Experimental Study on Partial Replacement of Fine Aggregate with Quarry Dust and Red Soil in Concrete

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Abstract- In the construction industry, there is a high demand for natural river sand, especially in the production of concrete, which creates major sustainability issues. The best way to deal with these environmental concerns is to use waste or recycled material, as substitute for natural river sand. This paper deals with replacement of sand used in concrete as fine aggregates by the waste generated by the stone quarry industry and red soil. This study has made an attempt to partially replace quarry dust + red soil in place of sand in M20 grade concrete. On experimentation, it was found that the partial replacement of sand with 20%, 30%, 40%, 50% of quarry dust + red soil has given the optimum results. Therefore, this study recommends that if partial replacement of sand with quarry dust +red soil upto 50% in M20 grade of concrete is done, the effective waste management can contribute towards saving of our environment. ***Keywords:*** **quarry dust, red soil, Fine Aggregate**

1. INTRODUCTION

1.1 General

Concrete is the most widely used man-made construction material in the world. It is obtained by mixing cementitious 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 annual sand demand for the construction industry in India is nearly 8 million cubic meters and all is obtained from major rivers. This present demand is expected to be 10 million cubic meters with in next three years. It is assumed that the removal rate of sand from these rivers exceeds by three times the annual transport rate of these rivers. Therefore, it is necessary to explore the possibilities for alternative sources to minimize river sand extraction. At present, the identified alternative sources are Red soil and quarry dust. Quarries are operating in many parts of India to supply coarse aggregates for various types of construction, especially for concrete, road construction and foundations of buildings.

1.2 Quarry Dust

It is rock particles. When huge rocks brake into small to construction in quarries. It is like sand but mostly grey in colour and in addition it is mineral particles. It can be reduced significantly by mixing with quarry dust. Quarries and aggregate crushers are basic requisites for construction industry and quarry dust is a byproduct of rubble crusher units. Geotechnical and mineralogical characterization of quarry dust and its interaction behavior with soils can lead to viable solutions for its large-scale utilization.

1.3 Red Soil

It is soil particles. Red soil is naturally available resources in plenty of quantity. It is like sand but mostly red in colour and in addition it is mineral particles. It can be reduced significantly by mixing with red soil.

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2. NEED FOR THE RESEARCH

Quarry Dust and red soil can be used as an alternative material for the river sand. At present, the construction industry in India is facing a serious shortage of sand due to over exploitation and government banning of river sand mining. Quarry Dust and red soil are replaced as fine aggregate in conventional concrete to achieve High strength.

3. OBJECTIVES

- ✓ Replace the manufactured sand (quarry dust) and red soil with fine aggregate in ordinary Portland cement concrete.
- ✓ Using quarry dust at various proportions like 8%, 12%, 16%, 20% in sand.
- ✓ Using red soil at various proportions like 12%, 18%, 24%, 30% in sand.

4. SCOPE OF THE PROJECT

- ✓ To compare the properties of replacement concrete with quarry dust + red soil and OPC (Ordinary Portland Cement).
- ✓ To improve the compressive, flexural and split tensile strength of concrete by adding quarry dust and red soil with concrete.

5. PREVIOUS STUDY

Sumit L (2015) The author says, This paper reports the experimental study which investigated the partial replacement of sand with quarry dust. Initially cement concrete cube was studied with various proportions of cement concrete + quarry dust (M 20, and M25). The experimental results showed that the addition of quarry dust as fine aggregate ratio of 30%, 40% and 50% was found to enhance the compressive properties. As the percentage of Quarry Dust gradually increases, the Compressive strength of concrete will also increase with condition that percentage of Quarry Dust should not exceed 50%.

Raghavendra Naik (2016), the author says, the aim of the work is to investigate the possibility of replacing the part of Portland cement by Red mud and Fine Aggregates Portland cement was replaced up to 30 % Red mud by the weight of cement and checking the compressive strength of mortar. Fine aggregate was replaced up to 60% Quarry dust and evaluating its compressive and splitting tensile strength of Red mud concrete.

Biju Mathew (2016) The author says, This paper presents a study conducted to determine the suitability of partial replacement of sand with laterite soil and manufactured sand in M20 grade concrete. Concrete mixes containing 0,10,20,30, 40% sand replacement levels were cast, with super plasticizer. Results show maximum of 20% replacement levels of sand by laterite attained workable concrete with satisfactory strength beyond that lateritic concrete is not workable And 40% replacement of sand by manufactured sand shows maximum strength.

Sachin S Fale (2017) Mechanical properties such as compressive strength tests have been carried out for red soil mixed concrete and plain concrete to differentiate the strength. The partial replacement of sand in concrete has been done using red soil in a mix proportion M20 of 1:1.94:3.17 which gives the significant improvement in strength.

6. EXPERIMENTAL INVESTIGATIONS

6.1 Preparation and Casting of Specimen

The total mixes that need to be prepared in this studies is about 6 mixing and this included a preparation of 24 cube samples (150 × 150 × 150 mm) for compressive strength test, 16 samples of beam (100 × 100 × 500 mm) for flexural test and 24 samples of cylinder (150 mm diameter × 300 mm height) for split tensile strength test. All the samples have been prepared for conventional concrete and replacement concrete (quarry dust + red soil) was prepared by replacement of fine aggregate with for 20%, 30%, 40% and 50%. The samples were categorized by age of the concrete at the day of testing, quarry dust and red soil content. For each mix, 3 cubes were tested for compressive strength at 7 days and 28 days of curing, 3 samples of cylinder were tested for split tensile strength for 7 days and 28 days of curing and 2 samples of beam were tested for flexural strength at 28 days.

Table 6.1 Designation of concrete & Percentage of replacement of Quarry Dust & Red Soil

MIX	Designation of concrete	Percentage of replacement of quarry dust	Percentage of replacement of red soil
CC	M1	-	-
8% QD 12% RS	M2	8%	12%
12% QD 18% RS	M3	12%	18%
16% QD 24% RS	M4	16%	24%
20% QD 30% RS	M5	20%	30%

CC - Conventional concrete, QD – Quarry Dust,
RS – Red Soil

6.2 Compression test Results

Table 6.2 comparison of compression strength

Concrete Type	7 days Compressive strength (N/mm^2)	28 days Compressive strength (N/mm^2)
M1	20.05	27.82
M2	19.90	32.83
M3	23.28	34.14
M4	28.75	36.04
M5	33.03	38.09

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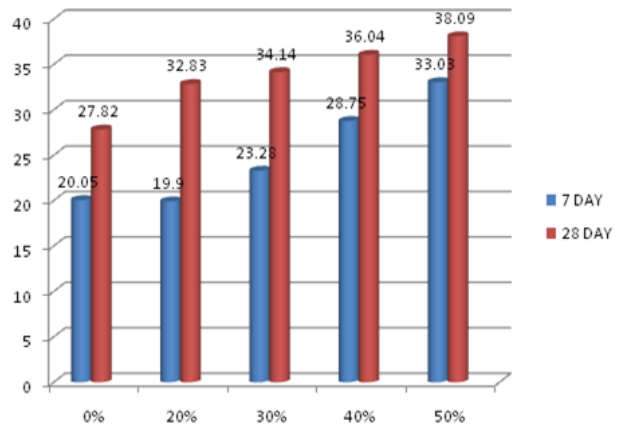

Fig. 6.1 Comparison of 7 days and 28 days compression strength of Conventional concrete and other mix

6.3 Split tensile test Results

Split tensile strength was calculated using the Equation

$$f_{sp} = \quad 2P/\pi D L \text{ N/mm}^2$$

Table 6.3 Split Tensile Strength of concrete for 7 days and 28 days

Concrete Type	7 days Compressive strength (N/mm^2)	28 days Compressive strength (N/mm^2)
M1	2.74	3.55
M2	2.275	3.235
M3	2.395	3.41
M4	2.52	3.61
M5	2.80	3.81

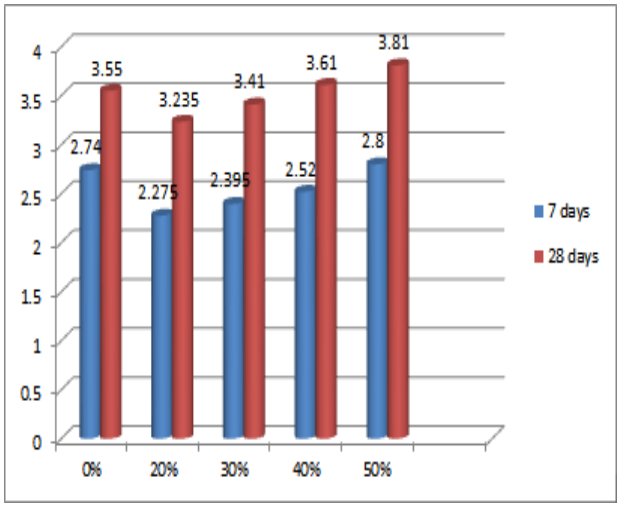

Figure 6.2 Comparison of 7 days and 28 days Split tensile strength of Conventional concrete and other mix

6.4 Flexure test Results

Flexural strength was calculated using the equation

$$f_b = \text{PL} / \text{BD}^2 \text{ N/mm}^2$$

Table 6.4 flexural Strength of concrete for 7 days&28 days

Concrete Type	7 days flexural strength (N/mm^2)	28 days flexural strength (N/mm^2)
M1	2.39	3.55
M2	2.28	3.115
M3	2.385	3.29
M4	2.63	3.60
M5	2.91	3.885

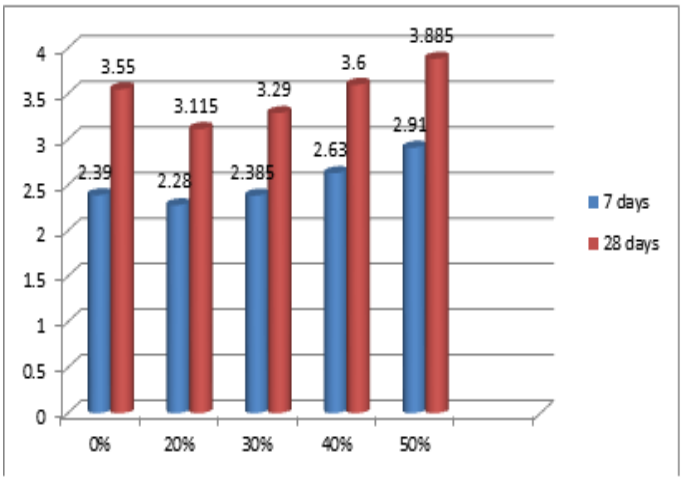

Fig. 6.3 Comparison of 7 days and 28 days Flexural strength of Conventional concrete and other mix

7. CONCLUSIONS

- Higher compressive strength, Split Tensile Strength and flexural Strength is obtained for 30% red soil and 20% for quarry dust added concrete.
- Compressive strength increases about 15.42% compared to conventional concrete while adding 30% red soil and 20% quarry dust.
- The slump value is decreased in order to increase the percentage of red soil and quarry dust.
- Slump value is decreases about 53.19% compared to conventional concrete while adding 30% red soil and 20% quarry dust.
- The annual sand demand for the construction industry in India is nearly 8 million cubic metres and all is obtained from major rivers. This present demand is expected to be 10 million cubic metres with in next three years
- As a part of preliminary work, the various material needed to be used for the further study, were obtained and their physical properties were determined.

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- A study on Quarry dust and Red soil was done which is proposed to be used in this experimental work.
- A review of literature was done which was helpful in getting a better idea on the topic.
- The various percentage of partial replacement of quarry dust + red soil concrete and testing method on concrete has been discussed in this my project.

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