

“UTILIZATION OF PLASTIC WASTE IN RIGID PAVEMENT”

**Kardile Sayali S. ^{*1}, Nimse Shaddha.S.², Shaikh Parvin S.³, Garudkar Sanket D. ⁴,
Prasad G. Nikam⁵**

¹²³⁴ Student Department of Civil Engineering, Shri Chhatrapati Shivaji Maharaj College of Engineering, Nepti, Ahilyanagar, Savitribai Phule Pune University, India.

⁵ Assistant Professor, Department of Civil Engineering, Shri Chhatrapati Shivaji Maharaj College of Engineering, Nepti, Ahilyanagar, Savitribai Phule Pune University, India.

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***Corresponding Author: Kardile Sayali S.**

Student Department of Civil Engineering, Shri Chhatrapati Shivaji Maharaj College of Engineering, Nepti, Ahilyanagar, Savitribai Phule Pune University, India.

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ABSTRACT

The quick rise in elastic unused generation positions a severe eco-friendly task universal. This project discovers an innovative and workable explanation by using recycled plastic unused as a partial replacement for coarse aggregate in M30 grade concrete suitable for rigid concrete structure. Using Ordinary Portland Cement (OPC), 20 mm coarse aggregate, and the given parameters (workability 75 mm slump, water-cement ratio 0.45, 0.5% admixture), the concrete mix is designed as per IS 10262:2019 guidelines. Plastic waste replaces coarse aggregate by weight at four levels: 7%, 11%, 15%, and 20%. The primary objectives are to reduce natural aggregate consumption, promote circular economy principles, minimize landfill burden, and develop eco-friendly rigid concretes with comparable or improved properties such as reduced self-weight and enhanced flexibility. The step-by-step mix design yields practical proportions for laboratory and field trials. This approach not only addresses plastic pollution but also supports workable infrastructure development in road construction, offering a cost-effective and environmentally responsible alternative without compromising the structural requirements of rigid pavements.

KEYWORDS: Rigid pavement, plastic waste coarse aggregate, Ordinary Portland cement (OPC).

I. INTRODUCTION

Every day, India produces 1,88,000 tons of plastic waste. (Pooja Lachyan, Yadav Megha, et al. 2022). The amount of plastic waste generated daily on Earth is one of the biggest environmental problems. The problem of plastic waste is severe everywhere in the world (Abdullahi Osman Abdirahman, Dr. Pawan Kumar Pranjapati. 2025). In order to contain this problem, experiments have been carried out to know whether this waste plastic can be reused productively. (Pooja Lachyan, Yadav Megha, et al. 2022). The increase in waste is a major global challenge. Various countries around the world have put in place different waste management mechanisms with the aim of effectively addressing this problem. (Advincula Salvador Annie Leandra, Laurencio Luna Manuel Ismael 2024). Various types of waste plastics like the PET, HDPE, LDPE and PP. (Dr. Nuha S. Mashaan 2024).



Photo 1- Plastic waste photographs.

II. LITERATURE REVIEW

1. Nuha S. Mashaan, et.al. (2025): “An Investigation of the Mechanical Properties of Concrete with Different Types of Waste Plastics for Rigid Pavement”

The replacement of plastic waste for HDPE is 0 to 20 %. LDPE is replaced by the 0 to 30%
The compressive strength values decreased by 21%, 39%, and 47% for HDPE replacement levels of 10%, 20%, and 30%, respectively. HDPE reduced split tensile strength by 16.1%, 30.5%, and 43.7% at replacement levels of 10%, 20%, and 30%, respectively.

2. Nuha S. Mashaan, et.al. (2024): “Waste plastic in concrete: Review and state of the art.”

The compressive strength decreases with an increase in the HDPE content; it decreased by 21%, 39%, and 47% for HDPE replacement levels of 10%, 20%, and 30%, respectively. (Islam, 2021), similarly, the compressive strength of concrete by Abbas et al. (2022) with 10%, 20%, and 30% of uncoated HDPE used as a partial replacement of coarse aggregates resulted to 28.1 MPa, 21.6 MPa, and 18.8 MPa, respectively, as compared to 35.6 MPa for the control mix. (Abbas, et al., 2022).

Chandu et al. have reported using 2.5%, 5%, and 7.5% replacement levels of LDPE plastic waste with M35 grade concrete. The maximum 28-day compressive strength (36 MPa) at the 5% replacement level was observed. For both split tensile strength and flexural strength, the increase with the increasing plastic content levels was observed, in which at 7.5% replacement the rise was to 5.9 MPa and 6.75 MPa, respectively, at 28 days.

3. Pooja Lachyan, et al, (2022): “Use of waste plastic in rigid pavement”

Greener and more sustainable construction projects are become the target of most agencies and officials, worldwide. Through simple process innovation, roads made of plastic trash have been built in a number of states, including Tamil Nadu, Karnataka, Himachal Pradesh, and to a lesser extent Goa, Maharashtra, and Andhra Pradesh. A severe issue with the disposal of plastic waste in India led to the implementation of the idea of "Use of Plastic Waste in Road Construction" in 2001. Not only the increase of solid waste but also especially plastic waste, many attempts are also made to incorporate these waste materials into construction projects.

There are sound concerns about the side effects of adding plastic waste to construction materials, mainly Portland Cement Concrete (PCC) mixes. Thus, this study was conducted to investigate the effects of adding plastic waste to PCC mixes when it comes to the performance of rigid pavements. Low percentages (2%,4%, and 6%) of plastic waste plastic were evaluated with replace to coarse aggregate.

III. PROBLEM STATEMENT

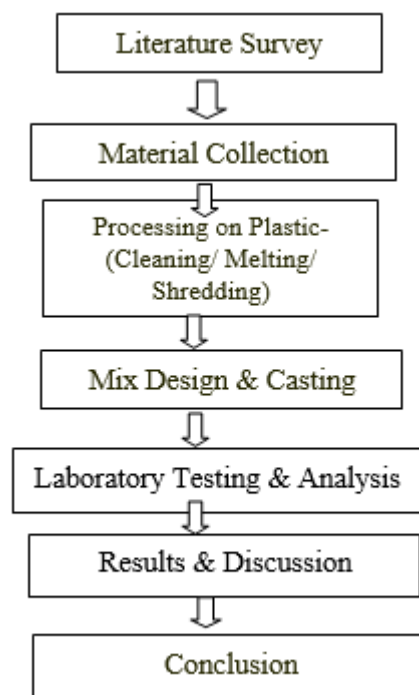
1. The quick increase in the generation of plastic waste has become a major environmental problem.
2. Due to harmful impact on soil, water, and air quality.
3. Improper disposal of plastic waste leads to land pollution, drainage blockages, and environmental health.

4. Our world is buried in plastic garbage that does not decompose, polluting our land and water.

IV. OBJECTIVES

1. To examine the effect of different plastic material used on the compressive strength properties of concrete mix.
2. To provide economical construction material.
3. To identify a better substitute for coarse aggregate in the construction of rigid pavement.

V. METHDOLOGY



Material Collection and Processing -

Collection and Cleaning: Waste plastic (plastic bottles, cups, HDPE, LDPA, toys) is collected, cleaned to remove contaminants, and washed.

Melting: The plastic is heated to its melting point. Specialized machines like a "plastic recycler" can be used for melting without pollution.

Shredding Process: The various plastic wastes are combined, and the plastic is then cut into 16 to 20 mm size pieces.

Mix Design and Casting: Replacement Percentage: Plastic aggregates are typically introduced in 0%, 7%, 11%, 15%, and 20% replacements by weight of natural coarse aggregate.

- **Mixing:** A standard mix (e.g., M30, 1:2:2:9.1) is prepared. Cement and fine aggregate (sand) are mixed in dry condition, followed by the addition of the prepared plastic coarse aggregates. Water is added last, often with Admixture to enhance binding.
- **Casting:** The concrete is poured into 150mm x 150mm x 150mm steel moulds in three layers, with each layer tamping 25-35 times to minimize voids.
- **Compaction:** A vibrating table is used to remove entrapped air.

Testing of Materials

- **Test on Coarse Aggregate**

Sr No.	Tests Conducted	Results on Coarse Aggregate	Range
1.	Impact Value [IS.2386 (4)-1963]	5.95%	10-30
2.	Crushing Value Test [IS.2386 (4)-1963]	1.67%	<30
3.	Abrasion Test [IS.2386 (3)-1963]	96.85%	<30
4.	Bulking of Aggregate	2.39	-
5.	Flakiness Index [IS.2386 (1)-1963]	11.694%	<15
6.	Elongation Index [IS.2386 (1)-1963]	11.864%	<15

- **Test on Plastic Coarse Aggregate**

Sr no.	Tests Conducted	Results on plastic Aggregate	Range
1.	Impact Value [IS.2386 (4)-1963]	8.5%	10-30
2.	Crushing Value Test [IS.2386 (4)-1963]	5.204%	<30
3.	Flakiness Index [IS.2386 (1)-1963]	17.36%	<15
4.	Elongation Index [IS.2386 (1)-1963]	60%	<15

VI. MATERIAL PROPERTIES

Coarse Aggregate - 20mm size were used for the experiment. The aggregates were washed to remove dust and dirty particles and were air dried. Passed by 16 mm to retained 20mm sieve.

Fine Aggregate – Sieve analysis of fine aggregates was carried out in the laboratory. The sand was first sieved through 4.75 mm IS sieve to remove particles greater than 4.75 mm. It is then passed through 2.75 mm IS sieve and the retained particles are taken.

Plastic Coarse Aggregate –

1. **Low density polyethylene (LDPE):** Sheets, collapsible bottles, shopping bags, durable sacks, Shopping bags, cosmetic and detergent bottles, garbage bags and milk bags.
2. **High density polyethylene (HDPE):** Juice bottles, bleach bottles, shampoo bottles, Engine oil and bottles Toys, Shopping bags, home furniture, Bottle caps.
3. **Polypropylene (PP):** Straws, wrappers, syrup bottles, packing tapes Automotive parts Detergent wrappers, bottle caps and holders, food containers and steamers, microwave able food trays.

Cement– The ordinary Portland Cement (OPC) was used for this experiment. The cement was in dry state with fine grey powder. The cement used was from a single lot throughout the experiment. It was in fresh form without any lumps.

Admixture - Here are the specific uses of in rigid pavements: Concrete Admixtures (During Construction) Added to concrete mix at a cement to reduce water permeability, improve workability, Compressive strength and prevent shrinkage cracks.

VII. MIX DESIGN

Mix Proportion for M30 grade (IS 10262:2019)

For 53 grade OPC Cement

4.75mm 16mm grade plastic aggregate Degree of workability 75 compaction factor, 40mm slump adopted Coarse aggregate size used plastic aggregate

Cement: Fine Aggregate: Coarse aggregate

1: 2: 2:9.1

Water used for M30 grade is 0.45 for mix design

VIII. PROCEDURE

Procedure for Concrete Cube Casting:

Preparation: Ensure moulds (typically 150mm x 150mm x 150mm) are clean, assembled, and coated with a thin layer of mould oil to prevent concrete adhesion.

Sampling: Take a representative sample of fresh concrete from the site mixer or batch.

Filling: Pour concrete into the moulds in three roughly equal layers (approx. 5 cm deep each).

Compaction:

Manual: Tamp each layer at least 35 times with the 16mm diameter standard tamping rod, ensuring the rod penetrates into the underlying layer, or use 35 strokes across the surface.

Vibration: Use a vibrating table to compact the concrete until a thin film of mortar appears on top and no air bubbles are trapped.

Finishing: After the final layer is compacted, level the surface with a trowel or float.

Marking: Identify the cube with a unique ID, date, and mix design details, typically by marking with a permanent marker.

Initial Setting: Allow the cubes to rest undisturbed for 24 hours.

Demoulding & Curing: Carefully remove the cubes from the moulds (demoulding) and submerge them in clean water for curing until the day of testing (usually 7, 14, or 28 days).

IX. RESULTS

Compressive Strength after 7 days

Sr. No	Block	Compressive Strength			Mean (N/mm ²)
		B1	B2	B3	
1	Normal	24.55	21.71	22.95	24.55
2	7% of plastic Aggregate	20.33	19.11	23.98	23.98
3	11% of plastic Aggregate	19.95	23.94	19.45	23.45
4	15% of plastic Aggregate	15.39	18.67	17.97	18.67
5	20% of plastic Aggregate	17.50	15.83	17.89	17.89

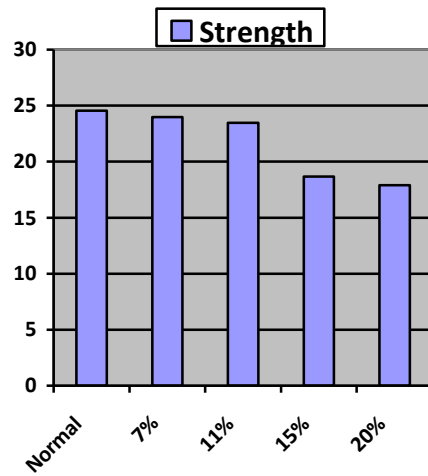
Compressive Strength after 14 days

Sr. No	Block	Compressive Strength			Mean (N/mm ²)
		B1	B2	B3	
1	Normal	32.05	28.96	21.86	32.05
2	7% of plastic Aggregate	28.68	27.09	25.75	28.68
3	11% of plastic Aggregate	22.76	25.34	25.93	25.93
4	15% of plastic Aggregate	22.14	22.96	22.20	22.96
5	20% of plastic Aggregate	20.44	22.57	18.71	22.57

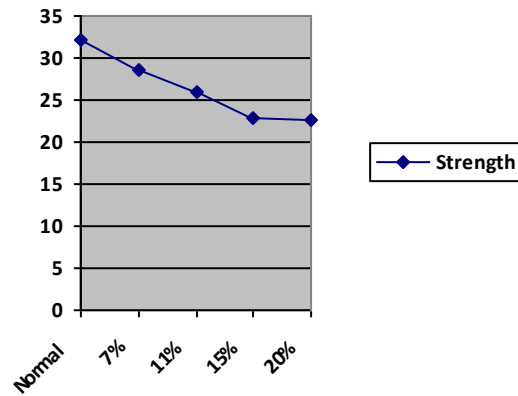
Compressive Strength after 28 days

Sr. No	Block	Compressive Strength			Mean (N/mm ²)
		B1	B2	B3	
1	Normal	30.32	35.90	32.79	35.90
2	7% of plastic Aggregate	29.45	29.08	29.90	29.90
3	11% of plastic Aggregate	28.40	26.09	26.94	28.40
4	15% of plastic Aggregate	20.47	25.25	24.61	25.25
5	20% of plastic Aggregate	24.72	21.44	19.84	24.72

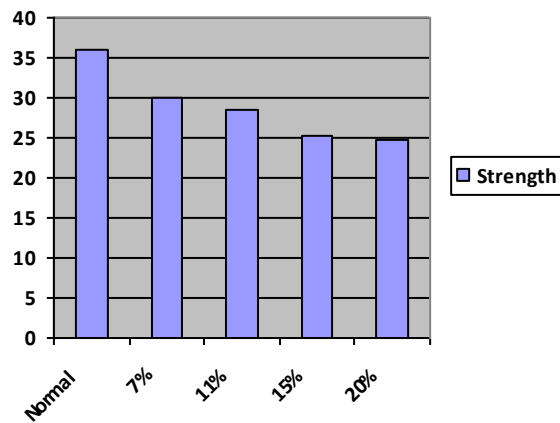
X. GRAPHS



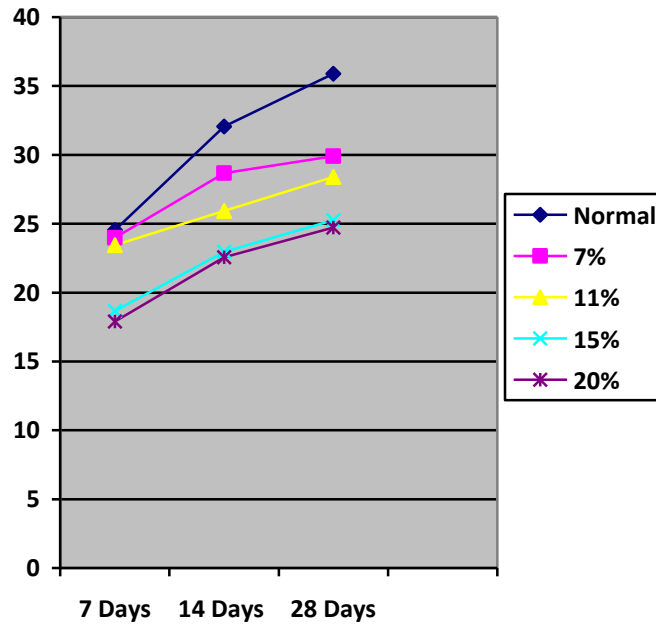
(Compressive Strength after 7 days)



(Compressive Strength after 14 days)



(Compressive Strength after 28 days)



XI. CONCLUSION

1. Using plastic waste in concrete construction have to been found to be an appropriate solution to the problems of dumping hundreds of thousands tones of industrial and environmental waste.
2. This study shows that the compressive strength decrease as the amount of plastic content increase.
3. It was also found that as we increase that amount of plastic waste than strength is decreases.

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