



ANALYSIS OF BACK DEFECT METHOD USING TOOLS BENKELMAN BEAM IN PLANNING LAYER THICKNESS ADD FLEXIBLE PAVEMENT (OVERLAY)

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Abstract :

This research is backgrounded by the level of road damage that occurs on the Isimu - Paguyaman road so that the need for handling so that the transportation route runs smoothly. This study aims to analyze and determine the thickness of the overlay layer (overlay) using the 2017 Road Pavement Design Manual (MDP 2017) method with the Benkelman beam test tool, which is carried out on the Isimu - Paguyaman Road section (STA 17 + 100 - STA 18 + 100). Based on the results of the study, the overlay thickness was obtained from the results of traffic volume analysis by taking into account the CESAL value for 10 years of planning age of 11,476,966 ESA 4 for 10 years of planning age of 19,233,188.4 ESA4 and CESAL value of 5. The difference in the results of calculating the CESAL value is due to the determination of equivalent numbers and different VDF values in each calculation. Overlay thickness based on the method of the 2017 Road Pavement Design Manual obtained a minimum AC-WC thickness of 11.23 cm by using an overlay thickness solution graph based on maximum characteristic deflection.

Keywords : *Benkelman beam; overlay; road pavement design manual 2017; CESA*

INTRODUCTION

Road damage can have a significant impact on the comfort and safety of passing road users (Rangkuti, 2016). Based on data from the Central Statistics Agency (2019) during the 2015-2019 period, the number of traffic accidents increased by an average of 4.87% per year (Zainafree et al., 2022). The increase in the number of accidents was

also accompanied by the number of deaths and minor injuries, namely 1.41% and 6.26% per year respectively (Indonesia, 2018). Apart from that, damage can also cause delays in the process of distributing goods and services, thereby impacting regional development (Pratama & Koesyanto, 2020). Therefore, a solution is needed in the form of a road preservation program in the form of road maintenance components to extend the service

life of the road. One of the pavement maintenance jobs is adding layer thickness work (*overlay*) which aims to increase the strength of the existing pavement structure so that it can serve the planned traffic during the future period (Tuna, 2016).

Visually, the pavement on Jalan Isimu - Paguyaman has some damage, such as reflection cracks, grooves on the asphalt pavement, peeling of the surface layer. In general, the functional condition of the Jalan Isimu - Paguyaman section has experienced a decline in pavement quality. This happens because Jalan Isimu - Paguyaman is one of the arterial roads in Gorontalo City which is often used by various types of light to heavy transportation. This is also the basis for this research to plan the design of added layer thickness using the 2017 Road Pavement Design Manual method with a deflection test tool *benkelman beam*.

Based on the background description, a problem formulation of how thick the added layer can be drawn can be formulated (*overlay*) needed to overcome the problem of decreasing pavement quality on the Isimu - Paguyaman Road section using the 2017 Road Pavement Design Manual (MDP 2017) method with testing equipment *benkelman beam* ? (Ahlak, 2022) (Pradani et al., 2016).

The aim of this research is to analyze road pavement strengthening or additional layer thickness (*overlay*) with the 2017 manual method of road pavement design using a back deflection test tool *Benkelman Beam*.

RESEARCH METHODS

A. Research sites

In this research, a case study was taken in Gorontalo Province on the Isimu – Paguyaman road section, at STA 17+100 – 18+100 (1 Km long)

which is an arterial road with type 2 lanes 2 directions (2/2 UD) with a time of 1 Sunday

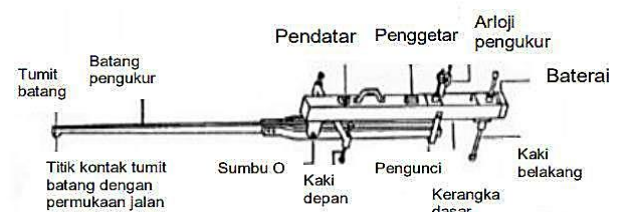


Figure 3. Research sites

A. Data collection method

This research uses 2 types of research data, namely primary data and secondary data:

- 1) *Data Primer*: Primary data is data obtained through survey observations in the field. The primary data obtained is deflection testing with tools *benkelman beam*. Testing was carried out on June 15 2021 at 13:00 WITA for a distance of 1 km on the Jalan Isimu - Paguyaman section with a total of 5 testing points. With temperature data obtained from direct measurements using a temperature measuring device/*thermometer*. During deflection testing, the temperature data obtained is in the form of:
 - T_P = Pavement Surface Temperature Data ($^{\circ}\text{C}$)
 - T_{IN} = Air Temperature Data ($^{\circ}\text{C}$)
- 2) *Data Seconds*: Secondary data is data obtained from related agencies. In this case, it is the Gorontalo Province National Road Implementation Agency (BPJN). The data required is daily traffic data (*LHR*).

B. Tools used

- 1) Truck with standard specifications (Figure 2);
- 2) The Benkelman beam apparatus consists of two rods with a total length of (366 ± 0.16) cm (Figure 4):

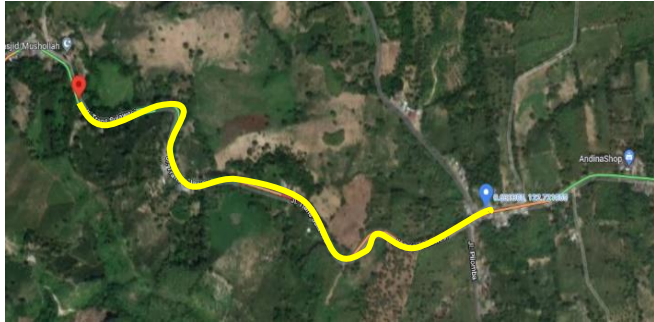


Figure 4. Benkelman Beam Tool

C. Data analysis

After obtaining back deflection data and daily traffic data (*LHR*), both data were analyzed using the 2017 Road Pavement Design Manual (MDP 2017) method. The stages in analyzing these two data include:

- 1) *Determining the life of the plan:*
- 2) *Calculating traffic volume:*
- 3) *Calculating transport standard axle loads (CESAL):*
- 4) *Determining handling triggers:*
- 5) *Determine the type of surface layer:*
- 6) *Determine the thickness of the added layer (overlay):*

D. Stages Study

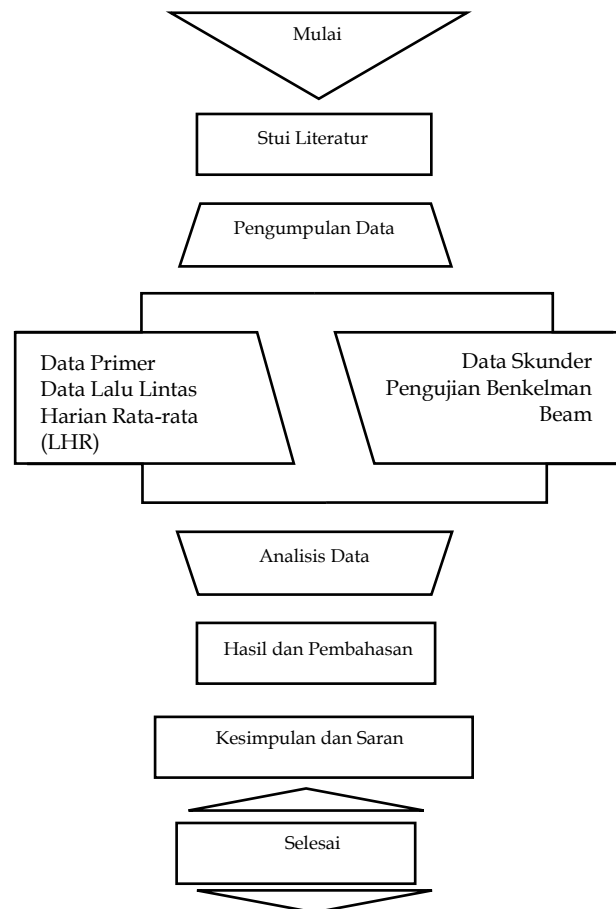


Figure 5. Research Implementation Flow Chart

RESULTS AND DISCUSSION

A. Traffic Volume Analysis Results

Results from field survey data obtained from the Gorontalo Province National Road Implementation Center for overlay thickness design purposes. Based on the data obtained, it can be seen the number of transportation groups per day during 2022, consisting of group 1 (motorbikes), groups 2, 3, 4 (sedans, jeeps, public transportation, st wagons), groups 5A and 5B (small and large buses). Groups 6A and 6B (2-axle trucks), groups 7A, 7B and 7C (3-axle trucks), and

class 8 (non-motorized transportation) which pass along Jalan Isimu – Paguyama.

Table 2
Traffic Data Analysis

NO	CLASSIFICATION		TRANSPORTATION TYPE	LHR 2021			(i)	LHR 2023	LHR 2024	VDF _{4FACTU} AL	VDF _{4NORM} AL	VDF _{5FACTU} AL	VDF _{5NORM} AL	ESA _{4FACTU} AL	ESA _{4NORM} AL	THAT _{5FACTU} L	THAT _{5NORM} AL
	Old	Evening		Normal	Opposite	Total		2	3								
1	1	1	- Motorbikes, scooters, 3 wheels	15578	15578	31156	4.75%	34186	35810								
2	2,3,4	2,3,4	- Sedan/Angkot/Pick up / Station Wagon	7488	7488	14976	4.75%	16433	17213								
3	5a	5a	- Small bus	2	2	4	4.75%	4	5								
4	5b	5b	- Big Bus	22	22	44	4.75%	48	51	1.20	1.20	1.30	1.30	52.80	60.69	57.20	65.74
5	6a.1	6.1	- Light cargo 2 axle truck	0	0	0	4.75%	0	0	0.50	0.50	0.40	0.40	0.00	0.00	0.00	0.00
6	6a.2	6.2	- Light 2 axle truck	23	23	46	4.75%	50	53	0.50	0.50	0.40	0.40	23.00	26.44	18.40	21.15
7	6b1.1	7.1.	- Medium cargo 2 axle truck	0	0	0	4.75%	0	0	2.40	0.90	4.70	0.80	0.00	0.00	0.00	0.00
8	6b1.2	7.2	- Medium 2 axle truck	1148	1148	2296	4.75%	2519	2639	2.40	0.90	4.70	0.80	5510.40	2375.07	10791.20	2111.17
9	6b2.1	8.1	- General load heavy 2 axle trucks	0	0	0	4.75%	0	0	2.40	0.90	4.70	0.80	0.00	0.00	0.00	0.00
10	6b2.2	8.2	- Heavy 2 axle trucks (soil, sand, iron, cement)	0	0	0	4.75%	0	0	2.40	0.90	4.70	0.80	0.00	0.00	0.00	0.00
11	7a.1	9.1	- Light 3 axle truck	0	0	0	4.75%	0	0	9.20	2.10	16.10	2.40	0.00	0.00	0.00	0.00
12	7a.2	9.2	- Medium 3 axle truck	64	64	128	4.75%	140	147	13.80	4.40	26.80	5.60	1766.40	647.33	3430.40	823.87
13	7a.3	9.3	- Heavy 3 axle truck	0	0	0	4.75%	0	0	13.80	4.40	26.80	5.60	0.00	0.00	0.00	0.00
14	7b	10	- 2 axle truck and 2 axle trailer	0	0	0	4.75%	0	0	13.80	4.40	26.80	5.60	0.00	0.00	0.00	0.00
15	7c.1	11	- Semi Trailer 4 axis	0	0	0	4.75%	0	0	16.70	6.40	29.10	8.10	0.00	0.00	0.00	0.00
16	7c2.1	12	- Semi Trailer 5 axis	63	63	126	4.75%	138	145	16.80	5.90	31.30	7.40	2116.80	854.45	3943.80	1071.68
17	7c2.2	13	- Semi Trailer 5 axis	0	0	0	4.75%	0	0	31.90	5.00	64.40	5.90	0.00	0.00	0.00	0.00
18	7c.3	14	- Semi Trailer 6 axis	0	0	0	4.75%	0	0	31.90	5.00	64.40	5.90	0.00	0.00	0.00	0.00
19			- Non-motorized vehicles	31	31	62	4.75%	68	71								
AMOUNT														9469	3963	18241	4093

B. Cumulative Equivalent Single Axle Load Calculation Results

Markvehicle damage factor 4th power obtained values of 1.20, 0.5, 2.4 and 0.9 for

transport classes 5B to 6B, while for 5th power obtained 1.3, 0.4, 4.7 and 0.80. These two VDF values will later be used in the CESAL calculation⁴ and CESAL⁵.

C. CESAL Calculation Analysis⁴

Table 4
Recapitulation of CESA Values⁴ and CESA⁵

Section Name	:	Linguistics – Paguyaman		
Road Classification	:	Arteries		
Year of Traffic				
Survey	:	2021		
Design Year	:	2022		
Year of				
Construction	:	2023		
Years of Service	:	2024		
Traffic Growth	:	0.0475		
CESA 4 (10 Years)	=	16414645.4	CESA 5 (10 Years)	= 23582921.5
		2		7
		30719303.2	CESA 5 (20 Years)	= 38355442.2
CESA 4 (20 Years)	=	8		8
		89658670.1	CESA 5 (40 Years)	= 99222540.6
CESA 4 (40 Years)	=	4		9

D. Analysis Results of Layer Thickness Adding Flexible Pavement (Overlay)

- 1) *Determination of Planned Age:* Determining the design life is the first stage in designing the thickness of the overlay layer. The design age is determined based on traffic load criteria obtained from CESAL calculations⁴ *overlay*. This is road quality improvement work, therefore the appropriate planning age is 10 years.
- 2) *Election Pavement Structure:* To determine the choice of pavement structure, the CESAL calculation must first be carried out⁴ first. Based on the results of CESAL calculations⁴ CESAL value is obtained⁴ $16,42 \times 10^6$ then adjusted to Table 2.7. Based on Table 2.7 CESAL value⁴ falls into the value range of 0.1 to 4 with the normal AC-BC pavement structure type being the main option for selecting the pavement structure.

- 3) *Trigger Deflection for Overlay and Reconstruction:* Based on Appendix 5 trigger and reconstruction deflections, the CESAL value is obtained⁵ > 1 to 2 ESAs⁵ which is adjusted to the CESAL value⁵. The result obtained is 23.59×10^6 year/year. Then the type of surface layer, namely AC or HRS, is obtained from selecting the pavement structure, with the trigger deflection for *overlay* (trigger deflection 1) and the trigger deflection for the reconstruction investigation (trigger deflection 2) are > 1.16 and > 1.50 mm which are adjusted to the results of the Benkelman beam corrected return deflection curve of 1.252 mm.

Determining Overlay Thickness: Determination of overlay thickness is determined based on Figure 2.1 for overlay solutions based on reverse deflection *benkelman beam* which has been corrected. The way to determine this is by

entering the maximum characteristic deflection value and the ESA design traffic load, the overlay thickness is obtained on the vertical axis. The results of the overlay thickness are shown in Figure 6

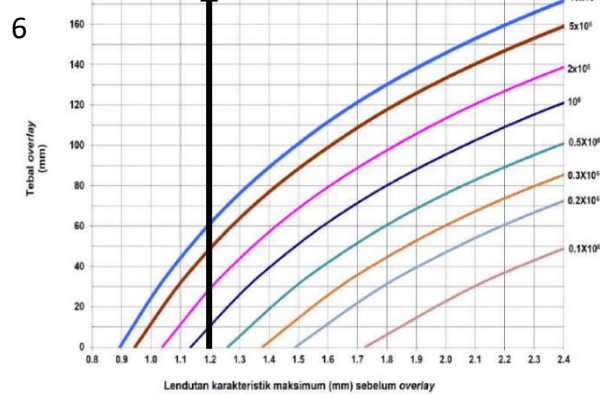


Figure 6. Thick overlay results

- Based on the average IRI value, namely 8 with an overlay thickness = 6.00cm
- Based on Fatigue Examination Pd-T-05-2005 = 14.46
- Based on graphs Figure 6.1, 6.3 & 6.4 Overlay Return Deflection BB = 0.00

Based on Figure 4.2, the thickness of the overlay used on Jalan Isimu - Paguyaman (STA 17+100 - STA 18+100) is 140 mm which is converted to 14 cm with AC-WC = 6 cm and AC-BC = 8 cm

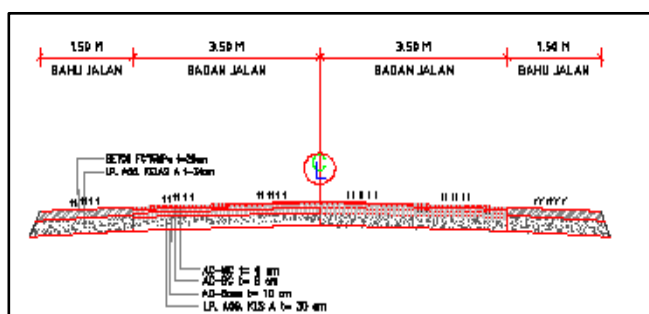


Figure 7. Typical Cross Section Scale 1:100

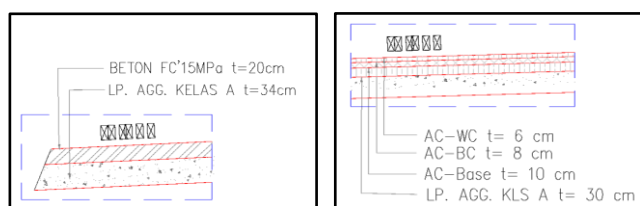


Figure 8. Detail Typical Cross Section Scale 1:50

CONCLUSION

Based on the research results, it can be concluded that the overlay thickness cannot be determined using the overlay solution graph based on the maximum characteristic deflection and ESA traffic load for rutting criteria. - Paguyaman is 140 mm or 14 cm with details AC-WC = 6 cm and AC-BC = 8 cm

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