Study of Road Damage Handling on Access Road to Soekarna – Hatta Airport North Perimeter – South Perimeter, Tangerang Banten.

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ABSTRACT

Pavement damage on the North Perimeter – South Perimeter Road is quite extreme. The damage is 1 kilometer long for a total of approximately 6 kilometers. The damage occurred, such as potholes, bumpy roads, chipped asphalt, and large deflection occurred when heavy load vehicles pass on the road. The damage occurred due to loads of heavy vehicles transporting materials during the Road and Connecting Bridge Construction at Soekarno-Hatta Airport. In addition to being overloaded, the condition of drainage channels on the road could not function optimally. Based on the phenomenon, the pavement damage on the North Perimeter – South Perimeter Road needs to be repaired. Two types of primary data consisted of traffic and road damage data, and secondary data was Basic Unit Price Activity (BUPA) were used in construction planning. The data were processed and analyzed in several steps. First, it carried out the road damage surveyed visually and riding quality. Then, it conducted a characteristic survey of the traffic at this moment, and it was analyzed during the life of the plan. After that, the thickness planning of a road pavement structure was carried out and continued with cost analysis. Finally, it selected the most appropriate type of road pavement in terms of cost over the life of the plan. The results of existing data analysis obtained the rigid pavement type as a repair of damage to the North Perimeter Road - South Perimeter with a drainage layer thickness of 15 cm, 10 cm LMC foundation layer, and 28.5 cm thick concrete slab. The initial cost of construction and maintenance of IDR 34,231,907,890.

INTRODUCTION

Roads are land transportation infrastructure to connect one area to another. Law Number 38 of 2004 states that roads have a significant role in realizing the nation’s life development. The rapid economic growth will result in an increasing number of vehicles and impact road quality. Therefore, roads must be in good and adequate condition. Thus, society can use the road safely, comfortably, and without any obstruction.

The North Perimeter - South Perimeter Road is a connecting road between Soekarno - Hatta Airport, Tangerang, and Jakarta, a non-toll road located in Tangerang, Banten. Perimeter is the boundary of land or areas under the control of the Airport. This boundary circles around the airport area and is recommended by the International Civil Aviation Organization (ICAO) to be fenced and declared as a Non-Public Area (NPA) because there are runways, taxiways, and aprons as areas aircraft movement areas as well as air navigation equipment facilities and other significant installations.

Pavement damage on the North Perimeter – South Perimeter Road is quite extreme. It is 1 kilometer long for a total of approximately 6 kilometers. The damage occurred, such as potholes, bumpy roads, chipped asphalt, and large deflection occurred when heavy load vehicles passed on the road. This condition is troubling to road users, especially during the rainy season. Many puddles on the road surface that are deep enough to endanger private vehicles and motorbikes often overturn will appear during the season. According to information from residents, this damage occurred during the construction of Soekarno Hatta Airport. Meanwhile, large vehicles transporting fill-in materials in the construction of connecting roads and bridges at Soekarno-Hatta Airport ensured that it was overloaded.

Based on the observation, we found some deep puddles in the North Perimeter – South Perimeter existing field during the rainy season. The condition impacted the road traffic because the passing vehicles must take turns on one side. It causes a long queue when it passes the North Perimeter – South Perimeter Road. In addition, at a certain point, there are no special channels for road drainage.

On the North Perimeter – South Perimeter Road section, various types of vehicles can be seen, ranging from light vehicles such as bicycles and motorbikes to heavy vehicles such as trucks. However, the heavy vehicles carrying materials for the construction of Soekarno Hatta Airport are more dominant on this road section. Some of them are dump trucks with 1.22 and 1.2 axle configurations loaded with fill material, articulated trucks with 1.2.2 - 2.2 axle configurations, 2-axle medium trucks with 1.2 axle configurations, and 3-axle trucks with 1.2.2 axle configurations, small and large buses with each axis configuration 1.1 and 1.2[2].

On the basis of this condition, the pavement damage that occurred in the North Perimeter – South Perimeter Road section, Banten Regency, needs to be repaired. Therefore, this study identified the level of road damage that occurred on that road section. After that, it conducted a traffic survey to determine the traffic characteristics on that road section. If the traffic characteristics are known, proceed with planning the construction (the thickness of the structure of each type of pavement) as well as the drainage channel and the calculation of the total cost during the service period to calculate the overall cost (initial construction and maintenance). Thus, it can be known what type of pavement is most suitable for repairing damaged pavement and the thickness of the pavement structure on the North Perimeter - South Perimeter Road sections.

METHODOLOGY

The flow chart can be seen in Figure 1.

This study used BUPA data of Tangerang Regency, which was adjusted to Tangerang City with the Construction Cost Index. The ADT data was obtained from a survey of the study location. The damaged road data was obtained using the survey method [5]. This data served to determine the level of road damage and drainage damage conditions in the study location.

D. Analysis

1. Road Damage

A road damage survey used [4] as carried out to find out the road damage and drainage value on North Perimeter – South Perimeter Road section. After obtaining the damage value, further will be carried out the handling following the existing damage level [4].

2. Traffic Characteristics

Traffic characteristics must be known in advance to calculate the thickness of flexible and rigid pavement structures for pavement repairs for North Perimeter Roads - South Perimeter Roads. It can be known from the number of vehicles obtained from the ADT survey that has been carried out by looking for the most dominant type of vehicle that crosses the road and has a major influential factor on road damage.

3. Pavement Thickness

After knowing the traffic characteristics, it is possible to plan the pavement thickness according to the life of

A. Preparation

Preparation is the first step to do before doing something. It aims to facilitate the implementation of further work. The following are the preparatory stages; seeking information from relevant agencies according to the data required, arranging required documents such as cover letters for relevant agencies, and studying all forms of activities that can support this study.

B. Literature Review

A literature review must be carried out before conducting and processing the data. It was carried out to determine the pavement types to be used. [3]. The literature regulates provisions regarding flexible and rigid pavements. Meanwhile, to assess road damage, it used “Road Pavement Design Manual Number 04/SE/Db/2017[4].

C. Data Collection

Data used in this study consisted of primary and secondary data. The Primary data included the data of traffic and road damage, drainage damage, and average daily traffic (ADT). On the other hand, the secondary data was obtained from existing research and sources. In this study, the secondary data used BUPA data.

The ADT data was used to find out the type of traffic vehicle. In addition, BUPA data was used to calculate the budget plan and road maintenance costs. the plan. Furthermore, the traffic growth factor and ADT data were used to calculate the cumulative trajectory of the standard equivalence axis. After getting the load, a match was made into the table in the guidelines [3]. The following is the equation used to calculate the thickness of flexible pavement:

$$ESA = \left(\sum ADT\ x\ VDF\right)\ x\ 365\ x\ DD\ x\ DL\ x\ R$$

Before carrying out the ESA calculation, a comparison between the VDF calculation in table [3] and the VDF equation to determine the largest VDF was made first, which will later be used as a determinant of traffic load. The VDF equation was calculated using the following equation:

$$Single\ axle\ -\ single\ wheel, VDF\ =\left(\frac{P}{540}\right)^5$$

$$Single\ axle\ -\ double\ wheel, VDF\ =\left(\frac{P}{816}\right)^5$$

$$Double\ axle\ -\ double\ wheel, VDF\ =\left(\frac{P}{13,76}\right)^5$$

$$Triple\ axle\ -\ double\ wheel, VDF\ =\left(\frac{P}{18,45}\right)^5$$

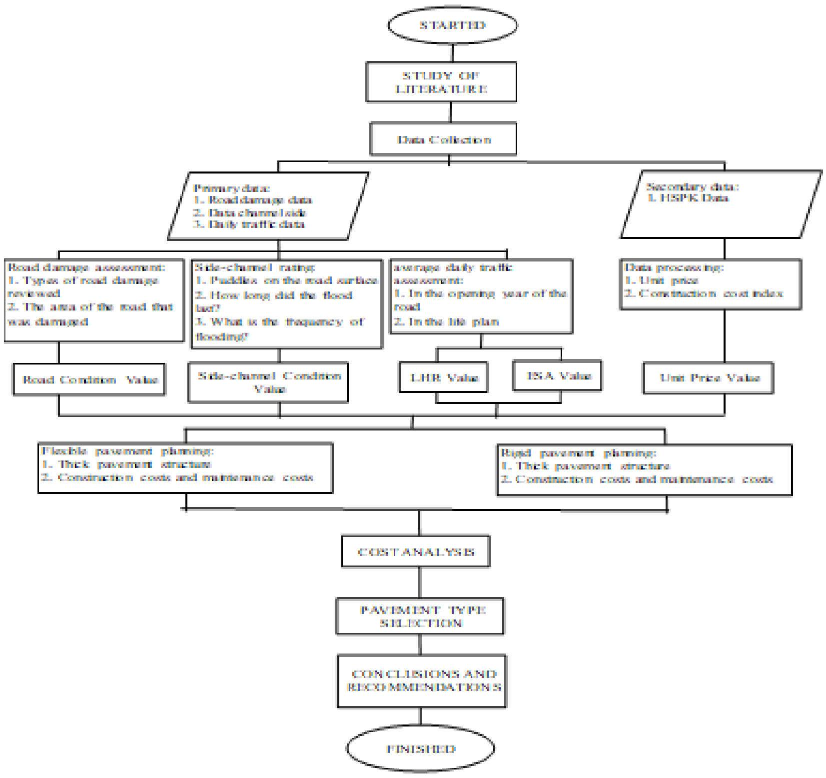

Figure 1. Calculation of Flow Chart

The following is the equation used to calculate the thickness of rigid pavement:

$$JSKN = JSKNH \ x \ 365 \ x \ R$$

The calculation of the budget plan was carried out after counting the thickness of each pavement structure. It counted work volume according to that planning. Furthermore, the work volume was multiplied by BUPA, which had been adjusted. Thus, it would obtain the total of the budget plan from each pavement. The selection of the type of pavement was based on the smallest cost between each type of pavement. However, in addition to referring to the calculation of the budget plan or initial construction costs that have been carried out, maintenance costs are also considered for each type of pavement during the life plan.

E. Flow Chart

Schematically, the flow of activities to be carried out in this study is shown in Figure 1.

RESULT AND DISCUSSION

A. Road Damage

Road damage value (RDV) and drainage damage value (DDV) were obtained from the average damage value for each segment. It can be seen in Table 1 for the average value of road damage (RDV) and Table 2 for the average value of drainage damage on the North Perimeter - South Perimeter Road per 1 km with a total length of the road reviewed of 6 km value for each segment. It can be seen in Table 1 for the average value of road damage (RDV) and Table 2 for the average value of drainage damage on the North Perimeter - South Perimeter Road per 1 km with a total length of the road reviewed of 6 km. From this value, handling will be carried out in accordance with the criteria of the damage types.

The result in Table 1 showed that the average value of road damage (RDV) with quite damaged lies in segments 17 to 20, with an average value of drainage damage of 48.13. The road section was quite critical damage. The damage occurred up to 60%, and some of them had reached a high level of severity, followed by category 1 of damage with a low level of moderate level maintenance of roads such as manual patching, sealing, and skin patching [5].

The result in Table 2 showed that the average value of drainage condition (DCV), which is quite badly damaged lies in segments 17 to 20 with an average value of drainage damage of 40. Drainage facilities are in severe condition, damage is > 60% where side canals are damaged. Drainage facilities required heavy maintenance or rebuilding of the entire road drainage system [5].

B. Traffic Characteristics

ADT data was obtained from a survey at the study location, and the year open was 2022. The ADT was made for ADT of the year open the road. The most dominant number of vehicles passing through the North Perimeter - South Perimeter Road was 1.1 HP, i.e., 3,511 out of 4,391 vehicles per day (77.98%). However, viewed from the CESAL generated, the type of vehicle that had the most influence on road pavement damage was 1.22 Trucks, which was 24,692,221 out of 53,063,992(46%).

Table 1. Average Value of Road Damage

Segment	The Average of RDV	Description
1 – 4	44,50	Require Moderate Repair
5 – 8	43,13	Require Moderate Repair
9 – 12	17,56	Don't Require Maintenance
13 – 16	37,56	Require Minor Repair
17 – 20	48,13	Require Moderate Repair
21 – 24	33,63	Require Minor Repair

Table 2. Average Value of Drainage Damage

Segment	The Average of DDV	Description
1 – 4	32	Require Major Repair
5 – 8	26	Require Major Repair
9 – 12	5	Don't Require Maintenance
13 – 16	37,5	Require Major Repair
17 – 20	40	Require Major Repair
21 – 24	28	Require Major Repair

C. Flexible Pavement Thickness Planning

After calculating ESA using Vehicle Damage Factor (VDF) calculation, namely manual calculations and calculations using tables [3]. The following is the calculation of the VDF equation and VDF MJP that is shown in Table 3 and Table 4.

The results of ESA calculations with two different VDFs found that CESAL used the VDF in table [3] of 53,063,992. Flexible pavement thickness planning used Cement Treated Base (CTB). Based on CESAL calculations, the life plan of 20 years (2040) is 53,063,992. Besides, based on Table [3] for flexible pavement design the minimum cost option with CTB was classified as F3, which is in the range of 50 million - 100 million CESAL, with a pavement structure as follows:

AC-WC = 40 mm
AC-BC = 60 mm
AC-BC or AC Base = 125 mm
CTB = 150 mm
Class A Aggregate Foundation = 150 mm

D. Rigid Pavement Thickness Planning

Rigid pavement thickness planning refers to Table [3] rigid pavement for roads with heavy traffic loads by calculating the heavy vehicle axle group (JKSN). The following is an example of the JKSN calculation:

It is known that the ADT of the open year of the road (2020) for the 1.2 bus axle configuration is 66 vehicles, and the number of axles is 2. In addition, it is also known that the R (20 years) for bus vehicles is 20.07. First, JKSNH is calculated by multiplying the ADT and the number of vehicle axles. Then, multiply JKSNH by R and 365 days.

JKSNH = ADT x Number of Vehicle Axles
= 66 x 2
= 132
JKSN = JKSNH x R x 365
= 132 x 20,07 x 365
= 966.973

Table 3. Calculation Results of CESAL 2040 (VDF Equation)

Conf. Axel	ADT (2022)	R	VDF Total	365	CESAL
1.1 HP	3.426	20,07	0,00044	365	11.041
1.2 Bus	66	20,07	0,26283	365	127.053
1.2 L Truck	665	20,07	1,11332	365	5.422.620
1.2 H Truck	78	20,07	8,86298	365	5.063.396
1.22 Truck	52	20,07	6,77499	365	2.580.355
1.2+2.2 Trailer	51	20,07	5,12951	365	1.916.080
1.2 -2.2 Trailer	55	20,07	23,76062	365	9.571.676
Total	4.393		45,9047		24.692.221

Table 4. Calculation Results of CESAL 2040 (VDF MDPJ)

Conf. Axel	ADT (2022)	R	VDF Total	365	ESA
1.1 HP	3.426	20,07	-	365	-
1.2 Bus	66	20,07	1,0	365	483.405
1.2 L Truck	665	20,07	1,7	365	8.280.148
1.2 H Truck	78	20,07	11,2	365	6.398.529
1.22 Truck	52	20,07	64,4	365	24.527.695
1.2+2.2 Trailer	51	20,07	-	365	-
1.2 -2.2 Trailer	55	20,07	33,2	365	13.374.215
Total	4.502		111,5		53.063.992

Thus, for the 1.2-axis configuration, the Bus has a JKSN of 966,973. It is shown in Table 5, the results of the JKSN calculations for all types of vehicles that cross the study location.

Based on the calculations, a total of 15,317,725 JKSN was obtained, and based on the table [3], rigid pavements for roads with heavy traffic loads were classified in R3. It was a range of 8.6 million to 25.8 million, with a pavement structure:

Concrete Plate Thickness = 285 mm
Base Layer LMC = 100 mm
Drainage Layer = 150 mm

It was planned to use rigid pavement without reinforcement. It used dowels as transverse shrinkage joints. With a concrete slab thickness of 285 mm has the following conditions:

Connection Depth = 0,5 x h
= 0,5 x 305 mm
= 142,5 mm
Connection Distance = 4 m
Diameter of Spokes = 36 mm
Length of Spokes = 45 cm
Distance between Spokes = 30 cm

Transverse construction joints with a concrete slab thickness of more than 17 cm are with the following provisions:

Connection Depth = 142,5
Diameter of Spokes = 20 mm
Length of Spokes = 84 cm

The longitudinal connections with tie bar aim to control the occurrence of longitudinal cracks. Here is the calculation:

At = 204 x b x h
= 204 x 3,5 x 0,285
= 203,49 mm^2

Tried, minimum D Tie Bar: D 16 mm distance 750 mm.

A = ¼ $\pi d^2 \times 1000$ / Reinforcement distance
= ¼ x 3,14 x (16^2) x 1000 / 750
A = 269,94 mm^2 > 203,49 mm^2

Table 5. Calculation of JKSN

Conf. Axel	ADT (2022)	Total Axel	JKSNH	R	JKSN
1.2 Bus	66	2	132	20,07	966.973
1.2 L Truck	665	2	1.330	20,07	9.742.982
1.2 H Truck	78	2	156	20,07	1.142.786
1.22 Truck	52	2	104	20,07	761.857
1.2+2.2 Trailer	51	4	204	20,07	1.494.412
12 -2.2 Trailer	55	3	165	20,07	1.208.716
Total	967				15.317.725

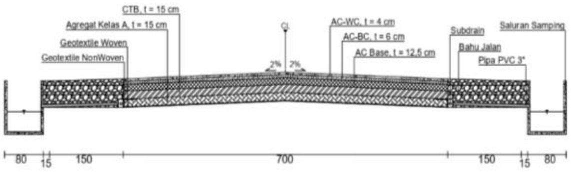

Figure 2. Flexible Pavement Thickness

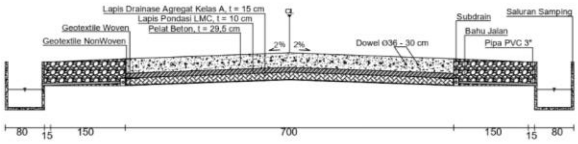

Figure 3. Rigid Pavement Thickness

Then, it used the diameter of Tie Bars Ø16 distance 75 cm,

I = (38,3 x Ø) + 75
= (38,3 x 16) + 75
= 687,8 mm = 68,78 cm

Then the longitudinal connection was installed with D16 threaded steel reinforcement with a length of 70 cm and a distance of 75 cm.

E. Budget Plan Calculation

The budget plan calculation of road pavement in this study used BUPA of Tangerang Regency by adjusting with Tangerang City. The budget plan calculation was carried out by multiplying the work volume with the BUPA that had been adjusted, and the road length calculated from the thickness of the construction structure was only 3.000 meters (3,0 km) with the road width of 7 meters for the total length of 6.0 km.

Volume = Thick $_{(AC\text{-}WC)}$ x Length $_{(Road)}$ x Width $_{(Road)}$ x Asphalt Specific Gravity

= 0,04 m x 3000 m x 7 m x 2,3 ton/m^3

= 1.932 ton

BUPA Jobs = IDR 1.039.424, -

Total Cost = IDR 2.008.167.933, -

The initial total construction cost of this flexible pavement is IDR 44,226,237,298. However, the cost of rigid pavement is IDR 57,608,465,895. Thus, the cost per km is:

Flexible Pavement Cost = IDR 22,113,118,649 / 3.0 km
= IDR 7,371,039,550 / km
Rigid Pavement Cost = IDR 28,344,863,929 / 3.0 km
= IDR 9,448,287,976 / km

Thus, the cost per km of flexible pavement construction with a life plan of 20 years is IDR 7,371,039,550 per km and rigid pavement with a life plan of 20 years is IDR 9,448,287,976 per km.

After obtaining the budget plan for each type of pavement, routine maintenance costs were carried out every year, assuming flexible pavements had damage of 5% of the initial cost each year and an increase in damage every 5 years by 5% of the annual cost of the previous 5 years. Meanwhile, rigid pavements had damage of 1% of the initial cost each year and an increase in damage every 10 years of 1% of the annual cost of the previous 10 years. Prior to calculating maintenance costs, it was necessary to adjust the time value of money and used *i* of 3.75% using the BI 7-day repo rate as the reference interest rate that applied from 19 November 2020.

The value of the initial cost (P) for flexible pavement is IDR 22,113,118,649 and for rigid pavements is IDR. 28,344,863,929. The cost calculation was calculated by calculating the annual cost every 5 years of 5% for flexible pavements. On the other hand, the rigid pavements calculated the annual cost every 10 years by 1%. The following calculations were used to calculate the annual cost:

1. Annual Cost for the first 5 years (A1)
   5% / 1% x *Initial Cost*
2. Annual Cost for the first 5 years (A2)
   A1 + 5% / 1% x A1
3. Annual Cost for the first 5 years (A3)
   A2 + 5% / 1% x A2
4. Annual Cost for the first 5 years (A4)
   A3 + 5% / 1% x A3

After it obtained the annual cost, present cost calculations were carried out to find out the maintenance costs of the life plan. The following is the formula used to calculate the present cost:

1. Present Cost 5 years (P1)
$$A1\ x\ \frac{(1+\mathrm{i})^{\mathrm{n}}-1}{\mathrm{i}x(1+\mathrm{i})^{\mathrm{n}}}$$
2. Present Cost 5 years (P2)
$$A2\ x\ \frac{(1+\mathrm{i})^{\mathrm{n}}-1}{\mathrm{i}x(1+\mathrm{i})^{\mathrm{n}}}\ x\ \frac{1}{(1+\mathrm{i})^{\mathrm{n}}}$$
3. Present Cost 5 years (P3)
$$A2\ x\ \frac{(1+\mathrm{i})^{\mathrm{n}}-1}{\mathrm{i}x(1+\mathrm{i})^{\mathrm{n}}}\ x\ \frac{1}{(1+\mathrm{i})^{\mathrm{n}}}$$
4. Present Cost 5 years (P4)
$$A3\ x\ \frac{(1+\mathrm{i})^{\mathrm{n}}-1}{\mathrm{i}x(1+\mathrm{i})^{\mathrm{n}}}\ x\ \frac{1}{(1+\mathrm{i})^{\mathrm{n}}}$$

The calculation results obtained the flexible pavement's maintenance cost was IDR 16,372,003,840 and the maintenance cost for rigid pavement was IDR 5,887,043,961. The cost per km of flexible pavement types was IDR 5,457,334,613 per km, while the rigid pavement was IDR 1,962,347,987 per km.

The total initial cost of construction and maintenance for the flexible pavement and rigid pavement for the life plan of 20 years is as follows:

Flexible Pavement Cost = IDR 22,113,118,649 + IDR 16,372,003,840
= IDR 38,485,122,489

Rigid Pavement Cost = IDR 28,344,863,929 + IDR 5,887,043,961
= IDR 34,231,907,890

The calculation result of the total cost of constructing a flexible pavement with a life plan of 20 years was IDR 38,485,122,489, while the rigid type of pavement with a life plan of 20 years was IDR 34,231,907,890.

F. Pavement Type Selection

The results of pavement calculations demonstrated that flexible pavements had a total thickness of 53.5 cm, and rigid pavements had a total thickness of 52.5 cm. From the thickness ratio, rigid pavement is 1 cm thinner than flexible pavement.

The analysis results of the initial cost for each showed that the flexible pavement construction was IDR 22,113,118,649 and the rigid pavement was IDR 28,344,863,929. It is known that the cheapest initial cost is flexible pavement. However, the cost is for 20 years, while the initial cost for rigid pavement is required for 20 years. If the two types of pavements are calculated with the same life plan for 20 years, the cost for flexible pavement is IDR 38,485,122,489. Therefore, if the pavement is calculated with the same plan life, the rigid pavement is much cheaper than the flexible pavement.

The calculation results of maintenance costs were for flexible pavements amounting to IDR 16,372,003,840, while for rigid pavements maintenance costs of IDR 5,887,043,961. Thus, flexible pavements are more expensive to maintain than rigid pavements.

From the two comparisons, it chose to use the Rigid Pavements for the pavement repair for Jalan Soekarno - Hatta North Perimeter - South Perimeter, Tangerang City. It is expected that it can be taken into consideration by the Public Works Department of Bina Marga Banten Province because the road is a provincial road, so the Public Works of Department Bina Marga Banten must choose the appropriate pavement.

CONCLUSION

1. From the analysis results of the road damage level [4] on Jalan Soekarno - Hatta obtained the average value of road damage and drainage damage. The damage that is quite extreme is in segments 17 to 20. The average value of road damage is 48.13 which means.
2. "Road Needs Minor Repair", and the average value pf drainage damage is 40 which means "Drainage Needs Major Repair." The average riding quality value is 4 which means "Poor". Speed is below the limit in situations along the road section.
3. Traffic characteristics of Jalan Soekarno - Hatta North Perimeter - South Perimeter showed the most dominant type is 1.1 HP vehicle with 77.98%. When viewed from the type of vehicle that is considered in the pavement, as well as the biggest factor in the occurrence of road damage are trucks with an axis configuration of 1.22 as much as 46%.
4. The thickness of the flexible pavement structure that is required to repair damage of Jalan Seokarno - Hatta North Perimeter - South Perimeter according to the life plan of 20 years is a class A aggregate foundation of 15 cm, CTB 15 cm, AC Base 125 cm, AC-BC 6 cm, and AC-WC 4 cm. The thickness of the rigid pavement structure according to the life plan of 20 years is the class A aggregate drainage foundation layer of 15 cm, the LMC foundation of 10 cm, and the concrete slab thickness of 28.5 cm.
5. The total initial cost of construction and maintenance costs for each type of pavement according to the 20-year life plan is IDR 38,485,122,489 for the flexible pavement and IDR 34, 231, 907, 8909,735 for the rigid pavement.
6. The rigid pavement was chosen as the appropriate pavement type for repairing road damage on Jalan Soekarno - Hatta North Perimeter - South Perimeter. It was decided after a comparison between the thickness of flexible pavement and rigid pavement, for the initial cost of pavement, and pavement maintenance costs during the 20-year construction period.

DAFTAR PUSTAKA

[1] C. A. Prastyanto and I. B. Mochtar, "The Effect of Overload Heavy Vehicles on The Values of Axle Load Distribution, Tire Pressure And Equivalent Axle Load (Case Study: Jenu -Tuban Aterial Road, East Java, Indonesia)," 2006. [Online]. Available: www.arpnjournals.com
[2] Pemerintah Republik Indonesia, "Undang-Undang Nomor 22 Tahun 2009 Tentang Lalu Lintas dan Angkutan Jalan," 2009.
[3] Direktorat Jenderal Permukiman dan Prasarana Wilayah, "Pd T-19-2004-B-Survei Pencacahan Lalu Lintas," 2004.
[4] Departemen Pekerjaan Umum Direktorat Jenderal Bina Marga, "Manual Desain Perkerasan Jalan Nomor 04/SE/Db/2017," 2017.
[5] Indrasurya and P. Dirgolaksono, "Metode Penilaian Kerusakan Jalan di Indonesia," Surabaya, 1990.

Figure 1. Calculation of Flow Chart (description)

Mulai : Started
Studi Literatur: Literature Review
Pengumpulan Data: Data Collection
Data Primer: Primary Data
1. Road Damage Data
2. Drainage Data
3. Average Daily Traffic
a. Penilaian Kerusakan Jalan: Evaluation of Road Damage
- Jenis kerusakan jalan yang ditinjau: Type of road damage reviewed.
- Luas Jalan yang mengalami kerusakan: The area of the road that was damaged.

Nilai Kondisi Jalan (Road Condition Value)

b. Penilaian Saluran Samping: Evaluation of Drainage Damage
- Genangan pada permukaan jalan: puddles on the road surface
- Berapa terjadinya banjir: Flood duration
- Berapa frekuensi terjadinya banjir: Flood frequency

Nilai Kondisi Saluran Samping: Drainage Condition Value)

c. Penilaian Lalu Lintas Harian Rata-Rarta: Evaluation of Average Daily Traffic
- Di tahun pembukaan jalan: in the opening year
- Pada umur rencana: In the life plan

Nilai LHR: ADT Value
Nilai ESA: ESA Value

Data Sekunder: Secondary Data
1. Data HSPK: BUPA Data

Pengolahan Data: Data processing
- Harga satuan: Unit price
- Indeks Kemahalan: Cost Index
- Konstruksi: Construction

Nilai Harga Satuan: Unit price value

Perencanaan Perkerasan lentur: Flexible Pavement Planning
Tebal Struktur Perkerasan: Thickness of Pavement Structure
Biaya Konstruksi dan Biaya Pemeliharaan: Construction and Maintenance Costs

Perencanaan Perkerasan Kaku:Rigid Pavement Planning
Tebal Struktur Perkerasan: Thickness of Pavement Structure
Biaya Konstruksi dan Biaya Pemeliharaan: Construction and Maintenance Costs

Analisis biaya: Cost analysis
Pemilihan Jenis PerkerasanL Pavement Type Selection
Kesimpulan dan Saran: Conclusion and Suggestion
Selesai: Finished

Figure 2. Flexible Pavement Thickness
Agregat Kelas A: Class A Aggregate
Baju Jalan: Roadside
Pipa: Pipe
Saluran Samping: Drainage

Figure 3. Rigid Pavement Thickness
Lapis Drainase Agregat Kelas A: Class A Aggregate Drainage Layer:
Lapis Pondasi: Foundation Layer
Pelat Beton: Concrete Slab
Baju Jalan: Roadside
Pipa: Pipe
Saluran Samping: Drainage