Department of Digital Business
Journal of Artificial Intelligence and Digital Business (RIGGS)
Homepage: https://journal.ilmudata.co.id/index.php/RIGGS
Vol. 4 No. 4 (2026) pp: 9211-9221
P-ISSN: 2963-9298, e-ISSN: 2963-914X

Geometric Analysis of the Kanggraksan-Jendral Sudirman Road Section Harjamukti District, Cirebon City, West Java STA 0+000 – STA 2+456

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Abstract

Road infrastructure is one of the main components in supporting urban transportation systems. Roads that are well managed can increase mobility efficiency, improve connectivity between areas, and support equitable development. This study was conducted on Jalan Kanggraksan No. 23, Harjamukti District, Cirebon City, West Java, which functions as a primary collector road and has experienced a decline in road quality as a result of high traffic loads. The purpose of this project is to analyze the geometric conditions of the road, determine the required thickness of the pavement layer, and calculate the estimated cost of rehabilitation. The research methods include collecting primary data in the form of average daily traffic surveys (ADT) and secondary data such as traffic growth, design speed, CBR values, rainfall, and pavement material types. Geometric analysis is carried out based on the standards of the Directorate General of Highways using AutoCAD Civil 3D software modelling, including terrain classification, horizontal and vertical bend calculations, superelevation, and sight distance. The results of the analysis show that the ±2.5 km road section has three bends with significant elevation variations, requiring geometric design adjustments to improve safety. A CBR value of 6.5 and annual rainfall of 1900–2500 mm necessitate the use of HRS-BC material with CTB and LFA class A foundations. Pavement thickness analysis resulted in recommendations for a layered structure with a planned lifespan of 12 years, while project cost estimates provided a comprehensive planning basis for sustainable development in the city of Cirebon.

Keywords: Road Infrastructure; Geometry; Pavement; CBR; Project Cost; Cirebon

1. Introduction

Background

Road infrastructure is a vital component of the transportation system that serves as a connection between regions, supports community mobility, and is a primary driver in the distribution of goods and services. In the context of national development, roads not only serve as a means of physical connectivity but also as a strategic instrument in promoting economic growth, equitable development, and regional integration [1], [2], [3]. Roads that are well designed and managed will have a positive impact on traffic flow, increased accessibility, and strengthened connectivity between regions [4], [5], [6]. This is increasingly important in areas experiencing rapid growth, both in terms of population, commercial activity, and physical development. Therefore, the planning and development of road infrastructure must be carried out comprehensively, taking into account technical, social, economic, and environmental aspects.

One of the roads that has a strategic role is Jalan Kanggraksan, located in Harjamukti District, Cirebon City, West Java. This road is part of the urban road network that plays an important role in supporting community mobility, distribution of goods and services, and access to various public facilities. Functionally, this road is classified as a primary collector road connecting residential areas with economic and social activity centers. Improving the quality of road infrastructure on this section not only impacts transport efficiency but also contributes to urban spatial development, improvements in local economic value, and a reduction in traffic accident risks [7], [8], [9], [10], [11]. As such, a technical assessment of the existing road conditions is required.

This issue focuses on evaluating the suitability of road geometric design based on established technical standards and analyzing the required thickness of pavement layers to optimally withstand traffic loads. The scope of this research is limited to the geometric analysis of roads, including road width, slope, curves, and sight distance in accordance with Bina Marga standards, as well as the analysis of pavement thickness using the California Bearing Ratio (CBR) method, taking into account the average daily traffic (ADT) and the planned road life [12], [13], [14]. The objectives of this study are to analyze the suitability of road geometry based on applicable geometric planning standards and to determine the required thickness of pavement layers based on subgrade conditions and traffic loads [15], [16], [17], [18], [19]. The results of this study are expected to provide technical guidelines for safe and efficient road geometric planning and to provide information on pavement structure requirements in accordance with existing conditions as a basis for consideration in road infrastructure planning and development [1], [20], [21], [22].

2. Research Methodology

This research method has been compiled in detail (see image 1).

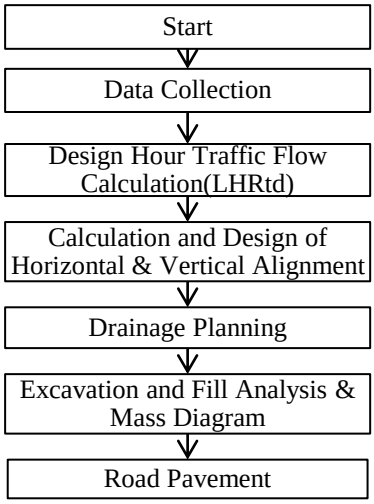

Fig 1. Research flow Diagram

3. Result and Discussion

Research Location

The location of this study is at Jl. Kanggraksan No. 23, located in the Harjamukti District, Cirebon City, West Java Province. The length of the road section observed is around ±2.5 km, and it is one of the main access roads connecting residential areas with various public facilities such as educational centers, traditional markets, and local offices.

This research location was chosen because the Kanggraksan–Jenderal Sudirman road section is representative of flat urban roads with fairly heavy mixed traffic, making it highly relevant for analysis from a road geometry perspective.

Fig 2. Research Location: Jl. Kanggraksan No. 23, Harjamukti, Harjamukti Subdistrict, Cirebon City, West Java

DOI: https://doi.org/10.31004/riggs.v4i4.5197

Field Data Analysis

There are three bends that match the planning criteria standards set by Road Geometric Design Guidelines No. 20/SE/Db/2021 for a planned speed of 90 kilometres/hour. The data used in this study includes primary and secondary data[23]

Table 1. LHR Data and General Characteristics of the Kanggraksan-Jendral Sudirman Road

Category of Vehicles	Configuration of Axes	Left direction	Right direction
(2) Light Vehicle	1,1	874	914
(5B) Large Bus	1,2	432	368
(6B) Two-Axle Truck	1,2	111	135
(7A2) Three-Axle Heavy Truck	1,22	87	76
(7A3) Three-Axle Heavy Truck	11,22	99	82
(7B1) Four-Axle Heavy Truck	1,2+2,2	47	67
(7C2A) Heavy Five-Axle Truck	1,22-22	16	9
Traffic growth before the road opened (%/year)		7	6
Planned speed (kilometres/hour)		90	
Planned service life of the pavement structure (years)		12	
CBR		6,5	
Rainfall (millimetres/year)		1900-2500	
Flatness (%)		3	
Adhesive Material		HRS-BC	
CTB		250	
LFA		Class A	
Lower Foundation Layer (LPB) Agregate		Class C	

Table 2. Road Planning Criteria Standards

Function of the road	Urban Localities
Road class	III A
Road maintenance authority	City road
Road type	Two lanes in each direction (2x2 lanes)
Plan speed	90 kilometres/hour
e maks (%)	8%
Lane width (metres)	4 metres
Shoulder width (metres)	2 metres
Distance of visibility (metres)	184,468 metres
Prepared visibility (metres)	628,256 metres
Maximum flatness (%)	3 %
Length of the road (metres)	2456,136 metres
Minimum radius R min (metres)	303,71 metres
Minimum transition curve length, Ls min	130,54 metres

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Bend Coordination

Existing image coordination data for Jalan Kanggraksan-Jendral Sudirman Elevation 0+00–2+456.06, which is divided into three bends (see images 4 to 6 below).

First bend

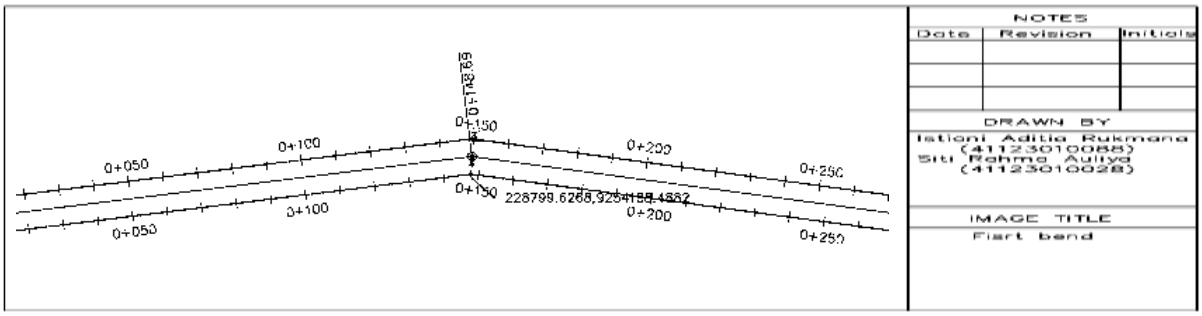

Fig 3. Coordination of Existing Alignment of Curve 1 (Elevation 0+00 to Elevation 0+250)

Second bend

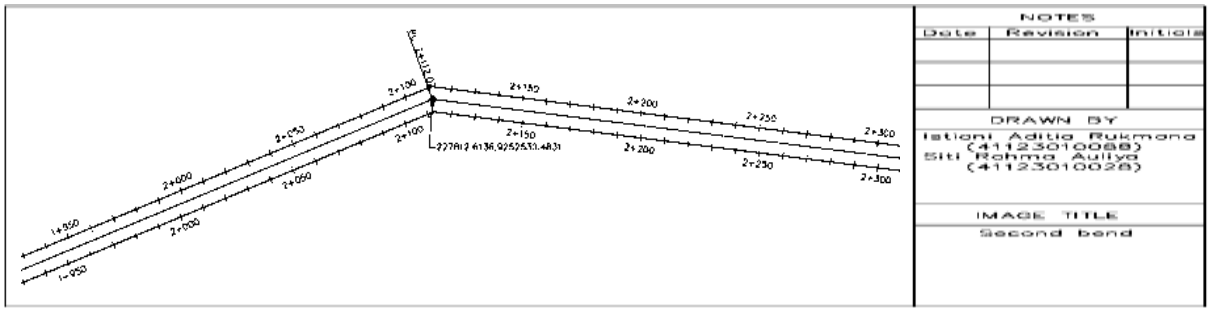

Fig 4. Coordination of Existing Alignment of Curve 2 (Elevation 0+250 to Elevation 0+450)

Third bend

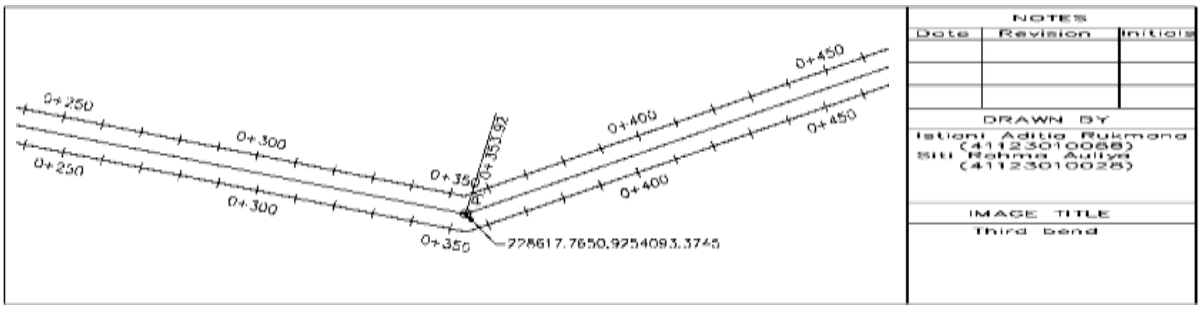

Fig 5. Coordination of Existing Alignment of Curve 3 (Elevation 1+950 to Elevation 2+300)

Overall, the projected future annual average daily traffic (AADT) can be seen in table 3.

Table 3. Design hour traffic flow

Category of Vehicles	LHR 2025		LHRTD 2037 (Vehicles/day)		(EMP)	LHRTD (passenger vehicle unit/day)	
	Left	Right	Left	Right		Left	Right
2	874	914	1968,42	1839,15	1,2	2362,10	2206,98
5B	432	368	972,95	740,49	1,2	1167,54	888,59

DOI: https://doi.org/10.31004/riggs.v4i4.5197

Category of Vehicles	LHR 2025		LHRTD 2037 (Vehicles/day)		(EMP)	LHRTD (passenger vehicle unit/day)	
	Left	Right	Left	Right		Left	Right
6B	111	135	249,99	271,65	1,6	399,99	434,63
7A2	87	76	195,94	152,93	1,6	313,51	244,68
7A3	99	82	222,97	165,00	1,6	356,75	264,00
7B1	47	67	105,85	134,82	1,6	169,36	215,71
7C2A	16	9	36,04	18,11	1,6	57,66	28,98
Amount	1666	1651	3752,15	3322,14		4826,90	4283,56
Total $LHRT_D$ 2037/day			7074,29			9110,46	
Total $LHRT_D$ 2037/day			294,76			379,60	

Horizontal Alignment

Based on the results of modeling and geometric analysis of the road using AutoCAD Civil 3D, the coordinates of each cross-section point of the road were obtained. This data was used to illustrate the existing profile in image 7[23]

Starting point

Fig 6. Existing road route

The calculations obtained for the horizontal alignment can be seen in table 4.

Table 4. Horizontal Bends

Number	Calculation	T1	T2	T3
1	Δ (˚)	14,64	35,13	29,26
2	V ((kilometres/hour)		90	
3	f max		0,130	
4	R minimum (metres)		303,71	
5	R (metres)		307	
6	D max (˚)		4,72	
7	FC method 1	Not F-C	Not F-C	Not F-C
8	FC method 2			
	a. dd (˚)	4,67	4,67	4,67
	b. ed (%)	7,78	7,78	7,78
9	FC method 3			
	a. Ls1 (metres)	75	75	75
	b. Ls2 (metres)	130,54	130,54	130,54
	c. Ls3 (metres)	42,86	42,86	42,86
	d. Ls used (metres)	130,54	130,54	130,54
10	P check	2,313	2,313	2,313
11	If it is not F-C			
	a. θs	12,18	12,18	12,18
	b. θc (˚)	-9,723	10,77	4,89
	c. Lc (metres)	-52,097	57,72	26,23

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Number	Calculation	T1	T2	T3
12	Check the type of bend	S-S Bend	S-C-S Bend	S-C-S Bend
	a. Xs	129,95	129,95	129,95
	b. Ys	9,25	9,25	9,25
	c. P	-13,21	-13,21	-13,21
	d. K	245,22	245,22	245,22
	e. Tt	282,96	338,23	321,91
	f. Et	-10,80	1,16	-3,37
	g. L total	261,08	318,80	287,31
13	widening of the bend	1,247	1,247	1,247
14	Stopping sight distance (J_{PH})	184,468	184,468	184,468
15	Line of sight precedes (J_{PM})	628,256	628,256	628,256

a. First bend

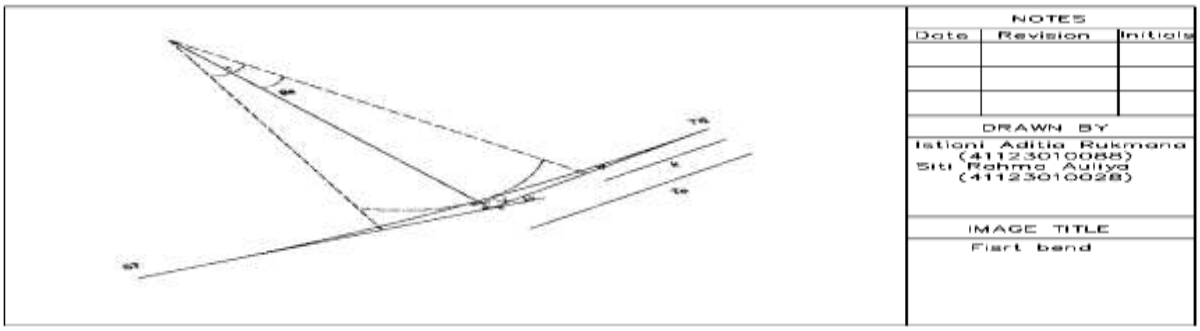

Fig 7. Spiral-Spiral (SS) Bend 1

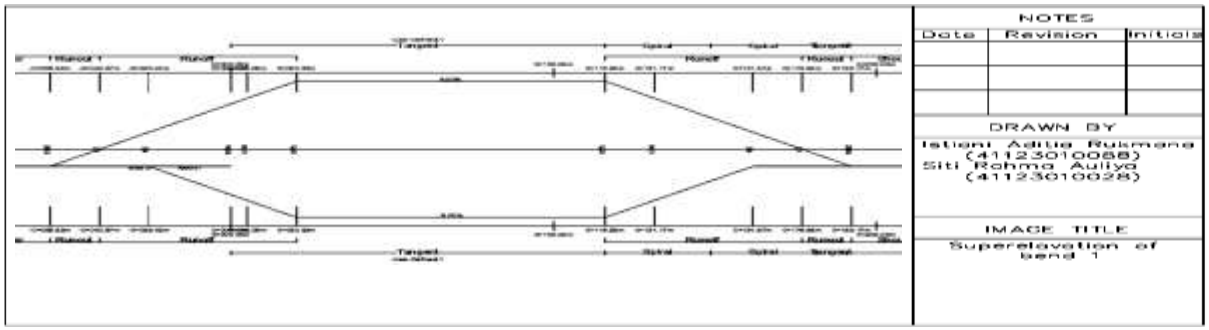

Fig 8. Superelevation of Bend 1

b. Second bend

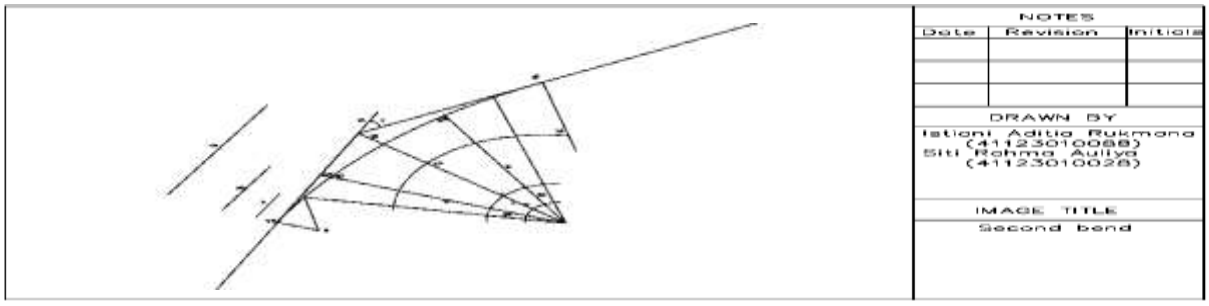

Fig 9. Spiral-Circle-Spiral (SCS) Bend 2

DOI: https://doi.org/10.31004/riggs.v4i4.5197

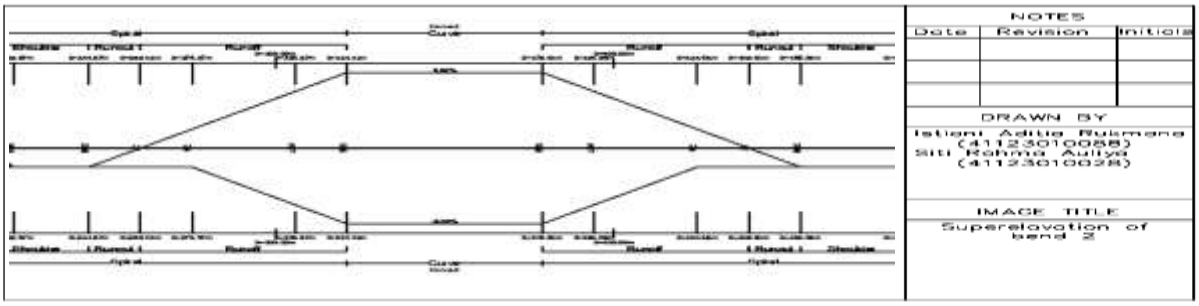

Fig 10. Superelevation of Bend 2

c. Third bend

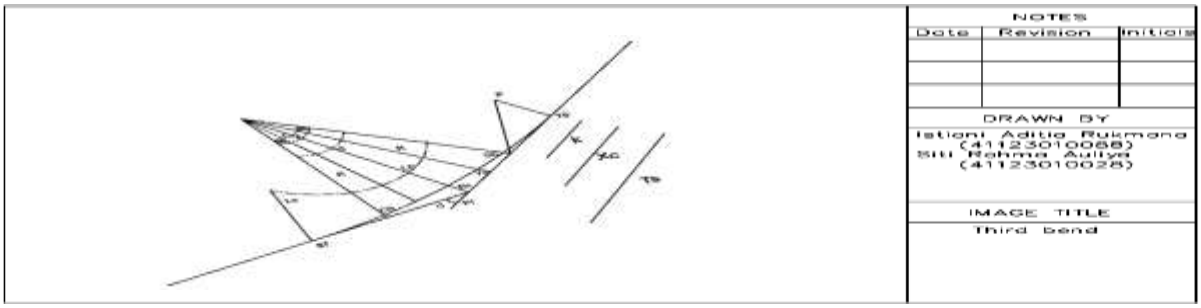

Fig 11. Spiral-Circle-Spiral (SCS) Bend 3

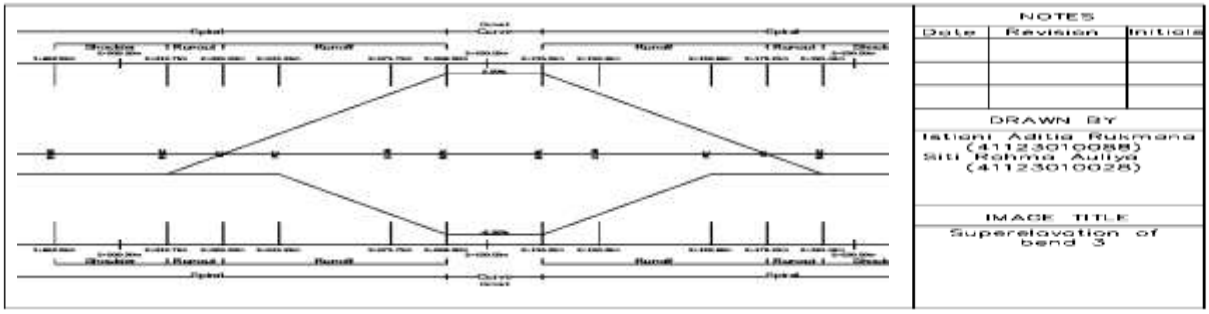

Fig 12. Superelevation of Bend 3

Vertikal Alignment

The planned road is an arterial road in a flat area with the following data and specifications:[23]

Table 5. Results of longitudinal slope calculations

Number	Point	STA	Elevation (metres)	Distance (metres)	Extended flatness (%)
1	A	0	14,166	0	0
2	PV1	148,69	15,227	148,77	0,714
3	PV2	353,92	16,691	205,23	0,713
4	PV3	2112,02	22,683	1758,10	0,341
5	B	2456,06	31,689	344,04	2,618

DOI: https://doi.org/10.31004/riggs.v4i4.5197

Table 6. Vertical Curve Recapitulation

Number	Calculation	T1	T2	T3
1	g1 (%)	0,7132	0,713	0,341
	g2 (%)	0,7133	0,341	2,618
	A (%)	-0,00014	0,373	-2,277
	Types of Curves	Concave (-)	Convex (+)	Convex (+)
2	Lv1 (metres)	54	54,000	54,000
	Lv2 (metres)	-0,0001	0,149	-0,911
	Lv3 (metres)	-0,0001	0,180	-1,101
	Lv4 (metres)	0,0000	0,077	-0,473
	Lv5 (metres)	54,0000	54,000	54,000
3	Ev	0,0000	0,025	-0,154
	X	13,5000	13,500	13,500
	Y	0,0000	0,101	-0,615
4	STA PLV1	121,6900	326,920	2085,020
	STA A1	135,1900	340,420	2098,520
	STA PPV1	148,6900	353,920	2112,020
	STA B1	162,1900	367,420	2125,520
	STA PTV1	203,1900	408,420	2166,520
5	Elevation PLV1	13,9734	16,498	13,481
	Elevation A1	14,0702	15,237	26,381
	Elevation PPV1	15,2270	16,716	22,529
	Elevation B1	15,3238	15,379	31,336
	Elevation PTV1	15,4196	16,783	23,390

Drainage Analysis

On the Kanggraksan–Jenderal Sudirman road section, land use is dominated by commercial areas in the city center with a high building density. Based on these conditions, a runoff coefficient (C) value of 0.95 was used, representative of commercial areas (urban areas) with a very high level of imperviousness.

The roughness coefficient value used is n = 0.025, in accordance with the type of rubble dry masonry channel surface, which has a rough texture and is unplastered.[24]

Excavation and Fill

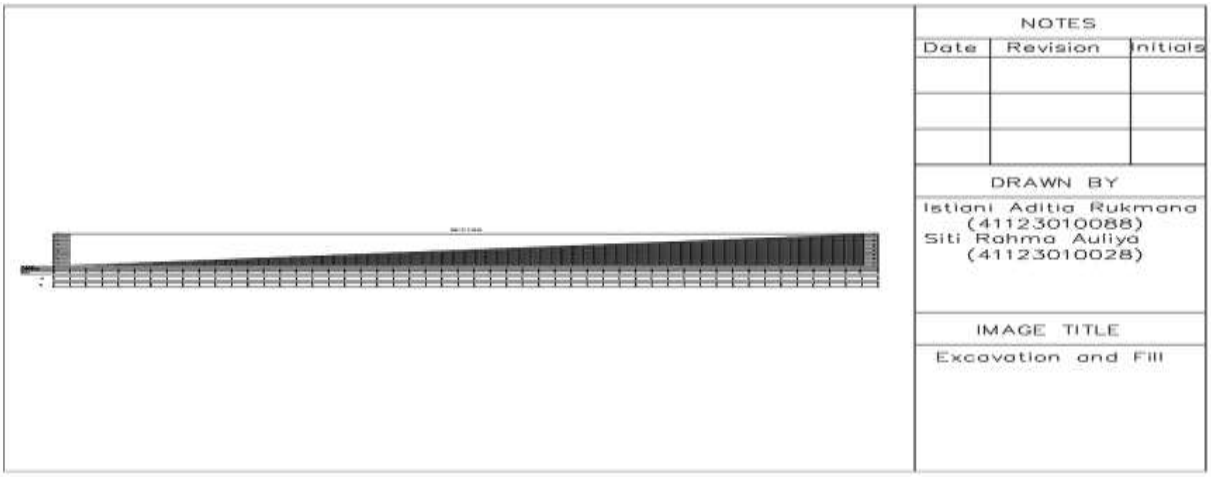

Fig 13. Excavation and Fill

DOI: https://doi.org/10.31004/riggs.v4i4.5197

For the mass diagram with elevation STA 0+00 to STA 2+456 as illustrated in image 15

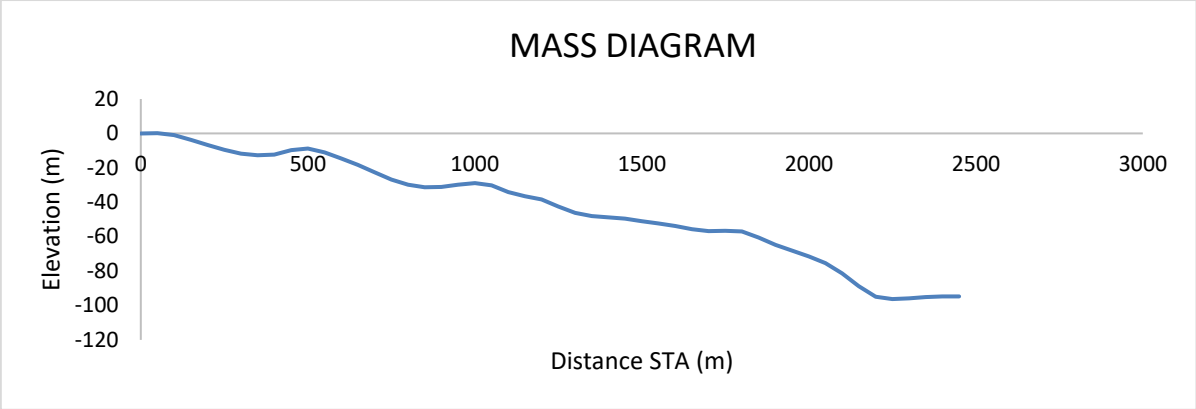

Fig 14. Mass Diagram with Elevation 0+00 to 2+456

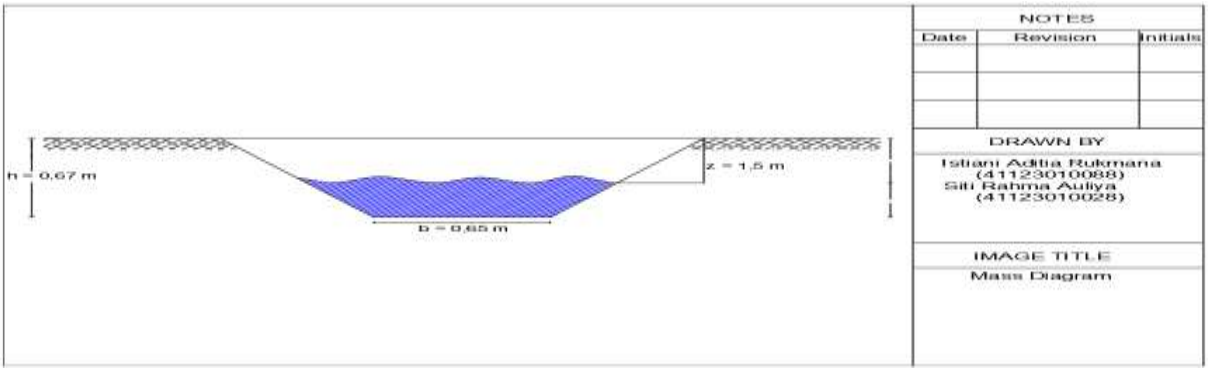

Fig 15. Mass Diagram

Pavement analysis

Pavement analysis is the process of planning road pavement structures, which includes determining the type of pavement and the thickness of each layer based on traffic loads, subgrade conditions, and planned service life.

Traffic Growth Rate

Research Location: Kanggraksan No. 23 is located in Harjamukti Subdistrict, Cirebon City, West Java.

With traffic growth (% year)
Left Direction = 7%
Right Direction = 6%

Distribution Direction and Distribution Factors

The planned road is classified as a four-lane road with two separate directions, resulting in a lane distribution factor of 0.8 [25].

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Traffic Calculation for Controlled Load Period in 2037

Table 7. LHR 2025 survey data based on vehicle class

Category of Vehicles	LHR 2025		LHR 2026		LHR 2029	
	Left	Right	Left	Right	Left	Right
2	874	914	935,18	968,84	1145,64	1153,90
5B	432	368	462,24	390,08	566,26	464,59
6B	111	135	118,77	143,1	145,50	170,43
7A2	87	76	93,09	80,56	114,04	95,95
7A3	99	82	105,93	86,92	129,77	103,52
7B1	47	67	50,29	71,02	61,61	84,59
7C2A	16	9	17,12	9,54	20,97	11,36

VDF 4		VDF 5		DD	DL	R			
Factual	Normal	Factual	Normal			2026-2029 (3 years) (Left)	2026-2029 (3 years) (right)	2029-2037 (9 years) (Left)	2029-2037 (9 years) (right)
-	-	-	-						
1,2	1,2	1,3	1,3						
3,8	0,8	5,5	0,7						
16,3	4,6	33,6	6,3	0,5	0,8	3,21	3,18	11,98	11,49
-	-	-	-						
-	-	-	-						
12,8	6,6	21,5	8,6						

CES A4				CES A5			
Factual 2026-2029 (left)	Factual 2026-2029 (right)	Normal 2029-2037 (left)	Normal 2029-2037 (right)	Factual 2026-2029 (left)	Factual 2026-2029 (right)	Normal 2029-2037 (left)	Normal 2029-2037 (right)
-	-	-	-	-	-	-	-
260356,90	217573,64	1188329,45	935352,15	282053,31	235704,78	1287356,9	1013298,16
211841,32	252751,99	203556,434	228754,60	306612,44	365825,25	178111,879	200160,28
712214,74	610349,25	917379,332	740487,12	1468123,64	1258143,23	1256410,82	1014145,40
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
102857,05	56758,34	242067,11	125815,03	172767,70	95336,28	315420,78	163940,80
2424703,23		4581741,23		4184566,63		5428845,02	
7006444,46				9613411,65			

Types of Road Pavement

The determination of the type and composition of layers refers to the provisions for road pavement (see image 17).

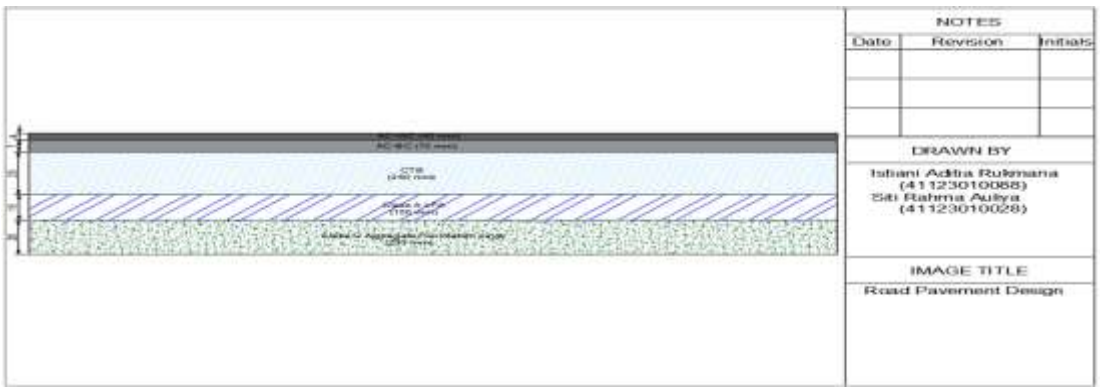

Fig 16. Road pavement design

DOI: https://doi.org/10.31004/riggs.v4i4.5197

4. Conclusion

Based on the results of geometric, pavement, and drainage analyses on the Kanggraksan–Jenderal Sudirman Road section STA 0+000–STA 2+456 (±2.5 km), it can be concluded that the geometric conditions of the road generally meet the Bina Marga planning standards, but adjustments are still needed on some bends and superelevations to improve safety. With a subgrade CBR value of 6.5 and a design life of 12 years, the recommended pavement structure is assessed to be capable of supporting fairly high traffic loads, and the resulting cost estimates can serve as a basis for effective and sustainable road rehabilitation planning in the city of Cirebon.

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DOI: https://doi.org/10.31004/riggs.v4i4.5197