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An Experimental Investigation on Precast Cement Concrete Paver Blocks Using Fly Ash and addition of Polypropylene

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ABTRACT :

Concrete strength and durability have been the subject of numerous recent attempts to improve them, particularly in aggressive concrete paver blocks that originated in the Netherlands following World War II. Globally, paver block technology is becoming more and more significant because of its improved quality, affordability, improved surface efficiency, ease of installation in any type of bond, and maximum salvage value in the event of replacement. In the current study, M30 and M40 grade paver blocks with thicknesses of 60 mm and 80 mm, respectively, were made to assess the suitability of Indian road surfaces for various applications. OPC was replaced with 30% fly ash, and polypropylene fibre was added at 0.0% to 0.5% with increments of 0.1% by weight of cement. The vibrating table system is used in the manufacturing of paver blocks. The blocks have undergone strength and durability tests at ages 7, 21, and 28 days. Tests of compressive strength and flexural strength were performed to determine the strength qualities; these tests are crucial for road surface applications.

Key Word- Paver blocks, compressive strength ,flexural strength, polypropylene fibre, Durability

INTRODUCTION :

Precast cement concrete paver blocks are composed of low water-to-cement ratio cement concrete and are solid, unreinforced products. To meet the demands of diverse traffic environmental circumstances, these are manufactured in a range of dimensions using different grades of concrete. The concrete composite used to make the paver blocks is made up of cement, water, aggregates, and super plasticizer, all of which are readily accessible across the nation. Before being used, paver blocks are prefabricated in the plant utilising a press and vibrating table technique. These find application in the top layer of pavements, as well as in urban and semi-urban highways, village roads, pavements, gardens, passenger waiting sheds, petrol pumps, bus stops, industry and so forth.Precast paver blocks are the best material for sidewalks and pavements beside roads when a lot of facelifting is being done since they are simple to install, have a better appearance, are quick to repair, and can be moved right away.Because they are unbreakable and have a 100% salvage value in the event that they need to be replaced, paver blocks are inexpensive. Precast refers to the fact that the blocks are made, dried, and transported to the construction site in preparation for placement.The paver blocks are designed to interlock with one another during installation in order to preserve structural integrity.

Blocks are used to create pavement surfaces. Individual interlocking paver blocks are installed one on top of the other. These are placed atop a prepared subgrade, surrounded on all sides by edge restraints, with a sand bed underneath. The blocks are positioned correctly, with joints separating them to ensure structural stability. Sand with an appropriate grading is used to fill these joints. There is enough space for load dispersion thanks to the concrete block pavement's interlocking system. Compared to asphalt and concrete pavements, concrete block pavements provide a few advantages. The overall benefits include economical, structural, operational, aesthetic, and maintenance aspects. Better performance is obtained from an interlocking pavement that is built correctly.

A. History of paver blocks

The first record of stone paving goes back to 4000 B.C. Clay brick paving was used in India in 3000B.C. Historyspeaks that Romans used blocks of stone in pavements.The Dutch have used natural stones and wood in urban streets. In Europe, there was a tradition for rectangular clay brick pavements. After 2nd World War, the clay bricks were required to rebuild building destroyed during the war, the demand for paver blocks grew enormously. As a result of this demand, the concrete paving block was first introduced in the Netherlands in 1951 (1). Over the past 50 years concrete block pavements have gained importance over conventional concrete and asphalt pavement. Concrete block pavement has become animportant paving surface in Europe where 100,000,999m2 are placed annually .

LITERATURE SURVEY :

Sachdeva et al. studied the effect of OPC replaced by fly ash in varying proportions from 20% to 40% for M30, M35, M40 and M50 grade paver blocks and observed same workability in all the grades resulting into reduced water to cementetious ratio

Raju et al. studied the replacement of cement with 40% fly ash and adopted water cement ratio 0.4 in concrete and reported compaction factor as 0.85.

Patel and Kulkarni investigated the workability of M40 grade concrete by adding polypropylene fibre @ 0.5%, 1% and 1.5% and concluded that workability reduces with increase in fibre contents.

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.

Ghorpade investigated the workability of fiber reinforced high volume concrete by replacing natural coarse aggregates @ 0%, 20%, 40%, 60%, 80% and 100% with recycled coarse aggregates and reported that compaction factor decreases with increase in percentage of recycled aggregates.

Jeevan Ghuge, Saurabh Surali, Dr. B M Patil, and S B Bhutekar examined the use of plastic waste in the production of paver blocks. This essay examines the usage of plastic as a bonding agent. Concrete blocks of 0.00205 cubic metres were cast for the investigation, each with plastic acting as a binder and without the need for water. This method involves burning plastic that has been collected from various sources in a closed chamber until it melts into a liquid form. Subsequently, the liquid plastic was combined with additional components to form plastic paver blocks.

Sachdeva et al. studied paver blocks of fly ash concrete using maximum size of coarse aggregate 12.5 mm with zero slump and of grade designation M30, M35, M40, M50 by replacing OPC with 20% to 40% fly ash in each grade. It was reported 26 that compressive strength increases with age in all the mixes and maximum strength gain was with 30% replacement level.

OBJECTIVE

- To prepare design mix for zero slump concrete composite for manufacture of paver block M30 and M40 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.
- To test fresh properties of various designed grades of concrete for paver blocks i.e. compaction factor for workability.

METHODOLOGY FOR THE PRESENT STUDY

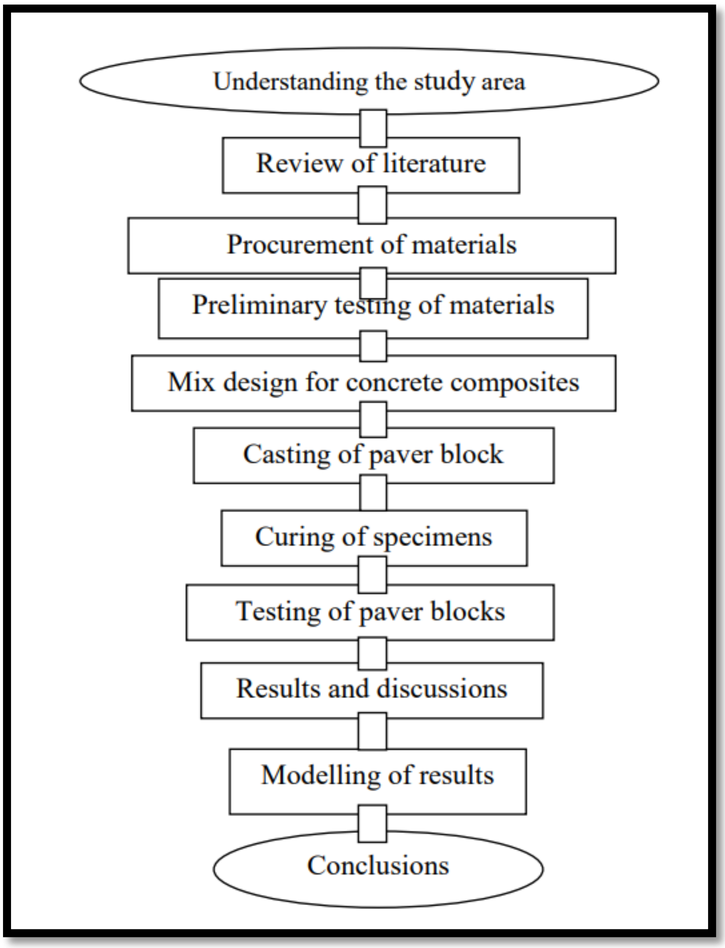

Figure 1: Methodology for present study

RESULTS AND DISCUSSIONS :

The results of mix designs, properties of fresh concrete composite mix and properties of hardened concrete composite like compressive strength, flexural strength and durability properties like water absorption, freeze-thaw resistance and abrasion resistance of paver blocks are discussed in the present chapter. The effect of replacement of OPC by 30% fly ash and addition of polypropylene fibres in varying proportions in concrete composite are discussed.

Table 1: a) Compaction Factor results for 60 mm thick paver blocks with different % PPF at 28 day For M30

SN	Sample Designation	Compaction Factor
1	FA-30,PF-0.0	0.77
2	FA-30,PF-0.1	0.76
3	FA-30,PF-0.2	0.76
4	FA-30,PF-0.3	0.75
5	FA-30,PF-0.4	0.75
6	FA-30,PF-0.5	0.75

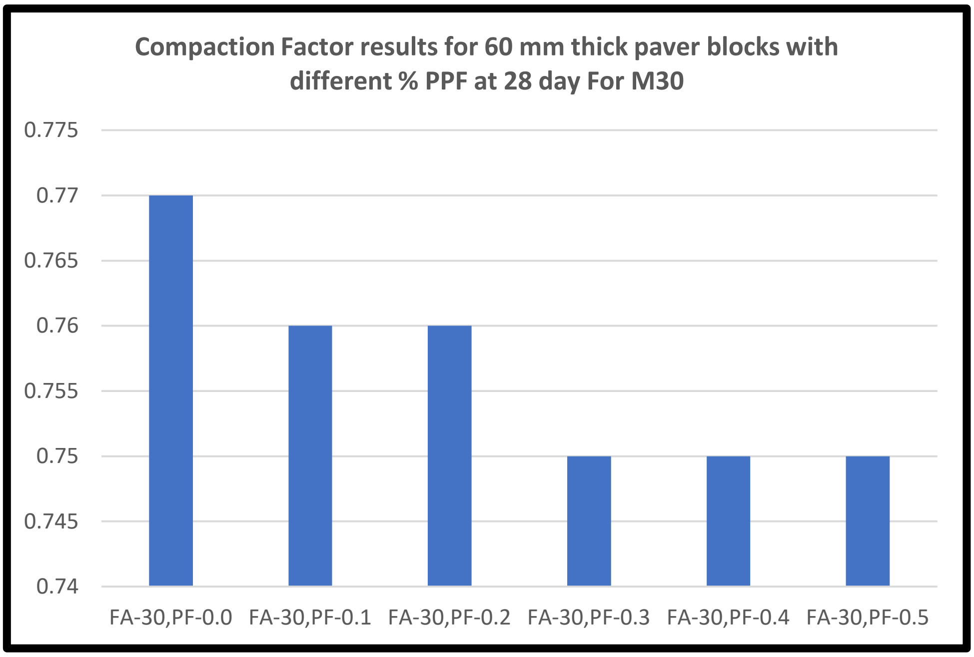

Figure 1: Compaction Factor results for 60 mm thick paver blocks with different % PPF at 28 day For M30

Table 1: b) Compaction Factor results for 60 mm thick paver blocks with different % PPF at 28 day For M40

SN	Sample Designation	Compaction Factor
1	FA-30,PF-0.0	0.77
2	FA-30,PF-0.1	0.76

3	FA-30,PF-0.2	0.76
4	FA-30,PF-0.3	0.75
5	FA-30,PF-0.4	0.75
6	FA-30,PF-0.5	0.75

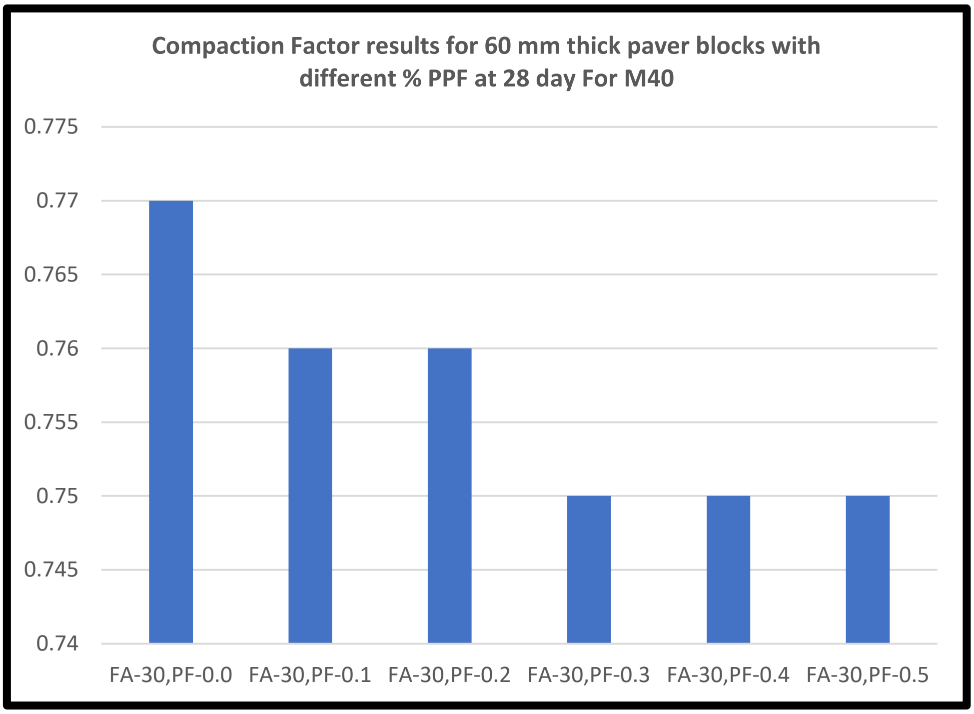

Figure 2: Compaction Factor results for 60 mm thick paver blocks with different % PPF at 28 day For M40

Discussion –

The result shows that the compaction factor does not change upto inclusion of 0.2% PPF in all three grades under discussion. However, beyond 0.3% PPF, a decrease was observed in the value of compaction factor for all the three grades. The reduction in workability with addition of higher volume of fiber content may be due to amount of air entrapped into the inner core of concrete composite. The results of compaction factor test ranging between 0.75 to 0.77 meets the requirement of workability for pavements as suggested by IS: 456 (36),

STRENGTH PROPERTIES OF PAVER BLOCK

The Compressive and Flexural strength of paver blocks are the most significant properties which have been studied in this research for M30, and M40 grade designation paver blocks at 7, 21, and 28 days.

COMPRESSIVE STRENGTH

Compressive strength of concrete paver blocks is the most significant property Compressive strength of paver blocks of concrete mixes with 30% replacement of OPC by fly ash and addition of PPF in increment of 0.1% ranging from0.0% to 0.5%, at different ages was observed. Four paver block specimens were used to observe average compressive strength and to obtain corrected compressive strength. The average observed compressive strength was multiplied by corresponding correction factor, for 60mm thick 1.06

TABLE 3 a) Compressive Strength results for 60 mm thick paver blocks with different % PPF at 7,21 and 28 day For M30

The corrected compressive strength results of 60 mm thick paver blocks with OPC replaced by 30% FA and addition of0.0% PPF at different ages are tabulated in Table 5.3 The paver blocks have been named according to their grade designation, FA replacement proportion and PPF addition.

SN	Sample Designation	compressive strength in N/mm2		
		7 days	21 day	28 day
1	FA-30,PF-0.0	21	28.7	35.8
2	FA-30,PF-0.1	23.1	31	37.5
3	FA-30,PF-0.2	24	31.2	38.4
4	FA-30,PF-0.3	24.4	32	39.1
5	FA-30,PF-0.4	24	31	38.8
6	FA-30,PF-0.5	23.4	30.23	38.4

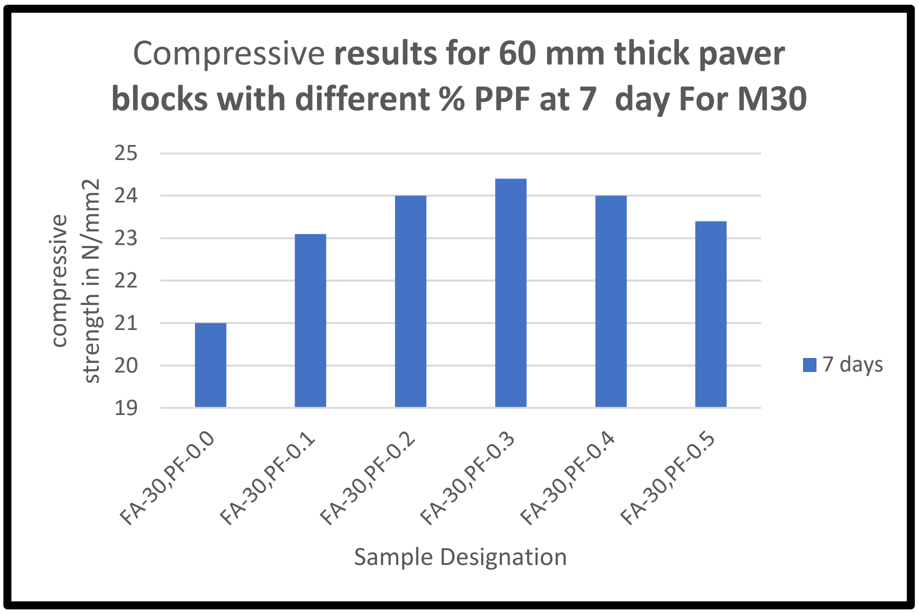

Figure 3: Compressive results for 60 mm thick paver blocks with different % PPF at 7 day For M30

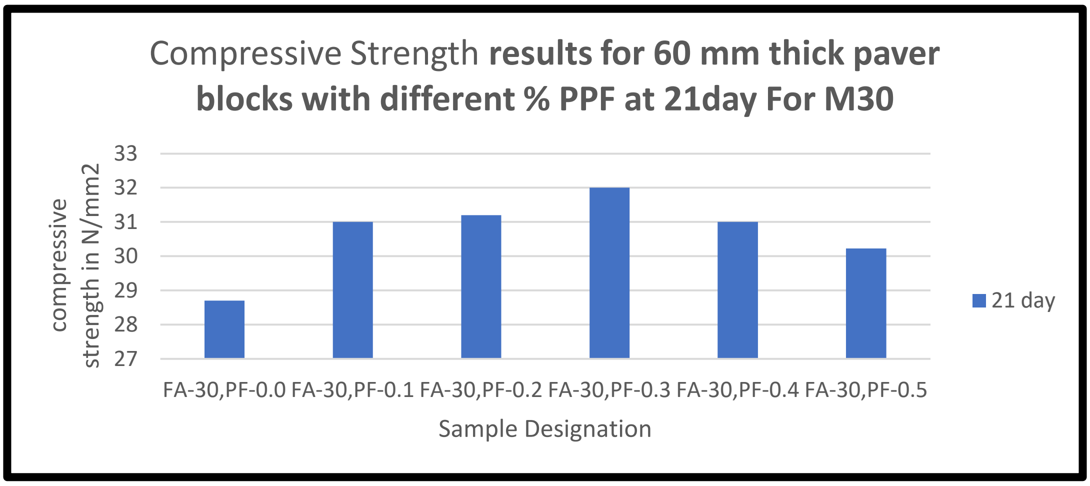

Figure 4 Compressive Strength results for 60 mm thick paver blocks with different % PPF at 21day For M30

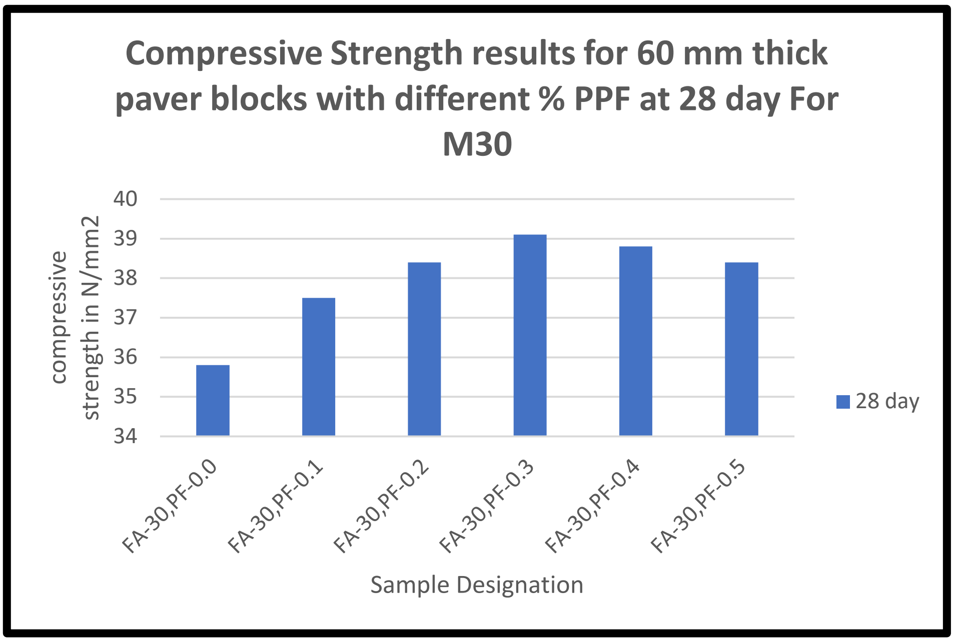

Figure 5: Compressive Strength results for 60 mm thick paver blocks with different % PPF at 28 day For M30

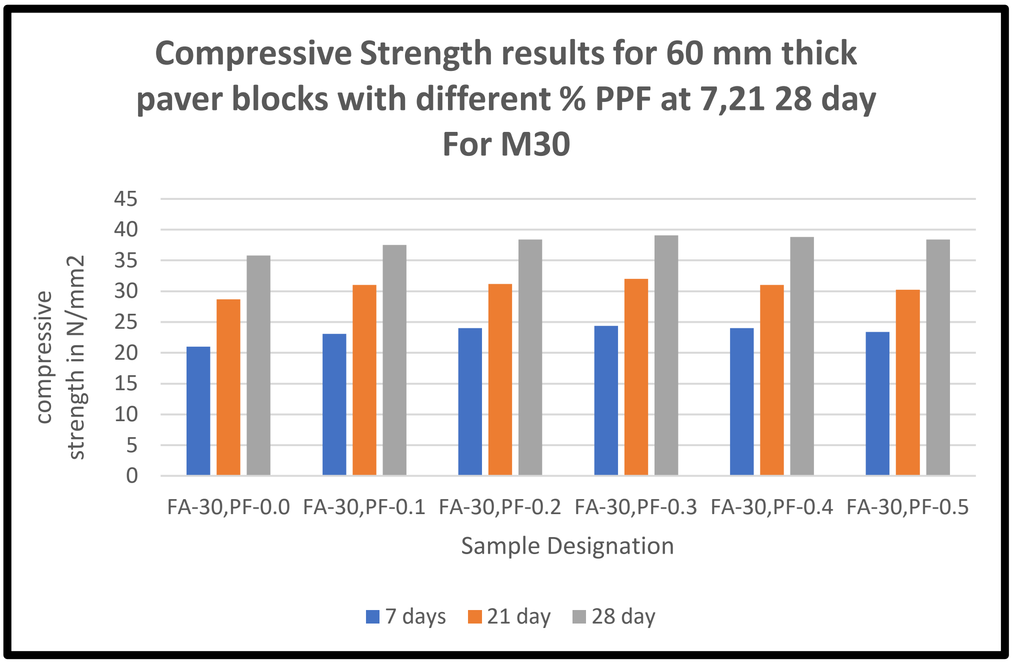

Figure 6: Compressive Strength results for 60 mm thick paver blocks with different % PPF at 7,21 28 day For M30

At 28 days, the reference mix without PPF achieved corrected compressive strength of 35.80N/mm 2 for M30

TABLE 5.3 b) Compressive Strength results for 60 mm thick paver blocks with different % PPF at 7,21 and 28 day For M40

SN	**Sample Designation**	**compressive strength in N/mm2**		
		7 days	**21 day**	**28 day**
1	FA-40,PF-0.0	27	36	44.77
2	FA-40,PF-0.1	27.5	36.4	45.75
3	FA-40,PF-0.2	28.5	37.5	46.9
4	FA-40,PF-0.3	28.4	39	47.29
5	FA-40,PF-0.4	28	37.5	46.9
6	FA-40,PF-0.5	27.5	37.5	46.6

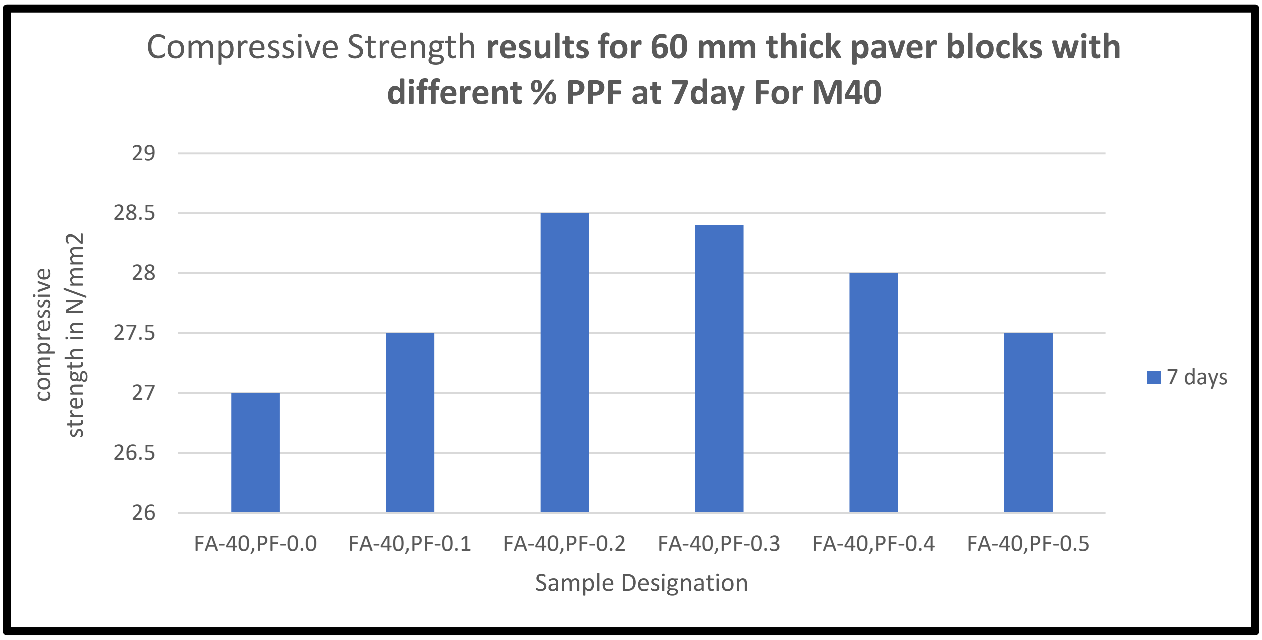

Figure 7: Compressive Strength results for 60 mm thick paver blocks with different % PPF at 7day For M40

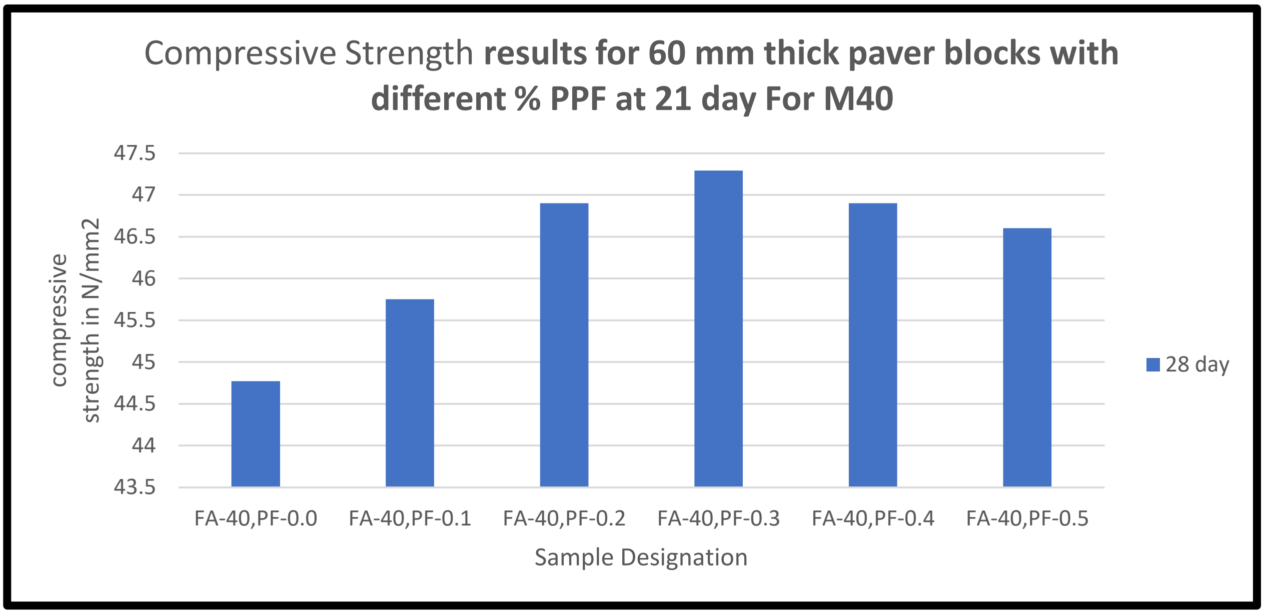

Figure 8: Compressive Strength results for 60 mm thick paver blocks with different % PPF at 21 day For M40

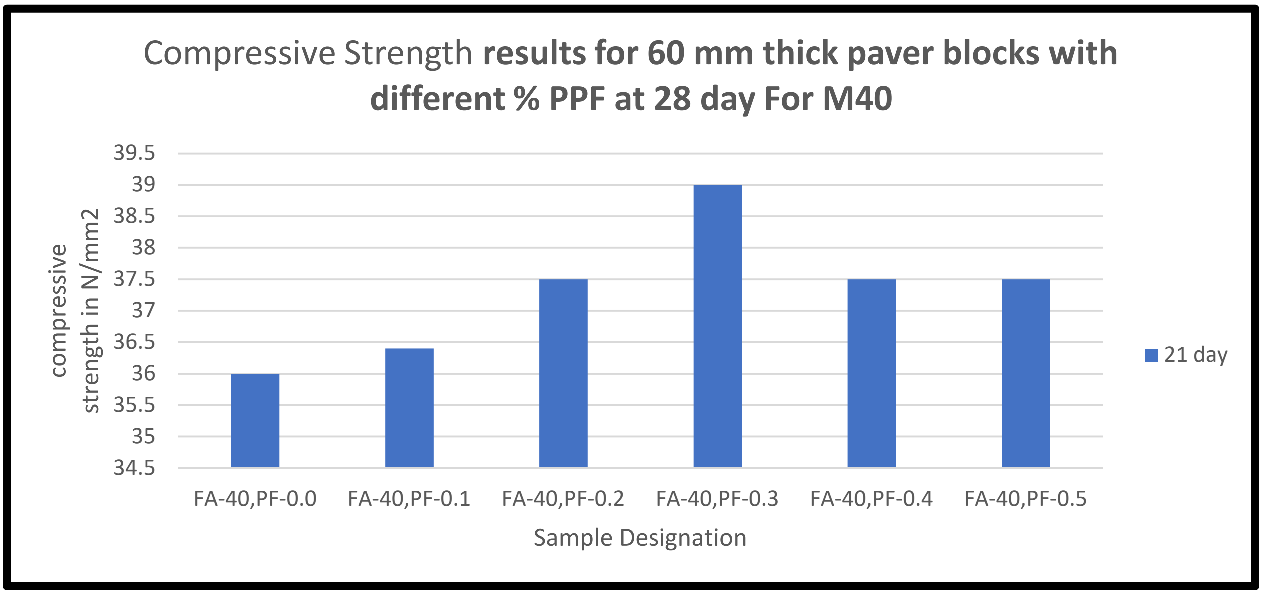

Figure 9: Compressive Strength results for 60 mm thick paver blocks with different % PPF at 28 day For M40

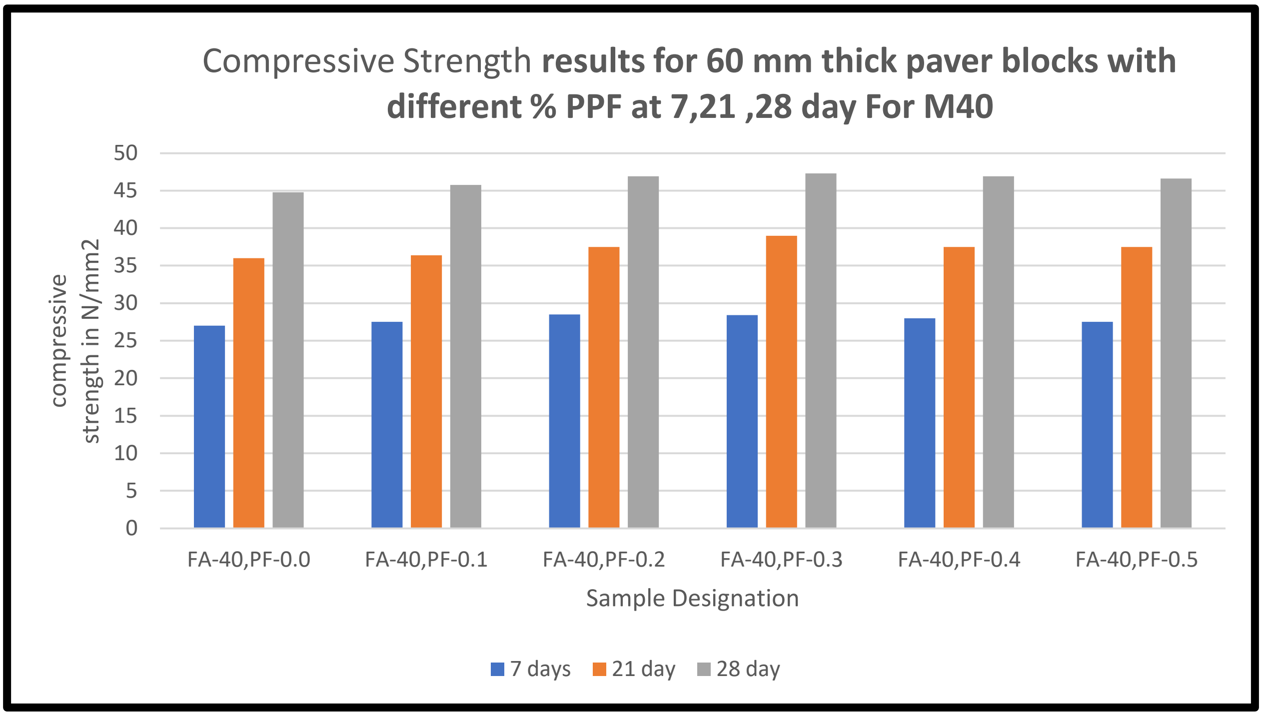

Figure 10: Compressive Strength results for 60 mm thick paver blocks with different % PPF at 7,21 ,28 day For M40

Higher grade designation of paver block exhibited higher corrected compressive strength due to more cement content used. The corrected compressive strength of reference mixes of paver block was found to increase with the age. The results of corrected compressive strength for various grade designation paver blocks with 0.1% PPF addition at different ages are given in above Table , Due to addition of PPF in all the grades the corrected compressive strength at all the ages has increased and has attained strength , It was observed that higher grade designation have attained higher strength due to higher cement content. The corrected compressive strength observed at 28 days for M30,and M40 grade designation with 0.1% PPF were 37.50N/mm 2 ,and 45.75N/mm 2 respectively, This is 4.75%, 2.21% and 2.19% higher than the reference mix. The corrected compressive strength at 28 days observed for M30, and M40 grade designation with 0.3% PPF were 38.10N/mm 2 , and 46.29N/mm2 respectively. This is 9.20%, and 5.60% higher than the reference mix.

The strength of all the three grades i.e. M30, and M40 paver block mix with 0.3% PPF was found to be maximum at all. Hence 0.3% PPF can be considered as optimum dosage. Also, it was observed that at 28 days the maximum gain in strength was observed for lower grade i.e. M30 and minimum for highest grade i.e. M40. It can be further concluded that higher the grade, higher the cement content and hence lower the gain percentage at 28 days corrected compressive strength.

At 28 days, all the three grades gain approximately 6 to 8% increase in strength than 21 days for all the mixes with varying percentages of PPF.

CONCLUSION :

- In 60 mm and 80 mm thick paver blocks, the corrected compressive strength for reference mixes improves with age in M30 and M40 grades. After 28 days of treatment, the strength has marginally above the goal strength.
- When PPF is added to cementitious materials in different weight proportions, all grades' strength rises with age, regardless of thickness. After 28 days, the addition of 0.3% PPF showed the greatest strength development for all grades, suggesting that this may be the ideal dosage.
- After 28 days, all mixes containing PPF in different amounts across all grades had reached the desired strength.
- Fly ash tends to reduce the strength of cemented paver blocks; nevertheless, the addition of PPF slightly increases strength.

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