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Road Geometric Planning at the Kertajati Toll Gate Towards Kertajati International Airport

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ABSTRACT

Roads are a very important infrastructure facility to connect one area to another. Indonesia with a large population result in the need for adequate infrastructure such as in terms of transportation. One of them is the West Java International Airport, to get to this place you need adequate access. So, you need precise, ideal, and fast road geometric planning using AutoCAD Civil 3D. This research using AutoCAD Civil 3D software aims to improve efficiency and optimize the Jatibarang-Kadipaten road. The method used in this study uses qualitative methods. The results of this study are to have 2 bends in the horizontal alignment with the Spiral-Cyrcle-Spiral bend type and the excavation and embankment volumes are 1562203.72 m² and 36412.31 m².

1. Introduction

Roads are vital infrastructure, the backbone of any country, enabling fast and safe transportation **[1]**Roads are infrastructure used to transport people or goods from one area to another **[2]**. Roads are an important part of everyday life as they provide access for people to travel and connect areas of a place **[3]**Development is very important to increase the economic productivity of a country **[4]**. The number of developed countries in the world is due to the existence of adequate road infrastructure. Like Singapore, this country has access to supporting areas so as to result in equitable regional development and progress**.**
Indonesia is a country with an area of 1.905 million km2, with many separate and relatively remote small islands. This high number must be balanced with the addition of lanes to existing roads to meet community mobilization support [5]. In addition, toll roads also play an important role in realizing distribution, especially logistics distribution, so that economic development can be evenly distributed [6]. For policy makers, transport infrastructure has always been a political tool, reflected in government plans and then implemented through public policy to reduce tensions and inequality and promote economic growth [7].

With the development of the economy, people's welfare also increases, so that the intensity of road use also increases [8]. So, the need for fast and ideal road geometric planning according to Highways standards and using AutoCAD Civil 3D. Classification, status, grouping, types of roads, considerations and other provisions in road construction (including freeways) are regulated by statutory regulations [9]. Road geometry design is part of road design that focuses on designing the physical form of the road to produce a road shape that can be used for fast, smooth, safe, comfortable and efficient traffic management [10].

Majalengka is experiencing rapid economic growth marked by several major developments such as BIJB Airport, Kertajati toll gate, bridges and many more. So that people come to Majalengka to carry

out activities [11]. Especially the road to the Kertajati area which has the West Java International Airport. Requires precise road geometric planning because it passes through residential areas and the Cimanuk River. In order for this International Airport to operate properly it requires adequate access. Quick and precise planning is one of the first steps to achieve this Many software have been developed to overcome problems that arise in various fields, one of which is AutoCAD Civil 3D® [12].

Geometry design is an important component that has a significant impact on the alignment of new paths. Road geometry planning involves sectional elements, visibility considerations, horizontal alignment, vertical alignment, and intersection elements to convey important factors such as design speed, topography or topography, traffic factors, design hourly flow and capacity, environment, and other factors [13]. This study aims to connect the Kertajati Toll Road section with the West Java International Airport in order to achieve efficiency and maximize services in traffic flow to the airport.

2. Literature Review

2.1 Road

Transportation is very important for human life and the development of global architecture [9]. Inter-regional transportation is inseparable from the development of a country's infrastructure, one of which is toll roads. Governments around the world are increasingly focusing on infrastructure spending, especially on building and maintaining roads [14]. Highways must guarantee user comfort and safety and enable efficient traffic operations while minimizing construction and maintenance costs [15].

Domestically in Indonesia, the construction of toll roads is currently a top priority because it is expected to boost the regional economy. Road infrastructure plays an important role in providing mobility for the efficient movement of people and goods and facilitating various commercial and social activities [16]. As a result, roads have a more significant impact on driving economic growth than other types of infrastructure [17]. With this, Indonesia has the potential to become a developed country.

but in fact many existing roads are necessary to meet the transportation needs of today's modern society [18]. One of the things that has not fulfilled these requirements is the existence of traffic jams that hinder mobility [19]. Therefore, the main goal of safe roads is to achieve safe, balanced and sustainable road performance [20]. Road planning must pay attention to rainwater runoff. Due to the alkalinity of the asphalt mixture itself, the pavement layer is easily damaged by standing water. The reason is that asphalt is not very resistant to flooding [21].

2.2 Road Geometric

Optimal highway can not be separated from planning according to the criteria. Road geometric planning is the first step in the progress of a country's infrastructure. In planning road geometry, attention needs to be paid to terrain and environmental conditions in order to carry out economical planning and provide optimal and efficient services [22]. The geometric design of the road is the physical design of the road which produces the cross section and dimensions of the road, vertical and horizontal sections [23].

The geometric design of this road takes into account the comfort and safety aspects for motorists. Selection, size, and placement of road geometry elements must meet design criteria such as visibility, vehicle stability, driver comfort, drainage, economy, and aesthetics [24]. The work carried out by highway planners includes alignment and road profile drawings consisting of coordinates and elevation, horizontal curve radius, vertical curve length, visibility calculation, and earthwork

calculation, as well as various calculations and analysis for alignment planning, design criteria, and constraint. while fulfilling optimization [10].

Transportation problem simulation has proven to be a reliable method for modeling complex systems, especially in the geometric design of highways [25]. With geometric planning that is less than optimal, it causes several problems that occur on the road. Vehicle speed depends on the driver's perception of the surrounding environment, which is influenced by road geometry, traffic control devices, driving environment, weather conditions, etc. Represents the driver's preferred speed when there is no other traffic [26].

2.3 Autocad Civil 3D

Road geometric planning needed at this time is speed, accuracy, and accuracy. By utilizing technological advances in the modern era so as to produce maximum results. One of them is the AutoCAD® Civil 3D application. This application is designed to make the planning process more effective and efficient in terms of cost, time and resources [27]. Civil 3D update has changed this paradigm so that design as well production is performed simultaneously. When executed manually, geometric design may be very cumbersome, tedious and quite helpless to costly blunders, the traditional technique is also based especially on a twodimensional analysis that doesn't make certain a pleasant layout [10].

On the road to the International Airport there are several bends and different elevations. Geometric planning is carried out using the AutoCAD® Civil 3D application and concerning the Road Design Standard of Indonesia 2021 [28]. This program works in graphic design and analysis so it is very appropriate for engineers to use this system.

AutoCAD® Civil 3D is a software engineering used to plan and design building construction projects, road engineering, and water work engineering, including the construction of dams, ports, canals, and embankments [28]. Civil 3D provides to create 3D models of the project and helps to adopt for both small- and large-scale projects [29]. This can help to implement things in 3D model visualization, speeding up time and reducing project budgets.

3. Method

Data is one of the main strengths in compiling a research and scientific modeling [30]. The process of systematic scientific research must begin with the identification of the right problem [31]. This study uses a qualitative method. The data needed in this research is contour data to Kertajati International Airport. This contour data is obtained from Google Earth which is then processed by Global Mapper. This research is located in Kertaji, Majalengka, West Java. The location of this research is in Figure 1.

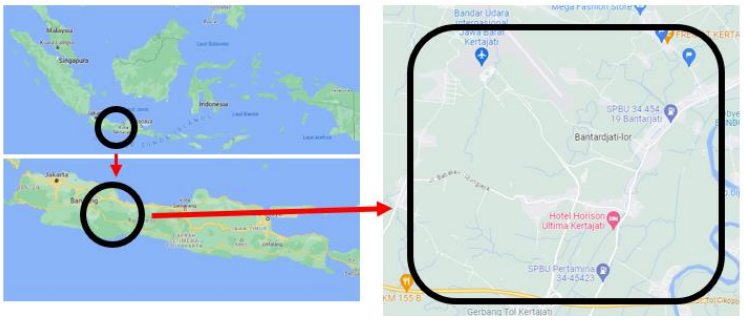

Figure 1 Research sites

In the geometric planning of this road, data from Global Mapper is imported into AutoCAD Civil 3D and generates horizontal and vertical alignments. The geometric planning of the road to the International Airport with planning criteria that functions as a Primary Collector Road, design speed of 80 km/hour, has 4 lanes in two directions using a median or middle barrier. In Autocad Civil 3D, the geometric planning of the road is planned which will later be analyzed regarding bends, slopes, excavations and backfilling. Autocad Civil 3D processes the initial and final STA shape and coordinate data as well as bend points which will determine the type of bend in horizontal alignment.

4. Result and Discussion

5.1 Road Alignment

From the design criteria described in sub-chapter 3, it is obtained that the road alignment connects the Kertajati Toll Road with the West Java International Airport, this alignment is very influential on road planning and there are things that the road alignment cannot pass through such as areas of nature reserves, settlements and places historic. The trace images are in Figure 2.

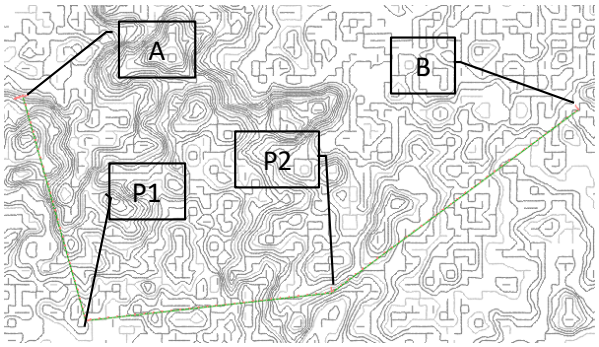

Figure 2 Road Alignment

This alignment is the first step in the operation of Autocad Civil 3D, starting from point A STA 0+000 to point B STA 4+139 meters. With the coordinate points found by Autocad Civil 3D, you get the straight distance (d), azimuth angle (Ø), and bend angle at points P1 and P2. After making this alignment, the next step is to determine the horizontal alignment with the results of Autocad Civil 3D calculations and analysis.

5.2 Alignment Horizontal

Horizontal alignment is the result of the first stage of road planning. The result of this horizontal alignment is the result of the formula used in equation 1.

$$R_{min} = \frac{Vd^2}{127x(e_{max} + f_{max})} \quad 1$$

In calculating the maximum radius used as the bend value in planning this type of bend, it is obtained from the design speed value, which is 80 km/h, with the maximum superelevation (emax) which is obtained in Table 5-1 in the 2021 Road Geometric Design Guidebook, which is 8 %, and the transverse tightness is obtained from Table 3-7 of the American Association of State Highway and Transport (AASHTO) in 2011. So that the value of the minimum bend radius (Rmin) is obtained with a value of 229,062. The horizontal alignment is shown in Figure 3.

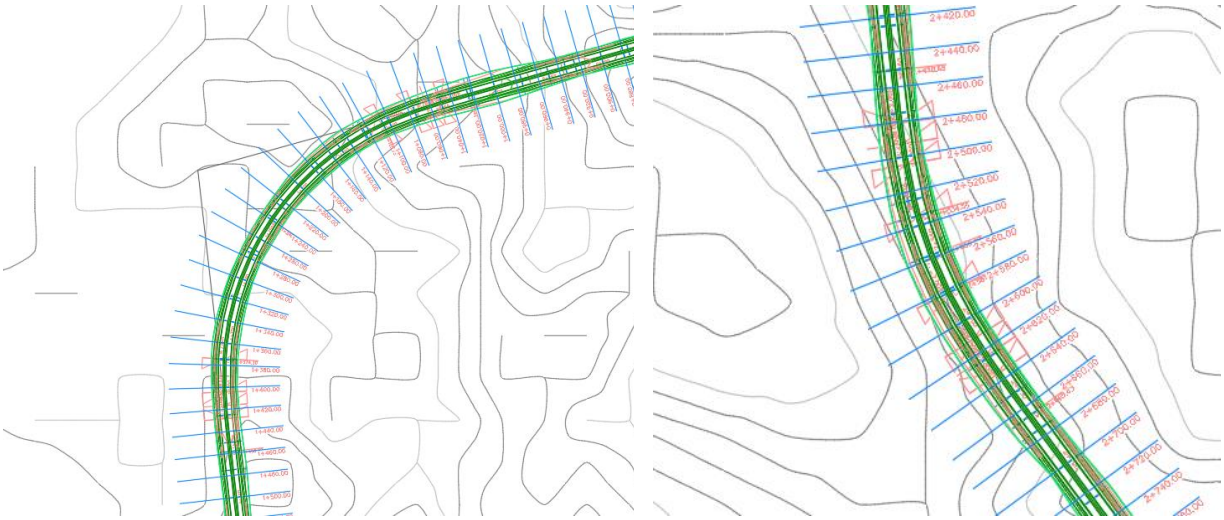

Figure 3 Alignment Horizontal

This horizontal alignment image uses a transition arc length (Ls) of 84 and a bend radius of 250 and a maximum relative value (e) of 7.9%. In this horizontal alignment, there are 2 bends at points P1 and P2 with the Spiral-Cyrcle-Spiral (SCS) bend type.

5.3 Alignment Vertical

After doing horizontal alignment analysis, the next step is vertical alignment. This vertical alignment is influenced by several things such as road function, road terrain, and results that allow for slope. This vertical alignment produces concave and convex curved sections. The vertical alignment image is shown in Figure 4.

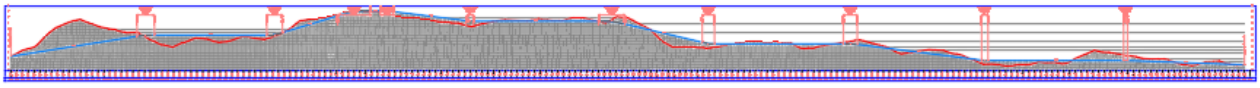

Figure 4 Alignment Vertical

From the results of the Autocad Civil 3D analysis, it produces several values from the vertical alignment. The data is contained in table 1.

Table 1 Data Alignment Vertical

Grade Out	A (Grade Change)	Profile Curve Type	Profile Curve Length	K Value	Minimum K for Stopp...	Minimum K for Passing Si...	Minimum K for Headlight Sig...	Curve Radius
1.57%								
0.00%	1.57%	Crest	59.819m	38.000	11.000	38.000		3800.000m
2.99%	2.99%	Sag	53.906m	18.000			18.000	1800.000m
0.00%	2.99%	Crest	113.801m	38.000	11.000	38.000		3800.000m
-1.21%	1.21%	Crest	46.126m	38.000	11.000	38.000		3800.000m
0.00%	1.21%	Sag	21.849m	18.000			18.000	1800.000m
-2.33%	2.33%	Crest	88.603m	38.000	11.000	38.000		3800.000m
0.00%	2.33%	Sag	41.970m	18.000			18.000	1800.000m
-1.24%	1.24%	Crest	47.168m	38.000	11.000	38.000		3800.000m
0.00%	1.24%	Sag	22.343m	18.000			18.000	1800.000m
-0.35%	0.35%	Crest	13.424m	38.000	11.000	38.000		3800.000m

After the horizontal and vertical alignment results are found, the next step is regarding superelevation.

5.4 Superelevation

5.5 The geometric planning of the curved section is intended to compensate for the centrifugal force received by vehicles traveling at a certain speed by forming a superelevation [32]. The transverse slope of this road is required at the planned bend. By using Autocad Civil 3D, you can find the results of superelevation drawings that are in accordance with road planning and criteria. The superelevation pictures on the 2 planned road bends are in the figure 5.

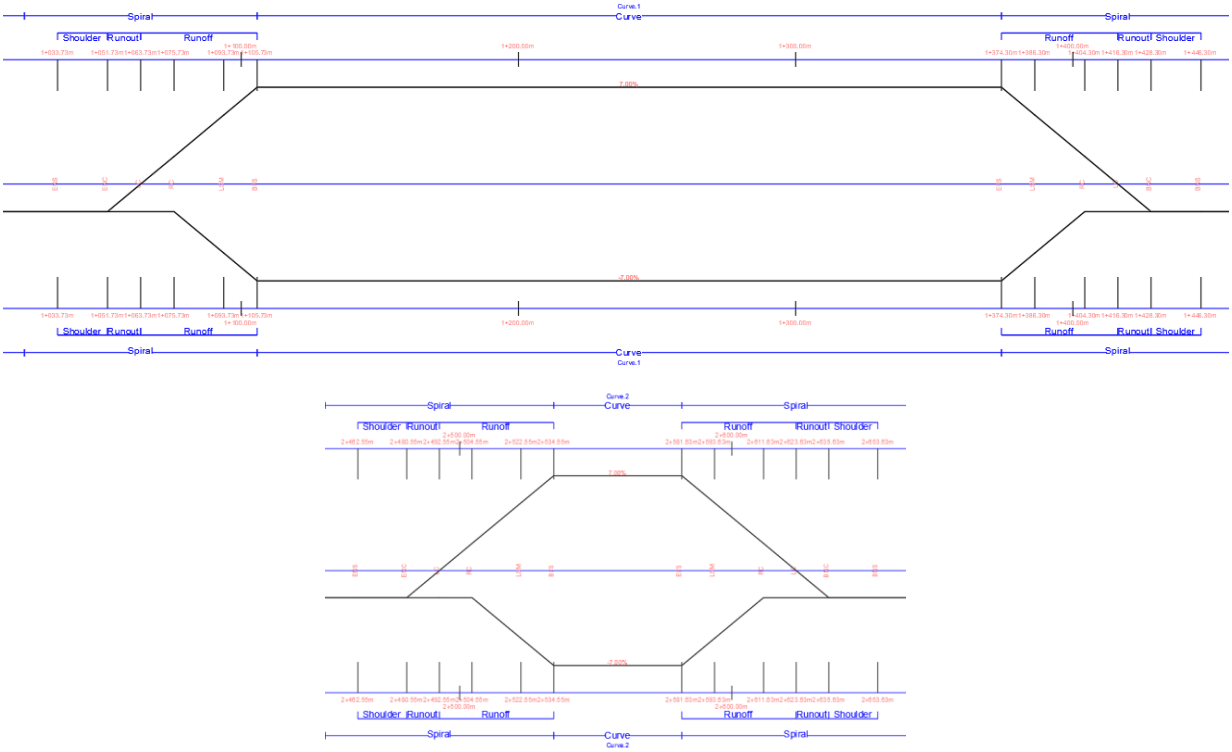

Figure 5 Superelevasi

5.6 Volume Cut and Fills

After carrying out an analysis for horizontal alignment, vertical alignment and super-elevation on the planned road, the volume of excavation and soil embankment along the road was found. The volume of excavation and stockpile analysis results using Autocad Civil 3D is in the table 2.

Table 2 Cut and Fills

Total Volume Table						
Station	Fill Area	Cut Area	Fill Volume	Cut Volume	Cumulative Fill Vol	Cumulative Cut Vol
4+000.00	0.00	16.74	0.00	478.82	36203.27	152417.08
4+020.00	0.60	4.70	5.97	214.47	36209.24	152631.55
4+040.00	2.50	2.25	30.94	69.53	36240.18	152701.08
4+060.00	6.03	2.18	85.26	44.24	36325.45	152745.31
4+080.00	1.32	4.78	73.49	69.52	36398.93	152814.83
4+100.00	0.00	18.22	13.19	229.95	36412.13	153044.78
4+120.00	0.00	30.27	0.00	484.84	36412.13	153529.62
4+140.00	0.00	34.81	0.00	650.79	36412.13	154180.41
4+160.00	0.00	32.68	0.00	674.89	36412.13	154855.30
4+180.00	0.00	21.19	0.03	538.63	36412.15	155393.93
4+200.00	0.00	12.41	0.03	336.00	36412.18	155729.93
4+220.00	0.01	10.35	0.06	227.64	36412.24	155957.57
4+240.00	0.00	12.61	0.06	229.65	36412.31	156187.22
4+241.31	0.00	12.55	0.00	16.50	36412.31	156203.72

From the results of Autocad Civil 3D calculations, the total amount of excavation on the planned road is 156203.72 m^3 and the volume of soil for embankment is 36412.31 m^3.

5.7 Cross Section

In road planning using Autocad Civil 3D, a longitudinal cross section is obtained to determine the left and right areas of the road used according to the planning criteria. The elongated cross-sectional picture is in the figure 5.

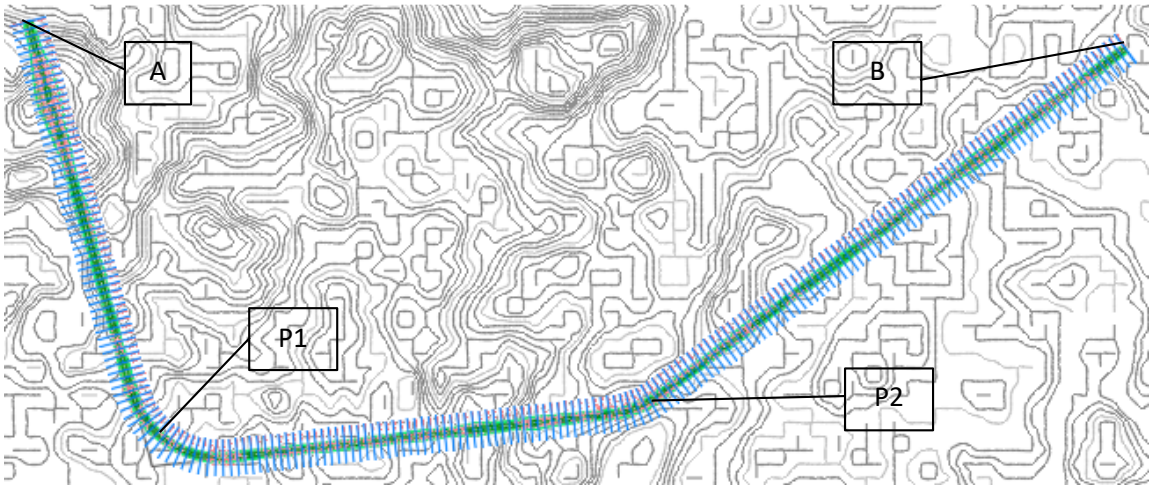

Figure 6 Penampang Memanjang

5. Conclusion

The results of the research on the geometric planning of the road at the Kertajati Toll Gate to the West Java International Airport produce horizontal and vertical alignments. There are 2 bends and the types of bends you get are Spiral-Cycrle-Spiral. From these results it was also obtained that the volume of excavation and embankment in accordance with the road planning criteria was 156203.72 m^3 for excavation and the volume of soil for embankment was 36412.31 m^3.

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