Effect of Quarry Fines in Concrete

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Abstract— This report is part of a survey investigating the structural features of concrete using various combinations of lateritic sand and quarry rubble as a complete substitute for conventional river sand fine aggregate. Samples of concrete cube were made using varying contents of laterite and quarry dust as fine aggregate. The quantity of laterite was varied from 0% to 100% against quarry dust at intervals of 20%. The samples were cured for specified periods and tested in the laboratory for compressive strength. Workability tests were earlier carried out to find out the optimum water/cement ratios for three different mixtures. M40 mix was projected as per IS specification with water cement ratio 0.45.

Key words: Concrete, Quarry Fines, Fine Aggregates, Sand

I. INTRODUCTION

Currently India has submitted a major initiative developing the infrastructures such as express highways, power projects and industrial structures and so on,, To meet the requirements of globalization, in the construction of buildings and other structure's concrete plays the rightful role and a large quantum of concrete is being utilized. River sand, which is one of the ingredients used in the yield of conventional concrete, has become highly expensive and also scarce. In the background of such a black atmosphere, there is great demand for substitute materials from industrial waste.

Quarry dust has been used in and continues to be used for concrete production as a switch for natural sands. Probes have been attempted using a crusher to produce manufactured quarry fines with an improved particle shape and grading, for use as a total or partial substitute for natural sands in concrete mixtures. Detailed investigations have been taken out to measure the particle shape improvement of the manufactured quarry fines together with assessment of gradings. The objective of the assessment was to optimize concrete mix design and be able to partially or totally accommodate the substitution of natural sounds. The probe was based on three types of quarry fines whereby it was employed within a broad scope of concrete applications and tested within a scope of concrete tests [3].

This report demonstrates the feasibility of the usage of Quarry Rock Dust as hundred percent substitutes for Conventional Concrete.. Trials were conducted on cubes and beams to study the compressive, flexural strengths of concrete made of Quarry Rock Dust for three different ratios and five different methods. Durability Studies were done in concrete with Quarry Rock Dust and compared with the Conventional Concrete.

Shortage of natural sand supplies in the concrete industry, regional sand shortages have encouraged an increased stake in the use of quarry tines produced as a byproduct of coarse-aggregate production in hard rock quarries. Depletion of existing sand reserves, the environmental impact of an eventual offshore dredging or the gap of new sand quarries, additional transportation and processing costs made the viability of manufactured quarry fines as distinct from quarry fines or crusher fines - a more attractive proposition than ever earlier. The perceptual experience that all quarry fines produced are a waste product is fundamentally incorrect as such products have been successfully incorporated as a supplement in asphaltic concrete, road infrastructure, concrete masonry, some pre-mixed concrete, drainage fill and other wares.

II. LITERATURE REVIEW

Crushed rock aggregate quarrying generates considerable volumes of quarry fines, often termed “quarry dust”. The fine fraction is normally smaller than 5mm in size. The use of quarry dust in concrete according to Chaturanga et al., Is desirable because of the benefits such as useful disposal of a byproduct, reduction of river sand consumption and increase in intensity. Quarry dust has rough, sharp and angular particles, and as such causes a gain in strength due to better mesh. Quarry dust has been keyed out as a possible substitute for sharp sand in concrete deeds. Jayawardena and Dissanayake in their paper “Use of quarry dust instead of river sand for future buildings in Sri Lanka” identified quartz, feldspar, biotite mica, hornblende and hypersthenes as the major minerals present in fresh rock which show mica percentages between 5% and 20%. They added that mica percentages in charnocktic gneiss and granitic gneiss are always less than 5%, similar to sand and hence desirable for usage in civil engineering construction. They reported that sand mining had been banished in some fields of major rivers in Sri Lanka because of its negative environmental impact. Granite stone is abundant in Nigeria giving rise to many quarry sites with great lots of quarry debris. Hence, quarry dust can be sensibly used as an alternative to river sand. Also, Shahul et al., Observed that natural sand is usually not placed properly and has excessive silt, while quarry rock dust does not contain silt or organic impurities and can be made to fit the desired gradation and fineness as per demand. This consequently leads to improve the durability of concrete. Agbede and Joel described quarry dust as a cohesionless sandy material acquired either naturally (which is rare) or artificially by the mechanical disruption of parent rocks (blasting of rocks) for building purposes, composed largely of particles with a diameter range of 0.05millimeter to 5.00millimeter. They establish in their written report on “suitability of quarry dust as partial replacement for sand in hollow block production” that quarry dust is cheaper than River Benue sand during rainy season. Sridharan, et al., Conducted shear strength studies on soil-quarry dust mixtures and observed that 20- 25% of the total output in each crusher unit in India is left out as waste-quarry dust. This waste problem may be warded off as it could be converted into useful application in concrete production.

Concrete with quarry dust as fine aggregate In a study in Thailand by Khamput on the compressive strength of concrete using quarry dust as fine aggregate and mixing with admixture type E, it was found that with 70% quarry dust the concrete produced compared well with normal concrete. He recommended quarry dust for replacement with sand in general concrete structures. Ilangovana et al., analyzed the effectiveness and strength attributes of concrete containing quarry dust as fine aggregate and base that the compressive, flexural strength and durability studies of concrete made with quarry rock dust were nearly 10% more than the conventional concrete. Their workability results showed slump values ranging between 60 - 90mm and compacting factor 0.87 - 0.90 for grade 20 concrete. The range of 28 - day's compressive and flexural strengths for grade 20 concrete were found to be
23.7 - 34.50 N/mm2 and 3.45 - 6.40 N/mm2 respectively.[2]

III. Methodology

A. Material Used:

1) Cement:

Ordinary Portland Cement of Grade 53 is used, which conforming IS 12269. 53 grade cement of ultra tech with a remarkably high CS3 (tricalcium providing long-lasting) durability of concrete constructions. Produces highly durable and sound concrete due to a really low percentage of bases chlorides, magnesia;

2) Fine Aggregate:

Natural river sand conforming to Zone II as per IS 383 (1987) was employed. The fineness modulus of sand used is 2.64 with a specific gravity of 2.59.

3) Coarse Aggregate:

Crushed granite coarse aggregate conforming to IS: 383 (1987) was employed. Coarse aggregate of size 20 mm down having the specific gravity of 2.77 and fineness modulus of 7.21 was used.

4) Quarry Fines Borrow Pit Site at Vidisha Local Government Area Of Cross River State At A Depth Of 2.5m. Quarry Dust, The Second Fine Aggregate Used In This Subject Was Contracted From The Abundant Deposits At Vidisha.

B. Mix Design:

Mix design of the concrete is done strictly as per the specification of the IS 10262 : 2009. According to IS code specification mix of M20 grade is designed, 6 different types of mix are prepared with different part of quarry fines. CC mix is prepared with 0% of quarry fines or we can also pronounce it is controlled concrete, QF20 contains 20% of the quarry fines. While QF40, QF60, QF80, QF100 contains 40, 60, 80, 100 percentage of the quarry fines respectively.

C. Casting and Curing:

Concrete cube of 15cm*15cm*15cm is cast according to IS 516 : 1959.For each block there is mix 3 + 3 cubes (3 for 7 days of curing and another 3 for 28 days of curing) was cast and average of three was noted as a final resolution of the compressive force. Healing is done strictly as per the specification of IS 156: 1959, curing is done at the room temperature in the curing tank filled with normal clean water.

D. Test Performed:

1) Compressive Strength:

The compressive strength is the capacity of a material or social system to withstand loads tending to reduce size. It can be measured by plotting applied force against deformation in a testing machine. Some material fracture at their compressive strength limit; others deforms irreversibly, so a given amount of distortion may be considered as the limit for compressive load. The compressive strength of concrete was determined using 150mm concrete cubes. The concrete was made by replacing 10, 15, 20% of the coarse aggregate by recycling aggregate and Coconut shells. Also concrete cubes without RA and CS were cast in comparison. Compressive strength is often evaluated along a universal testing machine; these range from very small tabletop systems to ones with over 53 MN capacity.e range from very small tabletop systems to ones with over 53 MN capacity. Measurements of compressive strength are affected by the specific test method and conditions of measurement. Compressive forces are usually identified in relation to a specific technical standard.

2) Workability:

Workability is one of the physical parameters of concrete, which involves the strength level and durability as well as the cost of labor and appearance of the finished product. Concrete is said to be workable when it is easily placed and compacted homogeneously Slump cone test was conducted to determine the workability of concrete mix. Metal molds, in the shape of the frustum of a cone, open at both ends, and furnished with the handle, top internal diameter 4 in (102 mm), and bottom internal diameter 8 in (203 mm) with a height of 1 ft (305 mm). A 2 ft (610 mm) long bullet nosed metal rod, 5/8 in (16 mm) in diameter. The test is carried out employing a mold known as a slump cone or Abrams cone. The cone is placed on a strong non-absorptive surface. This cone is filled with fresh concrete in three stages, each time it is tamped using a pole of standard dimensions. At the end of the third form, concrete is struck off flush to the top of the mold. The mold is carefully lifted vertically upwards, so as not to shake up the concrete cone. Concrete subsides. This subsidence is termed as slump, and is appraised into the nearest 5 mm if the slump is <100 mm and measured to the nearest 10 mm if the slump is >100 mm.

IV. Result and Discussion

A. 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 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

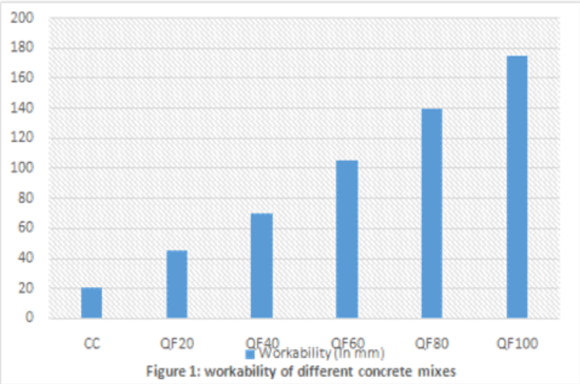


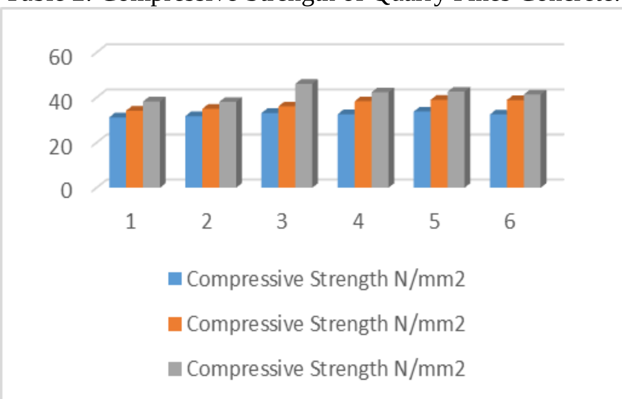
Fig. 1: Workability of different concrete mixes

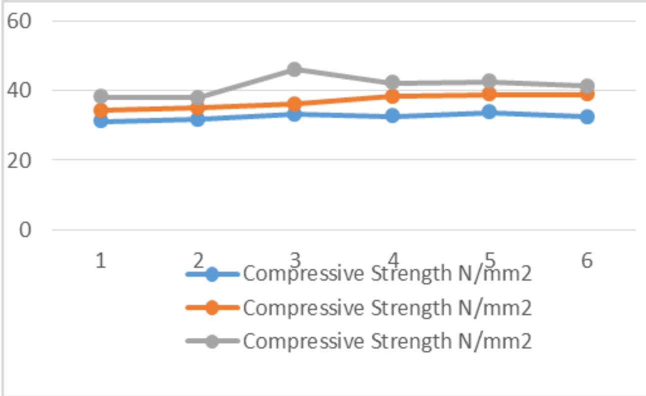
B. *Compressive Strength:*

Compressive strength of Quarry fines concrete with a comparison of control concrete is reported in Table 2 and in figure 2 with 7 days and 28 days of curing. It has been observed that compressive strength of concrete mix is increased when we replace the quarry fines by the fine aggregate but upto 80% and when increase percentage of quarry fines in concrete to upto 100 percentage, compressive strength of concrete goes down, it is also observed that 40-50 percentage of the strength in initial 7 days of curing. QF40 mix gives highest compressive strength while QF60 and QF80 also possess excellent compressive strength in 28 days of curing.

Mix	**Compressive Strength N/mm^2**		
	7 Days	**14 Days**	**28 Days**
CC	31.22	34.22	38.26
QF20	31.77	35.02	38.08
QF40	33.15	36.12	46.13
QF60	32.624	38.35	42.34
QF80	33.81	39.01	42.66
QF100	32.52	38.9	41.36

Table 2: Compressive Strength of Quarry Fines Concrete.





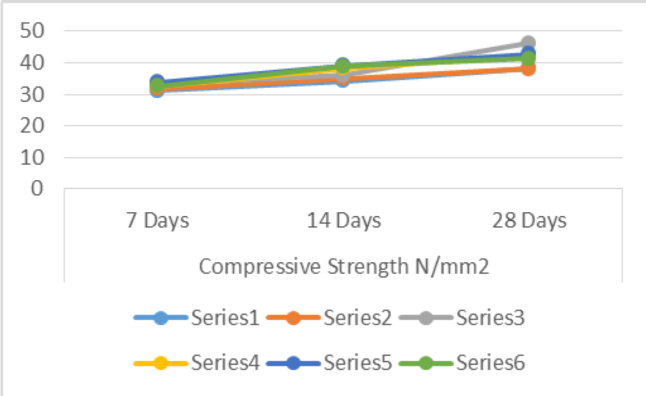


Fig. 2, 3& 4: Compressive Strength of Quarry fines Concrete

V. CONCLUSION

It can be determined from the effects of this study that the combination of quarry fines to put back the conventional river sand in the production of concrete for the building industry in India and other tropical lands of the world results in social systems with reasonable structural characteristics, and should be encouraged where there is a comparative price advantage. The following finishes can be drawn from this work:

1) The workability of the mix increased when replacement percentage of the quarry fine with natural river sand. And then we can also decrease the water cement ratio, with quarry fines good workability of the concrete is accomplished with low water cement ratio.
2) The compressive strengths of concrete using lateritic sand and quarry dust were measured in the lab. Compressive strength was found to increase with age as for normal concrete. The 28 - day compressive strength was found to range from 38 – 42 N/mm2 for different mixtures. The above strength properties were set up to compare closely with normal concrete. The balance of 40% laterite to 80% quarry fines produced higher values of compressive force. For the same proportion of 40% laterite and 80% quarry dust at M40 mix and 0.45 water/cement ratio, a logarithmic model has been developed for predicting the compressive force of concrete between 0 and 28 days.
3) Further work is needed to generate data for other structural properties of the experimental concrete. These include: flexural strength, tensile force, shear force, water concentration, resistance to impact,

creep, etc. The knowledge of the above properties will greatly assist engineers, constructors and designers when using the textiles for building works.

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