ANALYSIS AXLE AND WHEEL LOADS FOR CROSS-SECTIONAL DESIGN OF HIGHWAY IN NIGERIA (CASE STUDY YOLA-MUBI ROAD

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BEING A PROJECT TO BE SUMMITTD TO THE DEPARTMENT OF CIVIL ENGINEERING TECHNOLOGY, COLLEGE OF ENGINEERING TECHNOLOGY ADAMAWA STATE POLYTECHNIC, YOLA

IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF NATIONAL DIPLOMA IN CIVIL ENGINEERING TECHNOLOGY

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APPROVAL PAGE

This project has been submitted, meets and certified as meeting the requirement of the National Diploma in Adamawa State Polytechnic, College of Engineering Technology for the award of National Diploma in civil engineering technology.

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Date

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Date

DEDICATION

This project is dedicated to almighty God who in his infinite mercy gave us and strength, capability and endurance all through and also to our beloved parents, brother and sisters for their support both morally and financially.

Abstract

Axle and wheel loads as applied to road surface by heavy vehicle are believed to be an important cause of premature road failures, Yola-Mubi road the second busiest in Adamawa State, has recorded numerous fatal accidents due to various sections of the road. The aim of this project among others, is to determine the maximum axle and wheel loads that is being imposed on the carriage way and to analyze them, so to serve as a guide for future design. From the numerous methods available for the collection of data, the classified manual traffic census was formed most suitable for use. The axle load limit and the gross load limit methods of analysis were employed to analyses the collected results from the tabular format. The result showing gross load limit of 18946.8Tons and in a year is 985233.6Tons.*The method which has the highest values was recommended for use for loads of this nature.*

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CHAPTER ONE

1.0 Introduction

Axle and wheel loads applied to roads surface by heavy vehicle are believed to be an important cause of premature road failure, although the failure mechanism are not well understood, therefore an understanding of the pavement structure will be of great assistance.

A highway pavement is a structure consisting of super imposed layers of selected and processed materials whose primary function is to distribute the applied vehicle loads to the sub-grade. The ultimate aim is to ensure that the transmitted stresses are sufficiently reduced that they will not exceed the supporting capacity of the sub-grade. The vertical pressure being applied by the axle and wheel load on the surface is distributed over an area that is considerably longer than the area of contact between the tire and the carriage way. While the total vertical pressure occurred directly beneath center of the contact area and it becomes use and less as the horizontal distance away from the center becomes longer. The role of road transport system in this country is seen as being a necessity for stimulating economic activity. Because of this there is general understanding that improvement in road transportation should be taken as part of a carefully coordinated programme of development objective unfortunately, this is not the case at present due to the campus in planning procedures with this phenomenal increase in the volume of vehicles plying the roads and the excessive tonnage of goods being moved from one part of the state to another, these have caused a lot of damage or sometime both functional and structural failures of our roads the rate of this deterioration is enormous and alarming, especially in Adamawa. The intent of this project is to conduct traffic volume counts of all various categories of vehicles and analyze the axle and wheel loads and deduce which category causes the greater havoc in damage to our road especially in Yola to Mubi Road

1.1 Background of the Study

In Adamawa State of Nigeria there are three (3) major busy roads based on their economical activities being carried out in these areas and also being the major links to the other parts of the country. These major roads are;

i. Yola to Gombe state through Numan
ii. Yola to Borno State through Mubi
iii. Yola to Taraba State through Numan of three roads, Yola to Borno state through Mubi is the second busiest of the three.

Yola to Mubi covers a distance of 193Kmand links some very notable commercial town along the route link Girie (16Km, Song 73Km, GOmbi 114Km, Hong 141Km, Mararaba Mubi 173Km and Mubi a 193Km.
The first major construction work on the road was carried out in 1975 by an Italian construction company DTV. This was done to upgrade the road from an unpaved to a paved surface. The type of surfacing provided was simply surface dressed bituminous surface.
As the volume of commercial activities increase like the transportation of cows to the various part of the country grew higher in the volume of trucks increase the road deteriorated fast couple with bad maintenance culture inherent in government of this country.
In 1996 to 1998 during the Petroleum Trust Programme, the rehabilitation programme, the rehabilitation of these roads was awarded to Sterling Construction Company which eventually abounded the work with various sections of the road scarified and left opened. These sections become death trap to motorist plying the road.

In 2002, the federal government still awarded this section of the road to Julius Berger construction company and to extent the work based on the federal ministry of work standards and specification, that is the carriage way should be 7.3m with 2.75 surface dressed shoulders. Because of the commercial viability of the section of the road and because of the previous pavement failures in the past that is why the analysis of the axle and real roads becomes imperative.

1.2 Statement of the Problems

Over the years, Yola-Mubi road have witnesses tremendous increase in terms of vehicular movement of passengers and goods, while at the same time suffered neglect in terms of maintenance. This has led to numerous roads accident and frequent cross-sectional failures this project is aimed at analyzing the axle and whel load of vehicles currently plying the road to see if it is major factor causing failures. The result can be used as part of highway design to that roads can he built to achieve their design life.

1.3 Aims and Objective

The aims and objective of this project are listed below

i. To determine the maximum axle and wheel loas that the section can carry according to the standard code of civil engineering practice.
ii. To determine the maximum load that the road is design to carry and check whether the design life of the road can be achieved.

iii. To analyze these axle and wheel loading so as to serve as standards for various classes of roads in Adamawa state and the country in general.

1.4 Scope of the Study

This study is limited to the analysis of axle and wheel loads as it relates to road cross-sectional design and how these in turn affect the design life of the road.

CHAPTER TWO

2.0 Literature Review

For a mixture of historical and physical reasons, surface transportation in Africa is dominated by the rail and road system. Although the water ways were important avenues for the initial penetration of the continent, they have relatively title significance as a commercial means of transport. It is well known that the period of colonial occupation left Africa legacy of rail system oriented primarily towards the export of raw materials to Europe. In the road sector, there is no reliable estimate of kilometer movement since the post-1945 eras, but some influences can be drawn from changes in the number of vehicles and the length of the road system.

Prior now, the only existing work on pavement was that for (WAYNE COUNTRY, 1909) when he conducted research on pavement surface with various materials such as bricks, granite, wood, blocks and light concrete. This aim was evaluate the nature and level of which the axle and wheel of heavy duty equipment can affect the geometry of pavement. In 1922 and 1923, the Bates road test in illusion subjected 78 different pavement section to truck traffic. IT showed the benefit of ticking edges and longitudinal center line joints in reducing the amount of slab cracking in addition, the superiority of concrete over brick and asphalt pavement was demonstrated and the test led to the first thickness equation. Over the years from bates road lest to the late 1950s the bureau of public roads conducted many detailed measurement of pavement slap properties. In 1950 and 1951, the bureau of public roads (now federal highway administration) with highway research board (now the transportation research board). several state trucks manufacturer and other highway related industries conducted road test one MD just south Washington D.C. An existing 1.1mi (1.8Km) of two-long highway was carefully invented, instrumented and transverse by 1,000 trucks per day.

The AASHTO (American associated of state highway and transportation officials) road test was conducted at Ohawa from 1958 to 1960. Six loops of pavements were transverse by controlled truck traffic as part of statistical functional designs. The construction control at this test was a demonstration of all that had been learned about variabilities inherent in concrete production and pavement construction. This experiment yielded the best information ever developed on pavement, the AASHTO (American associate of staff highway and transportation officials) road test, two distinctive failure modes. The very thin pavement failed continues edge crack. The thicker pavement failed by joint pumping that caused transverse cracking starting particularly in traffic leave side of the joints. The dates from both were averaged together in the road test analysis to develop a performance equation, that of the 84 placement test sections greater than 81 (200m) thickness, only seven section had a series ability index of less than 40at the end of the testing in fact, only three sections would actually be considered as having failed. Hence, one can conclude that even through the AASHTO data is the best that we have, it hardly predicts failure of the thickness of pavement that are now being build (greater than 8in). Additionally, at the road test, there were no punch through (Shear failure) such as those produced a the Pitts burg road test under steel wheel, nor were there other types of environmental induced failures such as blow-ups, punch outs e.t.c.

Axle and wheel forces applied to road surfaces by heavy vehicle are believed to be an important course of premature road failure. Axle and wheel force are caused by vibration of moving vehicles excited by road surface roughness. They are influenced by vehicle speed, road roughness and the design of the vehicle, particularly its, suspension system. (CEBON, 1993 No. 372) carried out a comprehensive research and the influences of the road damage due to dynamic tire forces, suspension design and other vehicle features. There have been two main approaches for estimating the road damaging effect of axle and wheel forces. Some researchers (MITCHEL, 1989, No89, MONISMITH, 1988 No..90; O'CONNEL, 1986 No. 95) believe that the loading at each point along the road is essentially random, so that each point incurs statistically similar forces to each other point aid damage is uniformly distributed along the road. Studies in which such loading is assured predict an increase in road damage of approximately 20-30% due to dynamic loads, while (CEBON, 1885 #26,ERVIN, 1983 #44; HAHN 1985) believe that the peak forces applied by the heavy vehicle fleet are concentrated at specific locations along theroad. This effect has been term spatial repeatability under these circumstances, some locations along the road may be expected to incur up to four times more damage than average. The life of the road is then expected to be governed by the damage at these heavily loaded area.

Several studies have shown that a vehicle travelling over a road section at one speed generates a spatial distribution of dynamic loading that is repeated closely on subsequent test runs at the same speed. They suggested that because a large proportion of heavy vehicles tend to have similar geometry and dynamic characteristics and tend to travel at similar speed, spatial repeatability of road loading may be expected in normal traffic flow. Vehicles in a particular class tend to have similar mass distribution and geometry because of the nature of vehicle construction and use regulations most of experimental work on axle and wheel load has been performed using instrumented vehicles (CEBONO, 1993 #374). This approach has the advantage of relative simplicity and low cost when testing a small number of vehicles however, when the axle and wheel load of many vehicles are to be assessed quickly, instrumentry each one is not practical one methods of overcoming this problem is to drive vehicle over an instrumented section of road. The research described was performed by researchers at Cambridge University in conjunction with golden river traffic Ltd.

The mat contains capacity trip sensors, encapsulated in polyether tiles. The tiles are dimension 1.2mx13ml thick, and each one contains three sensors (1.2m long) laid transverse to the wheel path 0.4 apart.

Three methods of assessing road damage have been used to compare the vehicles measured in this equipment. The road survey efficient for each axle is calculated. This is a measure of how well a suspension group equalizes the total axle group between individual axle load, it does have implication for road damaging potential. Secondly, the dynamic load efficient is used to compare the R M A dynamic component of vehicle tire force.

Finally aggregate forces are calculated this road damage criterion has shown to be good for measurement errors by dividing the uncorrected SRI's by the corresponding reductions in peak SRI. The reference vehicles were chosen to be the vehicle that showed the highest aggregate correlation with all other vehicle in the fivet.

From the experiment, it can be seen that vehicles above threshold repeatability level of 0.7 is 53% which maybe compared to the 67% estimated for similar vehicles in Cole's theoretical study. This equipment were done by (SRFATMAN, 1983#127) than (POTTER, 1993# 1422). The different between the simulated and measured fleet of vehicles (e.g. axle spacing, suspension characteristics, gross vehicle weight e.t.c) the vehicle within each major calss have been sub-divided according to the type of suspension on the trailer limit (e.g. A2+2 (Air) refers to air suspension on the trailer). The reference vehicle was a 5-axle articulated vehicles traveling at 15m/s with a tri-axle air suspected trailer 41% of the articulated vehicle shows corrected Sri's above the threshold level of repeatability.

2.1 Highway and Airport Pavement Compared

Flexible pavement show distress at pavement edges, whereas, airfield pavement do not, the chief factors which must be considered in the design of highway and airfield pavement are the same, however, the difference exist in regards to the quantitative value assigned to each factor. The total weight of an aircraft is usually greater than that of a truck, but the number of repetitions of the load for a major highway in ordinary in the vicinity of 9000ibs

(4.082Kg) on dual tires and the expected trucks per day. In contrast, a heavy bomber may have wheel loads in excess of 100,00ibs (45, 359Kg) but only 20,000 to 40,000 coverage may be considered for the life of the pavement. Lateral placement of pavement of traffic on highway is such that nearly all trucks traffic travel within 1m to 1.2m of the pavement edge. In contrast traffic in the airfield is such that distribution of traffic on a runway is distributed over about 1m of pavement. From the above, it is seen that the major difference between highway and runway pavement are repetition of load distribution of traffic and geometry of the pavement width and the type of aircraft. For a given load and a given tire pressure highway pavements are thicker than airfield pavements because of repetition of load on highway is much greater or higher and also because the loads are applied closer to the pavement.

CHAPTER THREE

3.0 Materials and Methodology

3.1 Materials

The materials that were used to carry out this research work are as below,

i. using classified traffic census (foam Ai) used for national manual census by federal ministry of works

ii. using portable hand counters and the total entered into a tabulated data swet for analysis

iii. moving car observer method counting the number of vehicles plying the road

iv. automatic traffic counter with rubber tube fixed across the carriage way counted to the counter for recording traffic flow.

3.1.1 Classified Manual Traffic Census

This involves the manual counting of vehicle in both directions, which are those coming into the town and those going out of the town. Here vehicles are classified according to the carrying capacity and the number of axle of the vehicles. There is a specially formulated form (form AI) by the traffic unit of the federal ministry of works that is used to record the counted vehicles. The form has the following vital information which will enable enumerators to fill them accurately. The accuracy of the work is the most important consideration that will be able to provide the true data needed for design consideration.

i. Location: This gives the road number and also indicates where the side is in relation to a town or village.

ii. Direction: in the case where traffic passing in both directions will be recorded in one sheet by the enumerator, then the words "form" and "fo" should be struck out and replaced with "both" as the forms is designed for one directional flow.

iii. Day, Date and State: this information is very necessary and should be provide appropriately.

iv. Hour Ending: the forms hence been designed to cover a six hour period and "am" or "pm" should be added to identify what period of the day that the count is taking places

v. Classification: here the classification have been done into the following order;

a. passengers cars including taxis (carrying mainly passengers)
b. Pick-up and other small vehicles, includes pick-ups, vans, land rovers e.t.c used mainly for carrying goods.

c. Two axle commercial vehicles capable of carrying 30 cwt or more with also 2 axle tippers.
d. Buses, loaches and mumy wagon that is vehicles with more than 13 seats.
e. Vehicle with more than two axle this category include mainly heavy commercial vehicles, tankers, tippers, trailers e.t.c.
f. Recording: categories (a) to (d) the first five categories should be recorded by a diagonal strove in one of the small squares as each vehicle passes. Start at the top left hand square and work along to the end of the top line. After recording ten vehicles of the same type immense at the left hand end of the second row. Category (e) for vehicles with more than two axle should be recorded by showing in each square the number of axle possessed by the vehicle (e,g,3,4,5 e.t.c) after all ahs been done, totals of all the various categories are formed and analyzed by using any design method chosen.

3.1.2 Portable Hand Counter

This is a special equipment used to count the number of vehicles into plying the road. The counter is divided into four (4) having numbers that rotate as the knobs are pressed down to register a count. The four knob can be labeled according to the type of vehicles that needs to be counted. At the end of the days count the portable hand counter gives the total number of vehicles recorded by each of the fur divisions of compartments, this total of the various counts can then be analyzed. Here the count is fast but the tendency of miscounting types of vehicles designed for each compartment is very high which is mostly like to affect the accuracy of the counter.

3.1.2 Moving Car Observer Method

The moving car observer method of traffic stream movement has been developed to provide simultaneous measurement of stream variables like number of vehicles plying the road as at the time of conducting the count and also the space mean speed (n) and finally, the stream flow, that the number of vehicles per hour. This involves the use of a car and two observes noting vehicle moving in both directions. If "No" is number of vehicles overtaken the driver and "T" is the period of observation, then the observed flow is given by

$Q = \frac{No}{T}$ – (1)

If "NP" is the number of vehicles overtaken by the driver and of distance travelled of flow, then

$K = \frac{NP}{L}$ - (2)

Where L = VT, V measuring the observers speed from equation (1)
NO = QT and from (2)
NP = KTV
The relative cunt = No NP = N
N= QT - KTV

$$\frac{N}{T} = Q - KV - (3)$$

equation 3 is the basic equation for moving car observer method which relates the stream variable V and Q to NT and K, that can be measured by test vehicles when the car is travelling with the traffic stream then equation 3 become

$$\frac{NW}{Tw} = Q - KVW - (4)$$

and then the test car is moving "against" the travelling vehicle the equation (3(become

$$\frac{Na}{Ta} = Q - KVA - (5)$$

Therefore $Q = \frac{Na}{Ta} + \frac{NW}{TW} -$ (6)

This method is expensive and also cannot really capture the desired traffic volume at peak periods.

3.1.4 Automatic Traffic Counter

This consist of a computer (laptop), the traffic counter unit, metal box, 6mm rubber-hose and concrete nails. Then the metal box is fixed to a flat concrete base (slab). The traffic counter is kept inside the box with a special provision for its sitting the 6mm rubber-hose in laid across the entire length of the carriage way and fastened into the ground by the concrete nails, with special designed hooks for proper anchorage. The rubber is connected to the traffic counter which runs on special rechargeable dry cells. When activated the counter counts any vehicle that pases over the 6mm rubber-hose. Then vehicle pass over the rubber-hose it does not distinguishes the various categories of vehicles as may be required. The count is just wholesome of all vehicles, which is a very serious disadvantage for purpose, though the count is very accurate and precise. The results are retrieved by using laptop computer to down load the result from the traffic counter. The computer can now tell what number of vehicles that have passed within an hour, day, month and year. With these results average daily traffic ADT and annual average daily traffic AADT can be calculated. For the purpose of this project, this method is very expensive and the various categories of vehicles cannot be differentiated from the total traffic count.

From the four methods mentioned briefly above, the manual classified traffic census best suits the identifying which project and has the advantage of havoc or damage the roads. It is also very cheap compared to the other three methods, the only disadvantage is that it hectic and slow and might be associated with slight human errors here and there especially during counting using the tally max.

3.2 Methodology

The research methodology that will be employed to determine the axle and wheel loading in this road section of Yol-Mubi road and to analyze the result to see how these can affect the road section positively or negatively. The method that should be adopted is the classified manual traffic census. The reasons for the preference of this method have also been mentioned earlier. The traffic count was concluded seven (7) days from 7am to 6am. This is to give the true picture of the nature of traffic and the see why some certain period of the nature of traffic and see why some certain period generated more traffic than other. Here also peak periods can be noticed in the case, two enumerators where used, one for counting vehicles "to" and the other for counting vehicles "from" the counting is done for reduced by putting a designed stroke in one of the small square as each vehicles passes. This was started from the top left hand square and along to the end of the top line crow. After recording ten (10) vehicles of the same type (category) then counting commences again from the left hand and of the second row, then to the subsequent rows. At the end of the week along exercise the results gotten from the classified manual traffic count can be summarized into the format shown below and also a copy of the format attached for clarity.

Classified Traffic Census	Location		
	Direction From	To	State
	Weather Day	Date	
Hour ending			
Car and taxi axle			
Mini buses and pick-up axle			
Buses/watches2 axle			
Tippers and lorries 2 axle			
Semi tanker/trailer 3 axle			
More than 3 axle			

After collecting the results, there are various methods of analyzing the result, some of these methods are;

1. calculating the damage under axle load limits
2. calculating the damage under gross load limits
3. calculating the damage under legal load limits

CHAPTER FOUR

4.0 Analysis and Result

The analysis is carried out in tabular form in table below for result.

TABLE 1

DIRECTION OF FLOW → ←-SUNDAY 16-08-2015

TIME	DIRECTION OF FLOW	CARS & TAXI TAXCE	MINI BUSES & PICKINGS TAXCE	TIPPERS & LORRIES 2-AXLE [00]	BUSES/COACHES 2-AXLE [00]	TANKERS & TRAILERS 3-AXLE [00]	MORETHEM 3-AXLE E.G 5-AXLE [00]	TOTAL VEHICLE IN EACH DIRECTION	TOTAL VEHICLE PER HOR →→
	1	2	3	4	5	6	7	8	9
8AM	→	66	15	2	15	2	4	104	250
	←	105	9	1	21	4	5	145	
9AM	→	51	6	5	16	5	8	91	
	←	98	2	6	20	6	9	141	232
10AM	→	55	4	8	11	7	12	97	206
	→	62	12	7	12	1	15	109	
11AM	←	41	16	6	15	0	10	88	159
	→	28	8	5	25	1	4	71	
12PM	←	155	7	2	14	2	12	192	414
	→	166	8	1	31	1	15	222	
1PM	←	113	9	0	21	3	6	152	329
	→	121	12	1	31	4	8	177	
2PM	←	178	11	3	33	2	9	236	534
	→	210	15	2	51	3	17	298	
3PM	←	230	18	1	45	5	20	319	6[illegible]8
	→	181	21	0	62	7	18	289	
4PM	←	256	25	1	3[illegible]	8	15	335	612
	→	187	31	3	35	9	12	277	
5PM	←	310	42	5	40	2	7	406	758
	→	218	51	8	51	3	18	349	
6PM	←	321	45	13	35	2	21	437	892
	→	312	51	16	61	5	10	455	
	→ 1776 ← 1688	→ 198 ← 220	→ 46 ← 50	→ 275 ← 400	→ 38 ← 44	→ 124 ← 131			4994

TABLE 2

MONDAY 10-08-2015 ANNUAL CLASSIFIED TRAFFIC CENSUS IN YOLA ALONG YOLA –MUBI ROAD IN ADAMAWA STATE

TIME	DIRECTION OF FLOW	CARS & TAX 1 1-AXLE	MINI-BUSUSES & PICK-UPS 1-AXLE	TIPPERS & LORIES 2-AXLES [0,0]	BUSES/COACHES 2-AXLE (0,0)	TANKERS & TRAIKERS 3-AXLES (000)	MORETHAN 3-AXLES E.G 5-AXLES (00000)	TOTAL VEHICLE IN EACH DIRECTION	TOTAL VEHICLE PER HOUR
	1	2	3	4	5	6	7	8	9
8AM	→	345	39	12	12	9	3	420	686
	←	217	14	17	8	6	4	266	
9AM	→	343	15	10	12	4	7	391	675
	←	237	9	11	9	8	10	284	
10AM	→	220	15	12	14	7	6	274	478
	←	162	9	9	8	5	11	204	
11AM	→	232	16	12	9	5	4	278	454
	→	153	9	7	4	1	2	176	
12AM	←	220	8	15	7	4	3	257	434
	→	140	12	10	9	2	4	177	
1PM	←	270	9	13	7	4	2	305	488
	→	165	5	7	3	2	1	183	
2PM	←	280	7	6	8	3	5	309	505
	→	171	9	4	9	1	2	196	
3PM	←	215	3	5	6	4	2	235	404
	→	148	5	2	8	3	3	169	
4PM	←	287	6	4	9	6	1	313	532
	→	198	9	2	5	3	2	219	
5AM	←	310	7	3	13	9	5	347	685
	→	299	12	5	9	6	7	338	
6PM	←	361	9	7	15	17	6	415	
	→	314	14	12	7	12	4	363	778
									6116

TABLE 3 **7-07-2015** **TUESDAY**

TIME	DIRECTIONOF FLOW	CARS & TAXI 1-AXLE	MINI-BUSES & PICKUPS 1-AXLE	TIPPER & LORIES 2-AXLE(00)	BUSES/COACHES2-AXLE(00)	TANEERS & TRAILERS 3-AXLES(000)	MOORETHAN 3 AXLE E.G 5 AXLES (00000)	TOTAL VEHICLE IN DIRECTION	TOTAL VEHICLE PER HOUR
	1	2	3	4	5	6	7	8	9
8AM	→	329	42	4	7	4	10	396	738
	←	298	22	11	5	2	4	342	
9AM	→	302	21	5	10	4	6	348	630
	←	240	11	15	3	3	10	282	
10AM	→	298	15	7	8	2	6	336	551
	←	178	7	12	9	1	8	215	
11AM	→	232	14	21	22	12	4	305	545
	←	177	12	9	9	1	8	240	
12PM	→	210	17	8	11	6	5	251	444
	←	155	11	4	6	7	4	187	
1PM	→	212	3	7	7	9	3	241	421
	←	146	9	5	4	10	6	180	
2PM	→	278	2	3	5	9	3	300	487
	←	166	4	4	6	5	2	187	
3PM	→	281	7	8	3	7	4	310	552
		211	8	10	2	5	6	242	
4PM	←	298	9	9	10	14	7	347	600
	→	222	6	2	5	9	9	253	
5PM	←	313	11	5	19	16	10	374	672
	→	255	8	4	9	10	12	298	
6PM	←	330	15	3	22	14	9	393	672
	→	260	11	2	16	11	8	308	
								634	701

TABLE 4 WEDNESDAY 12-08-2015

TIME	DIRECTIONOF FLOW	CARS & TAXI 1-AXLES	MINI-& PICK UPS 1-AXLE	TIPERS& LORIES 2-AXLES (0,0)	BUSES/COACHES 2-AXLES(0,0)	TANKERS& TRAILERS 3-AXLES (0,0,0)	MORETHAN 3 AXLES E.G 5-AXLES (00000)	TOTAL VEHICLE IN EACH DIRECTION	TOTAL VEHICLE PER HOUR
	1	2	3	4	5	6	7	8	9
	→	445	12	5	12	4	8	486	845
8AM	←	298	17	9	14	16	5	359	
	→	390	16	5	13	1	10	435	768
9AM	←	295	7	6	9	9	7	333	
	→	390	18	26	9	6	11	460	683
10AM	←	165	15	17	15	4	7	223	
	→	225	16	25	20	10	10	306	493
11Am	←	120	13	21	18	9	6	187	
	→	177	18	11	10	9	5	230	371
12pm	←	98	12	7	9	12	3	141	
1pm	→	210	17	4	11	11	6	259	409
	←	115	14	3	8	6	4	150	
2pm	→	265	4	11	4	7	7	298	441
	←	117	12	3	4	4	3	145	
3pm	→	271	5	14	2	5	8	305	455
	←	125	11	5	3	2	4	150	
4pm	→	299	7	17	10	12	7	352	651
	←	260	15	9	6	4	5	299	
5pm	→	350	10	21	14	17	9	421	811
	←	310	22	19	15	13	11	390	
6pm	→	365	16	27	29	12	8	457	881
	←	320	25	25	31	11	12	424	
									6800

TABLE 5 THURSDAY 13-08-2015 DIRECTION OF FLOW ← TO MUBI → TO YOLA

Time	Direction offlow	Nim-buses & pickings 1-axle	Tippers & lontes 2- axle [00]	Buses / ceaches 2-axle [00]	Tankers & Trailers 3-axle [000]	Morethan 3-axle e.g 5 axles [00000]	Total vehicles in each direction	Total vehicles per hour	
	1	2	3	4	5	6	7	8	9
8am	→	327	16	3	5	2	4	357	619
	←	232	9	4	4	8	5	262	
9am	→	347	12	2	5	2	1	369	593
	←	192	16	3	8	3	2	224	
10am	→	205	22	3	8	3	2	224	448
	←	155	15	5	13	6	4	255	
11am	→	275	35	4	15	11	2	342	517
	←	152	11	2	3	3	4	175	
12pm	→	32	5	17	9	4	9	298	512
	←	13	4	2	4	6	4	214	
1pm	→	223	3	29	4	14	6	278	457
	←	154	2	11	3	3	4	179	
2pm	→	222	26	3	13	4	4	272	442
	←	148	10	4	3	3	2	170	
3pm	→	255	28	6	12	7	7	315	559
	←	210	12	4	4	6	8	244	
4pm	→	270	32	9	17	10	9	347	631
	←	220	16	10	20	12	6	284	
5pm	→	311	35	6	36	13	9	410	761
	←	281	17	4	30	11	8	351	
6pm	→	337	37	8	33	4	7	426	781
	←	292	19	6	28	7	3	355	
									6320

Table 6 **FRIDAY** **14-08-2015**

TIIME	DIRECTION OF FLOW	CARS & TAXI 1-axle	Mini-buses & pickups 1-axle	Tippers & lories 2-axle (00)	Buses/coaches 2-axle (00)	Tankers & trailers 3-axle (000)	More than 3-axle e.g5-axle (00000)	Total vehicle in each direction	Total vehicle per hour
	1	2	3	4	5	6	7	8	9
8am	→	331	19	5	6	2	5	368	649
	←	246	7	4	7	8	9	281	
	→	351	11	4	8	4	6	384	629
9am	←	199	18	5	7	5	11	245	
	→	210	21	6	9	9	12	267	472
10am	←	162	16	2	10	7	8	205	
	→	277	36	7	12	8	7	347	555
11am	←	161	12	4	15	12	4	208	
	→	241	33	9	18	9	5	315	564
12pm	←	192	15	3	21	11	7	249	
	→	260	12	5	6	4	3	255	435
1pm	←	161	11	3	2	2	1	180	
	→	120	9	0	3	1	2	135	341
2pm	←	198	5	0	1	1	1	206	
	→	221	15	2	4	4	2	248	450
3pm	←	166	19	1	9	3	4	202	
	→	241	20	7	11	9	11	229	567
4pm	←	199	25	8	15	8	15	268	
	→	310	30	10	19	12	18	399	765
5pm	←	260	37	12	22	14	21	366	
6pm	→	340	39	14	31	10	31	465	915
	←	311	42	10	32	13	36	450	6542

TABLE 7 **SATURDAY** **15-08-2015**

TIME	Direction of flow	Cars & taxi 1-axle	Mini-buses & pickups 1-axle	Tipper & lories 2-axle (00)	Buses coaches 2-axle (00)	Tankers & trailers 3-axles (000)	More than 3-axle e.g 5-axles	Total vehicle in direction	Total vehicle per hour
8am	1	2	3	4	5	6	7	8	9
	→	329	18	6	10	3	6	372	646
9am	←	231	5	8	15	5	10	274	
	→	312	10	7	12	6	11	358	630
10am	←	216	16	6	18	8	8	272	
	→	209	31	9	16	3	9	277	541
11am	←	192	22	10	22	5	13	264	
	→	11	33	13	18	7	11	393	677
12pm	←	212	14	16	31	3	86	284	
	→	219	33	9	45	4	7	316	570
1pm	←	161	27	8	49	2	4	254	
	→	201	21	5	21	1	3	253	466
2pm	←	156	15	8	28	3	2	213	
	→	199	18	7	19	2	1	247	426
3pm	←	141	13	2	21	1	1	179	
	→	231	25	5	15	4	3	281	538
4pm	←	178	36	6	25	9	4	250	
	→	251	41	9	45	10	5	360	679
5pm	←	210	33	12	51	8	7	319	
	→	341	45	10	55	11	8	469	908
6pm	←	298	51	9	61	12	6	439	
	→	350	41	13	56	15	13	481	888
	←	299	31	4	64	5	4	407	6969

SUMMARY OF DAILY COUNT

SUNDAY

CARS & TAXI 1-AXLES	MINI-BUSES & PICKUPS 1-AXLE	TIPPERS & LORIES 2-AXLE	BUSES/COACHES 2-AXLE	TANKERS &TRAILERS 3-AXLES	MORETHAN 3AXLE 5 AXLES	
3464	418	96	625	82	255	TOTAL=4994

MONDAY

CARS & TAXI 1-AXLE	MINI-BUSES & PICKUPS 1-AXLE	TIPPER & LORRIES 2-AXLES	BUSES/COACHES 2-AXLES	TANKERS & TRAILERS 3-AXLES	MORETHAN 3-AXLES 5-AXLES	
5287	217	185	191	121	96	TOTAL=6116

TUESDAY

CARS & TAXI 1-AXLE	MINI-BUSES & PICKUPS 1-AXLE	TIPPERS & LORIES 2-AXLES	BUSES/COACHES 2-AXLE	TANKERS & TRAILERS 3-AXLE	MORETHAN 3-AXLE 5-AXLE	
5391	265	158	206	173	148	TOTAL=6341

WEDNESDAY

Cars &taxi 1-axles	Mini-buses &pickups 1-axles	Tippers & lories 2-axles	Buses/coaches 2-axles	Tankers & trailer 3-axles	More than 3-axles 5-axles	
5610	302	290	266	184	156	Total=6808

THURSDAY

Cars & taxi 1-axle	Mini-buses pickups 1-axle	Tippers & lories 2-axles	Bus es/coaches 2-axles	Tankers & trailers 3-axles	More than 3-axles 5-axles	
5224	453	102	294	146	104	Total=6320

FRIDAY

Cars & taxi 1-axle	Mini-pickups 1-axles	Tippers & lorries 2-axles	Buses/coaches 2-axles	Tankers & trailers 3-axles	More than 3-axles 5-axles	
5117	452	127	268	156	222	Total=6342

SATURDAY

Cars & taxi 1-axle	Mini-buses pickups 1-axle	Tippers & lorries 2-axles	Buses/coaches 2-axles	Tankers& trailers 3-axles	More than 3-axles 5-axles	
5247	579	182	697	127	137	Total=6969

TABLE 8

TABLE OF DAILY TRAFFIC FLOW WITH AVERAGE DAILY TRAFFIC FACTORS [ADT]

A.D.T FACTOR	CARS & TAXI 1-AXLE	MINI-BUSES & PICKUPS 1-AXLE	TIPPERS & LORRIES 2-AXLES	BUSES/COACHES 2-AXLE	SMI TRAILER& SEMI TANKER2-AXLE	MORE THAN 3-AXLES
	1.2	1.3	1.6	1.5	1.6	1.6
SUNDAY	364*1.2=4157	418*1.3=544	96*1.6=154	675*1.5=1013	82*1.6=132	255*1.6=408
MONDAY	5287*1.2=6345	217*1.3=283	185*1.6=296	191*1.5=287	121*1.6=194	96*1.6=154
TUESDAY	5391*1.5=808	265*1.3=34	158*1.6=25	206*1.5=309	173*1.6=27	148*1.6=23
WEDNESDAY	5610*1.5=4815	302*1.3=393	290*1.6=464	266*1.5=399	184*1.6=234	104*1.6=167
THURSDAY	5224*1.5=7836	453*1.3=589	102*1.6=16	294*1.5=441	146*1.6=234	104*1.6=167
FRIDAY	5117*1.5=7811	452*1.3=588	127*1.6=204	268*1.5=447	156*1.6=250	222*1.6=356
SATURDAY	5247*1.5=7871	579*1.3=753	182*1.6=292	697*1.5=1046	127*1.6=204	137*1.6=220
TOTAL	50387	3495	1827	3942	1586	1792

TABLE 9

TABLE OF SUMMARY OF DAILY AND WEEKLY VEHICLE

TOTAL DAILY ALLOWANCE OF FLOW OF VEHICLE

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
6408	7559	9508	10216	9431	9521	10386

TABLE 10

TOTAL WEEKLY FLOW OF VEHICLE

Car & Taxi1-axle	Mini Buses & picks up 1-axle	Tippers & Lorries 2-axle	Buses/ Coaches 2-axle	Semi-Trailer & Semi Tankers 5-axle	More than 3-axle
50387	3495	1827	3942	1586	1792

TABLE 11

TABLE OF AXLE AND WHEEL LOADS FOR VARIOUS VEHICLES

S/N	Type of vehicle	No of axle	No of types	Tonnage of vehicles
1	Peugeot 504 [station wagon]	1	4	Net Weight=1219kg Allowance to carry=814kg Gross weight=2033kg Tonnage=2 Tons
2	Mini buses [Toyota Hiace	1	4	Net weight=1360kg Allowance to carry=900kg Gross weight=2,260kg Tonnage=2.3Tons
3	Mercedes Benz 911 [Tippers & Lorries]	2	6	Net weight=8000kg Allowance to carry=15000kg Gross weight=23,000kg Tonnage=23 Tons
4	DAF lorry	3	10	Net weight=11,000kg Allowance to carry=25,000kg Gross weight=36,000 Tonnage=41 Tons
5	DAT Trailer	4	14	Net weight=16,000kg Allowance to

				carry=30,000kg Gross weight=46,000kg Tonnage=46 Tons
	Iveco trailer	5	18	Net weight=19,000kg Allowance to carry=30,000kg Gross weight=49,000kg Tonnage=49 Tons

TABELE 11

TABLE OF ALLOWANCE AXLE LOADING OF VEHICLE

ars & Taxi -axle	Mini Buses & pick up	Tipper & Lorry 2-axle	Buses& Coaches 2-axle	Semi-trailers & Semi Tankers 3-axle	More than 3-axle
0387 *814 kg	3495*900kg	1827*15,000kg	3942*15,000kg	1586*25,000kg	1792*30,000kg
015018kg	314500kg	27405000kg	59130000kg	39,650000kg	53760000kg
1015.1 Tons	3145.5 Tons	2740.5 Tons	5913.0 Tons	3965.0 Tons	5376.0 Tons
AVERAGE LOADING					
22080259kg	43262500kg			3965.0Tons	5376.0 Tons
2208.0 Tons	4326.7 Tons				

TOTAL AXLE ALLOWANCE = 15875.7TONS

TABLE 12

TABLE OF WHEEL LOADING [GROSS WEIGHT] OF VEHICLES

s & Taxis 4 eels	Mini Buses & pick up 4 wheel	Tippers & Lorries 6 wheels	Buse & Coaches 6 whees	Semi-Trailers & Semi Tankers 10 wheels	Vehicles with 14 and above wheels
387*2033	3495*900kg	1827*15,000kg	3942*15,000kg	1586*25,000kg	1792*30000kg
2436771kg	3145500kg	27405000kg	59130000kg	49650000kg	53760000kg
24.3 Tons	3145.5 Tons	2740.5 Tons	5913.0Tons	3965.0 Tons	5376.0 Tons
AVERAGE LOADING					5376.0 Tons
791135.5K	43267500kg				
279.1 Tons	4326.7 Tons			**3965.0 Tons**	**5376.0 Tons**
OTAL WHEEL LOAD =18,946.8 Tons					

20 RESULTS

A. The total axle load from the week is 15875.7 Tons from the whole year, the total axle loading on the road will be multiply by 52 weeks that is

15875.7

*

52

<u>825536.4 Tons annually</u>

B. The total wheel with load that piled the road during the period of the census. To get the annual wheel load will multiply by 52 weeks that is

210,902.2

*

52

10,967,174.4 Tons.

V. Weigh bridges should be built all over the country so that approved axle and wheel loads are exceeded. Severe penalties should paid by every drivers.

VI. Government should seriously encourage private initiative in the construction and maintenance of roads as their contribution for national growth and development.

VII. National union of Road Transportation Workers [NURTW] should be educated of the dangers and damage caused by over loading of people and goods.

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