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EVALUATION OF COMPRESSIVE AND FLEXURAL STRENGTH BEHAVIOR OF POLYPROPYLENE FIBER REINFORCED CONCRETE PAVEMENT DESIGN

Pawan Kumar[1], Dr.A.K.Mishra[2]

[1]P.G. Student, [2]Assistant Professor, Department of Civil Engineering,
Madan Mohan Malaviya University of Technology Gorakhpur, Uttar Pradesh, (India)

ABSTRACT

Transportation always plays a key role in the development of the country and it is crucial concerned. In India, Bituminous pavements are mostly used across the country. Bitumen are obtained by petroleum crude which is used for the making the flexible pavements. As we know, Petroleum crude are gradually diminished on the earth, so there is a need to replace the bitumen pavement by cement concrete pavement. Cement concrete pavement has several advantages like providing smooth ride surface, high compressive strength, etc. But there are several disadvantages that is its low tensile strength, proper need to maintenance and repairing, low durability etc. Polypropylene fiber reinforced concrete pavement has better solution for overcoming the problems related to cement concrete pavement. PPFRC pavements provide better paving road, smart grip to tyres, high flexural strength and high durability. It also provides better solution frequently maintenance and repairing of the cement concrete pavements. The addition of polypropylene fibers makes it proper binding of the concrete ingredients and gets homogeneous fiber concrete. In this experiment we are analysed to get the optimum strength behaviour of polypropylene fiber reinforced concrete by adding the different percentage of polypropylene fiber by volume of concrete. The experiment is analysed to use various percentage of polypropylene fiber to evaluate the compressive and flexural behaviour of M30 grade of concrete. Overall Polypropylene fiber reinforced concrete pavement design open a new hope for world in road transport revolution. It makes a new advancement in highway engineering to make "Developing India to Developed India".

Keywords: Polypropylene fiber, Compressive strength, Flexural Strength

I. INTRODUCTION

Various researches have been done in the field of fibers for 3 to 4 decades, but at that time it was not popular so much. Concrete is the most widely used as a construction material in the world. Concrete is obtained by mixing cement, fine aggregate, coarse aggregate, and water. As it is well-known that concrete has high compressive strength and it is weak in tension so that steel reinforcement is provided for the improving the tensile strength

but it is not satisfactory to control the post cracking behaviour and durability of the life. So there is a need of proper maintenance and repairing of the plain cement concrete pavement. The best solution to increase the flexural strength and counter the post cracking nature is provided by reinforcing by fibers. There are various types of fibers used like steel fibers, glass fibers, synthetic fibers, natural fibers. In this experiment, polypropylene fibers are used for knowing the strength behaviour of the concrete. Polypropylene fibers reinforced concrete pavement is recently advanced researches in cement concrete pavement which removes almost all sorts of problems in cement concrete pavement. Without any types of fibers, there was development of plastic shrinkage, drying shrinkage and other causes like changing the volume of concrete. When the load is applied to fiber reinforced concrete, the strong fibers take the loads so there are a little chances of occur the cracks. In this experiment, the polypropylene fibers are added in various percentages by volume of concrete to know the optimum flexural strength and compressive strength. The strengths are calculated at 0%, 0.50%, 1.00%, 1.50 and 2.00% of polypropylene fibers by volume of concrete. S.Panda, N.H.S.Ray (2014) established an experiment on design procedure and operations of polymer fibre reinforced concrete pavements. They explained a brief comparison of PFRC pavement with conventional concrete pavement. Polymeric fibers are gaining popularity because of its properties like zero risk of corrosion and cost effectiveness. They analysed of various forms of recycled fibers like plastic wastes ,disposed tyres, carpet wastes and wastes from textile industry can also used as a fiber reinforcement. Concrete pavements may be weak in tension and against impact loads, but PPFRC is a suitable material which may be used for cement concrete pavement and it consist the extra strength in flexural fatigue and impact etc. There are two component of PFRC pavement; one is the concrete mix and other is polymer fibers .The polymer fibers increases the compressive strength 12 to 16% and also the flexural strength 7 to 14% over the normal concrete. Amit Rai, Dr. Y.P.Joshi (2014**)** conducted the experimental studies and application of fibers reinforced concrete. They study different types of fibers and their application. The improvement in concrete properties by polypropylene fibers, they analysed that compressive strength which is increased about 16%. The flexural strength of polypropylene fibers is improved about 30%.They studies the different types of fibres and the concrete properties. Fiber addition improves ductility of concrete Slump test were examined to find out the workability and consistency of fresh concrete. The efficiency of all fiber reinforcement is dependent upon achievement of a uniform distribution of the fibers in the concrete, their interaction with the cement matrix, and the ability of the concrete to be successfully cast or sprayed.

II. MATERIALS

Cement: In this experiment OPC Jaypee 43 grade cements are used which are locally available in Gorakhpur city. The initial and final setting time of cement has been found respectively 35 minutes and 350 minutes in experiment lab. The specific gravity of cement is 3.15. The compressive strength of cement is found 43.60 MPa at the age of 28 days.

Fine Aggregate: Fine aggregates are used which is locally available in Gorakhpur. The basic sources of fine aggregates are river sands. The specific gravity of fine aggregates are calculated 2.649 in the experiment. It lies on zone II having fineness modulus 3.02.

Coarse Aggregate: Coarse aggregate used in this experiment are crushed angular aggregate. The specific gravity of coarse aggregate is found 2.673. The absorption of water in coarse aggregate are calculated 0.40%. Combined aggregates (20mm and 10mm) are used for mix design of M30 grade of concrete.

Water: Fresh water is used in the mixing of concrete. The pH of water is found 8 in pH meter. The pH value of water should not be less than 6.

Admixtures: Admixtures are used as a super plasticizer for the reducing the water in the mix design. Super plasticizer can be reduced the water up to 29%. In this experiment, 16% of water is reduced by mixing the super plasticizer. The specific gravity of super plasticizer is found 1.18.

Polypropylene fiber: Polypropylene fibers are used having 12 mm long and 0.45 mm diameter. The polypropylene fibers are manufactured by Reliance Company. There are two types of fibers generally used micro fibers and macro fibers.

Figure1: Polypropylene fiber

III. EXPERIMENTAL DETAILS

Calculation of M30 Grade of concrete

a) Grade designation = M30

b) Type of cement = Jaypee cement 43 grade conforming to IS8112

c) Size of the aggregate = 20mm and 10mm

d) Min cement content = 320 kg/cu-m

e) Max W/C ratio = 0.40

Test Data

a) Ordinary Portland cement = 43 grade

b) Specific Gravity of cement = 3.15

c) Specific Gravity of coarse aggregates =2.672

d) Specific Gravity of fine aggregate = 2.649

e) Sand confirming to zone-II

f) Specific gravity of admixture (super plasticizer) = 1.18.

The mix design proportions are calculated by trial and error method mentioned in table1. The proportion 1:1.950:2.7375 are mixed with required quantity of water, admixtures and polypropylene fibers.

Ingredients	Quantity(kg/m3)
water	174.75
cement	400
Coarse aggregate (10mm)	437.42
Coarse aggregate (20mm)	657.46
Fine aggregate	780.04
admixture	4

Table1: Mix proportion of M30 grade of concrete.

IV. COMPRESSIVE STRENGTH RESULT

Compressive strength results are calculated at the age of 28 days to know their strength behaviour under compression load at different percentage of fiber content.

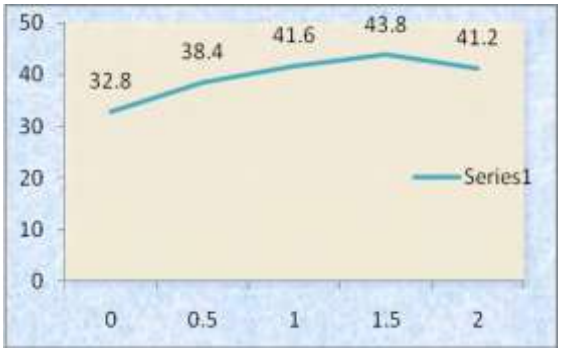

Figure2: Compressive Strength at 28 days

From the figure2, the compressive strength increases significantly with increasing the percentage of polypropylene fiber. The maximum compressive strength is obtained 43.8 Mpa at 1.50% of polypropylene fiber by volume of concrete.

V. FLEXURAL STRENGTH RESULT

Flexural strength result are calculated at the age of 28 days in different percentage of fibers. The results are mentioned in figure3:

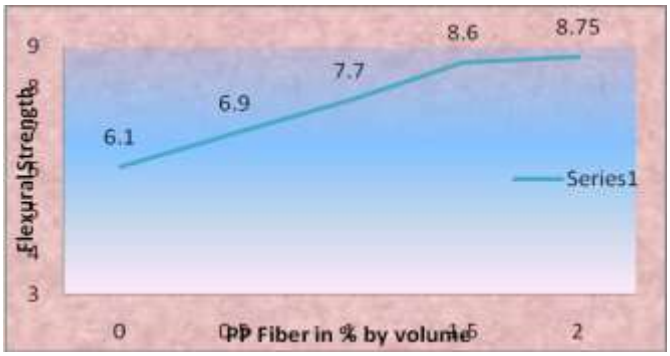

Figure3: Flexural strength at 28 days

In figure3: the flexural strength increases with increasing the percentage of polypropylene fiber. The maximum flexural strength has obtained 8.75 MPa at the age of 28 days.

VI. PAVEMENT DESIGN

The base coarse of Dry Lean Concrete serves as a working platform for supporting the PPFRC slab which distributed the working load into the larger area. The DLC layer lays on granular slab which rests on sub grade. Granular sub base is constructed by using boulders and stones. Over that DLC of mix 1:4:8 is made and compacted and doing leveled and floated. Surface of DLC makes correct for providing the camber. An antifriction membrane separation member is provided and spread over the DLC surfaces due to impart free movement of the upper slab. The separation membrane is patched or nailed so that membrane does not move during the placing of polypropylene fibers reinforced concrete. Thickness of pavement are adopted on various design method based on trial basis. The cross section of a typical PPFRC pavement shown in the following figure 4:

Figure4: Cross section of a typical PPFRC pavement

Paving Operation**:** For a faster pace of construction, and better riding qualities, PPFRC pavement mechanized operation are done because it cannot be achieved by manual laying technique. A highly sophisticated sensor machine is used for spreading the concrete and finishes the paving in continuous operations. Concrete is placed in the slip form pavers in such a manner that it requires minimum hand finishing. Finishing should be in such a way to get dense and homogeneous pavement conformity with plans and specifications.

Curing**:** Membrane curing is applied by using of texture cum curing machine. The resin curing based is used at the rate of 300ml per square meter of slab area. Hessian clothes are spread over the concrete slab for the curing

process. Water curing is done through the sprinkling of water to ensure for 3 days. No vehicular traffic is allowed to run on finished surface of PPFRC pavement until the completion of 28 days of curing, sealing of joints and completion of paved shoulder construction.

VII. CONCLUSIONS

From the experiment, the following results are concluded:

1. Compressive Strength increases with adding the percentage of polypropylene fiber. Compressive strength gets maximum at a particular percentages of fibers (here 1.50%) and then decreases with adding the fibers.
2. Flexural strength increases with increasing the percentage of polypropylene fiber. The maximum flexural strength has obtained at 2.00% of polypropylene fiber by volume of concrete.
3. The slump value decreases with increasing the percentage of polypropylene fiber.

VIII. ACKNOWLEDGEMENT

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