An Experimental Study on Concrete with Replacement of Fine Aggregate by Quarry Rock Dust

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Abstract- *Advance concrete technology can reduce the consumption of natural resources and energy sources thereby lessen the burden of pollutants on environment. We describe the feasibility of using the quarry rock dust in concrete production as partial replacement of fine aggregates. Leaving the waste materials to the environment directly can cause environmental problem. Hence the reuse of waste material has been emphasized. Waste can be used to produce new products or can be used as admixtures so that natural resources are used more efficiently and the environment is protected from waste deposits.*

The following proportions may be replacement in the concrete such as Quarry rock dust test specimens shall be made for sample for testing & Additional sample may be required for various testing purpose.

Keywords- Cement, Concrete, Rock Quarry Dust, Compressive strength

I. INTRODUCTION

1.1 GENERAL

Now a day's the most commonly used structural material for all types of construction is concrete. Concrete owes its unique position as the structural material to the fact, that it is economically highly resistant to fire, wind, water and earth quakes. In the recent times its use in construction has been increased considerably thus the cities and towns are virtually becoming concrete jungles. The demand is likely to increase in the future to match the growing population, housing, transportation and other amenities.

As modern engineering practices become more demanding, there is a corresponding need for special types of materials with novel properties. Scientists, engineers and technologists are continuously on the lookout for materials, which can act as substitute for conventional materials or which possess such properties as would enable new designs and innovations resulting in to economy, so that a structure can be built economically.

However on many occasions individual materials as such may not serve the specific purpose. There have been so far many attempts to develop new materials, which is the combination of two or more materials. Such materials are called composite materials. Concrete can be regarded as a composite material. For reducing the cost of concrete some replacement materials are suggested. The use of these materials as the substitute material in concrete would reduce the disposal problem now faced by thermal power plants and industrial plants and at the same time achieving the required strength of concrete.

Already investigations have been made by partial replacement of quarry dust in fine aggregates. Also revealed that with proper proportioning of quarry rock dust the required strength can be achieved at 28 days. In the present investigation quarry dust has been used as complete replacement of sand.

River sand has been the most popular choice for the fine aggregate component of concrete in the past, but overuse of the material has led to environmental concerns, the depleting of securable river sand deposits and a concomitant price increase in the material. Therefore, it is desirable to obtain cheap, environmentally friendly substitutes for river sand that are preferably by-products. Quarry dust 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, but it causes a reduction in the workability of concrete. When examining the above qualities of quarry dust it becomes apparent that if both are used together, the loss in early strength due to one may be alleviated by the gain in strength due to the other, and the loss of workability due to the one may be partially negated by the improvement in workability caused by the inclusion of the other .

1.2 CONCRETE

Concrete is the most widely used man-made construction material in the world. It is obtained by mixing cementations materials, water, aggregate and sometimes

admixtures in required proportions. Fresh concrete or plastic concrete is freshly mixed material which can be moulded into any shape hardens into a rock-like mass known as concrete. The hardening is because of chemical reaction between water and cement, which continues for long period leading to stronger with age.

The utility and elegance as well as the durability of concrete structures, built during the first half of the last century with ordinary Portland cement (OPC) and plain round bars of mild steel, the easy availability of the constituent materials of concrete and the knowledge that virtually any combination of the constituents, leads to a mass of concrete having bred contempt. Strength was emphasized without a thought on the durability of structures. As a consequence of the liberties taken, the durability of concrete and concrete structures is on a southward journey; a journey that seems to have gained momentum on its path to self– destruction. This is particularly true of concrete structures which were constructed since 1970 or thereabout by which time (a) the use of high strength rebar's with surface deformations started becoming common, (b)significant changes in the constituents and properties of cement were initiated, and engineers started using supplementary cementations materials and admixtures in concrete, often without adequate consideration.

1.3 QUARRY ROCK DUST

Quarry dust is a kind of waste material that is generated from the stone crushing industry which is abundantly available to the extent of 200 million tonnes per annum which has landfill disposal problems and health and environmental hazards. The present study is an attempt to experiment on use of quarry dust to replace sand in concrete.

Quarry dust is fine rock particles. When boulders are broken into small pieces quarry dust is formed. It is grey in colour and it is like fine aggregate.

The need for replacement of quarry rock dust is that the quarry fines are a by-product generated while crushing rocks of course aggregates. Its production is less than 1% of total aggregate production. Because of high fineness introducing quarry rock dust in normal concrete for a given workability and strength needs. The usage of quarry rock dust could turn this waste into a valuable material leading to savings in cost and natural resources like river sand.

Quarry rock dust has a number of properties take make it a very attractive aggregate for a variety of concrete products.

- **It is one of the most durable materials known to man that it has a high- performance in concrete.**
- **Quarry rock dust is grey in colour.**

A typical study is made in comparison of physical properties of sand and quarry rock dust.

Property	Quarry rock dust	Natural sand
Specific gravity	2.54-2.60	2.60
Bulk density(kg/m^3)	1720-1810	1460
Absorption (%)	1.20-1.50	Nil
Moisture content (%)	Nil	1.50
Fine particles less than 0.07	12-15	06
Sieve analysis	Zone 3	Zone3

II. LITERATURE REVIEW

2.1 GENERAL

Extensive research works both at National and International level has been done on the use of various admixtures in mortars and concrete's with a common goal.

- To combat the environmental hazards from the industrial wastes.
- To modify the properties of traditional concrete to the desired level suitable to the specific circumstances.
- To conserve the natural resources used in the production of construction materials.
- To bring down the increasing cost economics of cement, building blocks and high strength concrete.
- To combat the scarcity of traditional ordinary Portland cement and bricks.
- Of late, to rehabilitate the existing structures which are deteriorated over a period of time etc.

In India, only government educational and research institutions and construction departments are responsible for research while in advanced countries, the most remarkable breakthrough have been achieved by the building material industries and their R & D laboratories. An accepted fact is that these encouraging results on the use of admixtures are not

penetrating into the user community and the entire research work is getting flocked at their origination. With the result the very purpose of research work is questioned. Along with R & D units. The policy maker and consultants should take more interest in handling these issues directly keeping not only the techno economics in view but also national obligations.

2.2 REVIEW

- The choice of quarry dust as replacement for sand has been supported in the previous study (Manassa, 2010) [5] showing that up to 20% of sand has been effectively replaced by quarry dust in traditional concrete.
- Ilangovan et al. (2008) [9] reported that the strength of quarry rock dust concrete was comparably 10-12% more than that of similar mix of conventional concrete.
- Hameed and Sekar (2009) [10] studied the effect of crushed stone dust as fine dust and found that flexural strength increases than the concrete with natural sand but the values decreases as the percentage of crusher dust increases.
- Divakar et al. (2012) [8] have experimented on the behaviour of M20 grade concrete with the use of granite fines as a partial replacement for sand in 5%, 15%, 25%, 35% and 50%; and based on the results obtained for compressive, split-tensile and flexural tests, it was recommended that 35% of sand can be replaced by granite fines.
- Mahzuz et al. (2011) [11] have investigated on the use of stone powder in concrete as an alternative of sand using three concrete mix proportions, 1:1.5:3, 1:2:4 and 1:2.5:5. When the results of compressive strength were compared for these mixes between use of sand and stone powder, it was found that stone powder gives higher value than sand by about 14.76%, 4% and 10.44% respectively. In another study conducted by Wakchaure et al, (2012) [12] using artificial sand in place of river sand, it was found that for M30 mix using artificial sand, the compressive strength increased by 3.98%, flexural strength by 2.81% and split tensile strength by a marginal value than concrete which used river sand. Seeni et al. (2012) [13] have made an attempt to partially replace fine aggregates with waste material obtained from China Clay industries. Out of the replacement percentages of 10% to 50%, the highest strength was achieved at 30% in compressive, split and flexural strength.
- Ilangovana. R et al. carried out "an investigation on strength and durability properties of concrete containing quarry rock dust as fine aggregate". It was reported that the physical and chemical properties of quarry rock dust as well as the durability of quarry rock dust concrete under sulphate and acid action was better than that of conventional concrete.
- Shanmugapriya .T and Uma .R. N. made an investigation on " optimization of partial replacement of M-sand by natural sand in high performance concrete with silica fume". It was reported that M-sand and silica fume increased the flexural and compressive strength.
- Devi .M and Kannan. K. carried out "an investigation on strength and corrosion resistance behaviour of inhibitors in concrete containing quarry dust as fine aggregate". The incorporation of inhibitors as admixture did not show any adverse effects on the strength properties and there was a increase in strength up to certain percentage. The addition of inhibitors as admixture to concrete was found to lower the permeability and water absorption.
- Nima Farzadnia et al. Explored the possibility of in cooperating mineral admixtures in sustainable high performance concrete. It was found that mineral admixtures, whether industrial by products or agro-waste minerals, used to reduce cost of concrete.

III.METHODOLOGY

General

The present method deals with evolution of Mechanical Properties of Concrete Compressive Strength and Split-Tensile Strength. The program involves Casting and Testing of specimens where the standard size of the cube (150mm x 150mm x150mm) and standard size of cylinder (150mm x 300mm).Fine Aggregate is partially replaced with Waste Foundry Sand of dosages (5%,10%,15% and 2%) in Standard Grade of M20 according to IS: 10262-2009.

Procurement of Materials

The Materials used for the study are:

Cement

Cement is a material that has cohesive and adhesive properties in the presence of water. such cements are called hydraulic cements. these consist primarily of silicates and aluminates of lime obtained from lime stone and clay.

Quarry rock dust

Quarrying in hard rock deposits usually requires different techniques to those employed in working generally unconsolidated sand and gravel deposits. Whilst many of the overall considerations are essentially similar (*e.g.* establishing

a viable resource, determining the available area for development, assessing volumes of waste, overburden and other allowances, identifying the requirements for excavation, haulage and processing plant), there are several specific areas in which different assessment and design requirements are necessary.

IV. RESULTS AND DISCUSSION

4.1 Compressive Strength Values for Replacement of Sand by Quarry Dust

Table 4.1 3-Days Compressive Strength Results

S.No	Total Replacement QUARRY DUST (%)	BREAKING POINT	COMPRESSIVE STREGTH
1	0	487.5	21.6
2	20	520	23.1
3	40	347.5	15.4
4	60	427.5	19
5	80	417.5	18.5
6	100	550	23.3

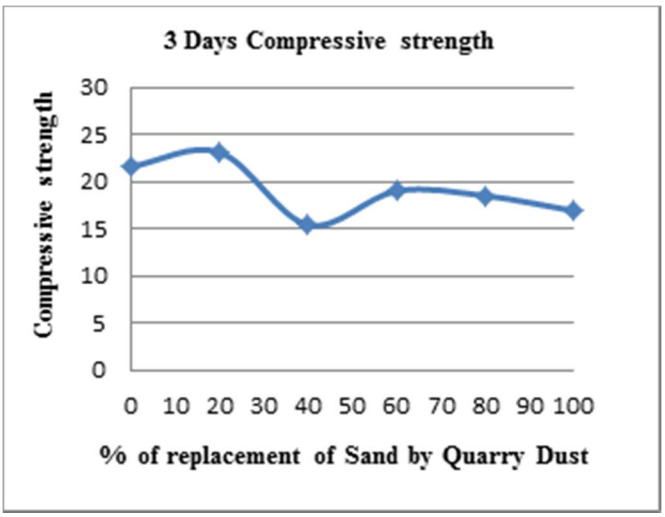


Table 6.2 7-Days Compressive Strength Results

S.No	Total Replacement QUARRY DUST (%)	BREAKING POINT	COMPRESSIVE STREGTH
1	0	537.5	25
2	20	667.5	27.56
3	40	645	28.6
4	60	635	28.2
5	80	600	26.6
6	100	650	24.4

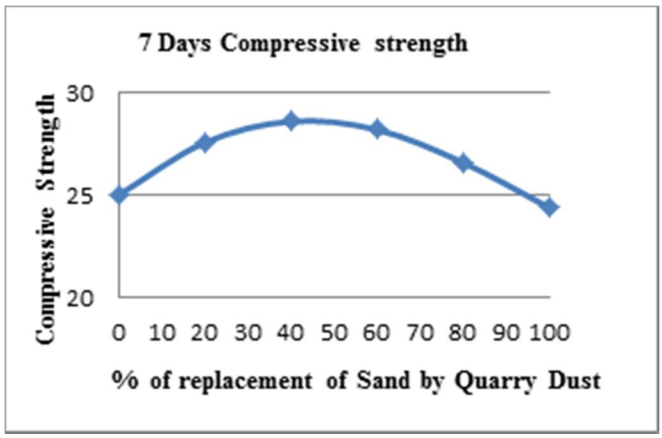
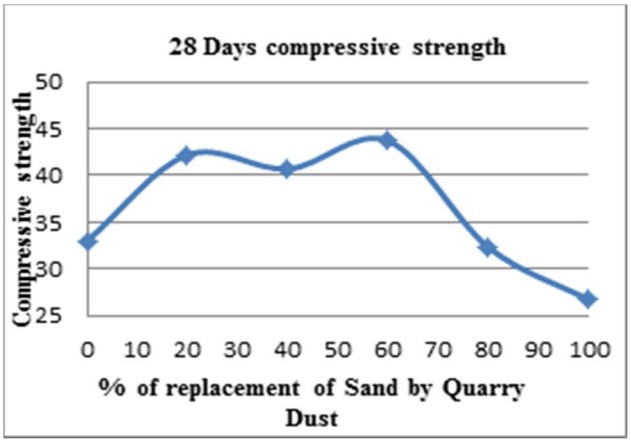


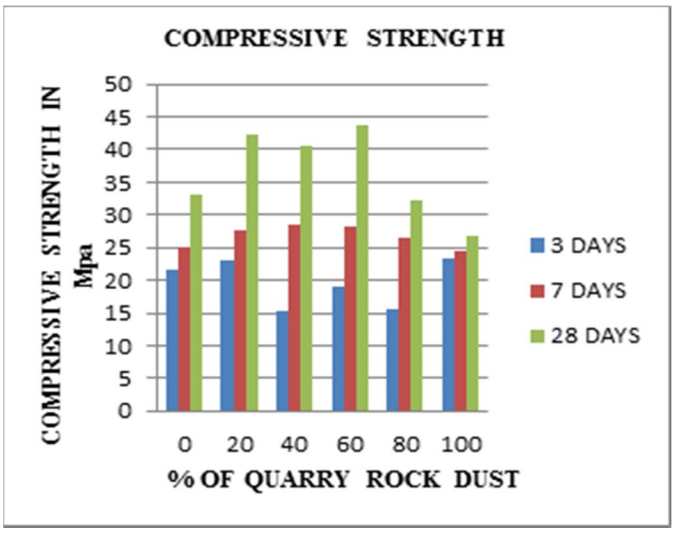
Table 6.3 28-Days Compressive Strength Results

S.No	Total Replacement QUARRY DUST	BREAKING POINT	COMPRESSIVE STREGTH
1	0	742.5	33
2	20	950	42.2
3	40	917.5	40.7
4	60	985	43.7
5	80	727.5	32.3
6	100	600	26.67



4.2 Comparison of Compression Strength Values for Replacement of Sand by Quarry Rock Dust

TOTAL REPLACEMENT BY QUARRY ROCK DUST	3 DAYS	7 DAYS	28 DAYS
0	21.6	25	33
20	23.1	27.56	42.2
40	15.4	28.6	40.7
60	19	28.2	43.7
80	18.5	26.6	32.3
100	23.3	24.4	26.67



V. CONCLUSION

- From the above study we conclude that the compressive strength of the concrete cubes has gradually increased up to addition of 60% of quarry rock dust.
- Compared to compressive strengths of 20%, 40%, 60% of addition of quarry rock dust, the compression strength of 80%, and 100% quarry rock dust has been decreased.
- Whereas comparing to traditional concrete, compressive strength of 60% has been increased.
- Hence for economical view 60% is preferable and in the perspective of compressive strength 80% is suggested.
- In our surroundings this material is easily available.
- The air pollution problem will be reduced for this use of replacement aggregate

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