The Study of Strength characteristics of concrete using crushed stone dust with special reference to fine aggregete

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Abstract— **Two basic mixes were chosen for natural sand to achieve M 20 and M 30 Grade concrete. The equivalent mixes were obtained by replacing natural sand by stone dust partially and fully. Test results indicate that crushed stone dust waste can be used effectively to replace natural sand in concrete. Concrete made with this replacement can attain the same compressive strength, comparable tensile strength, modulus of rupture and lower degree of shrinkage as the control concrete.**

.In the experimental study stone dust, the cubes were tested for 7days and 28days compressive strength 0%, 20%, 50% and 100% replacement of fine aggregate by stone dust in M25 and M30 grade concrete. The 7 days 28 days compressive strength is shown in tables 4.2 to 4.3and 4.6 to 4.7 respectively. The 7 days and28 days flexural strength beams obtained by replacing 0%, 20%, 50%, and 100% fine aggregate with stone dust is shown in tables 4.4 to 4.5 and 4.8 to 4.9 respectively. The result of cylinders that were tested for 28 days is shown tables 4.10 to 4.11.It has been observed that the result obtained in all compressive, flexural and spilt tensile strength are comparable with that of concrete with stone dust.

Index Terms— **Aggregate, Stone dust, Concrete, Compressive strength.**

I. INTRODUCTION

The concrete is a composite material which is predominantly used all over the world. The strength characteristics of concrete depend upon the properties of constituentmaterial and their combined action.Fine aggregate is one of the important constituent materials as far as strength characteristics of concrete are concerned. Increase in demand and decrease in natural sources of fine aggregate for the production of concrete has resulted in the need to identify news sources of fine aggregate. River and which is most commonly used as fine aggregate in the production of concrete and mortar poses the problem of acute shortage in many areas. At same time increasing quantity of crushed stone dust is available from crusher as waste. The disposal of this dust is serious environmental problem. If it is possible to use this crushed stone dust in making concrete and mortar by partial or full replacement of natural river sand then this will not only save the cost of construction but at the same time will solve the problem of disposal of this dust. Concrete made with this replacement can attain the same compressive strength comparable tensile strength and modulus of rupture. For satisfactory utilization of this alternatives material, the various phases of examination have to be technical feasibility, durability of processed concrete and economic feasibility. With the on going research being done to develop appropriate technology and field trail to monitor the performance and assessment of economic feasibility, the use of alternatives material will become more viable.

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II. CONSTITUENT MATERIALS USED

The constituent materials used are cement, fine aggregate,coarseaggregate, stone dust and water

CEMENT

Various type of cement can be used in concrete with stone dust. Ordinary Portland Cement (OPC) is used and cement is of 43 grade. The cement should be fresh, free from foreign matters and of uniform consistency. Usually ordinary Portland cement is used in normal condition.

FINE AGGREGATE

The most common fine aggregate used concrete is sand. The sand should be clean, hard, strong and free from organic impurities and deleterious substances. It should be capable of producing a sufficient workable mix with a minimum watercement ratio.

STONE DUST

Stone dust is obtained at crusher plants where the artificial crushing of the rock or gravels is done to obtain coarse aggregate. So the chemical composition of stone dust will be same as that of the coarse aggregate obtained from therein. Stone dust used for concrete should posses comparable fineness modulus as that of fine aggregate which is used in making concrete so that it will not absorb too much water from concrete or workability of concrete can be maintained.

Water

Mixing water should be fresh, clean and potable. Water should be free from impurities like clay, loam, soluble salts which lead to deterioration in the properties of concrete. Portable water is fit for mixing or curing of concrete

ADMIXTURE

Generally admixtures are used to alter or improve the properties of cement concrete. Commonly used admixtures are:

1. Water reducing admixtures
2. Retarding admixtures
3. Water reducing and accelerating admixtures

Addition of admixture is recommended to increase workability of concrete. However it is recommended that prior testing of any admixture should be carried out before use.

III. PROPERTIES OF MATERIAL USED

The basic properties and strength of the specimen depend on its constituents materials. It therefore becomes necessary to carry out tests as recommended by BIS on constituent's material namely cement, sand, coarse aggregate, and stone dust. The results of the tests that are carried out on various constituents' materials are described in this chapter.

3.1 CEMENT

Ordinary Portland cement of grade 43 was used for preparation of concrete mix. The quality of cement was checked through various tests and was compared with the specifications given in IS 81121989 for ordinary Portland cement. The test results of the cement used are presented in table 3.1.

3.2 FINE AGGREGATE

Locally available river sand was used. The sand was cleaned from all inorganic impurities and passed through 10 mm size sieve and retained on 75 micron sieve. The particle size and other properties are listed in table 3.2.

3.3COARSE AGGREGATE

Coarse aggregate available from nearby crusher is used. The aggregate was cleaned from all impurities and dust. The coarse aggregate passing through 10 mm sieve and retained on 600 micron sieve are mixed in proportion Of 60:40 percent. Particle size and other properties of the coarse aggregate are listed in table 3.3 and 3.4.

3.4 STONE DUST

Stone dust available from crusher plant at Ambala is used so that sieve configuration gets matched with that of river sand used for preparation of concrete mix. Stone dust passing through 4.75 mm sieve and retained 75 micron sieve has been used. That the particle sized and other properties of stone dust are listed in table 3.5.

3.5 WATER

Water used for mixing and curing was tap water free from injuries amounts of oil acids, alkyls salts organic matter or other substances that may be harmful to concrete as per clause 5.4 of IS 456-2000.

TABLE 3.2: SIEVE ANALYSIS OF FINE AGGREGRATE

IS SIEVE DESIGNATION	PERCENTAGE PASSING	COMMULATIVE PERCENTAGE RETAINED	GRADING LIMIT ACORDING TO IS : 383-1970
10mm	100	0	ZONEIII
4.75mm	94.6	5.4	
2.36mm	87.5	12.5	
1.18mm	76.5	23.5	
600micron	67.1	32.9	
300micron	34.4	65.6	
150micron	8.1	91.9	

FINENESS MODULES = 2.32

TABLE 3.4 : SIEVE ANALYSIS OF STONE DUST

IS SIEVES DESIGNATION	**PERCENTAGE PASSING**	**COMMULATIVE PERCENTAGE RETAINED**	**GRADING LIMIT ACORDING TO IS : 383 - 1970**
10mm	100	0	ZONE III
4.75mm	100	0	
2.36mm	91.8	8.2	
1.18mm	75.3	24.7	
600micron	65.9	34.1	

300micron	41.2	58.8	
150micron	11.6	88.4	

FINENESS MODULUS = 2.3
2

TEST SPECIMEN AND EXPERIMENTAL PROGRAMME

The purpose of this study was to investigate the possibility of using crushed stone dust as fine aggregate partially or fully replacing the natural sand for two different grades of concrete. The suitability of crushed stone dust waste as fine aggregate for concrete has been assessed by comparing the properties of concrete using stone dust with that of the concrete using river sand. Two basic mixes were chosen for natural sand to achieve M25 and M30 grade concrete. The equivalent was obtained replacing natural sand by stone dust partially and fully.

The present study involved observing the effect of stone dust on compressive strength, flexural strength, and spilt tensile strength of concrete.

CASTING OF TEST SPECIMENS

In the present study, 48 cubes, 48 beams and 24 cylinders were cast. 24 cubes, 24 beams, and 12 cylinders were of M25 grade of concrete and 24 cubes, 24 beams, and 12 cylinders were of M30 grade of concrete. out of 24,6 cubes and beams were cast for each 0, 20, 50, and 100 percentage of stone dust replacing river and for each grade of concrete and out of 12, 3 cylinder were cast for each 0, 20, 50 and 100 percentage of stone dust replacing river sand for each grade of concrete.

The size of cubes were150mm x 150mm x 150mm, the size of beam were 500mm x 100mm x 100 mm and the size of cylinder was 150mm diameter and 300mm in height.

4.4 EXPERIMENTAL SET UP

Specimens A1 - 0,A2 -0, A3 - 0, A1 - 20,A2 - 20, A3 – 20,A1 - 50, A2 - 50, A3 - 50, A1 - 100, A2 - 100 andA3 - 100 were tested for 7 days compressive strength of concrete in compression testing machine. Specimens A4 -0, A5 - 0, A6 - 0, A4 -20, A5 -20, A6 - 20, A4 -50, A5 - 50, A6 - 50, A4 -100, A5 - 100, A6 - 100 were tested for 28 days compressive strength of concrete in compression testing machine. Specimens A7 – 0, A8 – 0, A9 – 0, A7 20, A8 – 20, A9 – 20, A7 – 50, A8 – 50, A9 – 50, A7 – 100, A8 – 100, A9 – 100 were tested for 7 days flexural strength of concrete by three point load test, . Specimens A10 – 0, A11 – 0, A12 – 0, A10 20, A11 – 20, A12 – 20, A10 – 50, A11 – 50, A12 – 50, A10 – 100, A11 – 100, A12 – 100 were tested for 28 days flexural strength of concrete by three point load test. . Specimens A7 – 0, A8 – 0, A9 – 0, A7 20, A8 – 20, A9 – 20, A7 – 50, A8 – 50, A9 – 50, A7 – 100, A8 – 100, A9 – 100 were tested for 7 days flexural strength of concrete by three point load test, . Specimens A13 – 0, A14 – 0, A15 – 0, A13 20, A14 – 20, A15 – 20, A13 – 50, A14 – 50, A15 – 50, A13 – 100, A14 – 100, A15 – 100 were tested for split tensile strength of concrete in compression testing machine. The specimens were cured for 7 days and 28 days in a tank fully filled with water.

TESTING OF SPECIMENS

The cubes were tested in compressing testing machine after 7 and 28 days with uniformly increasing static loading using 300 ton capacity compression testing machine. The loading was transmitted from loading machine to the specimen by rigid steel plates placed on both above and below specimen. The load was applied until needle started deflecting backward after crushing of the specimen and the last reading was noted. The beams were tested in a frame having capacity 100 ton with two point load test. the specimens were divided in three parts equally and two point load were kept at the end of middle third part of specimen and the load was applied through cylindrical iron piece below the dial gauge.

The cylinders were tested in compression testing machine with uniformly increasing static loading using 300 capacity compression testing machine. The test consist of applying a compressive line load along the opposite generators of a concrete cylinder placed with its axis horizontal between the compressiveplatens. Due to the compression loading a fairly uniform tensile stress is develop over nearly 2/3of the loaded diameter as obtained an elastic analysis. The magnitude of this tensile stress (acting in a direction perpendicular to the line of action of applied loading) is given by the formula(IS: 5816-1970) =2P/IIDL = 0.673P/DL

The loading is applied until the test specimen fails and needle starts deflecting backward and final reading is noted.

TABLE 4.1 : **DETAILS OF SPECIMEN DESIGNATION**

SPECIMEN TYPE	GRADE OF CONCRETE	SPECIMEN LABEL	PROPERTY TESTED	NO. OF SPECIMEN
CUBE	M25	A1 - 0	7 DAYS COMPRESSIVE STRENGTH	3
CUBE	M25	A1 - 20	7 DAYS COMPRESSIVE STRENGTH	3
CUBE	M25	A1 - 50	7 DAYS COMPRESSIVE STRENGTH	3

CUBE	M25	A1 - 100	7 DAYS COMPRESSIVE STRENGTH	3
CUBE	M30	B1 - 0	7 DAYS COMPRESSIVE STRENGTH	3
CUBE	M30	B1 - 20	7 DAYS COMPRESSIVE STRENGTH	3
CUBE	M30	B1 - 50	7 DAYS COMPRESSIVE STRENGTH	3
CUBE	M30	B1 - 100	7 DAYS COMPRESSIVE STRENGTH	3
BEAM	M25	A2 - 1	7 DAYS COMPRESSIVE STRENGTH	3
BEAM	M25	A2 - 20	7 DAYS FLEXURAL STRENGTH	3
BEAM	M25	A2 - 50	7 DAYS FLEXURAL STRENGTH	3
BEAM	M25	A2 - 100	7 DAYS FLEXURAL STRENGTH	3
BEAM	M30	B2 - 0	7 DAYS FLEXURAL STRENGTH	3
BEAM	M30	B2 - 20	7 DAYS FLEXURAL STRENGTH	3
BEAM	M30	B2 - 50	7 DAYS FLEXURAL STRENGTH	3
BEAM	M30	B2 - 100	7 DAYS FLEXURAL STRENGTH	3

CUBE	M25	A3 - 0	28 DAYS COMPRESSIVE STRENGTH	3
CUBE	M25	A3 - 20	28 DAYS COMPRESSIVE STRENGTH	3
CUBE	M25	A3 - 50	28 DAYS COMPRESSIVE STRENGTH	3
CUBE	M25	A3 - 100	28 DAYS COMPRESSIVE STRENGTH	3
CUBE	M30	B3 - 0	28 DAYS COMPRESSIVE STRENGTH	3
CUBE	M30	B3 - 20	28 DAYS COMPRESSIVE STRENGTH	3
CUBE	M30	B3 - 50	28 DAYS COMPRESSIVE STRENGTH	3
CUBE	M30	B3 - 100	28 DAYS COMPRESSIVE STRENGTH	3

BEAM	M25	A4 - 0	28 DAYS FLEXURAL STRENGTH	3
BEAM	M25	A4 - 20	28 DAYS FLEXURAL STRENGTH	3
BEAM	M25	A4 - 50	28 DAYS FLEXURAL STRENGTH	3
BEAM	M25	A4 - 100	28 DAYS FLEXURAL STRENGTH	3
BEAM	M30	B4 - 0	28 DAYS FLEXURAL STRENGTH	3
BEAM	M30	B4 - 20	28 DAYS FLEXURAL STRENGTH	3
BEAM	M30	B4 - 50	28 DAYS FLEXURAL STRENGTH	3
BEAM	M30	B4 - 100	28 DAYS FLEXURAL STRENGTH	3
CYLINDER	M25	A5 - 0	28 DAYS SPLIT TENSILE STRENGTH	3
CYLINDER	M25	A5 - 20	28 DAYS SPLIT TENSILE STRENGTH	3
CYLINDER	M25	A5 - 50	28 DAYS SPLIT TENSILE STRENGTH	3
CYLINDER	M25	A5 - 100	28 DAYS SPLIT TENSILE STRENGTH	3
CYLINDER	M30	B5 - 0	28 DAYS SPLIT TENSILE STRENGTH	3
CYLINDER	M30	B5 - 20	28 DAYS SPLIT TENSILE STRENGTH	3
CYLINDER	M30	B5 - 50	28 DAYS SPLIT TENSILE STRENGTH	3
CYLINDER	M30	B5 - 100	28 DAYS SPLIT TENSILE STRENGTH	3

PHOTO 6: BEAM UNDER TESTING

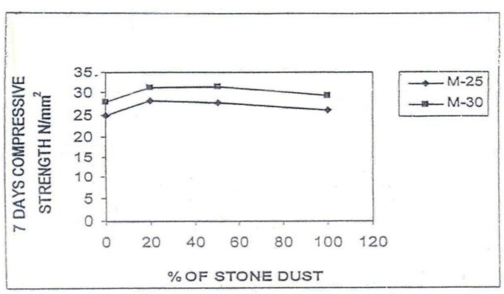

FIG1: COMPRESSIVE STRENGTH V/S% OF STONE DUST

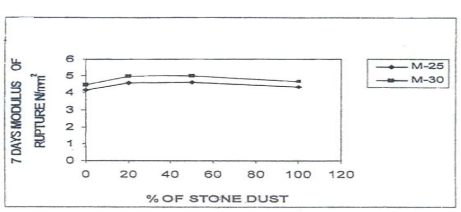

FIG2: MODULUS OF RUPTURE V/S% OF STONE DUST

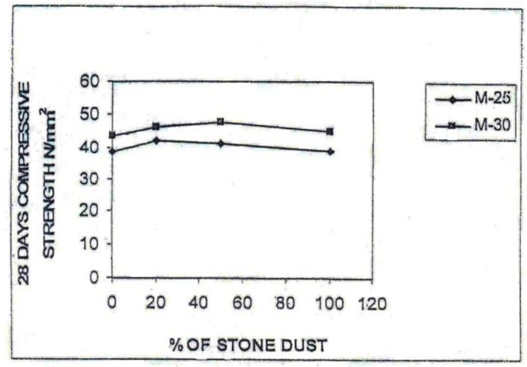

FIG3: COMPRESSIVE STRENGTH V/S% OF STONE DUST

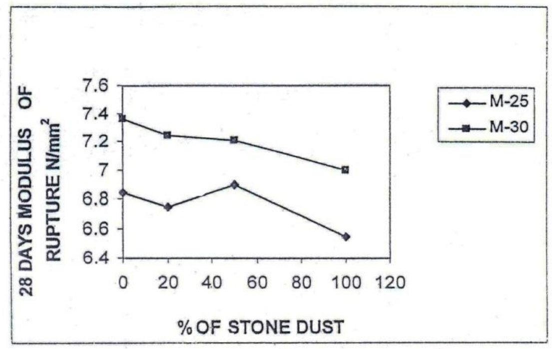

FIG4: MODULUS OF RUPTURE V/S% OF STONE DUST

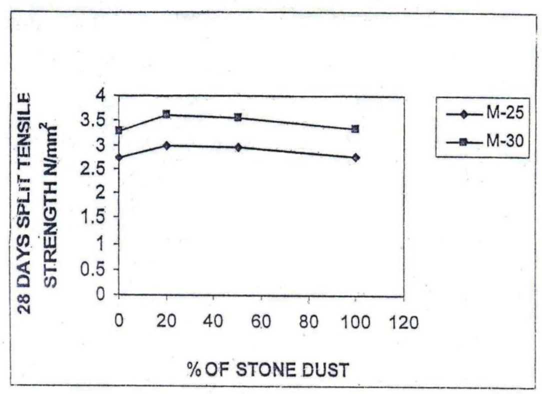

FIG5: SPLIT TENSILE STRENGTH V/S% OF STONE DUST

CONCLUSION

The following conclusion was drawn from the present experimental study.

The compressive strength, flexural strength and split tensile strength of concrete for grade M25 and M30 with stone dust as fine aggregate were found to be comparable with the concrete made with the river bed sand.

The increase in compressive strength of concrete with 20% replacement and 50% replacement of fine aggregate with stone dust is found to be 8 to 10%.

Stone dust can effectively be used in plain cement concrete in place of fine aggregate.

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