Investigation on Strength Properties of Concrete by Partial Replacement of Fine Aggregate by Quarry Dust

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Abstract: *This work presents the variation in the strength properties of concrete when replacing sand by quarry dust 0%, 50%, 75%, 100%. M25 grade of concrete were taken for study slump value is reducing for more % replacing quarry dust. The compressive strength of concrete cubes at the age of 7 and 28 days were obtained at room temperature. From test results it was found that the compressive strength got increased for up to 50% replacement of quarry dust in the place of sand .This result gave a quarry dust can be utilized partially in concrete mixtures as a good substitute for natural river sand giving higher strength. So, from the results which we have obtained, it is clear that quarry dust can be used as a good substitute the partial replacement of sand in the concrete.*

Keywords: Quarry Dust, Concrete, Compressive Strength, Tensile Strength

1. Introduction

Cement is a binding substance that sets and hardens and can bind other materials together.

The history of cementing material is as old as the history of engineering construction. Some kind of cementing materials were used by Egyptians, romans and Indians in their ancient construction. It is believed that the early Egyptians mostly used cementing obtained by burning gypsum. The word ''cement'' can be traced back to the roman term cementicious used to describe masonry resembling modern concrete that was made from crushed rock with burnt lime as binder

Cements used in construction can be characterized as being either hydraulic or non-hydraulic, depending upon the ability of the cement to set in the presence of water (see hydraulic and non-hydraulic lime paste.

Sand is a natural occurring granular material composed of final divided rock and mineral particles. It is defined by size being finer then gravel and coarser than silt. Sand can also rifer to textural class of soil or soil type; i.e. a soil containing more than 85% sand –sized particles

Figure 1: Sand

the composition of sand varies, depending on the local rock sources and condition but the most common constituent of sand in inland continental setting and non-tropical coastal settings is silica (silicon dioxide, orsio2) usually in the form of quartz. The mostly been created, over the past half billion years by various forms of life, like coral and shellfish. Quarry dust is a by-product of crushing with a typical grain size of 0-3.4 mm or 0-6.8 mm. because stone dust contains very fine aggregates it forms a hard, load bearing surface. Rock dust, also known as rock powders, rock minerals, rock flour, soil demineralization, and mineral fines**,** consists of finely crushed rock, processed by natural or mechanical means, containing minerals and trace elements widely used in organic farming particle. The igneous rock basalt and granite often contain the highest material content, whereas limestone, considered inferior in this consideration, is often deficient in the majority of essential macro-compounds, trace elements, and micronutrients.

2. Literature Review

Everton (2003) reported that knowledge gained from research should be used by quarry operators to optimize the performance of their equipment and to achieve lower quantities of quarry fines.

Petavratzi (2006) investigated that the large amount of dust fraction below 75m generated from various ores and found that the different types of rock produced different amounts of fines with physical properties

Mitchell (2007) suggested that the quarrying sector would consider using new technologies, which reduce the fines production and that further researches work is required in identifying the capital and operational costs associated with quarry fines.

3. Methodology

Materials used are
- Cement
- Fine aggregates
- Coarse aggregates
- Water

- Quarry dust is collected from quarry near perecherla

Material testing in laboratory:

Tests are conducted for materials
- Cement
- Fine aggregate
- Coarse aggregate
- Stone dust

Experimental testing for the above materials:
- Fineness of cements
- Standard consistency
- Initial setting time
- Final setting time
- Specific gravity of stone dust
- Compaction factor test
- Fineness modulus of stone dust
- Specific gravity of Coarse Aggregates
- Impact test on Coarse Aggregates
- Fineness modulus of Coarse Aggregate

Table: Properties of Cement

S.no	Properties	Test Results	IS: 12269-1997
1	Normal consistency	32%	31%
2	Initial setting time	130min	Minimum of 30 Min
3	Final setting time	253min	Maximum of 600 Min
4	Specific gravity	3.15	2.85

4. Experimental Programme

4.1 Mix Design

Mix design was carried out as per IS: 10262 – 2009.

4.2 Mix Ratio

We are using the grade of concrete is M25

Table: Mixing proportion

Grade	Proportion	w/c ratio
M20	1:1:2	0.5

4.2 Preparation of Test Specimen

Material calculation
0% fine aggregate replacing
Cement = 2.020 kgs
Sand = 2.020 kgs
Aggregates = 4.040 kgs

50% fine aggregate replacing
Cement = 2.020kgs
Fine aggregate = 1.010 kgs
Coarse Aggregates = 4.040 kgs
Quarry dust =1.010 kgs

75% fine aggregate replacing
Cement = 2.020kgs
Fine aggregate = 0.505kgs
 Coarse Aggregates = 4.040kgs
Quarry dust = 1.515kgs

100% fine aggregate replacing
Cement = 2.020kgs
Fine aggregates = 0kgs
Coarse aggregates = 4.040kgs
Quarry dust = 2.020kgs

Total quantities of materials used:
Total cement quantity = 8.080kgs
Total fine aggregate quantity = 5.555kgs
Total coarse aggregate quantity = 16.160kgs
Total quarry dust quantity = 4.545kgs

Slump Test
The result for the slump test of the fresh concrete is shown in Figure 5. The slumps obtained are in the medium range (35–70mm). The highest slump was obtained with concrete made with river gravel. River gravel has a relatively smooth surface and round in shape, being water-worn due to the action of running water and thereby enhanced the workability of fresh concrete.

Table: Slump test results

Test no	% of quarry dust	Slump value (mm)	Type of slump
1	0% quarry dust	70	shear slump
2	50% quarry dust	15	True Slump
3	75% quarry dust	10	True slump
4	100% quarry dust	75	Shear slump

Compacting Factor Test
The compacting factor test is designed primarily for use in the laboratory but it can also be used in the field. It is more precise and sensitive than the slump test and is particularly useful for concrete mixes of very low workability as are normally used when concrete is to be compacted by vibration. Such dry concrete are insensitive to slump test.

Test No.	Ratio	Compaction Value
Test – 1	For 0%quarry dust & 100% aggregate	0.945
Test – 2	For 50%quarry dust& 50% aggregate	0.962
Test – 3	For 75%quarry dust 25% aggregate	0.984
Test – 4	For100%quarry dust&0% aggregate	0.987

Compaction factor results for different ratios Preparation of samples

7 Days

Quarry Dust Replacement	0%	50%	75%	100%
No of cubes	3	3	3	3
No of cylinders	1	1	1	1

28 Days

Quarry Dust Replacement	0%	50%	75%	100%
No of cubes	3	3	3	3
No of cylinders	1	1	1	1

5. Results and Discussions

5.1 Results of tests done on cement

Type of tests	Results
Fineness	0.9%
Consistency	30.5%
Initial	30 mins
Final	350 mins
Specific Gravity	2.64

5.2 Results of tests done on aggregates

Type of Tests	Coarse Aggregates	Fine Aggregates	Quarry Dust
Specific Gravity(%)	2.72	2.65	2.56
Water Absorption(%)	0.5	1.0	0.5
Fineness Modulus(%)	4.51	3.54	3.81
Bulk Density	1469.8	1460	1765

5.4 Compression Test Results
0% of Quarry Dust

S.no	Age	Compression Strength			Average compression Strength
		Cube 1	Cube 2	Cube 3	
1	7 Days	28.56	28.68	29.57	28.93
2	28 Days	44.94	44.94	44.02	44.63

50% of Quarry Dust

S. no	Age	Compression Strength			Average compression Strength (N/mm^2)
		Cube 1	Cube 2	Cube 3	
1	7 Days	31.22	31.68	31.67	31.52
2	28 Days	49.21	49.54	49.24	49.33

75% of Quarry Dust

S. no	Age	Compression Strength			Average compression Strength
		Cube1	Cube2	Cube3	
1	7 Days	30.20	30.30	30.40	30.30
2	28 Days	46.30	47.10	46.70	46.70

100% of Quarry Dust

S. no	Age	Compression Strength			Average Compression Strength
		Cube 1	Cube 2	Cube3	
1	7 Days	28.73	29.12	29.22	29.02
2	28 Days	45.30	45.45	44.71	45.15

AVG Compression Strength Values

S.NO	Percentage	Age	Average Compression Strength(N/mm^2)
1	0%	7 Days	28.93
		28 Days	44.63
2	50%	7 Days	31.52
		28 Days	49.33
3	75%	7 Days	30.30
		28 Days	46.70
4	100%	7 Days	29.02
		28 Days	45.15
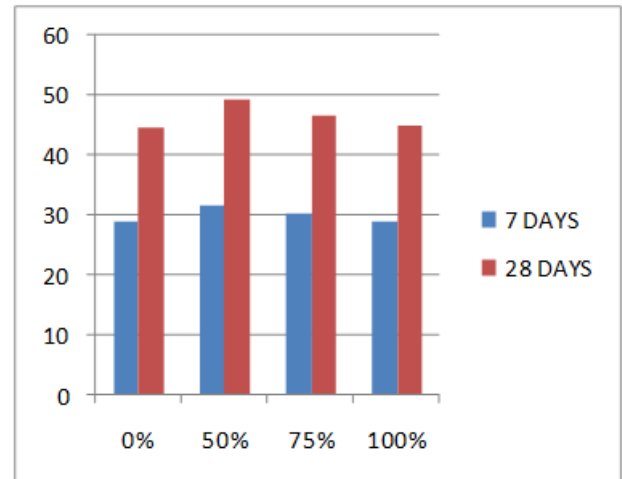
Compression strength vs. different % with bar chart
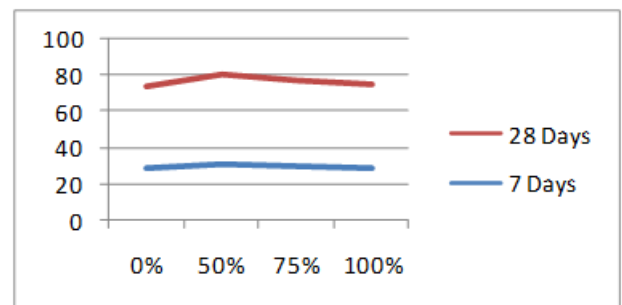
Compression Strength vs different % with line Graph

5.5 Tensile Strength Results

0% of Quarry Dust

S.no	Age	Tensile Strength
1	7 Days	19.28
2	28 Days	29.75

50% of Quarry Dust

S. No	Age	Tensile Strength
1	7 Days	21.01
2	28 Days	32.88

75% of Quarry Dust

S. No	Age	Tensile Strength
1	7 Days	20.2
2	28 Days	31.13

100% of Quarry Dust

S. No	Age	Tensile Strength
1	7 Days	19.34
2	28 Days	30.1
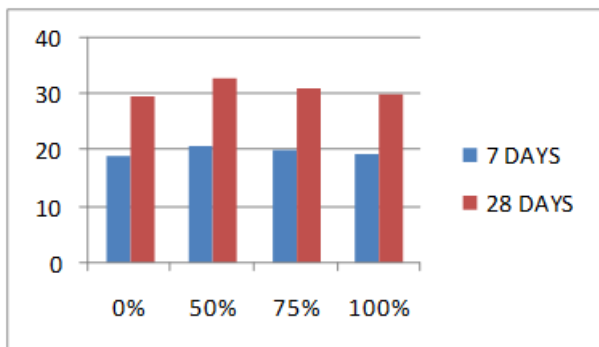
Tensile strength vs different % with bar chart
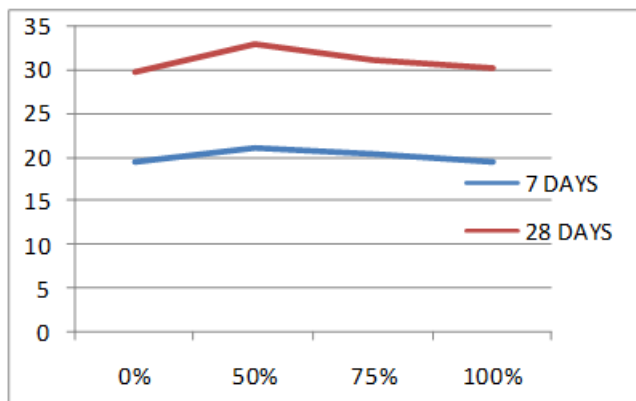
Tensile Strength vs different % with line Graph

6. Results

Compression Strength Test Results
0% replacement of quarry dust compressive strength @ 7 days 28.9N/mm2
0% replacement of quarry dust compressive strength @ 28days44.63 N/mm2

50% replacement of quarry dust compressive strength @ 7 days 31.52N/mm2
50% replacement of quarry dust compressive strength @ 28days 49.33N/mm2

75% replacement of quarry dust compressive strength @ 7 days 30.30N/mm2
75% replacement of quarry dust compressive strength @ 28days 46.70 N/mm2

100% replacement of quarry dust compressive strength @ 7 days29.02 N/mm2
100% replacement of quarry dust compressive strength @ 28 days45.15 N/mm2

7. Conclusions

Based on above results, following conclusions are drawn;
- A maximum compressive strength of 49.33MPa was obtained with 50% replacement of QD for 28 days.
- It was observed that 50% replacement of QD gave a satisfactory result when compared with conventional concrete for 7 days.
- Partial replacement of FA with QD showed encouraging results in terms of compressive strength.
- Environmental wastes which pose a difficult problem in its disposal can be efficiently addressed through the results of this research.

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