alternative for the timber in railway sleepers.

Table -3: Comparisons of existing materials of Railway Sleepers

Sample	Test 1	Test 2	Test 3	Average BHN
1	8.49	8.47	8.48	8.48
2	7.93	7.94	7.89	7.92
3	7.41	7.38	7.32	7.37
4	7.87	7.78	7.81	7.82
5	7.26	7.24	7.13	7.21
6	6.82	6.87	6.8	6.83

5. CONCLUSIONS

The alternative material for the timber sleepers are prepared by using recycled waste plastics. Both recycled plastic materials shows good strength compared to the timber sleepers in the hardness test results. The composite sleeper using recycled plastics will reduce the plastic waste content and also supports in deforestation.

6. FUTURE WORK

The composite sleeper prepared with the sample discussed can be fabricated as per the standard dimensions of the railway sleeper. The tests for determining the flexural strength, Young's modulus and Poisson's ratio are to be calculated and the railway sleeper is implemented commercially. These waste plastics can make as a fill material for cooling tower [11].

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