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# Quarry Dust as an Efficient Substitute for Sand

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***Abstract:-*** **The reduction in the sources of natural sand and the requirement for the reduction in the cost of concrete production has resulted in the increased need to identify substitute material to sand as fine aggregate in the production of various concretes. The present work is an attempt to understand the effect on concrete strength and durability characteristics of concrete by partial replacement of sand with quarry dust. This experimental study presents the variation in the strength and durability properties of concrete when replacing sand by quarry dust from 0% to 50% in interval of 10% .Various strength and durability tests conducted in the laboratory are compressive strength test, Flexural Strength test, Split tensile strength test, Acid resistant test, sulphate resistant test, Chloride resistant test and Water absorption test. The specimens were monitored for 7,14,28 and 56 days and results are tabulated.**

***Keywords:--*** **Comparison, Durability, Tests, Mechanical properties, Quarry dust.**

## I. INTRODUCTION

To overcome the acute crisis due to large scale exploitation of river sand, usage of various replacement technologies(1-4) has emerged as an innovative development to civil engineering material in recent years. Quarry dust, a by-product from the crushing process during quarrying activities is one of such material (5-6). Similarly the durability of concrete (7-9) in civil engineering structures is major engineering concern for Engineers. Since from ages the concrete was considered as very durable material with very little maintenance. Field experience shows that it fell short to withstand the hostile conditions of environment. In developing countries 40% of the total resource of the buildings and industries are spent on repairs and maintenance. The scope of present study is to enhance the industry understanding of the sustainable utilization of quarry fines and to identify any gaps in current knowledge. Present study focuses mainly on the variation in the strength and durability properties of concrete when replacing sand by quarry dust from 0% to 50% in interval of 10% .Various strength and durability tests conducted in the laboratory are compressive strength test, Flexural Strength test, Split tensile strength test, Acid resistant test, sulphate resistant test, Chloride resistant test and Water absorption test. The specimens were monitored for 7,14,28 and 56 days and results are tabulated.

## II. EXPERIMENTAL INVESTIGATION

**1) Cement:** For all the mixes in this project, 53 Grade (Birla Super), OPC was used. The cement was tested for codal specifications as per IS 12269-1897 to determine its properties.

**2) Fine aggregate:** Locally available river sand confined Grading zone II of IS: 383-1970.

**3) Coarse aggregate:** Locally available crushed granite stones conforming to graded aggregate of nominal size 12.5 mm as per IS:383-1970.

**4) Quarry Dust:** The quarry dust powder used is coarse, sharp and hard and passes through 4.75mm sieve. It is of standard specifications, clean and free from dust, dirt and organic matters.

**5) Chemical Admixture:** The super plasticizer is Master Rheobuild922c. The recommended dosage is in the range of 500ml to 1500ml per 100 kg of cementitious material.

**6) Water:** The water used is a potable drinking water free from salts and organic materials.

***Table 1: Material properties***

| Materials | Test | Result |
|---|---|---|
| Cement | Consistency test | 33% |
| | Fineness test | 4% |
| | Specific gravity | 3.2 |
| Fine Aggregate | Specific gravity | 2.62 |
| | Sieve analysis | Zone I IS 383 (1970) |
| Coarse Aggregate | Specific gravity | 2.7 |
| | Water absorption | 0.5% |
| | Sieve analysis | Zone I IS 383 |

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| | | |
|---|---|---|
| | | (1970) |
| | Aggregate impact | 24.86% |
| Quarry Dust | Specific gravity | 2.635 |
| | Sieve analysis | Zone I IS 383 (1970) |

***Mix Design Calculations:***

Using IS 10262:2009 for M40 grade,
Materials required for $1m^3$ of concrete
Cement= 351 $Kg/m^3$
Coarse Aggregates = 1086.5 $kg/m^3$,
Fine Aggregates=866.13 $kg/m^3$,
W/C= 0.45.

*Fresh property tests for Concrete:*

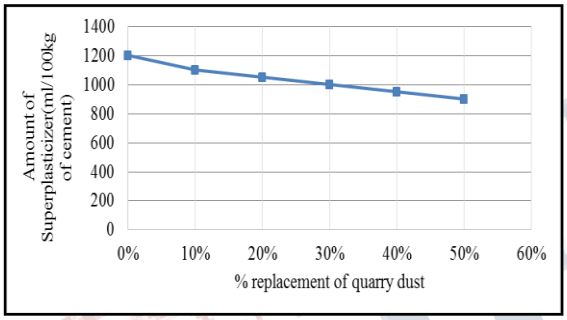


***Fig:1.Amount of super plasticizer required to produce 100mm slump***

## III. DURABILITY TESTS ON CONCRETE:-

### *1. ACID RESISTANCE TEST:-*

The acid resistance test was conducted on 150 mm size cubes specimen after curing for a period of 28 days. Then the specimen cubes were weighed and immersed in water diluted with 2N, 10% by weight of HCl acid for 8 weeks. In this process the specimen cubes were subjected to alternate drying and wetting for every 2 days. The specimen cubes were taken out of the solution in a sequence at an interval of 7,14,21,28 and 56 days. After taking out the cubes from solution, the effect of acid on compressive strength and weight loss of specimen is noted in Fig 2-13.

### *2. SULPHATE RESISTANCE TEST*

The effect of sulphate attack results in chemical break down in components of cement paste. In this study the sulphate resistance test was conducted on 150 mm size cube specimens after curing for a period of 28 days. Then the specimen cubes were weighed and immersed in water diluted with 5% by weight of $MgSO_4$ for 8 weeks. After taking out the cubes from solution, the effect of acid on compressive strength and weight loss of specimen is noted in Fig 2-13.

### *3. CHLORIDE RESISTANCE TEST*

Corrosion of R.C structures is major cause for deterioration of concrete structures. This test was conducted on 150 mm size cube specimens after curing for a period of 28 days. Then the specimen cubes were weighed and immersed in water diluted with 5% by weight of NaCl for 8 weeks. After taking out the cubes, the effect of acid on compressive strength and weight loss of specimen is noted in Fig 2-13.

### *4. WATER ABSORPTION TEST*

The test was conducted in accordance with ASTMC642 on concrete cubes of 100mm size. After 28 days of curing, specimens were dried for 24 hrs and placed in oven at $105^0$C. The specimens were immersed in water after cooling it to room temperature and variation of gain in mass is noted Later the percentage of water absorption was calculated. Fig 14.

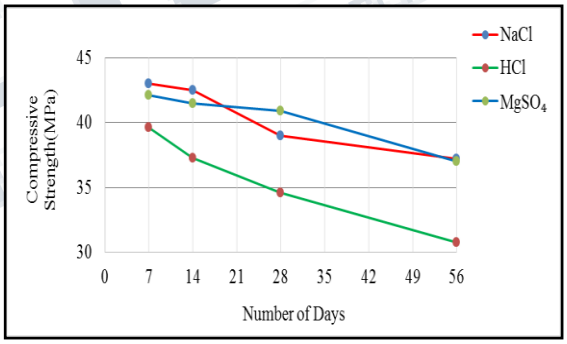


***Fig:2 Variations in Compressive strength for 0% Quarry Dust when immersed in chemicals.***

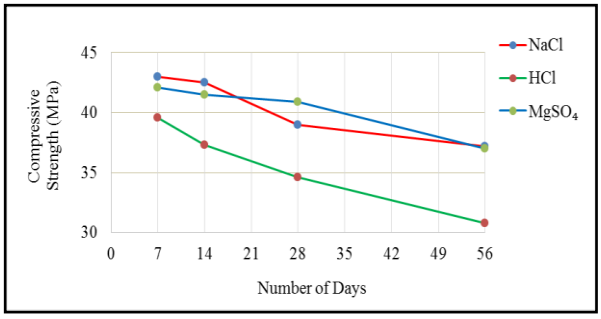


***Fig:3 Variations in Compressive strength for 10% Quarry Dust when immersed in chemicals.***

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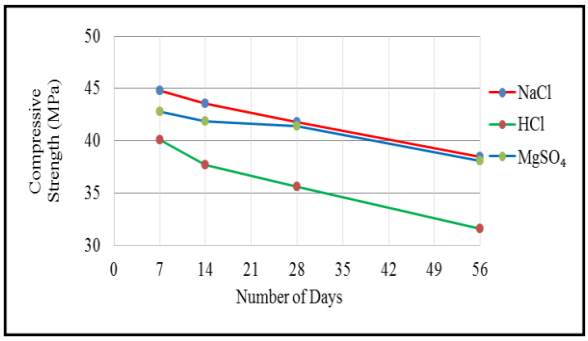


*Fig:4 Variations in Compressive strength for 20% Quarry Dust when immersed in chemicals.*

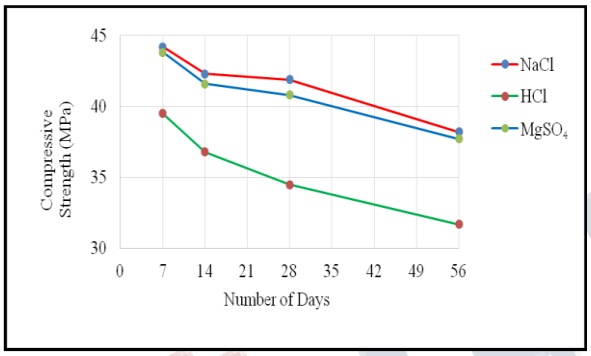


*Fig:5 Variations in Compressive strength for 30% Quarry Dust when immersed in chemicals.*

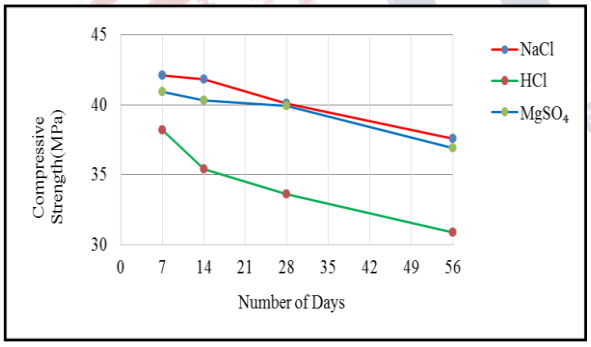


*Fig:6 Variations in Compressive strength for 40% Quarry Dust when immersed in chemicals.*

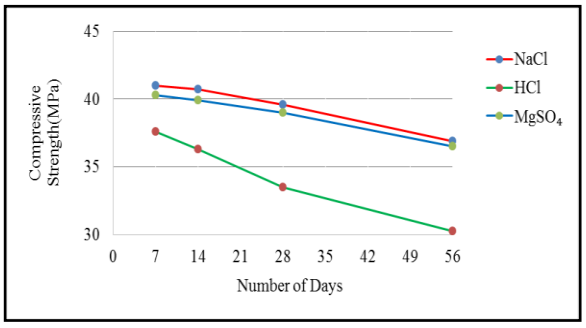


*Fig:7 Variations in Compressive strength for 50% Quarry Dust when immersed in chemicals.*

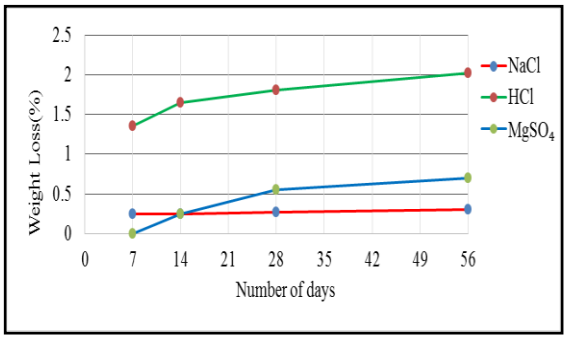


*Fig:8 Variations in Percentage Weight Loss for 0% Quarry dust Replacement*

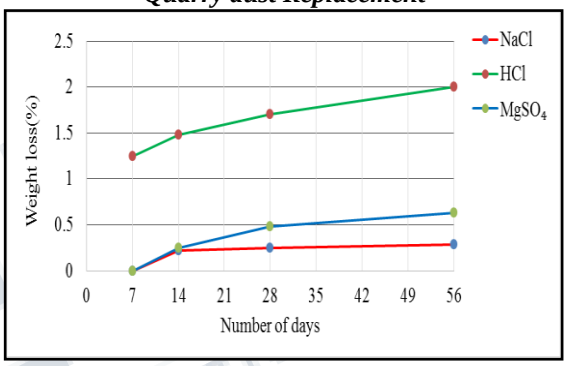


*Fig:9 Variations in Percentage Weight Loss for 10% Quarry dust Replacement .*

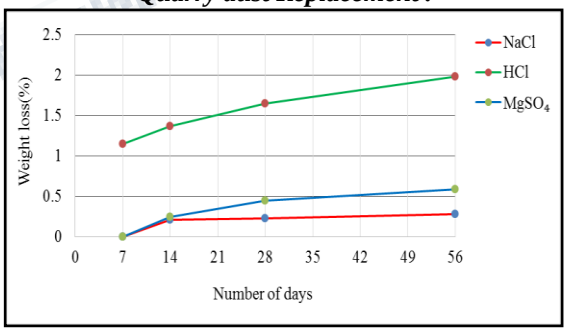


*Fig:10 Variations in Percentage Weight Loss for 20% Quarry dust Replacement .*

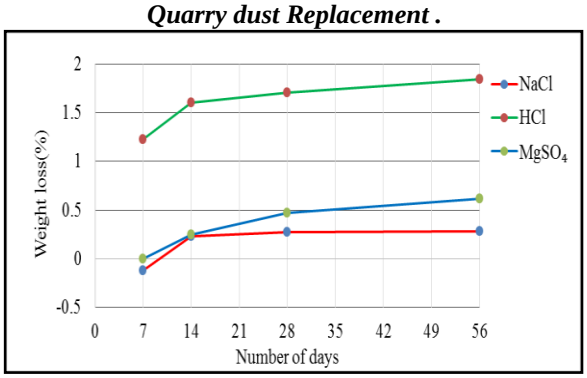


*Fig: 11. Variations in Percentage Weight Loss for 30% Quarry dust Replacement .*

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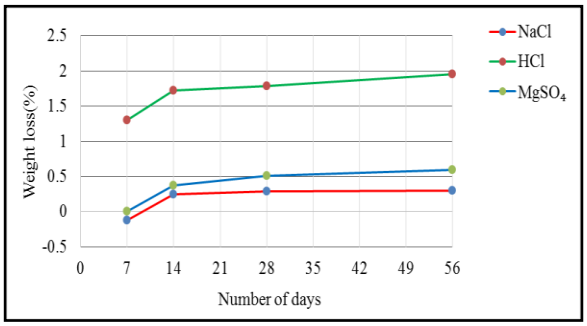


*Fig:12. Variations in Percentage Weight Loss for 40% Quarry dust Replacement .*

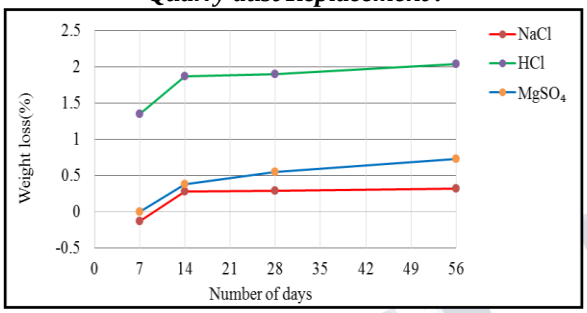


*Fig:13. Variations in Percentage Weight Loss for 50% Quarry dust Replacement .*

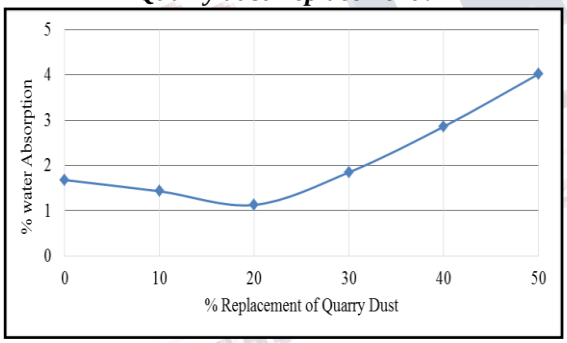


*Fig: 14. Variation of Water Absorption with Replacement of Quarry Dust Mechanical properties of M40 grade concrete:-*

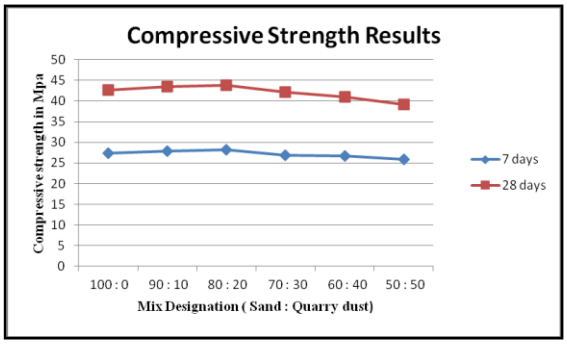


*Fig:15. Effect on compressive strength of concrete with variation in quarry dust percentage.*

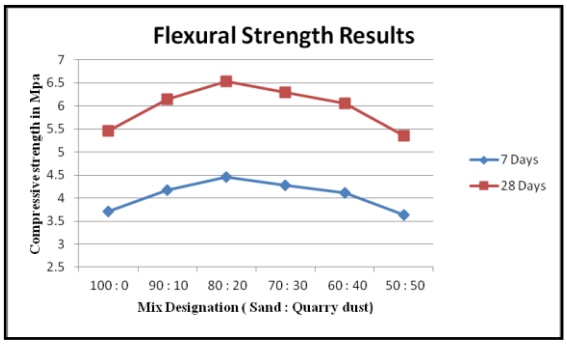


*Fig:16. Effect on Flexural strength of concrete with variation in quarry dust percentage.*

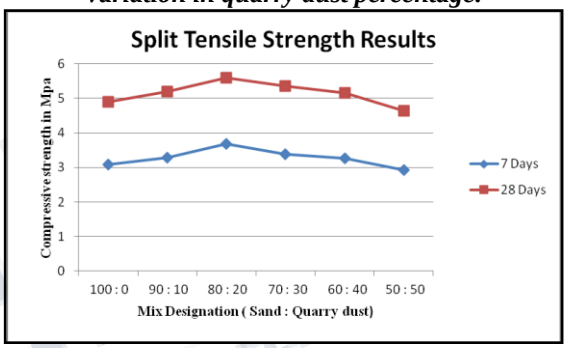


*Fig:17. Effect on split tensile strength of concrete with variation in quarry dust percentage.*

## IV. CONCLUSION

***The following conclusions are drawn from the of present study:-***

1. From the test result, it is noted that strength reduction of concrete cubes is more with increase in days of specimen immersion in chemicals. It can also be seen that the reduction in compressive strength was maximum in case of acid resistance test and minimum in the case of Chloride resistance test.

2. In Chloride resistance test the compressive strength of the specimens were found to be maximum for 20% replacement of quarry dust. There was a weight gain in some specimens in the initial 7 days. Thereafter percentage weight loss was found to be increasing till 56 days with minimum weight loss at 20% replacement of quarry dust.

3. In Acid resistance test, it was found that resistance to loss in compressive strength of concrete specimens was maximum at 20% quarry dust replacement. There was a significant weight loss in the initial 7 days. Thereafter the percentage weight loss increased progressively till 56 days

with minimum percentage weight loss at 20% to 30% replacement of quarry dust.

4. In Sulphate resistance test the compressive strength of the specimens were found to be maximum for 20% replacement of quarry dust. There was no loss of weight in the specimens in the initial 7 days. Thereafter the percentage weight loss increased progressively till 56 days with minimum percentage weight loss at 20% replacement of quarry dust.

5. In Water Absorption Test, water Absorption of concrete cubes decreased initially from 1.68 for 0% replacement to 1.13% for 20% replacement and then increased to 4.02% for the 50% replacement of quarry dust.

6. Effect on mechanical properties with replacement of 20% sand with quarry dust resulted that there is increase in Compressive strength by around 10%, Split tensile strength by 15% and Flexure Strength by 10%.

7. Hence, it can be concluded that quarry dust can be used as an effective substitute of natural sand taking durability and mechanical properties into consideration.

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