EXPERIMENTAL INVESTIGATION ON CONCRETE BY REPLACING CRUSHER DUST AS FINE AGGREGATE AND GRANITE CHIPS AS COARSE AGGREGATE

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Abstract

In this present work we identified and investigated the use of crusher dust and granite floor slab chips in concrete as an alternative fine aggregate and coarse aggregate respectively, the tests were conducted on standard concrete cubes (150 mm x 150 mm x 150 mm), cylinders (150 mm x 300 mm) and prisms (100 mm x 100 mm x 500 mm). Tests on the physical properties of crusher dust, granite chips and its influence on the strength of fresh and hardened state, along with a comparative study with the concrete of river sand are made. The properties investigated were specific gravity, fineness modulus, water absorption, free surface moisture, bulk density and grading zone. Tests were conducted on 6 cubes, 6 cylinders and 6 prisms for M20 grade mix design with sand and crusher dust as fine aggregates, granite metal and granite floor slab chips as coarse aggregates. The strength parameters compressive strength, Split-Tensile strength and flexural strength were compared at 7 days and 28 days respectively. Mix design procedure in accordance with IS 10262-2009, IS 456-2000 and Sp 23-1982 using 20mm coarse aggregate was adopted for investigation. The investigation indicates that crushed stone dust has vast potential as fine aggregate in concrete construction. Crusher dust not only reduces the cost of construction but also helps reduce the impact on environment by consuming the material hitherto considered as a waste product with few applications.

Keywords: *Crusher Dust, Granite Floor Slab Chips, Concrete Mix.*

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1. INTRODUCTION

The new technologies and processes were appearing from construction industry to economize, expedite and stream line the work process. There will be many differences seen in manufacturing process of concrete in accordance with the requirements of the structure say for example by utilizing new admixtures and the traditional materials. The cost of construction will tremendously increasing from 60 to 70 percent since due to utilizing of building materials like cement, steel, concrete and timber. In addition to this the cost of construction will be again rise nearly 15 to 18 percent in day to day life due to cost of materials. There is a great need to improve the manufacturing process of concrete and optimum quantity of utilization of its ingredients because more changes that are taking place in environment, economy and quality control.

Concrete is a heterogeneous material consisting of cement, fine aggregate and coarse aggregates. To meet requirements we can utilize alternative materials for coarse and fine aggregates such as crushed stones (Granite and Basalt as ingredients) of desirable sizes and river sand as fine aggregates in conventional concrete. While preparing mortar and concrete it will be more economical of using locally available materials as an alternative for fine aggregates rather than usage of river sand. Stone dust is one of the materials which is found abundantly from crusher units. By using crushed stone dust as an alternative for replacing fine aggregate. It not only reduces the cost of construction but also provides a solution for the disposal problem of stone dust, at the same time it avoids the stone dusts waste impact on environment.

1.1 Research Significance

Usually while making concrete and motor river sand is used as a fine aggregate, this is available from long distances. Furthermore, this causes dwindling resources and escalating costs of construction materials in manufacturing concrete. Hence it is necessary to find alternative material for river sand to fulfill the lack of fine aggregate in making concrete.

In the place of river sand crusher stone dust is found to be best suitable material to produce concrete mixes. During crushing of granite or basalt stones, in order to produce coarse aggregate, the crushed stone waste will be available abundantly as a by-product. From this, it’s an innovative way of receding waste materials instead of dumping into discarded areas. The main aim of this project is to explore the properties and the right choice to use stone dust in the formation of concrete. In addition, to this it’s also found, that the characteristic strength of concrete for 28 days, the spilt tensile strength and flexural tensile strength will be more with crusher stone dust compared to river sand, When it is used as a fine aggregate in making concrete. In case of reinforced concrete researchers has been observed that the crusher stone dust will have good prospects and economical rather than utilizing river sand in repairing concrete.

1.2 Summary

To achieve the economy, the construction industries are struggling more to bring out various methods in order to have the best quality of concrete. Among those materials crusher stone dust is one of the materials to replace river sand as an alternative for fine aggregate. By utilizing the crusher stone dust it will be serves as ecofriendly materials as well as economical in making concrete. The forms of crusher stone dust by disintegration are enormously used in production of mortar & concrete.

2. EXPERIMENTAL PROGRAMME

2.1 Materials

The materials which are used in this present research work are ordinary Portland cement 53 grade, River, crusher dust and crushed granite aggregate of 20 mm nominal size and crushed granite floor slab chips of 20 mm of nominal size.

2.2 Cement

For casting the specimens such as cube, cylinder and beams, the ordinary Portland cement of 53 grades is used. Table 1 reveals the physical properties of cement.

2.3 Fine Aggregates

River sand and crushed stone dust has been used as fine aggregate in concrete. Table 2 presents the physical properties of fine aggregates.

2.4 Coarse Aggregate

Crushed granite aggregate and granite floor slab chips of 20 mm nominal size was used as coarse aggregate for concrete. The test results for physical properties of coarse aggregate are presented in Table 3.

Table 1: Physical Properties of Cement

Test	53 Grade
Fineness	10.6
Specific gravity	3.15
Normal consistency	31 percent
Setting time	
a) Initial setting time	33 minutes
b) Final setting time	130 minutes
Soundness (Le Chatlier)	2.1 mm
Compressive strength at 28 Days	53.66Mpa

Table 2: Physical Properties of Fine Aggregates

Property	River sand	Crusher dust
Bulk density (kg/m^3)	1602.06	1742.5
Specific gravity	2.64	2.74
Fineness modulus	2.83	2.705
Free surface moisture	0.329 %	1.06 %
Water absorption	1.987 %	1.86 %

Table 3: Physical Properties of Coarse Aggregates

Property	Granite metal	Granite chips
Max nominal size	20 mm	20 mm
Bulk density (kg/m^3)		
a) Loose state	1562	1560
b) Compacted state	1686.7	1676.66
Specific gravity	2.595	3.07
Fineness modulus	8.38	7.85
Free surface moisture	0.258 %	0.184%
Water absorption	0.918 %	1.15%

2.5 Preparation of Specimens

Four concrete mixes designated as A (1:1.58:2.77, w/c = 0.5), B (1:1.791:2.77, w/c = 0.5), C (1:1.58:3.28, w/c = 0.5) and D (1:1.791:3.28, w/c = 0.5) were used in the investigations presented in this report.. Mix proportions for A, B, C and D are designed according to the principles of mix design of IS 10262 – 2009 and SP 23 – 1982 for M 20 grade concrete. The exact proportions of cement, sand, crusher stone dust and coarse aggregate were weighed accordingly as given in Table 4 and mixed thoroughly in the tray with water required quantities as per design calculations. The proportions for

- MIX A is designed with Granite metal and river sand as aggregates (here is referred to has conventional concrete).
- MIX B is designed with Granite metal and crusher dust as aggregates.
- MIX C is designed with Granite chips and River sand as aggregates.
- MIX D is designed with Granite chips and crusher dust.

Table 4: Mix proportions for plain concrete

Material	Mix designation			
	Mix A	Mix B	Mix C	Mix D
Cement (Kg/m3)	394	394	394	394
River sand (Kg/m3)	622.46	-	622.46	-
Crusher dust (Kg/m3)	-	705.933	-	705.933
Coarse aggregate (Kg/m3)	1090.83	1090.83	-	-
Granite chips (kg/m3)	-	-	1293.89	1293.89
Water cement ratio	0.5	0.5	0.5	0.5

2.6 Tests on concrete

2.6.1 Cubes tests

For each Mix of concrete, six 150 x 150 x 150 mm cubes were cast and tested to determine the compressive strength, three at the age of 7days and the remaining three at the age of 28days. The results of the tests on cubes for compressive strength are presented in Table 5 for River sand, crusher dust, granite metal and granite chips and also comparison of average compressive strength for concrete with sand and crusher dust is shown in table 5 exhibits the compressive strength test conducted on cubes prepared with crusher dust and granite chips.

Table 5: Cube compressive strength of M20 Grade design mix (Average of 3 cubes), Corresponding graph shown in Fig 1

Nominal size of C.A	Mix type	Fine aggregate	Coarse aggregate	W/c Ratio	Slump mm	C.F	Compressive Strength, N/mm^2		Percent increase in compressive strength compared to river sand	
							7 days	28 days	7 days	28 days
20 mm	A	River Sand	Crushed granite aggregate	0.5	25	0.9	21.77	26.203	-	-
	B	Crusher Dust	Crushed granite aggregate	0.5	24	0.8	21.782	26.265	0.06%	0.24%
	C	River sand	Granite chips (reduced to 20mm size)	0.5	25	0.9	24.44	25.68	12.26%	-1.99%
	D	Crusher dust	Granite chips (reduced to 20mm size)	0.5	23	0.8	19.173	24.913	-11.93%	-4.93%

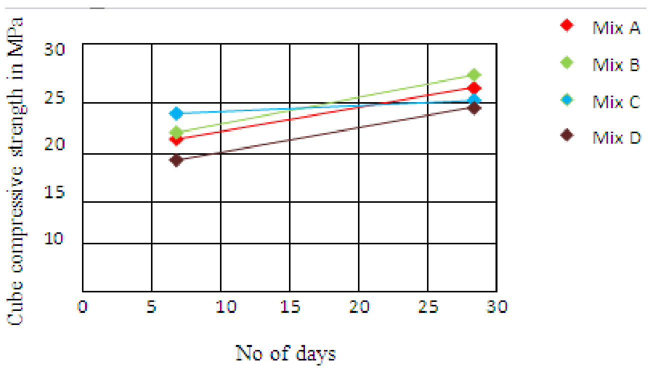

Fig 1: Cube compressive strength variation

2.6.2 Split Tensile Tests

Six 150 mm x 300 mm cylinder were cast and tested to determine the split tensile strength for each Mix; three cylinders were tested at the age of 7days and the remaining three at the age of 28days. The test results for split tensile strength are presented in Table 6 for river sand and crusher dust, granite metal and granite chips respectively and also comparison of average split tensile strength for concrete with sand and crusher dust is shown in table 6 exhibits the split-tensile test conducted on cylinders prepared with crusher dust and granite chips.

Table 6: Split Tensile strength of M 20 Grade design mix (Average of 3 Cylinders), Corresponding graph shown in Fig 2

Nominal size of C.A.	Mix type	Fine aggregate	Coarse aggregate	W/c Ratio	Tensile Strength, N/mm^2		Percent increase in tensile strength compared to river sand	
					7 days	28 days	7 days	28 days
20 mm	A	River Sand	Crushed granite aggregate	0.5	1.956	2.61	-	-
	B	Crusher Dust	Crushed granite aggregate	0.5	2.12	2.748	8.38%	5.28%
	C	River sand	Granite chips (reduced to 20mm size)	0.5	1.675	2.48	-14.36%	-4.98%
	D	Crusher dust	Granite chips (reduced to 20mm size)	0.5	1.713	2.131	-12.42%	-18.35%

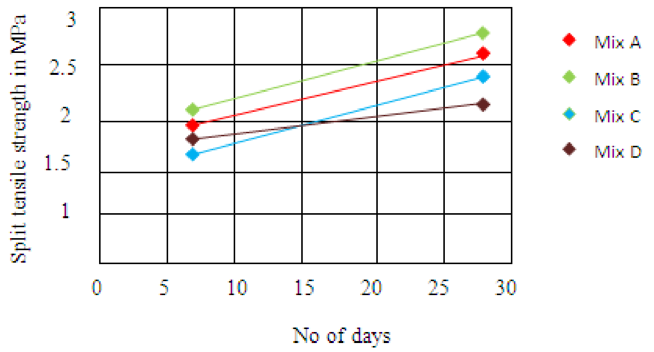

Fig 2: Split tensile strength variation

2.6.3 Flexural Tensile Strength Test

Six 100 mmx100 mmx500 mm size prisms were cast and tested in flexure for two – loading to determine the modulus of rupture, three at the age of 7 days and the remaining three at the age of 28 days. The test results for flexural tensile strength are presented in Table 7 for river sand, crusher dust, granite metal and granite chips, respectively and a comparison of average values for modulus of rupture for concrete with sand and crusher dust is shown in Table 7.

Table 7: Flexural Tensile strength of M 20 Graded design mix (Average of 3 prisms), Corresponding graph shown in Fig 3

Nominal size of C.A.	Mix type	Fine aggregate	Coarse aggregate	W/c Ratio	Flexure Tensile Strength, N/mm^2		Percent increase in tensile strength compared to river sand	
					7 days	28 days	7 days	28 days
20 mm	A	River Sand	Crushed granite aggregate	0.5	3.88	5.573	-	-
	B	Crusher Dust	Crushed granite aggregate	0.5	3.94	5.63	+1.546%	+0.484%
	C	River sand	Granite chips (reduced to 20mm size)	0.5	3.825	5.473	-1.417%	-1.794%
	D	Crusher dust	Granite chips (reduced to 20mm size)	0.5	3.78	5.343	-2.577%	-4.127%

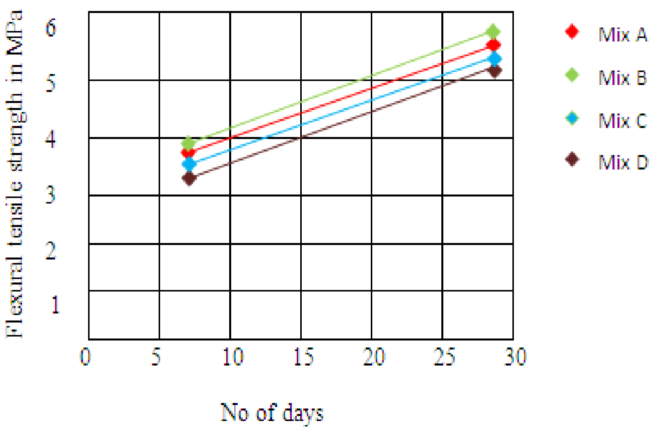

Fig 3: Flexural tensile strength variation

3. RESULTS AND DISCUSSIONS

The test results for physical properties of cement, fine and coarse aggregates are shown in Tables 1, 2 and 3. The proportions for design mix A, Mix B, Mix C and Mix D are shown in Table 4. The mean values of cube compressive strength are presented in tables 5, the mean values of spilt tensile strength are presented in table 6 and the mean values of modulus of rupture are presented in table 7.

3.1 Discussions

The physical properties, the workability and strength characteristics in compression, tension and modulus of rupture strength for M20 Grade concrete with sand and crusher dust as a fine aggregate and metal on 20mm Granite metal and crushed granite chips are sustained and discussed.

3.2 Crusher Dust As Fine Aggregate

Table 2 shows the results of tests for physical properties of fine aggregates. Fineness modulus for river sand crusher dust was found as 2.83 and 2.705, respectively. It indicates that crusher dust contains less percent finer particles compared to river sand. The sieve analyses on samples of fine aggregate shows that river sand and crusher dust belongs to same grading zone in many cases. The principles of mix design applied for concrete with crusher dust are same as those applied for river sand. On experimental investigation, it was found mortar and concrete prepared with crusher stone dust were relatively less workable than those prepared with sand. The increase in specific surface area for crusher dust due to the presence of high percent finer particles lead to high demand of water. The combined action of cement and stone dust produced a harsh concrete mix that lead for less consumption of cement. Previous investigations showed that the workability of mix prepared with crushed stone dust can best be improved by the addition of appropriate quantities of super plasticizers without affecting the strength of mix.

3.5 Summary

The use of crusher dust in plain concrete is most economical and there is no hesitation in using stone dust as fine aggregate for reinforced concrete where in its use is recommended. Use of granite chips as coarse aggregate for conventional concrete is scarily recommended for concrete as chips has no complete texture and angularly for making concrete.

4. CONCLUSIONS

Based on the experimental investigations the following conclusions can be concluded they are

- The crushed stone dust provides the strength to the concrete mix. There will be strong bonding between the crushed stone dust and ultra-fine particles due to roughness of crushed stone dust particles. The conventional concrete will be more permeable and durable than the concrete with crushed stone dust.
- When compared with conventional concrete, the concrete made with crushed stone dust will have increase in the compressive strength nearly of about 0.236 % for concrete. The tensile strength of concrete nearly increases of about 5.28%, in flexural strength nearly of about 0.484 % when concrete made with crushed stone dust as fine aggregate.
- To achieve strength and economy the crushed stone dust will be useful in plain concrete beams and also reduces its impact on environment.

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CODES OF PRACTICE

The following are the codes used in this work.

- IS456-2000, "Indian standard code of practice for plain and reinforced concrete" fourth revision, BIS, New Delhi.
- IS 10262-2009,"recommended guidelines for concrete mix design", BIS, New Delhi.
- IS383-1970,"Indian standard specifications for coarse and fine aggregate from natural source for concrete "2nd Edition, BIS, and New Delhi.
- SP 23-1982,"Hand book on concrete mixes" BIS, New Delhi.

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