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ROAD GEOMETRIC PLANNING USING AUTOCAD®2D CASE STUDY: PRAPATAN PANJALIN STREET, SUMBERJAYA DISTRICT, MAJALENGKA REGENCY

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ABSTRACT

Jalan Prapatan Panjalin is a road located in Sumberjaya sub-district, Majalengka district, which is a connecting road between Sumberjaya sub-district and Palasah sub-district, which has a road length of around 7 km. Besides that, the Panjalin Prapatan road is classified as an arterial class I road. In this study, it refers to the geometric roads issued by the Ministry of Public Works and Public Housing in 2020, the Director General of Highways. And the design results are visualized using AutoCAD 2D. for a predetermined design speed of 60 km/hour with a radius of 112 m. and elevation (e max) which is 10% , based on these design criteria, obtained a circular arc length (Lc) of 249.884 m. then formed by vertical alignment Long ppv (L) of a kind of concave curve.

1. Introduction

Road is a land transportation infrastructure in any form covering all parts of the road including auxiliary buildings and equipment intended for traffic (Road Law No.13/1980) [1].Increasing the number of roads proves the critical role of road infrastructure in the development of each country [2]. Public roads are roads designated for general traffic, special roads are roads built by agencies, business entities, individuals or community groups for their own interests. [3].

The level of economic growth in Indonesia is quite fast which causes a very large number of vehicles. In that case, we can conclude that the increased number of vehicles is not proportional to the road capacity. Road geometric design is road engineering that focuses on designing physical forms to fulfill road functions. In general, road geometry planning is done manually using drawing tools and mathematical techniques [4].

The rapid economic development in Indonesia makes traffic more congested. Indonesia currently has a population of more than 230 million people, and the country's economic growth has driven an increase in transportation and vehicle ownership demand [5].

Majalengka is one of the cities that is currently carrying out a fairly large development in terms of infrastructure such as roads. Roads are an essential means of transportation to connect various places such as industrial centers, agricultural areas, and settlements as well a means of distributing goods and services to support the economy [6]. Due to the relatively large number of vehicles and inadequate road capacity, Majalengka is a lucky city because it has toll road access. Due to the identified economic benefits, the construction of toll roads in Indonesia under President Joko Widodo was carried out massively [7]. infrastructure development that is currently underway and that has been built aims to

support community activities, entrepreneurs, factories and facilitate access to airports that are already standing in Majalengka.

Jalan Prapatan Panjalin is one of the roads in Sumberjaya District, Majalengka Regency, Prapatan Majalengka Road, which is a connecting road between the cities of Majalengka and Cirebon. road geometry planning, namely the planning of a road that is focused on planning in physical form. The application of AutoCAD® technology in highway surveying and design has led to major changes in traditional highway design methods [8]. Therefore, the results of considerations in terms of effectiveness as well as time efficiency of geometric planning on long-paved roads can use AutoCAD®2D software.

In connection with the passage of time, the Prapatan Panjalin road has undergone quite rapid changes. One of them is the improvement of the road and the planning of a road in the village of Panjalin Kidul, Sumberjaya District, Majalengka Regency. The purpose of writing this paper is to plan the geometry of the Prapatan Panjalin road. This aims to simplify and increase land transportation infrastructure that connects Sumberjaya sub-district and Palasah sub-district. From this planning using the Autocad®2D method.

2. Literature Review

2.1. Highway

Roads are land transportation infrastructure covering all parts of the road, including complementary buildings and equipment intended for traffic, which are at ground level, above ground level, below ground and or water level, and above water level, except railroads: fire, lorry, and a cableway [9]. Highways can be grouped based on their function, such as local roads, collector roads and arterial roads, but in terms of the type of highways, they are divided into village roads, city roads, district roads, provincial roads and national roads.

Highways are a type of land transportation infrastructure that functions as a road between one road or region and another [10]. Basically, the highways in the West Java region, especially the Majalengka district and other cities, have never been without traffic jams, whether in terms of road damage or inadequate road capacity. This is due to the poor road geometry. It is important to analyze the congestion and forecast future traffic models to prevent traffic congestion [11].

West Java province, especially Majalengka district, which is currently experiencing problems on highways, especially national roads. Highway authorities should prioritize improving the geometry of two-lane highways because they represent an essential road network component [12]. If the geometric design of the road is good, then there will be no problems on a road in Majalengka district, so it is important to apply good road geometry, namely to optimize road performance.

2.2. Road Geometrik

Road geometric planning is an effort to obtain a physical form of road infrastructure capable of fulfilling the essential functions of the road and providing optimal service, which can provide comfort and safety in road use and maximizes the ratio of the level of use of costs and environmental damage (Chakole & J.Wadhai., 2022) [13]. In the geometric design of the road must consider several things. Road geometric design is concerned with the physical layout as it appears from the road and includes factors like cross sections, visibility, alignment, curves, and superelevation. (Veer, Gupte, & Juremalani, 2018). [14].

The geometric design has several parts, namely horizontal alignment, vertical alignment and cross section of the road. Highway authorities should prioritize improving the geometry of two-lane highways because they represent an essential road network component [12]. This geometric planning must also be done carefully in order to get optimal results. Therefore, the planning and design of the geometric features of the road, including the planning of horizontal alignment, vertical alignment, calculation of visibility distance, and determination of horizontal and vertical curvature radii, must be carriedoutcarefully [9].

As time goes by, technological developments are increasingly rapid, one of which is support for designing road geometrics. Therefore, in today's modern era, to design road geometrics, you can use AutoCAD®2D or AutoCAD®CIVIL 3D software. The basic objectives in geometric design are to optimize efficiency and safety while minimizing cost and environmental damage [15].

2.3. AutoCAD®

AutoCAD is an interactive drafting software package developed in the early 1980s by Autodesk incorporation for construction of objects on a graphics display screen [16]. AutoCAD has an essential role in helping to simplify and help visualize the results of planning an object into a graph or image that many people easily understand. [9]. This software is useful for designing geometric roads and other buildings, this software is also commonly used by civil engineering people both at universities and in the world of work.

AutoCAD is used by universities and workers whose scope is in building projects or so-called civil engineering people. AutoCAD was developed and marketed by Autodesk. AutoCAD is usually used by industries, architects, project managers, engineers, interior designer, graphic designers, and many other professionals [17]. This software is usually intended for designing buildings and so on. The versions provided also vary because AutoCAD is updated every year or is usually called an update. However, for geometric planning this road is using AutoCAD®2D which will be visualized in 2D using AutoCAD.

AutoCAD® also aims to demonstrate how geometric designs can be carried out very quickly and accurately in a short time to enable civil engineering professionals from developing countries toplanroaddesigns (Gaikawad&Ghodmare,2020) [18]. in this case AutoCAD®2D can be operated on laptops that have low to high specifications according to the version, from 2GB onwards. That way this software can be operated by someone who has low laptop specifications. This software is versatile in various fields and can combine several aspects, such as architecture, structure, and construction, to facilitate design implementation with workers. In addition, with the difference in the appearance of the building form displayed in the program, repairs can be performed quickly and efficiently [19]The basic objectives in geometric design are to optimize efficiency and safety while minimizing cost and environmental damage [15].

3. Metodologi

In this case AutoCAD®2D can be operated on laptops that have low to high specifications according to the version, from 2GB onwards. That way this software can be operated by someone who has low laptop specifications.

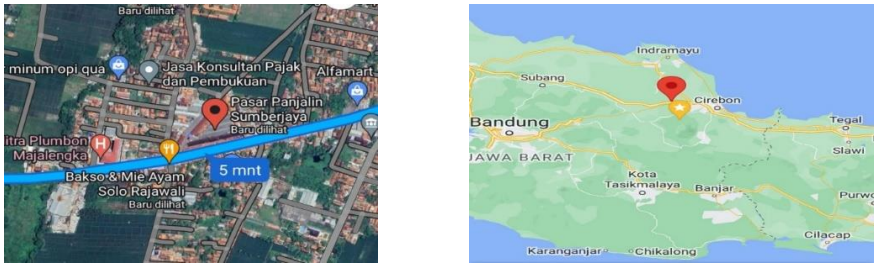

Figure 1 location

Road geometric planning requires supporting data to obtain and facilitate good work and efficiency. The method used is quantitative and qualitative methods. Quantitative research methods are

sourced from mathematical sample data to obtain road geometric planning results according to standards [20]. Data yang diperlukan untuk penelitian ini yaitu data primer dan sekunder.

Primary data obtained from field observations. The observatio nmethod is a data collection technique that involves observing and recording the state of the target object [21]. for secondary data obtained from existing sources without observation and research. Secondary data in this study is land contour data obtained from Google Earcth. The provisions of this study are guided by the geometric path of the circular letter of the Ministry of Public Works and Public Housing, Director General of Highways in 2020.

4. Result and Discussion

4.1. Design criteria

The Prapatan Panjalin road, which is located in the Sumberjaya sub-district, Majalengka district, is included in the criteria for class I arterial roads. the results of this study refer to the geometric design of the road (Director General of Highways, 2021).

Tabel 1. Criteria Design

Road Name	Road Type	Road Function	Classification	Plan Speed	Maximum Elevation(E maks)	Cross Error (f maks)	Width of Road
Road prapatan panjalin	2/2 UD	arteri	Hill	60 KM/hours	10 %	0,153	3,75 m x 2

4.2. Horizontal Alignment

The following data is data obtained from the Prapatan Panjalin road section which is used to calculate the horizontal alignment (full circle). The Prapatan Panjalin road section is included in the arterial road class I and for the road itself, namely a flat road so that the design speed range (VD) is obtained in the range of 20 to 60 km/hour, this determination refers to the geometric design of the road (Director General of Highways, 2021).

The first step is to calculate the minimum radius (R min) using the maximum superelevation value (e max) of 10%, the design speed (VD) of 60 km/hour, and the roughness value of the cross section itself (f max), calculated using the equation.

$$\begin{aligned} \text{F max} &= \text{-0,00065 . v + 0,192} \\ &= 0{,}00065 \,.\, 60 + 0{,}192 \\ &= 0{,}153 \end{aligned}$$

After determining (f max) using the equation above we can find the minimum radius data (R min) using the equation below.

$$\begin{aligned} \text{R min} &= \frac{v\text{^}2}{127\,(e\,\text{max} + f\,\text{max})} \\ &= \frac{60}{127\,(0{,}1+0{,}153)} \\ &= 112 \text{ m} \end{aligned}$$

If (R min) has been determined in an equation, the next step is to determine the arc length at the transition (LS). the values that must be required in this calculation include the value of the design speed (VD) = 60 km/hour and the travel time. The mileage itself is 3.

$$LS = \frac{VD}{3,6} \text{ X T}$$

$$LS = \frac{60}{3,6} \text{ X } 3 = 50 \text{ m}$$

The calculation above, the value of the transition arc length (LS) is 50 meters. And the radius is 112 . and has a maximum superelevation of 10% and a lane width of 3.75 . the e value itself refers to the road geometric planning table (Director General of Highways, 2021) the e value is 0.029 or 2.9%. The next step is to find the length of the tangent (TC) using the value (R) and known beta (β) values.

$$TC = R \text{ . Tg . } ½ \text{ . } \beta$$

$$= 716 \text{ . Tg . } ½ \text{ . } 10$$

$$= 126,25 \text{ m}$$

After knowing the tangent length (TC), which is 126.25 meters. Then we can find the outer length of the PI (EC). The required values are known (TC) and beta β values.

$$EC = TC \text{ . Tg . } ¼ \text{ . } \beta$$

$$= 126,25 \text{ . Tg . } 20$$

$$= 11,05 \text{ m}$$

If you have determined the outer length value of PI (EC) which is equal to 11.05 meters, then we can look for data on the length of a circular arc (LC) with the required values, namely beta β and radius (R) specified above.

$$LC = 0,01745 \text{ . } \beta \text{ . R}$$

$$= 0,01745 \text{ . } 20. 716$$

$$= 249,884$$

After calculating all the horizontal alignment needs, the results can be seen in the image below:

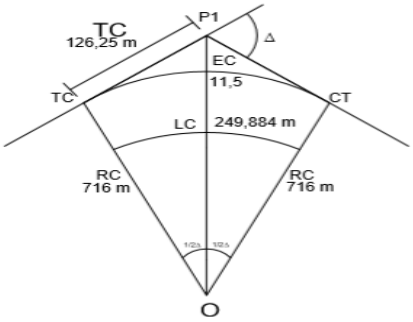

Figure 2 Horizontal Alignment

4.3. Superelevation Diagram

Referring to the alignment of the horizontal alignment image that is already known, it can be described as shown below:

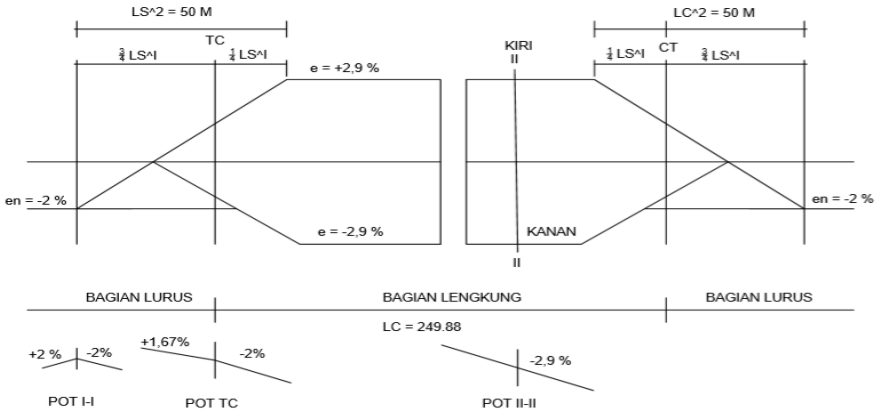

Figure 3 Superelevation Diagram

4.4. Vertical Alignment

On the road section, the vertical alignment obtained and visualized using AutoCAD 2D along the road from sta 0+000 to 5+600. The vertical alignment alignment image is shown in the image below.

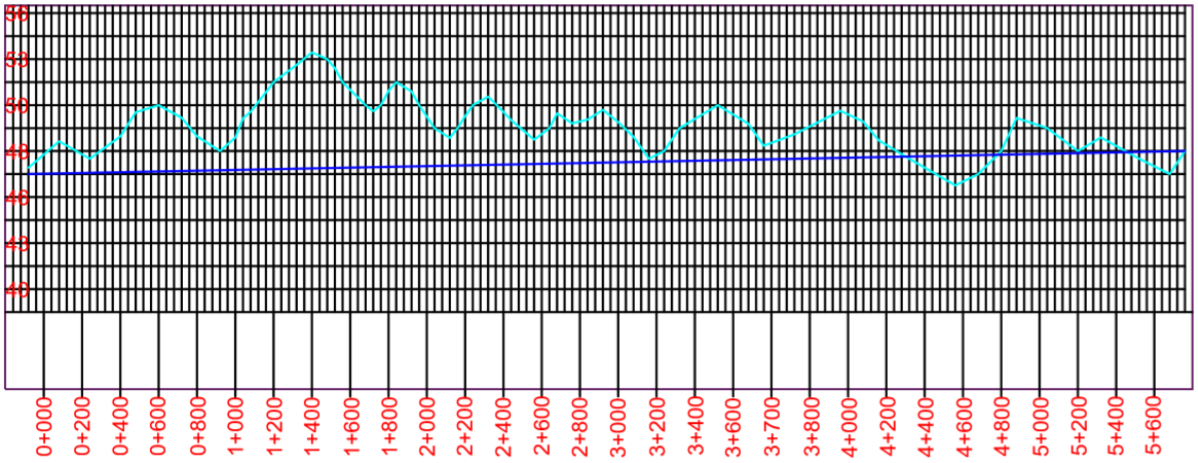

Figure 1. Vertical Alignment

According to the alignment above, sta 1+200 is defined as the point at the intersection of the vertical sections (ppv); The altitude at that point is 52.00 m. then the starting point is set at sta 1200, with a height of 52.00 m, the end point for the sta itself is 1+400 and for a height of 54.00. After the data is obtained, the slope values (g1 and g2), the algebraic difference of the slope (A) and the length of the vertical curve (L) can be calculated using the following equation:

$$g1 = \frac{elv.ppv - elv.beginning}{sta.ppv - sta.beginning} \text{ x } 100\%$$

$$g1 = \frac{52{,}00 - 52{,}00}{1.200 - 1.200} \text{ x } 100\% = 0\%$$

$$g2 = \frac{elv.ppv - elv.beginning}{sta.ppv - sta.beginning} \text{ x } 100\%$$

$$g2 = \frac{52{,}00 - 54{,}00}{1.400 - 1.200} \text{ x } 100\% = -10\%$$

$A = g1 - g2 = 0\%\text{-}10\%\text{=-}10\%$ (concave arch)

Referring to the value of the design speed (VD), which is 60 km/hour, the K value can be found in the speed plan table in the guidelines for the Director General of Highways, 2021 is used to calculate the vertical arc length (L) in the calculation below.

L = K . A

L = 16 X (-10%) = 1,6 m

In the value of the vertical arc length (L), the value of the vertical displacement at the PPV point to the bending point of the cross section can be determined using the following equation.

$Ev = \frac{A.L}{800}$

$Ev = \frac{10X1,6}{800} = 0{,}50\ m$

$X = \frac{1}{4}$ X L

$X = \frac{1}{4}$ X $1{,}6 = 0{,}4\ m$

Y = $\frac{A.X\text{^}2}{200.1,6}$

Y = $\frac{10\ .\ 0,4\text{^}2}{200.1,6} = 0{,}005\ m$

From the data above, the calculated value is obtained, the slope of the road (A) is -10% (concave curve). And for the value of the vertical arc length (A) is 1.6 meters. For vertical displacement from the point of PPV to the point of bending (elv) is 0.50 meters. the x value itself is 16 meters, for the Y value is 0.005 meters.

5. Conclusion

From the results of the geometric design of the Prapatan Panjalin highway, Sumberjaya sub-district, Majalengka district, using autoCAD® 2D calculations according to road geometric guidelines (Director General of Highways, 2021), set at a design speed of 60 km/hour, with a radius of 716 m with a maximum elevation of 10%. Based on the curve, a spiral curve with a circular arc (LC) is obtained, which is 249.884 m. then the results of the calculation of the vertical alignment The length of the PPV (L) of one of the concave types is calculated at a distance of 1.6 m.

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