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Study of Concrete Involving Use of Quarry dust as Partial Replacement of Fine Aggregates

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Abstract: - Concrete is globally used material. It is a site-made material unlike other materials of construction and as such can vary to a very great extent in its quality, properties and performance owing to the use of natural materials except cement and sand. The production of natural sand is diminishing and also their use has lead to severe environmental problems. Thus, there is a need to replace these materials by some cheap, environmental friendly by-products.. , The environmental and economic concern is the biggest challenge concrete industry is facing. In this paper, the issues of environmental and economic concern are addressed by the use of quarry dust as partial replacement of fine aggregates in concrete. Fine aggregates were replaced by quarry dust as 0%, 10%, 20%, 30% and 40% by weight for M-25 mix. The concrete specimens were tested for compressive strength, strength, durability (water absorption) and density at 28 days of age and the results obtained were compared with those of normal concrete. The results showed that by increasing the quarry dust content workability increases and compressive strength increased.

Keywords: - *Compressive strength, Durability, split tensile strength, Quarry Dust, Workability*

I. INTRODUCTION

In order to make concrete industry sustainable, the use of waste materials in place of natural resources is one of the best approaches. The raw materials for making cement and aggregates are essentially limitless, since practically all of earth's crust can be utilized, if associated costs and energy requirements can be complied with. This course of action cannot be taken as there are other constraints that merit closer examination. One is therefore faced with a question: Is recycling of waste material into a new building material whose binder may not be Portland cement and whose aggregates may not be a mineral a viable solution? Perhaps the answer is affirmative since planned exploitation of waste materials essentially helps to maintain ecological balance.

Over 300 million tones of industrial wastes are being produced per annum by various industrial and agricultural processes. These materials possess problems of disposal, health hazards and aesthetic problems. Quarry dust a byproduct of stone crushing has been proposed as an alternative to sand that gives additional benefit to concrete. Quarry dust is used to increase the strength of concrete over concrete made with equal quantities of sand. Quarry dust has been used for different activities in the construction industry such as in road construction and manufacture of building materials such as light weight aggregates, bricks and tiles. High percentage of dust in the aggregate increases the fineness and the total surface area of aggregate particles. The surface area is measured in terms of specific surface i.e the ratio of total surface area of all the particles to their volume. The main objective is to provide more information about the effects of various proportion of dust content as partial replacement of crushed stone fine aggregate on workability, air content, compressive strength, tensile strength, water absorption, percentage of concrete Experiments have been made to check some property of quarry dust and the suitability of those properties to enable quarry dust (Celik et.al.,) to be used as partial replacement material for sand in concrete. The use of quarry dust in concrete is desirable because of its benefits such as useful disposal of by products, reduction of river sand consumption as well as increasing the strength parameters and increasing the workability of concrete. Continuous generation of wastes from industrial by--products and agricultural residue, create acute environmental problems both in terms of their treatment and disposal. The construction industry has been identified as one that absorbs the majority of such materials as filler in concrete. If these Appropriate utilization of these materials brings ecological and economic benefit.

The successful utilization of a waste material depends on its use being economically competitive with the alternate natural material. These costs are primarily made up of handling, processing and transportation. The waste materials that can be used in concrete are countless in number. The form in which they are used is wide and varied- they may be used as binder, as a partial replacement of conventional Portland cement or directly as

aggregates in their natural or processed states. The stability and durability of products made of concrete using waste material over the expected life span is of utmost importance, particularly in relation to building and structural applications.

In this research, fine aggregates were partially replaced by quarry dust as 0%,10%, 20%, 30% and 40% by weight. Concrete specimens were tested for compressive strength, durability (water absorption) and light weight nature for different quarry dust percentages. The results obtained were compared with results of normal M-25 concrete mix and it was found that maximum increase in compressive strength occurred for the concrete mix containing 30% quarry dust as fine aggregate. With increase in quarry dust content, water absorption decreased indicating increase in durability. Density of concrete decreased with increase in quarry dust content thus making concrete light weight in nature. also by increasing the quarry Dust content workability increases also compressive strength also increased.
This paper summarized the behavior of concrete involving replacement of fine aggregates by quarry dust a 0%,10%, 20%, 30% and 40 % by weight which may help to reduce the disposal problems of quarry dust and enhance properties of concrete.

II. MATERIALS USED

2.1. Cement and Aggregates

Khyber ordinary Portland cement of 43 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 IS383-1970 [9] with specific gravity of 2.6. Coarse aggregates used consisted of machine crushed stone angular in shape passing through 20mm IS sieve and retained on 4.75mm IS sieve with specific gravity of 2.7.

2.2 Quarry dust

It is an industrial by product. It is a by-product of stone crushing which broken downs into fine aggregates. . It is grey in color and is like fine aggregate. The quarry dust was obtained from nearby crushers from Sopore It causes environmental problems like damping problems. Converting stones into useful by-product quarry dust has many benefits like maintenance of ecological balance. Also it is used for different activities in construction industry such as road construction and manufacture of building materials such as light weight aggregates bricks and tiles. It is sieved through 1.18mm IS sieve. Chemical composition of quarry dust is presented in TABLE 1. Fig.1 shows sieved quarry dust and Fig.2 shows manual mixing of quarry dust with sand.

III. EXPERIMENTAL INVESTIGATION

3.1. Mix Proportion

The concrete mix design was proposed by using IS 10262 [10]. The grade of concrete used was M-25 with water to cement ratio of 0.45. The mixture proportions used in laboratory for experimentation are shown in TABLE 2.

3.2. Test on Fresh Concrete

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 1199-1959 [11].

3.3. Tests on hardened concrete

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 at 7 days and 28days for determining compressive strength as per IS 516-1959 [13.

3.4. 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.

3.5. Light weight character

The average dry weight of concrete cube specimens containing 0%,10%, 20%, 30% and 40% quarry dust in place of fine aggregates was compared with average dry weight of normal M-25 concrete cube specimens and the percentage decrease in dry weight was measured.

IV. RESULTS AND DISCUSSION

4.1. Fresh concrete

The slump values of all the mixtures are represented in TABLE 2. The slump decreased with the increase in quarry dust content. Quarry dust particles absorbed more water as compared to sand and thus negatively impacting the workability of concrete mix. Slump was minimum for the concrete mixture containing 40% quarry dust in place of fine aggregates. The variation of slump with quarry dust content is depicted in Fig. 3.

Table1: Chemical Composition Of Quarry dust

Oxide	**Percentage (%)**
SiO_2	62.48
Al_2O_3	18.72
Fe_2O_3	6.54
CaO	4.83
MgO	2.56
Na_2O	Nil
K_2O	3.18
TiO_2	1.21

4.2. Hardened concrete

The compressive strength tests in TABLE 3. Compressive strength tests were carried out at 7 and 28 days. An increase in compressive strength was observed up to 30% replacement of fine aggregates by Quarry dust and there after decreasing. The maximum compressive strength measured was 26% more than that of reference mix at 28 days corresponding to concrete mix containing 30% quarry dust in place of fine aggregates. Compressive strength for concrete mix with 40% quarry dust content was found to be less than that of reference mix.

4.3. Water absorption

Water absorption test was carried out for all mixtures and percentage water absorption was measured. The percentage water absorption increased with increase in quarry dust content. The highest value of water absorption was found for concrete mix with 40% quarry dust content. TABLE 4 depicts the percentage water absorption for all mixtures.

4.4. Light weight character

Average dry weight of cube specimens of each mixture as compared to reference mix was studied and it was observed that density decreased with increase in quarry dust content. The results showed 3.7% reduction in dry weight of concrete cube specimens for concrete mix with 40% quarry dust content as compared to reference mix. Thus, quarry dust concrete is light weight in nature. TABLE 5 depicts the value of dry density and percentage change in dry weight with respect to reference mix.

Fig.1 – Sieved Quarry dust

Fig.2 –Quarry dust being mixed with sand

Table - 2 Mix proportions

Quarry Dust %	w/c ratio	Water (Kg/m^3)	Cement (Kg/m^3)	Fine Aggregate (Kg/m^3)	Quarry Dust (Kg/m^3)	Coarse Aggregate (Kg/m^3)	Slump (mm)
0	0.45	191.6	425.8	543.5	0.00	1199.36	60
10	0.45	191.6	425.8	489.15	54.35	1199.36	55
20	0.45	191.6	425.8	434.80	108.70	1199.36	35
30	0.45	191.6	425.8	380.45	163.05	1199.36	27
40	0.45	191.6	425.8	326.10	217.40	1199.36	20

Table - 3 Compressive Strength (150 mm cube)

Quarry Dust %	Avg. load @ 7days (KN)	Avg. Load @ 28 days (KN)	Avg. Compressive Strength @7 days(N/mm^2)	Avg. Compressive Strength @28 days(N/mm^2)
0	555	630	24.67	28.00
10%	560	745	24.85	33.11
20%	570	760	25.33	33.77
30%	595	795	26.44	35.33
40%	530	620	23.55	27.55

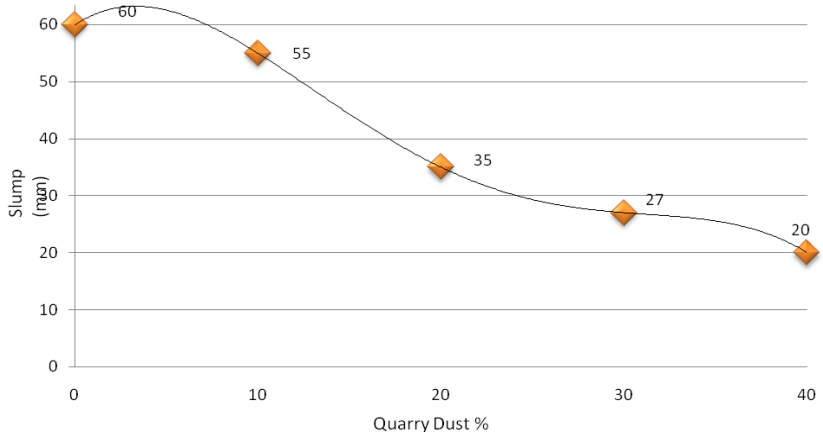

Fig.3 – Variation of slump with % quarry dust content.

TABLE 4 – Water absorption test results for cube specimens of size 150mm x 150mm x 150mm

Quarry Dust %	Avg. Dry weight of cube (gm)	Avg. Wet weight of cube (gm)	Water absorbed (gm)	Percentage water absorption
0	8260	8350	90	1.08%
10%	8220	8320	100	1.21%
20%	8160	8280	120	1.47%
30%	7980	8115	135	1.69%
40%	7930	8078	148	1.86%

Table 5 – Light weight test results for cube specimens of size 150mm x 150mm x 150mm.

Quarry Dust %	Avg. Dry weight of cube (gm)	Avg. dry density of cube (KN/m^3)	Percentage change in weight as compared to reference (%)
0	8260	24.47	0%
10%	8220	24.35	- 0.490%
20%	8160	24.17	- 1.225%
30%	7980	23.64	- 3.391%
40%	7930	23.56	- 3.710%

V. CONCLUSION

On the basis of results obtained, following conclusions can be drawn:

1 Based on experimental investigation, it is found that quarry dust can be used as an alternative material to the sand.
2 The physical and chemical properties of quarry dust satisfy the requirements of the fine aggregate.
3 It is found that the quarry dust improves the mechanical properties of concrete.
4 Usage of quarry dust also reduces the cost of concrete because it is a waste material from quarries.
5 It also reduces the problems of disposal.
6 The replacement of the sand with quarry dust shows an improved compressive strength of the concrete.

7 The replacement of the sand with quarry dust decreases the workability of the concrete due to absorption of the water by quarry dust.
8 The ideal percentage of quarry dust as partial replacement of sand is 30%.
9 With increase in quarry dust content, percentage water absorption increases.
10 With increase in quarry dust content, average weight decreases making quarry dust concrete light weight.
11 Workability of concrete mix decreases with increase in quarry dust content.
12 Use of quarry dust in concrete can prove to be economical as it is non useful waste and free of cost.
13 Use of quarry dust in concrete will eradicate the disposal problem of quarry dust and prove to be environment friendly thus paving way for greener concrete.
14 Use of quarry dust in concrete will preserve natural resources particularly river sand and thus make concrete construction industry sustainable.

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