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Experimental Investigation on replacement of Sand by Quarry Dust in Concrete-Main Paper

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Abstract - *Now a days the utilization and consumption of natural aggregates and cement as largest concrete component is rapidly and constantly increasing in the production of concrete. The developing countries like India, the infrastructure such as express highways, power projects, industrial structures, ports and harbors to meet the requirements of globalization in construction of buildings and other structures. River sand is one of the constituent used in the production of concrete, become expensive and also a scarce material. In view of this, there is a need to identify suitable alternative material from industrial waste in place of river sand. The utilization of quarry dust which is a waste material has been accepted as building material in many countries for the past three decades. Recycling involves processing used materials into new products in order to prevent the waste of potentially useful materials, reduce the consumption of fresh raw materials, reduce energy usage, reduce air and water pollution by reducing the need for conventional waste disposal. Concrete traditionally consists of cement, fine aggregate, coarse aggregate and water. An attempt has been made to replace the fine aggregate with quarry dust with an objective of utilizing the waste material.*

Concrete

Keyword -, *Quarry dust, Natural sand, compressive strength.*

1. INTRODUCTION

Concrete plays a very important role in the construction industry. It is widely used in the worldwide due to its durability, versatility and low cost.

For a concrete mix, fine aggregate is an essential component of the concrete and the most commonly used fine aggregates is the river sand. The demand of natural sand in the field of construction is increasing day by day due to extensive use of concrete, the price was increasing which resulting a huge reduction in the sources of sand. Natural River sand takes a million of years to form and it is not replenish able.

Because of its limited supply and excessive cost of transportation from natural source, The developing country like India facing shortage of good quality of natural sand and particularly in India, natural sand deposits are being used up and causing serious threat to environment as well as the society. Therefore it becomes more necessary to find alternative sources of fine aggregates to minimize river sand extraction.

Therefore, an investigation is required to find a suitable substitute which is eco-friendly and inexpensive. Quarry dust has been proposed as an alternative to river sand that gives the additional benefits to the strength of the concrete.

2. LITERATURE REVIEW:-

Sivakumar and Prakash(2012) investigated on the mechanical properties of concrete with quarry dust. According to their experiment they reported that the quarry dust is the effective replacement for river sand.

Ilangovana. R et al. (2010)carried out an experiment and reported that the physical and chemical properties of quarry dust and the durability and strength of concret200e having dust as fine aggregates under sulphate and acid action, was a better option than that of conventional concrete.

Shanmugapriya .T and Uma .R. N. (2012) made an investigation on optimization of partial replacement of natural sand in high performance concrete with silica fume. It was reported that sand and silica fume increased the flexural and compressive strength.

Devi .M and Kannan. K.(2011) they investigated on the strength of concrete and corrosion resistance nature in concrete having quarry dust as a fine aggregates. The admixture didn't show any adverse effect on the strength and also there was an increase of strength at certain percentage.

M. Shukla and A K Sachan (2000) they studied on the use of dust in concrete mix which is helpful in environment point of view as well as the utilization of stone dust in construction work. They found that the partially replacement of sand will not affect the strength. The workability of concrete reduces with the increase of stone dust and reduction of workability may improved by adding suitable admixtures.

3. NEED FOR THE REPLACEMENT OF SAND

- As the demand of natural sand is increasing day by day, the cost of natural sand is also increasing.
- The cost of transportation is high from natural source.
- From the environmental point of view, the continue depletion of sources of natural sand creates environmental problems.

4. MATERIALS USED

4.1 Quarry Dust:-

Quarry dust is a very fine rock particle. It is found when boulders are broken into small pieces quarry dust is formed. It is grey in color and it is like fine aggregate. In concrete production it could be used as a partial or full replacement of na ural sand. Besides, the utilization of quarry waste, which itself is a waste material, will reduce the cost of concrete production.

Fig 41. Picture showing the Quarry dust

The physical and chemical properties of quarry dust obtained by testing the sample as per the Indian Standards are listed in the below table-

Table 1 showing the Physical properties of quarry dust and natural sand:-

Property	Quarry rock dust%	Natural Sand%	Test method
Specific gravity	2.60	2.68	IS 2386 (Part III)1963
Bulk relative density(kg/m3)	1700	1550	IS 2386 (Part III) 1963
Absorption(%)	1.30	Nil	IS 2386 (Part III) 1963
Moisture Content (%)	Nil	1.50	IS 2386 (Part III) 1963
Fine particles Less than 0.075 mm (%)	14	06	IS 2386 (Part I)1963
Sieve analysis	Zone III	Zone III	IS 383 - 1970

Table-2 Typical Chemical Composition of quarry rock dust and natural fine aggregate:-

Constituent	Quarry rock dust (%)	Natural Sand (%)	Test method
SiO2	62.48	80.78	IS: 4032-1968
Al2O3	18.72	10.52	
Fe2O3	06.54	01.75	
CaO	04.83	03.21	
MgO	02.56	00.77	
Na2O	Nil	01.37	
K2O	03.18	01.23	
TiO2	01.21	Nil	
Loss on Ignition	00.48	00.37	

Application of quarry dust in construction industry:-

1. It is used in highway work for surface dressing.
2. In the manufacturing of building material such as light weight aggregates, bricks, tiles and in autoclave blocks.
3. It is also used in Fiber reinforced precast unit.
4. In Synthetic rock and in kerbs, quarry dust is used.
5. Also in used in Landfill capping, for filler applications and in embankment.
6. Also used in cement making, green roofs and in clay blocks.

4.2 Coarse aggregate:-

Aggregate**,** in building and construction, material used for mixing with cement, bitumen, lime, gypsum, or other adhesive to form concrete or mortar. The aggregate gives volume, stability, resistance to wear or erosion, and other desired physical properties to the finished product. For this experiment, 20 mm size of aggregate is used.

Fig 2. Showing an aggregate of size 20mm.

4.3 Fine aggregate:-

Locally available river sand is used as fine aggregate.

4.4 Cement :-

Ordinary port land cements of Grade-43 are used.

Fig 3. Showing the Cement Bag used in the Experiment

Test on cement

The field test has been conducted through which we know the quality, y of cement at site. It gives some ideas on touch, color and feel and other tests.

- **Color test: -** The color of the cement was uniform, grey in color.
- **Presence of lumps:-** The cement is free from hard lumps.
- **Cement Adulteration Test:-**
  The cement was smooth when it touched and rubbed between the fingers.

- **Temperature Test of Cement:-**
  It feels cool and not warm when hand is inserted in a bag of cement.

4.5 Water:-

Ordinary portable water was used in the overall investigation as well as for curing the concrete specimen.

5. EXPERIMENTAL PROGRAM:-

5.1 Workability:-

For the measurement of physical parameters of concrete, workability is one the important parameter which affects the durability and strength and also the appearance of the finished surface. The workability of concrete is depending on the water cement ratio and the capacity of the water absorption of aggregates.

In the concrete mix, if the volume of water added is more it results to bleeding and segregation of aggregates.

Indian standard IS 1199-1959 gives the test for the workability of concrete and also the test procedure along with using equipment.

In our case we have used slump cone test for measuring the workability of concrete. We have measured the height of the fall of the cone of concrete for various water-cement ratios and recorded the values for ordinary concrete. Then the same procedure is done with the concrete having the partial replacement of sand with raw quarry dust at various percentages. The value of slump had been measured during the casting of specimen.

As the percentage of dust increases the slump value get decreases. This reflects that as the percentage of dust is increases in concrete, the required water is also increase and the slump value get decreases, which may be due to the texture of dust. Generally, the crusher dust has rough texture than the sand. And the aggregates with rough texture need more water for the weight of surface.

Fig 4. Sample of concrete mix for Slump Test

5.2 Compressive strength:-

When concrete have the high compressive strength, but at the same time have very poor tensile strength.
The type of mixes gives the various strength. The freshly mixed concrete was field in the mould of size 150mm X 150mm X 150mm and then cubes were kept for curing. Testing of hardened cube was carried out in 7 days and 28 days respectively

using compression testing machine. The sample of cube was kept between the hardened steel bearing plates on a compression and load was applied.

Fig 5. Sample of cubes

Fig 6. Compression testing Machine

The first concrete mixtures were prepared fully replacing of fine aggregates i.e sand with the Quarry dust (100% & 0% Sand).

Second mixtures were prepared by replacing of sand with the Quarry dust (80%) i.e., (80% Quarry dust & 20% sand).
In third mixture both Quarry dust and sand partially used i.e., 50% Quarry dust and 50 % sand.
Fourth mixtures were prepared by replacing of sand with the Quarry dust (20%) i.e., (20% Quarry dust & 80% sand).
In last sample, we used only fine aggregates i.e., 100% sand in concrete mix.

6. RESULT:-

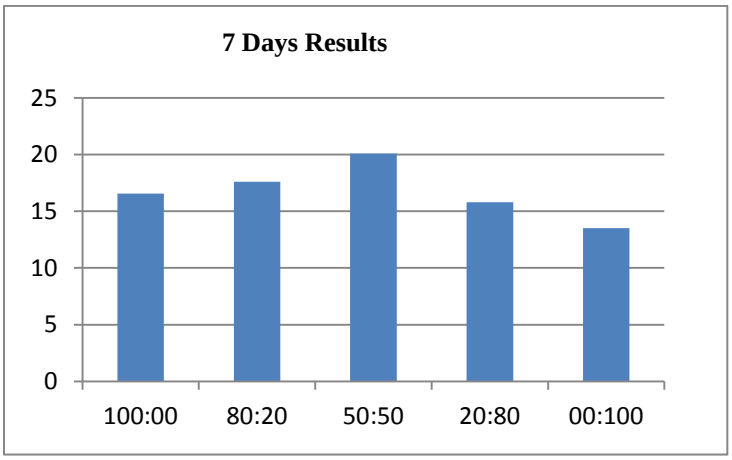
Compressive Strength in MPa

Sand: Dust	7 DAYS	28 DAYS
100:00	16.55	20.30
80:20	17.60	22.35
50:50	19.10	24.65
20:80	15.80	20.45
00:100	13.50	17.80

7. ANALYSIS:-

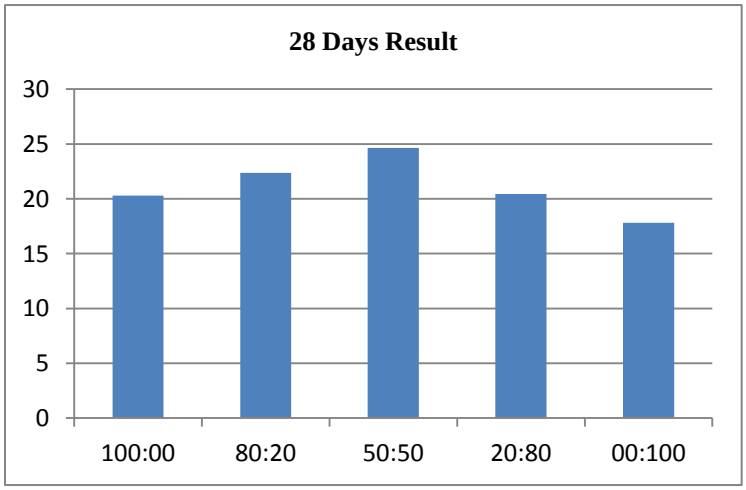
Graph for Compressive Strength

7 Days Result :-



Sand : Dust (M-20)

28 Days Result :-



8. CONCLUSION:-

According to the results and discussion the following conclusion is found:-

1. From following studies and results we found that the quarry dust as a fine aggregates relatively weaker as compared to river sand which is used in the study.
2. The various properties of used Quarry dust such as aggregate crushing value, pH value, flakiness index and soundness gives the significant effects to the strength and durability of concrete.
3. The concrete mix of dust as partial replaced to sand, results a reduction in the compressive strength.
4. But the reduction in the compressive strength of the quarry dust concrete was compensated by the inclusion of mineral admixtures into the concrete mix.
5. In the presence of silica fume or fly ash, quarry dust can be a suitable partial replacement material to sand to produce concretes with fair ranges of compressive strength.

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