COMPARATIVE ANALYSIS AND DESIGN OF PAVEMENT QUALITY CONCRETE SLAB USING DIFFERENT TYPES OF FIBERS

[1]Ananta Sharma [2]Shalini Thakur [3]Chanderkant Thakur
[1]Assistant Professor [2]MTech Student, [3]Assistant Professor
[1]Department of Civil Engineering,
Gulzar Group of Institutes, Ludhiana, India.

Abstract
This research paper describes the experimental studies on the comparative studies of the use of different fiber in pavement quality concrete as an improvement of increase of the strength and reduce maintenance. Fibers are very efficient as by addition of them increase the tensile strength, flexural and compressive strength. The ability to resist cracking and spalling were also enhanced. Now a day the present system required high cost investment. The life period is almost 20 years hypothetically but the real life of the road is depending on the maintenance and the applied load. Due to wheel load some problems occur like cracking due to excess loading. So, we use different fibers to increase the strength of concrete. In this we use steel fibers, polypropylene fibers and glass fibers at the rate of 1% by volume. Tests are performed and mix design of M40 is made. The tests results are tabulated and compared the results and result is drawn.

***Index Terms*:** Concrete, Steel Fiber, Polypropylene Fiber, Glass fiber, Tensile strength, Flexural strength.

I. INTRODUCTION

Pavement may be labeled as categories:

- Concrete pavement
- Bituminous pavement

Concrete pavements referred to as rigid pavements. Bituminous pavements as flexible pavements.

In our India and global over large scale construction of highways and bridges is going on. They are by and large manufactured from rigid pavements through using Pavement Quality Concrete (PQC). Concrete is a good and strong material however on it develops some cracks due to temperature, shrinkage, creep etc. Till except we take enough precautions, some cracks do come up on concrete floor.

Concrete pavement consists of 3 layers, sub-grade, base layer and the concrete slab. Typically, bound base layers are used for concrete pavement. These layers are mostly used for concrete pavement construction. The concrete slab of M4O to M50 grade of concrete is called paving quality concrete. In this undertaking, we use some fibers in pavement quality concrete consisting of steel fibers and bamboo fibers each of which lend various properties of concrete. The addition of these fibers will enhance the compressive, tensile and flexural strength.

II. MATERIALS

Ordinary Portland Cement, crushed coarse aggregates having maximum size 10mm, fine aggregates were used. The fibers used are steel fibers, glass fibers and polypropylene fibers.

Table -1: Concrete mixtures and properties

S.NO	Description of Material	Materials
1	Cement	350 kg
2	Fine Aggregate	761 kg
3	Coarse Aggregate	1228 kg
4	Water	140 kg/m³

Table 2: Properties of Concrete

S.NO	Concrete Properties
1	Specific Gravity= 3.15
2	Standard Consistency =30.5%
3	Max aggregate size=20mm
4	Initial setting time =30min

2.1 Steel fibers: Steel fibers are used in concrete to enhance the properties of concrete. Steel fiber concrete having high cracking control effects, resistance to shrinkage stress, resistance to tensile, high durability through high energy absorption capacity. They are having excellent bearing capacity to support dynamic loads which vary greatly in degree and nature.

Table 3: Properties of steel fiber

S.NO.	Properties	Values
1	Length (mm)	35
2	Diameter (mm)	0.78
3	Aspect Ratio (L/D)	45
4	Tensile (MPa)	1100

Fig. 1: Steel fiber

2.2 Polypropylene Fibers

Polypropylene fibers have been used in concrete in 1960's. These are hydrophobic in nature which do not absorb water. These fibers are cheap and are of like all manmade fiber of a consistent quality.

Fig 2: Polypropylene fibers

Table 4: Properties of polypropylene fiber

S.NO.	Properties	Value
1	Diameter (m)	20-200
2	Specific Gravity	0.91
3	Modulus of Rigidity (GPa)	5
4	Tensile Strength (N/mm²)	0.5
5	Elongation in failure (%)	20

2.3 Glass Fibers: The glass fibers used are of Anti-Crack HD with modulus of elasticity 72 GPA, Filament diameter 14 microns, pecific gravity 2.68, length 12 mm

Table 5: Properties of glass fibers

S.NO	Properties	Value
1	Diameter	14 µ
2	Specific Gravity	2.68
3	Length	12mm
4	Modulus of elasticity	72 GPA

Fig 3: Glass fibers

III. EXPERIMENTAL STUDY: In this study the concrete mix of M40 investigated in this study with standard Ordinary Portland cement of grade 43. The materials are weighted properly with digital weighing machine. For the preparation of plain concrete, fine aggregates, coarse aggregates, cement were added and mixed thoroughly by using hand mix. Steel fibers are mixed manually by sprinkled inside the concrete mix. Polypropylene fiber also mixed like steel fiber as same glass fiber is also mixed with concrete. Then we prepare beams, cylinders for the flexural and split tensile test.

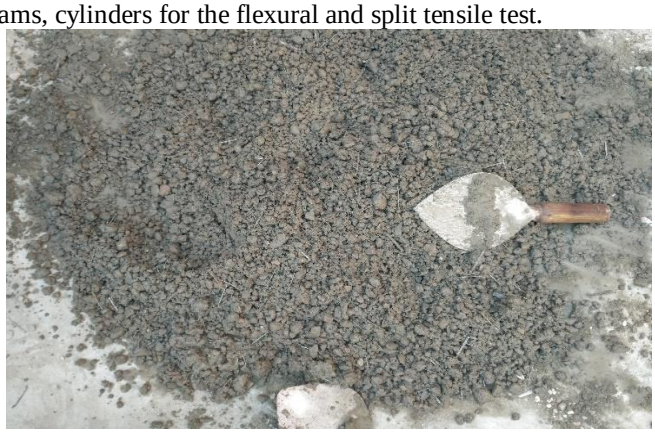


Fig. 4**:** Mixture of concrete and fibers

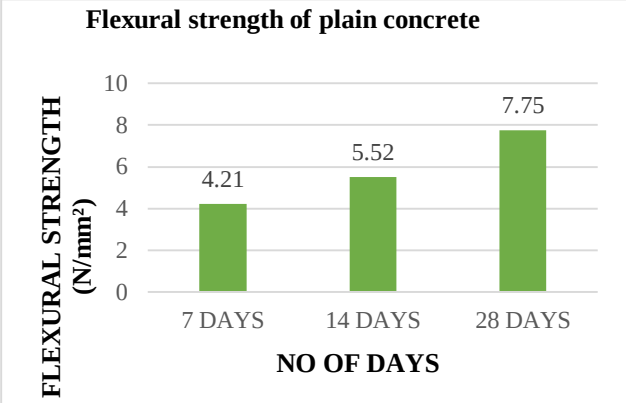
3.1 Flexural strength

Flexural Strength are tested through the standard size of beam specimen 700mm*150mm*150mm. The flexural beams are casted of each 1% of polypropylene fiber, steel fiber and glass fiber for the testing of 7, 14 and 28 days. In the following figure, flexural beams are tested through the manual compression testing machine.

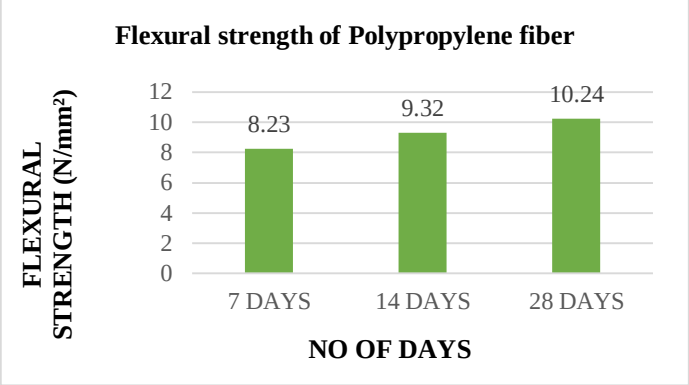
Fig. 5: Testing for flexural strength

Table 6**:** Flexural strength

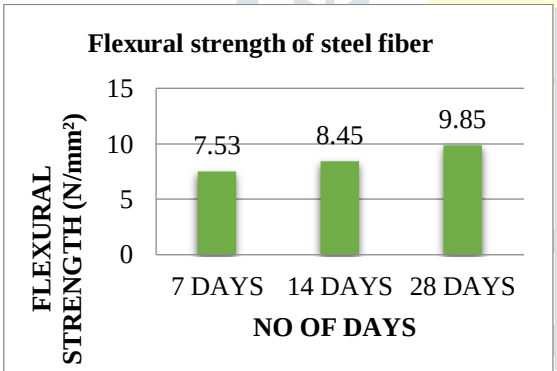
FIBER	FLEXURAL STRENGTH (N/mm²)		
	7 DAYS	14 DAYS	28 DAYS
PLAIN CONCRETE (0%)	4.21	5.52	7.75
STEEL FIBER (1%)	7.53	8.45	9.85
POLYPROPYLENE FIBER (1%)	8.23	9.32	10.24
GLASS FIBER (1%)	5.32	6.97	8.32



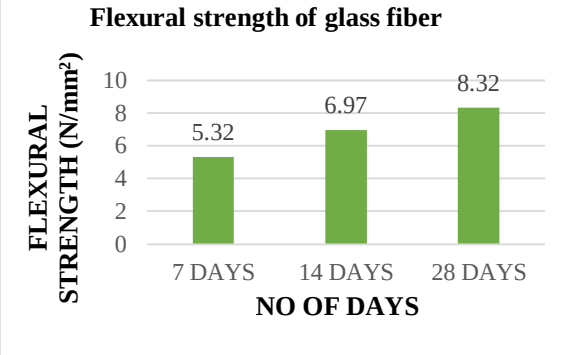
Graph 1**:** Flexural strength of plain concrete



Graph 2**:** Flexural strength of polypropylene fiber



Graph 3: Flexural strength of steel fiber



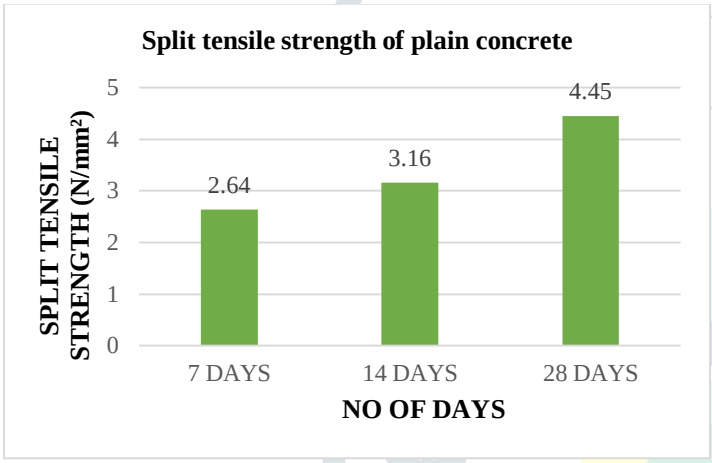
Graph 4: Flexural strength of glass fiber

3.2 Split tensile strength: The cylinder of diameter 150 mm and of height 300mm is casted and tested for the tensile strength with the varying ratio of fiber dosage ranging from 1% of volume of concrete and the specimen is tested for split tensile test after 7 days, 14 days and 28 days then the result will be compared with the plain concrete cylinder, and the graph is plotted.

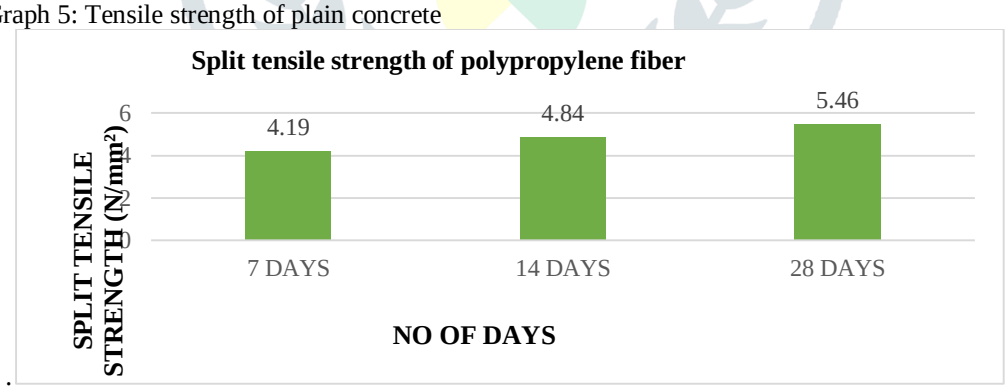
Table 7**:** Split tensile strength

Fig.6: Testing for split tensile strength

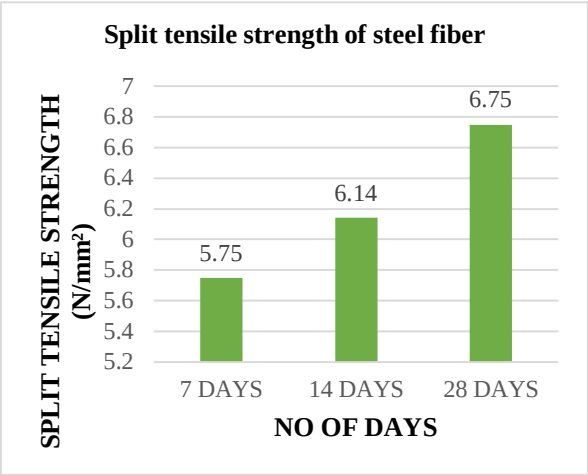
FIBER	SPLIT TENSILE STRENGTH (N/mm²)		
	7 DAYS	14 DAYS	28 DAYS
PLAIN CONCRETE	2.64	3.16	4.45
STEEL FIBER (1%)	5.75	6.14	6.75
POLYPROPYLENE FIBER (1%)	4.19	4.84	5.46
GLASS FIBER (1%)	3.33	3.64	4.97



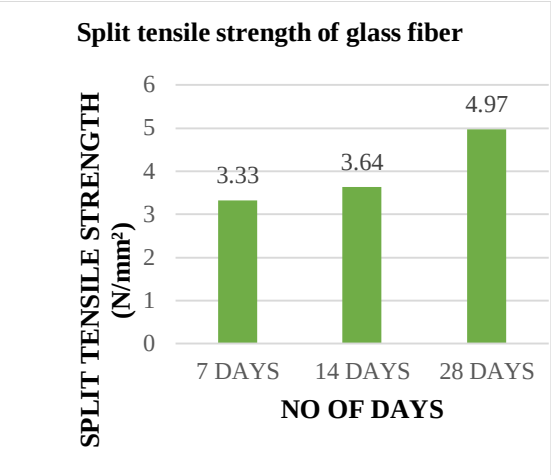
Graph 5: Tensile strength of plain concrete



Graph6: Tensile strength of polypropylene fiber



Graph 7: Tensile Strength of Steel Fiber



Graph 8: Tensile Strength of glass fiber

IV. CONCLUSION

From all the experimental study the results were conducted on beams, cylinder for flexural test and split tensile strength by mixing 1% of polypropylene fiber, steel fiber and glass fiber. With the all the experimental observations following results was concluded:

- Comparative study the strength was much larger than for polypropylene, steel and glass fiber.
- The flexural strength of these three-fiber reinforced concrete considered in this study, were found higher than plain concrete.
- The split tensile strength of these fibers considered in this study, were found higher than plain concrete
- The split tensile strength of steel fiber was more than polypropylene and glass fibers.
- The flexural strength of polypropylene fiber was greater than glass fiber and steel fiber.
- Polypropylene fibers decrease the shrinkage, water permeability and settlement.
- Polypropylene fibers increase the strength, without causing well known problems, which are normally associated with steel fibers.
- Steel fibers used for the decrease of warping stresses, short and long-term cracking and decrease in thickness of slab.
- By the addition of glass fibers ductility characteristics were improved, cracks can be controlled and helps in shrinkage cracks.
- Glass fibers gives corrosion free concrete as compared to steel fibers and polypropylene fibers.

4.1 Saving of Materials in Design of Slab Thickness Pavement

By addition of 1% polypropylene fiber to concrete there is 17cm saving in thickness of concrete pavement. This indicates that there will be a considerable saving in the cost of the project by saving the cost of the materials.

Table-8: Design of slab thickness for various mixes

Mix	Slab Thickness(mm)
CM as per IRC58:2011	330
PC	200
GF (1%)	180
SF (1%)	170
PF (1%)	160

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