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Experimental Studies on the Effect of Silica Fume and Quarry Dust in Concrete

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Abstract - *Concrete is most widely used construction material today in any structure. Increase in construction activities has lead to an increase in demand for various raw materials in concrete. This led to researches on alternate materials as ingredients of concrete that are in no way inferior to the conventional materials. By partially replacing the normal aggregate with in different proportions, the strength of concrete can be determined. Natural river sand is one of the key ingredients of concrete, is becoming expensive due to excessive cost of transportation from sources. Also large scale depletion of sources creates environmental problems. Unfortunately, production of cement also involves large amount of carbon dioxide gas into the atmosphere, a major contributor for green house effect and the global warming. To overcome these problems there is a need of cost effective, alternative and innovative materials. These materials are stone quarry dust, silica fume, rice husk, recycled waste aggregate etc. some of them are industrial by products and are substantially available. Based on the proportion of ingredients used in concrete, its properties can also be changed. In most of the building works normal weight concrete is used. This project work concentrates on the effective use of Silica Fume and Quarry Dust in concrete mix.*

The main parameter investigated in this study is M20 grade concrete with partial replacement of cement by silica fume by 0, 10 and 15% and Quarry dust by 20, 30 and 40%. This paper presents a detailed experimental study on Compressive strength, split tensile strength and Ultrasonic pulse velocity test. On durability aspect, Water absorption test is studied.

This project presents the laboratory investigations and a comparative study on the feasibility of Silica fume and Quarry dust in determination of strength of concrete.

***Key Words*: Silica fume, Quarry Dust, Concrete, Fine aggregate, Coarse aggregate, Tests on concrete, Mix Design**

1. INTRODUCTION

Concrete is one of the versatile heterogeneous materials, civil engineering has ever known. With the advent of concrete civil engineering has touched highest peak of technology. Concrete is a material with which any shape can be cast and with equal strength or rather more strength than the conventional building stones. It is the material of choice where strength, performance, durability,im-permeability,fire resistance and abrasion resistance are required.

Compressive strength of concrete comes primarily from the hydration of alite and belite in Portland cement to form C-S-H. Alite hydrates rapidly to form C-S-H and is responsible for early strength gain; belite has a slower hydration rate and is responsible for the long term strength improvements

1.1 Scope and Back Ground

In modern concrete technology, adding mineral admixtures to cement is a well-established practice. Mineral admixtures are added to concrete for various purposes.

Silica fume, also known as micro silica is an amorphous (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.

Dosages of the SF used are 0%, 5 % and 10 % of the material total cementitious.

Dosages of the QD used are 20%, 30%, and 40% of the total fine aggregate material.

2. MATERIALS

Basically we use materials like Cement ,Fine aggregate, Coarse aggregate, Water, Concrete, Quarry Dust and silica fume.

Concrete is a construction material composed of Portland cement and water combined with sand, gravel, crushed stone, or other inert material such as expanded slag or vermiculite. The cement and water form a paste which hardens by chemical reaction into a strong, stone-like mass. The inert materials are called aggregates, and for economy no more cement paste is used than is necessary to coat all the aggregate surfaces and fill all the voids.

Cement is a material, generally in powder form, that can be made into a paste usually by the addition of water and, when moulded or poured, will set into a solid mass. Numerous

organic compounds used for adhering, or fastening materials, are called cements, but these are classified as adhesives, and the term cement alone means a construction material. The most widely used of the construction cements is Portland cement.

The American Concrete Institute (ACI) defines silica fume as "very fine non-crystalline silica produced in electric arc furnaces as a by-product of the production of elemental silicon or alloys containing silicon". It is usually a gray colored powder, somewhat similar to Portland cement or some fly ashes.

Quarry Rock Dust can be defined as residue, tailing or other non-voluble waste material after the extraction and processing of rocks to form fine particles less than 4.75mm. Quarry dust is fine rock particles. When boulders are broken into small pieces quarry dust is formed. It is gray in color and it is like fine aggregate. Quarry dusts are produced during the extraction and processing of aggregates

3. RESULTS AND DISCUSSION

Tests were conducted for Compressive strength, Split tensile strength, Ultrasonic Pulse Velocity Test and Water absorption Test on hardened specimens. Standard procedures were adopted for testing.

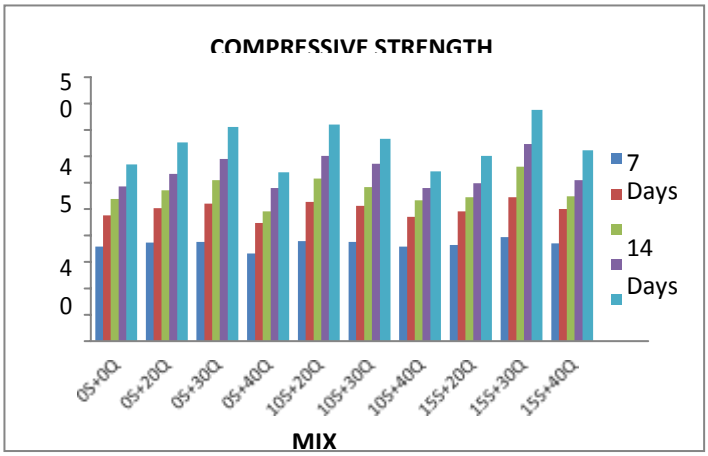
3.1 General Effect of Quarry Dust and Silica Fume:

The basic M20 concrete has given the design strength of 26.96 MPa at 28 days and with 20% Quarry dust the strength has gone up-to 28.59 MPa, 30% Quarry dust the strength has gone up-to30.52 MPa with work and 40% Quarry dust the strength has gone up-to 24.59 MPa. With 10% silica fume and 20% Quarry dust the strength is going up to

30.81 MPa, with 10% silica fume and 30% Quarry dust the strength is going up to 29.18 MPa, with 10% silica fume and 40% Quarry dust the strength is going up to 26.67 MPa, with 15% silica fume and 20% Quarry dust the strength is going up to 27.26 MPa, with 15% silica fume and 30% Quarry dust the strength is going up to 33.04 MPa, with 15% silica fume and 40% Quarry dust the strength is going up to 27.41 MPa.

Compressive strength of cubes for the age of 7, 14, 28, 56 and 90 days

SAMPLE	Compressive Strength (N/mm²)				
	7 Days	14 Days	28 Days	56 Days	90 Days
0S+0Q	17.92	23.85	26.96	29.33	33.48
0S+20Q	18.67	25.18	28.59	31.70	37.63
0S+30Q	18.81	26.07	30.52	34.52	40.59
0S+40Q	16.59	22.37	24.59	29.03	32.00
10S+20Q	18.96	26.37	30.81	35.11	41.04
10S+30Q	18.81	25.62	29.18	33.63	38.37
10S+40Q	17.92	23.56	26.67	29.03	32.15
15S+20Q	18.22	24.59	27.26	29.92	35.11
15S+30Q	19.70	27.26	33.04	37.33	43.85
15S+40Q	18.51	25.04	27.41	30.51	36.15



Compressive Strength of cylinders for 28 days:

The basic M20 concrete has given the design strength of 23.76 MPa at 28 days and with 20% Quarry dust the strength has gone up-to 22.45 MPa, 30% Quarry dust the strength has gone up-to 25.84 MPa with work and 40% Quarry dust the strength has gone up-to 24.90 MPa. With 10% silica fume and 20% Quarry dust the strength is going up to 23.76 MPa, with 10% silica fume and 30% Quarry dust the strength is going up to

MPa, with 10% silica fume and 40% Quarry dust the strength is going up to 26.22 MPa, with 15% silica fume and 20% Quarry dust the strength is going up to 26.78 MPa, with 15% silica fume and 30% Quarry dust the strength is going up to 30.18 MPa, with 15% silica fume and 40% Quarry dust the strength is going up to 25.28 MPa.

S.NO	SAMPLE	CYLINDER NUMBER	WEIGHT OF CUBES (g)	STRENGTH (kN)	AVERAGE STRENGTH (kN)	COMPRESSIVE STRENGTH (N/mm²)
1	0S+0Q	1	12941	410	420.00	23.76
		2	12658	430		
		3	12357	420		
		1	12954	400		

2	0S+20Q	2	12845	400	396.67	22.45
		3	13195	390		
3	0S+30Q	1	12965	460	456.67	25.84
		2	12874	460		
		3	12884	450		
4	0S+40Q	1	12745	450	440.00	24.9
		2	12846	420		
		3	12786	450		
5	10S+20Q	1	12886	410	420.00	23.76
		2	12984	420		
		3	12968	430		
6	10S+30Q	1	12758	440	446.67	25.28
		2	12514	460		
		3	12689	440		
7	10S+40Q	1	13215	470	463.33	26.22
		2	12957	460		
		3	12929	460		
8	15S+20Q	1	12853	470	473.33	26.78
		2	12885	480		
		3	12827	470		
9	15S+30Q	1	12859	540	533.33	30.18
		2	12852	540		
		3	12858	520		
10	15S+40Q	1	12518	450	446.67	25.28
		2	12874	450		
		3	12578	440		

4. CONCLUSIONS

Silica Fume and Quarry Dust are used in production of concrete cubes by replacement levels of 10% and 15% by weight of cement and 20%, 30%and 40% by weight of sand respectively. These cubes were cured and tested for compressive strength for 7 days, 14 days, 28 days, 56 days and 90 days and results were noted. Based on the experimental investigation conducted following conclusions are made.

- Industrial waste materials are used as partial replacement of cement at different levels produced concrete with high strength and acceptable structural grade concrete. Curing conditions adopted in this research produced significant changes in the properties of concretes especially those containing different replacement levels.
- Silica Fume retards the initial setting time and accelerates the final setting time of concrete.
- High volume Silica Fume replacement is not appropriate because of its high water absorption capacity.
- There will be a good reduction in the cost of concrete by the usage of Quarry Dust.
- Strength of concrete of different mixes increases at early ages than later ages.
- By replacement of 15% silica fume with cement and 30% Quarry Dust with sand , we observed that the compressive strength for cubes was increased by 9.93%, 14.30%, 22.55%, 27.28% and 30.97% for 7days,14days,28 days, 56 days and 90 days respectively.
- By replacement of 15% silica fume with cement and 30% Quarry Dust with sand, we observed that the split tensile strength for cylinders attains maximum strength of 3.02 N/mm2 which was increased by 23.26%.
- By replacement of 15% silica fume with cement and 30% Quarry Dust with sand, we observed that the compressive strength for cylinders attains maximum strength of
- By replacement of 15% silica fume with cement and 30% Quarry Dust with sand, we observed that the Ultrasonic pulse velocity strength of cubes indicates the quality of concrete is excellent.

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