THE EFFECT OF PEAK LOAD ON DEPTH OF RUTTING DURING NARROW CRACKS ON ASPHALT PAVEMENT

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Abstract

The Pantoloan-Taweli road section with an Arterial Road arterial road function has a Pantoloan Port as a national logistics and goods center, as the location of the Palu Special Economic Zone (SEZ) location is estimated to have a much larger percentage of heavy vehicles and cause rutting damage to the asphalt surface, so it is necessary to know how the peak load affects the thickness of the pavement, the time of occurrence of narrow cracks, wide cracks, and 50% cracks and rutting is used Highway Development and Management (HDM) III, from CBR data and ADT pavement service life is planned for 5,10,15, and 20 years. From the results of the study, it is known that the longer the service life or the design life, the greater the peak load value where the greater the peak load value, the thicker the flexible pavement layer, and the faster the predicted that the road will crack. Effect of crack occurrence time on rutting depth (RDM) with variations in design life, i.e. the longer the design life of a road, the faster the time for narrow cracks, wide cracks, and 50% cracks, and the deeper the rutting that occus on asphalt pavements.

Keywords: Peak Load, Narrow Cracks, Age of Plan, TYN, and Rutting

Abstrak

Ruas jalan Pantoloan-Tawaeli dengan fungsi jalan arteri memiliki Pelabuhan Pantoloan sebagai pusat logistik dan barang nasional, sebagai lokasi Kawasan Ekonomi Khusus (KEK) Palu yang diperkirakan presentase kendaraan beratnya jauh lebih besar dan menyebabkan kerusakan rutting pada permukaan aspal, sehingga perlu diketahui bagaimana pengaruh beban puncak terhadap tebal perkerasan, waktu terjadinya retak halus, retak lebar, dan retak 50% dan rutting, digunakan *Highway Development and Manajemen* (HDM) III, dari data CBR dan LHR direncanakan umur layanan 5, 10, 15 dan 20 tahun. Dari hasil penelitian diketahui bahwa semakin lama umur layanan maka nilai beban puncak akan semakin besar. dan semakin besar nilai beban puncak maka lapis perkerasan lentur yang dibutuhkan akan semakin tebal dan semakin cepat jalan tersebut diprediksi mengalami retak. Pengaruh waktu terjadi retak terhadap kedalaman rutting dengan variasi umur rencana yaitu semakin lama umur rencana maka semakin cepat waktu terjadi retak Halus (TYN), Retak Lebar, Retak 50% maka semakin dalam rutting yang terjadi pada perkerasan beraspal.

Keywords: Beban Puncak, Retak halus, Umur Rencana, TYN, and Rutting

INTRODUCTION

Background

The Taweli-Pantoloan Road section, which is 4 km long, belongs to Class III-A Road, this is in accordance with the Decree of the Minister of Transportation No. 13 of 2001, regarding the determination of Class Roads on Sulawesi Island. if related to the Government

Regulation of the Republic of Indonesia, Number 43 of 1993, regarding Road Infrastructure and Traffic, then this road class, from a functional standpoint, is an Arterial Road that can only be passed by motorized vehicles with a width that may not exceed 2,500 millimeters, length does not exceed 18,000 millimeters, and the maximum permitted Axle Load (MST) is 8 tones.

But the reality on the ground, the heavy vehicles that pass on the road all violate the required maximum weight. This is reinforced by the data released by the Kayumalue Motorized Vehicle Weighing Implementation Unit (UPPKB) on July 30 2020, where out of 43 heavy vehicles inspected at the weighbridge all the MST exceeded 8 tones. This is exacerbated by the weighing unit's policy which allows vehicles weighing more than 8 tons to pass on these roads. Recorded overweight of heavy vehicles varied from 136% to 362%.

No wonder the road surface on the Taweli-Pantoloan Section suffers such rapid damage. This violation is suspected to be the main trigger for plastic deformation (rutting) and cracking (cracking) along the road section. The reason is, because MST is the amount of maximum pressure the vehicle wheels against the road. In other words, the axle load is the load of the vehicle that is distributed on a vehicle's supporting axis in the form of the axle. The heavier a vehicle, the load on the axle will be heavier. If the carrying capacity of the road is not able to withstand the axle load, the road will be damaged.

In the coming years, heavy vehicles with an MST of over 8 tons that will pass through the Taweli-Pantoloan Road Section will continue and even tend to increase with the integration of the Pantoloan Port with the Palu Special Economic Zone through Government Regulation Number 31 of 2014 The Palu SEZ will support Indonesia, which is a producer of nickel, cocoa and seaweed, and is the first area designed by the government as an integrated logistics center and mining processing industry in the Sulawesi economic corridor.

The road that is around the Pantoloan Port, in 2014 the government established the Pantoloan port as a national logistics and goods center, and now the Pantoloan port has the status of an international port. The development of this port is also to support the Palu Special Economic Zone (SEZ), which is divided into 3 zones, namely the industrial zone, export processing zone and logistics zone. This happens because the logistics transportation to and from the port every day is relatively high, which can cause fine cracks on the asphalt pavement of the Trans Pantoloan Road.

With the above background, the author wants to examine how many heavy vehicles pass during peak hours around Pantoloan Harbor on the Pantoloan-Taweli Arterial Road Section, as well as the effect of rutting damage caused to the asphalt surface, by taking the research topic "The Effect of Peak Load on Depth of Rutting During Narrow Cracks on Asphalt Pavement”.

Research Purpose

1. To determine the thickness of the flexible pavement layer at the peak load on the Trans Pantoloan Road based on the design age group.

2. To determine the effect of variations in heavy vehicle loads until narrow cracks (NC) occur during peak load conditions on flexible pavements.
3. To analyze the effect of peak load on rutting depth when narrow cracks, wide cracks, and 50% cracks.

RESEARCH METHODS

The research location is on the Tawaeli-Pantoloan road, Central Sulawesi Province. Meanwhile, when the traffic survey was conducted for 5 days, namely 4 working days and 1 holiday, the traffic survey was carried out for 16 hours, starting at 06.00 in the morning until 22.00 at night.

Primary Data

ADT data survey: ADT data is obtained from vehicle surveys carried out manually by surveyors at observation points on the Pantoloan road section. From this road section, traffic data is taken for 16 hours, ie from 6 am to 10 pm. And Subgrade CBR Data (CBRsg) : CBR data retrieval is carried out directly in the field (field CBR) using the DCP tool.

Secondary Data

In the form of a location map obtained from google earth. For existing road data and CBR sub-base and CBR base data obtained from the Balai Jalan Nasional XIV. The data on the density of the asphalt layer and the volumetric data of the asphalt mixture obtained from previous studies are by the aggregates used on the Tawaeli-Pantoloan road section.

Data analysis

Value of Elastic Modulus (Stiffness) of Asphalt, Sb is Factors that affect changes in asphalt stiffness are asphalt characteristics and loading time. And Value of Elastic Modulus (Stiffness) Asphalt Concrete, SME is Factors that affect the stiffness value of asphalt concrete are the stiffness of asphalt as a binding material and the density level of the mixture expressed in VMA. And Traffic Survey Results Data obtained from the calculation results of the equations, which include the equivalent figures for vehicle axle load (E), daily cumulative standard axle load (w18 days), annual cumulative standard axle load (w18 years), and standard axle load for the design lane during the design life (Wt)

LITERATURE REVIEW

Components of Road Drainage System

The components of a pavement structure dewatering system consist of a) crossfall leading water away from pavement, road shoulders allowing water to flow to the ditches and not infiltrate into the pavement structure and c) impermeable pavement, which means practically a high enough compaction degree and a low enough air voids content (Molenaar, 1994) . The dewatering system should be always improved during a paving or pavement rehabilitation process. The best results will be obtained if this is done one year before paving operations. This will for instance make asphalt compaction easier.

The components of the pavement structure dewatering system consist of a) crossfall that directs water away from the pavement, b) the shoulder which allows water to flow quickly into the drainage so as to prevent it from seeping into the pavement structure and c) impermeable pavement, which means a fairly high level of compaction and the content of voids. the air is low enough so that rainwater does not seep into the pavement structure (AASHTO, 1993).

According to Molenaar (2018) and Hadijah et al (2017) that the main purpose of a road drainage system is to remove water from the road and its surroundings. The road drainage system consists of two parts: dewatering and drainage. What is meant by "dewatering" is the disposal of rainwater from the road surface or the collection and transportation of water from the road surface so that there are no puddles on the road bodies and in ditches. Meanwhile, “drainage” includes all the different infrastructure elements to keep the road structure dry.

Over Dimension and Loading

If traffic survey data will be used for road pavement design needs, which include selecting the type of material, determining the thickness of each pavement layer, analyzing the causes and handling of road damage, then the peak load is defined as the highest number of heavy vehicles passing at an observation point in the area certain roads (Sukirman, 1999) and Ramadhan et al (2017).

According to KD No.273/Hk.105/DRJD/96 that the definition of heavy vehicle is any vehicle with a tire configuration of more than four wheels, which can be a bus, 2 axle truck, 3 axle truck, or a combination truck. Meanwhile, according to SKBI 2.3.26.1987/SNI 03-1732-1989 that heavy vehicles are vehicles with a total load greater than 5 tons. In this joint decree, the types of heavy vehicles referred to are buses, trucks, tractors, semi-trailers and traillers.

Trucks are motorized vehicles for transporting goods, so they are commonly referred to as goods cars. In a smaller form, a freight car is referred to as a pick-up, while in a larger form it is referred to as a tronton truck, while those used for transporting containers in patch form are referred to as trailer trucks. Truck carrying capacity depends on several variables, including the number of tires, number of axles/axle configuration, axle load, tire strength, and road carrying capacity.

In the Decree of the Minister of Transportation Number 13 of 2001, regarding the determination of the Road Class on Sulawesi Island, the Taweli-Pantoloan Road Section with a length of 4 km is included in the Class III-A Road, which if it is associated with the Government Regulation of the Republic of Indonesia, Number 43 of 1993, concerning Infrastructure and Road Traffic, then this road class, from its functional point of view, is Arterial Road which can only be traversed by motorized vehicles with a width that cannot exceed 2,500 millimetres, a length that does not exceed 18,000 millimetres, and a maximum permitted Axis Load (MST) 8 tons.

According to Undang-Undang No. 14 of 1992, that the definition of road class is a road classification based on the Heaviest Axis Load (MST) and traffic characteristics. Furthermore, it is explained in the Undang-Undang that MST is the maximum allowable axle load of motorized vehicles, which must be supported by roads. Setting MST restrictions according to road class is needed to prevent early damage and so that road construction can provide services in accordance with the planned design life.

MST is the maximum amount of pressure the vehicle's wheels have against the road. In other words, the axle load is the vehicle load that is distributed on an axle supporting the vehicle in the form of a wheel axis (Huang, 1993), AASHTO (1993). The heavier the vehicle, the heavier the load on its axle. The more axles, the load on each axle will decrease because the overall load will be distributed over many axles to the road foundation. If the carrying capacity of the road is not able to withstand the axle load, the road will be damaged (Brown, S. F, et al, 1984) and (Hilmi et al, 2016). Therefore, the MST restrictions that are allowed to pass on a certain road class are set. In Indonesia, the MST for road class I has not been determined (for some European countries it is set at 13 tons), for road class II it is 10 tons, and for road class III it is 8 tons (NAASRA. 1987).

Damage occurs due to loads that exceed the capacity of the road, meaning that if the road is only designed to withstand an MST weighing 8 tons, then this infrastructure will be damaged when a vehicle with an MST above 8 tons passes (Ramadhan et al, 2017) and Hutauruk, 2015). Violations of Axis Loading are controlled through Weighbridges by the Provincial Transportation Service, especially on strategic routes so that overloads can be better controlled.

According to the Road Maintenance Manual No: 03/MN/B/1983 issued by the Directorate General of Highways, that the Groove (Ruts) is one form of damage from the many structural damage to road construction that results in the pavement being unable to properly bear the traffic load. that crossed over it. Grooves occur in the track of the wheels parallel to the axle, which is where rainwater collects, thereby reducing comfort levels, and eventually causing cracks. Abdillah (2013) stated that the occurrence of grooves is caused by a less dense pavement layer, thus additional compaction occurs due to the repetition of traffic loads on the wheel track. Asphalt mixtures with low stability can also cause plastic deformation.

RESULTS AND DISCUSSION

Table 1. Traffic Survey Results

No	Transportation Type	Group	ADT 2020					
1	Motorcycle	1	569	549	438	1254	599	492
2	Sedans, Jeeps	2	144	139	183	134	251	80
3	Pick Up, City Transportation	3	6	10	10	30	36	17
4	Pick Up Box	4	10	9	32	77	83	35
5	Small Bus	5a	0	1	0	0	0	0
6	Big Bus	5b	0	0	0	1	0	0
7	2 Axis Light Truck	6a	13	35	58	2	0	1
8	2 Axis Medium Truck	6b	17	67	47	56	114	40
9	3 Axis Truck	7a1	29	23	25	3	16	5
10	Trailer Truck	7b	1	1	0	0	0	2
11	Semi-Trailer Truck	7c1	1	0	2	9	4	2
12	Non-Motorized Vehicles	8	0	0	2	0	0	0

Source: Traffic Survey Results (2020)

Table 2. UPPKB Kayumalue Vehicle Data Date 30 July 2020

Group	Transportation Type	Axis Configura tion	Allowabl e Weight (Ton)	Number of Vehicle s/ Day	Total Weight	Overload Weight (Ton)	Overload (%)
4	Pick Up	1.1	1950	20	2810	860	44,103
6a	2 Axis Light Truck	1.2	8000	40	10928,3	2928,25	36,603
6b	2 Axis Medium Truck	1.2	14050	2	20540	6490	46,192
7a	3 Axis Truck	1.2.2	19380	1	28970	9590	49,484

Source: UPPKB Kayumalue

Table 3. Traffic Growth Value

No.	Transportation Type	Grou p	ADT 2017	ADT 2018	ADT 2019
1	Motorcycle	1	16871	16854	17451
2	Sedans, Jeeps	2	619		2675
3	Pick Up, City Transportation	3	2295	4516	453
4	Pick Up Box	4	1382		1294
5	Small Bus	5a	18	10	14
6	Big Bus	5b	5	2	3
7	2 Axis Light Truck	6a	401	30	78
8	2 Axis Medium Truck	6b	269	687	621
9	3 Axis Truck	7a	240	143	74
10	Trailer Truck	7b	0	5	2
11	Semi-Trailer Truck	7c	257	88	3
12	Non-Motorized Vehicles	8	47	0	13
	Amount		22404	22335	22681
	$x = ADT_n / ADT_{n-1}$			0,9969	1,0155
	$\sqrt[n]{x}$			0,9969	1,0155
	$\sqrt[n]{x} - 1$			-0,003	0,015
	i (%)			-0,308	1,549
	i (%) a year			1,241	

Source: LHR (Central Sulawesi Province National Road Implementation Center)

Traffic growth over the life of the plan is calculated based on traffic data for 2017, 2018, and 2019 on the Tawaeli-Pantoloan Road Section, from the results of the analysis of the annual traffic growth rate (i) on the Tawaeli-Pantoloan Road Section of 1.241%.

Pavement Layer Thickness

In determining the pavement thickness based on the 2017 Pavement Design Manual guidelines, the pavement thickness design is based on the ESA value to the power of 5, the power of 5 is used for flexible pavement design (related to the asphalt concrete fatigue factor in the design with an Empirical Mechanistic approach) including overlay thickness planning based on the graph curvature curve for fatigue crack criteria. The calculation of the Cumulative Standard Axis Load for each design age is presented in table 4.

Table 4. Cumulative Standard Axis Load for each design life

Design Life	5	10	15	20
I	1,24%	1,24%	1,24%	1,24%
R	5.126	10.577	16.376	22.543
CESA	4,50E+05	9,29E+05	1,44E+06	1,96E+06
	9,09E+05	1,88E+06	2,90E+06	4,00E+06
	6,76E+05	1,40E+06	2,16E+06	2,97E+06
	6,41E+05	1,32E+06	2,05E+06	2,82E+06
	1,24E+06	2,57E+06	3,97E+06	5,47E+06
	6,00E+05	1,25E+06	1,94E+06	2,67E+06

The thickness of the pavement layer is determined based on the cumulative axis load on the planned lane so that the pavement thickness for each design life is obtained as follows:

Table 5. Pavement Design Thickness for each design life

Design Life	AC-WC	AC-BC	AC-Base	Base Course	Pavement Thickness
5	40	60	-	400	100
	40	60	-	400	100
	40	60	-	400	100
	40	60	-	400	100
	40	60	-	400	100
	40	60	-	400	100
10	40	60	-	400	100
	40	60	-	400	100
	40	60	-	400	100
	40	60	-	400	100
	40	60	70	300	170
	40	60	-	400	100
15	40	60	-	400	100
	40	60	70	300	170
	40	60	70	300	170
	40	60	70	300	170
	40	60	70	300	170

Design Life	AC-WC	AC-BC	AC-Base	Base Course	Pavement Thickness
	40	60	-	400	100
20	40	60	-	400	100
	40	60	70	300	170
	40	60	70	300	170
	40	60	70	300	170
	40	60	80	300	180
	40	60	70	300	170

Bitumen Elasticity Modulus (Sb)

From the calculation results, it is found that the Bitumen Modulus (Sb) value decreases with increasing Pavement Thickness (h), Pavement Thickness, a flexible pavement design table is obtained based on the cumulative axis load for each design life.

Table 6. Calculation of the Elasticity Modulus

Design Life	Pi (mm, 25°C, 5 Sec)	Pr	SPr	27 log Pi	76.35 log Pi	Plr	h (mm)	v (km/hour)	log t	T	Sb (Mpa)	Sb (Psi)
5	66,6	43,29	55,281	49,234	139,222	-0,295	100	60	-1,82	0,015	18,51	2685,06
	66,6	43,29	55,281	49,234	139,222	-0,295	100	60	-1,82	0,015	18,51	2685,06
	66,6	43,29	55,281	49,234	139,222	-0,295	100	60	-1,82	0,015	18,51	2685,06
	66,6	43,29	55,281	49,234	139,222	-0,295	100	60	-1,82	0,015	18,51	2685,06
	66,6	43,29	55,281	49,234	139,222	-0,295	100	60	-1,82	0,015	18,51	2685,06
	66,6	43,29	55,281	49,234	139,222	-0,295	100	60	-1,82	0,015	18,51	2685,06
10	66,6	43,29	55,281	49,234	139,222	-0,295	100	60	-1,82	0,015	18,51	2685,06
	66,6	43,29	55,281	49,234	139,222	-0,295	100	60	-1,82	0,015	18,51	2685,06
	66,6	43,29	55,281	49,234	139,222	-0,295	100	60	-1,82	0,015	18,51	2685,06
	66,6	43,29	55,281	49,234	139,222	-0,295	100	60	-1,82	0,015	18,51	2685,06
	66,6	43,29	55,281	49,234	139,222	-0,295	170	60	-1,79	0,016	17,97	2606,60
	66,6	43,29	55,281	49,234	139,222	-0,295	100	60	-1,82	0,015	18,51	2685,06
15	66,6	43,29	55,281	49,234	139,222	-0,295	100	60	-1,82	0,015	18,51	2685,06
	66,6	43,29	55,281	49,234	139,222	-0,295	170	60	-1,79	0,016	17,97	2606,60
	66,6	43,29	55,281	49,234	139,222	-0,295	170	60	-1,79	0,016	17,97	2606,60
	66,6	43,29	55,281	49,234	139,222	-0,295	170	60	-1,79	0,016	17,97	2606,60
	66,6	43,29	55,281	49,234	139,222	-0,295	170	60	-1,79	0,016	17,97	2606,60
	66,6	43,29	55,281	49,234	139,222	-0,295	100	60	-1,82	0,015	18,51	2685,06
20	66,6	43,29	55,281	49,234	139,222	-0,295	100	60	-1,82	0,015	18,51	2685,06
	66,6	43,29	55,281	49,234	139,222	-0,295	170	60	-1,79	0,016	17,97	2606,60
	66,6	43,29	55,281	49,234	139,222	-0,295	170	60	-1,79	0,016	17,97	2606,60
	66,6	43,29	55,281	49,234	139,222	-0,295	170	60	-1,79	0,016	17,97	2606,60
	66,6	43,29	55,281	49,234	139,222	-0,295	180	60	-1,78	0,017	17,90	2595,58
	66,6	43,29	55,281	49,234	139,222	-0,295	170	60	-1,79	0,016	17,97	2606,60

Asphalt Mixture Modulus of Elasticity (SME)

The value of the modulus of elasticity of the asphalt mixture (SME) was obtained based on the VMA and bitumen modulus (Sb) data, the percentage of VMA was obtained from the previous test, with the manufacture of hot compacted asphalt mixture and the volumetric analysis of the mixture for each asphalt content used. Based on the 2018 Bina Marga General Specifications, the minimum VMA value is 15% so the existing data meets the specifications.

Table 7. Calculation of the Elasticity Modulus of Asphalt Mixture (SME)

Design Life	VMA	Sb	N	257.5 - 2.5 VMA	n (VMA - 3)	Sme (Mpa)	Sme (Psi)
5	16,53	18,51	2,77	216,18	37,44	2370,67	343837,3
	16,53	18,51	2,77	216,18	37,44	2370,67	343837,3
	16,53	18,51	2,77	216,18	37,44	2370,67	343837,3
	16,53	18,51	2,77	216,18	37,44	2370,67	343837,3
	16,53	18,51	2,77	216,18	37,44	2370,67	343837,3
	16,53	18,51	2,77	216,18	37,44	2370,67	343837,3
10	16,53	18,51	2,77	216,18	37,44	2370,67	343837,3
	16,53	18,51	2,77	216,18	37,44	2370,67	343837,3
	16,53	18,51	2,77	216,18	37,44	2370,67	343837,3
	16,53	18,51	2,77	216,18	37,44	2370,67	343837,3
	16,53	17,97	2,78	216,18	37,59	2319,95	336481,5
	16,53	18,51	2,77	216,18	37,44	2370,67	343837,3
15	16,53	18,51	2,77	216,18	37,44	2370,67	343837,3
	16,53	17,97	2,78	216,18	37,59	2319,95	336481,5
	16,53	17,97	2,78	216,18	37,59	2319,95	336481,5
	16,53	17,97	2,78	216,18	37,59	2319,95	336481,5
	16,53	17,97	2,78	216,18	37,59	2319,95	336481,5
	16,53	18,51	2,77	216,18	37,44	2370,67	343837,3
20	16,53	18,51	2,77	216,18	37,44	2370,67	343837,3
	16,53	17,97	2,78	216,18	37,59	2319,95	336481,5
	16,53	17,97	2,78	216,18	37,59	2319,95	336481,5
	16,53	17,97	2,78	216,18	37,59	2319,95	336481,5
	16,53	17,90	2,78	216,18	37,61	2312,79	335442,4
	16,53	17,97	2,78	216,18	37,59	2319,95	336481,5

Pavement Analysis to the Occurrence of Narrow Cracks (TYN), Wide Cracks (TW), and 50% Cracks

To predict the occurrence of Narrow Cracks (TYN), Wide Cracks (TW), and 50% Cracks, cumulative standard axis load data (wt) is needed for each design life, namely 5 years, 10 years, 15 years, and 20 years.

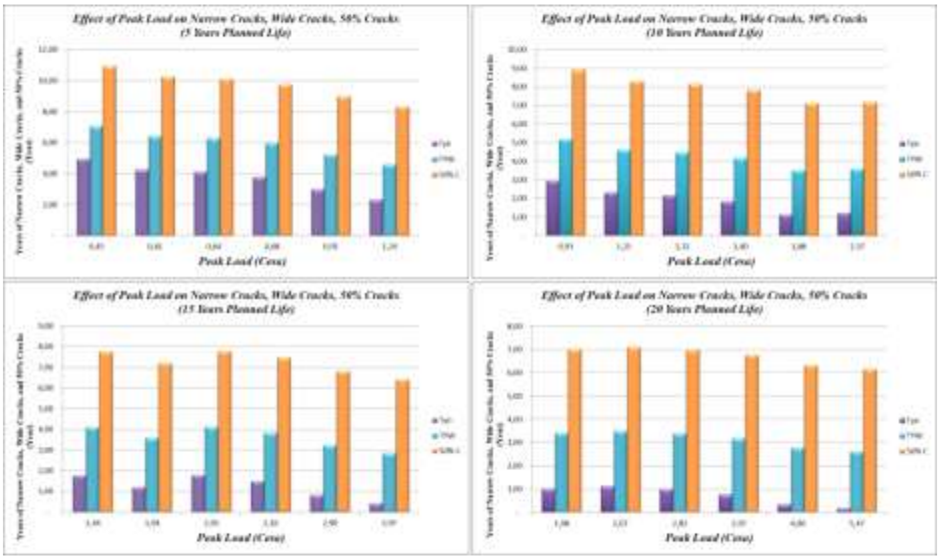

Figure 1. Effect of Peak Load on Narrow Cracks, Wide Cracks, and 50% Cracks for 5, 10, 15 and 20 Years of Service

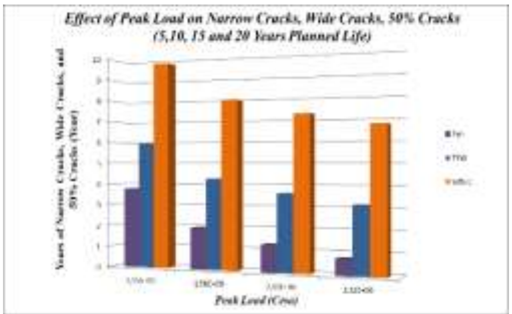

Figure 2. Effect of Average Peak Load on Average Narrow Cracks, Wide Cracks, and 50% Cracks

From Figure 2 it is known that the effect of peak load on the time of cracking with a design age of 5, 10, 15, and 20 years, namely the longer the planned service life, the greater the peak load, so the greater the peak load, the faster the cracking time. Narrow cracks, wide cracks, or 50% cracks.

Pavement Analysis of Narrow Cracks (TYN), Wide Cracks (TW), and 50% Cracks to Rutting Depth (RDM)

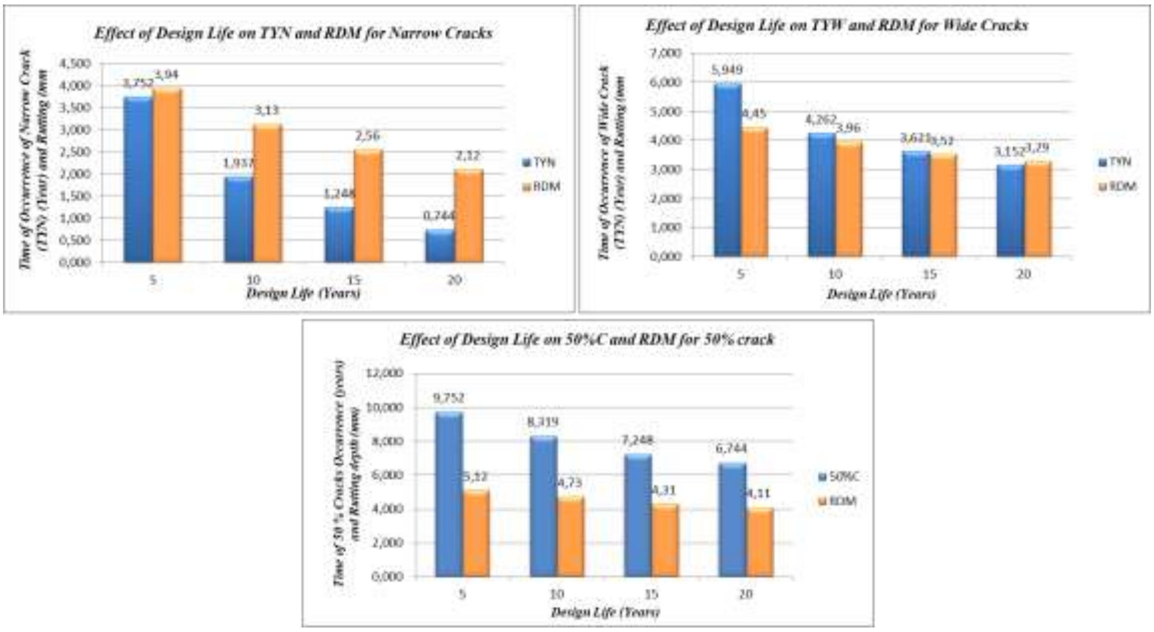

Figure 3. Effect of Planned Life on TYN, TYW, 50% Cracks and RDM

From Figure 3 it can be seen that the higher the age of the planned pavement, the faster the time for cracks to occur, both narrow cracks, wide cracks, and 50% cracks, but there is a smaller rutting depth that accours.

CONCLUSION

Based on the results of the analysis of traffic survey data, CBR data, and other secondary data, and taking into account the objectives of this research, the following conclusions can be drawn:

1. In each design age group (5, 10, 15 to 20 years), the total thickness of flexible pavement tends to increase as the cumulative peak load increases. in the 20-year age group the average HTot was higher. the largest is 180 mm, while the smallest is 100 mm recorded in the 5-year planning age group.
2. The effect of variation of the peak load based on the design life of 5,10,15, and 20 years, the longer the planned service life, the greater the traffic load at peak hours, so the greater the peak load, the faster the narrow cracks occur.
3. The effect of the time of occurrence of narrow cracks (TYN), wide cracks (TYW), and 50% (50% C) cracks with rutting depth (RDM), i.e., the higher the service life or the planned pavement life, the faster the prediction of the road will experience narrow cracks (TYN), wide cracks (TYW) and 50% cracks (50% C) and the longer the time for narrow cracks, wide cracks, and 50% cracks, the deeper the rutting will be.

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