International Journal of Trend in Scientific Research and Development (IJTSRD)
Volume 4 Issue 6, September-October 2020 Available Online: www.ijtsrd.com e-ISSN: 2456 – 6470

Comparative Study on Strength and Water Absorption of M35 Grade Paver Block using Fly Ash and Varying Proportions of Polypropylene Fibre

Ankit Singh[1], Prof. Toshi Bhawsar[2]

[1]Research Scholar, [2]Assistant Professor,

[1,2]Department of Civil Engineering, Lakshmi Narain College of Technology, Bhopal, Madhya Pradesh, India

ABSTRACT

Fly ash is a huge waste available at thermal power plants in the country. Large consumption of fly ash in paver blocks will help the nation to make economical paver blocks and will address challenges associated with environmental issues and disposal of waste In the present study on M35 grade paver blocks with thickness 60mm and 80mm with replacement of OPC by 30% fly ash and addition of polypropylene fibre @ 0.0% to 0.5% with increment of 0.1% by weight of cement have been manufactured to access the suitability for Indian road surfaces for different applications. The blocks have been tested at the age 7 and 28 days for strength and durability criteria. For strength properties compressive strength and flexural strength test were conducted, both being important for applications for road surfacing. For durability properties water absorption has been studied. The result of compressive strength and flexural strength indicates that it is feasible to use OPC replaced by 30% fly ash and addition of 0.3% PPF in manufacturing of paver blocks. Paver blocks have attained target compressive strength and flexural strength at 28 days in all the grades.

KEYWORDS: *Polypropylene fibre, Fly ash, Compressive Strength, Flexural Strength, Paver block, water absorption*

How to cite this paper: Ankit Singh | Prof. Toshi Bhawsar "Comparative Study on Strength and Water Absorption of M35 Grade Paver Block using Fly Ash and Varying Proportions of Polypropylene Fibre" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-4 | Issue-6, October 2020, pp.1257-1263, URL: www.ijtsrd.com/papers/ijtsrd33649.pdf

IJTSRD33649

1. INTRODUCTION

Pavements surface using blocks are made by using individual interlocking paver blocks by installing one to another. These are laid on prepared sub grade with sand bed below bounded by edge restraints from both sides. The blocks are laid in proper bond with joints in between to have structural stability. These joints are filled with sand of suitable grading. The interlocking mechanism of concrete block pavement provides sufficient area for load spreading. Concrete block pavements have certain advantages over asphalt and concrete pavements. The general advantages are maintenance, operational, structural, aesthetics and economical. A well-constructed interlocking pavement provides better performance. The paver blocks are manufactured from concrete composite comprising of cement, water, aggregates and super plasticizer, which are available locally everywhere in country. Pavers blocks are pre-fabricated in the factory using press/vibrating table system before their actual use. These are used in surface layer of pavements, urban and semi urban roads, village roads, streets, foot paths, gardens, passengers waiting sheds, petrol pumps bus stops, platforms, industry, etc. Precast paver blocks are ideal materials for pavements and footpaths along roadside where a lot of face lift is being given owing to easy laying, better look, easy to repair and ready to move after laying.

Paver blocks are economical as they do not break and these have 100% salvage value in case of replacement. The term precast means that the blocks are manufactured and hardened before laying and are brought to job site. The paver blocks are manufactured in such a fashion that these interlock with each other during laying to maintain structural strength. Cement concrete is strong under compressive loads at the same time it is inherently poor under tensile stresses. It is of brittle nature so it is not advisable to make paver blocks from concrete of such nature. The material for paver blocks has to be ductile. Thus to make concrete ductile, polypropylene fibres are added in small proportions during manufacturing of paver blocks to encounter the impact and flexural stresses which are inevitable on road surface during running of traffic. The micro crack formation in concrete at early stage due to plastic shrinkage may also be addressed with the addition of polypropylene fibres.

2. OBJECTIVES

A. To prepare design mix for zero slump concrete composite for manufacture of paver block M35 grade designation of thickness 60 mm and 80 mm by replacing OPC with 30% fly ash and adding PPF @0.1%, 0.2%, 0.3%, 0.4% and 0.5% in each grade.

B. To test the strength properties of hardened paver blocks for various design mixes i.e. compressive strength and flexural strength at 07 and 28 days of age.
C. To test the durability properties of hardened paver blocks for various design mixes i.e. Water absorption at 28 days of curing.
D. To establish optimum dosage of PPF addition in manufacturing of paver blocks with 30% fly ash.
E. To study cost effectiveness of paver block with optimum dosage of polypropylene fiber.

3. LITERATURE REVIEW

Raju and John studied high volume fly ash concrete by replacing cement with 60% fly ash and adding Recron 3s fibers @ 0.1%, 0.2% and 0.3% by weight of cement and observed that with fiber addition compaction factor decreases. Singh and Goel studied the effect of replacing polypropylene fibers with PET fibers in concrete and reported that with addition of fibers in concrete workability reduced. Mohod et al. observed workability of M30 and M40 grade concrete by adding polypropylene fibre @ 0%, 0.5%, 1.0%, 1.50% and 2.0% and found that increase in volume proportions of fibres led to decreased workability. Thirumurgan and Sivakumar observed fresh concrete properties of M 40 grade by adding PPF@ 0.1%, 0.2% and 0.3% by volume fractions, using water cement ratio 0.3 replacing OPC with fly ash by 25% and 50% and reportedthat workability decreases. Ramujee et al. studied workability of fiber reinforced concrete by adding PPF @ 0%, 0.5%, 1.0 % 1.5% and 2.0 % by weight of cement and noticed reduction in slump with increase in fiber content beyond 1.5%. Gencel et al. studied paver blocks made with waste marble by replacing aggregates with waste marble@0%,10%, 20%, 30% and 40% for 32.5 and 42.5 cement type and found that compressive strength at higher replaced level resulted into lower compressive strength. Patel and Modhera experimented by replacing F- type fly ash at levels 50%, 55%, 60% with addition of 0.25% PPF by weight and found compressive strength increases for all replacement levels in M25, M30, M35 and M40 and the optimum level of fly ash replacement was 55%.

4. Materials Used

A. Ordinary Portland cement (OPC)

The Portland cement has mainly three grades, namely OPC33 grade, OPC43 grade and OPC53grade. The classification of cement is attained on the basis of the strength of cement at 28 days as per Aggarwal ei.al. Cement acts as a binder in production of paver block. In this research, 43 grade OPC procured from local market of Patna conforming to IS: 8112 has been used. The results obtained for the physical properties are given in Table1.

Table 1: Physical properties of OPC 43 grade

Physical property	Observed results
Normal consistency (%)	30
Initial setting time (minute)	94
Final setting time (minute)	245
Fineness (using 90 µm IS sieve) (%)	6
Soundness (mm)	2.0
Specific gravity	3.15
Compressive strength (N/mm^2) 03 days 07 days 28 days	25 35.5 44.5

B. Coarse Aggregates (CA)

In the present research stone cursed aggregates has been used of maximum nominal size 10 mm procured from local market, maihar, M.P. The coarse aggregates tested according to IS: 2386. Test results of sieve analysis and physical properties of coarse aggregates

Table 2: Physical properties of coarse aggregates

Properties	Results
Bulk density (loose) kg/m^3	1440
Specific gravity	2.63
Water absorption (%)	0.48
Impact value (%)	14
Abrasion value (%)	19

C. Fine Aggregate (FA)

The river sand procured from son river, Satna (M.P.) conforming to IS: 383 has been used for the present research. The sand has been tested as per IS: 2386. The test results of the sieve analysis and physical properties observed of fine aggregates.

Table 3: Physical properties of fine aggregates

Properties	Observed values
Bulk density (loose) kg/m^3	1567
Specific gravity	2.57
Water absorption (%)	0.60

D. Fly Ash (FA)

The fly ash concrete results in poor early strength and long term good strength. It has low heat of hydration. It fills the voids of concrete resulting in more durable concrete products and thus increases the life of product. In the present study, the fly ash has been procured from Vijay tiles, khramseda satna, M.P

Table 4: Physical properties of fly ash

Sr. No.	Property	Observed value
01.	Specific gravity	2.08
02.	Class	F-type

E. Chemical Admixture (Super Plasticizer)

Use of chemical admixture improves workability as per Concrete Institute. Midrand. BASF Master Glenium SKY 8233 super-plasticizer based on Polycarboxylic Ether (PCE) chemical admixture has been used for manufacture of cement concrete interlocking paver blocks. It complies with IS: 9103 BASF Master Glenium SKY 8233 procured from local market Govindpura J.K Road, Bhopal

F. Water

Potable tap water was used for casting and curing of paver blocks. The water confirms to the requirements of IS: 456.

G. Polypropylene (PP)

The polypropylene has been used in the form of polypropylene fibre (PPF) of Suppliers Real door & Frame, Supplier Company is located in Industrial area Govinpura J.K Road, Bhopal. The brand name of PPF is Recron 3s. Standard dosage of 125gm/50 kg bag of cement is recommended by the manufacturer. The required quantity of PPF is soaked in water for a minute and then this water added to concrete batch and mix, to get excellent dispersion. The specifications of Recron 3s supplied by the supplie

Table 5: Specifications of Recron 3s

Property	Value
Cut length	12 mm
Shape of fiber	Triangular
Specific gravity	0.91
Effective diameter	25-40 micron
Tensile strength	4000-6000 kg/cm^2
Melting point	165^o C
Dosage rate	125gm/50 kg cement

Source: Real door & Frame

Figure 2: Polypropylene fibre

Table 6: Mix design of M35 grade concrete with 30% fly ash and varying % of PPF

Mix ID	Cementitious material		Water	Fine aggregate	Coarse aggregate	SP	PPF
	Cement	Fly ash	kg/m3				
M35F30P0.0%	273	117	152	951	877	2.11	0
M35F30P0.1%	273	117	152	951	877	2.11	0.39
M35F30P0.2%	273	117	152	951	877	2.11	0.78
M35F30P0.3%	273	117	152	951	877	2.11	1.17
M35F30P0.4%	273	117	152	951	877	2.11	1.56
M35F30P0.5%	273	117	152	951	877	2.11	1.950

5. Compressive Strength Test

The compressive testing machine of capacity 200 tons used for test. The specimen shall be capped with 4mm thick plywood sheets of size larger than the specimen and placed between the bearing plates of the CTM and tightened by hand. The load shall be applied without any jerk and increase continuously @15±3 N/mm^2 per minute until the specimen fails. The failure load is recorded in N. The apparent compressive strength of the paver block is calculated by using formula, compressive strength = failure load/ plan area in N/mm^2, for the individual specimen.

Figure 3: Compressive strength test setup

6. Flexural Strength Test

The flexural property of the paver block is very important to be observed when used on roads where traffic is running. The test specimen shall be checked for length, width, thickness and aspect ratio. The apparatus used for the test shall be same as per IS: 15658 and IS: 516. The supporting rollers of the machine should have diameter in the range of 25mm to 40mm. The distance from centre to centre of rollers shall be adjusted to fix the specimen -50mm. Four paver block randomly selected for the test and kept with capping material as per IS: 15658. The load shall be applied without any shock and increased continually @ 6kN/minute and shall be increased until failure of the specimen.

Figure 4: Flexural strength test setup

7. Water Absorption Test

The water absorption of paver blocks was determined to assess its durability. The test was conducted as per IS: 15658. For observation of water absorption, three specimens were taken after curing of 28 days, randomly selected. Immerse the specimens in water completely for 24±2 hours. Remove the specimens from water and allowed to be dry for one minute at room temperature. Remove the visible water with cloth, and weigh the specimen immediately in kg to nearest 0.001kg (W_S), the weight measurement setup is shown in the Figure.

Figure 5: Weight measurement setup

8. RESULTS AND DISCUSSION

A. Compressive Strength

I. Corrected Compressive Strength of 60 mm Thick Paver Blocks with OPC Replaced by 30% Fly Ash and varying proportions of PPF for M35grade of paver blocks

The corrected compressive strength results of 60 mm thick paver blocks with OPC replaced by 30% FA and addition of 0.0% to 0.5% PPF at different ages are tabulated in Table 7. The paver blocks have been named according to their grade designation, FA replacement proportion and PPF addition. The variation of corrected compressive strength with age for M35 grades of paver blocks has been shown graphically.

Table 7: Corrected compressive strength results of 60 mm thick M35 grade of paver blocks with varying proportions of PPF

Grade	WCR	SP	PPF	Thick	Corrected compressive strength (N/mm²)	
					07 Days	28 Days
M30F30P0.0	0.43	2.11	0.000	60	27.34	40.60
M30F30P0.1	0.43	2.11	0.390	60	27.55	41.50
M30F30P0.2	0.43	2.11	0.780	60	27.66	42.10
M30F30P0.3	0.43	2.11	1.170	60	28.10	42.90
M30F30P0.4	0.43	2.11	1.560	60	26.69	42.10
M30F30P0.5	0.43	2.11	1.950	60	26.40	41.80

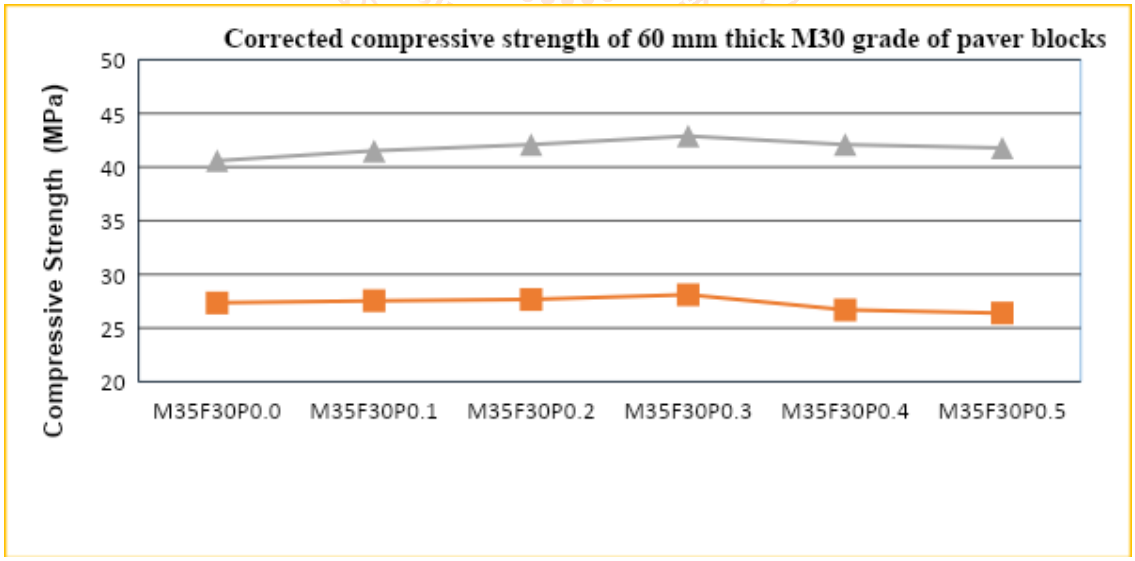

Figure 6: Line graph for Variation of corrected compressive strength with age for M30 grade with varying proportions PPF for 60mm thick paver block

II. Corrected Compressive Strength of 80 mm Thick Paver Blocks with OPC Replaced by 30% Fly Ash and varying proportions of PPF for M35 grade of paver blocks

The corrected compressive strength results of 80 mm thick paver blocks with OPC replaced by 30% FA and addition of 0.0% to 0.5% PPF at different ages are tabulated in Table 8. The paver blocks have been named according to their grade designation, FA replacement proportion and PPF addition. The variation of corrected compressive strength with age for M35 grades of paver blocks has been shown graphically in Figure 7.

Table 8: Corrected compressive strength results of 80 mm thick M30 grade of paver blocks with varying proportions of PPF

Grade	WCR	SP	PPF	Thick	Corrected compressive strength (N/mm²)	
					07 Days	28 Days
M30F30P0.0	0.43	2.11	0.000	80	26.84	40.19
M30F30P0.1	0.43	2.11	0.390	80	27.15	41.15
M30F30P0.2	0.43	2.11	0.780	80	27.60	41.90
M30F30P0.3	0.43	2.11	1.170	80	27.90	42.60
M30F30P0.4	0.43	2.11	1.560	80	26.50	41.70
M30F30P0.5	0.43	2.11	1.950	80	26.18	41.52

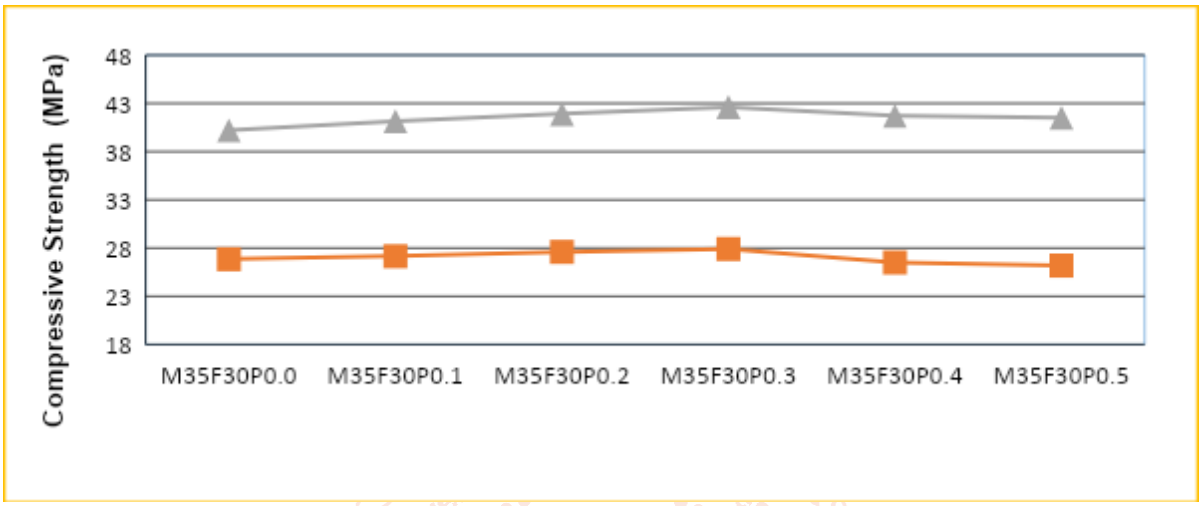

Figure 7: Line graph for Variation of corrected compressive strength with age for M35 grade with varying proportions PPF for 80mm thick paver block

B. Flexural Strength

I. Flexural Strength of 60 mm Thick Paver Blocks with OPC Replaced by 30% Fly Ash and varying %age of PPF for M35 grade of paver blocks

Flexural strength of M35 grade paver blocks of 60 mm thickness with replacement of OPC by 30% fly ash and addition of polypropylene fiber at the rate of 0.0% to 0.5% for 7 and 28 days was observed and tabulated in Table 9, shown graphically in Figure 8.

Table 9: Flexural Strength results of 60 mm thick M35 grade of paver blocks with varying proportions of PPF

Grade	WCR	SP	PPF	Thick	Flexural strength (N/mm²)	
					07 Days	28 Days
M30F30P0.0	0.43	2.11	0.000	60	3.96	4.84
M30F30P0.1	0.43	2.11	0.390	60	4.10	5.10
M30F30P0.2	0.43	2.11	0.780	60	4.31	5.68
M30F30P0.3	0.43	2.11	1.170	60	4.56	6.24
M30F30P0.4	0.43	2.11	1.560	60	4.66	6.18
M30F30P0.5	0.43	2.11	1.950	60	4.40	5.90

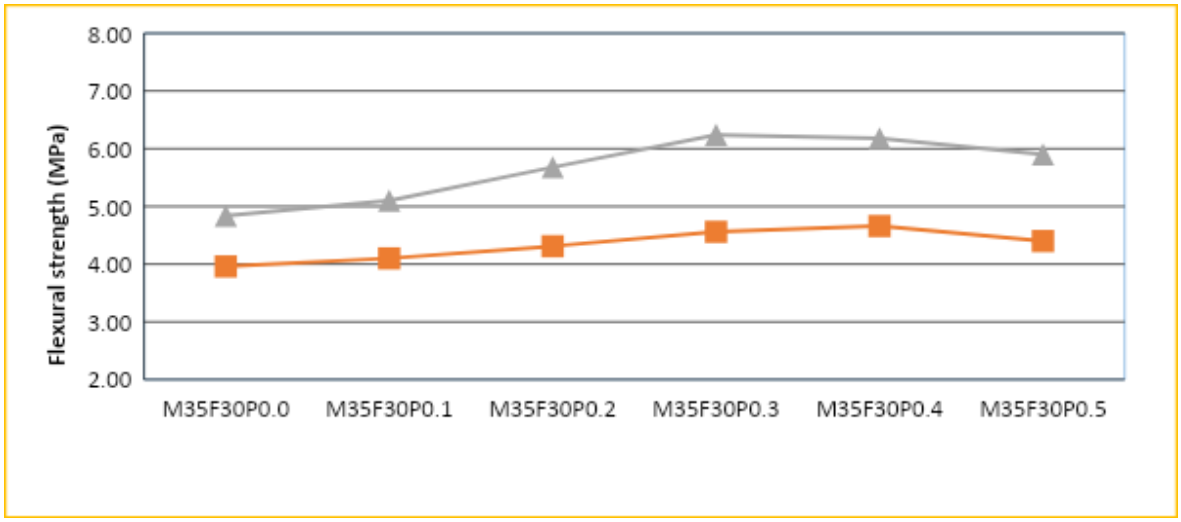

Figure 8: Line graph for Variation of Flexural Strength with age for M35 grade with varying proportions PPF for 60mm thick paver block

II. Flexural Strength of 80 mm Thick Paver Blocks with OPC Replaced by 30% Fly Ash and varying %age of PPF for M30 grade of paver blocks

Flexural strength of M35 grade paver blocks of 80 mm thickness with replacement of OPC by 30% fly ash and addition of polypropylene fiber at the rate of 0.0% to 0.5% for 7 and 28 days was observed and tabulated in Table 10, shown graphically in Figure 9. The paver blocks have been named as per their proportions in the mixes.

Table 10: Flexural Strength results of 80 mm thick M35 grade of paver blocks with varying proportions of PPF

Grade	WCR	SP	PPF	Thick	Flexural strength (N/mm²)	
					07 Days	28 Days
M30F30P0.0	0.43	2.11	0.000	80	3.70	4.74
M30F30P0.1	0.43	2.11	0.390	80	4.00	5.00
M30F30P0.2	0.43	2.11	0.780	80	4.16	5.56
M30F30P0.3	0.43	2.11	1.170	80	4.56	6.12
M30F30P0.4	0.43	2.11	1.560	80	4.20	5.80
M30F30P0.5	0.43	2.11	1.950	80	4.28	5.72

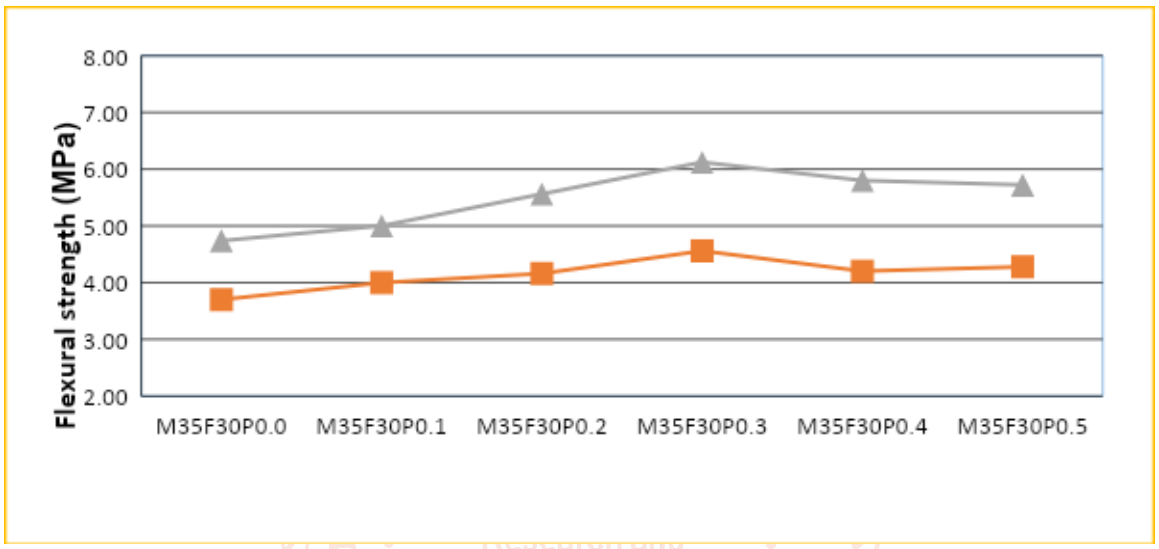

Figure 9: Line graph for Variation of Flexural Strength with age for M35 grade with varying proportions PPF for 80mm thick paver block

C. Water Absorption Test Results for M35 Grade 60 and 80 mm Thick Paver Blocks

Table 11: Water absorption results for M35 grade 60 mm thick paver blocks

Mix ID	Average saturated weight (W_S) (kg)	Average dry weight (W_d) (kg)	$W_{Percent}$ = (Ws-WdWd)×100
M35F30P0.0	3.674	3.542	3.72
M35F30P0.1	3.678	3.575	2.90
M35F30P0.2	3.696	3.597	2.74
M35F30P0.3	3.743	3.645	2.69
M35F30P0.4	3.762	3.683	2.16
M35F30P0.5	3.786	3.688	2.65

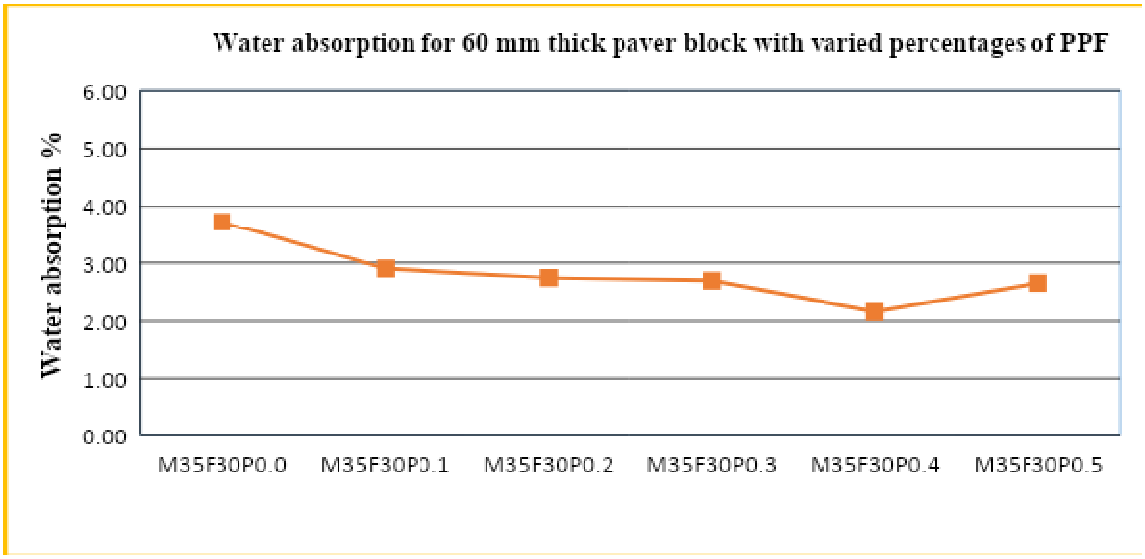

Figure 10: Water absorption for M35 grade 60mm thick paver blocks

Table 12: Water absorption results for M35 grade 80 mm thick paver blocks

Mix ID	Average saturated weight (W_s) (kg)	Average dry weight (W_d) (kg)	$W_{Percent}$ = (Ws-WdWd)×100
M35F30P0.0	4.795	4.621	3.77
M35F30P0.1	4.845	4.675	3.65
M35F30P0.2	4.736	4.577	3.47
M35F30P0.3	4.864	4.723	2.98
M35F30P0.4	5.016	4.930	1.76
M35F30P0.5	4.796	4.683	2.41

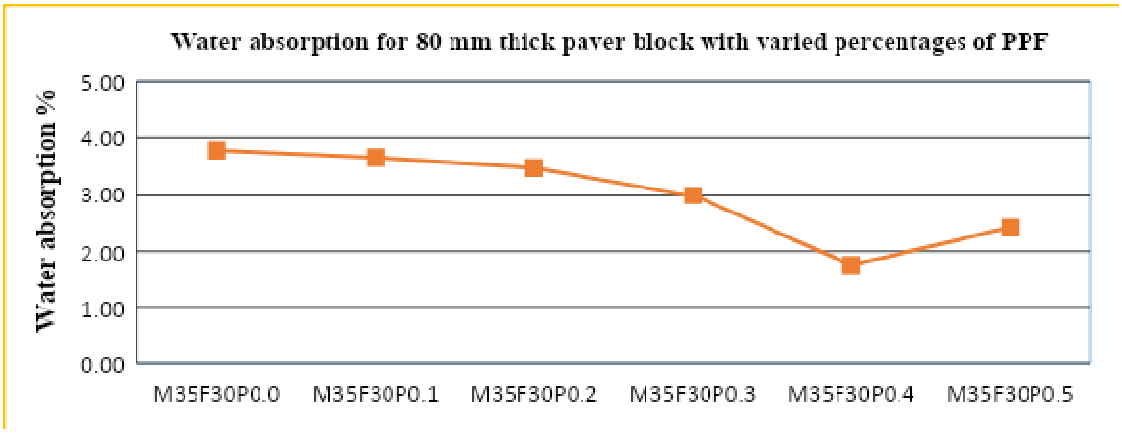

Figure 11: Water absorption for M35 grade 80mm thick paver blocks

9. CONCLUSIONS

1. Corrected compressive strength for reference mixes increases with age in M35 grade in 60 mm and 80 mm thick paver blocks. At 28 days of curing the strength has increased slightly from target strength.
2. With addition of PPF in varying proportions by weight of cementitious materials the strength increases with age in all grades with both the thickness.
3. Maximum gain in strength for all the grades at 28 days was observed with 0.3% PPF addition which may be taken as optimum dose.
4. All the mixes with addition of PPF in varying proportions in all the grades at 28 days have attained the target strength.
5. Effect of fly ash on hardened paver blocks tends to decrease the strength and with addition of PPF strength marginally increased.
6. Flexural strength for the reference mixes increases with age in, M35 grade in 60 mm and 80 mm thick paver blocks. At 28 days reference mix attained target strength.
7. With addition of PPF in varying proportions by weight of cementitious materials the strength increases with age in all the grades with both the thickness.
8. Maximum gain in flexural strength for all the grades at 28 days was observed with 0.3% PPF addition which may be taken as optimum dose
9. The water absorption decreases on addition of PPF up to 0.4% and there after increases.
10. In all the grades including reference mix the water absorption was much less as compared to the codal provision of 6% as per IS:15658.

10. REFERENCES

[1] Sachdeva SN, Aggarwal V, Gupta SM. High volume fly ash concrete for paver blocks. World Academy of Sci, Engg and Tech, Inter J of Civ, Arch, Stru and Cons Engg. 2014; 8(3): 238-244.

[2] Siddique R. Performance characterstics of high-volume class F fly ash concrete. Cem and conc res. 2004; 34:487-493.

[3] Raju JJ, John J. Strength study of high volume fly ash concrete with fibers. Inter J of AdvStruct and GeotechEngg. 2014; 3(1): 60-64.

[4] Singh G, Goel S. Performance evaluation of pet-polypropylene hybrid fiber reinforced concrete in terms of workability, strength and cost effectiveness. Inter J of Civ and StructEngg Res. 2016; 3(2):85-94.

[5] Mohod MV. Performance of polypropylene fibre reinforced concrete. J of Mech and CivEngg. 2015; 12(1): 28-36.

[6] Thirumurugan S, Sivakumar A. Compressive strength index of crimped polypropylene fibers in high strength cementitious matrix. World App Sci J. 2013; 24(6):698-702.

[7] Kolli R. Strength properties of polypropylene fiber reinforced concrete. Inter J of Inno Res in SciEngg and Tech. 2013; 2(8): 3409-3412.

[8] Gencel O, Ozel C, Koksa F, Erdogmus E. Barrera GM, Brostow W. Properties of concrete paving blocks made with waste marble. J of Clean Prod. 2012; 21: 62-70.

[9] Patel I, Modhera CD. Study effect of polyester fibers on engineering properties of high volume fly ash concrete. J of Engg Res and Studies. 2011; 2(1):159-166.

[10] Muhammed R, Varkey D. Experimental investigation on properties of geopolimer concrete paver block with the inclusion of polypropylene fibers. Inter J of Sci&Engg Res. 2016; 4(10):10-15.

[11] Rao MVK, Murthy NRD, Kumar VS. Behavior of polypropylene fiber reinforced fly ash concrete deep beams in flexure and shear. Asian J of CivEngg (Building and Housing) .2011; 12(2):143-154.

[12] Uygunglo T, Topcu IB, Gencel O, Brostow W. The effect of fly ash content and types of aggregates on the properties of pre-fabricated concrete interlocking (pcibs). Const and Build Mater. 2012; 30: 180-187.