IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)
e-ISSN: 2278-1684, p-ISSN: 2320-334X.
PP 12-17
www.iosrjournals.org

Development of Paver Blocks from Industrial Wastes

Kalingarani.K[1], Harikrishna Devudu.P[2] ,Jegan Ram.M[2], Sriramkumar.V[2]
[1](Assistant professors, Department of civil engineering Easwari engineering college, Chennai)
[2](UG Students, Department of civil engineering Easwari engineering college, Chennai)

***Abstract**: Interlocking concrete paver blocks (ICPB) are brick-like piece of concrete commonly used as exterior flooring which can be used as an alternative pavement to asphalt and concrete pavements. ICPB is formed from individual concrete paver blocks (CPBs) that fit next to one another on a suitable sub base leaving a specific joint space among them to be filled with jointing sand. The main aim of this study is to produce interlocking concrete paver blocks from industrial wastes .The main reason for the use of the industrial wastes is to reduce the landfill problem and also to control the depletion of the natural resources. For this purpose various industrial wastes such as copper slag, fly ash, phosphogypsum, and sludge were selected and their physical and chemical properties were studied. Various mixes with different proportions of these industrial wastes were casted and tested as per the standards given in the Indian standards for precast concrete blocks for paving (is.15658:2006). These test results are then compared with the results of the conventional paver blocks.*
***Keywords** - paver blocks, ICPB, industrial wastes, fly ash, copper slag*

I. INTRODUCTION

Interlocking concrete block paving is a system of individual shaped blocks arranged to form a continuous hardwearing surface overlay. Over the past two decades, paving composed of concrete blocks has become a feature of our towns and cities. It is to be found in commercial industrial and residential areas, in the paving malls, plazas, parking areas and bus stops. It has been successfully used for embankment walls, slope protection and erosion control. Interlocking Concrete Block Pavement has been extensively used in a number of countries for quite some time as a specialized problem-solving technique for providing pavement in areas where conventional types of construction are less durable due to many operational and environmental constraints. Interlocking Concrete Block Pavement technology has been introduced in India in construction, a decade ago, for specific requirement viz. footpaths, parking areas etc. but now being adopted extensively in different uses where the conventional construction of pavement using hot bituminous mix or cement concrete technology is not feasible or desirable. It provides a hard surface which is aesthetically pleasing, comfortable to walk on, trafficable, extremely durable and easy to maintain. Paving blocks are fully engineered products, manufactured in factory conditions, ensuring consistency and accuracy. Laid with an edge restraint over a granular bedding course, individual blocks interlock to act compositely which can distribute large point loads evenly.

II. EXPERIMENTAL INVESTIGATIONS

2.1. MATERIALS

a). Cement and Cement Admixtures

53Grade ordinary Portland cement conforming to IS 12269 was used and Mineral admixtures, namely, fly ash conforming to Grade 1of IS3812 (Part 1) Fly ash used in this experimental work was obtained from National Thermal Power Corporation (NTPC), ENNORE. Fly ash is finely grained residue resulting from the combustion of ground or powdered coal were used as part replacement of ordinary Portland cement provided uniform blending with cement is obtained.

b). Coarse Aggregates

Coarse aggregates complied with the requirements of IS 383 was used. As far as possible crushed/semi-crushed aggregates were used.

c). Fine Aggregates

River sand which is used as fine aggregates in conventional concrete was completely replaced by copper slag. Copper slag is a by-product obtained during the copper smelting and refining process. Produced from a copper concentrate containing around 30 - 35% of copper, iron and sulphur each along with around 12% of silica and 5% of calcium. While producing copper the anode, a slag with rich iron and moderate silica content is also generated or copper slag is a by-product created during the copper smelting and refining process.

2.2. MIX DESIGN

In this study of development of paver blocks from industrial wastes the mix design was determined to achieve target strength of M30. Cement was partially replaced by fly ash i.e. fly ash replaced 30% of cement. Fine aggregate i.e. River sand was replaced completely by copper slag and coarse aggregates less than 12mm were used in mix. The final mix was 1:1.36:2.42

2.3. CASTING AND CURING OF PAVER BLOCKS

With the finalized mix proportions of cubes the mix design for paver blocks using fly ash (FA), copper slag (CS), cement (C) and coarse aggregate (CA) was prepared, casted and checked for the result. The criteria assumed for these mixes are to attain the basic compressive strength 30 to 35 N/mm^2. The same ratio was adopted, 1 :1.3621 :2.4216 (cement(70%) and fly ash(30%) : Copper Slag: coarse aggregate).

In the production process all the raw materials were placed in a concrete mixer and the mixer is rotated for 15 minutes. The prepared mix is discharged from the mixer and consumed in the next 30 minutes. Vibrating table is used for compacting the concrete mix in the moulds of desired sizes and shapes. After compacting the blocks are de-moulded and kept for 24 hours in a shelter away from direct sun and winds. The blocks thus hardened are cured with water to permit complete moisturisation for 14 to 21 days. Water in the curing tanks is changed every 3 to 4 days. After curing, the blocks are dried in natural atmosphere and sent for use. The concrete paving blocks gain good strength during the first 3 days of curing and maximum gains in strengths are secured in the first 10 to 15 days of curing.

FIG 1. MIXING PROCESS

FIG 2. SPECIMENS

III. RESULTS AND DISCUSSIONS

The following tests were conducted on designed paver blocks and their results are as follows

3.1.Tensile Splitting Strength

Tensile splitting strength was conducted on the paver blocks. On comparing the result of 14th day and 28th day it was observed that there is an increase in average value from 3.22 N/mm2 to 3.42 N/mm^2

Table 1. Tensile Splitting Strength Results

Specimen	Split tensile strength (N/mm)	
	14th day	28th day
1	3.90	3.56
2	3.09	3.63
3	3.38	2.43
4	2.35	2.82
5	3.75	4.02
6	2.9	4.10
AVERAGE	3.22	3.42

3.2. Flexural Strength Test

Three point loading test was conducted on the paver blocks. On comparing the 14th day result and 28th result of the flexural strength we observe that there is an increase in the average value from 6.75 to 7 N/mm^2

Table 2. Flexural Strength test Results

Specimen	Weight (kg)		Load test (kN)		Flexural (N/mm^2)	
	14th day	28th day	14th day	28th day	14th day	28th day
1	3.020	2.975	6	6.56	6	6.90
2	3.041	3.084	8.88	6.72	8	6.24
3	3.08	2.993	8.80	6.72	8.35	7.07
4	3.02	3.036	6.32	7.28	6.25	7.34
5	2.99	3.082	6.92	6.24	7.05	6.29
6	3.20	3.064	5.36	8.48	4.9	8.21
AVERAGE			7.04	7	6.75	7

3.3. Water Absorption Test

On comparing the water absorption test result of 14th and 28th day it was observed that water absorption rate is less than 6% in both instance and the more promising thing is that the water absorption is comparatively reduced from 5.89 to 5.56.

Table 3. Water Absorption Test Results

Specimen	Actual weight (kg)		After water absorption(kg)		Water absorption (%)	
	14th day	28thday	14th day	28th day	14th day	28th day
1	1.202	1.202	1.274	1.097	5.99	5.78
2	1.109	1.109	1.180	1.413	6.40	5.30
3	1.225	1.225	1.299	1.084	6.04	5.65
4	1.055	1.055	1.127	1.187	5.82	6.07
5	1.120	1.120	1.193	1.183	5.52	5.62
6	1.104	1.104	1.166	1.231	5.61	5.03
AVERAGE					5.89	5.575

3.4. Compression Strength Test

The compressive strength test was conducted on paver blocks and it's 28th test result was found to be 38.6KN which is equal to the desired concrete strength.

Table 4. Tensile Compression Strength Result

S.NO	DIMENSION H	C.A IN mm^2	LOAD IN kN	APPARENT COMPRESSION STRENGTH	CORRECTION FACTOR	MODIFIED COMPRESSION STRENGTH
1	50	23776	886	37.3	1.03	38.4
2	50	23776	934	39.3	1.03	40.5
3	50	23776	852	35.8	1.03	36.9
AVERAGE						38.6

IV. COMPARISON BETWEEN CONVENTIONAL PAVER BLOCKS AND INDUSTRIALWASTE PAVER BLOCKS a).COMPRESSIVE STRENGTH:

4.1. COMPRESSIVE STRENGTH:

Compressive strength test was conducted on conventional paver blocks and test paver blocks and their average 28th day test results were

Table 5.Compressive Strength Comparison results

AVERAGE COMPRESSIVE STRENTH (N/mm^2)	
Conventional	31.65
Test	38.6

on comparing the test results with the specifications given in the code book (IS15658:2006) we conclude that the designed paver block can be used for light traffic areas such as pedestrian plazas, shopping complexes ramps, car parks, office driveways, housing colonies, office complexes, rural roads with low volume traffic, farm houses, beach sites, tourist resorts local authority footways, residential roads, etc

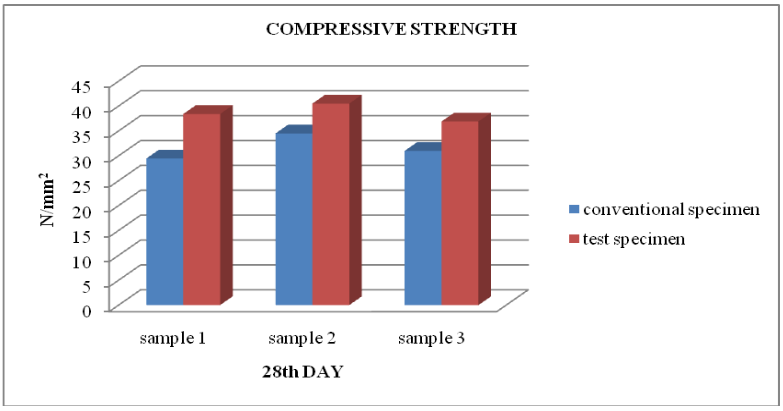

Fig 3. Comparision between conventional specimen and test specimen for compressive strength

4.2. FLEXURAL STRENGTH:

Flexural strength test was conducted on conventional paver blocks and test paver blocks and their average 28th day test results were

Table 6.Flexural Strength Comparison results

AVERAGE FLEXURAL STRENTH (N/mm^2)	
Conventional	3.305
Test	7

On comparing the test results with the specifications given in the code book (IS15658:2006). When required by the purchaser, the test values for flexural strength breaking load of paver blocks may be specified by the manufacturer

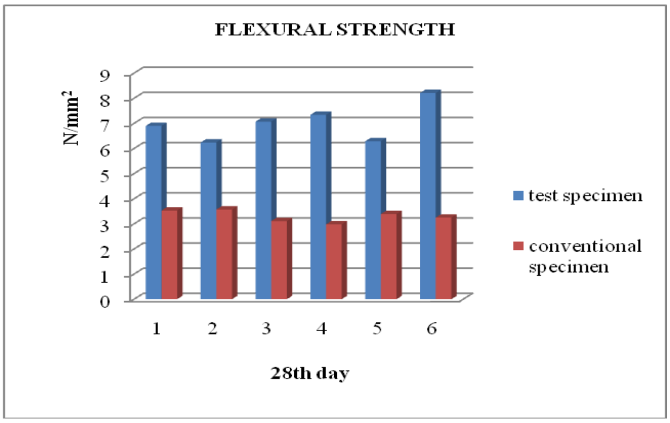

Fig 4. Comparision between Conventional specimen and test specimen for Flexural strength

4.3. SPLIT TENSILE STRENGTH:

Tensile splitting strength test was conducted on conventional paver blocks and test paver blocks and their average 28th day test results were

Table 7.Tensile Splitting Strength Comparison

TENSILE SPLITTING STRENGTH:(N/mm)	
Conventional	1.477
Test	3.42

On comparing the test results with the specifications given in the code book (IS15658:2006) When results required by the purchaser, the test values for tensile splitting strength of paver blocks may be specified by the manufacturer.

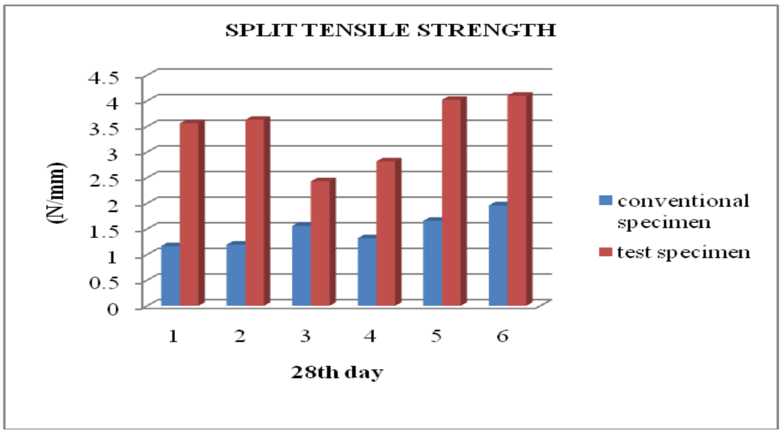

Fig 5.Comparision between Conventional specimen and test specimen for Split tensile strength

V. CONCLUSIONS

Our main aim of the experiment was to produce interlocking paver blocks from industrial wastes thereby avoiding land filling and reduction in the use of naturally available resources. In order to produce eco friendly interlocking paver blocks various industrial wastes such as copper slag, fly ash, phosphogypsum, sludge were tested for its physical and chemical properties. From these industrial wastes suitable trial mixes were designed and cubes were casted. The casted specimen was then subjected to many tests such as compressive strength test, water absorption test, flexural strength test, tensile splitting strength test. The tests results were computed and the best among the trial mixes was selected.

(a). The selected trial mix was 1:1.36:2.42 where the first part is 70% cement-30% fly ash, second part is copper slag and the third part is coarse aggregate. paver blocks were castes in this mix and was tested as per the provisions given in the Indian standards for precast concrete blocks for paving(IS15658:2006) and the results were computed.

(b). The computed results were then compared with the results of the conventional paver blocks which are available commercially in the market. On comparing it was found that the designed paver block was on par to the conventional paver blocks for all the tests specified in the Indian standards for precast concrete blocks for paving(IS15658:2006).

REFERENCES

[1] Concrete lock paving guidelines from concrete manufacturing association.
[2] Indian standard for precast concrete blocks for paving I.S 15658:2006.
[3] Indian standards for Concrete mix proportioning I.S 10262:2009
[4] Kumar. S, “Fly ash-lime- phosphogypsum cementitious binder: A new trend in paver blocks’’ Department of Civil Engineering, B.I.E. T, Jhansi, India. Paper received: March 3, 1999; Paper accepted: June 22, 1999.
[5] Patel S, Shahu. S.J, Senapati .A ,“Feasibility of Copper Slag – Fly Ash Mix as a Road Construction Material” ACEE Transportation and Urban Development, Vol. 2, Number 1, April 2012.
[6] Performance of copper slag on strength properties as partial replace of fine aggregate in concrete mix design r r chavan*1 & d b kulkarni2