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Evaluation of Structural Conditions of Rigid Pavement Using AASHTO 1993 and MDP 2017 Method (Case Study: Soekarno – Hatta Road (Bandung) Km.8+100 s/d 11+600

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Abstract. The rigid pavement of Soekarno-Hatta (Bandung) road is an avoidance or bypass road where congestion often occurs after the Padaleunyi toll road and the intersection of five intersections. Therefore, it is necessary to evaluate the structural conditions and design an overlay of AC using the AASHTO 1993 and MDP 2017 methods. Evaluation of pavement stiffness using the average daily traffic data and deflection obtained from the FWD testing tool. Structural evaluation using the AASHTO 1993 back-calculation method obtained the concrete modulus of elasticity (Ec) below the typical value between 3 million and 8 million psi, so the concrete pavement strength has decreased, while the evaluation of load transfer efficiency (LTE) obtained very poor results. Analysis using the AASHTO 1993 method based on the remaining life is thinner than the condition survey. In the MDP 2017 method, the overlay option is based on the maximum deflection (D0), and CESA4 does not require overlay. Whereas the deflection curvature (D0-D200) and CESA5 approaches require a thick layer of overlay. The result of the overlay obtained for the slow lane in the AASHTO 1993 method is thinner than the MDP 2017 method. Meanwhile, the fast lane in the AASHTO 1993 method is thicker than the MDP 2017 method. The predicted remaining life with a design life of 20 years is in the Cibiru direction around 78,30% and the direction of Gede Bage around 80,00%.

Keywords: *AASHTO 1993; back-calculation; deflection; structural evaluation; MDP 2017; overlay.*

1 Introduction

One of the rigid pavements for the Soekarno-Hatta (Bandung) road is an avoidance or bypass road that aims to reduce vehicles entering the city of Bandung from the south to Jakarta and vice versa. However, as time went on, the Soekarno-Hatta (Bandung) road often had traffic jams after the Padaleunyi toll road and the intersection of five intersections, namely Kopo Cibeureum road, Moh. Toha road, Buah Batu road, Kiaracondong road, and Gede Bage road. The initial stage in the evaluation of this road pavement is the analysis of traffic data to predict the repetition of the traffic load that passes on the analyzed rigid pavement. Then an analysis of the deflection obtained from the FWD tool is carried out to determine the capacity of the existing pavement structure. In order to maintain road conditions at an optimal level of service, an appropriate evaluation method is needed. This research will discuss the structural evaluation and design of overlay thickness (AC) on rigid pavements using the AASHTO 1993 and MDP 2017 methods. What is the structural condition of the existing rigid pavement using the AASHTO 1993 back-calculation method and load transfer efficiency (LTE)?; What are the results of calculating the overlay thickness of rigid pavement using the AASHTO 1993 method and the MDP 2017 method?; Is the life of the rigid pavement proportional to the remaining life?. The research objectives to be achieved are to analyze the condition of rigid pavement against traffic loads in the form of deflection, design asphalt overlay thickness (AC), and compare the parameters based on the results obtained.

2 Research Methodology

- The choice of location for this study was due to the fact that the rigid pavement suffered quite a lot of damage, such as cracks and punchout, and heavy traffic at the Gede Bage intersection and the Cibiru roundabout.
- Collecting literature reviews related to the research topic.
- Compare the parameters used.
- Collection of secondary data, where the data collected was obtained from field or laboratory test result. The collected secondary data will then be included as input in the design of each method: traffic data analysis, existing pavement analysis, and deflection analysis,
- Based on the results of the data analysis, it can be concluded that the structural conditions of the existing rigid pavement produce a flexible pavement design (AC) with the required overlay thickness based on the deflection in the middle of the slab using the AASHTO 1993 method, then comparing the results of the overlay thickness with the MDP 2017 method and the parameters that affect the results of the overlay thickness of the two methods. Furthermore, predicting the remaining life of the planned pavement in the future.
- Then, from these results, conclusions are drawn regarding the results obtained and the parameters used.

The stages of this research are described as a whole in the flowchart shown in Figure 1, Figure 2 and Figure 3 below.

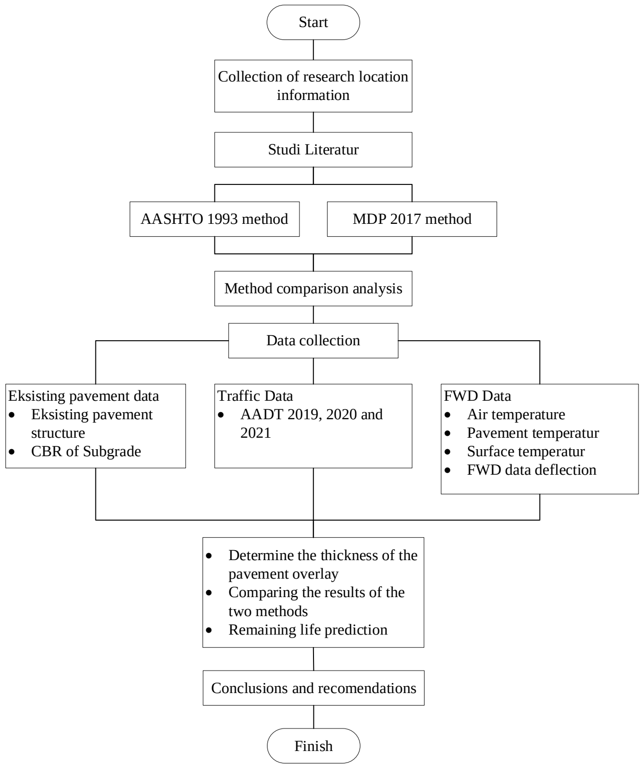


Figure 1 Flowchart of research methods

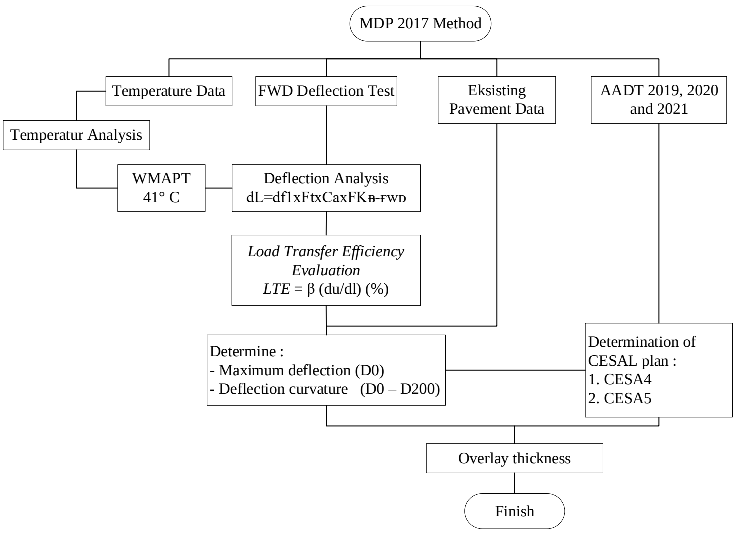


Figure 2 Flowchart of the MDP 2017 Method

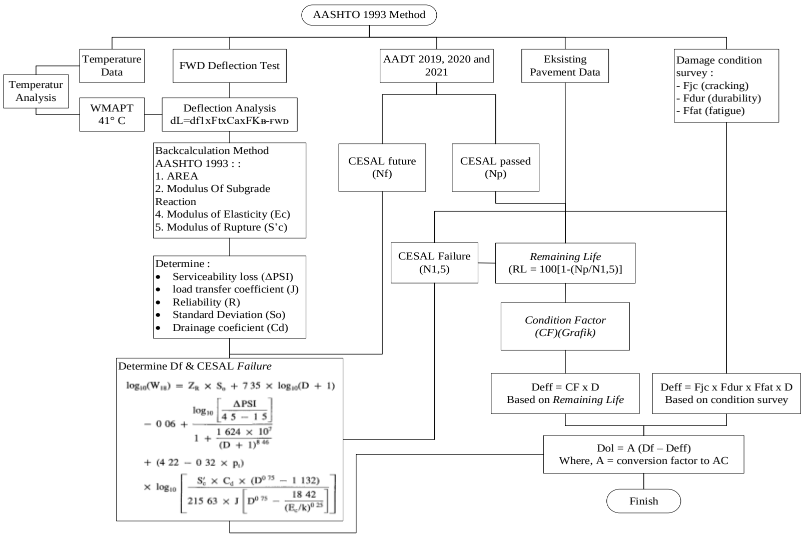
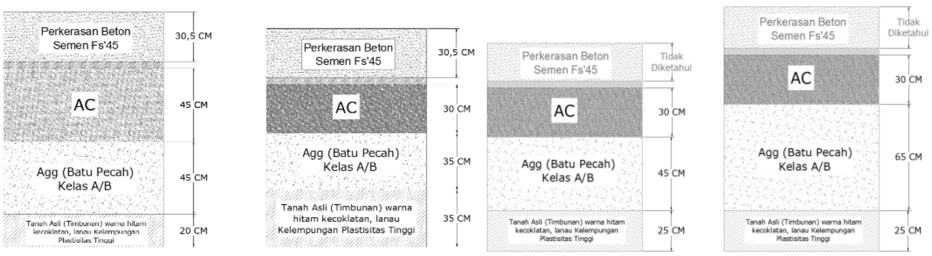


Figure 3 Flowchart of the AASHTO 1993 Method

3 Presentation Data

Data used in this study are existing pavement structure data, traffic volume data, air and pavement temperature data, and deflection data from FWD measurements.

3.1 Existing Pavement Structure Data



(a) (b) (c) (d)

Figure 4 The structure of the existing pavement layer (a) Km.10+300 in the direction of cibiru (fast lane), (b) Km.11+300 in the direction of cibiru (slow lane), (c) Km.9+600 in the direction of gede bage (fast lane), (d) Km.9+200 in the direction of gede bage (slow lane) (BBPJN DKI Jakarta – Jawa Barat).

3.2 Traffic Volume Data

Traffic data uses primary and secondary data shown in Table 1 and Table 2 below.

Table 1 Annual average daily traffic volume (AADT) in 2019, 2020 and 2021 Soekarno – Hatta (Bandung) road section (BBPJN DKI Jakarta – Jawa Barat).

Groups	Vehicle type groups	Year					
		2019		2020		2021	
		N	O	N	O	N	O
2	Sedan, Jeep, and Station Wagon	11.896	13.410	13.167	7.542	23.185	21.882
3	Passenger Cars	1.516	1.612	7.581	6.812	627	756
4	Pick-up, Micro trucks and Vans	1.597	1.646	2.122	1.012	1.578	1.719
5a	Buses	139	151	40	20	830	836
5b	Big Buses	181	195	63	165	249	261
6a	Two axle, single-unit trucks	959	1.045	1.293	938	1.627	1.706
6b	Two axle, medium-unit trucks	491	508	1.623	993	364	359
7a	Three axle, single-unit trucks	417	417	204	189	228	241
7b	Four or less axle, single trailer	1	1	-	-	2	3
7c	5-axle tractor semitrailer	69	61	63	59	57	59
Total		17.266	19.045	26.157	17.732	28.747	27.822

Groups 2 – 4 include light vehicles and groups 5a – 7c include heavy vehicles. Comparison of the number of light vehicle and heavy vehicles is shown in Figure 5 below.

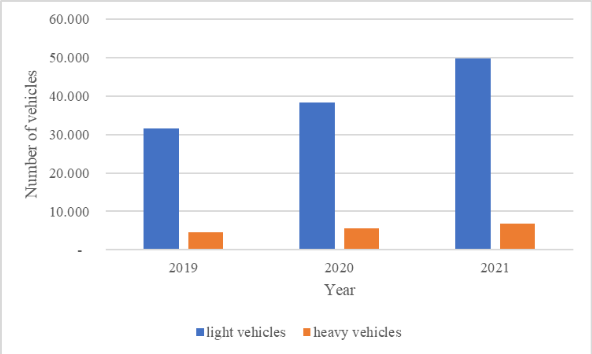


Figure 5 Comparison of light vehicle and heavy vehicle traffic volumes in 2019, 2020 and 2021 (BBPJN DKI Jakarta – Jawa Barat)

Table 2 Vehicle traffic volume per day (Primary Survey, 2022)

Groups	**Cibiru Direction**		**Gede Bage Direction**	
	Slow lane	**Fast lane**	**Slow lane**	**Fast lane**
5a	9	26	4	17
5b	64	29	44	103
6a	398	1.289	453	897
6b	231	503	137	496
7a	214	168	52	286
7b	1	1	-	2
7c	162	17	6	200
Total	1.079	2.033	696	2.001

3.3 FWD Deflection Data

The pavement deflection and temperature data used in this study are secondary data on structural conditions from the FWD tool on March 31, 2019 on the Soekarno-Hatta (Bandung) road section. At the time of measurement, the deflection test is carried out every 100 meters. The distance interval for NDT testing using the FWD tool is not uniform. FWD testing is carried out locally; due to limited data, it is assumed that the location where the test is not carried out is considered to be the same as the position of the nearby FWD test. A deflection analysis is carried out to determine the capacity of the existing pavement structure. For overlays on grained pavements, the deflection measurement results need to be corrected. This is because pavement temperature affects pavement stiffness and performance in response to loads. The next step is to determine the uniformity of the deflection based on the length of the segment. Very good uniformity has a range of uniformity factors between 0 - 10, good uniformity between 11 - 20 and fairly good uniformity between 21 - 30. The results of deflection correction calculations for the N (Cibiru) and O (Gede Bage) directions can be seen in Figure 6 and Figure 7 below.

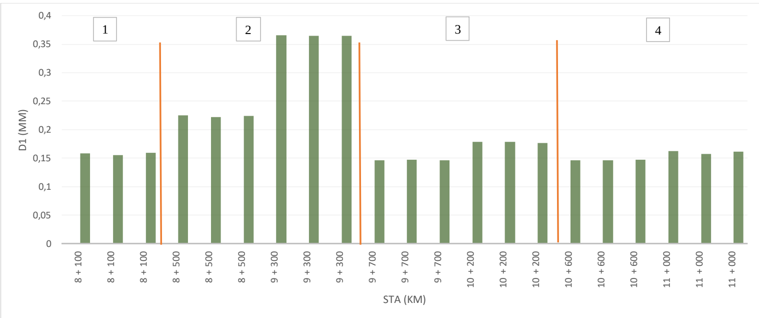


Figure 6 Division of segmentation deflection in the direction of N (Cibiru)

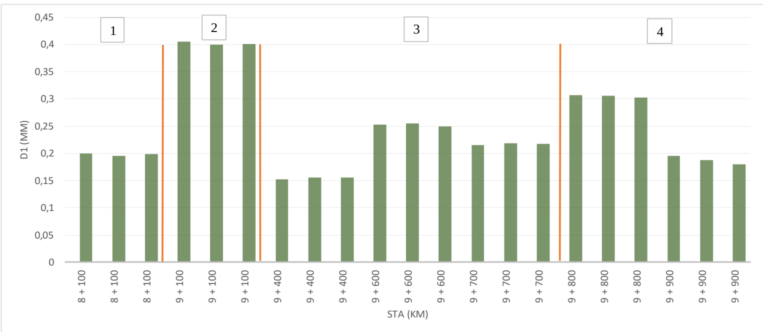


Figure 7 Division of segmentation deflection in the direction of O (Gede Bage)

4 Analysis Data

Data analysis used the AASHTO 1993 method and the MDP 2017 method, namely CESAL calculations, structural analysis of pavement conditions, and calculation of overlay thickness.

4.1 Analysis of The AASHTO 1993 Method

The stages of analyzing the condition of the pavement structure using the AASHTO 1993 method are calculating CESAL passed (Np) and CESAL future (Nf), evaluating the condition of the structure using the back-calculation method, and designing the overlay thickness using the remaining life method and the condition survey method.

4.1.1 Calculation CESAL

The calculation of CESAL passed (Np) and CESAL future (Nf) is shown in Table 3, Table 4 and Table 5 below.

Table 3 Recapitulation of CESAL passed (Np) for the period 2017 – 2022 Soekarno – Hatta (Bandung) road section

Year	ESAL for year		CESAL future (Np)	
	N (Cibiru) Direction	**O (Gede Bage) Direction**	**N (Cibiru) Direction**	**O (Gede Bage) Direction**
2017	431.726,24	448.509,58	431.726,24	448.509,58
2018	532.555,07	553.905,76	964.281,31	1.002.415,34
2019	658.471,15	684.069,20	1.622.752,46	1.686.484,54
2020	1.091.531,14	755.272,35	2.714.283,59	2.441.756,88
2021	739.545,19	767.198,13	3.453.828,78	3.208.955,01
2022	992.212,34	863.789,88	4.446.041,13	4.072.744,89

Table 4 Recapitulation of CESAL future (Nf) for the period 2023 – 2042 Soekarno – Hatta (Bandung) road section fast lane

Year	R (%)	ESAL for year		CESAL	
		N (Cibiru) Direction	**O (Gede Bage) Direction**	**N (Cibiru) Direction**	**O (Gede Bage) Direction**
2023	1,05	669.388,79	725.338,12	669.388,79	725.338,12
2042	2,42	3.580.902,28	3.880.203,77	35.133.194,75	38.069.722,17

Table 5 Recapitulation of CESAL future (Nf) for the period 2023 – 2042 Soekarno – Hatta (Bandung) road section slow lane

Year	R (%)	ESAL for year		CESAL	
		N (Cibiru) Direction	**O (Gede Bage) Direction**	**N (Cibiru) Direction**	**O (Gede Bage) Direction**
2023	1,05	414.380,75	218.158,67	414.380,75	218.158,67
2042	2,42	2.216.734,11	1.167.042,07	21.748.974,22	11.450.163,40

4.1.2 Calculation of AASHTO 1993 back-calculation method

Back-calculation to determine elastic modulus based on deflection bowl data, pavement thickness and composition. The calculation results are shown in Table 6 and Table 7 below.

Table 6 The Concrete Modulus of Elasticity (Ec) and the Modulus Of Rupture (S'c) slow lane

Information	STA	D (cm)	D (inch)	Ec (psi)	S'c (psi)
Segment 1 Direction N (Cibiru)	8 + 100	30,50	12,01	1,49E+06	553,37
Segment 4 Direction N (Cibiru)	11 + 000	30,50	12,01	9,31E+05	529,00
Segment 1 Direction O (GedeBage)	8 + 100	30,50	12,01	4,20E+06	671,03
Segment 3 Direction O (GedeBage)	9 + 600	30,50	12,01	2,61E+05	499,85

Table 7 The Concrete Modulus of Elasticity (Ec) and the Modulus Of Rupture (S'c) fast lane

Information	STA	D (cm)	D (inch)	Ec (psi)	S'c (psi)
Segment 2 Direction N (Cibiru)	9 + 300	30,50	12,01	4,24E+05	506,94
Segment 3 Direction N (Cibiru)	10 + 200	30,50	12,01	1,07E+06	534,88
Segment 2 Direction O (GedeBage)	9 + 100	30,50	12,01	2,61E+05	499,87
Segment 4 Direction O (GedeBage)	9 + 800	30,50	12,01	4,67E+05	508,82

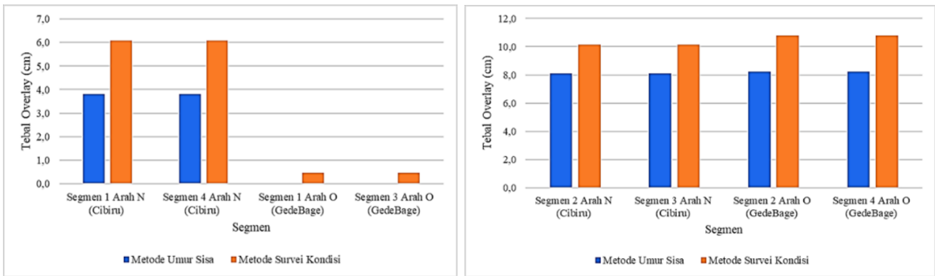
The results of the AASHTO 1993 back-calculation method show that the typical value of the concrete modulus of elasticity (Ec) is between 3 million and 8 million psi. The results obtained show that the concrete modulus of elasticity (Ec) value is below the typical value, except in segment 1 direction O (Gede Bage) slow lane, which is within the typical value. If the results obtained are outside the range of these typical values, then the concrete pavement is damaged quite badly, meaning that the concrete slab has decreased in strength to serve traffic loads. The modulus of rupture (S'c) describes a measure of the strength of concrete pavements. Typical modulus of rupture (S'c) values are between 600 and 800 psi. The results obtained show that the modulus of rupture (S'c) value is below the typical value, and only the slow lane segment 1 direction O (Gede Bage) is within the typical value range. If it is below typical, this means that the wheel load placed on the surface must first overcome the residual stress before the concrete is stressed. The remaining slab strength provides a significant increase in resistance to loading, which can result in cracking. The concrete modulus of elasticity (Ec) and the Modulus of Rupture (S'c) will control the performance of the AC layer.

4.1.3 Calculation of Overlay Thickness AASHTO 1993 Method

The parameters used to calculate the overlay are reliability (R) = 98% with ZR = -2.054, standard deviation (S0) = 0.45 for rigid pavements, serviceability parameters consisting of Terminal serviceability index (Pt) = 2.5 for roads main; Initial serviceability index (P_0) = 4.5 for concrete pavements; Total loss of Serviceability (ΔPSI) = Po – Pt = 4.5 – 2.5 = 2;

Good drainage quality is taken based on the historical frequency of floods that occurred on the Soekarno - Hatta (Bandung) road Km. 8+100 to 11+600 water receding time of about 2 to 4 hours with the percentage of time the pavement structure is exposed to water until the moisture level is close to water saturation <1%, namely 1.15 – 1.10, the median value of Cd = 1.175; load transfer coefficient parameter (J) = 3.2.

Then the overlay calculation is carried out using the remaining life method and the condition survey method. The calculation results are shown in Figure 8 below.



(a) Slow lane (b) Fast lane

Figure 8 Overlay results using the AASHTO 1993 method on: (a) slow lane and (b) fast lane

The results of the analysis show that the overlay thickness on the remaining life method is thinner than the condition survey method, both in slow and fast lanes. This is due to the reduced structural capacity (Deff) in the remaining life method using the condition factor obtained from the actual cross load compared to the failure condition cross load, as well as the effect of the thickness of existing rigid pavement. The thicker of existing rigid pavement, the thinner the overlay thickness is obtained, as well on the contrary. In contrast to the condition survey method, the reduced structural capacity (Deff) is obtained by taking into account the adjustment factors for joints and cracks, durability and fatigue. The pavement surface damage factor greatly influences the thickness of the overlay. Each 1% damage factor is equivalent to 0.50 cm thick overlay obtained.

4.2 Analysis of the MDP 2017 Method

The stages of analyzing the condition of pavement structure using the MDP 2017 method are the traffic load that is calculated as the cumulative traffic during the design life, namely the number of vehicles that turn into load repetitions in the equivalent standard axle (ESA), ESA4 for the statistical - empirical and ESA5 for the mechanistic-empirical. Then evaluate the load transfer efficiency and design the overlay thickness with an approach to determining the overlay that generally includes two criteria, namely maximum deflection (d0) and deflection curve (d0-d200) to determine fatigue cracks.

4.2.1 Calculation CESAL

The calculation of the CESA4 and CESA5 uses AADT data for 2022, which was obtained through surveys at study locations and then projected for 20 years later. The recapitulation of the calculation of CESA 4 and CESA 5 can be seen in Table 8, Table 9, Table 10 and Table 11 below.

Table 8 Recapitulation of the calculation for CESA4 fast lane

Year	R (%)	ESA4		CESA4	
		N (Cibiru) Direction	O (Gede Bage) Direction	N (Cibiru) Direction	O (Gede Bage) Direction
2022	1,00	210.084,88	277.427,38	210.084,88	277.427,38
2042	2,42	1.227.555,50	1.621.047,20	12.043.876,93	15.904.529,83

Table 9 Recapitulation of the calculation for CESA4 slow lane

Year	R (%)	ESA4		CESA4	
		N (Cibiru) Direction	O (Gede Bage) Direction	N (Cibiru) Direction	O (Gede Bage) Direction
2022	1,00	169.880,13	67.926,50	169.880,13	67.926,50
2042	2,42	992.633,48	396.904,10	9.738.993,91	3.894.132,82

Table 10 Recapitulation of the calculation for CESA5 fast lane

Year	R (%)	ESA5		CESA5	
		N (Cibiru) Direction	O (Gede Bage) Direction	N (Cibiru) Direction	O (Gede Bage) Direction
2022	1,00	228.453,50	315.679,38	228.453,50	315.679,38
2042	2,42	1.334.885,96	1.844.559,02	13.096.924,94	18.097.464,38

Table 11 Recapitulation of the calculation for CESA5 slow lane

Year	R (%)	ESA5		CESA5	
		N (Cibiru) Direction	O (Gede Bage) Direction	N (Cibiru) Direction	O (Gede Bage) Direction
2022	1,00	196.324,38	72.790,13	196.324,38	72.790,13
2042	2,42	1.147.150,96	425.322,95	11.255.006,39	4.172.957,75

4.2.2 Calculation Load Transfer Efficiency (LTE)

Evaluation of deflection data to determine load transfer at a joint involves determining the load transfer efficiency (LTE). If load transfer is present, the ratio will be 100% to 0%. Poor load transfer can cause a large increase in plate stress and deflection, resulting in plate breakage and a loss of service life. The calculation of load distribution efficiency is shown in Table 12 and Table 13 below.

Table 12 Load transfer efficiency (LTE) slow lanes

Segment	Load	d1 (du)	d2 (dl)	d12	LTE	Ket.
	kN	Mm	Mm	mm	β*(du/dl) (%)	
A	c	D	E	f	g=(d/f)*(d/e)	H
Segment 1 Direction N (Cibiru)	42,06	0,1596	0,1161	0,1137	1,9300	*Very poor*
Segment 4 Direction N (Cibiru)	40,96	0,1620	0,1081	0,1055	2,3004	*Very poor*
Segment 1 Direction O (GedeBage)	40,77	0,2000	0,1915	0,1906	1,0961	*Very poor*
Segment 3 Direction O (GedeBage)	40,43	0,2552	0,2220	0,2203	1,3318	*Very poor*

Table 13 Load transfer efficiency (LTE) slow lanes

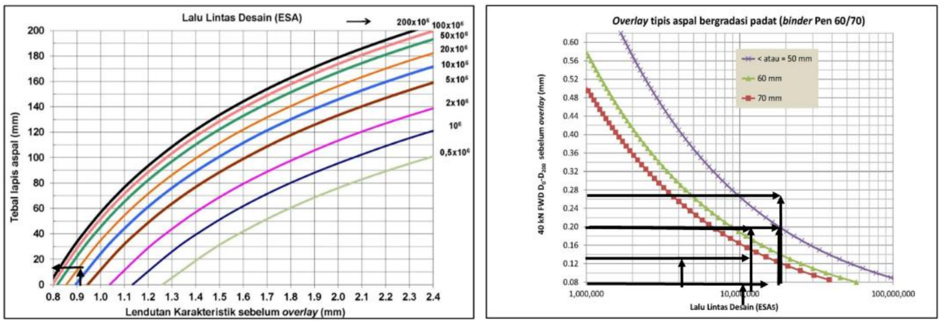
Segment	Load	d1 (du)	d2 (dl)	d12	LTE	Ket
	kN	Mm	Mm	mm	β*(du/dl) (%)	
A	C	D	E	F	g=(d/f)*(d/e)	H
Segment 2 Direction N (Cibiru)	40,76	0,3654	0,2723	0,2664	1,8404	*Very poor*
Segment 3 Direction N (Cibiru)	41,11	0,1786	0,1455	0,1397	1,5687	*Very poor*
Segment 2 Direction O (GedeBage)	36,06	0,4054	0,2690	0,2501	2,4422	*Very poor*
Segment 4 Direction O (GedeBage)	40,83	0,3067	0,2100	0,1898	2,3594	*Very poor*

4.2.3 Calculation of overlay thickness MDP 2017 method

The calculation of overlay thickness using the maximum deflection (d0) and deflection curve (d0-d200) by finding the value of which has been corrected with a seasonal correction factor (Ca) and normalized deflection to a standard load of 40 kN and the ratio of WAMPT and concrete temperature when measuring 41°C. The results of deflection measurements need to be corrected because pavement temperature affects pavement stiffness and performance in response to load. Maximum deflection (do) and deflection curves (d0-d200) are corrected by pavement temperature. Convert the value FWD to BB using the deflection adjustment factor. Calculate the maximum deflection (d0) average, deviation standard, and coefficient of variation ≤ 30 % (uniform segment). Calculate representative maximum deflection for 98% represented by :

Dwakil = dR + 2s, for arterial/toll roads. (1)

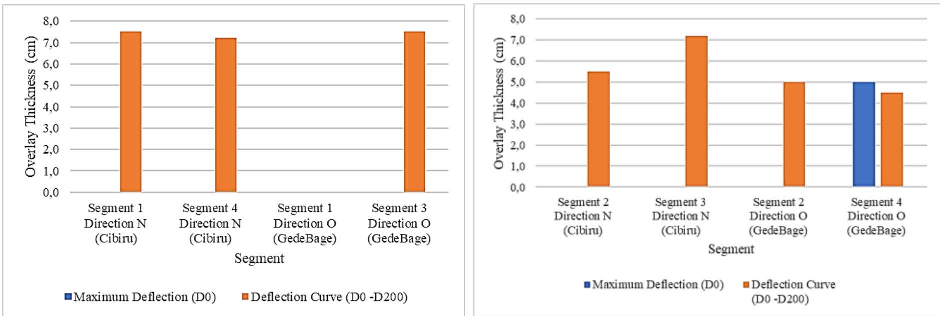
Calculate deflection curves (d0-d200) the representative curvature function for 98% represented using equation (1). The calculation results for the maximum deflection (d0) and deflection curve (d0-d200) to determine the overlay thickness based on curve analysis can be seen in Figure 9 below.



(a) (b)

Figure 9 Calculation results on: (a) overlay thickness based on maximum deflection (d0) (benkelman beam); (b) thin overlay thickness based on deflection curve (d0-d200) (MDP, 2017)

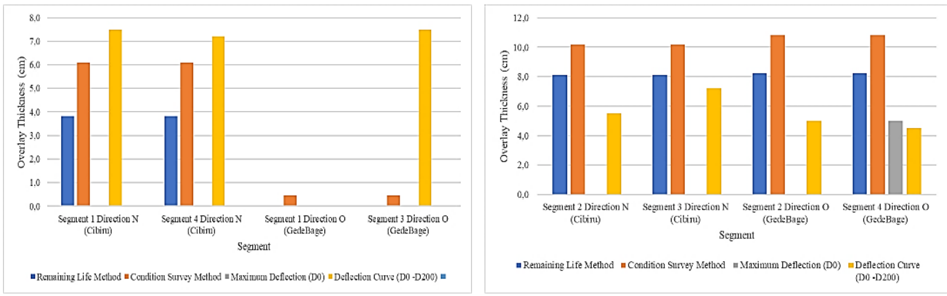
The results of the calculation of overlay thickness based on the maximum deflection (d0) and the deflection curve (d0-d200) are shown in Figure 10 below.



(a) Slow lane (b) Fast lane

Figure 10 Results of Overlay Using the MDP 2017 Method on: (a) Slow lane and (b) Fast lane

4.3 Comparison of overlay thickness analysis results with AASHTO 1993 method and MDP 2017 method



(a) Slow lane (b) Fast lane

Figure 11 Comparison of overlay results with the AASHTO 1993 method and the MDP 2017 method on: (a) Slow lane and (b) Fast lane

The difference in the results of the overlay in the two methods, where the AASHTO 1993 method based on the remaining life and condition survey requires an overlay with a thick variation. In the MDP 2017 method based on the maximum deflection (d0) no overlay is needed except for the segmen 4 direction O (Gede Bage) fast lane and based on the deflection curve (d0-d200) an overlay is needed. The similarities between the two methods are that both use an empirical mechanistic approach, which means that the structural damage to the road is caused by fatigue cracking.

4.4 Prediction of remaining life of rigid pavement

Prediction of remaining life of the rigid pavement must first calculate the CESAL failure (N1.5) use the following equation (2) (AASHTO, 1993).

$$RL = 100\ [\ 1 - (\ Np/N1{,}5\ )] \tag{2}$$

From the results of the evaluation of the structural conditions of rigid pavement, it can be predicted that the remaining life of the rigid pavement with a design life of 20 years is shown in Table 14 and Table 15 below.

Table 14 Prediction of the remaining life of a rigid pavement on a slow lane

Segment	STA	Np	N1,5	RL (%)
Segment 1 Direction N (Cibiru)	8 + 100	4.446.041,13	20.411.704,37	78,22
Segment 4 Direction N (Cibiru)	11 + 000	4.446.041,13	20.496.653,65	78,31
Segment 1 Direction O (GedeBage)	8 + 100	4.072.744,89	20.340.325,97	79,98
Segment 3 Direction O (GedeBage)	9 + 600	4.072.744,89	13.403.375,41	69,61

Table 15 Prediction of the remaining life of a rigid pavement on a fast lane

Segment	STA	Np	N1,5	RL (%)
Segment 2 Direction N (Cibiru)	9 + 300	4.446.041,13	20.485.419,91	78,30
Segment 3 Direction N (Cibiru)	10 + 200	4.446.041,13	20.441.410,06	78,25
Segment 2 Direction O (GedeBage)	9 + 100	4.072.744,89	20.594.825,87	80,22
Segment 4 Direction O (GedeBage)	9 + 800	4.072.744,89	20.511.366,41	80,14

5 Conclusion

1. Evaluate condition of the existing rigid pavement

- According to the evaluation results of the AASHTO 1993 back-calculation method, the concrete slab has lost its strength in serving traffic loads and then, the remaining slab strength provides a significant increase in resistance to loading, which could result in cracking.

- The results of the Load Transfer Efficiency (LTE) evaluation on the MDP 2017 method are included in the very poor category, which means the loss of support causes large deflection and stress on the plate.

- Predicted remaining life in the N direction (Cibiru) segments 1, 2, 3 and 4 lanes slow and fast lane predicted remaining life of around 78.30% and in the O direction (Gede Bage) segments 1 slow lane, segments 2 and 4 fast lane predicted remaining life of about 80.00% while in the direction of O (Gede Bage) segment 3 slow lane predicted remaining life of around 69.61%.

2. The results of the overlay thickness

- In the AASHTO 1993 method based on the remaining life method, an overlay thickness of 4 cm is obtained for Segments 1 and 4 in the N direction (Cibiru) slow lane, and no overlay thickness is required for the slow lane segments 1 and 3 in the O direction (Gede Bage) while for the fast lane, N (Cibiru) and O (Gede Bage) directions require an overlay thickness of 8 cm each.

- In the AASHTO 1993 method based on the condition survey method, the thickness of the overlay on the slow lane segment 1 and 4 in the N direction (Cibiru) is 6 cm, the slow lane segment 1 and 3 in the O direction (Gede Bage) is 0.4 cm while the overlay thickness obtained on the segment 2 and 3 fast lane direction N (Cibiru) is 10 cm each, and on the fast lane segment 2 and 4 direction O (Gede Bage) each is 11 cm.

- In the MDP 2017 method, the overlay thickness results for the slow lane with (d0) no overlay is needed, while (d0-d200) obtains an overlay thickness on the segment 1 direction N (Cibiru) is 8 cm, on segment 4 direction N (Cibiru) is 7 cm, on segment 1 direction O (Gede Bage) no overlay is needed, on the segment 3 direction O (Gede Bage) is 8 cm.

- In the MDP 2017 method, the overlay thickness results for the fast lane with (d0), no overlay is needed except for the segment 4 direction O (Gede Bage) an overlay thickness is 5 cm, while for (d0-d200) the overlay thickness is obtained for the segment 2 direction N (Cibiru) is 6 cm, on the segment 3 direction N (Cibiru) is 7 cm, on the segment 2 direction O (Gede Bage) an overlay is 5 cm, and on the segment 4 direction O (Gede Bage) is 5 cm.

- The comparison between the AASHTO 1993 and the MDP 2017 methods shows that the AASHTO 1993 method is more complete because it has taken into account the structural strength of the existing pavement based on the deflection value and the deterioration of the existing pavement condition and damage to the study site. Meanwhile, the MDP 2017 method is only based on deflection.

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