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Effect of Ultra-fine Flyash and Ultra-fine GGBS on the Workability and Compressive Strength of concrete

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Abstract- Concrete with binary and ternary blends of Portland cement, flyash, ultrafine flyash, and ultrafine ground granulated blast furnace were produced to investigate their effects on compressive strength and workability of concrete. Portland cement was partially replaced by ultrafine flyash and ultrafine ground granulated blast furnace. Concrete with water/binder ratio 0.35 were produced and Portland cement was replaced by:-(i) 4%,5%,6% and 7% ultrafine flyash; (ii) 4%,5%,6% and 7% ultrafine ground granulated blast furnace; and (iii) 2%,2.5%,3%,3.5% ultrafine flyash 2%,2.5%,3%,3.5% ultrafine ground granulated blast furnace.

Keyword-Ultrafine Flyash, Ultrafine GGBS, Sustainable Development, Ternary Blended, High workability retain concrete

I. INTRODUCTION

Concrete presently is most widely used construction material in the world. Concrete produced should be strong enough to carry design load and durable enough so that structures constructed live for its design life.

As per U.S Geological survey report world cement production was 3400 million tons in year 2011. It is expected that cement requirement will grow three fold to 3.2 billion tones by year 2015. [1] The cement production is an expensive process and it also emits carbon dioxide (CO_2). The researchers have estimated that for production of 1 ton of cement, nearly 1.5 tones of earth minerals are consumed and 1 ton of CO_2 is emitted in the atmosphere due to burning of fuel and calcinations of limestone. [2]

Construction is a major economic activity. In India, it accounts for over 6% of Gross Domestic Product (GDP). A construction project has to deal with environmental aspects. The threat of global warming is real. According to a report by Environmental Protection Agency (EPA) of the U.S.A. Greenhouse gases are accumulating in the earth's atmosphere as a result of human activities, causing global mean surface temperatures and sub-surface ocean temperatures to rise. The challenge for the civil engineering community in the near future will be to realize projects in harmony with the concept of sustainable development.[5]

The cost of construction increasing rapidly, today the industry demands that the concrete used for building structures should not only have high strength but also have high durability and the structure has a relatively higher service life compared to previously built structures.

The efficient methods to conserve the Mother Nature's resources and reduce the environmental impact is to use Supplementary Cementitious Materials (SCMs) by replacing OPC in concrete because most of SCMs are pozzolanic in nature and hence they are helpful in increasing later strength of concrete. Blending of SCMs with cement has many advantages such as saving in cement, recycling of waste products, increase in physical properties of concrete and reduce

environmental impact through reduce green house gases production. So blending them in concrete becomes safe disposal method for them. Some SCMs are Fly ash, Ground Granulated Blast furnace Slag (GGBS), Micro Silica (Silica Fume) Metakaolin Rice Husk Ash (RHA) etc [3].

Fly ash improves the performance and quality of concrete. Fly ash affects the plastic properties of concrete by improve workability; reduce water demand and reducing heat of hydration. Due to spherical shape of particles, it can also increase workability of cement while reducing water demand. Fly ash possesses very less to no cementitious properties, but in presence of moisture it reacts with calcium hydroxide to form Calcium silicate hydrate (CSH) which adds to the strength.[4]

Ultrafine Slag is a new generation, ultrafine, low calcium silicate product, manufactured in India. It has distinct characteristics to enhance 'performance of concrete' in fresh and hardened stages. It can be considered and used as practical substitute for Silica Fume (Micro Silica) as per the results obtained. If the advantages of Ultrafine Slag are observed in the concrete mix design, the initial rate of strength development was found to be increased or similar as that of Silica Fume.

Pozzocrete 100 is a very high efficiency pozzolanic material for use as a component of cement with Portland clinker (i.e. as a partial replacement of Portland cement) to yield high performance concrete. It is produced by careful selection, processing and testing of fly ash resulting from the combustion of coal used at electricity generating power stations. It is a top of the range product in terms of all the International Standard specifications for fly ash and is subjected to stringent quality control.

Keeping all these things in view, an attempt has been made in the present paper to study of properties namely workability and compressive strength of M30 grade using ternary blends incorporating Cement, Fly Ash, Ultrafine flyash and Ultrafine Slag along with napta based super plasticizer.

II. EXPERIMENTAL PROGRAM

Experiments were carried out by varying ultrafine flyash and Ultrafine Slag. The tests carried out are slump cone test and compression test. The percentage of ultrafine flyash and ultrafine ground granular blast slag furnace replaced with Portland cement by volume are as given below in table:-

Table 1. Trail mix by varying ultrafine flyash & ultrafine GGBS

Mix Name	Ultrafine- GGBS %	Ultrafine- flyash %
H1	0	0
H2	4	0
H3	0	4
H4	2	2
H5	5	0
H6	0	5
H7	2.5	2.5
H8	6	0
H9	0	6
H10	3	3
H11	7	0
H12	0	7
H13	3.5	3.5

The proportions of amount of ingredients used in each trail mix are as follows.

Table 2. Proportion of amount of ingredients for each trail mix

Mix No	Cement (kg/m^3)	Flyash (kg/m^3)	Alcofine (kg/m^3)	P100 (kg/m^3)	Crush Sand (kg/m^3)	C.A I (kg/m^3)	C.A II (kg/m^3)	Water (kg/m^3)	S.P %
H1	383	97	0	0	845	323	627	168	1.2
H2	362	97	19	0	846	324	627	167	1.2
H3	362	97	0	14	848	324	629	166	1.2
H4	362	97	10	7	847	324	628	165	1.2
H5	357	97	24	0	846	324	627	167	1.2
H6	357	97	0	18	849	325	629	165	1.2
H7	357	97	12	9	848	324	628	166	1.2
H8	351	97	29	0	847	324	628	167	1.2
H9	351	97	0	22	850	325	630	165	1.2
H10	351	97	14	11	848	324	629	166	1.2
H11	346	97	33	0	847	324	628	167	1.2
H12	346	97	0	25	851	325	630	164	1.2
H13	346	97	17	13	849	325	629	165	1.2

SP: - Super Plasticizer

III. EXPERIMENTAL RESULT AND DISCUSSION

3.1.Workability test

Workability test was carried out by the slum cone test. Workability of the mix was tested initially (immediately after preparing the mix) then after an interval of 30mins. (i.e. 30mins, 60mins, 90mins, & 120mins).

Table 3. Workability value obtain through slum cone test

	Workability (mm)				
Mix No	Initial	30mins	60mins	90mins	120mins
H1	220	215	200	195	160
H2	215	200	190	170	120
H3	225	210	205	200	175
H4	220	210	205	200	155
H5	225	205	185	175	160
H6	220	210	195	155	120
H7	230	215	205	200	130
H8	220	195	140	135	105
H9	210	190	165	125	115
H10	220	190	170	145	130
H11	215	200	185	165	145
H12	215	195	190	180	155
H13	210	190	180	170	120

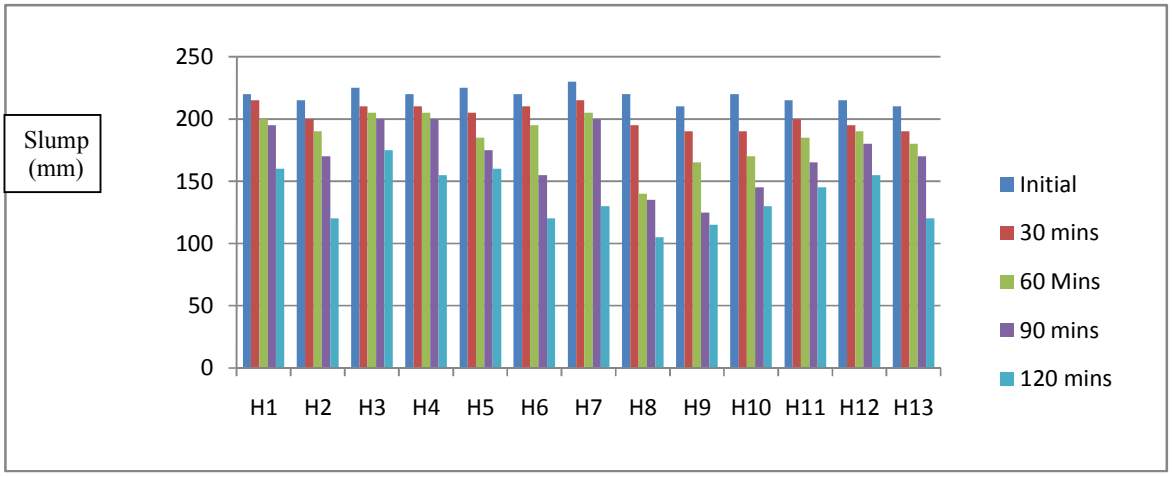

Fig 1. Slump of each trail mix

3.2.Compression test

Compression test is done on 3days, 7days and 28 Days. Concrete is design for M30.

Table. 4 compression Test result

Compression Strength (N/mm^2)			
Mix No	3 days	7 days	28 days
H1	16.74	25.7	43.16
H2	15.96	22.88	39.7
H3	16.4	25.02	40.57
H4	16.78	23.72	40.76
H5	16.48	23.87	35.36
H6	15.02	23.23	36.15
H7	15.87	23.27	38.47
H8	16.91	23.03	38.73
H9	13.29	20.81	35.79
H10	13.79	19.88	35.03
H11	15.8	26.17	38.72
H12	11.17	17.37	34.59
H13	15.23	24.54	33.32

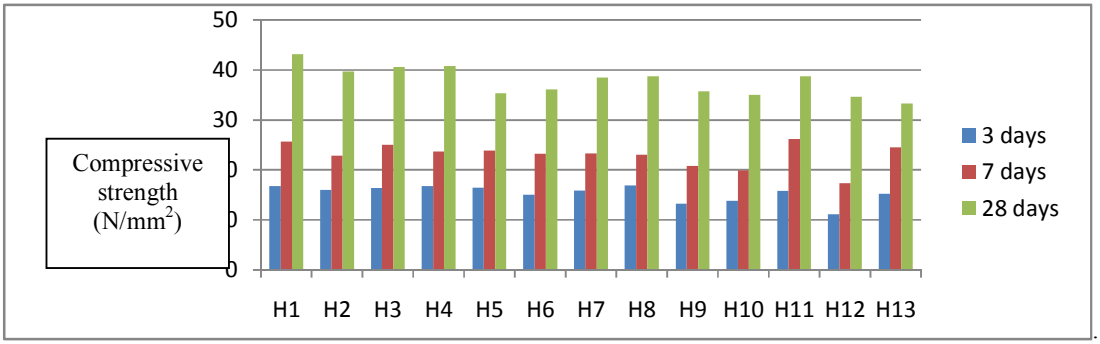

Fig 2 Compressive Strength of various trail mix

IV. CONCLUSION

Workability: - The trail mix H7 has a highest workability in initial stage i.e. 230mm but after 120mins it suddenly dropped to 130mm.H7 mix has 2.5% of ultrafine fly ash and 2.5% of ultrafine GGBS. But if we observe H5 mix, it has initial slum 225 mm. Then slum gradually reduced to 205mm after 30mins. Later on slum was reduced to 185 mm, 175mm and160mm after 60mins, 90mins and 120mins respectively. It is one of the highest slum retention among all mixes after 120mins.Reduction of slum is gradual and sudden drop of slum is not observed in the mix. This H5 trail mix has 5% of ultrafine GGBS.

Compression strength:-Target compression strength of 30N/mm^2 was achieved for all the mix after 28days. For H4 mix where 2% ultrafine GGBS and 2% ultrafine flyash was used, the compression strength is highest after 28days as compared to other combination of ultrafine GGBS and ultrafine flyash.

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