

ROAD GEOMETRIC ANALYSIS: CASE STUDY OF ROAD PANGKALAN PARI - KERTICALA

Kamaludin¹, Indrastuti²

¹Civil Engineering, Faculty of Engineering, University of Majalengka, Indonesia

²Civil Engineering, Faculty of Engineering and Planning, Batam International University

Correspondence email: kamaldanu920@gmail.com

ARTICLE INFO

ABSTRACT

Keywords:

Horizontal Alignment, Bends, Road Geometry

In order to facilitate the movement of people from the place of origin to the place of destination, adequate transportation facilities must be fulfilled, both land, sea and air. In general, land dominates more to support these activities, such as railroads, which are one of them. The existence of this journal is to analyze the horizontal alignment of the 9.4 km long pari-kertical road section. At coordinate point $X = 200180.40$; $Y = 9239557.46$ and ends at coordinates $X = 201072.18$; $Y = 9239177.37$. From the results of the calculation of the horizontal alignment of the existing field data at a bend with a speed $VR = 60$ km/hour, the radius at the bend is $Rc = 716$ m, the value for Ls (transition curve) = 50 m, $Ts = 621.76$.

1. Introduction

The road is one type of transportation infrastructure on land which is related to all aspects of the existing parts that are part of that infrastructure (Rokhman, 2022). The success of transportation is greatly influenced by the availability of transportation facilities and infrastructure itself. The road is one part that is closely related to transportation which is a necessity in today's development (Frans, 2020).

A highway is defined as a path that is at ground level. Infrastructure made with geometric, certain shapes and sizes, with different types of construction. The purpose of building this road infrastructure is so that it can be used as a means of transportation to channel the distribution and traffic of people and goods from one region to another quickly (Rokhman, 2022). To build new roads or upgrades, a planning method that is in accordance with Highways is required (Mahmud, 2021). Road geometry is a highway structure that describes the shape or size of the highway both in terms of cross section, length, and other aspects related to the physical shape of the road. This greatly supports comfort and safety in driving. (Kaharu, 2020). According to Dewi and Amrita Winaya Shinta (2009), the geometric analysis of the road in terms of pavement widening at bends uses a method originating from Geometric Design For Highway and Streets-American Association of State Highway and Transportation Officials (AASHTO) (Lubis, 2019). The increase in traffic flow in Indonesia is caused by economic growth that continues to develop following the government's plan. Therefore, so that an increase in traffic flow does not become a problem in the future, facilities and infrastructure are needed that collect it so that the distribution of goods and Inter-regional services run smoothly. Road construction in developing countries aims to connect isolated areas and promote economic growth through better population mobility (Salsabila, 2022). In Indramayu itself, especially the Jatibarang-Kadipaten road section where the road connects the two regencies, this road section is used by many types of vehicles, both public and private vehicles. In addition, many large vehicles pass this road, especially on during the day with a large load, many public vehicles also pass through this section, not only vehicles with a small capacity such as public

transportation and elves, but public vehicles with a large capacity, namely buses, pass through this section. Transportation policy in increasing the efficiency and effectiveness of the use of traffic space and controlling traffic movement is carried out through traffic demand management based on criteria for comparing the volume of motorized vehicle traffic with road capacity, the availability of public transport networks and services and the general environment (Al Qurni, 2019). research needs to be done with another approach, which is called the proactive approach (Fitra, 2020).

The existence of this journal is to analyze the geometric of the road consisting of horizontal alignment and vertical alignment to facilitate access besides that vehicles that comply with Highways guidelines are safe for road users (Artiwi, 2023) crossing the Jatibarang-Kadipaten road section, especially starting from Pangkalanpari Village, Kec. Jatiseven District, Majalengka to Kerticala Village, Kec. Tukdana Kab.Indramayu It is planned to add land transportation facilities and connect between these regions. (Ulchurriyyah, 2022).

2. Literature Review

2.1 road

Highways are an infrastructure consisting of buildings and auxiliary designs for the maintenance of traffic and subsurface and water (Setyawan, 2021). Highways have an important role as a means of transportation in various community activities in urban and rural areas. In addition, roads have an important impact as infrastructure for the movement of people and goods (Dong, 2019). Transportation is a support for human activities to carry out activities (in whatever form) social, cultural, office, educational and all parameters that trigger the movement of people which are generally facilitated by transportation, in this case vehicles and their facilities. These two things are an inseparable unit . (Masitoh, 2020). Transportation between regions is inseparable from the development infrastructure of a country, one of which is the highway. Governments worldwide are increasingly prioritizing infrastructure expenditures, particularly for the construction and maintenance of highways (Castañeda, 2022). Highways can guarantee user comfort and safety, enable efficient traffic operations and at the same time, attract construction and maintenance costs to a minimum (Rizki, 2022).

2.2 Road Geometry

A geometric road is a road body building above the ground level vertically and horizontally assuming the ground surface is uneven. Geometric planning is very important in designing new alignments on roads following current trends (Sukalkar, 2022), Road geometrics also has an essential role as a factor causing accidents. The leading causes of death and injury in the United States are caused by motor vehicle accidents, resulting in enormous socioeconomic losses (Milton, 2021).

Road Geometric Design is a physical road design that produces road cross-sections and dimensions, vertical and horizontal paragraphs (Agniya, 2022). The geometric planning process for this road includes analysis and calculations. Efforts made by highway planners include making alignments and plotting road profiles consisting of coordinates and elevation, horizontal curve radius, vertical curve length, calculation of visibility distance and calculation of earthwork quantity, as well as various calculations and analysis planned for alignment. optimally while meeting design standards and limitations (Gaikawad, 2020).

2.3 Horizontal Alignment

Horizontal alignment is the projection of the road axis on the horizontal plane. Horizontal alignment is also known as "road situation". Horizontal alignment consists of straight lines connected by curved lines. The curved lines may consist of circular arcs plus intermediate arcs, only transitional arcs or only circular arcs (Rambitan, 2022).

Horizontal alignment is generally a series of straight and curved parts in the form of circular arcs, and which are connected by transitional curves or without transitional curves. The speed of the vehicle

used by the driver to walk on the road is influenced primarily by the driver's perception of the Horizontal Alignment feature in addition to features of other road elements such as speed limit signs. Based on this fact, if the direction of the alignment design track has to be changed for some reason or because it adjusts to the topographical conditions, a horizontal curve is used. The radius of bend must be large enough to permit the same travel speed on the curve as on the straight section or along the section of road being designed.

3. Method

In this study, the dependent variable (y) is the radius of the bend which is quite sharp and the independent variable (x) is Horizontal Alignment and Vertical Alignment. The method used in this data analysis is using quantitative methods . (Rochmanto, 2019).The process of systematic scientific research must begin with the identification of a proper problem (Rifai, 2016).

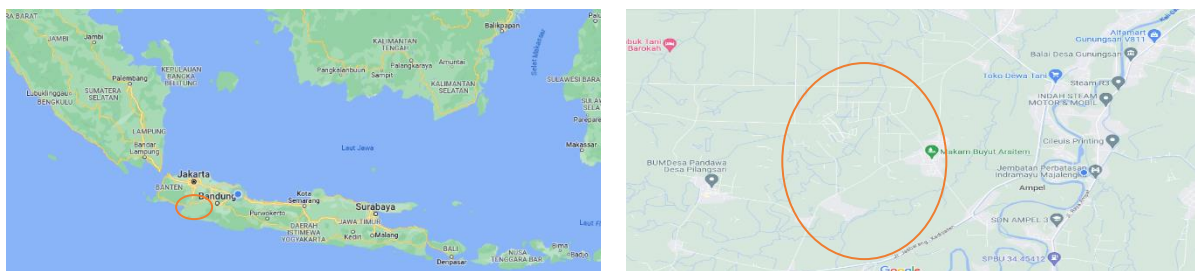


Figure 4 . Research sites

4. Result and discuss

To avoid accidents, for a certain speed, the minimum radius for the maximum superelevation and the maximum friction coefficient can be calculated . The following is the formula based on the regulations of the Director General of Highways.

$$F_{max} = -0.00065 * V_R + 0.192$$

(For $V_R < 80$ Km/Hour)

$$F_{max} = -0.00125 * V_R + 0.240$$

(For $V_R 80 - 112$ Km/Hour)

$$R_{max} = \frac{V_R^2}{127 (e_{max} + F_{max})}$$

$$D_{max} = \frac{181913,53 (e_{max} + f_{max})}{V_R^2}$$

a. coordinate point

Table 1 . Coordinate point.

Point	X	Y
A	200180,40	9239557,46
P1	200570,90	9239171,04
P2	200921,67	9239212,46
B	201072,18	9239177,37

b. Distance Between Points

Table 2 . Calculation of the distance between points

Point	Coordinate		d(mm)
	X	Y	
A	200180.40	9239557.46	
			549,44
P1	200570.99	9239171.04	
			353.07
P2	200921.67	9239212.06	
			154,46
B	201072.18	9239177.37	
Long distance from A - B (m)			1056.96
Long distance from A - B (km)			1,1

c. Azimuth

Table 3 . Azimuth

Point	Coordinate		α (°)
	X	Y	
A	200180.40	9239557.46	
			135
P1	200570.99	9239171.04	
			263,1
P2	200921.67	9239212.06	
			282.98
B	201072.18	9239177.37	

d. Bend Angle

Table 4. Bend Angle

No	α (°)	Δ (°)	Point
1	135	41.9	P1

4.1 Count

Specifies F_{max} for $e_{max} = 10\%$
 $F_{max} = -0.00065 * V_R + 0.192$
 $= -0.00065 * 60 + 0.192$
 $= 0.153$

Specifies the minimum radius value

$$R_{min} = \frac{VR^2}{127 (e_{max} + F_{max})}$$

$$R_{min} = \frac{60^2}{127 (0,1 + 0,153)}$$

$$= 112.04 \text{ m}$$

Determines the maximum degree of bend value

$$D_{max} = \frac{181913,53 (e_{max} + f_{max})}{VR^2}$$

$$D_{max} = \frac{181913,53 (0,1 + 0,153)}{60^2}$$

$$= 12.78$$

Full Circle Type Bend

Design radius (Rd) = 716 m > R_{min} (112.04 m) for a speed of (C) 60 Km/hour according to geometric planning procedures for inter-city roads no 038/TBM/1997, minimum radius R_{min} for a full circle bend = 60m > design radius (Rd).

Determine the transition arc length (L_s)

- Based on the maximum travel time (3 seconds)

$$L_s = \frac{Vr}{3,6} \times t$$

$$L_s = \frac{60}{3,6} \times 3$$

$$L_s = 50\text{m}$$

- Based on the modified short formula

$$L_s = 0.022 \frac{VR^3}{Rd \cdot c} - 2,727 \frac{VR \cdot e}{c}$$

$$= 0.022 \frac{60^3}{716 \cdot 0,4} - 2,727 \frac{60 \cdot 0,029}{0,4}$$

$$= 0.022(754.19) - 2.727(4.35)$$

$$= 4.73 \text{ m}$$

- Based on the achievement level of the vehicle change

$$l_s = \frac{em - en}{3,6 \cdot re} \times V_R$$

Where re = level of achievement of changes in the transverse road slope.

For $V_R \leq 70$ km/h, $re = 0.035$ m/s

$$l_s = \frac{em - en}{3,6 \cdot re} \times V_R$$

$$L_s = \frac{0,1 - 0,02}{3,6 \cdot 0,035} \times 60$$

$$= 38.10$$

$$L_{stabel} = 40$$

, the greatest transition curve () is taken = $50L_s$

$$TC = RD \times \tan\left(\frac{1}{2}\Delta\right)$$

$$= 716 \times \tan\left(\frac{1}{2} 45^\circ\right)$$

$$= 296.58 \text{ m}$$

$$\begin{aligned}
 E_c &= T_c \times \tan\left(\frac{1}{4}\Delta\right) \\
 &= 58.99 \text{ m} \\
 L_c &= \frac{\Delta \cdot 2 \cdot \pi \cdot R_d}{360^\circ} \\
 &= \frac{45 \cdot 2 \cdot 3,14 \cdot 716}{360} \\
 &= 562.06 \text{ m} \\
 Y &= \left(\frac{e_{max} + e_n}{L_s} \times \frac{2}{3L_s}\right) - e_n \\
 &= \left(\frac{0,029 + 0,02}{50} \times \frac{2}{3 \cdot 50}\right) - 0.02 \\
 &= 0.00127 = 1.27\% \\
 e_{Tc} &= 2.9\% - 1.27\% \\
 &= 1.63\%
 \end{aligned}$$

5. Conclusion

From the results of the geometric analysis of the pari-kertical base road section that has been carried out, several conclusions can be drawn, including having a 9.4 km alignment. For horizontal alignment, there are two bends, namely full circle and spiral circle spiral. It also has the largest superelevation number at the second corner (full circle), which is 1.63%. From the results of the calculation of the horizontal alignment of the existing field data at the bend with a speed VR = 60 km/h, the radius at the bend Rc = 716 m, the value of Ls (transition curve) = 50 m, Ts = 621.76 is obtained.

References

- Rokhman, A. P. (2022). Analisis Ruas Jalan Nasional Klari Kabupaten Karawang Menggunakan Metode MKJI 1997. In *FORUM MEKANIKA (Vol. 11, No. 1)*, 1-10 .
- Frans, J. H. (2020). Analisis Geometrik Jalan Dengan Civil 3D Dan Sig Pada Universitas Nusa Cendana. *Jurnal Teknik Sipil, 9(1)*, 41-54.
- Mahmud, S. D. (2021). Analisis Kondisi Geometrik Jalan terhadap Tingkat Kecelakaan (Studi Kasus: Jalan Lintas Sumatera Desa Tarahan, Katibung, Lampung Selatan). *Jurnal Komposit: Jurnal Ilmu-ilmu Teknik Sipil, 5(2)*, 47-53.
- Kaharu, F. L. (2020). Evaluasi geometrik jalan pada ruas jalan trans sulawesi Manado-Gorontalo di desa Botumoputi sepanjang 3 km. *Jurnal Sipil Statik, 8(3)*., 353-354.
- Lubis, M. R. (2019). Evaluasi geometrik jalan pada tikungan Laowomaru. In *Seminar Nasional Teknik (SEMNASTEK) UISU (Vol. 2, No. 1)* , 37-43.
- Salsabila, V. F. (2022). The Geometric Design of Horizontal Curved on Jalan Drono–Nganom, Wonogiri Using Autocad® Civil 3D. *ndonesian Journal of Multidisciplinary Science*, 304-317.
- Al Qurni, I. (2019). Analisis Daerah Rawan Kecelakaan Lalu Lintas (Studi Kasus Jalan Nasional Arteri Primer Dan Arteri Sekunder Kabupaten Kendal). *Jurnal Geografi: Media Informasi Pengembangan Dan Profesi Kegeografian, 13(1)*, 52-60.

- Fitra, A. M. (2020). Analisis Uji Laik Fungsi Jalan Aspek Teknis Pada Ruas Jalan Nasional Tambu–Tompe Provinsi Sulawesi Tengah. *Journal of Civil Engineering and Planning (JCEP)*, 1(2), 137-150.
- Artiwi, N. P. (2023). ANALISIS DESAIN GEOMETRIK JALAN RAYA PALIMA-PASANG TENENG KABUPATEN SERANG PROVINSI BANTE. *Journal of Sustainable Civil Engineering (JOSCE)*, 5(01), 18-30.
- Ulchurriyyah, N. R. (2022). The Geometric Redesign of Horizontal Curved Using AutoCAD Civil 3D®: A Case Jalan Garuda–Jalan Moh. Hatta, Tasikmalaya West Java. *Indonesian Journal of Multidisciplinary Science*, 1(1), 288-303.
- Setyawan, A. Y. (2021). The Evaluation of Deflection and Tensilestress in Jointed Plain Concrete Pavement for a Damaged Road. In *Journal of Physics onference Series*, 1912.
- Dong, Z. Z. (2019). Research on Application of Highway Green Construction Technology. In *IOP Conference Series: Earth and Environmental Science*, (Vol.310, No 2,, p. 022002). IOP Publishing.
- Masitoh, S. R. (2020). Analisis Geometrik Jalan Ruas Jalan Lingkar Utara Majalengka Kabupaten Majalengka. *Jurnal Konstruksi dan Infrastruktur*, 467.
- Castañeda, K. S. (2022). Highway Planning Trends: . *A Bibliometric Analysis. Sustainability*, 14(9), 5544.
- Rizki, R. R. (2022). Geometric Redesign of Jalan Cisauk–Jaha, Banten with Manual Method (Sta. 0+ 000–Sta. 0+ 350). *Citizen: Jurnal Ilmiah Multidisiplin Indonesia*, 2(5), 859-864.
- Sukalkar, V. G. (2022). A Study and Design of Two Lane with Paved Shoulder in Green Filed corider. *By Using Civil 3D*.
- Milton, J. &. (2021). The relationship among highway geometrics, traffic-related elements and motor-vehicle accident frequincess. *Transportation*, 25(4), 395-413.
- Agniya, A. H. (2022). The Geometric Design of New Jakarta-Cikampek Highway Access Using Autocad® Civil 3D: A Case of West Karawang Industrial Are. *Indonesian Journal of Multidisciplinary Science*, 1(1), 189-198.
- Gaikawad, P. &. (2020). A Review-Geometric Design of Highway with the Help of Autocad Civil 3D. . *International Journal for Research in Applied Science and Engineering Technology*, 8(5), 916. *A Review-Geometric Design of Highway with the Help of Autocad Civil 3D. . International Journal for Research in Applied Science and Engineering Technolog*, 916.
- Rambitan, D. W. (2022). analisis Geometrik Jalan Pada Ruas Jalan Tondano. *Suluan STA 0+ 000â€“STA 3+ 000. TEKNO*, 20(81), 52.
- Direktorat Jenderal Bina Marga. 1997, T. C. (n.d.).
- Direktorat Jenderal Bina Marga. 1997, T. C. (n.d.).
- Direktorat Jenderal Bina Marga. 1997, T. C. (n.d.).
- Rochmanto, D. K. (2019). “Evaluasi Geometrik Jalan Ditinjau Dari Aspek Alinyemen Horisontal Terhadap Pelebaran Tikungan Jalan Bangsri. *Reviews in Civil Engineering 3* (2), 29-35.
- Rifai, A. I. (2016). Genetic Algorithm Applied for Optimization of Pavement Maintenance under Overload Traffic: Case Study Indonesia National Highwa. *Applied Mechanics and Materials (Vol. 845)*, 369-37.
- Direktorat Jenderal Bina Marga. 1997, T. C. (n.d.). (n.d.).

