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The Implementation of Autocad® Civil 3D for Road Geometric Redesign on Educational Areas: A Case Leumah Neundet Bandung

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Abstract. Infrastructures, especially those directly related to the transportation system and has a crucial role in society is the road. "Jalan Leumah Neundeut" is a road transportation infrastructure in Sukawarna Village, Sukajadi District, Bandung City, West Java, Indonesia. It has the potential for trip attraction because it very close to the education area and passed by public transportation. This paper's problem formulation arises based on the need for a well-road transportation infrastructure on "Jalan Leumah Neundeut". It will be geometrically redesigned in its horizontal alignment to be as ideal as possible to fit the design criteria using AutoCAD® Civil 3D because it does not meet the design criteria, especially regarding the road spaces and lane configuration. The geometric redesign of the "Jalan Leumah Neundeut" horizontal alignment resulted in 450 meters of the total road length, 7 meters of carriageway width with 2/2 UD (undivided with two lanes and two ways) type, 60 km/hour of velocity design, S-C-S type of road curve, 47 meters of LS value, 130 meters of curve design radius, 2% of normal super-elevation, and 8% of maximum super-elevation. With the results obtained, Jalan Leumah Neundeut can maximize its potential.

1 Introduction

Many of the policymakers in the world today focus on infrastructure development in their country. Infrastructures, especially those directly related to the transportation system, are one of the essential components that need to construct as well as possible because that existence can provide convenience for people in terms of mobility. The transportation system will only run well if the infrastructure is proper. If the condition of the transportation system and its infrastructures are ideal, this will positively impact society, especially for economic development. In the 1950-2004 periods, a study entitled "Infrastructure, Economic Growth and Population Density in Turkey" shows that railway length causes real GDP per capita to increase only in the long run. Still, it causes population density to grow both in the long and the short run. These results confirm that transportation infrastructure leads to a higher income and population in the investigated area [1]; [2].

One transportation infrastructure that has a crucial role in society is the road. The roads are built and maintained to make it easier for people and products to move from one place to another within a set time frame. The move should cause as minor damage to goods as possible and cause as little injury to people as possible injured [3]. The benefits of road existence are probabilities of creating a potential trip generation and attraction, especially using public transportation. Roads that pass through residential or densely populated areas raise the potential for a trip generation because many people from these areas want to move to other places to do activities such as work, study in school, and many more. Besides that, the potential for trip generation will also create high demand for better facilities, infrastructures, and transportation systems. Meanwhile, places such as offices, educational, and market or store areas can be potential for trip attraction because many people are attracted to these places. In line with this, places with the potential for trip attraction will eventually also have the same demands as areas with potential for trip generation, such as developing better facilities, infrastructures, and transportation systems.

In Indonesia, infrastructure development, especially roads, has not been evenly distributed and concentrated only in big cities. Now, Indonesia is in the developing stage of becoming a country with good road infrastructure. There have been many neither initiations nor realizations of road development projects such as highways, overpasses, underpasses, etcetera. In developing countries such as Indonesia, road construction aims to connect isolated places and boost economic growth through better mobility of people [4]. Therefore, it is essential to construct the road with good planning. It will ensure the roads can safely and comfortably pass. Also, the vital thing that must ensure is its users' safety. In addition, well construction planning and fit with the

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design criteria can encourage a better transportation system.

Bandung City is one of the areas where the existing road condition is still damaged and heavily damaged. Based on the latest data compiled in an official release entitled "Bandung City in Numbers 2023", the damaged road is 29.33 kilometers long, and the heavily damaged road is 32.40 kilometers long in 2022 [5]. It can undoubtedly strengthen the fact that more attention is needed to road conditions in Bandung City. The real action to overcome this problem is to carry out road repairs. One of the critical things that need to prioritize in road repair, besides the pavement condition, is the road geometric design. The geometric design, which plays a vital role in every road, focuses on road alignment. Horizontal alignment has three geometric components: curves, tangents, and transition. Meanwhile, vertical alignment is a longitudinal section with geometric additives such as crest curves, sag curves, and the gradients interfacing them [6]; [7]. If the road pavement conditions are good and the geometric is terrible, the road problems in Bandung City still need to repair. The excellent road geometric condition can provide mobile access for people who are safe, comfortable, and environmentally sound [8]. Therefore, it is necessary to review the existing road conditions in Bandung City and then redesign the geometric roads that do not meet the design criteria.

Jalan Leumah Neundeut is in Sukawarna Village, Sukajadi District, Bandung City, West Java. This road has the potential for trip attraction because it is close to educational areas such as the Politeknik Negeri Bandung, Politeknik Pos Indonesia, and Universitas Kristen Maranatha. Jalan Leumah Neundeut includes routes passed by modes of transportation such as Trans Metro Bandung (TMB) and Angkutan Kota (Angkot). As mentioned before, the potential for trip attraction raises opportunities to develop a better transportation system, facilities, and infrastructure. In this context, the area with the trip attraction, such as the one traversed by Jalan Leumah Neundeut, also could develop a better road transportation infrastructure. Then, an excellent geometric design for this road is also needed to accommodate people's needs in reaching educational institutions near this road with safe, comfortable, and environmentally sound, guaranteeing safety aspect. The role of geometric design is very crucial because one way to improve the safety aspect of the road is to improve the geometric design to reduce the occurrence and severity of road accidents [9]; [10].

In this paper, the authors present road geometric redesign recommendations, mainly focused on horizontal alignment, for Jalan Leumah Neundeut in Bandung City, West Java, Indonesia, as a road transportation infrastructure with a modern approach using computer software. The software used in this paper is AutoCAD® Civil 3D from Autodesk, Inc. AutoCAD Civil 3D® often used by civil engineers to plan and design roads, dams, ports, canals, embankments, etcetera. The AutoCAD® Civil 3D is newbie friendly for design and drafting, significantly dropping the time it takes to appliance design changes and evaluate multiple situations [11]. The results of this paper can be a reference for the government to make improvements for the Jalan Leumah Neundeut, especially in providing better public transportation infrastructure. And then this paper can also be used as a reference for future research to develop better transportation systems than the current conditions.

2 Literature review

2.1 Horizontal alignment

The geometric design of the road is a planning stage related to the physical form of the road, mainly focusing on alignment. Implementation of the road geometric design result must be passable properly by its users in their needs for the mobility of both people and goods. The main goal of geometric design is to create a safe, efficient, and economical path in maintaining its aesthetics and environmental quality. In geometric road planning, attention to the topographic and environmental conditions is essential to provide economic planning and services efficiently. Geometric design has a significant role in influencing the alignment of its paths [12]; [4]; [13].

Horizontal alignment is a component of the geometric design commonly known as the trace. This alignment can identify as the road axis projection on the horizontal plane. When viewed from the top view or satellite imagery, horizontal alignment can be visible as a straight line representing a straight road and curved lines representing bends on the road. Many factors influence the horizontal alignment design, including the terrain's functional classification, the design's speed, the traffic volume, the right of way, environmental conditions, and the level of service required. The horizontal alignment must provide better connectivity between one place with another [14]; [15].

Currently, curves in horizontal alignment have at least two types commonly applied in the field: S-C-S (spiral-circle-spiral) type and F-C (full circle) type. Previously, there was one more type of curve in horizontal alignment: S-S (spiral-spiral), but this type is rarely used nowadays in geometric design. The F-C (full circle) type is a bend with the curvature of one circle. The F-C (full circle) type is usually used on roads with a significant bend radius. The S-C-S (spiral-circle-spiral) type is a bend that consists of a fixed radius curve (circle) and intermediate form (spirals). And then, the S-S (spiral-spiral) type is a bend that consists only of two intermediate forms [9].

2.2 Road transportation infrastructuretal

To provide convenience for people’s mobility, a road ideally needs to be well planned so that the road can be used optimally. Road planning must comply with the latest applicable design criteria so that, apart from being used comfortably and safely, it can also be integrated into an excellent road-based transportation system. The existence of a road with an excellent transportation system will increase convenience for people's mobility. Road transportation infrastructures, which consist of the entire road network, are the largest and most widely used transportation infrastructure among others. The advantages of road transport infrastructure, compared to other types, are flexibility, door-to-door services, relatively high trip frequency, ease of use, low transportation costs, and speed and ease of transportation over short distances [16].

Road-based transportation can have an impact on improving the standard of living of the surrounding community. As mentioned before, road-based transportation is the most flexible, easy to use, and lowest transportation cost compared to other transportation. These advantages allow many people to travel efficiently and affordably. Besides that, low transportation costs contribute to the development of new markets, transforming previously unattractive locations into attractive locations to visit. In the case of private investment, these can lead to better employment opportunities. In essence, road-based transportation can create connectivity between regions so that the two regions can mutually encourage the progress of their respective regions, especially regarding socioeconomic development issues [17]; [18].

In essence, roads as transportation infrastructure have a very vital role. Not only providing short-term positive impacts such as providing access to move from one area to another efficiently, but roads as transportation infrastructure can also have long-term positive impacts on regional progress. One of the impacts of regional progress from a road-based transportation system is the opening of employment opportunities for the surrounding community. Thus, it is crucial to encourage the construction of roads that can operate the transportation system on it. Before carrying out construction, well road planning also needs to be well prepared, especially regarding the geometric design of the road. Many road conditions in Indonesia still need to fit the road geometric design criteria. The consistency of the geometric design needs to be considered carefully because all the elements in the geometric design affect the safety aspect [19]. The safety aspect can ensure the people who pass through on the road can get to their destination unharmed. With many people traveling unharmed, the economy will continue to run in the area, along with the unlimited mobility of people.

2.3 Autodesk AutoCAD® Civil 3D

Now, the world has entered the era of the Industrial Revolution 4.0, the main characteristic of which is the large amount of technological involvement in the industrial world. Applying technology at the planning, construction, and building maintenance stages is commonplace in construction. One of the technologies often used by engineers, especially in road planning, is the AutoCAD® Civil 3D software. The software is a product developed by a multinational company called Autodesk, Inc. One of the main functions of AutoCAD® Civil 3D software is for the geometric design of roads. This software is often used and very reliable for design and drafting. Their use reduces the time needed to change tool designs and evaluate various situations [20].

The road geometric design method using AutoCAD® Civil 3D allows geometric calculations to be carried out more accurately without having to do manual calculations on multiple sheets of paper like in the past. In addition, using AutoCAD® Civil 3D software via a computer device can reduce the possibility of calculation errors. Miscalculations are more prone to occur in manual road geometric design methods due to human negligence. AutoCAD® Civil 3D software's role in geometric design helps save a lot of time and effort so that the project can be completed on time [21]. Therefore, road designers worldwide now prefer software, such as AutoCAD® Civil 3D, in designing roads compared to manual methods.

AutoCAD® Civil 3D can be applied to all road construction conditions, whether when designing new roads or redesigning an existing route by improving the geometry of the road. Besides being capable of designing various kinds of road conditions, this software is also very flexible. It can be integrated with geographic mapping software such as Global Mapper® and ArcGIS®. The AutoCAD® Civil 3D software can be integrated into other BIM-based software, including the Autodesk Revit®. The Autodesk Revit® is excellent software in terms of architecture-based design. However, the software could not be used independently in the electromechanical-based designs. The workflow must involve the Autodesk® Civil 3D software, such as piping isometric design [22].

3 Method

Jalan Leumah Neundeut is in Bandung City, West Java, Indonesia. The total length of this road is 450 meters with 2/1 UD (undivided road with two lanes and one way) type. As previously mentioned, the location of this road is very strategic. It has the potential for trip attraction due to the Jalan Leumah Neundeut is very close to the education area and passed by public transportation, namely Trans Metro Bandung (TMB) Corridor III Cicaheum – Sarijadi route and Angkutan Kota (Angkot) Stasiun Hall – Sarijadi route. In addition, Jalan Leumah Neundeut connects with Jalan Prof. Dr. Surya Sumantri, which leads directly to Simpang Pasteur. The Simpang Pasteur is one of the strategic intersections in Bandung City due to this intersection is connected to the entrance gate to Bandung City via the Pasteur Toll Gate. With the potential of trip attraction, the opportunities to develop a better transportation system are wide open, mainly in providing reliable public transportation. These opportunities include developing a better Trans Metro Bandung (TMB) Corridor III Cicaheum – Sarijadi route or Angkutan Kota (Angkot) Stasiun Hall – Sarijadi route system to make it more efficient, providing better public transport facilities and infrastructures, improving convenience in using public transportation, involving technology in the transportation system such as online ticketing or real-time Trans Metro Bandung (TMB) or Angkutan Kota (Angkot) locations monitoring via a mobile application, and many more. In this case, the authors present a geometric redesign, especially horizontal alignment, of Jalan Leumah Neundeut as a transportation infrastructure to maximize the potential of trip attraction. More clearly, the location of Jalan Leumah Neundeut in Bandung City, West Java, Indonesia, in three view ranges from satellite imagery via Google Maps® and Google Earth® can be seen in Fig. 1 below.

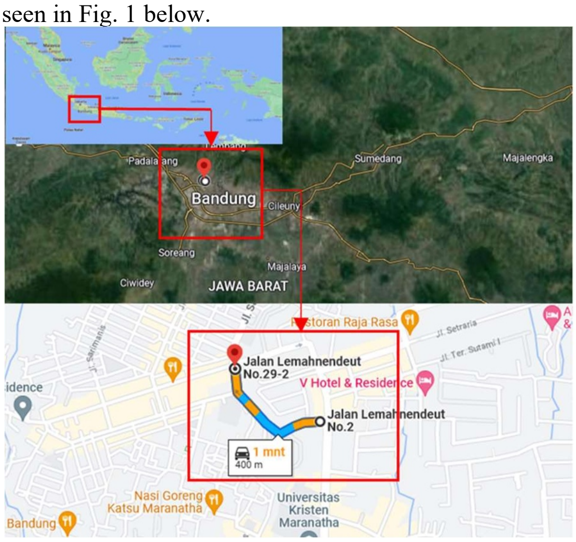

Fig. 1. The location of the research.

In this paper, the authors carry out the geometric redesign, especially the horizontal alignment, of Jalan Leumah Neundeut, Bandung City, West Java, Indonesia, in April 2023. The method used is a modern approach with the help of AutoCAD® Civil 3D software. A systematic and chronological scientific research process must begin with identifying the right problem [23]. This paper's problem formulation arises based on the need for a well-road transportation infrastructure on Jalan Leumah Neundeut. This road will be geometrically redesigned in its horizontal alignment to be as ideal as possible to fit the design criteria. The existing road still does not meet the design criteria, especially regarding the road spaces and lane configuration. Before carrying out the design, it is necessary to have the data regarding the road object to be designed. Data is one of the most fundamental components in compiling research and scientific modeling [24]. In this case, the author uses secondary data from several sources, such as journals with a similar topic, national road geometric standards containing all the road's design criteria, and regulations issued by Bandung City Government. In addition, the authors also use software such as Google Earth®, Google Maps®, and Global Mapper® to obtain the data needed in the geometric redesign of the road. The data obtained is then processed in the AutoCAD® Civil 3D software to gain the geometric redesign result of the road according to the design criteria.

4 Result discussion

Before redesigning the road geometric of Jalan Leumah Neundeut, the road needs to be classified first as part of determining the main design criteria. Based on the documents, namely Bandung City Regional Regulation Number 5 of 2022 and Indonesian Road Geometric Design Guidance (IRGDG), Jalan Leumah Neundeut can be classified into the Secondary Roads Network System with a function as a Secondary Artery Road and status as City Government Road. This road can be included in the Class I category to accommodate the operations of TMB Corridor III for the Cicaheum – Sarijadi route with the heaviest axle load greater than 8 tons based on Table 4-1 in the IRGDG [25]; [26]. After the road classification has been determined, the technical design criteria of Jalan Leumah Neundeut can be determined, also based on the IRGDG document as the most recent and valid guideline for geometric design in Indonesia. Specifically, the design criteria of Jalan Leumah Neundeut can be seen in Table 1.

Table 1. The Design Criteria for Geometric Redesign.

No.	Design Criteria	Value
1	Road Network System	Secondary
2	Road Function	Artery
3	Road Status	District Road
4	Road Class	I (first)
5	Specifications for the Provision of Road Infrastructure	Moderate Road
6	Road Terrain Classification	Flat (< 10%)
7	Lane Configuration	2/2 UD
8	Velocity Design, VD	60 km hour-1
9	Grade-max	5%
10	Maximum Cross-sectional Roughness (fmax)	0.17
11	Normal Super-elevation, (en)	2%
12	Maximum Super-elevation (emax)	8%

The road spaces of Jalan Leumah Neundeut can be determined based on the most significant design vehicle that will pass through the road. In this context, the most significant design vehicle is TMB which is included in large mass transit buses type. In IRGDG, the road requires at least 7 meters of carriageway width with 2/2 UD (undivided road with two lanes and two ways) type and 3.5 meters width of each lane to accommodate large mass transit buses. The existing Jalan Leumah Neundeut has only 6.6 meters of carriageway width with a 2/1 UD type [27]. Therefore, Jalan Leumah Neundeut needs to be widened, and the lane configuration also needs to be changed (mentioned in Table 1). All aspects of the design spaces for Jalan Leumah Neundeut can be seen in Table 2.

Table 2. Aspects of The Design Spaces.

No.	Design Spaces of the Road	Value (m)
1	Carriageway	7
2	Right of Way (Width)	10
3	Right of Way (Height)	5.1
4	Right of Way (Depth)	1.5

Jalan Leumah Neundeut has two points of intersection (PI). The geometric redesign, especially the horizontal alignment, starts by calculating the road curvature's minimum radius (Rmin) at each PI. The formula of Rmin is as follows:

$$R_{min} = \frac{V_D{}^2}{127(f_{max}+e_{max})} \tag{1}$$

The Rmin result calculated by the formula in equation (1) is 113.386 meters. The design radius used in subsequent calculations must be above the Rmin value. Hence, 130 meters was chosen as the design radius (RC). After that, the value of the road transition curve length (LS) can be calculated. In the IRGDG, the Directorate General of Highways, Ministry of Public Works and Housing has made Table 5-23 until 5-40 to make determining LS's value easier. Based on Table 5-23, with RC value is 130 meters, VD value is 60 km/hour, en value is 2%, emax value is 8%, and the width of one lane on Jalan Leumah Neundeut carriageway is 3.5 meters, then the value of LS is 47 meters.

Before implementing the calculations that have been done in the previous paragraph, the existing horizontal alignment of the road must be modeled in AutoCAD® Civil 3D with involved of Google Earth® and Global Mapper® software to obtain contour data and road coordinates. After modeling the existing road with the data obtained, the geometric redesign of Jalan Leumah Neundeut's horizontal alignment can be carried out in AutoCAD® Civil 3D, starting with the road curves. By entering the LS and VD¬ values into the horizontal alignment editor of AutoCAD® Civil 3D, the new road curves of Jalan Leumah Neundeut can be obtained. When the new road curves have been obtained, the straight road will also automatically adjust. In this new horizontal alignment, the total length of Jalan Leumah Neundeut is still 450 meters, with two curves represented by PI1 and PI2 marks. These two road curves use the S-C-S type, but in the following calculation, it is necessary to check whether the type of road curves still uses S-C-S or needs to be changed to the F-C type. A visualization of Jalan Leumah Neundeut's new horizontal alignment can be seen in Fig. 2.

Before continuing the redesign of Jalan Leumah Neundeut's horizontal alignment, all the road length components must be checked to comply with the standard in IRGDG. The road length components in this context are the length of a straight road (LL), the length of road curves (LC), and the length of road transition curves (LS). Checking the road length components is carried out through the following equations:

$$L_L \leq 2.5 \text{ minutes x } V_D \tag{2}$$

$$L_C \leq 6 \text{ seconds x } V_D \tag{3}$$

$$L_S \leq 0.5(2.5 \text{ minutes x } V_D) \tag{4}$$

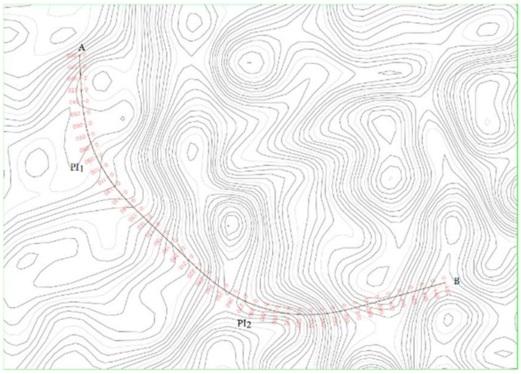

Fig. 2. Visualization of New Horizontal Alignment

More clearly, the result of the Jalan Leumah Neundeut's new horizontal alignment length components checking can be seen in Table 3 below. The result in this table is Processing and Calculations in AutoCAD® Civil 3D.

Table 3. The New Alignment Length Components

No.	Mark	Length Component	Value (km)	Equation Calculation Result (km)	Status
1	A – PI_1	L_L	0.0159	2.50	OK
2	PI_1	L_C	0.0519	0.10	OK
		L_S (In & Out)	0.0470	1.25	OK
3	PI_1 – PI_2	L_L	0.0425	2.50	OK
4	PI_2	L_C	0.0875	0.10	OK
		L_S (In & Out)	0.0470	1.25	OK
5	PI_2 – B	L_L	0.0643	2.50	OK

The horizontal alignment has two types of road curves, as mentioned in the literature review subtitle. In the design process, the S-C-S type is used first before the F-C type to obtain the LS value. The geometric redesign of Jalan Leumah Neundeut's horizontal alignment above used the S-C-S type. The LS value can be used in calculating the shift (P) value for transition at curves. The P value can also determine whether the horizontal alignment can still use the S-C-S or F-C type. If possible, the F-C type has priority to be selected as the road curve. The formula of the P value and the P distance (k) value to the tangent-spiral (TS) or spiral-tangent (ST) point are as follows:

$$P = \frac{L_S{}^2}{24R_C} \geq 0.25 \text{ meters} \quad (5)$$

$$k = L_S - \frac{L_S{}^3}{40R_C{}^2} - R_c sin\theta_s \quad (6)$$

The horizontal alignment uses the S-C-S type if the P value equals or exceeds 0.25 meters. Otherwise, the horizontal alignment uses the F-C type. After calculating, the result of the P value using the formula in equation (5) is 0.708 meters. At the same time, the result of the k value using the formula in equation (6) is 23.475 meters. Therefore, the road curve used to redesign Jalan Leumah Neundeut's horizontal alignment is still the S-C-S type. The final coordinates of Jalan Leumah Neundeut's new horizontal alignment can be seen in Table 4.

Table 4. Final Coordinates of New Horizontal Alignment

No.	Mark	Coordinates	
		X (meters)	Y (meters)
1	A	784979.473	9238668.260
2	PI1	784984.003	9238576.758
3	PI2	785140.475	9238427.841
4	B	785296.574	9238471.648

The curves of Jalan Leumah Neundeut are included as the combined curve, more precisely, a broken-back curve. It is because the length of the straight road between PI1 and PI2 is quite close to the curves. Due to limited land, making changes to the horizontal alignment is difficult. However, since the new horizontal alignment uses the S-C-S type, which provides for a transition curve, the problem of the straight road length that is quite close to the curves can be resolved as recommended in IRGDG. Thus, all the redesign results of this road can be accepted. The overall curve data of Jalan Leumah Neundeut's new horizontal alignment can be seen in Table 5.

Table 5. Overall Curve Data of New Horizontal Alignment

No.	Curve Component	Value
1	Curve Angle PI1, β	43.583°
	Curve Angle PI2, β	59.259
2	Arc Central Angle PI1, θ_C	22.868°
	Arc Central Angle PI2, θ_C	38.544°
3	Spiral Angle PI1 and PI2, θ_S	10.357°
4	Transition Curve Length PI1 & PI2, LS	47 meters
5	Curve Length PI1, LC	51.89 meters
	Curve Length PI2, LC	87.45 meters
6	Total Length PI1, Le = LC + LS	145.89 meters
	Total Length PI2, Le = LC + LS	181.45 meters
7	Curve Design Radius PI1 & PI2, RC	130 meters

Visualizing the S-C-S curves of the Jalan Leumah Neundeut's new horizontal alignment is necessary to provide a more realistic picture of all the curve data. Visualization of the S-C-S curves is also one of the steps to check whether the calculations and road model have been identical. As shown in Fig. 2, the visualization of the S-C-S curves is also obtained directly from the AutoCAD® Civil 3D software. However, it is just that there are a few modifications, namely adding notations, adding auxiliary lines, and adding dimensions. The S-C-S curves visualization of Jalan Leumah Neundeut's new horizontal alignment is shown in Fig. 3.

After all the results of the geometric redesign above are acceptable and comply with the design criteria based on the IRGDG document, the last step is to calculate the length of tangent runout and make a super-elevation diagram. The way to calculate the length of tangent runout is to use the simple comparison formula as follows:

$$L_{runout} = \frac{L_S \, x \, e_n}{e_{max}} \quad (7)$$

In the super-elevation diagram, LS length equals the super-elevation runoff length. Hence in equation (7). Fig. 4 provides the super elevation diagram resulted in this paper.

In this paper, the geometric redesign of Jalan Leumah Neundeut, especially in its horizontal alignment. The main goal of this paper is to provide a geometric redesign that meets the requirements of design criteria in IRGDG, particularly regarding the geometric redesign of a road that accommodates road-based public transportation. In this context, Jalan Leumah Neundeut has been geometrically redesigned, especially in its horizontal alignment, to accommodate Trans Metro Bandung (TMB) Corridor III for the Cicaheum – Sarijadi route as the most significant design vehicle on this road. The existing condition of Jalan Leumah Neundeut does not fit the

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design criteria as a road transportation infrastructure because of the limited road spaces and lane configuration. The carriageway width of this existing road is only 6.6 meters, and the existing lane configuration is 2/1 UD, which does not match the function of Secondary Artery Road and the Class I category.

The result of the geometric redesign of Jalan Leumah Neundeut's horizontal alignment uses the S-C-S type of curves. The existing components, such as the carriageway width and lane configuration, have been repaired in the new horizontal alignment. The carriageway width of this road widened from 6.6 meters to 7 meters, and the lane configuration of Jalan Leumah Neundeut needs to change from 2/1 UD to 2/2 UD to fit the design criteria. Thus, the authors believe that if Jalan Leumah Neundeut applied this new horizontal alignment, the potential of Jalan Leumah Neundeut as a road transportation infrastructure could maximize. The trip attraction potential of educational areas around this road could also maximize if this road transportation infrastructure geometric is excellent.

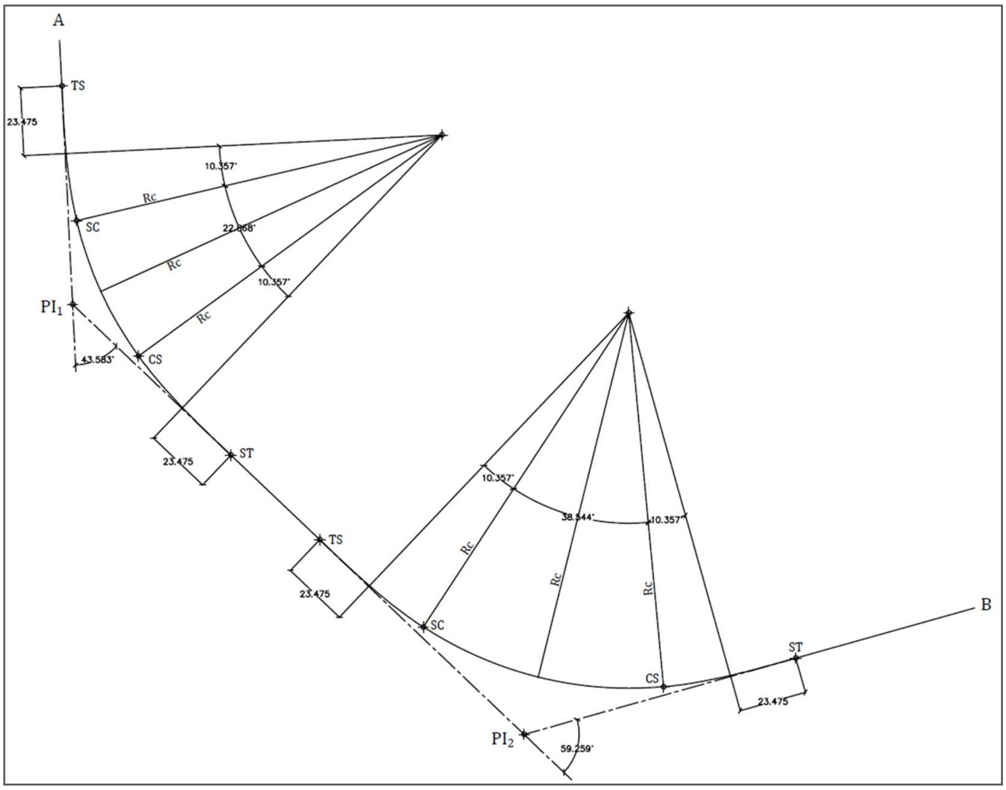

Fig. 3. S-C-S Curves Visualization

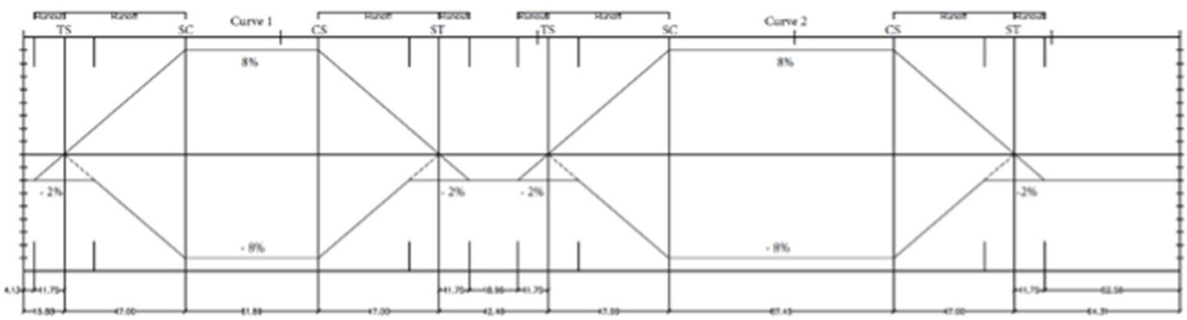

Fig. 4. Super-elevation Diagram

5 Conclusion

The geometric redesign of the Jalan Leumah Neundeut horizontal alignment resulted in 450 meters of the total road length, 7 meters of carriageway width with 2/2 UD (undivided with two lanes and two ways) type, 60 km/hour of velocity design, S-C-S type of road curve, 47 meters of LS value, 130 meters of curve design radius, 2% of normal super-elevation, and 8% of maximum super-elevation. With the results obtained, Jalan Leumah Neundeut can maximize its potential as a road transportation infrastructure that serves Trans Metro Bandung (TMB) as the most significant design vehicle on that road. Apart from that, these results can also maximize the trip attraction potential of the area around Jalan Leumah Neundeut by providing an excellent road transportation infrastructure.

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