Economic Evaluation of Plastic Filled Concrete Block Pavement

Mr.Shirke Siddhesh Sanjay[1], Mr. Satre Mayur Rajendra[2], Mr. Tekale Madhur Sanjay[3], Mr.Amar Chipde[4]
[1, 2, 3] Dept of civil Engineering
[4]Asst Prof, Dept of Civil Engineering
[1, 2, 3, 4] Dr. D. Y. Patil Institute of Technology Pimpri Pune, India.

Abstract- *A systematic full scale experimental study on the structural performance of Plastic Cell filled Concrete Block Pavement (PCCBP) for various cell thicknesses subjected to live traffic conditions is presented in this research work. Five test sections of different thicknesses viz., 50 mm, 80 mm, 100 mm, 120 mm and 150 mm, of PCCBP over 100 mm thick water bound macadam (WBM) sub-base layer has been constructed at the approach road towards Indian Institute of Technology Guwahati (IIT Guwahati), India, from National Highway 31 (NH 31). In addition, to check the feasibility of PCCBP overlay to strengthen the existing old bituminous pavement, 50 mm thick PCCBP overlay test section was also constructed. Further, in order to optimize the cost of pavement construction, an attempt has been made to use waste stone dust (byproduct of aggregates crushing) in place of the traditional river sand. This paper presents economic evaluation of Plastic Cell filled Concrete Block Pavement (PCCBP) over conventional flexible and Concrete pavements for low volume rural roads. The cost comparison has been carried out considering both construction and maintenance cost for a period of 5 years, based on design analysis and performance studies of 100 mm thick PCCBP laid over 100 mm thick WBM sub-base course. It has been observed that the initial construction costs for both flexible and rigid pavement were higher than that of PCCBP by ~9% and~150% respectively and the total cost of flexible and rigid pavement are found to be higher by ~43% and~141% respectively as compared to that of PCCBP. Cent percent replacement of river sand in concrete by waste stone dust proved to be cost cutting without significant change in strength of the concrete.*

Keywords- Abaqus, Backga, Falling Weight Deflect Meter (Fwd), Kenlayer, Low Volume Roads, Plastic Cell Filled Concrete Block Pavement (Pccbp), Stone Dust.

I. INTRODUCTION

In India, the proportion of low volume rural roads is about 80% of the total road length (NHAI, 2011). As such pavement engineers and researchers are concerned for designing sustainable rural roads with reasonable riding quality and with an emphasis on 'low life cycle cost'. Whilst conventional flexible pavement with a thin cover of premix bituminous carpet is normally adopted for rural roads, frequent maintenance are required (to maintain both functional and structural efficiencies) due to damages caused by poor drainage conditions, overloaded vehicular traffic, iron wheeled bullock carts etc. As a result such pavement incurs huge maintenance cost. To offset such expensive maintenance cost, concrete pavements are increasingly used in rural road connectivity in India because of their durability. However it not only involves high initial cost but can also fail due to various reasons like day and night variations in warping stresses, seasonal changes in the modulus of sub-grade reaction etc. Although pre-cast concrete block pavement; provides more flexible response (depending upon the dilantancy of the jointing sand) as compared to the normal concrete pavement mentioned above, there is a tendency for block movements under braking or accelerating force of the vehicular traffic and the interlocking caused by the jointing sand needs frequent maintenance which may not be practical for rural roads.

The motivating factor as an alternative, for construction of sustainable rural roads with low life cycle cost and better riding quality, a new pavement technology called Plastic Cell filled Concrete Block Pavement (PCCBP) was developed in South Africa. In PCCBP, diamond shaped heat welded plastic cells (Figure 1) are used to encase concrete blocks. The cells are tensioned and spread across the foundation layer and concrete is filled and compacted into the cells. Upon compaction the cell walls get deformed resulting in interlocking of adjacent individual concrete blocks. In India, limited studies on PCCBP technology have been reported on the cost effectiveness and feasibility for rural roads. Lack of the above information has hindered the development of design standards, at least in the Indian road context. The present work aims at the cost effectiveness (considering construction and maintenance cost for 5 years only) of flexible concrete block pavement over traditional flexible and rigid pavements is presented.

Problems Statement

The rapid industrialization and urbanization in the country leads lot of infrastructure development. This process leads to several problems like shortage of construction materials, increased productivity of wastes.

Scope of the Work

As the world population grows, wastes of various types are being generated. The creation of non–decaying and low biodegradable waste materials, combined with a growing consumer population has resulted in waste disposal crisis. To explore the possibility of laying PCCBP as overlay on existing old bituminous pavement and to study the various Distresses of PCCBP based on pavement condition index.

II. LITERATURE SURVEY

A.PanimayamThe rapid industrialization and urbanization in the country leads lot of infrastructure development. This process leads to several problems like shortage of construction materials, increased productivity of wastes and other products. This paper deals with the reuse of waste plastics as partial replacement of coarse aggregate in M20 concrete. Usually M20 concrete is used for most constructional works. Waste Plastics were incrementally added in 0%, 2%, 4%, 6%, 8% and 10% to replace the same amount of Aggregate. Tests were conducted on coarse aggregates, fine aggregates, cement and waste plastics to determine their physical properties. Paver Blocks of I section of casted and tested for 7, 14 and 28 days strength. The result shows that the compressive strength of M20 concrete with waste plastics is 4% for Paver Blocks.

S. Vanitha1 The rapid industrialization and urbanization in the country leads lot of infrastructure development. This process leads to several problems like shortage of construction materials, increased productivity of wastes and other products. This paper deals with the reuse of waste plastics as partial replacement of coarse aggregate in M20 concrete.

Frasson Jr The use of concrete masonry units for high-rise load bearing construction has created a need for concrete block with high compressive strength. To achieve high strength levels, block producers generally define concrete mixtures by a trial and error process. The most common procedure is to produce some trial mixtures possessing different cement content using the equipment available in the block plant and test the strength of blocks. This approach is costly, time consuming and generally leads to expensive solutions for using large amounts of cement. Besides, it makes difficult to test new combinations of aggregates and admixtures once disturbs very much the plant routine. In this paper is presented a mix design procedure for structural concrete blocks based on laboratory tests. Initially a reference mixture is studied. In this phase it is possible to vary the type and proportion of aggregates, admixtures and water content in order to achieve a suitable face texture with lower energy of compaction. After that, several mixtures are produced varying the cement content and density. Cylindrical specimens was produced with these mixtures and tested in compressive strength. With the results, it is elaborated a mix design chart where the desired compressive strength can be obtained by varying the aggregate/binder ratio and density. The last phase is testing some selected mixtures in actual block machine, determining both density and compressive strength. With the results it is possible to make the final adjustments in the mix proportions. The application of this procedure in a block plant of the south of Brazil led to satisfactory results showing that is possible to forecast of the mechanical resistance of the concrete blocks starting from laboratory studies in cylindrical specimens and also demonstrated the importance of the control of several parameters related to the productive process for the compressive strength of the units.

Gokul K.L During the past two decades, the issue of upgrading the existing pavements has become of great importance. The use of fiber reinforced concrete in rehabilitation of pavements has become very popular. Fiber reinforced concrete is an economical method to overcome flexural failure, micro cracks etc. Human hair is a no degradable fiber which can be used as a reinforcement material in concrete. Human hair fiber modified concrete can be used as cell filling and white topped concrete has pavement rehabilitation methods. In white topping a concrete overlay is provided over the existing deteriorated bituminous pavement. In cell filled concrete overlay a mesh of cell is provided and is filled with concrete. In this study the mechanical properties such as compressive strength, tensile strength and flexural strength of white topped and cell filled concrete overlays incorporated with human hair is investigated.

Vishal Kumar Interlocking Concrete Block has been presented in India in development, 10 years prior, for particular requirement to be specific footpaths and parking areas and so on. Presently Interlocking Concrete Block Pavement is being received broadly in various uses where the traditional development of pavement utilizing hot bituminous blend (for flexible pavement) or cement concrete (for rigid pavement) is not desirable or attractive. In this paper, strength properties of paver blocks comprising of waste aggregates is presented. Interlocking Concrete Block are perfect materials on the pathways and streets for simple laying, better look and finish. In this paper, a study for producing paver blocks utilizing waste aggregates (specially in the form of rounded bearings of size 6.35 mm) is introduced. Waste rounded steel bearings are included in concrete of paver blocks in different rates. Compressive strength of paver blocks with different rates of waste steel aggregates and utilizing elastic cushions is examined. Test results demonstrate that including different rates of waste steel aggregates in paver blocks gives up-to 50% more strength quality than customary paver blocks.

Abhishek Chhazed The 21ST century is facing a serious situation in waste management, especially Plastic waste. Plastic has many advantages but with it comes with many problems too. Being non-degradable for years, it has become a global problem in recycling it. PET being one of the most common consumer plastic as it is used to build many basic and day to day life products like bottles, containers for food industry and beverage industry. PET waste has become major environmental issue due to its various properties like non-biodegradability and gases released on incineration. Therefore PET waste has to be utilized and recycled efficiently. This paper provides a review of different products such as Plastic bricks, Flexible pavement and Plastic bottles as a constructional block which can effectively use PET waste as an alternating material

Jeevan Ghuge Concrete is the most widely used construction material in the world. Using waste and recycled materials in concrete mixes for paver blocks becoming increasingly important to manage and treat both the solid waste generated by industry and municipal waste. These blocks were rectangular in shape and had more or less the same size as the bricks. During the previous five decades, the block shape has relentlessly developed from non inter locking to somewhat interlocking to completely interlocking to multiple interlocking shapes. Use of plastic waste which is non-biodegradable is rapidly growing in the surroundings and becoming threat to environment in many aspects. This study demonstrates use of waste plastic for manufacturing the concrete paver blocks and with this efficient disposal way of plastic waste is possible.

R. Vasudevan Waste plastics, littered both by domestic and industrial sectors was found to be a source of raw material for the flexible pavement. Waste plastics, mainly used for packing are made up of PE, PP and PS, their softening point varies between 110 _C and 140 _C and they do not produce any toxic gases during softening. But the softened plastics have a tendency to form a film like structure over the aggregate, when it is sprayed over the hot aggregate at 160 _C. The formed PCA is a better raw material for the construction of flexible pavement. PCA was then mixed with hot bitumen of different types and the mixes were used for road construction. PCA + bitumen mix showed improved binding property and poor wetting property. The sample showed higher Marshall Stability value in the range of 18–20 kN and the load bearing capacity of the road is increased by 100% and there is no pothole formation. The roads laid since 2002 using PCA + bitumen mixes are performing well. A detailed studies on the performances of these roads shows that the PCA bitumen mix roads are performing well. This is an ecofriendly and economic process too

S.Rajasekaran Waste plastics both by domestic and industrial sectors can be used in the production of asphalt mix. Waste plastics, mainly used for packing are made up of Polyethylene Polypropylene polystyrene. Their softening varies between 110oC – 1400C and they do not produce any toxic gases during heating but the softened plastics have tendency to form a film like structure over the aggregate, when it is sprayed over the hot aggregate at 1600C. The Plastics Coated Aggregates (PCA) is a better raw material for the construction of flexible pavement. PCA was then mixed with hot bitumen of different types and the mixes were used for road construction. PCA - Bitumen mix showed improved binding property and less wetting property. The sample showed higher Marshall Stability value in the range of 18-20KN and the load bearing capacity of the road is increased by 100%. The roads laid since 2002 using PCA-Bitumen mixes are performing well. A detailed study on the performances of these roads shows that the constructed with PCA –Bitumen mix are performing well. This process is eco-friendly and economical too.

Yendrembam Arunkumar Singh This paper presents a systematic full scale field study on the structural performance of Plastic Cell filled Concrete Block Pavement (PCCBP) for different cell thicknesses subjected to live traffic conditions. Five test sections of various thicknesses viz., 50 mm, 80 mm, 100 mm, 120 mm and 150 mm of PCCBP over 100 mm thick water bound macadam (WBM) subbase layer has been constructed at the approach road towards Indian Institute of Technology Guwahati (IIT Guwahati), India, from National Highway 31 (NH 31). Further, in order to optimize the cost of pavement construction, an attempt has been made to use waste stone dust (by- product of aggregates crushing) in place of the traditional river sand. Structural performance of PCCBP was evaluated using a custom fabricated Falling Weight Deflect meter (FWD) by measuring the surface deflections at specified radial distance from the load centre. Genetic Algorithm (GA) based back calculation program (Reddy et. al., 2002) was used for back calculating the layer moduli of the PCCBP test sections using pavement surface deflection data obtained through FWD. For the thicknesses tested, elastic layer modulus of PCCBP (~1995 MPa for 50 mm thick) has been seen to increase linearly with increasing thickness (~90% increase in elastic modulus was observed for 200% increase in thickness).

III. METHODOLOGY

Introduction

In this chapter, a systematic experimental study of the structural performance of PCCBP for various cell thicknesses subjected to live traffic conditions is presented. Five test sections of different thicknesses viz., 50 mm, 80 mm, 100 mm, 120 mm and 150 mm, of PCCBP over 100 mm thick water bound macadam (WBM) sub-base layer has been constructed at the approach road towards Indian Institute of Technology Guwahati, India (IIT Guwahati) from National Highway 31 (NH31). Further, to explore the feasibility of using PCCBP as overlay layer for strengthening old bituminous surfaced rural roads, 50 mm thick PCCBP overlay section has also been constructed adjacent to the PCCBP test section. For optimizing the cost of pavement construction, an attempt is made to use waste stone dust (byproduct of aggregates crushing) in place of the traditional river sand. It may be noted that with increasing infrastructure development in road projects, housing sector and other major concrete structures etc.

Materials used for the construction of PCCBP

3.2.1 Low Density Polyethylene (LDPE) Plastic Cell The plastic cell formwork used in the present study is made of Low Density Polyethylene (LDPE) sheet of thickness 0.49 mm. Flexible translucent water delivery LDPE pipe having diameter of ~101.6 mm which is available in the local market of Guwahati, Assam, India was used for preparation of cell formwork.

3.2.2 Cement Fly ash based portland pozzolana cement (PPC) conforming to IS 1489 (1991), was used for casting concrete blocks. The cement (TOPCEM cement) for the whole work was procured in a single consignment and stored properly. The standard consistency and specific gravity of the PPC cement was found to be 31% and 3.15. The initial and the final setting time were found out to be 102 and 372 minutes respectively.

3.2.3 Stone dust Stone collected from a stone crusher factory located nearby IIT Guwahati, Assam, India was used as fine aggregates for casting concrete blocks. The particle size distribution of stone dust obtained from the sieve analysis is shown in Table 3.1, and it is found to be closely conforming to Zone II of IS 383 (1970). Water absorption and specific gravity of the stone dust as per IS 2386 (1963a) was obtained to be 0.73% and 2.63 respectively. Fineness modulus of the stone dust was found to be 2.3 which lie within the specified limit of 3.37-2.10 for Zone II of IS 383 (1970). 19

3.2.4 Coarse Aggregate The crusher run coarse aggregates were obtained from the same stone crusher factory from where the stone dust was collected. These coarse aggregates were crushed from hilly stone boulders brought from Dewdwar quarry, Baicharali, Guwahati, Assam, India. The physical properties of the coarse aggregates for concrete as per IS 2386 (1963a, 1963b) were given in Table 4.2. Single size stone aggregates of 22.4 mm (i.e. passing 26.5 mm sieve and retained on 13.2 mm sieve) as per specification of MORTH (2001) were selected for casting the concrete in the study.

3.3. Laboratory investigations

Laboratory investigations were carried out to determine an appropriate construction technique which would be labor intensive, cost effective and appropriate for execution by semi-skill villagers so as to generate employment for the economically challenged rural inhabitants. Two different types of construction techniques were tested (Visser, 1994): 1. Premix technique: It is a type of construction where the plastic cell formwork are spread and tensioned over a prepared foundation layer and the concrete is placed into the cells and compacted (Ryntathiang et. al., 2005; Pandey, 2006; Roy et. al., 2009,2010 and Shivaprakash, 2011). 202Grouting technique: Here, plastic cell formworks are spread and tensioned over the foundation layer as done in the previous case and cells are filled with coarse aggregates and mortar (slurry) is vibrated into the voids between coarse aggregates (e.g., using a plate vibrator) (Visser, 1994, 1999; Visser and Hall 1999, 2003).

3.4 Structural evaluation of PCCBP test sections

3.4.1 Test section

A full scale field study on the structural assessment of different thicknesses of PCCBP (50 mm, 80 mm, 100 mm, 120 mm and 150 mm) over 100 mm WBM sub-base course was carried out at IIT Guwahati main approach road from the National Highway, NH31. A section of the existing bituminous pavement, measuring 15 m in length and 7 m in width was selected for construction of five different thicknesses of PCCBP test sections. A schematic plan and sectional view of the test sections

Distress Study of PCCBP

4.1 Introduction

As mentioned in the literature review limited distress observations have been reported on PCCBP. To the best of author‟s knowledge, no systematic work is available on distress studies of PCCBP, although limited distress (e.g., edge spalling ,block disintegration, scaling, permanent deformation) inspections were first reported by Vissar and Hill (1999) and Vissar (1999). As such, an attempt has been made in this chapter to report various types of distresses that are observed in the short duration(~ 11 months) of investigation. Due to the similarities in load transfer mechanism between interlocking concrete pavement and PCCBP, and in the absence of standard sand guidelines for evaluation of PCI for PCCBP, Interlocking Concrete Pavement Distress Manual (ICPI, 2007), published by International Concrete Pavement Institute, Toronto, Canada, has been adopted for the present study

4.2 Terminology

1) Pavement distress: External indicators of pavement deterioration caused by loading, environmental factors, construction deficiencies, or a combination thereof. Typical distresses are depressions, rutting and edge spalls of the test section.
2) Pavement Condition Index (PCI):It is a numerical rating of the pavement condition that ranges from 0 to 100 with 0being the worst possible condition and 100 being the best possible condition. It may be noted that PCI does not measure structural capacity nor does it provides direct measurement of skid resistance or roughness. The basic flowchart for developing the PCI values for a section of pavement is shown in
3) Pavement Condition Rating (PCR):It is a description of pavement condition as a function of the PCI value that varies from failed to excellent

V. ECONOMIC EVALUATION

Design of Different Types of Pavement
Design parameters

In order to assess the economic advantage of PCCBP (using stone dust as 100% sand replacement in concrete) over conventional flexible and rigid (concrete) pavements cost comparison have been carried out considering both construction and maintenance costs for a period of 5 years. To demonstrate the cost analysis, similar design parameters adopted elsewhere (e.g., Roy et al., 2009, 2010, Ryntathiang, 2005) are considered:

1. Lane width= 3.75 m (single lane carriageway)
2. Sub-grade CBR= 5%
3. Design traffic= 300,000 standard axle load repetitions

Design of flexible pavement

The flexible pavement has been design as per IRC (2007) for the design parameters mentioned in Section 5.2.1. From the pavement design chart, Figure 4 of IRC (2007),the thicknesses of the pavement layers have been obtained as 150 mm thick granular sub-base course (CBR > 20%), 175 mm thick WBM course and 20 mm thick bituminous premix carpet as surfacing.

Design of rigid pavement

The rigid pavement has been design for a wheel load of 51 kN (legal limit for axle load is 102 kN) as per IRC (2004) for the design parameters mentioned in Section 5.2.1. The effective modulus (k) of sub-grade reactions (20% increased for providing150 mm sub-base course) for 5% CBR value for sub-grade is 50.4 X10-3 N/mm2/mm as per IRC (2004)

Flexural strength of concrete Adopt a 28 day compressive strength of 30 MPa (fc)Flexural strength, ft = 0.7fc = 3.834 MPa Therefore, the 90 day flexural strength = 1.20 x 3.834 = 4.6 MPa

Design thickness check

Edge load stress

As per IRC (2004), the design thickness of pavement slab is 220 mm, and the co rresponding edge stress is 2.35 MPa (for k = 50.4 X10-3 N/mm2/mm).

Temperature stress

The radius of relative stiffness (l) for 220 mm thick slab as per IRC (2004) = 857.36mm. Assuming a contraction joint spacing of 3.75 m and width of slab as 3.75 m, the edge temperature stress was calculated to be 1.35 MPa (see Table 4 of IRC, 2004 for Assam state).

Total stress

The total stress = edge stress + temperature stress = 3.7 MPa, which is less than 4.6MPa (flexural strength of the concrete). Hence, the slab thickness is safe and can be adopted.

VI. RESULT AND DISCUSSSION

PCCBP as overlay construction

the effect of load repetitions on the moduli for PCCBP and bituminous overlay constructions. It can be observed from Figure 3.41 that the decrease of moduli for PCCBP and bituminous overlays are 0.9% and 3% respectively after 62,000 ESAL repetitions. This may be due to thicker, well compacted and consolidated underlying base/sub-base courses of the existing old pavement. From Figures 3.42 and 3.43 it can be observed that there is no significant variation in layer moduli of both sub-base and sub-grade layers with increase in passes of traffic. Again, the reason may be well compacted and consolidated underlying layers of the existing pavement.

Sievesize (mm)	Percentagepassingby weight(%)	Specifiedlimit(passing %)forZoneII
10	100	100
4.75	98.4	90-100
2.36	91.5	75-100
1.18	70.3	55-90
0.6	52.3	35-59
0.3	35.7	8-30
0.15	21.4	0-10

Particlesize distributionof stonedust

Properties	Value
Los-Angelesabrasionvalue	26.58%
Aggregateflakinessindex	9.2%
Specificgravity	2.700
Waterabsorption	0.3%

Physicalpropertiesof coarseaggregatesforconcrete

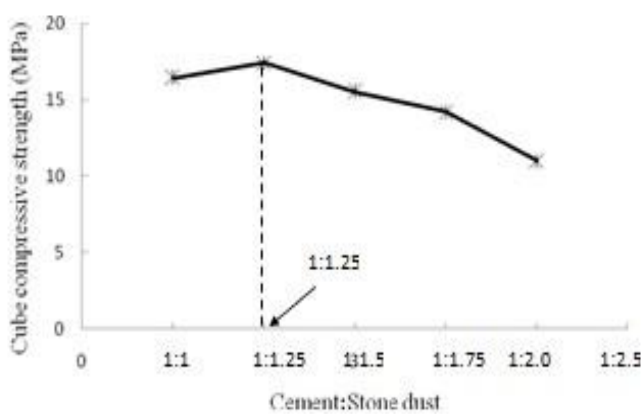
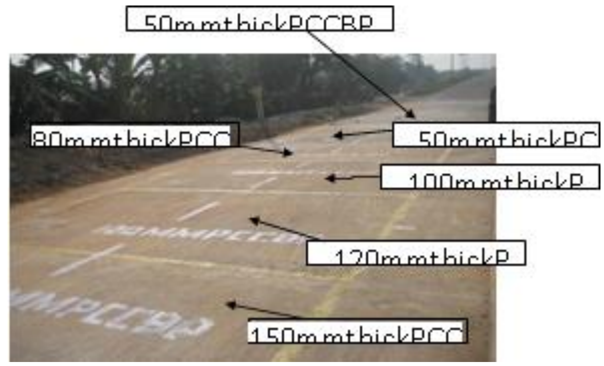
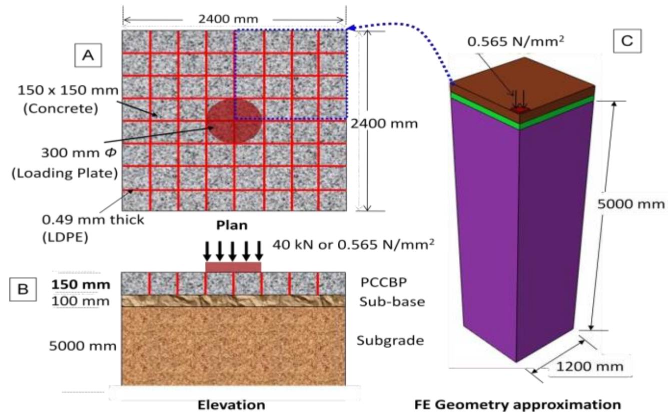


Figure 3.5: Variation of 7 days average cube compressive strength with cement:stone

Casting of the PCCB Pover layover adhesive prime coat



CompletedPCCBPtest roadwithmarkingsfordifferenttest



Schematic diagram showing a) top plan view of PCCBP, b) sectional elevation of PCCBP, andc) idealized geometr

VII. DISCUSSIONS

Studies on various types of distress carried out as per ICPI distress guide lines (ICPI, 2007) based on the deduct value and PCI values showed that different thicknesses of PCCBP test section can be rated as Fair to Very Good (Table 4.10). Comparing the PCI rating with variation in layer elastic modulus of PCCBP(Figure 3.38), it has been observed that 50 mm, 80 mm and 100 mm thick PCCBP is rated “Fair” even though there is no significant reduction in elastic modulus value. The reason may be edges palls due to extra layer of concrete (6%-10% of cell height) above the cell formwork resulted from deformation of cellwall (Figure 4.11). In addition the PCCBP test sections showed some specific distress types of low severity like cell opening, exposed cells, edge spalls etc. which are not common to interlocking concrete block pavements.

Cost comparison

Construction and maintenance cost

The construction and maintenance cost have been estimated based on Public Works Department, Government of Assam schedule rates 2007-08 (PWD, 2007) and the guidelines for the estimation of the maintenance cost for construction of the rural roads (IRC, 2002; PMGSY, 2010).

VIII. CONCLUSION

In this work full scale field experimental investigation have been made to assess the structural behaviour of different thicknesses (50 mm, 80 mm, 100 mm, 120 mm and150 mm) of Plastic Cell Filled Concrete Block Pavement (PCCBP) over 100 mm sub-base layer of Water Bound Macadam (WBM) course, using „waste “stone dust(produced as by-product of aggregates crushing) in place of the traditional river sand as fine aggregates in concrete. The feasibility study of PCCBP as overlay construction to strengthen the existing bituminous pavement was also carried out. Layer elastic moduli of different layers of PCCBP have been calculated using a genetic algorithm based moduli back calculation computer code BACKGA (Reddy et al.,2002) from the surface deflection data obtained through a custom fabricated Falling Weight Deflectometer (FWD, anon-destructive test equipment which simulates the moving vehicular wheel load on the pavement).

1. An increase in the size of surface deflection bowl was observed for decreasing PCCBP thickness. The deflection bowl has been observed to be significant up to an approximate radial distance of twice the load plate diameter from the center of the load (~600 mm).
2. Peak surface deflections decreased with increasing PCCBP thickness linearly, with 200% increase in thickness from 50 mm thick PCCBP, a decrease of~48% (0.8481 mm for 50 mm PCCBP) in deflection was observed.
3. A thin PCCBP of about 50 mm over thin sub-base can result in sufficiently high elastic moduli (> 1900MPa) of PCCBP to be used for rural roads.
4. Elastic modulus of PCCBP increases with increasing thickness, approximately in a linear manner for the thicknesses tested, 90% increase in elastic modulus was observed for 200% increase in thickness.
5. It has been observed that for the initial 38,000 ESAL passes the degradation in layer modulus of PCCBP is of the range~3-20%. , however there appears to be a stabilization after 38,000 passes with the degradation dropping to ~1-7% (from 38,000 to 62,000 ESAL passes). The lowest thickness of PCCBP (50mm) has shown a high elastic modulus(~1800 MPa)even after a wheel load repetition of 62,000 passes.

IX. FUTUREWORK

Although considerable understanding have been obtained in the present work for the structural behavior of different thicknesses of PCCBP using stone dust as fine aggregate in concrete, significant amount of work may be identified as future scope of work on Plastic cell filled concrete block pavement.

1) Studies may be carried out on the effect of varying thicknesses of WBM (subbase) course.
2) The effect of soil strength (in terms of CBR) on the elastic layer moduli of PCCBP may be investigated.
3) Possibilities of using different sub base materials such a slime treated, cement treated and bituminous emulsion treated sub-bases need to be examined.
4) Investigation canal so bed one for different thicknesses of plastic. Use of waste plastics can also checked for using as cell formwork.
5) Development of deduct curves is important for evaluation of distresses based on pavement condition index.

REFERENCES

[1] AASHTO, 1962. Road Test, Highway Research Board, Report No. 9,61-E,Washington D.C.
[2] AASHTO,1993.Guide for design of pavement structures, AASHTO, Washington, D.C., II-12.
[3] ABAQUS,2009. Dassault Systems Similua Corp., Providence, RI,USA.
[4] ASTM 2487, 2006. Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System), ASTM-D 2487, American Society for Testing and Materials, ASTM-D, United States.
[5] ASTM 6433, 2009. Standard Practice for Roads and Parking Lots Pavement Condition Index Surveys,ASTM-D6433, American Society for Testing and Materials, ASTM-D, United States.
[6] ASTM 5340, 2010. Standard Test Method for Airport Pavement Condition Index Surveys, ASTM-D5340,American Society for Testing and Materials, ASTM-D, United States.

[7] Chakroborty, P. and Das A., 2003. Principles of Transportation Engineering, Prentice Hall of India Private Limited, New Delhi-110001.

[8] CPWD, 1996. Construction Specification for Government Contractors for Roadwork, Hoticulture and Land Scaping, Central Public Works Department, New Delhi, Volume-5.

[9] FHWA, 1992. Local Low Volume Roadsand Streets, FHWA-SA-93-006, Federal Highway Administration, U.S. Department of Transportation, Washington D.C.Geller, R., 1996. Concrete Block Paving Condition Survey and RatingProcedures, Pave Israel, TelAviv,Israel, 405-412.

[10] Gerald,T.C.,2010.OpportunitiesforLow-VolumeRoads(Online),http:/onlinepubs.trb.org/onlinepubs/millennium/00068.pdf.December,2010.

[11] Gourley, C.S. and Greening P.A.K., 1999. Performance of Low Volume Sealed Roads; Results and Recommendations from studies in South Africa, Project Report No.PR/OSC/167/99, Transportation Research Laboratory, Crowthrone, U.K.

[12] Hall, K.D. and Bettis, J.W., 2000. Development of Comprehensive Low-Volume Pavement Design Procedures, Final Report, MBTC 1070, Mack-Blackwell Rural Transportation Center, University of Arkansas, Akansas, USA.

[13] Hein,D.K.andBurak,R.,2007.Development of a Pavement Condition Rating Procedure for Inter locking Concrete Pavements, Cost-Effective Assessment / Rehabilitation of the Condition of Materials, Transportation Association of Canada, Saskatoon, Saskatchewan, Canada.

[14] Hein, D.K. and Burak, R., 2009. Development of Pavement Condition Index Procedure for Interlocking Concrete Pavements, 9th International Conference on Concrete Block Paving, Buenos Aires, Argentina, 18-21,October, 1-11.

[15] Huang, Y.H, 2010. Pavement Analysis and Design, Dorling Kindersley (India)Pvt. Ltd., licensees of Pearson Education of South Asia,Noida-201309 (U,P), New Delhi.

[16] Huurman,M.(1997).“Permanent Deformation in Concrete Block Pavement.” PhDthesis, Delft University of Technology, Netherlands.

[17] ICPI,2000. Life-Cycle Cost Analysis–Inter locking Concrete Pavements, Interlocking Concrete Pavement Institute, John Emery Geotechnical Engineering Limited, Washington, D.C.

[18] ICPI, 2007. Interlocking Concrete Pavement Distress Manual, Interlocking Concrete Pavement Institute,13921Park Center Road,Suite270, Herndon, Canada.

[19] Ilangovana, R., Mahendrana, N., Nagamanib, K., 2008. Strength and Durability Properties of Concrete Containing Quarry Rock Dust as Fine Aggregates, ARPN Journal of Engineering and Applied Sciences, 3(5),October, 20-26.