ANALYSIS OF POROUS INTERLOCKING CONCRETE PAVER BLOCK WITH FLY ASH & COCONUT FIBER

[1]Yash Chaurasiya

ME Student, Department of Civil Engineering, Samrat Ashok Technological Institute Vidisha (M.P)

[2]Dr.S.S.Goliya

Associate Professor, Department of Civil Engineering, Samrat Ashok Technological Institute Vidisha (M.P)

Abstract : In developing country like India, the growth of population is increasing day by day and as a civil engineer it is our duty to provide the facility with minimum cost and maximum output. Paver blocks are the better replacement for the pavement where concrete or bitumen pavements are less durable due to large use of the pavement. Paver blocks also increases the aesthetic view of the area, can be easily laid and have better finishing property. The main problem arises with paver blocks are that in rainy season the water logging creates problem. Since the concrete paver block is not porous so water gets collected on the surface and there is no way for passage of water other than providing slope. To solve this problem porous concrete paver block is prepared with the help of locally available materials and fly ash.

Porous concrete paver block will reduce the problem of water logging in rainy season and the use of fly ash and coconut fibre will increase its strength considerably. Coconut fibre is also helpful in reducing the cracks of paver blocks. Porous concrete paver block is also helpful in reducing the mixing of surface waste to surface water. Maintenance cost of paver block pavement is considerably low as compared to concrete or asphalt pavement. In modern days the use of steel in construction is increasing day by day and by using the fibers we can get the desired flexural strength. Various proportions of cement, sand, coconut fibre & fly ash are used to examine the properties of porous concrete paver block. In this study various properties such as compressive strength, split tensile strength & water absorption test was carried out between porous concrete paver and concrete paver.

The porous concrete paver block is economical as compared with conventional paver block. Water absorption test is conducted on paver blocks with various proportions of fly ash & coconut fiber. Coconut fiber is used in different proportions such as 0.2%, 0.5%, 0.8% & 1% in the volume of concrete. Fly ash is used as replacement of cement in 10%, 15%, 20%, 25% by total weight of cement and gypsum is added in 1-2% by total weight of cement. After addition of coconut fiber the compressive strength of paver block changes considerably at 7 days, 14 days & 28 Days and maximum compressive strength is found when there is addition of 20% replacement of cement with fly ash and 0.8% replacement of sand with coconut fiber. For production of paver blocks 250-300 kg/m^3 of cement is required. Conventional paver block cost 15-25 rupees in Indian market but pervious concrete paver block costs 10-20 rupees which indicates the from cost point of view also pervious concrete block is economical.

Index Terms **– Copmressive Strength, Coconut Fiber, Fly Ash, Porous, Paver Block.**

1. INTRODUCTION

In country like India Interlocking Concrete Paving Blocks (ICPB) has been used for many years as a specialized problem-solving method for providing pavement in the location where conventional types of construction works are less durable due to many operational and environmental reasons. In India Interlocking concrete paving block technology has been introduced in construction 10-15 years ago for specific purpose such as footpaths, parking areas, gardens, and many more places but now being used extensively in different places where the conventional construction of pavement using hot bituminous mix or cement concrete method is not feasible or desirable. Interlocking concrete paving blocks are prepared from semi-dry mixes. Vibration and pressure is applied to the mix in the process of manufacturing. By this process dense and strong concrete paving blocks can be produced to form strong and durable paving surfaces. Interlocking property of concrete paving block gives the ability of spreading loads to larger areas. There are several advantages Interlocking concrete paving blocks has over asphalt and concrete pavements in their structural design, aesthetics view, construction and maintenance work, operational and economical point of view. Design of concrete paving blocks is depends upon various factors such as environmental conditions, nature of traffic, sub grade support conditions and pavement materials conditions.

2. PROBLEM STATEMENT

In moderns times paver blocks are used in construction work in huge amount because it is more durable than concrete and from aesthetic point of view also it is good. But, as we know the concrete paver blocks are not permeable creates problem for flow of surface water to the ground, because of this all the water from the surface of paver block reaches to the surface water source with polluting materials in it. This increases the pollution level of surface water. In heavy rainfall areas the water logging problem occurs most often. Water logging problem decreases the aesthetic view of the place.To solve this problem we need to prepare porous concrete paver block which will allow the water to directly reach the ground surface without taking any polluting materials to the ground. Use of fly ash will decrease the load of pollutants on the environment. Porous concrete paver will also reduce the cost of construction.

3. OBJECTIVE OF THE STUDY

- To enhance the strength of interlocking paver block by the use of fly ash & coconut fiber.
- To decrease the mixing of surface pollutants to surface water.
- To reduce the use of natural resources in construction work which will reduce the depletion of environment.
- Use of pollutants like fly ash and coconut fibers will also helpful in decreasing the pollution of environment.
- To prepare the blocks that is more economical than conventional paver blocks.

4. STUDY APPROACH

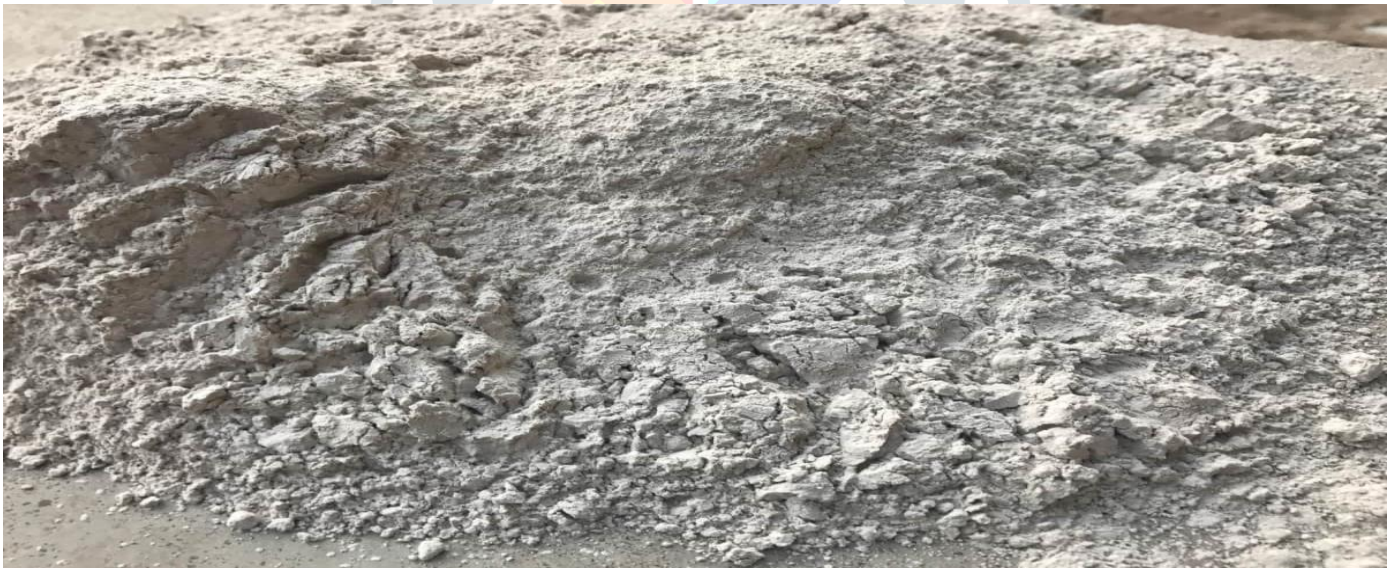
- To study the previous research work on mixing of fly ash & coconut fiber in interlocking concrete paver block.
- Designing the mix with various proportions of fly ash & coconut fiber.
- Various test such as water absorption, compressive strength, tensile strength etc are carried out on both conventional and porous interlocking paver block.
- Analysis of the results is to be done and to find out a proportion where maximum strength is achieved.
- Cost comparison of both conventional and porous interlocking paver block is to be carried out.

5. FLY ASH & COCONUT FIBER

FLY ASH

Fly ash can be defined as a heterogeneous outgrowth material resulted in the combustion process of coal used in thermal power stations. It is a very fine grey coloured powder having spherical shape glassy particles that rises with the flue gases in power stations. Fly ash also contains components of pozzolanic materials which react with lime to form cementatious materials and can be replaced with cement in concrete. Fly ash can be used in concrete, mines, landfills and dams construction. Fly ash can be obtained from burning pulverized coal in thermal electric power generating plants.

During the process of combustion, various mineral impurities in the coal such as clay, feldspar, quartz, & shale etc. fuses in suspension and comes out of the combustion chamber with the exhaust gases together. When fused material rises to a height, it cools down and solidifies into spherical glassy particles which are known as fly ash. With the help of electrostatic precipitators or bag filters fly ash is collected from the exhaust gases. The fine powder collected does match with Portland cement from chemical composition point of view it is different. Fly ash chemically mixes with the byproduct i.e. calcium hydroxide released during the chemical reaction between cement and water to form additional cementitious materials that will improve many properties of concrete.



Applications of Fly Ash

The major applications of fly ash are given below

- For the manufacturing of Portland cement fly ash is used.
- For the construction of embankment fly ash is used
- Fly ash is also used as a stabilisation material.
- For the production of flow able fill fly ash is used as a component.
- For lying of asphalt roads fly ash is used as a filler minerals.
- For the production of geo polymers fly ash is used as a component.

❖ COCONUT FIBER

Coconut fiber is also known as coir obtained from unripe coconuts. It comes under the category of natural fiber extracted from the husk of coconuts. The coconut is submerged in hot seawater, and after that, the fibers are removed from the shell of coconut by the methods of combing and crushing, the same process is applied in the case of jute fiber. The individual fiber cells are narrow and hollow with thick walls made of cellulose, and length of each cell is 1 mm long and diameter of cell varies between 10–20 µm. The fibers of raw coconut shows the variation in length between 15 to 35 cm and diameter varies from 50 to 300 µm. When they are immature a layer of lignin is deposited on their walls and because of this it becomes hard and yellowed. Coconut fiber shows a good stiffness with strength point of view and is used in various products such as floor mats, doormats, brushes, mattresses etc.

Coir fibers are classified in two ways. First classification is based on whether they are recovered from ripe or immature coconut husks. Brown Coir is obtained from the husks of fully ripened coconuts. Dark brown coir, is used in primarily in brushes, floor mats, etc. On the other hand, from the husks of coconuts harvested shortly before they ripen white coir is obtained. White coir is softer and less strong than brown coir. The coconut fiber have good resistant property to salt water, they are almost impervious to the weathering condition. Coconut fiber is becoming a useful choice for making geo textiles because of its durability, ability to hold water, and hairy texture.

6.RESULT DATA & ANALYSIS

Table 1.Grade Recommendations of Paver Blocks for Different types of traffic as per IS 15658-2006 is as follows

S.N	Grade Designation	Compressive Strength (28 Days) N/MM^2	Categories of Traffic
1	M-30	30	Non-Traffic
2	M-35	35	Light-Traffic
3	M-40	40	Medium-Traffic
4	M-50	50	Heavy-Traffic
5	M-55	55	Very Heavy-Traffic

Tests on Ordinary Portland cement of 43 – Grade

Table 2. Tests Result on Ordinary Portland cement of 43 – Grade

S.N	Name of Test	Results	Recommended Values as per IS 8112-1989
1	**Compressive Strength Test**		
	3 Days (Strength in MPa)	27.62	23
	7 Days (Strength in MPa)	39.47	33
	28 Days (Strength in MPa)	50.71	43
2	**Setting Time Test**		
	Initial Setting Time(in minutes)	112	Greater than 30
	Final setting time(in minutes)	237	Lesser than 600
3	**Specific Gravity**	3.12	No Recommendations
4	**Consistency Test**	32.16%	No Recommendations

Test on Coarse Aggregates

Table 3. Test Result on Coarse Aggregates

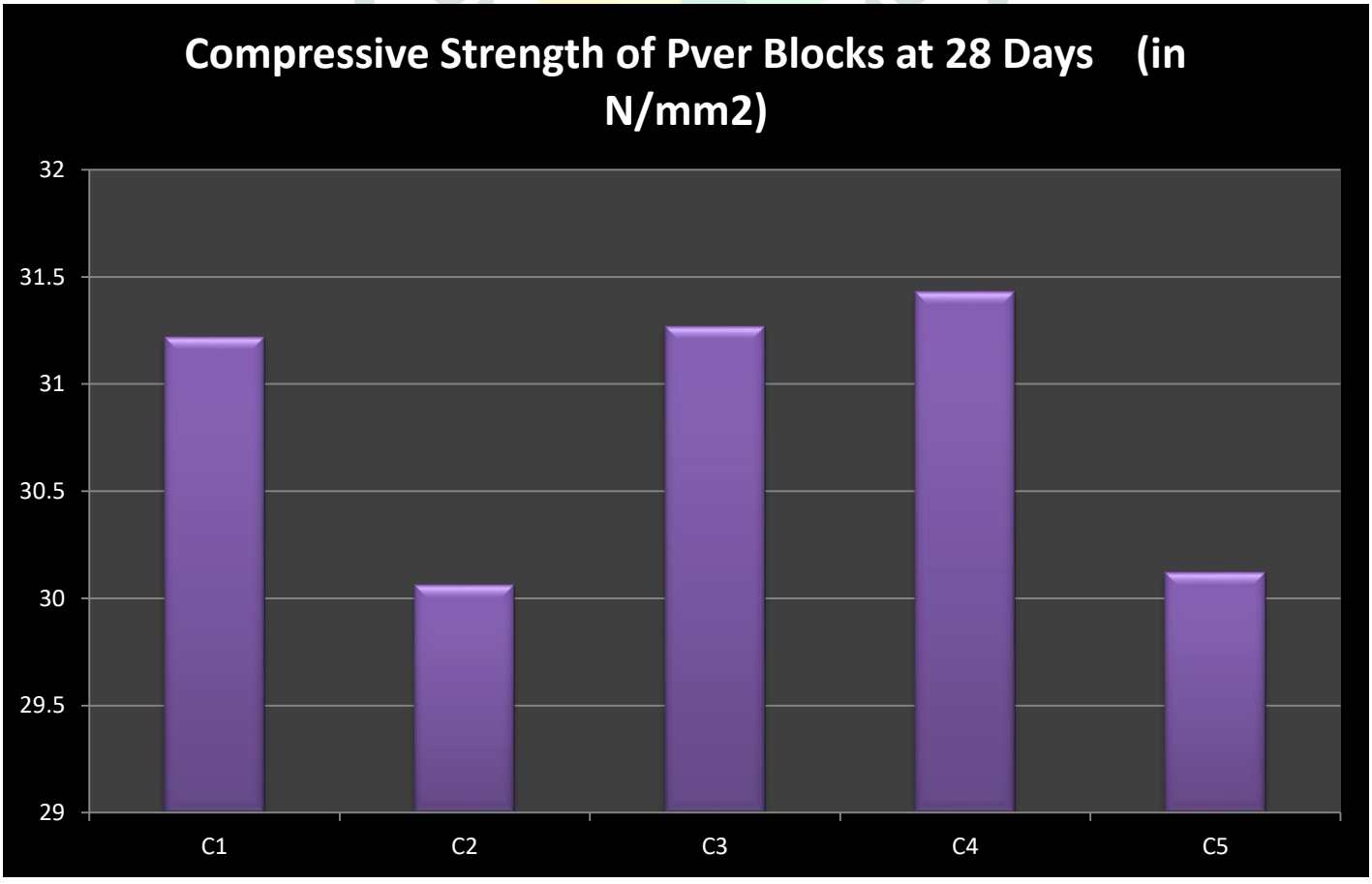
S.No	Test Performed on Aggreagtes	Results	Permissible limits as per IS 2386-1963 Part V
1	**Specific gravity**	2.7	Minimum 2.6
2	**Water absorption Test**	1.42%	Maximum 3%
3	**Crushing value Test**	29%	Maximum 30%
4	**Impact value Test**	19.59%	Maximum 30%
5	**Bulk Density**	20 mm Size- 1510 Kg/m^3	
		10 mm size- 1500 kg/m3	
6	**Flakiness Index**	22%	No Recommendations
7	**Elongation Index**	23%	No Recommendations

Compressive Strength Test Results at 28 Days

Table 4. Compressive Strength Test Results at 28 Days

S.N	Different Composition of Mixes	Sample Name	Wt. of Sample (in kg)	Breaking Load (in KN)	Area (in mm2)	Compressive Strength (in N/mm2)
1	**Nominal Mix M-30**	**C1**	4.6	790.26	25312.5	31.22
2	**Replacement with 10 % FA & 0.2% CF**	**C2**	4.84	760.89	25312.5	30.06
3	**Replacement with 15 % FA & 0.5% CF**	**C3**	4.66	791.52	25312.5	31.27
4	**Replacement with 20 % FA & 0.8% CF**	**C4**	4.72	795.57	25312.5	31.43
5	**Replacement with 25 % FA & 1% CF**	**C5**	4.77	762.41	25312.5	30.12

Chart 1. Compressive Strength of Pver Blocks at 28 Days (in N/mm2)

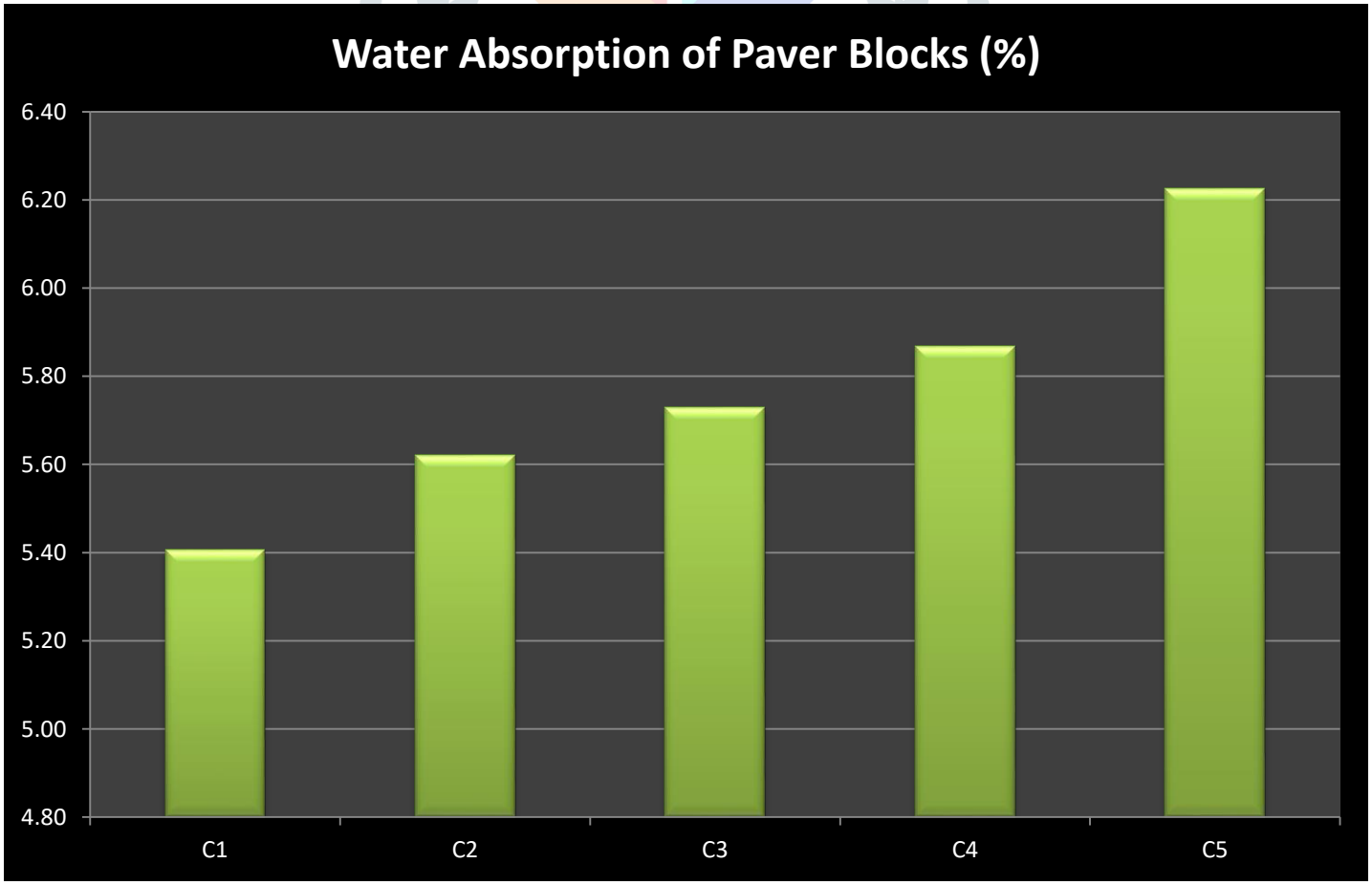


Water Absorption Test on Paver Blocks

Table 5. Water Absorption Test Results on Paver Blocks

S.N	Different Composition of Mixes	Sample Name	Wt. of Sample(in kg)	Wt. of Soaked Sample(in kg)	Water Absorption (%)
1	**Nominal Mix M-30**	**C1**	4.625	4.875	5.41
2	**Replacement with 10 % FA & 0.2% CF**	**C2**	4.840	5.112	5.62
3	**Replacement with 15 % FA & 0.5% CF**	**C3**	4.660	4.927	5.73
4	**Replacement with 20 % FA & 0.8% CF**	**C4**	4.720	4.997	5.87
5	**Replacement with 25 % FA & 1% CF**	**C5**	4.770	5.067	6.23

Chart 2. Water Absorption Test Results on Paver Blocks



CONCLUSIONS

A properly designed interlocking concrete paver blocks may reduce the amount of pollutants reaching surface source of water, by passing the water to infiltrate into the sub surface layers of ground. Permeable paving blocks allow rain water to quickly infiltrate the surface layer to enter into a high-void aggregate base layer, which forms a detention reservoir in underground. A permeable paver block can be used as an alternative in the building of roads, parking lots and other areas where conventional paving block would be used. Fly ash increases strength of paver block with respect to time, and also continues to combine with free lime. Due to long term pozzolanic actions of fly ash, which holds up free lime, results in fewer bleed channels in the paver block. The strength was increasing with increase in the amount of fly ash and coconut fiber but after addition of 20% of fly ash & 0.8% of coconut fiber the material as replacement strength started to decrease. The maximum compressive strength is obtained when fly ash and coconut fiber is used in 20% & 0.8% respectively as replacement of cement and sand respectively. The paver block was permeable and allowing the water to pass through it. Flexural strength of paver block is increased very highly up to 130% to 150% compared to flexural strength of the conventional standard paver block.

This study looked upon various studies conducted on permeable pavement systems and their current application in construction work in India. This paper also discussed about the detailed design criteria of permeable interlocking concrete pavement. The aspects of maintenance and water quality control are relevant to the engineer were outlined for permeable pavement systems. New innovations and techniques were highlighted and explained in details, and their potential for further research work and study was outlined.

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