Experimental study on Use of Stone Dust as a Partial Replacement of Fine Aggregates in concrete as a Rigid Pavement

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ABSTRACT - *The purpose of this study was to investigate the possibility of using crushed stone dust as fine aggregate partially or fully with different grades of concrete composites. The suitability of crushed stone dust waste as fine aggregate for concrete has been assessed by comparing its basic properties with that of conventional concrete. Two basic mixes were chosen for natural sand to achieve M30 grade concrete. The equivalent mixes were obtained by replacing natural sand by stone dust partially and fully. The test result indicate that crushed stone dust waste can be used effectively used to replace natural sand in concrete. In the experimental study, of strength characteristics of concrete using crushed stone dust as fine aggregate it is found that there is increase in compressive strength, flexural strength and tensile strength of concrete.*

1. 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 constituent material and their combined action. Fine aggregate is one of the important constituent materials as far as strength characteristic of concrete is concerned. Increase in demand and decrease in natural sources of fine aggregate for the production of concrete has resulted in the need to identify new sources of fine aggregate. River sand 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 the same time increasing quantity of crushed stone dust is available from crushers as waste. The disposal of this dust is a 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 alternative material, the various phases of examination have to be technical feasibility, durability of processed concrete and economic feasibility. With the ongoing research being done to develop appropriate technology and field trials to monitor the performance and assessment of economic feasibility, the use of this alternative material will become more viable.

2. CONSTITUENT MATERIALS USED

The constituent materials used are cement, fine aggregate, coarse aggregate, stone dust and water. The recommended materials have been described below.

2.1 Cement

Various types of cement can be used in concrete with stone dust. The cement should be fresh, free from foreign matters and of uniform consistency. Usually ordinary Portland cement is used in normal conditions.

2.2 Fine Aggregate

The most common fine aggregate used in 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 sufficiently workable mix with a minimum water-cement ratio.

2.3 Coarse Aggregate

The aggregates are formed due to natural disintegration of rocks or by artificial crushing of the rock or gravels. The properties of coarse aggregate are chemical and mineral composition, spectrographic description, specific gravity, hardness, strength, physical and chemical stability, pore structure and color. Some other properties of the aggregate not possessed by the parent rocks are particle size and shape, surface texture and absorption etc. All these properties may have a considerable effect on the quality of concrete in fresh and hardened states.

2.4 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 comDo5ition 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.

2.5 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. Potable water is fit for mixing or curing of concrete.

2.6 Admixture

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

- Water reducing admixtures

• Retarding admixtures

• Water reducing and accelerating admixtures.

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

3. CASTING OF TEST SPECIMENS

The ingredients of concrete were mixed in 0.06 m3 capacity mixer. Weighed quantities of cement, sand were dry mixed until uniform colour was obtained without any cluster of cement and sand. Then weighed quantity of coarse aggregate was added and mixed in dry state until homogenous mixture was obtained. Measured quantity of water was added and ingredients were mixed in the mixer. All the moulds were oiled before casting the specimens. Cube specimens of size 150 mm x 150 mm x 150 mm of each concrete mixture were cast to determine the compressive strength, splitting tensile strength, cylindrical specimens of size 150 mm x 300 mm were cast to measure the modulus of elasticity of concrete. The specimens were de-moulded after 24 ±1 hr of adding water to concrete mixture. After demoulding the specimens were cured in water at room temperature.

4. DESIGN MIX

Mix design is made according to the IS specifications [BIS 10262-1982 and BIS 456-2000]. The sand used is of zone II obtained from Dera Bassi Punjab. Moulds are made on the basis of mix design and various tests are done on these moulds in order to check the strength parameters. The mix design is as follows:

Mix	Sand zone	Water	Cement	Fine aggregate	Coarse aggregate
M-X	II	191.6 kg/m^3	383.2 kg/m^3	670.377 kg/m^3	1127.927 kg/m^3
			1	1.76	2.94

Table 1-Mix Design

S. No	Mix	%age of coal bottom ash	Water kg/m^3	Cement kg/m^3	F.A kg/m^3	C.A kg/m^3	Coal bottom ash kg/m^3
1.	M-0	0	191.6	383.2	670.377	1127.927	0.0
2.	M-1	10	191.6	383.2	603.339	1127.927	67.0377
3.	M-2	20	191.6	383.2	536.3016	1127.927	134.0754
4.	M-3	30	191.6	383.2	469.2639	1127.927	201.1131
5.	M-4	40	191.6	383.2	402.2262	1127.927	268.1508

Table 2 Mix Proportion

5. TESTING OF SPECIMENS

The cubes were tested in compression 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 the 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 of 100 ton with two point load test The specimens were divided in three parts equally and two point loads were kept at the end of middle third part of specimen and the load was applied through cylindrical iron piece kept 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 consists of applying a compressive line load along the opposite generators of a concrete cylinder placed with its axis horizontal between the compressive platens. The following tests have been carried on various specimens:

- Compressive strength test
- Split tensile strength test
- Flexure strength test

6. RESULT ANAYLSIS

In the present chapter the result of the investigation conducted on the effect of partial replacement of coarse aggregates by waste tyre rubber on the strength and durability characteristics of concrete has been presented and discussed in detail. A Cube specimen of size 150mm×150mm×150mm and 100×100×100mm were tested for determining compressive strength and durability respectively, a cylindrical specimen of size 150mm (diameter) ×300mm(length) were tested for determining the split tensile strength and beams of size 100mm (width)×100mm(depth)×500mm(length) were tested for determining flexural strength. The results obtained from this study are presented and discussed in the preceding sections.

S. No	Mix designation	Average compressive strength	% increase average compressive strength
1	M-0	22.32	
2	M-1	22.91	1.02%
3	M-2	23.1	1.01%
4	M-3	24.03	1.04%
5	M-4	22.71	-1.05%

Table 3 Compressive strength after 7 days

S. No	Mix designation	Average compressive strength	% increase average compressive strength
1	M-0	35.25	
2	M-1	36.05	1.02%
3	M-2	37.31	1.03%
4	M-3	38.4	1.02%
5	M-4	36.24	-1.06%

Table 4 Compressive strength after 28 days

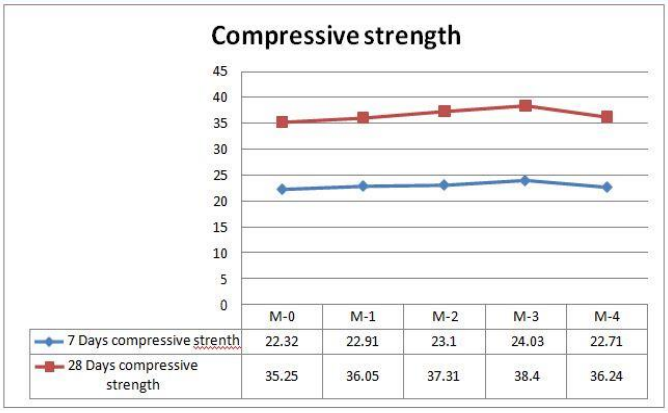

Fig 1 Comparison between 7 and 28 days Compressive Strength

S. No	Mix designation	Average flexural strength	% increase average flexural strength
1	M-0	3.04	
2	M-1	3.23	1.06%
3	M-2	3.38	1.04%
4	M-3	3.5	1.04%
5	M-4	3.26	-1.07%

Table 5 Flexural strength after 7 days

S. No	Mix designation	Average flexural strength	% increase average flexural strength
1	M-0	4.94	
2	M-1	5.08	1.02%
3	M-2	5.22	1.027%
4	M-3	5.47	1.04%
5	M-4	5.3	1.03%

Table 6 Flexural strength after 28 days

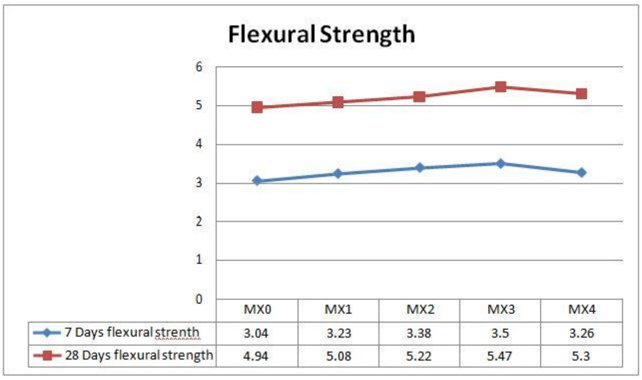

Fig 2 Comparison between 7 and 28 days Flexural Strength

S. No	Mix designation	Average split tensile strength N/mm^2	% increase average split tensile strength
1	M-0	2.05	
2	M-1	2.26	1.10%
3	M-2	2.33	1.03%
4	M-3	2.51	1.07%
5	M-4	2.26	-1.11%

Table 7 Split tensile strength after 7 days

S. No	Mix designation	Average split tensile strength N/mm^2	% increase average split tensile strength
1	M-0	3.65	
2	M-1	3.71	1.01%
3	M-2	3.9	1.05%
4	M-3	3.96	1.01%
5	M-4	3.52	-1.12%

Table 8 Split tensile strength after 28 days

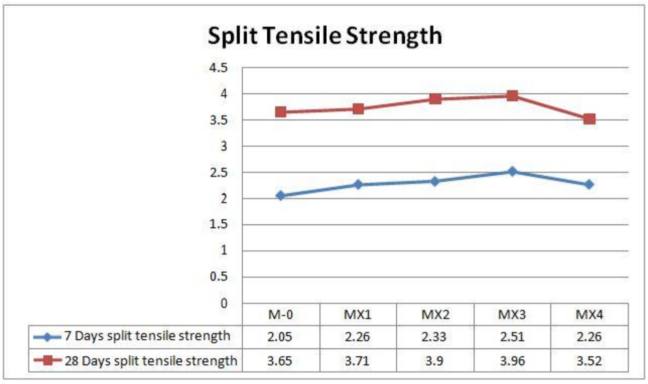

Fig 2 Comparison between 7 and 28 days Flexural Strength

7. CONCLUSION

In the experimental study stone dust, the cubes were tested for 7days and 28 days compressive strength 0%, 10%, 20%, 30% and 40% replacement of fine aggregate by stone dust in M30 grade concrete. The 7 days and 28 days compressive strength is shown in tables respectively. The 7 days and 28 days flexural strength beams obtained by replacing 0%, 10%, 20%, 30% and 40% fine aggregate with stone dust is shown in tables respectively. The result of cylinders that were tested for 28 days is shown tables. It has been observed that the results obtained in all compressive, flexural and spilt tensile strength are comparable with that of concrete with stone dust.

The following conclusions were drawn from the present experimental study.

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

2. The increase in compressive strength of concrete with 30% replacement of fine aggregate with stone dust is found to be 8 to 10%.

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

4. The Physical and chemical properties of stone dust is satisfied by the requirements of code provision in properties studies Natural river sand, if it is replaced by hundred percent Quarry Rock Dust from quarries, may sometimes give equal or better than the reference concrete made with Natural Sand, and in the terms of flexural and compressive strength studies.

5. From this test, replacement of OPC cement with this stone waste material provides maximum compressive strength at 30% replacement.

6. Non- availability of sand at reasonable costs as fine aggregate in cement concrete for various reasons, search for alternative material stone crusher (quarry) dust qualifies itself as a suitable substitute for sand at very low cost.

8. FUTURE SCOPE

1. Use of admixtures to add to workability of concrete made with stone dust can be studied.

2. Durability aspects of concrete made with stone dust as fine aggregate can be investigated.

3. People approach to the stone waste in concrete will be more and more as it will strengthen the building at economical cost.

4. Environmental effects of wastes and disposal problems of waste can be reduced through this research and make the environment green.

5. It will reduce the wastage and solve dumping problem of the industry.

6. Effective utilization of quarry dust in concrete can save the waste of quarry works; and also produces a ‘greener’ concrete.

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