UTILIZATION OF PLASTIC WASTE AS ALTERNATIVE CONSTRUCTION MATERIAL

Abstract

In response to the global challenge of plastic pollution, innovative solutions are emerging to repurpose plastic waste as a valuable resource in the construction industry. Plastic waste, often considered a problematic material due to its non-biodegradable nature, can be transformed into various construction materials with diverse applications. Harnessing the potential of plastic waste as a construction material signifies a significant step towards a circular economy, where resources are utilized efficiently, waste is minimized, and environmental stewardship is prioritized. Our study focuses on innovation, collaboration, and responsible management, plastic waste can be transformed from a problem into a valuable asset in shaping a more sustainable future for the construction industry and the planet.

Keywords: Non-Biodegradable, Plastic Pollution, Construction Materials.

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I. INTRODUCTION

1. **General Introduction:** Plastic is the general term for a wide range of synthetic or semi synthetic polymerization products. They are composed of organic condensation or addition polymers and may contain other substances to improve performance or economics. There are few natural polymers generally considered to be "plastics". These polymers are broken in presence of suitable catalyst, into monomers such as ethylene, propylene, vinyl, styrene and benzene. These monomers are then chemically polymerized into different categories of plastics.

   Plastic products have become an integral part of our daily life as a basic need. It is produced on a massive scale worldwide and its production crosses the 150 million ton per year globally. In India approximately 8 Millionton plastic products are consumed every year (2008). Its broad range of application lies in films, wrapping materials, shopping and garbage bags, fluid containers, clothing, toys, household and industrial products, and building materials. It is a fact that plastics will never degrade and remains on landscape for several years. Mostly, plastics are recyclable but recycled products can again be recycled but the litter left over in earth system and water systems are more hazardous to the environment. The recycling of a virgin plastic material can be done many times, but after every recycling, the plastic material is deteriorated due to thermal pressure. Considering, 70% of plastic consumption is converted as waste over time, approximately 5.6 million tons per annum (TPA) plastic waste is generated in country, which equals to 15342 tons per day.

2. **Plastics Consumption in India:** National plastic waste management task force in 1997 projected the polymers demand in the country. Polymers Demands in India (Million Ton) documents the demand of different polymers in India during years 1995-96, 2001-02 and 2006-07. The comparison of demand and consumption from more than one fourth of the consumption in India is that of PVC which is being phased out in many countries. Poly bags and other plastic items except PET in particular have been a focus, because it has contributed to host of problems in India such as choked sewers, animal deaths and clogged soils.

II. OBJECTIVES

1. To investigate the actual supply chain network of plastic waste from households to commercial units along with the other recyclables.
2. To identify and propose a sustainable plastic waste management by installing Waste Exchange centers and bins for collection of recyclables with all the plastic waste and a Waste Processing Unit for primarily non-recyclable plastics waste.
3. Preparation of a Project Report, system design, sourcing of equipment, and necessary modalities for implementation and monitoring.
4. To Emphasize the reduced use of "**Plastic waste**".
5. Efficient transformation of plastic waste into "**Construction Materials" .**
6. Controlling the impact of plastic waste on the environment, making our environmentan "**Eco Friendly Zone" .**
7. Grow the contribution of the waste sector to **GDP.**
8. Ensure the design and manufacture of products that avoid or minimize waste

generation.

9. Stabilise quantity of waste disposed to landfill then reduce the volume of plastic waste.

III. PROCESS

The raw materials used are Recycled Plastic waste, Cement of OPC 53 grade, M-sand, Sea sand, 20mm down size coarse aggregate, standard concrete mould of 15cm cube and **I shape** cast iron mould for the paver blocks. The different categories of plastics are specified below

1. Categories Of Plastics

- Polyethylene Terephthalate (PETE or PET)
- High-Density Polyethylene (HDPE)
- Polyvinyl Chloride (PVC)
- Low-Density Polyethylene (LDPE)
- Polypropylene (PP)
- Polystyrene or Styrofoam (PS)
- Polystyrene
- Other (like CD, Toys and etc.

Figure 1: Categories of Plastic

2. **Methodology:** To prepare Sea-sand & M-sand paver as per proportion (1:2, 1:3, 1:4).

- Plastic waste collection, intosegregation and storage
- Shredding plastic waste required size

Figure 2: Plastic waste Collection

Figure 3: Plastic Shredding

- Provide the heat to the Plastic waste until it melts
- Mix the melted plastic in to the sand as per proportion

Figure 4: Heating of Plastic

Figure 5: Mixing

- Added mixture in to mould
- Demoulded plastic paver

Figure 6: Added mixture in to mould

Figure 7: Demoulded plastic paver

3. Methodology: To prepare Sea-sand & M-sand block as per proportion (1: 1.5: 3).

- Mixture of sand plastic grains and cement as per mix proportion

- Adding the water per mix

Figure 8: Mixing

Figure 9: Adding of water

- added mixture in to the mould
- demoulded concrete block

Figure 10: Added mixture in to the mould

Figure 11: Demoulding of Blocks

4. Mix Designs

- **Mix Proportions of Plastic Pavers:** The mix proportion of pavers are obtained from the standard results the mix proportions weadopted fro the manifacturing of pavers is (1:2,1:3,1:4). The mix proportion 1:2 indicates that the one proportion of plastic and two proportion of fine aggregate

The Volume of a Paver mould or Block (v) = Area x Height

= 27500 x 60

= 1653000 mm^3
= $1.653x10^{-3}$ m^3
Considering 25% Extra Volume

= $1.653x10^{-3}$ x 1.25

Total Volume (V) = $2.06625 x10^{-3}$ m^3

Table 1: Mix Proportions of Plastic Pavers

Mix proportion	Volume of plastic in m3	Weight of plasticin kg	Weight of fineaggtegate in kg
1:2	4.130×10^{-4}	0.570	2.28
1:3	5.16563×10^{-4}	0.7128	2.138
1:4	6.8875×10^{-4}	0.9504	3.80

- **Mix Proportions of Concrete Block:**

  - Mix proportion for a concrete block using Recycled plastic waste as the partial replacement of M-sand

Table 2: Mix Proportions of Concrete Block

Water Cement Ratio (kg/m3)	Cement(kg/m3)	Fine Aggregate (kg/m3)	Coarse Aggregate(kg/m3)
186	383.16	685.58	1178.13
0.5	1	1.789	3.074

Table 3: Mix Proportions of Concrete Block

Mix	Replacement (%)	Mass of fine aggregate (kg)	Mass of plastic replacedby fine aggregate (Kg)	Watercement ratio	Mass of cement (Kg)	Mass of coarse aggregate (Kg)
M0	0	3.5	0	0.5	1.94	6.2
M1	10	3.15	0.35	0.5	1.94	6.2
M2	15	2.975	0.525	0.5	1.94	6.2
M3	20	2.8	0.70	0.5	1.94	6.2

  - Mix proportion for a concrete block using Recycled plastic waste as the partial replacement of Sea sand

Table 4: Mix Proportions of Concrete Block

Water CementRatio (kg/m3)	Cement(kg/m3)	Fine Aggregate (kg/m3)	Coarse Aggregate (kg/m3)
186	383.16	666.8	1216.14
0.5	1	1.74	3.174

Table 5: Mix Proportions of Concrete Block

Mix	Replacement (%)	Mass of fine aggregate (kg)	Mass of plastic replaced by fine aggregate (Kg)	Water cement ratio	Mass of cement (Kg)	Mass of coarse aggregate (Kg)
M0	0	3.4	0	0.5	1.94	6.2
M1	10	3.06	0.34	0.5	1.94	6.2
M2	15	2.89	0.51	0.5	1.94	6.2
M3	20	2.72	0.68	0.5	1.94	6.2

IV. RESULTS AND DISCUSSIONS

1. **Tests on Cement:** The different tests conducted on cement are "specific gravity test, Normal consistency test, Initial setting time and final setting time test" and its values are listed in below table.

Properties of Cement

Table 6: Properties of Cement

S. No.	Properties	Values obtained	Standard values
1.	Specific gravity	3.114	3.15
2.	Normal consistency	30%	30%
3.	Initialand Final setting time	30 minand 580 min	Not less than 30 mins Not greater than 10 hrs

2. **Tests on Fine Aggregates**

- **Tests on M-sand:** The different tests conducted on M-sand are specific gravity test and particlesize distribution test are conducted on M-sand and the values are listed on a below table

➢ **Properties of fine aggregates (M– sand):**

Table 7: Tests on M-sand

Properties	Values obtained
Specific gravity	2.63
Fineness Modulus	3.67

- **Tests on Sea sand:** The different tests conducted on Sea sand are specific gravity test and particlesize distribution test are conducted on Sea sand and the values are listed on a below table

➢ **Properties of fine aggregates (Sea sand)**

Table 8: Tests on Sea sand

Properties	Values obtained
Specific gravity	2.702
Fineness Modulus	2.42

3. **Tests on coarse aggregates (20mm down size aggregate):** The test conducted on coarse aggregate is specific gravity test and the value islisted in below table.

➢ **Properties of coarse aggregates**

Table 9: Properties of coarse aggregates

Properties	Values obtained
Average Specific gravity of coarse aggregate	2.77

4. **Properties of Low Density Poly Ethylene (LDPE)**

Table 10: Properties of Low Density Poly Ethylene (LDPE)

Properties	Values
Physical State	Solid
Appearance	Granules
Grain size	5-7 mm
Density	.930 g/cm^3
Heat Resistance	80^o C

V. COMPRESSION TESTS ON PAVERS AND BLOCKS

1. Results of Compression Test on Pavers:

- **Test on M-Sand Paver:** Compression strength on pavers of ratio (1:2)

Table 11: Test on M-Sand Paver

Sl no	Area (mm^2)	Load (kN)	Compressive strength (N/mm^2)	Avg compression strength(N/mm^2) or Mpa
1	27500	685.0	24.92	25.16
2	27500	690.0	25.12	
3	27500	700.0	25.45	

Compression strength of pavers of ratio (1:3)

Table 12: Test on M-Sand Paver

Sl no	Area (mm^2)	Load (kN)	Compressive strength (N/mm^2)	Avg compression strength(N/mm^2) or Mpa
1	27500	650.0	23.63	23.66
2	27500	635.0	23.10	
3	27500	670.0	24.24	

Compression strength of pavers of ratio (1:4)

Table 13: Test on M-Sand Paver

Sl no	Area (mm^2)	Load (kN)	Compressive strength (N/mm^2)	Avg compression strength(N/mm^2) or Mpa
1	27500	625.0	22.78	23.57
2	27500	645.0	23.45	
3	27500	675.0	24.55	

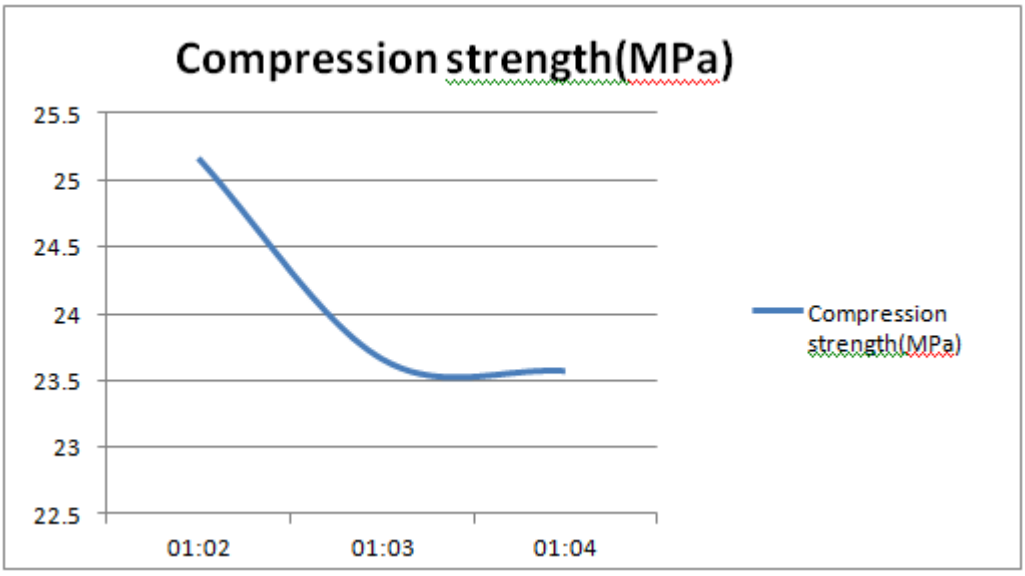

Figure 12: Compression Strength

- **Test on Sea sand Paver:** Compression strength on pavers of ratio (1:2)

Table 14: Test on Sea sand Paver

Sl no	Area (mm^2)	Load (kN)	Compressive strength (N/mm^2)	Avg.compression strength(N/mm^2) or MPa
1	27500	595.0	21.63	22.17
2	27500	630.0	22.90	
3	27500	605.3	22.00	

Compression strength of pavers of ratio (1:3)

Table 15: Test on Sea sand Paver

Sl no	Area (mm^2)	Load (kN)	Compressive strength (N/mm^2)	Avg.compression strength (N/mm^2) or MPa
1	27500	710.0	25.82	25.91
2	27500	680.0	25.73	
3	27500	720.0	26.19	

Compression strength of pavers of ratio (1:4)

Table 16: Test on Sea sand Paver

Sl no	Area (mm^2)	Load (kN)	Compressive strength (N/mm^2)	Avg.compression strength(N/mm^2)or MPa
1	27500	685.0	24.90	24.78
2	27500	675.0	24.55	
3	27500	685.0	24.9	

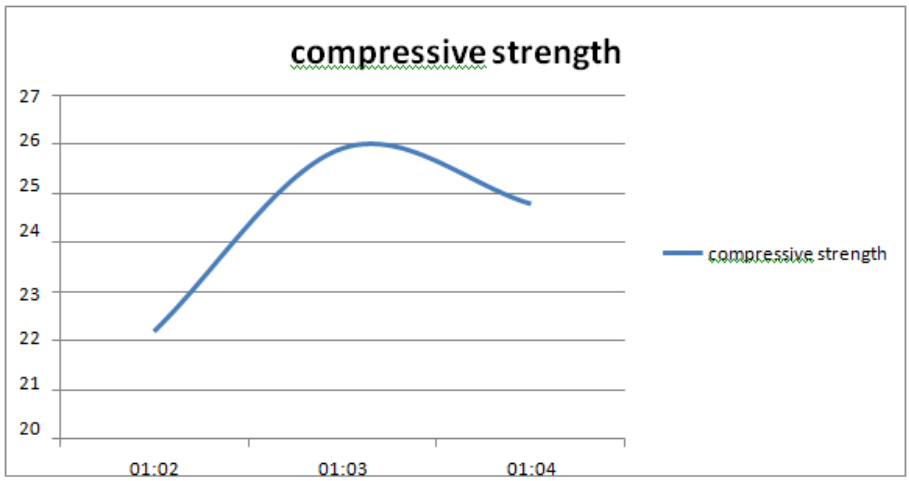

Figure 13: Compressive strength

2. Results of Compression Test on Blocks

- **Test on M-Sand Block:** Compression strength of block (15 mm x 15 mm x 15 mm) for 0% (zero) replacement ofPlastic by sand

Table 17: Test on M-Sand Block

Sl no	Area (mm^2)	Load (kN)	Compressive strength (kN/mm^2)	Avg compression strength(N/mm^2) or Mpa
1	22500	565.1	24.94	25.280
2	22500	576.8	25.64	
3	22500	568.4	25.26	

Compression strength of block (15mmX15mmX15 mm) 10% replacement of Plastic by sand

Table 18: Test on M-Sand Block

Sl no	Area (mm^2)	Load (kN)	Compressive strength (kN/mm^2)	Avg compression strength(N/mm^2) or Mpa
1	22500	619.3	27.53	27.97
2	22500	647.8	28.79	
3	22500	620.8	27.6	

Compression strength of block (15mm x15mm x15 mm) 15% replacement of Plastic by sand

Table 19: Test on M-Sand Block

Sl no	Area (mm^2)	Load (kN)	Compressive strength (kN/mm^2)	Avg compression strength(N/mm^2) or Mpa
1	22500	632.7	28.12	27.89
2	22500	610.9	27.15	
3	22500	639.2	28.41	

Compression strength of block (15mm x15mm x15 mm) 20% replacement of Plastic by sand

Table 20: Test on M-Sand Block

Sl no	Area (mm^2)	Load (kN)	Compressive strength (kN/mm^2)	Avg compression strength(N/mm^2) or Mpa
1	22500	591.5	26.29	27.85
2	22500	568.7	25.28	
3	22500	584.6	25.98	

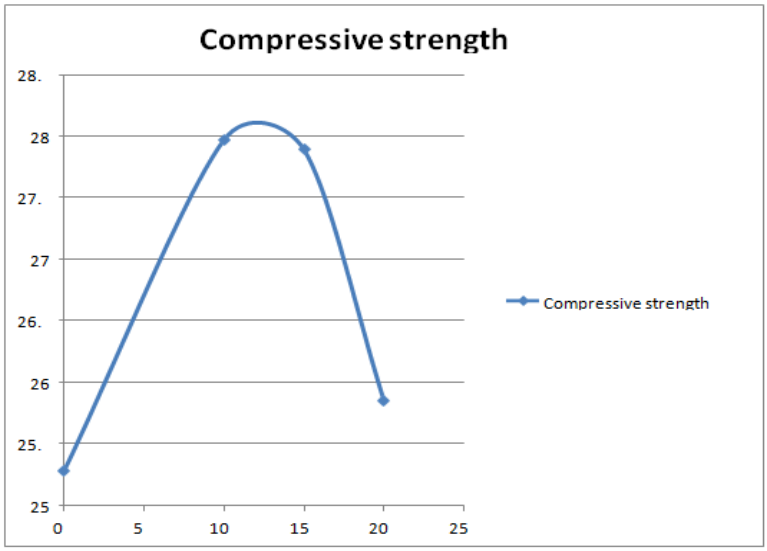

Figure 14: Compressive strength

- **Test on Sea Sand Block :** Compression strength of block (15mmX15mmX15 mm) for 0% (zero) replacement ofPlastic by sand

Table 21: Test on Sea Sand Block

Sl no	Area (mm^2)	Load (kN)	Compressive strength (kN/mm^2)	Avg.compression strength(N/mm^2) or Mpa
1	22500	852.5	37.89	36.34
2	22500	817.8	36.34	
3	22500	783.1	34.80	

Compression strength of block (15mmX15mmX15 mm) 10% replacement of Plastic by sand

Table 22: Test on Sea Sand Block

Sl no	Area (mm^2)	Load (kN)	Compressive strength (kN/mm^2)	Avg.compression strength(N/mm^2) or Mpa
1	22500	548.2	25.36	24.36
2	22500	570.7	24.36	
3	22500	525.7	23.36	

Compression strength of block (15mmX15mmX15 mm) 15% replacement of Plastic by sand

Table 23: Test on Sea Sand Block

Sl no	Area (mm^2)	Load (kN)	Compressive strength (kN/mm^2)	Avg.compression strength(N/mm^2) or Mpa
1	22500	486.4	21.62	20.75
2	22500	447.5	19.89	
3	22500	467.0	20.75	

Compression strength of block (15mmX15mmX15 mm) 20% replacement of Plastic by sand

Table 24: Test on Sea Sand Block

Sl no	Area (mm^2)	Load (kN)	Compressive strength (kN/mm^2)	Avg.compression strength(N/mm^2) or Mpa
1	22500	442	19.64	18.66
2	22500	420	17.68	
3	22500	420	18.67	

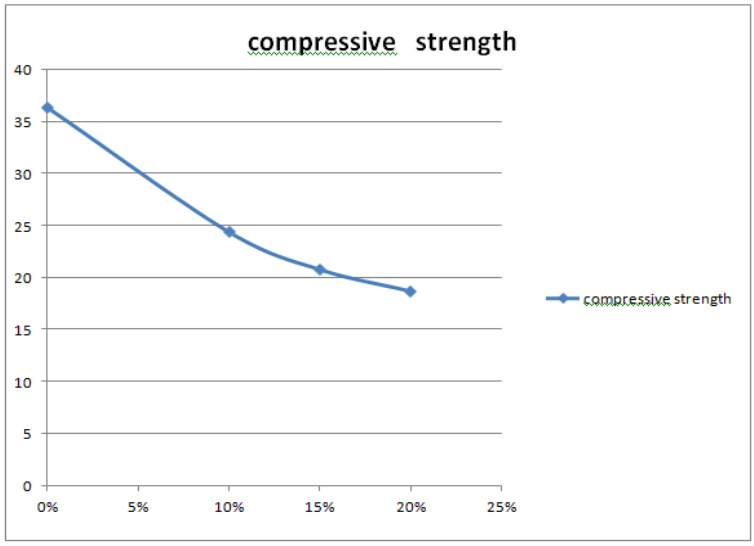

Figure 15: Compressive strength

VI. CONCLUSION

1. Conclusion for PAVERS

- **M sand:** The compressive strength of pavers for the proportion 1:2 will be maximum compared to 1:3 and 1:4 so it is concluded that 1:2 proportion is good for the manufacture of the pavers it gives the maximum strength of 25.16Mpa.
- **Sea sand:** From the graph of compressive strength vs different proportion, it concluded that the strength will be increases up to 1:4 then gradually decreases the maximum compressive strength will be 25.92Mpa for 1:4 proportion.

2. Conclusion for Blocks

- **M- sand:** It was noted that the compressive strength of M-sand was increased from 0% replacement to 10% of replacement of M-sand by the plastic grains after replacement of 15 & 20% of replacement again it will decrease hence it I concluded that 10% of replacement gives a maximum compressive strength of 27.96 Mpa.
- **Sea sand:** The compressive strength of Sea sand it was gradually decreases from 0% to 20% of replacement of Sea-sand by the plastic grains for replacement of 0% of replacement 0% of replacement we got the maximum compressive strength of 36.34Mpa so we are concluded that we can use only sea sand for the manufacture of block

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