Indian J.Sci.Res. 17(2): 228 - 232, 2018
ISSN: 0976-2876 (Print)
ISSN: 2250-0138(Online)

INFLUENCE OF MINERAL ADMIXTURES ON STRENGTH AND DURABILITY PROPERTIES OF CONCRETE

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Abstract-This paper describes about an experimental investigation was conducted to study the strength and durability properties of concrete with and without mineral admixtures. The conventional concrete has several drawbacks like very low tensile strength, lack of durability, etc. These drawbacks may be overcome by introducing mineral admixtures. The scope of the project is to improve the strength and durability properties of concrete by the way of including mineral admixtures in the concrete at the different level of replacement of cement. About 30% of cement and sand is replaced by the combination of admixtures. For the admixture with higher fineness it is replaced with sand. Super plasticizer is used at 0.2% by weight of cement in order to improve the properties of fresh concrete. Strength and durability characteristics have been carried out for both the control concrete as well as blended concrete.

Keywords - Strength, durability, fly ash, silica fume

I. Introduction

Concrete is an artificial material, which has wider application in construction industry. The basic ingredients of concrete are

- Cement
- Sand
- Coarse aggregate
- Water

Now a days concrete is being used for wide varieties of purpose to make it suitable in different conditions. In these conditions ordinary concrete may fail exhibit the required quality performance or durability. In such cases, admixture is used to modify the properties of concrete so as to make it more suitable for any situation. Since the cost of cement and sand have increased due to increased cost of production and or increased demand, there is an urgent need to replace them partially or wholly by cheaper material.

Admixture is defined as a material, other than cement, water, aggregates, that is used as an ingredient of concrete and is added to the batch immediately before or during mixing. It will be slightly difficult to predict the effect and the results of using admixtures because the change in the brand of cement, aggregate grading, mix proportions and richness of mix alter the properties of concrete. At times, they affect the desirable properties adversely. Sometimes more than one admixture is used is used in the same mix. Admixtures can be used to improve the concrete properties either in the handling process or consolidation of fresh concrete, in the performance of concrete both in fresh and hardened stages and even for economy in the cost of construction. Almost every property of concrete can be modified to some extent. However the effectiveness of an admixture in a concrete mix depends on type and amount of cement, temperature of concrete, etc.

A. Role of Admixtures

It has been demonstrated that the best pozzolans in optimum proportion mixed with Portland cement improves many qualities of concrete, such as

- Improvement in workability
- Lower the heat of hydration and thermal shrinkage
- Increase the water tightness
- Reduce the alkali aggregate reaction
- Improve resistance to attack by sulphate soils and sea water
- Reduction in bleeding and segregation
- Increased impermeability
- Increase in setting time
- Improved strength at lower cost
- Decrease in capillary flow of water
- Prevention of shrinkage
- Increase in bond between steel reinforcement and concrete.

The siliceous or aluminous compound in a finely divided form react with the calcium hydroxide to form highly stable cementitious substances of complex composition involving water, calcium and silica. Generally, amorphous silicate reacts much more rapidly than the crystalline form. It is pointed out that calcium hydroxide; otherwise, a water soluble material is converted into soluble cementation material by the reaction of pozzolanic material.

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The reaction can be shown as

Pozzolans + Calcium Hydroxide +Water --> C-S-H(Gel)

This reaction is called pozzolanic reactor. The characteristic feature of pozzolanic reaction is firstly slow, with the result that the heat of hydration and strength development will be accordingly slow. The reaction involves the consumption of $Ca(OH)_2$. The reduction of $Ca(OH)_2$ improves the durability of cement paste by making the paste dense and impervious . Mineral admixtures are in organic material both natural and industrial by products that are added in small quantities in cements. Such additives may be blended or inter grounded with OPC or added directly to concrete before or during mixing. It has been observed that incorporation of certain mineral additives such as Ground Granulated Blast Furnace Slag (GGBS), Fly Ash (FA) , Rice Husk Ash(RHA) and Silica Fume(SF) can have beneficial impact on quality of cement . By adding such admixtures , the performance characteristics like workability, water tightness, mechanical properties and resistance under aggressive environment have shown much improvement.

B. Type of Admixtures:

- Mineral admixtures
- Chemical admixtures

II. Scope

The conventional concrete has several drawbacks like very low tensile strength, lack of durability, etc. These drawbacks may be overcome by introducing mineral admixtures. The scope of the project is to improve the strength and durability properties of concrete by the way of including mineral admixtures in the concrete at the different level of replacement of cement. Super plasticizer is used at 0.2% by weight of cement in order to improve the properties of fresh concrete. Strength and durability characteristics have been carried out for both the control concrete as well as blended concrete.

III. Objectives

- To select the suitable admixtures to improve the strength and durability characteristics.
- To find out the optimum percentage of replacement of cement by mineral admixtures.
- To design the concrete mix for M30 concrete with various proportions of mineral admixtures.
- To cast the concrete specimens like cubes, cylinders and prism etc. and to study the mechanical properties of concrete.
- To compare the results obtained from the various tests with reference to strength and durability characteristics of concrete.

IV. Experimental Study

A. General:

Concrete is an artificial material, which is made up of cement, fine aggregate, coarse aggregate and water. In this project, an attempt has been made to replace the part of cement by Ground Granulated Blast Furnace Slag (GGBS), Fly Ash (FA), Limestone powder (LP) and Silica Fume (SF) to improve some of the properties of concrete.

B. Compressive Strength of Cubes:

The compressive strength of concrete cube was found for the control concrete and the admixture concrete with single, binary

Blended ternary blended and multi-blended mineral admixture as a replacement of cement. Table 1 shows the compressive strength of cubes with and without admixture.

Table 1 Compressive Strength of Cylinder

NO	MIX	7 Days N/Mm^2	14 Days N/Mm^2	28 Days N/Mm^2
1	M30	27.35	31.31	35.97
2	FA20%+SF10%	30.14	38.79	44.42
3	FA20%+GGBS10%	28.11	33.14	37.32
4	SF 20%+GGBS 10%	16.25	21.33	28.31
5	FA 20%+LP 10%	22.12	28.56	33.34

6	SF 20%+LP 10%	31.93	33.48	38.57

C. Split Tensile Strength of Cylinder:

The split tensile strength of concrete cylinder was found for the control concrete and the admixture concrete with binary blended mineral admixture as a replacement of cement. Table 2 shows the split tensile strength of cylinder specimen of control concrete and binary blended concrete with combination of SF 20% + LP 10% and FA 20% + SF 10%.

Table 2 Split Tensile Strength of Cylinder

S.No	MIX	SPLIT TENSILE STRENGTH (N/mm^2)	
		7 days	28 days
1	M30	2.54	2.98
2	SL	2.65	3.05
3	FS	2.76	3.14

D. Flexural Strength of Prism:

The flexural strength of concrete prism was found for the control concrete and the admixture concrete with binary blended mineral admixture of combination of SF20%+LP10% and FA20%+SF10% as a replacement of cement. Table 3 shows the flexural strength of prism specimen of control concrete and binary blended concrete.

Table 3 Flexural Strength of Prism

S.No	MIX	FLEXURAL STRENGTH (N/mm^2)	
		7 days	28 days
1	M30	4.02	4.38
2	SL	4.65	5.76
3	FS	5.39	6.4

Load Deflection Behaviour of Beam:

The load deflection behavior of concrete beam was found for the control concrete and the admixture concrete with binary blended mineral admixture as a replacement of cement. Table 5.12, 5.13 and 5.14 shows the load deflection behavior of concrete beam specimen of control concrete and binary blended concrete with combination of FA20%+SF10%.

Table 4.1 Deflection Test on Beam

S.No	**LOAD(kN)**	**DEFLECTION of M30 (mm)**
1	0	0
2	10	0.60
3	20	1.10
4	30	1.65
5	40	2.20
6	50	2.60
7	60	3.40
8	69	3.90

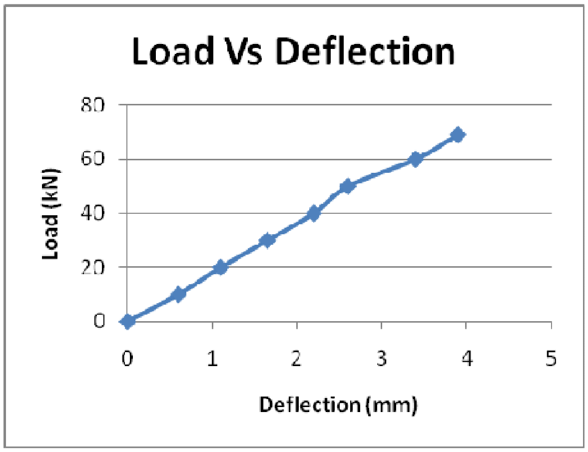
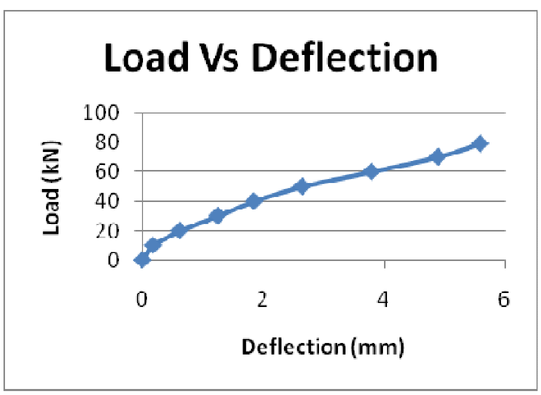


Table 5.14 Load Deflection Behavior of Beam

S.No	Load(Kn)	Deflection (Mm)
		FS
1	0	0
2	10	0.18
3	20	0.62
4	30	1.25
5	40	1.85
6	50	2.65
7	60	3.80
8	70	4.90
9	79	5.60

Table 4.2 Deflection Test on Beam



V. Durability Properties Of Concrete:

A. Results of Water Absorpton Test:

Table 5.1 shows the water absorption test results of average % water absorption of concrete cube specimen of control concrete and binary blended concrete with combination of FA20%+SF10%.

Table 5.1 Average % Water Absorption

S.No	MIX	Average % Water Absorption
1	M30	3.38
2	FS	1.50

B. Results of Acid Attack Test:

Table 5.2 and 5.3 shows the acid attack test results of average % loss in weight and % loss in strength of concrete cube specimen of control concrete and binary blended concrete with combination of FA20%+RHA10% and FA20%+SF10% when immersed in H_2SO_4 solution and HCl solution.

Table 5.3 Average % Loss in Weight of Acid Attack Test

S.No	MIX	Average % Loss In Weight (%)	
		H_2SO_4 solution	HCl solution
1	M30	3.38	3.38
2	FS	2.84	2.66

VI. Conclusion

1. Compressive strength results of binary blended admixture concrete shows 13% higher than the control concrete.
2. Split tensile strength of binary blended concrete increases by 7% and flexural strength of binary blended increases by 4.62% than the ordinary control concrete.
3. The combination of GGBS and silica fume, Fly ash and Limestone powder shows lower result than the control concrete due to inherent chemical reactions.

4. The compressive strength of binary blended ,tri blended and quaternary blended concrete with the combination of GGBS and silica fume, Fly ash and Limestone powder shows very low result than the control concrete.
5. In general, it is concluded that the combination of different admixtures (multi-blended) improves the strength and durability properties of concrete.

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