PAVED SURFACE FINE CRACK STUDY WITH 2017 MDP METHOD

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Abstract. Fine cracks have a gap width of ≤ 3 MM, the distribution properties can be local or road surface area. Some of the main causes of fine cracks are pavement material is not good, surface weathering, and sub-surface soil or layer is less stable. Fine cracks will develop into larger cracks if left unchecked because water on the surface layer will enter the other layers. This research aims to determine how thick the surface layer was using the MDP 2017 and IRC methods. This research aims to determine how thick the surface layer by using the MDP 2017 and IRC methods. The results of the thickness of the two methods are used in determining the period of fine cracks using the HDM III method. Then, the results of the fine cracks period based on the thickness of the two methods were compared. Based on the analysis, the total thickness of the pavement layer obtain by using the MDP 2017 method is 59 cm, consisting of 4 cm of the surface layer (AC-WC), 25 cm of the base layer, and 30 cm of sub-base layer, the period of fine cracks are 2.717 years. The IRC method obtain 37 cm of a total thickness, consisting of 8 cm of the surface layer, 15 cm of the base layer, and 14 cm of the sub-base layer, a period of 1.415 years of fine cracks. The MDP 2017 method is 37.29% thicker than the IRC method, and the MDP 2017 method is 47.92% longer for the occurrence of fine cracks compared to the IRC method.

Keywords: Fine Cracks, MDP 2017, IRC, HDM III.

I. INTRODUCTION

1.1 Background

Road damage in the form of cracks on flexible pavement is a problem that often occurs in road transportation infrastructure in Indonesia. According to the road maintenance manual No.03/MN/B/1983 issued by the directorate general of bina marga, cracking is a symptom of pavement surface damage that will cause water on the pavement surface to enter the layer below it and this is one of the factors that will make a lot of damage.

Some of the main causes of fine cracks are: poor pavement material or material quality, surface weathering, and unstable subgrade or subsurface. Fine cracks if left unchecked can develop into larger cracks, because water on the surface layer can enter other layers. In this study, we want to know the initial period of the occurrence of fine cracks in flexible pavement.

1.2 Aims and Objectives

The objectives of this research plan are as follows:

- To find out how thick the pavement layer is using the 2017 MDP method
- To find out how thick the pavement layer is using the IRC method
- To determine the period of occurrence of fine cracks on the surface layer using the HDM III method based on the thickness obtained using the 2017 MDP method.

II. THE RESEARCH LOCATION

The location of LHR data collection and subgrade sampling is on Jalan Jabal Nur, Talise Village, Mantikulore District, Palu City, Central Sulawesi Province.

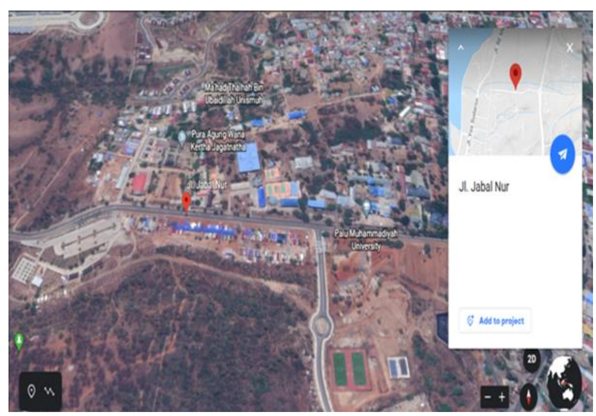

Fig. 1. Sampling Location of AVDT and Subgrade Data**.**

III. LITERATURE REVIEW

3.1 General

Highway pavement is formed from various layers, where each layer consists of materials that are located and have different thicknesses according to the road. According to the Department of Public Works (1987) what is meant by flexible pavement is a pavement that generally uses a mixture of asphalt as the surface layer and a granular material underneath. This pavement generally consists of 3 layers or more, namely: the surface layer, the top foundation layer and the bottom

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foundation layer which is located above the subgrade (Suprapto, 2004). In the road pavement structure, the forces acting on it are vertical forces due to vehicle loads, horizontal forces due to vehicle brake forces and vibrations due to vehicle wheel strikes (Sukirman, 1999).

The road pavement layer is planned to be able to withstand or accept vehicle loads with the limits of its support capacity, it is also intended to be able to spread wheel loads. Loads that work on road pavement construction, namely traffic that crosses the road, affects the effect on the road pavement surface with the emergence of loads due to vehicle wheels.

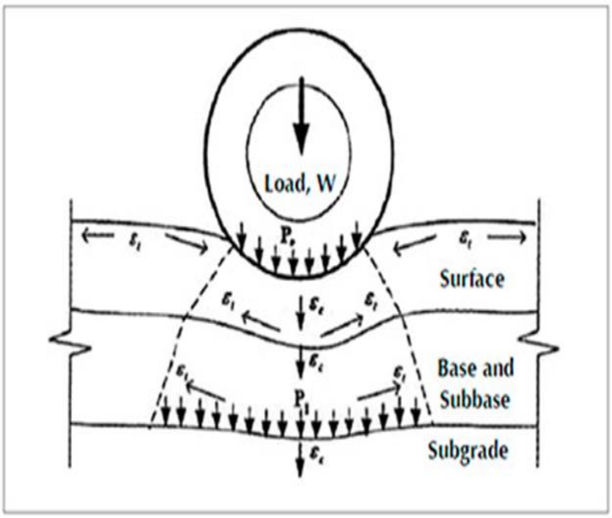

Fig. 2. Stress from Vehicle Wheels To Subgrade.

Capacity The bearing capacity of pure flexural pavement, depends on the load distribution characteristics of the layer system forming it. Flexible pavement consists of several layers with high quality material placed near the surface. Thus, the flexural pavement strength is more likely to result from the cooperation of thick layers in spreading the load to the subgrade.

Through the contact area of the wheel, the vehicle load is transferred to the pavement, then the load is received by the surface layer and distributed to the next layers. Until finally the subgrade bears a small burden from the carrying capacity of the subgrade.

Due to the nature of the distribution of forces, the charge received by each layer is different and the lower the force received, the smaller the force. The surface layer must be able to accept all kinds of working forces, the top layer of the foundation accepts vertical forces and vibrations. The sub-base layer receives the same force as the upper foundation but is smaller, while the subgrade is considered to receive only vertical forces. Therefore, there are several different requirements that must be met by each layer.

In addition to depending on the materials used, the performance of the road pavement also depends on several factors as follows:

- Climatic conditions
- Ground conditions
- Composition of vehicles passing on it

3.2 Asphalt Concrete

Asphalt concrete is one type of flexible pavement construction pavement layer. The asphalt concrete mixture consists of coarse aggregate, fine aggregate, filler and uses asphalt as a binder. Filler, which is also known as filler, can be obtained from the results of natural or artificial rock breakdown. The commonly used filler is rock ash (dust) filler.

3.3 Traffic Volume

Sukirman (1999), for road planning requires an ability to estimate the volume of traffic that passes through a road lane. Traffic volume is the number of vehicles that pass an observation point on a road lane, to get the traffic volume a traffic volume survey is carried out. Based on the traffic volume survey, it is carried out for 3 x 24 hours or 3 x 16 hours continuously.

3.4 Axle Load Equivalent Figure

The equivalent number (E) is calculated based on the vehicle axle load calculated from the location of the vehicle's center of gravity in providing a percentage of the load on the front wheels (single axles) and rear wheels (single/double axles).

3.5 Cumulative Axle Load

The cumulative standard axle load (W18) is the cumulative traffic on the design lane, both W18 in 1 day and W18 in 1 year. In reality, heavy vehicles tend to pass only in certain lanes which are used as planned lanes, so in calculating this quantity it must be multiplied by the direction distribution factor (DD) and the lane distribution factor (DL) before being used as w18.

3.6 Determining Bitumen Elasticity Modulus (Sb) and Asphalt Mixture Modulus of Elasticity

Modulus of Elasticity is a number used to measure an object or a material's resistance to elastic deformation when a force is applied to that object. One of the types in the modulus of elasticity is the stiffness modulus.

Stiffness is the resistance of a material to elastic deformation, because of its rheological properties, asphalt stiffness is the relationship between stress and strain as a function of loading time and temperature. Van Der Poel (1954) gave the term Stiffness of bitumen (Sb) as a comparison between the strains in asphalt, which is a function of the duration of loading (frequency) applied, the temperature difference with T800 and the Penetration Index. T800 is the temperature at which the penetration reaches 800.

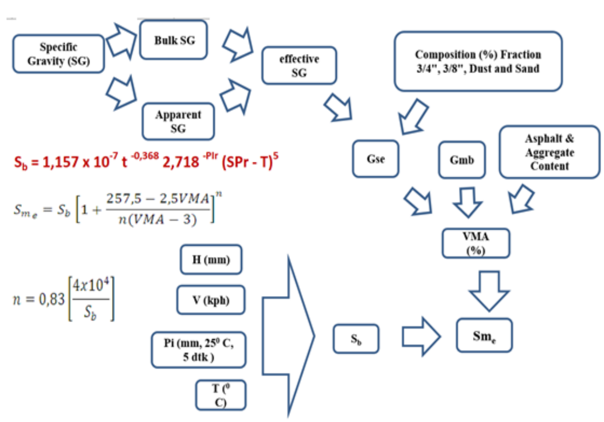

Fig. 3. Sme Calculation Step Sequence Diagram.

According to the method of Brown and Brunton (1984) the stiffness modulus of asphalt-concrete mixture (Sme) is influenced by the stiffness modulus of asphalt (Sb) and VMA (Voids in Mineral Aggregate). The asphalt stiffness modulus (Sb) is influenced by temperature, recovered penetration, recovered softening point, penetration index and duration of loading. As for this study, to determine the modulus of elasticity, the steps based on Figure 3 below are used, the calculations are carried out at a temperature of 68^0F or 20^0C.

3.7 Determination of Total Pavement Thickness Using The 2017 MDP Method

The data needed in determining the total pavement using the 2017 MDP method are LHR data, CBR data, design age, traffic growth factor, and lane distribution factor. The steps in determining the total pavement layer using the 2017 MDP method:

- Calculating cumulative standard axle load (CESA)
- Determination of road foundation structure
- Determine the thickness of the pavement layer using the pavement layer design chart.

3.8 Determination of Total Pavement Thickness Using the IRC Method

In determining the total pavement layer using the IRC method, CBR data and design traffic data are needed. The steps in determining the total pavement layer using the IRC method:

- IRC nomogram: 37-2001 is a graph used to determine the total thickness of the flexible pavement layer based on the CBR value of the subgrade and the desired design traffic (NE4) value. In this graph, there are several CBR options that can be used ranging from 2%, 3% to 10%, while for alternative traffic designs available ranging from 1 msa, 2 msa to 10 msa.
- The procedure that must be followed is to draw a line from bottom to top (vertical line) starting from design traffic of 1 msa, 2 msa and ending at 10 msa until it stops at one meeting point on the curved line of the CBR being reviewed, starting from CBR 2%, 3 % up to 10% CBR. At each meeting point, draw a horizontal line to the left and stop at the vertical line (H-Tot points).
- It is realized that the technical use of the nomogram must be done carefully in order to produce rational results. Obtaining a simpler method with more accurate results is needed to help avoid minimal errors in plotting CBR data and design traffic data on the nomogram. For this reason, it is necessary to translate the nomogram into an equation or mathematical model so that it will be easy and convenient more flexible in determining the total number of pavement thicknesses.

3.9 Determination of Initial Period of Fine Cracks Using the HDM III Method

The steps in determining the initial period of fine cracking using the HDM III method are as follows:

- The data we need in this method is CBR data and the total value of the pavement layer thickness that has been obtained using the 2017 MDP method and the IRC method.
- Calculating the characteristic pavement strength based on the structural number (SNC) using equation.
- Calculating the determination of the initial period of fine cracks on the surface layer
- Calculating the determination of the initial period of fine cracks on the surface layer.

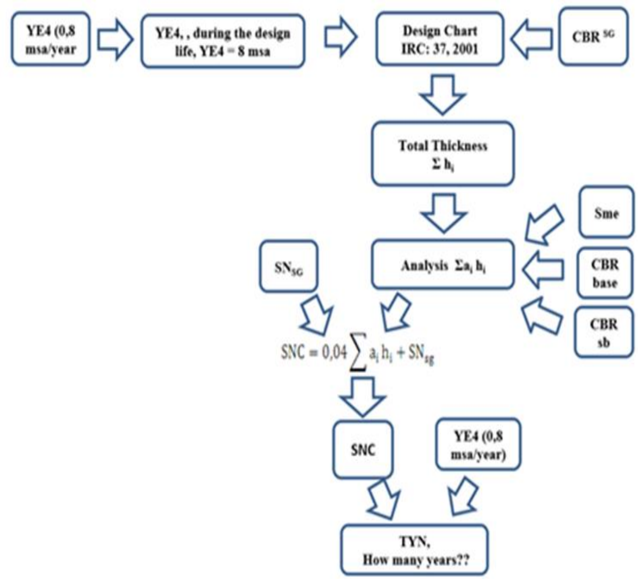

Fig. 4. Procedure for Predicting the Occurrence of TYN.

IV. RESEARCH METHODOLOGY

Broadly speaking, as can be seen in figure 5, the author provides an overview of the stages that will be carried out in conducting research on this Potential Study which includes:

- Literature review.
- Data collection and research locations.
- Primary and secondary data retrieval.
- Management of primary data and secondary data.
- Calculation of the equivalent number of axle loads, cumulative axle loads, axle loads per day and per year, modulus of elasticity of bitumen and modulus of elasticity of asphalt mixtures.
- Determination of pavement layer thickness using the 2017 MDP method and the IRC method.
- Determination of the initial period of fine cracks in the surface layer using the HDM III method.
- Discussion of calculation results.
- Conclusions and suggestions.

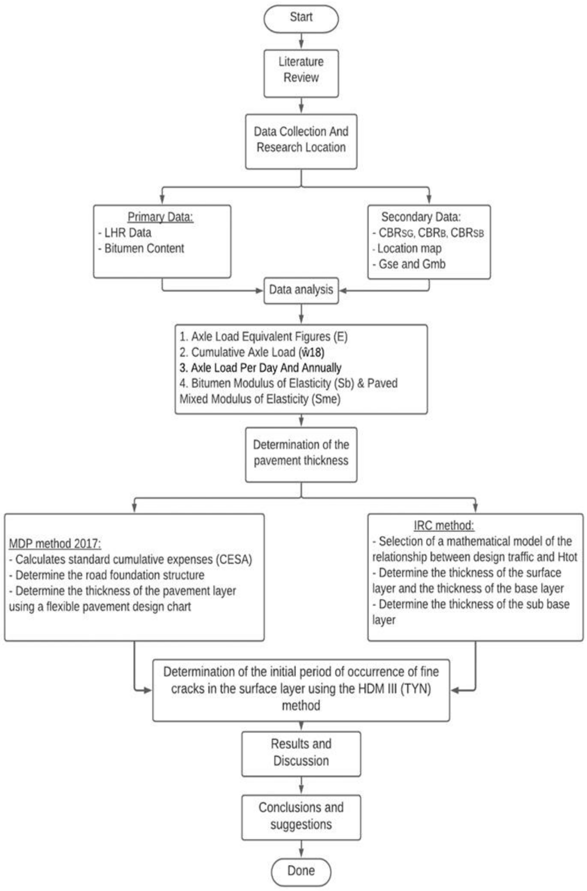

Fig. 5. Flowchart of Research Flow.

V. RESULT AND DISCUSSION

5.1 Daily Traffic and Standard Axle Load Distribution

Daily Traffic Survey Results can be seen in below table.

Table 1. Survey Result Data

No.	Vehicle Type	Number of Vehicles (SMP/hour)
1	Passenger car (LV)	5284
2	Light Truck (HV)	169
3	Heavy Trcuk 1.2 (HV)	27
4	Bus 1.2 (AU)	12
Total		5492

The value in table-1 is the result of multiplying the number of each type of vehicle according to the survey results at the research location with the equivalent value of passenger cars as determined by MKJI 1997. It can be seen that passenger cars dominate the number of vehicles, namely 96% of the total 5492 AVDT, while for three Types of heavy vehicles recorded only around 4%.

Table 2. Vehicle Load Distribution

No.	Vehicle Type	Total Weight		Total Vehicle (SMP/hours)	Load Distribution		
					Front	Middle	Rear
1	Passenger Car (LV)	2	ton	5284	50%	-	50 %
2	Light Truk (HV)	8,3	ton	169	34%	-	66 %
3	Heavy Truk 1.2 (HV)	18,2	ton	27	34%	-	66 %
4	Bus 1.2 (AU)	9	ton	12	34%	-	66 %

D = 80% = 0, 0.50 is taken except in locations where the number of commercial vehicles tends to be higher in one particular direction.

5.2 Axle Load Equivalent Figure

In calculating the equivalent number of axle load (E) of a vehicle, it is carried out by taking into account the percentage of front axle load, middle and rear axle load for each type of vehicle, where for:

- Passenger car 2 tons

E = STRT + STR

$$= \left(\frac{axle\ load\ (ton)}{5,4}\right) + \left(\frac{axle\ load\ (ton)}{5,4}\right)$$

$$= \left(\frac{0,5 \times 2}{5,4}\right)^4 + \left(\frac{0,5 \times 2}{5,4}\right)^4$$

= 0,0024

- Light Truck (LV) 8,3 ton

E = STRT + STRG

$$= \left(\frac{axle\ load\ (ton)}{5,4}\right)^4 + \left(\frac{axle\ load\ (ton)}{8,16}\right)$$

$$= \left(\frac{0,34 \times 8,3}{5,4}\right)^4 + \left(\frac{0,66 \times 8,3}{8,16}\right)^4$$

= 0,278

- Heavy Truck (1.2 HV) 2 as 18,2 ton

E = STRT + STRG

$$= \left(\frac{axle\ load\ (ton)}{5,4}\right)^4 + \left(\frac{axle\ load\ (ton)}{8,16}\right)$$

$$= \left(\frac{0,34 \times 18,2}{5,4}\right)^4 + \left(\frac{0,66 \times 18,2}{8,16}\right)^4$$

= 6,420

- Bus (AU) 9 ton

E= STRT + STRG

$$= \left(\frac{axle\ load\ (ton)}{5,4}\right)^4 + \left(\frac{axle\ load\ (ton)}{8,16}\right)$$

$$= \left(\frac{0,34 \times 9}{5,4}\right)^4 + \left(\frac{0,66 \times 9}{8,16}\right)^4$$

= 0,384

thus daily cumulative standard axle load for two ways (w18) can be calculated as below;

w18 = E x number of vehicles

- Passenger car (LV) 2 ton

ŵ18 = 0,0024 x 5284
= 12,428 CESA

- Light Truck (LV) 8,3 ton

ŵ18 = 0,278 x 169
= 46,930 CESA

- Heavy Truck (1.2 HV) 18,2 ton

ŵ18 = 6,420 x 27
= 173,342 CESA

- Bus (AU) 9 ton

ŵ18 = 0,384 x 12
= 4,607 CESA

Then, the total axle load :

ŵ18 = 12,428 + 46,930 + 173,342 + 4,607
= 237,307 CESA

Therefore axle load per day (w18 per day) can be calculated;
DD = 0.30 – 0.70 (based on the 2017 MDP for two-way roads, the direction distribution factor is generally taken as 0.50 except in locations where the number of commercial vehicles tends to be higher in one particular direction).
DL = 80% = 0,8

ŵ18 per day = DD x DL x ŵ18
= 0,50 x 0,8 x 237,307
= 94,923 CESA

Table 3. Commerce on Design Track

Number of Lanes Each Direction	Commerce on Design Track (% of commercial vehicle population)
1	100
2	80
3	60
4	50

Calculating w18 per year
Knowing the number of days in 1 year = 365 days
Hence:

ŵ18 per year = 365 x ŵ18 per day
= 365 x 94,923 = 34.646,829 CESA = 34.647 CESA

5.3 Pavement Material Inspection Results

Sampling of asphalt for each damage was taken using a core drill tool, followed by an extraction experiment to determine the asphalt content in the mixture in the pavement layer.

Experiment I (Point 1):

- Mixed Weight = 900,3 gr
- Filter weight before testing = 12,7 gr
- Filter weight after testing = 13,63 gr
- Dust Weight
  = 13,63 gr – 12,7 gr = 0,93 gr
- Aggregate weight after test = 840,79 gr
- Total weight of aggregate
  = 840,79 gr + 0,93 gr = 841,72 gr
- Losing weight
  = 900,3 gr – 841,72 gr = 58,58 gr
- Percentage of bitumen to aggregate mixture
  = (58,58 / 841,72) x 100 = 7,0 %
- Percentage of bitumen to mixture
  = (58,58 / 900,3) x 100 = 6,5 %

Table 4. Extraction Test Results (Asphalt Content Check)

Testing Sample	Location	Bitumen Content of the Mixture (%)
Point 1	KM. 0 + 300	6,5
Point 2	KM. 0 + 350	6,1
Point 3	KM. 0 + 375	7,5
Point 4	KM. 0 + 300	7,6
Point 5	KM. 0 + 350	8,0
Average		7,1

5.4 Calculation of Void in Mineral Aggregate (VMA)

To get the value of air voids in the asphalt mixture, previously needed the value of asphalt content which is abbreviated Mb and aggregate content or Ma. The asphalt content value that will be used in this study is = 7.1%, and the aggregate content (MA), used:

MA = 100 – asphalt content
= 100 – 7,1 = 92,9%

Thus, to get the VMA value, the equation formula is used:

VMA = 100 - {MA x (2,305/2,733)}
= 100 – {92,9x (2,305/2,733)} = 21,640 %

The VMA value will be required in the calculation of determining the value of the elastic modulus for the asphalt layer (Sme) in the next discussion.

5.5 Modulus of Elasticity of Bitumen (Sb)

The calculation results can be seen in the example below, it is known:

h = 100 mm, v = 60 kph, pi = 67 mm, and T = 25^{0}C

- Pr = 0,65 pi
  = 0,65 x 67
  = 43,55
- Log t = $5 \times 10^{-4} h - 0,2 - 0,9 \log v$
  = (-0,1500) – 16,7
  = -1,82
- SPr = 98,4 – 26,35 Log Pr
  = 98,4 – 26,35 Log (43,55)
  = 55,2127
- Pir $= \frac{27 \log Pi - 21,65}{76,35 \log Pi - 232,82}$
  $= \frac{27 \log 67 - 21,65}{76,35 \log 67 - 232,82}$
  = -0,296
- Sb $= 1,157 \times 10^{-7}\, t^{-0,368}\, 2,718^{-PIr}\, (SPr - T)^5$
  $= 1,157 \times 10^{-7}\, t^{-0,368}\, 2,718^{-PIr}\, (SPr - T)^5$
  = 18,330 MPa = 272.236,775 PSi

5.6 Modulus of Elasticity of Paved Mixture

The VMA percentage can be calculated after hot mixing between the aggregate and asphalt fractions is carried out, followed by compaction and volumetric analysis of the mixture.

The VMA value obtained, which is 21.640 %, meets the General Specifications Division 6, 2010 (minimum 15%), the Asphalt Institute Specification, 2001 (minimum 14%) and Nottingham University Specification, 1982 (12% < VMA < 30%).

Based on the asphalt elastic modulus (Sb) data, an overview of the calculations is presented in table 4.4 above and the VMA data that has been obtained in the previous calculation, the calculation of the Elasticity Modulus of the Asphalt Mixture (Sme) can be found

$$n = 0{,}83 \log \left[\frac{4 \times 10^4}{18{,}33}\right] = 2{,}771$$

so that:

$$Sme = Sb \left[1+ \frac{257{,}5-2{,}5(VMA)}{n(VMA-3)}\right]^n$$

$$Sme = 18{,}330 \left[1+ \frac{257{,}5-2{,}5(21{,}640)}{2{,}771(21{,}640-3)}\right]$$

Sme = 1.531,306 MPa
= 221.932,149 Psi

5.7 Determination of Total Pavement Thickness

To plan the total thickness of asphalt pavement, a number of data are needed, including; desired design life data and vehicle growth factor data, whose value is taken based on the 2017 MDP provisions as in the table below.

Table 5. Design Life of New Pavement

Pavement Type	Pavement Elements	Design Life (year)
Flexible Pavemnt	Asphalt Coating And Granular Coating	20
	Road Foundation	
	All pavements for areas where overlay is not possible, such as urban roads, un-derpasses, bridges, tunnels	40
	Cement Treated Based (CTB)	
Rigid Pavement	Upper foundation layer, lower foundation layer, cement concrete layer, and road foundation	
Road Without Cover	All elements (including road foundation)	Minimum 10

Meanwhile the percentage figure for the vehicle growth factor is determined in the 2017 MDP based on road classes in several major islands in Indonesia, as presented in the following table.

Table 6. Traffic Growth Factor (I) Minimum For Design

	Jawa	Sumatra	Kalimantan	Average of Indonesia
Arteri and Urban	4,80	4,83	5,14	4,75
Collector or Rural	3,50	3,50	3,50	3,50
Rural Road	1,00	1,00	1,00	1,00

Traffic growth multiplier

$$R= \frac{(1+\ 0{,}01\, i)^{UR}-1}{0{,}01\, i}$$

$$= \frac{(1+\ 0{,}01 \times 0{,}0475)^{20}-1}{0{,}01 \times 0{,}0475} \qquad =20{,}091$$

Next step is calculating the Cumulative Standard Load (CESA) values, including: ESA, CESA4, and CESA5.

Table 7. Calculation Results of ESA, CESA4, CESA5

Type of Vehicle	Total Weight (ton)	AVD	VDF	ESA 4	ESA	CESA4	CESA5
Passenger Car (LV)	2	5284	0.02	84.5	446730.5	3275970774.2	5896747393.6
Light Truck (LV)	8.3	169	1.07	144.6	24448.2	179284024.3	322711243.7
Heavy Trcuk 1.2 (HV)	18.2	27	24.75	534.5	14432.4	105836261.7	190505271.2
Bus 1.2 (AU)	9	12	1.5	14.2	170.5	1250283.8	2250510.9
Total		5492				3562341344.1	6412214419.4

Based on the subgrade value taken directly in the field with a value above 6%, a design life of 20 years and with an ESA value below 1 million, the subgrade's CBR value does not need to be increased, as described in table below.

Table 8. Calculation Results of ESA, CESA4, CESA5

CBR Subgrade (%)	Strength Class of Subgrade	Structural Description of Foundation	Flexible Pavement: Traffic load on the design lane with a design life of 20 years (Million ESA5) < 2	2 - 4	> 4	Rigid Pavement: Cement Stabilization
≥ 6	SG6		No need upgrade			
5	SG5	Subgrade improvement can be in the form of stabilization of cement/fill material of choice (according to the requirements of General Specifications, Division 3-Soil Works)			100	300
4	SG4				200	
3	SG3				300	
2,5	SG2,5				350	

From the table above, the results obtained Subgrade strength class = SG6.

For knowing the thickness of the pavement layer one can use table 9. regarding the flexible pavement layer design chart.

n = 20 years
W18 peryear = 34.647 CESA
A = $(1 + g)^n$ = 2,53
B = A – 1 = 1,53
C = B / g = 32,206

Table 9. Chart of Flexible Pavement Layer Design

	Pavement Structure: FFF 1	FFF 2	FFF 3	FFF 4	FF 5	FFF 6	FFF 7	FFF 8	FFF 9
Preferred Solution					View Note 2				
Cumulative axle load of 20 years on design lane (10^6	<2	≥ 2- 4	> 4 - 7	> 7 - 10	> 10 - 20	> 20 - 30	> 30 - 50	> 50 - 100	> 100 - 200

	Pavement Structure								
	FFF 1	FFF 2	FFF 3	FFF 4	FF 5	FFF 6	FFF 7	FFF 8	FFF 9
CESA 5)									
Pavement Layer Thickness (mm)									
AC - WC	40	40	40	40	40	40	40	40	40
Base	0	70	80	105	14 5	160	180	210	245
LPB Class A	400	300	300	300	30 0	300	300	300	300
Note	1		1		3				

Note Chart Design – 3B:

1. FFF1 or FFF2 should take precedence over solutions FF1 and FF2 (Design Chart-3A)
2. Pavement with CTB & rigid pavement options can be more cost effective but impractical if the required resources are not available
3. Solutions for FFF5-FFF9 in Design Charts - 3B can be more practical Than Design Charts Solutions - 3A or 4
4. For flexible pavement designs with loads >10 million CESA5, it is preferred to use Design Chart - 3B.

From the table above, the pavement results are obtained as follows:

AC-WC = 40 mm = 4 cm
AC Base = 245 mm = 24,5 cm = 25 cm
LPA class A = 300 mm = 30 cm

So, the total thickness of the pavement layer that can be obtained using the 2017 MDP method is 59 cm.

5.8 Determination of The Initial Period of Fine Cracks on The Surface Layer

It is required to calculate the value of SNC. Therefore, before the value of the pavement layer strength coefficient (ai) should be known first.

Table 10. Coefficient of Pavement Layer Strength

Pavement Layer	**Strength Coefficient (a1)**
Base Course	
Granular Material	
CBR = 30 %	**0,07**
CBR = 50 %	**0,10**
CBR = 70 %	**0,12**
CBR = 90 %	**0,13**
CBR = 110 %	**0,14**
Bituminous materials	
Subbase and selected Subgrade Layers (to total pavement depth of 700 mm)	
Granular materials	
CBR = 5 %	**0,06**
CBR = 15 %	**0,09**
CBR = 25 %	0,10
CBR = 50 %	0,12
CBR = 100 %	0,14

Based on secondary data:

CBRb = 90%
CBRsb = 60%

So that the pavement layer coefficient value is:

CBRb = 0,13
CBRsb = 0,124

As for the relative coefficient of the surface layer, it is determined using the approximate formula. The formula in question is:

Y = 7E-07 X + 0,158

Where Y is the relative coefficient and X is the modulus of elasticity of the asphalt mixture. The Sme value that has been obtained from the previous calculation is 1,531,306 MPa = 221,932,149 PSi. So:

y = 7E-07x + 0,158
y = 7E-07(221.932,149) + 0,158
y = 0.155 + 0,158
y = 0.313

Table 11. Coefficient of Pavement Layer Strength

Layer	Ai	hi (mm)	ai x hi
Aspal	0.313	40	13
Base	0.130	250	33
Sub base	0.124	300	37
∑		590	82.220

SNsg = 3,51 log CBR – 0,85 (log CBR)² - 1,43
= 3,51 LOG 7,63 – 0,85 (log 7,63)² - 1,43 = 1,006

$$SNC \quad = 0{,}04 \sum a_i\, h_i + SNsg$$

= 0,04 x 82,220 + 1,006
= 4,294

Hence: the initial period of fine cracks;

YE4 = Wt = 1.115.828,61 CESA = 1,116 msa
TYN = 4,21 exp (0,139 SNC - 17,1 YE4 / SNC^2)
= 4,21 exp (0,139 x 4,294 - 17,1 x 1,116 /4,294²)
= 4,21 exp (-0,438)
= 4,21 x 0,645
= 2,717 years

From the calculation results, the total thickness using the 2017 MDP method is 59 cm. This result is influenced by the traffic growth multiplier (R) which is calculated on 2017 MDP method. From the thickness value, the TYN value for the 2017 MDP method is 2.717 years.

VI. CONCLUSION AND RECOMEMENDATION

6.1 Conclusions

Based on the analysis of the data obtained from a direct survey at the research site (LHR survey) and the results of the study, the following conclusions can be drawn:

1. The total thickness of the pavement layer obtained using the 2017 MDP method is 59 cm, consisting of 4 cm surface layer (AC-WC), 25 cm base layer, and 30 cm sub base layer.
2. The period of occurrence of fine cracks is obtained based on the layer thickness value from the 2017 MDP method is 2,717.

6.2 Recommendations

1. Fine cracks on the surface layer if left unchecked can develop into crocodile skin cracks, it is recommended to complete an aqua proof system in the repair stage.
2. As explained in the first point, fine cracks can develop into crocodile skin cracks. So, it is recommended to conduct similar research that can predict how long it will take from

the occurrence of fine cracks to develop into crocodile skin cracks.

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