Civil Engineering Students‘ Conceptual Understanding On Centrifugal Force Implementation Through Geometrical Design Of Inter-City Road In Indonesia

Syaiful Syaiful, Juang Akbardin

Abstract: The development of inter-city road infrastructure development in Indonesia has already increased sharply along with economic growth and regional development. The geometrical design of the road has already been designed by the standard provisions and needs of the functions of the road services built. The application of physics concept in designing geometrical platform as a function in applying theoretical physics to the standardized-geometrical design. A centrifugal force in the physics concept is a basic principle in designing geometric horizontal alignments of the road. Conceptual understanding of engineering students in term of designing geometrical design perspective, has been based on the implementation of centrifugal force in the case of work on vehicles ride in the road bends. The implementation has ever been based on variables which were determined by understanding to apply logic of thinking constructively. The variables are determining the students‘ conceptual understanding on the parameters of the centrifugal force equation which is working on the bend. The analytical method which is regarded on the categories of parameter functions used, is the approach of implementing centrifugal force. Civil engineering students‘ conceptual understanding on geometrical designs through the implementation of centrifugal forces are able to increase the ability of analyzing process on the functions of comfort and driving safety. These procedures are collocating with reducing the effect of greater centrifugal force. Moreover, the application is also able to reduce accident-prone areas due to the influence of magnitude-centrifugal forces on the geometrical design of the road.

Index Terms: Centrifugal Force, Geometrical design, Engineering Students‘ Conceptual Understanding.

1 INTRODUCTION

The development of road infrastructure that is growing rapidly requires understanding socially and academically [1]. Inter-city roads in Indonesia that are connected with roads with traditional routes require development based on the development of more modern traffic volumes and planned vehicles. The geometric standard of inter-city road design requires an understanding of the driving safety and comfort factors [2-6]. Understanding of the geometric design design of inter-city roads in Indonesia by civil engineering students must be able to be implemented in accordance with the geometric standard requirements and engineering problems of road construction [7]. The concept of applying centrifugal force from the laws of physics requires an engineering approach to the geometric design of the road according to the geometric requirements of the function of the road [8-10]. The standard geometric formulation of the road with an estimate of the centrifugal force on an absolute road bend must be calculated based on good road design requirements.

a. Formulate the concept of centrifugal force on geometric designs of roads between cities in Indonesia
b. Analyzing the concept of centrifugal force in the geometric design of inter-city roads in Indonesia on the academic understanding of civil engineering students.
c. Implementation of understanding the concept of centrifugal force in the design of geometric designs between cities

In learning about the geometry of this highway, accuracy is needed, especially in the basic concepts of vehicle traffic that passes for each point 13]. So that proper analysis is needed so that the road planning is not in accordance with the applicable regulations. A discussion of the concept of a good road requires precise calculations so that vehicles passing through the road are comfortable [14-17]. Passengers will also feel safe if the roads and curves are planned with a suitable slope [18]. So that geometric planning is studied by students using materials from clear guidelines [19-22].

2. RESEARCH METHODS

This research approach is formulated in methodology with the variables used as follows:

a. Variable of characteristic Design Speed Vehicle
b. Variable of characteristic Design Maximum Vehicle
c. Variable of Vehicle volume Number

With the though flow diagram shown in figure 1:

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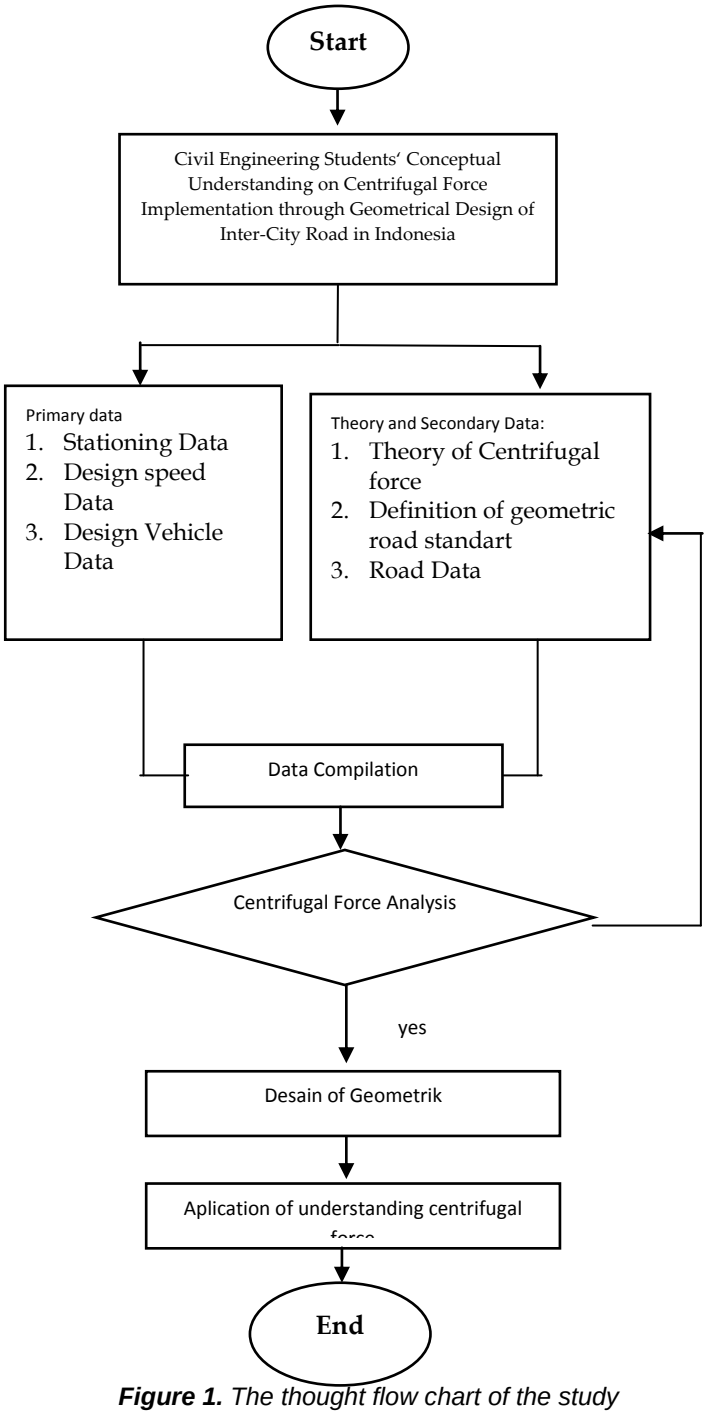

Figure 1. *The thought flow chart of the study*

3. RESULTS AND DISCUSSIONN

3.1 Analysis of centrifugal force

The results of the centrifugal force analysis of the physical theory approach indicate that the centrifugal force is obtained from the analysis shown in Figure 2.

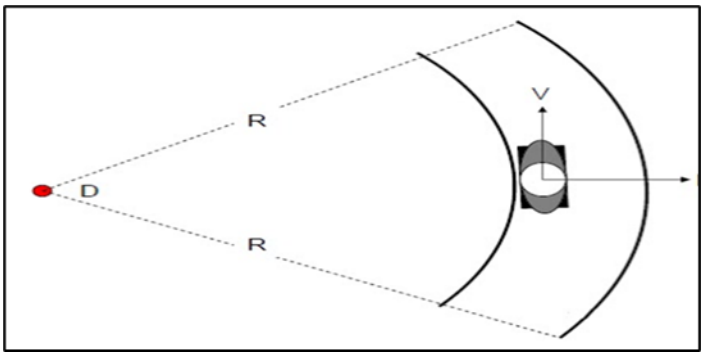

Figure 2. *Formulation of centrifugal force*

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

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

With understanding:
F = centrifugal force
m = vehicle mass
a = centrifugal acceleration
G = vehicle weight
g = gravitational force
V = vehicle speed
R = bend radius

The formulation of centrifugal force is analyzed based on the maximum force based on the maximum weight of the vehicle designed for the inter-city road specified [11-12].

3.2 Superelevation analysis on the slope of the road

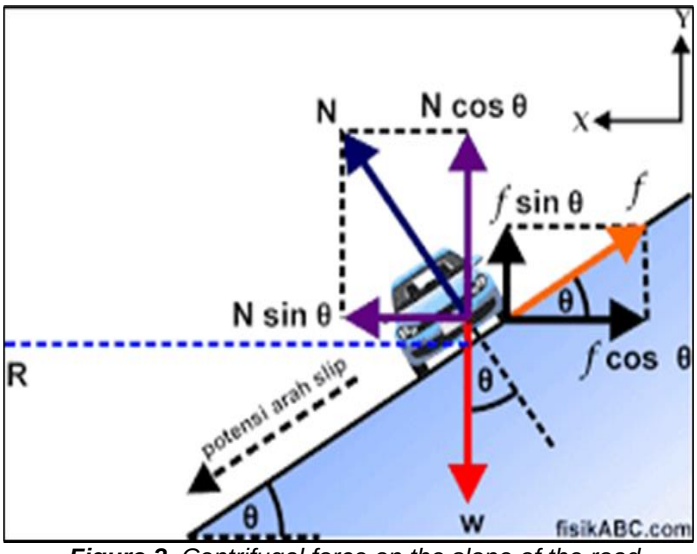

Figure 3*. Centrifugal force on the slope of the road*

The analysis of centrifugal force on the slope of the road shown in Figure 3 is the basic physical condition estimated at the road bend at the location of the study which is an identification of the formulation of the centrifugal force applied.

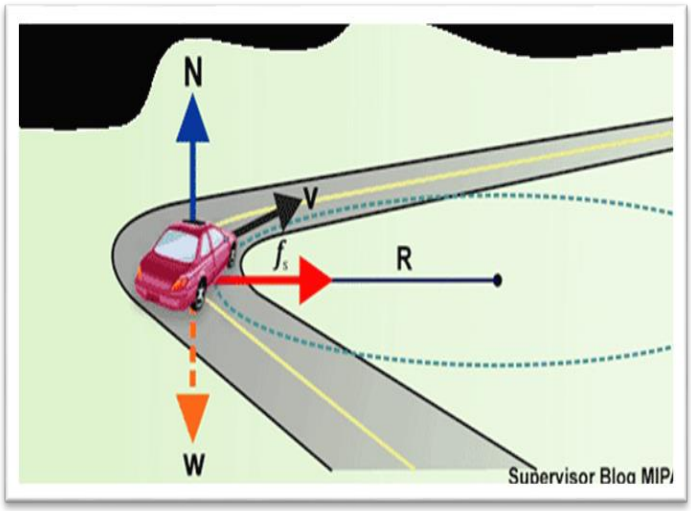

***Figure 4**. Analysis of the motion force of a vehicle on a bend*

Analysis of curvilinear sharpness is estimated by formulating the equation shown in Figure 5.

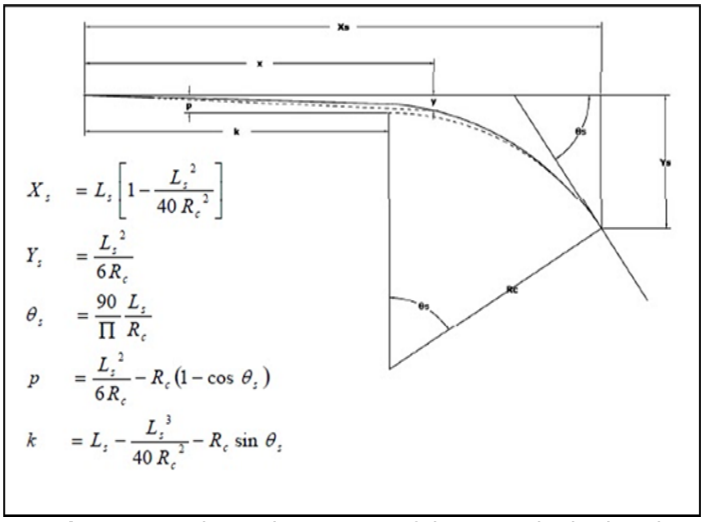

***Figure 5**. Estimated curvature of the curve in the bend*

Horizontal curve sharpness (bend) is expressed by the magnitude of the arch radius (R) or the magnitude of the curvature (D). The curvature (D) is the magnitude of the curved angle which results in a 25 meter arc length. D = (25 / π.R). 360. D = 1432.39 / R. The curved radius (R) is strongly influenced by the magnitude of the superelevation (e) and the coefficient of friction (f) and the planned speed (V). Estimated curvature with the above equation is applied to the research design with the characteristics shown in the superelevation design obtained.Superelevation design analysis with the formulation of the curvilinear sharpness is then used to determine the type of bend in accordance with the variables that determine the centrifugal force factors acting on the bend. The estimation of the centrifugal force obtained is adjusted to the application of bends which allow the centrifugal force to work on the bend. Centrifugal forces that work large will be minimized by the superelevation design which decreases the variable centrifugal force. Plan speed is a determinant of the permissible centrifugal force working and the superelevation design used must be able to reduce the centrifugal force working maximally in the bend that is safely used for maneuvering vehicles passing through the bend.

3.3 Analysis and implementation of centrifugal forces on bends.

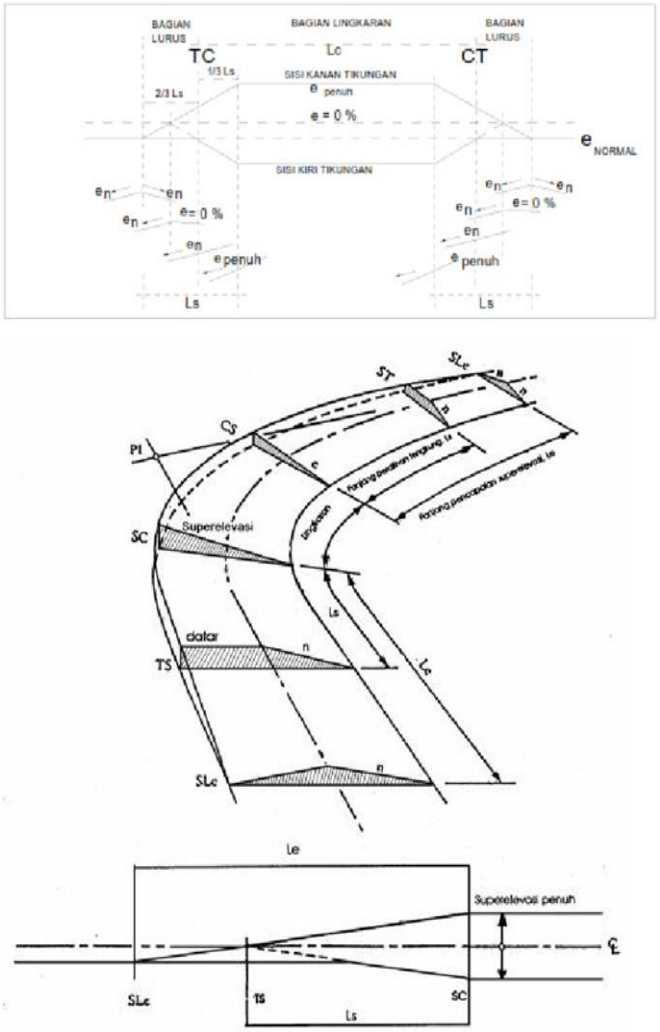

***Figure 6**. Stages of superelevation design estimation analysis*

The superelevation design estimation is determined by calculating the slope of the road with normal road conditions formulated in the analysis diagram of the superelevation design shown in Figure 6. The slope of the road on the bend is formed by the boundary between the edge of the outermost road and the edge of the road due to differences in height. The stages of estimation analysis are:

a. Stages calculate the slope from a straight road condition to a transition point or spiral curve at the TS point (Tangen Spiral).
b. The stage calculates the slope of the elevation by determining the spiral arch length until reaching the maximal height, the elevation is measured at the curve of the Circle. The attainment of the maximal value in the spiral or transverse arch elevation is determined by determining the spiral arch length with the indication of the SC (spiral circle)
c. Stages of calculating the circle's arch length are estimated based on the maximum radius of centrifugal force acting

maximally based on the specified plan speed. So that the maximum circle arch length can be estimated according to the provisions of the speed function that works on the road.

d. Steps 1 - 3 are repeated to estimate the different sides of the curve. Determination of superelevation design reference points by combining all superelevation design parameters shown in figure 6.

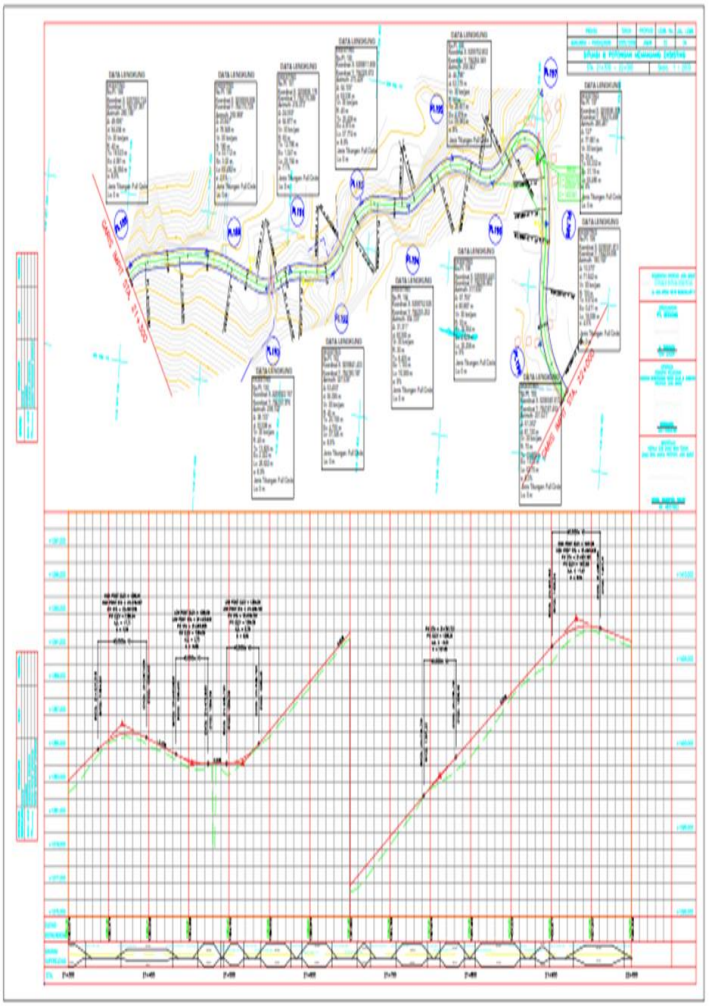

Figure 7. *Results of estimation of centrifugal forces on the implementation of road geometric designs.*

The results of the analysis and estimation of centrifugal forces obtained from the next research variables were analyzed and implemented in the geometric design of inter-city roads in Indonesia which were reviewed based on studies in certain locations with characteristic road functions determined based on the regional topographic terrain with certain technical requirements. The geometric design of the road estimated based on the centrifugal force that works can be measured by bend parameters based on the topography of the area used in the geometric path of the road. The results of the road geometric implementation are based on the estimation and analysis of centrifugal force shown in Figure 7. That the function of the road from the estimation of the function of the centrifugal force can be formulated by the suitability of the centrifugal force on the condition of the topography on the geometric path of the road. Geometric paths with some superelevational changes will be adjusted to the conditions of the road function so as to minimize the maximum sentriful force that works. Thus understanding centrifugal force on geometric design by civil engineering students can be formulated in determining a good geometric design for the function of road geometric needs. Understanding is determined how the estimation of centrifugal force can be estimated and implemented in a good geometric design and in accordance with the topographic field.

3.5 Analysis understanding on centrifugal force implementation through geometrical design

Understanding the implementation of centrifugal force indicated by the index results and discussion of learning outcomes analysis results are shown in the figure 8

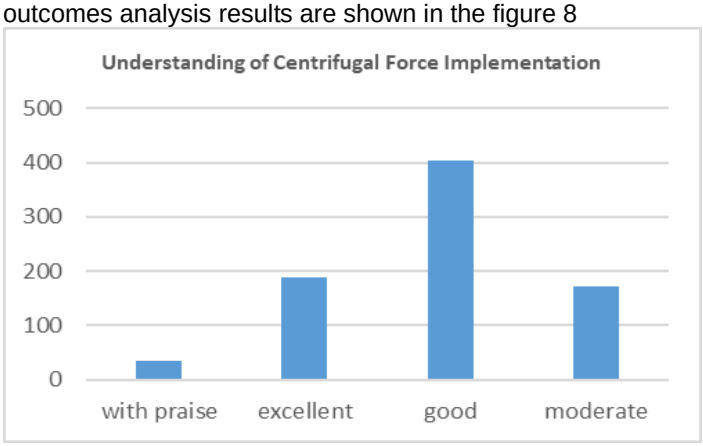

Figure 8*. Result understanding of centrifugal force implementation*

The results of understanding the implementation of centrifugal force indicate that the learning index shows that the results with praise are obtained based on the engineering ability in the analyzed case. The results are very well demonstrated with an indication of the application of the standards being developed. Good results obtained with the standard application process to meet the criteria used by the rules. And the results that are being obtained in accordance with the standard results with minor deficiencies.

4 CONCLUSION

Based on the results of the study, centrifugal force is strongly influenced by the condition of the vehicle speed of the vehicle plan. The need to reduce centrifugal force is strongly influenced by the superelevation design of the arches that are designed from the specified minimum radius. Understanding the centrifulgal style concept in road design in Indonesia is adjusted to environmental conditions and planned road functional standards.

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