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Analysis of Damage to Abdul Haris Nasution Road Section from STA 4+400 to STA 8+700, Batu Nadua District, Padangsidimpuan City

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ABSTRACT

Highways are one of the most important land transportation infrastructures, so good road pavement design is a must. Good road pavement is also expected to provide a sense of safety and comfort in driving, especially affect the smooth flow of traffic. One of the causes of road damage is the lack of maintenance costs which results in a decrease in the quality of implementation. The rapid growth of vehicles has an impact on traffic density, both on inner-city and outer-city roads, so that it is necessary to improve the quality and quantity of road infrastructure. The goal to be achieved in writing the results of this thesis is to find out what types and percentages of damage occurred Abdul Haris Nasution Road Section and maintenance handling and knowing the thickness of the pavement layer required Abdul Haris Nasution Road Section. Road damage is analyzed using the Indonesian Road Capacity Manual Method while flexible pavement thickness planning is adjusted to the Component Analysis Method with a design life of 20 years. From the results of data analysis, it can be concluded that: the types of damage that occur on Jalan Abdul Haris Nasution consist of 2 types, namely: crocodile skin cracks of 10.47% and holes of 6.53%. The percentage value of damage is 17.00%, so the damage category is included in the slight due to the length of the span being reviewed as quite long and the maintenance handling is increasing. The thickness of the pavement layer required on Jalan Abdul Haris Nasution, namely: surface layer 15 cm, upper foundation layer 20 cm and lower foundation layer 10.00 cm.

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1. Introduction

The rapid growth of vehicles has an impact on traffic density, both on inner-city and outer-city roads, so that it is necessary to improve the quality and quantity of road infrastructure. The high growth of traffic due to economic growth can cause serious problems if it is not balanced with improvements in the quality of existing road facilities and infrastructure. As in the research location reviewed, traffic jams often occur due to damaged, potholed and bumpy roads due to lack of road maintenance, especially drainage maintenance. In addition, a poor drainage system causes rainwater to not flow smoothly when it rains. Flexible pavement is a pavement that is not resistant to waterlogging because asphalt is brittle. In relation to the problem of damage to road pavement layers that affects the level of service, this study aims to determine the type of damage, the percentage value of damage that occurs. and handling of its maintenance and knowing the thickness of flexible pavement needed to repair the damaged road. Flexible pavement is a pavement that is not resistant to water puddles because asphalt is brittle. When a flexible pavement has reached the end of its service life so that it is no longer able to withstand the traffic load on it, the planner has two options to improve the ability of the flexible pavement, namely by reconstructing or replacing the pavement with a new pavement and by adding layers to the existing pavement. Therefore, road conditions greatly affect the comfort and safety of every road user.

2. Literature review

Highways are the most important land transportation infrastructure, so good road design is a must. In addition to connecting one place to another, good roads are also expected to provide a sense of security and comfort for drivers. Good pavement conditions can reduce user costs, travel time delays, collisions and fuel consumption, vehicle equipment repairs and possibly reduce accidents.

Road pavement is a mixture of aggregate and binding material used to serve traffic loads. The aggregates used include crushed stone, split stone, river stone and steel smelting by-products. While the binding materials used include asphalt, cement and clay.

2.1 Types and Functions of Pavement

Road pavement is a mixture of aggregate and binding material used to serve traffic loads. The aggregates used include crushed stone, split stone, river stone and steel smelting by-products. While the binding materials used include asphalt, cement and clay. Based on the binding material, road pavement construction can be distinguished as follows:

a. Flexible pavement construction, which is a pavement that uses asphalt as a binding material. The pavement layers are designed to carry and distribute traffic loads to the subgrade.
b. Rigid pavement construction, which is a pavement that uses cement (Portland Cement) as a binding material. Concrete slabs with or without reinforcement are placed on the base soil with or without a sub-base layer. Most of the traffic load is borne by the concrete slab.
c. Composite pavement construction, namely rigid pavement combined with flexible pavement, can be in the form of flexible pavement on rigid pavement or rigid pavement on flexible pavement.

2.2 Flexible Pavement Construction

Flexible pavement construction is a pavement that uses asphalt as a binder and the layers of the pavement are designed to carry and distribute traffic loads to the subgrade. Flexible pavement construction consists of layers placed on compacted subgrade. These layers function to receive loads received by the subgrade that are smaller than the loads received by the surface layer and smaller than the bearing capacity of the subgrade. Flexible pavement construction consists of: subgrade layer, subbase layer, upper base layer and surface layer (Figure 1).

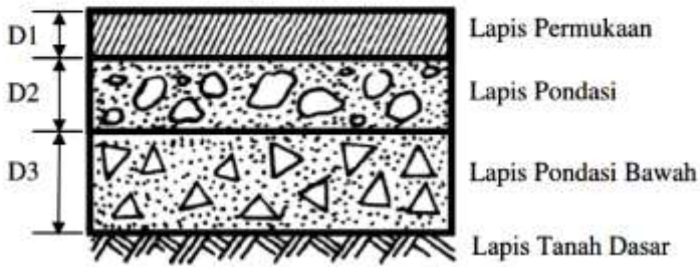

Figure 1. Flexible pavement layer arrangement (Anonymous, 1987)

1. **Lsubgrade layer**

The base soil layer is the lowest pavement structure forming the road formation consisting of undisturbed native soil or selected soil excavated from other places and spread as embankments. The base soil must be compacted well and in accordance with the specifications in terms of material quality and density. The nature of the base soil affects the resistance of the layers above it and the overall quality of the road. Generally, problems related to the base soil are:

a. Permanent deformation of certain types of soil due to traffic loads.
b. The expanding and contracting properties of certain soils due to changes in water content.
c. The carrying capacity of the soil is uneven and difficult to determine with certainty in areas with very different types of soil properties and position or consequences of implementation.
d. Deflection and back deflection during and after traffic loading from certain types of soil.
e. Additional compaction due to traffic loading and settlement the result is that coarse-grained soil (granular soil) does not well compacted during implementation.

2. Sub base course

The subbase course is a flexible pavement construction section located between the subgrade layers. It usually consists of a layer of compacted, stabilized or unstabilized granular material, or a stabilized soil layer. The function of the subbase course is:

a. As part of the pavement construction to support and distribute wheel loads to the subgrade.
b. As part of the pavement construction to support and distribute wheel loads.
c. Achieving efficiency in the use of relatively inexpensive materials so that the layers above can be reduced in thickness (cost savings). construction).
d. To prevent the base soil from entering the foundation layer.
e. As the first layer so that implementation can run smoothly.

3. Top foundation layer (base course)

The upper base course is a flexible pavement construction section located between the lower base course and the surface course. The upper base course is built on the lower base course or, if not using a lower base course, directly on the subgrade. The functions of the upper base course are:

a. As part of the pavement construction that supports wheel loads.
b. As a placement for the surface layer.

4. Top foundation layer (base course)

The surface layer is the part of the flexible pavement construction that is located at the very top. The surface layer of the flexible pavement structure consists of a mixture of mineral aggregate and binding materials that are placed as the topmost layer and are usually located above the top foundation layer. The functions of the surface course are:

a. As a pavement component to withstand wheel loads, a layer with high stability withstands wheel loads during the service period.
b. As an impermeable layer, so that rainwater that falls on it does not seep into the layer below and to protect the road body from damage due to weather.
c. Wear layer (wearing course), a layer that directly receives friction due to the braking force caused by the vehicle so that it wears out easily.
d. A layer that spreads the load to the lower layer, so that it can be carried by the other layers.
e. Provides a flat surface area.

2.3 Flexible Pavement Damage

Road damage is an incident that causes a road pavement to not be in accordance with the original pavement shape, so that it can cause the road pavement to be damaged, such as holes, cracks, waves, and so on. Road pavement layers often experience damage or failure before reaching the design life. Damage to highway pavement can be seen from functional and structural failures. Functional failure is when the road pavement can no longer function as planned and causes discomfort for road users. While structural failure occurs when there is damage to one or more parts of the road pavement structure caused by unstable subgrade layers, traffic loads, surface fatigue, and the influence of environmental conditions.

According to the Department of Public Works (2007), damage to road construction (including asphalt shoulders) can be caused by several factors, namely:

a. Traffic, resulting from increased loads exceeding the design load, or repeated loads exceeding the design volume so that the design life of the road is not achieved.
b. Water, which can come from rainwater, poor road drainage systems, rising water due to capillary properties.
c. Pavement material. This can be caused by the nature of the material itself or it can also be caused by a poor material processing system.
d. Climate. High air temperatures and rainfall can damage road pavement.
e. The condition of the underlying soil is unstable, due to its poor nature or due to a poor implementation system.
f. The process of compacting layers other than the base soil is not good.

Generally, the damage that occurs is not caused by one factor alone, but can be a combination of interrelated causes. For example, edge cracks can initially be caused by poor support from the side. The occurrence of edge cracks allows water to seep into the layer below which weakens the bond between the asphalt and the aggregate. This can cause holes in the sides and weaken the bearing capacity of the layer below.

2.4 Assessment of Flexible Pavement Damage Condition

The Directorate of Land and Road Problem Investigation, now the Road Research and Development Center, has developed a method for assessing road surface conditions that is introduced based on the type and extent of damage and traffic comfort. The types of damage reviewed are cracks, loose, holes, grooves, waves, sinkholes and splits. The extent of damage is the percentage of the outer surface of the damaged road to the total area of the road reviewed.

a. Damage Percentage Value

The percentage value of damage is obtained from the percentage of damaged road surface area to the total area of the road section being reviewed. The formula used to determine the percentage value of damage (Np), namely:

$$Np = \left(\frac{\text{Luas Jalan Rusak}}{\text{Luas Jalan Keseluruhan}} \right) x\, 100\ \%$$

Table 1. Percentage Value of Damage (Anonymous, 1997)

Percentage	Category	Mark
< 5 %	So little	2
5% – 20%	A little	3
20 – 40 %	Currently	5
> 40 %	Lots	7

Data analysis using the Bina Marga Method with several references where at the beginning of the discussion LHR data was obtained, with this data the road class value was determined using Table 2 below.

Table 2.LHR and Road Class Value (Anonymous, 1997)

LHR (smp/day)	Road Class Value
< 20	0
20 - 50	1
50 - 200	2
200 - 500	3
500 - 2000	4
2000 - 5000	5
5000 - 20000	6
20000 - 50000	7
> 50000	8

b. Road Condition Check

In the Bina Marga method, the road pavement condition survey is carried out by walking along the road and recording data on the road damage data form. The manual method is divided into 2, namely the Binkot Method and the UMRS Method. In this study, the method discussed is the Binkot Method. In this method, the road pavement condition survey is carried out by walking along the road and the things that need to be noted in conducting the survey are: Holes, Patches, Cracks, Grooves and Collapse.

For the priority order used as a reference for handling road inspections, we can see Table 3.

Table 3. Selection Criteria(Anonymous, 1997)

Order of Priority	Handling
> 7	Routine Maintenance
4 - 6	Periodic Maintenance
0 - 3	Improvement

The formula used to determine the priority order is as follows:

Order of Priority =17 – (LHR class + Road Condition Value)

2.5 Flexible Pavement Thickness Planning Stages

There are many ways to determine the thickness of the pavement and almost every country has its own way. In addition to the Bina Marga method, there is also something called the Flexible Pavement Thickness Planning Guidelines for Highways with the Component Analysis Method published by the Department of Public Works. In this study, the method used to analyze the thickness of the pavement needed for future repairs is the Component Analysis Method. There are several stages in completing this method that we can follow as below, namely:

a. Number of lanes and vehicle distribution coefficient
b. Calculating equivalent numbers
c. Determining Regional Factors
d. Calculation of LHR and Equivalent Numbers
e. Determining the final equivalent cross
f. Determining the middle equivalent cross
g. Determining the cross-equivalent plan
h. Determining Surface Index, Bearing Capacity of Subgrade, Relative Strength and Surface Index
i. Determining the Thickness of the Pavement

The minimum limits for the thickness of the pavement layers for flexible pavement structures consist of: surface layer, upper foundation layer and lower foundation layer, namely:

a. Surface layer
   The minimum thickness of the surface layer can be seen in Table 4, below.

Table 4. Minimum thickness of the surface layer (Anonymous, 1987)

ITP	Minimum Thickness (cm)	Material
< 3.00	5	Protective layer: (Buras / Burtu / Burda)
3.00 - 6.70	5	Lapen/Asphalt Macadam, HRA, Lasbutag, Laston
6.71 - 7.49	7.5	Lapen/Asphalt Macadam, HRA, Lasbutag, Laston
7.50 - 9.99	7.5	Lasbutag, Laston
≥ 10.00	10	Laston

b. Top foundation layer
   The minimum thickness of the top foundation layer can be seen in Table 5, below.

Table 5. Minimum thickness of the top foundation layer (Anonymous, 1987)

ITP	Minimum Thickness (cm)	Material
< 3.00	15	Crushed stone, soil stability with cement, soil stability with lime
3.00 - 7.49	20	Crushed stone, soil stability with cement, soil stability with lime
	10	Upper Laston
7.50 - 9.99	20	Crushed stone, soil stability with cement, soil stability with lime, macadam foundation
	15	Upper Laston
10 – 12.14	20	Crushed stone, soil stability with cement, soil stability with lime, macadam foundation, Lapen, Upper Laston
≥ 12.25	25	Crushed stone, soil stability with cement, soil stability with lime, macadam foundation, Lapen, Upper Laston

Notes: If the thickness of the top foundation layer is 20 cm, it can be reduced to 15 cm if granular material (crushed stone) is used for the bottom foundation.

c. Sub-base layer

The bottom foundation layer for each ITP value when using a bottom foundation, the minimum thickness is 10 cm.

3. Method

In this study, the methods used to obtain the solution are: MKJI method and component analysis method. The MKJI method isThe introduced road surface condition assessment method is based on the type and extent of damage and traffic comfort. The types of damage reviewed are cracks, loose, holes, grooves, waves, sinkholes and splits.

The extent of damage is the percentage of the damaged road surface compared to the total area of the road being reviewed. This component analysis method is the basis for determining the thickness of flexible pavement needed for a highway planning. The technical data obtained from the results of field research based on survey results, namely:

a. Road classification.

The types of road classifications reviewed are: provincial roads with the number of lanes, namely:1 lane 2 wayand 7 m wide.

b. Traffic growth.

Traffic growth plan (i%) = 5% with planned life (n) = 20 years.

c. CBR subgrade.

Soil density is greatly influenced by the CBR value of the soil itself. The planned CBR value required is = 7%.

d. Data Average Annual Daily Traffic (ADR)

Average Annual Daily Traffic (ADR) is the average number of vehicles passing through one lane of road during 24 hours and is obtained from data for a full year.

$$LHRT = \frac{\text{Jumlah lalu lintas dalam 1 tahun}}{365}$$

LHRT is expressed in pcu/day/2 directions or vehicles/day/2 directions for 2-lane 2-way roads, or pcu/day/1 lane or vehicles/day/1 direction for multi-lane roads with medians. In this study LHRT is assumed (Table 6).

Table 6. Average daily traffic plan (ADR)

Vehicle type	Traffic Amount	Types of Pavement Materials
Light Vehicle 2 tons	220 Vehicles	Asbuton (MS 744) .... al = 0.30
8 ton bus	80 Vehicles	Crushed stone (CBR 100) .. a2 = 0.14
2 axle 16 ton truck	175 Vehicles	Sirtu (CBR 70) ……..... a3 = 0.13
24 ton 3 axle truck	145 Vehicles	
4 axle 34 ton truck	28 Vehicles	
5 axle 37 ton truck	15 Vehicles	
6 axle 45 ton truck	8 Vehicles	
Total LHR = 671 Vehicles/day/2 lanes		

4. Results and Discussion

4.1 Road Damage Survey Results

The following are the results of a survey of road damage found at the location.Abdul Haris Nasution Road Section STA 4+400 to STA 8+700, Batu Nadua District.

Table 7. Road Damage Data

No	Station		Type of Damage	Position	Dimensions		Area (m2)	(%)
	From	To			Wide	Long		
1	4+400	4+500	RKB	Left	3.00	25.00	75.00	0.25%
2			LB	Middle	3.00	2.00	6.00	0.02%
3			LB	Right	5.00	6.00	30.00	0.10%
4			LB	Left	4.00	6.00	24.00	0.08%
5	4+500	4+600	RKB	Middle	3.00	30.00	90.00	0.30%
6			LB	Left	3.00	2.00	6.00	0.02%
7			LB	Right	5.00	6.00	30.00	0.10%
8			LB	Middle	4.00	6.00	24.00	0.08%
9			LB	Right	3.00	2.00	6.00	0.02%
10			LB	Middle	4.00	6.00	24.00	0.08%
11	4+600	4+700	RKB	Left	3.00	25.00	75.00	0.25%
12			LB	Left	3.00	2.00	6.00	0.02%
13			RKB	Right	3.00	26.00	78.00	0.26%
14			LB	Middle	4.00	6.00	24.00	0.08%
15			LB	Right	3.00	2.00	6.00	0.02%
16			LB	Left	4.00	6.00	24.00	0.08%
17	4+700	4+800	RKB	Left	2.00	18.00	36.00	0.12%
18			LB	Left	2.00	3.00	6.00	0.02%
19			LB	Right	2.00	3.00	6.00	0.02%
20			LB	Left	2.00	20.00	40.00	0.13%
21	4+800	4+900	RKB	Left	2.00	15.00	30.00	0.10%
22			LB	Left	4.00	6.00	24.00	0.08%
23	4+900	5+000	LB	Left	3.00	2.00	6.00	0.02%
24			LB	Right	3.00	2.00	6.00	0.02%
30	5+000	5+100	LB	Left	3.00	2.00	6.00	0.02%
31			LB	Right	3.00	2.00	6.00	0.02%
32			RKB	Left	2.00	20.00	40.00	0.13%
33	5+100	5+200	LB	Left	7.00	15.00	105.00	0.35%
34			LB	Right	2.00	20.00	40.00	0.13%

35	5+400	5+500	RKB	Left	2.00	20.00	40.00	0.13%
36			LB	Middle	3.00	10.00	30.00	0.10%
37			RKB	Right	2.00	40.00	80.00	0.27%
38	5+500	5+600	LB	Left	4.00	6.00	24.00	0.08%
39			LB	Middle	5.00	6.00	30.00	0.10%
40			LB	Right	2.00	3.00	6.00	0.02%
41	5+600	5+700	RKB	Left	2.00	30.00	60.00	0.20%
42			RKB	Right	2.00	40.00	80.00	0.27%
43			LB	Middle	3.00	10.00	30.00	0.10%
44	6+000	6+100	RKB	Right	2.00	40.00	80.00	0.27%
45			LB	Left	2.00	4.00	8.00	0.03%
46			LB	Middle	3.00	5.00	15.00	0.05%
47	6+100	6+200	LB	Right	3.00	5.00	15.00	0.05%
48			RKB	Left	2.00	20.00	40.00	0.13%
49			RKB	Left	2.00	40.00	80.00	0.27%
50			LB	Middle	3.00	10.00	30.00	0.10%
51	6+200	6+300	RKB	Right	2.00	30.00	60.00	0.20%
52			LB	Left	2.00	4.00	8.00	0.03%
53			LB	Middle	3.00	5.00	15.00	0.05%
54	6+300	6+400	LB	Left	3.50	5.00	17.50	0.06%
55			LB	Right	3.50	5.00	17.50	0.06%
56			RKB	Left	3.00	20.00	60.00	0.20%
57	6+400	6+500	RKB	Left	2.50	15.00	37.50	0.12%
58			LB	Middle	3.00	12.00	36.00	0.12%
59			RKB	Right	2.50	30.00	75.00	0.25%
60			LB	Left	2.50	4.00	10.00	0.03%
61			LB	Middle	3.00	5.00	15.00	0.05%
62			LB	Right	3.00	6.00	18.00	0.06%
63			RKB	Left	3.00	20.00	60.00	0.20%
64	6+500	6+600	LB	Left	2.00	40.00	80.00	0.27%
65			RKB	Right	2.00	30.00	60.00	0.20%
66			LB	Middle	3.00	5.00	15.00	0.05%
67			LB	Right	2.50	5.00	12.50	0.04%
68	6+800	6+900	LB	Left	2.00	3.00	6.00	0.02%
69			LB	Middle	2.00	4.00	8.00	0.03%
70			RKB	Right	2.00	28.00	56.00	0.19%
71	6+900	7+000	LB	Left	2.00	6.00	12.00	0.04%
72			RKB	Right	2.00	28.00	56.00	0.19%
73			RKB	Left	3.00	35.00	105.00	0.35%
74			LB	Left	2.00	5.00	10.00	0.03%
75	7+000	7+100	RKB	Right	3.00	20.00	60.00	0.20%
76			LB	Left	2.50	8.00	20.00	0.07%
77			RKB	Left	2.50	20.00	50.00	0.17%
78			LB	Right	2.50	7.00	17.50	0.06%
79	7+100	7+200	RKB	Right	2.50	30.00	75.00	0.25%
80			RKB	Left	2.00	25.00	50.00	0.17%
81	7+200	7+300	LB	Road Body	7.00	25.00	175.00	0.58%
82			RKB	Left	3.00	10.00	30.00	0.10%
83			LB	Middle	3.00	5.00	15.00	0.05%
84			RKB	Right	2.50	25.00	62.50	0.21%
85	7+300	7+400	LB	Left	2.00	4.00	8.00	0.03%
86			LB	Middle	4.00	8.00	32.00	0.11%
87			RKB	Right	4.00	20.00	80.00	0.27%

88			LB	Right	3.00	5.00	15.00	0.05%
89			RKB	Left	3.00	35.00	105.00	0.35%
90	7+400	7+500	RKB	Left	3.00	25.00	75.00	0.25%
91			LB	Left	2.50	8.00	20.00	0.07%
92			RKB	Left	3.00	40.00	120.00	0.40%
93	7+500	7+600	RKB	Left	2.00	25.00	50.00	0.17%
94			LB	Left	2.00	6.00	12.00	0.04%
95			LB	Right	3.00	8.00	24.00	0.08%
96			RKB	Right	2.50	28.00	70.00	0.23%
97			LB	Middle	3.00	6.00	18.00	0.06%
98			RKB	Left	2.00	20.00	40.00	0.13%
99	7+600	7+700	LB	Left	2.00	5.00	10.00	0.03%
100			LB	Middle	2.50	4.00	10.00	0.03%
101			RKB	Right	2.00	15.00	30.00	0.10%
102			RKB	Left	3.00	20.00	60.00	0.20%
103	7+700	7+800	LB	Left	2.00	10.00	20.00	0.07%
104			LB	Middle	2.00	6.00	12.00	0.04%
105			RKB	Right	2.00	20.00	40.00	0.13%
106			RKB	Left	4.00	25.00	100.00	0.33%
107			LB	Left	3.00	5.00	15.00	0.05%
108			RKB	Left	3.00	15.00	45.00	0.15%
109	7+800	7+900	LB	Left	2.00	30.00	60.00	0.20%
110			RKB	Left	2.00	25.00	50.00	0.17%
111	8+000	8+100	RKB	Right	2.50	25.00	62.50	0.21%
112			LB	Middle	3.00	10.00	30.00	0.10%
113			LB	Right	3.50	4.00	14.00	0.05%
114			LB	Middle	3.00	10.00	30.00	0.10%
115			RKB	Left	3.00	40.00	120.00	0.40%
116	8+100	8+200	LB	Middle	4.00	5.00	20.00	0.07%
117			LB	Left	2.00	30.00	60.00	0.20%
118			LB	Middle	3.00	10.00	30.00	0.10%
119			LB	Left	3.00	20.00	60.00	0.20%
120			LB	Right	4.00	5.00	20.00	0.07%
121	8+200	8+300	RKB	Left	2.00	35.00	70.00	0.23%
122			LB	Right	4.00	5.00	20.00	0.07%
123			LB	Left	2.00	6.00	12.00	0.04%
124	8+300	8+400	LB	Right	2.00	10.00	20.00	0.07%
125			LB	Left	3.00	15.00	45.00	0.15%
126			LB	Right	2.00	8.00	16.00	0.05%
127			LB	Left	2.50	10.00	25.00	0.08%
128			LB	Right	3.00	5.00	15.00	0.05%
129			LB	Left	2.00	6.00	12.00	0.04%
130	8+400	8+500	RKB	Left	2.00	30.00	60.00	0.20%
131			LB	Right	2.00	4.00	8.00	0.03%
132	8+500	8+600	LB	Left	2.50	6.00	15.00	0.05%
133			LB	Middle	2.00	4.50	9.00	0.03%
134			LB	Right	3.00	5.00	15.00	0.05%
135			LB	Middle	2.00	6.00	12.00	0.04%
136			LB	Right	2.00	5.00	10.00	0.03%
137			LB	Middle	2.00	4.00	8.00	0.03%
138			RKB	Left	2.50	30.00	75.00	0.25%
139	8+600	8+700	RKB	Left	3.00	25.00	75.00	0.25%

140			LB	Middle	2.00	4.00	8.00	0.03%
141			LB	Right	3.00	5.00	15.00	0.05%
142			LB	Left	2.00	3.00	6.00	0.02%
143			RKB	Right	2.00	15.00	30.00	0.10%
144			LB	Right	2.00	5.00	10.00	0.03%
Total number							**5090.50**	**17.00%**

Percentage value of damage determined based on Table 1 above. From Table 1 with the price percentage of damage17.00% is between5% - 20%then the damage category is included in the slight category with a value percentage of damage = 3. This category is included in the slight category considering the length of the road reviewed is very long and the damage that occurred was only at a few points.

From the total percentage value of the road condition obtained, which is 17.00, we can find out the type of appropriate handling to handle the damage problem. From Table 3above thenat a price p percentage of damage total by 17.00%, then the selection criteria for handling that we use is Routine Maintenance.

4.2 Determining the Thickness of Flexible Pavement

From the research results, the ITP price for a 20-year design life was obtained at 10.00. From these results, we can determine the limits the minimum thickness of the pavement layer for flexible pavement structures consists of: surface layer, upper foundation layer and lower foundation layer, namely:

a. From Table 1 above, with an IPT price of 10.00 ≥ 10.00, the minimum surface layer thickness (D1min) = 10 cm is obtained with the Laston material type.
b. From Table 2 above, with an IPT price of 10.00 ≥ 12.25, the minimum thickness of the upper foundation layer (D2min) = 20 cm is obtained with the type of crushed stone material.
c. Minimum thickness of the base layer (D3 min) = 10 cm for all ITPs.

From the above parameters, the ITP value and the relative strength coefficient value for each pavement material are then obtained. This planning calculation is based on the relative strength of each long-term pavement layer, where the determination of the pavement thickness is stated by the ITP (Pavement Thickness Index), with the following formula:

ITP $= a_1 \cdot D_1 + a_2 \cdot D_2 + a_3 \cdot D_3$

$= (0.40 \cdot D1) + (0.14 \cdot 20 \text{ cm}) + (0.13 \cdot 10 \text{ cm})$

10.00 = 0.40 D1 + 2.80 cm + 1.30 cm

10.00 = 0,40 D1 + 2.80 cm

$$D1 = \frac{10{,}00 - 2{,}80}{0{,}40} = 14.75 \text{ cm} \approx 15 \text{ cm}$$

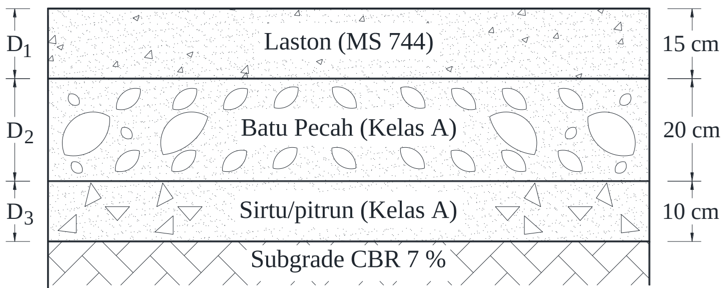

Figure 2. The composition of the pavement layers with a design life of 20 years

4.3 Discussion

The results of the discussion obtained after conducting the Analysis of Damage to the Abdul Haris Nasution Road Section Sta 4+400 to Sta 8+700, Batu Nadua District, then several results were obtained, namely:

a. The types of damage that occurred on Jalan Abdul Haris Nasution consisted of 2 types, namely: crocodile skin cracks of 10.47% and holes of 6.53%.
b. As for the percentage value of damage of 17.00%, the damage category is included slightly due to the length of the span reviewed is quite long and the maintenance handling is an increase. The damage that occurs is only at a few points but has an impact on the distance traveled by road users.
c. As for the thickness of the pavement layerwhich is needed on Abdul Haris Nasution Road Sectionby using flexible pavement, namely:
    - Surface layer of Laston MS 744 material type = 15.00 cm
    - Top foundation layer (100% CBR crushed stone) = 20.00 cm
    - Sub-base layer (Sirtu/pitrun CBR 70%) = 10.00 cm
    - Subgrade (base soil) CBR 7%

5. Conclusion

Based on the results of the damage analysis carried out, several conclusions can be obtained, namely:

a. The types of damage that occurred on Jalan Abdul Haris Nasution consisted of 2 types, namely: crocodile skin cracks of 10.47% and holes of 6.53%.
b. As for the percentage value of damage of 17.00%, the damage category is considered slight due to the span length being quite long and the maintenance handling is increasing.
c. The thickness of the pavement layer required on the Abdul Haris Nasution Road Section is: 15 cm surface layer, 20 cm upper foundation layer and 10.00 cm lower foundation layer.

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