International Journal of Innovative Research in Advanced Engineering (IJIRAE) ISSN: 2349-2163
Issue 05, Volume 6 (May 2019) www.ijirae.com

COMPARATIVE STUDY OF PAVER INTERLOCKS FROM DEMOLISHED CONCRETE WASTE AND COPPER WIRE

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Manuscript History
Number: **IJIRAE/RS/Vol.06/Issue05/MYAE10086**
Received: 02, May 2019
Final Correction: 08, May 2019
Final Accepted: 15, May 2019
Published: **May 2019**
Citation: Arya.s, Ayana.j, Sajina, Swathy & Lekshmy (2019). COMPARATIVE STUDY OF PAVER INTERLOCKS FROM DEMOLISHED CONCRETE WASTE AND COPPER WIRE. IJIRAE::International Journal of Innovative Research in Advanced Engineering, Volume VI, 361-367. **doi://10.26562/IJIRAE.2019.MYAE10086**
Editor: Dr.A.Arul L.S, Chief Editor, IJIRAE, AM Publications, India

Abstract—Construction and demolition (C&D) waste generation and handling issues have been in focus to achieve sustainable goals. Owing to growth in construction in India, it is appropriate to link generation of C&D waste with the growth. If measures to minimize and handle the C&D waste are not developed and efficiently adopted it may threat the environment as well as sustainable movement of Indian construction industry. The amount of C & D wastes in India has been estimated to be 10 - 12 million tonnes annually and the proportion of concrete estimated as 23 to 35% of total waste. This concrete waste can be qualitatively reused for the manufacturing of paver interlocks. In this report. we represent the sustainable use of demolished concrete waste along with copper wire ,collected from the wiring of demolished buildings , for the manufacturing of paver interlocks. In our project, we did a comparative study of conventional paver interlocks, paver interlocks with demolished concrete waste, paver interlocks with copper wire and paver interlocks with demolished concrete waste along with copper wire. After crushing the demolished concrete waste into size of coarse aggregates, we partially replaced the same for first specimen. Copper wire of varying length is added into second specimen and its optimum length is found out. This optimum length is then added to the third specimen along with demolished concrete waste. All these specimens are compared with conventional paver interlocks. Copper wire of 3 cm length gave optimum compressive strength, flexural strength & least percentage water absorption. Paver interlocks with demolished concrete waste along with 3 cm copper wire gave maximum compressive strength and least percentage water absorption among the four specimens.

Keywords— Demolished concrete waste; Copper wire; Paver interlock; Optimum length; Partial replacement;

I. INTRODUCTION

India being a developing nation and in several other developing countries similar to Indian country, economical building material along with economical construction plays a dynamic role in construction of countries in overall expansion. Building waste material in building construction sector can show remarkable role to make it economical and durable due to some of its specific properties relevant to construction materials. Nearly about 12 to 14 million tons per year waste is generated from construction industry.

From this total waste brick and concrete waste is about 7 to 8 million tonnes. The activity like demolition, construction and renovation are producing concrete waste in huge amount. This waste is either dumped or it is diverted towards landfill. Illegal dumping is common issue created from physical construction waste which needs attention. This concrete waste can be qualitatively reused for manufacturing of various concrete blocks. Concrete paving block is versatile, aesthetically attractive, functional and cost effective and requires little or no maintenance if correctly manufactured and laid. Paver block is solid, unreinforced precast cement concrete paving units used in the surface course of pavements. Interlocking concrete paving block technology has been introduced in India in construction, a decade ago, for specific requirement like footpaths, parking areas, gardens, etc.

In this project, it is presented the concept of sustainable use of concrete waste in concrete which can be reused in manufacturing of interlocking paver block with copper wire. Manufacture of paver blocks was made in two layers, one is its top layer having specified thickness and another is bottom layer. In our project, we had decided the thickness of paver block as 80 mm having 10mm top layer thickness and 70mm bottom layer thickness. Shape of paver block plays an important role in interlocking, so paver block of zigzag shape is manufactured in project. Concrete waste is to be collected from the nearby demolished site and must be crushed manually. After crushing of the concrete waste, aggregates obtained is to be used as a replacement of coarse aggregates as partial replacement in bottom layer. Copper wire is collected and is cut into varying length before being added into specimens.

II. METHODOLOGY FOR EXPERIMENTATION

A. Materials and its testing

The various materials used are cement, fine aggregates, coarse aggregates, demolished concrete waste and copper wire. The various experimental results of the materials are shown in table below.

TABLE 1 -TEST RESULTS OF MATERIALS

S.No.	Title of the Experiment	Result
1	Specific gravity of cement	3.2
2	Fineness of cement	26%
3	Consistency of cement	35%
4	Initial setting time of cement	32 min
5	Specific gravity of fine aggregate	2.51
6	Fineness modulus of fine aggregate	4.73
7	Specific gravity of coarse aggregate	2.59
8	Fineness modulus of coarse aggregate	4.73
9	Bulk density of coarse aggregate	1.53
10	Water absorption of coarse aggregate	0.738%
11	Specific gravity of demolished concrete waste	2.53
12	Fineness modulus of demolished concrete waste	4.13
13	Bulk density of demolished concrete waste	1.34
14	Water absorption of demolished concrete waste	0.77%

B. Casting of Conventional Paver Interlock

12 paver interlocks of sizes 260mmx140mmx80mm were casted. Mix design for M_{40} grade concrete obtained as 1:1.33:1.37 as per IS 10262:2009.

C. Casting of paver interlocks with demolished concrete waste.

12 paver interlocks of sizes 260mmx140mmx80mm were casted with M_{40} mix. 50% of coarse aggregate is replaced by demolished concrete waste in bottom layer of specimens.

D. Casting of paver interlocks with copper wire of varying length.

12 paver interlocks of sizes 260mmx140mmx80mm were casted with M_{40} mix.Copper wire is cut into specified lengths of 1cm, 3cm, 5cm and 7cm. Copper wire of 0.3% of volume of concrete is added in the bottom layer.

E. Casting of paver interlocks with demolished concrete waste and copper wire of optimum length.

48 paver interlocks of sizes 260mmx140mmx80mm were casted with M_{40} mix.50% of coarse aggregate is replaced by demolished concrete waste and copper wire of optimum length among 1cm, 3cm, 5cm and 7cm is added along with it in the bottom layer. Copper wire of 0.3% of volume of concrete is added.

Fig.1 Casted paver interlocks

F. Experimental study

The specimens are tested in the universal testing machine and compression testing machine. After the curing period of 7 days.

The flexural strength is calculated using the equation, $F_b = 3PL/2bd^2$

The compressive strength is calculated using the equation, $F = P/A$.

Percentage water absorption is calculated using the equation, W percent= $(W_w - W_d)/W_d$

The load arrangements for testing of paver interlocks are as shown in figure,

Fig. 2 Compressive strength test on paver interlock

Fig. 3 Flexural strength test on paver interlock

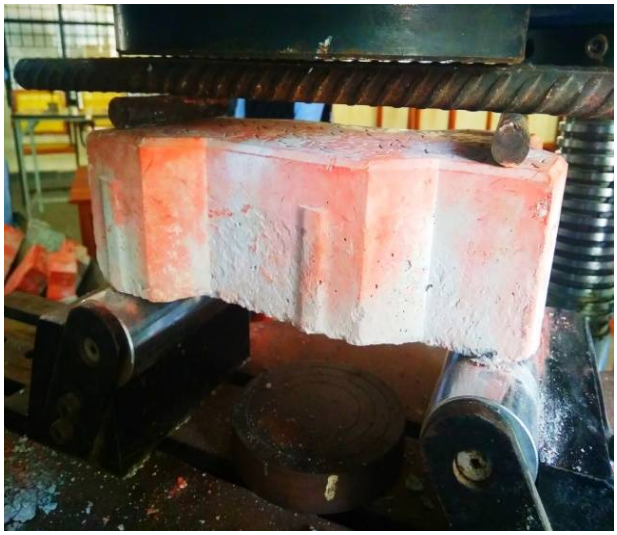

Fig. 4 Paver interlock loaded on UTM

Fig. 5 Water absorption test on paver interlock

III.RESULTS

TABLE 2 - COMPRESSIVE STRENGTH TEST RESULTS OF CONVENTIONAL PAVER INTERLOCKS AND PAVER INTERLOCKS WITH DEMOLISHED CONCRETE WASTE

Specimen	Specimen No.	Load (KN)	Apparent Compressive Strength (N/mm^2)	Corrected Compressive Strength (N/mm^2)	Avg. Compressive Strength (N/mm^2)
Conventional Paver Interlock	SC 1	860	23.6	27.848	29.024
	SC 2	880	24.1	28.438	
	SC 3	950	26.09	30.786	
Paver interlocks with demolished concrete waste	SD 1	690	18.95	22.361	27.766
	SD 2	840	23.07	27.223	
	SD 3	1040	28.57	33.713	

TABLE 3 - COMPRESSIVE STRENGTH TEST RESULTS OF PAVER INTERLOCKS WITH THE ADDITION OF COPPER WIRE

Specimen No:	Length Of Copper Wire (cm)	Load (KN)	Apparent Compressive Strength (N/mm^2)	Corrected Compressive Strength (N/mm^2)	Avg. Compressive Strength (N/mm^2)
SW 1	1	1100	30.22	35.659	35.876
SW 2		1100	30.22	35.659	
SW 3		1120	30.77	36.309	
SW 4	3	1310	35.99	42.468	37.819
SW 5		990	27.19	32.084	
SW 6		1200	32.97	38.905	
SW 7	5	930	25.55	30.149	30.578
SW 8		960	26.37	31.117	
SW 9		940	25.82	30.468	
SW 10	7	1060	29.12	34.362	31.981
SW 11		1020	28.02	33.06	
SW 12		880	24.17	28.521	

TABLE 4 - COMPRESSIVE STRENGTH TEST RESULTS OF PAVER INTERLOCKS WITH DEMOLISHED CONCRETE WASTE AND COPPER WIRE OF OPTIMUM LENGTH

Specimen	Specimen No.	Load (KN)	Apparent Compressive Strength (N/mm^2)	Corrected Compressive Strength (N/mm^2)	Avg. Compressive Strength (N/mm^2)
Paver interlocks with demolished concrete waste and 3cm copper wire	SDW 1	1220	33.52	39.554	39.55
	SDW 2	1260	34.62	40.852	
	SDW 3	1180	32.42	38.256	

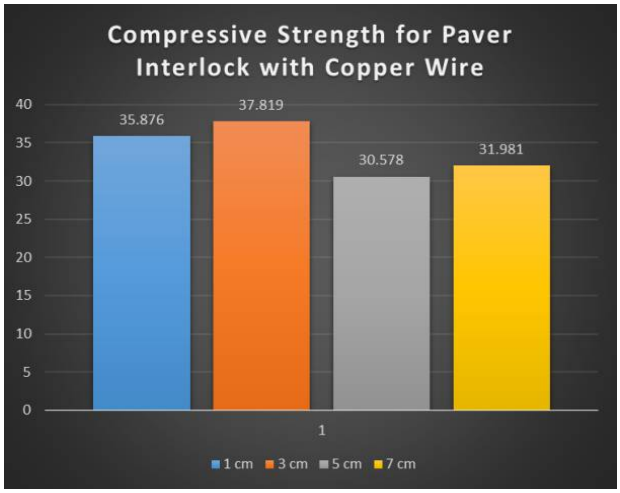

Fig. 6 Graphical representation of compressive strength of paver interlocks with copper wire of specimens varying length

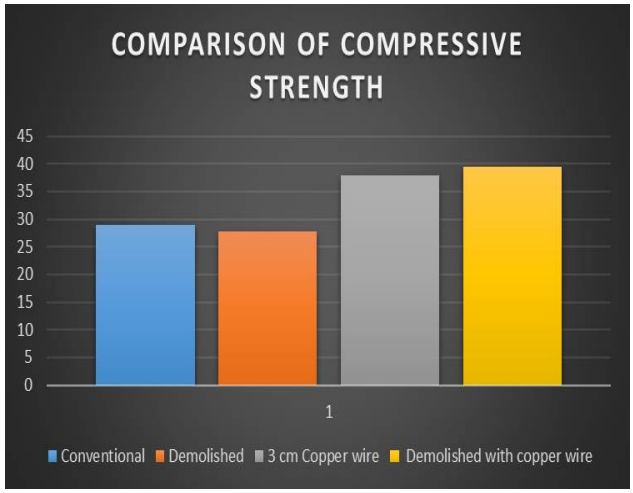

Fig. 7 Graphical representation of comparison of compressive strength of various paver interlock

TABLE 5 – WATER ABSORPTION TEST RESULTS OF CONVENTIONAL PAVER INTERLOCKS AND PAVER INTERLOCKS WITH DEMOLISHED CONCRETE WASTE

Specimen	Specimen No:	Dry Weight (W_d)	Wet Weight (W_w)	Water Absorption (%)	Average Water Absorption (%)
Conventional Paver Interlock	SC 1	5.637	5.724	1.54	
	SC 2	5.669	5.756	1.53	
	SC 3	5.716	5.793	1.34	1.47
Paver interlocks with demolished concrete waste	SD 1	5.759	5.884	2.17	
	SD 2	5.531	5.635	1.84	
	SD 3	5.557	5.669	2.01	2

TABLE 6 – WATER ABSORPTION TEST RESULTS OF PAVER INTERLOCKS WITH THE ADDITION OF COPPER WIRE

Specimen No:	Length Of Copper Wire (cm)	Dry Weight (W_d)	Wet Weight (W_w)	Water Absorption (%)	Average Water Absorption (%)
SW 1		5.801	5.872	1.22	
SW 2		6.070	6.135	1.07	
SW 3	1	5.856	5.952	1.63	1.31
SW 4		6.063	6.128	1.07	
SW 5		5.674	5.741	1.18	
SW 6	3	5.615	5.693	1.38	1.21
SW 7		5.786	5.922	2.35	
SW 8		5.607	5.730	2.19	
SW 9	5	5.673	5.790	2.06	2.2
SW 10		5.835	5.935	1.71	
SW 11		5.739	5.834	1.65	
SW 12	7	5.817	5.884	1.15	1.5

TABLE 7 – WATER ABSORPTION TEST RESULTS OF PAVER INTERLOCKS WITH DEMOLISHED CONCRETE WASTE AND COPPER WIRE OF OPTIMUM LENGTH

Specimen No:	Dry Weight (W_d)	Wet Weight (W_w)	Water Absorption (%)	Average Water Absorption (%)
SDW 1	5.886	5.936	0.84	
SDW 2	6.044	6.099	0.909	
SDW 3	5.838	5.891	0.907	0.88

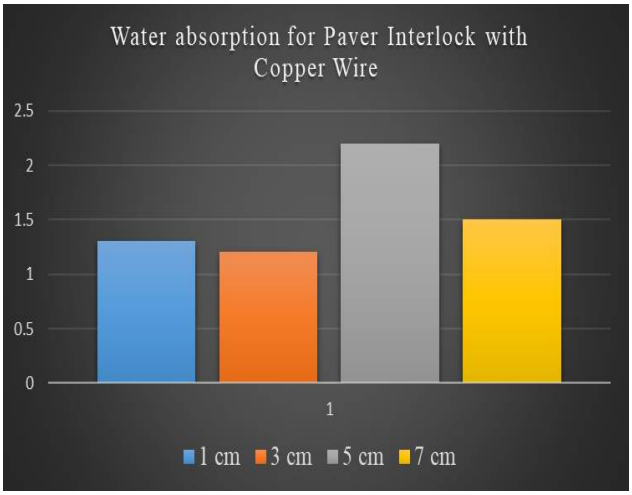

Fig. 8 Graphical representation of water absorption of paver absorption interlocks with copper wire of varying length

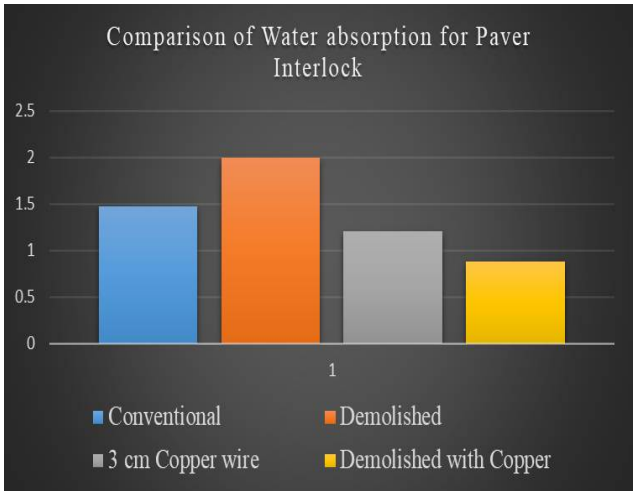

Fig. 9 Graphical representation of comparison of water of various paver interlock specimens

TABLE 8 - FLEXURAL STRENGTH TEST RESULTS OF CONVENTIONAL PAVER INTERLOCKS AND PAVER INTERLOCKS WITH DEMOLISHED CONCRETE WASTE

Specimen	Specimen No.	Breaking Load (KN)	Flexural Strength (N/mm^2)	Avg. Flexural Strength (N/mm^2)
Conventional Paver Interlock	SC 1	26.8	9.423	9.727
	SC 2	28.2	9.914	
	SC 3	28	9.844	
Paver interlocks with demolished concrete waste	SD 1	22.2	7.805	7.594
	SD 2	21.6	7.594	
	SD 3	21	7.383	

TABLE 9 – FLEXURAL STRENGTH TEST RESULTS OF PAVER INTERLOCKS WITH THE ADDITION OF COPPER WIRE

Specimen No:	Length Of Copper Wire (cm)	Breaking Load (KN)	Flexural Strength (N/mm^2)	Avg. Flexural Strength (N/mm^2)
SW 1	1	38.6	13.57	13.429
SW 2		40	14.063	
SW 3		36	12.656	
SW 4	3	42.6	14.977	14.836
SW 5		42.8	15.047	
SW 6		41.2	14.484	
SW 7	5	40.8	14.344	14.133
SW 8		38.6	13.570	
SW 9		41.2	14.484	
SW 10	7	29.6	10.406	10.359
SW 11		30.8	10.828	
SW 12		28	9.844	

TABLE 10 - FLEXURAL STRENGTH TEST RESULTS OF PAVER INTERLOCKS WITH DEMOLISHED CONCRETE WASTE AND COPPER WIRE OF OPTIMUM LENGTH.

Specimen	Specimen No.	Breaking Load (KN)	Flexural Strength (N/mm^2)	Avg. Flexural Strength (N/mm^2)
Paver interlocks with demolished concrete waste and 3cm copper wire	SDW 1	34.4	12.094	12.023
	SDW 2	33.6	11.813	
	SDW 3	34.6	12.164	

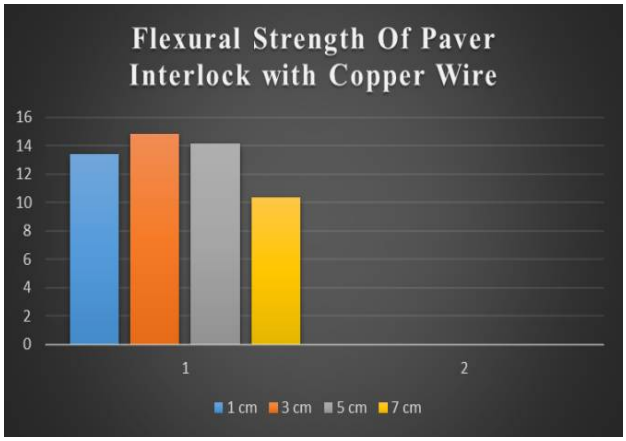

Fig. 10 Graphical representation of flexural strength of paver interlocks with copper wire of varying length.

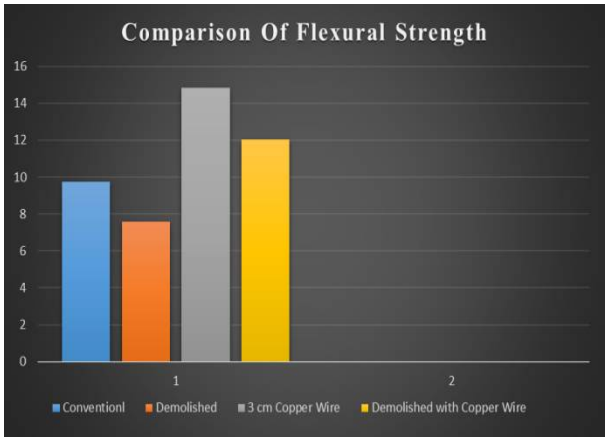

Fig. 11 Graphical representation of comparison of flexural strength of various paver interlock specimens.

IV. CONCLUSIONS

1. Compressive strength increases with the addition of copper wire. Copper wire of 3cm length gave optimum compressive strength of 37.8 N/mm^2.
2. Paver interlocks with demolished waste along with 3cm copper wire have 26.61% greater compressive strength than conventional paver interlocks.
3. Interlocks with 3cm copper wire have least % water absorption of 1.21 & gave optimum flexural strength of 14.8 N/mm^2.
4. Paver interlocks with demolished waste along with 3cm copper wire have 40.13% lesser water absorption than conventional paver interlocks.

ACKNOWLEDGEMENT

First of all, I would like to thank The Almighty for all the blessings and guidance in making me to take this project. I wish to place on records my ardent and earnest gratitude to my project guide **Prof. Lekshmy.D**, **Dept. of Civil Engineering**, MES Institute of Technology and Management. Her tutelage and guidance was the leading factor in translating my efforts to fruition. I would like to thank our **Principal Dr. J. Nazar** for providing all facilities in campus for my project. I am extremely happy to mention a great word of gratitude to **Prof. Abi Basheer, Head of the Dept. of Civil Engineering** for providing me with all facilities for the completion of the project. I also extend my gratefulness to all my staff members in the department. I also thank all my friends and well-wishers who greatly helped me in my Endeavour.

REFERENCES

1. Dinesh w. Gawatre “Review Paper on Sustainable Use of Debris in Paver Blocks” Indian Journal Of Applied Research December 2015, Vol :5 Issue: 12.
2. Vishal Kumar “utilization of waste material in concrete paver block” International Journal for Research in Applied Science & Engineering, Volume 4 Issue IV, April 2016 IC Value: 13.98 ISSN: 2321-9653
3. UmmiKalsum “recycling of clay based demolition wastage for the production block” International Conference on Environment 2008 (ICENV 2008).
4. G. Navya “experimental investigation on properties of concrete paver block with inclusion of natural fibre” International Journal of Engineering Research and Applications.
5. M.C.Nataraja & Lelin Das.”Study on strength properties of paver blocks made from unconventional Material.”IOSR Journal of Mechanical and Civil Engineering
6. Shivkumar Hallale,Suraj Swami and Vikas Londhe , “Utilization of demolished building waste in paving block with coir fibre,” IJARIIE-ISSN(O)-2395-4396,Vol-3 Issue-3,2017.
7. Shirgire Anil V, Dr.Ambadkar Swati D , “USE of demolished and construction building waste in paving block with coir fibre, ”International Journal of Advance Research in Science and Engineering, Vol. No.6, Issue No., September 2017

