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Investigation on Concrete with M-Sand and Silica Fume

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Abstract
The global construction industry uses a significant amount of concrete. In India, the ordinary concrete is created utilizing natural sand from river beds as fine aggregate. Because dwindling natural resources constitute an environmental risk, government restrictions on sand mining have led to a shortage and a sharp rise in the price of the material. The optimization of M-Sand with silica fume as a partial replacement for natural sand is discussed in this work. Compressive and split tensile strengths of concrete mixtures were assessed. Natural sand was substituted with manufactured sand in five proportions of 0, 10, 20, 30 and 40%, while silica fume was substituted for standard Portland cement in amounts of 0, 5, 7.5 and 12.5%. The findings showed that concrete with 30% M-Sand and 7.5% silica fume has increased compressive and split tensile strength.

Keywords: M-Sand, Silica Fume, Compressive Strength, Split Tensile Strength

1. Introduction

When concrete is used for structures such as buildings in harsh environments, marine structures, nuclear structures, tunnels, precast units, etc., it affects the strength, durability, and life of the reinforcing steel because natural sand is primarily excavated from river beds and always contains high percentages of organic materials, chlorides, sulphates, silt, and clay. Manufactured sand, created by crushing natural stone into the right size and grade, is the quickest, cheapest option to obtain the material for natural sand. Crushed stone dust can be used in place of natural sand in concrete to achieve the same compressive strength and less shrinkage than control concrete.

2. Objectives

- Because of its improved durability, increased strength, and overall economy, M-Sand has balanced physical and chemical qualities that can survive any challenging ambient and climatic circumstances.
- To substitute silica fume for cement and M-Sand for natural sand.
- To compare it to conventional concrete and determine the split tensile strength and compressive strength.

3. Materials

3.1. Cement

53 grade cement is used. The properties are presented in the Table 1.

Table 1: Properties of Cement

Sr. No.	Property	Cement (53 Grade)
1	Specific Gravity	3.12
2	Fineness	9.19
3	Consistency	34%
4	Initial Setting Time	55 min
5	Final Setting Time	488 min

3.2. M-Sand

Artificial sand, also known as manufactured sand (M-Sand), is created by crushing hard stones into small, angular particles the size of sand, which are then cleaned and finely graded for use as construction aggregate. It is a better option for construction than river sand.

3.3. Silica Fume

The physical properties of silica fume are presented in Table 2.

Table 2: Physical properties of Silica fume

Sr. No.	Properties	Silica Fume
1	Colour	Dark Grey
2	Specific Gravity	2.20
3	Fineness	20,000 m^2/kg

4. Experimental Investigations

4.1. Compressive Strength Results

The compressive strength conducted in the cast and cured specimen and results presented in tables 3 to 5.

Table 3: Compressive Strength of Concrete for M-Sand

Mix. No.	M-Sand	Compressive Strength, N/mm²		
		28 Days	56 Days	90 Days
1	0%	49.95	54.14	58.38
2	10%	54.45	59.07	63.58
3	20%	55.92	60.07	65.24
4	30%	56.92	61.16	66.58
5	40%	53.78	58.38	62.75

Table 4: Compressive Strength of Concrete for Silica Fume

Mix. No.	Silica Fume	Compressive Strength, N/mm²		
		28 Days	56 Days	90 Days
1	0%	49.95	54.14	58.38
2	5%	53.23	57.96	62.20
3	7.5%	58.06	63.01	67.77
4	12.5%	53.50	58.10	62.45

Table 5: Combined Compressive Strength of Concrete with M-Sand and Silica Fume

Mix. No.	M-Sand + Silica Flume	Compressive Strength, N/mm²		
		28 Days	56 Days	90 Days
1	0%	49.95	54.14	58.38
2	30% MS + 7.5% SF	61.48	66.71	71.59

4.2. Split Tensile Strength Results

The split tensile strength conducted in the cast and cured specimen and results presented in tables 6 to 8.

Table 6. Split Tensile Strength of Concrete for M-Sand

Mix. No.	M-Sand	Split Tensile Strength, N/mm²		
		28 Days	56 Days	90 Days
1	0%	4.85	5.28	5.65
2	10%	5.27	5.72	6.16
3	20%	5.34	5.81	6.23
4	30%	5.56	6.03	6.48
5	40%	4.84	5.25	5.65

Table 7: Split Tensile Strength of Concrete for Silica Fume

Mix. No.	Silica Fume	Split tensile Strength, N/mm²		
		28 Days	56 Days	90 Days
1	0%	4.85	5.28	5.65
2	5%	5.20	5.66	6.07
3	7.5%	5.92	6.40	6.89
4	12.5%	4.81	5.21	5.63

Table 8: Combined Split Tensile Strength of Concrete with M-Sand and Silica Fume

Mix. No.	M-Sand + Silica Flume	Split Tensile Strength, N/mm^2		
		28 Days	56 Days	90 Days
1	0%	4.85	5.28	5.65
2	30% MS + 7.5% SF	6.27	6.82	7.33

6. Conclusions

(1) At 30% replacement of natural sand by M-Sand, the compressive strength of concrete is 56.92, 61.16 and 66.58 N/mm^2 at 28, 56 and 90 days.

(2) At 7.5% replacement of cement with silica fume, the compressive strength of concrete is 58.06, 63.01 and 67.77 N/mm^2 at 28, 56 and 90 days.

(3) At 30% M-Sand + 7.5% SF, the compressive strength of concrete is 61.48, 66.71 and 71.59 N/mm^2 at 28, 56 and 90 days.

(4) At 30% replacement of natural sand by M-Sand, the split tensile strength of concrete is 5.56, 6.03 and 6.48 N/mm^2 at 28 , 56 and 90 days.

(5) At 7.5% SF, the split tensile strength of concrete is 5.92, 6.40 and 6.89 N/mm^2 at 28, 56 and 90 days.

(6) At 30% M-Sand + 7.5% SF, the split tensile strength of concrete is and 6.27, 6.82 and 7.33 N/mm^2 28, 56 and 90 days.

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