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STUDY ON INTERLOCKING CONCRETE BLOCK PAVEMENT

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ABSTRACT

In interlocking concrete block pavement, the blocks make up the wearing surface and are a major load-spreading component of the pavement. It differs from other conventional form of pavement that the wearing surface is made from small paving units embedded and joined in sand rather than continuous paving. Beneath the bedding sand the substructure is similar to that of a flexible pavement. The interlocking concrete block pavement (ICBP) has gained rapid popularity in many foreign countries as an alternative to concrete and asphalt pavements. However the manifest advantages of ICBP has not fully extended in India because of lack of proven indigenous design and construction information. The use of interlocking concrete blocks for structural pavements, carrying traffic and industrial loads, has increased steadily throughout the world over the past thirty years. It is also commonly used in urban roads, airport taxiway, parking area, port and industrial area. Due to segmental nature of the paving block, the concrete block is easily removed and the under laying utilities could be accessed easily for maintenance works. ICBP is preferred as the ideal choice in urban areas. Application of ICBP is developing very fast for various reasons such as high resistance to deformation, durability, easy and rapid quality construction, ability to carry traffic immediately after construction, compatibility with the environment and aesthetic features etc. This paper presents the results of a series of tests conducted to assess the influence of block shape, thickness, size, compressive strength, and laying pattern on the overall pavement performance. It is found that shape, size, thickness of block have a significant influence on the behavior of concrete block pavement.

Keywords*: Deformation, Durability, ICBP, Flexible pavement, Concrete block pavement, etc.*

I. INTRODUCTION

An Interlocking Concrete Paving Block is an accurately dimensioned combination of well-graded aggregates and hydrated Portland cement which fits closely together with other paving blocks to form a pavement surface. Generally, the blocks are about the size of a common brick with a thickness of 2-3/8 to 4 inches and weigh about 9 to 12 lb each. It is commonly used in urban roads, airport taxiway, parking area, port and industrial area. Due to its segmental nature of the paving block, the concrete block is easily removed and the under laying utilities could be accessed easily for maintenance works. ICBP is preferred as the ideal choice in urban areas. A thin, 1- to 2-inches-thick leveling course of sand is used under the blocks. The blocks are generally laid by hand on a sand layer. The blocks are then compacted with a manually operated vibratory plate compactor which seats the blocks in the sand layer, compacts the sand layer, and forces some sand into the joints between the blocks. Additional sand is then applied to the surface and swept into the joints between the blocks. More passes are made with the vibratory plate compactor to compact and wedge the sand into the joints. A base and sub-base course under the leveling course provides structural support similar to that of a conventional flexible pavement. Many different patterns for laying blocks are possible. The structural behavior of ICBP is similar to flexible pavement. However, the performance of ICBP depends upon on block shape, size, thickness, type of bedding and jointing sand, joint width. The laying pattern of blocks is also important which affects the overall performance of the ICBP. The edge restraint is one of the features which are essential to stop mitigation of the block outward. The interlocking mechanism is one of the unique characteristics of the ICBP. The performance of ICBP largely depends on how well the interlock has achieved. Concrete block pavements provide a low-maintenance, high-strength pavement: surface that resists heavy, concentrated, or abrasive loads and chemical spil1s involving fuel, hydraulic fluid, and other materials. A block

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pavement's unique characteristics (strength, abrasion resistance, flexible structure, and esthetics) make it applicable to many pavement uses, including military applications.

II. LITERATURE REVIEW

Shackel B. (1993)," Design and constructions of interlocking concrete block pavement". First International Conference on Concrete Paving, Newcastle-upon-time,U.K,113-120[1]. The shape, size, thickness, laying patterns are important block parameters which influences the block parameters. The study on CBP reveals that the load is being spread through the jointing sands. For a same plan area rectangular or square block have lesser vertical surface area than complex shaped blocks. Higher vertical surface area results in large load spreading ability. It is obvious that the shaped blocks have better load distribution ability than the rectangular or square block. Although, earlier plate load test study by Knapton (1976) does not support this finding. Panda B.C., and Ghosh A.K.,"Structural behavior of concrete block pavement". ASCE Journal of Transportation Engg, 128(2), 123-129[2].Concrete pavers are compacted into coarse bedding sand, the joints filled with sand and compacted again to interlock. The paving units and bedding sand are placed over an unbound or bound, compacted aggregate base. ICP can be designed to receive heavy traffic from major urban thoroughfares. Oluwapelumi O. Ojuri,Federal University of Technology, Akure, Nigeria[3]. Interlocking Paving Stones Pavement as a Solution to Marshy Roads and the study is focused on the use of interlocking paving stones pavement for marshy roads and high groundwater table terrain. The permeable interlocking paving type of stones was used to combat intrusion of underground/saline water for the road of case study (Akin-Adesola Street, Victoria Island, Lagos). Hydrogeologic data, i.e., groundwater level information for marshy roads terrain including the area of case study was obtained in form of investigation hole/borehole data. Different scientific tests and researches put together show the effectiveness and durability of the modified exfiltration system type of permeable pavement for high ground water table terrain. IRC SP 063:Guidelines for the Use of Interlocking Concrete Block pavement[4]. Cement concrete tiles and paving blocks are precast solid products made out of cement concrete. The product is made in various sizes and shapes viz. rectangular, square and round blocks of different dimensions with designs for interlocking of adjacent tiles blocks. The raw materials required for manufacture of the product are portland cement and aggregates which are available locally in every part of the country. Cement concrete tiles and paving blocks find applications in pavements, footpaths, gardens, passenger waiting sheds, bus-stops, industry and other public places. The product is commonly used in urban areas for the above applications. Hence, the unit may be set up in urban and semi-urban areas, near the market. A lot of face-lift is being given to roads, footpaths along the roadside. Concrete paving blocks are ideal materials on the footpaths for easy laying, better look and finish. Whereas the tiles find extensive use outside the large building and houses, lots of these materials are also used in flooring in the open areas of public offices and commercial buildings and residential apartments.

III. RESULTS AND DISCUSSIONS

Table.1.Compressive Strength Readings

Days	Loads				Compressive Strength (N/mm^2)
	Trial (1)	Trial (2)	Trial (3)	Mean (KN)	
7	1560	1570	1580	1570	24.19
14	1690	1700	1705	1698.33	26.16
21	1815	1830	1835	1826.66	28.14
28	1980	1990	1995	1988.33	30.63

The compressive strength of the concrete cuboids (29.5cm X 22cm X 7cm) was calculated as below.
Top area of the cuboids - 64900 mm^2
Average load taken by three cubes (28 days) – 1988 KN
Compressive Strength – 30.63 N / mm^2.

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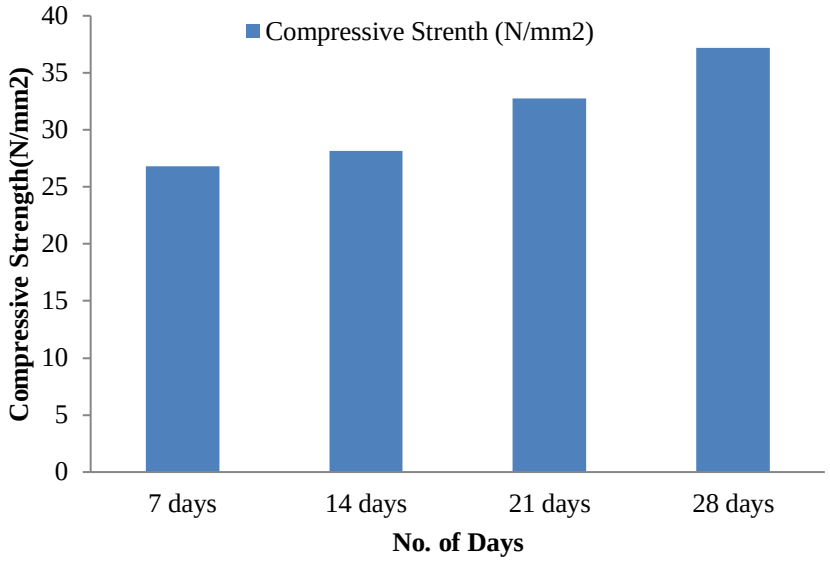

Fig. 1 Compressive Strength Test

Table. 2 Total Cost Comparisons

S. No.	Type of Pavement	Cost of Materials required per sq. m
1	Interlocking concrete block pavement	Rs.1,350 /-
2	Conventional concrete pavement	Rs.16,550 /-

From the above analysis of cost of the materials required for interlocking concrete block pavements and conventional concrete pavements for 1 m2 , we can conclude that ICBP is cost effective and economical. Another cost saving is achieved because the simplicity with which the blocks can be laid and aligned reduces the number of high wage skilled masons required on a construction project. When compared to convention masonry block construction, interlocking blocks, which are dry assembled, save a great deal of mortar which is normally used for vertical and horizontal joints, which again produces savings in terms of both cost and time. Moreover, ICBP have many other advantages when compared to conventional concrete pavements are it provides a low-maintenance or zero-maintenance pavement surface, it can support large, concentrated loads and heavy, abrasive traffic, these are resistant to environmental damage (e.g. freeze-thaw) and to damage from fuel and oil spillage, these are aesthetically pleasing, they can last for over 25 years with very little maintenance, they also require very few future repairs, these are easily repaired by replacing the affected bricks with a new one. They require less energy and resources over their life cycle compared to concrete or asphalt and environmentally Friendly: They are a great sustainable option because they prevent excess water run-off and erosion by capturing the storm water run-off, filtering and retaining the water on site back into the surrounding soils. According to some stats, they're proven to reduce runoff by as much as 100%. Hence, from the above analysis we should prefer this type of pavement and spread awareness to adopt this methodology.

IV. CONCLUSION

A simple laboratory-scale test setup can be utilized to assess the behavior of concrete blocks with respect to their shape, thickness and laying pattern, etc. The effectiveness of load transfer depends on the vertical surface area of

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individual blocks. Block shape influences the deflections of blocks. Shaped blocks perform better than rectangular blocks of similar thickness installed in same laying pattern. Blocks with larger size produce lower deflection. Strength of blocks has no significant influence on deflection. Block pavements stiffen more progressively with an increase in load repetition, but gain full elastic property after some repetitions. Interlocking Concrete Block Pavement technology can provide durable and sustainable road infrastructure where construction and maintenance of conventional pavements are not cost effective. Difference in the performance of segmental paving associated with paver shape or the choice of laying patterns both during construction and under traffic. ICBP is much cheaper than rigid pavement design for identical locations. Compare to bituminous pavement for low traffic volumes and high strength sub-grade, the initial construction cost of ICBP is likely to be equal to or marginally higher but then have a longer life span. For high traffic volumes and low strength sub-grade, ICBP will be cheaper than flexible pavement. A hypothetical case application of ICBP for a road subjected to medium traffic road indicates that, for urban and semi-urban conditions, ICBP is likely to be cheaper by as compared to the conventional flexible pavement about 10 % initially, and by about 27 % after 20 years. The overall exposure to the real construction work helped as to gain practical knowledge on various aspects whose theory was only known to us.

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