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Effect of Steel Fiber and Jute Fiber In High Strength Concrete

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Abstract - *In the present scenario, concrete use has increased very fast. It is shown that the concrete isa the most commonly used material in the world for the engineering works. Especially high strength concrete is nowadays very well utilized in many aspects. To increase the strength and the durability of the concrete some fibers are used here. Steel fiber is commonly used fiber in comparison of other fibers. Jute fiber is best for environmental and economical aspect. In this study the steel fiber and jute fiber is used as hybrid fiber in high strength concrete. With the different percentage of steel fiber and jute fiber has been use in concrete mix. Steel fiber and jute fiber having length of 15 mm and different percent by weight of concrete are 0.00%(conventional), 0.25%, 0.50%, 1.00% and 1.50% were added to prepare concrete cubes and beams. The mix design of concrete has been carried out for the M60 grade of concrete. The compressive strength and flexural strength has been carried out for the different mix proportions of steel fiber and jute fiber. The result shows that the compressive strength was increase till some extent of mix proportion and same for the flexural strength of the different mix proportion.*

Key Words: **High Strength Concrete, Steel Fiber, Jute Fiber, Hybridization of Fiber, Slump, Compressive strength, Flexural strength**

1. INTRODUCTION

In present scenario the use of concrete being increased day by day very fast. The concrete is very most used construction material in the world. Concrete gives the best strength to the building or any structure. The addition of the fibers in the concrete gives the good benefits in form of the cracking resistant, toughness and the strength. High strength concrete used in high rise buildings. The addition of proper percentage of fiber gives more strength to the building. In this chapter, the materials and fibers are introduced. In this chapter the basic information of the concrete and fibers are described. Fibers gives the better strength to the concrete. Concrete is the must needed material in the building and structure and in infrastructure development. Concrete are the widely used material in the construction. We can't avoid it due to its heavy use in the world. The concrete at some instinct considered as the environmental undesirable. Concrete characterised by its low strength-strain capacity in the tension. Also the low fracture toughness. Concrete can gives the high compressive strength. But concrete can't provide tensile strength.

2. Material Properties

The various materials are used in making good concrete. The different material properties and its characteristics is need to make good concrete. To make the good performance concrete the material should be proper determined. In this chapter, Here the all required properties to make high strength concrete is determined and the mix design of M60 grade of concrete is calculated and determined.

2.1 Cement

Cement is the most needed material in concrete. Cement is a binding material. Generally two types of cement is used 1.Portland cement and 2.ordinary Portland cement. Here in the project the Ordinary Portland Cement (OPC)is taken. There are also grades in ordinary Portland cement which is 33,43 and 54 grade. Here in the project the cement used is OPC 53 grade. For using the cement, it should be confirmed by the Indian Standard Code IS 269 & IS 12269. According to IS 269 the minimum compressive strength of OPC should be 27 MPa. The fineness of cement = 225 m^2/kg.

2.2 Fine Aggregate

Fine aggregate is which passed through 4.75 IS sieve then is called as the fine aggregate. Fine aggregate role is to make concrete dense which is done by filling the voids in concrete due to coarse aggregates by using fine aggregates. Crushed stone, sand, crushed gravel sand all are fine aggregate. According to IS code fine aggregates are divided in four zone; Zone I, II, III and IV. For mixing design of concrete the sand is used.

Table 1 - Fine Aggregate Properties

Properties	Result
Specific Gravity	2.65
Water Absorbtion	1%
Moisture Content	Nil

2.3 Coarse Aggregate

For coarse aggregate, the aggregate which passed through 75 mm mesh and all retained on the 4.75 mm sieve these all aggregates called as coarse aggregates. Coarse aggregates are naturally available and also can be obtain by blasting

quarries. Coarse aggregate makes concrete strong and durable. For the project the 20 mm size crushed angular aggregate is taken for use.

Table 2 - Coarse Aggregate Properties

Properties	Result
Specific Gravity	2.74
Water Absorbtion	0.5%
Moisture Content	Nil

2.4 Fly Ash

Fly ash is generally produced by coal fired electric and steam generating plants. Fly ash is fines part of ash which is transported by flue gases. Fly ash addition reduces cement content so it gives environmental and economical benefits. Fly ash use in concrete improves workability of concrete, strength and durability of hardened concrete. In the project M60 grade is being used so to improve concrete strength some percentage of fly ash is use.

Table 3 - Fly Ash Properties

Properties	Result
Specific Gravity	2.2
% use in concrete mix	15%

2.5 Silica Fume

Silica fume is the by product of the ferrosilicon industries. In the project M60 grade of concrete is being used so some percentage of silica fume is used. Silica fume is highly pozzolanic material which improves mechanical and durability properties of concrete. Silica fume is very fine material which refines pore structure and make concrete of improved mechanical strength. Their oxides (SiO_2) react with and consumed calcium hydroxide, which is been produced by the hydration of OPC.

Table 4 - Silica Fume Properties

Properties	Result
Specific Gravity	2.2
% use in concrete mix	5%

2.6 Steel Fiber

Steel fiber is the ne of the most used fiber. The use of steel fiber in concrete gives the significant improvement in the flexural strength, impact strength of the concrete. Steel fiber is used for the pavement of bridge decks. Also in thin plates construction the steel fiber is used. Steel fiber is comes under metallic fiber in the classification of the fibers. Steel fiber gives the bridging cracks and also provide increase in the stress bearing capacity of concrete. Use of steel fiber is very widespreaded. The steel fiber benefits depend upon various factors like shape, length, strength, and the fiber content, also a mix design. The crack bridging mechanism, post cracking strength and ductility improves by using the steel fiber in concrete.

Table 5 - Steel Fiber Properties

Properties	Result
Length	15 mm
Diameter	0.5 mm
Aspect Ratio	30

2.7 Jute Fiber

The natural fibers are used in the concrete mix to provide the more compressive strength and also provides some tensile strength. The use of natural fiber is taken on consideration as an economical aspects and also as the socioeconomical aspect. By the origin of natural fibers, it is classified as plant, animal and the mineral. Adding the plant based natural fibers in the concrete improve the compressive and tensile strength of concrete. Also the another advantage of using natural fiber is the it takes less energy to extract into the fibers. From all different fibers the jute fiber is best economical and most durable fiber.

Table 6 - Jute Fiber Properties

Properties	Result
Length	15 mm
Diameter	0.2 mm
Aspect ratio	75

2.8 Admixture

Admixtures are natural or manufactured chemicals or additive added during concrete mixing to enhance specific properties of the fresh or hardened concrete like workability, durability or early and final strength. An admixture is defined as a material other than the water, cement,cementitious material to modify its fresly mixed or setting. It is added before or during mixing of concrete. CONFLOW-MPC is MID range Polycarboxylic Ether based superplasticizer of a new generation confirming to IS:9103-1999. The product has been primarily developed for application in high performance concrete where the highest durability and performance is required.

Table 7 – Admixture Properties

Name	CONFLOW-MPC
Specific Gravity	1.110 ± 0.02
Appearance	Dark Brown

2.9 Water

For the hydration of the cement, water is used. Waster added to cement which makes paste and also work as lubricate for the aggregate to form concrete very well. The quantity of water should be calculated and determined for the perfect mix. The water which is about to use in concrete it should be checked for clean and free from harmless quantities such as acids, vegetable growth, salt, oils. Water mixing in the concrete is very important for the good concrete mix.

3. Experimental Work

The experiment was carried out for the M60 grade of concrete. The test on fresh concrete was of slump come test and the tests on hardened concrete were like compressive strength test and flexural strength performend for the different fiber content pecentages. The mix proportions for different fiber content shown in Table – 8.

Table 8 – Mix Proportions

Mix Proportion	% of Steel Fiber	% of Jute Fiber
1	0.00	0.00
2	0.25	0.25
3	0.50	0.50
4	1.00	1.00
5	1.50	1.50

4. Results

4.1 Compressive Strength Test

The compressive strength test is carried out for cubes at 7,14 and 28 days. The size of concrete cube is 150 mm × 150 mm × 150 mm. The cubes with the different fiber percentage content were tested.

Table 9 – Compressive Strength Test at 7 Days

Mix Proportion	% of Steel Fiber	% of Jute Fiber	7 Days (N/mm²)
1	0.00	0.00	41
2	0.25	0.25	43.7
3	0.50	0.50	45
4	1.00	1.00	46.5
5	1.50	1.50	39

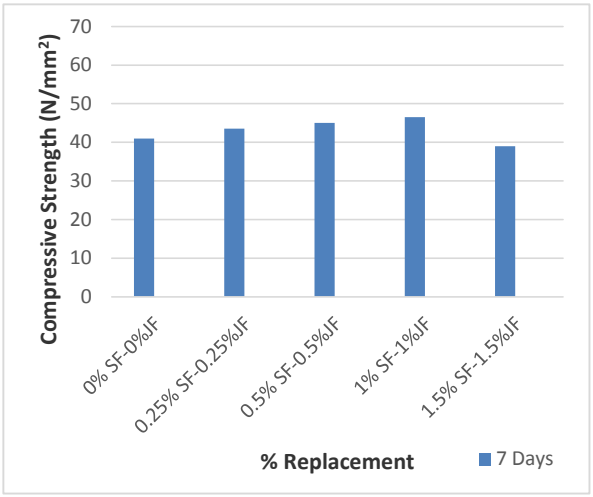

Chart 1 - Compressive Strength Test at 7 Days

Table 10 – Compressive Strength Test at 14 Days

Mix Proportion	% of Steel Fiber	% of Jute Fiber	14 Days (N/mm²)
1	0.00	0.00	56.8
2	0.25	0.25	57.3
3	0.50	0.50	58
4	1.00	1.00	58.8
5	1.50	1.50	52.6

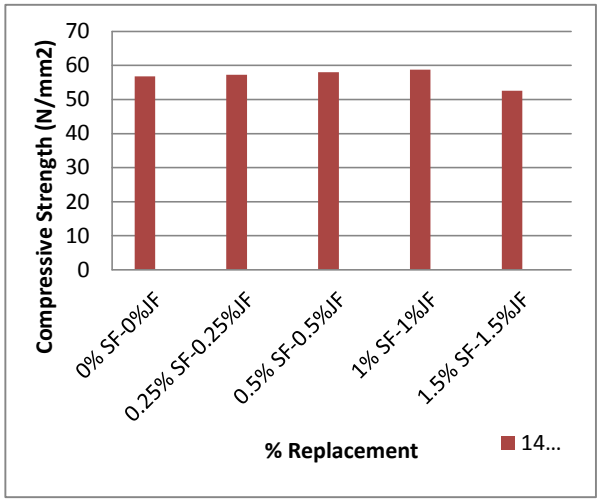

Chart 2 - Compressive Strength Test at 14 Days

Table 11 – Compressive Strength Test at 28 Days

Mix Proportion	% of Steel Fiber	% of Jute Fiber	28 Days (N/mm²)
1	0.00	0.00	66.3
2	0.25	0.25	66.9
3	0.50	0.50	67.3
4	1.00	1.00	68.1
5	1.50	1.50	56

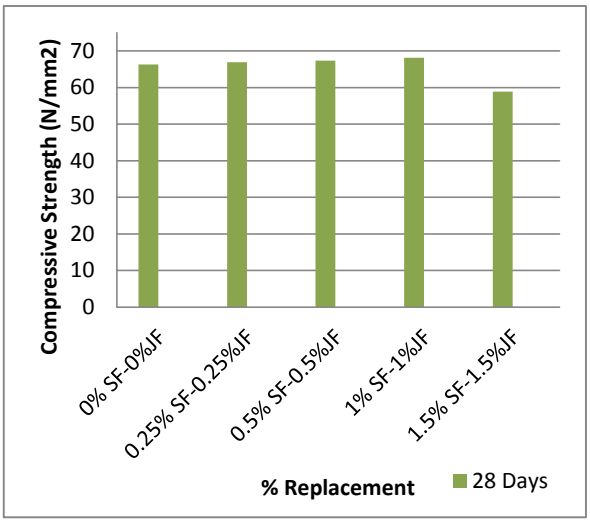

Chart 3 - Compressive Strength Test at 28 Days

The combined 7, 14 and 28 days of compressive strength shown in chart-4.

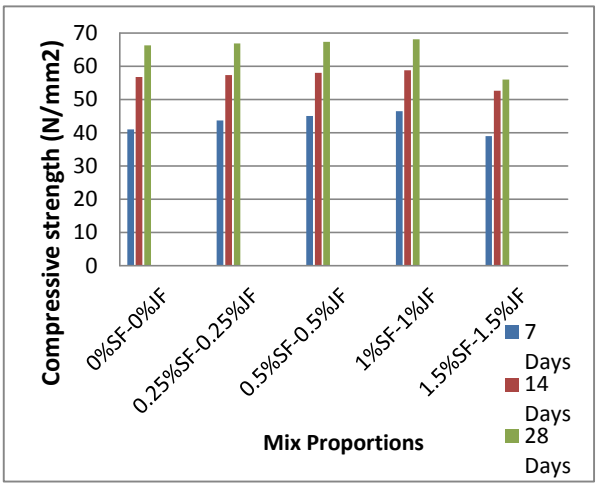

Chart 4 - Compressive Strength Test at 7,14 and 28 Days

4.2 Flexural Strength Test

The flexural strength of the beams were tested at 7, 14 and 28 days. Beams size is 150 mm × 150 mm × 150 mm. With different percentage of fiber content were tested for the beams.

Table 12 – Flexural Strength Test at 7 Days

Mix Proportion	% of Steel Fiber	% of Jute Fiber	14 Days (N/mm²)
1	0.00	0.00	7.2
2	0.25	0.25	7.27
3	0.50	0.50	7.45
4	1.00	1.00	7.61
5	1.50	1.50	5.45

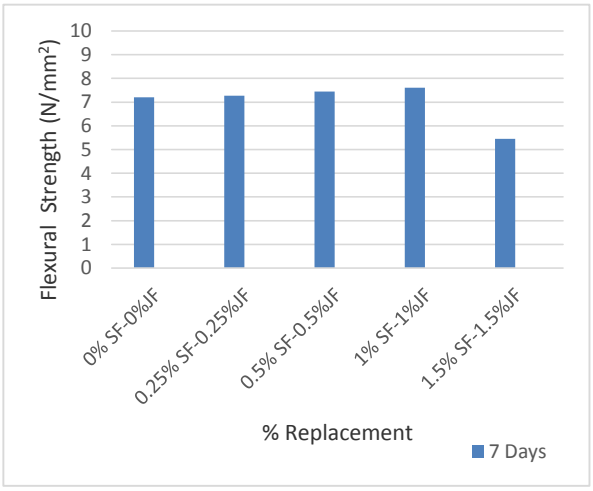

Chart 5 – Flexural Strength Test at 7 Days

Table 13 – Flexural Strength Test at 14 Days

Mix Proportion	% of Steel Fiber	% of Jute Fiber	14 Days (N/mm²)
1	0.00	0.00	7.22
2	0.25	0.25	7.35
3	0.50	0.50	7.55
4	1.00	1.00	7.7
5	1.50	1.50	6.1

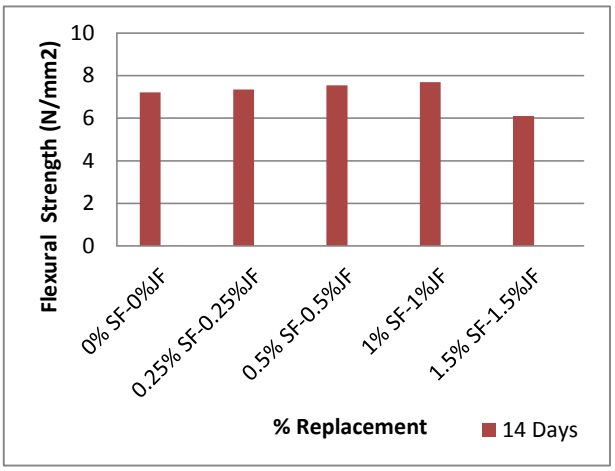

Chart 6 – Flexural Strength Test at 14 Days

Table 14 – Flexural Strength Test at 28 Days

Mix Proportion	% of Steel Fiber	% of Jute Fiber	14 Days (N/mm²)
1	0.00	0.00	7.8
2	0.25	0.25	8
3	0.50	0.50	8.1
4	1.00	1.00	8.4
5	1.50	1.50	7.15

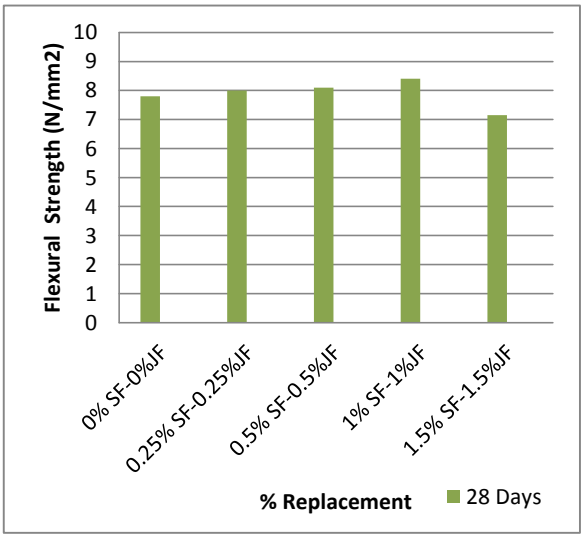

Chart 7 – Flexural Strength Test at 28 Days

The combined 7, 14 and 28 days of compressive strength shown in chart-8.

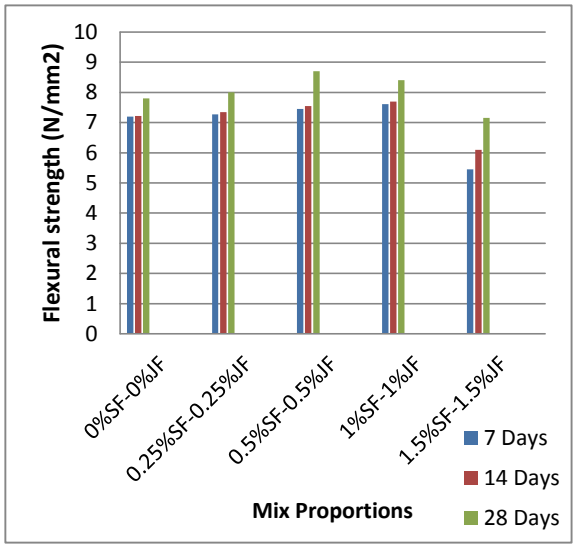

Chart 8 - Flexural Strength Test at 7, 14 and 28 Days

4.3 Slump Test

Slump test is been carried out for according to the IS 1199 code. It also specify the method for the procedure adopted. During casting of the concrete mix the test been carried out. The slump values are shown in Table-15.

Table 15 – Slump Test Results

Mix Proportion	% of Steel Fiber	% of Jute Fiber	Slump Value (mm)	Degree of Workability
1	0.00	0.00	110	High
2	0.25	0.25	107	Good
3	0.50	0.50	99	Medium
4	1.00	1.00	93	Low
5	1.50	1.50	87	Low

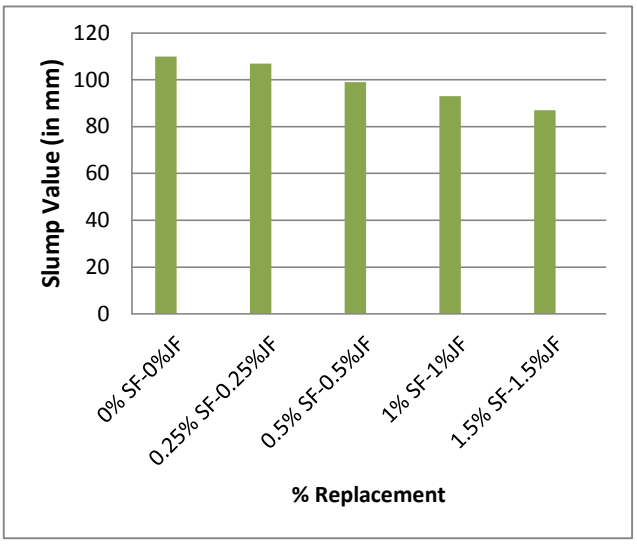

Chart 9 – Slump Test Results

5. CONCLUSIONS

In this study with different percentage of steel fiber and jute fiber content the tests were performed. The compressive strength test and flexural strength test and slump test were performed. Its results and conclusion are as follows:

- The slump test concluded that while increasing percentage of the fiber content, the slump value decrease which means that increasing fiber content reduces the workability of concrete.
- Compressive strength increase till the increasing of fibers at 1%SF-1.5%JF. At 1.5%SF-1.5%JF compressive strength of fiber concrete decreases. Inclusion of more that 1%SF-1%JF does not provides any better impact.
- Compressive Strength of fiber concrete was nearly maximum at 0.5%SF-0.5%JF fiber content and 1%SF-1%JF fiber content.
- For the flexural strength, strength increases as increasing the fiber content but till 1%SF-1%JF. More than this content gives no improvements. For the fiber content of 1.5%SF-1.5%JF the flexural strength decreases.
- So, the maximum flexural strength was observed nearly at 0.5%SF-0.5%JF fiber content and 1%SF-1%JF fiber content.

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