Study on High Strength Concrete with Various Pozzolons

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Abstract— The main intention of this experimental study is to study the durability of high strength concrete and to observe the behaviour of the high strength concrete in severe exposure conditions. For this study the high strength concrete of M75 grade concrete has been prepared. In this present work, an attempt is made to achieve compressive strength of 75 N/mm2 by using locally available materials. These attempts are made with various supplementary cementitious materials which make the partial replacement to ordinary Portland cement such as fly ash, silica fume, ground granulated blast furnace slag, quartz powder, metakaoline, to achieve the targeted strength. It also reduces the effect of cement industry on greenhouse gases. The test result shows that the concrete containing about 15% of silica fume and 15% metakaolin shows better results. From the various attempts the compressive strength of 60 N/mm2 was achieved.

Keywords: Compressive Strength, Pozzolons, Coarse Aggregate, Sand

I. INTRODUCTION

Concrete durability has been defined by the American Concrete Institute as its resistance to weathering action, chemical attack, abrasion and other degradation processes. Durability is the ability to last a long time without significant deterioration. A durable material helps the environment by conserving resources and reducing wastes and the environmental impacts of repair and replacement. According to ACI definition, concrete which meets special performance and uniformity requirements that cannot always be achieved routinely by using only conventional materials. Use of chemical admixtures reduces the water content, thereby reducing the porosity within the hydrated cement paste. Mineral admixtures, also called as cement replacement materials, act as pozzolanic materials as well as fine fillers, thereby the microstructure of hardened cement matrix becomes denser and stronger. High strength concrete has been widely used in civil engineering in recent years. This is because most of the rheological, mechanical, and durability properties of these materials are better than those of conventional concretes. A definition of high strength concrete in quantitative term, as per ACI code, high strength concrete is usually considered to be a concrete with a 28-day compressive strength of at least 42 N/mm2. Production of HSC may or may not require special materials, but it definitely requires materials of highest quality and their optimum proportion. To protect the environment from being polluted by carbon dioxide released by cement industries and to meet the rising demand in the world economically without affecting the strength characteristics of concrete, mineral admixtures are used as supplementary cementing materials. The pozzolons are improved the mechanical and durability characteristic of both normal and High strength concrete. HSC contains large amount of cement it will result of high amount of heat of hydration, shrinkage and microcracks etc. at fresh state.

II. MATERIAL PROPERTIES

Pycnometer	Trial 1 (g)	Trial 2 (g)	Trial 3 (g)
Empty weight of bottle (W1)	670	670	670
Weight of bottle+sand (W2)	1170	1174	1170
Weight of bottle +sand+water (W3)	1858	1860	1852
Weight of bottle+water (W4)	1168	1158	1160
Specific gravity	2.63	2.54	2.60

Table 1: Specific Gravity of Sand

Property	Value
Specific gravity of sand	2.59
Water absorption	1.4%
Dry rodded unit weight	1760 kg/m3
Void content of sand	35.5%
Fineness modulus	3.12

Table 2: Physical Properties of Sand

Pycnometer	Trial 1 (g)	Trial 2 (g)	Trial 3 (g)
Empty weight of bottle (W1)	670	670	670
Weight of bottle+sand (W2)	1148	1120	1043
Weight of bottle +sand+water (W3)	1856	1840	1789
Weight of bottle+water (W4)	1547	1547	1547
Specific gravity	2.82	3	3

Table 3: Specific Gravity of Coarse Aggregate

constituents	Cement (%)	Fly (%) ash	GGBS (%)	Silica (%)	Fume	Metakaolin (%)
Cao	60 -67	15-40	37.34	0.5		0.20
Sio 2	17 -25	15-45	37.73	90.26		51-53
Al 2 O 3	3 -8	20-25	14.42	5.84		42-44
Fe 2 O 3	0.5-6	4 -15	1.11	1.11		2.20
MgO	0.1-4		8.71	0.3		0.10
So 3	1-3			-		
K 2 O	0.5 -1.3			0.7		0.40

Loss ignition	on				2.20		0.5

Table 4: Chemical Composition of Binders

Fig. 1: Materials for concrete

Fig. 2: Concrete mix

Fig. 3: Concrete filled moulds

III. TEST RESULTS

Cubes	Density (kN/m3)	Compressive strength(N/mm2)	Average Compressive Strength (N/mm2)
1	24.5	24.45	
2	24	20.7	22.95
3	24.5	23.4	

Table 5: Test Results of Control Mix Concrete

Mix	Cement	Fly ash	GGBS	Silica fume	Meta kaoline	Q.Powder	Fine Agg	Coarse Agg
1	561	99	-	-	-	-	565	1138
2	462	-	198	-	-	-	565	1138
3	561	-	-	99	-	-	565	1138
4	561	-	-	-	99	-	565	1138
5	462	-	99	99	-	-	565	1138
6	462	-	-	99	-	99	565	1138
7	462	-	-	99	99	-	565	1138

Table 6: Overview of Mix Proportion

IV. RESULT

Mixes	Average Compressive Strength (N/mm2)	Average compressive Strength (N/mm2)
Control Mix	22.95	44.8
Mix 1	23.66	48.4
Mix 2	25.46	51.2
Mix 3	30.5	56.5
Mix 4	29.13	53.2
Mix 5	26.56	49.45
Mix 6	21.93	43
Mix 7	30.86	60.40

Table 7: Overview of Test Results

A. Results Comparison:

The test results are shows the compressive strength of 22.95 – 30.86 N/mm2 at 7 days, and the compressive strength of 44.4 – 60.6 N/mm2. The compressive strength of various concrete mixes were tabulated and graphically represented in the below charts.

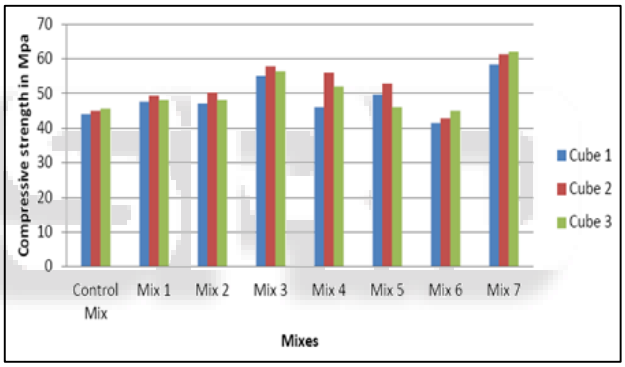

Fig. 4: 28 Days Compressive Strength of Different Mixes

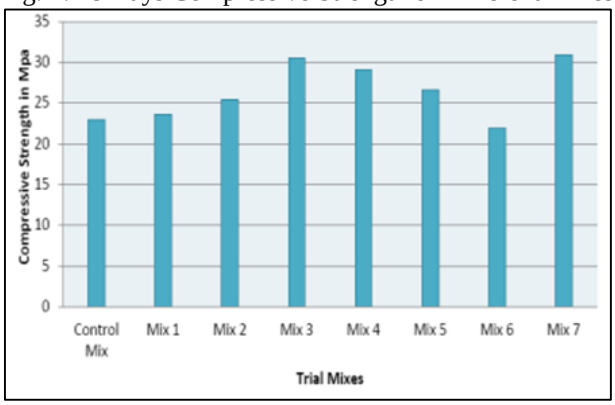

Fig. 5: Average Compressive Strength of Different Mixes

Mixes	% of Strength improvement	
Mix 1	3.09	8.03
Mix 2	11	14.2
Mix 3	32.89	26.11
Mix 4	27	18.75
Mix 5	16	10.3
Mix 6	-4.44	-4.01
Mix 7	34.46	34.82

Table 8: Strength Improvement

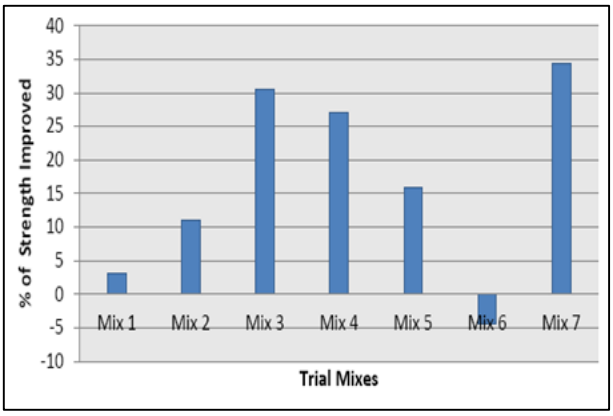

Fig. 5: Strength Improvement

V. Conclusion

Based on the results of this study, it can be concluded that mix contains silica fume can improve the strength of concrete more than other pozzolons. Considerably, a higher compressive strength was achieved at 15% admixing level of silica fume by weight of cement. The increase in strength can be attributed to the improved aggregate-matrix bond resulting from the formation of a less porous transition zone in the silica fume concrete. From the different mixes, the mix contains silica fume produce better result compared to the other pozzolons. In this present work the compressive strength of 50 N/mm2was targeted at 7 days, but the test results shows the unsatisfactory result of 33.4 N/mm2at 7 days. Hence the experimental works will continue to achieve the target strength.

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