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Road Geometry Analysis on Jl. Nyi Ageng Serang, Sindangjawa, Dukupuntang District, Cirebon Regency, West Java STA 0+000 – STA 2+000

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Abstract

Nyi Ageng Serang Road is an important access road connecting several areas in Cirebon Regency. This study aims to analyze the suitability of the horizontal and vertical geometric elements of Nyi Ageng Serang Road, particularly in the segment from STA 0+000 to STA 2+000, against the applicable road planning standards, namely Regulation of the Minister of Public Works No. 19/PRT/M/2011 concerning Technical Requirements for Roads and Technical Planning for Roads. The research method used was a direct survey in the field to obtain primary data in the form of horizontal curve data, vertical slope, and other existing road geometric conditions. In addition, secondary data was obtained through literature studies and relevant supporting technical documents. The analysis was conducted by comparing existing geometric parameters, such as curve radius, transition curve length, maximum slope, and stopping sight distance, with applicable road technical standards, taking into account the planned speed according to road classification. The analysis results showed that several geometric elements on the road section from STA 0+000 to STA 2+000 did not fully meet planning standards. The discrepancies found include horizontal curve radii that are smaller than the minimum requirements, the presence of inadequate transition curves, and vertical gradients that exceed the maximum limits. These conditions have the potential to reduce the safety, comfort, and efficiency of road users' journeys. These findings are expected to form the basis for recommendations for road improvements in the future.

Keywords: Road Geometry, Horizontal Curves, Vertical Gradient, Stopping Sight Distance, Road Planning Standards

Introduction

Road infrastructure is an important component of national development because it serves as a link between regions, supports community mobility, and facilitates the distribution of goods and services. Adequate roads play a role in improving connectivity, economic growth, and the smooth running of social and economic activities [1], [2], [3], [4]. However, problems such as road damage, limited construction quality, and lack of maintenance still occur frequently, reducing road performance [5], [6], [7], [8], [9].

Therefore, road infrastructure planning and maintenance must be carried out thoroughly, taking into account technical, environmental, and community needs. The number of motor vehicles in Indonesia continues to increase, causing various problems, especially in urban areas. In 2024, the number of vehicles will reach around 164 million units, with motorcycles dominating. This condition causes congestion, decreased transportation efficiency, increased air pollution, and a high number of traffic accidents [10], [11], [12], [13], [14]. In addition, the burden on road infrastructure is increasing, accelerating damage and increasing maintenance costs [15], [16], [17], [18].

This study aims to evaluate road geometric conditions based on the Road Geometric Design Guidelines. Primary data was obtained through geometric profile measurements and road damage conditions, while secondary data in

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the form of road maps was obtained from Google Earth [19], [20], [21]. Observations on the $\pm 3,500$ m section of Nyi Ageng Serang Road, Cirebon Regency, show that there are three main bends. The objectives of this study are to evaluate the geometric condition of the section of Jl. Nyi Ageng Serang, Sindangjawa, Kec. Dukupuntang, Cirebon Regency STA 0+000 – STA 2+000 and to design the geometry of the Nyi Ageng Serang Road section, Sindangjawa, Dukupuntang District, Cirebon Regency, STA 0+000 – STA 2+000.

Research methodology

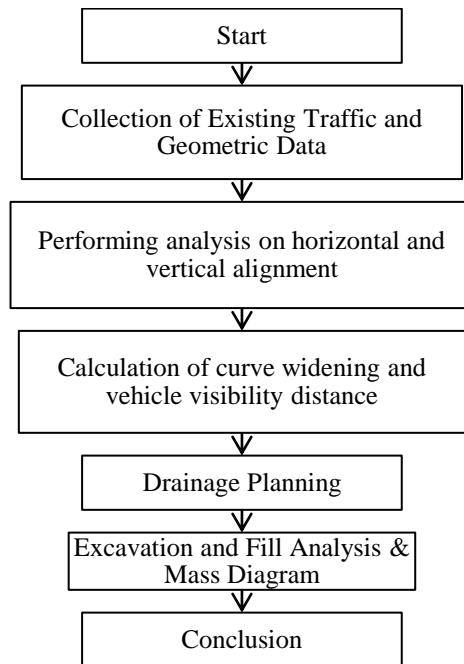


Figure 1. Flow Chart

Results and Discussion

Research Location

The research location is Jalan Nyi Ageng Serang, Sindangjawa, Dukupuntang District, Cirebon Regency, with the study area limited to STA 0+000 to STA 2+000.



Figure 2. Research Location Map

Field data analysis

There are four curves that meet the planning criteria set by Road Geometric Design Guidelines No. 20/SE/Db/2021 for a design speed of 60 km/h. The data used in this study includes primary and secondary data. The primary data obtained is in the form of traffic survey results that record the number of vehicles based on traffic class and direction, while secondary data includes traffic growth, design speed, pavement design life, CBR value, rainfall, slope, and type of road pavement material [22], [23], [24], [25].

Table 1. Field data

Vehicle Class	Axis Configuration	Left Direction	Right Direction
(2) Light Vehicles	1,1	874	914
(5B) Large Bus	1,2	432	368
(6B) 2-Axle Truck	1,2	111	135
(7A2) Heavy 3-Axle Truck	1,22	87	76
(7A3) Heavy 3-Axle Truck	11,22	99	82
(7B1) Heavy 4-Axle Truck	1,2+2,2	47	67
(7C2A) 5-Axle Heavy Truck	1,22-22	16	9
Traffic growth before the road opened (%/year)		8	4

Planned Speed (km/h)	60
Planned service life of paved structures (years)	10
CBR	7
Rainfall (mm/year)	1900-2500
Flatness (%)	3
Binding Material	HRS-WC
CTB	150
LFA	Class B
Lower Foundation Layer (LPB) Aggregate	Class B

Road Function	Primary Local
Street Class	II
Road Maintenance Authority	Provincial Road
Road Type	Two undivided lanes (2/2 TT)
Planned Speed	60 km/h

e max (%)	8 %
Lane Width	5,2 m
Shoulder width	2 m
Stopping Distance	85,39 m
Visibility Preparing	342,73 m
Maximum Slope	3 %
Minimum Radius R min	123,24 m
Minimum transition curve length, Ls min	26,19 m

Geometric analysis of roads

Jalan Nyi Ageng Serang, Sindangjawa, Dukupuntang District, Cirebon Regency, with the study limited to STA 0+000 to STA 2+000.

Turn 1

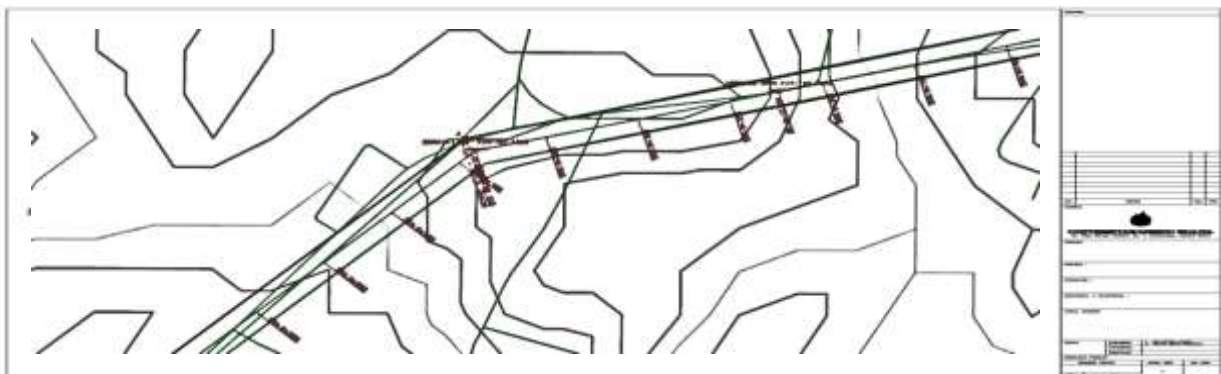


Figure 3. Geometric analysis of curve 1

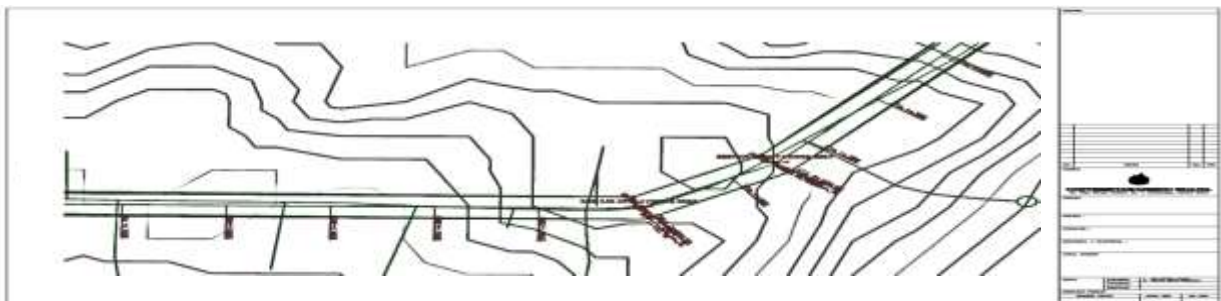


Figure 4. Geometric analysis of curve 2

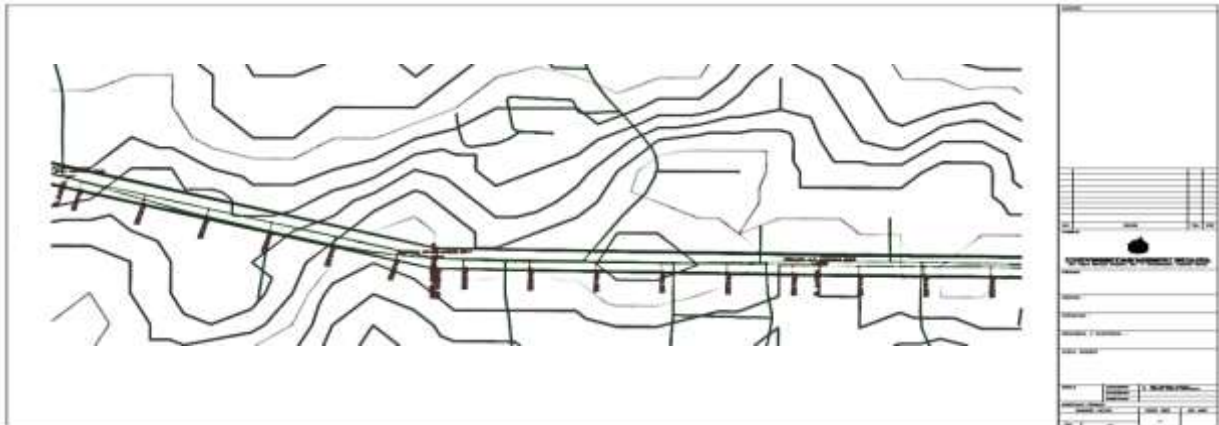


Figure 5. Geometric analysis of curve 3

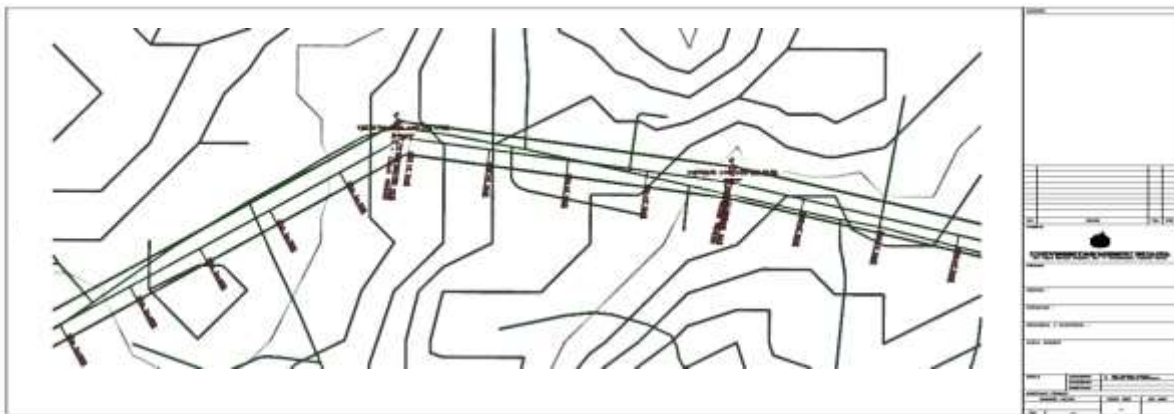


Figure 6. Geometric analysis of curve 4

Horizontal alignment analysis

Traffic data:

LHR 2025: 3596.8 vehicles/day (left), 2443.9 vehicles/day (right)

LHRT design projection 664.47 SMP/day.

Curves:

Curve 1: $\Delta = 34.138$, $R = 103.5604245$

Curve 2: $\Delta = 14.208$, $R = 103.5604245$

Curve 3: $\Delta = 12.865$, $R = 103.5604245$

Turn 4: $\Delta = 42.473$, $R = 103.5604245$

Turn type: SCS (Spiral-Circle-Spiral)

Stopping sight distance (Jph): 85.39472194

Preparing sight distance (jd): 342.7381

Vertical alignment analysis

Based on data from research conducted through calculations, the location is on flat terrain. From the results obtained on the existing vertical alignment:

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Point PV1:

- $G1 = 3,33\%$, $G2 = 0\%$, $A = 80,27$
- $Lv = 33$, $Ev = 0,137$

Table 2. Horizontal Alignment

SUMMARY TABLE OF TURN CALCULATION RESULTS						
No	Calculation	T1	T2	T3	T4	T5
1	$\Delta(^{\circ})$	34,13	14,20	35,93	12,86	42,47
2	V Plan (km/h)	60	60	60	60	60
3	V Average (km/h)	55	55	55	55	55
4	f max	0,15	0,15	0,15	0,15	0,15
5	R min	123,24	123,24	123,24	123,24	123,24
6	R	103,56	103,56	103,56	103,56	103,56
7	D max	11,62	11,62	11,62	11,62	11,62
8	FC method 1	Not F-C	Not F-C	Not F-C	Not F-C	Not F-C
9	FC method 2					
	a. dd	13,83	13,83	13,83	13,83	13,83
	b. ed	0,08	0,08	0,08	0,08	0,08
10	FC method 3					
	a. Ls 1	45,83	45,83	45,83	45,83	45,83
	b. Ls 2	58,36325	58,36325	58,36325	58,36325	58,36325
	c. Ls 3	26,19	26,19	26,19	26,19	26,19
	d. Used LS	58,36325	58,36325	58,36325	58,36325	58,36325
11	P check	1,37	1,37	1,37	1,37	1,37
	If not F-C					
	θ_s	16,14	16,14	16,14	16,14	16,14
	θ_c	1,848	-18,081	3,64	-19,42	10,182
	Lc	3,340	-32,682	6,587	-35,109	18,4

12	Check the type of turn	S-C-S	S-C-S	S-C-S	S-C-S	S-C-S
	a. Xs	57,89	57,89	57,89	57,89	57,89
	b. Ys	5,48	5,48	5,48	5,48	5,48
	c. P	1,39	1,39	1,39	1,39	1,39
	d. K	29,10	29,10	29,10	29,10	29,10
	e. Tt	220,44	147,55	229,65	143,95	269,30
	f. Et	-114,44	-107,95	-115,24	-107,65	-118,50
	g. L Total	120,06	84,04	123,31	81,61	135,13
13	Curve Widening	1,65	1,65	1,65	1,65	1,65
14	Stopping distance	85,39	85,39	85,39	85,39	85,39
15	Forward visibility (JPM)	342,73	342,73	342,73	342,73	342,73

Table 3. Vertical Alignment

No	Calculation	T1	T2	T3	T4	T5
1	g1 (%)	0,0333	0	0,0467	0,06	0,0181
	g2 (%)	0	0,0467	0,06	0,0181	0
	A (%)	0,0333	0,0467	0,06	0,0419	0,0181
	Types of Turns	Concave (+)	Convex (+)	Convex (+)	Convex (+)	Convex (+)
2	Lv1 (m)	33	33	33	33	33
	Lv2 (m)	1,332	1,868	0,532	1,676	0,724
	Lv3 (m)	2,442E-08	3,4306E-08	9,7704E-09	3,0780E-08	1,3296E-08
	Lv4 (m)	0,2582884	0,36222435	0,10316025	0,32499359	0,14039102
	Lv5 (m)	33	33	33	33	33
3	Ev	0,1373625	0,1926375	0,0548625	0,1728375	0,0746625
	X	8,25	8,25	8,25	8,25	8,25
	Y	0,54945	0,77055	0,21945	0,69135	0,29865
4	STA PLV1	470	965	1425	1910	2405
	STA A1	453,5	948,5	1408,5	1893,5	2388,5
	STA PPV1	461,75	956,75	1416,75	1901,75	2396,75
	STA B1	470	965	1425	1910	2405
	STA PTV1	478,25	973,25	1433,25	1918,25	2413,25

No	Calculation	T1	T2	T3	T4	T5
5	Elevation PLV1	79,45055	80	180,22945	180,01	195,70135
	Elevasi A1	80,274725	80,77055	180,834175	181,19635	196,149325
	Elevation PPV1	79,8626375	79,8073625	180,9451375	180,8271625	195,9253375
	Elevation B1	80,54945	81,155825	181,71445	181,840675	196,29865
	Elevation PTV1	80	80,77055	181,99	181,29865	196

Drainage analysis

Case study

Primary Local Road Project along a 2 km stretch. With horizontal and vertical alignment plans, the following data was obtained:

- Average longitudinal slope: 3%
- Pavement width: 10 m (2 lanes on the right and left)
- Local drainage area coefficient (C_{weight}) = 0.5 (hilly)
- IDF data: F = 10 years, I = 1900 – 2500 mm/year.
- Channel Material: concrete pipe channel (n : 0.025)

Drainage Design

- Rainfall data conversion (I)

I = 1900 – 2500 mm/year → Convert to mm/hour. (take the largest value, which is 2500 mm/year)

$$I = 2500 / (24 \times 365)$$

$$I = 0.285 \text{ mm/hour}$$

- Calculate the Cross-sectional Area of the Drainage Trapezoid (A):

For the initial drainage cross-section design, the following assumptions were used:

- B (Channel width) = 1 m
- H (Channel height) = 0.5 m
- Z (Channel slope) = 0.5

Calculate the area of the channel (A) :

$$A = (B + ZH) \cdot H$$

$$A = (1 + (0,5 \times 0,5)) \times 0,5$$

$$A = 1,125 \text{ m}^2$$

- Calculate debit Q :

$$Q = \frac{1}{3,6} \times C \times I \times A$$

$$= \frac{1}{3,6} \times 0,5 \times 0,285 \times 4$$

$$= 0,16 \text{ m}^3/\text{s}$$

- Calculate the speed (V) :

$$V = \frac{Q}{A}$$

$$= \frac{0,16}{1,125}$$

$$= 0,1422 \text{ m/s}$$

(because the velocity is greater than $0.6 < 1$, the soil is not sedimented). Therefore, the trapezoidal drainage design is sufficient.

e. Calculate the threshold height (*Free Board*) :

$$W = \sqrt{0,5 \times h}$$
$$W = \sqrt{0,5 \times 0,5}$$
$$W = 0,5 \text{ m}$$

Because the threshold height is greater than 15 cm ($15 \text{ cm} < 50 \text{ cm}$). So, the total depth of the channel $h + w$ ($0.5 \text{ m} + 0.5 \text{ m}$) is 1 m.

f. Illustration of water drainage

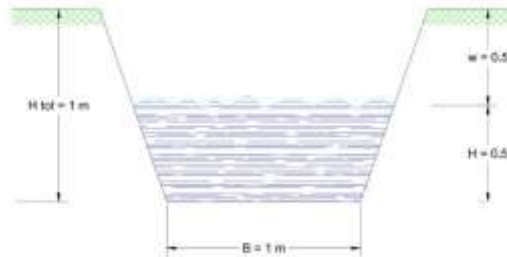


Figure 7. Drainage Design

Mass diagram

A mass diagram is a graph showing the relationship between distance and cumulative volume of soil cut and fill along an earthwork route.

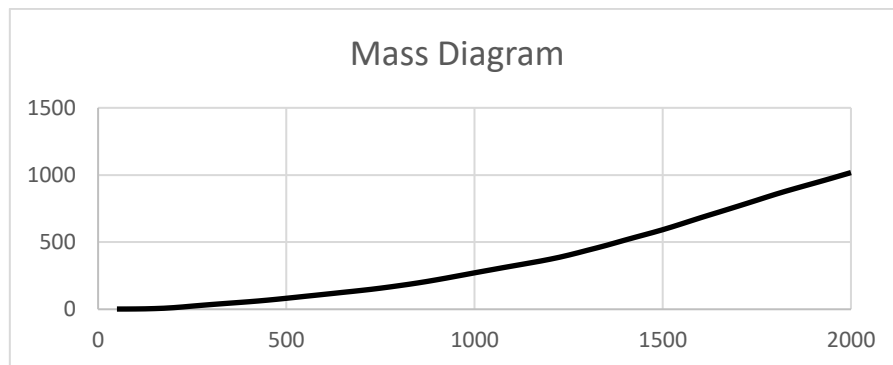


Figure 8. Graph of Mass diagram

Conclusion

Based on the results of the geometric design study of the ± 3.55 km Nyi Ageng Serang Road, the road section is classified as flat terrain with fairly heavy traffic, requiring evaluation of the horizontal and vertical alignment and drainage system. The analysis results show that all curves are of the Spiral–Circle–Spiral (S-C-S) type due to a Pcek value > 0.25 and the need for pavement widening. The stopping and overtaking sight distances meet the 2024 Bina Marga safety standards. The vertical alignment also meets the requirements for slope, comfort, and drainage with an optimal curve length of 33 meters. The trapezoidal drainage system can accommodate runoff flow stably without causing sedimentation. Overall, the road geometry and drainage planning meet technical standards and have the potential to improve safety, road service, and structural durability in the long term.

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