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Effect of Dosage and Length of Macro Synthetic Fiber on Flow and Mechanical Characteristics of Fly Ash Blended Self Compacting Concrete.

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Abstract:- Self compacting concrete (SCC) is a concrete that flow under its own weight. It does not require vibration for placing and compaction. Self compacting concrete is particularly useful in casting heavily reinforced sections, complicated formwork or in places where it is difficult to use vibrators. In this experiment cement was partially replaced by 20% and 30% of fly ash. Replacing cement by fly ash saves the amount of cement requirement, thus reduces the cost of concrete. Further Macro Synthetic fiber with different length and dosage were added. Workability and mechanical properties of this fiber reinforced concrete were studies.

Keywords:- Self compacting concrete, Fly ash, Fiber, Length, Dosage.

I. INTRODUCTION

Self compacting concrete was developed in Japan to offset the shortage of labour. Self Compacting Concrete flows under its own weight. Self compacting concrete does not require vibration for placing and compaction. In order to achieve self compacting concrete, the fresh concrete must have high workability. The flow characteristic of SCC is determined by the superplasticizer dosage and water/cementitious material ratio. Mineral admixtures are used as extra fine material other than cement. In this study, the cement content was partially replaced with fly ash.

Fly ash is a by product of coal based thermal power station and is collected by electrostatic precipitation. It is a pozzolanic material which may be defined as siliceous or siliceous and aluminous material which by itself possesses no or little cementitious character. Fly ash will chemically react with Calcium hydroxide in the presence of water and forms additional cementatious material having cementitious property similar to the cement. Fly ash also reduces the heat of hydration. Use of fly ash reduces volume of cement in concrete. The main aim of using fly ash in concrete is to get concrete at a reduced cost. Use of fly ash in concrete gives many environmental benefits and thus it is environmental friendly. It saves the amount of cement required, thus saves the raw materials such as limestone, clay and coal required for manufacture of cement.

Fiber reinforced concrete is concrete containing short discrete fibers that are distributed uniformly and oriented randomly. The character of fiber reinforced concrete changes with change in the concretes, type of fiber, shape of fiber, orientation, distribution and density of fiber. Fibers in concrete are known to affect workability and flow characteristics. The type of fibre, volume of fiber and shape of fiber added, affects the flow characteristics of SCC.

II. MATERIALS AND PROPERTIES

The materials used in this research work are:

A. Cement: In this experimental work Ordinary Portland cement of 53grade was used. The specific gravity of cement was found to be 2.95

B. Fly ash: Fly ash is a fine powdered by product of coal based thermal power stations collected from electrostatic precipitation. In this experimental work, the specific gravity of fly ash used is 2.06

C. Coarse aggregate: In this experimental work crushed stone of 12.5 mm maximum size and retained on 4.5mm IS sieve is used.

Table I: Physical Properties of Course Aggregate

Sl. No	Property	Result
1	Bulk density	1.62
2	Water Absorption	0.40 %
3	Moisture content	0.20 %
4	Specific Gravity	2.7

D. Fine aggregate: In this experimental work manufactured sand was used as fine aggregate. Manufactured sand is a fine aggregate that is produced by crushing stone or gravel. In this investigation fine aggregate used is 4.75 mm down size.

Table II: Physical properties of fine aggregates

Sl. No.	Property	Results
1	Specific Gravity	2.68
2	Water absorption	4.5%
3	Moisture content	1.6%

E. Water: Water is the least expensive material available for making concrete. The water is used for making concrete and for curing. Water available in the college laboratory was used in this study.

F. Fiber: In this experimental study Macro Synthetic Fiber is used. Macro synthetic fibers of 36mm length and 47 mm length were used in this experimental work. The properties of macro synthetic fiber are shown in below table III.

Table III: Property of Macro synthetic fiber

Sl. No.	Characteristic	Material Property
1	Base Resin	Modified olefin
2	Surface texture	Continuously Embossed
3	Specific Gravity	0.90 - 0.92
4	Length	36 mm and 47 mm

G. Chemical admixture: In this experimental study Master Glenium SKY 8233 manufactured by BASF is used.

III. EXPERIMENTAL PROGRAM

Experimental investigation was carried out to study the effect of macro synthetic fiber and fly ash on self compacting concrete. Workability and mechanical properties of concrete were studied. Cement was partially replaced by fly ash. Macro synthetic fiber with different length and dosage were used.

Following are the variations in parameters:

1. Cement replacement: Cement was partially replaced by 20% and 30% of fly ash by volume.
2. Fiber dosage: Macro synthetic fibers of 2 kg/m³ and 4 kg/m³ were used in this experimental work.
3. Fiber length: 36mm and 46 mm length of macro synthetic fibres were used.

Table IV: Tabular column for variation in parameters.

Mix	Cement %	Fly ash %	Macro Synthetic Fiber	
			Length mm	Dosage Kg/m^3
Mix A	80	20	-	-
Mix A1	80	20	36	2
Mix A2	80	20	36	4
Mix A3	80	20	47	2
Mix A4	80	20	47	4
Mix B	70	30	-	-
Mix B1	70	30	36	2
Mix B2	70	30	36	4
Mix B3	70	30	47	2
Mix B4	70	30	47	4

A. Tests on concrete.

Following tests are conducted to find the properties of concrete in fresh and hardened state.

1. Test on concrete in fresh state - Slump flow, J ring test, V funnel test, L box test.
2. Test on concrete in hardened state - Compressive strength test, Split Tensile strength test, Flexural strength test.

B. Mix Proportion.

To achieve optimum SCC mix various trail mix where done by varying cement, coarse aggregate, fine aggregate, water and super plasticizer. Once getting the optimum mix design, two mixes were prepared by replacing cement with fly-ash at 20% and 30 %. To this two mixes macro synthetic fibers were added. In this experimental work, mixing of concrete was carried out by electric mixer machine.

Table V: Mix Proportion of concrete

Mix proportion	Cement kg/m³	Fly ash kg/m³	Fine Aggregate kg/m³	Course Aggregate kg/m³	Water Lt/m³	SP kg/m³	W/C ratio	Density kg/m³	Fiber	
									Length mm	Dosage kg/m³
Mix A	**431.75**	**75.37**	**905.16**	**746.17**	**182.95**	**4.057**	**0.361**	**2341.41**	**-**	**0**
Mix A1	**431.75**	**75.37**	**905.16**	**746.17**	**182.95**	**4.057**	**0.361**	**2341.41**	**36**	**2**
Mix A2	**431.75**	**75.37**	**905.16**	**746.17**	**182.95**	**4.057**	**0.361**	**2341.41**	**36**	**4**
Mix A3	**431.75**	**75.37**	**905.16**	**746.17**	**182.95**	**4.057**	**0.361**	**2341.41**	**47**	**2**
Mix A4	**431.75**	**75.37**	**905.16**	**746.17**	**182.95**	**4.057**	**0.361**	**2341.41**	**47**	**4**
Mix B	**377.78**	**113.06**	**905.16**	**746.17**	**182.95**	**3.926**	**0.373**	**2325.12**	**-**	**0**
Mix B1	**377.78**	**113.06**	**905.16**	**746.17**	**182.95**	**3.926**	**0.373**	**2325.12**	**36**	**2**
Mix B2	**377.78**	**113.06**	**905.16**	**746.17**	**182.95**	**3.926**	**0.373**	**2325.12**	**36**	**4**
Mix B3	**377.78**	**113.06**	**905.16**	**746.17**	**182.95**	**3.926**	**0.373**	**2325.12**	**47**	**2**
Mix B4	**377.78**	**113.06**	**905.16**	**746.17**	**182.95**	**3.926**	**0.373**	**2325.12**	**47**	**4**

C. Casting and Curing:

Concrete cubes of 15cm side were casted for compressive test, cylinders of 15cm diameter and 30cm length were casted for split tensile test and prisms of 10cm x 10cm x 50cm were casted for flexural strength test. All this specimens were removed from the moulds after 24 hours and immersed in water for curing till test day. The specimens were water cured for 28 days and 56 days. The tests were conducted at the age of 28 days and 56 days.

IV. RESULTS AND DISCUSSION

A. Tests on Fresh Properties of SCC

Following are different workability tests results performed on fresh concrete

Table VI: Workability Test Results

Mix proportion	Slump flow test Diameter mm	J ring test H_2-H_1 mm	V funnel test Times	L box test H_2/H_1
Mix A	695	5	8	0.88
Mix A1	686	7	8	0.86
Mix A2	673	9	9	0.85
Mix A3	678	10	9	0.83
Mix A4	663	11	10	0.80
Mix B	688	6	8	0.87
Mix B1	677	8	9	0.84
Mix B2	662	10	9	0.83
Mix B3	667	10	10	0.82
Mix B4	655	11	11	0.79

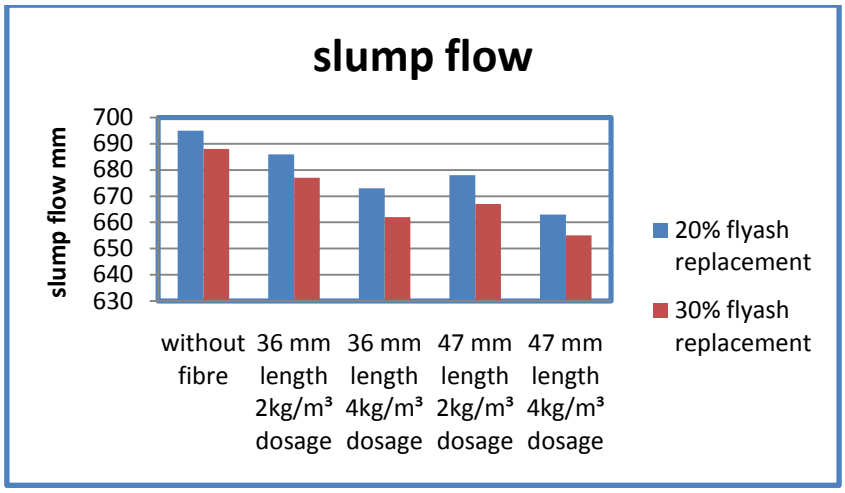

Fig.1: Slump flow v/s Fiber length and dosage

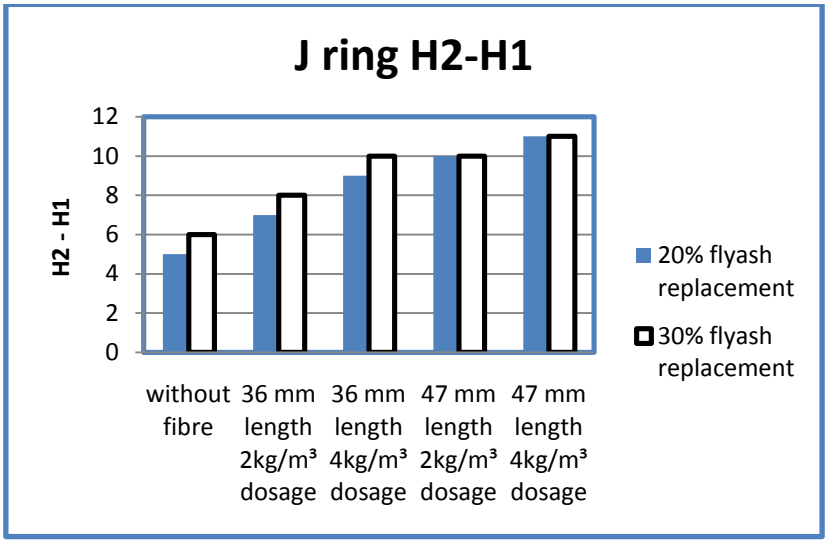

Fig.2: J ring v/s fiber length and dosage

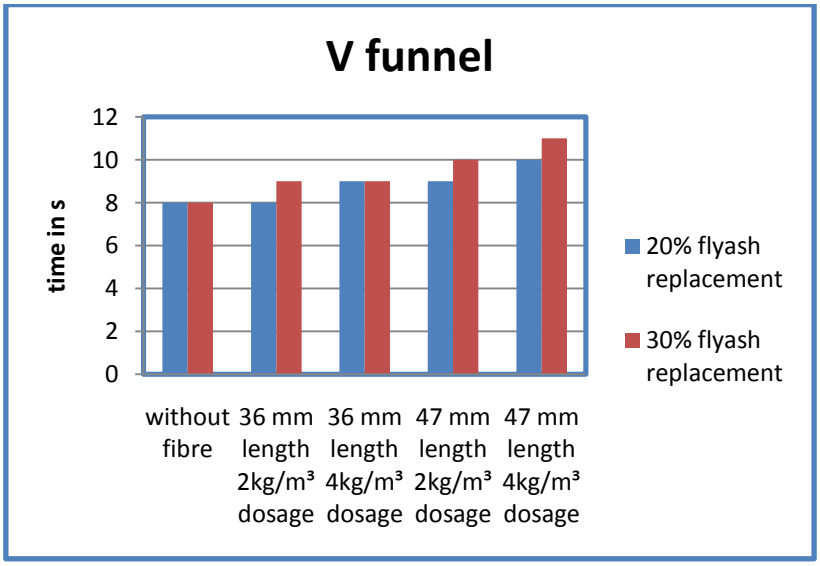

Fig.3: V funnel time v/s fiber length and dosage

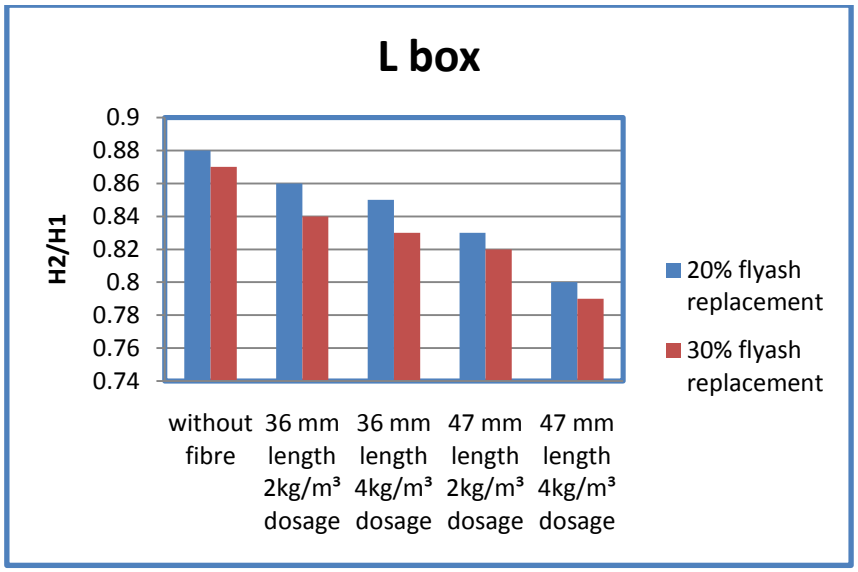

Fig.4: L box ratio v/s fiber length and dosage

B. Test results on hardened concrete

Table VII: Compressive strength test results

Mix	28 day compressive strength N/mm²	56 day compressive strength N/mm²
Mix A	**61.88**	**64.311**
Mix A1	**65.688**	**69.303**
Mix A2	**63.229**	**65.288**
Mix A3	**65.837**	**68.355**
Mix A4	**64.488**	**66.637**
Mix B	**56.251**	**64.637**
Mix B1	**57.985**	**65.096**
Mix B2	**54.207**	**64.162**
Mix B3	**57.051**	**65.748**
Mix B4	**56.459**	**64.059**

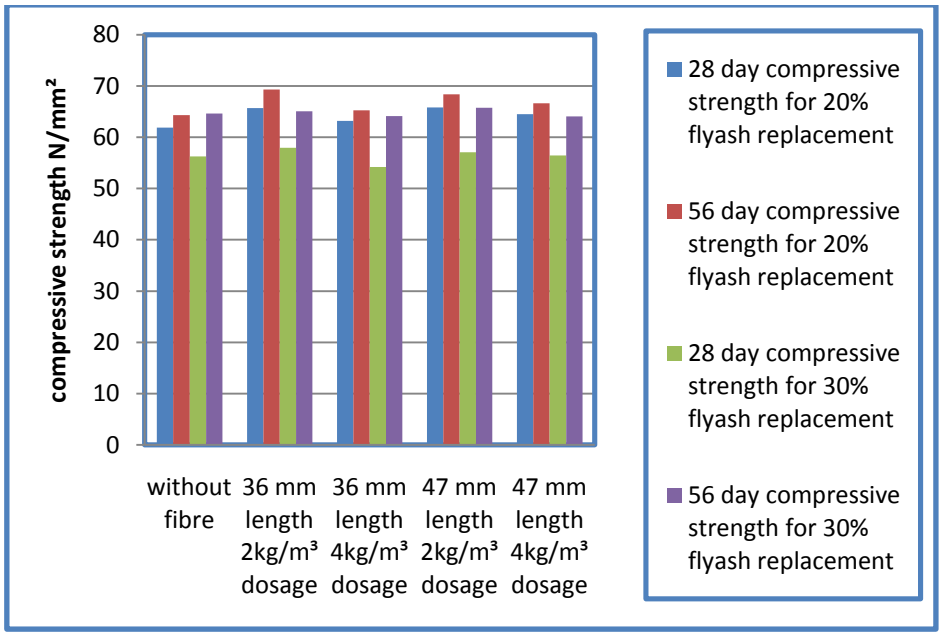

Fig.5: Compressive strength v/s fiber length and dosage

Table VIII: Split Tensile Strength test results

Mix	28 day tensile strength N/mm²	56 day tensile strengthN/mm²
Mix A	**4.079**	**4.314**
Mix A1	**4.456**	**4.597**
Mix A2	**4.904**	**5.210**
Mix A3	**4.644**	**4.951**
Mix A4	**5.234**	**5.375**
Mix B	**3.961**	**4.291**
Mix B1	**4.267**	**4.668**
Mix B2	**4.692**	**5.163**
Mix B3	**4.621**	**4.880**
Mix B4	**5.281**	**5.540**

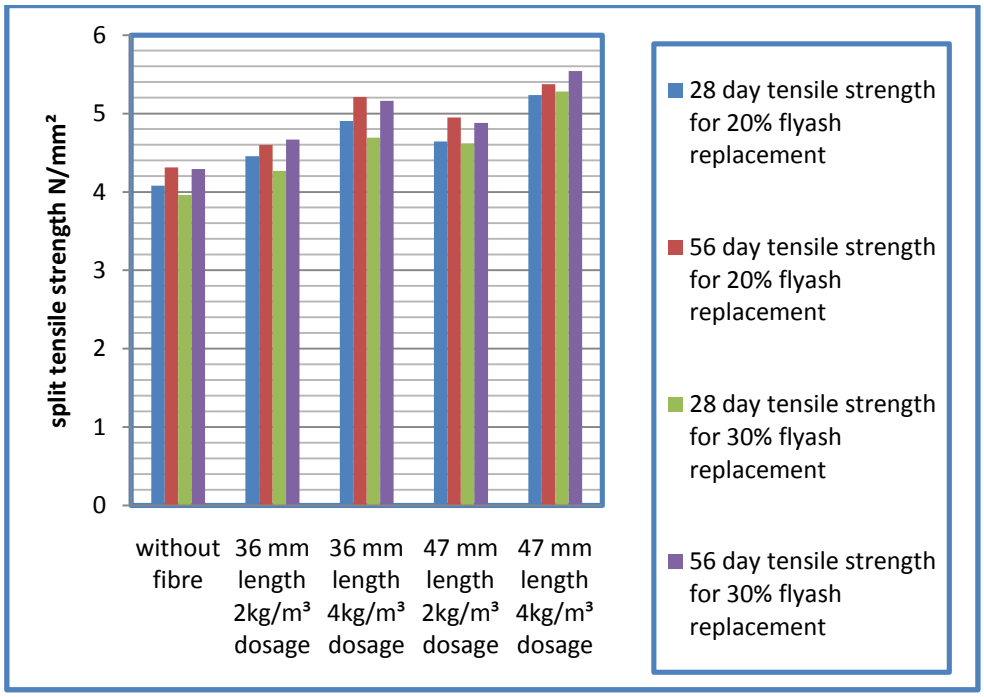

Fig.6: Split tensile strength strength v/s fiber length and dosage

Table IX: Flexural strength test result

Mix proportion	28 day flexural strength N/mm²	56 day flexural strength N/mm²
Mix A	**6.624**	**7.344**
Mix A1	**6.66**	**7.488**
Mix A2	**6.696**	**7.596**
Mix A3	**6.732**	**7.524**
Mix A4	**6.804**	**7.596**
Mix B	**5.472**	**7.74**
Mix B1	**5.58**	**7.848**
Mix B2	**5.544**	**7.956**
Mix B3	**5.58**	**7.992**
Mix B4	**5.616**	**7.776**

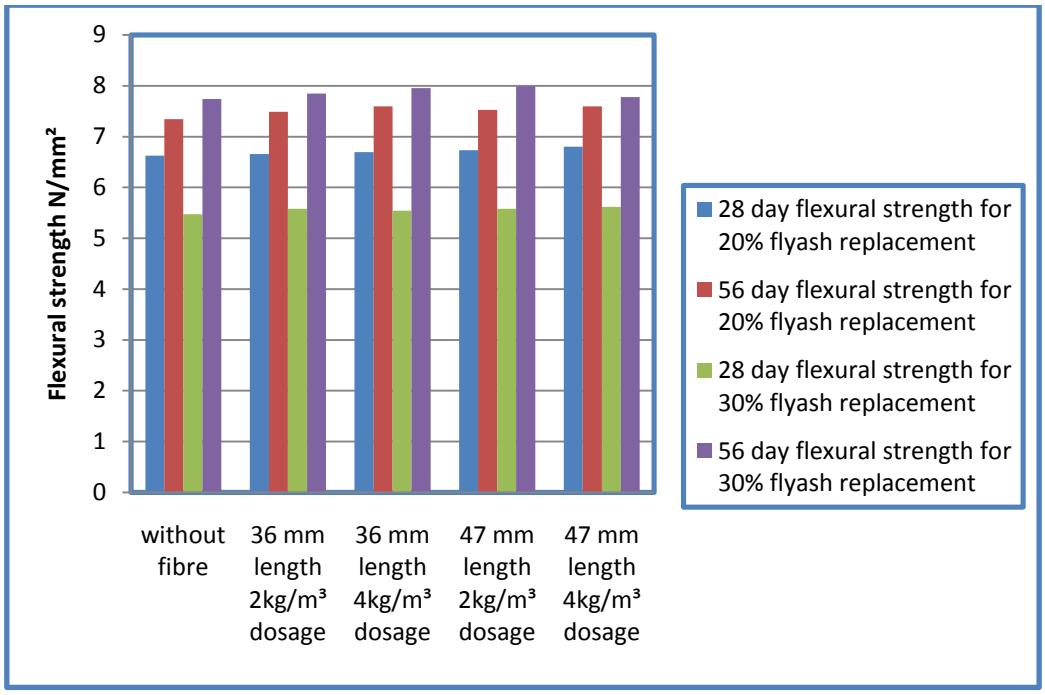

Fig.7: Flexural strength v/s fiber length and dosage

V. CONCLUSION

The following conclusions can be drawn from this study based on the results obtained:

[1]. With increase in percentage of fly ash, the amount of workability was observed to be reduced.
[2]. Decrease in workability was observed with increase in fiber dosage.
[3]. Decrease in workability was observed with increase in fiber length.
[4]. 28 day compressive strength was observed to be greater for 20% fly ash replaced mix when compared with 30% fly ash replaced mix.
[5]. A marginal increase in split tensile strength was observed with increase in fiber dosage from 2kg/m^3 to 4kg/m^3.
[6]. A marginal increase in split tensile strength was observed with increase in fiber length from 36mm to 47mm.
[7]. In this study, addition of macro synthetic fiber did not improve significantly the flexural strength of concrete specimen.
[8]. Flexural strength at the age of 28 days was observed to be more for 20% fly ash replaced mix when compared with 30% fly ash replaced mix.

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