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Study on High Strength Concrete Using M-Sand

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Abstract: High Strength Concrete (HSC) is widely used in modern construction due to its superior strength, durability, and improved structural performance. The growing demand for natural river sand in concrete production has led to depletion of natural resources and environmental concerns. Manufactured sand (M-sand), produced by crushing hard granite stones, has emerged as a sustainable and economical alternative to natural sand. This study investigates the use of M-sand as a replacement for natural sand in high strength concrete. Different concrete mixes were prepared with varying percentages of M-sand and tested to evaluate mechanical properties such as compressive strength, split tensile strength, and flexural strength. Workability tests were also carried out to assess the fresh concrete properties. The results show that M-sand improves particle packing and bonding between aggregates and cement paste, resulting in enhanced strength characteristics. Although the angular shape of M-sand slightly reduces work ability, it can be controlled through proper mix design and the use of admixtures. The study concludes that M-sand can effectively replace natural sand in high strength concrete and can contribute to sustainable and eco-friendly construction practices.
Keywords: High Strength Concrete, M-sand, Manufactured Sand, Compressive Strength

INTRODUCTION

Concrete is the most widely used construction material in the world due to its versatility, durability, and high compressive strength. It plays a vital role in the construction of buildings, bridges, dams, pavements, and other infrastructure projects. In recent years, the demand for High Strength Concrete (HSC) has increased significantly due to the need for stronger and more durable structures, particularly in high-rise buildings and heavy load-bearing constructions. High strength concrete provides improved mechanical properties, better durability, and higher resistance to environmental effects compared to conventional concrete. Fine aggregates are an essential component of concrete, traditionally obtained from natural river sand. However, the excessive extraction of river sand has led to environmental issues such as riverbed degradation, lowering of groundwater levels, and ecological imbalance. Due to these environmental concerns and the increasing scarcity of naturals and, alternative materials are being explored for use as fine aggregates in concrete production. Manufactured sand (M-sand) is one such alternative that is produced by crushing hard rock's such as granite or basalt into fine particles that resemble natural sand. M-sand is gaining popularity in the construction industry because of its consistent quality, controlled grading, and availability. The angular shape and rough surface texture of M-sand particles improve the bonding between cement paste and aggregates, which can enhance the strength and durability of concrete. The use of M-sand in high strength concrete has attracted significant attention from researchers and engineers. In corporating M-sand as a partial or complete replacement for natural sand can help reduce dependency on river sand while maintaining or even improving the mechanical properties of concrete. In addition, the use of M-sand supports sustainable construction practices by conserving natural resources and reducing environmental impacts. This study focuses on investigating the performance of high strength concrete using M-sand as a replacement for natural sand. The research evaluates the workability and mechanical properties of concrete, including compressive strength, splittensile strength, and flexural strength. The results obtained from this study aim to determine the suitability of M-sand for producing high strength concrete and its potential benefits in modern construction.

MATERIAL PROPERTIES

The properties of materials used in concrete play a significant role in determining the strength, durability, and overall performance of high strength concrete. In this study, the primary materials used include Ordinary Portland Cement (OPC), manufactured sand (M- sand), coarse aggregates, water, and chemical admixtures. The physical and mechanical properties of these materials are described in the following subsections.

A. Cement

Ordinary Portland Cement (OPC) is widely used in the production of high strength concrete due to its good binding properties and strength development. Cement acts as the primary binding material that holds aggregates together when mixed with water. The important properties of cement include fineness, consistency, setting time, and compressive strength. In this study, OPC of grade 43 or 53 was used as it provides higher early strength and better durability suitable for high strength concrete.

B. Manufactured Sand (M-Sand)

Manufactured sand (M-sand)was used as the fine aggregate in this study as a replacement for natural rivers and. M-sand is produced by crushing hard rock's such as granite into fine particles and grading them to meet construction standards. It has a cubical shape and rough texture, which improves the bonding between cement paste and aggregates. Compared to natural sand, M-sand provides better particle size distribution and contains fewer impurities such as clay and silt. The specific gravity of M-sand generally ranges between 2.6 and 2.8, which contributes to improved strength and durability in concrete.

C. Coarse Aggregates

Coarse aggregates provide bulk and strength to the concrete mix. In this study, crusheds tone aggregates of sizes 20mm and 10mm were used. The aggregates were clean, strong, and free from organic impurities and harmful substances. Important properties of coarse aggregates such as specific gravity, water absorption, impact value, and crushing value influence the strength and durability characteristics of concrete.

D. Water

Water is essential for the hydration process of cement and for providing work ability to the concrete mix. Potable water free from harmful substances such as oils, acids, salts, and organic materials was used in the preparation of concrete. The water–cement ratio was carefully controlled to achieve the required strength and work ability in high strength concrete.
concrete using M-sand and achieving the desired mechanical and durability properties.

METHODOLOGY

In this study, High Strength Concrete (HSC) was prepared by replacing natural river sand with Manufactured Sand (M-sand). The replacement levels considered were 20%, 25%, and 30%. Concrete mixes were prepared according to the designed mix proportions, and specimens were cast to determine compressive strength, split tensile strength, and flexural strength.

Table I 20% Replacement of Fine Aggregate With M-Sand

Material	Ratio
Cement	1
Natural Sand	1.60
M-Sand	0.40
Coarse Aggregate	2
Water	0.40

Mix Ratio = 1:1.60:0.40:2

Table II 25% Replacement of Fine Aggregate With M-SAND

Material	Ratio
Cement	1
Natural Sand	1.50
M-Sand	0.50

Mix Ratio=1:1.50:0.50:2

Table III 30 % Replacement of Fine Aggregate With M-Sand

Material	Ratio
Cement	1
NaturalSand	1.40
M-Sand	0.60
CoarseAggregate	2
Water	0.40

Mix Ratio=1:1.40:0.60:2

RESULTS AND DISCUSSION

The experimental investigation was carried out to study the strength characteristics of high strength concrete using Manufactured Sand (M-sand) as a partial replacement for natural river sand.

Concrete specimens were tested after 7 days, 14 days, and 28 days of curing. The results obtained from compressive strength, splittensile strength, and flexural strength tests are presented below.

Table IV Compressive Strength (Cube–150×150×150 mm)

M-Sand Replacement	7 Days (MPa)	14 Days (MPa)	28 Days (MPa)
20%	26.5	32.4	37.2
25%	27.8	34.1	39.0
30%	25.4	31.0	35.6

The compressive strength of concrete increased with the increase in M-sand replacement upto 25%andthen slightly decreasedat30%replacement.Themaximumcompressive strength was obtained at 25% replacement.

Table V Splittensile Strength(Cylinder–150×300 mm)

M-Sand Replacement	7 Days(MPa)	14 Days(MPa)	28 Days(MPa)
20%	2.40	2.95	3.50
25%	2.55	3.15	3.75
30%	2.25	2.85	3.30

The split tensile strength results also showed improvement with M-sand replacement up to 25%. The highest tensile strength was observed in the 25% replacement mix.

Table VI Flexural Strength (Prism–100×100×500mm)

M-Sand Replacement	7Days(MPa)	14 Days(MPa)	28 Days(MPa)
20%	3.9	4.7	5.5
25%	4.2	5.0	6.0
30%	3.7	4.4	5.2

Flexural strength results indicate that 25% replacement of natural sand with M-sand gives the highest flexural strength compared to other mixes.

Table VII Final Comparison of Results

Replacement	Compressive Strength	SplitTensile Strength	Flexural Strength
20%	37.2MPa	3.50MPa	5.5MPa
25%	39.0MPa	3.75MPa	6.0MPa
30%	35.6MPa	3.30MPa	5.2MPa

From the experimental results, it is observed that 25% replacement of natural sand with M-sand provides the best overall strength performance for high strength concrete.

CONCLUSION

This study investigated the performance of high strength concrete using Manufactured Sand (M-sand) as a partial replacement for natural river sand. Based on the experimental results obtained from compressive strength, split tensile strength, and flexural strength tests, the following conclusions can be drawn. The use of M-sand as a fine aggregate in high strength concrete is a suitable alternative to natural river sand. The experimental results indicate that the strength characteristics of concrete improve when M-sand is used in appropriate proportions. Among the different replacement levels studied, the25%replacementofnaturalsandwithM-sandshowedthe best overall performance in terms of compressive strength, split tensile strength, and flexural strength. It was also observed that the angular shape and rough texture of M-sand particles improve the bonding between cement paste and aggregates, which contributes to enhanced strength development. In addition, the use of M-sand helps in reducing the environmental problems associated with excessive extraction of natural river sand. Therefore, M-sand can be effectively used as a partial replacement for natural sand in the production of high strength concrete. The adoption of M-sand in construction practices can promote sustainable development while maintaining the required strength and durability of concrete structures.

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