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ANALYSIS OF PAVEMENT IMPROVEMENT PLANNING FOR THE LUMAJANG CITY BOUNDARY ROAD SECTION – BTS, JEMBER DISTRICT

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Abstrak
Road damage is a common issue that arises due to various factors, including substandard construction quality, overloaded vehicles, and extreme weather conditions. The road segment connecting Lumajang City Limits to Jember District Limits has been identified as experiencing deterioration at several locations, predominantly caused by vehicles carrying loads that exceed the maximum allowable capacity. This study focuses on evaluating the current condition of the road, estimating the required repair costs, and assessing the economic feasibility of implementing the repairs. The research methodology incorporates field surveys to gather primary data, such as the extent, severity, and distribution of road damage, along with secondary data on traffic volumes and vehicle loads. The analysis involves classifying road conditions and calculating repair costs using the overlay method, which considers structural improvements needed to restore optimal functionality. The results indicate that out of the total road length, 1.66 kilometers are classified as being in good condition, 1.3 kilometers are in fair condition, 7.2 kilometers have minor damage, and 4 kilometers are severely damaged. These findings provide essential insights for prioritizing repair works and formulating cost-effective strategies to improve road infrastructure in the region.

Keywords: Road Repair, Road Damage, Overlay Method.

INTRODUCTION

Infrastructure development is important in today's society. This can be seen from the rampant development of various infrastructure facilities in various sectors, ranging from energy systems, highways, office buildings and schools, to telecommunications, and reliable clean water service networks (Witjaksana., 2024). This is done because the available infrastructure is not able to serve the traffic flow. For this reason, efforts need to be made so that transportation needs can be met properly. The smooth flow of traffic is highly dependent on the existing road conditions, the better the road conditions, the smoother the flow of movement of goods and people.

The purpose of road transportation development is to improve transportation services in an efficient, reliable, quality, safe and affordable manner. This road transportation development is expected to realize an integrated transportation system with regional development and also with other transportation, so that it becomes part of a distribution system that is able to provide services and benefits to the community.

Good pavement design is very important because the highway is one of the important infrastructure needed to complete an activity. As stated (Hendarsin 2000: 1) the existence of highways is important to be used by transportation media to support the economy because more and more people are using transportation to get to remote areas. Roads with a solid pavement structure are expected to provide a sense of security and comfort for its users.

Over time and service life, road conditions will eventually deteriorate, both in terms of level of service and structural condition. An increase in traffic volume will cause a decrease in service due to a decrease in road capacity (Purnama et al., 2022). This is related to the increase in side obstacles and the increase in traffic volume itself. This will cause the saturation level of the road to increase, so an effective pavement design is needed. According to Hendarsin (2000:1) the existence of highways is needed to support the rate of economic growth along with the increasing need for transportation facilities that can reach remote areas.

The handling of provincial roads plays an important role and is the backbone of improving the community's economy. Good road conditions can facilitate mobility and accessibility so as to reduce vehicle operating costs (BOK) so that the community gets the maximum benefit. The current authority for the implementation of Provincial roads is based on Law Number 38 of 2004 and Government Regulation Number 34 of 2004 concerning Roads which includes Development, Development and Supervision activities with the length of sections and bridges that are the authority and responsibility of UPT PJJ Probolinggo is 162.09 Km and for bridges is 749.21m. The responsibility for road repair and maintenance is absolutely in the road organizer in accordance with Law no 22 of 2009 where "Every road organizer who does not immediately, and properly repair damaged roads that result in traffic accidents as referred to in Article 24 paragraph (1) causing minor injuries and / or damage to vehicles and / or goods shall be punished with imprisonment for a maximum of 6 (six) months or a maximum fine of Rp12,000,000.00 (twelve million rupiah)". With the provisions of the law, the organizers must ensure that the road is in good condition, without potholes and safe from potential traffic accidents that may occur due to damaged or potholed roads.

In this study, a visual-based pavement condition assessment system known as the Treatment Triggered Index (TTI) method can be used as a reference in maintenance efforts. The road that needs to be surveyed must be divided into segments before the TTI method can be used in the field. By adding up all known pavement damage values, a road condition score is determined based on the value of each type of damage found. The higher the cumulative damage number, the worse the road condition and thus the need for better maintenance. The road performance scale called Treatment Triggered Index (TTI) is derived from field-based visual observations of road defects. The condition of the road surface cracks (total area and average crack width), other defects (number of potholes per 200 m of road length), and ruts/rutting (depth) are factors that influence the TTI index.

Pavement planning is something that must be properly planned so that road construction can serve the traffic flow according to the planned life of the road. If no significant damage occurs during the planned life of the road, road users will be able to use the road comfortably. So far, many pavement planning has not been done properly so that the pavement does not last for the planned life. In order for this not to happen again, it is necessary to design the right type of pavement for the Bts. Lumajang City - Bts. Jember Regency.

The condition of provincial roads in Lumajang district, especially on the Bts. Lumajang City - Bts. Jember Link 35.027 is mostly severely damaged, dominated by crocodile cracks and rutting as an early indication that the road has suffered foundation damage, requiring reconditioning and road improvement. Damage due to high traffic volume and triggered by heavy vehicles overloading, especially vehicles transporting raw materials and cement products that cause congestion and increase the daily volume of vehicles, ultimately causing considerable losses, especially for road users, congestion, traffic accidents, longer travel distances and so on.

Condition of the road section Bts. Lumajang City - Bts. Jember Regency Link 35,027 requires reconstruction and improvement handling considering the age of the pavement which has not been handled for a long time, only on the Mahakam Road section which received treatment with PHJD in 2021, this damage is also in accordance with the Minister of Public Works Regulation number 19 of 2011 concerning the technical requirements of the provincial road section Link 200 is a Primary Collector Road which is the main link between the National Activity Center (PKN) and the Regional Activity Center (PKW) and the Local Activity Center (PKL) so that it needs to be further studied regarding road capacity to meet the requirements of road disconnection.

It is necessary to conduct an analysis to determine the right type of pavement for the Bts. Lumajang City - Bts. Jember Regency. Based on the results of the survey that has been carried out, on the road section Bts. Lumajang City - Bts. Jember Regency has been damaged at several points due to vehicles that are estimated to exceed the load and dimension limits set. Therefore, this research was carried out with the aim of knowing the conditions and characteristics of traffic before and after construction. Based on this background, the purpose of this study is to determine the pavement improvement plan needed on the Bts. Lumajang City - Bts. Jember Regency.

RESEARCH METHOD

Research Subject

The research subject in this writing is the road section Bts. Lumajang City - Bts. Jember Regency Link 35.027.

Location and Time of Research

This research is located on the road section Bts. Lumajang City - Bts. Jember Regency Link 35.027. This research will be carried out for 12 weeks starting from the colloquium until the completion of the thesis report, which is in the first week of January 2025.

Data

The data in this study includes primary data and secondary data. Primary data collection in this study includes existing width, survey documentation, type of damage, and location of damage. Meanwhile, secondary data is taken from such as the East Java Province Bina Marga Public Works Office which includes vehicle traffic volume, field CBR value, deflection value, GRDP data.

Data Analysis Technique

Data analysis technique is the most decisive step of a study, because data analysis serves to conclude the results of the study. Data analysis can be done through the following stages:

1. Damage Analysis
   a. A road condition survey was conducted on the Bts. Lumajang City - Bts. Jember Link 35.027 using Blackvue and PKRMS program.
   b. Items reviewed in the road defect survey:
      - Pavement Surfaces such as arrangement, condition, settlement and patching
      - Type, width and area of cracks
      - Other damages such as number of holes, size of holes, ruts and edge damage

c. Furthermore, road damage analysis is carried out with the PKRMS program which will produce a road damage index based on TTI, namely good, medium, light and heavy damage conditions as a reference for pavement repair work.
2. Flexural Pavement Planning
   a. Data Collection
   b. Average Daily Traffic (LHR) Calculation
   c. Traffic Data Analysis
   d. Standard Axis Load
   e. Determination of Soil Support Capacity
   f. Surface Index Determination
   g. Determination of Surface Thickness Index
   h. Determination of Additional Pavement Thickness

RESULTS AND DISCUSSION

Analysis of Existing Traffic Data

Traffic data analysis is an important step to determine the Average Daily Traffic (LHR) value used in calculating pavement thickness, preparing the CESA (Cumulative Equivalent Single Axle Load) plan, and obtaining the Volume Capacity Ratio (VCR) value. This analysis process follows the guidelines contained in the Indonesian Road Capacity Manual (MKJI 1997) and the Pavement Design Manual No. 03/M/BM/2024.

Using these guidelines, an analysis was conducted to calculate key traffic parameters, such as vehicle flow, average speed and road capacity under existing conditions. The results of this analysis are the main reference in understanding the performance of existing roads and supporting decision-making related to the management and development of the road network in the study area.

Traffic Volume

Traffic data plays an important role as the basis for determining Average Daily Traffic (LHR) values, which are a key component in designing pavements and evaluating road capacity. These LHR values are obtained from traffic plan data collected through a direct observation process at the job site. To ensure the data generated is accurate and representative, the survey is conducted over a full 24-hour period. This method allows traffic measurements to cover a variety of vehicle movement patterns at various times of the day and night, giving a true picture of traffic conditions relevant to the location.

In traffic analysis, vehicle data is classified by type as follows:

1. Motorcycles (MC) consist of class 1;
2. Light vehicles (LV) consist of class 2, class 3 and class 4;
3. Medium heavy vehicles (MHVs) consist of class 5a and class 6a;
4. Large trucks (LT) consist of class 6b, class 7a, class 7b and class 7c;
5. Large bus (LB) consists of class 5b

Table 1 way traffic volume on the existing road Year 2022

Time	Traffic Volume (Kend.)					Total	
	MC	LV	LB	MHV	LT	(Kend/hour)	(smp/hr)
06.00-07.00	1.703	92	2	10	10	1.817	1.674,73
07.00-08.00	968	108	1	2	38	1.117	1.087,58
08.00-09.00	578	86	1	1	24	689	673,68
09.00-10.00	482	89	1	1	41	615	638,6
10.00-11.00	423	94	2	1	31	552	564,59
11.00-12.00	422	93	2	3	34	555	574,74

Time	Traffic Volume (Kend.)					Total	
	MC	LV	LB	MHV	LT	(Kend/hour)	(smp/hr)
12.00-13.00	500	109	1	1	56	667	713,22
13.00-14.00	398	125	1	2	41	568	601,23
14.00-15.00	476	94	0	5	35	611	627
15.00-16.00	661	172	1	0	27	861	841,56
16.00-17.00	570	124	2	0	31	728	725,02
17.00-18.00	433	124	1	2	46	605	642,11
18.00-19.00	428	102	1	1	38	571	595,23
19.00-20.00	303	70	0	0	28	402	418,76
20.00-21.00	227	86	0	0	22	334	348,59
21.00-22.00	184	70	0	1	39	295	344,24
22.00-23.00	91	47	0	0	28	166	204
23.00-00.00	57	39	0	2	21	119	150,18
00.00-01.00	25	22	0	1	22	69	104,64
01.00-02.00	27	13	0	0	25	65	104,74
02.00-03.00	18	6	0	0	23	47	83,52
03.00-04.00	19	12	0	0	24	55	93,46
04.00-05.00	76	22	2	0	20	119	146,56
05.00-06.00	271	48	0	1	57	377	447,22

Table 2. Percentage of Traffic to Each Vehicle Type in 2022

Time	Vehicle Type										Traffic Volume	
	MC	%	LV	%	LB	%	HV	%	LT	%	(Kend/ hour)	(smp/ hour)
06.00-07.00	1.703	93,70	92	5,10	2	0,10	10	0,60	10	0,60	1.817	1,675
07.00-08.00	968	86,70	108	9,60	1	0,10	2	0,20	38	3,40	1.117	1.088
08.00-09.00	578	83,80	86	12,50	1	0,20	1	0,20	24	3,50	689	674
09.00-10.00	482	78,50	89	14,50	1	0,20	1	0,20	41	6,70	615	639
10.00-11.00	423	76,70	94	17,10	2	0,40	1	0,20	31	5,60	552	565
11.00-12.00	422	76,10	93	16,80	2	0,40	3	0,60	34	6,20	555	575
12.00-13.00	500	75,00	109	16,30	1	0,20	1	0,20	56	8,40	667	713
13.00-14.00	398	70,10	125	22,00	1	0,20	2	0,40	41	7,30	568	601
14.00-15.00	476	78,00	94	15,40	0	0,00	5	0,80	35	5,80	611	627
15.00-16.00	661	76,80	172	20,00	1	0,10	0	0,00	27	3,10	861	842
16.00-17.00	570	78,40	124	17,10	2	0,30	0	0,00	31	4,30	728	725
17.00-18.00	433	71,50	124	20,50	1	0,20	2	0,30	46	7,50	605	642
18.00-19.00	428	75,00	102	17,90	1	0,20	1	0,20	38	6,70	571	595
19.00-20.00	303	75,50	70	17,50	0	0,00	0	0,00	28	7,00	402	419
20.00-21.00	227	67,80	86	25,70	0	0,00	0	0,00	22	6,50	334	349
21.00-22.00	184	62,50	70	23,90	0	0,00	1	0,40	39	13,30	295	344
22.00-23.00	91	55,00	47	28,10	0	0,00	0	0,00	28	16,90	166	204
23.00-00.00	57	47,80	39	33,00	0	0,00	2	1,70	21	17,40	119	150
00.00-01.00	25	35,80	22	31,30	0	0,00	1	1,50	22	31,30	69	105
01.00-02.00	27	41,30	13	20,60	0	0,00	0	0,00	25	38,10	65	105
02.00-03.00	18	37,80	6	13,30	0	0,00	0	0,00	23	48,90	47	84
03.00-04.00	19	34,00	12	22,60	0	0,00	0	0,00	24	43,40	55	93
04.00-05.00	76	63,50	22	18,30	2	1,70	0	0,00	20	16,50	119	147
05.00-06.00	271	72,00	48	12,60	0	0,00	1	0,30	57	15,10	377	447

Peak Hour Volume

To get a more in-depth picture of the traffic characteristics on a particular road section, one important indicator that can be used is the Peak Hour Volume (PMV). This parameter refers to the number of vehicles crossing the road within one hour when traffic reaches its peak, which usually occurs at a certain time of the day. The VJP calculation is done separately for each traffic direction in order to capture vehicle movement patterns in more detail and accurately. With this data, VJP becomes a very useful basis in a variety of applications, including road infrastructure design, traffic operations analysis, and road use efficiency evaluation. Based on the survey and measurement results, information on peak hour vehicle volumes for the road sections under review was obtained, the results of which are described below:

Table 3. Peak Hour Volume

Time	Vehicle Type										Traffic Volume	
	MC	%	LV	%	LB	%	HV	%	LT	%	(Kend/ hour)	(smp/ hour)
06.00 - 07.00	1.703	93,70	92	5,10	2	0,10	10	0,60	10	0,60	1.817	1,675

Source: Planning Data

Based on the table presented, it can be seen that the highest traffic volume or peak hour occurs in the time period between 06:00 to 07:00 WIB. This condition is very reasonable considering that at this time many people start doing various daily activities, such as going to work, taking children to school, or doing other activities that require mobility. During these hours, there is a significant increase in the number of vehicles compared to other times. The dominance of vehicles during the peak hour period is still dominated by small vehicles, especially motorcycles, which reflects the high use of this mode of transportation as the main means of transportation for the community in the morning. This also indicates the dense mobility pattern of the community at the beginning of the working day.

Average Daily Traffic

In transportation analysis, the unit often used to measure traffic volume is Average Daily Traffic (LHR). LHR refers to the average number of vehicles traveling in both directions through a given point during a single day, and is usually expressed in vehicles per day (vehicles/day). The use of LHR is very important in various aspects of transportation planning, because this data is the main basis for calculating the traffic load on a road section. This information is also used to evaluate infrastructure needs, road capacity, and traffic service levels.

In this work, the traffic data obtained came from observations for a full 24 hours. The data is used to analyze the LHR on the road section being planned. By knowing the LHR, it is possible to identify road usage patterns more accurately, which in turn helps the decision-making process in the design and management of an efficient transportation system. The following are the results of the LHR analysis on the road sections that are part of this study:

Table 4. Existing LHR Analysis

Vehicle Type	**Group Vehicle**	**LHR**
Motorcycles, scooters, beetle bikes and 3-wheelers	Group 1	10.574
Jeep sedans and station wagons	Group 2	1.336
Oplet, pick-up, suburban, combi and mini buses	Group 3	39
Pick ups, micro trucks and intermediate cars	Group 4	493
Small bus	Group 5a	6
Large bus	Group 5b	21
3/4" 2-axle truck/tanker	Group 6a	30
2-axis truck/tanker	Group 6b	350
3-axis truck/tanker	Class 7a	279
Truck/tanker trailer	Group 7b	38
Semitrailer truck/trailer truck	Class 7c	95
Non-motorized vehicles and carts	Group 8	81

Existing Road Flow and Capacity Analysis

The relationship between traffic flow, speed and density can be explained as follows: The relationship between speed and density is linear, where the higher the speed, the more space between vehicles is required, resulting in a reduced number of vehicles per kilometer. Meanwhile, the relationship between speed and flow is parabolic, where speed decreases as flow increases until it reaches maximum capacity, after which both speed and flow decrease further. The relationship between flow and density is also parabolic, where the flow increases with density until it reaches capacity, after which the flow decreases as density increases.

Traffic data analysis is required to determine the LHR (Average Daily Traffic) used in pavement calculations. LHR data is obtained from traffic data on the road section in 24 hours. For two-way road planning without median, the LHR calculation for each direction is combined. The traffic data used is obtained from the relevant agencies, with the aim of planning road widening on the Bts. Lumajang City - Bts. Jember Regency. The calculation of road capacity is important to ensure that the road can accommodate the traffic volume during the pavement life. The guidelines used are the Indonesian Road Capacity Manual (MKJI 1997), Road Pavement Design Manual No. 03/M/BM/2024, and MDP 2024 Supplement. The following is the calculation of Road Capacity:

$$C \quad = Co \; x \; FCw \; x \; FCsp \; x \; FCSF \; x \; FCcs$$

Description:

(Co) : Base Capacity

(FCw) : Effective Lane Width Factor

(FCsp) : Directional Separation Factor

(FCSF) : Side Obstacle Factor

(FCCS) : City size adjustment factor

Table 5. Existing Flow Calculation

Line	**Type of vehicle. emp direction 1 emp**	**Kend. Lightweight**		**Medium Weight**		**Big bus**		**Large Trucks**		**Motorcycle**		**Total current Q**
1,1 **1,2**		**LV:** **LV:**	**1,00** **1,00**	**MHV:** **MHV:**	**1,80** **1,80**	**LB:** **LB:**	**1,80** **1,80**	**LT:** **LT:**	**2,70** **2,70**	**MC:** **MC:**	**0,90** **0,90**	

	direction 2													
2	**Directions (1)**	**kend/hours (2)**	**high school hours (3)**	**kend/hours (4)**	**high school hours (5)**	**kend/hours (6)**	**high school hours (7)**	**kend/hours (8)**	**high school hours (9)**	**kend/hours (10)**	**high school/hour (11)**	**Directions % (12)**	**kend/hours (13)**	**high school/hour (14)**
3	1+2	92	92,12	10	18,63	2	3,73	10	27,95	1.703	1.532,32	100%	1.817	1.674,73

Table 6. Existing Capacity Calculation

Directions	**Capacity Basic**	**Adjustment factor for capacity**			**Capacity**
	CO	**Width path**	**Separator Directions**	**Barriers side**	**C**
	smp/hour	**FCW**	**FCSP**	**FCSF**	**(11) x (12) x (13) x (14)**
(10)	**(11)**	**(12)**	**(13)**	**(14)**	**(15)**
1	1.550	0,91	1	0,91	1.283,56
2	1.550	0,91	1	0,91	1.283,56
1+2	3.100	0,91	1	0,91	2.567,11

Table 7. Calculation of Existing Degree of Saturation

Directions	**Total current**		**Capacity**	**Degree of Saturation**
	Q		**C**	**(VCR)**
	Kend/hour	**smp/hour**	**smp/hour**	**(3)/(4)**
(1)	**(2)**	**(3)**	**(4)**	**(5)**
1+2	1817	1674,73	2567,11	0,65

Pavement Design Analysis

Cumulative Standard Axis Load (CESA)

Cumulative standard axis load or Cumulative Equivalent Single Axle Load (CESA) is the cumulative amount of planned traffic axis load on the plan lane during the plan life (Bina Marga 2024). In connection with the pavement analysis method used, namely planning the thickness of the added layer of flexible pavement with the deflection method (Benkelman Beam), traffic analysis is calculated using VDF4 and VDF5 to obtain ESA4 and ESA5. Traffic data analysis refers to the guidelines of Pavement Design Manual No.03/M/BM/2024. The VDF value used is in accordance with Table 4.4 VDF Value for Each Type of Commercial Vehicle. The data required in the analysis are as follows:

- Road Type: 2/2 UD
- Traffic growth (i) : 3.5% (Table 4.1 MDP 2024)
- Plan life (n): 10 years (Table 2.1 MDP 2024)
- Plan life period 1 (U1) : 1 year

- Period 2 plan life (U2) : 9 years
- Directional distribution factor (DD): 0,5
- Lane distribution factor (DL) : 1 (Table 4.2 MDP 2024)

The daily traffic data used for planning was obtained from the survey results in 2022. The annual traffic growth rate is 3.5% according to Table 4.1 of the 2024 MDP. The first year after opening for traffic is 2023 (1 year after 2022), the beginning of the 12-ton MST normal load period is 2023 (9 years after 2023).

The following is a detailed calculation of the traffic growth multiplier factor, where the uncontrolled factual load conditions are assumed to last until 2023, after 2023 it is assumed that the vehicle load is under control with the heaviest nominal axis load (MST) of 12 tons.

Table 8: Cumulative Estimated Traffic Load

Vehicle Type	**2-way Average Daily Traffic (2022)**	**2-way Average Daily Traffic (2023)**	**Factual**		**Normal**		**ESA (2022)**		**ESA (2023-2031)**	
			VDF 4	**VDF 5**	**VDF 4**	**VDF 5**	**ESA 4**	**ESA 5**	**ESA 4**	**ESA 5**
(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**
Passenger cars and other light vehicles	12.422	12.877	-	-	-	-	-	-	-	-
5A	6	6	-	-	-	-	-	-	-	-
5B	21	22	1,2	1,3	1,2	1,3	4.599,00	4.982,25	55.621,64	60.256,78
6A	30	31	0,5	0,4	0,5	0,4	2.737,50	2.190,00	33.108,12	26.486,50
6B	350	362	1,2	1,7	0,5	0,5	76.650,00	108.587,50	386.261,40	386.261,40
7A1	279	289	4,7	6,5	2,2	2,3	239.312,25	330.963,75	1.354.784,28	1.416.365,39
7A2	-	-	5,9	9,4	3,5	4,3	-	-	-	-
7B1	38	39	2,5	3,4	1,5	1,6	17.337,50	23.579,00	125.810,86	134.198,25
7B2	-	-	7,2	9,2	4,7	5,3	-	-	-	-
7C1	95	98	12,5	19,8	6,6	8,3	216.718,75	343.282,50	1.383.919,43	1.740.383,52
7C2A	-	-	7,5	11,7	4,4	5,2	-	-	-	-
7C2B	-	-	5,4	8,4	2,1	2,1	-	-	-	-
7C3	-	-	9	14,8	4,4	5,2	-	-	-	-
					ESA Amount		**557.355,00**	**813.585,00**	**3.339.505,73**	**3.763.951,83**
					CESA		**3,90,E+06**		**4,58,E+06**	
							CESA 4		**CESA 5**	

Source: Planning Data

Based on the table above, the CESA (Cumulative Equivalent Single Axle) value during the plan life is 3,896,860.73 ESA4 and 4,577,536.83 ESA5. The following shows an example of calculations for vehicle type Class 5b under factual load conditions and using VDF 4, as for other vehicle classes the calculation adjusts.

$$ESA\,4 = LHR\ x\ VDF\ 4\ x\ DD\ x\ DL\ x\ 365\ x \left[\frac{(1+g)^n - 1}{g}\right]$$

$$= 21\ x\ 1{,}2\ x\ 0{,}5\ x\ 1\ x\ 365\ x \left[\frac{(1+3{,}5\%)^1 - 1}{3{,}5\%}\right]$$

$$= 4.599,00\ ESA4$$

Subgrade Testing Results Using CBR

The following are the results of the STA 4+600 Left Side CBR test.

Table 9. CBR Testing Table STA 4+600 Left Side

Specimen & Equipment Details			
Specimen Reference	A	**Method of Sample Preparation**	
Diameter	152,000 mm		
Height	126,000 mm		
Dry Density before Soak	1.61 kg/m3	**Dry Density after Soak**	1.61 kg/m3
Surcharge Weight	4000.00 g	**Comments**	
Moisture Content			
Before Compaction	0.00 %	**After Compaction**	0.00 %
Top 1" Layer after penetration	0.00 %	**Average after soak**	1.72 %

Determination of Pavement Thickness

In planning the thickness of flexural pavement based on the Flexural Pavement Planning Guidelines (PdT 01-2002-B), there are several parameters required to obtain the planned thickness. In this work, the planned pavement width is 7.0 m. The following is a detailed calculation of flexible pavement for Overlay.

The calculation of pavement thickness planning in this guideline is based on the relative provisions of each pavement layer, with the following formula:

ITP = aov Dov + a1 D1 + a2 D2 + a3 D3 + an Dn

Where ITP value = SN value, obtained from the nomogram for flexible pavement thickness planning.

ITP = a1 D1 + a2 D2 + a3 D3 + a4 D4

4,9856 = 0.4 x D1 + 0.35 x D2 + 0.12xD3 + 0.08 x D4

4,9856 = 0.4 x D1 + 3.60

D 1 = 3.458 inches

= 8.784 cm

Obtained Layer Thickness = 9.00 cm

Table 10: Pavement Sketch

Surface Layer		*AC-WC*	*4.0 cm*
		AC-BC	*6.0 cm*
Existing			

CONCLUSION

Based on the analysis using the Treatment Triggered Index (TTI) method, it was found that the road conditions on the Bts. Lumajang City - Bts. Jember requires comprehensive repair with details of 1.66 km (11.7%) in good condition, 1.3 km (9.2%) in moderate condition, 7.2 km (50.8%) slightly damaged, and 4 km (28.3%) severely damaged. The damage was dominated by crocodile skin cracking and rutting, indicating the need for structural repairs using the overlay method. The choice of overlay was supported by the results of Falling Weight Deflectometer (FWD) measurements that showed degradation of the strength modulus of the road structure. This method is designed to restore the bearing capacity of the road by adding an additional layer whose thickness is calculated in accordance with the Flexural Pavement Design Manual. This improvement considers the average daily traffic volume (LHR) of 18,000 vehicles per day, heavy vehicle composition, and vehicle axle load distribution. The implementation of the overlay is expected to improve the structural and functional strength of the road, extend the service life to more than 10 years, while improving the comfort, safety, and smoothness of traffic on the road section.

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