Improving Hardened Properties of Concrete by Adding Fly Ash and Micro Silica

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Abstract:An Experimental study was conducted to investigate the influence of nano materials on high performance of high strength of self-compacting concrete. SCC is a highly flowing concrete that consolidated without any vibration effort. Researchers have conducted experiments relating to nano particles into concretes such as SCC aiming to improve fresh properties, mechanical properties and durability of the system. As this SCC has no vibration effort can reduce the noise pollution and vibration problems which can lead to health and safety problems.

This study revealed that nano materials can influence the strengths of SCC like compressive strength, split tensile strength and flexural strength of SCC. These nano particles act as nano fillers to improve the resistance to water permeability of concrete at 7 and 28 days of curing. This overview can be referred as short guide for Self-Compacting Concrete.

Keywords:Self-compacting,Compressive strength, Split tensile strength,Flexural strength.

1. INTRODUCTION:

Since then, the term HPC has been used around the world to refer to high durability concrete, Prof.Okamura has changed thename for the newly invented concrete to 'Self Compacting High Performance Concrete, in 1997.After 1988, European countries started working on Self-Compacting Concrete(SCC).

Now a days, SCC is widely developed and is a new type of concrete under self-weight to reach every corner of the form work. As it has no vibration effort it would increase the properties of SCC with addition of different nano particles. Adding these nano fillers would improve fresh properties of SCC i.e. Rheological properties and workability. And Also improves mechanical properties of Self compacting concrete like Compressive strength, Split tensile strength and Flexural strength.

Though SCC has high cost, it can be decreased by using some of mineral additives like nano materials. These nano particles can accelerate cement hydration due to their high activity and they act as nano fillers, compacting the microstructure and reduces the porous nature.

It is a highly flowing concrete without bleeding or segregation. This reduces the demoulding time, surface of the hardened concrete is smooth and homogeneous to improve the strength. By adding these admixtures into the concrete can make it flow and fill all the air pockets. This paper describes the procedure to develop high strength Self-Compacting Concrete.

2. REVIEW OF LITERATURE:

The following papers were studied which gives the summary of work done for the improvement of self compacting concrete.

2.1. Jianxin Ma and Jorg Dietz: This paper show the application of super plasticizers and powder content like silica fumes in the high performance of self compacting concrete which resulted in a good workability and quality of the concrete with a water cement range of 0.28 to 0.38. It concludes that addition of 18% of silica (with the weight of cement) was enough to consume the carbon hydroxide released from the cement.

2.2. Kazumasa Ozawa Et Al: His investigation focused that the partial replacement of cement with fly ash and blast furnace slag has remarkably improved the flow ability of the concrete. Trying with the different proportions of admixtures the research work concludes that replacement of 10% to 20% of fly ash and 20% to 25% of blast furnace slag by cement content showed the better flowing ability and strength properties.

2.3. M.Shahul Hameed, V. Saraswathi, A.S.S.Sekar: His investigation was carried out to determine the effect of rapid chloride permeability on high performance SCC Green concrete. He used Marble Sludge Powder as filler to fill and reduce the voids which subsequently increased the strength of the concrete.

2.4 Mehta and Neville: This investigation shows a way that increment of sand quantity at the cost of coarse aggregate of range 5% so as to reduce the segregation when super plasticizers are added.

3. RESEARCH SIGNIFICANCE:

- Micro silica gives stability in fresh concrete. Also it acts as a pumping acid in which it reduces viscosity making the concrete a non segregating concrete.
- It also observed that the micro silica will reduce the risk of blocking when concrete is pumped.
- Replacement of cement with quartz will show environmental benefits as the content of cement is reduced and also improves the serviceability criteria.
- Size of fine particles and reactivity of silica fumes results in lower permeability and improved durability.

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4. MATERIALS:

The materials which were used to develop the high strength self-compacting concrete are Ordinary Portland Cement, Fly ash, Micro Silica and chemical admixtures.

4.1 Cement - It is a binding material which helps to bind the construction materials.

Cement is a combination of minerals like Lime - 65% , Silica - 25% , Ferrous oxide - 2%

Sulphur trioxide - 1-2% , Alumina - 2% , Magnesia - 1-2%, Alkalines- 2%.

4.2 Fly Ash-It will increase the chemical resistance of the concrete and also improves the workability and durability of the concrete.

4.3 Micro silica -Micro-silica increase the strength of concrete.

4.4 Fine aggregate - This helps in filling the voids between coarse aggregate and decreases the pores in the concrete. he sizes of the fine aggregate in this experiment is taken below 4.75mm

4.5 Coarse aggregate - This is helpful in reducing the shrinkage .In this experiment we took the size of the coarse aggregate between 4.75mm - 10 mm

4.6 Admixture - Adding Admixtures to concrete improves certain properties of concrete like mechanical properties and strengths of the concrete.In our test procedure we used Viscosity Modifying Admixture (V.M.A) which helps to control the Viscosity, Workability and cohesive nature of fresh concrete.

4.7 Super Plasticizers -The Super Plasticizers are used DAF as super plasticizer , this will improve the flowability of concrete.

5. MIX PROPORTIONS:

The main aim this research is to find out the effective use of fly ash and micro silica in high strength self-compacting concrete of grade M60 and to compare the fresh and mechanical properties of these concretes with the control mix. In this program 4 different proportions i.e. 10%, 20%, 30% and 40% of fly ash in addition of cement content s and Micro silica content was taken as 10% of cement content as constant for all mixes. Total five mixes were casted in this program out of which 4 are of varying fly ash content with cement content. and shown as table 1.

Table 1. Mix designations of various mixes

Mix	Cement (kg/m3)	Fly ash(kg/m3)	Micro silica(kg/m3)	Fine aggregate(kg/m3)	Coarse aggregate(kg/m3)	Water (kg/m3)	Super plasticizer	V.M.A
Mix 1	450	0	45	820	750	190	1.8	1.5
Mix 2	450	45	45	820	750	190	1.8	1.5
Mix 3	450	90	45	820	750	190	1.8	1.5
Mix 4	450	135	45	820	750	190	1.8	1.5
Mix 5	450	180	45	820	750	190	1.8	1.5

6. **FLOW PROPERTIES:** The fresh properties of various Mix designations are listed below as shown in table 2

Table 2 Flow properties of the material.

S.No	Property	Limits	Mix1	Mix2	Mix3	Mix4	Mix5
1	Slump flow in mm	650-800	680	790	790	730	650
2	T50cm slump in sec	2-5	6	2.4	5	3	4
3	V-Funnel time for concrete in sec	6-12	20	10	9	8	10
4	V-Funnel T5 min in sec	6-15	25	14	10	10	14
5	L-Box H2/H1 ratio	0.8-1	0.5	0.67	0.43	0.88	0.8
6	U-Box (H2-H1	0-30	30	20	20	15	20

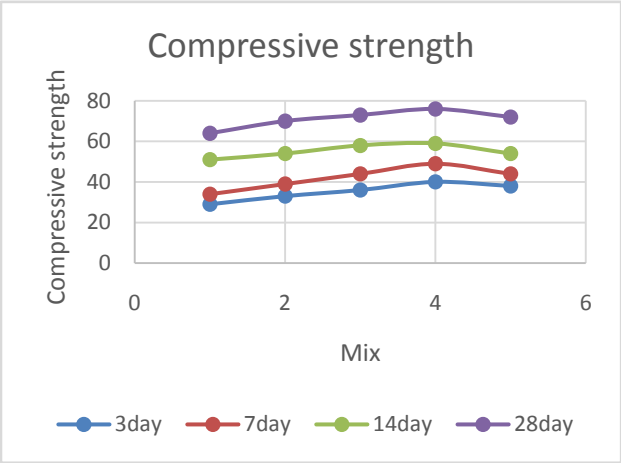
7. MECHANICAL OR HARDENED PROPERTIES:

7.1 COMPRESSIVE STRENGTH:

The following table shows the compressive strength of the materials when tested 3,7,14 and 28 days respectively.

Mix	Compressive strength (MPa)			
	3 day	7day	14day	28day
Mix 1	29	34	51	64
Mix 2	33	39	54	70
Mix 3	36	44	58	73
Mix 4	40	49	59	76
Mix 5	38	44	54	72

Table3: Compressive strength values.



`Fig1: Compressive strength graph

7.2 SPLIT TENSILE STRENGTH: The materials are tested for split tensile strengthfor 28 days and the observed values are tabulated as shown.

Mix no	Tensile strength(MPa)		
	7 days	28 days	90 days
HSSCC 1	3.162	5.27	6.50
HSSCC 2	3.18	5.30	6.40
HSSCC 3	2.94	4.9	6.0
HSSCC 4	2.92	4.87	6.95
HSSCC5	3.53	5.88	6.0
HSSCC 6	3.23	5.47	6.6
HSSCC 7	3.42	5.07	6.2

Table 4.Split tensile strength values

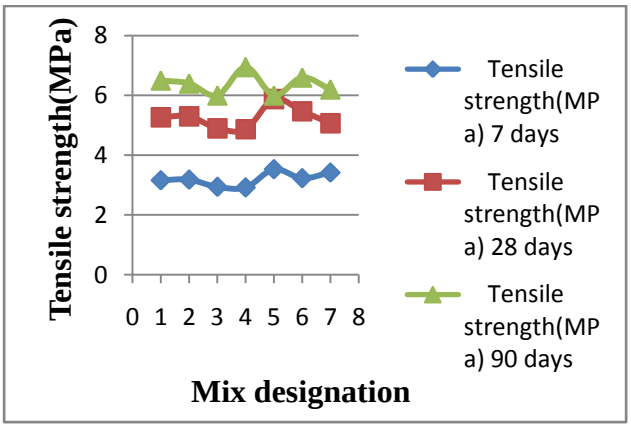


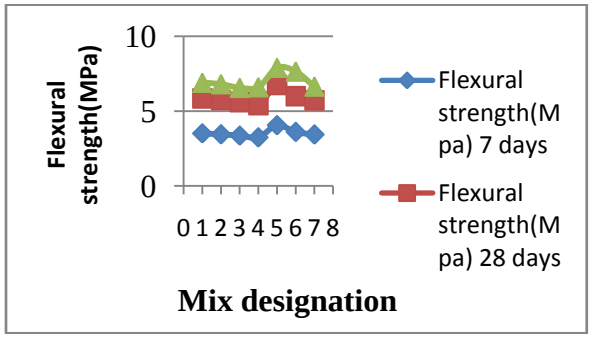
Fig2:Split tensile strength graph

7.3. FLEXURAL STRENGTH: The materials are tested for felexural strength and the observed values are tabulated below.

Mix no	Flexural strength(Mpa)		
	7 days	28 days	90 days
HSSCC 1	3.51	5.85	6.9
HSSCC 2	3.44	5.74	6.8
HSSCC 3	3.36	5.60	6.56
HSSCC 4	3.24	5.40	6.60
HSSCC5	4.05	6.75	7.90
HSSCC 6	3.6	6.00	7.65
HSSCC 6	3.43	5.72	6.64

Table: flexural strength values

Fig3: Flexural strength graph



We can observe in Split tensile strength test that 30% fly ash content in mix4, strength was increased by 11.11% within 3days of curing and increased by 13.55% within 7days and also increased by 15.13% within 28days. On further addition if fly ash after 30% there will be decrease in the tensile strength of the concrete.In the same way we can observe in flexural strength test that there was increase in flexural strength of concrete upto 30% addition of fly ash.It was observed that maximum strength was achieved at 30% fly ash content i.e.,strength was increased by 32.9% within 3 days of curing, strength was increased bu 40.63% at 14days of curing and there was increase in flexural strength bu 43.71% within 28days of curing.We can observe that there was decrease in flexural strength on further addition of fly ash content after 30%

We can observe the same in compressive strength test that, there was increase in compessive strength of concrete by 30% addition of fly ash.It was observed that maximum strength was achieved at 30% fly ash content i.e.,strength was increased by 37.93% within 3days of curing, strength was increased by 44.12% at 7day curing and there was increase in the compressive strength by 15.69% within 14days of curing and increase in strength by 18.75% at 28day

8.CONCLUSIONS:

In this research we found that by increasing the amount of fly ash percentage upto 30% in the concrete ,there will be increase in the Compressive, Flexural and Split Tensile Strengths of concrete .There will be decrease. in strength on further addition of fly ash content after 30%.curing.We can observe that there was decrease in the compressive strength on further addition of fly ash content, that is after 30%.

From this we can conclude saying that Optimum percentage of fly ash to be used in concrete to achieve good strength is 30%.

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