Effect of use of Mono Polypropylene Fibers on Properties of Concrete Paving Block

Suresh S. Mandlik[1] Sachin B. Kandekar[2] Manesh B. Satpute[3] Prof. N. U. Mate[4]
[1]Student of M.E [2]Assistant Professor [3]Lecturer [4]Associate Professor
[1,2,3,4]Department of Civil Engineering
[1,2,3,4]Amrutvahini College of Engg. Sangamner, Maharashtra, India

Abstract— Cement concrete paving blocks are precast solid products made out of cement concrete. The product is made in various sizes and shapes viz. rectangular, square, and round blocks of different dimensions with designs for interlocking of adjacent paving blocks. The raw materials require for manufactures of the product are Portland cement and aggregates which are available locally in every part of the country. In this modern age, Concrete paving blocks are ideal materials on Open spaces surrounding residential, public, commercial, & industrial buildings. They are used for the footpaths in the city and walk way in the gardens know a day's paving blocks are also used for light and heavy traffic roads due to their easy laying, better look and finish. In this paper, a experimental study for producing paving blocks using Mono Polypropylene fibres is presented In fibre reinforced concrete (FRC), thousands of small MonoPP fibres are dispersed and distributed randomly in the concrete during mixing, and thus improve concrete properties in all directions. FRC is being increasingly used to increase static strength, energy absorbing qualities and better fatigue strength of paving blocks.

Key words: Mechanical Properties, MonoPP fibers, Paving Block, and Compressive Strength

I. INTRODUCTION

Paving stones were used in European countries for construction of roads serving as footpaths and tracks for steel-wheeled vehicles. Concrete Block Pavement (CBP), an environment friendly and labour intensive technology, has been developed at CRRI for providing pavements in areas where conventional types of construction are less durable due to many technical and environmental. Cement concrete paving blocks are precast solid products made out of cement concrete. The product is made in various sizes and shapes viz. rectangular, square, and round blocks of different dimensions with designs for interlocking of adjacent paving blocks. The raw materials require for manufactures of the product are Portland cement and aggregates which are available locally in every part of the country.

The study of various research papers it is found that more emphasis is given on concrete used for structural purposes various fibers are added for increasing the properties of structural concrete whereas very less attempts are made to use the fibers in precast concrete paving blocks. As day by day the cost of ingredient material like cement, sand,& coarse aggregate increasing which affect on the cost of paver blocks, Same is the reason behind present study that to study the effect of MonoPP fibers on strength parameter of concrete paving block and also to find by using M40 mix of concrete by the use of fibers how much higher strength we are able to achieve, so that cost of high grade concrete will be reduced.

Fibers are usually used in concrete to control cracking due to plastic shrinkage and to drying shrinkage. They also reduce the permeability of concrete and thus reduce bleeding of water. Some types of fibers produce greater impact, abrasion, and resistance in concrete.

This study presents the results of an experimental investigation on M40 grade, Mono Polypropylene fiber reinforced concrete. The effect of these fibers on density and various strengths of concrete are studied. Fiber content varies from 0 to 2.5% by weight of cement. The various strengths studied in this investigation are compressive strength, flexural strength, split tensile strength and durability strength. All the specimens are water cured and tested after 28 days

II. EXPERIMENTAL WORK

Fiber reinforced concrete is produced by adding MonoPP fibers to the cement concrete. MonoPP fibers were varied from 0.25% to 1.25% at a constant interval of 0.25% by average weight of one cement paving block considered as 5.25 Kg when casted with conventional concrete without fiber.

The ingredients of concrete i.e. cement, fine aggregate & coarse aggregate are tested before producing the concrete. The relevant Indian standard codes were followed for conducting various tests on the concrete.

A. Cement:

The cement used in this experimental work is "53 grade Ordinary Portland Cement". All properties of cement are tested by referring IS 12269 - 1987 Specification for 53 Grade Ordinary Portland cement.

Sr. No.	Description of Test	Results
01	Fineness of cement (residue on IS sieve No. 9)	7.5 %
02	Specific gravity	3.15
03	Standard consistency of cement	27.5 %
04	Setting time of cement	
	Initial Setting time	60 Minute
	Final Setting time	460 minute
05	Compressive strength of cement: (28 days)	62.03 N/mm^2

Table 1: Physical Properties of Cement

B. Aggregates:

Crushed sand from Sangamner is used. Various tests such as specific gravity, sieve analysis etc. have been conducted on CA & FA to know their quality & grading. The above said test results are shown in Tables .2 to (3.5). Crushed black trap basalt rock of aggregate size 10mm down was used confirming to IS 383-1970.

Sr. No.	Description of Test	Results
01	Fineness Modulus	2.62
02	Specific Gravity	2.70
03	Water Absorption	1.1%

Table 2: Physical Properties of Fine Aggregate

Sr. No.	Description of Test	Results
01	Particle Shape, Size	Angular, 10mm down
02	Fineness Modulus of 10mm aggregates	4.54
03	Specific Gravity	2.65
04	Water absorption	0.6%

TABLE 3: Physical Properties of Coarse Aggregate

C. Super plasticizer:

Sodium Naphthalene Sulphonate based SNF150 super plasticizer 400-850 ml/ bag of cement (0.8 % to 1.2 % by volume of weight of cement) used.

D. Tests on MonoPP Fibers Paving Block:

Casted MonoPP fiber reinforced concrete paving block are cured in water and tested after 28 days. Water absorption, compressive strength, Flexural strength, Abrasion test, and Split tensile strength test on precast concrete paving block are carried out as per IS-15658-2006.

III. Result and Discussions

A. Water Absorption Test:

The tests were performed on specimen as per Annex-C of IS-15658-2006 using MonoPP and steel fibers. Their water absorption test results are shown in Table-IV.

Sr.No	% Mono pp fiber	Wetted Weight (kg) Ww	Dry Weight (kg)Wd	W percent	Avg W%
1	0.00	5.86	5.54	5.78	5.49
		5.92	5.63	5.15	
		5.90	5.59	5.55	
2	0.25	5.74	5.43	5.71	5.66
		5.82	5.51	5.63	
		5.79	5.48	5.66	
3	0.50	5.64	5.16	9.30	7.97
		5.48	5.10	7.45	
		5.70	5.32	7.14	
4	0.75	4.84	4.12	17.48	14.68
		5.18	4.59	12.85	
		4.98	4.38	13.70	
5	1.00	4.36	3.65	19.45	16.77
		4.80	4.12	16.50	
		4.78	4.18	14.35	
6	1.25	4.60	3.89	18.25	17.42
		4.85	4.12	17.72	
		5.00	4.30	16.28	

Table 4: Water absorption of Mono Polypropylene Fiber used paving block

Results of water absorption test are shown in Table IV and Fig. 1 indicates that for Mono PP fibers percentage 0.25% gives results as 5.49% of water absorption. and as percentage of fibers increases from 0.50% to 1.25% water absorption increases with increase in fiber percentage from 5.66% to 17.42% and as per IS criteria the permissible water absorption criteria is 6.00%. Hence, optimum Mono PP fiber dose recommended up to 0.25%.

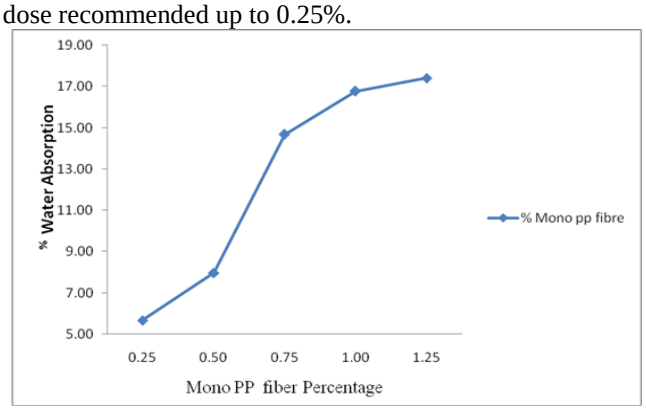

Fig. 1: Water absorption of Mono Polypropylene Fiber used paving block.

B. Compressive Strength Test:

The tests were performed on specimen as per Annex-D of IS-15658-2006 using Mono PP fibers. Their compressive strength results are shown in Table-V.

Sr. No.	% Mono PP fiber	Compressive Strength in MPa	Avg. Compressive Strength
1	0.00	53.26	54.93
		56.69	
		54.83	
2	0.25	63.52	61.05
		60.13	
		59.49	
3	0.50	51.05	48.74
		50.31	
		44.86	
4	0.75	39.27	40.41
		41.23	
		40.74	
5	1.00	36.81	36.19
		35.59	
		36.18	
6	1.25	33.13	33.95
		33.87	
		34.85	

Table 5: Compressive Strength Test on Mono Polypropylene Fiber used paving block

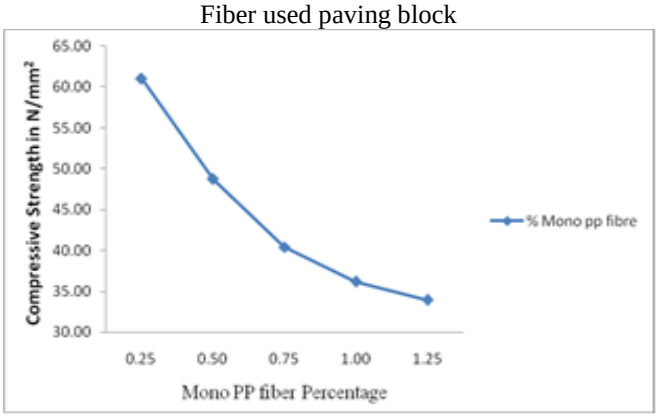

Fig. 2: Compressive Strength Test on Mono Polypropylene Fiber used paving block.

Results of compressive test are shown in Table V and Fig. 2 indicates that strength of block increases for 0.25 % addition of MonoPP fibers from 54.93 MPa to 61.05 Mpa ,But after that even if percentage of fibers increased from 0.50% to 1.25% compressive strength get decreased from 48.74 Mpa to 33.95 Mpa respectively.

C. Abrasion Test:

The tests were performed on specimen as per Annex-E of IS-15658-2006 using Mono PP fibers. Their abrasion value results are shown in Table-VI

Sr.No	% Mono pp fiber	Loss in Volume Δv	Avg. Wear	Permissible value mm^3
1	0.00	916.67 958.33 1041.67	972.22	1125
2	0.25	916.67 875.00 833.33	875.00	1125
3	0.50	1083.33 958.33 1000.00	1013.89	1125
4	0.75	1166.67 1250.00 1166.67	1194.44	1125
5	1.00	1250.00 1166.67 1291.67	1236.11	1125
6	1.25	1375.00 1208.33 1291.67	1291.67	1125

Table 6: Abrasion Test on Mono Polypropylene Fiber used paving block

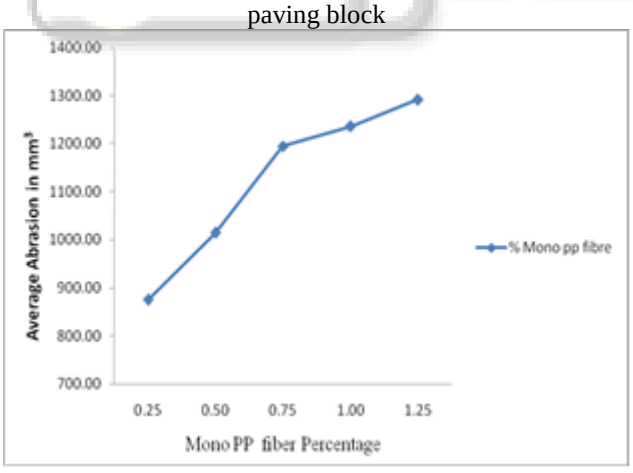

Fig. 3: Abrasion Test on Mono Polypropylene Fiber used paving block.

Results of abrasion test are shown in Table VI and Fig. 3 indicates that for 0.25 % addition of MonoPP fibers abrasion value is at its minimum as 875 mm^3, But after that even if percentage of fibers increases from 0.50% to 1.25% the abrasion increases from 1013.89 mm^3 to 1291.67 mm3 respectively.

D. Split Tensile Test:

The test was performed on specimen as per Annex-F of IS-15658-2006 using MonoPP fibers. Their split tensile test results are shown in Table-VII

Sr. No	% Mono PP fibre	Dimension			Split Strength Mpa	Avg. Split strength
		L	S	C/S Area		
1	0.00	120	80	9600	1.54	1.57
		120	80	9600	1.60	
		120	80	9600	1.58	
2	0.25	120	80	9600	1.64	1.67
		120	80	9600	1.70	
		120	80	9600	1.66	
3	0.50	120	80	9600	1.14	1.20
		120	80	9600	1.23	
		120	80	9600	1.25	
4	0.75	120	80	9600	0.92	0.97
		120	80	9600	0.96	
		120	80	9600	1.03	
5	1.00	120	80	9600	0.76	0.81
		120	80	9600	0.82	
		120	80	9600	0.86	
6	1.25	120	80	9600	0.55	0.61
		120	80	9600	0.62	
		120	80	9600	0.67	

Table 7: Split Tensile Test on Mono Polypropylene Fiber used paving block

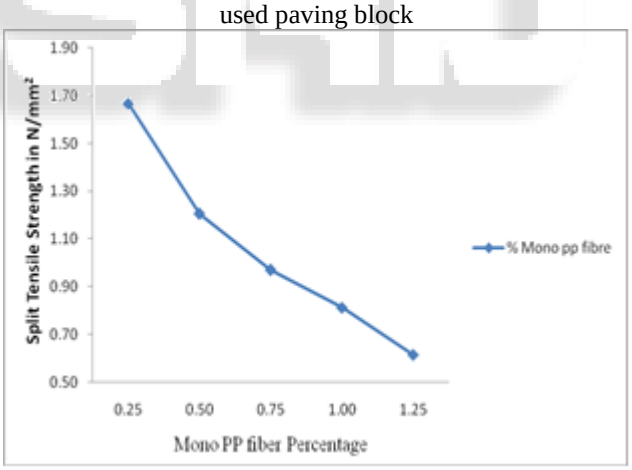

Fig. 4: Split Tensile Test on Mono Polypropylene Fiber used paving block.

Results of split tensile test are shown in Table VII and Fig. 4 indicates that for 0.25 % addition of MonoPP fibers gives maximum tensile strength as 1.67 Mpa , But after that even if percentage of MonoPP fibers increases from 0.50% to 1.25% the tensile strength get reduced from 1.20 Mpa to 0.61 Mpa respectively.

E. Flexural Strength Test:

The tests were performed on specimen as per Annex-G of IS-15658-2006 using MonoPP fibers. Their flexural strength test results are shown in Table-VII.

Sr.No	% Mono PP	Dimension			Flexural strength in Mpa	Avg. flexural strength
		b	d	l		

	fibre					
1	0.00	110	80	175	9.15	9.16
		110	80	175	8.77	
		110	80	175	9.55	
2	0.25	110	80	175	13.69	13.29
		110	80	175	13.25	
		110	80	175	12.93	
3	0.50	110	80	175	9.23	9.37
		110	80	175	9.58	
		110	80	175	9.31	
4	0.75	110	80	175	6.87	7.02
		110	80	175	7.17	
		110	80	175	7.02	
5	1.00	110	80	175	4.09	4.10
		110	80	175	4.02	
		110	80	175	4.18	
6	1.25	110	80	175	2.55	2.64
		110	80	175	2.70	
		110	80	175	2.67	

Table 8: Flexural Strength Test on Mono Polypropylene Fiber used paving block

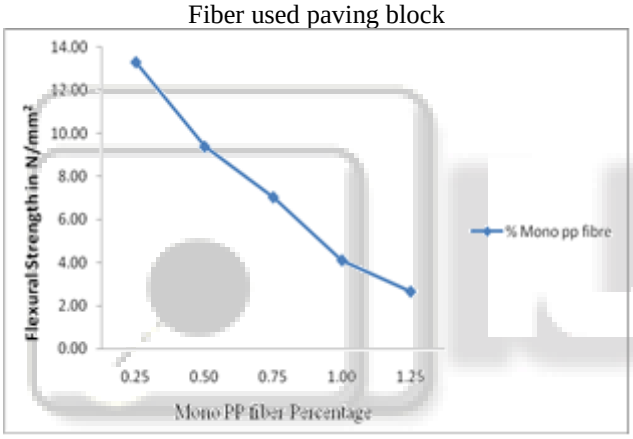

Fig. 5: Flexural Strength Test on Mono Polypropylene Fiber used paving block.

Results of flexural strength test are shown in Table VIII and Fig. 5 indicates that for 0.25 % additions of MonoPP fibers gives maximum flexural strength as 13.29 Mpa, but after that even if percentage of fibers increased from 0.50% to 1.25% the flexural strength get reduced from 9.37 Mpa to 2.64 Mpa respectively.

IV. Conclusion

Following conclusion are drawn based on the result discussed in the result and discussion.

(1) For Mono PP fibers percentage 0.25% gives results as 5.49% of water absorption, Permissible value for water absorption as per IS recommendation is 6.00%. But as percentage of fibers increases from 0.50% to 1.25% water absorption increases from 7.97% to 17.42% .Hence as percentage of fibers increased it also increases voids in blocks which also affect on other properties of block. So,The optimum percentage MonoPP fiber volume fraction is 0.25%.

(2) Compressive test are indicates that strength increases for 0.25 % addition of MonoPP fibers is 61.05 Mpa which is for plain block is 54.93 Mpa, & permissible value by target mean strength of mix design is 48.25Mpa.But after that even if percentage of fibers increases from 0.50% to 1.25% compressive strength get decreased from 48.74 Mpa to 33.95 Mpa. So,The optimum percentage MonoPP fiber volume fraction is 0.25%.

(3) Abrasion test indicates that for 0.25 % addition of MonoPP fibers abrasion value at its minimum i.e.875 mm3 which is for plain block is 972.22 mm3 & permissible value by IS recommendation is 1125 mm3 But after that even if percentage of fibers increases from 0.50% to1.25% the abrasion value also increases from 1013.89 mm^3 to 1291.67 mm3 So, The optimum percentage MonoPP fiber volume fraction is 0.25%.

(4) Split tensile test indicates that for 0.25 % addition of MonoPP fibers gives maximum tensile strength 1.67 Mpa as compared to plain blocks of 1.57 Mpa, But after that even if percentage of fibers increases from 0.50% to1.25% the tensile strength get reduced from 1.20 Mpa to 0.61 Mpa. So, the optimum percentage MonoPP fiber volume fraction is 0.25%.

(5) As per flexural strength criteria minimum breaking load as per IS recommendation for Heavy duty/Industrial road is 7 KN.and our test indicates that for 0.25 % addition of MonoPP fibers gives maximum flexural strength is about 35 KN , But after that even if percentage of fibers increases the flexural strength get reduced. So, The optimum percentage fiber volume fraction is 0.25%.

V. Scope for Future Work

The present work has good scope for future research. Some of the research areas are as follows:

(1) Investigation of reduction in cement content for different percentage addition of fibers in mix. when permissible strength results are achieved.

(2) Investigation of ductility characteristics of FRC for potential application in seismic design and construction

(3) Behaviour under creep and shrinkage.

(4) Behaviour of mechanical and physical properties of FRC at various temperatures

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