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REDESIGN OF ROAD GEOMETRIC WITH AUTOCAD CIVIL 3D® CASE STUDY: JL. KADIPATEN-KASOKANDEL (STA 0+000-STA 4+800)

Noviar Dwi Hartati[1], Ade Jaya Saputra[2], Adinda Fajarika[3]
[1]Faculty of Civil Engineering, Universitas Majalengka, Indonesia
[2]Faculty of Civil Engineering and Planning, Universitas Internasional Batam, Indonesia
[3]Faculty of Engineering Universitas Mercu Buana, Indonesia
Email korespondensil: noviardwi247@gmail.com

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ABSTRACT

Road geometric planning is part of road development planning which aims to determine the actual dimensions of the road and its function to suit traffic needs. In the geometric planning of the Kadipaten-Kasokandel road at STA 0+000-STA 4+800, geometric patterns and shapes must be planned so that the related streets can produce optimal service to traffic according to their function. Road geometric planning on the Kadipaten-Kasokandel road section from Sta 0+000 to Sta 4+800 using AutoCAD®Civil 3D using the design speed plan (VD) criteria of 80 km/hour, the terrain classification on this road section is flat terrain. In the horizontal alignment, there are four bends with three curves using the Spiral-Circle-Spiral type, while the first use the Full Circle bend type. In the vertical alignment, there are seven segments of the inclined plane.

1. Introduction

Roads are infrastructure used to transport people or goods from one area to another. The road is also a very important part of the community, where the comfort and safety of road users are guaranteed, as well as the time and place for effective maintenance (Zulfa, Rifai, & Taufik, 2022). Various countries in the world are very aggressively carrying out road construction. Road repair is also very important to maintain the quality of a road. In 2014, in Europe, road vehicles were responsible for 72.8 percent of all greenhouse gas emissions from transportation. In the United States (US), emissions follow a similar trend (Llopis-Castelló, Pérez-Zuriaga, Camacho-Torregrosa, & García, 2018). In road construction, of course, there are positive and negative impacts.

Indonesia has built much infrastructure in the last few years, especially road infrastructure. The geometric must be planned properly. The geometric design of the roadway is concerned with the creation of the elements of cross-section, visibility, alignment, curves, superelevations, and other related factors that are physically visible on the roadway (Rizqi, Rifai, & Bhakti, 2022) The Indonesian economy, which is starting to develop rapidly, certainly affects the effectiveness of a road. Major investments in public infrastructure projects in the Indonesian economy are expected to increase quickly after a decade of focusing on new roads, railways, ports, airports, power generation and distribution, water and sanitation, schools, and hospitals (Nugroho, Rifai, & Akhir, 2022).

The rapid economy in Indonesia, especially in West Java, has made more and more transportation available in this region. It has made road construction a lot to do, such as constructing the Cisumdawu toll road, etc. However, the community still needs to feel the road infrastructure development in Majalengka Regency fully. The geometric structure of the road has three main elements: horizontal alignment, vertical alignment, and road sections (Ulchurriyyah, Rifai, & Taufik, 2022). Thus, these three geometric elements must be considered to maintain the success of road construction. Therefore, the geometric planning of the road must be designed as well as possible.

Road geometric planning is part of road development planning which aims to determine the actual dimensions of the road and its functions to suit traffic needs. Road infrastructure development in Majalengka still needs to be fully experienced by all cities. Road geometric planning is used as an initial step in constructing connecting roads or access roads (Joice, Rifai, & Taufik, 2022). One of them is the Kadipaten-Kasokandel road. The Kadipaten-Kasokandel road that connects Bandung City and Cirebon City is a provincial road that is the main artery in the primary road network system that connects between district/city capitals. Road geometric planning is crucial important for developing good road infrastructure (Farid, Rifai, & Taufik, 2022).

The development of highly advanced computer technology for the geometric design of highways offers excellent precision and saves a lot of time and effort. Road geometric designs can be created using AutoCAD®Civil 3D software. In designing a road geometry, of course, you have to consider the interrelated safety and comfort issues of mobility. Things that must be regarded as mobility are not only the mobility of motorized vehicles but also the mobility of pedestrians. AutoCAD Civil 3D® can solve problems in various areas of Civil Engineering, such as designing geometric models and drawing designs for roads, highways, treads, and rails (Salsabila, Rifai, & & Isradi, 2022). In this case study, the purpose of geometric planning is to improve road safety by improving the geometric design of the road to minimize traffic accident rates by road factors using 3d civil AutoCAD. In the geometric planning of the Kadipaten-Kasokandel road at STA 0+000-STA 4+800, geometric patterns and shapes must be planned so that the related streets can produce optimal service to traffic according to their function.

2. Literature Review

2.1 Road Geometric Design

A geometric road is bodybuilding above the ground level, assuming the ground surface is not flat vertically and horizontally (Rizqi, Rifai, & Bhakti, 2022). Road planning that is focused on planning the physical form of the road is part of Road geometric planning (Adiputra, Rifai, & Bhakti, 2022). Of course, several things must be considered in planning a geometric road design. A geometric design should provide reasonable efficiency values considering development costs and desired future economic value (Zulfa, Rifai, & Taufik, 2022). In planning the road design, you must pay attention to horizontal and vertical alignment. Horizontal alignment is a collection of points that form a straight line (tangent) or a curve (arch) as a projection of the axis of the road in the horizontal plane (Arifin & Rifai, 2022).

Horizontal alignment is one of the most challenging aspects of highway planning by considering the road radius to produce a flat curve that meets the criteria. In the horizontal plane, the axis of the road is projected to make a horizontal curve (Stefanus, Rifai, & & Nasrun, 2022). In addition to horizontal alignment, the driving speed of different vehicle classifications can affect the selected road class, which is a determining factor in designing horizontal alignment and will undoubtedly affect the project cost of the work. Straightness calculations usually include centrifugal force, bend degree, bend radius, superelevation, bend transition, bend widening, and horizontal curve shape.

While the vertical alignment is a cross-section of the highway, geometric design is a critical phase in a highway project and directly affects its construction costs (Gunawan, Rifai, & Irianto, 2022). Several factors influence this alignment, including design speed, topography, road function and class, bridge deck elevation, and subgrade soil.

2.2 Sight Distance

Sight distance is an important aspect of the design element from a safety perspective and is the length of the road visible in front of the driver (Nurjannah, Rifai, & Akhir, 2022). Sight distance is, of course, very much needed by the driver. The Availability of sufficient visibility allows the driver to adjust the speed and try to avoid the danger ahead. Sight distance for various operating speeds is based on a consistent design size (Godumula & Ravi Shankar, 2023). Vehicle speed is greatly influenced by factors of the physical condition of the road, including road geometry, side clearance, traffic signs, and traffic rules.

Visibility is one of highway safety's most important geometric design factors (Gargoum & Karsten, 2021). where the geometric design of the designed road must meet the requirements for the Availability of adequate visibility along the road alignment, planners must understand this to consider safe visibility for motorists.

There are two types of sight distance calculations: line-of-sight distance in a horizontal arc and sight distance in a vertical arc. Horizontal curvature visibility, namely the presence of visibility is very important when the vehicle goes through a bend (Said, 2022). Many cases on the road have impaired vision caused by trees, cliffs, buildings and other obstacles. Meanwhile, the visibility in the vertical arc, namely two types of longitudinal slopes, is prepared to change smoothly in every required position.

This is done to reduce the shock caused by gradient changes and provide a safe stopping view when driving.

2.3 AutoCAD Civil 3D

AutoCAD Civil 3D® is a civil engineering design and documentation tool developed by Autodesk (Maulana, Rifai, & Isradi, 2022). This civil engineering software can be used for modeling, analysis, and design in various infrastructure projects in civil engineering, including road, rail, land development, water, and airport design planning. AutoCAD Civil 3D software can help engineers process data more efficiently and respond quickly to project changes.

3D modeling is one of the leading technologies needed to create an integrated system to ensure road safety in big cities and global industrial developments. The development of world design infrastructure is progressing rapidly (Agniya, Rifai, & Taufik, 2022). One is the emergence of various software, including AutoCAD Civil 3D®. AutoCAD Civil 3D® software is very effective for geometric road planning because it can process and draw drawings simultaneously, making the road geometric planning process easier and faster (Salsabila, Rifai, & &, 2022). The advantage of this application is that it can shorten the time in planning a design. AutoCAD Civil 3D® provides various features for creating project models and 3D assistance for implementing small and large-scale projects. In addition, it can assist civil engineers in imagining 3D visualizations (Mandal, Pawade, & Sandel, 2019).

This software has used the notion of dynamic modeling to display the integrated design process, which will automatically adapt and update the entire integrated design process while designing (Wibowo & & Putra, 2022). This feature makes the geometric design of the road look more integrated and creates a good working impression of the design. Comparison of the AutoCAD Civil 3D® application in the geometric design of roads using a manual approach produces figures far outside the range of the given effectiveness and efficiency values.

3. Method

In compiling research, of course, one must have one of the main strengths: data. Data can be used so that we know the condition of the area that we are going to study. The data used in planning this geometric design uses data obtained from Google Earth which will be processed back into the global mapper and then AutoCAD®Civil3D.

The area planned in this study starts from the Duchy to Kasokandel, with a distance of STA 4+800.

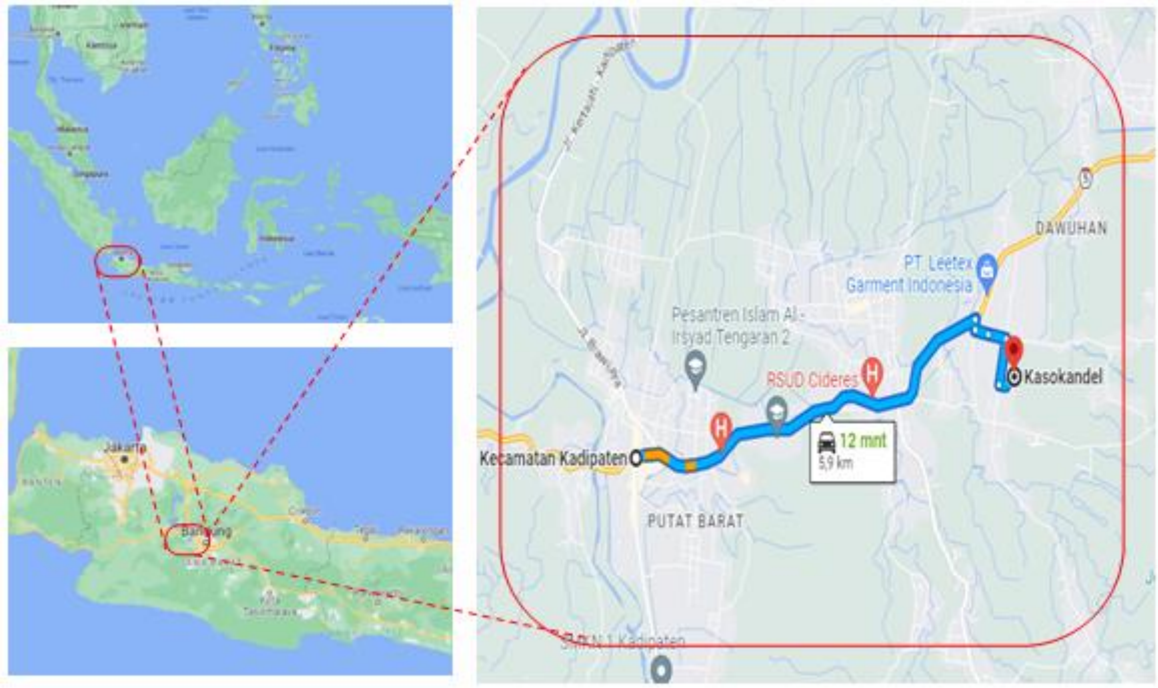

Figure 1. Location

In this design, of course, you should have supporting data to get a safe and efficient job. Systematic scientific research must identify the right problem (Rifai, Hadiwardoyo, Correia, & Pereira, 2016). The research method used in this design is to process quantitative data from the results of google earth, global mapper, and AutoCAD®Civil3D. Primary data in a study is usually obtained after going through field observations. The observation method is a data collection technique that involves observing and recording the state of the target object (Oktobrianto, Rifai, & Akhir, 2022).

Meanwhile, secondary data comes from related institutions that have conducted field observations. The data used in this study are the topographic data of the existing road along with a situation map of the current location (Nurjannah, Rifai, & Akhir, 2022). This design's provisions follow the geometric road guidelines issued by the circular of the Ministry of Public Works and Public Housing, Director General of Highways, in 2020. The results of this geometric design will be visualized using AutoCAD®Civil3D.

4. Result and Discussion

The following is a geometric plan for the horizontal alignment of Jalan Kadipaten-Kasokandel with STA 0+000-4+800 using the Bina Marga Method, accompanied by the steps taken and the standards used. Data was obtained from Jalan Kadipaten-Kasokandel with STA 0+000-4+800. For horizontal alignment calculations (spirals, circles, spirals) are class IA roads, clarification of flat terrain using the Bina Marga method (Rizki, Rifai, & & Djamal, 2022).

4.1 Design Criteria

Table 1. Design Criteria

Medan Classification	Flat	
Road Classification	Public Roads (Primary Local) (Provincial Government)	
Road Network System	Primary	
Road Status Provincial Roads	Road Status Provincial Roads (Provincial Government)	
Path Configuration	2/2 T	
Plan Speed	80	km/h
RUMAJA width	24	m
RUMIJA width	25	m
RUWASJA Width	15	m
Lane Width	3,5	m
Inside Shoulder Width	0,5	m
Outer Shoulder Width	2	m
Median Width	2	m
Normal Superelevation	2%	%
Shoulder Superelevation	6%	%
Maximum Superelevation	8%	%
Maximum Slope	5%	%

4.2 Horizontal Alignment

Field measurement data is drawn or visualized using the Autodesk Civil 3D Student Version 2023 application to obtain bend-shape results (Wibowo & & Putra, 2022). An illustration of the existing bend is shown in Figure 1. Through testing, Autodesk Civil 3D obtained Student Version 2023 bend data, and the calculation results of the horizontal alignment bend analysis can be seen in the calculation below. Calculate the minimum radius using the formula below to find the horizontal alignment yourself.

$$Rmin = \frac{Vd\text{^}2}{127(Emaks + Fmaks)} \quad (1)$$

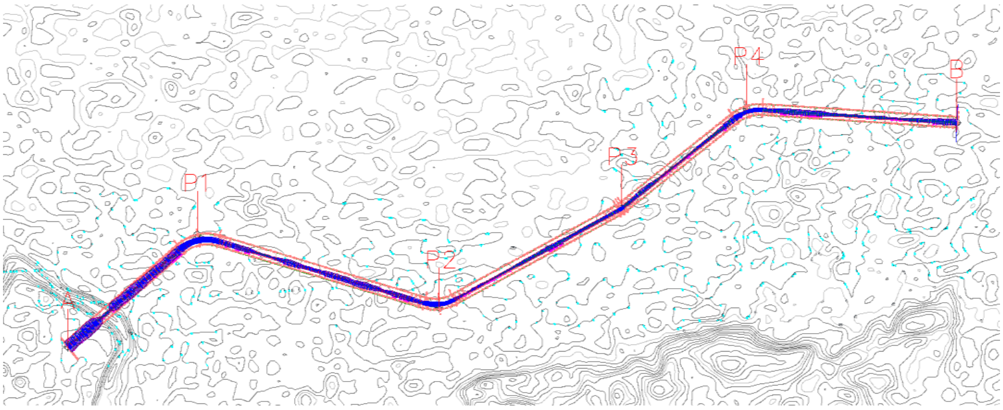

Figure 2 Horizontal alignment

Table 2. Coordinate calculation

POINT	COORDINATE		DISTANCE			Azimuth	Bend Angle
	X	Y	ΔX (m)	ΔY (m)	d (m)	α	Δ
A	186.243.685	925.117.415					
			628856	8,33E+09	8,33E+09	0,004327	
PI 1	186.872.541	9.252.136.944					**105,970**
			1179925	-337759	1227316	105,974	
PI 2	188.052.466	9.251.799.185					**43,317**
			885312	457781	996664,8	62,65722	
PI 3	188.937.778	9.252.256.966					**9,755**
			612634	463299	768092,7	52,90193	
PI 4	189.550.412	9.252.720.265					**40,673**
			1023250	-63928	1025245	93,57493	
B	190.573.662	9.252.656.337					

4.3 Superelevasi

After creating horizontal paragraphs and Circle Spiral (S-C-S) curves, superelevations are made by right-clicking on the curves made and then clicking the calculated superelevations (Pangesti, Rifai, & & Prasetijo, 2022). After that, enter the lane type, road type, shoulder type, and other planning criteria.

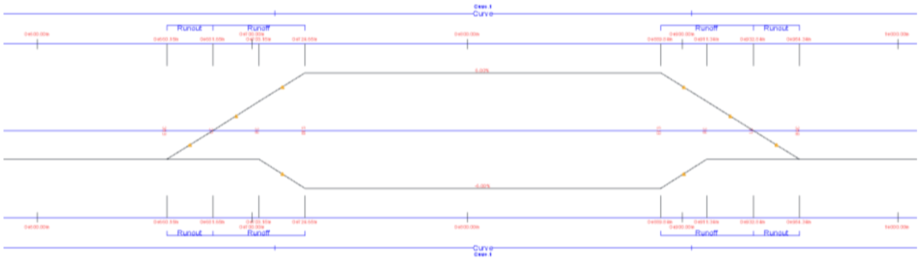

Figure 3 Superelevation P1

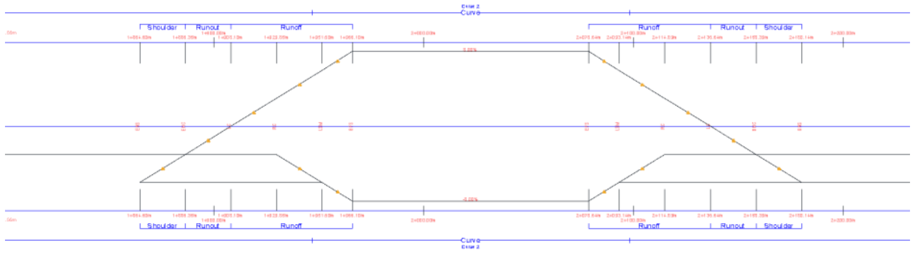

Figure 4 Superelevation P2

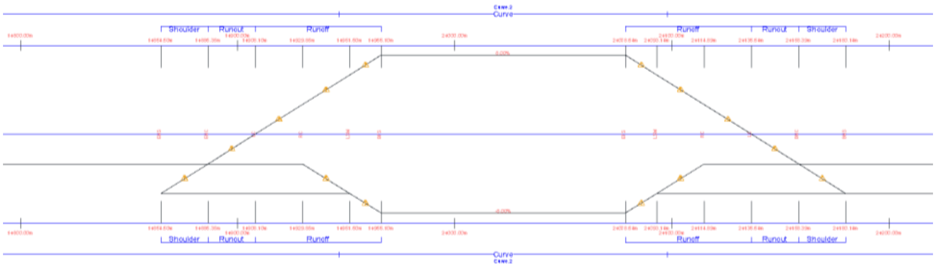

Figure 5 Superelevation P3

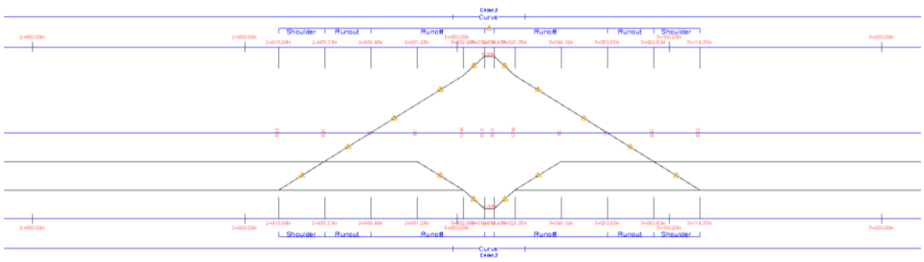

Figure 6 Superelevation P4

4.4 Vertical Alignment

Once the horizontal alignment is generated, superelevation. Next, look for a vertical alignment on the Kadipaten-Kasokandel road with Sta 0+000 to Sta 4+800. The vertical alignment on this plan is visualized using the AutoCAD Civil 3D application. For vertical alignment, images can be seen in the image below.

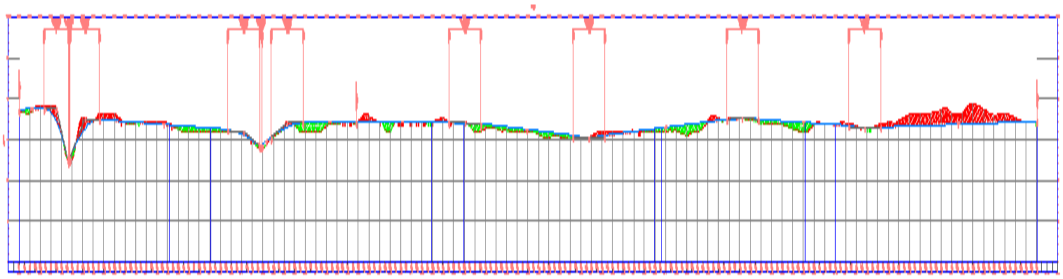

Figure 7 Vertical Alignment

Based on the picture above, it can be seen that the Kadipaten-Kasokandel road section is included in the flat terrain classification after knowing the alignment picture on this road segment. Furthermore, we can get a picture of the corridor on this road segment. Corridor images can be seen in Figure 7.

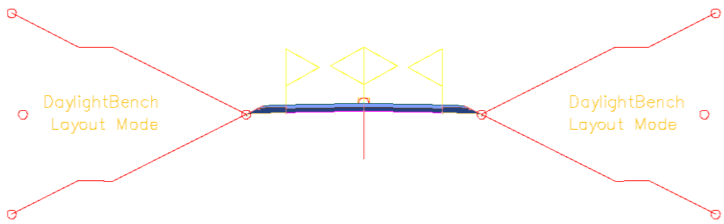

Figure 8. The Road Cross-Section Planning

The picture above is a corridor on the Kadipaten-Kasokandel road section. The corridor is visualized using the AutoCAD®Civil 3D application. Thus the drawings for vertical alignment and corridors can be found.

5. Conclusion

Road geometric planning on the Kadipaten-Kasokandel road section from Sta 0+000 to Sta 4+800 using AutoCAD®Civil 3D using the design speed plan (VD) criteria of 80 km/hour, the terrain classification on this road section is flat terrain. In the horizontal alignment, there are four bends, with three curves using the Spiral-Circle-Spiral type, while the first bend uses the Full Circle bend type. In the vertical alignment, there are seven segments of the inclined plane.

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