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"Traffic Study For The Design Of Rigid Pavement In The Municipality Of Arauquita"

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Abstract

In this research work, a traffic study was conducted on race. 2A between 9th and 11th streets in the Municipality of Arauquita, Department of Arauca, because it is necessary to complement information and obtain the traffic parameter for the design of a rigid pavement in this sector, in order to improve the conditions of the road. Initially, through an analysis, the equivalent axles for this design are calculated; a vehicle count of the main road to be intervened is performed because it lacks historical series of traffic counts and characteristics of the traffic in the low volume roads and lanes. A vehicle count was performed during one week to determine the vehicle volume, resulting in 205 vehicles per day, with a design period of 20 years; an annual growth rate of 2.5%; a roadway width of 7m, a reliability of 80%; and the TPDs were transformed into equivalent axles of 80KN to obtain the result of 603,609,563 equivalent axles of 80Kn.

Keywords*:* traffic; vehicular; parameters; axles; count.

1. Introduction

The purpose of the traffic study is to determine the incidence of vehicular loads and volume (Molina Martínez, C. J., & Ortega Cabascango, A. P. (2022) in order to obtain the design TRANSIT or traffic parameter (Cachay Puitiza, F. R., Chávez Menacho, M. A., & Marquina Valles, F. E. (2021).

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This variable is determined through the use of historical series of vehicle counts, which after an analysis, the equivalent axles of 80 KN are calculated for the design of pavement structures.

The construction industry faces great challenges (Hurtado-Figueroa, O., Cárdenas-Gutiérrez, J. A., & Acevedo Peñaloza, C. H. (2018) as the paving of roads in poor condition with concrete, commonly made with cement, aggregates and water, is currently the most used material (O Hurtado Figueroa, J A Cárdenas Gutiérrez and O Gallardo, 2018), in this case in the Department of Arauca this traffic study is carried out in order to perform a rigid pavement design.

Unfortunately, a quite frequent situation is the lack of information on the historical series and characteristics of traffic on highways and low volume roads.

For this reason, for the value of the traffic used for the design of the pavement structure, a vehicular capacity measurement was carried out on the main road to be intervened (Cachay Puitiza, F. R., Chávez Menacho, M. A., & Marquina Valles, F. E. (2021).

Method

- Design traffic estimation
- Vehicle counts and vehicle volume
- Conversion of average daily weekly traffic TPDs to 80 Kn equivalent axles
- Traffic design parameters
- Determination of equivalent axles (Veneziani, M., & de la Sotta Lazzerini, P. (2022).

2.1. Sample

Traffic study of Cra. 2A between 9th and 11th streets in the municipality of Arauquita.

2.2. Instrument(s)

In this research study, a vehicle count is carried out by means of field work (López, J. F. S., & Torres, J. C. C. (2022), using tools such as Microsoft Excel.

2.3. Parameters and design variables

2.3.1. Traffic

In this case it is considered according to the field work carried out by means of a vehicle count (Bellot Rodríguez, F., Peñas Martínez, E., & Ruiz Valero, A. (2022)..

2.4. Data analysis

Heavy traffic is considered, in which the total number of axles equivalent to 20 years is transformed and calculated (Montes de Oca Hidalgo, M. P., Sequeira Rojas, W., Ávila Esquivel, T., & Aguiar Moya, J. P. (2021).. According to the traffic that is projected to support the pavement structure.

Given that there is no historical series for the road under study, the gauging carried (Vallejo, P. M., Guacho, G. B., & Sanaguano, M. V. (2021) out during one week of the vehicles that travel on the main road leading through the sector was taken as a reference, in order to have data on the volume of vehicular traffic and the type of vehicles that travel on this road. The determination to take as reference the vehicular volume (Mendoza Raymundo, J. A., & Mendoza Valdizan, G. A. (2021) of this main road for the pavement design (Venecia-Camargo, C. A., & Niño-Castellanos, J. S. (2022), is due to the fact that the design road is directly interconnected with this main avenue, which will be taken as a percentage of the calculated vehicular volume, with which the iterations for the determination of the thickness of the granular layers and the concrete slab will be carried out.

3. Results and discussion

Vehicles were counted on the main road during one week to determine the volume of vehicles circulating in the project's area of influence; the results of the count are shown in the following table:

Table 1. Vehicle count

Day	Automobiles		Buses			Small two-axle truck	Large two-axle truck
	Cars	Trucks	Bus	Bus	Metro-politan bus	C2-P	C2-G
							
Monday	140	99	50	40	20	20	9
Tuesday	150	108	52	41	41	16	4
Wednesday	168	103	48	39	39	19	8
Thursday	135	117	51	42	42	18	7
Friday	155	120	53	39	39	17	9
Saturday	150	110	50	35	35	13	8
Sunday	90	81	9	7	7	6	5
Total weekly traffic	988	738	313	243	243	109	50
TPDS (veh/day)	141	105	45	35	35	16	7

Day	C3 y C4				C5	>C5
	Truck C3	Truck C4	Tractor truck C2S1	Tractor truck C2S2	Tractor truck C3S1	Tractor truck C3-S3
						
Monday	8	1	4	1	1	1
Tuesday	7	1	5	1	0	0
Wednesday	8	0	3	0	1	0
Thursday	6	1	5	1	0	0
Friday	6	0	4	0	1	0
Saturday	5	0	3	1	0	0
Sunday	4	0	2	0	0	0
Total weekly traffic	44	3	26	4	3	1

TPDS (veh/día)	6	0	4	1	0	0
TPDS (veh/day) automobiles	246					
TPDS (veh/day) buses	99					
TPDS (veh/day) trucks	34					
TPDS (veh/day) vehicles, buses and truck	133					
% Buses	74%					
% Trucks	26%					

Source. Prepared based on INVIAS

The average daily weekly traffic (Hudiel, S. J. N., & Arteaga, F. J. B. (2021) of commercial vehicles is determined to be 205 vehicles per day.

Since the design requires traffic in 80 Kn (Fajardo, C. A. H.) equivalent axles, the different equations are applied to calculate the 80 Kn equivalent axles in the design period.

3.1. Conversion of weekly average daily traffic (TPDs) to 80 Kn equivalent axles

In the conversion of TPDs to equivalent axles, the historical load damage factors for each vehicle group must be taken into account (Pacheco Colorado, C. A. (2021).

For the calculation of 80 Kn equivalent axles, the following formula is used

$$N_{80KN,TPDS\,2020} = TPDS_{2020} * \sum_{VEH1}^{VEHi} \frac{(\%Veh\ * Fdaño)/100}{100}$$

The damage factor is taken from the table proposed by Invias, depending on the type of axles counted in the vehicle capacity, this value is taken at full load since it is the most critical condition that can circulate on the pavement.

Table 2. Load damage factor by vehicle group**.**

Type of vehicle	Damage factor (DF)	
	Vacuum	Uploaded
Cars		0.0
Large bus		1.0
C2p	0.01	1.01
C2g	0.08	2.72
C3-C4	0.24	3.72
C5	0.25	4.88
>C5	0.26	5.23

Source. Prepared based on INVIAS

$$N_{80KN,TPDS\,2020} = \quad 178\ 80\ Kn\ shafts$$

3.2. Traffic design parameters

Table 3. Design Parameters

Design period (years)	20
Annual growth rate {r}	2.5%
Roadway width (m)	7.0
Directional factor	0.5
Reliability	80%
Zr	0.842

Source. Prepared based on INVIAS

- Design period (n): The design period taken is twenty (20) years.
- Annual growth rate (r): For this case a growth rate of 2.5% is taken, taking into account the percentages suggested by the INVIAS design manual, based on roads with low traffic volumes ranging from 2.0% - 3.0% (Hudiel, S. J. N., & Arteaga, F. J. B. (2021).
- Roadway width: The roadway width is 7 meters.
  - Directional factor: Given that the roadway will have more than six (6) meters, half of the total traffic is considered as design traffic (Bazan Cabrera, C. J., & De la Rosa Briones, J. A. (2022).

Table 4. Directional factor.

Roadway width	Design traffic	Fd
Less than 5m	Total in both directions	1.0
Equal to or greater than 5m and less than 6m	3/4 of the total in both directions	0.75
Equal to or greater than 56m	1/2 of the total in both directions	0.50

Source. Prepared based on INVIAS

  - Reliability: Reliability is taken as 80%, which means that at least 80% of the slabs are expected to be in good condition during the design period.
  - Zr: Depends on the reliability percentage taken for this case of 80%, the Zr is equal to 0.842.

3.3. Determination of the number of equivalent axles in the design lane for the base year.

The following formula was used to calculate this variable;

$$N_{80KN,DESIGN\ TRACK,BASE\ YEAR} = 365 * \left\{ \sum \left(\frac{Commercialvehiclesday}{both\ addresses} * \%Veh * Fdaño \right) \right\} * F_d$$

From this formula we have already calculated the value inside the bracket, leaving only the value obtained by Fd and the 365 days of the year to be affected (Pari Jimenez, S. D., & Chipana Jimenez, L. M. (2021)..

$$N_{80KN,CARRIL\ DE\ DISEÑO,AÑO\ BASE} = 48.906$$

3.4. Determination of the cumulative number of equivalent axles in the design lane for the design period

We take the following mathematical formula:

We take the following mathematical formula:

$$N_{80KN,DESIGN\ RAIL,ACCUMULATED} = N_{80KN,DESIGN\ TRACK,BASE\ YEAR} * \frac{(1+r)^n - 1}{r}$$

For

r = 2.5% and

n = 10 years, we have:

3.5. Determination of the number of equivalent axles in the design lane during the design period at the 80% confidence level.

For a confidence level of 80% the Zr is equal to 0.842

$$N'_{80KN,NORMAL\ DESIGN\ RAIL} = N_{80KN,DESIGN\ RAIL,ACCUMULATED} * (10^{0,05*Zr})$$

$$N'_{80KN,NORMAL\ DESIGN\ RAIL} = 603.690{,}563 Equivalent\ 80\ Kn\ shafts$$

5. Conclusions

A one-week vehicle gauging was carried out to obtain information on the volume and type of vehicles traveling on the road, where data was obtained for 205 vehicles per day.

In the calculation of the equivalent axles for the design period, taking into account the damage factors, the annual growth rate of 2.5%, the traffic volumes, the width of the roadway, the directional factor; with a reliability of 80%, a total of 603,690.563 equivalent axles of 80 Kn was obtained, data that will be used for the design of the rigid pavement of this roadway.

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