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Partial Replacement of Fine Aggregates with Quarry Dust in Concrete Pavements

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Abstract: ***The study aims to determine the strength properties of concrete by replacing sand with quarry dust for M30 grade with 20%, 25% and 30% replacement. It is observed that for 20% of quarry dust (3 days, 7 days, 28 days) the average compressive strength is 22.58N/mm², 25.02N/mm², 36.66N/mm² where as for natural sand it is 20.56 N/mm², 23.15N/mm², 35.45N/mm² respectively. For 25% quarry dust (28 days) the strength increased to 36.82N/mm², for 30% it is 37.76N/mm² instead of 35.45N/mm² for sand. The properties of quarry dust are as good as fine aggregates in replacement with sand in the cement concrete.***

Keywords: Alternate building materials, Concrete, Quarry Dust, aggregates

Introduction

Concrete is a widely used construction material consisting of cementing material, fine aggregate, coarse aggregate and required quantity of water, where in the fine aggregate is usually natural sand,. The use of sand in construction results in excessive sand mining which is objectionable .due to rapid growth in construction activity, the available sources of natural sand are getting exhausted. (Palaniraj, 2003) Also, good quality sand may have to be transported from long distance, which adds to the cost of construction .In some cases, natural sand may not be of good quality.

(Dhir & carthy, 2000) quarry dust is one such material which can be used to replace sand as fine aggregate. The present study is aimed at utilizing quarry dust as fine aggregate in cement mortar and cement concrete, replacing natural sand. The study on mortar includes determination of compressive strength of different mortar mixes. (Nadgir & Bhavikatti, 2006) the study on concrete includes determination of compressive strength of concrete.

Experimental program

In this investigation, the compressive strengths of cement mortar are observed by replacing natural sand by quarry dust at different levels of replacement namely 20%, 25%, and 30 %. Mix design of M30 was chosen for the study. Moulds of size 150mm x150mmx150mm were used .the compressive strength of three percentages types of mortars are obtained at age of 3days, 7days and 28days. (jaafer et al.,2002) the strength properties of concrete with quarry dust replacement are compared with that of normal concrete which does not contain quarry dust

Experimental procedure:

Materials used

In this study, 53 grade ordinary portland cement conforming to is 12269 -1987 is used. Natural sand belonging to zone III as per IS 383-1970 is used in this investigation.

Test procedures

Compressive strength of quarry dust mortars:

The materials required for the number of specimens were dry mixed and then mixed with calculated amount of water. the quantity of water is obtained as per IS4032-1988.it is given by percentage of water equal to (p/4 +3) percent of combined weight of cement and fine aggregate, where p is the percentage of water required to produce a cement paste of standard consistency.

While preparing the specimens for each proportion, a reference mix using cement and natural sand is prepared. This is done in order to compare quarry dust mortar with the normal mortar. For each quarry dust replacement, the total fine aggregate quantity is obtained as the combination of natural sand and quarry dust .for example, the first set of specimens consist of 20% quarry dust and 80% of natural sand.

For each mortar mix and for each replacement level of Quarry Dust, 9 specimens were casted. The results were obtained by testing 3 specimens each at 3 days, 7 days and 28 days. The testing of specimens was carried out as per IS 4031-1988. Specimens were tested with a gradually increasing compressive load until they fail by crushing. Compressive strength of Quarry Dust mortars: (Sahu et al., 2003) the specimens were prepared by replacing sand by Quarry Dust at same levels of replacement as in natural sand mortar. The specimens were tested at the end of desired curing period to get the compressive strength. Tests on Quarry Dust concrete: The mix design of M30 grade concrete was obtained as per IS10262- 1982. The mix proportion for M30 concrete was 1:1.05:2.52 with a water-cement ratio of 0.4.

Results and discussions

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The results are discussed with respect to different parameters. Effect of replacement of quarry dust compressive strength of mortar:

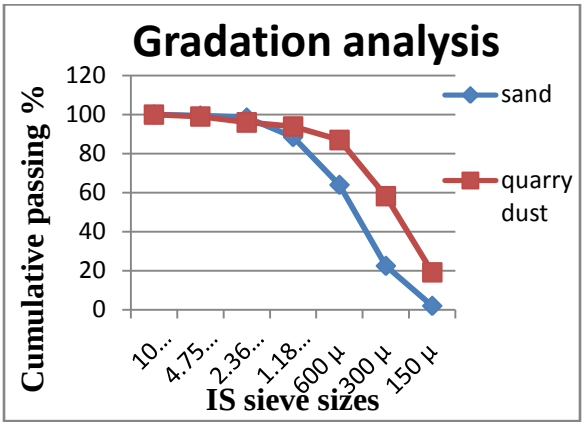

Fig 1: Gradation Analysis, Show the differences between Sand & Quarry Dust.

Sieve analysis helps to determine the particle size distribution of the coarse and fine aggregates.This is done by sieving the aggregates as per IS: 2386 (Part I) – 1963. In this we use different sieves as standardized by the IS code and then pass aggregates through them and thus collect different sized particles left over different sieves. The results should be calculated and reported as:

i) The cumulative percentage by weight of the total sample

ii) the percentage by weight of the total sample passing through one sieve and retained on the next smaller sieve, to the nearest 0.1 percent. The results of the sieve analysis may be recorded graphically on a semi-log graph with particle size as abscissa (log scale) and the percentage smaller than the specified diameter as ordinate.

The results of compression test on quarry dust and compressive strength ratios with respect to normal mortars. The results of Quarry dust mortars are represented in *Fig 2, 3 and 4.*

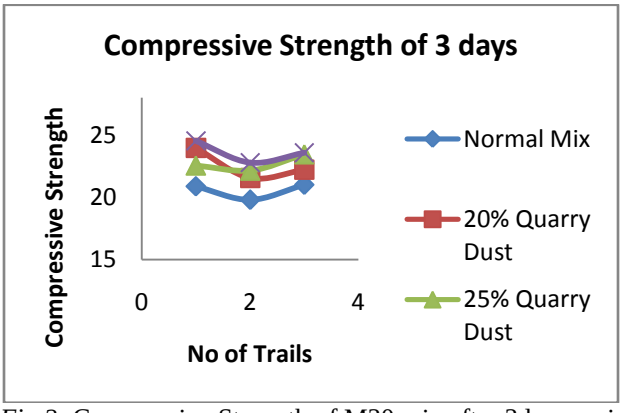

Fig 2: Compressive Strength of M30 mix after 3days curing

The values of compressive strengths of concrete with mix proportions of 20%, 25% and 30% gave good and positive results. From *Fig 1, 2* and *3*, it is observed that the compressive strength of concrete increases with the increase in percentage of proportions of quarry dust. *Fig 1* shows that the compressive strengths of concrete increases with the increase in quarry dust compare with Natural sand for 3 days strength.

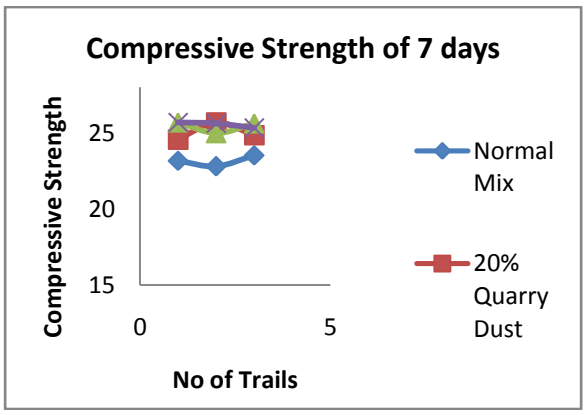

Fig 3: Compressive Strength of M30 mix after 7days curing

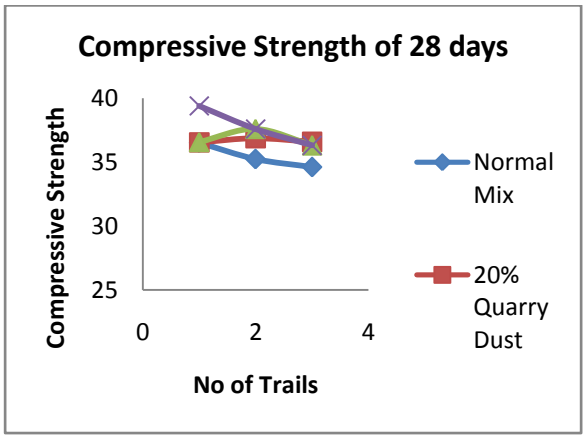

Fig 4: Compressive Strength of M30 mix after28days curing

It is clearly observed that for 20% of quarry dust (3 days) the average compressive strength is 20.16N/mm² where as for natural sand it is 13 N/mm². For 25% quarry dust the value increased to 29.6N/mm² and for sand is 27 N/mm². Finally for 30% the strength increased to 37.76N/mm². *Fig 2* shows the compressive strength variation with respect to various mix proportions (20%, 25%, 30%) for 7 days strength. For 20% of quarry dust the compressive strength of concrete is 21.23N/mm². For 25% of quarry dust the compressive strength of concrete is 28.14N/mm². For 30% of quarry dust the compressive strength of concrete attains 38.13N/mm². *Fig 3* shows the compressive strength variation with respect to various mix proportions (20%, 25%, and 30%) for 28 days strength. For 20% of quarry dust the compressive strength of concrete is 23.167N/mm². For 25% of quarry dust the compressive strength of concrete is 28.4N/mm². For 30% of quarry dust the compressive strength of concrete attains 37.56 N/mm² same as natural sand.

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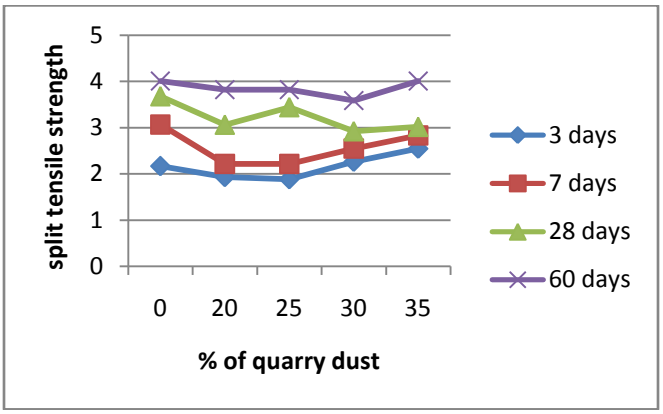

Fig 5: Split Tensile Strength of M30 mix after 60 days curing

The split tensile strength results of M30 mix of 35% quarry dust are as shown in *Fig 5*. The split tensile strength is increasing as the % of quarry dust increases.

Conclusions

All the experimental data shows that the addition of the industrial wastes improves the physical and mechanical properties. These results are of great importance because this kind of innovative concrete requires large amount of fine particles Due to its high fines of quarry dust it provided to be very effective in assuring very good cohesiveness of concrete. From the above study it is concluded that the quarry dust may be used as a replacement material for fine aggregate. Quarry dust has been used for different activities in the construction industry such as for road construction and manufacture of building materials such as light weight aggregates, bricks, tiles and auto clave blocks. However its use as rigid payment is very much limited. Thorough reaction with the concrete admixture, quarry dust, improved pozzolanic reaction, micro aggregate filling and concrete durability. As the properties are good as sand, the quarry dust is used as fine aggregate in replacement with sand in the cement concrete. This study reveals that in case of cement mortars, the natural sand can be replaced by quarry dust. The strength of concrete containing 20%, 25%, 30% mix of quarry dust proportions is much higher than normal concrete containing only sand as fine aggregate. It is better to use Quarry dust without removing the finer particles. For lean mortar mixes, quarry dust can be replaced up to 100%. As the quarry dust particles are finer there is an increase in the value of specific gravity which is more than fine aggregate. The water absorption percentage of quarry dust concrete decreased for dust content from (0-20) % and then it started to increase for 20%, 25%, and 30% of dust contents. Lower the particle size results in faster absorption and greater surface area results in faster evaporation leading to concrete setting quickly. It is found that there is enough workability with the w/c ratio provided. It is concluded that the compressive strength of concrete are not affected with the replacement of sand by quarry dust as fine aggregate up to 30%. It is clearly observed that for 20% of quarry dust (3 days) the average compressive strength is 20.16N/mm² where as for natural sand it is 13 N/mm². For 25% quarry dust the value increased to 29.6N/mm² and for sand is 27 N/mm². Finally for 30% the strength increased to 37.76N/mm² whereas for natural sand it is 35.6N/mm². Finally the compressive strength of quarry dust results says that the natural sand can be replaced with respect to various mix proportions (20%, 25%, and 30%). Hence, quarry dust can be effectively used to replace natural sand, without reduction in the strength of concrete with sand replacement level up to 30%.

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