

AN EXPERIMENTAL STUDY ON PARTIAL REPLACEMENT OF FINE AGGREGATE WITH STONE DUST IN CONCRETE

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ABSTRACT

Concrete is a substantially used material inside the worldwide. Based on international usage it is located at second function after water. Common river sand is high priced due to excessive charge of transportation from natural sources. River sand is most often used wonderful aggregate within the manufacturing of concrete poses the problem of acute scarcity in plenty of areas and non-save you usage has commenced out posing severe problems with appreciate to its availability, rate and environmental impact. So Engineers commenced to search for possibility for splendid combination. The easy purpose of this examine was to select out opportunity deliver of top high-quality aggregates. The present investigation has been undertaken to examine the impact of stone dust on the mechanical properties of concrete, at the same time while stone dust is replaced with quality combination in unique chances the primary parameters check out were compressive strength, flexural strength and split tensile strength. In this work, M25 grade concrete is developed using IS method mix design. The test results indicates that with the use of replacing stone dust by fine aggregate with partial or complete replacement. For evaluation of strength parameters each grade of concrete for each proportion in the form of cubes, beams and cylinders were casted for testing at after 7days and 28 days curing periods.

Keywords: Concrete, M25 grade

INTRODUCTION

Leaving waste materials in to surroundings at once effects to harm of natural climatic conditions, hence use of waste materials is made at most importance in present study.

Stone dust a waste obtained from stone crushing process is used as partial replacement or complete replacement as fine aggregate in concrete. Advancement in utilization of wastes in concrete as admixture reduces pollutants in environment. Rapid urbanization in developing countries such as India is creating a shortage of adequate housing in cities. Using artificial aggregates for quality concrete is a natural step to mitigating this problem. The world wide consumption of fine aggregate in concrete production is very high, and several developing countries have been countered difficulties in meeting the supply of natural fine aggregate in order to satisfy the increasing needs of infrastructural development in recent years. To overcome the stress and demand for river fine aggregate, research sand practitioners in the construction industries have identified some alternative materials such as flyash, slag and limestone powder and siliceous stone powder. In India attempts have been made to replace river sand with stone dust

1.2 NEED FOR THE PARTIAL REPLACEMENT OF FINE AGGREGATE WITH STONE DUST:

Concrete is the most popular building material in the world. Concrete is a mixture of cement, fine aggregate, coarse aggregate and water. At present economical status fine aggregate is higher cost material comparing to availability of waste stone dust.

LITERATURE REVIEW

G. BALAMURUGAN(2013)

studied about the strength of concrete when replacing sand by quarry dust from 0% to 100% in steps of 10%. M20 and M25 grades of concrete were taken for studied keeping a constant slump of 60mm. the compressive strength of concrete cubes at the age of 7 and 28 days were obtained at room temperature. Also the temperature effect on concrete cubes at 100°C on 28th day of casting was carried out to check the loss of strength. from the results it was found that the maximum compressive strength is obtained only at 50% replacement at room temperature and net strength after the loss due to hike in temperature was above the recommended strength value due to 50% replacement itself. this result gives a clear picture that the quarry dust can be utilized in concrete mixtures as a good substitute for natural river sand giving higher strength.

Balapgol et al (2002)

presented the results of an experimental study on strength and durability of concrete with crushed basalt stone fine aggregates as a substitute to diminishing natural sand. An experimental study was performed to observe the performance of concrete incorporating crushed basalt stone fine aggregates replacing the natural sand. The strength and durability properties of concrete viz. compressive strength, flexural strength and permeability of hardened concrete were investigated. The test results indicate that the performance of concrete with crushed basalt stone fine aggregates were excellent. The compressive strength of concrete for different grades increased from 8 % to 26 %, the flexural strength was increased from 1 % to 5 % and coefficient of permeability was decreased significantly. The test results indicated that strength and durability of

concrete would be better with crushed sand replacing natural sand.

G. Hymavathi (2016)

It gives good strength when compared to normal mix. Partial replacement of GGBS decrease the environmental pollution such as ground pollution, water pollution etc. Partial replacement of GGBS increase the strengths at 10%, 20%, 30% as well as decrease the strength at 40%, 50%. It also reduce the cost of construction.

MATERIALS AND METHODS

3.1 GENERAL

In the present experimental investigation stone dust used has been used as partial replacement of fine aggregate in concrete mixes. On replacing fine aggregate with different weight percentage of stone dust the mechanical strengths were studied at different ages of concrete. To follow the standard experimental procedure laid down in IS code for design of concrete mix.

3.2 MATERIALS

The materials used in the experimental investigation include:

- 53-Grade Ordinary Portland Cement (OPC)
- Fine Aggregate (Sand)
- Coarse Aggregate
- Stone Dust
- Water the properties of these materials are given in the following sub-sections

3.2.1 CEMENT

Ordinary Portland Cement (53 grade) with specific gravity of 3.05 was used for this experimental investigation. Since we have used it because it is highly available and cost is low to the common people and initial

experiments like initial setting time final setting time, compressive strength, specific gravity, fineness and standard consistency tests were conducted on 53-grade OPC cement with regards to various water quality parameters. However, no significant variations were observed in the trends of the experimental results. Hence, 53-grade ordinary Portland cement was used in construction works.

3.3 METHODOLOGY

mix design procedure of M25

Test results of mix design

Characteristic Comp. Strength required in the field at 28 days = 25Mpa

- Max. size of aggregate = 20 mm
- Degree of workability (specified or not) = 40 – 75 mm
- Type of exposure = Moderate

Min. Cement (if specified) = 300kg/m³
Test data for materials:

- Cement Used = OPC 53 Grade
- Specific Gravity of 1) Fine Aggregate = 2.69 2) Coarse Aggregate – 20mm = 3.08
Specific Gravity of Cement = 3.05
- Sand corresponds of Zone = Zone II
- The target mean strength is determined using following relation $f_t = f_{ck} + (t * S)$

Where f_t = Target Mean Strength @ 28 days

f_{ck} = Characteristic Compressive Strength @ 28 days

t = A Statistical value depending upon the results and no. of tests.

S = Standard deviation shown from IS: 10262-2009

Assuming not more than 5% results are expected to fall below the characteristic compressive strength. In which cases the value of 't' is 1.65. Standard deviation for M25 Grade of concrete is 4.

$$f_t = 25 + (1.65 * 4) = 31.6 \text{ MPa}$$

- Target mean Strength of Concrete = 31.6 MPa
- Selection of w/c ratio corresponding to the target mean Strength of 31.6 MPa = 0.47 (From Table 5 of IS 456, maximum water-cement ratio = 0.5)
- From Table - 2 IS: 10262-2009 for nominal maximum size of aggregate 20mm, the maximum water content is 186 liters per cubic meter.

From Table-3 IS: 10262-2009 Volume of coarse aggregate per unit volume of concrete for zone-II fine aggregate is 0.62.

For change in value of w/c ratio the following adjustments are required according to IS: 10262-2009 in water content and percentage of sand in total aggregate.

- Selection of water and sand content water per cubic meter for 20mm maximum size aggregate and sand of zone II water content per cubic meter of concrete is 186 kg and sand content (as % of total aggregate) = 35%

Table 3.1: Correction table

Therefore required Sand content as percentage of total aggregate by absolute

$$\text{Volume} = 35 - 2.6 = 32.4\%$$

Table 3.3: Mix design details for concrete with stone dust

Adjustment in water & sand change in condition	Adjustment required in water percent	sand in total aggregate
For decrease in W/C ratio by (0.6-0.47) / 0.05	-	2.6%
Total	-	2.6%

Mix designation	Cement	Fine aggregate	Coarse aggregate	Water	Stone dust
Mix1	396	592.20	1376.66	186	0
Mix2	396	473.76	1376.66	186	118.44
Mix3	396	355.32	1376.66	186	236.88
Mix4	396	236.88	1376.66	186	355.32
Mix5	396	118.44	1376.66	186	473.76
Mix6	396	0	1376.66	186	592.20

All quantities are in kg/m³

Mix1: represents the standard concrete mix consisting of cement, coarse aggregate, fine aggregate and water.

Mix2: represents the concrete mix containing fine aggregate replaced with 20% of stone dust.

Mix3: represents the concrete mix containing fine aggregate replaced with 40% of stone

dust.

Mix4: represents the concrete mix containing fine aggregate replaced with 60% of stone dust.

Mix5: represents the concrete mix containing fine aggregate replaced with 80% of stone dust.

Mix6: represents the concrete mix containing fine aggregate replaced with 100% of stone dust.

RESULTS AND DISCUSSIONS



Table 5.1: Test results for compressive strength of concrete

Mix designation	Compressive strength of concrete in N/mm ²	
	7days	28 days
Mix1	24.21	32.03
Mix2	24.97	32.52
Mix3	25.29	33.54
Mix4	24.60	32.33
Mix5	21.58	31.24
Mix6	20.67	29.33

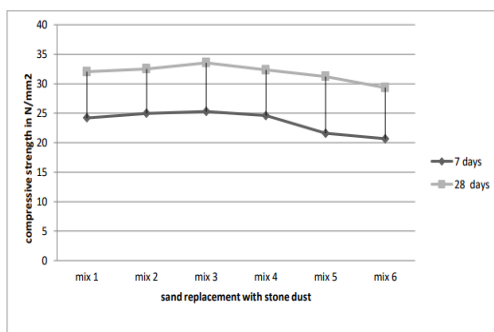


Fig 5.2 Variation of compressive strength of concrete with different % replacement levels of stone dust at different curing ages

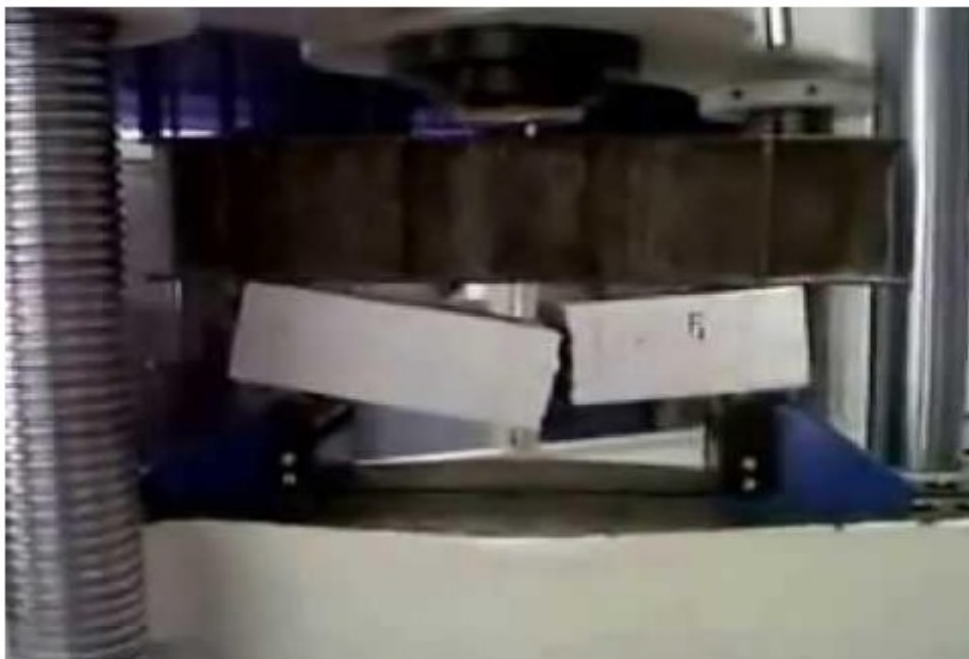


Fig 5.3: flexural testing of beam

Table 5.2: Test results for flexural strength of concrete

Mix designation	Flexural strength of concrete in N/mm ²	
	7days	28 days
Mix1	5.50	6.41
Mix2	5.44	6.67
Mix3	5.52	6.93
Mix4	5.24	6.45
Mix5	5.13	5.99
Mix6	4.98	5.81

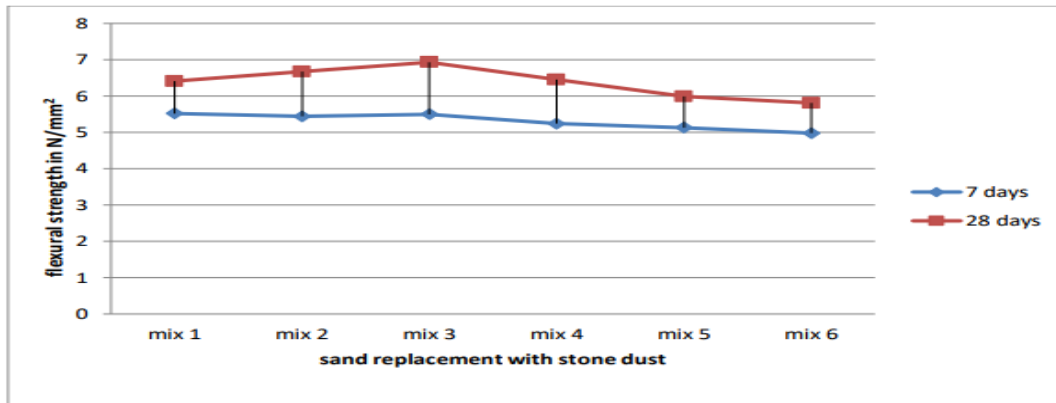


Fig 5.4 Variation of flexural strength of concrete with different % replacement levels of stone dust at different curing ages



Table 5.3: Test results for split tensile strength of concrete

Mix designation	Split tensile strength of concrete in N/mm ²	
	7days	28 days
Mix1	3.43	4.11
Mix2	3.45	4.22
Mix3	3.52	4.31
Mix4	3.44	4.19
Mix5	3.11	4.01
Mix6	2.98	3.82

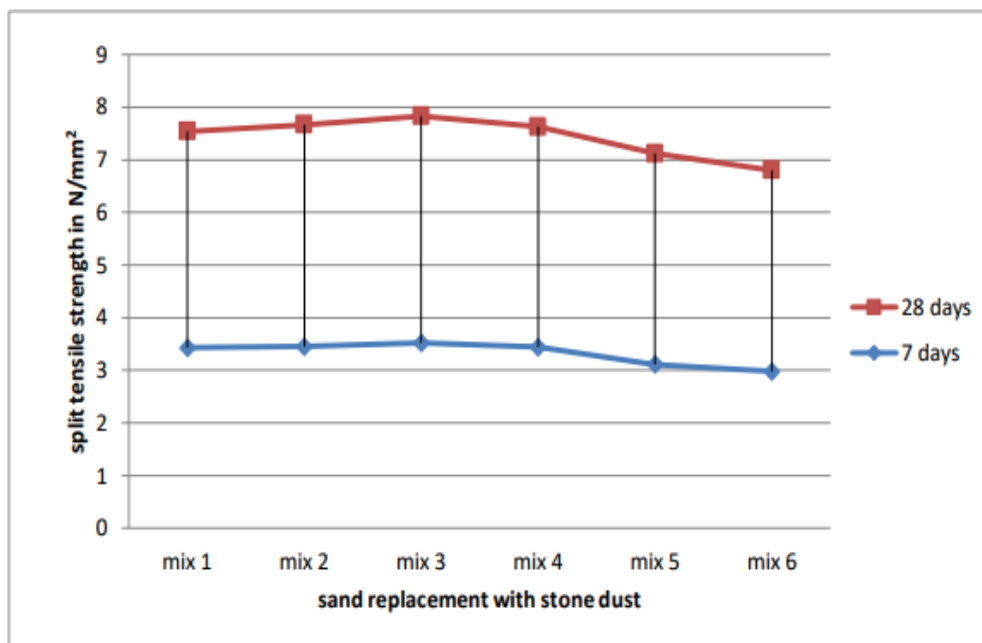


Fig 5.6 Variation of split tensile strength of concrete with different % replacement levels of stone dust at different curing ages

Conclusion

The strength of stone dust concrete has been determined in this study. The following conclusions were drawn from the results.

1. The physical properties of stone dust is satisfying the requirements of fine aggregate. The cost of concrete made with

stone dust is less than conventional concrete because the availability stone dust at less cost.

2. The maximum compressive strength occurred at 40% replacement of fine aggregate and it was observed as 25.59MPa and 33.54MPa at 7days and 28 days respectively.

3. The maximum flexural strength occurred at 40% replacement of fine aggregate and it was observed as 5.52MPa and 6.93MPa at 7days and 28 days respectively.

4. The maximum split tensile strength occurred at 40% replacement of fine aggregate and it was observed as 3.52MPa and 4.31MPa at 7days and 28 days respectively.

5. Based on this experimental investigation, it is found that stone dust can be used as an alternative material to the natural river sand up to 40% replacement in future.

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