Paver blocks using Paper Waste

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***Abstract*- Concrete paver blocks in road pavement is better option in roads construction if conventional road construction is not desirable, uneconomical and has some environmental constraints. Interlocking Concrete Block Pavement (ICBP) is widely now used in India as a part of construction for footpaths, parking areas etc. In present study, paver blocks were prepared of M40 design mix proportions as per IS standards and an attempt is made for experimental investigation on strength of paver block by partial replacement of cement via 5%, 7%, 9%, 11%, 13% and 15% of Hypo Sludge. Water absorption, Compressive strength test and Flexural strength test are performed to check the water content and strength of paver blocks. Results are compared with standard paver block and finally cost comparison is done.**

***Index Terms*- Hypo sludge, Water absorption, Compressive Strength, Flexural Strength.**

I.INTRODUCTION

In today's era, when hot bituminous mix or cement concrete technology is not feasible or desirable due to some constraints, Interlocking Concrete Block Pavement (ICBP) has extensively used in a number of countries. As per IS 15658:2006, for different road traffics, such as light, medium, heavy and very heavy traffic, different paving applications is used. The advantages of Paver blocks are that it eliminates laborious construction work, reduce storage place, reduces extra cost and give smooth finishes. Lastly it also saves time and energy as they are ready to use thus it is overall cost effective. Paver blocks of size 250 x 250 x 80 mm is prepared and various tests on it are performed

II. MATERIALS AND TEST PERFORMED

Cement: Confirming to IS: 8112 (1989), Ordinary Portland cement (OPC) of 53 grade is used for experimental casting of paver blocks. Physical properties of OPC are given in Table 1.

Table 1 : Physical Properties of Ordinary Portland Cement

Sr No	Properties	Test Results
1	Specific gravity	3.15
2	Consistency limit	33%
3	Setting time in minutes (a) Initial setting time (b) Final setting time	 30 minutes 600 minutes

Coarse aggregate: Confirming to IS: 383, locally available coarse aggregate of nominal size 20 mm is used for preparing paver blocks. Physical properties of coarse aggregate are given in Table 2

Table 2 : Physical Properties of Coarse Aggregate

Sr No	Properties	Test Results
1	Specific gravity	2.603
2	Water absorption	0.206%
3	Aggregate Impact value	13.70%

Fine aggregate: Confirming to IS: 383, the river sand is used in design mix. Physical tests conducted on fine aggregate are given inTable 3.

Table 3 : Physical Properties of Fine Aggregate

Sr No	Properties	Test Results
1	Specific gravity	2.57
2	Water absorption	0.328%
3	Fineness Modulus	2.75

Hypo sludge: Hypo sludge is produced in a large amount as by product of paper industry. It contains low calcium and minimum amount of silica and it can be used as a partial replacement of cement. Hypo sludge is shown in Fig 1. Physical tests conducted on Hypo sludge are given inTable 4.

Fig 1 : Hyposludge

Table 4 : Physical Properties of Hyposludge

Sr No	Properties	Test Results
1	Setting time in minutes (a) Initial setting time (b) Final setting time	 35 595

III. MIX DESIGN

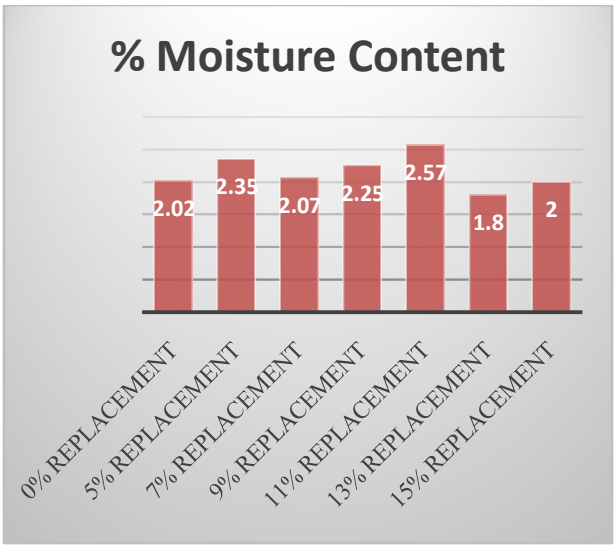
For preparation of paver blocks, M40 grade concrete was designed as per Indian Standard method and the same was used to prepare various test samples. The design mix proportion considered is 0% replacement considering conventional concrete is 1:1.64:2.93 having a water cement ratio of 0.43

IV.EXPERIMENTAL METHODOLOGY

4.1Water Absorption: One of the most important properties of a good quality paver block is to have low permeability. Paver blocks are not impervious to water, and in order to bond well with mortar, they must be able to absorb some water. The increase in weight as a percentage of the original weight is expressed as its absorption (in percent). As per Indian standards the average absorption of the test samples shall not be greater than 5% with no individual unit greater than 7%. Average dry weight of three samples of same proportions is taken and after 28 days the blocks are removed from water and kept for 4 hours and again average wet weight of three samples was taken. The values comes within IS code range. Thus it will not cause any dampness**.** Table 7 shows the values of dry weights and wet weights of paver blocks.

Table 5: Water Absorption values

Description	Dry weight	Wet weight	% Absorbed
0%Replacement	5.916kg	6.036kg	2.02%
5%Replacement	5.940kg	6.080kg	2.35%
7%Repalcement	6.038kg	6.163kg	2.07%
9%Replacement	6.076kg	6.213kg	2.25%
11% Replacement	5.949kg	6.120kg	2.57%
13% Replacement	5.920kg	6.023kg	1.80%
15% Replacement	6.048kg	6.169kg	2.00%



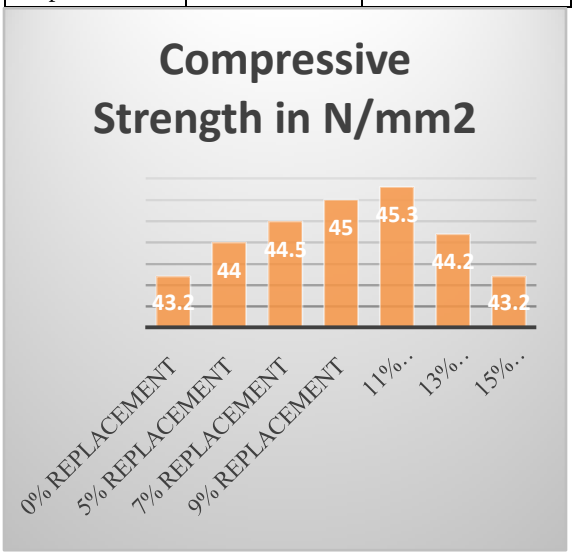
Graph 1 - Replacement of hypo sludge v/s Moisture content

4.2Compressive Strength: Compressive strength is an important parameter in evaluation of paving block quality. The compressive strength of the specimens was determined at 28 days of age. Three sample of paving block were tested using Standard compression testing machine, average strength value is calculated in Table 8 for 28 days. Individual paver block strength shall not be less than 85% of the specified strength. The specified average 28 days compressive strength of different grades of paver blocks are grade of the concrete >= F_{ck} + 0825 x standard deviation (round of nearest 0.5 N/mm^2). Table 8 shows the results of ultimate compressive strength for 28 days.

Table 6 : Compressive Test results

Description	Ultimate Load in kN	Ultimate compressive strength in N/mm^2
0% Replacement	2415	43.2
5% Repalcement	2452	44
7% Replacement	2479	44.5
9% Replacement	2518	45
11% Replacement	2527	45.3
13% Replacement	2468	44.2

15% Replacement	2412	43.2

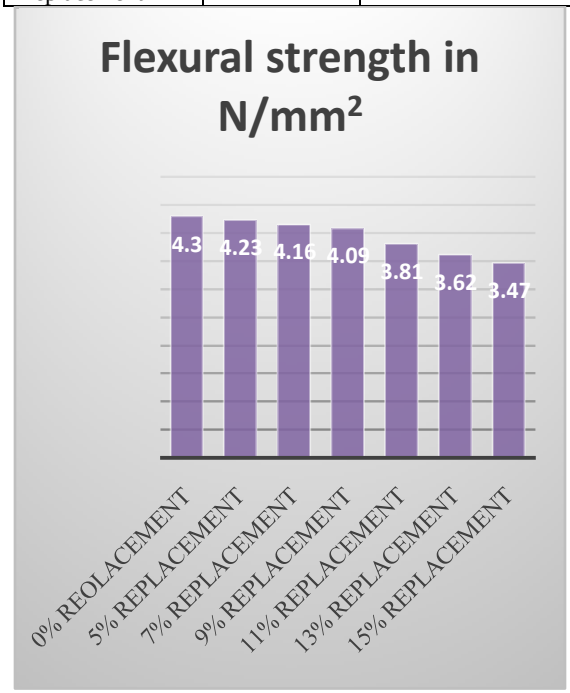


Graph 2 – Replacement of hypo sludge v/s compressive strength

4.3 Flexural Compressive Strength: The flexural strength of paving blocks can be expressed in term of flexural stress or in from of breaking load. Larger paving slabs and under heavy traffic conditions paver blocks react differently under wheel loads to normal concrete pavers. Having a larger surface area, aspect ratio and thinner, the slabs bend easily under wheel loads – much like a beam. The flexural length of the panel units is taken as the end to end plan dimension of the units. Loading shall be applied at a uniform rate such that the total load is applied in not less than one min and not more than 3 min. Table 9 shows the results of flexural compressive strength of paver blocks. Three samples were tested of each proportions and average flexural strength is carried out.

Table7 - Results for Flexural Strength test

Description	Ultimate Load in kN	Flexural strength in N/mm^2
0% Replacement	30.6	4.30
5% Repalcement	30.1	4.23
7% Replacement	29.6	4.16
9% Replacement	29.1	4.09
11% Replacement	27.1	3.81
13% Replacement	25.8	3.62
15% Replacement	24.7	3.47



Graph 3 - Replacement of hypo sludge v/s Flexural Strength

V.COST EVALUATION

Cost analysis is carried out for the optimum proportion of percentage of hypo sludge in concrete. The work is carried at Dhorajia Projects LLP-Karjan The cost is compared to the conventional concrete.

a) Cost of Materials

Cost of cement per bag = Rs 320/-

Cost of sand per m3 = Rs 1260/-

Cost of hypo sludge per kg = Rs 1.5/-

Cost of coarse aggregate per m3 = Rs 980/-

(All the rates are included with lead charges).

Table 7 : Cost evaluation for different design mix proportions

Description	Replacement	Cement (per m^3)	Coarse Aggregate (per m^3)	Fine Aggregate (per m^3)	Hypo sludge (per kg)	Total Cost
Quantity(kg)	0% with cement	432	1097	652	-	
Rate (per kg)		6.8	2.8	2.2	-	
Cost		2937.6	3071.6	1434.44		
						7443.6

Quantity(kg)	05% with cement (A)	410.4	1097	652	21.6	
Rate		6.8	2.8	2.2	1.5	
Cost		2790.72	3071.6	1434.44	32.4	
						7329.12
Quantity(kg)	07% with cement (B)	401.76	1097	652	30.24	
Rate		6.8	2.8	2.2	1.5	
Cost		2731.96	3071.6	1434.44	45.6	
						7283.32
Quantity(kg)	09% with cement (C)	393.12	1097	652	38.88	
Rate		6.8	2.8	2.2	1.5	
Cost		2673.21	3071.6	1434.44	58.32	
						7237.53
Quantity(kg)	11% with cement (D)	384.48	1097	652	47.52	
Rate		6.8	2.8	2.2	1.5	
Cost		2614.16	3071.6	1434.44	71.28	
						7191.68
Quantity(kg)	13% with cement(E)	375.84	1097	652	56.16	
Rate		6.8	2.8	2.2	1.5	
Cost		2555.71	3071.6	1434.44	84.24	
						7145.94
Quantity(kg)	15% with cement(F)	367.2	1097	652	64.8	
Rate		6.8	2.8	2.2	1.5	
Cost		2496.96	3071.6	1434.44	97.2	
						7100.2

VI.CONCLUSION

Study have been carried out on M40 grade concrete, where test like water absorption, compression test and flexural tests were carried out on standard concrete and various proportions.

1. Study shows that water absorption values for 13% replacement gives minimum value and as the percentage of hypo sludge is increasing, more the value of water absorption is coming.
2. It has been observed that in case of compression test, for 11% hypo sludge, compressive strength comes to be maximum
3. The values for 5% hypo sludge, the flexural strength comes to be maximum.
4. Cost of cement will be reduced by addition of hypo sludge as obtained from cost analysis

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