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Studies on the characterstics of high strength self compacting concrete of M-70 grade using flyash and microsilica

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Abstract— Self compacting concrete (SCC) is a new category of high performance concrete which flows under its own weight. It does not require any external vibration and compaction. The work focused on concrete mixes having water/cement ratios of 0.25, with a packing factor of 1.12. The Concrete mixes contains constant proportions of Super plasticizers, and constant proportions of Cement, Micro Silica, VMA, Coarse aggregate and Fine aggregate for a constant water cement ratios. The percentage of Micro Silica added is 7% for all mixes. The mix proportions are obtained on the basis of NAN-SU mix design. The mixes contain Cement of 574 kg/m^3 for 0% addition of fly ash, it vary for 5%, 10% &15% addition but with same total binder content. The workability tests performed in this research were as per EFNARC specifications. Based upon the experimental results, for a water cement ratio of 0.25, fresh and hardened state properties of high strength self-compacting concrete are evaluated. Due to so many advantages of this concrete, it is suitable for the situations where congested reinforcement is used. In this paper presents self compacting concrete is developed using various percentages of fly ash 0%, 5%, 10%, 15% by weight of cement as partial replacement of cement and the strength of concrete has been assessed.

Keywords— Self compacting concrete, workability, Fly ash, Micro silica, super plasticizer and VMA.

I INTRODUCTION

Self Compacting Concrete (SCC) was very fast developed in concrete industry. Self compacting concrete having advanced viscosity and workability properties can easily fill the moulds without the necessity of using vibrators. High volume of mineral powder is necessary for a proper self compacting concrete design procedure. For this purpose ,mineral admixtures such as fly ash, micro silica, lime stone powder, blast furnace slag, rice husk ash can be used .Self compacting concrete (SCC) mainly used for highly congested reinforcement structures and to meet the durability problems of concrete. This concrete has gained wide acceptance in many countries for different applications, but in India this knowledge is to be wide spread. The objective of this study is to understand the fresh state properties of SCC containing fly ash and micro silica. Fly ash in various proportions as partial replacement of cement and small quantity of super plasticizer. An experimental study has been developed to investigate the behavior of self compacting concrete containing fly ash and micro silica. The fresh state properties like slump flow, T_{50} time-V-funnel and L-box blocking ratio have been assessed using the methods as per EFNARC specifications. Workability depends on a number of interacting such as water content, aggregate type and grading, fine aggregate and coarse aggregate ratio, packing factor, kind of dosage of super plasticizers contents of the mix since by adding them inter particle lubrication is increased. In this research mix design is based on NAN-SU method. His design is based on packing factor (PF) of aggregate. In this research PF and FA/CA used are 1.12 and 52/48 for 0.25 water cement ratio. Proportions of water cement ratio, super plasticizer and water binder ratios, micro silica, VMA, coarse aggregate and fine aggregate are constant and due to replacement of fly ash with cement quantity of cement is different. The percentages of Micro Silica and VMA added are 7% and 0.3% for all mixes. The properties of fresh concrete and hardened concrete have also been evaluated. The compressive strength at 7 days and 28 days has also assessed for the mixes containing different percentages of fly ash i.e.0%, 5%, 10% and 15% of the weight of cement.

II MATERIALS AND MIX PROPORTIONS

Materials used in this research are Ordinary Portland cement (OPC 53 grade), and micro silica used as a cementitious materials, natural river sand and a crushed gravel with a nominal maximum size of 10 mm were used as the aggregates. Chemical admixtures used were GELENIUM B233 (Poly carboxylic ether) as super plasticizer and Gelinium stream -2 as a VMA.

Mix proportions and constant water cement ratio (0.25) cement replacing with fly ash

Table: 1 Material Quantities obtained as per NAN SU design Method per cum of concrete is for cement replacing with fly ash 0%,5%, 10%, 15%.

Mix Components	Concrete Mixes.			
	Design mix Cement replacing with fly ash 0 %	M1 W/C (0.25) Cement replacing with fly ash 5%	M2 W/C (0.25) Cement replacing with fly ash 10%	M3 W/C(0.25) Cement replacing with flyash15%
	Qty (kg/m3)	Qty (kg/m3)	Qty (kg/m3)	Qty (kg/m3)
Cement	574.02	545.319	516.618	487.91
Fly ash	27.60	56.30	85.00	113.70
Micro silica	40.18	40.18	40.18	40.18
Fine aggregate	844.48	844.48	844.48	844.48
Coarse aggregate	805.32	805.32	805.32	805.32
Water/binder	146.97	146.97	146.97	146.97
Super plasticizers	10.3	10.3	10.30	10.30
VMA	1.722	1.722	1.722	1.722

III WORKABILITY AND COMPRESSIVE STRENGTH

The useful internal work is a physical property of concrete and is the work or energy required to overcome the internal friction between the individual particles of the mixture. Because of the very high workability of self-compacting concrete, it needs no external vibration and can spread into place, fill the framework and congested reinforcement without any bleeding or segregation.. Moreover, aggregate particles in self compacting concrete are required to have uniform distribution in the specimen and the minimum segregation risk should be maintained during the process of transportation. The strength of concrete is adversely

affected by the presence of voids in the compacted mass it is difficult to achieve a maximum possible density. This requires a sufficient workability or full compaction. The presence of voids in concrete reduces the density and reduces the strength, which means the presence of 5 percent of voids can lower the strength by as much as 30 percent. This research compares the compressive strength, split tensile strength and flexural strength of self compacting concrete mixes for constant water cement ratio (0.25) and cement replacing with fly ash 0% , 5%, 10%, 15%.

IV RESULT AND DISCUSSION

In this research work, the experimental results of self-compacting concrete mixes related to compressive strength, split tensile strength, flexural strength and workability are discussed for same water cement ratio .The workability tests performed in this research were as per EFNARC specifications. They are slump test, L-box and V –funnel.

A. Experimental results

The results of workability tests on self compacting concrete are shown in Table 2. It is observed that workability value increases increase in fly ash content. The results of compressive strength, Split tensile strength and flexural strength are shown in Table 3. It is observed that Compressive strength and Split tensile strength decreases at higher rate for 7days strength when compared to 28days strength, where as the Flexural strength increases at higher rate for 28days strength when compared to 7days strength

B. Fresh and Hardened state properties of Self -compacting concrete

Test results on fresh concrete the workability test i.e. Slump flow test, V-funnel test, L-box test results obtained for different fly ash replacement with cement i.e. (0%, 5%, 10% & 15%) With constant water cement ratio (0.25.) The results of the SCC Mixes prepared and summarized in table 2 and 3.The characteristics results are given in table 3.
Slump Flow (SF) increases as the fly ash increases. For w/c 0.25, slump flow increases from 665mm to 668mm (0.45%).
T500, V-funnel, T5 values are increasing with fly ash replacement increases. For w/c 0.25 T500 time increases from 3.84 to 3.85 sec (0.26%),V-funnel time increases from 8.20 sec to 8.32 sec (1.46%), T5 time increases from 10.60sec to 10.66 sec(0.56%) a. It is observed that workability Value increases increase in fly ash content 0 to 15%..L-box value increases 0.968 to 0.969 as the fly ash value increases in 0 to 15%.

Compressive strength increases as the fly ash replacement increases from 0 to 15%for w/c ratio 0.25 from 0 to 15%. 7days Compressive strength increases from 53.10Mpa to 53.87 (1.45%). Whereas 28days Compressive strength increases from 81.65Mpa to 82.87Mpa (1.49%). (Figure 7) Split tensile strength for w/c ratio 0.25. When fly ash replacement increases from 0 to 15% 7days Split tensile strength increases from 3.44Mpa to 3.45MPa (0.29%). Whereas 28days Split tensile strength increases from4.06 MPa to 4.07MPa (0.24%). Flexural strength for the w/c0.25.When fly ash replacement increases from 0 to 15%. 7days Flexural strength decreases from 5.72MPa to 5.73MPa (0.174%).Where as 28days Flexural strength decreases from 6.20MPa to 6.30Mpa (1.62%). It is observed that Compressive strength and Split tensile strength decreases at higher rate for 7days strength when compared to 28days strength, where as the Flexural strength increases at higher rate for 28days strength when compared to 7days strength.

Table: 2 Workability Test Results of the concrete Mixes.

S.NO	Method	Unit	M0 (Cement replacement with fly ash0%)	M0 (Cement replacement with fly ash 5%)	M2 (Cement replacement with fly ash 10%)	M3 (Cement replacement with fly ash15%)	EFNARC specification	Remarks
1	Slump flow test	mm	665	665	666	668	SF1:550-650 SF2:660-750 SF3:760-850	SF2
2	T500	Sec	3.84	3.82	3.83	3.85	VS1:T500<2 VS2:T500>2	VS2
3	V-Funnel	sec	8.20	8.22	8.25	8.32	VF1:≤ 8 VF2:9-25	VF2
4	T5min	sec	10.60	10.62	10.64	10.66		

5	**L-Box**	**H2/H1**	**0.968**	**0.967**	**0.966**	**0.969**	**PA1:>0.8(2 rebars) PA2:>0.8(3 rebars)**	**PA2**

Table: 3 Development of Compressive strength split tensile strength and flexural strength

Concrete mix	Compressive strength(N/mm2)		Split tensile strength(N/mm2)		Flexural Strength (N/mm2)	
	7 Days	28 Days	7 Days	28 Days	7 Days	28 Days
M1 (w/c =0.25)	53.10	81.65	3.44	4.06	5.72	6.20
M2(w/c = 0.25)	51.53	82.00	3.42	4.04	5.71	6.00
M3(w/c =0.25)	52.65	82.25	3.43	4.05	5.72	6.10
M4(w/c =0.25)	53.87	82.87	3.45	4.07	5.73	6.30

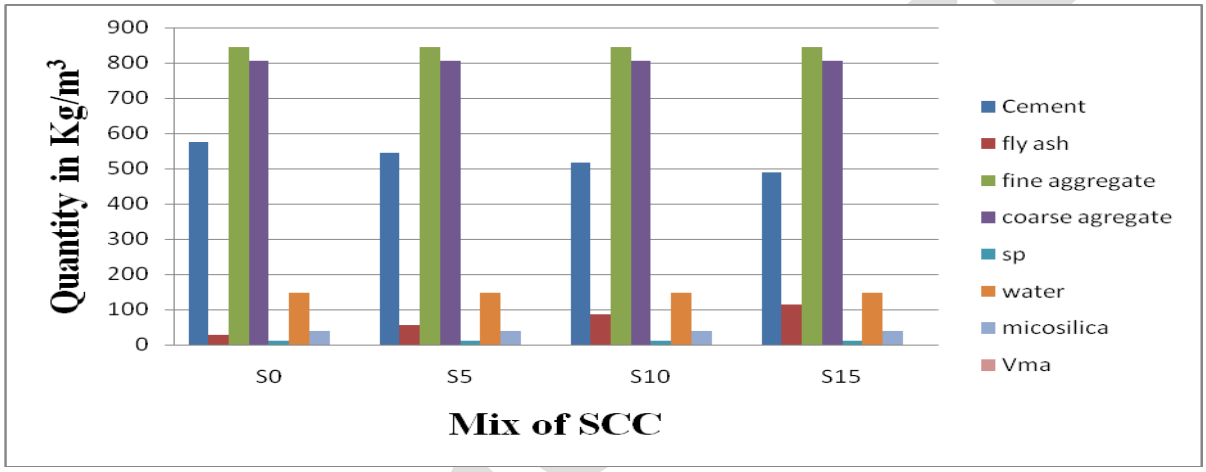


Fig: 1 Mixes of SCC showing quantity of ingredients (Mix VS Quantity).

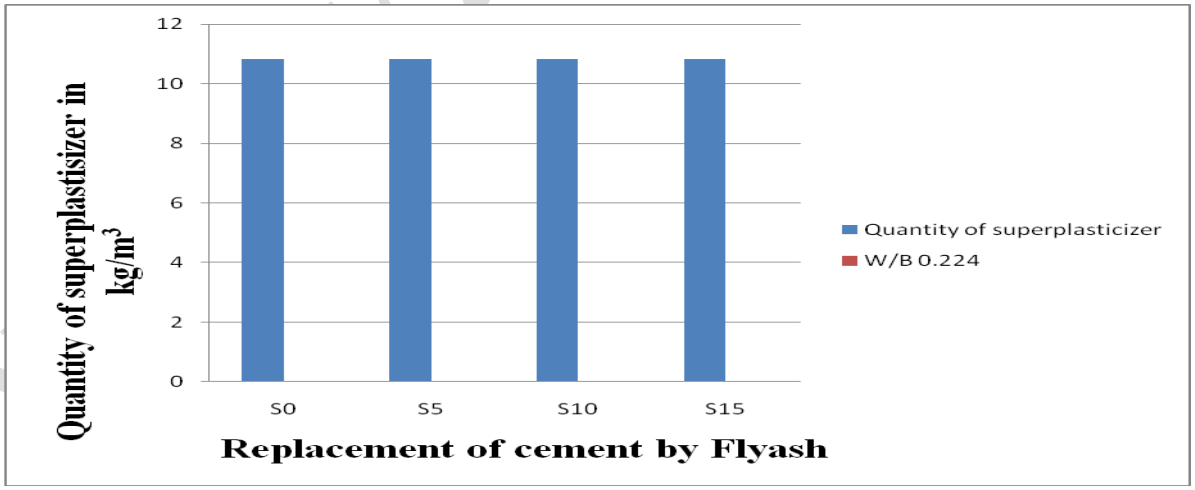


Fig 2 Replacement of cement by flyash VS quantity of superplasticizer

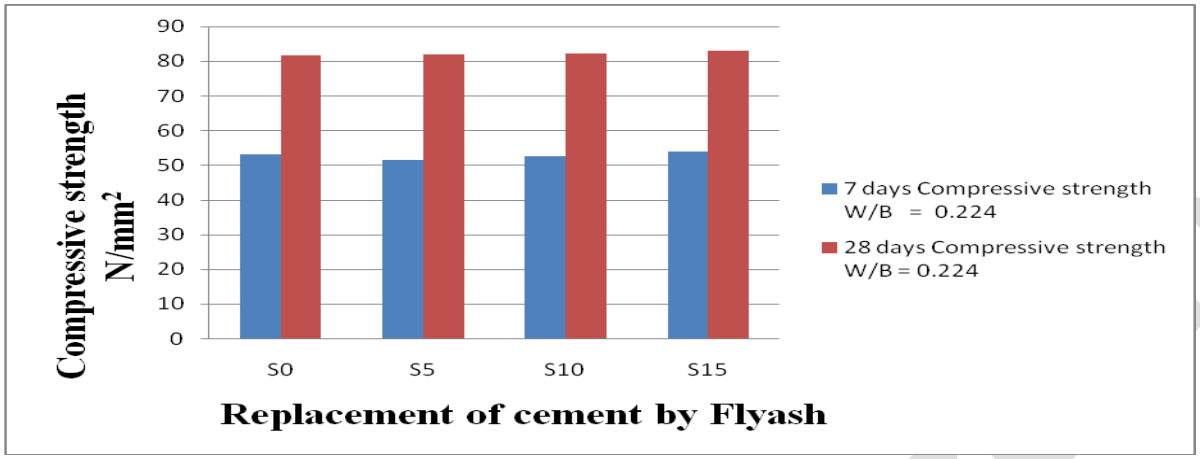


Fig3 Replacement of cement by fly ash VS Compressive strength.

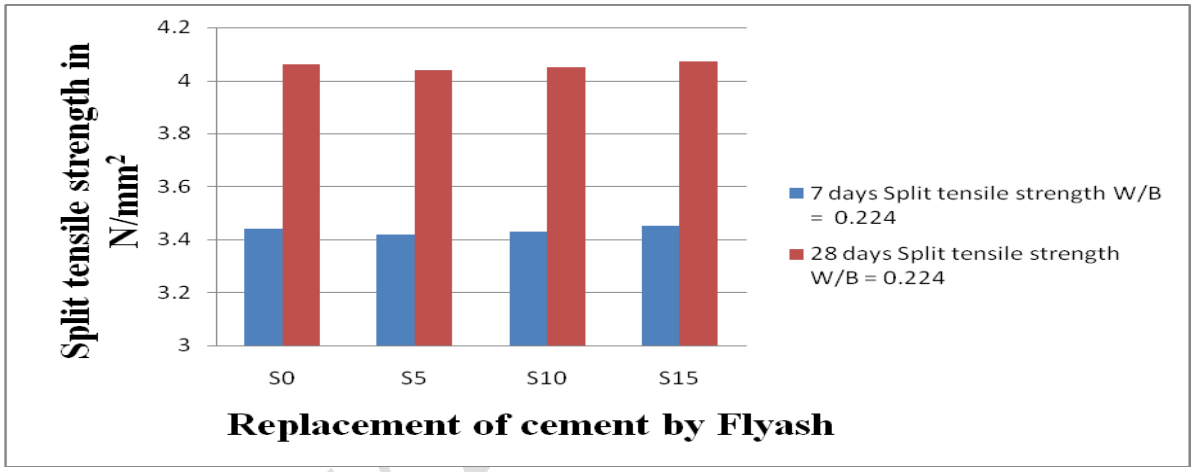
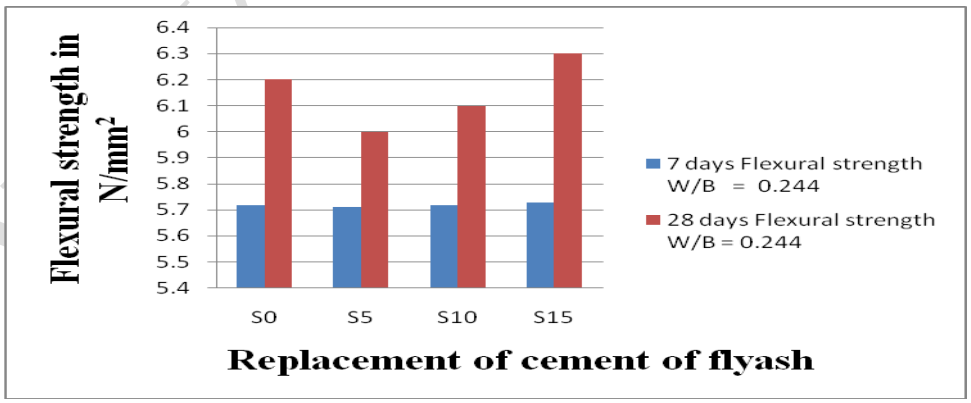


Fig4 Replacement of cement by flyash VS Split tensile strength.



V CONCLUSIONS

The following conclusions are made based on the experimental investigations done in the Concrete Technology lab.

1. All the mixes used in this study exhibits the good workability characteristics, in accordance with the EFNARC specifications.
2. The results of compressive strength of fly ash concretes when replaced with 15% of cement are more than12.87% compared to Conventional concrete at the end of 28 days.
3. It is observed that compressive strength and split tensile strength less 17.97% at higher rate for 7 days strength when compared to 28 days strength. Where as it is observed that flexural strength value less 9.94%at higher rate for 28 days strength compared to 7 days strength.
4. Based on the result of the investigation it has been observed that the use of fly ash in SCC mixes reduces the possibility of bleeding and segregation, increases the filling and passing ability of the concrete.
5. The addition of Fly ash resulted in constant proportion of super plasticizer content for same or better workability. The 28 days compressive strength increaseto12 % to 18.5%.

With these Experimental results all the mixes were develop a higher strength concrete without any Vibration with complies all the workability requirements of SCC.

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