LEADER
Civil Engineering and Architecture

Civil Engineering and Architecture Journal Vol 1 No.3 (2023) E-ISSN
DOI 10.37253/leader.v1i3.8304

The Road Geometric Design of Jalan Weleri - Patean (65+850 - 67+850)

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ARTICLE INFO

Keywords:

Road Geometric Design
Bina Marga Guidelines
Horizontal Alignment

ABSTRACT

Road geometric planning focuses on two important points, horizontal and vertical alignment, to fulfill the road function, providing optimal comfort according to the planned speed. In this paper, the authors carry out a geometric analysis of horizontally curved roads on Weleri - Patean Road (65+850 - 67+850) using the Bina Marga Guidelines. The planning results show that the horizontal alignment has two bend designs using the Full Circle (FC) bend type with a first bend radius of 716 m, a second bend radius of 819 m, and a maximum superelevation of 10%.

1. Introduction

The current global economic situation is uncertain due to the increasing geopolitical pressures, which have had some impact on Indonesia. According to data from the Central Statistics Agency (BPS), in 2022, the Indonesian economy was able to grow by 5.31 percent, demonstrating strong growth amidst global geopolitical pressures. Indonesia requires economic development to boost its economy and progress toward becoming a developed country. Various criticisms often arise regarding Indonesia's products, but it cannot be denied that the results are felt in all aspects of people's lives [1].

Infrastructure development plays a role in driving economic growth, reducing unemployment rates, and improving the welfare of society. Economic growth, in general, can be defined as a positive change or improvement in a country's economy over a specific period, as evidenced by an increase in national income [2]. One of the physical forms of infrastructure is roads, bridges, railroads, airports, and even canals and water reservoirs. In the provision of infrastructure, the government has a critical role. Although infrastructure procurement can be carried out through cooperation with designated business entities, not all infrastructure services can be carried out by the private sector because there are infrastructure services that require significant capital with a long payback period and considerable investment risk [3].

There has been significant progress in increasing the budget for infrastructure development in Indonesia during the reign of Joko Widodo. The availability of reliable infrastructure is crucial in supporting economic activities and business growth. Infrastructure development is an important and vital aspect in accelerating the national development process, particularly on the island of Java, as it significantly affects economic and people mobility, especially by the year 2025, when the population is projected to reach around 151 million people [4].

Good road geometric design is essential in supporting infrastructure development, especially road infrastructure. The geometric design of the road must consider the factors of safety and comfort for road users because this is an essentialrequirement in road planning. It was found that there was a strong relationship between the road accident and the geometrical characteristics of the road, such as sight

Receieved 2 Juli 2023
Available online 1 Agustus 2023
Published by Fakultas Teknik Sipil dan Perencanaan UIB

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distance, the radius of curvature, and slope [5]. Therefore, secondary data is needed, including the average daily traffic, to determine the speed of the plan.

In this paper, the author will develop the geometric road design for Weleri - Patean using the Bina Marga Road Design Guidelines. The Bina Marga method is a methodology used in Indonesia that provides a final result consisting of priority rankings and a maintenance program based on the values obtained from the priority rankings. This method combines the values obtained from visual surveys, such as the type of damage, and ADT surveys (Average Daily Traffic) to determine the road condition and the ADT class value [6]. The scope of the planning method in this journal only employs horizontal alignment design, which focuses on curve analysis.

2. Literature Review

2.1 Road Geometry

Road Geometric design is a technique for drawing roads that encompasses horizontal alignment, vertical alignment, and other aspects related to the physical form of the road. The application of geometric road design aims to create a road shape that can be utilized for fast, smooth, safe, comfortable, and efficient traffic flow. Geometric road design, which forms the basis for road safety factors, mainly refers to positioning symmetric physical road elements, cost (efficiency) analysis, reduction of harmful environmental impact, traffic volume, road accessibility, and more [7].

A well-designed road geometry must adhere to several parameters and standards. The parameters that serve as the basis for geometric road planning include design vehicles, design speeds, road volume, and capacity. In addition, it is essential to incorporate design criteria, general provisions, and geometric procedures of roads as standards in the process of geometric road planning [8] [9] [10]. Design criteria are elements that simplify the road geometric planning process. The highest plan speed of the plan speed range is used so that the worst-case scenario possible on the road can be taken [11] [12].

Road conditions naturally vary in different regions; therefore, geometric road planning is supported by geometric data. Geometric data of the road encompasses everything related to the road and its traffic, such as types of curves and measurement data. The geometric condition data is collected through measurements using total stations and GPS [13].

2.2 Highway Classifications

Highways are major roads that connect one region to another. They serve as transportation routes for vehicles, including two-wheelers, four-wheelers, and more. Highways are essential for driving the economy in developing countries [14]. It is expected that highways provide comfort and safety for traffic users. In urban areas, highways tend to have a dense traffic flow. A severeproblem in urban areas is the high population density which causes traffic conditions to become congested/saturated in critical areas of a city, which increases driving travel time [15].

Arterial roads have the characteristic of having a width of more than 7 meters as their primary function is to serve long-distance travel, with an average vehicle speed exceeding 60 km/h. The primary road network system is designed based on spatial planning and the distribution of goods and services to facilitate the development of all regions at the national level by connecting various distribution centers [16].

2.3 Horizontal Alignment

Horizontal or road alignment refers to the projection of the road's axis perpendicular to the map plane, consisting of straight lines and curves. Horizontal alignment, or arches, bends, or turns, is integral to a

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road. In certain situations, researchers may aim to create a straight path without horizontal alignment; however, alignment becomes necessary to accommodate the existing topography [17] [18].

Horizontal alignment is formed by connecting straight line segments with curved lines, creating bends or turns. The curved lines can consist of circular arcs with transition curves and circular arcs, known as the transition curve or circular arcs [19]. Planning curves without adhering to applicable regulations can lead to traffic accidents. Horizontal curves are a crucial aspect of rider safety. A well-designed alignment will allow for higher speeds and improve road performance in terms of safety and comfort [20] [21].

Planning curves can have a significant impact on traffic flow. The most critical part of the horizontal alignment is in the bend, where a centrifugal force pushes the vehicle out of the corner area [22]. In horizontal alignment planning, curves are divided into three types: full circle (FC), Spiral-Circle-Spiral (SCS), and Spiral-Spiral (SS). These different types of curves have significant impacts on traffic flow. For instance, on sharp turns, vehicles tend to decrease their speed or increase the longitudinal gap, which leads to a reduction in traffic flow [23].

3. Method

The road planning location is in the Kendal Regency, Central Java. The road aims to connect Weleri Highway and Patean Highway. The road will be constructed from Station (STA) 65+850 to STA 67+850, lasting 2 kilometers. This road is classified as a Class II A Arterial Road.

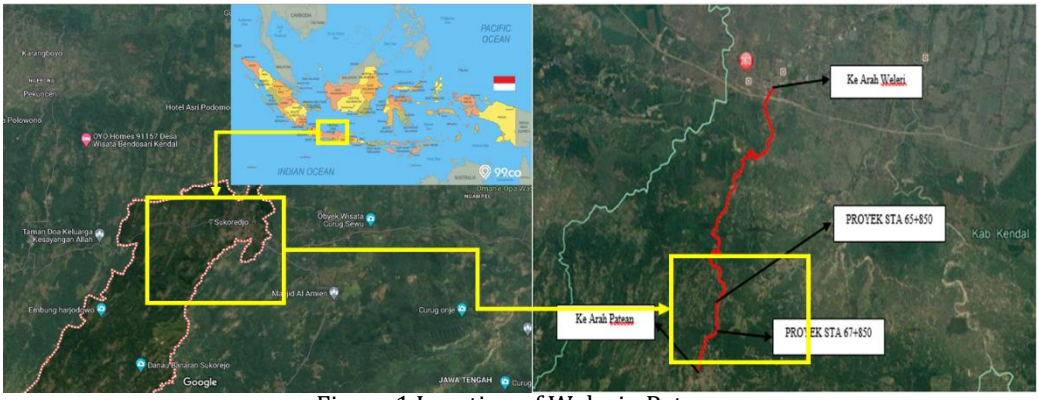

Figure 1 Location of Weleri - Patean

In this paper, the author carried out a horizontal alignment design focusing on curve analysis using the Bina Marga guidelines. Before the design process, collecting data on the road objects being examined is essential. Data collection is an interactive process integral to data analysis activities [24]. The data used in the analysis are secondary data obtained from journal references and local regulations discussing the road object under review. Identification and analysis are then conducted, and conclusions are drawn based on the available data.

4. Result and Discussion

During the planning of horizontal alignment, coordinate data is needed, which can be visualized using Google Earth and assisted by the Global Mapper application. The coordinates for the Weleri-Patean Road case study can be seen in Table 1.

Table 1. Horizontal Alignment Coordinates

TITIK	KOORDINAT		JARAK			Azimuth	Sudut Tikungan
	X	Y	ΔX (m)	ΔY (m)	d (m)	α	Δ
A	395180,873	9220820,35					

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TITIK	KOORDINAT		JARAK			Azimuth	Sudut Tikungan
	X	Y	ΔX (m)	ΔY (m)	d (m)	α	Δ
			-48,352	-698,329	700,0009	3,960814	
B	395132,521	9220122,02					**168,310**
			87,424	-644,094	650	172,2704	
C	395219,945	9219477,93					**160,087**
			-137,182	-635,359	650	12,18385	
D	395082,763	9218842,57					

The geometric road planning for horizontal alignment uses the Guidelines for Geometric Road Design by Bina Marga in 2021. The road data generated from the horizontal alignment calculation includes a radius (R) of 716 m for Curve B (Full Circle) and 819 m for Curve C (Full Circle), a transition curve length (Ls) of 50 m, a design speed of 60 km/h, and a maximum superelevation slope (e) of 10%.

Table 2. Full Circle (FC) arch calculation results

FULL CIRCLE			
No PI	**Bend A**	**Bend B**	
VR	60,000	60,000	km/jam
Lane width	3,500	3,500	m
Number of lanes	2,000	2,000	
Road Classification	Arteri	Arteri	2/2 UD
Δ	168,310	160,087	
Rc	716	819	m
emax	0,100	0,100	
fmaks	0,1545	0,1545	
Rmin	111,38	111,38	
D	2,00	1,75	o
Dmaks	12,86	12,86	o
e	0,02	0,01	
LS	50,00	50,00	m
Tc	6993,985	4665,378	m
Lc	2103,290	2288,316	m
Ec	6314,540	3917,720	m
Ts	6993,985	4665,378	m
P	0,145	0,127	

Based on the calculation results in table number 2 uses the Guidelines for Geometric Road Design by Bina Marga in 2021, it is a Full Circle (FC) bend because it meets the P < 0.25 m bend requirements. In the PI bend STA 65 + 850 to STA 67 + 850, Tc is 6,993.98 m, Ec is 6,314.54 m, P is 0.145.

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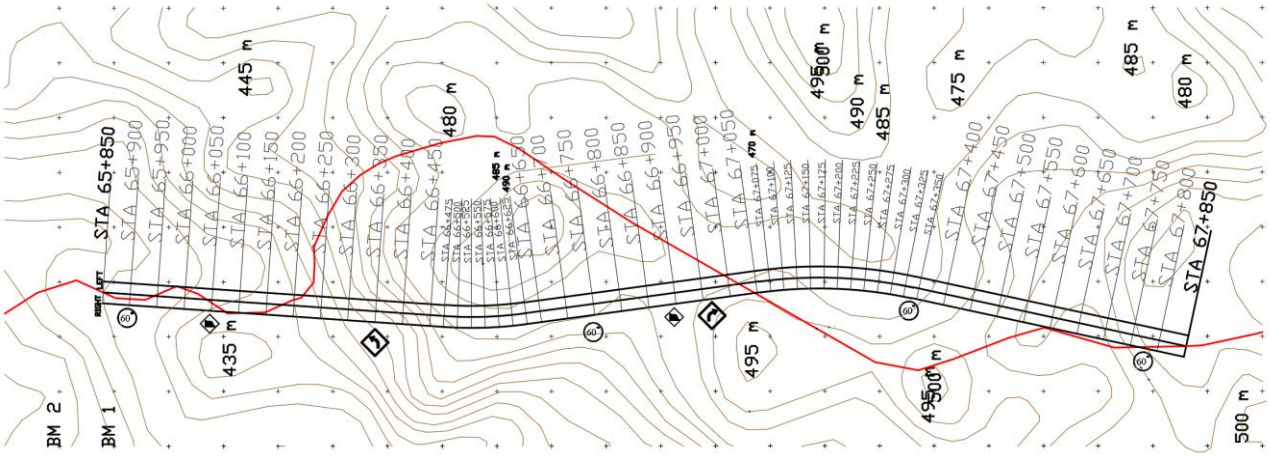

Figure 2 Horizontal alignment design

Figure 2 is an illustration of the horizontal alignment of the Weleri - Patean Road (65+850 - 67+850) case study using AutoCAD® 2D.

5. Conclusion

Based on the planning results of the horizontal alignment calculation on the Weleri - Patean Road (65+850 - 67+850) using the 2021 Road Geometric Design Guidelines, the Weleri - Patean Road (65+850 - 67+850) with a road length of 2 km consists of 2 bends with the first and second bend types are Full Circle (FC). The first bend type has a radius of 716 m, and the second bend has a radius of 819 m.

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Receieved 2 Juli 2023
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Receieved 2 Juli 2023
Available online 1 Agustus 2023
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Receieved 2 Juli 2023
Available online 1 Agustus 2023
Published by Fakultas Teknik Sipil dan Perencanaan UIB