International Journal of Engineering Research-Online
A Peer Reviewed International Journal
Articles available online http://www.ijoer.in

Vol.3., Issue.2, 2015

RESEARCH ARTICLE

ISSN: 2321-7758

EFFECT OF PARTIAL REPLACEMENT OF CEMENT BY FLY ASH USING NYLON FIBER IN CONCRETE PAVER BLOCK

ANUBHAV TIWARI[1], DEVANSH JAIN[2], RAJESH JOSHI[3]
[1]M.E Scholar, [2,3] Assiatant Professor
[1,3]Rajiv Gandhi Proudyogiki Mahavidyalaya, Department of Civil Engineering, Bhopal.
[2]UIT-RGPV, Department of Civil Engineering, Bhopal

Article Received: 14/03/2015 | Article Revised on:20/03/2015 | Article Accepted on:26/03/2015

ANUBHAV TIWARI

DEVANSH JAIN

ABSTRACT

Solid unreinforced pre-cast cement concrete paver blocks is a versatile, aesthetically attractive, functional, cost effective and requires little or no maintenance if correctly manufactured and laid. Paver blocks can be used for different traffic categories i.e. Non-traffic, Light-traffic, Medium-traffic, Heavy-traffic and Very heavy traffic. In present study work paver blocks of M-40 grade of 80mm thickness for medium traffic with varying percentage of nylon fiber (0.1%, 0.2%, 0.3%, 0.4% & 0.5%) is used to improve the compressive strength is casted. After finding optimum percentage of nylon fiber, the same is used as constant and fly ash in varying percentage (10%, 20% & 30%) is added (as cement replacement) to examine the changes in compressive strength of paver block. It has been foud that using Nylon Fiber increases the compressive strength up to 18.86% when we use Nylon fiber upto 0.3%, as compared to conventional mixture; and Nylon Fiber makes the blocks more opaque as compare to other paver blocks and The optimum dose of 20 % of fly ash gives maximum strength of paver block.

Keywords: Flyash, Nylon fibre, Compressive strength, Paver block.

I.INTRODUCTION

Interlocking concrete Pavement has been extensively used in a number of countries for quite something as a specialized problem solving technique for providing pavement in areas where conventional types of construction are less durable due to many operational and environment constraints. Intermediate concrete block pavement (ICBP) technology has been introduced in India in construction a decade ago, for specific requirements viz. footpaths, parking areas etc. but now being adopted extensively in different uses where the conventional construction of pavement using hot bituminous mix or cement concrete technology is not feasible or desirable.

Interlocking concrete pavements or pavers are a special dry mix pre-cast piece of concrete commonly used in exterior landscaping pavement applications. Unit Pavements or block paving, nick named pavers in the United States were developed before the Second World War by the Dutch and introduced into the United States in the early 1970s. Concrete block pavement (CBP) can be use an alternative pavement to asphalt and concrete pavements. Interlocking paving stones are installed over a compacted stone sub-base and a leveling bed of sand. CBP is formed

from individual concrete paving blocks that fit next to one another on a suitable sub base leaving a specific joint space among them to be filled with jointing sand. The sand does not easily wash out with rain or garden hose water. Polymeric Sand or a sealant can be used to further lock or coagulate the sand. Standard thicknesses are 60mm (for light traffic), 80mm (heavy traffic) and 50mm too is common in some countries like Pakistan (used for footpaths etc.).

We all know for pavement of paver block required high compressive strength and to increase the compressive strength of paver blocks various efforts have been made. In this particular study M40 paver blocks have been cates of 80 mm thickness for medium traffic and to increase its compressive strength Nylon fiber is added to concrete.

II Experimental Program

1. Materials Used

There are different type of materials used in the construction of paving blocks.

Cement: Ordinary Portland Cement of Grade 53 is used, which conforming IS 12269. 53 grade cement of ultra tech with a remarkably high CS3 (tricalcium providing long-lasting) durability to concrete structures. Produces highly durable and sound concrete due to very low percentage of alkalis chlorides, magnesia;

2. Fine Aggregate: Natural river sand conforming to Zone II as per IS 383 (1987) was used. The fineness modulus of sand used is 2.64 with a specific gravity of 2.59.

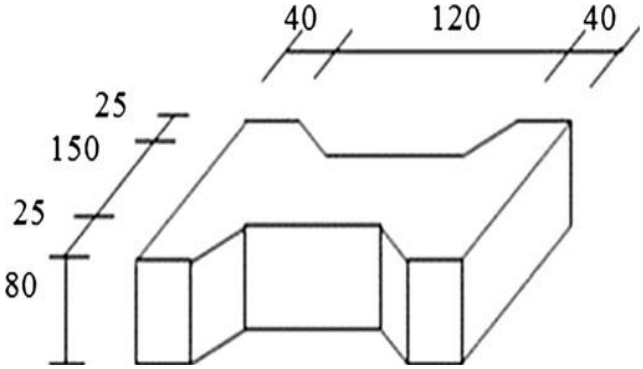
3. Coarse aggregate: Natural Crushed Stone conforming to IS: 383 (1987) was employed. Coarse aggregate of size 20 mm down having the specific gravity of 2.77 and fineness modulus of 7.21 was applied.

4.Nylon Fiber

Nylon fibre is a generic designation for a family of synthetic polymers generically known as polyamides. It is used in construction because of its qualities like it arrests cracks, increases strength and greatly improves quality of construction. Properties of Nylon fibre as shown in table5

5.Flyash

Flyash is define as the finely divided residue resulting from the combustion powdered coal, which is transported from the firebox through the boiler by flue gases. Flyash is a by-product of coal-fired electric plants. The fly ash used in the work was of class C and the specific gravity was 1.99 g/cm^3.



All Dimension are in mm

Figure 1: Dimension of Paver Block

Table 1: Mix Proportion using Nylon Fibers

Table1: mix proportion using nylon fibre

Material	**% Mixed**	**Mix**	**Ingredient**	**Mix Design (Kg/m3)**
Nylon Fiber (FB)	0.1	FB1	Cement	490
			Nylon Fiber	0.49
			Water	197
			Coarse aggregate	892.33

			Fine aggregate	648.65
	0.2	FB2	Cement	490
			Nylon Fiber	0.98
			Water	197
			Coarse aggregate	892.33
			Fine aggregate	648.65
	0.3	FB3	Cement	490
			Nylon Fiber	1.47
			Water	197
			Coarse aggregate	892.33
			Fine aggregate	648.65
	0.4	FB4	Cement	490
			Nylon Fiber	2.45
			Water	197
			Coarse aggregate	892.33
			Fine aggregate	648.65
	0.5	FB5	Cement	490
			Nylon Fiber	2.94
			Water	197
			Coarse aggregate	892.33
			Fine aggregate	648.65
	—	Standard	Cement	490
			Water	197
			Coarse aggregate	892.33
			Fine aggregate	648.65

2. Mix Proportions

The mixture proportions for the controlled concrete of M40 grade were arrived at from the trail mixes. Concrete mix of M40 grade was designed as per specification of IS 10262 : 2009, for water cement ratio 0.40. In this method, firstly five mix proportion of varying percentage of nylon fiberi.e0.1%, 0.2%, 0.3%, 0.4% & 0.5% by cement as an admixture is made (table 1)and then varying percentage of Fly Ash mix Proportion is also prepared as a cement replacement with constant percentage of nylon fiber i.e 0.3%. (Table 2)

3. Preparation of Test Specimen

For manufacturing of paver block first we have decide that size of the paver block, which is according to manufacturer is given below:

Shape: I section

Length: 200 mm

Width: 160 mm

Thickness = 80 mm

Aspect ratio (L/T) = 200/80 = 2.5 <4.0 as per IS 15658 : 2006

Material	**% Mixed**	**Mix**	**Ingredient**	**Mix Design (Kg/m3)**
Fly Ash (FA)	10	FA 10	Cement	487.58
			fly ash	54.18
			Nylon Fiber	1.47
			Water	197
			Coarse aggregate	892.33
			Fine aggregate	648.65
	20	FA 20	Cement	433.4
			fly ash	108.35
			Nylon Fiber	1.47
			Water	197
			Coarse aggregate	877.27
			Fine aggregate	638.35
	30	FA 30	Cement	379.23
			fly ash	162.52
			Nylon Fiber	1.47
			Water	197
			Coarse aggregate	877.27
			Fine aggregate	638.35
	—	Standard	Cement	490
			Water	197
			Coarse aggregate	892.33
			Fine aggregate	648.65

Table 2: Mix Proportion using Fly Ash and with Nylon Fibers

Its not easy to calculate area of the paver blocks by conventional way or method because of its shape, so to calculate the area of paver block we adopted plan area method as per IS 15658. In plan area method the specimen shall be placed, wearing face facing up, on cardboard and its perimeter is traced with the pencil. The shape shall be cut accurately with the scissors and weighted to the nearest

0.0001N, and the result recorded as mass (m_{sp}). A rectangle measuring 200mm x 100mm cut out from same cardboard shall also be weighted to nearest 0.0001 N, and result recorded as mass (m_{std}). the plan area for the block shall be calculated from the formula:

$$A_{sp} = \frac{20000\ m_{sp}}{m_{std}} mm^2$$

As per method reading recorded is Msp= 0.020 Kg, Mstd= 0.014 Kg therefore the Area (Asp) is 28571.4286 or 28572 mm^2. Now Mix has been prepared for different mix proportions and for all mix hand mixing is done, after this I section paver blocks is casted and its dimension is given in figure 1, For paver block the rubber mould is used. It shall be constructed in such a manner as to facilitate the removal of the molded specimen without damage, and shall be so machined that, when it is assembled ready for, the dimensions and internal faces shall be accurate within the following limits. As per IS: 516:1959, the height of the mould and the distance between opposite faces shall be the specified size + 0.2mm. The angle between adjacent internal faces and between internal faces and top and bottom planes of the mould shall be 90^o+-0.5^o. The interior faces of the mould shall be plane surface with a permissible variation of 0.03mm. Each mould shall be provided with a metal base plate having a plane surface. The base plate shall be such dimensions as to support the mould during the filling without leakage and it shall be preferably attached to the mould by spring or screws. The part of the mould when assembled shall be positively and rigidly held together, and suitable methods of insuring this, both during the filling and on subsequent handling of the field mould, shall be provided. In assembling the mould for use, the joints between the sections of mould shall be thinly coated with mould oil and a similar coating of mould oil shall be applied between the contact surfaces of the bottom of the mould and the base plate in order to insure that no water escape during the filling. The interior surfaces of the assembled mould shall be thinly coated with mould oil to prevent adhesion of the concrete. After 24 hours of moulding, paver are taken out from mould by simple push and the curing of the specimen done as per IS 516 : 1959, The test specimen shall be stored on the site at a place free from vibration, under damp matting, sacks or other similar material for 24 hours +- ½ hour from the time of adding the water to the other components. The temperature of the place of storage shall be inside the range of 22^o to 32^o C. After the period of 24 hours, they shall be noted for later identification, taken away from the molds and, unless required for testing within 24 hours, stored in clear water at a temperature of 24^o to 30^oC until they are sent to the testing lab. They shall be committed to the testing laboratory well packed in damp sand, damp socks, or other suitable material so as to arrive there in a damp condition not less than 24 hours before the time of the trial. On arrival at the testing laboratory, the specimen shall be stored in water at a temperature of 27^o+-2^oC until the time of the trial. A platter of the daily maximum and minimum temperature shall be kept both during the menstruation of the specimen remain on the website and in the laboratory, and test conducted for the specimen after 7, 14 and 28 days.

Paver Block	**Compressive Strength (N/mm^2)**		
	7 Days	**14 Days**	**28 Days**
Standard	36.56	37.59	40.36
FB1	37.37	38.51	39.33
FB2	37.79	39.23	39.74
FB3	41.12	43.35	44.2
FB4	40.05	41.51	42.1
FB5	39.9	41.33	41.79

Table 3: Compressive Strength of Nylon Fiber Paver Blocks

Paver Block	**Compressive Strength (N/mm^2)**		
	7 Days	**14 Days**	**28 Days**
Standard	43.1408	44.3562	47.6248
FB1	44.0966	45.4418	46.4094
FB2	44.5922	46.2914	46.8932
FB3	48.5216	51.153	52.156
FB4	47.259	48.9818	49.678
FB5	47.082	48.7694	49.3122

Table 4: Corrected Compressive Strength of Nylon Fiber Paver Blocks as per IS 15658

Paver Block	**Compressive Strength (N/mm^2)**		
	7 Days	**14 Days**	**28 Days**

Standard	36.56	**37.59**	40.36
FA10	39.36	41.54	42.24
FA20	40.11	42.45	43.12
FA30	38.95	49.8	40.1

Table 5: Compressive Strength of Fly Ash Paver Blocks with Nylon Fiber

Paver Block	**Compressive Strength (N/mm²)**		
	7 Days	**14 Days**	**28 Days**
Standard	43.14	44.36	47.62
FA10	46.44	49.02	49.84
FA20	47.33	50.09	50.88
FA30	45.96	58.76	47.32

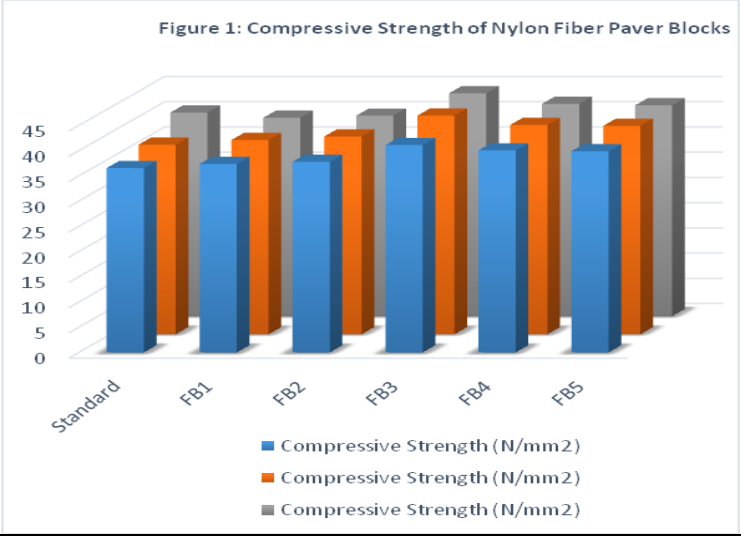
Table 6: Corrected Compressive Strength of Fly Ash Paver Blocks with Nylon Fiber as per 15658

III. Experimental program

The paver block specimen selected as per sampling procedure specified in IS 15658 : 2006 shall be tested for compressive strength. Compressive Strength test is performed on pavers block as per specification given in IS15658 : 2006. Firstly nylon fibers pavers blocks are tested and after a deep discussion on result new pavers which was casted with fix percentage of Nylon Fibers and varying percentage of Fly ash is tested, for test blocks are taken out from water tank after specified curing days and their temperature is maintained 20 +- 5°C. The bearing plates of the testing machine shall be wiped clean. The specimens are aligned with those of the bearing plates. The load shall be applied without shock and increased continuously at a rate of 15 ± 3 N/mm^2/min until no greater load can be sustained by the specimen or delamination occurs. The maximum load applied to the specimen shall be noted in N.The apparent compressive strength of individual specimen shall be calculated by dividing the maximum load (in N) by the plan area (in mm2). The corrected compressive strength shall be calculated by multiplying the apparent compressive strength by the appropriate correction factor from given in IS 15658 : 2006. The strength shall I be expressed to the nearest 0.1 N/mm^2.in project arrised / Chamfered I section blocks of 80mm thickness is casted so correction factor which is used here is 1.18.

IV. Result and Discussion

When paver blocks goes through compressive strength test it has been observed that compressive strength of paver blocks increases in the nylon fiber content upto 0.3%; when we increase the nylon fiber content further 0.4% and 0.5% it posses comparatively lower compressive strength. 0.3% of nylon fiber paver blocks possess 44.2 N/mm^2 compressive strength, when we correct it according to 15658 : 2006 it goes to 52.156 N/mm^2; after testing the nylon fiber pavers for their compressive strength we get the optimum percentage of nylon fiber is 0.3%. with this optimum percentage of nylon fiber we replace cement by fly ash upto 30% at regular interval of 10% in paver blocks mixes and after compressive strength test it has been observed that FA20 mix i.e. 20% fly ash replacement mix with optimum nylon fiber content gives maximum compressive strength 43.12 N/mm^2 and when corrected it gives 50.88 N/mm^2 as per IS 15658 : 2006.



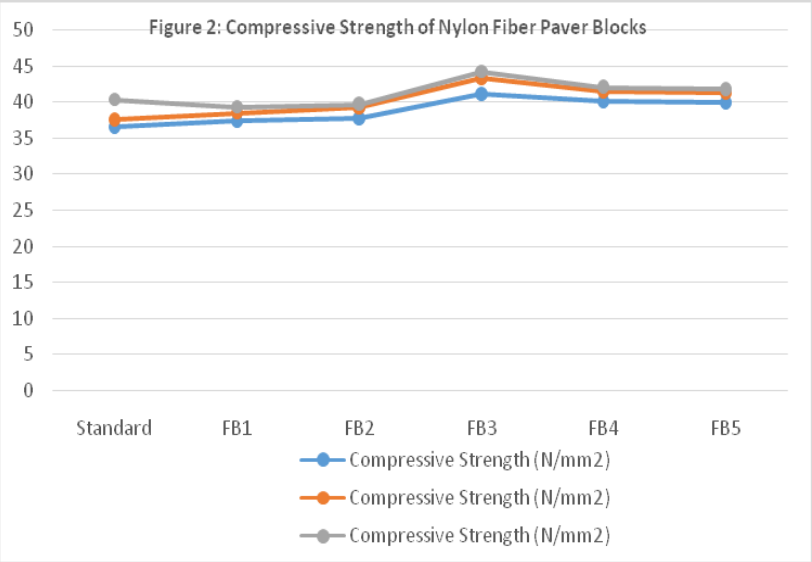


Figure 2: Compressive Strength of Nylon Fiber Paver Blocks
50
45
40
35
30
25
20
15
10
5
0
Standard
FB1
FB2
FB3
FB4
FB5
Compressive Strength (N/mm2)
Compressive Strength (N/mm2)
Compressive Strength (N/mm2)

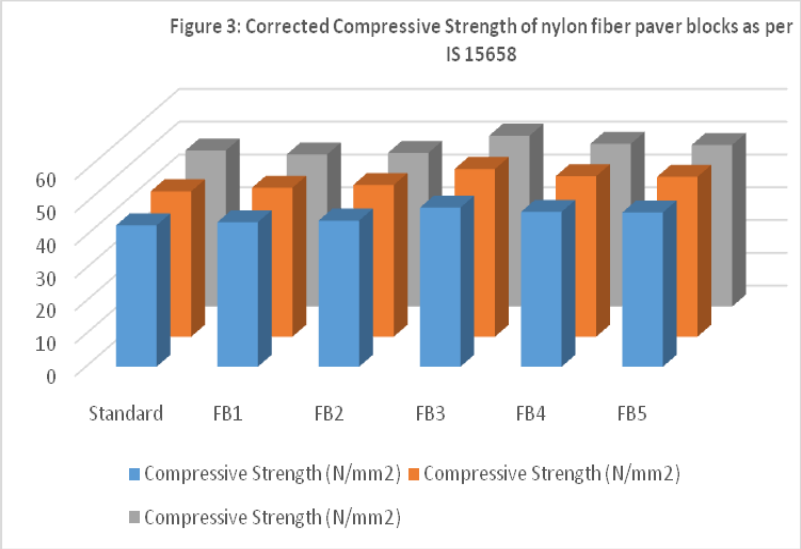


Figure 3: Corrected Compressive Strength of nylon fiber paver blocks as per IS 15658
60
50
40
30
20
10
0
Standard
FB1
FB2
FB3
FB4
FB5
Compressive Strength (N/mm2)
Compressive Strength (N/mm2)
Compressive Strength (N/mm2)

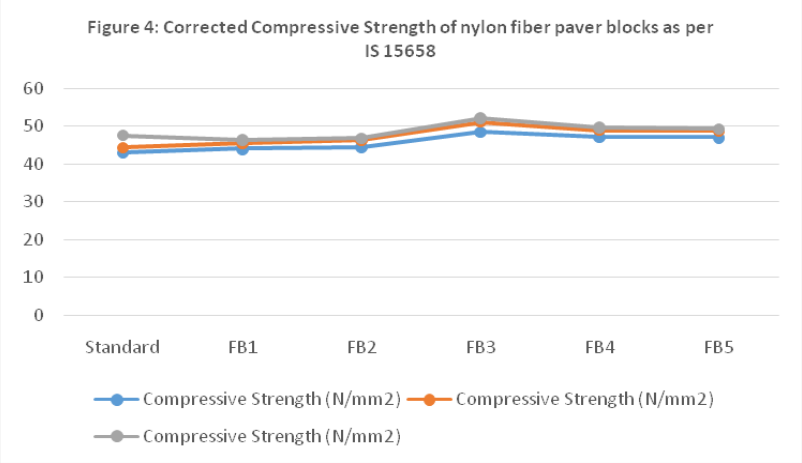
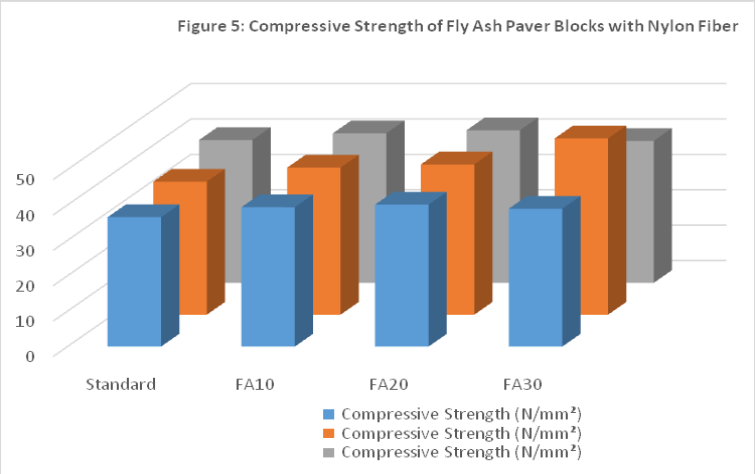


Figure 4: Corrected Compressive Strength of nylon fiber paver blocks as per IS 15658
60
50
40
30
20
10
0
Standard
FB1
FB2
FB3
FB4
FB5
Compressive Strength (N/mm2)
Compressive Strength (N/mm2)
Compressive Strength (N/mm2)

.



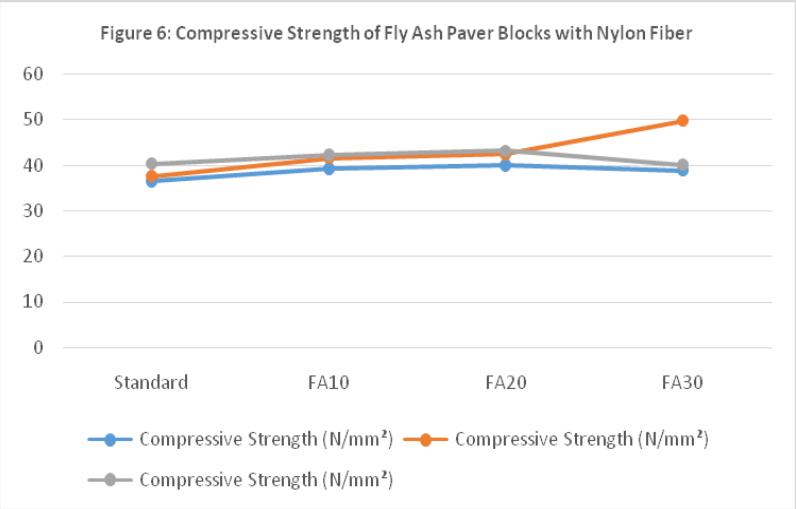
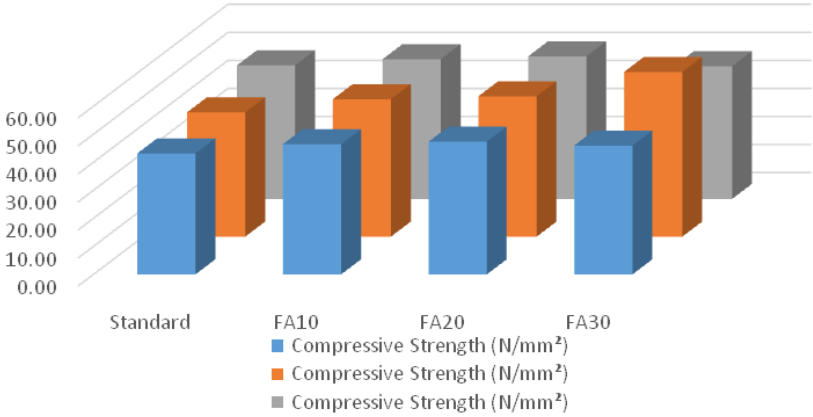
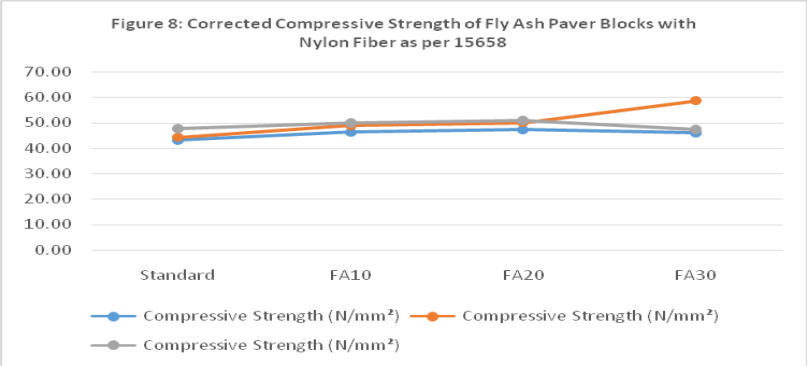


Figure 7 Corrected Compressive Strength of Fly Ash Paver Blocks with Nylon Fiber as per 15658





V. CONCLUSION

Following conclusion is carried out from present study.

I. When optimum percentage of Nylon Fiber is added to concrete i.e. 0.3% of cement, it gives maximum compressive strength when it is compare to conventional concrete paver blocks and also other nylon fiber paver blocks (0.1%,0.2%,0.4%,0.5%).

II. When we prepare mix of concrete with 0.3% Nylon Fiber by cement, also with fly ash as cement replacement, we observe that 20% of cement replacement by Fly Ash (FA20 mix) gives maximum strength.

VI. REFERENCE

[1] IS 15658 : 2006 Code of Practice for Precast concrete blocks for paving. Bureau of Indian Standards. New Delhi.

[2] The manufacturing of concrete paving blocks; Cement & Concrete Institute, Midrand, 1997, reprinted 1999, 2000, 2005.

[3] Cement concrete blocks and paving tile; Small Industries Service Institute, Rajajinagar Industrial Estate, Bangalore.

[4] ACI Committee 201, ''Proposed Revision of Guide to Durable Concrete (ACI201.2R)'', ACI Material Journal, V.88, No.5, pp 554-551, Sept-Oct, 1991

[5] Bikasha C. P., and Ashok K.G., ''Structural Behaviour of Concrete Block Paving 2: Concrete Blocks'', Journal of Transportation Engineering, Vol 128, No.2, pp. 130-135, 2002

[6] Dr. S.D. Sharma, “An Easy Approach For Road Construction-interlocking Concrete Paver Blocks”, New Delhi, NBMCW, September 2009

[7] IS 456:2000 Code of Practice for Plain and Reinforced Concrete, Bureau of Indian Standards. New Delhi.

[8] IS 7245 : 1974 Specification for concrete pavers

[9] IRC SP: 63-2004 Guidelines for Use of Interlocking Concrete Block Pavement

[10] IS 1893:2002 Code of Practice for Plain and Reinforced Concrete. Bureau of Indian Standards. New Delhi.

[11] Prof. Indrajit Patel, Dr. C. D. Modhera, “Experimental Investigation On Study Effect Of Polyester Fibre On Abrasion And Impact Resistance Of High Volume Fly Ash Concrete With Class-f Fly Ash”, Gujarat, India, September 2012

[12] Ravikumar C.M. “Experimental Studies on Interlocking Iron-ore-Tailing Based Paving. Tiles”, M-Tech (I.S) Thesis, Mangalore University, May- June 2000.

[13] Sampathkumar N.N et al. “Utilization Waste Tailing in Roofing Tiles & Bricks”, Workshop on Cost effective Building Technology, NITK, Surathkal, March 1988.

[14] Shackel.B, ”The Design of Interlocking Concrete Block Pavements for Road Traffic” Proceedings of 1st International conference on Concrete Blocks Paving, London, pp. 23-32, 1980.

[15] Shackel.B. “Design & Construction of Interlocking Concrete Block Pavements”, Elsevier Applied Science, London, pp 229-230, 1990.

[16] Sunil Kumar Jaladi, “Studies on Concrete Hollow Blocks with Iron ore Tailings as Fine Aggregate”, M. Tech dissertation, Mangalore University, 2001.