Overload Effect on National Road Overlay Planning in North Kalimantan

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Abstract: The issue in the community that causes damage to the road was by trucks carrying fresh fruit bunches (FFB) of oil palm. The purpose of this study is to know the effect of overload on the service life, knowing the overlay thickness, thickness due to overloading and determining the effective thickness from the method used. This study was conducted by surveying overloaded FFB transport trucks. The location of research was on Tanjung Selor Road Section, limited to Bulungan in Sta 16 + 000 to Sta 18 + 000. Analysis of overload data uses overload scenarios, while for planning the overlay layer thickness uses deflection method Pd T-05-2005-B and Bending Pavement Design Software (SDPJL). Both methods are mechanically evaluated by the Kanpave program to determine the efficient overlay thickness. The results showed that the $ESAL_{overload}$> $ESAL_{Standard}$.Based on the analysis of the high load on service life since the road was opened, there was a reduction in service life, an overlay thickness of 4.86cm with Pd T-05-2005-B method, 4cm with SDPJL method. Based on analysis of overload on planning occurred an increase in each scenario where $d_{Overload}$> $d_{Planning}$. The mechanical results from the Kenpave program showed that the load repetition that was close to the design load was the Pd T-05-2005-B method of 130,606,838.49 ESA, thus planning the Overlay thickness with the Pd T-05-2005-B method was more efficient than the SDPJL method.

1 INTRODUCTION

In Indonesia the movement of goods and services is dominated by the modes of land transportation by using Trucking vehicles because it can be done door-to-door with the right time, exact quantity, quality, and exact receiver. In addition, transportation costs are the largest cost component in the logistics cost structure. No less than 60% of the total cost is the cost of transportation.

With the increasing economic growth of a region and the lack of supervision, some transport services are willing to carry relatively large quantities of goods to reduce transportation costs in a travel process at once, making it more cost effective to transport. This will have a negative impact on road pavement conditions due to overloading repeated loads.

Repeated loads caused by heavy vehicles will have an impact on the degradation of the highway bending structure of the road which further leads to a decrease in the hardness of the pavement support because it always receives a voltage greater than the standard load.

If this condition continues to occur it will result in the occurrence of road damage early because the load received has been reached before the age of the planned road at the time of the initial design.

Any vehicle of a certain weight that crosses a road, will contribute to the destruction of the road. Overload contributes a power of 4 (four) to the road destructive factor or Vehicle damage factor (VDF). The increase in damaged power of road is much greater than the percentage of the burden that is violated.

So this cause is considered to be the most responsible cause for road damage. This condition may be made possible by changes in vehicle dimensions and weight across the road when compared to the dimensions and weight of the vehicle used in the planning.

Therefore, this study conducts more cargo survey of fresh palm fruit bunch (FFB) vehicles using more load scenarios, calculates Equivalent Single Axle Load (ESAL), Age of service. In this research, the

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overlay thickness planning process with PdT-05-2005-B deflection method, the software design method of flexible pavement stretching (SDPJL), comparing the thickness value of overlay due to more load with thickness of planning, knowing the thickness of the effective overlay layer with using kenpave mechanical program of both methods used.

2 METHOD

The research location is in National road North Kalimantan, Bulungan precisely located on the boundary roads Bulungan Tanjung Selor Sta 16 + 000 to Sta 18 + 000.

Obtained primary data by surveying the damage to roads and fruit bunches weighing and measuring tailgate loading and unloading at the site of FFB.

Secondary data is supportive data obtained from the Planning and Monitoring Unit of the National Road North Kalimantan.

Once the data is acquired then the next stage analysis of both the analysis and planning overloading Overlay, phases as follows:

The first stage manage the resulting data fruit bunches weighing, measuring the volume of the container box FFB and Volume tailgate using the formula Density = $\frac{Weight}{Volume}$. So of the relationship between the volume of the truck with a cargo of oil palm FFB can be obtained. Furthermore, oil palm FFB Freight transported by trucks is assumed to be 60 cm above the truck bed with a full payload, making the scenario more payload carried by TBS load variation of a high rise above the truck every 10 cm.dengan these assumptions can be made 7 more payload scenarios so obtained a charge over each scenario.

Based on secondary data Roads Bulungan Tanjung Selor limit is a class IIIA collector roads with the heaviest axle load (MST) ≤ 8 tons. Damage Factor ($ESAL_{overload}$) and ($ESAL_{Standard}$) with the formula D = $(\frac{\mathbf{P}}{\mathbf{8160\ kg}})^4$, Configuration trucks axis palm with 1.2 L type truck front axis configuration with 34% and 66% rear axis. Can be calculated Equivalent Single Axle Load (ESAL) Based on data from more payload scenarios and formulas to find the value can be obtained $ESAL_{overload}$ for all scenarios and $ESAL_{Standard}$ overloading.

Further analyzes Overlay design life based on the cumulative results ESAL planning data and survey data scenario more cargo truck field. Cumulative ESAL calculated per year starting from the first year until the end of service life with the traffic growth of 5% and a service life of over 10 years of age.

The second stage the planning process with a thick layer of additional deflection method use Pd T-05-2005-B and methods of road pavement design software malleable (SDPJL).

Using the method of deflection Pd T-05-2005-B, the Code was initiated by the Transport Infrastructure R & D Center, Research and Development Agency Infrastructure Development district. Guidelines ex.Departemen a road Pavement Inspection Manual revision by means of Benkelman Beam (01 / MN / B / 1983) and in addition to apply to the data deflection allowed based tool Benkelman Beam. with this method Overlay layer thickness is obtained in accordance with the data obtained.

Using methods of road pavement design software malleable (SDPJL), the calculation process with only input required data and software will execute to generate output roughness. Method additional layer thickness was approved by the Ministry of Public Works General Directorate of Highways in 2013 became Manual Design pavement No. 02 / M.BM / 2013. with this method Overlay layer thickness is obtained in accordance with the data obtained.

Further analyzes of the high payloads Overlay layer. By using methods Pd T-05-2005-B because the method is flexible in its application VDF value, according to the road conditions are analyzed, whereas the method of Software pavement Road Bending (SDPJL) can not be used because the data VDF has been programmed.

Based on an analysis of more obtained load scenarios resulting increase Overlay thickness of each scenario.

The third thos thick evaluate Overlay using the program mechanistic Kenpeva of both the method used to produce a thick layer of Overlay. This program is the planning of pavement design software developed by Dr.Yang H Huang, PE Professor Emeritus of CIVEL Engineering University of Kentuck. Software is also written in Visual Basic programming language and can be run with any version of Windows 95 or above, this program can only be run in the Windows 95 operating system to windows xp professional service park 2.

Program kenpave second edition 'Pavement Analysis and Design' is a Windows version of DOS substitute four programs Layernip, Kenlayer, Slabship and Kenslap. Layerinp and Kenlayer an analysis program for flexible pavements, while Slabinp and Kenslab an analysis program for rigid pavement.

After the evaluation of the two methods will retrieved results pavement structure response data in the form of a vertical strain on the upper layer subgrade (εv) and tensile strain at the bottom of the surface layer (εt). Furthermore, the data will be processed further by using a transfer function of asphalt Institute then obtained values Nf and Nd.

The fourth overall stage evaluation results, this stage determine an efficient method for the additional layer thickness, provided the value Nd of the second method is used closest to the value of the design load repatisi.

3 RESULTS AND DISCUSSION

3.1 Scenario overload

Calculations from 7 to charge more oil palm scenario can be seen in Table 1 below:

Table 1: Scenario Truck Loads More Palm Oil

Scenario	High payload FFB (m)	Payload more (Ton)
1	0	6
2	1	7.66
3	1.2	9.19
4	1.4	10.72
5	1.6	12.25
6	1.8	13.78
7	2	15.31

Source: Analysis

From the results of the calculations in Table 1, it can be graphed the relationship between high-load FFB with more cargo truck as shown below:

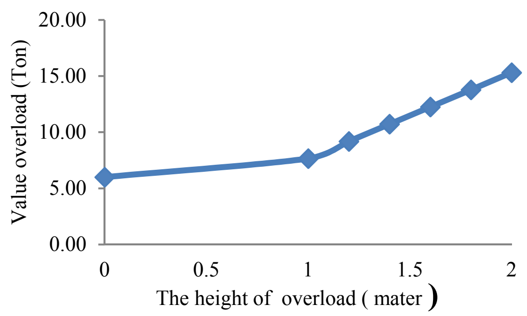


Figure 1: Graph relationship between height FFB with more payload cargo truck.

In Figure 1 it can be seen that there is an increase in load in scenario 2 to scenario 7 exceeding 6 tons, where the Tanjung Selor road is the Bulungan limit of the allowed load of 6 tons for medium truck type 1.2L.

3.2 Equivalent Single Axle Load

Calculation of Equivalent Single Axle Load (ESAL) based on scenarios more payload and standard ESAL calculation can be seen in the table below:

Table 2: $ESAL_{overload}$ All Scenarios Loads More

No	Weight total (kg)	Configuration Axis Front 34%	Configuration Axis Back 66%	ESAL total load more truck
1	8300	2822.00	5478.00	0.22
2	9960	3386.40	6573.60	0.45
3	11490	3906.60	7583.40	0.80
4	13020	4426.80	8593.20	1.32
5	14550	4947.00	9603.00	2.05
6	16080	5467.20	10612.80	3.06
7	17610	5987.40	11622.60	4.41

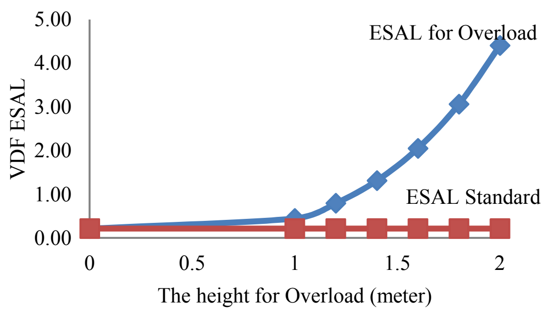
Source: Analysis

Table 3: ESALstandard

No	Weight total (kg)	Configuration Axis Depan 34%	Configuration Axis Belakang 66%	ESAL total more load truck
1	8300	2822.00	5478.00	0.22

Source: Analysis

$ESAL_{standard}$ = 0.22 has the same number for each scenario loading.



Source: Analysis

Figure 2: Graph the relationship between high-value cargo FFB with VDF.

Table 4: Analysis of the charge of the lifetime high serviceability

Year	Comulative ESAL				
	Planning (ESA)	Height Overload 0 m (ESA)	Height Overload 1 m (ESA)	Height Overload 1,2 m (ESA)	Height Overload 1,4 m (ESA)
2017	52,906.20	53,649.63	56,461.96	60,741.58	67,099.88
2018	108,457.72	109,981.75	115,747.02	124,520.25	137,554.76
2019	166,786.80	169,130.47	177,996.33	191,487.85	211,532.39
2020	228,032.35	231,236.63	243,358.10	261,803.82	289,208.89
2021	289,277.89	293,342.79	308,719.88	332,119.80	366,885.39
2022	356,801.10	361,814.83	380,781.24	409,643.16	452,523.74
2023	427,700.47	433,710.47	456,445.66	491,042.70	542,444.00
2024	502,144.81	509,200.89	535,893.31	576,512.20	636,860.28
2025	580,311.37	588,465.84	619,313.34	666,255.19	735,997.37
2026	662,386.25	671,694.03	706,904.37	760,485.32	840,091.31

Table 5: Analysis of the charge of the lifetime high serviceability

Year	Comulative ESAL			
	Planning (ESA)	Height overload 1,6 m (ESA)	Height overload 1,8 m (ESA)	Height overload 2 m (ESA)
2017	52,906.20	76,025.96	88,375.73	104,882.86
2018	108,457.72	155,853.22	181,170.26	215,009.86
2019	166,786.80	239,671.84	278,604.50	330,643.21
2020	228,032.35	327,681.39	380,910.46	452,058.23
2021	289,277.89	415,690.94	483,216.42	573,473.26
2022	356,801.10	512,721.47	596,008.74	707,333.31
2023	427,700.47	614,603.53	714,440.68	847,886.38
2024	502,144.81	721,579.69	838,794.21	995,467.09
2025	580,311.37	833,904.65	969,365.42	1,150,426.85
2026	662,386.25	951,845.87	1,106,465.19	1,313,134.58

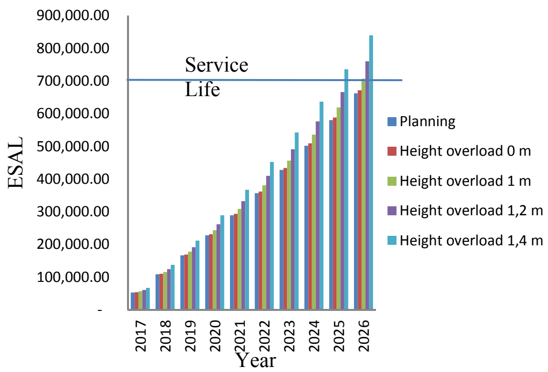


Figure 3: Graph the relationship between high-load FFB with Age serviceability.

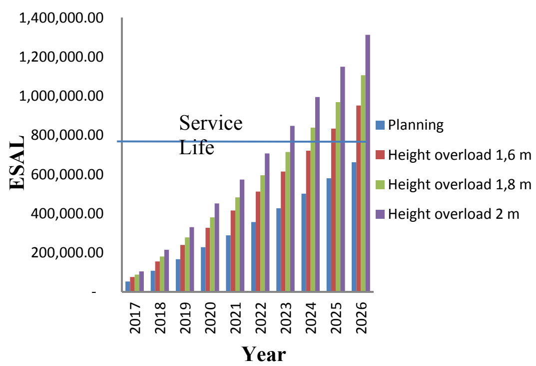


Figure 4: Graph the relationship between high-load FFB with Age serviceability.

In the Figure 2, it can be seen that ESAL $_{load}$ is greater than ESAL $_{Standard}$, so that there is an overload on the Tanjung Selor road in the Bulungan boundary.

3.3 Service life

Cumulative ESAL calculated per year starting from the first year until the end of service life with the traffic growth of 5% and a service life of over 10 years of age. Results of analysis of the high payloads of the lifetime serviceability shown in the Table 4 and Figure 3.

When viewed from the graph above, there is a decrease in service life for 1 (one) year from the planned age caused by a high 1.4 meter load. For the next high load can be seen in Table 5 and Figure 4.

When viewed from the graph above, there is a decrease in the age of Layan for 4 (four) years from the age of the 10-year plan, which is caused by a high load of 2 meters.

3.4 Metode defletion PdT-05-2005-B and SDPJL

Planning an extra layer thickness (Overlay) using the method of deflection Pd T-05-2005-B and methods of road pavement design software malleable (SDPJL) each obtained result Overlay thickness values as follows:

- Pd T-05-2005-B = 4,86 cm
- SDPJL = 4,00 cm

3.5 Kenpave mechanical program

Kenpave mechanistic program evaluation results of deflection methods Pd T-05-2005-B and methods of road pavement design software malleable (SDPJL) respectively results obtained Nd values as follows:

- Pd T-05-2005-B = 130.606.838,49 ESA
- SDPJL = 113.903.693,48 ESA

Overall Evaluation Results With ESA repatisi 589,561,48 the design load of the two methods is the method of Pd T-05-2005-B with a value of 130,606,838.49 ESA and SDPJL value with a value of 113,903,693.48 ESA, so we can conclude planning of additional layer thickness (Overlay) efficient SDPJL method than Pd T-05-2005-B method.

4 CONCLUSIONS

From the results of this study can be summarized that from the truck load scenario, the value of scenario 2 to 7 is greater than the National Road permit load on the Tanjung Selor road, the Bulungan limit is 6 tons. so that the ESAL $_{Overload}$ value is greater than the ESAL $_{Standard}$. Truck loads with a height of 2 meters have a deteriorating effect on the service life of 4 (four) years from the age of the 10-year plan. Planning additional layer thickness by the method of deflection Pd T-05-2005-B obtained amounted to 4.86 cm thick layer and methods of road pavement design software malleable (SDPJL) obtained layer thickness of 4.00 cm with a design life of 10 years.

The evaluation results with program loading mechanistic kenpave of both the methods used obtained value of Nd, Pd deflection method T-05-2005-B obtained Nd value of 130,606,838.49 ESA and methods of road pavement design software malleable (SDPJL) Nd values obtained by ESA 113,903,693.48. With ESA repatisi 589,561.48 the design load of the two methods is the method of Pd T-05-2005-B with a value of 130,606,838.49 ESA and SDPJL value with a value of 113,903,693.48 ESA, so we can conclude planning of additional layer thickness (Overlay) efficient SDPJL method than Pd T-05-2005-B method. Trucks carrying FFB oil palm are not the main factor causing the initial damage to the national road on the Tanjung Selor road to the Bulungan boundary.

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