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Effect on Mechanical Property of M20 Grade of Concrete with Partial Replacement of Sand by Quarry Dust and Iron Slag

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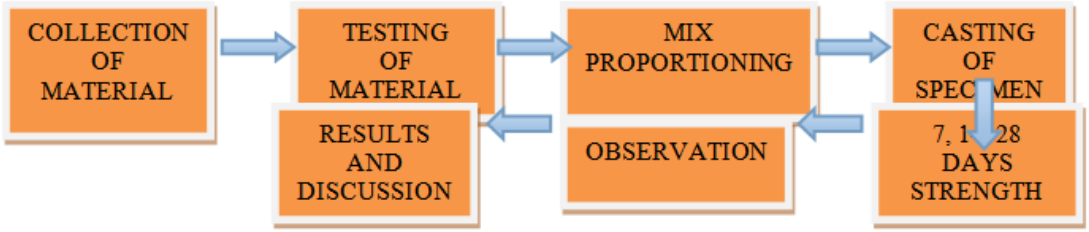
ABSTRACT :*Sand is widely and mostly used material in concrete. River is the only source of sand most commonly. To save river from degradation we must find some replacement for sand. The environmental and economic concern is the biggest challenge concrete industry is facing now. Iron slag and Quarry dust are industrial by product and waste product after the demolition of mountains for construction respectively. Both materials are easily and cheaply available. In this paper, the issue of environment and economic concerns are addressed by the use of iron slag and quarry dust as partial replacement of fine aggregate in concrete. Sand was replaced by quarry dust as 30%, 40%, 50% and 60% keeping iron slag constant as 30% by weight for M-20 mix. The specimens were tested after 3, 7, and 28 days of curing for compression test and results obtained were compared with conventional concrete results. The results showed that at 50% replacement of quarry dust, compression strength is maximum. Decrease in slump height and water absorption % was obtained in different mixes whereas increase in density has been evaluated*

KEYWORDS - *Compressive strength, Density test, Iron slag, Quarry dust, Workability.*

I. INTRODUCTION

Concrete is the most widely used construction material today. The constituents of concrete are coarse aggregate, fine aggregate binding material and water. It is conventional that sand is being used as fine aggregate in concrete. For the past some years, the escalation in cost of sand due to administrative restrictions in India, demands comparatively greater cost at around two to three times the cost of quarry dust even in places where river sand is available nearby. The materials usually researched for replacement purpose are either by-product materials or even sometimes manufactured aggregates Quarry dust, a by-product from the crushing process during quarrying activities is one of those materials being studied, especially as substitute material to sand as fine aggregates. It has been proposed as an alternative to river sand that gives additional benefit to concrete. Quarry dust is known to increase the strength of concrete over concrete made with equal quantities of river sand. They have been used for different activities in the construction industry such as for road construction and manufacture of building materials such as lightweight aggregates, bricks, tiles and autoclave blocks. High percentage of dust in the aggregate increases the fineness and the total surface area of aggregate particles. The main objective is to provide more information about the effects of various proportion of dust content as partial replacement fine aggregate on workability, air content, compressive strength, tensile strength, water absorption, percentage of concrete. Iron slag is a byproduct obtained in the manufacture of iron in the blast furnace and is produced by the blend of down to earth constituents of iron ore with limestone flux. Mostly, the slag consists of magnesium, aluminum silicates calcium and manganese in various arrangements. The history of the use of iron and steel slag dates back a long. The present research work mainly deals with the influence of different replacement proportion of sand with quarry dust and iron slag on the properties of concrete. The present study is planned to study the effects of quarry dust and iron slag addition in normal concrete and to assess the rate of compressive strength development.

II. METHODOLOGY AND MATERIAL PROPERTIES



2.1. Cement and aggregates:

Ordinary Portland Cement of 53 grade confining to IS 8112 [8] was used throughout the work. Fine aggregates used throughout the work comprised of clean river sand with maximum size of 4.75mm conforming

to zone II as per 383-1970[9] with specific gravity of 2.532 coarse aggregates used consisted of machined crushed stone angular in shape passing through 20mm IS sieve and retained on 4.75mm IS sieve with specific gravity of 2.64.

2.2 Iron slag:

Iron slag was collected from the SUNFLAG steel, Bhandara, Maharashtra. The iron slag was used as partial replacement of natural river sand in concrete. Iron slag was passed through 4.75 micron sieves with specific gravity 2.81 confirming to IS 383:1970.

2.3 Quarry dust

Quarry dust was collected from the traders of Manewada, Nagpur. The quarry dust was used as a partial replacement of natural river sand in concrete. Iron slag was passed through 4.75 micron sieve with specific gravity 2.59 confirming to IS 383:1970.

III. EXPERIMENTAL INVESTIGATION

3.1 Mix proportion

By using IS 10262[10], the concrete mix design was proposed. The grade of concrete used was M20 with water to cement ratio of 0.45. The mixture proportion used in laboratory for experimentations are shown in TABLE.1.

Table.1. Proportion of mix design for M20 grade concrete

	Water	Cement	Fine aggregate	Coarse aggregate
By weight	191.6	425.77	613.45	1137.10
By volume	0.55	1	1.44	2.67

3.2 Test on fresh concrete

3.2.1 Slump test:

The workability of all concrete mixtures was determined through slump test utilizing a metallic slump mould. The difference in level between the height of mould and that of highest point of the subsided concrete was measured and reported as slump. The slump tests were performed according to IS 11991959 [11].

3.2.2 Compression test:

From each concrete mixture, cubes of size 150mm x 150mm x 150mm have been casted for the determination of compressive strength. The concrete specimens were cured under normal conditions as per IS 516-1959 [12] and were tested at3 days 7 days and 28days for determining compressive strength as per IS 516-1959 [13].

3.2.3 Density test on concrete:

This test is performed on freshly prepared concrete to measure the unit weight i.e. density of concrete by using cylinder. Weight of different mixes are obtained and compared with conventional concrete. (I.S. EN 12350-6)

3.2.4 Water absorption test:

The average dry weight of cube specimens after removing from moulds was measured and the average weight of cube specimens after submerging in water for curing was measured at 28 days of age. The percentage of water absorption was measured for each concrete specimen and it gave indirect measure of durability.

IV. RESULT AND DISCUSSION

4.1 Workability of Concrete

Sand was partially replaced with quarry dust and iron slag keeping w/c ratio constant, we found decrease in the slump height.

Table.2. Workability of Concrete

Fine aggregate Sand : Iron slag : Quarry dust	Water Cement Ratio	Slump(mm)
100 : 0 : 0	0.55	88
40 : 30 : 30	0.55	76
30 : 30 : 40	0.55	64
20 : 30 : 50	0.55	56
10 : 30 : 60	0.55	34

4.2 Compression Test

Compressive strength of conventional concrete of specimen size 150*150*150mm and with 30% iron slag constant and % of quarry dust varying as follows- (IS: 516-1959).

Table.3. Compression Test results

Mix Sand : Iron slag : Quarry dust	Average compressive strength (N/mm^2)		
	3 days	7 days	28 days
100 : 0 : 0 (M)	10.74	17.04	28.43
40 : 30 : 30 (M1)	14.07	20.07	29.93
30 : 30 : 40 (M2)	14.83	20.83	32.26
20 : 30 : 50 (M3)	16.07	21.70	33.43
10 : 30 : 60 (M4)	14.59	19.43	29.4

The results shown above is the numerical representation of all the tests performed on the test specimen of 150x150x150mm after the curing days of 3, 7 and 28 days. Three cubes were casted for each mix and for respective curing days and tests were performed over CTM i.e. compression testing machine having maximum load limit of 2000KN. Readings are taken where cubes are totally demolished. Then it has been converted into N/mm^2 by dividing the load by area of test specimen.

4.3 Density Test on Concrete

Table.4. Density Test on Concrete

Mix Sand : Iron slag : Quarry dust	Density Kg/m^3
100:0:0M	2430
40:30:30M1	2506.12
30:30:40M2	2578.20
20:30:50M3	2636.53
10:30:60M4	2683.24

4.3 Water Absorption Test

Table.5. Water absorption Test Results

Mix Sand : Iron slag : Quarry dust	Water Absorbed (%)
100:0:0	3.06
40:30:30	2.57
30:30:40	2.53
20:30:50	2.46
10:30:60	2.35

V. CONCLUSION

Decrease in slump height has been observed for all mixes i.e, M1, M2, M3 and M4 than the conventional concrete. Compressive strength has increased with increase in % of quarry dust and obtained maximum at the replacement of 50% with constant of 30% of iron slag. Density has increased for all the mixes. Water absorbed % has decreased after increasing the % of quarry dust keeping iron slag constant

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