GEOTECHNICAL INVESTIGATION AND REHABILITAION ON ROAD DISTRESSES IN PHUENTSHOLING THROMDE

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Abstract

The project on Geotechnical Investigation and Rehabilitation on Road distresses in Phuentsholing city embraces the study on structure of the existing pavement and geotechnical properties of subgrade that relates the behavior of the pavement structure. It exercises on the principal factor resulting in pavement deterioration which is either led by deficiency of the pavement materials or due to subgrade behavior. Thus, the information collected accompanied by test results is used to assist in reporting of geotechnical investigation with suitable engineering rehabilitation measures.

The study area is divided into five sections and the pavement deteriorations at each corresponding sections are outlined in a layout map generated by total station survey. The pavement distresses based on attributes are studied and graphically represented. Based on the extent of deterioration, the location for sampling is chosen for both pavement and subgrade study. The adoption of suitable methods to conclude an appropriate rehabilitation measures involve collection of traffic volume data, test and analysis on geotechnical tests which feature Dynamic Cone Penetration (DCP) test, Moisture Content, Atterberg's Limit, Compaction, Specific gravity, Sieve Analysis and California Bearing Ratio (CBR). The test on pavement structure consist of Bitumen Content and AC grading.

The study areas have the predominant modes of distresses which were uncovered as crackings, potholes and surface texture deficiencies. The dominating distresses include longitudinal crackings, potholes, alligator crackings including the minor distresses such as raveling and rutting. Subgrade of Road Section 1, Section 3 and Section 4 were found to have plastic index having more than 3. [(0-3) - Nonplastic, (3-15) - Slightly plastic, (15-30) - Medium plastic, >30- Highly plastic)]. The plasticity of the subgrade at these sections was a contributing factors for pavement deteriorations led mainly by improper drainage systems. Other sections were deteriorated by improper composition in the pavement materials.

The proposed rehabilitation measures include total reconstruction for the low CBR rated sections with surface and subsurface drainage to control water table fluctuations. Subgrade stabilization in high plastic soils with capillary cutoff mechanisms. The common rehabilitation measures required are cold plane and overlay for sections having deficiency in pavement materials.

Key Words : *geotechinical investigation, pavement, functional defect, structural defect, distresses, Dynamic Cone Penetration (DCP) test, Moisture Content, Atterberg's Limit, Compaction, Specific gravity, Sieve Analysis and California Bearing Ratio (CBR). The test on pavement structure consist of Bitumen Content, AC grading.*

1. INTRODUCTION

A pavement section may generally be defined as the structural material placed over subgrade layer (Woods and Adcox, 2006). Structure of a specific pavement represents three distinct layers of surface, base and sub-base whereas, the characteristics of the soil bed over which the entire pavement system rests on represents geotechnical properties of the pavement (Mcghee, 2010). Research has shown that if a subgrade has CBR value less than 10, the sub-base material will deflect under traffic loadings in the same manner as the subgrade and cause pavement deterioration (Islam, 2011).

A pavement is said to be defective when it can no longer perform its function during its design life. The pavement failure is either by structural or functional failure. Structural failure includes the deterioration of pavement components making pavement incapable of sustaining the loads imposed upon its surface. Functional failure is when the surface isn't performing its intended function, however functional failure may or may not be accompanied by the structural failure.

The performance of the pavement depends on the quality of its subgrade and sub base layer. The foundation for the pavement's upper layers, the subgrade and sub-base layers play a key role in mitigation the detrimental effects of climate and the static and dynamic stresses generated by traffic.

The purpose of the pavement is to carry traffic safely, conveniently and economically over its extended life. The pavement must provide smooth riding quality with adequate skid resistance and have adequate thickness to ensure that traffic loads are distributed over an area so that the stresses and strains at all levels in the pavement and subgrade are within the capabilities of the materials at each level (S.Adlinge & Gupta, 2004).

2. OBJECTIVES

i. To identify and analyze predominant pavement distresses.

ii. To form a pavement distress layout for Phuentsholing.

iii. To determine the structural condition of the existing pavement with respect to geotechnical properties.

iv. To provide optimal rehabilitation strategies with respect to interpreted results.

3. METHODOLOGY

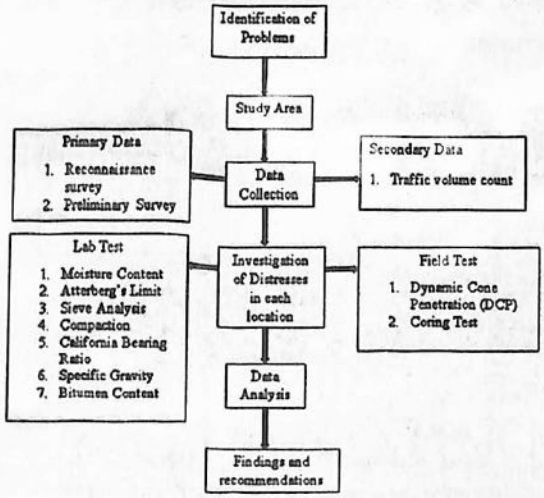


Fig.1 Methodology

3.1 Preliminary survey

The area of interest for study is divided into various sections each having a certain stretch, depending on the severity of the located distresses.

The data obtained from the attributes from each corresponding sections are represented in terms of area affected to the various pavement distresses. The predominant distresses are being recorded at each sections.

Fig.2 Scope area of project

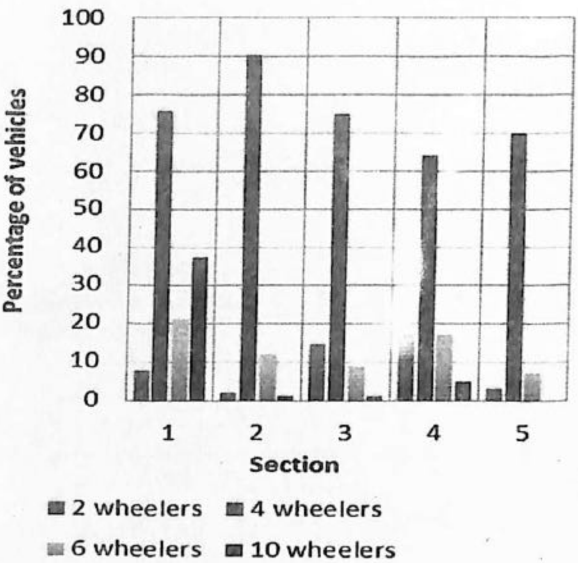
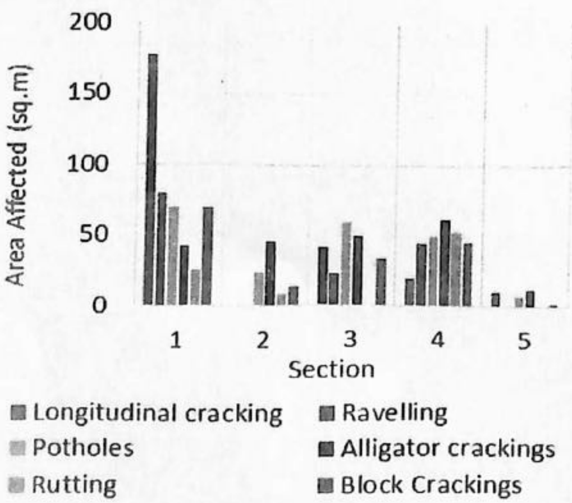
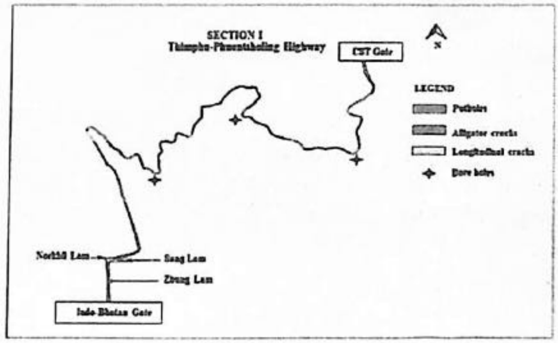
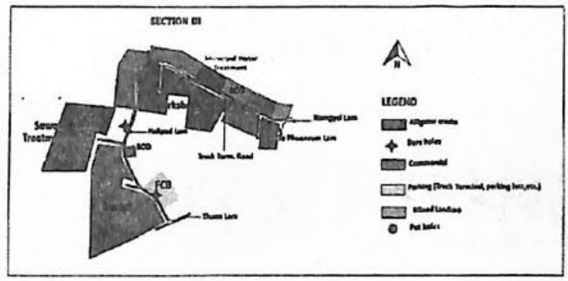
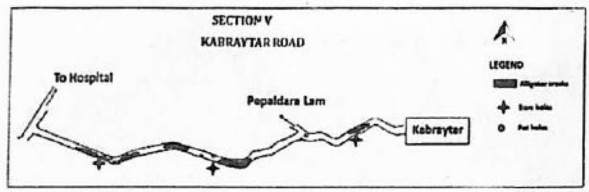


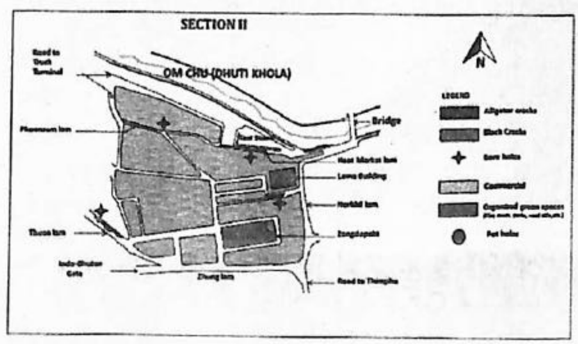
Fig.3 Numbers of Vehicle count

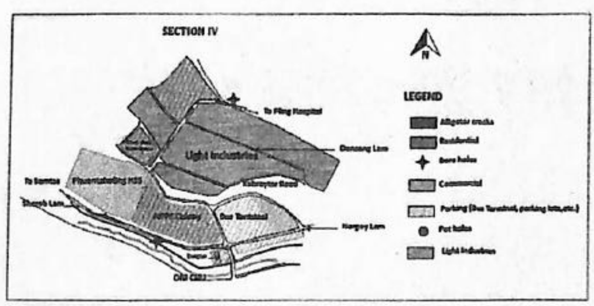












3.2 Geotechnical investigation and pavement structural evaluation

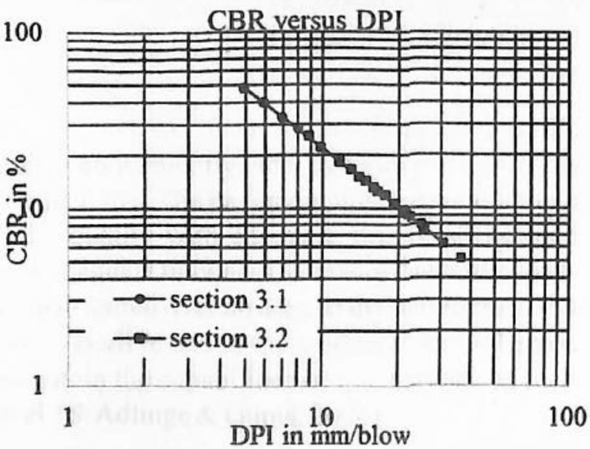
The investigation on defects involves the investigation to determine whether the pavement's materials are within the specified standards and how the geotechnical parameters are contributing towards the performance of the pavement structure. The investigation involves the tests on each sections at three locations at specified are bisected as Field Test and Laboratory Test.

3.3 Analysis and interpretation of result

The analysis and interpretation of result obtain from the geotechnical investigation and test conducted and there core-relationships in the derivation of conclusion as to determine the causes for the road distress.

Table 1 Bitumen content for section III

Location	Sample No	Wt. of aggregate + Bitumen (A) in Kg.	Wt. of aggregate kg.	Bitumen Content in (%)	Avg. Bitumen Content in %	Remarks
Municipal area	1	1.093	0.998	9.47	7.34	critical
	2	1.5	1.42	5.63		
	3	1.08	1.01	6.93		
Sewerage treatment Area	1	0.401	0.385	4.16	4.87	critical
	2	0.965	0.925	4.32		
	3	0.986	0.929	6.14		
FCB Colony	1	0.428	0.406	5.42	6.30	range
	2	0.65	0.61	6.56		
	3	0.85	0.795	6.92		



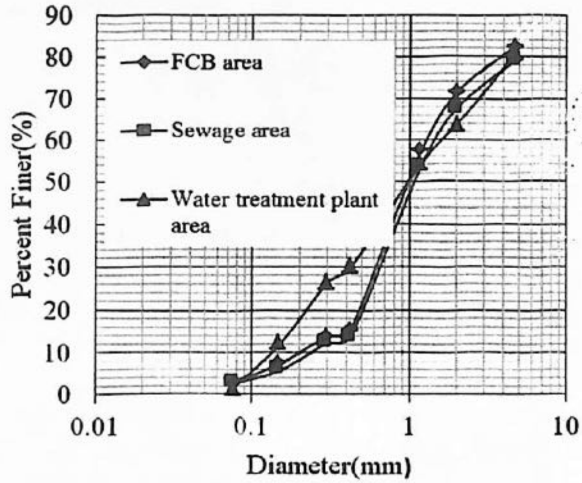


Fig.7 Grain Size Analysis for Section III

Table 2 California Bearing Ratio for section III (Municipal area)

Penetration	Proving Dial Reading	Load On Plunger	Load	Corrected Load	Standard Load	CBR
(mm)	(Divi.)	(KN)	(kg)	(KN)	(KN)	*(%)*
0	0	0.00	0.00			
0.5	3	0.17	16.99			
1	6	0.33	33.98			
1.5	9	0.50	50.97			
2	14	0.78	79.28			
2.5	18	1.00	101.94	1.00	13.20	***8***
3	21	1.17	118.93			
4	26	1.44	147.24			
5	32	1.78	181.22	0.78	20.00	***4***
7.5	44	2.44	249.18			
10	50	2.78	283.16			
12.5	55	3.00	305.81			

4. REHABILATATION

Table 3 Counter Measures for critical Zones (upstream protection)

Section	Dominating Distresses	Causes	Rehabilitation methods
I.	Longitudinal cracks	Differential settlement and Lateral shrinkage due to high plasticity index and low CBR value (PI=20.54, CBR value=6%)	Total reconstruction and Design new pavement

II	Alligator cracking	Rupture of surface course due to low subgrade strength and low bitumen content or brittleness of the binder (BC= 4.76%)	Resurfacing, lime stabilization and addition of Bitumen within the range
III	Potholes	Inadequate thickness of surface layer and high liquid limit due to poor drainage system (PI= 30.12)	Design new pavement with oper drainage system and Lime stabilization
IV	Longitudinal cracks	Differential settlement and Lateral shrinkage due to high plasticity index and low CBR value (PI=7.08, CBR=5%)	Total Reconstruction and Design new
V	lock cracking	Low MDD due to Inadequate compaction (PI=21.20)	Square patching with proper compaction

1. CONCLUSION

i. The most critical zones are section I, III and IV based on the preliminary survey.

ii. The most commonly found soils were poorly graded sandy soil and clayey soil.

iii. The major distresses identified in Section I are longitudinal cracking and alligator crack and their rehabilitation method to be incorporated are total resurfacing and new pavement design.

iv. The predominant distresses observed in Section III are potholes and ravelling which are to be rehabilitated by full depth reconstruction, stabilizing the soil with cement, lime or fly-ash and new pavement design.

v. The mostly detected failures in Section IV are longitudinal cracks that is rehabilitated by redesigning of the pavement.

6. RECOMMENDATIONS

The following recommendations should be taken into account for the future researchers:

I. This project has concentrated in area of repetitive (re-occurrence of distresses in same location upon resurfacing after few weeks) distresses and provided reliable rehabilitation based on findings.

ii. Record keeping such as date of construction, resurfacing or maintenance and the types of materials used and its source needs to be documented by the concerned authority for the future study and improvement in road maintenance.

iii. The causes of distresses are not only related to climatic and traffic loadings or pavement materials, but also due to subsurface condition. Therefore, it is recommended that the proper road design is adopted based on the bearing strength of soil or adopt good engineering soil stabilization and proceed with construction with proper monitoring and supervision in construction phase.

iv. This project only focusses on the rehabilitation techniques for geotechnical failures and surface failures but the upcoming teams can do detailed study on water table rise and its effect on the pavement.

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