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Comparative Study of Polymer Fiber Reinforced Concrete with Conventional Concrete Pavement

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***Abstract* - transportation is without a doubt the lifesaver of the country and its improvement is a critical concern. The conventional bituminous pavement and its requirements for ceaseless upkeep and recovery tasks focus on the extension for cement concrete pavement. There are a few benefits of concrete substantial asphalts over bituminous asphalts. This paper underlines POLYMER FIBRE REINFORCED CONCRETE PAVEMENTS, which is a new headway in the field of supported substantial asphalt plans. A similar investigation of this pavement with the ordinary concrete pavement has been made utilizing Polypropylene fiber squander as fiber support.**

***Index Terms*- Polymer fibre concrete pavement, Polypropylene fiber waste as fiber reinforcement**

I. INTRODUCTION

In an agricultural nation like India, street networks structure the courses of the country. Pavement is the layered design on which vehicles travel. It fills two needs, to be specific, to give an agreeable and strong surface for vehicles, and to decrease weights on fundamental soils. In India, the conventional arrangement of concrete pavement is broadly utilized. Locally accessible concrete cement is a superior substitute to bitumen which is the side-effect in the refining of imported oil rough. Oil and its side effects are damning step by step. At whatever point we think about a street development in India it is underestimated that it would be a bituminous pavement and there are extremely uncommon possibilities for thinking about an elective like concrete pavement. Inside a few decades, bituminous asphalt would be a set of experiences and along these lines, the requirement for an option is exceptionally fundamental. The ideal arrangement would be POLYMER FIBER Built-up concrete pavement, as it fulfills two of the much-requested prerequisites of asphalt material in India, economy and diminished contamination. It additionally enjoys a few different benefits like longer life, low upkeep cost, eco-friendliness, and great riding quality, expanded burden conveying limit, and impermeability to water over adaptable asphalts. Fiber-built up concrete pavements are more effective than customary concrete pavements. "FRC is characterized as a composite material comprising of cement supported with discrete arbitrarily however consistently short length strands scattered." The filaments might be of steel, polymer, or normal materials. FRC is viewed as a material of improved properties and not as supported concrete cement while in strain district.

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Filaments for the most part utilized in concrete pavements are steel strands and natural polymer filaments such as polyester or polypropylene. This is a climate well-disposed methodology in the field of asphalt development as practically a wide range of polymer waste can be reused and utilized as a building-up admixture in the substantial asphalts. As waste polymers which are delivered in huge amounts are non-biodegradable they can cause huge ecological issues. Rather than arranging it, we can proficiently utilize its properties in the pavementConstruction. Polymeric filaments ordinarily utilized are either polyester or polypropylene. It ought to be 100% virgin engineered fiber size 12mm long and 0.45 mm breadth. It will be blended at the pace of .25 % of the volume of cement. Different filaments utilized are acrylic, aramid, carbon and so forth these strands decrease plastic shrinkage and substance breaking. This expansion the durability and post-breaking honesty. Strands named Fiber lattice and Recron 3S are presently created by FIBERCOM-CF Organization Ltd USA and in India Strands like polypropylene and Recron 3S are fabricated by Dependence Enterprises Ltd.

A. Polypropylene

Polypropylene is one of the least expensive and richly available polymers. Polypropylene strands are impervious to most substance assaults. Its liquefying point is high (around 165 degrees centigrade). So it can withstand a functioning temp, as (100 degrees centigrade) for brief periods without burden to fiber properties.

Fig 1 Polypropylene fiber

B. History of Polypropylene

Propylene was first polymerized to a translucent isotactic polymer by Giulio Natta just as by the German physicist Karl Rehn in Spring 1954. This spearheading revelation prompted the enormous scope of business creation of isotactic polypropylene by the Italian firm Montecatini from 1957 onwards. Syndiotactic polypropylene was likewise first combined by Natta and his colleagues.

II. METHODOLOGY

A primer report on compressive strength, pliable fortified flexural utilizing various extents of polypropylene strands brought about a fluctuating proportion of fiber measurement of 0.25percent by volume of cement. In the current examination, test substantial 3D shapes of size 150mm x 150mm, in thickness of 150mm and chamber of width 150mm and tallness of 300mm, both with PCC (plain concrete) and OPFRC (ideal fiber built up concrete) with trial filaments were projected and tried for pressure, elastic for 7 and 28 days of restoring. The momentary compressive strength test was done to contemplate if there is any decrease in strength because of conceivable debasement of the strands in the substantial's soluble climate. A cement footer of size 150mm x 150mm x 700 mm was cast and tried for flexural strength following 7 and 28 days.

A. Materials

Ordinary Portland Concrete (OPC) of evaluation 43 adjusting to IS: 12269 was utilized for the examinations. Locally accessible quartzite total with a most extreme size of a total of 20mm downsize, and pit sand (privately known as Badarpur sand), were utilized as coarse total and fine total, discretely. The discrete polypropylene filaments of 12 mm length, utilized in the investigation were tried for remarkable properties and the test outcomes are introduced.

B. Mix Proportion

The FRC blend was set up by adding 0.25 percent (by volume of cement) strands of 12 mm length to the PCC blend. The strands were added to the dry blend first and afterward; water was added as this strategy seemed to deliver a uniform FRC blend. The PCC and OPFRC blends were utilized for laying the Pavement Quality Control (PQC) shapes, for the readiness of test example for rigidity test, and the present moment

Compressive strength. The concrete utilized will be OPC 43 evaluation. Coarse sand of fineness modulus 2.42, washed and a stone total of 20 mm downsize with least fineness modulus of 5.99 will be utilized. PFRC has been furnished with a planned blend of 1:1.5:3 evaluating. The substantial will have a flexural strength of 40 kg/m² at 28 days. Water concrete proportion will be according to IS detail referenced for M30 grade concrete. The code IRC: 44-2008 is followed for concrete substantial blend plans for asphalts in with strands.

III. CONCRETE MIX DESIGN

A. Mix Design for M20

Specification for Proportion

a) Grade assignment = M20
b) Type of concrete = Portland slag concrete 43 evaluation adjusting to IS8112
c) Max ostensible size of the total = 20mm
d) Min concrete substance = 320 kg/cu-m
e) Max W/C proportion = 0.55
f) Exposure condition = Moderate
g) Type of total = Crushed precise
h) Max concrete substance = 425 kg/cu-m

B. Test Data

a) Cement-Portland Slag concrete 43 evaluation
b) Specific Gravity of concrete = 3.15
c) Specific Gravity of coarse totals =2.8
d) Specific Gravity of fine total = 2.67
e) Sand affirming to zone-II

Target mean strength for blend extent is given by
fck= fck+1.65*s
= 20+1.65*4 (esteem is as per IS 10262:2009)
= 26.6 N/mm2
From Table 5 of IS 10262: 2009
W/C proportion received is 0.55

Mix Calculation

a) Volume of concrete = 1cu-m
b) Volume of cement = (mass of cement/sp.gr of cement)*(1/1000)
= (338.18/3.15)*(1/1000)
= 0.1074 cu-m
c) Volume of water = (mass of water / sp.gr of water)*(1/1000)
= (186/1)*(1/1000)
= 0.816 cu-m
d) Volume of aggregate = 1-(0.1074+0.186)
= 0.7066 cu-m
e) Mass of coarse aggregate = e* vol of fine agg * sp.gr of fine agg * 1000
= 0.7066*0.39*2.62*1000
= 722.00 kg

Cement = 338.18 kg, Water = 186 kg/cu-m, F.A = 722.00 kg/cu-m, C.A = 1284.45 kg/cu-m, W/C = 0.55

- Max W/C for 20mm aggregate = 186 litre
- Estimated water content for 50mm slump = 186 liter

Calculation of Cement Content:

- W/C = 0.55
- Cement content = 186/0.55=338.18 kg/cum> 320kg/cu-m & less than 425kg/cu-m Hence this value can be adopted.
- **Proportion of volume of coarse aggregate & fine aggregate content =** W/C = 0.5= 0.62
- In present case W/C ratio is = 0.55
- Therefore, Volume of coarse aggregates required to be increased to decrease the fine aggregate content.
- As W/C is lowered by 0.05, proportion of volume of coarse aggregate is decreased by 0.01 @ a rate of for every change in W/C
- Volume of coarse aggregate = 0.61
- Volume of fine aggregate = 0.39
- As W/C is lowered by 0.05, proportion of volume of coarse aggregate is decreased by 0.01 @ a rate of for every change in W/C
- Volume of coarse aggregate = 0.61
- Volume of fine aggregate = 0.39.

The arrived mix proportion by weight is 1:1.5:3

IV. RESULTS

A. Salient Properties of OPFRC from Laboratory Study

OPFRC exhibited an increase in 28 days compressive and flexural strength by about 21 percent and 6.4 percent, respectively, as compared to the control mix. It also exhibited a significant reduction in drying shrinkage. The drying shrinkage of the control concrete was 0.062 percent while that of the FRC was 0.03 percent.

Fig 2 Mixing polypropylene fibers with concrete

B. COMPRESSIVE STRENGTH TEST:

Table 1: 7- Day cube test result for plain concrete (Check for M20 mix design)

m	Load (kn)	Compressive strength (n/mm^2)
1.	450	20.3
2.	470	21.29
3.	440	19.93

Table 2: 28TH-day cube testing result for plain concrete

Trial	Load (kn)	Average load (kn)	Compressive strength(n/mm^2)
1.	720		
2.	760	740	32.88
3.	740		

Calculation:

Compressive strength = Load /area
= 740/225
= 32.88 N/mm^2

The average 28th-day strength from the above data is 32.88 N/mm^2

Table 3: Split tensile strength test for (PCC)28 days:

Trial no	load (kn)	Average load	Tensile strength(n/mm^2)
1.	200		
2.	210	206.67	29.80
3.	210		

Calculation:

Tensile strength =2P/(3.142DL)
=2(206.67)/ (3.142x15x30)
=29.80 N/mm^2

Table 4: Flexural strength test

Beam no	Load (kn)	Average load (kn)	Flexural strength(n/mm^2)
1.	2100		
2.	2090		18.87
3.	2100	2090.67	

Calculation:

Flexural strength=PI/bd^2
=$2096.67x9(10x10^2)$
=18.87 N/mm^2

Table 5: Compressive strength for PFRC

S.l. no.	% Polymer Fiber	Average load (kn)		Compressive strength(n/mm^2)	
		7 Days	28 Days	7 Days	28 Days
1.	.25	470	750	20.88	33.33
2.	0.5	480	800	21.33	35.55
3.	.75	510	880	22.66	39.11
4.	1	430	820	19.11	36.44
5.	1.25	420	760	18.66	33.77

Table 6: Tensile strength of PFRC

S.l. no.	%Polymer fiber	Average load (kn)	Tensile strength($n/m m^2$)
		28days	8days
1.	.25	220	31.11
2.	0.5	240	33.94
3.	.75	270	38.9
4.	1	260	36.77
5.	1.25	240	33.94

Table 7: Flexural Strength of PFRC

S.l. no.	%Polymer fiber	Average load (kn)	Flexural strength(n/mm2)
		28days	8days
1.	.25	2100	18.9
2.	0.5	2180	19.62
3.	.75	2250	20.25
4.	1	2200	19.62
5.	1.25	2130	19.17

C. Tensile Strength ofConcrete

The cylinder of diameter mm and of peak 300mm is cast and examined for the tensile power with the various ratio of fiber dosage ranging from 0.25% of the quantity of concrete and the specimen is examined for the break up tensile take a look at after 7 days and 28 days then the result will be in contrast with the simple concrete cylinder, and the diagram is plotted.

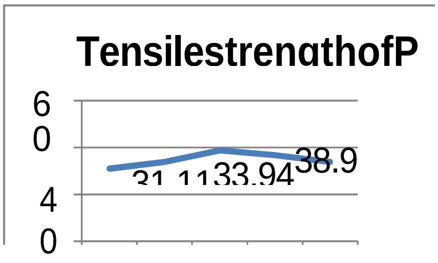

Fig 3: Graph showing Tensile Strength of PFRC for 28 days

Fig 4: Tensile strength test for PFRC Cylinder

D. Compressive Strength ofConcrete

The cubes of dimension 150mm x 150mm x150mmwith the various ratio of fiber dosage ranging from 0.25% of the quantity of concrete have been forged and examined for compressive power after 7 and 28 days of curing.

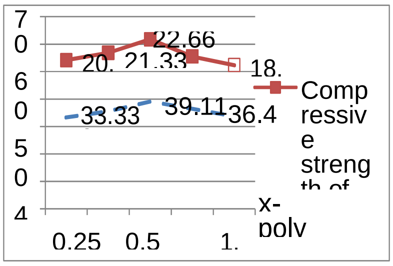

Fig 5: Graph showing Compressive Strength of PFRC for 7 days.

E. Flexural Strength of the Concrete Beam

The beam of measurement 700mm x 150mm x 150mm is cast and examined below three-factor loading for 7 and 28 days with the various ratio of fiber dosage of 0.25% of the extent of concrete.

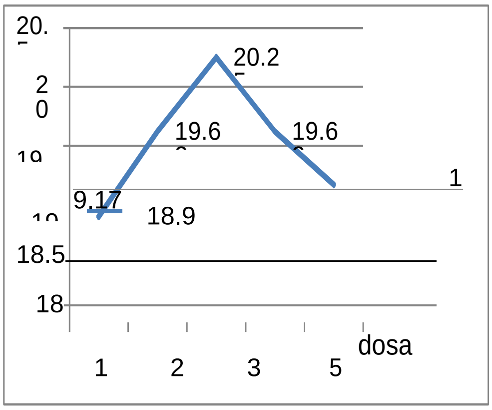

Fig 5: Graph showing Flexural Strength of PFRC for 28 days.

V. CONCLUSIONS

PFRC can be used advantageously over the everyday concrete pavement. Polymeric fibers such as polyester or polypropylene are being used due to their fee high-quality as properly as corrosion resistance. PFRC requires particular layout concerns and development techniques to gain the choicest performance. The greater preliminary fee by using 15-20% is counterbalanced through the reduction in protection and rehabilitation operations, making PFRC more cost-effective than bendy pavement by using 30-35%. In a speedy growth and the substantial United States like India, street networks make certain mobility of resources, verbal exchange and in flip make contributions to increase and development.

Resistance to alternate even though then again small disturbs our society subsequently we are continually reluctant to receive even the best. Its excessive time that we overcome the resistance and attain the peaks. PFRC opens new hope to growing and globalizing the best and reshaping the face of the "True Indian Roads".

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