IOSR Journal of Engineering (IOSRJEN) **www.iosrjen.org**
ISSN (e): 2250-3021, ISSN (p): 2278-8719
Vol. 08, Issue 4 (April. 2018), ||VIII|| PP 81-84

Development of a Mix Design Methodology for Concrete Paving Blocks. Part II: Experimental Investigation

A.K. Pani*, Dr. B.C. Panda**, A.K. Pattnaik*** and A.K. Padhi****
** Assistant Professor, Department of Civil Engineering, KIIT University, Bhubaneswar, Odisha.*
*** Professor, Department of Civil Engineering, IGIT, Sarang, Dhenkanal, Odisha.*
**** Superintendent Engineer, Mahanadi Coal Fields, Talcher, Odisha*
***** Researcher Scholar, Department of Civil Engineering, KIIT University, Bhubaneswar, Odisha.*
Corresponding Author: A.K. Pani

Abstract- Interlocking concrete paving blocks are widely used in India on the petrol pumps, footpaths, parking areas, gardens, etc. for easy laying, better look and finish. Now a day, the technology is slowly being adopted extensively in urban pavements, boarder military roads, hilly areas, industrial hardstands etc. where the conventional construction of pavement using hot bituminous mix or cement concrete technology is not feasible or desirable. Since the engineers and manufacturers have taken more active interest in this type of products, there has been a demand for the principles of mix design procedure for production of concrete paving blocks. In the first part (Part I, Pani and Panda 2018) of this research study, the theoretical developments of the mix design procedures for concrete paving blocks have been discussed. In this part (Part II), mix proportioning of three grades of concrete i.e. M30, M35 and M40 with different cement content and water cement (W/C) ratios will be designed as per the procedure laid down in first part. The compressive strength, flexural strength, strength will be performed and be presented for each mix at 7, 14, and 28 days.

Keywords - Interlocking concrete block pavement (ICBP), Mix design, Paving blocks, Mechanical strength.

Date of Submission: 23-04-2018 Date of acceptance: 11-05-2018

I. INTRODUCTION

Worldwide since 1950's, interlocking concrete block pavements (ICBP) have been extensively used in a number of countries since 1950's in special problem areas, where conventional types of pavement are less durable due to many operational and environmental constraints (Panda and Ghosh 2000). For 30 years, the use of ICBP has started in India especially in footpaths, parking lots, petrol pumps, city roads, military roads, industrial hardstands, etc.

In general, for the use of interlocking concrete block pavements, paving units are manufactured from a dry, low-slump concrete mix (IRC: SP:63-2004). In the production process vibration or pressure or both of them is applied to the mix (Dowson 1980). As there is a huge demand of concrete paving block in the country, there is a need for developing a local mix design method using available guidelines (IS 10262-2009, IS 15658:2006, IRC: SP:63-2004, IS 456:2000). The theoretical calculations of the mix design procedures for concrete paving blocks have already been published elsewhere (Pani & Panda 2018). In this part of the research (Part II), experimental investigation will be carried out after developing three grades of concrete i.e. M30, M35 and M40 in the laboratory. The compressive strength, flexural strength, will be performed on the laboratory specimens. Paving blocks of 80 mm thickness in rectangular will be casted. The results there of will be presented paving blocks at 7 and 28 days for achieving a dense, strong and durable block.

II. BACKGROUND

In 1980, Dowson was the first researcher to propose the mix design methodology and its procedure for concrete paving blocks. He had developed the details of design considering the most important properties of concrete like, the compressive strength and durability in the hardened state, and its workability and cohesiveness in plastic state. After that worldwide, several researchers have followed to develop different mix design methods as per suitability for many grades of concrete for manufacture of concrete blocks. Cement Concrete Institute of South Africa (SABS 1058:2002) has advised through a Technical Note covering basic principles of mix design to assist manufacturers for producing a durable and consistent quality of concrete blocks. Nanda et. al (2010) have used stone crusher dust as fine aggregate for making concrete paving blocks. They have successfully replaced 50 % of fine aggregate by of crusher dust. Natraj and Das (2012) have made concrete paving blocks using recycled aggregate with mixed proportion of 1:1.5:3 with W/C of 0.5. They have suggested to replace 50 % of natural aggregate with recycled aggregate keeping the absorption limit of paving blocks at 7 %. Sachdeva et. al. (2014) have performed laboratory experiments replacing cement up to 40% by fly ash. Compressive strength and flexural strength of different concrete mix starting from M30 to M50 were determined. Santhos and Talluri (2015) have manufactured paving blocks by replacing cement with fly ash and glass powder at varying percentage (i.e. 0, 10, 20, 30 and 40). Gawatre et. al. (2016) have tested paving blocks by replacing coarse aggregate with demolished concrete waste up to 13.25 % for M35 grade of concrete. Sultan et. al. (2017) have performed experiments on concrete paving blocks by replacing natural aggregate with construction and demolition (C & D) concrete wastes for a target design strength of 33 Mpa. They have concluded that C & D waste has good potential in producing recycled concrete for manufacturing interlocking concrete blocks.

From the above discussion, it is found that most of the researchers have followed the mix design procedure provided in IS 10262:2009 without referring to IS 15658:2006 and IRC: SP:63-2004 specially published for manufacturing of concrete paving blocks. Hence, it is required to follow IS 10262:2009, IS 15658:2006 and IRC: SP:63-2004 simultaneously in the mix design for producing concrete paving blocks at the end.

III. EXPERIMENTAL PROGRAM

3.1. Materials

Ordinary Portland cement of 43 grade conforming to IS 8112(1989) with specific gravity of 3.15 is used. The fine aggregate of Brahmini river sand confirms to grading zone II as per IS 383-1970. Locally available crushed granite of talcher area is used as coarse aggregate. The coarse aggregate used is of 10 mm nominal size as the nominal maximum size of aggregate is 12mm (IRC: SP: 63:2004). The specific gravity of fine aggregate and coarse aggregate are 2.74 and 2.74 respectively. Portable water available from laboratory tap has been used for mixing and curing.

3.2. Mix Proportion

Three grades of concrete (M30, M35 and M40) are prepared in the laboratory for casting of cubes and prisms. W/C ratio of 0.38, 0.37 and 0.36 have been used for M30, M35 and M40 respectively. The proportion of coarse aggregate in all the design mixes is 40% and that of fine aggregate is 60%. Water content of 6.60%, 6.50% and 6% of the total mix have been used for M30, M35 and M40 respectively. Finally, the mix proportions of 1:2.72:1.81, 1:2.69:1.79 and 1:2.91:1.94 have been calculated as per IS 10262:2009 for M30, M35 and M40. The mix proportions thus obtained have remained within prescribed parameter limit as per guidelines of IRC: SP: 63:2004 and IS: 15658:2006.

3.3. Test methods

For each mix proportion, six cubes of size 150mm X 150mm X 150mm and 6 prisms of size 100mm X 100mm X 500mm were prepared also, concrete paving blocks with size 100mm breadth, 200mm length have been casted in three different thickness of 80mm, 100mm and 120mm. The cubes and the prisms are tested for compressive strength and flexural strength respectively as per IS 516 – 1959. Similarly, the concrete paving units have been tested for compressive strength as per IS: 516 – 1959. Corresponding results from experiment have been presented for 7 days and 28 days.

IV. RESULT AND DISCUSSION

4.1 Compressive strength

The 7 days and 28 days mean compressive strength of concrete cubes for each grade have been presented in Table 1. Corresponding theoretical 28 days target mean strengths are also presented in the same table. From the experimental results, it is found that the 28 days mean compressive strength of concrete cubes are above the mean target strength.

Table:1 Compressive strength of concrete cubes

Days tested	Designed grade of concrete cubes		
	M30	M35	M40
7 days (N/mm^2)	29.4	33.14	37.52
28 days (N/mm^2)	41.7	47.33	50.7
Target mean strength (N/mm^2)	38.25	43.25	48.25

4.2 Flexural strength

The 7 days and 28 days mean flexural strength of concrete prisms for each grade have been presented in Table 2. Corresponding theoretical 28 days target mean strengths (calculated as per IS 456-2000) are also presented in the same table. The results thus obtained are well above the calculated values of target mean strength.

Table:2 Flexural strength of concrete prisms

Days tested	Designed grade of concrete cubes		
	M30	M35	M40
7 days (N/mm^2)	4.37	4.70	4.94
28 days (N/mm^2)	5.03	5.40	5.39
Target mean strength (N/mm^2)	4.51	4.82	4.98

4.3 Compressive strength of concrete paving blocks

The 7 days and 28 days mean compressive strength of concrete paving blocks of different thickness for M30 grade have been presented in Table 3. Corresponding theoretical minimum average 28 days strengths (Calculated as per 15658:2006, Dowson 1980) are also presented in the same table. From the experimental results, it is found that the 28 days mean compressive strength of concrete paving blocks are above the minimum average strength.

Table:3 Compressive strength of concrete paving blocks

Days tested	Thickness (mm) of concrete paving blocks		
	80	100	120
7 days (N/mm^2)	13.88	22.13	23.56
28 days (N/mm^2)	33.62	40.89	44.08
Minimum average strength (N/mm^2)	32.89		

V. CONCLUSION

Based on the experimental results as obtained for concrete cubes and concrete paving blocks, following conclusions can be drawn:

1. The average 28 days compressive strength of concrete cubes have remained above the mean target strength calculated as per IS 10262:2009.
2. Similarly, the 28 days flexural strength of concrete prisms are well above the mean target strength calculated as per IS 456:2000.
3. The 28 days average compressive strength of concrete paving blocks as obtained are above the minimum average 28 days compressive strength calculated as per IS 15658:2006 and Dowson 1980.
4. Thus, the mix design procedure followed in this research study may be used by manufacturers for producing concrete paving blocks.

REFERENCE

[1]. Pani, A.K. and Panda, B.C., (2018), “Development of a Mix Design Methodology for Concrete Paving Blocks. Part I: Mix Design Procedure”, International Journal of Engineering Technology Science and Research, V-05, Issue 4, pp 744 – 750.

[2]. Panda, B.C. and Ghosh, A.K., (2000), “Concrete block pavement: A critical review Indian Highways”, Indian Road Congress, New Delhi, pp 27-37.

[3]. IRC: SP: 63:2004, “Guidelines for use of Interlocking Concrete Block Pavement” Indian Roads Congress, New Delhi, India.

[4]. Dowson, A.J., (1980), “Mix design for concrete block paving”, Proceedings of the First International Conference on Concrete Block Paving, Newcastle-upon-Tyne, U.K., pp 121-127.

[5]. IS 10262:2009 on “Indian standard concrete mix proportioning – Guidelines (First revision)”, Bureau of India Standard, New Delhi, India.

[6]. IS: 15658:2006 on, “Precast Concrete Blocks for Paving – Specification, “Bureau of Indian Standards, New Delhi, India.

[7]. IS 456:2000 on, “Indian standard plain and reinforced concrete code of practice (fourth revision)”, Bureau of India Standard, New Delhi, India.

[8]. SABS 1058:2002 on, “South African standard specification for concrete paving blocks”, Johannesburg, S.A.

[9]. Nanda, Radhikesh P., Das, Amiya k., and Moharana, N.C, (2010), “Stone crusher dust as a fine aggregate in Concrete for paving blocks”, International Journal of Civil and Structural Engineering, volume 1, No. 3, pp 613 – 620.

[10]. Nataraja, M.C., and Das, Lelin, (2012), "A study on the strength properties of paver blocks made from unconventional materials", IOSR Journal of Mechanical and Civil Engineering, pp 01 – 05.
[11]. Sachdeva, Som Nath, Aggarwal, Vanita and Gupta, S.M., (2014), "High volume fly ash concrete for paver blocks", International Scholarly and Scientific Research & Innovation, volume 8, No. 3, pp 242 – 248.
[12]. Santhosh, Joel and Talluri, Ravikant, (2015), "Manufacture of interlocking concrete paving blocks with fly ash and glass powder", International journal of civil engineering and technology, volume 6, issue 4, pp 55 – 64.
[13]. Gawatre, Dinesh W., Chhajed, Rohit S., Panpatil, Prashik B., Desarda, Shubham S., Waghchaure, Chetan S., and Agrawal, Nikhil S. (2016), "Manufacture of paver block using partial replacement of construction and demolition concrete waste", International Journal of Pure and Applied Research in Engineering and Technology, Volume 4, issue 9, pp 11 – 18.
[14]. Sultan, Dr. Suad Abdul- Aziz, Abduljalel, Dr. Ban Sahib, and Talib, Talib Qasim (2017), "Evaluating the performance of sustainable interlocking concrete blocks manufactured from recycled Concrete aggregate", Journal of Engineering and Sustainable Development, pp 1 – 23.
[15]. IS 8112:1989 on, "Grade Ordinary Portland Cement – Specification (First Revision)", Bureau of India Standard, New Delhi, India.
[16]. IS 383:1970 on, "Specification for Coarse and Fine Aggregates from Natural Sources for Concrete (Second Revision)", Bureau of India Standard, New Delhi, India.
[17]. IS: 516 – 1959 on, "Methods of Tests for Strength of Concrete", Bureau of India Standard, New Delhi, India.

IOSR Journal of Engineering (IOSRJEN) is UGC approved Journal with Sl. No. 3240, Journal no. 48995.

A.K. Pani "Development of a Mix Design Methodology for Concrete Paving Blocks. Part II: Experimental Investigation." IOSR Journal of Engineering (IOSRJEN), vol. 08, no. 5, 2018, pp. 81-84.