

Use of Foundry Sand as Construction Material

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ABSTRACT

Rapid urbanization and accelerated infrastructure development have significantly increased the demand for concrete, leading to excessive consumption of natural resources, particularly river sand used as fine aggregate. Uncontrolled extraction of river sand has resulted in severe environmental consequences such as riverbed degradation, groundwater depletion, and ecological imbalance. At the same time, the metal casting industry generates enormous quantities of waste foundry sand (WFS) as a by-product of molding and casting operations. Disposal of this waste in landfills poses serious environmental challenges including air pollution, land contamination, and potential groundwater pollution.

This study presents an experimental investigation on the feasibility of utilizing waste foundry sand as a partial replacement for natural fine aggregate in concrete. Concrete mixes of M25 grade were prepared with 0%, 20%, 25%, 30%, and 35% replacement of natural sand by waste foundry sand. The experimental program included tests on fresh concrete to assess workability and tests on hardened concrete to evaluate compressive strength at 7 and 28 days of curing. The results indicate that workability decreases with an increase in foundry sand content due to its finer particle size and higher surface area. However, compressive strength improves up to an optimum replacement level of approximately 25–30%, which is attributed to improved particle packing and reduced porosity within the concrete matrix.

The findings of this study demonstrate that waste foundry sand can be effectively used as an alternative fine aggregate in concrete when used in controlled proportions. The utilization of foundry sand not only reduces the burden on natural resources but also provides an environmentally sustainable solution for industrial waste management. This research supports the principles of sustainable development and circular economy by promoting the beneficial reuse of industrial by-products in construction applications.

Keywords:- Waste foundry sand, sustainable concrete, fine aggregate replacement, industrial waste utilization, compressive strength

1. INTRODUCTION

Concrete is the most widely used construction material worldwide due to its strength, durability, and versatility. With rapid urbanization and infrastructure growth, the demand for concrete has increased substantially, leading to extensive use of natural aggregates. River sand, commonly used as fine aggregate, is becoming increasingly scarce due to excessive mining activities. This has resulted in environmental issues such as erosion of riverbeds, loss of aquatic habitats, and increased construction costs.

Simultaneously, the foundry industry produces large volumes of waste foundry sand during metal casting operations. Although foundry sand is reused multiple times, it eventually loses its properties and is discarded as waste. Improper disposal of waste foundry sand creates environmental pollution and health hazards. Therefore, utilization of waste foundry sand in concrete provides a sustainable solution to both environmental and resource-related issues.

1.1 Foundry Sand

Foundry sand is a high-quality silica sand used in the metal casting industry for preparing molds and cores. Depending on the casting process, foundry sand may be classified as green sand or chemically bonded sand. After repeated recycling cycles, the sand becomes unsuitable for further use and is discarded as waste foundry sand. This material generally exhibits uniform grain size distribution and finer particles compared to natural river sand.

1.2 Need for Sustainable Alternatives

The growing scarcity of natural sand and increasing environmental concerns associated with industrial waste disposal necessitate the development of sustainable construction materials. Utilizing waste foundry sand as a partial replacement for fine aggregate in concrete conserves natural resources and reduces environmental

pollution.

2. MATERIALS AND METHODOLOGY

Ordinary Portland Cement conforming to relevant IS standards was used in this study. Natural river sand of Zone II grading was used as fine aggregate and partially replaced with ferrous waste foundry sand. Crushed stone aggregate with a maximum size of 20 mm was used as coarse aggregate. Potable water was used for mixing and curing of concrete. Concrete of M25 grade was designed in accordance with IS 10262 guidelines.

2.1 Experimental Program

Concrete mixes were prepared with 0%, 20%, 25%, 30%, and 35% replacement of natural sand by waste foundry sand. For each mix, concrete cubes of size 150 × 150 × 150 mm were cast. Workability of fresh concrete was assessed using slump tests. Compressive strength tests were conducted at 7 and 28 days of curing using a compression testing machine.

3. RESULTS AND DISCUSSION

The test results indicate that the workability of concrete decreases with increasing percentage of foundry sand. This reduction in workability is attributed to the finer particle size and higher surface area of foundry sand, which increases water demand. Compressive strength results show an increase in strength up to 25–30% replacement of natural sand. Beyond this level, a slight reduction in strength is observed due to excessive fines affecting the cement–aggregate bond.

The improved compressive strength at optimum replacement levels can be attributed to better particle packing, reduced voids, and improved interfacial transition zone between cement paste and aggregates.

4. ENVIRONMENTAL AND ECONOMIC BENEFITS

The utilization of waste foundry sand in concrete offers significant environmental and economic benefits. It reduces the need for landfill disposal of industrial waste, conserves natural river sand, and minimizes environmental pollution. Additionally, the use of locally available foundry sand can reduce material transportation costs, making concrete more economical.

5. CONCLUSIONS

Based on the experimental investigation, it can be concluded that waste foundry sand can be effectively used as a partial replacement for natural fine aggregate in concrete up to 25–30%. This practice improves compressive strength, promotes sustainable construction, and provides an eco-friendly solution for industrial waste management.

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7. REFERENCES

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