

Use of Different Waste Materials In Concrete: A Review

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Abstract- *T* Plastics offer numerous benefits, including affordability, durability, lightness, and design flexibility, leading to their increasing use. However, their non-biodegradable nature poses significant environmental concerns. When disposed of in the open environment, plastics harm the ecosystem, contaminate soil and subsoil, and release toxic gases. They can also clog sewer lines, drainage systems, and waterways, while posing health risks to humans due to potential toxic content. Recycling plastics is crucial to mitigate these issues. One potential solution is incorporating waste plastics into concrete by converting them into aggregates, providing a viable way to consume and manage plastic waste.

exploring ways to incorporate waste materials into road construction, driving innovation and sustainability globally.

I. INTRODUCTION

Various waste materials, such as fly ash, silica fumes, concrete waste, marble waste, industrial waste, agricultural waste, and red soils, possess desirable properties that can be leveraged in construction. Many of these materials are already being used to produce innovative products like fly ash concrete and jute boards. However, plastic waste, generated in massive quantities worldwide, poses a significant environmental challenge due to its low biodegradability and abundance. To address this issue and explore potential applications, an experimental study was conducted to investigate the feasibility of replacing coarse aggregates with plastic granules in concrete. This research aims to evaluate the performance of concrete incorporating plastic waste and contribute to sustainable construction practices

Plastics and polythene are non-biodegradable and pose significant environmental concerns, necessitating alternative recycling methods. To enhance road surface characteristics, various modifiers are used, but most are raw or natural materials that are scarce and costly. Using waste plastic bottles as a modifier in road construction offers a promising solution, reducing material waste and improving road properties. Recycling waste materials in asphalt pavements can alleviate the burden of expensive and environmentally hazardous waste disposal. With the risks associated with landfilling and dumping, researchers are

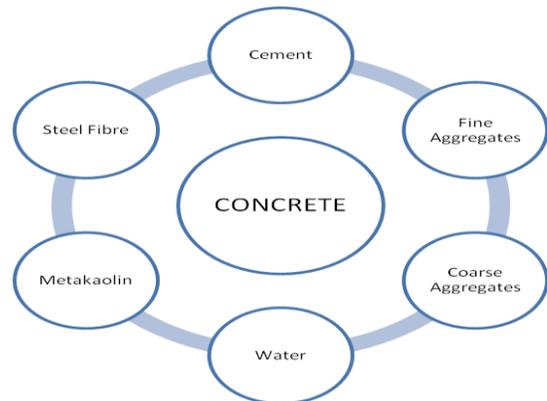


Fig. 1. – Concrete Ingredients

1. Cement: Grade 43 cement has been selected as per IS 8112:1989.

Properties of cement used in the experiment are as follows:

Table 1 -Properties of cement used in the experiment

| S.No. | Characteristics | Experimentally Obtained Values | Values Specified By IS 8112:1989 |
|-------|--------------------------------|--------------------------------|----------------------------------|
| 1 | Specific Gravity | 3.2 | - |
| 2 | Standard Consistency % | 26 | - |
| 3 | Initial Setting Time (minutes) | 148 | 30 (minimum) |
| 4 | Final Setting Time(minutes) | 255 | 600 (maximum) |
| 5 | Crushing Strength | | |
| | 3 days | 27.5N/mm ² | 23 N/mm ² (minimum) |

| | | | |
|--|---------|------------------------|---------------------------------------|
| | | | m) |
| | 7 days | 35.5 N/mm ² | 33 N/mm ² (minimu m) |
| | 28 days | 47.6 N/mm ² | 43 N/mm ² (minimu m) |

2. Fine Aggregate: The aggregates in which most of aggregates pass through 4.75 mm (IS) sieve are termed as fine aggregates. In this experimental program, fine aggregates have been collected from local dealer conforming to grading zone II. The sand sieved through 4.75 mm sieve to eliminate particles greater than 4.75 mm size. Sieve analysis and physical properties of fine aggregate are checked as per IS: 383-1970 and results are shown in Table 3.2. Specific gravity of fine aggregates experimentally determined as 2.60. Sieve analysis of fine aggregates has been performed to obtain Fineness Modulus.

Table 2 - Sieve Analysis of Fine Aggregate

| Weight of sample taken = 1000gm | | | | | |
|---------------------------------|---------------|-------------------|------------|-----------|-----------------------|
| S. No | IS-Sieve (mm) | Wt. Retained (gm) | % retained | % passing | Cumulative % retained |
| 1 | 4.75 | 6 | 0.6 | 99.4 | 0.6 |
| 2 | 2.36 | 59 | 5.9 | 93.5 | 6.5 |
| 3 | 1.18 | 220 | 22 | 71.5 | 28.5 |
| 4 | 600 μ | 159 | 15.9 | 55.6 | 44.4 |
| 5 | 300 μ | 316.5 | 31.65 | 23.95 | 76.05 |
| 6 | 150 μ | 196.5 | 19.65 | 4.3 | 95.7 |
| 7 | Pan | 43 | 4.3 | 0 | |
| | Total | 1000 | SUM | | 251.75 |
| <i>FM</i> | | | | | <i>2.51</i> |

3. Coarse Aggregate: The aggregate which do not pass through IS Sieve 4.75 mm is termed as coarse aggregate. The nominal maximum size is 10-20 mm; though particle sizes up to 40 mm or more have been used in Self Compacting Concrete. Crushed aggregates tend to get better the strength because of interlocking of angular particles, while rounded aggregates improves the workability of flow because of lesser internal friction.

The coarse aggregate used in experiment consist of two locally available crushed stone of 20 mm and 10 mm size in 70:30 fraction. The aggregates firstly washed to remove dirt, dust and then dried to surface dry condition. After proportioning of coarse aggregates, fineness modulus is obtained.

Table 3 -Properties of Coarse Aggregate used in the experiment

| Characteristics | Value |
|------------------|-------------|
| Colour | Grey |
| Shape | Angular |
| Maximum Size | 20 mm/10mm |
| Specific Gravity | 2.66/2.65 |
| Water Absorption | 0.20%/0.35% |

II. LITERATURE REVIEW

Vyawahare and Modani (2022) performed a study to improve the workability and strength of concrete with flaky and elongated aggregates using super-plasticizer with other admixture for determining the allowable percentages of aggregates in the concrete mixes.

According to Chu et al. (2022), Elastic modulus is a crucial parameter in structural design, evaluating the stiffness of concrete members. Despite its excellent mechanical properties and durability, ultra-high-performance concrete (UHPC) has limited use due to its relatively low elastic modulus. This study designed high elastic modulus UHPC (HEMUHPC) using the Modified Andreasen and Andersen particle packing model. The effects of alumina micro-powder on workability, microstructure, and mechanical properties of HEMUHPC were investigated. Results showed that adding alumina micro-powder reduced porosity and improved flexural strength, compressive strength, and elastic modulus. The optimal alumina content was 10%. Nanoindentation tests revealed that the high elastic modulus of alumina micro-powder (90-135 GPa) contributed to the improvement in HEMUHPC's elastic modulus.

According to **Yu et. al (2022)**, Epoxy resin-based pervious concrete faces challenges due to high costs and brittleness-induced cracking. This study developed a cost-effective solution by modifying epoxy resins with wood tar and formaldehyde via the Mannich reaction. The reaction's byproduct, water, facilitated cement hydration, enhancing

adhesion with coarse aggregates. The modified epoxy resin pervious concrete showed significant improvements: 21.9% increased compressive strength and 52.5% enhanced abrasion resistance, while maintaining comparable aging and frost resistance. FTIR, DSC, and NMR analyses revealed the enhancing mechanism behind the modified epoxy resin.

Nazeer et. al (2023) examined the strength, durability, and microstructural properties of pervious concrete (PC) with fly ash (FA) and silica fume (SF) substitution. Nine mixes were cast using four aggregate gradations and three proportions. The effects of FA and SF on PC properties, including paste drain-down, workability, density, porosity, permeability, and various strength parameters, were evaluated. Microstructural analysis via SEM and EDX was also conducted. Results showed that 10% FA and SF substitution significantly improved strength and durability, with notable compressive strength increases of 41%, 85%, and 94% at 28, 56, and 120 days, respectively. Microstructural analysis revealed densified micrographs with C-S-H and C-A-S-H gel formation, contributing to enhanced mechanical and durability properties.

Hari and Mini (2023) studied the properties of pervious concrete rely on void characteristics and cementitious paste properties. To enhance these properties, a hybrid fiber system combining basalt and steel wool fibers was used. A Box-Behnken design of experiments approach was employed to generate response surfaces with fewer trials. The study investigated the effects of cementitious paste volume, fiber volume, fiber ratio, and coarse aggregate size on pervious concrete properties. Forty-five mix combinations were tested, with 5% silica fume added to enhance paste volume. Results showed that fiber addition increased void ratio and decreased fresh concrete density. While compressive strength was slightly reduced, flexural strength significantly improved. Basalt-rich composites exhibited enhanced abrasion resistance. Coarse aggregate size influenced fresh-stage density and void content. Statistical analysis and prediction modeling confirmed a strong match between experimental and predicted values.

Yang and Jiang (2003) developed a low-strength pervious concrete pavement material for roadways, consisting of a surface and base layer. The material achieved a compressive strength of 50 MPa and flexural strength of 6 MPa. It demonstrated excellent water penetration, abrasion resistance, and freeze-thaw durability, making it suitable for both footpaths and vehicle roads. This pervious material offers an environmentally friendly pavement solution.

III. CONCLUSION

Locally available waste materials can be incorporated into concrete production, with the choice of material depending on regional accessibility. This overview highlights various supplementary products, guiding the selection of suitable waste materials. The addition of these products impacts concrete properties, such as workability, shear resistance, and tensile behavior, with the extent of influence determined by the quantity of supplementary materials used.

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