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Evaluation of Road Geometry at the Toll Gate to Kertajati International Airport: Case Study of Kertajati Toll Gate Road

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ABSTRACT

Many cities have adapted to overcome the challenges they face. Resources and weather changes are the main factors that make cities around the world intend to advance urban infrastructure in their countries. Majalengka is experiencing rapid economic growth marked by several major developments such as BIJB Airport, Kertajati toll gate, bridges, and many more. Especially the road to the Kertajati area, which has the West Java International Airport. Quick and precise planning is one of the first steps to achieve this. These findings also revealed that the excavation and embankment volumes required by the road planning requirements were 156203.72 m³ for the excavation and 36412.31 m³ for the embankment.

1. Introduction

Road accidents, traffic jams, air and noise pollution, a reduction in public transportation, and other issues plague cities in emerging nations. Many cities have adapted to overcome the challenges they face. Resources and weather changes are the main factors that make cities around the world intend to advance urban infrastructure in their countries. There are many urban infrastructure systems, one of which is roads. Roads are a type of infrastructure that are used to move people and products from one place to another (Zulfa, Rifai, & Taufik, 2022). Roads are an important part of everyday life as they provide people with access to travel and connect areas of a place (Rizqi, Rifai, & Bhakti, 2022).

Indonesian cities have been identified as being overly congested, especially Jakarta, the country's capital, which has regular traffic jams that may ultimately cause chaos and air pollution. (Putra & Warnars, 2020). 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 (Adiputra, Rifai, & Bhakti, 2022). In addition, toll roads also play an important role in realizing distribution in order for economic development to be evenly distributed (Gunawan, Rifai, & Irianto, 2022).

With the development of the economy, As people's well-being rises, so does the intensity of road use (Prasetyo, Widyastuti, & Kartika, 2020). So, the need for fast and ideal road geometric

Planning according to highway 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 (Stefanus, Rifai, & Nasrun, 2022). Road geometry design is a branch of road design that focuses on creating a road shape that may be utilized for quick, easy, safe, comfortable, and effective traffic control.

Rapid economic expansion in Majalengka is seen in a number of significant developments, including the BIJB Airport, the Kertajati toll gate, bridges, and many more. so that visitors to Majalengka can engage in various activities (Firmansyah, Rifai, & Taufik, 2022). Especially the road to the Kertajati area, which has the West Java International Airport. Quick and precise planning is one of the first steps to achieve this. Many software has been developed to overcome problems that arise in various fields, one of which is AutoCAD Civil 3D® (Maulana, Rifai, & Isradi, 2022).

An essential element that significantly affects how new pathways align is geometry design. In order to communicate crucial components like design speed, road geometry planning includes sectional features, visibility concerns, horizontal and vertical alignment, and junction elements. In order to increase efficiency and optimize services in the flow of traffic to the airport, this research intends to link the Kertajati Toll Road segment with the West Java International Airport.

2. Literatur Review

2.1. Road Geometric

Optimal highways must be kept 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 to carry out economic planning and provide optimal and efficient services. The physical layout of the road, which determines its size, cross-section, and vertical and horizontal sections, is known as the geometric design of the road. (Agniya, Rifai, & Taufik, 2022).

Driver comfort and safety are taken into consideration in the geometric design of this route. Road geometry components must be chosen, sized, and positioned to satisfy design requirements for drainage, economy, visibility, driver comfort, and vehicle stability. Highway planners do a variety of computations and analyses for alignment planning, design criteria, and constraint, in addition to creating alignment and road profile drawings with coordinates and elevation, horizontal curve radius, and earthwork computation. While completing optimization (Gaikawad & Ghodmare, 2020).

Transportation problem simulation has proven to be a reliable method for modelling complex systems, especially in the geometric design of highways (Bagdasar, Berry, O'Neill, Popovici, & Raja, 2020). Geometric planning that could be more optimal causes several problems to occur on the road. Traffic control systems and road layout have an impact on the driver's perception of their surroundings, which in turn affects the car's speed.

2.2. Alignment

A transitional arch connects many circular arc-shaped straight and curved sections that make up a road's horizontal alignment. The road's horizontal alignment consists of linear sections joined by bends. (Rizqi, Rifai, & Bhakti, 2022). Three curves are available for horizontal alignment: complete circle, spiral circle spiral, and spiral spiral. An arch that assumes the shape of a whole circle of arcs is called a full circle (FC)(Arifin & Rifai, 2022). When planning a roadway, one of the most crucial elements is horizontal alignment. Naturally, a highway's design needs to be exact. As a result, it may deliver excellent security, efficiency, speed, and comfort performance.

The functional clarity of the road topography, traffic volume, and the degree of service necessary are only a few of the numerous contributing elements to horizontal Alignment (Abdulhafedh, 2020). With functions that are by the site being developed, some aspects affect designing this horizontal Alignment. In designing a horizontal alignment, an understanding of design speed and horizontal curves is required. Horizontal curves themselves usually function as direction changers found on every two straight alignments on a highway.

A road's longitudinal portion is called a vertical alignment, also known as a road profile, and is separated by features like hills, sag arches that link the road's segments (Ulchurriyyah, Rifai & Taufik, 2022). Additives to highway geometry must be selected, measured, and planned to meet design requirements like sight distance. A step in the design process is drafting.

2.3 Autocad Civil 3D

Road geometric planning needed at this time is speed and accuracy, and utilizing technological advances in the modern era can produce maximum results. This application is designed to make the planning process (Pandey, Atul, & Bajpai, 2020). Civil 3D updates change this paradigm, allowing design and production to proceed simultaneously. Geometry design can be cumbersome when done manually.

On the road to the International Airport, there are several bends and different elevations. Utilizing the AutoCAD® Civil 3D program, geometric planning is completed. This program works in graphic design and analysis, so it is very appropriate for engineers to use this system.

Building construction projects are planned and designed using software engineering called AutoCAD® Civil 3D. Civil 3D makes it possible to create 3D models of the project and aids in project adaptation for both small- and large-scale undertakings (Mandal, Pawade, Sandel, & Infrastructure, 2020). This can help implement things in 3D model visualization, speeding up time and reducing project budgets.

3. Method

In this path, qualitative research methodologies are employed in geometric study. Following that, the data were assessed using the criteria for road geometric design. The Kertajati Majalengka road served as the site of this investigation. Global Mapper processes the contour data once it is extracted from Google Earth. The study is situated in Majalengka, West Java, in Kertajati. This research is located in Figure 1.

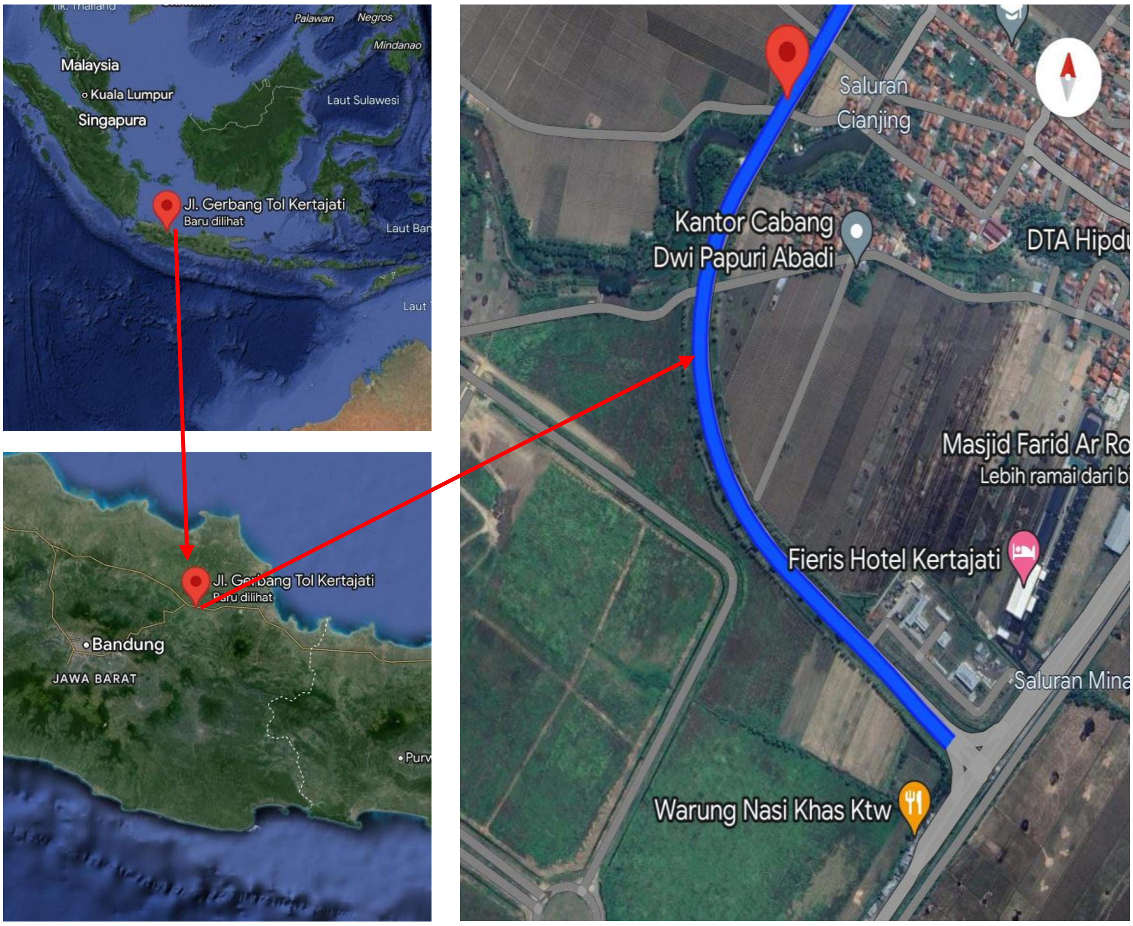

Figure 1 The research location

When imported into AutoCAD Civil 3D, Global Mapper produces alignments in both the horizontal and vertical directions. The route to the International Airport is designed with four lanes in each direction, a median or middle barrier, and planning requirements that serve as a Primary Collector route. The road's intended speed is 80 km/h. After the road's geometric plan is created in Autocad Civil 3D, it will be reviewed with regard to bends, slopes, excavations, and backfilling. Autocad Civil 3D processes coordinate data, the beginning and terminal STA shapes, and bend points, which indicate the type of bend in a horizontal alignment.

4. Result and Discussion

4.1 Alignment Horizontal

The outcome of the initial road planning step is horizontal alignment. Equation 1's formula yields the same outcome as this horizontal alignment.

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

The maximum superelevation and the design speed of 80 km/h (emax) of 8% are derived from Table 5-1 of the Roadway Geometric Design Guidebook 2021 when calculating the maximum radius of the curve value used in the planning of such curves. The lateral tightness is derived from American Association of

State Highway and Transportation Officials (AASHTO) in 2011. So, the value of the minimum bend radius (Rmin) is obtained with a value of 229,062. The horizontal Alignment is show in Figure 2.

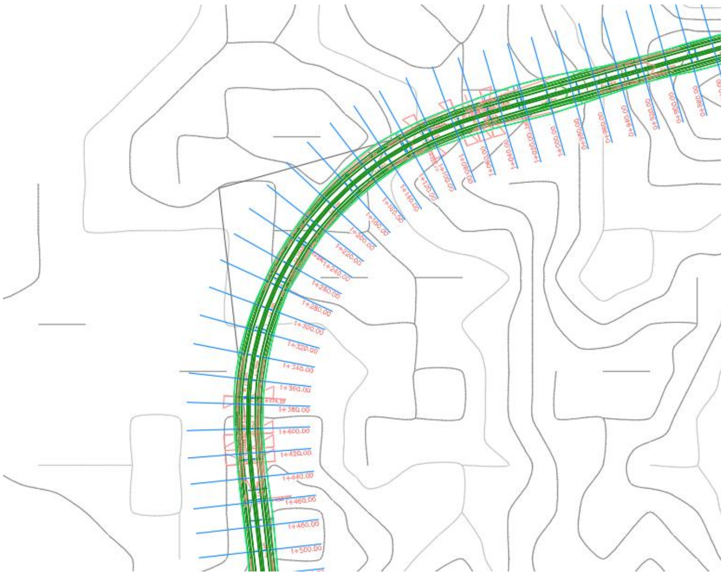

Figure 2 Alignment Horizontal

This horizontal alignement image uses a transition arc length (Ls) of 84, a bend radius of 250, and a maximum relative value (e) of 7.9%. In this horizontal Alignment, there are two bends at points with the Spiral-cylinder-spiral (SCS) bend type.

4.2 Alignment Vertical

After doing a horizontal alignment analysis, the next step is vertical Alignment. Several factors, including road function, road topography, and outcomes that accommodate slope, affect this vertical alignment. This vertical Alignment produces concave and convex curved sections. The vertical alignment image is show in Figure 3.

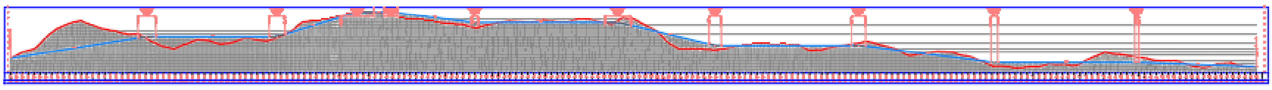

Figure 3 Alignment Vertical

The results of the Autocad Civil 3D analysis produce several values from the vertical Alignment.

4.3 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 historic places. The trace images are in Figure 4.

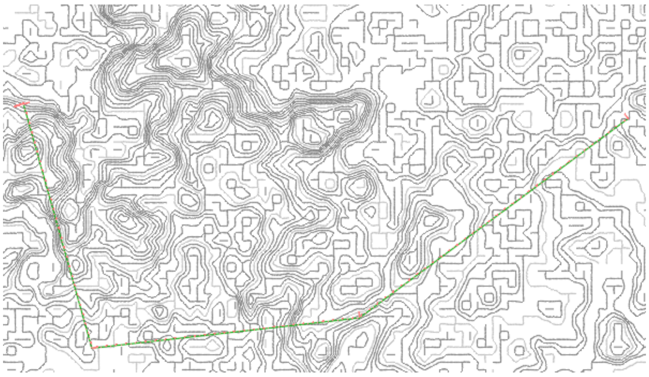

Figure 4 Road Alignment

The Autocad Civil 3D program begins with this alignment, which moves point A STA 0+000 meters to point B STA 4+139 meters. You may calculate the azimuth angle (Ø) and straight distance (d) using the coordinate points that Autocad Civil 3D discovered. The next step after creating this alignment is to use the outcomes of Autocad Civil 3D calculations and analysis to establish the horizontal alignment..

4.4 Superelevation

By creating a superelevation, the geometric design of the curved portion aims to counteract the centrifugal force experienced by cars moving at a specific speed (Subkhan, 2019). At the intended curve, this road must have a transverse slope. You may determine the outcomes of superelevation drawings based on road planning and criteria by utilizing Autocad Civil 3D. Figure 5 shows the superelevation images of the two planned road bends.

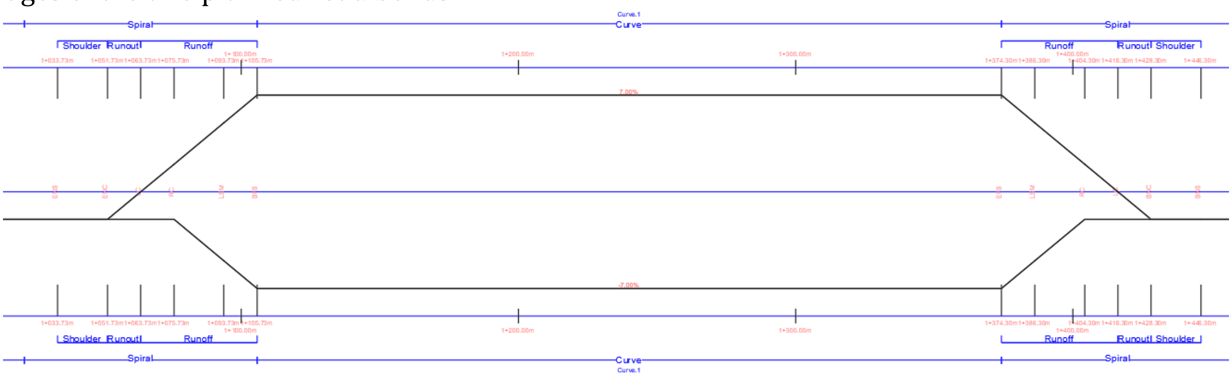

Figure 5 Superelevasi

5. Conclusion

Geometric planning analysis of the West Java International Airport to Kertajati Toll Gate route yields both horizontal and vertical alignments. There are two bends, and you obtain a spiral-cylinder spiral sort of bend. These findings also revealed that the excavation and embankment volumes required by the road planning requirements were 156203.72 m3 for the excavation and 36412.31 m^3 for the embankment.

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