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## Geometric Design and Pavement Analysis of Kopi Luhur Road, Argasunya Village: A Case Study in Cirebon Regency

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### Abstract

*Street Kopi Luhur, located in Argasunya Village, Harjamukti District, Cirebon City, is a local road that plays a strategic role as the main access for residents to housing areas and centers of local economic activity. The research employed a descriptive quantitative approach. Primary data were obtained through direct field surveys, including visual inspections and measurements of pavement conditions, while secondary data were collected from relevant local government agencies. The analysis of pavement conditions was conducted using the Road Condition Index (RCI) method to determine the level of damage, whereas traffic performance was evaluated based on the Indonesian Road Capacity Guidelines (PKJI, 2023) to determine the Level of Service (LOS) and the Degree of Saturation (Dj). The results indicate that the pavement condition of Street Kopi Luhur is generally categorized as moderate to severely damaged, with an average RCI value of 53, corresponding to a class D service level. The dominant forms of pavement distress include longitudinal cracking, potholes, and surface unevenness. These damages are mainly caused by inadequate drainage systems, high traffic loads, and limited maintenance activities. Furthermore, the Degree of Saturation (Dj) value of 0.79 shows that the road segment is approaching congested conditions, leading to reduced service performance. Based on these findings, recommended improvement measures include rehabilitation of the pavement structure using HRS-WC and Cement Treated Base (CTB) layers, enhancement of the roadside drainage system, and the implementation of a community-based periodic maintenance program.*

**Keywords:** Road Design, Horizontal Geometry, Vertical Alignment, Curve Widening, Flexible Pavement

### a Introduction

#### 1.1. Background

Road infrastructure design is an important element in the land transportation system that plays a major role in supporting social, economic, and community mobility activities. Roads in good condition can facilitate traffic flow, reduce vehicle operating costs, and improve connectivity between regions [1], [2], [3], [4]. Conversely, damaged roads can reduce transportation efficiency, increase the risk of accidents, and hamper regional economic growth. Therefore, the sustainability of road infrastructure development and maintenance is a vital aspect of improving the quality of life of the community [5], [6], [7].

One area that has experienced problems in terms of road infrastructure is Jl. Kopi Luhur, located in Argasunya Village, Harjamukti District, Cirebon City, West Java. This road serves as the main connecting route between residential areas and economic centers and public facilities in Cirebon City. The high volume of traffic, including both two-wheeled vehicles and heavy vehicles, coupled with an inadequate drainage system, has caused damage to the road pavement, such as longitudinal cracks, potholes, and surface deformation [8], [9], [10], [11].

In addition, environmental factors such as high rainfall and the lack of routine maintenance programs accelerate road degradation. These conditions reduce user comfort, increase travel time, and pose potential traffic safety risks [12], [13], [14], [15]. If these issues are not addressed immediately, they could affect the smooth distribution of goods and services as well as the economic activities of the surrounding community [16], [17], [18].

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**b Research Methodology and Data**

Research Methodology [19], [20], [21], [22]:

- a. Collection of existing traffic and geometric data
- b. Analysis of horizontal and vertical alignment
- c. Calculation of curve widening and sight distance
- d. Evaluation of pavement requirements and cost estimation

Research Data

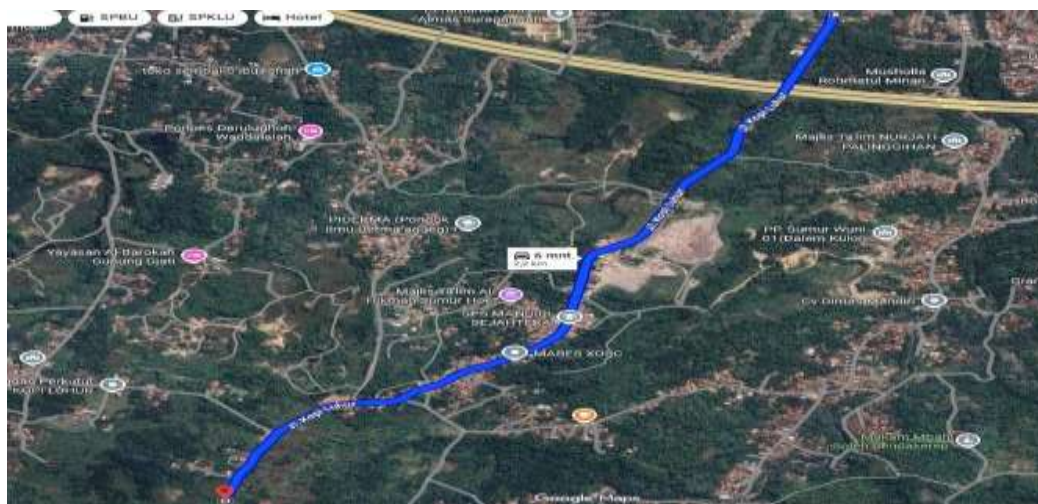
Based on field observations on Jl. Kopi Luhur, located in Argasunya Village, Harjamukti District, Cirebon City, West Java, the following table summarizes the results of observations on daily traffic data and road geometry [23], [24], [25]:

**Table 1 LHR Data for 2025**  
**Traffic data recorded in 2025**  
**With LHR**

Vehicle Class	Axis Configuration	Left Direction	Right Direction
(2) Light Vehicles	1.1	874	914
(5B) Large Buses	1.2	432	368
(6B) 2-Axle Trucks	1.2	111	135
(7A2) Heavy 3-Axle Trucks	1.22	87	76
(7A3) Heavy 3-Axle Trucks	11.22	99	82
(7B1) Heavy 4-Axle Trucks	1.2+2.2	47	67
(7C2A) Heavy 5-Axle Trucks	1.22-22	16	9
Traffic growth before the road opened (%/year)		7,5	6,5
Design Speed (km/h)			70
Design Life of Pavement Structure (years)			15
Rainfall (mm/year)			1900 – 2500
Slope (%)			2,5
Binding Material			AC - WC
Lower Foundation Layer (LPB) Aggregate			Class A

**c Results and Discussion**

Research Location



**Figure 1 Location Map**

The research location is in the JL. Kopi Luhur area, Argasunya, Cirebon City, West Java. Topography & Environment The area is likely to have a slightly hilly or mountainous contour, rather than being completely flat. Vegetation and natural conditions are likely to be quite lush, with a combination of open land and trees. Access & Roads As it is located somewhat inland (not directly in a major city), access roads may be village roads or provincial roads in fair condition, possibly without any highways or major roads in the vicinity. Surrounding Land Use The surrounding land is likely to be agricultural, low-density residential, and possibly small forests or shrubs. It could also be a more rural or suburban area. Connectivity to City Center / Infrastructure This location is likely to be somewhat distant from major city centers. Access to public facilities (such as city centers, major hospitals, universities) may require a longer commute.

Data collection in this study was conducted through two types of sources, namely primary data and secondary data. Primary data was obtained directly from the field through measurements and observations of existing road conditions. This data includes road cross-sections that record lane width, shoulders, medians, and cross slopes to ensure proper drainage, as well as existing road geometry consisting of horizontal curves, vertical slopes, stopping sight distances, and others. Road cross-sectional measurements were taken to determine the variation in width per segment and side obstacles that affect road capacity. Secondary data was obtained from relevant agencies in the form of research location maps that provide a spatial overview of road corridors, land use, and drainage networks, as well as daily traffic data containing the number of vehicles, vehicle type composition, and traffic growth factors. These two types of data complement each other, where primary data provides actual conditions in the field, while secondary data provides spatial and quantitative context, enabling comprehensive analysis and generating appropriate recommendations for road planning and improvement.

**Table 2 Road Profile**

<b>Profile of Kopi Luhur Highway - Argasunya</b>	
Road function	Primary Local (IKK – IKK)
Road status	Provincial Road
Pavement type	Flexible pavement
Road length (under study)	1,5 Km
Road width	6 m
Traffic lane width	3 m

Road shoulder width	1,5 1 m
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**Table 3 Planning Criteria**

<b>Road Planning Criteria</b>	
Road type	2/2 TT
Lane width LL	7m
Outer shoulder width (L <sub>BL</sub> )	1,5m
Road shoulder slope	5%
Roadside channel	1,5m
Safety barrier	1,0m
Median width	No median
Cross slope	3%
Rumaja	12m
Rumija	15m
Ruwasja	10m

## Geometric Analysis of Kopi Luhur Road – Argasunya

### a. Analysis of Existing Horizontal Alignment

The average daily traffic volume in the current year ( $LHRT_{TB}$ ) n 2025 is 1666 vehicles/day in the left direction and 1651 vehicles/day in the right direction, which is projected to be the average annual daily traffic value for the next 15 years ( $LHRT_D$ ).

$LHRT_D$

$LHRT_D$  Left : 2825 SMP/day

$LHRT_D$  Right : 3932 SMP/day

$LHRT$  design projection for 2037: 6758 SMP/day

The design hour factor (K) value for typical congested roads is 8% - 11%. Therefore, the value used is 11%, so the design hour factor (K) is 11% →  $qJD = 953$  SMP/day.

Design speed (V): 60 km/h

Maximum superelevation (emaks): 8%

Transverse friction coefficient (fmax): 0.18

Minimum radius (Rmin): 109.02 m

Curves

Curve 1:  $\Delta = 32.53^\circ$ , R = 140 m

Curve 2:  $\Delta = 52.71^\circ$ , R = 130 m

Curve 3:  $\Delta = 56.34^\circ$ , R = 150 m

Curve type: S-S (Spiral–Circle–Spiral)

Maximum widening: 0.61 m

Transition curve (Spiral)

The length of the transition curve (Ls) is calculated using three methods: travel time, centrifugal force, and slope change.

The largest value is taken: 58,66 m.

The curve is categorized as S-S (Spiral-Spiral) because it meets the requirements for curve length and spiral angle.

Pavement widening

Calculations show that the pavement width on the curve ( $W_c$ ) = 7.61 m < straight road width (8.56 m).  
 Therefore, pavement widening is not required.

Sight Distance

Stopping sight distance ( $J_h$ ): 85.39 m

Preparing sight distance ( $J_d$ ): 386.59 m

The curve on the road section was analyzed using the parameters of minimum radius, superelevation, and sight distance. The results show that the curve falls into the S-S category with a safe radius for a design speed of 60 km/h.

**Table 4 Horizontal Alignment**

Horizontal Alignment Existing Conditions							
No	Point	Coordinates (X; Y)	Distance Between Points (m)	Curve Angle (°)	Curve Type	Radius (R) (m)	Pavement Widening (m)
1	A-Turn 1	(224837874; 9248446249) – (225305976; 9248605792)	494,54	32,53	S-S	140	0,57
2	Curve 1–2	(225305976; 9248605792) – (226089483; 9248414715)	806,47	52,71	S-S	130	0,61
3	Curve 2–3	(226089483; 9248414715) – (226453441; 9248709447)	468,33	56,34	S-S	150	0,55
4	Turn 3–B	(226453441; 9248709447) – (226704306; 9248631077)	262,82	—	—	—	—

b. Analysis of Existing Vertical Alignment

Based on data from research conducted through calculations, the location is on flat terrain. From the results obtained on the existing vertical alignment:

Point PV1 :

$g_1 = -2,14\%$

$g_2 = -1,56\%$

$A = -0,58\%$

$L_v = 36$  m,

$E_v = -0,026$  m

Point PV2 :

$g_2 = -1,56\%$

$g_3 = 0,85\%$ ,

$A = -2,41\%$

$L_v = 36$  m

$E_v = -0,109$  m

Point PV3 :

$g_3 = 0,85\%$

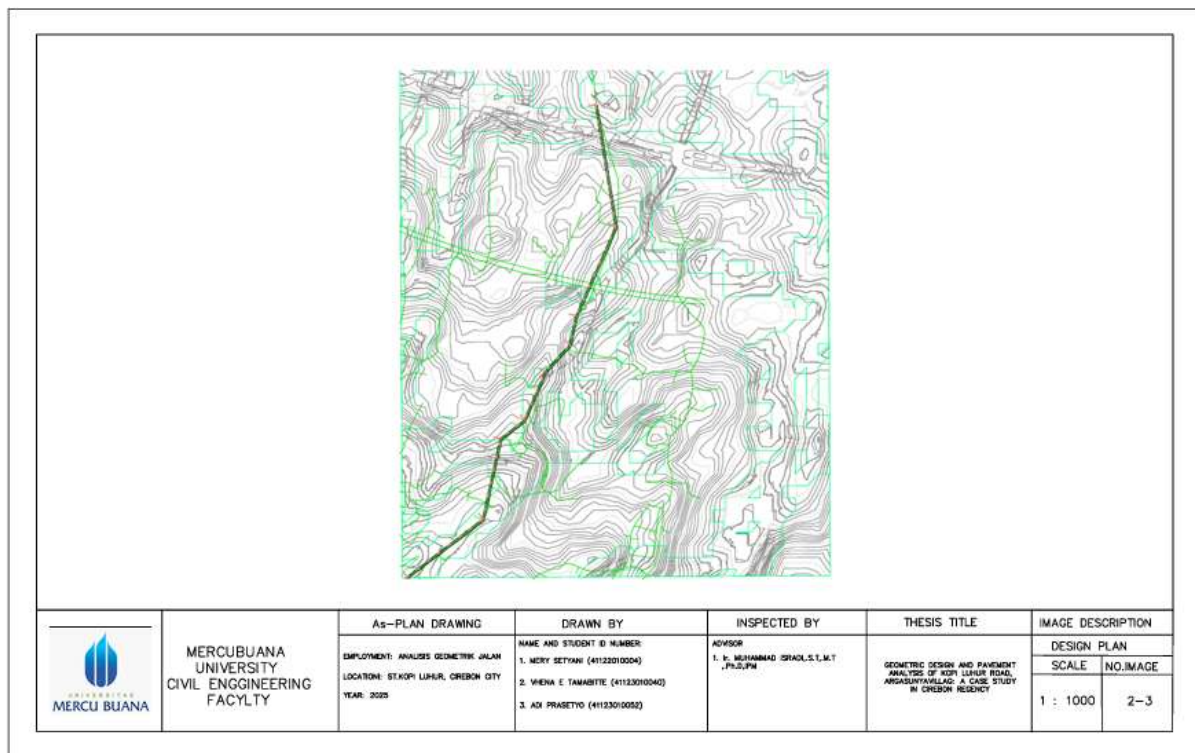
$g_4 = -2,94\%$

$A = 3,79\%$

Lv = 151,64 m  
 Ev = 0,719 m

**Table 5 Vertical Alignment**  
**Vertical Alignment Existing Conditions**

No	PVI Point	Stationing (Sta)	Elevation (m)	Inlet Gradient (g <sub>1</sub> )	Outlet Gradient (g <sub>2</sub> )	Δ Gradient (A)	Vertical Curve Length (Lv)	Mid point Elevation (Ev)	Curve Type
1	PV1	0+494,5	217,00	-2,14%	-1,56%	-0,58%	36,00 m	-0,026 m	Concave
2	PV2	1+301	204,38	-1,56%	0,85%	-2,41%	36,00 m	-0,109 m	Concave
3	PV3	1+769	208,36	0,85%	-2,94%	3,79%	151,64 m	+0,719 m	Convex



**Figure 2 Research Location Plan**

c. Excavation and Fill Analysis

Drainage analysis is a system designed to handle excess water problems, both above and below ground. According to Laoh et al., drainage can generally be defined as a technical measure to reduce excess water, whether from rain, seepage, or irrigation, so that the function of an area/land is not disrupted.

In the initial segment, between STA 0+000 and STA 0+400, the existing elevation is higher than the planned elevation. This indicates the need for excavation work to lower the ground surface to match the design elevation. Excavation in this segment generally occurs in hilly areas or on sloping terrain, and aims to maintain the slope and visibility of the road in accordance with technical standards.

Conversely, in the middle to final segment, specifically between STA 1+000 and STA 2+000, the existing elevation is below the planned elevation. This condition indicates the need for filling work to raise the ground surface. Filling is carried out in low-lying or concave areas and serves to create uniform road slope and support a good drainage system.

The difference in elevation between the existing line and the planned line on the longitudinal profile forms the basis for calculating the volume of excavation and embankment. This analysis plays a role not only in estimating construction costs, but also in determining the method of implementation and management of soil materials. Thus, excavation and embankment work must be carefully planned in order to produce safe, efficient, and sustainable road construction.

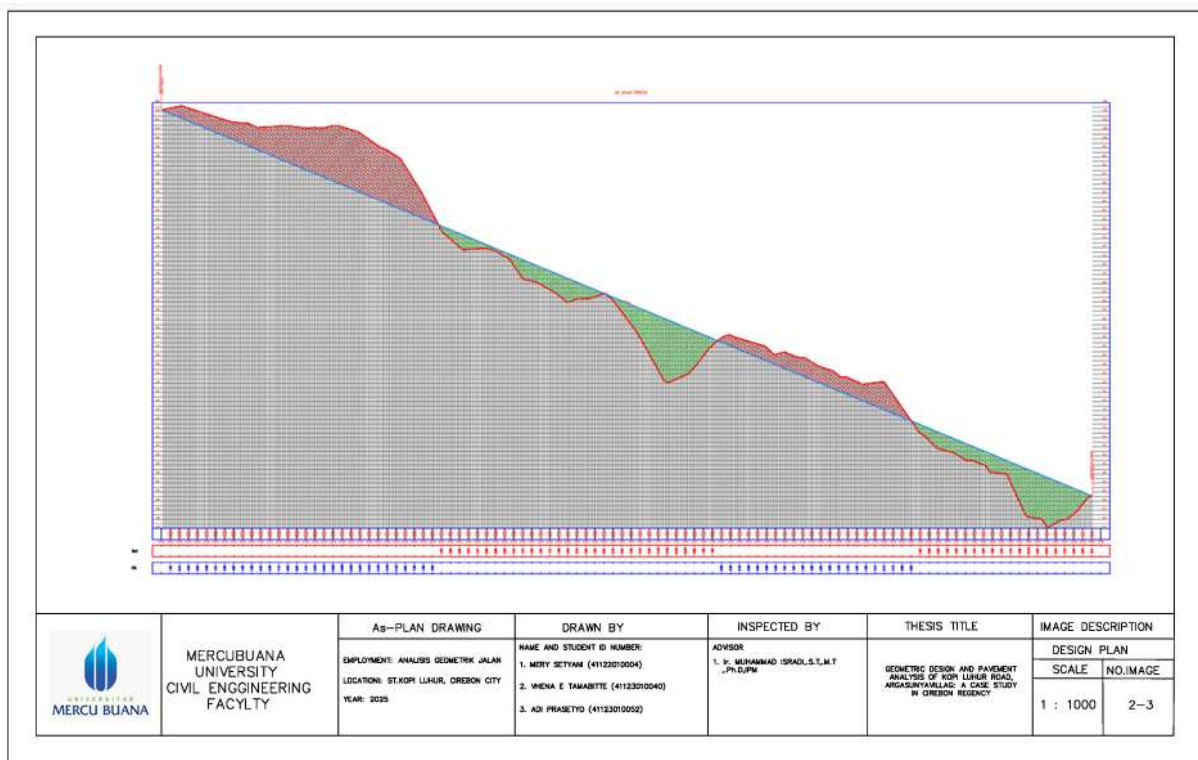


Figure 3 Vertical Longitudinal Section

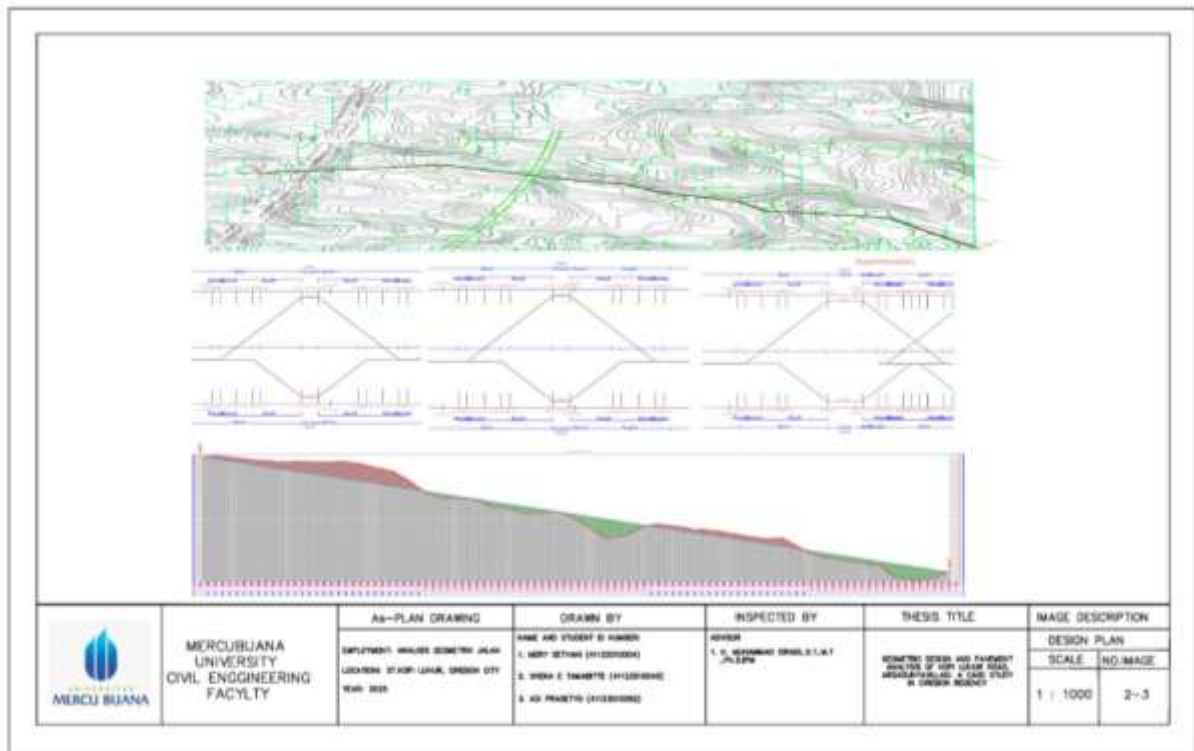


Figure 4 Super Elevation

#### d. Conclusion

Based on the results of a study of the Kopi Luhur and Argasunya road sections, it was found that the geometric performance and pavement structure of the road are generally still within technical feasibility limits, but require optimization of several planning elements in order to accommodate future traffic growth. The projected traffic volume of 6,758 SMP/day at the end of the plan's lifespan indicates the need for road planning that not only meets existing conditions but is also adaptive to significant vehicle growth. The horizontal alignment evaluation shows that the application of the Spiral–Circle–Spiral type curve is in accordance with safety standards for a design speed of 60 km/h, with a curve radius and transition curve length that can provide comfort and vehicle stability. Similarly, the results of the stopping sight distance and preparation distance analysis show that the visual safety aspects for drivers have been fulfilled. In terms of vertical alignment, the relatively flat terrain with small gradient differences means that the design of both concave and convex vertical curves meets technical criteria and does not cause operational disturbances to vehicles. From a pavement structure perspective, the use of flexible pavement with an HRS-WC surface layer and CTB base layer is considered appropriate to withstand planned traffic loads and local environmental conditions, especially considering the CBR value of the subgrade soil and rainfall intensity. Additionally, soil analysis indicates that a combination of excavation and embankment on several segments is a necessary solution to maintain elevation uniformity, road slope, and drainage system effectiveness. Overall, the geometric and pavement planning for the Kopi Luhur–Argasunya Highway has been prepared based on applicable technical standards and can be used as a basis for road construction and improvement. The implementation of an appropriate design, accompanied by construction supervision and periodic maintenance, is expected to improve traffic flow, road user safety, and support economic activities and community mobility in Cirebon Regency.

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