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STRENGTH AND DURABILITY STUDIES ON CONCRETE USING QUARRY DUST AS FINE AGGREGATE

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Abstract— Conventional Cement Concrete (CCC) consists of Portland Cement (PC) as binder, which binds the inert aggregate system. Concrete has found its wide application in buildings throughout the world because of positive attributes such as durability, high resistance to loads, and the possibility of using local raw materials in the preparation of concrete (Sand, Crushed Stone). The use of river sand in making the concrete is the best Fine Aggregate (FA). Seasonal non – availability and scarcity leads to the higher cost. There is a need to tackle this problem. So the replacement of conventional river sand is necessary. For this the abundantly available material at all season at a cheaper rate is in need. The use of Quarry Dust – the fines which is found as the remains of the crusher industry, as a replacement of sand is being tried at different places, but no authentic results are available for the characteristics strength and the optimum proportion by which it can be included as FA. Properties such as: compressive, split tensile and flexural strengths besides durability of concrete made with Quarry Dust have been investigated. Cement Concrete mix using Quarry Dust as Fine Aggregate is designed using M20.

Keywords: Durability, Quarry dust, Material test

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 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

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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 ongoing 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.

2. LITERATURE SURVEY

Felekoglu et al. [2] observed that the incorporation of quarry waste at the same cement content generally reduced the super plasticizer requirement and improved the 28 days' compressive strength of SCC. Normal strength SCC mixtures that contain approximately 300–310 Kg of cement per cubic meter can be successfully prepared by employing high amount of quarry waste.

Sukumar et al. [3] found that the relations have been established for the increase in compressive strength at premature ages of curing (12 h to 28 days) for different grades of SCC mixes and are compared with the IS Code formula for straight concrete as per IS: SP 23-1982.

Ho et al. [4] explained that the granite fines can be used in the SCC production. However, it is important to spot out that, as a waste material, the properties of stone fines are likely to vary with time. Then, after that, the fineness of granite fines could solve durability problems, such as silica-alkali reactions. These two issues would require to be addressed if the material is to be used with assurance.

Muhit et al. [6] determined that passing from 200 mm sieve is used as cement replacement whereas retaining from 100 mm sieve is used as sand replacement. Cement was replaced with stone dust in percentage of 3, 5, and 7 percent. Similarly, sand was replaced with stone dust in percentage of 15 to 50 with an increase of 5 percent. Test result gives that compressive strength of mould with 35% of sand and 3% of cement replacing dust increases to 21.33% and 22.76% in that order compared to the normal mortar mould at 7 and 28 days for tensile strength which increased to 13.47%

Ukpata and Ephraim [7] identified the flexural and tensile strength properties compared with those for normal concrete. Hence, concrete proportion of lateritic sand and quarry dust can be used for construction provided the mixture of lateritic sand content is reserved below 50%. Both flexural strength and tensile strength are increased with increase in lateritic content.

3. Application of Quarry rock dust

1.It is being used as surface dressing in highway work. 2. It is also used in the manufacturing of

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building material, such as lightweight aggregates, bricks, tiles and autoclave blocks. 3. Fiberrein forced pre-cast units are also made up of this. 4. It is used in synthetic rock and kerbs. 5. Few more uses are in embankment construction, landfill capping, filler applications,manufactured sand, cement making, green roofs, straw and clay blocks. Properties of Quarry rock dust: a. Resistant to heat and fire b. Alkaline in presence of moisture c. Non-plastic d. Consistent chemistry e. Excellent load bearing capacity

4. Materials:

1) Cement

Cement is a binding material that has cohesive and adhesive properties in the presence of water. It is of Silicates and Aluminates of Lime obtained from Limestone and Clay. The cement combines chemically with water to form a hardened mass. The hydraulic cement is usually known as Portland Cement because of its resemblance upon hardening to the Portland stone found near dourest England.

Tests on Cement

1) Fineness of Cement The fineness of cement test is done according to IS: 269-1989 & IS: 4031-1988 is 5%.

2) Normal Consistency of Cement The standard consistency test of a cement is done by according to IS: 269 - 1989 & IS: 4031 – 1988, Part – 4 is 32%.

3) Initial & Final Setting Times of Cement Initial setting time for the given sample of cement = 3 Hrs = 180 min Final setting time for the given sample of cement = 4 Hrs = 240 min

4) Compressive Strength of Cement The compressive strength of cement mortars is IS: 269-1989, IS: 8112-1989, IS: 12269 -1987, IS: 4031-1988, Part - 4 & IS: 4031-1988. Compressive strength of the given cement

at 3 days = 25.6 N/mm2
at 7 days = 30.5 N/mm2
at 28 days = 52.9 N/mm2

Aggregates (Fine & Coarse)

The aggregate like sand, stone are inert materials. The behavior of concrete since they occupy about 70 to 75% of the total volume of the concrete. It is logical to use maximum of aggregate, since they provide bulk to the concrete, are less expensive than cement and are freely available in nature.

a) Tests on Fine Aggregate Coarse Aggregate

1) Fineness Modulus Of Fine Aggregate The fineness modulus of given conventional sand = 3.27 The fineness modulus of given laterite sand = 3.25

2) Specific Gravity Of Fine Aggregate The specific gravity test of fine aggregate is done according to IS: 2386 -1963, Part -3. For Conventional Sand = 2.56. For Conventional Sand = 2.44.

3) Bulk Density Of Sand Bulk density of Conventional Sand = 1.08 Kg/ m3 Bulk density of Laterite Sand = 1.01 Kg/ m3

4) Bulking Of Sand The maximum bulking of the given normal sand is 820 ml at 4% of moisture content The maximum bulking of the given laterite sand is 860 ml at 6% of moisture content.

5) Fineness Modulus Of Coarse Aggregate The fineness modulus of given coarse aggregate = 2.86

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6) Specific Gravity Of Coarse Aggregate The specific gravity of coarse aggregate is done according to IS: 2386 -1963, Part – 3 is 2.72. 7) Bulk Density Of Coarse Aggregate Bulk density or unit weight is done according to relevant IS code is 0.94 Kg/ m3 .

Water For proper chemical action, the amount of water required is about 25% of the weight of cement used, however, more water is used for proper workability of concrete. The water used for both mixing and curing should be free from injurious amount of oils, acids, alkalis, salts, organic materials or other substances that may be harmful to concrete. According to IS 456 – 2000, the pH value of the water shall not be less than 6. In the Present study, The pH value of water used in the concrete mix is 5.5.

5. Test Specimens and Test Procedure

The 150 mm size concrete cubes, concrete beams of size 100 mm x 100 mm x 500 mm were used as test specimens to determine the compressive strength and flexural strength respectively. The specimens were cast for M20, M30 and M40 grade and for coarse aggregates of size 20 mm was used. The workability of fresh concrete was measured in terms of slump values, V-B time and compaction factor. To obtain the required slump value, VB time and equivalent compacting factor superplasticiser (0.7 to 2.4 % of weight of cement) were added. The properties of fresh concrete were measured according to IS: 1199-1959 [6]. The ingredients of concrete were thoroughly mixed in mixer machine till uniform consistency was achieved. The cubes were compacted on a vibrating table while the beams were compacted using needle vibrator.

6. Split Tensile Strength

From the table 2, it is inferred that the control mix and mix M1 will give approximately equal strength in 7 days. For mix M2, the strength was reduced, but it is acceptable. For M3, the strength was reduced by about
3.77 %. For 14 days, the control mix and mix M1 gives approximately equal strength. For the mix M2, strength was reduced, but it is acceptable. For mix M3, the strength gets reduced by 25.9 %. For 28 days, it is inferred that the control mix and the mix M1 gives equal strength of 37.99 MPa. For M2,
the strength was reduced but it is acceptable. For the mix M3, the strength was reduced by about 21.23 %

7. Workability

The variation of workability of fresh concrete is measured in terms of slump and reported in Tables 1 and in figure 1. For the given water/cement ratio, the highest slumps were recorded for the mixes designed by IS code method. The overall workability value of Quarry Rock Dust concrete is less compared to conventional concrete, it has been observed that workability of concrete is increased as we increase the percentage of quarry fines, where control concrete mix gives 20mm, QF20 45mm and QF 175mm slump which clearly shows

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that workability in concrete increase due to adding of quarry fines in concrete

S.No.	Mix	Workability (in mm)
1	CC	20
2	QF20	45
3	QF40	70
4	QF60	105
5	QF80	140
6	QF100	175

Table 1: Workability of Concrete of different mixes

8. CONCLUSION AND FUTURE WORK

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. B. 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%. C. Stone dust can effectively be used in plain cement concrete in place of fine aggregate. D. 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. E. Crushed stone dust is free from chemical impurities such as sulphates and chlorides which improves the properties of concrete like strength and durability. F. Effective utilization of quarry dust in concrete can save the waste of quarry works; and also produces a 'greener' concrete.

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