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A Comparative Study of Different Types of Fine Aggregates in High Strength Concrete

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ABSTRACT

The effect of artificial sand and crush sand as fine aggregate in concrete is to substitute the natural sand content in concrete. The experimental work is mainly concerned with the study of mechanical properties like compressive strength, split tensile strength and flexural strength of concrete by full replacement of natural sand by artificial sand as fine aggregate Common river sand is expensive due to cost of transportation from natural source. Also large scale depletion of these source create environmental problem. Thus the artificial sand produced by proper machines can be a better substitute to river sand. The sand should be sharp, clean and course. The grains should be of durable material. The promotional use of artificial sand will conserve the natural resources for the sustainable development of the concrete in construction industry. The use of high strength concrete results in many advantages, such as reduction in sizes of beam and column and increase in the building height by many stories. In pre-stressed concrete construction, a greater span-depth ratio for beams may be achieved with the use of high strength concrete. Thus overall research study looks forward at introducing a way to make use of these different types of fine aggregates in HSC to increase the strength and durability of concrete and also to reduce the micro cracking effect in concrete. The project study reveals that the artificial sand gives better economical aspect if used in addition to the mineral admixtures and chemical admixtures in high strength concrete. Use higher dose of super plasticizer, for enhancing workability of mixture with artificial sand.

Keywords : Natural Sand, Crushed Sand, Compressive Strength, High Strength Concrete, Super Plasticizer,

I. INTRODUCTION

Inventions could be out of knowledge or necessity. Time and again mankind has proved itself by attaining higher levels of technologies. Excluding exceptions, man has most of the times made and applied -science of materials, to develop the appropriate equipments and paved ways for the other fields of research. But the field of concrete technology has no exception. For the past 90 years there has been an incredible rise in the research work (and their outcomes) on the concrete technology. Earlier concrete of specified strength was achievable with 1:2:4 volumes mix and was somehow satisfactory. But for higher strength of concrete, the composition ratio again changed.

Due to rapid growth in construction activity, the consumption of concrete is increasing every year. This results in excessive extraction of Natural aggregates. The use of these materials is being constrained by urbanization, zoning regulations, increased cost and environmental concern. Thus, it is becoming inevitable to use alternative materials for aggregates in concrete which include recycled aggregates, manufactured sand, Crushed rock powder etc. The use of such materials not only results in

conservation of Natural resources but also helps in maintaining good environmental conditions.

The present investigation aims in the study of properties of concrete in which Crushed Rock Powder (CRP) is used as a full replacement for Natural sand without compromising the quality of concrete. The basic strength properties of concrete were investigated by replacing Natural sand by CRP at replacement levels of 100%

1.1 Natural Sand:

The Natural or river sand are weathered and worn out particles of rocks and are of various grades or sizes depending upon the amount of wearing and it is the product of sedimentation. Mica, coal, fossils and other organic impurities are present in the river sand. The increase of these impurities above certain percentage makes the sand useless for concrete work. There is discrepancy in the sand in two trucks lifted from the same source. Hence for important work and to achieve the quality of each truck of sand should be tested. For getting required fineness modulus the sand should be sieved. In routine average wastage of sieving is about 35 % and extra labor cost is involved. For this reason, to fulfil the requirement of fine aggregate (Sand) some alternative material must be found1.

1.2 Crushed Sand:

Crushed sand is a form of construction aggregate, typically produced by mining a suitable rock deposit and breaking the removed rock down to the desired size using crushers. It is distinct from gravel which is produced by Natural processes of weathering and erosion, and typically has a more rounded shape. Developing new approaches in the field of Crushed sand production and then its increase in markets is one of the reasons that it involves many parties. This can be described as a sort of chain, starting with rock blasting in a hard rock quarry, advancing to rock crushing and screening, then continuing to a ready-mix producer, and finally ending up at the construction site, where the Crushed sand concrete is to be evaluated by the end user, i.e. the contractor.

II. SCOPE OF STUDY

Major scope of our study is to examine the suitability of different types of fine aggregate in high strength concrete. The present investigation aims in the study of properties of concrete in which Crushed sand is used as a full replacement for Natural sand in High Strength Concrete to increase the strength and durability of concrete and also to reduce the micro-cracking effect. The basic strength properties of concrete were investigated by replacing Natural sand by Crushed sand at replacement levels of 100%.

III. MATERIALS USED

3.1. Cement:

The Ordinary Portland Cement-53 grade was used. The physical properties determined in the laboratory. The cement satisfies the requirements of IS: 12269-1987 specifications.

Table 1. Physical Properties of cement

Component	Results (%)	Requirements of IS : 8112
Fineness, m^2/kg	1.63%	< 10%.
Initial setting Time, Minutes	135	Minimum 30
Final setting Time, Minutes	315	Maximum 600

3.2. Coarse aggregates:

The crushed stone aggregate was collected from Gadgadsangvi near Nasik. The coarse aggregate was used in the experimentation were about 20 mm and 10 mm size aggregate and tested as per IS: 2386-1963 (III) specifications.

Table 2. Physical properties of coarse aggregates.

Sr. No.	Characteristics	10 mm	20 mm
1	Specific gravity	2.80	2.84
2	Water Absorption	1.77%	1.93%
3	Aggregate Crushing value	15.73%	16.2%

3.3. Natural Sand:

The natural sand confirming to zone I as per IS: 383-1970 was used for the experimentation after washing it with water. The specific gravity of this natural sand was found to be 2.83. The water absorption values obtained for the sand used was found to be 2.78%.

3.4. Crushed Sand:

The crushed sand conforming to zone I as per IS: 383-1970 was used for the experimentation after washing it with water. The specific gravity of this artificial sand was found to be 2.95 The water absorption values obtained for the sand used was found to be 2.08%.

3.5. Admixture:

Sika [Sikament 170 (H) is used for increasing the workability of concrete mix even in case of less water cement ratio. The admixture was used by percentage of mass of cement (1.2% by mass), The same was adopted for all five mix proportion for maintaining the slump during the fresh concrete condition.

IV. EXPERIMENTAL PROGRAM

A total number of 24 cubes were prepared to investigate the properties of concrete with Crushed sand & Natural sand. In each series 6 mixes of both Crushed sand and Natural sand were prepared as explained above. The workability of concrete was determined by slump test for both mixes, having different w/c for 2 different grades. For determination of compressive strength at 7 & 28 days tests mould of 15x 15x15cm cube were made. Test results are shown in Table No.: 3 & 4 for Natural Sand and Table No.: 5 and 6 Crushed Sand.

Figure 12. Casting of Cubes M50 and M60 grade of concrete.

4.1. Compressive Strength Test:

Compressive strength test is the most common test conducted on concrete, because it is easy to perform and most of the desirable characteristic properties of concrete are quantitatively related to its compressive strength. Compressive strength was determined by using Compression Testing Machine (CTM) of 3000 KN capacity. The compressive strength of concrete was tested using 150 x150x150 mm cube specimens. The test was carried out by placing a specimen between the loading surfaces of a CTM and the load was applied until the specimen fails. Three test specimens were cast and used to measure the compressive strength for each test conditions and average value was considered.

4.2. RESULTS

A) For Natural Sand

Table 3. M 50 Natural Sand Cubes

CONCRETE COMPRESSIVE STRENGTH [IS-516]								
Concrete Grade: M 50				Date Of Casting : 26/02/17				
				Date Of Testing :		7 days		28 days
						05/03/17		26/03/17
Specimen No.	Age Of Cubes	Testing Date	Weight gm.	Density gm./cm³	Correct Load KN	Strength Mpa	Average Strength Mpa	Remark
1	7 days	05/03/17	8400	2.49	773	34.33	32.36	
			8460	2.51	722	32.08		
			8510	2.52	690	30.67		
2	28 Days	26/03/17	8550	2.53	1098	48.8	47.13	
			8520	2.52	1002	44.52		
			8500	2.52	1014	45.07		
Remarks: This is as per concrete mix design trial reports, conducted in laboratory condition.								

Table 4. M 60 Natural Sand Cubes.

CONCRETE COMPRESSIVE STRENGTH [IS-516]								
Concrete Grade :M 60				Date Of Casting :25/02/17				
				Date Of Testing :		7 days		28 days
						04/03/17		25/03/17
Specimen No.	Age Of Cubes	Testing Date	Weight gm.	Density gm./cm³	Correct Load KN	Strength Mpa	Average Strength Mpa	Remarks
1	7 Days	04/03/17	8410	2.49	1005	44.65	43.13	
			8440	2.50	992	44.08		
			8470	2.51	915	40.67		
2	28 Days	25/03/17	8530	2.53	1341	59.60	58.08	
			8490	2.51	1267	56.31		
			8510	2.52	1313	58.33		
Remarks: This is as per concrete mix design trial reports, conducted In laboratory condition.								

B) For Crushed Sand:

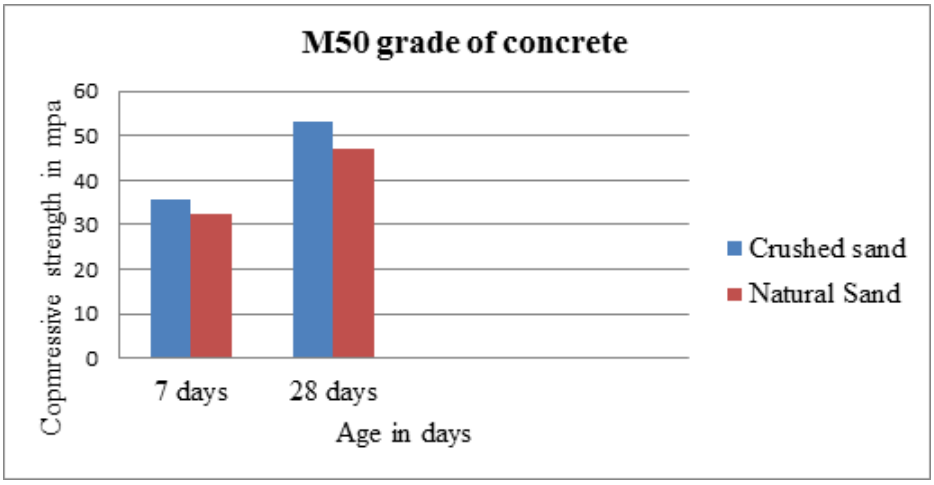
Table 5. M 50 Crushed Sand Cubes.

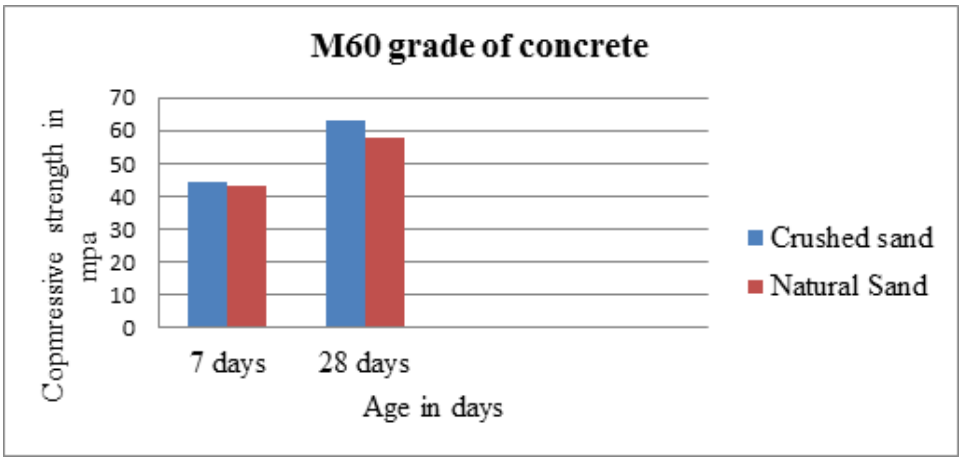
CONCRETE COMPRESSIVE STRENGTH [IS-516]								
Concrete Grade : M 50				Date Of Casting : 26/02/17				
				Date Of Testing :		7 days		28 days
						05/03/17		26/03/17
Specimen No.	Age Of Cubes	Testing Date	Weight gm.	Density gm./cm³	Correct Load KN	Strength Mpa	Average Strength Mpa	Remark
1	7 Days	05/03/17	8572.5	2.54	863	38.33	35.88	
			8505	2.52	791	35.13		
			8707.5	2.58	772	34.31		
2	28 Days	26/03/17	8673.75	2.57	1172	52.08	53.00	
			8606.25	2.55	1274	56.60		
			8808.75	2.61	1133	50.33		
Remarks: This is as per concrete mix design trial reports, conducted In laboratory condition.								

Table 6. M 60 Crushed Sand Cubes

CONCRETE COMPRESSIVE STRENGTH [IS-516]								
Concrete Grade : M 60				Date Of Casting : 25/02/17				
				Date Of Testing :		7 days	28 days	
						04/03/17	25/03/17	
Specimen No.	Age Of Cubes	Testing Date	Weight gm.	Density gm./cm³	Correct Load KN	Strength Mpa	Average Strength Mpa	Remark
1	7 Days	04/03/17	8572.5	2.54	1040	46.23	44.09	
			8505	2.52	999	44.38		
			8707.5	2.58	938	41.67		
2	28 Days	25/03/17	8673.75	2.57	1418	63.02	62.95	
			8606.25	2.55	1379	61.28		
			8808.75	2.61	1453	64.56		
Remarks: This is as per concrete mix design trial reports, conducted In laboratory condition.								

4.3. Comparison of M 50 and M60 Grade of Concrete





4.4. DISCUSSION:

It is observed that from results, Crushed sand gives more compressive strength than Natural sand and it proves to be more economical, easy available and environment friendly.

V. CONCLUSION

- The cost of Crushed sand is in the range of 40% to 70% to that of Natural sand and considering cost of screening, washing and wastage due to oversize particle of Natural

sand, the Crushed sand concrete will be about 15% to 25% cheaper than that of Natural sand concrete.

- The test results obtained from well planed and carefully performed experimental programme encourages the full replacement of Natural sand by Crushed sand considering the technical, environmental and commercial factors..
- The Crushed sand reduces the production cost and it is conducive to environmental protection.
- The Crushed sand has more wide different particle shapes, surface texture and grading of the fines compare to Natural sand. The sharp edges of the particles in Crushed sand provide better bond with cement than the rounded particles of Natural sand resulting in higher strength.
- It was also known that the Crushed sand concrete generally indicated lower workability than that of the Natural sand concrete and crusher dust is flaky and angular in shape which is troublesome in working.

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