# STUDY OF STEEL FIBER IN PCC, RCC & PRESTRESSED CONCRETE FOR SHEAR & BENDING

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## ABSTRACT

*Investigation for M-40 grade of concrete having mix proportion 1:1.27:2.52 with water cement ratio 0.4 to study the compressive strength, flexural strength of steel fibre reinforced concrete (SFRC) containing fibers of 1% volume fraction of dramix fiber. A result data obtained has been analyzed and compared with a control specimen (0% fiber). Result data clearly shows percentage increase in 28 days Compressive strength, Flexural strength for M-40 Grade of Concrete.*

***Keywords:* Steel fibre increases Compressive, Flexural Strength of Concrete.**

## I. INTRODUCTION

Concrete is most widely used construction material in the world due to its ability to get cast in any form and shape. It also replaces old construction materials such as brick and stone masonry. The strength and durability of concrete can be changed by making appropriate changes in its ingredients like cementitious material, aggregate and water and by adding some special ingredients. Hence concrete is very well suitable for a wide range of applications. However concrete has some deficiencies as listed below: 1) Low tensile strength 2) Low post cracking capacity 3) Brittleness and low ductility 4) Limited fatigue life 5) Incapable of accommodating large deformations 6) Low impact strength The presence of micro cracks in the mortar-aggregate interface is responsible for the inherent weakness of plain concrete[1]. The weakness can be removed by inclusion of fibres in the mixture. Different types of fibers, such as those used in traditional composite materials can be introduced into the concrete mixture to increase its toughness, or ability to resist crack growth. The fibres help to transfer loads at the internal micro cracks. Such a concrete is called fibre-reinforced concrete (FRC).

Fiber-Reinforced Polymer Shear Strengthening of Reinforced Concrete Beams: Experimental Study and Analytical Modeling" by Carlo Pellegrino and Claudio Modena. The results provide some new insights into the complex failure mechanisms that characterize the ultimate shear capacity of RC members with transverse steel reinforcement and FRP sheets and the internal shear steel reinforcement with different static schemes

An experimental work on the steel fiber reinforced concrete to analyze effective moment of Inertia and flexural rigidity was reported by J Premalatha and R Sundara rajan. In this experimental work eighteen beams with 8mpa compressive strength and having tension and compression reinforcement and deformed steel fibers were tested under two point loading.

The introduction of the paper should explain the nature of the problem, purpose, and the contribution of the paper. The contents of each section may be provided to understand easily about the paper our future work is trying use of steel fiber in prestressed also.

## II. EXPERIMENTAL WORK

### 2.1) Material used

The materials used for this experimental work are cement, sand, water, steel fibres. Cement: Ordinary Portland cement of 43 grade was used in this experimentation. Coarse aggregate of 10-20 mm size having specific gravity of 2.70, Water: Potable water was used for the experimentation, Steel Fibers: - In this experimentation Dramix Steel fibres were used.. we casted total 18 beams, in that proportion i.e. 1% by volume of concrete and beams of same proportion[3], 3 for 28 days without steel fiber and also 3 plain beams for 28 days . Also by using same percentages 6 cubes are casted in that 3 are plain and 3 are with steel fiber(table 1)

Table.1 Mix Design Proportion of ingredients for M40

| **Water** | **Cement** | **F.A.** | **C.A.** |
|---|---|---|---|
| 186 kg/cum | 465 Kg/cum | 592.28 Kg/cum | 1171.83 Kg/cum |
| 0.4 | 1 | 1.27 | 2.52 |

### 2.2) Experimental methodology for P.C.C.

Compressive strength test:

For compressive strength test, cube specimens of dimensions 150 x 150 x 150 mm were cast for M40 grade of concrete[5]. The mould were filled with 1% fibres[3]. Vibration was given to the mould using table vibrator. The top surface of the specimen was levelled and finished. After 24 hours the specimens were demolded and were transferred to curing tank where in they were allowed to cure for 28 days. After 28 days curing, these cubes were tested on digital compression testing machine (fig1). The compressive strength was calculated as follows (table 2 & 3).

Fig.1 Cubes after testing

Table.2 Plain cubes test results M40

| **Cube** | **Fiber %** | **Load ($N/mm^2$)** |
|---|---|---|
| PL1 | 0% | 39.6 |
| PL2 | 0% | 40.4 |
| sPL3 | 0% | 40.4 |
| Avg. | 0% | 40.13 |

Table.3 Strength of cubes with 1% fiber[3] for M40

| Cube | Fiber content % | Load($N/mm^2$) |
|---|---|---|
| SF1 | 1.0% | 51.44 |
| SF2 | 1.0% | 49.87 |
| SF3 | 1.0% | 49.99 |
| | | **50.43** |

**Flexural strength test:**

For flexural strength test beam specimens of dimension 700x150x150 mm were cast. In that 3 are without steel fiber and 3are with steel fiber. The specimens were demolded after 24 hours of casting and were transferred to curing tank where in they were allowed to cure for 28 days. These flexural strength specimens were tested under two point loading on Flexural testing machine. Load and corresponding deflections were noted up to failure. In each category three beams were tested and their average value is reported (table 4,fig3),(table 5, fig 4). Fig.3 Mixing of Steel Fiber

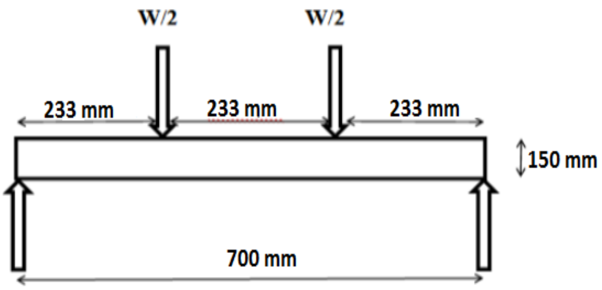


Fig.2 Beam with Double Point Load[1]

Table.4 Double Point Loading On Plain Beam :

| LOAD KN | PB1 | PB2 | PB3 |
|---|---|---|---|
| 100 | 0.17 | 0.13 | 0.18 |
| 200 | 0.3 | 0.23 | 0.37 |
| 300 | 0.55 | 0.54 | 0.47 |
| 400 | 0.62 | 0.71 | 0.58 |
| 500 | 0.7 | 0.75 | 0.65 |
| 600 | 0.84 | 0.86 | 0.83 |
| 700 | 0.87 | 0.89 | 0.9 |
| 800 | 0.9 | 0.97 | 0.98 |
| 900 | 1.1 | 1.02 | 1.09 |

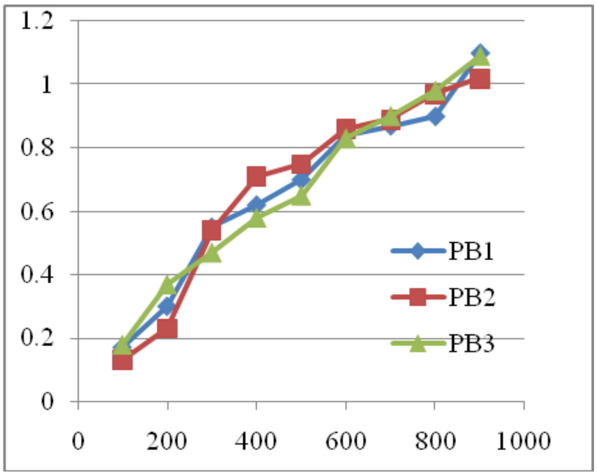


Fig.3 Graph (Deformation vs Load)

Table.5 Double Point Loading with Steel fiber Beam :

| LOAD KN | SFB1 | SFB2 | SFB3 |
|---|---|---|---|
| 100 | 0.05 | 0.11 | 0.06 |
| 200 | 0.12 | 0.3 | 0.14 |
| 300 | 0.16 | 0.31 | 0.29 |
| 400 | 0.35 | 0.3 | 0.34 |
| 500 | 0.36 | 0.36 | 0.4 |
| 600 | 0.43 | 0.42 | 0.42 |
| 700 | 0.47 | 0.47 | 0.53 |
| 800 | 0.7 | 0.55 | 0.62 |
| 900 | 0.76 | 0.7 | 0.72 |
| 1000 | 0.83 | 0.82 | 0.79 |

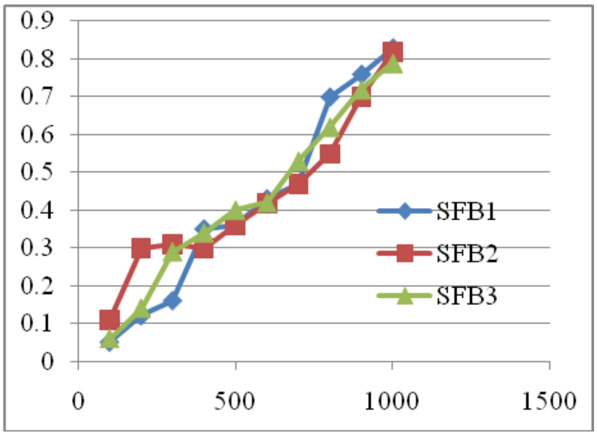


Fig.4 Graph (Deformation vs Load)

**2.3) Reinforced Concrete[5]**

Concrete is good in resisting compression but is very weak in resisting tension. Hence reinforcement is provided in the concrete wherever tensile stress is expected. The best reinforcement is steel, since tensile strength of steel is quite high and the bond between steel and concrete is good. As the elastic modulus of steel is high, for the same extension the force resisted by steel is high compared to concrete.

However in tensile zone, hair cracks in concrete are unavoidable. Reinforcements are usually in the form of mild steel or ribbed steel bars of 6 mm to 32 mm diameter (fig.5). A cage of reinforcements is prepared as per the design requirements, kept in a form work and then green concrete is poured. After the concrete hardens, the form work is removed. The composite material of steel and concrete now called R.C.C. acts as a structural member and can resist tensile as well as compressive stresses very well.

For flexural strength test 6 beam specimens of dimension 700x150x150 mm were cast with r.c.c (Fig.5). In this 3 are plain and 3 are with addition of steel fiber. The specimens were demolded after 24 hours of casting and were transferred to curing tank where in they were allowed to cure for 28 days. These flexural strength specimens were tested under two point loading on Flexural testing machine. Load and corresponding deflections were noted up to failure. In each category three beams were tested and their average value is reported.

Fig.5 R.C.C. beam filling

**2.4) Prestressed Concrete:**

**Flexural strength of prestressed beam:**

When prestressed concrete members are subjected to bending loads, different types of flexural failures are possible at critical sections, depending upon the principal controlling parameters, such as the percentage of reinforcement in the section, degree of bond between tendons and concrete, compressive strength of concrete and the ultimate tensile strength of the tendons.

**Types of flexural failure**

**1) Fracture of steel in tension**

The sudden failure of a prestressed member without any warning is generally due to the fracture of steel in the tension zone. This type of failure is imminent when the percentage of steel provided in the section is so low that when the concrete in the tension zone cracks, the steel is not in position to bear up the additional tensile stress transferred to it by the cracked concrete.

**2) Failure of under- reinforced sections**

As bending loads are increased, excessive elongation of the steel raises the neutral axis closer to the compressive face at the critical section (shown below). The member approaches failure due to the gradual reduction of the compression zone, exhibiting large deflections and cracks, which develop at the soffit and progress towards the compression face. When the area of concrete in the compression zone is insufficient to

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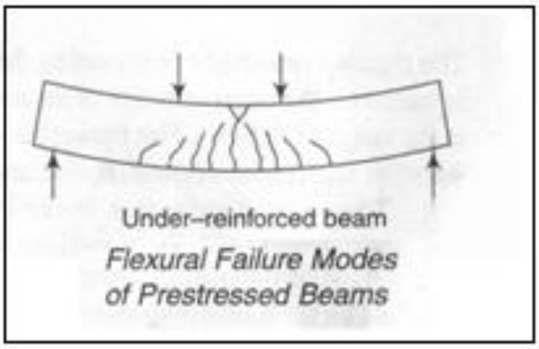
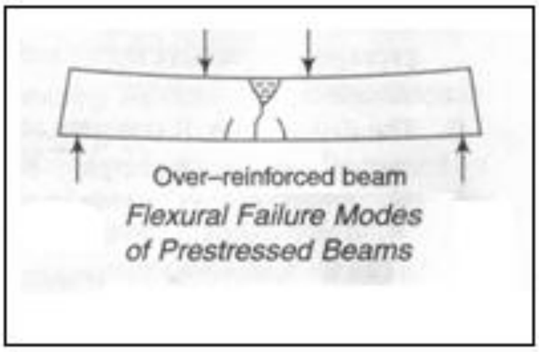
resist the resultant internal compressive force, the ultimate flexural failure of the member takes place through the crushing of concrete.



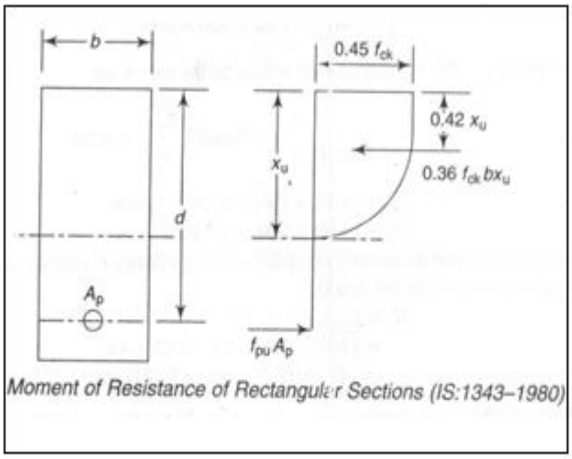

**3) Failure of over- reinforced sections**

Over reinforced members fail by the sudden crushing of concretes, the failure being characterized by small deflections shown below and narrow cracks the area of steel being comparatively large, the stress developed in still at failure of the member may not reach the tensile strength and in many cases it may will be within the proof stress of the tendons.




**Indian Code Provisions**

The Indian standard code method (IS: 1343-1980) for computing the flexural strength of rectangular sections or T-sections in which neural axis lies within the flanges is based on the rectangular and parabolic stress block (as shown in fig. below)




Moment of Resistance of Rectangular Sections (IS: 1343-1980)

The moment of resistance is obtained from the equation,

$$M_u = f_p A_p(d - 0.42x_u)$$

Where,

$M_u$= ultimate moment of resistance of the section ,

$f_{pu}$= tensile stress developed in tendons at the failure , $f_p$ = characteristic tensile strength of the prestressing ,

$f_{pe}$ = effective prestress in tendons after losses,

$A_p$ = area of prestressing tendons ,

$d$ = effective depth

$x_u$ = neutral-axis depth

Formula:-

$$P = \partial l \times A \times E / l$$

Where, $A = \pi / 4 \times d^2$

**Flexural strength test:**

For flexural strength test of prestressed beam specimens of dimension 700x150x150 mm were cast. The specimens were demolded after 24 hours of casting and were transferred to curing tank where in they were allowed to cure for 28 days. These flexural strength specimens were tested under two point loading on Flexural testing machine. Load and corresponding deflections were noted up to failure.

## III. CONCLUSION

On the basis of limited experimental investigation undertaken, following conclusions are drawn purpose of this research project is to study the behavior of Prestressed Steel Fiber Concrete (PSFC) beams under flexural and shear design of prestressed concrete beam.From above discussion it is conclude that,1) There is improvement in bending and shear strength of concrete by addition of steel fiber. 2)Addition of steel fibers in concrete increased the load carrying capacity, ductility and energy absorption capability (i.e. flexural toughness) of the beam. 3)From literature review the flexural behavior of PSFC beams was critically examined by full-scale tests on three beams flexural-shear failure modes. 4)From the experimental results of three PSFC beams, steel fibers were found very effective in resisting the deflection and mild steel shear reinforcement can be completely replaced with steel fibers.5)Reduces Crack width.

## IV. ACKNOWLDGEMENT

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