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AN EXPERIMENTAL STUDY OF PARTIAL REPLACEMENT OF CEMENT BY SILICA FUME AND COMPLETE REPLACEMENT OF NATURAL SAND BY QUARRY DUST

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Abstract - *The huge quantity of concrete is consumed by construction industry all over the world. In India, the conventional concrete is produced using natural sand from river beds as fine aggregate. Decreasing natural resources poses the environmental problem and hence government restriction on sand quarrying resulted in scarcity and significant increase in its cost. This paper present the optimization of partial replacement of natural sand by quarry dust and cement by silica fume. Concrete mixes were evaluated for compressive strength. The ordinary Portland cement was partially replaced with silica fume by 5%, 10 %, and 15% and natural sand was replaced with manufactured sand completely. The results indicated that there is an increase in the compressive strength nearly 20% and 15% respectively with the increase of silica fume percentage. The result gave increasing value up to 15% replacement of silica fume. However, further additions of silica fume caused reduction in the strength. The optimum percentage of replacement of cement by silica fume is 15%.*

***Index Terms*: Silica Fume, Quarry Dust.**

I.INTRODUCTION

Cement and aggregate, which are the most important constituents used in concrete production, are the vital materials needed for the construction industry. This inevitably led to a continuous and increasing demand of natural materials used for their production. Parallel to the need for the utilization of the natural resources emerges a growing concern for protecting the environment and a need to preserve natural resources, such as aggregate, by using alternative materials that are either recycled or discarded as a waste.
High performance concrete (HPC) exceeds the properties and constructability of normal concrete. Normal and special materials are used to make these specially designed concrete that must meet a combination of performance requirements. HPC are made with carefully selected high quality ingredients and optimized mixture designs. HPC will have a low water cement ratio of 0.2 to 0.45. HPC almost always has a higher strength than normal concrete. There are many methods of mix design for HPC. Experiments were conducted with silica fume and Quarry dust on high performance concrete with replacement of silica fume 0 to15% instead of cement and complete replacement of natural sand by quarry dust and the HPC mixes are tested experimentally for workability, compression, split tension and concluded that the performance of the design mixes are very good. The project concluded by explaining that 28 days compressive strength was maximum at 15% silica fume replacement at a w/b ratio of 0.45.

1.1 Objective

(i) Sustainable concrete construction.

(ii) Cost of construction is reduced.

(iii) To attain high strength

(iv) To solve the issues of cement and coarse aggregate demand.

2. MATERIALS USED

2.1 Cement:

In the present study Ordinary Portland cement (OPC) 53 grade was used. Super Star brand OPC was used.
Specific gravity- 3.14
Fineness- 7%
Consistency- 33
Initial setting time- 30minutes
Final setting time- 1hr

2.2 Quarry dust:

Quarry dust is a waste from the stone crushing unit accounts 25% of the final product from stone crushing unit. This quarry dust which is released directly into environment can cause environmental pollution. To reduce the impact of the quarry dust on environment and humans, this waste can be used to produce a new product by partially replacing fine aggregates with quarry dust in concrete.

Specific gravity- 2.6
Water absorption- 1.4%
Fineness modulus – 2.6

Table 2.1: Chemical composition of Quarry dust

S. No.	Constituents	Quantity (%)
1.	SiO2	70.74
2.	Al2O3	20.67
3.	Fe2O3	2.88
4.	TiO2	0.33
5.	Na2O	0.11
6.	K2O	0.19
7.	MgO	1.57
8.	M2O2	0.01
9.	CaO	0.2
10.	ZnO	0.01
11.	Pb	625 ppm
12.	Cr	125 ppm
13.	LOI	0.72

2.3 Silica Fume:

Silica fume, also known as micro silica is a non-crystalline polymorph of silicon dioxide, silica. It is an ultrafine powder collected as a by-product of the silicon and ferrosilicon alloy production and consists of spherical particles with an average particle diameter of 150 nm. Silica fume is added to Portland cement concrete to improve its properties, in particular its compressive strength bond strength, and abrasion resistance.
Chemical Composition of Silica fume:

2.4. Aggregates:

Aggregates Locally available natural sand with 4.75 mm maximum size confirming to class II-IS 383 was used as fine aggregate,and crushed stone with 16mm maximum size was used as coarse aggregate.

Table 2.2 :

Property	Fine aggregate	Coarse Aggregate
Specific gravity	2.5	2.85
Fineness modulus	2.8	7

3.MIX DESIGN

The mix design for M20 grade concrete is done as recommended in IS 10262-1982 and according to IS 10262-1982 the following data is required for concrete mix design.

Table3.1. material quantity

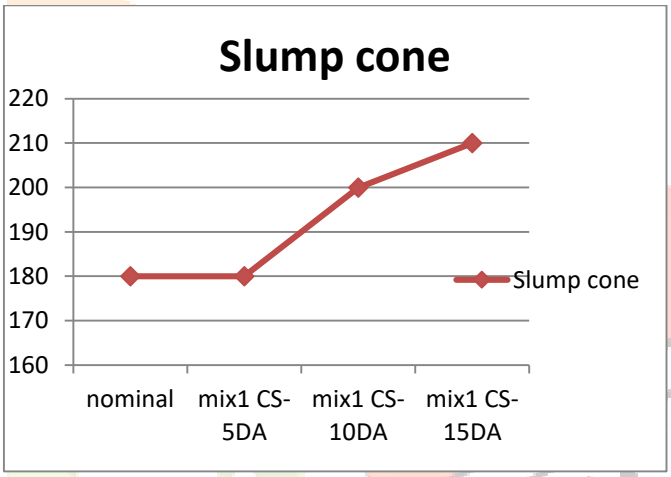
S.No	Material	Quantity
1	Cement	320 kg/m³
2	Quarry dust	754 kg/m³
3	Coarse aggregate	1131 kg/m³
4	Water	176 litres/m³

4. EXPERIMENTAL STUDY:

4.1. Fresh Concrete

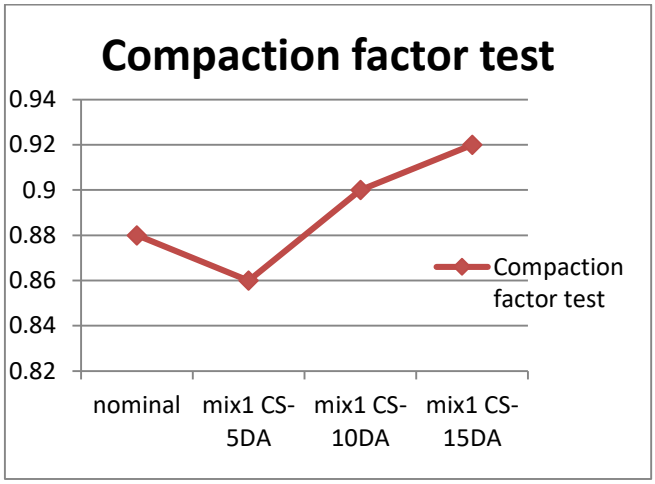
4.1.1 Slump test:

Nominal Mix (mm)	mix1 C5 (mm)	mix2 C10 (mm)	mix3 C15 (mm)
180	180	200	210



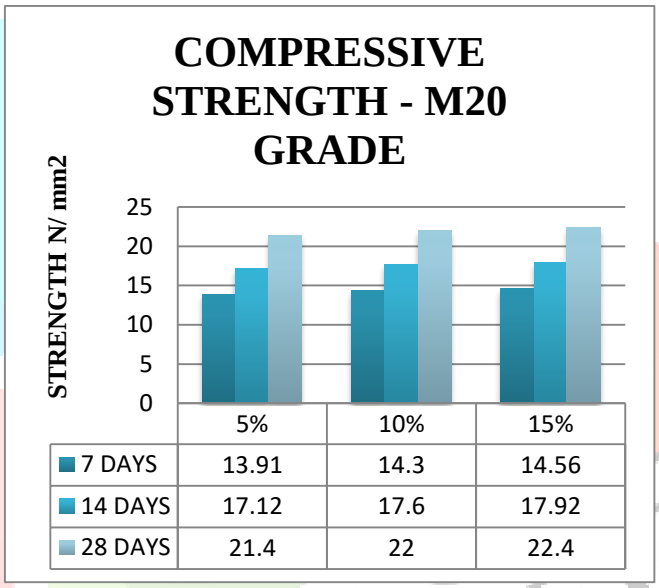
4.1.2 Compaction factor test:

	NORMAL	5%	10%	15%
Mass with partially compacted concrete	11.44	11.52	11.64	11.72
Mass with fully compacted concrete	13.30	13.40	12.93	12.74
Compaction factor value	0.88	0.86	0.90	0.92

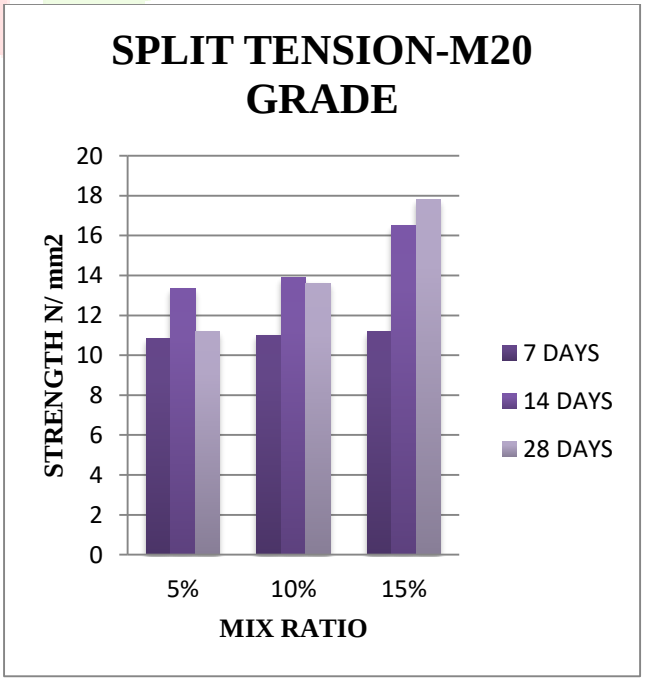


4.2 Hardened concrete:

4.2.1 Compressive strength Test



4.2.2 Split tensile strength test:



5. CONCLUSION:

- It is observed that the compressive strength and split tensile strength of concrete can be improved by partial replacement of Silica fume for cement and complete replacement of Quarry dust for fine aggregate.
- From the above experimental results it is proved that, quarry dust can be used as complete replacement for the natural sand, and the compressive and split tensile strengths are increased.
- The percentage of increase in the compressive strength is 12% and the split tensile strength is 7% at the age of 28 days by replacing natural sand with quarry dust and 15% of cement by silica fume.
- High Performance Concrete with silica fume can be effectively used in high rise buildings since high early strength is required, and the construction period can be reduced.
- The dwindling sources of natural sand and its high cost could encourage the adoption of quarry dust by complete replacement of natural sand.

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