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Optimalization of Geometric Design on Nagreg Ring Road STA 1+925 S.D. STA 3+200, Bandung Regency, West Java Provincy

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Abstract: ***The first phase construction in Nagreg Ring Road in the construction fromSTA 0+000 to STA 1+925 (not yet functioned) and STA 4+600 to STA 5+266 (functioned). The next phase will be from STA 1+925 to STA 3+950 (phase II plan) and STA 3+950 to STA 4+600 (phase III plan) and it has not been constructed. The Nagreg Ring Road is planned to be an Arterial Road which National status. Based on the technical data, the Nagreg Ring Road type is one way two lanes. The evaluations result mentioned that the geometric design from STA 1+925 to STA 3+200 doesn't fulfil the specification for rural road especially the vertical alignment which has the maximum grade more the 12%. The discussion for this paper is begun from STA 1+800 to STA 3+500 with the idea to have the best connection either with the previous or the following steps. Three alternatives were made in trying to achieve the specification. Then the earth work volume derived from those alternatives are calculated. The relative smallest earth work volume is chosen include the fill volume and the earth work operation between cut and fill. Nagreg is a hilly area that force the geometric design to surround it to fulfil the vertical alignment demand and it results a long curving road and a large volume of cut and fill will be needed. To overcome this problem there will be some alternatives considerations to design a bridge over the extreme fill and tunnelling instead of extreme cut. This type of design may shortened, fastened, and straightened the road route to achieve a more safe and comfortable travelling for the road needs. Beside it the environment surrounding will be saved.***

Keywords: Design Optimalization, Road Geometric, Safe and Comfort

1. Background

General

Roads as part of the national transportation system have an important role, especially in supporting activities in the economic, social and cultural and environmental fields. Roads are developed through regional development approaches in order to achieve equilibrium and equitable distribution of development between regions, establish and strengthen national unity, and form spatial structures in order to realize national development goals.

To clarify the problem and make it easier to analyze, it is necessary to make a problem boundary. The design and discussion carried out is a follow-up of the results of the previous Case Study which was carried out entitled The Case of Nagreg Ring Road Technical Planning, Bandung Regency, West Java Province. The results of the Case Study conclude that the solution was chosen for handling problems in Nagreg STA 1 + 925 Ring Road Technical Planning. STA 3 + 200 is in the form of Road Alinement Improvement, so that the discussion on the Final Project covers the following:

a) Improvements in vertical alignment with gradients of up to 12% and curvature that are not in accordance with the provisions contained in the inter-city road design.
b) The efforts to improve the design were carried out on the Nagreg STA 1 + 925 Ring Road Technical Planning s.d. 3 + 200.

Figure 1.1: Map of the Nagreg Ring Road Project Development Site
Source: Nagreg Ring Road Construction Project

2. Literature Review

Street

Pursuant to Law Number 38 of 2004 concerning Roads, Roads as one of the transportation infrastructures are important elements in the development of national and state Roads in accordance with the designation consist of Public and Special Roads. Public Roads are roads intended for public traffic, while Special Roads are roads that are built and maintained by people or institutions to serve their own interests. A special road segment when used for public traffic, as long as it is not detrimental to the interests of special road operators built in accordance with the requirements of public roads

2.1.1 Definition

Based on the Law of the Republic of Indonesia Number 38 of 2004 concerning Roads, that is meant by Road is a land transportation infrastructure which covers all parts of the road, including complementary buildings and equipment intended for traffic, which is at ground level, above ground level, below ground level and / or water, and above the water surface, except railroad tracks, lorry roads and cable roads.

2.1.2 Road Network System
2.1.2.1 Primary Road Network System
2.1.2.2 Secondary Road Network System
2.1.3 Road Function
2.1.4. Road Status
2.1.5. Village Road class
2.1.6. Road Classification Matrix based on Functions, Classes and Infrastructure.
2.1.6.1. Intercity Road Network
2.1.6.2. National Road
2.1.6.3. Classification by Road Class
2.1.7. Road Technical Requirements.
2.1.8. Road Parts and Utilization of Road Parts.
2.1.8.1. Space Benefits Road (Rumaja).
2.1.8.2. Street Space (Rumija)
2.1.8.3. Space Supervision (Ruwasja).
2.2 ROAD COMPLETE BUILDING.
2.3 OTHER BUILDINGS
2.3.1 Buildings for Traffic Safety.
2.3.2 Traffic Facilities and Regulatory Systems.
2.4 LANSEKAP ROAD.
2.5 ROAD DEVELOPMENT.
2.5.1 Road Technical Planning.
2.5.2 Implementation of Road Construction.
2.5.3 Worth the Function of the Road.
2.6 SAFETY IMPROVEMENT STRATEGIES.
2.6.1 According to Acting T-09-2004-B concerning Handling of Traffic Accident-Prone Locations
2.6.1.1 Prevention of accidents or accident prevention.
2.6.1.2 Handling techniques and accident reduction rates.
2.6.2 According to the Highway Technical Planning Practical Guidebook, 2000, Shirley L. Hendarsin.

3. Basic Theory

Roads as part of the national transportation system have an important role, especially in supporting activities in the economic, social and cultural and environmental fields. life, in fostering the unity and integrity of the nation, the territory of the state and the function of society and in advancing public welfare as referred to in the Preamble The 1945 Constitution of the Republic of Indonesia.

Roads are developed through regional development approaches in order to achieve equilibrium and equitable distribution of development between regions, establish and strengthen national unity to strengthen national defense and security, and form a spatial structure in order to realize national development goals.

3.1 Road Classification
3.1.1 Classification of Roads by Function.
3.1.1.1 Arterial Road
3.1.1.2 Road Collector
3.1.1.3 Local Roads
3.1.2 Classification by Road Class.
3.2 PLANNING CRITERIA
3.2.1 Vehicle Plan.
3.2.2 Volume of Traffic Plans.
3.2.3 Speed of Plan.
3.3 ROAD PARTS
3.3.1 Space Benefits of Roads
3.3.2 Road Space
3.3.3 Road Monitoring Space
3.4 CROSSING APPEARANCE
3.4.1 Composition of Cross section
3.4.2 Traffic lanes.
3.4.3 Lane
3.4.4 Shoulder Road
3.4.5 Median.
3.4.6 Pedestrians.
3.5 Visibility
3.5.1 Stop Viewing.
3.5.2 Preliminary Visibility.
3.5.3 Side-Free Areas.
3.6 Horizontal Alinemen.
3.6.1 Length of Straight Section.
3.6.2 Bend.
3.6.3 Traffic Line Widening in
3.6.4 Bend.
3.6.5 Combined Bend.
3.7 VERTICAL ALINMENT.
3.7.1 Maximum Ramps.
3.7.2 Vertical Curves.
3.7.2.1 Convex Vertical Curvature.
3.7.2.2 Concave Vertical Curves.
3.7.2.3 Length for Comfort.
3.7.3 Climbing Lane.
3.7.4 Alinemen Coordination.

4. Methodology

4.1. Working procedure for implementation of final duties

The work flow in the preparation of this Final Project is as follows

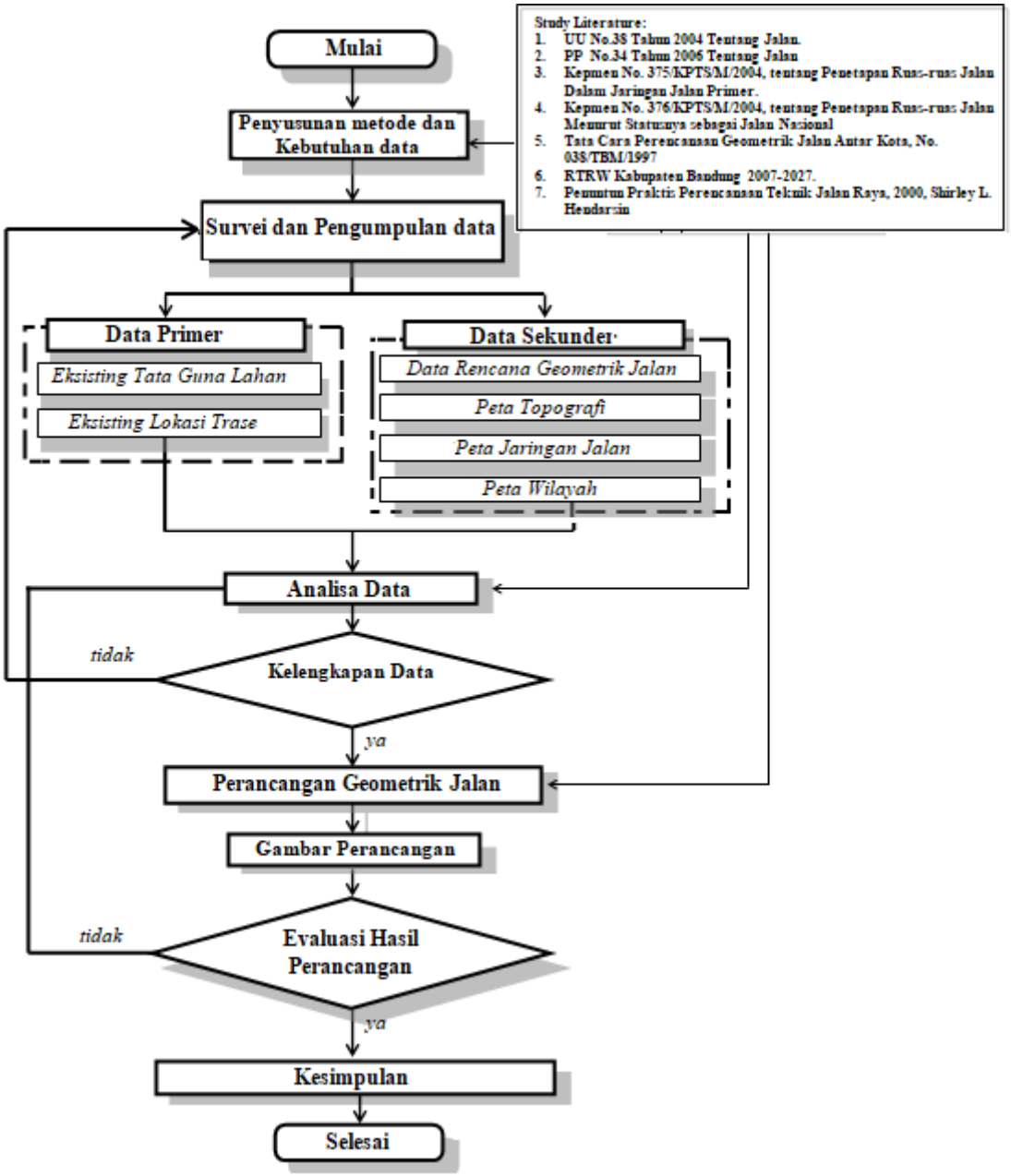


Figure 4.1: Final Project Flow Chart

4.2. DATA

The data used in the preparation of this Final Project consists of primary data and secondary data. As for the types of data needs, how to collect data and how to analyze data are as follows:

4.2.1. Data Needs.

Before conducting data collection, so that the data is effective and relevant to the needs in accordance with the topic of review, it is necessary to analyze data needs. Data requirements as analysis material are given as in table 4.1 as follows:

Table 4.1: Data Needs

Document	Document type	purpose
Primer	Existing land use documents document location plan	Environmental information & actual land use in the field
Sekunder	Data Perencanaan Teknis Pembangunan Jalan Lingkar Nagreg	Technical Planning Document for the Development of Nagreg Ring Road
	road network map documents	Information on the role, function and status of roads in the West Java region
	Map of landslides / natural disasters in West Java	Information on areas prone to landslides / natural disasters in West Java.
	West Java RTRWP	Land use information on the location of the Nagreg Ring Road plan according to government policy.
	Topographic document	Information on altitude and slope of the land..

Source: Results of data needs analysis

4.2.2 Konten document

Documents are very important input, for design. Based on the method of acquisition, the data can be divided into two, namely:

a) Primary document
b) Secondary document

4.2.3 Document Analysis

1) Technical Planning Document for the Development of Nagreg Ring Road.
2) Map of the West Java Province road network.
3) Map of landslides and natural disasters in West Java Province.
4) Province of West Java Regional Spatial Plan (RTRWP).

Design Method

The geometric design method that will be carried out on the Nagreg Ring Road technical design are as follows:

1) Identify the technical design of the Nagreg Ring Road plan.
2) Formulate problems in the design of the Nagreg Ring Road technical plan for matters that still do not meet the requirements for planning criteria / standards for inter-city roads.
3) The design is based on the Inter-City Road Geometric Planning Procedure (TPGJAK) No. 038 / T / BM / 1997.
4) Trying to improve the design that has not fulfilled these requirements by doing a design that refers to TPGJAK No. 038 / T / BM / 1997.
5) Evaluate the results of the design so that results can be obtained as expected.
6) Describe the results of the design of efforts to improve these problems so that conclusions can be obtained regarding the design conditions before and after the improvement of the design.

5. Conclusion

Based on the results of the discussion on the Nagreg Ring Road technical design and design improvements in STA 1 + 925 s.d. 3 + 200 for things that do not meet the requirements, it can be concluded as follows:

a) Based on traffic data from the 2009 survey using KAJI, the performance of the Nagreg Ring Road segment will be able to serve well for the next 10 years (2019).
b) The design design of vertical alignment improvement needs to be reviewed by the STA before STA 1 + 925 and STA after STA 3 + 200. Design improvements, can be produced technical design of a well-connected road starting from STA 1 + 800 s.d. STA 3 + 400 with a maximum slope of 10% according to TPGJAK.
c) 3 (three) alternative design designs were obtained to improve STA 1 + 925 vertical alignment s.d. STA 3 + 200. The selection of design alternatives is based on the difference in the volume of excavated earthwork and embankment work that is the lowest relative to the project design and each end can be well connected to the previous stage and the subsequent stage.
d) The selected design is Alternative III which is carried out based on the elevation of the STA 3 + 400 road plan towards STA 1 + 925 up to STA 1 + 800. The difference in the volume of landwork for the project's technical design is:
   - The soil excavation is 115,303.71 m3.
   - Landfill of 5,183.43 m3.
e) Estimation results required the cost of adding work to the design of the repair design is Rp. 9,608,319,000.00. (Nine Billion Six Hundred Eight Million Three Hundred Nine Nineteen Thousand Rupiah). The additional time required is 4 months with a production capacity of 1,000 m3 per day.
f) To get the ideal geometric design and meet the comfort requirements, at the extreme dig location STA 1 + 800 s.d. STA 2 + 650 (850 meters long) can be used for tunnel technology, while at the extreme embankment location STA 2 + 650 s.d. STA 3 + 000 (350 meters long) and STA 3 + 050 s.d. STA 3 + 400 (350 meters long) can be used bridge technology. Tunnel and bridge systems can be used as a solution to avoid extreme excavation and embankment work which causes difficult implementation techniques, long implementation times, high costs and large environmental damage.

6. Suggestions

Based on the results of the design and discussion, there are several suggestions regarding the construction of the Nagreg Ring Road, including:

6.1 Planning the technical design of the road in stages.

a) The construction of roads with physical construction of the construction carried out in stages, need to be considered so that in the design of technical design planning can be calculated carefully to the construction stages of the next road construction, so that road construction projects can be connected properly in accordance with applicable planning provisions.
b) To get the ideal road geometric design, you need to consider the following:
   - The trajectory route is confirmed to be the shortest path with the most efficient estimate of earthwork.
   - Geometric design must really refer to the provisions of the appropriate road planning. In vertical alignment, especially regarding the maximum ramps and vertical arch length, it is important to design according to the provisions.
   - To obtain optimal road product results in an effort to provide adequate road infrastructure, the geometric design of the road will be better if the minimum requirements on the provisions in planning can be fulfilled, but it will be much better if an ideal road geometric planning is carried out and meets the requirements of comfort.

6.2 Handling excavation slopes and embankment slopes

Nagreg STA 1 + 925 Ring Road Development s.d. STA 3 + 200 is an extreme location for excavation and embankment work. The design of the improvement design results, at the excavation site there is a height difference between the elevation of the original road plan and land up to 32.837 meters in STA 2 + 200, and at the embankment location there is a high difference between the road plan and the original land reaching 31,374 meters in STA 2 + 850. In this

case, it is necessary to consider the stability of the excavation slope and embankment by referring to the provisions concerning strengthening the slope / slope considering the formation of the road body requires high excavation and embankment work.

Handling of cliff reinforcement in excavated areas can be done by:
Design slope per 5 meter height, to be prepared by terracing (trap-trap), or adjusted to the condition of the soil carrying capacity on the slope. Terracing is the condition of a stepped slope that can be used in embankments or high excavation and serves to increase slope stability, facilitate maintenance, and can be used for landscaping.

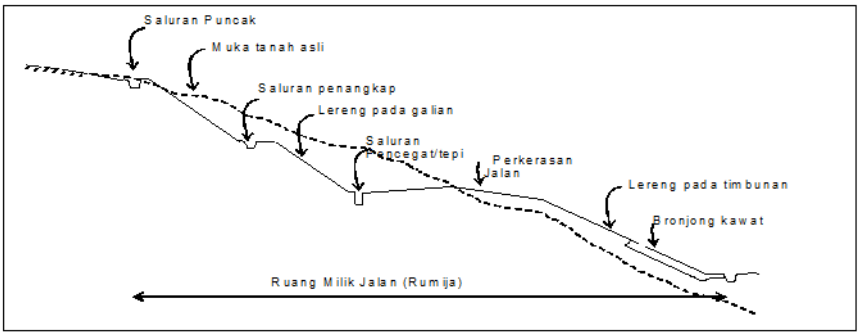
a) Handling the strengthening of the cliff in the embankment area can be done by:

- Compaction of landfill must be closely monitored, and proper density testing is carried out according to technical instructions.
- Using a gabion (gabion).
- Using stone pairs.
- Using a retaining wall.
- Using vetiver plants.
- Using a terramesh system.
- Using a geotextile membrane.

To determine the choice of handling embankment cliff reinforcement, firstly carried out inspection and research on the condition of soil bearing capacity on the embankment slope so that the most appropriate and most efficient handling method can be obtained.

b) Making slope drainage.
Slope drainage, including surface drainage applied to protect slopes from erosion hazards or decrease in stability caused by surface water in excavation, urugan, and natural slopes or groundwater that seep into the slope can affect the stability of the road below.

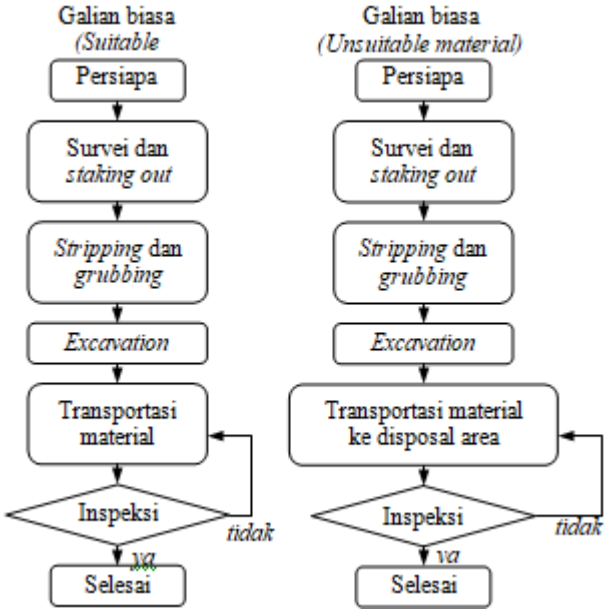
In illustration, it can be done by handling drainage on the slopes as shown in Figure 6.1. following.



Source: Slope drainage, "training technology construction training material", Pusbiktek, 2009

6.3 Handling excavation and embankment work.
Excavation work and embankment on the construction of the Nagreg Ring Road are dominant jobs. Where in this activity most of the excavation will be used as a payment. The improvement design results show that the height difference between the original soil for the excavation area reaches 32.837m and the embankment area reaches 31.374 (see table 5.18).

6.3.1 How to handle excavated area work.
a. Excavation for disposal. Ordinary excavations that cannot be used for embankment work because they do not comply with the specifications of the specifications are disposed of outside the project location / disposal area.



6.3.2 How to handle the work of the embankment area
The embankment area includes STA 2 + 650 s.d. STA 3 + 000 and STA 3 + 050 s.d. STA 3 + 400 or 700m long. The improvement design results show that the height difference between the original land for the embankment area reaches 31,374m (see table 5.18).

Further inspection is carried out on excavated soil whether it is suitable material or unsuitable material according to specifications. What is used is suitable material, while unsuitable material is discharged to the disposal area.

Sebelum dilakukan pekerjaan penimbunan, terlebih dahulu diadakan pemeriksaan lokasi timbunan (*trial compaction*) untuk memastikan bahwa lokasi telah sesuai dengan ketentuan teknis.

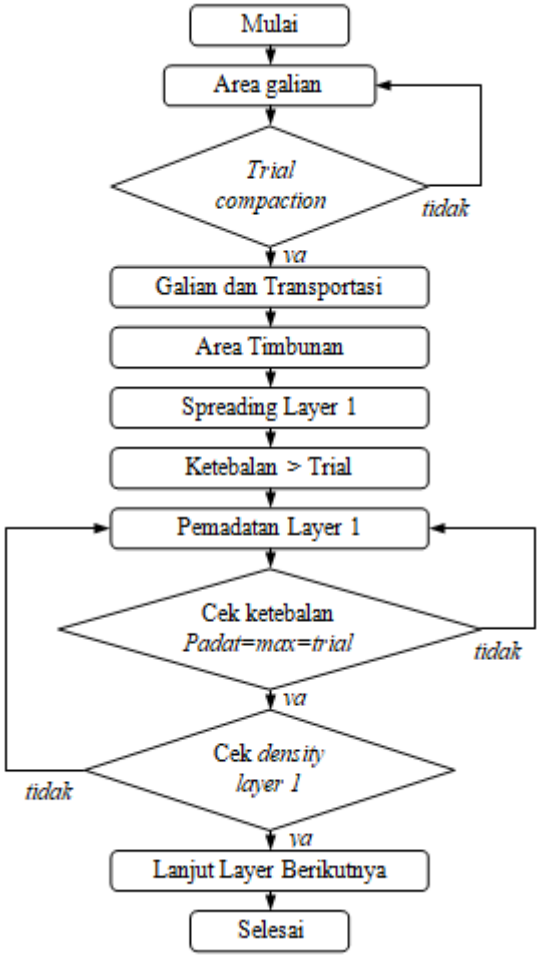


Figure 6.7: Stock / embankment flow chart

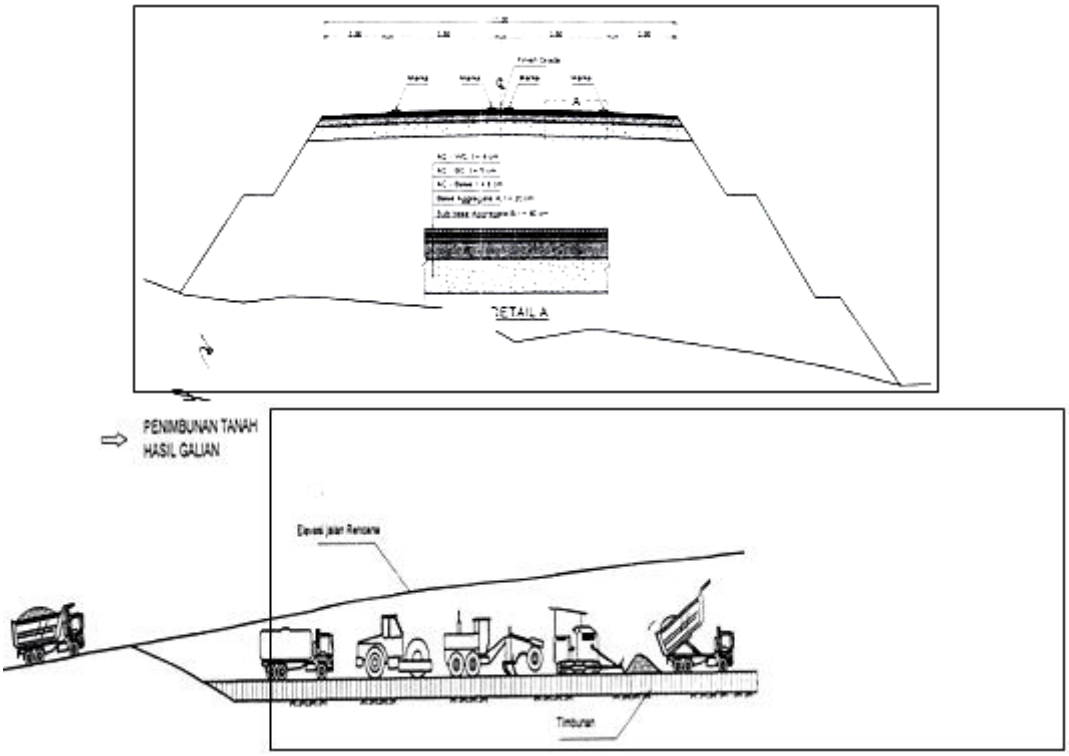


Figure 6.8: Sketch the cut across the embankment area.

6.3.4 Prevention of the emergence of side barriers around rumaja.

With the construction of the Nagreg Ring Road, it will better facilitate the people who use the road. This can trigger the growth of traffic and activities around the Nagreg Ring Road both directly and indirectly. These activities can be in the form of villages around the road and buying and selling activities considering that around Nagreg is a place for street vendors selling typical souvenirs of Bandung and its surroundings. Generally, traffic congestion is caused by high side barriers. This is very possible, Nagreg Ring Road will become new land for traders to sell similar things that have the potential to cause congestion and other traffic problems.

To overcome this, it is necessary to encourage traders to occupy locations and provide parking spaces outside Rumaja. Things that can cause disruption to the traffic service function must be avoided. Furthermore, it is necessary to apply and supervise the provisions of the use of Rumaja, and Rumija around the road stipulated in Law No. 38 of 2004 concerning Roads and Government Regulation No. 34 of 2006 concerning efficient roads. These efforts can be done with socialization, invitations to law enforcement efforts by giving sanctions to violators.

6.3.5 Prediction of Nagreg Ring Road performance plan based on KAJI.

Estimated traffic planned through Nagreg Ring Road according to table 5.5. (Chapter V, sub-chapter 5.3., Sub-section 5.3.3.)

Table 6.1: Estimated Traffic Volume of Nagreg Ring Road (2009)

Arah	Volume Lalu-Lintas (kend/jam)				
	Ringan (LV)	BeratMenengah (MHV)	Bus Berat (LB)	TrukBerat (LV)	Sepeda Motor (MC)
Bandung	636	31	47	77	324

Source: table 5.5. (Chapter V, sub-chapter 5.3., Sub-section 5.3.3.)

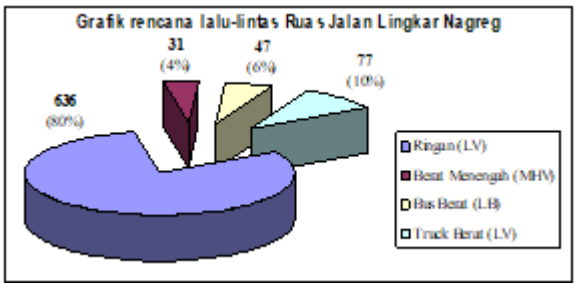


Figure 6.12: Graph composition of estimated Nagreg Ring Road traffic estimates for 2009

Source: Results of data analysis

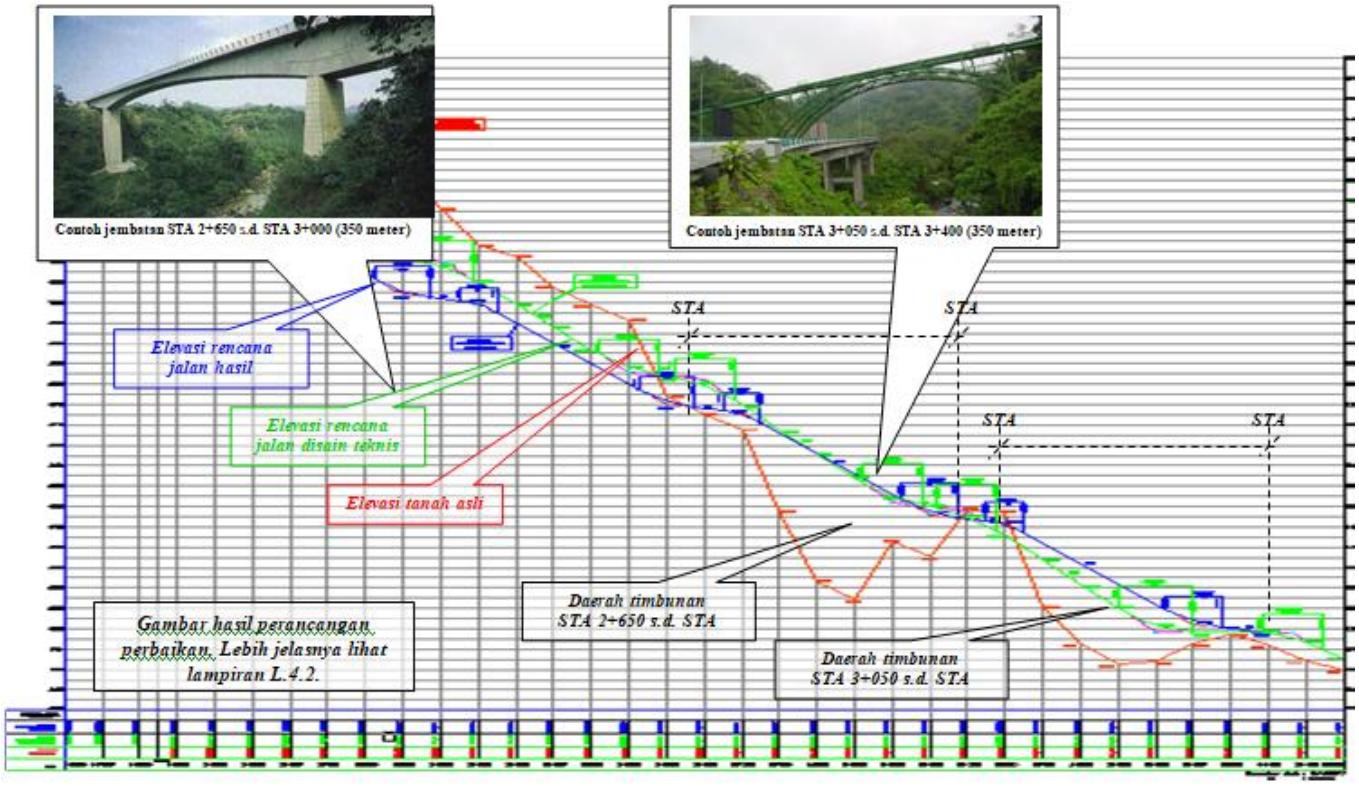
From the graphic image it can be seen that 80% of the composition of the vehicle is a type of light vehicle (LV). For heavy vehicle types by 16% (LB and LV).

The results of the analysis using KAJI, obtained the degree of saturation (Q / C) for light vehicles of 0.363 with a good service level until 2019 (for 10 years), see table 5.7., Chapter V. In 2020 the Q / C value = 0.764 > 0.75 (terms set by MKJI). This means that the performance of the Nagreg Ring Road with good conditions can last until 2019 (10th year), so that by 2020 it takes the form of advanced handling as one of the solutions to restore the performance of the road segment. Along with the growth of increasingly crowded traffic and uphill roads, heavy vehicles are more quickly affected, especially when road performance is no longer feasible.

This form of handling is an effort to restore the performance of the Nagreg Ring Road segment with an indication that the Q / C value is back less than 0.75, so that the service can be optimized again.

6.3.6. Arranging traffic movements on climbs and browsers.

The Nagreg Ring Road section consists of 2 lanes, the width of each lane is 3.5 meters. With initial performance conditions and as long as it is still in good performance service size, traffic movements can be arranged for the climbing lane on the left, or to the left specifically for lanes of buses and trucks (slow vehicles). So that light vehicles or other vehicles that go faster can go through the right lane. The smooth movement of traffic is also strongly influenced by the presence of signs. In order for the installation of signs to be carried out in accordance with the needs and installed in a location that is clearly visible to the driver (in accordance with the provisions for planning and signage). Because besides being a regulator of traffic movements, signs are also useful to guide road users so that they are safe and comfortable as they pass through the road.



Gambar 5.27: Contohpenerapanteknologijembatanuntukmelintasi sungai ataucekungan STA 2+650 s.d. STA 3+000 (350 meter) dan STA 3+050 s.d. STA 3+400 (350 meter)

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