Strength Characteristics of Quarry Dust in Replacement of Sand

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Abstract: The replacement of natural fine aggregate by using quarry dust leads to consumption of generated quarry dust, the requirement of land fill area can be reduced and solves the natural sand scarcity problem. The sand availability as a fine aggregate at low cost which needs the reason to search as a alternative material. Even it causes saddle to dump the crusher dust at one place which causes environmental pollution. The chemical analysis, specific gravity, sieve analysis and compressive strength is identified for various percentage and grades of concrete by replacement of sand with quarry dust.

Key Words: Concrete, Compressive strength, Quarry Dust, Replacement, Sand.

1. INTRODUCTION
Quarry dust, is a by-product releases from the cutting and crushing process of stone which is a concentrated material to use as fine aggregates. By exploding mountain, rock will be crushed to small size stones and along with this dust type particles called quarry dust will be formed during the process which is going as waste. So it becomes as a useless material and also fallout in air pollution too. Therefore, quarry dust can be used in building works, which will decrease the cost of construction and the construction material would be saved and the natural resources can be used properly. Most of the upcoming countries are in pressure to replace fine aggregate by an alternate material also to some extent or totally without compromising the quality of concrete. Quarry dusts have been used for different purposes in the construction industry, such as building materials, road construction materials, fine aggregates, bricks and tiles.

The present research study mainly deals with the influence of different replacement proportion of sand with quarry dust on the properties of concrete. The present work is planned to study on specific gravity, chemical analysis, zone properties due to addition of quarry dust and also to assess the rate of compressive strength development in concrete. The major portion of material collected from Kondapalli region which is study area is compound of rock types like hornblende, biotite, hypersthenes and gneiss.
2. LITERATURE REVIEW

The suitability of quarry dust as a sand replacement material shows that the mechanical properties are enhanced and also elastic modulus. The compressive strength analysed optimum by replacing fine with quarry in ratio of 60:40 said by Azar Hamid Mir [1]. Burak Felekoglu [2], identified that the integration of quarry waste and the equal amount of cement content generally reduced the super plasticizer requirement and improved the 28 days compressive strength of SCC. Normally the strength mixture of SCC contains nearly 300 to 310 kg of cement by inducing the quarry dust it can be increased a lot per cubic meter. Consumption of Quarry Dust in Concrete is suggested particularly in regions where sand is not easily available, H.A.F. Dehwah [5]. Joseph. O. Ukpata [7], was identified that properties of tensile and flexural strength compared with conventional concrete. Hence, the proportion of concrete with lateritic sand and quarry dust is below 50% for construction purpose. Both flexural and tensile strength are increase with increase in lateritic content.

It is clearly observed that there is reliable increase in the strength of plain concrete when natural sand is fully replaced by quarry dust, Mahendra R. et al. [9]. R. Ilangovana [12], the study gives attention towards physical and chemical properties of quarry dust are satisfied in respect of requirements of codal provision. The complete replacement of sand with quarry dust gives the better results in terms of compressive strength studies.

3. TEST ON QUARRY DUST

Silica, SiO$_2$, is a colorless crystalline compound found mainly as sand, quartz, flint, and many other minerals. Silica is an important element to manufacture to enhance the strength property in a wide variety of materials.

It is understood that the SiO$_2$ is the main chemical component which possess the strength parameters in cement and sand. So, in this regards it is recommended to crusher owners to check chemical property of SiO$_2$ of their quarries shows higher than 80% may gives the good working results to civil engineering related construction works. Fe$_2$O$_3$ nanoparticles with the average diameter of 15 nm were used with four different contents of 0.5%, 0.1%, 1.5% and 2.0% by weight. The results possess that the utilization of Fe$_2$O$_3$ particles up to greatest replacement level of 2.0% produces concrete with better split tensile strength. The results also possess that the utilization of Al$_2$O$_3$ particles up to utmost replacement level of 2.0% produces concrete with better strength. However, the maximum strength of concrete was attained at 1.0 wt% of cement replacement. The chemical analysis of sand and quarry dust of crusher samples as shown in Figure no. 1.
Figure 1: Chemical Analysis of Sand and Quarry Dust crusher samples

The specific gravity of most common minerals found in soils fall within a range of 2.6 to 2.9. The specific gravity of sand, which is mostly made of quartz, may be estimated to be about 2.65, but for soils like clayey and silty may be from 2.6 to 2.9. Soils with porous material and contains organic matter possess below 2 specific gravity, whereas soils with heavy substances may have above 3. These values fall into the average specific value range for most soils. The specific gravity of quarry dust of crusher samples as shown in Figure no. 2

Figure No. 2: Specific gravity for 40 quarry dust crusher samples

It was observed that all the samples of quarry dust are in the range of sand, indicating that soil with high silt content replaced by the quarry dust will reduce the swelling and shrinking of the soil.

Here in the Figure no. 3 possess that the most of the quarry dust samples follows the well graded curve. Some of the quarry dust samples are leads to the uniformly graded particle distribution curve. Very less quarry dust samples are in the form of the gap graded type of soil particles distribution curves.
Quarry dust, is a result of crushers while doing quarrying activities. Quarry dust was taken from paritala region quarries in Vijayawada. The present research work is planned to study the importance of quarry dust when it is replaced with sand in concrete as partially from various crusher samples. The study mainly involve on compressive strength. The series involves casting and testing cube specimens in each set. The cubes were casted using standard cubes of 150mm X 150mm X 150 mm. Compression testing machine of 2000 KN capacity was used to test the cubes specimens. The two set of series is as follows

a) In the first set, M20 grade of concrete with 20, 30 and 40 percentage substitute of quarry dust tested for 3 days, 7 days and 28 days is identified and presented the results.

b) In the second set, M30 grade of concrete with 20, 30 and 40 percentage substitute of quarry dust tested for 3 days, 7 days and 28 days is identified and presented the results.

### 4. DISCUSSION ON RESULTS

a) In the first set, M20 grade of concrete with 20, 30 and 40 percentage substitute of quarry dust tested for 3 days, 7 days and 28 days is identified and presented the results.

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**Figure No. 3:** Particle size distribution of 40 crusher samples of quarry dust

**Figure 4:** Compressive strength with 20, 30 and 40 percentage substitute of quarry dust tested for 3 days, 7 days and 28 days
As the increase in concrete age the compressive strength increases up to 40 percent replacement of quarry dust as sand. The fractional replacement of Quarry Dust gave a satisfied compressive strength at 20%, 30% and 40% replacement level. The figure 4 shows that the compressive strength of M20 grade with varying age of concrete by replacement level up to 40%.

b) In the second set, M30 grade of concrete with 20, 30 and 40 percentage substitute of quarry dust tested for 3 days, 7 days and 28 days is identified and presented the results.

Figure 5: Compressive strength of M30 with 20%, 25% and 30% replacement for 3, 7 and 28 days

The slight variation is observed in compressive strength for 3 days and 7 days age in concrete. The compressive strength of M30 concrete has been tested for 3, 7, 28 days of curing with the percentage of quarry dust varying from 20%, 25% and 30% replacement. The compressive strength results are presented in Figure no. 5.

5. CONCLUSIONS

It is observed that the strength characteristics of quarry dust is same as sand. The chemical composition of quarry dust and sand possess that the strength property remains constant for both the materials. The silica percentage is above 80% which gives the high strength as same as sand. It is observed that the difference of chemical composition for the quarry dust samples collected from various crushers. All the crusher’s samples are seen adequate results.

The specific gravity and sieve analysis result shows that the quarry dust can be used as alternative to sand. The specific gravity of all the crusher samples is lies in between 2 to 2.7 which fulfill the sand requirement. The sieve analysis is carried out for the collected quarry dust crusher sample and sand which possess the sand zone.

From the experimental study it is concluded that the quarry dust can be used as a substitute for sand. It is identified that 40% replacement of sand by quarry dust give good result in strength than normal concrete for M20 and M30 grade. The results possess that 40% replacement of sand by the quarry dust induced higher compressive strength and the workability of concrete decreases as replacement increases. Thus the environmental effects and waste can be significantly reduced.
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