Performance Evaluation of a Trunk-A Road in North Central Nigeria

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Abstract

A trunk-A road of about 120km, spanning through Bida basin, within Niger State of Nigeria, was recently rehabilitated by complete reconstruction in 2015. The reconstruction essentially involved resurfacing of the entire stretch of the road, with complete replacement of base and sub-base course materials at portions where complete failure was observed. Where base course was replaced, stone base was used as against lateritic material, used on the existing road. Before the replacement, the strength of the resultant sub-base and subgrade were tested using Dynamic Cone Penetration Test (DCPT). Thereafter, the entire road was resurfaced with quality asphalt concrete. In July 2017, a performance evaluation was carried out at five selected positions within the road to assess the strength and stability of the road after two years of reconstruction. This was done by coring the asphalt concrete for complete pavement evaluation and conducting DCPT below the hole created by the corer from the base course through the sub-base course to the sub-grade course. The results obtained from both the pavement evaluation as well as the Dynamic Cone Penetration tests were compared with those carried out during reconstruction. It was observed that the two results have very good agreement. However, one position showed slightly lower strength, probably due to the influence of erected speed bump on this position.

Introduction

► Road is referred as a facility that provides access for the movement of man, goods and services, animals, with use of vehicles, motor bikes, horse, carts, etc between two locations .

► Singh and Singh [2] stated that out of all types of transport systems, roads are nearest to the man.

► Roads represent the major areas of investment in transportation and are the most dominant travel mode accounting for over 90% of passenger and goods transport in Nigeria [3].

► According to CBN [4], the total road network in Nigeria is about 194,000 kilometers. These road network systems are classified, according to Okigbo [5], into four categories, one of which is a trunk A road.

Introduction Contd.

► Out of the total road network in Nigeria, about 28,980 km are paved, while 164,220 km are not [1]. 27% of these roads are classified as good, 38% is fair and 35% are poor [6].

► Annual loss from vehicle maintenance only, due to bad roads in Nigeria, is valued at over 420 million dollars [1]. Performance evaluation of constructed roads in Nigeria has not been given due attention over the years.

► The need to routinely evaluate the performance of these roads in Nigeria cannot be over emphasized.

Methodology

► The methodology adopted in the study involved field work and laboratory tests.

► The field work involved carrying out the following operations at five different identified locations (CH 18+600, CH 25+800, CH 55+550, CH 68+00 and CH 84+400) along the road:
● Coring through the pavement structure (Figure 1);
●Collection of core samples of asphalt (Figure 2);
●Evaluation of thicknesses of asphalt, base and sub-base courses;
●Dynamic Cone penetration (DCP) test (Figure 3) to infer CBR values of Base, Sub-base and Sub-grade.

Figure 1: Coring through the pavement structure

Figure 2: Collection of core samples of asphalt

Figure 3: Dynamic Cone penetration test

Laboratory tests

► The following laboratory tests were carried out on the cored asphalt:
- Marshall Stability
- Bulk Density
- Bitumen Content
- Flow
- Void ratio
- Percentage voids filled with bitumen
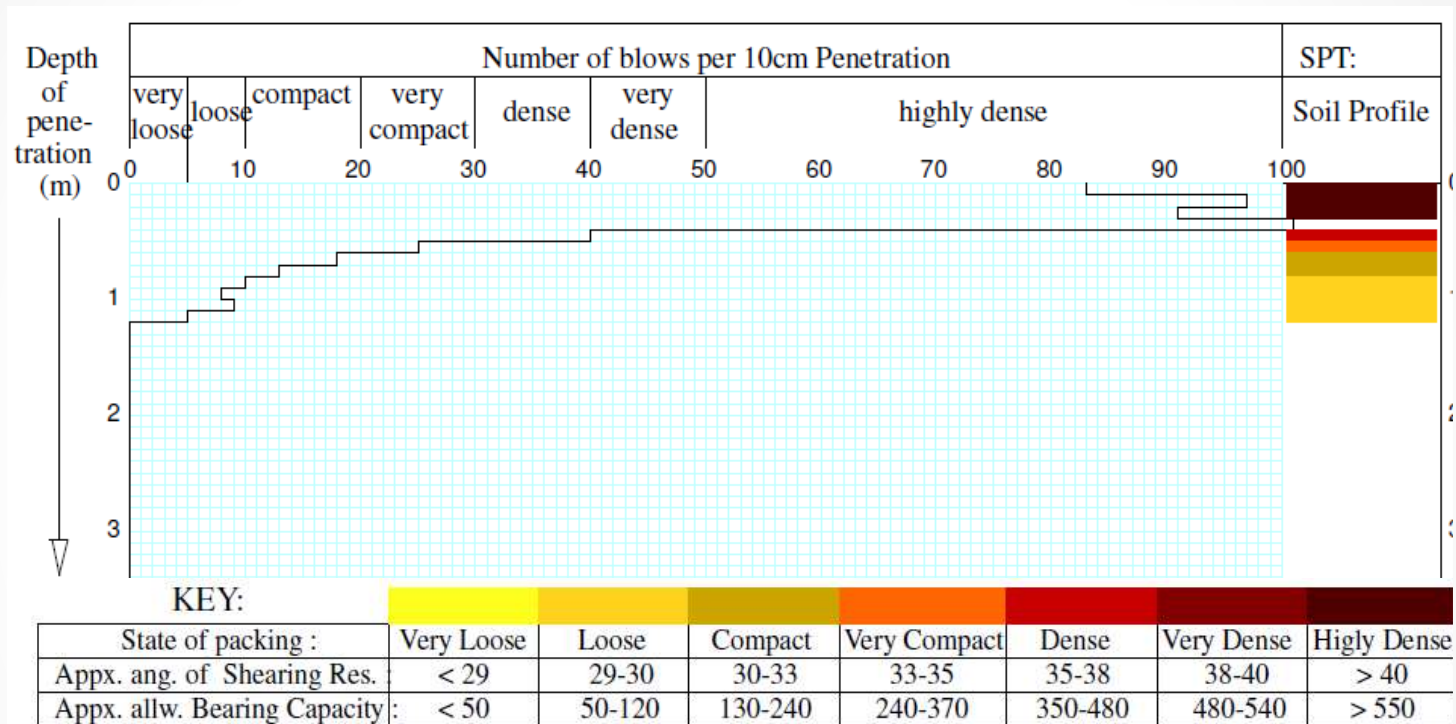- Aggregate grading

Results and discussion

Figure 4: DCPT Result for test location one (CH 18+600)

Table 2: Summary of Coring and DCP Results

			ASPHALT			Base Course		Sub-base Course		Sub-grade	
LOCATION OF CORING			Thickness of Binder (mm)	Thickness of Wearing (mm)	Total Thickness (mm)	Thickness (mm)	Average CBR (%)	Thickness (mm)	Average CBR (%)	Thickness (mm)	Average CBR (%)
	GPS										
Chainage	N	E									
CH 18+600	9°16'49.68''N	5°17'8.70''E	55	40	95	200	180	200	193	600	35
CH 25+800	9°16'3.45''N	5°20'47.52''E	102	50	152	200	81	200	64	600	43
CH 55+550	9°8'2.19''N	5°32'24.08''E	95	40	135	200	167	200	187	600	77
CH 68+000	9°12'8.72''N	5°35'39.60''E	90	40	130	200	159	200	180	600	91
CH 84+400	9°12'16.44''N	5°43'47.82''E	72	40	112	200	167	200	155	600	184

Table 3: Summary of the Marshall Stability test and extraction test of the tested core asphalt samples

Location of Core	Unit weight (gm/ml)	Specific gravity	Marshall Stability (kN)	Flow (mm)	Bitumen content (%)		Void ratio	Percentage void filled with bitumen (%)
					By total	By Aggregate		
CH 18+600	2.56	2.71	3.47	3.8	8.0	8.7	5.45	75.34
CH 25+800	2.56	2.69	3.47	3.8	6.2	6.6	4.85	72.72
CH 55+550	2.56	2.69	3.19	3.8	5.9	6.2	4.85	71.72
CH 84+400	2.56	2.69	3.25	3.8	8.9	9.8	4.85	72.72

Conclusion

► The results obtained from both the pavement evaluation as well as the Dynamic Cone Penetration tests were compared with those carried out during reconstruction.

► It was observed that the two results have very good agreement. However, one position showed slightly lower strength, probably due to the influence of erected speed bump on this position.

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