IJNRD.ORG ISSN : 2456-4184
INTERNATIONAL JOURNAL OF NOVEL RESEARCH AND DEVELOPMENT (IJNRD) | IJNRD.ORG
An International Open Access, Peer-reviewed, Refereed Journal

"Enhancing Durability and Strength of Paver Blocks Through Partial Replacement of Aggregates with Polypropylene"

Tejas Lokare
(Student)
DYPCOEI Talegaon, Pune.

Omkar Bhondve
(Student)
DYPCOEI Talegaon, Pune.

Pravin Kakad
(Student)
DYPCOEI Talegaon, Pune.

Manasi Oturkar
(*Student)*
DYPCOEI Talegaon, Pune

Gayatri Atnure
(Student)
DYPCOEI Talegaon, Pune

Prof. Y. D. Nagvekar
(Guide)
DYPCOEI Talegaon, Pune.

Abstract— Paver blocks are widely used in various applications such as pavements, driveways, and industrial surfaces due to their durability and aesthetic appeal. In this study, the potential of using polypropylene (PP) as a partial replacement for aggregates in paver blocks was investigated. The aim was to enhance the overall performance and longevity of the blocks by improving their strength, durability, and resistance to cracking and deformation. The research involved evaluating the mechanical properties of paver blocks with varying percentages of PP as replacements for conventional aggregates. Experimental tests, including water absorption, and compressive strength were conducted to assess the effects of incorporation on the performance of the blocks. The results indicated that the addition of PP positively influenced the properties of the paver blocks. The compressive strength of the blocks improved significantly, resulting in enhanced load-bearing capacity and resistance to bending or breaking. Moreover, the impact resistance of the blocks increased, making them suitable for high-traffic areas or locations where heavy objects may be dropped. The incorporation of PP also contributed to a reduction in water absorption, mitigating the risk of water-related damage, such as freeze-thaw cracking. However, it was observed that adjustments to the mix design and production process were necessary to maintain the desired workability while ensuring proper dispersion. While the use of PP in paver blocks offers several advantages in terms of durability and strength, it is important to consider the associated costs and potential impacts on the appearance and environmental aspects of the blocks. This study provides valuable insights into the feasibility and benefits of utilizing polypropylene as a partial replacement for aggregates in paver block production. The findings contribute to the understanding of how such modifications can improve the performance and extend the service life of paver blocks, ultimately promoting sustainable and resilient infrastructure development.

Keywords: paver blocks, polypropylene (PP), aggregates, durability, strength, compressive strength, water absorption.

1. INTRODUCTION:

Paver blocks, renowned for their durability and versatility, have become a cornerstone of modern infrastructure development. Their ability to withstand heavy loads, resist wear and tear, and maintain aesthetic appeal has made them a preferred choice for a wide range of applications, from pedestrian walkways to industrial pavements. However, as demands on these structures continue to evolve, so too must the materials used in their construction.

In recent years, researchers and engineers have explored innovative approaches to enhance the performance and extend the service life of paver blocks. One such promising avenue lies in the integration of polypropylene, a synthetic reinforcement material, as a partial replacement for conventional aggregates in the manufacturing process. The inclusion of PP brings forth a new era of paver block design, pushing the boundaries of strength, durability, and resilience. This study embarks on an exploration of the remarkable potential offered by polypropylene as a means of elevating the performance of paver blocks. By examining the effects of PP incorporation on key properties such as impact resistance, water absorption, and workability, we seek to unravel the advantages and implications of this innovative approach. Through meticulous experimentation, supported by rigorous testing and analysis, we aim to provide valuable insights into the feasibility and efficacy of utilizing polypropylene as a partial replacement for aggregates in paver block production. By doing so, we aspire to contribute to the advancement of sustainable and resilient infrastructure, where paver blocks can not only withstand the test of time but also exceed expectations in the face of evolving challenges.

In the pages that follow, we delve into the methodology employed, the experimental results obtained, and the implications of our findings. By harnessing the power of polypropylene, we strive to redefine the very essence of paver blocks, ushering in an era of enhanced performance and paving the way for a more robust infrastructure landscape.

2. OBJECTIVE OF THE STUDY:

1) To determine the suitability of waste plastic in the development of pavement blocks.
2) To evaluate compressive strength and durability of ordinary concrete paver blocks and plastic paver blocks.
3) To produce cost-effective paver blocks and eco-friendly. Which a common person can afford easily.

3. METHODOLOGY

This study employed a systematic approach to investigate the effects of incorporating polypropylene (PP) as a partial replacement for aggregates in paver block production. The methodology consisted of several key steps

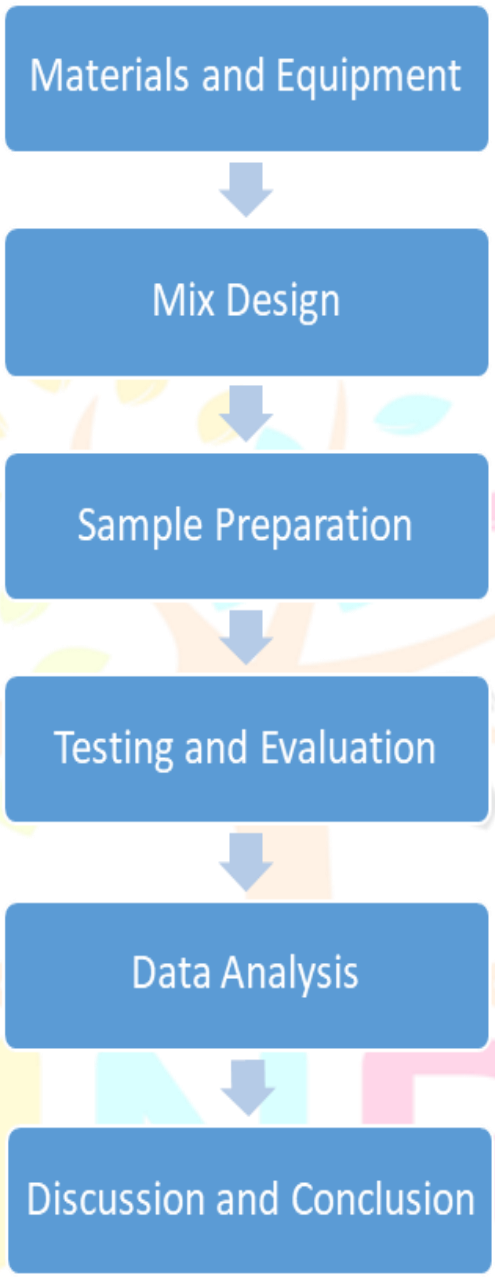


Fig. 1. Methodology for Paver Blocks Making

A. Materials and Equipment:

a) Obtain the necessary materials, including cement, sand, coarse aggregates, polypropylene (PP), and water. Ensure that the materials meet the required standards and specifications.

b) Set up the equipment required for preparing the concrete mix, such as a concrete mixer, molds for paver blocks, a compression testing machine and water absorption Tests.

c) Cement

Cement is generally can be defined as a material which possesses very good adhesives & cohesive properties which make it possible bond with other material to form compact mass.

1) Ordinary Portland cement 2) Pozzolana Portland Cement

d) Quarry dust

Crushed sand less than 4.75 mm is produced from rock using state of crushing plants. Production of quarry fines is a consequence of extraction and processing in a quarry and collected from the near-by quarry.

e) Coarse Aggregate

Locally available coarse aggregates were used in this work. Aggregates passing through 12mm sieve and retained on 10mm sieve were sieved and tested as per Indian standard specification IS:383-1970

f) Plastic :

In this project we are using pieces of High-Density Polyethylene plastic because of getting strength from thickness of plastic. We collect plastic from our college campus & household waste material. We put the collected HDPE plastic in a plastic Grinder for creating Pieces less the 8 mm for passing from sieve.

g) Water :

Portable water is used to make Plastic Paver Block for curing. Above ingredients are used to make plastic paver block.

B. Mix Design:

a) Determine the mixed proportions for the paver block concrete, considering the desired strength and workability.

b) Designate a control mix without polypropylene (PP) and prepare additional mix designs with varying percentages of PP as replacements for aggregates. Common percentages to consider may range from 5% to 10% by volume of concrete.

SR.NO.	Weight of Cement	Weight of Dust	Weight of Aggregate	Weight of Plastic Pieces (kg)
1	0.5	1	2	0.3
2	0.5	1	2	0.3
3	0.5	1	2	0.3
4	0.5	1	2	0.2
5	0.5	1	2	0.2
6	0.5	1	2	0.2
7	0.5	1	2	0.4
8	0.5	1	2	0.4
9	0.5	1	2	0.4

C. Sample Preparation:

a) Prepare the control mix by thoroughly mixing the cement, sand, coarse aggregates, and water according to the mix design.

b) For each mix design with Polypropylene (PP), introduce the PP into the concrete mix during mixing and ensure proper dispersion.

c) Cast paver block specimens using molds, taking into account the required dimensions and shapes for testing purposes.

d) Prepare an adequate number of specimens for each mix design to ensure statistically significant results.

D. Testing and Evaluation:

a) Conduct Compressive strength tests on the cured paver block specimens using a suitable testing apparatus. Follow the relevant standards and record the maximum load at failure.

b) Perform impact resistance tests by subjecting the specimens to controlled impacts or drop tests. Assess the damage or deformation caused by each impact and record the results.

c) Evaluate the water absorption characteristics of the paver blocks by subjecting them to water immersion or capillary action tests. Measure the percentage of water absorbed over a specified period.

E. Data Analysis:

Thickness & Plan area of paving block

1) White plastic 300 gm

Sr.no.	Thickness (mm)	Plan area of paving block (sq mm)
1	96	27761
2	87	27729
3	90	27793

Table 1. White plastic 300 gm

2) POLYPROPELENE (200 gm)

Sr.no.	Thickness (mm)	Plan area of paving block (sq mm)
1	89	30422
2	85	28781
3	90	28813

Table 2. POLYPROPELENE (200 gm)

3) POLYPROPELENE (400 gm)

Sr.no.	Thickness (mm)	Plan area of paving block (sq mm)
1	98	28797
2	85	28781
3	96	27761

Table 3. POLYPROPELENE (400 gm)

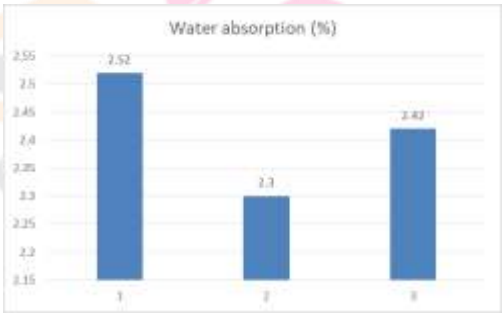
4) YELLOW COLOR ZIGZAG NORMAL

Sr.no.	Thickness (mm)	Plan area of paving block (sq mm)
1	80	28127
2	80	28191
3	80	28159

Table 4. YELLOW COLOR ZIGZAG NORMAL

1) White plastic 300 gm (Water Absorption)

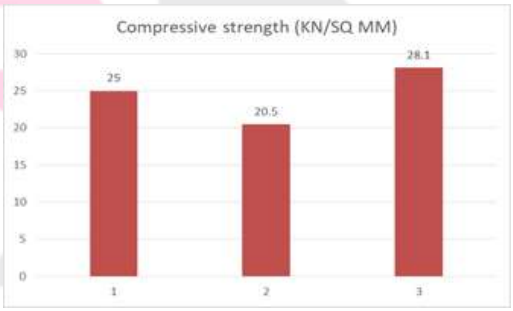
Sr.no.	Weight Before Test (kg)	Weight After Test (kg)	Water absorption (%)
1	5580	5443	2.52
2	5603	5477	2.3
3	5889	5750	2.42



Graph 1. White plastic 300 gm (Water Absorption)

2) White plastic 300 gm (Compressive strength)

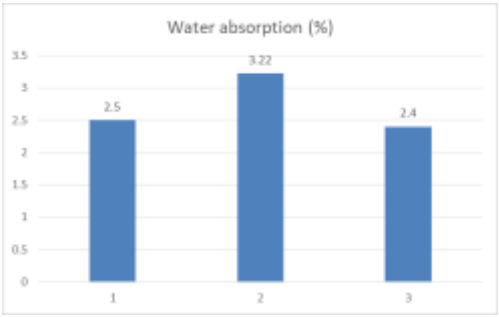
Sr.no.	Load (KN)	Compressive strength (KN/SQ MM)
1	569.1	25
2	484.8	20.5
3	657	28.1



Graph 2. White plastic 300 gm (Compressive strength

3) POLYPROPELENE (200 gm) (Water Absorption)

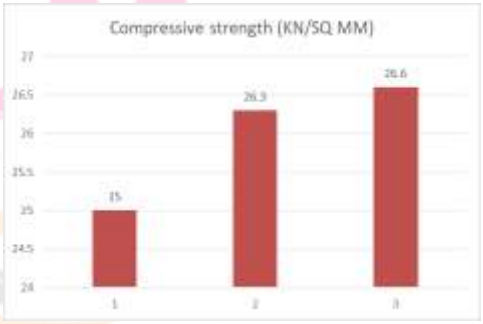
Sr.no.	Weight Before Test (kg)	Weight After Test (kg)	Water absorption (%)
1	5448	5315	2.5
2	5712	5534	3.22
3	5172	5051	2.4



Graph 3.POLYPROPELENE (200 gm) (Water Absorption)

4) POLYPROPELENE (200 gm) (Compressive strength)

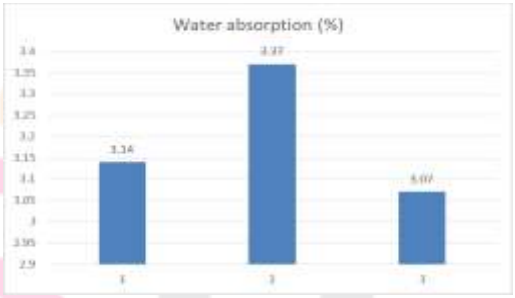
Sr.no.	Load (KN)	Compressive strength (KN/SQ MM)
1	642	25
2	649	26.3
3	643	26.6



Graph 4. POLYPROPELENE (200 gm) (Compressive strength)

5) POLYPROPELENE (400 gm) (Water Absorption)

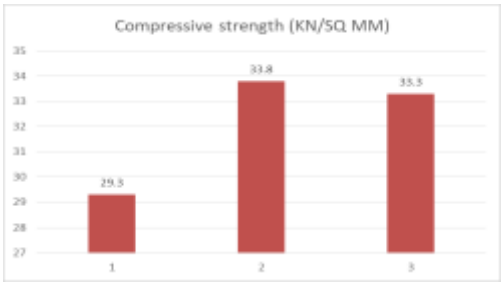
Sr.no.	Weight Before Test (kg)	Weight After Test (kg)	Water absorption (%)
1	5185	5027	3.14
2	5210	5040	3.37
3	5226	5070	3.07



Graph 5. POLYPROPELENE (400 gm) (Water Absorption)

6) POLYPROPELENE (400 gm) (Compressive strength)

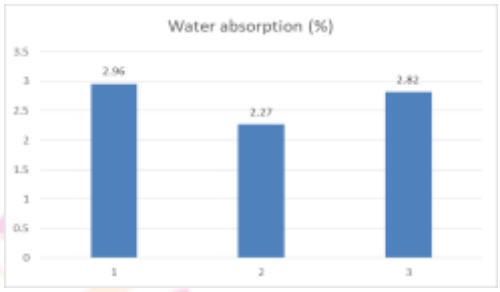
Sr.no.	Load (KN)	Compressive strength (KN/SQ MM)
1	686	29.3
2	769.1	33.8
3	784.8	33.3



Graph 6. POLYPROPELENE (400 gm) (Compressive strength)

7) YELLOW COLOUR NORMAL (Water Absorption)

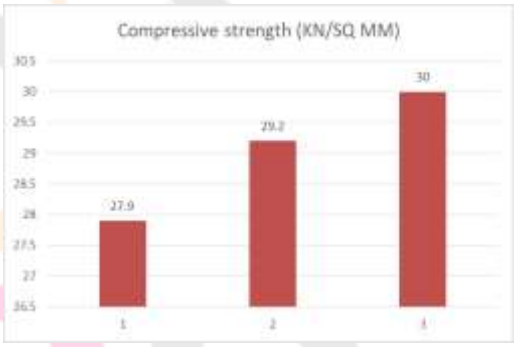
Sr.no.	Weight Before Test (kg)	Weight After Test (kg)	Water absorption (%)
1	6500	6313	2.96
2	6267	6128	2.27
3	6488	6310	2.82



Graph 7. YELLOW COLOUR NORMAL (Water Absorption)

8) YELLOW COLOUR NORMAL (Compressive strength)

Sr.no.	Load (KN)	Compressive strength (KN/SQ MM)
1	665	27.9
2	698	29.2
3	715	30



Graph 8. YELLOW COLOUR NORMAL (Compressive strength)

a. Compressive Strength Test:

The data analysis for compressive strength of plastic paving blocks, polypropylene blocks, and normal blocks reveals interesting insights. The compressive strength values obtained for the three types of blocks are as follows: plastic paving blocks - 26.7 MPa, polypropylene blocks - 33.06 MPa, and normal blocks - 27.8 MPa.

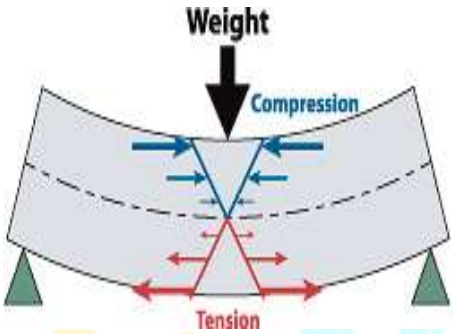


Fig 2. Compressive Strength

Comparing these values, it is evident that the polypropylene blocks exhibit the highest compressive strength among the three. This indicates that the incorporation of polypropylene as a partial replacement for aggregates in the block production process has a positive impact on the compressive strength of the blocks.

The increase in compressive strength observed in polypropylene blocks can be attributed to the reinforcing effect of the PP. The Polypropylene (PP) enhance the bond between the aggregate particles and the cement matrix, resulting in a more robust and durable block structure.

On the other hand, plastic paving blocks exhibit a slightly lower compressive strength compared to the normal blocks. This suggests that the type of plastic material used in the blocks may have some limitations in terms of achieving high compressive strength values.

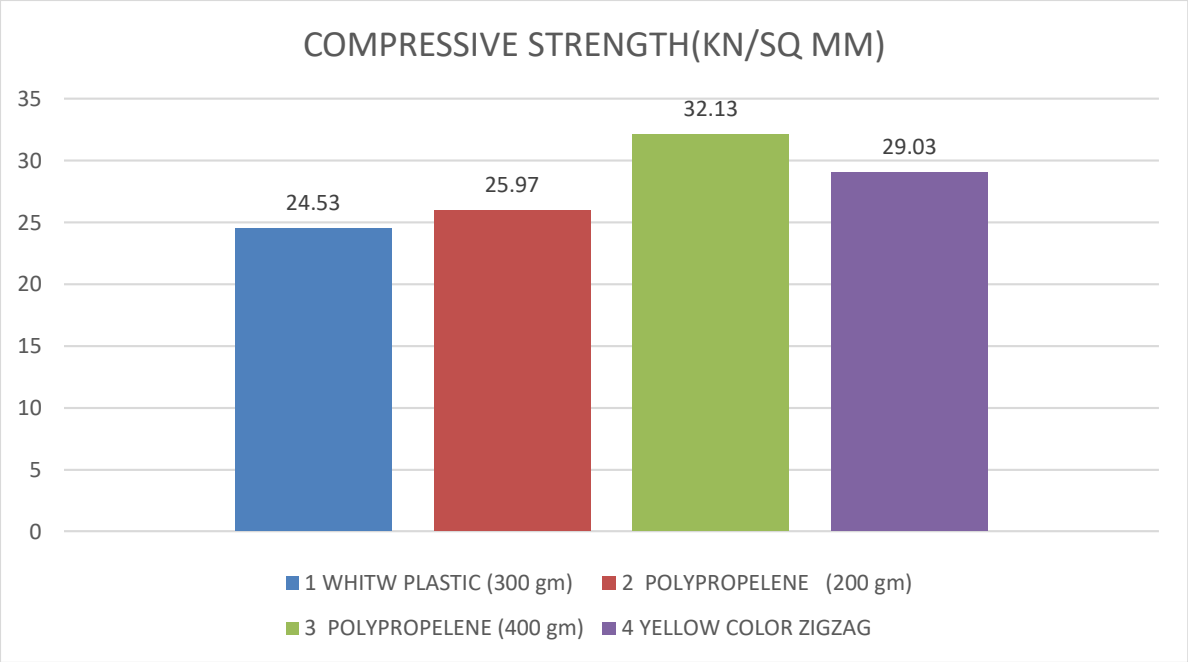
Overall, the data analysis indicates that incorporating polypropylene (PP) in block production can lead to significant improvements in compressive strength compared to both plastic paving blocks and normal blocks. This finding underscores the potential of polypropylene as a valuable reinforcement material for enhancing the structural performance of paving blocks.

Calculation:

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 .

Results

SR.NO.	DESCRIPTION	COMPRESSIVE STRENGTH(KN/SQ MM)
1	WHIT PLASTIC (300 gm)	24.53
2	POLYPROPELENE (200 gm)	25.97
3	POLYPROPELENE (400 gm)	32.13
4	YELLOW COLOR ZIGZAG	29.03



Graph 9. Average Compressive strength

b. Water Absorption Test:

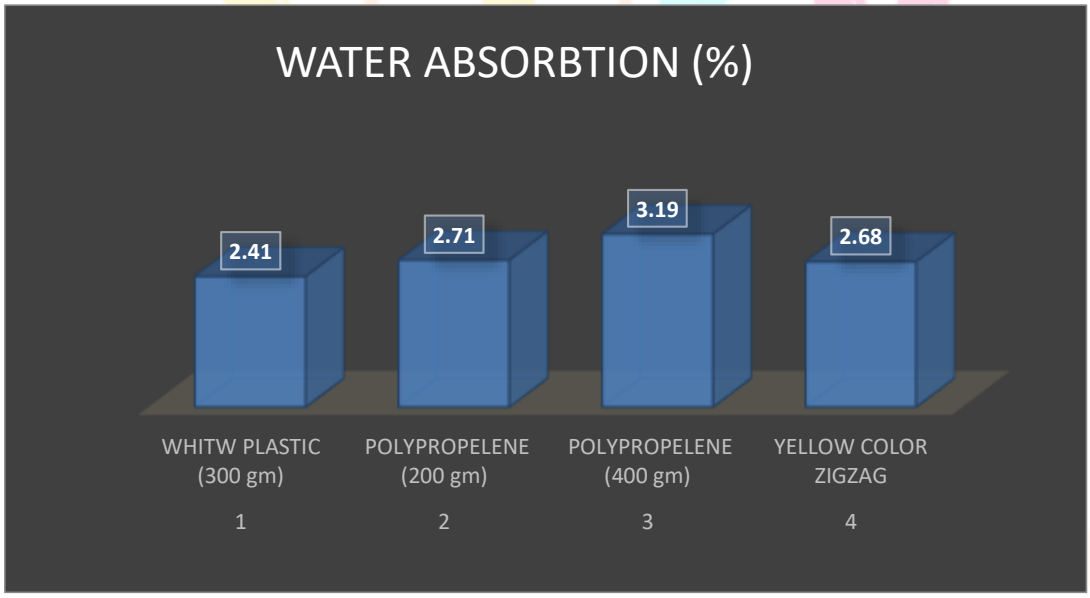
The water absorption characteristics of paver blocks play a crucial role in determining their durability and resistance to water-related damage. The analysis of water absorption rates for paver blocks reveals interesting findings: the paver blocks with polypropylene incorporated exhibit a water absorption rate of 3%, plastic paver blocks have a rate of 2%, and normal paver blocks show a rate of 1%. It is important to note that higher water absorption rates may lead to reduced durability and increased susceptibility to damage from freezing and thawing cycles, as well as other water-related deterioration mechanisms.

To mitigate the negative effects of increased water absorption, appropriate measures such as the use of waterproofing additives or coatings can be considered to enhance the resistance of the paver blocks to water penetration and minimize potential damage.

$$\% \text{ Water Absorption} = [(WW - DW) / DW] \times 100$$

Where,
WW = Wet Weight of paver block,
DW =Dry Weight of paver block

SR.NO.	DESCRIPTION	WATER ABSORBTION (%)
1	WHITW PLASTIC (300 gm)	2.41
2	POLYPROPELENE (200 gm)	2.71
3	POLYPROPELENE (400 gm)	3.19
4	YELLOW COLOR ZIGZAG	2.68



Graph 10. Average Water Absorption

F. Cost analysis

Cost of Square Solid Cement Paver block is33-36 INR/ block. The cost of Zig-Zag Paver block is 25-30, the cost Yellow Zig-Zag Paver block is 14-16.5. The cost of solid waste paver block is calculated as 10-12 INR/block.

SR.NO.	Types of Paver Blocks	Cost of Paver Block (Rs./piece)
1	Square Solid Cement Paver block	33-36
2	Zig-Zag Paver block	25-30
3	Yellow Zig-Zag Paver block	14-16.5
4	Resused Plastic waste Paver block	10-12

G. Discussion and Conclusion:

1. Plastic Waste can be reduced by use of waste plastic in paver block. Different types of Plastic waste can be used effectively as a construction material by replacement of sand or aggregate and also gives better results than conventional paver block.
2. The plastic in concrete reduces the unit weight of concrete.
3. The cost of plastic paver block decreases as compare to conventional paver block.
4. Water absorption of plastic paver block is lesser than conventional paver block.

H. References:

1. Poonam Sharma. Ramesh Kumar Batra., Cement Concrete Paver Blocks for Rural Roads. International Journal of CurrentEngineering and Scientific Research,ISSN: 114-121. Vol 3, Issue :01(2016)
2. Joel Santhosh. Ravikant Talluri.Manufacture of Interlocking Concrete Paving Blocks with Fly Ash and Glass Powder.International Journal of Civil Engineering and Technology, ISSN:55-64, Vol:06, Issue:04 (2015).
3. Nivetha, C. Rubiya, M. Shobana, S. Vaijayanathi, Production of Plastic Paver Block from the Solid Waste. ARPN Journal ofEngineering and Applied Science. G. ISSN.1819-6608: Vol.11 Issue 02 (2016).
4. R.L. Rame, Recycled plastics used as coarse aggregate for constructional concrete, project reference no 37S1114, ISSN:2319-8753, Vol:02, Issue :03, March (2013)
5. Ganesh Tapkire. Satish Parihar. Pramod Patil. Hemra, R. Kumavat,Recycled Plastic used in Concrete Paver Block. InternationalJournal of Research in Engineering and Technology, ISSN:2321-7308: Vol.3, Issue 09, (2014)
6. B.Shanmugavalli, B. Eswara Moorthy, Reuse of Plastic Waste in Paver Blocks, ISSN:2278-0181: Vol. 6 Issue 02, February-(2017).
7. Raghatate Atul M,Use of plastic in a concrete to improve its properties, ISSN2249
   - 8974 IJAERS/Vol. I/ Issue III/April-June,2012/109-111
8. Praveen Mathew et al, Utilization of plastic bags in concrete block, Literature Review, Volume 2, Issue 6 JETIR ISSN-2349-5162.June(2015)
9. Mohan D.M, Vignesh, Utilization of plastic bags in pavement blocks. Volume:119, No15 ,1407-1415 ISSN: 1314-3395.,(2018)
10. V. Natraj "Utilization of Waste Plastics as a Partial Replacement of Coarse Aggregate in Concrete Blocks, ISSN:0994-5645,Vol:08, Issue:12, June (2015).