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Evaluating the Effects of Development Traffic towards Achieving Sustainable Road Network in Nigeria

[1]Muhammad Sani Aliyu, [2]Saleh Mamman Abdullahi, [3]Jibrin Abdullahi Mairiga, [4]Hamza Hamza Musa, [5]Abubakar Shamsudeen

[1,2,4,5]*Department of Civil Engineering Technology, Federal Polytechnic Nasarawa, Nigeria*
[3]*Department of Building Technology, Federal Polytechnic Nasarawa, Nigeria*
Corresponding Author: Muhammad Sani Aliyu

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ABSTRACT

Road deterioration is a normal phenomenon that occurs within the life span of a road and is usually corrected by routine maintenance at the appropriate time. It becomes an issue when the failure is sudden and rapidly escalating. The aim of this research work is therefore to determine the causes of worsening condition of Keffi-Nasarawa road and suggest the mode of maintenance or upgrade, going forward. Physical survey and traffic census techniques were employed as methods of data collection and the data so collected were analysed using physical examination and traffic volume evaluation procedure. The results obtained indicate that poor or lack of drainages, culverts and improper elevation of the road formation levels at many locations are prevalent. Traffic volume had also increased greatly in comparison with the value obtained same month in 2022. The major causes of the failure were found to be poor construction/maintenance standard and excessive hiking of traffic volume due to development traffic.

Keyword: Road Failure, Physical Survey, Traffic Census, Traffic Volume, Development Traffic

I. INTRODUCTION

In Nigerian highways, pavement failures are a frequent occurrence after a few years of use and frequently before the pavement reaches its design age. These roads are constantly being rebuilt or repaired, but no attempt is being made to pinpoint the causes of their ongoing failure. The process through which distresses in pavement are created by the influence of environmental factors and traffic loads is known as pavement failure. The serviceability, safety, and riding quality of the road are all significantly impacted by the distress that has developed in the pavement. Road pavement needs to be maintained to guarantee that safety and durability criteria are met because it deteriorates with age due to use (Abam, T. K. S., Ofoegbu, C. O., Osadebe, C. C., & Gobo, A. E. 2010).Pavement failures can be classified as structural (deep-seated pavement failure) or functional (surface pavement failure). The performance of the pavement structure on highways can be influenced by a variety of factors. These consist of the following: design, material selection, construction techniques, maintenance, geomorphology, geotechnical, and usage factor. Roads and sidewalks with cracks are signs of damage. By reducing the structural safety of the road, the extent of damages may increase to the point where one or more pavement structures

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collapse. The cost of maintenance and repairs can often surpass the initial cost of the road, placing a financial burden on developing nations. These damages typically cause financial losses. (Feng Hand Dar.H., 2009; David P. Orr, 2006; GTC (Geotechnical Testing Center), 1998). inadequate pavement design, inadequate drainage.Based on the findings of Kekere, A. A., Lawal, L.O., and Awotayo, G.P. (2012). The two primary causes of road failure in asphalt pavement are fatigue cracking, which is brought on by excessive vertical compressive and horizontal tensile strain at the top and bottom of the asphalt layer as a result of repeated traffic loading, and rutting deformation, which is brought on by densification and shear deformation of the subgrade. In flexible pavements, excessive vertical surface deflections have long been a cause for concern and a design need. Most pavement distress is caused by a variety of variables, including the surrounding environment, the caliber of the materials used, the building methods used, and/or structural issues. To choose the best maintenance and/or rehabilitation strategies, it is crucial to distinguish between these variables (Khosla, G.B. Birdsall, & S. Kawaguchi, N.P.,The pavement along Nasarawa-Keffi roadin Nasarawa State has shown many signs of failure with resultant effects on the road users. Hardly any attempts have been made to know the levels and causes of the pavement failure, so that specific findings are documented.

The aim of this study therefore is to investigate the causes of pavement failure on the road, through the following objectives:

1. To know the level of the pavement deterioration through physical survey
2. To determine the current total traffic volume of the road and compare the results with the traffic census conducted last year.
3. And to suggest the most sustainable solutions in line with modern practices.

III. RESEARCH METHODOLOGY

2.1 PHYSICAL SURVEY

Materials used

- Pen
- Book
- Bike
- Car
- Camera

Procedure

This was observed by determining the area or demarcation of pavement by firmly identifying its boundaries, using the simultaneous data collection in static mode at two or more fixed points.

The physical inspection involved the preliminarysurvey and mapping of the damaged locations. The drainage condition along the length of the road was also assessed.

The survey was started from from Lowcost Junction down to keffi flyover at a stretch of 1km interval from Lowcost Junction, with the aid of a car moving at a slow speed to observe the physical condition of the road on getting to a spot of deterioration we alighted from the car to observe the level of deterioration and causes of the failure of the pavement. As the car moves along the stretch of the road, the road distresses were observation was taken note of.

From Loko junction down to tammah; as we were moving along that section of the road, the physical condition of that axis was taken note of. We made a stop by tammah MARKET where some major distresses were observed to take pictures of the road condition and its furniture.

Taking the section of the road from tammah to marmara we took picturesof the road furniture and took note of the condition too. We alighted at tammah and walked down to marmara.The rest of the road section was covered, the road conditions and physical furnitures of the road were taken into consideration. Similar process was repeated until entire stretch of the road was covered.

2,2TRAFFIC CENSUS

Material used

- Pen
- Book

Procedure

The method involved counting of vehicular traffic, which is conducted along a particular road, path, or intersection. manual counting method was used.

In manual counting method techniques, trained persons are posted to lag of an intersection to count and record the number of trucks, buses, cars etc. It is manual fashion distinguishes it from machine that records passing vehicles automatically. It is the most traditional method. In this case trained observers gather traffic data that cannot be efficiently obtained through automated

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count. The most common equipment's used are tally sheet.

The traffic census data were collected within the duration of May 2022 and May 2023. We use the manual method counting for our research, the data were collected using one hour interval with the time duration of 12 hours for the research and the data were collected for 3 days in a week to determine the day with highest traffic.

This traffic census was carried out to analyze the characteristics and issue of transportation on Keffi-Nasarawa road, in order to cope with the existing problem and issue of transportation, Traffic conditions and volume of traffic will be analyzed. Traffic census analysis had been conducted in May 2022 by comparing the traffic survey result with the existing result in May 2023 after one year,The percentage (%) change in traffic will be analyzed. In this survey, the present traffic of this year 2023 will be obtained.

Traffic census survey was conducted for the clarification of general traffic movement in the survey area. The traffic census surveys of major Keffi- Nasarawa was conducted at welcome to Nasarawa boundary, in Nasarawa state, targeting the improvement of the road conditions. The method of the survey is to count the traffic volume of according to the type of the vehicles at every direction along the road sections.

Traffic data collection is a highly useful tool that offers valuable insights for traffic management and infrastructure developments. With the help of traffic data, traffic engineer can make informed decisions based on details such as traffic volume, types of vehicles or visitors on the road, the speed those vehicles are travelling at, and more. Precise surveys, and scientific analysis of traffic is necessary for traffic Engineering and find wide application in anticipating future requirements of roads, the advancement of existing facilities, design aspects, pavement design ,and traffic guideline and control. It covers all kinds of traffic, size and weight,traffic flow, traffic volume per hour, and per day, including seasonal variations or annual variations, distribution in different parts of a road network, and distribution in different direction at intersections.

The traffic census or traffic survey was carried out to analyze the traffic characteristics. This studies help in deciding the geometric design feature and efficient traffic movements. The traffic census was carried out to determine the number of vehicles crossing the particular section of the road per unit time. It is expressed in vehicles/hour. The information acquired from traffic volume are introduced in various structures for coming to suitable end results relying upon the reason for examines:

2.3.1 USING DURATION MODELS TO ANALYZE EXPERIMENTAL PAVEMENT FAILURE DATA

Predicting the actual performance of a specific pavement section under the combined action of highway traffic and environmental conditions provides valuable information to the highway agency for proper planning of maintenance and rehabilitation activities, budget estimation, and allocation of resources. Pavement failure is a variable event that depends not only on layer material properties, environmental and subgrade condition, and traffic loading, but also on the specific definition of failure adopted by the highway agency. Failure is usually defined in terms of amount of cracking, rut depth, surface roughness, skid resistance, or combinations of these or other indicators of performance. Two types of pavement performance are of interest to the pavement engineer:

• Functional performance, which is a subjective measure of the quality of the riding condition of the road from the users' point of view—for example, serviceability and riding quality; and

• Structural performance, which is a more objective measure that takes into account the appearance of various forms of distress such as cracking, rutting, raveling, and faulting.

IV. RESULTS AND DISCUSSIONS

The results carried on these techniques are listed below;

Physical survey

Traffic counting

3.1 PHYSICAL SURVEY

Physical survey was carried out in the study area through visual assessment of the road and its surrounding environment. The approach adopted for this study is physical survey. The physical inspection involved the reconnaissance survey and it consisted of three tasks: the first covered the visual inspection of the existing pavement failures, the second looked into the road furniture, whereas the third investigated the causes of the failures.

The conditions of the road as seen are listed below.

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1. Surface distress: this is an indication of poor or unfavorable performance of the pavement. This is seen as a form of roughness, raveling, cracking; which allows moisture infiltration into the base and subgrade, eventually resulting into pothole as seen.

Fig 1: Some Distresses Located at about 1.03 km from the Origin (Low-cost Junction)

Fig 2: Some Distresses Located at about 7km from the Origin (Low-cost Junction)

Fig 3: Some Distresses (Raveling) Located at about 1.1 km from the Origin

Fig 4: Some Distresses (Polished aggregate) Located at about 15 km from the Origin

2.

3. There is nodrainage: there is obstruction in the natural drainage along the section of the road which impedes the flow of water.This can cause failure of the pavement as water may tend to pass through the pavement

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Fig 5: Some Effects of Lack of Drainages at about 31 km from the Origin

4. Absence of Pavement markings: due to lack of maintenance: the road markings were wiped off either by the effect of vehicular wheels or climate condition.

Fig 6: Some of the Many Areas with Erased Pavement Markings (within about 1-13km from origin)

5. Absence of Shoulders: due to absence of shoulder the water that flows off the natural drainage tends to settle by the pavement side which penetrates into the base and subgrade andmay lead to pavement failure.

Fig 7: Some of the Many Scraped Shoulders (within 20-31km from origin)

6. Blockage of culvert: obstruction in the flow of water which tend to hinder the directional flow of water. This may lead to infiltration of water into the base or subgrade which might lead to pavement failure

Fig 8 : Some of the few Blocked Culverts (located at about 2.1 and 13.5 km from origin respectively)

4.2 TRAFFIC COUNTING The method involved counting of vehicular traffic, which is conducted along a

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particular road, path, or intersection using the manual counting method.

The survey was carried out along Abuja-Keffi road to determine traffic count of vehicles plying the road. This data was collected on Monday 15th May 2022 both incoming and outgoing vehicles.

TABLE 3: 19TH MAY 2022 TRAFFIC CENSUS (FOR THE PEAK DAY OUT OF 3 CONSECUTIVE DAYS)

TIME	MOTORCYCLES	CARS	BUSES	TRACTORS	PICKUP	TRUCKS	TRICYCLES
6-7	69	88	67	11	72	55	51
7-8	80	118	83	9	63	72	53
8-9	75	106	80	6	58	73	73
9-10	80	139	112	12	95	72	72
I0-11	80	114	90	11	77	77	75
11-I2	88	122	117	4	72	67	60
I2-1	90	152	94	2	72	93	69
1-2	110	143	104	4	85	91	70
2-3	107	150	106	3	72	79	76
3-4	88	134	81	1	74	79	70
4-5	92	113	95	6	78	78	74
5-6	90	138	100	4	83	82	80
TOTAL	1049	1517	1129	73	901	918	823

1.
2. Total traffic volume for both incoming and outgoing for Monday 15th May 2023 was 2135 traffic.
3. Total traffic volume for both incoming and outgoing for Wednesday 17th May 2023 was 2788 traffic.
4. Total traffic volume for both incoming and outgoing for Friday 19th may 2023 was 6410 traffic.

The survey was carried out along Abuja- Keffi road to determine traffic count of vehicles plying the road. This data was collected on Monday 30th May 2023 both incoming and outgoing vehicles.

TABLE 6: 5TH MAY 2023 TRAFFIC CENSUS (FOR THE PEAK DAY OUT OF 3 CONSECUTIVE DAYS)

TIME	MOTORCYCLES	CARS	BUSES	TRACTORS	PICKUP	TRUCKS	TRICYCLES
6-7	686	392	343	4	18	132	16
7-8	702	483	332	5	25	138	18
8-9	712	433	329	2	16	112	11
9-10	651	410	336	1	29	112	27
I0-11	691	420	328	4	17	118	16
11-I2	721	430	329	1	6	117	20
I2-1	682	430	339	2	15	100	12
1-2	736	448	340	1	8	90	7
2-3	699	400	341		17	103	9

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3-4	701	454	344		8	119	6
4-5	727	468	337	1	9	127	7
5-6	712	467	341	4	6	131	4
TOTAL	**8420**	**5235**	**4039**	**25**	**1740**	**1399**	**158**

The total traffic volume for both incoming and outgoing vehicles for Friday 5th may 2023 was 14790 vehicles.

Taking Friday as the peak day for the traffic census

- The total traffic volume/day for May 2022 = 6410 vehicles/day.
- The total traffic volume/day for May 2023=19450 vehicles/day.

Percentage change (% in traffic (from 2022-2023) = = 213.46%increase in traffic between 2022 and 2023.

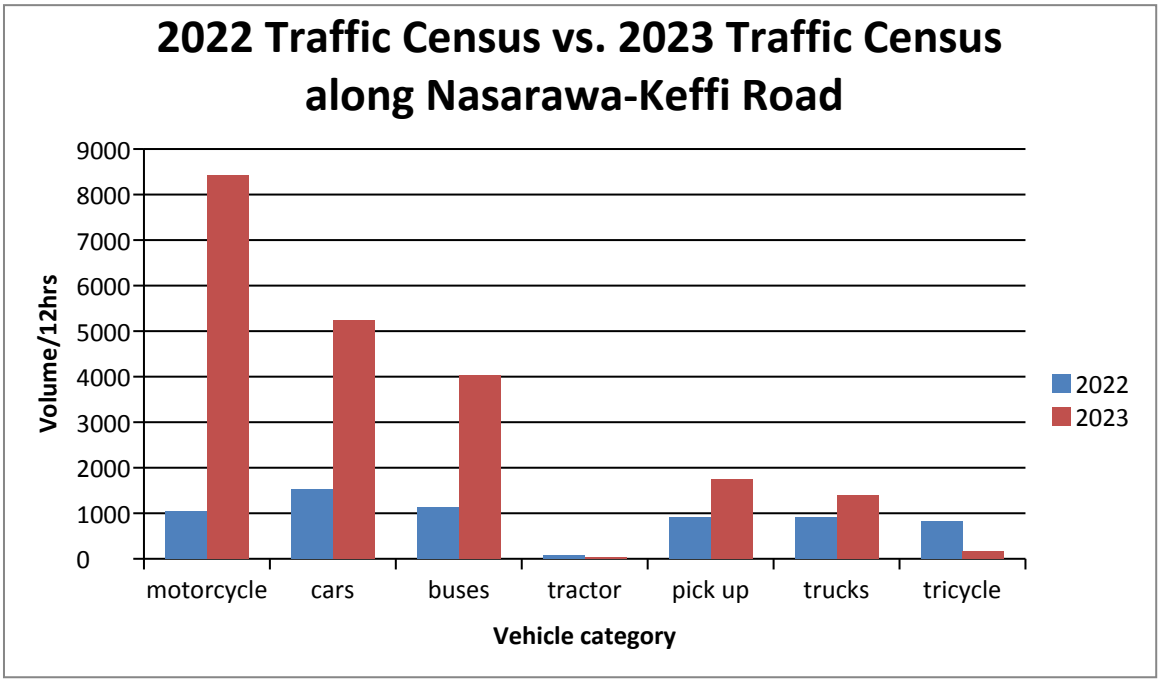

Fig 8: 2022 Traffic Census vs. 2023 Traffic Census along Nasarawa-Keffi Road

V.

VI. CONCLUSION AND RECOMMENDATION

4.1 CONCLUSION

At the end of the field works and the analyses of data collected for both the physical survey and the traffic census the following conclusions have been made:

i. The huge increase in the volume of traffic from May, 2022 to May, 2023 is an indication that the road is stressed way beyond its design capacity.

ii. This increase is largely due to the converted traffic from Lafia-Makurdi road to the newly rehabilitated Nasarawa-Oweto road through to Makurdi and south eastern region of the country.

iii. The much higher volume of trucks/day recorded in May, 2023is worrisome. Even as the volume recorded in 2022 was that high due to movement of construction trucks for hauling materials and equipment to and fro Loko-Oweto Bridge site and Nasarawa-Loko

road site, because then the two projects were still ongoing.

iv. The physical survey revealed serious surface defects (ranging from polished aggregate to complete stripping of the pavement in many areas) on the road pavement which affects riding comfort and journey time.
v. Lack of proper culverts at some valley areas which require such provisions has caused water logging and subsequent deterioration of the pavement layers
vi. Drainages are either not provided or damaged completely in most of the areas where the structures are seriously required.
vii. Shoulders have almost gone completely off probably due to uncontrolled runoff and vehicle navigating the shoulders due to poor condition of the carriageway at those points.

4.2 RECOMMENDATION

The following recommendations have been provided:

i. Adequate and standard drainages and culverts should be provided and the formation levels be appreciably raised in all the problem areas.
ii. The shoulders should be reconstructed as they are virtually non-existent in most areas along the stretch of the road.
iii. The pavement layers should be scarified, the subgrade stabilized and upgraded, and suitable pavement layers laid.
iv. Proper corrective maintenance should be done on those portions of the road affected by minor to medium distresses.
v. For the fact that two major highways, Nasarawa-Oweto road and Nasarawa-Abaji road linked up to the Nasarawa-Keffi road, there is need for the road to be expanded.
vi. Also because of very high traffic increase rate of about 214% from 2022 to 2023, there should be need for expansion of the road.
vii. The entire contract, design, construction, maintenance and operation plans should be guided by the most modern (state of the art) approaches as can be obtained in advanced countries from some parts ofEurope and Asia.

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