Indonesian Journal of Advanced Research (IJAR)
Vol. 4, No. 10, 2025: 2223-2236

Technical Planning Analysis of the Garut-Tasikmalaya-Cilacap Toll Road Section I (Gedebage Station 0+000 – North Garut Station 45+200)

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A R T I C L E I N F O

Keywords: Toll Road, Traffic Performance, Road Geometric, Interchange, Road Pavement

Received : 8, September
Revised : 22, September
Accepted: 24, October

A B S T R A C T

Population growth and economic activity in West Java and Central Java increase traffic volume and congestion, especially in the southern lanes that do not have toll roads. The distribution of goods and people's mobility still rely on arterial roads such as Jalan Nagreg which is narrow and prone to congestion. This study aims to analyze the planning of the Gedebage-Tasikmalaya-Cilacap Toll Road Section I of the Gedebage-North Garut section with a quantitative descriptive method. The results show segments 1–6 are heavy traffic, while segments 7–10 are smooth. Trase 2 was chosen because it was more optimal in terms of technical, cost, and environmental aspects. The planning includes 41 PIs, 79 PVIs, three main interchanges, as well as the construction of 300 mm JRCP pavement, 150 mm thin concrete, 200 mm class A concrete, and 200 mm optional stacks.

DOI prefix: https://doi.org/10.55927/ijar.v4i10.15520
ISSN-E: 2986-0768
https://journal.formosapublisher.org/index.php/ijar

INTRODUCTION

According to Law No. 2 of 2022 concerning the second amendment to Law No. 38 of 2004, roads are defined as land transportation infrastructure that includes all parts of roads and their complements, except for rail, truck, and pedestrian lines. Government Regulation No. 34 of 2006 emphasizes that the implementation of public roads is aimed at strengthening the unity of the national territory and reaching remote areas. One type of road is a toll road, which is part of a national road network whose use is subject to tariffs. Therefore, the construction of public roads and toll roads needs to be designed according to the provisions so that the purpose of road implementation can be achieved.

The provinces of West Java and Central Java have the largest population in Indonesia, 48.15 million and 36.43 million people respectively in 2020, with a projection of a significant increase until 2050 (BPS, 2023). Population growth contributes to economic activity, as reflected in economic growth of 4.57% in West Java and 4.92% in Central Java in 2023. Increasing economic activities encourage community mobility and the distribution of goods, especially agricultural products from Central Java and West Java, which are the main suppliers of basic necessities for Jakarta and its surroundings (Prabayanti et al., 2022). However, the southern regions of the two provinces do not have toll roads, so the distribution still depends on old arterial roads, such as the Nagreg Line, which is narrow, winding, and often causes congestion and extends travel time. This condition makes the distribution of staples less efficient.

To overcome this problem, the government plans to build the 206.65 km Gedebage-Tasikmalaya-Cilacap Toll Road which is divided into four sections. This research is focused on Section I, namely the 45.20 km Gedebage-North Garut section. This toll road is expected to improve the smooth movement between regions, support the achievement of the Sustainable Development Goals (SDGs), especially point 8 on decent work and economic growth, and provide safer, more comfortable, and efficient transportation infrastructure. Currently, the Gedebage-Garut traffic flow is still passing through the Nagreg Line which is prone to congestion and endangers driving comfort, so adequate technical planning alternatives are needed to support the construction of the toll road.

LITERATURE REVIEW

Toll Road Construction and Regional Connectivity

Toll roads play a crucial role in improving regional connectivity, reducing travel times, and facilitating economic development. According to Indonesian Law No. 38/2004 on Roads, toll roads are part of a national road network designed to improve service levels and traffic performance. Previous studies have shown that the construction of toll roads significantly reduces congestion on arterial routes and promotes a more efficient logistics chain (Syahrin, 2017; Alisjahbana & Murniningtyas, 2018).

Road Classification and Capacity

The classification of roads in Indonesia follows functional and administrative criteria, including arterial, collector, and local roads as described in Government Regulation No. 34/2006. The concept of road capacity and service level (LOS) is critical in evaluating whether existing roads can handle the projected volume of traffic. According to the Indonesian Highway Capacity Manual (IHCM), capacity analysis involves parameters such as saturation level, speed-flow relationship, and passenger car equivalence (Nurristi et al., 2021).

Traffic Performance Indicators

Traffic performance indicators such as Vehicle Speed (VS), Travel Time (TT), Degree of Saturation (DS), and Vehicle Density (VD) are commonly used to assess highway operational conditions. A high DS value (>1.0) indicates congested conditions, which is the main justification for upgrading or building new infrastructure. Research by Prabayanti et al. (2022) highlights the importance of integrating these indicators in transportation planning in high-demand corridors.

Geometric Design Standards for Toll Roads

Indonesia's national standard (Bina Marga) sets geometric design criteria for toll roads, including horizontal and vertical alignment, minimum curve radius, lane width, and median requirements. Precise alignment design (horizontal and vertical) ensures safety, comfort and efficiency in traffic flow. This includes the identification of Intersection Points (PIs) and Vertical Intersection Points (PVI), which form the basis of the geometry of the design.

Pavement Design Considerations

Pavement performance is a key element in toll road planning. Rigid pavements such as Jointed Reinforced Concrete Pavement (JRCP) are preferred for high-volume roads due to their durability under heavy traffic loads. Factors such as cumulative axle load (ESA), ground CBR, and design service life are considered in determining the thickness and reinforcement of the pavement (PPP of the Republic of Indonesia, 2022).

Intersections and Roadside Facilities

Intersections (class-separated intersections) are essential for distributing traffic and improving safety on highways. Design elements include ramp geometry, acceleration and deceleration paths, and spacing between intersections to maintain service levels. Roadside facilities such as guardrails, traffic signs, and road markings further improve operational efficiency and safety.

Sustainable Development Perspective

The construction of the Gedebage–Tasikmalaya–Cilacap Toll Road is in line with Indonesia's Sustainable Development Goals (SDGs), especially Goal 8 on Decent Work and Economic Growth, by promoting efficient transportation infrastructure and encouraging local economic development.

Based on the literature review above, the hypothesis of this research is formulated as follows:

H1: The existing arterial route between Gedebage and Garut experiences a high level of congestion and does not meet the projected traffic demand in the future.
H2: The development of a new toll road (Gedebage–Tasikmalaya–Cilacap Section I) with optimized alignment and design will significantly improve traffic performance indicators compared to existing arterial roads.
H3: Implementing national geometric and pavement standards (horizontal and vertical alignment, rigid pavement design) will ensure the new expressway meets the safety, capacity, and durability requirements for the projected traffic volume.
H4: The inclusion of properly designed intersections and roadside facilities will improve accessibility and operational efficiency while reducing travel time and improving safety.

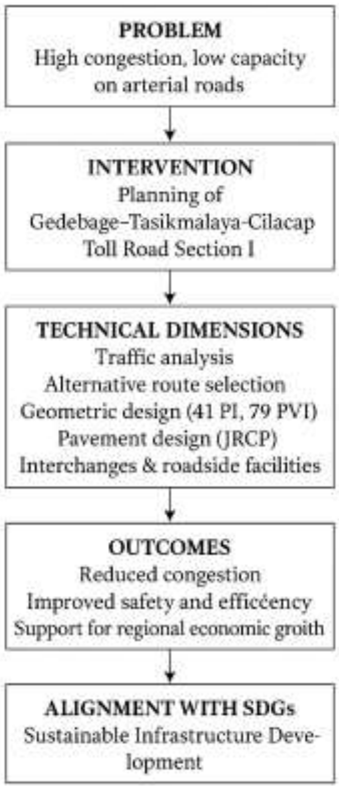

Figure 1. Conceptual Framework

METHODOLOGY

The research method used in this study is the quantitative descriptive research method. In this study, primary and secondary data analysis approaches were carried out. This data analysis process is carried out by utilizing primary data and secondary data obtained from various sources. This data is the main data source for the technical planning of the Gedebage-Tasikmalaya-Cilacap Toll Road Section I.

Primary Data and Secondary Data

The main sources of this research are from primary data and secondary data. The details of the primary data and secondary data are as follows:

Table 1. Primary Data and Secondary Data

No.	Data Type	Data Source
1	Topographic and Land Use Maps (Primary Data)	Digital *Elevation Model* (DEM) maps obtained from Indonesia *Geospatial Portal* and processed using *ArcGIS/Global Mapper*
2	Data LHR (Data Seconds)	West Java Provincial Transportation Agency
3	Toll Road Tracks (Secondary Data)	National Road Implementation Center for the DKI Jakarta – West Java Region

RESEARCH RESULTS

This study uses a phased approach to develop a comprehensive technical plan for the Gedebage–Tasikmalaya–Cilacap (Getaci) Toll Road Section I. The stages are summarized as follows:

Analysis of Existing Road Traffic Performance

One of the initial stages in the Technical Planning of the Gedebage-Tasikmalaya-Cilacap Toll Road Section I is the analysis of the existing road. This stage aims to find out the extent of the current road conditions in meeting the mobility needs of the community and supporting smooth traffic.

Table 2. Recapitulation of Existing Road Traffic Performance

Segmen	C0(SMP /hour)	DJ	VB(km/ hour)	VT(km/ hour)	WT(hour)	OF	Description
1	1345	0.91	50	36	0.08	0.08	The road began to experience saturation, the traffic flow began to be congested, and road users felt discomfort
2	1290	0.94	50	34	0.08	0.08	The road began to experience saturation, the

Segmen	C0(SMP /hour)	DJ	VB(km/ hour)	VT(km/ hour)	WT(hour)	OF	Description
							traffic flow began to be congested, and road users felt discomfort
3	1142	1.07	40	22	0.06	0.06	The road is in a congested condition, the traffic flow is very congested, and road users feel significant discomfort
3'	1126	1.08	40	22	0.06	0.06	The road is in a congested condition, the traffic flow is very congested, and road users feel significant discomfort
4	1274	0.96	50	32	0.01	0.01	The road began to experience saturation, the traffic flow began to be congested, and road users felt discomfort
5	1267	0.96	40	26	0.04	0.04	The road began to experience saturation, the traffic flow began to be congested, and road users felt discomfort
5'	1142	1.07	40	22	0.02	0.02	The road is in a congested condition, the traffic flow is very congested, and road users feel significant discomfort
6	1329	0.92	50	36	0.24	0.24	The road began to experience saturation, the traffic flow began to be congested, and

Segmen	C0(SMP /hour)	DJ	VB(km/ hour)	VT(km/ hour)	WT(hour)	OF	Description
							road users felt discomfort
7	1758	0.69	60	48	0.16	0.16	The road has good service performance, smooth traffic flow, and road users feel comfortable
8	1631	0.75	60	44	0.04	0.04	The road has good service performance, smooth traffic flow, and road users feel comfortable
9	1567	0.78	60	42	0.08	0.08	The road has good service performance, smooth traffic flow, and road users feel comfortable
9'	1701	0.72	60	46	0.12	0.12	The road has good service performance, smooth traffic flow, and road users feel comfortable
10	2923	0.42	50	42	0.36	0.36	The road has good service performance, smooth traffic flow, and road users feel comfortable

Alternative Planning of the Gedebage-Tasikmalaya-Cilacap Toll Road Section I

In the planning of the Gedebage-Tasikmalaya-Cilacap Toll Road Section I, the author has identified 2 (two) alternative tracks that have the potential to be implemented. These two alternatives are the result of a comprehensive analysis of various aspects, namely topography, land use, cost, and protected areas.

Table 3. Comparison of Trase Alternatives 1 and 2

CRITERION	ROUTE 1	SHOES	ROUTE 2	SHOES
Technical Factors				
Number of Bends (points)	34	1	41	0
Elongated Average Slope (%)	7.39%	0.5	5.40%	0.5
Average Horizontal Slope (%)	4.93%		4.47%	
Terrain Classification (%)	DATAR		DATAR	
Bridge Potential Length (m)	9476	0	7045	1
Number of Existing Road Crossings (points)	66	0	53	1
Cost Factor				
Alternate Length Trase	42.592	0	39.887	1
Settlement Land Acquisition (km2)	0.272	0	0.069	1
Agricultural Land Acquisition(km2)	2.923		2.819	
Factors of Protected Areas				
Affected Protected Area Area (m2)	0	0.5	0	0.5
Total Score	**2.00**		**5.00**	
Selected Trase	**ROUTE 2**			

Source : ArcGIS and AutoCAD Processing Results, 2025

Based on the results of the points in the table above, an alternative to TRASE 2 was obtained as the selected trase with 5.00 points.

Gedebage-Tasikmalaya-Cilacap Toll Road Geometry Planning Section I

Based on the planned traffic volume, the design criteria for the Gedebage-Tasikmalaya-Cilacap Toll Road Section I can be determined as follows:

Table 4. Design Criteria for Gedebage-Tasikmalaya-Cilacap Toll Road Section I

No.	Description	Specifications
1	Road Classification	Freeway
2	Road Function	Arteri
3	Street Class	I
4	Terrain Classification	Datar
5	Plan Age	40 Years
6	LHRT 2025	6,243 junior high schools/hour
7	VJD	7,180 junior high schools/hour
8	Road Type	6/2 – T
9	Service Standards	A
10	Plan Speed	100 km/am
11	Width of Road Benefit Space (Ruwasja)	75 m
12	Column Width	3,60 m
13	Outer Shoulder Width (hardened)	3,50 m
14	Deep Shoulder Width (hardened)	1,50 m
15	Lebar Median	5,00 m
16	Transverse Slope	2,00 %
17	Pavement Type	Rigid Pavement

Geometry Planning of Interchange

The design criteria for the geometry of the interchange used in this final project are as follows.

Table 5. Criteria for Interchange Geometry Design

No.	Description	Specifications
1	Road Classification	Freeway
2	Road Function	Ramp (Connecting Road)
3	Street Class	I
4	Plan Age	40 Years
5	LHRT 2025	6,243 passenger car units/hour
6	VJD	7,180 passenger car units/hour
7	Road Type	2/1 – TT
8	Plan Speed	50 km/am
9	Width of Road Benefit Space (Ruwasja)	75 m
10	Column Width	3,60 m
11	Outer Shoulder Width (hardened)	3,00 m
12	Deep Shoulder Width (hardened)	1,00 m
13	Transverse Slope	2,00 %
14	Pavement Type	Rigid Pavement

Planning Rigid Pavement for Toll Roads

Traffic projections and soil strength are analyzed to determine the cumulative axle load and required pavement thickness. Rigid sidewalks with JRCP are chosen.

Table 6. Recapitulation of Pavement Layer Thickness

Pavement Coating	Thickness (mm)
JRCP, FS 4.5 MPa	300
Thin Concrete Foundation, B-0	150
Class A Foundation Layer, CBR 90%	200
Granular Option Stack, CBR 30%	200
Basic Soil, CBR 6%	-

Table 7. Repetition Recapitulation

Plate Thickness (m)	0.30
Plate Segment Width (m)	3.60
Plate Segment Length (m)	5.00
Elongated Joints	
-Diameter	D16
-Length (cm)	75
-Distance (cm)	70
Transverse Connection	
-Diameter	Ø38
-Length (cm)	45
-Distance (cm)	30

Wiremesh reinforcement	M8

Road Equipment Installation Planning

The design included traffic signs, road markings, and guardrails. These elements were designed to comply with national safety standards.

Table 8. Traffic Sign Planning

Yes	Types of Signs	Placement Location	Placement Distance	Information
1	Warning Signs	Teens (Road Benefit Room) on the side of the road before the hazard point	Standard: 100 m (VD = 100 km/h); Planned: 80 m	Placed before dangerous sections of the road to provide warnings to drivers
2	Command Signs	Teenagers on the side of the road according to the signs	Not fixed distance specified (as required)	Giving specific instructions to road users
3	Rambu Larangan	The beginning of the part of the road where the ban begins	As per the point where the ban starts	Imposing certain restrictions on road users
4	Signage Instructions	Teens on the side of the road as close as possible to the indicated area/area/route	±50 m	Provide directions or location information to the driver

DISCUSSION

The analysis revealed that the existing arterial routes, especially in segments 1 to 6, experienced high levels of saturation, resulting in significant congestion, while traffic flows in segments 7 to 10 remained relatively smooth. This condition underscores the urgency of the development of the Gedebage-Tasikmalaya-Cilacap (Getaci) Section I Toll Road as a strategic effort to improve road connectivity and capacity in the southern corridor of West Java. Based on the technical evaluation, Alternative Route 2 was selected as the most optimal alignment due to its advantages in technical feasibility, construction cost efficiency, and environmental conservation considerations.

The geometric design of the expressway is comprehensively developed, consisting of 41 horizontal Points of Intersection (PI) and 79 vertical Points of Vertical Intersection (PVI), which ensures optimal alignment for safety and operational performance. The planned interchanges—the Gedebage Interchange (STA 0+000), the Majalaya Interchange (STA 11+050), and the North Garut Interchange (STA 38+700)—are designed to facilitate smooth traffic distribution and better regional access, thereby increasing mobility and reducing travel time between city centers.

In addition, the pavement structure uses rigid pavement technology with a 300 mm thick JRCP plate, a 150 mm (B-0) lean concrete base, and a 200 mm Class A subbase (90% CBR) to ensure durability and long service life under projected traffic loads. Roadside facilities such as traffic signs, road markings, and semi-rigid guardrails have been planned according to national standards to ensure user safety and operational efficiency.

Overall, the discussion highlighted that the comprehensive technical planning of the Getaci Toll Road Section I can effectively address existing road congestion and limited capacity. It is also projected to have significant socio-economic benefits by facilitating regional economic development, improving logistics and mobility, and supporting national infrastructure goals. These findings provide practical insights for policymakers and engineers regarding toll road planning in areas with similar topographic and traffic conditions.

CONCLUSION

Based on the results of the study entitled Technical Planning Analysis of the Gedebage-Tasikmalaya-Cilacap Toll Road Section I (Gedebage STA 0+000 – North Garut STA 45+200) the following conclusions were obtained:

1. Traffic Density: Segments 1, 2, 4, 5, and 6 experienced high congestion (DJ 0.85–1.00), segments 3, 3', and 5' experienced significant congestion (DJ >1.00), while segments 7, 8, 9, 9', and 10 had smooth traffic (DJ <0.85).
2. Alternative Tracks: Track 2 was chosen as the best option because it has a sloping longitudinal and transverse slope, shorter bridge and track lengths, fewer road crossings, and lower land acquisition requirements than track 1.
3. Geometric Design of Toll Roads: Gedebage–Tasikmalaya–Cilacap Toll Road Section I is classified as a 6/2-T type expressway, planned speed of 100 km/h, rigid pavement, 41 horizontal curve points, 79 vertical curve points, as well as climbing lanes and emergency stop lanes according to standards.
4. Interchange Design: There are three main interchanges (Gedebage Junction, Majalaya Junction, North Garut Junction) with S-C-S and FC curved types, planned speed of 50 km/h, and rigid pavement pavement.
5. Pavement Structure Design: JRCP 300 mm thick, 150 mm thin concrete foundation, 200 mm class A concrete layer, 200 mm optional stack, with repetition and connection according to technical standards.

1. Road Equipment: Installation of road markings, traffic signs (warnings, orders, instructions), and W Beam type semi-rigid guard rails at risky locations to improve the safety and comfort of road users.

RECOMMENDATION

Actual traffic surveys are needed to support advanced traffic studies so that traffic performance analysis is in line with future loads. Traffic performance analysis should include the calculation of the degree of saturation on alternative tracks 1, tracks 2, and existing tracks. The selection of alternative trase is recommended to increase the trase options to obtain a more optimal choice, taking into account the aspects of efficient excavation and heaping. The design of horizontal and vertical siding needs to be optimized to reduce the volume of earthworks and improve road efficiency. In addition, in the analysis of toll road pavement, it is recommended to make a comparison between rigid and flexible pavement methods using cycle cost analysis (LCCA) to obtain the most economical long-term solution, as well as to perform real feasibility calculations if using JRCP cement concrete.

ADVANCED RESEARCH

For further research, it is recommended to conduct an in-depth analysis of the financial feasibility of the Gedebage-Tasikmalaya-Cilacap Toll Road Section I Gedebage-North Garut Section I including IRR, NPV, and BCR analysis. This analysis is carried out based on realistic toll rates (based on user WTP).

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