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Research Article

The Development of the Application of Centrifugal Force in the Geometric Design of Highways for Driving Comfort on the Pangalengan-Banjaran Roads

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Abstract.

The Pangalengan-Banjaran road section has a winding geometric condition. The large number of bend geometries resulted in many accidents due to visibility, radius, and widening of the pavement at the corner, inappropriate road slopes caused many accidents to occur. The research method used in this research is the evaluative research method and quantitative method. The growth of suburban highway infrastructure in Indonesia has previously improved suddenly lengthways with economic growth. The geometrical strategy of the highway has previously remained planned by the typical requirements and needs of the purposes of the highway amenities constructed. The submission of physical science ideas in planning the geometrical stage as a meaning in smearing theoretic physical science to the identical-geometric design. A centrifugal strength in the physical science idea is a straightforward value in scheming geometric straight configurations of the road. Theoretical thoughtful of engineering term of scheming geometrical design viewpoint, has remained created on the method of centrifugal strength in the circumstance of effort on vehicles drive in the highway caisson disease. The operation has constantly remained built on variable quantity which remained strong-minded by thoughtful to spread on reason of rational usefully. These measures are lumped through dipping the result of bigger centrifugal strength. Furthermore, the submission is also able to decrease chance-disposed to areas due to the impact of size-centrifugal services on the geometrical plan of the highway.

Keywords: centrifugal force, geometric design, highways, driving comfort, Pangalengan-Banjaran roads

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1. INTRODUCTION

Pangalengan is one District in Bandung is quite have the potential of agriculture, plantation, farming and tourism in the province of West Java. Most of the tourism potential in Pangalengan District comes from the many natural tourism potentials such as lakes, hot springs, nature reserves and waterfalls. As for agricultural potential, among others, most of them are dominated by vegetables for basic community needs such as cabbage, tomatoes, carrots, potatoes and mustard greens. For plantation potential, it is dominated by quinine, tea and coffee. The potential for livestock is dominated by cows with milk, meat and fertilizer. Pangalengan District is surrounded by mountains and hills and is at an altitude of 1,500 masl with the highest peak on Mount Malabar with an altitude of 2,343 mdpl [1–4]. The research objectives are (1) Formulate the thought of centrifugal strength in the geometric plan of highways on the Pangalengan - Banjaran road; (2) Analyze the thought of centrifugal strength in the geometric plan of Pangalengan highways below current conditions; and (3) Development of the application of centrifugal force with the implementation of spiral - circle - spiral bends to improve driving comfort.

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The geometry design of the curved section is planned to reimburse for the centrifugal strength established by a vehicle itinerant at a speediness of Vr. For the safety of highway users, visibility and roadside clearance must be taken into account. c. Vertical Alignment According to the 1997 Bina Marga Guidelines on Geometric Planning Procedures for Inter-City Roads, the vertical configuration contains of a vertical sloping section and a vertical bent segment. Judging from the planning starting point, the vertical ramps can be either positive (incline) or negative (descending) or zero (flat) ramps. Curved vertical sections can be curved concave and concave convex [1, 5–9]

2. RESEARCH METHOD

The research technique used in this research is scheming research method. This research was supported available by investigative and observing the condition of the current highway sections using existing data, followed by estimating the ailment of the current highway segments with the Bina Marga 1997 method. Moreover, quantitative methods are used to calculate speed, density, and volume and look for relationships. The understood diagram of the research shown in Figure 2.

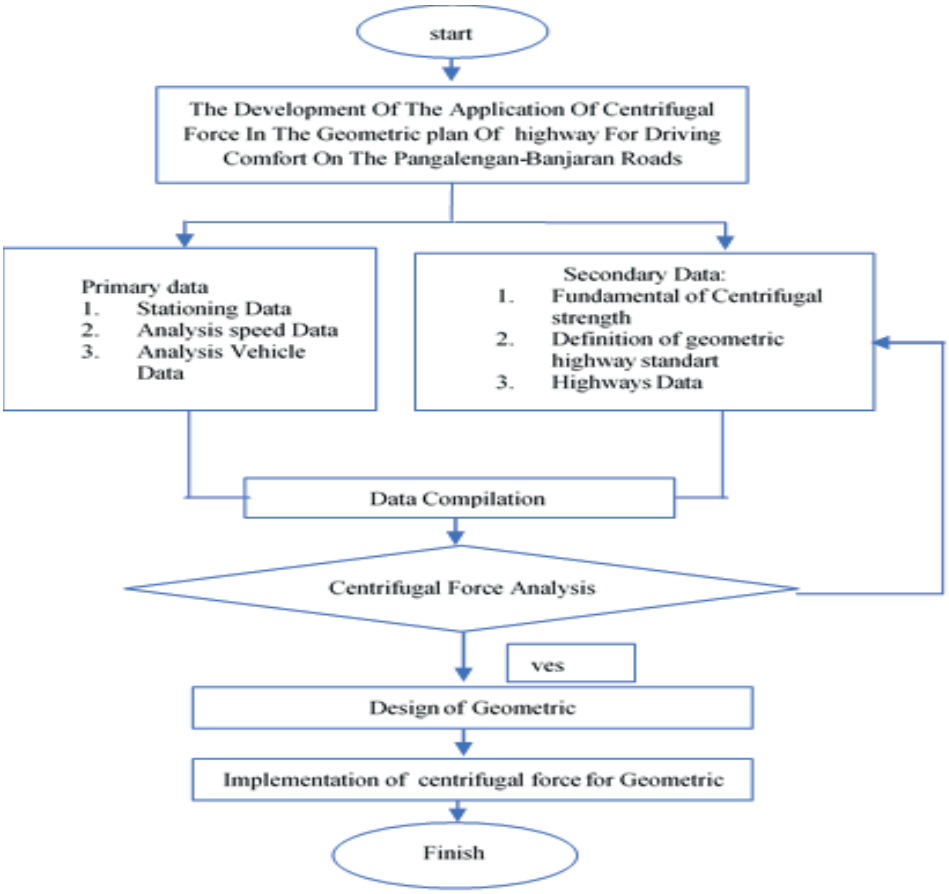

Figure 1: The understood diagram of the research.

The data collection technique used in this study was to make field observations to see and calculate the speed of the plan. Apart from field observations, data collection was also carried out by observing the relevant institutions to fulfill the geometric and traffic data [1]. This study method is expressed in methodology through the variable quantity used as follows: (1) Adjustable of typical Design Speed Vehicle; (2) Adjustable of typical Design Maximum Vehicle; and (3) Adjustable of Vehicle volume Number.

3. RESULTS AND DISCUSSION

3.1. Analysis of Centrifugal Force

The outcomes of the centrifugal strength study of the physic theory method specify that the centrifugal force is attained as of the study exposed in Figure ??.

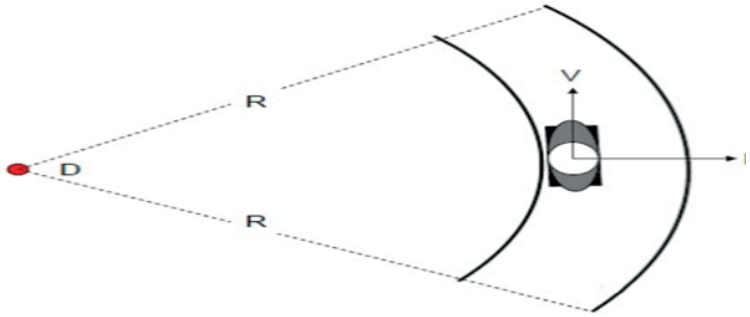

Figure 2: Formulation of centrifugal force.

$$F = m.a(1)$$

$$F = (G \,.\, V2) \,/\, (g.R)(2)$$

By considerate:

F = centrifugal strength

m = vehicle physique

a = centrifugal hastening

G = vehicle weightiness

g = gravitational force

V = vehicle speediness

R = bend radius

The construction of centrifugal force is studied created on the maximum strength based on the maximum weightiness of the vehicle calculated for the sub urban highway specified.

3.2. Superelevation Study on the Gradient of the Highway

The study of centrifugal strength on the gradient of the highway exposed in Fig. 3 is the elementary physic science valued at the highway curve at the site of analyze which is a proof of identity of the design of the centrifugal force implementation.

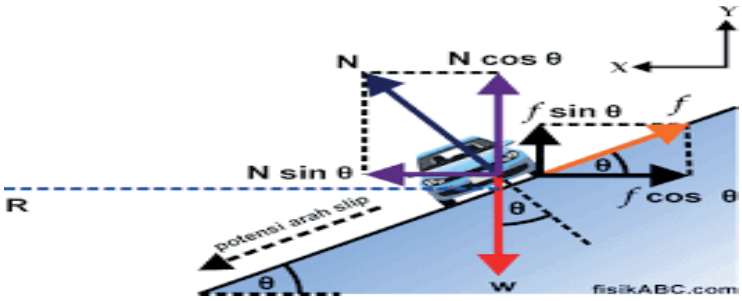

Figure 3: Centrifugal strength on the gradient of the highway.

3.3. Analysis of Arch Sharpness

Examination of curved perceptiveness is valued by expressing the calculation exposed in Figure 4 and Figure 5.

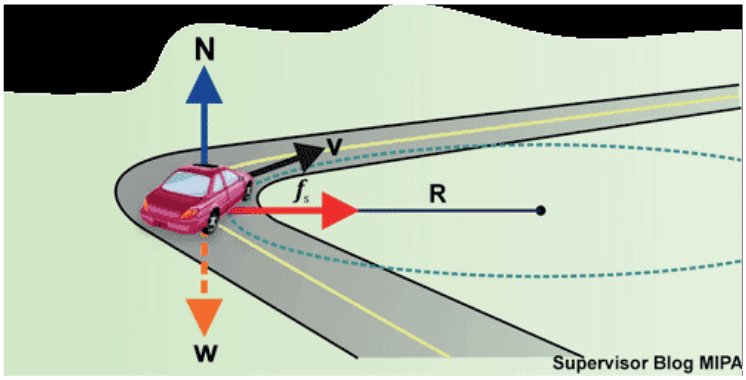

Figure 4: Analysis of the gesture strength of a vehicle on a curve.

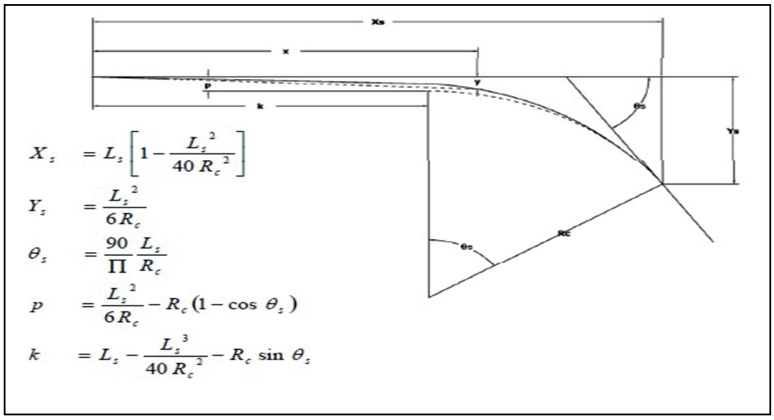

Figure 5: Valued bend of the arc in the curve.

Straight arc perceptiveness (bend) is articulated by the size of the arch radius (R) or the size of the curving (D). The curving (D) is the size of the curved angle which

outcomes in a 25 meter arc length. D = (25 / π.R). 360. D = 1432.39 / R. The bent radius (R) is powerfully prejudiced by the size of the superelevation (e) and the constant of friction (f) and the premeditated speed (V). Valued curving with the upstairs calculation is practical to the research plan with the features exposed in the superelevation plan attained. Stages of superelevation curve calculation analysis showed in Figure 6.

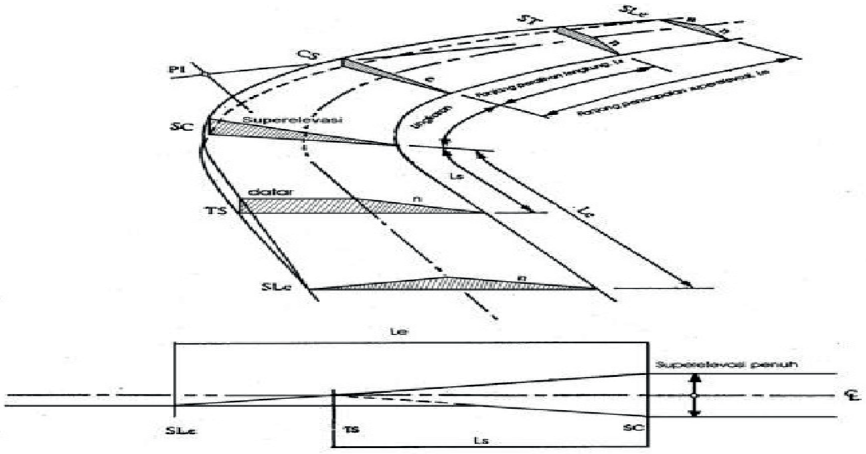

Figure 6: Stages of superelevation curve calculation analysis.

The design of the curved acuity is at that point used to control the category of curve in accordance with the variable quantity that determine the centrifugal force factors acting on the bend. The valuation of the centrifugal strength attained is in step to the submission of curves which permit the centrifugal strength to effort arranged the curve. Centrifugal strength that work great resolve be minimalized by the superelevation plan which reductions the adjustable centrifugal strength. Design speed is a aspect of the satisfactory centrifugal strength occupied and the superelevation plan used requirement be able to decrease the centrifugal strength at work excellently in the curve that is securely used for turning vehicles transient through the bend [1].

3.4. Analysis and Application of Centrifugal Forces on Bends

The superelevation plan approximation is strong-minded by conniving the gradient of the road with standard highway conditions expressed in the analysis plan of the superelevation design shown in Figure 6. The gradient of the highway on the curve is designed through the boundary among the edge of the farthest highway and the control of the highway due to modifications in altitude. The steps of estimate study are: Evaluation and Redesign of Existing Horizontal Alignment Geometric Conditions After being evaluated, geometric components that do not match the requirements will be re-designed to match the requirements. Here are the results of the redesign calculation

The PI.197 bend

Δmaks ≥ Δdesain ≥ Δmin

54.574° ≥ 127° ≥ 30.48°

Not according to the requirements

Modified coordinates so that the turning angle change

Δmaks ≥ Δdesain ≥ Δmin

18.85° ≥ 14.040° ≥ 12.79°

according to the requirements

Rdesain ≥ Rmin

30 m ≥ 130 m

Not according to the requirements

Changed to bend : Spiral-Circle Spiral

Rdesain ≥ Rmin

30 m ≥ 30 m

according to the requirements

Based on the outcomes of the study of the application and evaluation of the forces acting on the bends above, it shows that the analysis of the design parameters of the bends made shows that they are in accordance with the comfort requirements in driving after using the spiral - circle - spiral bend type [2]. PI-197 before evaluation showed in Figure 7 and PI-197 after evaluation showed in Figure 8.

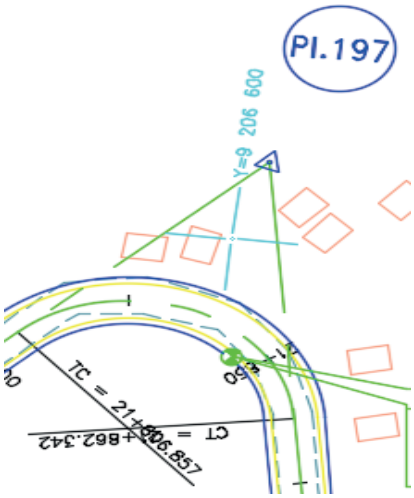

Figure 7: PI-197 before evaluation.

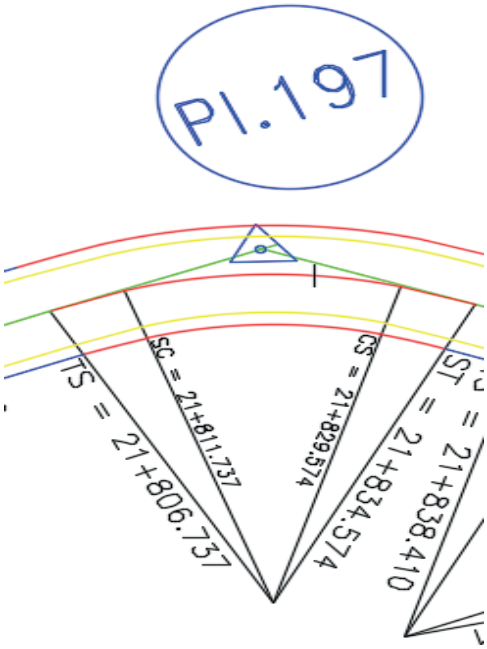

Figure 8: PI-197 after evaluation.

Based on the results of the analysis of the application and evaluation the forces acting on the bends above, it shows that the analysis of the design parameters of the bends made shows that they are in accordance with the comfort requirements in driving after using the spiral - circle - spiral bend type. So that driving comfort on the Pangalengan - banjaran road can be obtained by minimizing the centrifugal strength substitute on the corners by reducing the sharpness of turning corners and using better superelevation. The use of transitional arcs in the spiral - circle - spiral type of bend will reduce the magnitude of the centrifugal force acting on that level. So that the comfort of driving on these roads will be more felt by the application of the type of bend that uses a transitional curve [1–4].

4. CONCLUSION

Based on the consequences of data study, it shows that the Banjaran Pangalengan road is a road with curves that cause large centrifugal force to work. So that it causes discomfort in driving. Analysis of centrifugal strength is strongly prejudiced by the state of the vehicle speediness of the planned vehicle. The requirement to decrease the centrifugal force is greatly prejudiced by the super elevation plan of the arch which is planned from a specified minimum radius. By evaluating and implementing the design of a smaller centrifugal force, driving comfort can be improved by using a type of spiral-circle-spiral bend which has a transitional curve that allows the centrifugal force to work

less and with the use of superelevation that dampens the centrifugal force. So that the driving comfort will be felt by the driver with the view of the decrease in centrifugal force at the corner.

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