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Research Article

Effect of fly ash on properties of self-compacting concrete (SCC)

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ABSTRACT

In this paper, the effect of fly ash on properties of self-compacting concrete (SCC)has been investigated. Pozzolanic Portland cement (PP) with values up to70-10percenthas been replaced with fly ash. The ratio of water to binder mixture is keptataconstant0.30.The properties include properties of self-compacting concrete (slump flow, V-funnel time and the obstruction of boxes L) mechanical properties(compressive strength, tensile strength and modulus of elasticity) and durable properties(water absorption and permeability to water and chloride penetration depth). The results show that fly ash with ppc can beem powered to build high-strength concrete, used in the SCC. Replacing 30 percent ppc with FA resulted in resistance is about 100M pain 56 days. Tensile strength and modulus of elasticity also follow a similar trend. High water absorption is achieved by increasing the amount FA. Althoug hall SCCs, the initial uptake values of less than 3% is shown. Deep water penetration in SCCs in there placement of 10 and 30 percent of ash wind is lesser, but the replacement of 50 and 70% is higher. In 30 percent fly ash replacement, a systematic decrease in chloride permeability there SCCs.

1-THE INTRODUCTION OF SELF-COMPACTING CONCRETE

SCC concrete that without any external energy and be compacted under its own weight. This concrete materialis very fluid and homogeneous mixture, many ordinary concrete problems such as detachment, bleeding, water absorption; permeability, etc. have been solved. . In addition to these fixes and without any vibration (vibration) within or body vibration format is compressed under its own weight. The concrete ability to easily fill out the format the site of compression fittings networks have been recognized and even in places where access to them is difficult to easily pass. SCC mix design and structure is not significantly different from the normal concrete. However, certain substances to achieve special characteristics this concrete are used in their production. These materials generally include lubricating above, combined pozzolan and filler materials(stone powder beads with a diameter smaller than125 microns), respectively. In addition, special precautions regarding aggregate gradation used in this type of concrete considered. Pozzolanic Portland cement (PP) with values up to70-10percent has been replaced with fly ash. The ratio of water to binder mixture is kept at a constant30. The properties include properties of self-compacting concrete (slump flow, V-funnel time and the obstruction of boxesL) mechanical properties(compressive strength, tensile strength and modulus of elasticity) and durable properties(water absorption and permeability to water and chloride penetration depth) are. The results show that fly ash with ppc can be empowered to build high-strength concrete, used in the SCC. Replacing 30 percent ppc with FA resulted in resistance is about 100M pain 56 days. Tensile strength and modulus of elasticity also follow a similar trend. High water absorption achieved with increased levels of FA. However, all SCCs, the initial uptake values of less than3%areshown. Deep water penetration in SCCs in there placement of 10 and 30 percent fly ash is lower but there placement of 50 and 70% higher. In 30 percent fly ash replacement, a systematic decrease in chloride permeability there SCCs.

2-**MATERIALS**

Used in all of our blends, pozzolanic Portland Cement(PPC)according to IS 1489Part1.The percentage of fly ash mixed in PPC 28 percent.In addition, fly ash is used as a mineral additive. Their chemical composition is specified in Table1.Good quality aggregate for the study is provided. Broken granite with a maximum nominal size 20mm grain and fine river sand with a maximum grain size of 4.75mm respectively as coarse and fine aggregates are used. 20 and 12.5mm coarse aggregate fraction has a specific gravity of 2.91 and 2.80, respectively, are as fine aggregate has a specific gravityis 2.73. Commercially available there carboxylate(PCA)based super plasticizer(SP)in all concrete mixes have been used. Water is a strong reducing in accordance with ASTM: C494.

Table1. Detailsmixing ratios in Kg/m3

Constituent	SCC10	SCC30	SCC50	SCC70
Cement	495	385	275	165
Water	165	165	165	165
Fine aggregate	836	818	800	783
20 mm	382	374	366	357
12.5 mm	525	514	503	491
Fly ash	55	165	275	385
HRWR	6.6	7.15	7.15	8.80
VMA	0.55	1.10	1.10	2.75

An essential component of SCC is strong reducing water(HRWRA), which is also known as super-lubricants. Often contains additives to lower water SCC mixes high (HRWRA) is to ensure that concrete can flow under its own weight. Several experimental blending to achieve the optimal dose for each of the above lubricant mixtures needed to achieve self-compacting properties EFNARC standards have been implemented. Extradoses of lubricant for each batch is carefully selected high doses may slow leak and provide resistance. Upgradation of concern(related) is, in the present study, the combined aggregate gradation suggested by the standards DIN 1045, been useful. 20 and 12.5 and 4.75mm aggregates composed of acomposite gradation curve so that it roughly to the specifications of DIN B approaches. Used aggregate defeat percent, respectively, for20mm, -21% and to12.5mm, -30% and for4.75mm, -49% of the total amount of aggregate are. Aggregate mixture through a high resistance to adhesion is self-compacting concrete. Effects of coarse aggregate size 20mm and 10mm on short-term mechanical properties of SCC are also performed.

3-Details mixing and pouring(paid)

All materials with the tub(container) mixer with a maximum capacity of 80 liters have been mixed. Materials and PC, respectively, coarse aggregate and fly ash and sand are fed in a blender. Nowater for 1.5min materials has been mixed. Subsequently, water is added, followed by three-fourths of the above lubricant and the remaining water until the mixture for more than6minutes to obtain a homogeneous mixture has continued. Upon discharge from the mixer, self-compacting testing on new properties has been mixed. Fresh concrete is poured in the form of steel were dense and without any vibration. Finally, the level is finished (paid) to obtain a uniform smooth surface is done carefully.

4-Fresh concrete tests

Compressibility tests to calculate their properties (slump flow, timeT_50,funnel flow timeV, obstruction of boxesL) was conducted on all mixes. Testing arrangement is as follows:

(A) Slump flow test and measure the timeT_50
(B) Flow test funnel V.
(C) By blocking L-box testing. EFNARC tested in accordance with the standards have been applied.

5-RESULTS

Demand (need) HWA and VMA

The3-demand (need) and VMAHRWA additives used in all mixes are presented. It can be seen that the addition of fly ash in cement pozzolanica significant effect on the flow characteristics in the SCC. It can be seen that when the amount of fly ash increases, demand increases for HRWA and VMA. To replace 70percent of SCC requires some 1.6percent and 5percent is HRWA and VMA. The reason may be that 70percent of the replacement of an abnormal increase in the volume of adhesive in paste volume SCC is high due to low specific gravity PPC and fly as his. PPC also used in this study, a high particle 406m ^ 2 / Kg is. A number of experiments to optimize the dose to 70percent replacement HRWA and VMA been implemented. VMA initially low dose of about 2percent, sticky concrete looks, current slump shows good about 700mm. But after a few minutes and sedimentation significantly leakage has been observed in the form of metal aggregates observed.

Table 2: Properties of fresh concrete reviewed

Concrete name	Plastic density (kg/m^3)	T_{50} (s)	Slump flow (mm)	V-funnel flow time (s)	L-box blocking ratio
SCC10	2432	6	620	28.19	0.77
SCC30	2399	5	685	16.0	0.80
SCC50	2390	5	705	20.39	0.93
SCC70	2332	7	670	28.16	0.83

It makes use of much more VMA to prevent the detachment and leakage. VMA dose of 5percent to 70percent compared to previous studies published in the alternative press is relatively high. Despite the use of large amounts of VMA very little leakage was observed in the mixture. Results published almost contradict previous results, which is good flow and adhesion of SCC in 70% fly ash to replacement OPC, is developed. From the results we can see that when the development of SCC, PPC is used, the replacement of fly ash in the range of 50-30percent is ideal.

6-**Fresh concrete test results**

Figure 4shows the current slump than the dose of fly ash. The results can be observed when two of fly ash is increased, the current slump as much as 50% increase and then decrease during the 70% replacement there. Four mixed slump flow values between 620 and 705mm have shown that represents the deformation of concrete under its own weight. During the slump of 650 ± 50mm for SCC is required. And all concretes of the range, to meet the requirements. 10percent showed Thixotropic behavior and current replacement 620mm slump has shown, however, 30% and 50% replacement values between 680 to 700mm are shown. T_50alsofor all mixes, showed no significant change. On the other hand, SCC mixes with fly ash, 30 percent and 50 percent, equal to 6 second shave shown. Although the amount of 10% and 70% replacement values are 7 and 8seconds. Funnel flow time V also have offered similar behavior. Measuring hopper V some mix more than the upper limit. Although all concrete mixes under its own weight without having to shake, fill the molds. Many researchers both time and funnel VT_50 as much flow viscosity index of concrete mixes, have used. The relationship between these results is presented in Figure5. This figure shows that an acceptable correlation(R ^ 2 = .74) between the time of T_50and funnel V to this mixture there SCC. Laboratory measurements of the ratio of L showed the ability to fill and pass each box is mixed. L-box test is much more sensitive to blockage. L-box ratios measured for four doses mixed with fly ash are presented in Figure6.It can be seen that when the fly ash content of 30 to 70percent increases, larger amounts of 8 to show that SCC mixes. Although 10 percent of the replacement SCC is low because it thixotropic of less than 8 show but still able to maintain self-compacting. In the same shape (similar shape) change funnel flow time V in the presence of doses of fly ash is also provided. SCC is ideal for development.

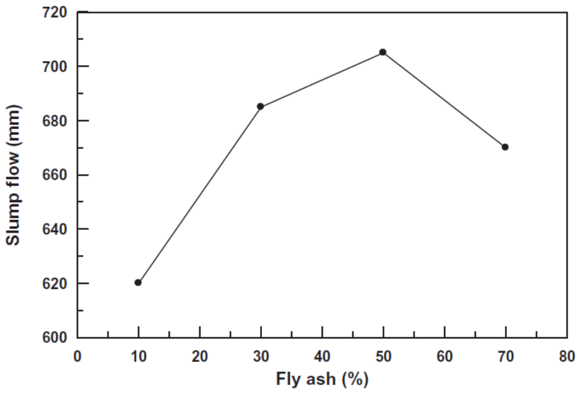

Figure 1: Change the slump towards the replacement of fly ash

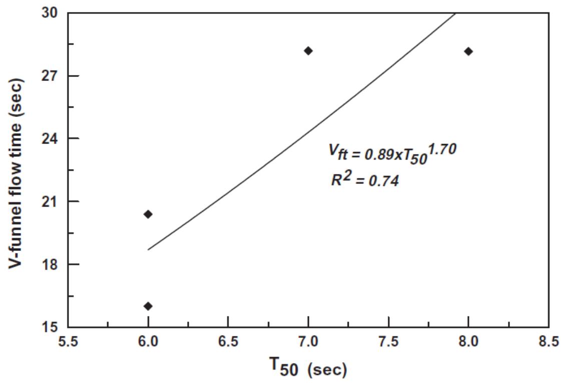

Figure 2: The relationship between the funnel flow timeVandT_50

7-Hardened concrete tests

After discussing the SCC over the new state of knowledge about their performance in the hardened state is essential. In this paper, the mechanical properties of all SCC, such as compressive strength, tensile strength and modulus of elasticity are studied. Compression strength at ages 3, 7, 28 and 56 days were carried out and the results are presented in Table4. Figure 7shows the change of compressive strength on days 28 and 56 of the fly ash is an alternative. As the results shown in Figure 7is significant, SCC compressive strengthof10 to 30 percent fly ash replacement in the replacement of 50 and 70percent strongly increased, but has started to decline. 30% replacement in 56-day high compressive strength of about 100Mpa is achieved by mixing fly ash contains 10% compared to other alternative high compressive strength 88Mpa obtained approximately 56 days.

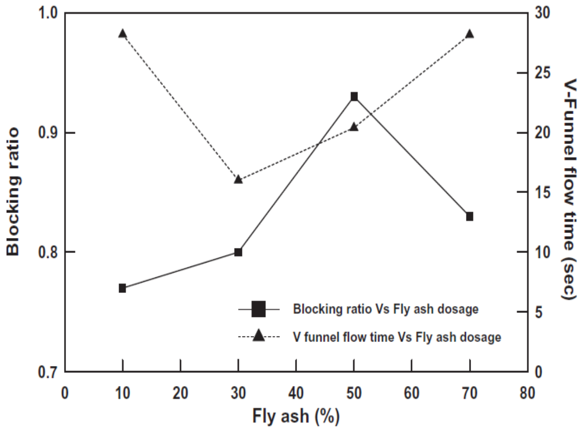

Figure 3: Effect of fly ash replacement on the obstruction and funnel flow time V

Table 3: Mechanical properties of concrete review

Concrete name	Compressive strength (MPa)				Splitting tensile strength (MPa)		Modulus of elasticity (GPa)	
	3 day	7 day	28 day	56 day	28 day	56 day	28 day	56 day
SCC10	44.42	58.37	78.97	87.85	5.62	5.55	43.24	42.14
SCC30	48.33	51.20	88.06	99.43	5.93	6.06	45.42	46.24
SCC50	27.1	35.91	60.83	66.20	4.12	4.20	36.63	36.01
SCC70	18.14	21.77	44.21	50.21	2.61	2.84	31.56	32.78

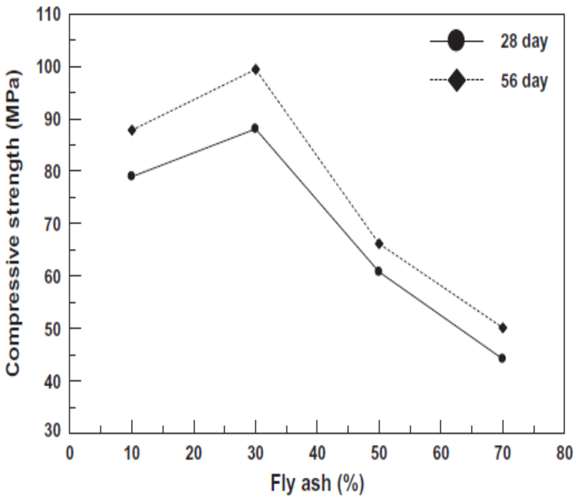

Figure 4: The change in resistance with respect to the replacement of fly ash

In general, and with the same ratio of water to binder, a reduction in strength concrete containing fly ash compared to control samples there. However, even in the amount of fly ash high (70%), long-term strength of 50Mpa in the same binder ratio is obtained. If a high erresistance in the fly ash mixture ratio of binder to achieve the same work ability with less control, is expected. Similar growth with results obtained elsewhere in the SCC with fly ash. Modulus of elasticity of concrete compressive strength basically depends on it. This fact is well known that normal weight aggregates with a modulus of elasticity greater than the hydrated cement paste, is. Considering the more aggregate result in larger modulus of elasticity of concrete compressive strength is taken. Many traditional concrete terms to predict the compressive strength and modulus of elasticity which is essentially dependent on the density of concrete is there. Since it is a different matter, may show a different relationship between stress-strain behavior of the SCC mixes with low course, the powder and the use of mineral additives such as fly ash or slag are. Several studies on the modulus of elasticity of SCC, the results were the opposite result. It is well established that once remained constant resistance, modulus of elasticity SCC is often similar to those in traditional concrete. On the other hand, has already been carried out by a laboratory study has proved that its elastic modulus SCC less than traditional concrete. It has been observed that for a given resistance, modulus of elasticity than that of conventional concrete is SCC. This is because the maximum grain size smaller SCC and SCC is further cement paste. The review may conclude that compared with traditional concrete modulus of elasticity is not easy. These results maybe described in consistent with the fact that the rheological properties of SCC slightly different components with traditional nor any of the aggregates and cement properties are the same size and not the maximum.

8-Water absorption

Water absorption results in 30 minutes (initial surface absorption) absorption after72 hours (final absorption) for all concrete is presented in Table5. From these results it can be seen that when the fly ash replaced by increased absorption also increased. Table 10absorption values of 30 minutes (initial) and final attracted 28 have provided concrete results. The initial conversion value and ultimate absorption of all of fly ash concrete self-compacting with an increase in the percentage of fly ash replacement, has increased. Table 10 recommendations (recommendations) given by Concrete Association (CEB, 1989) for 30 minutes attraction has to offer. It shows that all self-compacting concrete absorbs less water a certain amount of fly ash concrete are good.Fromday28 today56reduceduptakeisshownin Table5.The uptake 70percent fly ash mixed with hydration products due to the low quantity produced, on 28more.Curing have a significant effect on pore structure of concrete curing time longer, smaller pores and capillary pores are less connected and in addition, common area between paste and aggregate porous formed at an early age to continue curing in water filled(denser and denser it is).As hydration products have been produced in 56days, attracted relatively is little SCC within 56 days of the 28's. This is similar to some results of the NVC.

Concrete name	Absorption (28 day) (%)		Absorption (56 day) (%)		Water penetration (mm)		Chloride permeability (Coulombs)	
	Initial (30 min)	Final (72 h)	Initial (30 min)	Final (72 h)	28 day	56 day	28 day	56 day
SCC10	0.89	3.54	0.84	3.14	5	4	1812	1188
SCC30	1.00	4.53	0.95	3.74	5	3	923	692
SCC50	1.29	5.55	1.18	4.95	11	9	1312	823
SCC70	1.49	12.12	1.32	10.52	35	24	3520	1876

Table:4 durability properties investigated

The ultimate absorption at the end of 72 hours follows a similar growth. SCC 70 attract more of the SCC are shown. This may be due to high amount fly ash (70%) in the system. Apart from SCC 70, the final absorption of other SCC is similar to the final conversion value in the range of 3:54 to 5:55 SCC is located percent. Water absorption is fundamentally affect the test phase, mainly depends on the amount of interconnected porosity, capillary. Concrete mixed with more dough values, are bound to attract more amounts of concrete with less pulp, are (in the same binder ratio). Water absorption is less, thus less visible alternative is to fly ash, appointed to the volume of pulp is relatively less; the smaller the capillary pore volume. Considers that, self-compacting concrete with high fly ash replacement, have been shown to absorb more water. Increase in the volume of pulp specific gravity lower due to an increase in the volume of fly ash and PPC capillary porosity and water absorption, helps. This is clearly reflected in SCC 70

9-Water penetration depth

One of the most important factors of concrete is durability, permeability. Low permeability concrete to show improved resistance to chemical attack. When water penetrates into the concrete, the amount of salt solution containing chloride ions penetrates into the concrete and causing corrosion. In general, it seems that permeability is less likely to cause more strength concrete. Water penetration test is used to evaluate the permeability of concrete and verified the accuracy of these tests. Figure 11showsthe results of the depth of penetration of water all SCC mixtures.

Similar to attraction, the depth of penetration increases to 50%when fly ash is not very impressive, though significant increase in the penetration depth was recorded at 70percent replacement. On both days 28and 56, growth is the same.

10-Chloride Permeability

Results measured on days 28 and 56 of the rapid chloride test, are presented in Figure12. Customer evaluation by ASTM 1202 is given in the same form. Results can be seen that electric charge Coulomb for SCC70 more than it is in other SCC. For SCC70, electric charge Coulomb, 5320, which represents chloride penetration profile is relatively weak. It is well known that the combination of fly ash to a sharp reduction in the Coulomb electric charges. The effect of FA on concrete chloride ion diffusion also been studied by other researchers. For example, Shi said that the use of supplementary cementation materials (surcharge), such as FA may have a significant effect on the transfer (migration) have concrete chloride RCPT measured by the test. These effective alternative scenarios for theother70percent, that's right. A significant effect on the properties of concrete is curing. On day28, SCC10 and SCC30 and SCC50 and SCC70, Colomb by(charge) 9231812,and1312 and3520have shown, however, this amounts to charge 56per day, and 692 and 823 in 1188 and 1876 have been reduced. In many alternative fly ash has a significant effect on chloride penetration profile and the replacement of 30 and 50percent have shown similar behavior.

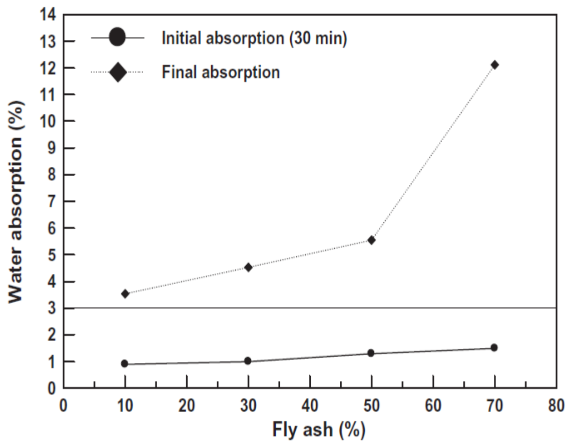

Figure 5: The relationship between water absorption andreplacementfly ash

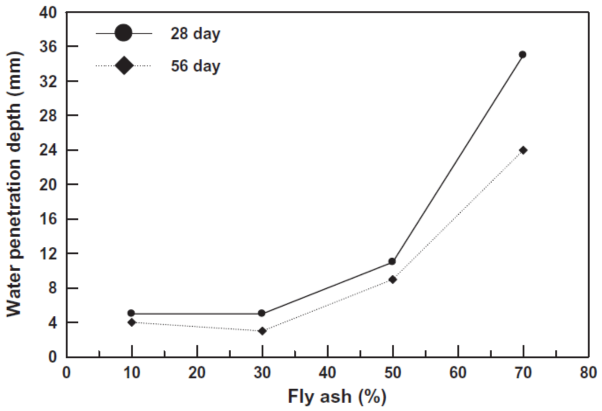

Figure 6: The relationship between depth of water infiltration and replacement fly ash

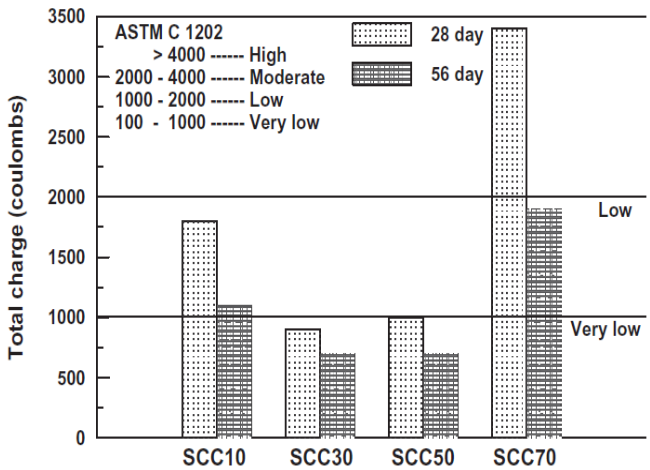

Figure 7: concrete chloride permeability values

This may be due to refining (softening) fly ash to replace high pore refining pores in addition to the fly ash is in PPC. The influence of chloride ions less fly ash concrete with FA may be appointed to attend. The use of fly ash, reducing pore size and thickness of the transition zone between aggregate and cement matrix in scribed, is likely to result in dense rmatrix. You can also get the results RCPT result in electrical conductivity depends pore solution is determined by the composition of pore solution. Electrical conductivity or RCPT amount of concrete can be made by reducing the alkaline concrete pore solution, reduced. When fly ash (especially with low lime and low alkali content) is used to replace part of the PC, Alkali ion concentration of hydroxyl ions in the pore solution significantly reduced. And the size of the reduction depends on the level of FA replacement. For expected differences in electrical resistance between the mixture of SCC, as well as electrical conductivity values may also be different. As a result, CPT values may reflect this difference and therefore should be carefully interpreted. Because of the high chloride 70% due to the porous nature of concrete is an alternative mode. SCC with 70percent of the replacement value of more super plasticizer and VMA dose in comparison with other developed SCC, would require. This leads to more air in the mixture developed and eventually to the porous nature makes. This clearly on other characteristics of durability has already been discussed, reflected.

CONCLUSION

1-The use of SCC concrete problems caused by vibration and eliminates non-uniform density.

2-LimePozzolanic presences of moisture released from the hydration of cement compounds with properties that improve the properties of concrete are creating.

3-FA increased flexural strength reduces the ages of 7 and 28 days; however, the overall improvement has been observed bending strength at the age of 90 days.

4-FE increase in the percentage in the mix to improve the efficiency and rheological properties of fresh SCC is a high performance by adding FA so that less lubricant is used when the above is achieved.

5-Water absorption, capillary absorption and chloride penetration by adding up to 25percent fly ash replacement, declined.

6-In vitro evaluation of multi-pozzolan can be used to provide new results.

7-Can be used instead of Portland cement and pozzolanic cements, including Portland cement pozzolanic particular, and in addition to economic and environmental savings achieved better results.

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