Mechanical characteristics of Hardened concrete with mineral admixtures Silica fume and fly ash

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Abstract - In the present day construction practice where large quantities of concrete are being poured daily, accelerated curing techniques are quite popular to predicting the 28 days strength within a short time. The accelerated strength procedure given by the IS Code are being adopted in the case of normal concrete without admixtures. In the present experimental investigation silica fume admixture& fly ash has been employed as a replacement at various percentages, Like 0, 14,28,42,56 for M20 are considered and the 7,28 day strengths are predicted using the codal procedure and the co-relation formula. The co-efficient of variation is useful in the strength prediction of silica fume concrete mixes are considered. The investigation has high practical importance and use.

Literature Review

Balendran, et al(2001) demonstrated the effect of quick and slow cooling on residual compressive strengthsof various high strength concrete grades (60, 90, 110, 130 MPa) cured for 28 days with an optimum dosage ofmicro silica as 10% of cementations material, 10 mm maximum size of coarse aggregate and water binder ratio ranging from 0.5 to 0.24.

Belaoura Mebarek, et al (2013) explained the use of super plasticizers, and ultrafine particles such as silicafume, has significantly minimized the amount of mixing water in concrete while improving workability.Owning to this water reduction (and thus the w/c ratio), the mechanical strength of such concretes hasconsiderably increased. The compressive strength may exceed 80 MPa. Therefore, their use is very promisingfrom an economic point of view and quality of civil engineering an hydraulics works.

Borys and Patrick (2004) completed a study on several ultra-fines used to produce very high performance concrete and ultra-high performance concrete. The ultrafine powders used were met kaolin (MK), pulverized fly ash (PFA), limestone micro filler (LM), siliceous micro filer (SM) and micronized phonolith (PF). Despite
a significant higher dosage of super plasticizer in comparison of those with silica fume, the UHPC with metkaolin shows poor workability with a slump of 17 cm. the fluidity of met kaolin blended cement become poorer than that of Portland cement at the same dosage of super plasticizer and the same w/c ratio. The UHPCwith pulverized fly ash required significant higher water content. All the compressive strength of UHPC was above 150 MPa at the age of 28 days except for those with pulverized fly ash.

Dilip Kumar Singha Roy (2012) has investigated on the strength parameters of concrete made with partial replacement of cement by SF.

Duval and Kadri (2000) results show that partial cement replacement up to 10% silica fume does not reduce the concrete workability. Moreover, the super plasticizer dosage depends on the cement characteristics. Atlow water-cementitious materials ratios, slump loss with time is observed and increased with highreplacement levels. Silica fume at replacement contents up to 20% produce higher compressive strength thancontrol concretes; nevertheless, the strength gain is less than 15%. Models to evaluate the compressive strength.

OBJECTIVE OF THE STUDY: Objectives of the study. The main objective of this study is to determine the suitable percentage of fly ash, and silica fume in CC that gives the highest value of concrete compressive strength. As well as studying the influence of different curing conditions

Fly ash is one of the residues generated in the combustion of coal. Fly ash is generally captured from the chimneys of coal-fired power plants, and is one of two types of ash that jointly are known as coal ash; the other, bottom ash, is removed from the bottom of coal furnaces. Depending upon the source and makeup of the coal being burned, the components of fly ash vary considerably, but all fly ash includes substantial amounts of silicon dioxide (SiO_2) (both amorphous and crystalline) and calcium oxide (CaO). Fly ash is classified as Class F and Class C types. The replacement of Portland cement with fly ash is considered to reduce the greenhouse gas "footprint" of concrete, as the production of one ton of Portland cement produces approximately one ton of CO_2 as compared to zero CO_2 being produced using existing fly ash. New fly ash production, i.e., the burning of coal, produces approximately twenty to thirty tons of CO_2 per ton of fly ash. Since the worldwide production of Portland cement is expected to reach nearly 2 billion tons by 2010, replacement of any large portion of this cement by fly ash could significantly reduce carbon emissions associated with construction

Silica fume is a byproduct in the reduction of high-purity quartz with coke in electric arc furnaces in the production of silicon and ferrosilicon alloys. Silica fume consists of fine particles with a surface area on the order of 215,280 ft^2/lb (20,000 m^2/kg) when measured by nitrogen adsorption techniques, with particles approximately one hundredth the size of the average cement Because of its extreme fineness and high silica content, silica fume is a very effective pozzolanic material particle

Silica fume is added to Portland cement concrete to improve its properties, in particular its compressive strength, bond strength, and abrasion resistance. These improvements stems from both the mechanical improvements resulting from addition of a very fine powder to the cement paste mix as well as from the pozzolanic reactions between the silica fume and free calcium hydroxide in the paste

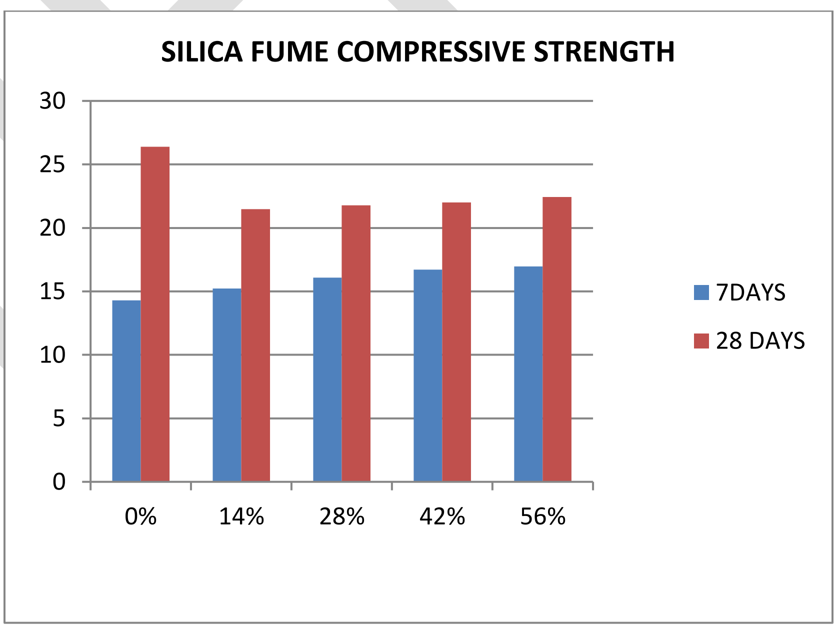
Silica fume	ASTM-C-1240	Actual Analysis
SiO2	85% min	84.7%
LOI	6% max	2.2%
Moisture	3%	0.8%
Pozz Activity Index	105% min	134%
Sp Surface Area	>15 m2/gm	22 m2/gm
Bulk Density	550 to 700	556

TEST RESULTS:

COMPRESSIVE STRENGTH RESULTS

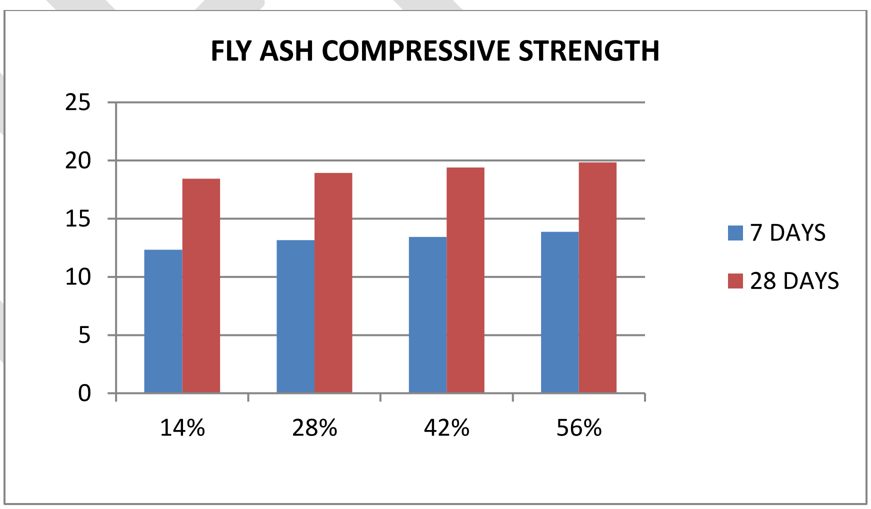
CSA REPLACMENT (0 TO 56 %)

Mix type	Trail	Peak Load (kN)		Compressive Strength (Mpa)		Avg Compressive Strength (Mpa)	
		7 days	28 days	7 days	28 days	7days	28 days
M (0%)	1	773.2	821	14.31	26.8	**14.3**	**26.4**
	2	697.2	880.2	14.23	26.3		
	3	738.6	613.9	14.56	26.2		
M-1(14)	1	778.4	826.3	15.26	21.40	**15.23**	**21.48**
	2	773	842.1	15.20	21.52		
	3	768	808	15.23	21.53		
M-2 (28)	1	830.2	647.7	16.12	21.75	**16.08**	**21.77**
	2	788.9	714.9	16.00	21.73		
	3	433.7	862.9	16.12	21.83		
M-3(42)	1	620.1	601	16.56	21.92	**16.7**	**22.00**
	2	447.4	792	16.73	22.00		
	3	753.2	922	16.83	22.31		
M-4(56)	1	578	863.5	16.92	22.36	**16.96**	**22.43**
	2	597.1	902.2	16.98	22.45		
	3	721.3	913.2	16.98	22.48		



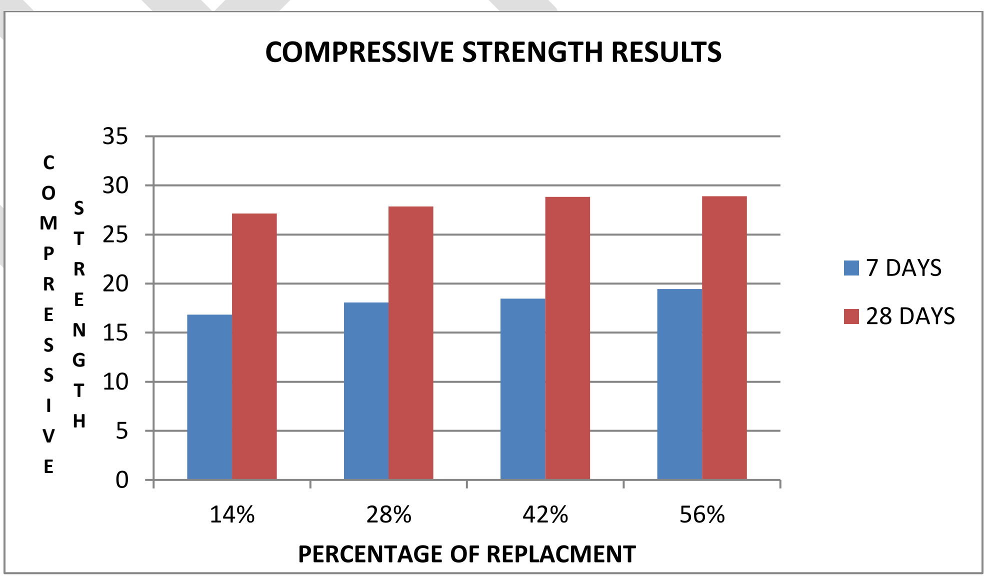
FLY ASH REPLACEMENT (0 TO 56%)

CUBE ID	TRAIL	PEAK LOAD(7 DAYS)	PEAK LOAD (28 DAYS)	COMPRSSIVE STRENGTH(7 DAYS & 28 DAYS)		AVERAGE COMPRESSIVE STRENGTH	
M-5 (14%)	1	613.3	921	12.23	18.48	12.34	18.44
	2	476.5	922	12.48	18.42		
	3	713.6	770.9	12.32	18.43		
M-6 (28%)	1	764.8	768.4	13.12	18.96	13.17	18.92
	2	539.8	713.7	13.25	18.91		
	3	455	918.2	13.15	18.90		
M-7 (42%)	1	918.1	808.4	13.45	19.56	13.44	19.4
	2	715.6	917.3	13.48	19.56		
	3	741.6	917.9	13.39	19.28		
M-8 (56%)	1	646.4	917.6	13.83	19.83	13.86	19.83
	2	718.2	757.8	13.89	19.82		
	3	743.6	718.1	13.86	19.84		



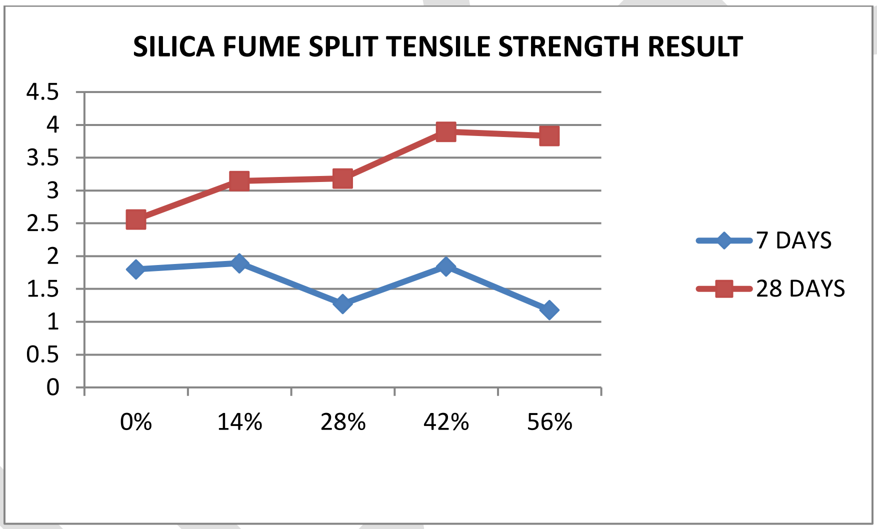
CSA & FLY ASH REPLACEMENTS RESULTS

CUBE-ID	TRAIL	PEAK LOAD(7 DAY)	PEAK LOAD(28 DAY)	CS. (7 DAY)	CS .28 DAY)	AVG.CS(7 DAY)	AVG .CS(28 DAY)
M-9 (14%)	1	710.2	720.3	16.79	27.38	**16.82**	**27.13**
	2	711.2	728.9	16.83	27.01		
	3	712.8	728.6	16.84	27.00		
M-10 (28%)	1	694.06	740.8	17.86	27.86	**18.08**	**27.86**
	2	698.8	740.3	17.89	27.83		
	3	712.6	752.4	17.89	27.89		
M-11 (42%)	1	750.3	780.36	18.46	28.83	**18.45**	**28.82**
	2	754.2	790.62	18.42	28.82		
	3	758.3	788.36	18.49	28.83		
M-12 (56%)	1	798	800.1	19.47	28.91	**19.45**	**28.91**
	2	792.3	810.23	19.42	28.91		
	3	798.12	810.58	19.48	28.91		



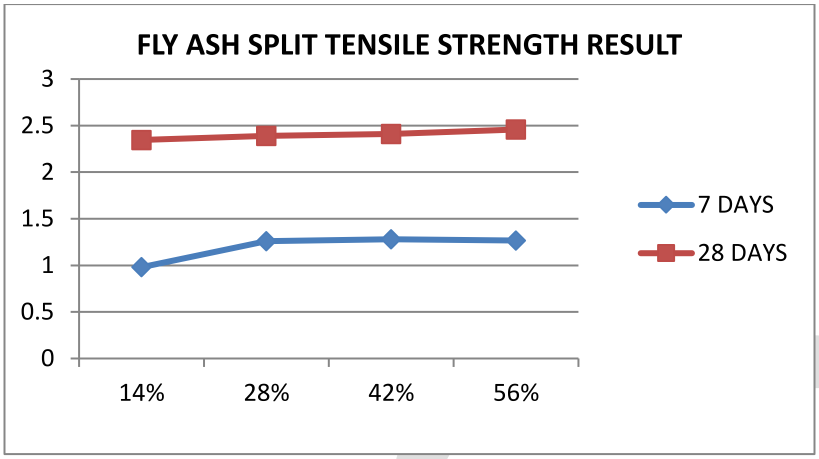
SPLIT TESNILE STRENGTH: CONDENSED SILICA FUME

MIX TYPE	% Of CONDENSED SF	7 DAYS	28 DAYS
M-0	**0**	**1.8**	**2.56**
M-1	**14**	**1.893**	**3.145**
M-2	**28**	**1.274**	**3.185**
M-3	**42**	**1.843**	**3.896**
M-4	**56**	**1.179**	**3.893**

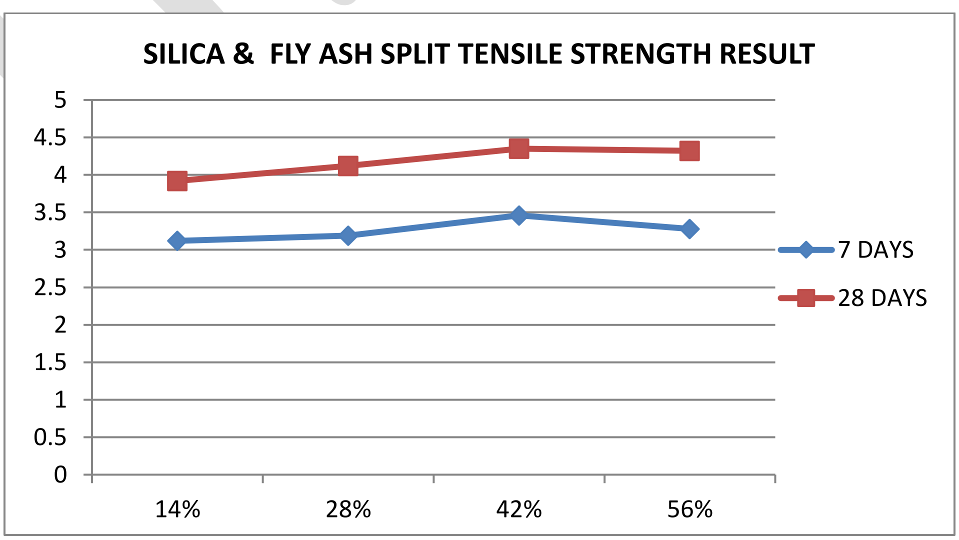


MIX TYPE	% Of FLY ASH	7 DAYS	28 DAYS
M-5	**14**	**0.98**	**2.346**
M-6	**28**	**1.26**	**2.389**
M-7	**42**	**1.28**	**2.41**
M-8	**56**	**1.268**	**2.458**

SPLIT TESNILE STRENGTH FLY ASH



MIX TYPE	% Of CSA & FLY ASH	7 DAYS	28 DAYS
M-9	**14**	**3.12**	**3.92**
M-10	**28**	**3.189**	**4.12**
M-11	**42**	**3.46**	**4.35**
M-12	**56**	**3.28**	**4.32**

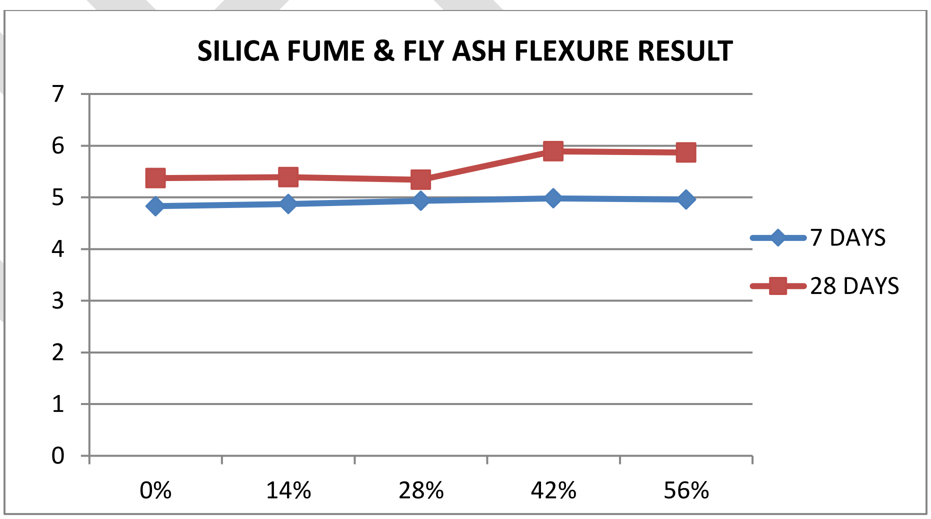


ULTRA SONIC PULSE VELOCITY TEST

S NO	% of CSA & FLY ASH	Obtained average velocity(m/s)	Quality of Concrete
M-0	**0**	**3500**	**GOOD**
M-9	**14**	**3512**	**GOOD**
M-10	**28**	**3670**	**GOOD**
M-11	**42**	**3689**	**GOOD**
M-12	**56**	**3900**	**GOOD**

FLEXTURAL STRENGTH OF CONCRETE

S.NO	CSA & FLY ASH	7 DAYS	28DAYS
M-0	**0**	**4.83**	**5.37**
M-9	**14**	**4.87**	**5.39**
M-10	**28**	**4.93**	**5.34**
M-11	**42**	**4.98**	**5.89**
M-12	**56**	**4.96**	**5.87**



CONCULSIONS

- The optimum percentage of cement replacement by fly ash & CSA for achieving maximum cube compressive strength, cylinder compressive strength, split tensile and beam flexural strengths

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- With the above replacement, concrete with a strength of **30Mpa** canbe produced with water to cementitious materials ratio of 0.3 withAppropriate dosages of compatible superplasticisers.

- Substantial savings can be achieved through total replacement levelsof 50-55% of cement with locally available fly ash and silica fume.

- The maximum 28 days split tensile strength was obtained with 28%fly ash 14% silica fume mix, the strength is about 31% more at 28Days of curing compared.

- The maximum 28 days flexural strength was obtained again with28% fly ash and 14% silica fume mix, a strength gain about 34%More than that of reference.

- The transition zone gets improved and densified with the use of Ternary mix concretes containing micro silica and fly ash.

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