Pavement Failures in Southern and South Eastern Nigeria, Causes, Effect and Remedies

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ABSTRACT

Pavement failures in most developing countries especially Nigeria is worrisome and this is one of the challenges which the government of the day constantly have to grapple with willy-nilly. To appreciate the dangers of pavement failures before suggesting remedial measures, this research was undertaken. It focuses on pavement failure in Nigeria, using the south eastern and southern states as case study. Survey methods which involve the use of questionnaires were distributed mostly to civil engineering companies. Likert’s scale was used to analyse the returned questionnaires from the respondents.

Analysis of the questionnaires from the respondents shows that quality of construction materials, poor maintenance practice and the presence of moisture on the pavement are factors that are highly responsible for pavement failures in the south eastern and southern Nigeria and these results in the high congestion and waste traffic time as agreed by respondents to be the key problems of the resultant effect of pavement failure.

Keywords--- Pavement failure, questionnaire, sample size, poor planning, Likert scale

I. INTRODUCTION

Adequate planning and design of good pavement is germane to the development of a nation. This is because properly constructed road network enhances economic growth of any nation by encouraging efficient movement of goods and services. Thus, good road network reduces haulage vehicle accidents by minimizing human and material losses (Akintorinwa, Ojo, & Olorunfemi, 2010). In the developing countries such as Nigeria, road network is the most developed transport mode and the vastest in usage (Okigbo, 2012). Roads represent the major areas of investment in transportation according to Oguara (Oguara, 2010) and are also the dominant travel mode accounting for over 90% of passenger and goods transport in Nigeria.

Regrettably, despite huge financial resources being sunk into the transportation sector in Nigeria, its roads have continued to pose serious dangers to motorist due to its deplorable state with attendant economic losses to the populace especially as a result of loss in man hours arising from delays on several bad portions of the road. Despite its vast potentials for growth and development, the Nigeria roads have not been satisfactory in terms of its performance (Adewumi, 2008). Most of the problems leading to the deplorable state of Nigerian roads are directly or indirectly related to the poor planning of pavement design but an adequate knowledge of the effect of pavement failure on our roads will help in reducing the menace arising therefrom.

There are two major types of pavement – the flexible pavements and the rigid pavement. Both pavement types contribute in making highway transportation possible. A highway pavement is a structure consisting of superimposed layers of selected and processed material whose function is to distribute the applied vehicle loads to the subgrade (Saurabh, Joshi, & Goliya, 2013). Most Nigeria roads are designed as flexible pavements and so only flexible pavement was considered in this research. Flexible pavement deflects when loads are imposed on it. It consists of several layers of materials with each layer receiving load from the above layer, spreading out the received load and passing it on to the next layer directly below it. A good flexible pavement is expected to be stable, non-yielding surface for the movement of heavy vehicles (Arora, 2003) and when this is jeopardize as a result of poor planning, it could lead to disastrous consequences and whatever negates the qualities of a good pavement during its useful life could well be described as pavement failure.
Factors that lead to pavement failure are numerous and it is pertinent to first identify such factors and then classify them for effective understanding and management of the problems for developmental growth of a nation. It is said that pavement failure arises from functional failures (Woods & Adcox, Spring 2002,) and the assignment of categories makes the understanding of pavement somewhat easier. Proper identification of pavement will ultimately enable the relevant agencies to appreciate the causes of pavement failure with a view to providing remedial measures to mitigate the failure.

II. GEOLOGY OF THE STUDY AREA

There are two study areas used for this research (Enugu and River states) and a brief description of the study areas will suffice. Figures 1 and 2 are maps showing the study areas used for this research. Both study areas are made up largely of flexible pavement. The roads are classified as trunk A, trunk B and trunk C (Okigbo, 2012). The trunk A roads are owned and managed by the federal government, trunk B roads are owned and managed by state government while the trunk C are under the supervision of the local government. However, in this research, no effort was to categorize the roads because it is outside the scope of the research.

2.1 Enugu state

The name Enugu means hilltop in the Igbo language and this presupposes that Enugu state lies on a hill. This is not the case as it lies at the foot of an escarpment. It is one of the 36 states in Nigeria. Situated in the Cross River basin and Benue trough, Enugu state has a humid climate which is highest between March and November with a mean daily temperature of 26.7°C (80.1°F) and it lies in the south eastern geopolitical zone of Nigeria. Its geographical coordinates are at latitude 6°30’0" N and longitude 7°30’0" E. The state has a population of 3,267,837 million people according to the National population commission 2006 censuses (National Population Commission, Nigeria, 2006). The inhabitants of the states are predominantly rural dwellers with most of them involve mainly in agriculture. The major language spoken by the inhabitants is Igbo language.

2.2 River state

River state is also one of the 36 states in Nigeria with geographical coordinates at latitude 4°44’59"N and longitude 6° 49’39"E. It is situated in the southern geopolitical zone of Nigeria and has its capital at Port Harcourt. The state covers about 11,077 square kilometres. According to the 2006 censuses conducted by the National population Commission, it has a population of 5,185,400 million people (National Population Commission, Nigeria, 2006). The entire topography of the state is said to be characterized by a maze of effluents, rivers, lakes, creeks, lagoons and swamps criss-crossing the low-lying planes in varying dimensions (Niger Delta Budget Monitoring Group, 2005). The major occupation of the people in that area in rivers is farming (fish farming) especially among the rural dwellers. However, the state is famous for its oil and gas production because of the abundant reserves of crude oil.
III. METHODOLOGY

Several research methods are used to carry out research work, but for the purpose of this research work, the survey methodology which studies the sampling of individual units from a population and the associated survey data collection techniques, such as questionnaire construction was employed. The survey research method is considered the most suitable for this research work as it is more viable in evaluating responses from unique experts such as consultants, project managers, site engineers, research engineers, geologist, labourers etc. The survey method consists of the primary and secondary survey sources as a means of collection of information which is both quantitative and qualitative. This is a common approach and helps to triangulate i.e. to back up one set of findings from one method of data collection underpinned by one methodology, using questionnaire (normally quantitative) to gather statistical data responses, and then backing it up extensively by interviewing (normally qualitative) selected members of the questionnaire sample.

3.1 Sample size

The sample was chosen from the sampling frame which consists of a list of all member of the population of interest which is the construction industries in the south eastern and southern part of Nigeria. Hence, information and data collection was centred on the various stakeholders of the construction industry. Due to the non-feasibility of carrying out research for the entire members of the construction industry, sample size was also extended to a large population outside the construction industries so as to obtain a more reliable result.

A total of 100 questionnaires were distributed to different engineering organization/ companies. Face to face delivery and collection were used to increase response rate. A total of 17 did not participate in the research which reduced the sample size to 83. This represents a total of 83% response rate.

3.2 Data collection

Closed questionnaire was used to obtained data from the respondents. Closed questionnaire method was chosen in lieu of the open ended method due partly to the ease with which it enables one to code and score and also partly due to the fact that a thorough researched pavement failure have been carried out extensively and itemized.

The closed questionnaires were designed using Likert’s scale in which respondents were asked to respond to each question based on their degree of agreement according to the scale of 1. Strongly disagree, 2. Disagree, 3. Neither agrees nor disagree, 4. Agree and 5. Strongly disagree. Statistical data involving bar charts, grouped charts were used to analyze the data collected.

Each questionnaire was divided into four different sections. Section A contains questions on the bio-data of the respondents. Section B relates to the concept of pavement and its failures while section C contains the factors causing the pavement failure in the south eastern and southern Nigeria in tabular form. The respondents, as mentioned earlier, were asked to respond to the questions by ticking in the box of their choice using the Likert’s scale that best suited their answer. The last part of the questionnaire (section D) enumerates the effect of pavement failure also in tabular form and the respondents were asked to respond in the same manner as that of section C.

IV. DATA PRESENTATION
The data collected from the survey were analysed using tables and diverging stacked bar chart and percentage to determine proportion between variables.

4.1 Data analysis on research questions based on factors influencing the performance of pavement in the South eastern and South southern Nigeria.

The result presented and analysed below represent the analysis for the samples gotten.

4.1.1 Data analysis using tables

Table 1: table showing the factors influencing the performance of pavement based on the respondent

<table>
<thead>
<tr>
<th>Causes of pavement failures</th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Neither agree nor disagree</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic</td>
<td>13</td>
<td>9</td>
<td>7</td>
<td>25</td>
<td>29</td>
</tr>
<tr>
<td>Moisture</td>
<td>4</td>
<td>4</td>
<td>8</td>
<td>31</td>
<td>36</td>
</tr>
<tr>
<td>Weak subgrade</td>
<td>4</td>
<td>9</td>
<td>11</td>
<td>27</td>
<td>31</td>
</tr>
<tr>
<td>Construction quality</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>28</td>
<td>48</td>
</tr>
<tr>
<td>Poor maintenance practice</td>
<td>1</td>
<td>8</td>
<td>5</td>
<td>34</td>
<td>34</td>
</tr>
<tr>
<td>Unskilled staff</td>
<td>2</td>
<td>7</td>
<td>19</td>
<td>36</td>
<td>19</td>
</tr>
<tr>
<td>Poor workmanship</td>
<td>2</td>
<td>7</td>
<td>16</td>
<td>41</td>
<td>17</td>
</tr>
<tr>
<td>Poor supervision</td>
<td>1</td>
<td>9</td>
<td>9</td>
<td>39</td>
<td>25</td>
</tr>
<tr>
<td>Inadequate quality control</td>
<td>0</td>
<td>2</td>
<td>13</td>
<td>41</td>
<td>27</td>
</tr>
<tr>
<td>Poor planning</td>
<td>4</td>
<td>2</td>
<td>14</td>
<td>38</td>
<td>24</td>
</tr>
<tr>
<td>Climatic and weather condition</td>
<td>12</td>
<td>8</td>
<td>13</td>
<td>37</td>
<td>13</td>
</tr>
<tr>
<td>Poor highway facilities</td>
<td>2</td>
<td>4</td>
<td>11</td>
<td>40</td>
<td>26</td>
</tr>
<tr>
<td>Poor geotechnical test and inadequate data collection</td>
<td>4</td>
<td>13</td>
<td>13</td>
<td>28</td>
<td>25</td>
</tr>
<tr>
<td>Inadequate sanction for highway failure</td>
<td>5</td>
<td>15</td>
<td>21</td>
<td>33</td>
<td>11</td>
</tr>
</tbody>
</table>

4.1.2 Data analysis using diverging stacked bar chart

Both Table 1 and figure 3 clearly shows that construction quality, poor maintenance practice and moisture are highly responsible for pavement failures in the south eastern and southern Nigeria while inadequate...
sanction for highway failure was surprisingly the least factor responsible for highway failure. The very high increase in both construction quantity and poor maintenance practice stem from the fact that most contractors handling several projects are wont to make more profit in the face of the current harsh economic realities and in a bid to achieve their obnoxious aim sacrifice the success of the project in the process. Other likely reason could be that a contractor may be handling multiple projects at the same time with little equipment to execute such projects in record time. In the end the very likely result of such project are shoddy work apparently done to beat the time given to accomplish the projects.

4.2 Data analysis on research questions based on the effect of poor planning on pavement

4.2.1 Data analysis using tables

<table>
<thead>
<tr>
<th>Effect of pavement failure</th>
<th>StrONGLy disagree</th>
<th>Disagree</th>
<th>Neither agree nor disagree</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accidents</td>
<td>9</td>
<td>2</td>
<td>10</td>
<td>33</td>
<td>29</td>
</tr>
<tr>
<td>Increase in faulty vehicles</td>
<td>3</td>
<td>11</td>
<td>10</td>
<td>36</td>
<td>23</td>
</tr>
<tr>
<td>Traffic congestion</td>
<td>2</td>
<td>1</td>
<td>15</td>
<td>30</td>
<td>35</td>
</tr>
<tr>
<td>Waste of journey time</td>
<td>2</td>
<td>2</td>
<td>14</td>
<td>32</td>
<td>33</td>
</tr>
<tr>
<td>It's an aid to crime</td>
<td>13</td>
<td>9</td>
<td>21</td>
<td>32</td>
<td>8</td>
</tr>
<tr>
<td>Causes soil erosion</td>
<td>0</td>
<td>12</td>
<td>11</td>
<td>38</td>
<td>22</td>
</tr>
<tr>
<td>Delay in economic development</td>
<td>1</td>
<td>3</td>
<td>24</td>
<td>35</td>
<td>20</td>
</tr>
</tbody>
</table>

4.2.2 Data analysis using diverging stacked bar chart
Strikingly, the effects of pavement failure are numerous but it has been collapse into seven points (Okigbo, 2012) listed in table 2. In the results from table 2 and figures 5 and 6, a high respondent strongly agreed that both traffic congestions and waste of journey time are the main effects of pavement failure while the aiding of crime was found to be least. Though being the least, it does not in any suggest that it is far less important on the effect of pavement failure. The reason is that any motorists disposed of its valuable by criminals that waylay them or even abducted by kidnappers may live with the trauma of such gory experience for the rest of their lives.

V. CONCLUSION AND RECOMMENDATION

(a) Engagement of highly skilled personnel

Professionals with the technical know-how and requisite knowledge regarding the construction of pavement design should be approached in any design and construction of pavement within the south-eastern and southern part of Nigeria and indeed the entire country. Employment of quacks for design and construction pavement should be highly discouraged and any thought of it should be jettisoned so as to achieve quality work that will stand the test of time

(b) Provision of improved drainage system

To mitigate against the problem of pavement failure, good surface and sub surface drainage system should be constructed to channel moisture away from the pavement. Drainage is the most important aspect of road design (Magdi, 2014) Accumulation of water could subsequently lead to excessive pore water pressure building up at the base of the pavement and this could
undermine the integrity of the pavement. Also, siltation and debris in the drainage channel should be frequently cleared to allow for easy flow of water in the drainage channels.

(c) Enactment of laws to curb sharp practice

Sharp practices are rife in the construction industries partly because the existing laws are too weak to deal with defaulters and partly because of the sheer lack of will to enforce the law due to the insincerity of those employed to enforce it.

The existing laws should be strengthened and also enshrined within the constitution to sanction any erring contractor and construction companies involved in the design and construction of pavement within the south eastern and southern states of Nigeria that may want to embark on any shoddy pavement construction.

(d) Adequate and prompt supervision of construction of pavement

Regular supervision during the construction stage of pavement is highly recommended to ensure durability of the pavement. This is achieved by insisting that the design specifications are met. Any deviation from the specification could ultimately lead to failure during the useful life of the pavement.

(e) Periodic maintenance of road

To ensure that the constructed pavement meets its design life, routine maintenance should be constantly carried out from time to time when the pavement is still in good condition with no structural damage. The cost of maintaining a road is usually small when compared to when the structure fails. When it fails, lot of cost will be incurred for the reconstruction of pavement with its attendant economic drain on the government.

(f) Excessive overloading should be discouraged

To promote the life span of pavement within the southern and south eastern part of Nigeria, motorist plying the roads should be highly discouraged from loading vehicles excessively and indiscriminately so as not to lead to unwarranted increase in the axle load which might quicken the damaging effect of the pavement.

(g) Adequate geotechnical test in road construction

Sound geotechnical exploration should be carried out before any construction work is done. Results obtained from good geotechnical test on the soil samples taken from various locations on the actual sites for the construction of the pavement should be relied upon. Relevant data from the site for the construction of pavement should also be sourced and utilized. The effect of preliminary geotechnical exploration on the life span of the project cannot be over-emphasized.

REFERENCES


