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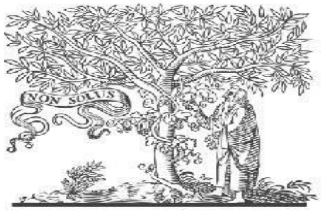

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Studies on Quarry Dust as Partial Replacementof Fine Aggregates in Concrete

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Abstract: - *Natural sand is most commonly used fine aggregates in the production of concrete possess the problem of acute shortage in many areas. Quarry dust can be used as an economic alternative to the natural sand. In this investigation an attempt is made to utilize quarry dust as a partial substitute for natural sand in producing concrete. Natural sand is replaced by Quarry dust at an interval of 5%, 10%, 15%, 20% and 25%. Mix proportions for M_{20} concrete is prepared with reference to IS: 10262-2009 and IS: 456-2000 for the study of workability. Compressive strength and Flexural strength test results are compared with the conventional concrete. The strengths were obtained at the ages of 3, 7 and 28 days. Compressive and Flexural strength increased marginally from 5% to 15% replacement. There is a slight decrease in the corresponding compressive and flexural strength at 20% replacement. Good correlation was observed between compressive strength and flexural strength. It was observed that the addition of quarry dust that would replace the fine material at particular proportion has displayed an enhancing effect on properties of concrete. This investigation proves that quarry dust can be used as a partial substitute for natural sand in preparing concrete.*

***Keywords*: compressive strength, flexural strength, quarry dust, workability.**

INTRODUCTION

The global consumption of natural sand is very high due to extensive use of concrete. In particular, the demand for natural sand is quite high in developing countries owing to rapid infrastructural growth. India has taken a major initiative in developing the infrastructure such as express highways, power projects and industrial structures etc., to meet the requirements of globalized world. Therefore, the construction industries are in stress to identify alternative materials to lesser or eliminate the demand for natural sand. Some alternative materials have already been used as a part of natural sand. For example, fly ash, slag, iron ore tailings, limestone and siliceous stone powder were used in concrete mixtures as a partial replacement of natural sand.

A comparatively good strength is expected when sand is replaced partially or fully with or without concrete admixtures.

Quarry dust has been used for different activities in the construction industry such as road construction and manufacture of building materials such as light weight aggregates, bricks and tiles. This paper presents the result of experimental investigations carried out on Quarry dust and the details of concrete designed using Quarry dust.

Quarry dust is used an alternative for natural sand is collected from nearby quarry. Quarry dust is easily available, effective usage of quarry dust as a partial or full replacement to natural sand can reduce the demand for natural sand, pollution in environment and topography of the area. Hence, it is essential to find some way to use the quarry dust.

This study initiated to assess the suitability of quarry dust as partial substitute for fine aggregate in concrete. The evaluation is based on parameters such as gradation results, workability, compressive strength and flexural strength.

I. SCOPE OF PRESENT STUDY

In this study, concrete of M_{20} grade was obtained and the mixtures were modified by partially replacing natural sand with quarry dust. The properties of concrete in the fresh and hardened state examined are workability and strength respectively. The workability of concrete mixtures was evaluated in terms of slump and compaction factor tests. The strength of concrete was evaluated in terms of compressive and flexural strength.

II. COLLECTION OF SAMPLES

The quarry dust was collected from the dumps of quarry near chickballapur, Karnataka.

III. MATERIAL PROPERTIES

4.1 Quarry dust

The suitability of the material was determined by analyzing particle size distribution, specific gravity and chemical composition. The particle size distribution for quarry dust was evaluated as per IS: 383-1970 which conforms to Zone III.

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The chemical compositions of quarry dust were evaluated and are shown in Table 1.

4.2 Fine Aggregates

Natural sand is used as fine aggregates. The particle size distribution for natural sand was evaluated as per IS: 383-1970 which conforms to Zone III.

4.3 Coarse Aggregates

Crushed granite obtained from machine crusher is used as coarse aggregate. The aggregate used is 20mm and downsize. Coarse aggregates conform to SSD condition.

Table1: **Chemical composition of quarry dust and fineaggregate**

Constituent	Quarry Dust (%)	Natural Sand (%)
SiO_2	62.48	80.78
Al_2O_3	18.72	10.52
Fe_2O_3	6.54	1.75
CaO	4.83	3.21
MgO	2.56	0.77
Na_2O	Nil	1.37
K_2O	3.18	1.23
TiO_2	1.21	Nil
Loss on ignition	0.48	0.37

4.4 Cement

OPC 53 grade conforming to IS: 8112-1989 is used.

The preliminary tests conducted and results obtained are tabulated as shown in table 2.

Table2: Preliminary Test Data

Preliminary Test Conducted	Result
Standard consistency test	36%
Initial setting time	35 min
Final setting time	6 Hours
Specific gravity of cement	3.09
Soundness of cement	0.3 cm
Specific gravity of fine aggregate	2.57
Specific gravity of coarse aggregate	2.676
Specific gravity of quarry dust	2.56
Fineness modulus of fine aggregates	2.67
Fineness modulus of coarse aggregates	7.19
Fineness modulus of quarry dust	4.09

IV. METHODOLOGY

The experimental work is broadly classified into three stages, namely

a) Sieve analysis

b) Evolving mix proportions

c) Strength studies

5.1 Sieve Analysis

The main objective of the investigation is to partially replace natural sand with quarry dust and study the behavior of concrete in the fresh and hardened state. The materials used for the investigation is first sieved and grading of aggregates is carried out then the zone value is obtained.

Natural sand replaced with quarry dust at an interval of 5% up to 25%.

5.2 Mix Proportions

Water cement ratio is an important factor in the process of mix proportioning. Primary requirement of good concrete is satisfactory compressive strength in its hardened state. Many of the desirable properties like durability, impermeability and abrasion resistance is highly influenced by the strength of concrete. The strength can be considered to be solely dependent on water cement ratio for low and medium strength concrete mixes. Workability of concrete varies with water cement ratio and quantity of cementitious material. In this investigation, Mix proportions for M_{20} concrete were obtained as per the guidelines given in IS: 10262-2009. The mix proportion is obtained as 1:1.72:3.19 with a water cement ratio of 0.5.

5.3 Strength Studies

5.3.1 Compressive Strength

Standard moulds of 150mmx150mmx150mm size are used for casting concrete cubes. The cubes were compacted in three layers. Nine concrete cubes were casted for each mix. A total of forty five concrete cubes were casted. Cubes were immersed in water for curing till the date of testing. The specimens were prepared as per IS: 516-1989 and tested for uniaxial compressive strength at 3, 7 and 28 days. The results obtained are the average of three specimens tested and the results are presented in Table 3.

5.3.2 Flexural strength

Standard moulds of section 150mm x 150mm and length 700mm were used for casting beams. Nine beams were casted for each mix. The specimens were prepared as per IS: 516-1989 and tested for flexural strength at 28 days. Two point loading test was conducted using Universal Testing Machine (UTM) of 400KN capacity. The results obtained are the average of three specimens tested and the results are presented in Table 4.

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Mix design (% of replacement)	Workability (Slump in mm)	Avg. Compressive Strength (N/mm2)		
		3 Days	7 Days	28 Days
0	29	19.64	23.99	29.92
5	28	19.62	25.18	34.14
10	26	20.44	26.07	35.92
15	25	23.88	26.92	45.11
20	24	16.96	20.58	32.30
25	23	14.22	17.66	28.36

Table 3: Compressive strength with age

Table 4: Flexure strength value at 28 days

% of replacement	Workability (Slump in mm)	Avg. Flexural Strength (N/mm2)
0	29	4.22
5	28	4.896
10	26	5.413
15	25	5.800

V. RESULTS

Compressive strength and flexure strength variation is as shown in figure 1 and figure 2.

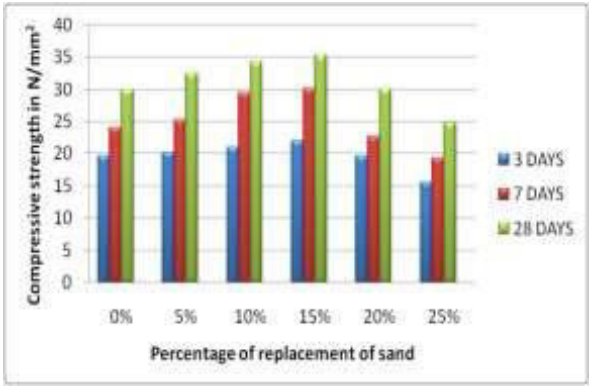

Figure 1: Graph of variation of compressive strength with age

VII. CONCLUSIONS

In this experimental investigation, an attempt has been made to use Quarry dust to replace the fine aggregates in concrete.

Following are some of the conclusions drawn from the results of this investigation:

1. Quarry dust can be used as a finer material which can reduce the voids in concrete.
2. Up to 20% replacement of fine aggregates by quarry dust, the results obtained are satisfactory.
3. From the above results 15% replacement of quarry dust gives high Compressive and Flexural Strength.
4. By using quarry dust wastes instead of conventional materials, which would not only be preserving the natural precious resources, but also solving the problems of disposal of waste, which has become a serious problem.
5. Construction of buildings from quarry waste is eco-friendly as it utilizes waste and reduces air, land and water pollution. It is energy efficient and also cost effective.

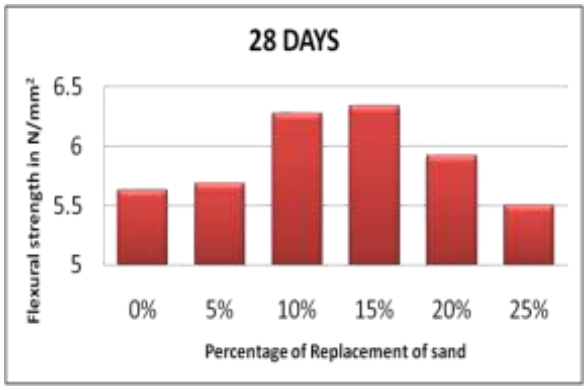

Figure 2: Graph of variation of Flexural strength value at 28 days

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