EVALUATION OF THE STRENGTH PROPERTIES OF HOOKED END STEEL FIBER REINFORCED CONCRETE PRODUCED WITH FLY ASH.

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Abstract - *In this paper, an attempt has been made to study the strength properties of concrete with different percentages of hooked end steel fibers and fly ash. The concrete mixture design is done for M30 grade of concrete with water cement ratio 0.45. The steel fiber reinforced concrete containing fibers of 0.5%, 1.0% and 1.5% volume fraction of hooked end steel fibers of 60 aspect ratio were used. The cement in concrete is replaced with percentage of 10%, 15% and 20% by weight of fly ash. The cube size is 150mm x150mm x150 mm for testing the compressive strength of concrete. Flexural strength is checked by testing beams of size 700 mm x 150 mm x 150 mm beneath two points loading. From experiment, it was concluded that the most optimum fiber and fly ash content that gives maximum compressive strength and flexural strength was 1.5% and 10% respectively. The reduction in workability due to fiber addition can be compensated by addition of fly ash.*

Key Words: Fiber, Fly ash, Concrete, Flexural Strength, Compressive Strength.

1. INTRODUCTION

Concrete is mostly wide construction material in the world due to its ability it can be mould and shape. However concrete has some deficiencies as listed below, Low tensile strength, Low post cracking capacity, Brittleness and low ductility, Low impact strength. These properties can be improved by the use of steel fiber reinforced concrete. The addition of fibers improves the post cracking response of the concrete, i.e., it improves its energy absorption capacity and apparent ductility, and also provides crack resistance and crack control.

Recent report aimed at energy conversation in the cement and concrete industry has in part, focused on the use of less energy intensive materials such as Fly ash, Slag and Silica Fume. Fly ash is a byproduct obtained from thermal industry which is used as mineral admixtures in concrete. The addition of fly ash improves the latter strength and durability of the concrete.

2. RESEARCH SIGNIFICANCE

This research is aimed at studying the improvement in properties of concrete like compressive strength and flexural strength which increases with adding steel fibers and fly ash with different percentages in concrete. The optimum percentage of volume fraction of steel fiber and fly ash by weight of cement is determined at which it gives more compressive and flexural strength. The study also aims at determining the flexural strength of the concrete beams based on the cross sectional dimensions, span and amount of Steel Fibers + Fly Ash used and compared with actual strength obtained based on experimental results. The research findings will help engineers to understand the overall performance of concrete for compressive strength, flexural strength.

3. EXPERIMENTAL PROGRAM & SETUP

In this Chapter, the test results are presented and discussed. The test results cover the compressive strength, flexural strength, workability of concrete and compaction factor. The main aim of this experimentation is to study the effect of adding volume fraction of hooked end steel fibers and partial replacement of cement by fly ash on the properties of concrete.

The experimental program is divided in four phases.

a) Concrete mix design as per IS 10262-2009 for M30 grade of concrete. Volume fraction of hooked end steel fibers and partial replacement of cement by fly ash with varying percentages.

b) Casting of cubes and beams.

c) Curing of cubes and beams for 7 days and 28 days.

d) Testing of all beam specimens with single point loading for flexural strength and compressive strength for all cubes.

Each test result plotted in the Figures or given in the Tables is the mean value of results obtained from at least three specimens.

4. MATERIAL AND METHODS

4.1 Cement

The cement used in this experimental work is 43 grades Ordinary Portland Cement. All properties of cement are tested by referring IS 12269 - 1987 Specification for 43 Grade Ordinary Portland cement.

4.2 Water

Potable water used for the experimentation.

4.3 Fine Aggregate

Locally available sand passed through 4.75mm IS sieve is used. The specific gravity of 2.63.

4.4 Coarse Aggregate

Crushed aggregate available from local sources has been used. The coarse aggregates with a maximum size of 20mm having the specific gravity value of 2.68.

Table -1: Properties of FA and CA

Properties	Fine Aggregate (River Sand)	Coarse Aggregate (Crushed Stone)
Specific Gravity	2.63	2.68
Fineness Modulus	3.75	7.13
Loose Bulk Density (Kg/m^3)	1450	1350
Compacted Bulk Density (Kg/m^3)	1700	1610

4.5 Steel fibers

Steel fibers are the most commonly used type of fibers. Steel has high modulus of elasticity. Use of steel fibers provides significant improvements in flexure, impact and fatigue strength of the concrete. Concrete containing hydraulic cement, water, aggregate, and discontinuous discrete fibers is called fiber reinforced concrete. The steel fiber used in the study is hooked end type MSH 5030 having aspect ratio 60. The length of fiber is 30mm and the diameter of fiber is 0.50mm.

Table -2: Properties of Steel Fiber

Mechanical Properties of Hooked End Steel Fiber	
Length	30mm
Diameter	0.50mm
Aspect ratio	60
Tensile Strength	1186Mpa
Tolerance for diameter and length	(+-) 10% (As per ASTM)

4.6 Fly Ash

The usage of cement blended with mineral admixtures such as fly ash and slag is growing rapidly in construction industry due to the considerations of cost saving and sustainability. The addition of fly ash in concrete results in improvement of properties such as workability, later age strength development and durability characteristics.

ASTM broadly classified fly ash into two classes as

Class F fly ash: Fly ash normally produced by burning anthracite or bituminous coal, usually has been than 5% CaO. Class F fly ash has pozzolanic properties only.

Class C fly ash: Fly ash normally produced by burning lignite or sub-bituminous coal. Some fly ash may have CaO content in excess of 10%. In addition to pozzolanic properties, class C fly ash also possess cementitious properties.

Table -3: Chemical composition of fly ash

S.No.	Chemical Composition (%)	Fly Ash
1	Silica (SiO_2)	58.3
2	Alumina (Al_2O_3)	31.7
3	Ferric Oxide (Fe_2O_3)	5.9
4	Calcium oxide (CaO)	2.0
5	Magnesium oxide (Mgo)	0.1
6	Sodium oxide (Na_2O)	0.8
7	Potassium oxide (K_2O)	0.8
8	Sulphuric anhydride (SO_3)	0.2
9	Loss on Ignition (LOI)	0.3

4.7 Concrete

A control concrete mix of M30 grade was mix proportioned. The mix design procedure was according to the guidelines of IS 10262-2009. The fine aggregate confirming to zone II of IS 383:1970 and coarse aggregate of nominal size 20mm was used in the study. The cement used was 43 grade OPC with w/c ratio 0.45. Specific gravity of fine aggregate and coarse aggregate are 2.63 and 2.68 respectively.

Mix Proportion :

Table -4: Mix Proportion

water	cement	Fine Aggregate	Coarse Aggregate
185	412	612	1158
0.45	01	1.48	2.81

5. RESULTS AND DISCUSSION

5.1 Compressive Strength Test

Standard cube specimens of 150mm x 150mm x 150mm size were casted. The cube compressive strength for different mixes at period of 7 days and 28 days curing was calculated by following formula:

Compressive strength (N/mm^2) = P/A
Where,
P: Failure load
A: cross sectional area of cube

Table -5: Compressive Strength at 7 days and 28 days

Mix No.	Steel Fiber%	Fly Ash%	Compressive Strength (N/mm^2)	
			7 Days	28 Days
S0	00%	00%	24.13	34.16
S1	0.5%	10%	29.68	36.04
S2	0.5%	15%	23.79	30.81
S3	0.5%	20%	24.02	30.55
S4	1.0%	10%	39.04	43.24
S5	1.0%	15%	31.77	37.30
S6	1.0%	20%	24.80	26.38
S7	1.5%	10%	30.54	46.91
S8	1.5%	15%	27.62	41.42
S9	1.5%	20%	31.66	33.31

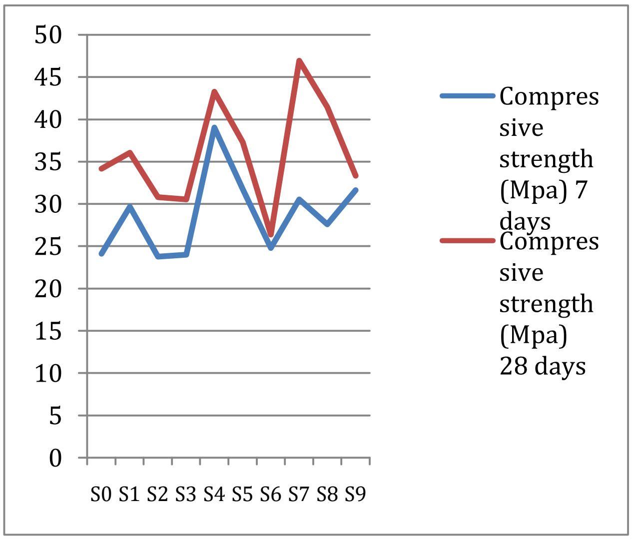

Chart -1: Compressive strength at 7 days and 28 days

5.2 Flexural Strength Test

Standard cube specimens of 150mm x 150mm x 700mm size were casted. The cube compressive strength for different mixes at period of 28 days curing was calculated by following formula:

Flexural strength (N/mm^2) = PL/bd^2
Where,
P: Failure load,
L: centre to centre distance between the supports,
b: width of specimen,
d: depth of specimen

Table -6: Flexural Strength at 28 days

Mix No.	Steel Fiber%	Fly Ash%	Flexural Strength(N/mm^2)
			28 Days
S0	00%	00%	3.55
S1	0.5%	10%	3.97
S2	0.5%	15%	3.61
S3	0.5%	20%	2.96
S4	1.0%	10%	5.09
S5	1.0%	15%	4.14
S6	1.0%	20%	3.85
S7	1.5%	10%	5.27
S8	1.5%	15%	4.62
S9	1.5%	20%	4.26

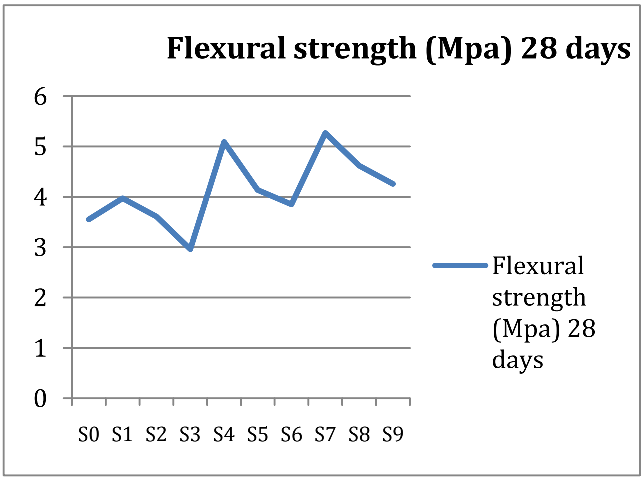

Chart -2: Flexural Strength at 28 days

6. CONCLUSIONS

[1] As the percentage of steel fiber content by total volume of the concrete increases it gives high compressive strength and flexural strength compare to plain concrete.
[2] Workability of concrete is improves when fly ash percentage increases.
[3] The S4, S7and S8 gives high compressive strength.
[4] The S4 and S7 gives high flexural strength
[5] The compressive strength and flexural strength of concrete increases with steel fiber & fly ash content. Therefore it is always preferable to use 1.5% volume fraction of steel fiber & fly ash as 10% replacement by weight of cement and it gives us better result.

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REFERENCES

[1] Mr. Christin Varghese, Mr. Nidhin Joseph (2015), “Optimum flyash and fiber content for M20 grade concrete”, IJMER.

[2] Rahul D. Pandit, S. S. Jamkar (2013), “Mechanical behavior of high strength fiber reinforced concrete”, IJERA.

[3] Olutoge festus, ofuyatan olatokunbo and Richard ayinde (2015), “Evaluation of the strength properties of steel fiber reinforced concrete produced with fly ash as partial cement replacement ”, ACSEE.

[4] Ashish Lodhi, Prof. Anubhav Rai (2015), “Compressive property of steel fiber concrete with mineral admixture for M35 grade”, SSRG-IJCE.

[5] Misba Gul, Alsana Bashir (2014), “Study of modulus of elasticity of steel fiber reinforced concrete”, IJEAT.

[6] Mekala Prathap Reddy, Dr. K. Chandrasekhar Reddy (2013), “Determination of mechanical properties of steel fiber reinforced concrete with mineral admixtures”, IJSR.

[7] IS: 10262-2009, Recommended guidelines for concrete mix design, Bureau of Indian standards, New Delhi, India.

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