International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 2 Issue 9, September - 2013

Improvement and Performance of Cement Concrete pavement using Polypropylene Fiber

***Anil Kumar T.B*[1], Mallikarjun Hiremath[2], *Dr.V.Ramachandra*[3],**

[1]M.tech, Dept. Of Civil Engg. S.I.T.Tumkur, Asst.proffeser, Dept. Of Civil[2] Engg. SIT, Tumkur,[3]Technical Head, Ultratech cement, Bangalore

Abstract: The use of Fiber Reinforced Concrete (FRC) in highway pavements has been limited. However, its use in other areas indicates that there is potential for significant benefits from its use in pavements. Possible benefits include, improved pavement durability, reduced studded-tyre wear and increased pavement life. The major benefits of Fiber Reinforced concrete in highway pavements would be improved durability and the resultant increase in service life.In present study include mix design of M40 grade Plain Concrete with different percentage of Class F fly ash 15 and 25%.to improve the engineering properties viz. Compressive strength, flexural strength, tensile strength and abrasion resistance 12mm polypropylene fibers is used at 0.2%,0.4%,0.6% by the mass of cementations material. The test result for compressive strength at 3,7,28 days for plain concrete with and without fly ash and polypropylene fibers increases at 0.2, 0.4% in order of 3-7% after adding 0.6% reduced strength by 3%. tensile strength at 28 days for plain concrete with and without fly ash and polypropylene fibers increases at 0.2,0.4% in order of 24-38% after adding 0.6% reduced strength by 25%. Flexural strength at 28 days for plain concrete with and without fly ash and polypropylene fibers increases at 0.2% in order of 24-38% after adding 0.6% reduced strength by 25%. Abrasion resistance at 28 days reduced % of wear with increasing percentage of polypropylene fibers with and without fly ash.

Key Word: Cement, Class F Fly Ash, Polypropylene Fiber.

Introduction: Concrete is well known as a brittle material when subjected to normal stresses and impact loading, especially with its tensile strength being just one tenth of its compressive strength. It is only common knowledge that, concrete members are reinforced with continuous reinforcing bars to withstand tensile stresses, to compensate for the lack of ductility and is also adopted to overcome high potential tensile stresses and shear stresses at critical location in a concrete member. Fibers are intended to improve tensile strength, flexural strength, toughness and impact strength (2). Polymeric fibers are gaining popularity because of its properties like zero risk of corrosion and cost effectiveness. The polymeric fibers commonly used are Recron 3s, polypropylene. Various forms of recycled fibers like plastic, disposed tires, carpet waste and wastes from textile industry, and Forta Econo net, can also be used as fiber reinforcements. These fibers act as crack arresters, restricting the development of cracks and thus transforming a brittle material into a strong composite with superior crack resistance, improved ductility and distinctive post cracking behavior prior to failure. Compressive Strength, Flexural Strength &tensile Strength of cement concrete mix treated with Polypropylene fiber with different Dosage (0.2, 0.4 and 0.6% by wt. of Cement) with or without Fly Ash. In the present study an attempt was made to study the Compressive, Split Tensile and Flexural strength of cement concrete mix treated with 15% and 25% (replace of cement) fly ash and along with 0.2, 0.4, 0.6% of polypropylene Fiber .Abrasion resistance of cement concrete mix treated with 15% and 25% (replace of cement) fly ash and along with 0.2,0.4,0.6% of polypropylene Fiber 0.2,0.4,0.6% of Polypropylene fiber along with fly ash.

Materials and Methodology:

Materials:

OPC 53 grade cement, Class-F Fly Ash, aggregate – maximum size of 20 mm down and 12.5 mm retained, river sand and potable water are used.
Super plasticizer – 2.4 Kg/m^3 is used to achieve adequate fiber dispersion and workability.
Triangular Shaped polypropylene fiber of 12 mm length is used. Density of fiber is 1400 kg/m3. The mixture Proportions and properties of concrete used in the test program are given in Table 1.
Variable: Fiber volume fraction – 0%, 0.2%, 0.4%, 0.6%, Fly Ash-15%, 25% various.

Table-1.Mix Proportion

	Plain Concrete	15% Fly Ash	25% Fly Ash
Cement (kg/m^3)	398	372	329
Fly Ash (kg/m^3)	0	66	110
Water Content (kg/m^3)	162	162	162
Fine Agg. (kg/m^3)	665	650	650
Coarse Agg. (kg/m^3)	1189	1161	1157
Super Plasticizer(kg/m^3)	2.4	2.63	2.63
Polypropylene Fiber (gm.) (by wt. of cement)	796 (0.2%) 1592(0.4%) 2388(0.6%)	876 (0.2%) 1752(0.4%) 2628 (0.6%)	878 (0.2%) 1756(0.4%) 2634 (0.6%)

Methodology

- Mix design as per IRC-44-2008
- Mix Design As per IRC-SP-46-1997
- Check out Compressive strength, tensile strength, flexural strength of mixes.
- Check out abrasion resistance of mixes.

Experimental Details:

In this experimental work, effect of polymer fibers on different properties of concrete was seen by adding different amounts of polypropylene fibers and replacement of cement by fly ash to the concrete mix. To check the effect of fibers on compressive strength of concrete, total of 108 concrete Cubes of 150x150x150 mm were made in 12 sets of 9 each. In three sets, different amounts of fibers were added whereas the fourth set was made without fibers as control cylinders. Remains 8 Set two set are 15% and 25% cement replaced by fly ash concrete and other 6 set are fly ash concrete treated with polypropylene Concrete. The results are compared with the control specimens. To see the effect of fibers on tensile strength of concrete, total of 36 concrete Cylinder of 150X300 mm were made in 12 sets of 3 each. In three sets, different amounts of fibers were added whereas the fourth set was made without fibers as control cylinders. Remains 8 Set two set are 15% and 25% cement replaced by fly ash concrete and other 6 set are fly ash concrete treated with polypropylene Concrete. The results are compared with the control specimens. To evaluate the effect of fibers on flexural strength of plain concrete, total of 36 concrete prism of 100X100x500 mm were made in 12 sets of 3 each. In three sets, different amounts of fibers were added whereas the fourth set was made without fibers as control cylinders. Remains 8 Set two set are 15% and 25% cement replaced by fly ash concrete and other 6 set are fly ash concrete treated with polypropylene Concrete. The results are compared with the control specimens. To see the effect of fibers on abrasion resistance at 28 Days, different amounts of fibers and fly ash were added. The results are compared with the control specimens.

RESULTS AND DISCUSSION

Compressive Strength: The addition of polypropylene fibers at low values i.e. 0.2% to0.40% actually increases the 28 days compressive strength by about 3%-7% but when the volumes get Higher like 0.60% then the compressive strength decreases from original by 5%.The results in Table 2 seem to indicate that there may be an effective volume threshold for adversely affecting the compressive strength of concrete that is exceeded at 0.40%.All things considered, it appears that at low dosage rates (0.2% to 0.4% the addition of polypropylene fibers does not significantly detract from, and even improve the compressive strength. Higher dosage rates however decrease the strength of concrete matrix due to higher volumes of fibers interfering with the cohesiveness of the concrete matrix. The graphical representation of the test results is given in Figure 1 .

Split Tensile Strength: The tensile strength of concrete is only about 55-65 % of its Flexural strength. It is clear that addition of fibers to a concrete mixture is beneficial to the tensile properties of concrete. The fibers act as crack arresters in the concrete matrix prohibiting the propagation of cracks in plastic state and propagation of cracks in hardened state. According to Table 2, Tensile strength of concrete increases linearly only with addition of fibers up to about 0.40% after which the tensile strength decreases with addition of more fibers. The graphical Representation of the test results is given in Figures 3.

Flexure Strength (plain concrete): The behavior of concrete in flexure Strength to be identical with polypropylene fiber reinforced concrete as that in tensile strength, but the difference that dosage amount for which best result is achieved is 0.2%. There is about 12% increase in flexure strength by adding 0.20% fibers in concrete after which strength starts reducing with further increment in fiber ratios.

As shown in Table2 and figure 2, the highest strength increase at 28 days in 15% Fly Ash treated with 0.2% polypropylene fiber.

Abrasion resistance (ASTM-C-33): Abrasion test was carried out as per ASTM-C-33 recommended.Conrete Cube crashed Sample size passing 20mm and retaining 12.5 mm sieve, properly dries in oven at temperature of 1100 C was placed on los angle machine rotating 500 revolutions at 33 rpm. Material discharges from machine sieved using 1.7mm sieve and take weight of retained on sieve. The value shall be checked up with the average loss in material obtained by the following formula:

$$\text{Los Angles abrasion values} = \frac{(W1 - W2)}{W1} \times 100$$

Where,
W1 = original weight of specimen in g,
W2 = wt. of sample retained in 1.7mm sieve in g

Abrasion resistance in terms of %of wear after application of specified abrasive charge for given duration was measured for plain and fiber reinforced HVFA test specimens at age of 28 days with different inclusion of fly ash and fiber dose of 0,0.2,0.4% & 0.6% by mass of cementations material. The results are laid down in Table 2 and Figure 4.

CONCLUSIONS

- The addition of polypropylene fibers in Plain Concrete at low values i.e. 0.2% to 0.40% increases at 28 days compressive strength by about 6%-8% but when the volumes get higher like 0.60% then the compressive strength decreases from original by 5 %.
- The addition of polypropylene fibers in 15% and 25% fly ash Concrete at low values i.e. 0.2% to 0.40% increases at 28 days compressive strength by about 4%-12% but when the volumes get higher like 0.60% then the compressive strength decreases from original by 8%.
- The addition of polypropylene fibers in Plain Concrete at low value i.e. 0.2% increases at 28days flexural strength by about 12%-14% but when the volumes get higher like 0.40%-0.6% then the flexural strength decreases from original by 19 %.
- The addition of polypropylene fibers in 15% and 25% fly ash Concrete at low values i.e. 0.2% increases at 28days flexural strength by about 8-10% but when the volumes get higher like 0.4-0.60% then the flexural strength decreases from original by 12-16%.

- The addition of polypropylene fibers in Plain Concrete at low values i.e. 0.2% to 0.40% increases at 28days tensile strength by about 12%-24% but when the volumes get higher like 0.60% then the tensile strength decreases from original by 13 %.
- The addition of polypropylene fibers in 15% and 25% fly ash Concrete at low values i.e. 0.2% to 0.40% increases at 28days tensile strength by about 12%-33% but when the volumes get higher like 0.60% then the tensile strength decreases from original by 14%.
- The addition of polypropylene fibers in Plain Concrete at values i.e. 0.2%, 0.40%,0.6% polypropylene increases at 28days reduced by about 24% and addition of polypropylene fibers in 15% and 25% fly ash Concrete at values i.e. 0.2%, 0.40%,06% PP reduced % of wear at 28days by about 33-40%.

REFERENCES

1. Balaguru, P. N., and Shah, S. P., Fiber-Reinforced Cement Composites, Singapore, McGraw-Hill, 1992.
2. Orozco A & Maji A, "Energy Release in Fiber-Reinforced Plastic Reinforced Concrete Beams" J. Compos. For Constr., (Jan/Feb 2004) Volume 8, Issue 1, pp. 52-58
3."Evaluation of engineering properties forpolypropylene fibre reinforced concrete" Priti A. Patel1, Dr. Atul K. Desai2 and Dr. Jatin A. Desai3
4. "A study on properties of polypropylene fiber reinforced concrete" Saeed Ahmed*,Imran A Bukhari, Javed Iqbal Siddiqui,Shahzad Ali Qureshi, University of Engineering & Technology Taxila, Pakistan
5. Kodur V., Cheng F., Wang T., "Effect of Strength and Fiber Reinforcement on Fire Resistance Concrete Columns" (Feb 2003), Volume 129, Issue 2, pp. 253-259
6. Tavakoli M., "Fiber Reinforced Concrete Developments & Innovations" 1993

Table-2 Test Results

Type of Concrete	Compressive Strength (N/mm2)			Flexural Strength (N/mm^2) At 28 Days	Tensile Strength (N/mm2) At 28 Days	Abrasion Resistance %	Density of Concrete Kg/m3
	3 Days	7 Days	28 Days				
Plain	20.89	32.15	50.56	5.94	3.56	39.2	2410.8
Plain+0.2% PP	22.08	34.95	52.09	6.59	3.95	36.2	2394.4
Plain+0.4% PP	23.38	35.79	54.08	5.54	4.43	32.8	2384.9
Plain+0.6% PP	18.26	30.54	48.03	4.80	3.12	30	2378.2
Plain+15% Fly Ash	17.33	26.68	51.57	6.41	3.85	36.4	2392.2
Plain+15% Fly Ash +0.2% PP	19.19	29.58	53.5	7.91	4.16	32.8	2396.0
Plain+15% Fly Ash +0.4% PP	20.97	30.79	54.10	5.90	4.72	30.8	2388.4
Plain+15% Fly Ash +0.6% PP	16.85	25.47	50.3	5.21	3.38	27.2	2368.2
Plain+25% Fly Ash	15.87	26.04	48.02	5.45	3.37	34.8	2384.7
Plain+25% Fly Ash +0.2% PP	17.18	27.53	50.85	6.27	3.96	30.4	2374.3
Plain+25% Fly Ash +0.4% PP	18.38	29.3	52.97	5.67	4.54	28	2369.4
Plain+25% Fly Ash +0.6% PP	15.24	25.39	46.33	5.02	3.01	26	2363.6

Figure:1 Compressive Strength at 28 Day

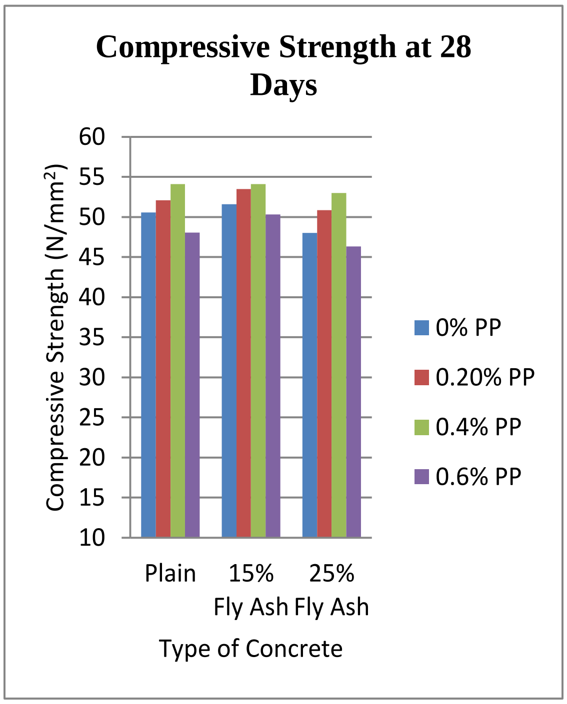

Figure: 2 Flexural Strength at 28 Day

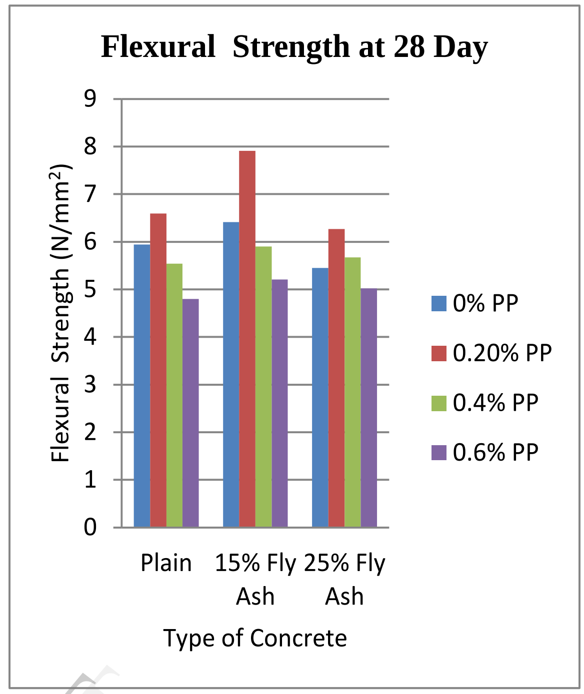

Figure: 3 Split Tensile Strength at 28 Day

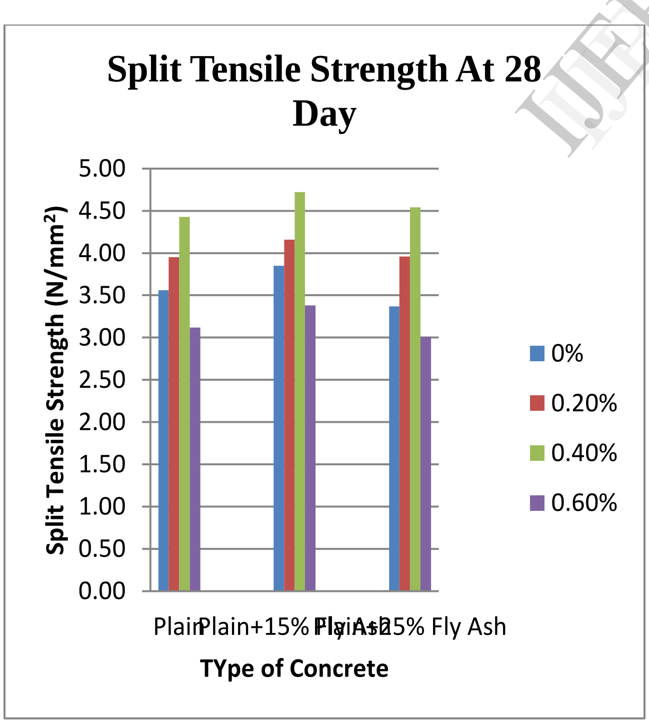

Figure: 4 Abrasion Resistance of concrete at 28 Day