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THE IMPACT OF EXCESS CARGO LOADED ON THE SERVICE LIFE OF THE PAVEMENT PLAN ON JALAN KHATULISTIWA, SIANTAN HILIR, SUB-DISTRICT PONTIANAK UTARA, KOTA PONTIANAK

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Abstract

The highway in Pontianak at this time has experienced rapid development, with the existence of commodity highways that can flow to the local market and economic products from one place can be sold to markets outside the area. One of the impacts of this industrial growth is the increase in cases of violations of overloading vehicles, especially goods transport vehicles. Vehicles crossing a road segment are sometimes not in accordance with the vehicle's load capacity and the maximum permissible load. Violation of this overload has a negative impact on the highway, namely the reduced life of the pavement. Jalan Khatulistiwa is a Primary Arterial Road that connects Kota Pontianak and Kota Singkawang. This road section consists of 1 lane with 2 lanes, and has a width of 9 meters. This study aims to review the impact of overload vehicle overload, vehicle damage capacity (VDF) on flexible pavement and decrease the service life of flexible pavement on Jalan Khatulistiwa. The method used is to analyze the service life of pavement based on the cumulative ESAL results for each change in load weight. The survey was conducted on Jalan Khatulistiwa in 2022. The data on vehicle weighing results was obtained from UPPKB Siantan using data in 2021. LHR data was obtained from the Pontianak P2JN office in 2020 and 2021. The study was carried out using the 1993 AASHTO method and the 2017 Highways. From the calculation results in the 20th year, the W18 value for the plan is 96,974,719.09 ESAL and the W18 overload in the 20th year is 110,929,554.2 ESAL. The increase in the value of W18 resulted in a decrease in the service life in the 19th year, namely the Ri value of -1.341% and in the 20th year the value of Ri was -14.390% whereas under normal conditions the value of Ri in the 20th year was 0% it could be interpreted that the service life of the road that has been determined is appropriate and the road pavement is able to last for the period of the plan that has been determined. Meanwhile, the remaining life of the plan caused by the addition of a 5% simulation load is the remaining 18,556 years and 100% of the remaining plan life is 9,297 years.

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1. Introduction

The development of Kota Pontianak is currently very advanced, one of which plays an important role in this regard is the means of road transportation. The highway in Pontianak at this time has experienced rapid development, it can be seen that there are currently more and more construction of new roads as well as efforts to improve the quality of existing roads. Highways can increase economic activity in a place because they help people to go or send goods faster to a destination. With the existence of roads, commodities can flow to local markets and economic products from one place can be sold to markets outside the area. In addition, the highway can also develop the economy along its trajectory. One of the impacts of this industrial growth is the increase in cases of violations of overloading vehicles, especially goods transport vehicles. Overloading carried out because this behavior can provide benefits such as reducing transportation costs, saving travel time, saving vehicle operating costs, and reducing overhead costs such as administrative costs, permit fees, and user fees. Even though behind all of that, this overload violation has a negative impact on the highway, namely the reduced life of the pavement. The quality of transportation infrastructure in an area is determined by the level of road service that is passed by each vehicle. Jalan Khatulistiwa is a National Road with a primary arterial road network system, which means that the road is used to serve and connect cities between centers of economic activity.

Jalan Khatulistiwa is one of the access roads for industrial areas, where this road segment is traversed by many goods transport vehicles of various sizes and loads of normal and overloaded vehicles that violate the provisions for the allowable amount of weight. A road construction is designed to be able to provide services according to the service life, but in reality many sections experience a reduction in their service life due to pavement damage. The most dominant factor that causes rapid road damage is because the load received by a road construction exceeds the design load, thus accelerating the process of damage to the construction.

Mechanically, overload will cause the stress experienced by a construction to exceed the over stress on a construction, this excess stress will then give permanent deformation to the pavement construction, so that the material will crack faster than it should. In this study, it will be studied how the impact of overload on the flexible pavement structure so that it can be seen how much influence it has on the service life of the road due to excessive load on the vehicle. Flexible pavement that generally using asphalt mixture as a layer surface as well as granular material as a coating on underneath. So that the pavement layer have flexibility that can be create vehicle comfort in passing on. The Department of Dinas Pekerjaan Umum (2007) said that road damage is caused by four main things, namely construction materials, traffic, climate and water. Based on the problems that occur, the objectives to be achieved in this study are as follows:

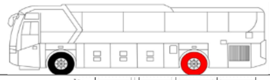
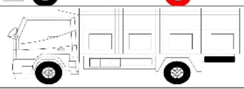
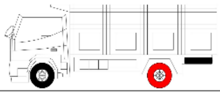
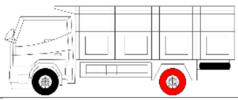
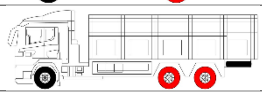
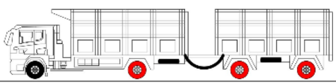
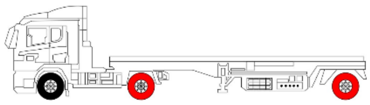
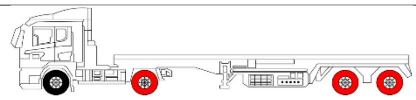
1. Knowing the percentage of overload that occurs
2. Knowing the effect of overload on vehicle damage (VDF) flexible pavement on Jalan Khatulistiwa, Pontianak
3. Knowing the effect of overload on flexible pavement on the service life of flexible pavement on Jalan Khatulistiwa, Pontianak.
4. Knowing the description of the addition of overload loads through simulations with an increase in overload loads 5%-100% that affect the value of the axle load sharing, VDF, and remaining life

2. Materials and Method

Heavy Vehicles

Heavy vehicles are motorized crossing the road with 4 wheels or more such as buses, 2 axles trucks, 3 axles trucks, Trailer truck and combination trucks and have a variety of axles and tires according to the Bina Marga classification system.

Table 1. Type of Heavy Vehicle

Type	**Picture of Vehicle**
Mini Bus	
Large Bus	
Truck 2 As 1.1	
Truck 2 As 1.2L	
Truck 2 As 1.2H	
Truck 3 As 1.22	
Articulated truck 1.2+2.2	
Truk semi trailer 1.2+2	
Truk semi trailer 1.2+2.2	

Classification of Vehicle Traffic

classification of traffic is carried out to calculate the vehicle damage factor and to analyze traffic so that there is harmony between the classification of average daily traffic vehicles (ADT) and *VDF*. This alignment is to facilitate the analysis of the calculation of the impact of overloading heavy vehicles on the age of the pavement. Vehicle classification has several versions that can be used as guidelines in traffic analysis according to data needs.

Table 2. Classification of Vehicle by Bina Marga

Group	Vehicle Type
1	Motorcycles, Scooters, Mopeds and 3-wheeled motorized vehicles
2	Sedan, Jeep, and Station Wagon
3	Oplet, Pick up oplet, Sub Urban, and combi
4	Pick up, Micro truk, truk box and delivery cars

Group	Vehicle Type
5a	Mini Bus
5b	Large Bus
6a	Truck 2 axle 4 wheel
6b	Truck 2 axle 6 wheel
7a	Truck 3 axle
7b	Trailer Truck
7c	Semi Trailer Truck
8	Non-motorized vehicles

Advanced **Table 2.**

Heaviest Axle Load (MST)

The heaviest axle load is the maximum amount of wheel pressure against the road, the determination of the heaviest axle load is aimed at optimizing construction costs with transport efficiency. Heaviest Axle Load is determined taking into account the lowest grade of road traveled, tire strength, axle design strength and GVW or the allowable amount set by the manufacturer.

Table 3. MST Each Road Class (Bina Marga, 2002)

	Class I	Class II	Class IIIA	Class IIIB	Class IIIC
Road Function	Arteri	Arteri	Arteri/ Kolektor	Kolektor	Kolektor
MST	>10 Ton	10 Ton	8 Ton	8 Ton	8 Ton

Total Permit Expenses (JBI)

The total permitted weight (JBI) is the maximum weight of the vehicle, along with the allowable load based on the class of road traversed, the amount of permitted weight increases the more the number of axles of the vehicle. JBI is determined by the Government by considering the carrying capacity of the lowest road class traversed, tire strength, axle design strength as an effort to increase the life of roads and vehicles as well as aspects of road safety.

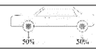
$$JBI = BK + G + L \quad (1)$$

Where:
BK = empty weight of the vehicle;
G = weight of person (allowed);
L = weight of the load (allowed).

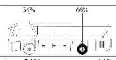
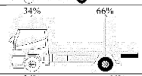
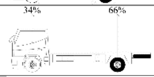
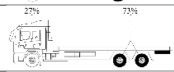
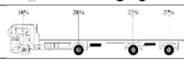
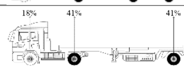
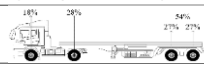
Vehicle Axle Load Sharing

VDF damage caused by vehicle load. The distribution of the vehicle axle load aims to divide the front wheel load and the rear wheel load which is calculated from the total weight in accordance with the vehicle axle configuration of each group that has been determined. VDF is a comparison of the level of damage caused by a single-axis vehicle load path in one single-axis standard load path, which is 8.16 tons.

Tabel 4. Distribution of Vehicle Axle Load

CONTRIBUTION OF AXEL AND TIPE	EMPTY WEIGHT (TON)	WEIGHT OF MAX LOAD (TON)	UE 18KSAL EMPTY	UE 18KSAL EMPTY	○ DOUBLE WHEEL ON WHEEL END ● DOUBLE WHEEL ON WHEEL END
1.1 HP	1,5	0,5	0,0001	0,0005	

Advanced **Table 4.**

CONTRIBUTION OF AXEL AND TIPE	EMPTY WEIGHT (TON)	WEIGHT OF MAX LOAD (TON)	UE 18KSAL EMPTY	UE 18KSAL EMPTY	○ DOUBLE WHEEL ON WHEEL END ● DOUBLE WHEEL ON WHEEL END
1.2 BUS	3	6	0,0037	0,3006	
1.2 L TRUCK	2,3	6	0,0013	0,2174	
1.2 H TRUCK	4,2	12	0,0143	5,0264	
1.22 TRUCK	5	20	0,0044	2,7416	
1.2+2.2 TRAILER	6,4	25	0,0085	3,9083	
1.2+2 TRAILER	6,2	20	0,0192	6,1179	
1.2+2.2 TRAILER	10	32	0,0327	10,183	

Vehicle Damage Factor (VDF)

The road damage caused by vehicles or better known as the Vehicle Damage Factor, hereinafter referred to as VDF, is one of the parameters that can determine the thickness of the pavement which is quite significant, and the heavier the vehicle (especially the freight vehicle) especially with overloaded loads, the VDF value will automatically increase. really growing. The following is the formula for determining VDF:

$$\text{Single axle, single wheel} = \left(\frac{L}{5404}\right)^4 \quad (2)$$

$$\text{single axle double wheel} = \left(\frac{L}{8158}\right)^4 \quad (3)$$

$$\text{Tandem axle, single wheel} = \left(\frac{L}{9177}\right)^4 \quad (4)$$

$$\text{Tandem axle, double wheel} = \left(\frac{L}{13766}\right)^4 \quad (5)$$

$$\text{Tridem axle, double wheel} = \left(\frac{L}{18457}\right)^4 \quad (6)$$

$$\text{Four axle, double wheel} = \left(\frac{L}{22536}\right)^4 \quad (7)$$

With:

L : Vehicle axle load (Kg)

Load Overload

According to the 2008 Dinas Pekerjaan Umum Term Dictionary page 57, overload is the axle load of the vehicle that exceeds the provisions as stated in the applicable regulations (PP 43 of 1993).

$$\%\ Overload = \frac{\text{Weighing result} - \text{JBI}}{\text{JBI}} \times 100\% \quad (8)$$

Where:

JBI = Amount of Load Allowed

Road Pavement Performance

Pavement performance includes 3 things, namely:

1. Safety is determined by the magnitude of friction due to contact between the tires and the road surface. The amount of friction that occurs is influenced by the shape of the vehicle, the texture of the road surface, weather conditions etc.
2. The form of pavement in relation to the physical condition of the road such as pavement and its general function is a unit that can be done with "riding quality". The performance of flexible pavements can be expressed in the Surface Index (Serviceability Index) and Road Condition Index.
3. In this study, the only parameter used was the surface index. The Surface Index (Serviceability index) introduced by AASHTO is obtained from observing road conditions, including damages, deflection in wheel lanes, surface roughness and so on that occur during the life of the road. The Surface Index varies from numbers 0-5, Table 3 of the level of road service function.

Table 5. Level of Road Service Function

Surface Index(IP)	Service Function
4-5	excellent
3-4	good
2 - 1	enough
1 - 0	less
0 - 1	is very less

Quality of Road Service

The quality of road service is measured by the ability of the road to provide services for road users while still anticipating high vehicle speeds, various types of vehicles that cause repeated loads in existing conditions according to the service life. The main problem in the implementation and handling of roads is the acceleration of the decline in the quality of national road services due to several causes such as:

- There is no legal certainty of violation of the Heaviest Axis Load (MST) even though the vehicle axle load overload and low reliability.
- Freight transport vehicles use road modes which cause long loading times due to low speed.

Road Damage

Technically, road damage indicates a condition where the structural and functional of the road are no longer able to provide optimal service to traffic crossing the road. Factors Affecting Road Damage The most dominant factors that influence, namely:

- Traffic is the most important factor in road pavement planning that provides repetitive load and load growth.
- Material fatigue can occur due to repeated loads, environmental conditions and temperature changes, as well as material factors of the road construction itself.

Types of Road Damage

Road damage when viewed from the form of damage is distinguished into:

1. Cracking
2. Distortion
3. Surface defects (disintegration)

Service Life

Service life is the number of years from the time the road is opened to serve vehicular traffic (end of implementation) until a structural repair or improvement is required. During the life of the plan, road pavement maintenance must still be carried out. Service life can also be interpreted as the number of repetitions of traffic load (in units of Equivalent Standard Load, ESAL) which is expected to pass within a certain period of time. In pavement design, it is necessary to choose the service life or pavement period.

$$W18 = LHR \ x \ VDF \ x \ D_D \ x \ D_L \ \text{x} \ 365 \ \text{x} \ [\frac{(1+0{,}01i)^{UR}-1}{0{,}01i}] \quad (9)$$

Where:

DD = Directional distribution factor

DL = Lane distribution factor

i = Traffic Growth Factor

UR = Service life

Remaining Life

A decrease in the life of the plan or the remaining life of the plan is the concept of damage caused by the number of repetitions of traffic loads in Equivalent Standard Load (ESAL) units that are expected to pass within a certain period of time (AASHTO,1993). To calculate the decrease in the life of the road plan caused by overload using the Vehicle Damage Factor value.

$$Rl = 100 \ [1-[\frac{NP}{N1{,}5}]] \quad (10)$$

Where:

Rl = Percentage of remaining life,

Np = cumulative axle load of year.

N1.5 = cumulative axle load over

Traffic growth factors

The traffic growth rate factor is the average result obtained on the traffic volume. Traffic growth using traffic over the life of the plan is calculated by cumulative growth factor (Cumulative Growth Factor):

$$\boldsymbol{R} = [\frac{(1+0{,}01\ i)^{UR}-1}{0{,}01\ i}] \quad (11)$$

Where:

R =Cumulative traffic multiplier factor
I = Annual traffic growth rate (%)
UR = Service life

Traffic On Design Lane
Design lane is one of the traffic lanes of a section of road that will bear the most traffic of commercial vehicles (trucks and buses). Traffic on the planned lane takes into account two factors, namely:

- Directional Distribution Factor (DD), for a two-way road the directional distribution factor is generally taken a value of 0.50.
- Lane Distribution Factor (DL), a lane distribution factor used to adjust the cumulative load (ESA) on a road with two or more lanes in one direction.

Table 6. Value of DL

Number of lanes in each direction	(DL) %
1	100
2	80-100
3	60-80
4	50-75

Data Collection
The data obtained in the study were grouped into two, namely secondary data and primary data:
Secondary Data:

- The Location Map of Jalan Khatulistiwa
- ADT Data for 2020 and 2021
- Geometric Data of Jalan Khatulistwa
- Data on Weighing Results of Goods Transportation Vehicles

Primary Data:

- Location Sketch of Jalan Khatulistiwa

Research Location
Jalan Khatulistiwa is located in Siantan Hilir, North Pontianak District, Kota Pontianak. The length of the Jalan Khatulistiwa is 6,880 km.

Fig 1. Research Location

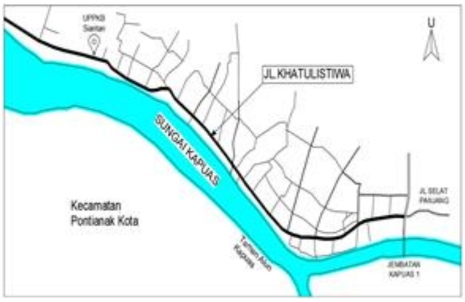


Fig 2. Research Site

Data Analysis

1. Calculates the percentage value of excess charge of each group.
2. Calculates the axis load sharing of each class of vehicles under normal conditions, under overload conditions, and overload simulation condition.
3. Calculates vehicle damage factor under normal conditions, conditions due to overload and overload simulation condition.
4. Calculates the remaining service life due to normal loads, overload loads, and overload simulation.

Flow Chart

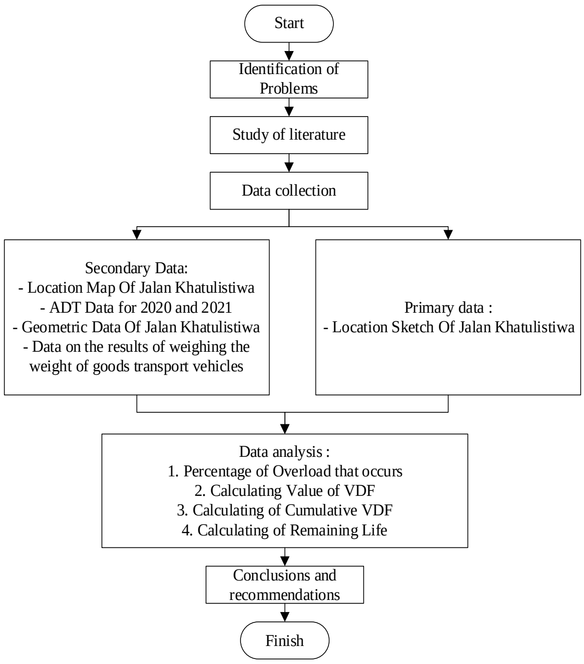


Fig 3. Research Flow Chart

3. RESULTS AND DISCUSSION

Daily Traffic and Traffic Growth Factor Daily traffic uses data in 2020 and 2021 obtained from Dinas P2JN Bidang Bina Marga Kalimantan Barat which is then processed into PCU/day and PCU/year.

Table 7. Average Daily Traffic (ADT)

No	Vehicle	ADT 2020	ADT 2020	ADT 2021	ADT 2021
		PCU/ Day	PCU/ Year	PCU/ Day	PCU/ Year

1	Group 1	8345	3046003	8955	3268562
2	Group 2	1514	552506	1862	679734
3	Group 3	3884	1417556	4182	1526430
4	Group 4	1785	651368	2025	739073
5	Group 5a	131	47869	197	71832
6	Group 5b	1	438	2	688
7	Group 6a	305	111377	378	137907
8	Group 6b	4616	1684861	5203	1899105

Advanced **Table 7.**

No	Vehicle	ADT 2020	ADT 2020	ADT 2021	ADT 2021
		PCU/ Day	PCU/ Year	PCU/ Day	PCU/ Year
9	Group 7a	202	73834	296	108123
10	Group7c	272	99426	345	126081
	Total	20783	7685238	23100	8557537

After obtaining and processing the PCU data, then look for traffic growth factors, namely by:

$$i \quad = \frac{\text{LHR 2021} - \text{LHR 2020}}{\text{LHR 2020}} \text{ x } 100\%$$

$$= \frac{23100 - 20783}{20783} \text{ x } 100\%$$

$$= 11{,}11\ \%$$

Percentage Of Overload

The percentage of overload is obtained from the Siantan UPPKB Weighbridge.

Table 8. Precentage Of Overload

No	Class Of Vehicle		Overload Precentage (%)
1	4	Pick Up 1.1	31,84
2	6a	Truck 2 As 1.1	33,00
3	6b	Truck 2 As 1.2	32,64
4	7a	Truck 3 As 1.22	28,43

Vehicle Axis Load Sharing Normal, Overload, and Simulation Condition

The distribution of the vehicle axis load is calculated by the Bina Marga method. The value of the vehicle axis load division serves to separate the weight of the front and rear of the vehicle. Example of Vehicle Axis Load Division Calculation for group 2:

Front wheels = 2,00 x 50% = 1,00 ton
Rear wheels = 2,00 x 50% = 1,00 ton

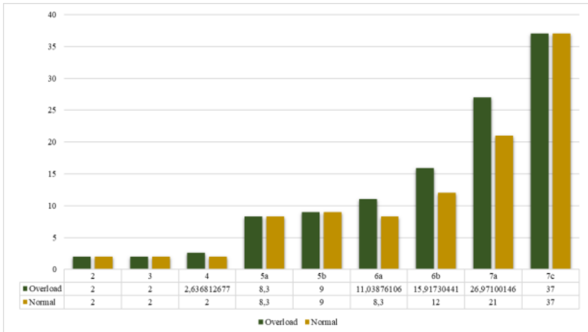
Total Weight $= \text{Wheel}_{\text{Front}} + \text{Wheel}_{\text{Rear}}$
$= 1{,}00 + 1{,}00$
$= 2{,}00$ ton

The following is the result of the load sharing of the axis of the vehicle under normal conditions and under overload load conditions, we can see in the table:

Table 9. Vehicle Axis Load Sharing

	Type Of Vehicle			Total Weight (Ton)	
				Normal	Overload
1	Sedan, Jeep, Star Wagon	2	1.1	2	2
2	Oplet, Combi and Mini	3	1.1	2	2
3	Pick Up and Micro Truk	4	1.1	2	2,636
4	Mini Bus	5a	1.2	8,3	8,3

Advanced **Table 9.**



No	Type Of Vehicle			Total Weight (Ton)	
				Normal	Overload
5	Big Bus	5b	1.2	9	9
6	Truck 2 As	6a	1.1	8,3	11,038
7	Truck 2 As	6b	1.2	12	15,917
8	Truk 3 As	7a	1.22	21	26,971
9	Truck Semi Triler	7c	1.2 +2.2.2	37	37

Fig 4. Comparison Graph of Normal Load and Overload Axis Load Sharing

The distribution of the vehicle axis is also calculated in the simulated state, here are the results of the vehicle load simulation recap can be seen in the table:

Table 10. Vehicle Axis Load Sharing Simulation

Golongan Kendaraan		Simulasi 5%	25%	50%	75%	100%
		Total (Ton)	Total (Ton)	Total (Ton)	Total (Ton)	Total (Ton)
Sedan	2	2,00	2,00	2,00	2,00	2,00
Oplet	3	2,00	2,00	2,00	2,00	2,00
Pick Up	4	3,29	3,95	4,351	4,61	5,27
Mini Bus	5a	8,30	8,30	8,30	8,30	8,30
Large Bus	5b	9,00	9,00	9,00	9,00	9,00
Truck 2 AS	6a	13,79	16,55	18,21	19,31	22,07
Truck 2 AS	6b	19,89	23,87	26,26	27,85	31,83
Truck 3 As	7a	33,71	40,45	44,50	47,19	53,94

Truk Semi Trailer	7c	37,00	37,00	37,00	37,00	37,00

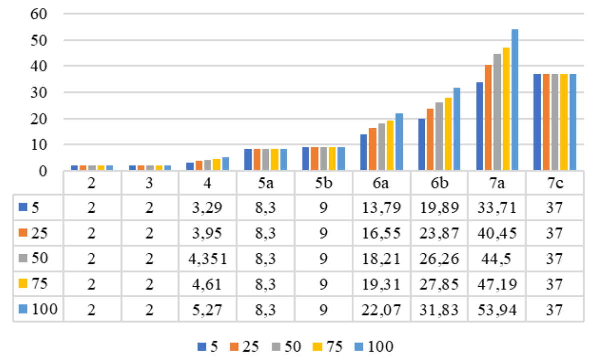


Fig 5. Graph Of Simulation Axis Load Sharing

VDF Normal, Overload and Simulation

VDF is calculated using the Bina Marga method, the VDF value serves to determine the effect of road damage due to vehicles which is then used for the calculation of the decrease in the service life.

Example of VDF Calculation for group 2:

Axis As-1

$$= \left(\frac{\text{Beban satu sumbu tunggal dalam kg}}{5404}\right)^4$$

$$= \left(\frac{1000}{5404}\right)^4$$

$$= 0{,}00118$$

Axis As-2

$$= \left(\frac{\text{Beban satu sumbu tunggal dalam kg}}{5404}\right)^4$$

$$= \left(\frac{1000}{5404}\right)^4$$

$$= 0{,}00118$$

$$VDF_{total} = 0{,}00118 + 0{,}00118$$

$$= 0{,}00235$$

Here is the result of the VDF under normal and overload conditions we can see in the table

Table 11. VDF

No	Tipe Kendaraan			*VDF* akibat muatan normal aktual	*VDF* akibat muatan berlebih aktual
1	Sedan, Jeep	2	1.1	0,002352096	0,002352096
2	Oplet, Combi	3	1.1	0,002352096	0,002352096
3	Pick Up	4	1.1	0,002352096	0,00710644
4	Mini Bus	5a	1.2	0,277892715	0,277892715
5	Large Bus	5b	1.2	0,383904614	0,383904614
6	Truck 2 2 As	6a	1.1	1,133626986	3,546819913
7	Truck 2 As	6b	1.2	1,213328162	3,756050146
8	Truck 3 As	7a	1.22	2,609951913	7,101394131
9	Truck Semi Triler	7c	1.2+2.2.2	6,287310627	6,287310627
	Total			10,80943802	20,26154949

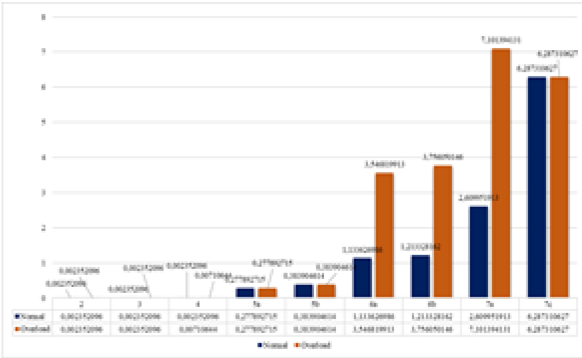


Fig 6. VDF

Here are the results of the VDF recap in the simulated overload load condition we can see in the table

Table 12. VDF Simulation

Type Of Vehicle		Simulation				
		5%	25%	50%	75%	100%
		Total (Ton)	Total (Ton)	Total (Ton)	Total (Ton)	Total (Ton)
Sedan	2	2,00	2,00	2,00	2,00	2,00
Oplet	3	2,00	2,00	2,00	2,00	2,00
Pick Up	4	3,29	3,95	4,351	4,61	5,27
Mini Bus	5a	8,30	8,30	8,30	8,30	8,30
Large Bus	5b	9,00	9,00	9,00	9,00	9,00
Truk 2AS 1.1	6a	13,79	16,55	18,21	19,3	22,07
Truck 2 AS 1.2	6b	19,89	23,87	26,26	27,85	31,83
Truck 3 As	7a	33,71	40,45	44,50	47,19	53,94
Truk Semi Triler	7c	37,00	37,00	37,00	37,00	37,00

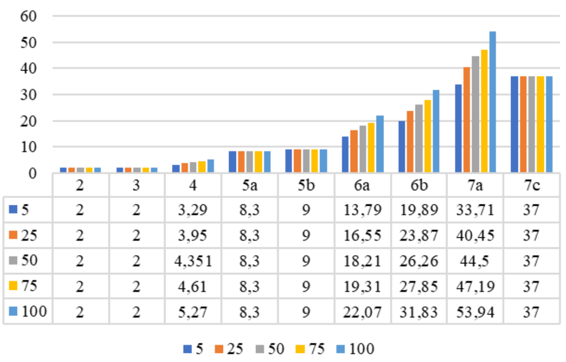


Fig 7. Graph Of VDF Simulated Comparison

VDF Normal,Overload, and Simulation Condition

VDF is calculated using the Bina Marga method, the VDF value serves to determine the effect of road damage due to vehicles which is then used for the calculation of the decrease in the service life. Example of VDF Calculation for group 2:

Cumulative group 2 VDF = Number of vehicles group 2/year x normal VDF of group 2
= 679734 x 0,002352
= 1598,800

Here is the result of VDF under normal and overload conditions we can see in the table:

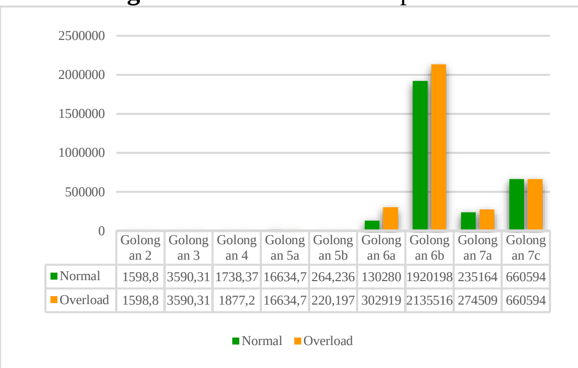
Table 13. VDF Cumulative

No	Type Of Vehicle	Normal	Overload
1	Group 2	1598,799974	1598,799974
2	Group 3	3590,309178	3590,309178
3	Group 4	1738,369963	1877,196818
4	Group 5a	16634,65793	16634,65793
5	Group 5b	264,2360613	220,1967178
6	Group 6a	130279,6522	302919,4742
7	Group 6b	1920198,416	2135516,114
8	Group 7a	235164,1244	274509,1582

Advance **Table 13.**

No	Type Of Vehicle	Normal	Overload
9	Group 7c	660594,2548	660594,2548
	Total	2970062,821	3397460,162

Fig 8. VDF Cumulatif Comparison



Here is a recap of the Simulation VDF Cumulative

Table 14. VDF Cumulative Simulation

Group	Simulation				
	5%	25%	50%	75%	100%
Sedan	1598,8	1598,8	1598	1598,8	1598,8
Oplet	3590,3	3590,3	3590	3590,3	3590,3
Pick Up	1921,9	2176,3	2720	3615,9	4989,8
Mini Bus	16634	16634	16634	16634,7	16634
Large Bus	220,2	220,2	220	220,2	220,2
Truck 2 AS 1.1	357601,9	668661	1333736	2428978	4109011
Truck 2 As 1.2	2204060	2593973	3427644	4800530	6906451
Truk 3 As	287915	364176,	527230	795745	1207632
Truck Semi Trailer	660594	660594	660594	660594	660594

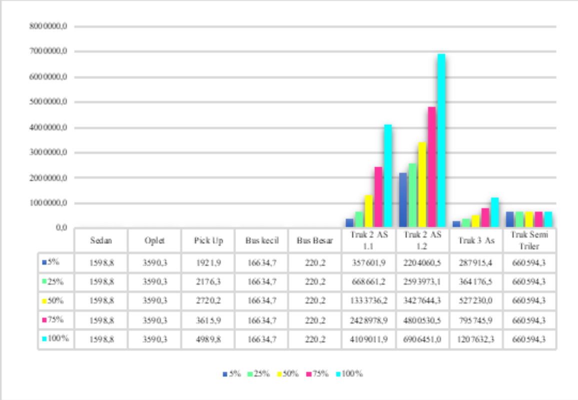


Fig 9. VDF Cumulative Simulation

Cumulative VDF Percentage Increase Due to Actual Overload

From the previous calculations obtained the following results.

VDF Cumulative Normal = 2970062,821
VDF Cumulative Overload = 3397460,162
VDF upgrades
= $VDF_{\text{cumulative overload}} - VDF_{\text{Normal cumulative}}$
VDF = 3397460.162 – 2970062.821
= 427397.3409

So that the cumulative percentage of VDF due to actual overload is as follows.

% Increases VDF Cumulative

$$= \frac{\text{Peningkatan VDF}}{\text{Total VDF Komulatif Normal}} \text{ x } 100\%$$

$$= \frac{427397{,}3409}{2970062{,}821} \text{ x } 100\%$$

= 14,39017848%

Remaining Life

The RL decrease is calculated by the formula Rl, here is an example of calculating the decrease in RL of the normal load condition in the 20th year

$$Rl = 100 \left[1-\left[\frac{Np}{N1{,}5}\right]\right]$$

$$= 100 \left[1-\left[\frac{1485031{,}41}{96974719{,}09}\right]\right]$$

= 98,46864067 %

All stages of calculation are carried out the same as both normal and overload loads, for the decrease in UR under normal load conditions and overloads are all calculated up to 20 years according to the service life, Here is a recap of the results of UR reduction in normal load conditions and overload which can be seen in the table

Table 15. Remaining Life

No	Year	Rl (%)	
		Normal	*Overload*
1	1	98,46864067	98,24827533
2	2	96,76656988	96,30127351
3	3	94,87475722	94,13722564
4	4	92,77205083	91,73193604
5	5	90,43494088	89,0585118
6	6	87,83729675	86,08706204

Advance **Table 15.**

No	Year	Rl (%) Normal	Rl (%) *Overload*
7	7	84,95007486	82,78436377
8	8	81,74099392	79,11349036
9	9	78,17417403	75,03339872
10	10	74,2097355	70,49847041
11	11	69,80335297	65,45800157
12	12	64,90575981	59,85563601
13	13	59,4621973	53,62873514
14	14	53,41180237	46,70767758
15	15	46,68692713	39,01508079
16	16	39,21238248	30,46493582
17	17	30,90459746	20,96164571
18	18	21,67068489	10,39895664
19	19	11,40740277	-1,341230093
20	20	0	-14,39017848

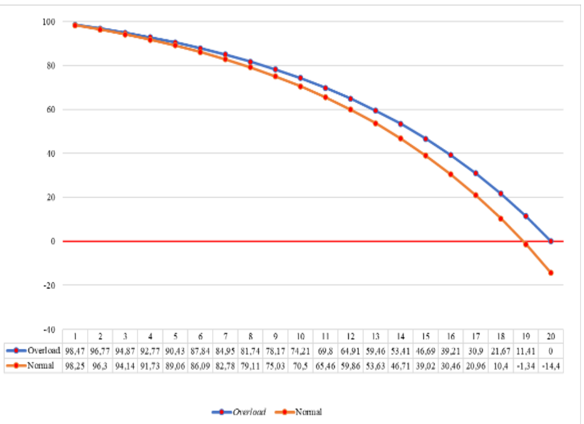


Fig 10. Graph of Remaining Life

From the graph, it is obtained that the plan life value at the service life presetage of 0%. It is known from the chart that the percentage of 0% occurs between the 18th year and the 19th year, in the 18th Year the Percentage of Age of the plan is 9.941009859% and in the 19th year the Percentage of service life is -1.859180425%.

So the calculation becomes as follows:

$$\frac{10{,}39895664-(-1{,}341230093{,}54187)}{19-18} = \frac{10{,}39895664\%}{x}$$

$$X = \frac{10{,}39895664\%}{10{,}39895664\%+1{,}341230093\%} \times (19-18)$$

$$X = 0{,}885757346$$

So that the value of the service life when the value of the percentage of the service life reaches 0% is:

Value Of RL 0% = 18 + X
= 18 + 0.885757346
= 18.885757346 years

So that the value of the service life when the percentage value of service life reaches 0% is as follows.

% Of Service Life = 20 – 18,885757346
= 1,114242654 tahun
= 5,571213271 %

The calculation of the decrease in RL overload simulation is the same as the calculation of the decrease in RL of vehicle overload . The following is a recap of the calculation of the simulated overloaded RL:

Tabel 16. RL Simulation

Advanced **Table 16.**

20 Year	Rl Overload 5%	Rl Overload 15%	Rl Overload 25%	Rl Overload 35%
0	100	100	100	100
1	98,178	98,255	98,057	97,805
2	96,152	95,784	95,306	94,698
3	93,901	93,317	92,560	91,597
4	91,399	90,576	89,507	88,149
5	88,618	87,529	86,114	84,317
6	85,527	84,142	82,343	80,058
7	82,092	80,377	78,152	75,324
8	78,273	76,193	73,493	70,062
9	74,029	71,543	68,316	64,214
10	69,312	66,374	62,560	57,714
11	64,068	60,628	56,164	50,489
12	58,241	54,243	49,054	42,458
13	51,763	47,145	41,151	33,533
14	44,564	39,256	32,368	23,613
15	36,562	30,488	22,606	12,586
16	27,668	20,743	11,755	0,331
17	17,782	9,911	-0,305	-13,291
18	6,794	-2,129	-13,710	-28,431
19	-5,418	-15,511	-28,609	-45,259
20	-18,992	-30,384	-45,169	-63,963

Year	Rl Overload 55%	Rl Overload 65%	Rl Overload 75%	Rl Overload 85%	Rl Overload 95%	Rl Overload 100%
0	100	100	100	100	100	100
1	97,104	96,636	96,073	95,406	94,621	94,181
2	93,006	91,874	90,516	88,904	87,008	85,944
3	88,915	87,120	84,967	82,412	79,407	77,721
4	84,367	81,835	78,800	75,196	70,959	68,580
5	79,312	75,962	71,945	67,176	61,569	58,421
6	73,693	69,434	64,326	58,262	51,132	47,129
7	67,449	62,178	55,857	48,354	39,531	34,579
8	60,508	54,113	46,444	37,342	26,637	20,629
9	52,793	45,150	35,983	25,102	12,306	5,124
10	44,218	35,186	24,354	11,497	-3,623	-12,109
11	34,688	24,113	11,430	-3,624	-21,327	-31,263
12	24,095	11,805	-2,935	-20,430	-41,005	-52,553
13	12,321	-1,876	-18,902	-39,111	-62,877	-76,216
14	-0,766	-17,081	-36,648	-59,873	-87,186	-102,517
15	-15,311	-33,981	-56,373	-82,951	-114,206	-131,749
16	-31,478	-52,765	-78,297	-108,601	-144,238	-164,241
17	-49,446	-73,644	-102,664	-137,110	-177,618	-200,354
18	-69,419	-96,849	-129,748	-168,797	-214,719	-240,494
19	-91,617	-122,642	-159,851	-204,017	-255,956	-285,108
20	-116,290	-151,310	-193,311	-243,163	-301,789	-334,695

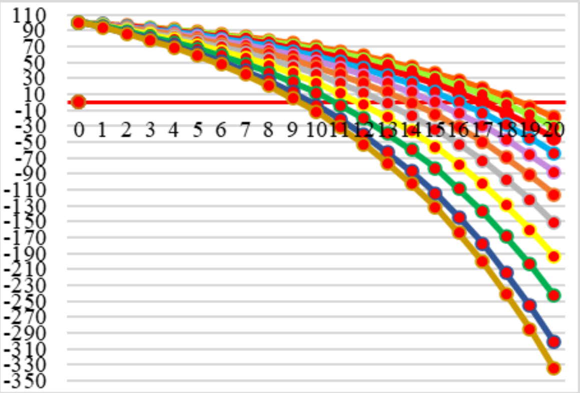


Fig 11. Graph of Remaining Life Simulation

4. Conclusion and Suggestion

Conclusion

1. VDF due to overload load obtained the largest value in class 7a vehicles (Truck 3 As 1.22) which was 7.10139 and the smallest value in class 4 vehicles (Pick Up 1.1) with a VDF value of 0.00710644
2. For the cumulative overload value, the largest value was obtained by a class 6b vehicle (Truck 2 As 1.2) which was 2,135,516,114 and the smallest cumulative VDF overload value in a class 4 vehicle (Pick Up 1.1) which was with a value of 1,877,196818
3. From the graph of service life reduction graph obtained, the calculation results show that the normal vehicle load can work properly so that the service period in the form of a percentage of the service life is exactly 0% at the age of 20 years according to the planned road service life while the actual overload load can cause a decrease in the life of the plan to be reduced by 5.571% which is in the 19th year, so that the road has been damaged earlier, namely in a period of 18.8857 years from the 20 years of service life of the planned road.
4. The addition of the simulated load aims to describe and consider that the overload is overcharged in the actual conditions of the field. The addition of this simulation load is because the vehicles weighed on the UPPKB Siantan Weighbridge are only a small part of it. The subduction of the life of the plan is greater, the greater the value of the VDF so that the remaining life of the plan is obtained due to the addition of a 5% simulation load, namely the remaining 18,556 years and 100% of the remaining life of the plan of 9,297 years.

Suggestion

1. To get the actual results of the field, we can maximize the survey by using a portable weighbridge and using the help of cctv to find out the type of vehicles passing through the road.
2. For further research, data on the number of vehicles overloaded in the actual field is needed, so that the research will be better.

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