Department of Digital Business
Journal of Artificial Intelligence and Digital Business (RIGGS)
Homepage: https://journal.ilmudata.co.id/index.php/RIGGS
Vol. 4 No. 4 (2026) pp: 8964-8975
P-ISSN: 2963-9298. e-ISSN: 2963-914X

Analysis and Design of Road Infrastructure: Geometric Design of the Subang-Ciasem Road

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Abstrak

The construction and improvement of road networks play an important role in supporting mobility, economic growth, and equitable regional development. The Subang-Ciasem corridor is a strategic route in Subang Regency that connects centers of economic activity, industry, and agricultural distribution to the northern coast road. This study aims to redesign the geometry of the Subang–Ciasem road to meet technical standards in accordance with the Procedures for Intercity Road Geometric Planning (Bina Marga, 2021) and the Indonesian Road Capacity Guidelines (PKJI, 2023). The design method was carried out by collecting existing data, including average daily traffic (ADT), soil conditions and CBR values, and geometric data. Slope and rainfall. The analysis results show that the road is classified as flat terrain with a design speed of 80 km/h and a final design life ADT of 7,470 vehicles per day. The design produced three main curves with a Spiral–Circle–Spiral (S–C–S) type, a minimum radius of 229 m, and a maximum superelevation value of 8%. The pavement design life is set at 12 years, with a composition of the HRS-WC layer and CTB 200 mm. LPA Class A, and LFA Class B. The analysis results yielded a safe geometric design. efficient and in accordance with technical standards. thereby improving traffic performance, comfort, and safety for road users in the Subang–Ciasem corridor and supporting regional economic growth.

Keywords: Geometric Road Design, Subang–Ciasem, Pavement, Traffic, Bina Marga 2021.

1. Introduction

1.1 Background

The development and improvement of road networks are important factors in supporting mobility, economic growth, and equitable regional development. The Subang–Ciasem corridor plays a strategic role because it connects agricultural production centers, small and medium industrial areas, and public service facilities. Increased economic activity and traffic in this corridor require the availability of safe, comfortable, and efficient road infrastructure[1], [2].

However, the existing condition of the Subang–Ciasem road section still faces various problems. such as road geometry that is inadequate for current and future traffic volumes, accident-prone points, poor drainage and road shoulders and conflicts between heavy vehicles and local vehicles [1], [3]. These problems have an impact on increased travel time, vehicle operating costs, and safety risks. Road geometric design that complies with technical standards is the main solution to improve capacity, safety, and comfort for road users [4], [5]. Through the application of appropriate geometric design. It is hoped that road performance can be improved and the risk of accidents minimized [6], [7].

Academically and practically, this study is important because it provides data-based design solutions. integrates technical and socio-economic aspects. and serves as a reference for regional stakeholders. Therefore, this task aims to design and evaluate the geometric design of the Subang–Ciasem corridor, specifically the horizontal and vertical alignment, to generate practical and sustainable recommendations for improvement [8], [9], [10].

1.2 General Overview

The Subang–Ciasem road corridor is a strategic section in Subang Regency that connects the city center with the northern region leading to Ciasem Port and the Pantura route. and plays an important role in the distribution of agricultural, plantation, industrial, and trade products.

The existing road conditions generally consist of a two-lane, two-way road with a pavement width of 5–7 meters. However, some segments have geometries that do not meet standards, such as small curve radii, uneven cross slopes, and narrow shoulders. thereby reducing comfort and safety, especially for heavy vehicles [11], [12], [13]. Therefore, it is necessary to upgrade and redesign the road geometry based on national standards to support smooth traffic flow, travel time efficiency, user safety, and regional development [5], [14], [15].

1.3 Study Location

The research location is on the Subang–Ciasem road. Subang Regency, West Java Province. Administratively. This route passes through several subdistricts. namely Subang Subdistrict. Kalijati Subdistrict, Pamanukan Subdistrict, and Ciasem Subdistrict.

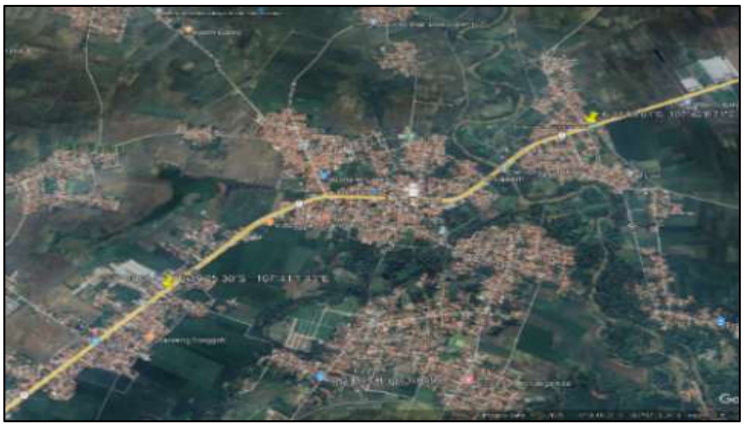

Figure 1. Study Area

The research location is on the Subang–Ciasem road. Subang Regency, West Java Province. Administratively. This route passes through several subdistricts namely Subang Subdistrict, Kalijati Subdistrict, Pamanukan Subdistrict, and Ciasem Subdistrict.

- To the north. It borders the Java Sea.
- To the east. It borders Indramayu Regency.
- To the south. It borders West Bandung Regency.
- To the west. It borders the Purwakarta and Karawang Regencies.

2. Research Methodology

2.1 General Description

In road infrastructure planning based on transportation engineering and geotechnical principles. Each pavement element, subgrade layer, and drainage system must be designed with a capacity and bearing strength that meets or exceeds the specified technical standards [9], [16]. Road projects are planned using technical data as the basis for analysis and design. with the following data:

Route length	: 2 km
Number of turns	: 3 turns
Route conditions	: Suburban/intercity road
Image description	: Starting point (Start) ← near Alfamart and ending point (Finish)

DOI: https://doi.org/10.31004/riggs.v4i4.5095

Figure 2. Starting point and ending point

2.2 Geometric Data

Geometric data is technical information that describes the shape, size, and physical elements of a designed road. Its purpose is to ensure that the road can be used safely, comfortably, and efficiently by users. This data usually refers to standards such as RSNI, Bina Marga, or AASHTO [17], [18], [19], [20], [21], [22].

Design speed : 80 km/jam
Road gradient : 2.5%
Design life of pavement : 12 year
Rainfall : 1500-2500 mm/year

3. Result and discussion

3.1 Horizontal Alignment Design

3.1.1 Classification of terrain based on slope conditions

According to Bina Marga in the Geometric Planning Procedures for roads in Medan. Terrain is classified based on the condition of most of the slope measured perpendicular to the contour line. Terrain classification is differentiated as shown in the following table:

Table 1. Terrain Classification

No	Terrain Type	Notation	Terrain Slope (%)
1	Flat	D	<10
2	Hill	B	10-25
3	Mountain	G	>25

Based on the existing sketch and contour data. A stationing and road gradient table was developed.

Table 2. Stationing and Road Gradient Data

CODE	STATIONING			KOORDINAT		ELEVATION (m)			Δh (m)	L (m)	GRADIENT (%)	TERRAIN TYPE
				X	Y	LEFT	CENTER	RIGHT				
A	0	+	0	797255.43	9300587.91	9.52	9.4	9.44	0.08	50	0.16	Flat
	0	+	50	797298.59	9300613.16	8.76	8.73	8.75	0.01	50	0.02	Flat
	0	+	100	797341.74	9300638.42	8.29	8.31	8.33	0.04	50	0.08	Flat
	0	+	150	797384.89	9300663.67	8.55	8.58	8.62	0.07	50	0.14	Flat
	0	+	200	797428.04	9300688.93	8.59	8.62	8.66	0.07	50	0.14	Flat
	0	+	250	797471.20	9300714.19	7.89	7.95	8	0.11	50	0.22	Flat
	0	+	300	797514.35	9300739.44	8.71	8.74	8.77	0.06	50	0.12	Flat
	0	+	350	797557.50	9300764.70	9.15	9.24	9.33	0.18	50	0.36	Flat
	0	+	400	797600.66	9300789.95	9.97	9.99	9.99	0.02	50	0.04	Flat
	0	+	450	797643.81	9300815.21	9.71	9.68	9.65	0.06	50	0.12	Flat
P1	0	+	493	797680.98	9300836.97	8.71	8.75	8.79	0.08	43	0.19	Flat

	0	+	543	797730.97	9300835.76	8.75	8.71	8.67	0.08	50	0.16	Flat
	0	+	593	797780.95	9300834.56	9.1	9.09	9.08	0.02	50	0.04	Flat
	0	+	643	797830.94	9300833.35	10.06	10.06	10.05	0.01	50	0.02	Flat
	0	+	693	797880.92	9300832.15	10.5	10.48	10.47	0.03	50	0.06	Flat
	0	+	743	797930.91	9300830.94	11	11	11	0	50	0.00	Flat
	0	+	793	797980.90	9300829.73	10	10	10	0	50	0.00	Flat
	0	+	843	798030.88	9300828.53	10	10	10	0	50	0.00	Flat
	0	+	893	798080.87	9300827.32	9.35	9.35	9.33	0.02	50	0.04	Flat
	0	+	943	798130.85	9300826.12	9.96	9.96	9.96	0	50	0.00	Flat
	0	+	993	798180.84	9300824.91	9.72	9.7	9.69	0.03	50	0.06	Flat
	1	+	43	798230.82	9300823.71	8.43	8.43	8.43	0	50	0.00	Flat
	1	+	93	798280.81	9300822.50	8.84	8.8	8.79	0.05	50	0.10	Flat
P2	1	+	108	798296.16	9300822.13	8.95	8.93	8.91	0.04	15	0.27	Flat
	1	+	158	798333.04	9300855.89	9.88	9.87	9.85	0.03	50	0.06	Flat
	1	+	208	798369.93	9300889.64	10	10	10	0	50	0.00	Flat
	1	+	258	798406.81	9300923.40	9.46	9.49	9.52	0.06	50	0.12	Flat
	1	+	308	798443.70	9300957.16	8.94	8.93	8.91	0.03	50	0.06	Flat
	1	+	358	798480.58	9300990.92	7.57	7.56	7.55	0.02	50	0.04	Flat
	1	+	408	798517.47	9301024.67	6.21	6.2	6.18	0.03	50	0.06	Flat
	1	+	458	798554.35	9301058.43	8.07	8.04	8.01	0.06	50	0.12	Flat
	1	+	508	798591.23	9301092.19	8.96	8.93	8.9	0.06	50	0.12	Flat
	1	+	558	798628.12	9301125.94	9.78	9.78	9.78	0	50	0.00	Flat
	1	+	608	798665.00	9301159.70	9.77	9.73	9.68	0.09	50	0.18	Flat
P3	1	+	635	798685.00	9301178.00	10	10	10	0	27	0.00	Flat
	1	+	685	798730.54	9301198.64	10.51	10.51	10.5	0.01	50	0.02	Flat
	1	+	735	798776.08	9301219.28	10.42	10.5	10.57	0.15	50	0.30	Flat
	1	+	785	798821.62	9301239.91	10.17	10.21	10.24	0.07	50	0.14	Flat
	1	+	835	798867.17	9301260.55	10	10	10	0	50	0.00	Flat
	1	+	885	798912.71	9301281.19	10	10	10	0	50	0.00	Flat
	1	+	935	798958.25	9301301.83	9.76	9.78	9.81	0.05	50	0.10	Flat
	1	+	985	799003.79	9301322.46	9	9.05	9.1	0.1	51	0.20	Flat
	2	+	35	799049.65	9301342.57	9.01	9	9.08	0.07	50	0.14	Flat
B	2	+	48	799095.71	9301362.04	9	9.78	9.01	0.01	13	0.08	Flat
					Total (%) =						4.07	Flat
					(%) =						0.092	Flat

The slope percentage obtained is 0.092%. so according to the terrain classification table from Bina Marga. The terrain type is flat.

3.1.2 Alternative route planning

A route with an elevation close to the contour line was chosen. This route is efficient because it only has two bends. taking into account the equal amount of excavation and embankment required.

DOI: https://doi.org/10.31004/riggs.v4i4.5095

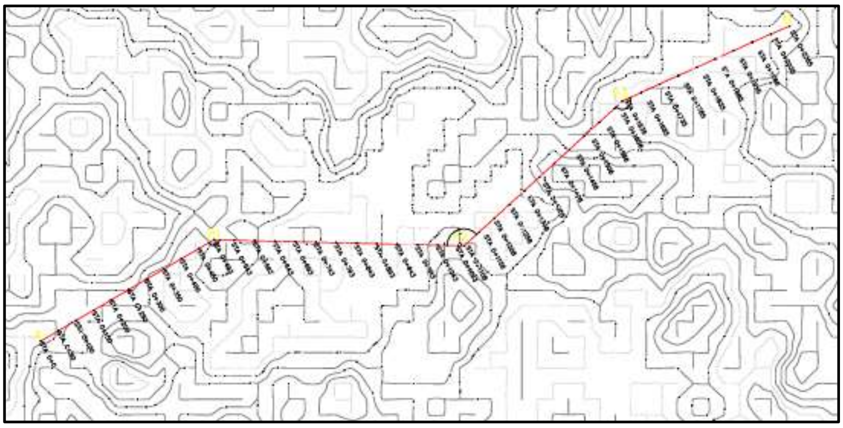

Figure 3. Alternative Route Alignment Design

3.1.3 Determination of Coordinate Points

Based on the contour map analysis. The coordinates of key alignment points were obtained as follows:

Point A = (797255.43 ; 9300587.91)
Point P1 = (797680.98 ; 9300836.97)
Point P2 = (798296.16 ; 9300822.13)
Point P3 = (798685.00 ; 9301178.00)
Point B = (799016.00 ; 9301328.00)

3.1.4 Calculation of the distance between points and the angle of the curve intersection

The calculation of the distance between points and the angle of the curve is obtained by direct measurement on the AutoCAD drawing.

Table 3. Intersection Angles of Horizontal Curve (From Civil 3D)

Curve	Angle (°)
Curve 1 (P1)	148
Curve 2 (P2)	136
Curve 3 (P3)	162

From the known coordinates. The respective distances can be calculated as follows:

$d_i = \sqrt{(x_B - x_A)^2 + (y_B - y_A)^2}$ .... (1)

3.1.5 Horizontal alignment recapitulation table

Table 4. Horizontal alignment recapitulation

No	Calculations	P1	P2	P3
1	Δ (°)	32	44	18
2	V (km/h)	80	80	80
3	f maks	0.14	0.14	0.14
4	R min	229.062	229.062	229.062
5	R	250	250	400
6	D maks	6.253	6.253	6.253
7	Fc Method 1	FC can be applied.	FC can be applied.	FC can be applied.
8	Fc Method 2			
	a. dd	5.730	5.730	3.581
	b. ed	0.062	0.062	-0.014
9	Fc Method 3			
	a. Ls1	66.667	66.667	66.667
	b. Ls2	79.057	79.057	78.044
	c. Ls3	0.635	0.635	8.889
	d. Adopted Ls	79.057	79.057	78.044

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10	P check	1.042	1.042	0.634
11	If not F-C			
	a. θs	9.059	9.059	5.590
	b. θc	13.881	25.881	6.821
	c. Lc	60.569	112.929	47.620
12	Curve type verification			
	a. Xs	79.055	79.055	78.043
	b. Ys	4.167	4.167	2.538
	c. P	1.048	1.048	0.636
	d. K	39.691	39.691	39.083
	e. Tt	111.677	141.121	102.538
	f. Et	11.165	20.764	5.630
	g. L total	218.683	271.043	203.708
13	Curve Widening	0.565	0.565	0.441
14	Stopping Sight Distance (SSD)	129.591	129.591	129.591
15	Passing Sight Distance (PSD)	497.125	497.125	497.125

3.1.6 Curved shape on bends

- Turn 1 (P1). Turn (P2) and Turn (P3)

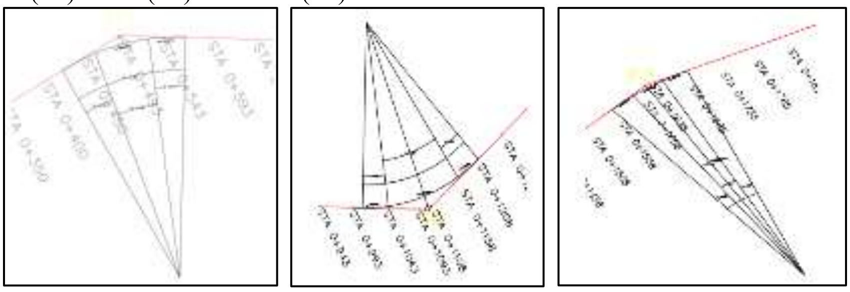

Figure 4. Curve Geometry at Curves 1 (P1). 2 (P2). and 3 (P3)

3.1.7 Superelevation diagram

- Turn 1 (P1)

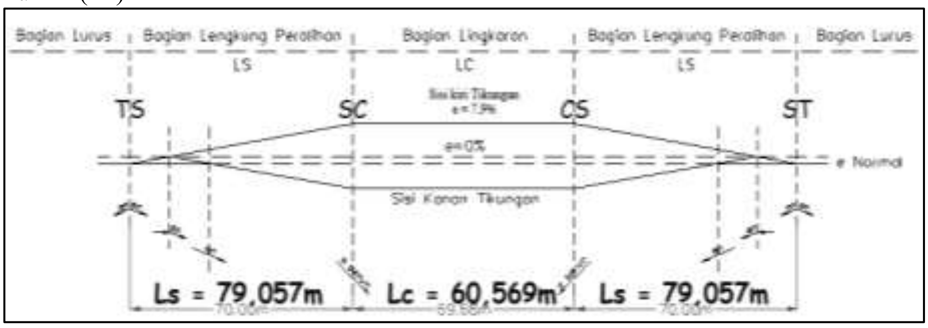

Figure 5. Geometric Shape of Curves 1 (P1). 2 (P2). and 3 (P3)

- Turn 2 (P2)

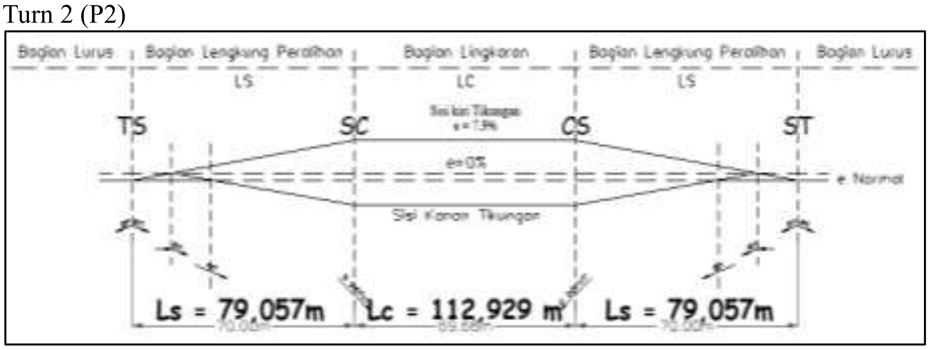

Figure 6. Superelevation Diagram of Curve 2 (P2)

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- Turn 3 (P3)

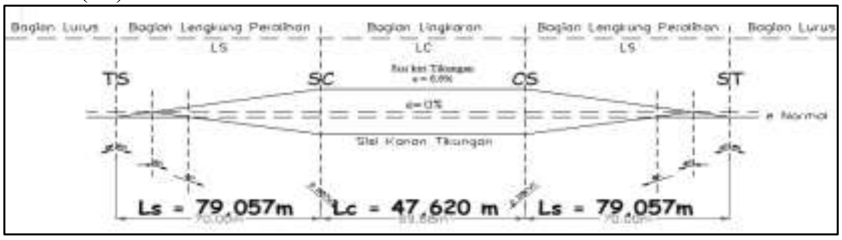

Figure 7. Superelevation Diagram of Curve 3 (P3)

3.2 Vertical Alignment Design

Vertical alignment is a vertical section of the road pavement surface that passes through the road axis or center line. In this plan, we will look at the longitudinal section, or surface, of the road that we will build. From here, we will carry out "cut and fill" for economic considerations and plan vertical curves for the safety and comfort of road users.

There are two types of vertical curves used in this plan:

1. Concave Vertical Curve:
   A curve where the intersection point between the two tangents is below the road surface. The difference between the two gradients of the connecting lines is negative (-).

2. Convex Vertical Curve:
   A curve where the intersection point between the two tangents is above the road surface. The difference between the two gradients of the connecting lines is positive. (+)

3.2.1 Curve planning

The transition from one slope to another is achieved using vertical curves. These curves are designed to ensure safety and drainage comfort.

The effect of the slope can be seen from the reduction in vehicle speed (or vehicles starting to use lower gears). A certain slope is still tolerable if it results in the vehicle's speed being greater than half of its planned speed.

Table 5. Summary of Horizontal Alignment Design

Point	Stationing			Elevation (m)
A	0	+	0	9.4
P1	0	+	493	8.75
P2	1	+	108	8.93
P3	1	+	635	10
B	2	+	48	9.78

3.2.2 Mass diagram table

Table 6. Mass diagram table

CURVE	NO	TYPE STA	STA			ELEVATION	
P1 (Sag Curve)	1	PLV	0	+	459.6667	8.706	
	2	PPV	0	+	493		
	3	PTV	0	+	526.3333	8.740	
	4	1/2 L before PPV	0	+	476.3333	8.728	Elevation I
	5	1/2 L after PPV	0	+	509.6667	8.281	Elevation II
P2 (Crest Curve)	1	PLV	1	+	74.66667	8.920	
	2	PPV	1	+	108		
	3	PTV	1	+	141.3333	8.862	
	4	1/2 L before PPV	1	+	91.33333	8.925	Elevation I
	5	1/2 L after PPV	1	+	124.6667	8.443	Elevation II

DOI: https://doi.org/10.31004/riggs.v4i4.5095

P3 (Crest Curve)	1	PLV	1	+	601.6667	10.000	
	2	PPV	1	+	635		
	3	PTV	1	+	668.3333	9.984	
	4	1/2 L before PPV	1	+	618.3333	9.966	Elevation I
	5	1/2 L after PPV	1	+	651.6667	9.267	Elevation II

3.2.3 Mass diagram

Figure 8. Mass diagram

3.3 Excavation and Fill

Excavation and filling are two main activities in earthworks for construction projects. Excavation is the process of removing or moving soil material from the earth's surface to achieve a certain elevation or depth in accordance with the design plan. usually carried out in foundation, drainage, or underground structure works. Meanwhile, backfilling is the process of adding or depositing soil material to an area to achieve the desired height, shape, or surface, such as in the construction of roads, embankments, or reclamation areas. Both of these tasks aim to create ground surface conditions that meet the technical requirements and stability of the structure to be built.

3.3.1 Embankments and Excavations

Example at STA 0+300

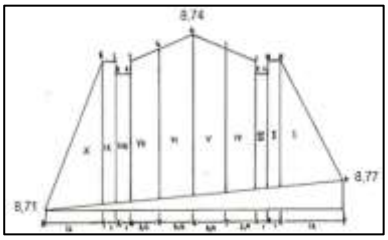

Figure 9. Embankment at STA 0+300

Example at STA 0+400

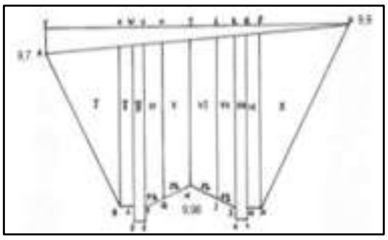

Figure 10. Excavation at STA 0+400

3.3.2 Table of ground elevation, fill, and excavation

Table 7. Ground elevation

STA	Type	Elevation (m)					
		H	G = I	F = C = B = J = M = N	D = E = K = L	A	O
0+50	Embankment	8.76	8.67	8.59	7.59	8.76	8.75
0+100	Embankment	8.31	8.22	8.15	7.15	8.29	8.33
0+150	Embankment	8.59	8.50	8.42	7.42	8.55	8.62
0+200	Embankment	8.63	8.54	8.46	7.46	8.59	8.66
0+250	Embankment	7.95	7.86	7.78	6.78	7.89	8.00
0+300	Embankment	8.74	8.65	8.58	7.58	8.71	8.77
0+350	Excavation	9.24	9.15	9.08	8.08	9.15	9.33
0+400	Excavation	9.98	9.89	9.82	8.82	9.97	9.99

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0+450	Excavation	9,68	9.59	9.52	8.52	9.71	9.65
0+593	Embankment	9.09	9.00	8.93	7.93	9.10	9.08
0+643	Embankment	10.06	9.97	9.89	8.89	10.06	10.05
0+693	Embankment	10.49	10.40	10.32	9.32	10.50	10.47
0+743	Embankment	11.00	10.91	10.84	9.84	11.00	11.00
0+793	Embankment	10.00	9.91	9.84	8.84	10.00	10.00
0+843	Embankment	10.00	9.91	9.84	8.84	10.00	10.00
0+893	Embankment	9.34	9.25	9.18	8.18	9.35	9.33
0+943	Embankment	9.96	9.87	9.80	8.80	9.96	9.96
0+993	Embankment	9.71	9.62	9.54	8.54	9.72	9.69
1+43	Excavation	8.43	8.34	8.27	7.27	8.43	8.43
1+93	Embankment	8.82	8.73	8.65	7.65	8.84	8.79
1+158	Excavation	9.87	9.78	9.70	8.70	9.88	9.85
1+208	Excavation	10.00	9.91	9.84	8.84	10.00	10.00
1+258	Excavation	9.49	9.40	9.33	8.33	9.46	9.52
1+308	Embankment	8.93	8.84	8.76	7.76	8.94	8.91
1+358	Embankment	7.56	7.47	7.40	6.40	7.57	7.55
1+408	Embankment	6.20	6.11	6.03	5.03	6.21	6.18
1+458	Embankment	8.04	7.95	7.88	6.88	8.07	8.01
1+508	Embankment	8.93	8.84	8.77	7.77	8.96	8.90
1+685	Embankment	10.51	10.42	10.34	9.34	10.51	10.50
1+735	Embankment	10.50	10.41	10.33	9.33	10.42	10.57
1+785	Embankment	10.21	10.12	10.04	9.04	10.17	10.24
1+985	Embankment	9.05	8.96	8.89	7.89	9.00	9.10
2+35	Embankment	9.05	8.96	8.88	7.88	9.01	9.08

Table 8. Excavation and Embankment Data

STA	Type	Area (m²)							Triangular Area (m²)
		I	II and IX	III and VIII	IV and VII	V and VI	XI	X	
0+50	Embankment	97.110	8.593	7.593	21.575	30.489	175.000	51.555	41.914
0+100	Embankment	91.770	8.148	7.148	20.463	28.932	166.600	48.885	38.744
0+150	Embankment	95.070	8.423	7.423	21.150	29.894	172.400	50.535	40.094
0+200	Embankment	95.550	8.463	7.463	21.250	30.034	173.200	50.775	40.334
0+250	Embankment	87.390	7.783	6.783	19.550	27.654	160.000	46.695	35.854
0+300	Embankment	96.930	8.578	7.578	21.538	30.437	175.400	51.465	41.124
0+350	Excavation	109.365	9.078	8.078	22.788	32.187	183.000	54.465	52.959
0+400	Excavation	118.725	9.818	8.818	24.638	34.777	199.400	58.905	56.279
0+450	Excavation	115.365	9.518	8.518	23.888	33.727	194.200	57.105	53.919
0+593	Embankment	101.130	8.928	7.928	22.413	31.662	181.600	53.565	44.024
0+643	Embankment	112.710	9.893	8.893	24.825	35.039	201.000	59.355	49.714
0+693	Embankment	117.870	10.323	9.323	25.900	36.544	209.400	61.935	52.494
0+743	Embankment	124.050	10.838	9.838	27.188	38.347	220.000	65.025	55.284
0+793	Embankment	112.050	9.838	8.838	24.688	34.847	200.000	59.025	49.284
0+843	Embankment	112.050	9.838	8.838	24.688	34.847	200.000	59.025	49.284
0+893	Embankment	104.130	9.178	8.178	23.038	32.537	186.600	55.065	45.524
0+943	Embankment	111.570	9.798	8.798	24.588	34.707	199.200	58.785	49.044
0+993	Embankment	108.510	9.543	8.543	23.950	33.814	193.800	57.255	47.814

DOI: https://doi.org/10.31004/riggs.v4i4.5095

1+43	Excavation	100.185	8.268	7.268	20.763	29.352	168.600	49.605	46.839
1+93	Embankment	97.830	8.653	7.653	21.725	30.699	175.800	51.915	42.674
1+158	Excavation	117.495	9.703	8.703	24.350	34.374	197.600	58.215	55.239
1+208	Excavation	119.025	9.838	8.838	24.688	34.847	200.000	59.025	56.259
1+258	Excavation	112.725	9.328	8.328	23.413	33.062	189.200	55.965	53.619
1+308	Embankment	99.150	8.763	7.763	22.000	31.084	178.200	52.575	43.134
1+358	Embankment	82.770	7.398	6.398	18.588	26.307	151.000	44.385	34.844
1+408	Embankment	66.390	6.033	5.033	15.175	21.529	123.600	36.195	26.754
1+458	Embankment	88.530	7.878	6.878	19.788	27.987	160.200	47.265	38.124
1+508	Embankment	99.210	8.768	7.768	22.013	31.102	178.000	52.605	43.464
1+685	Embankment	118.110	10.343	9.343	25.950	36.614	210.000	62.055	52.414
1+735	Embankment	117.990	10.333	9.333	25.925	36.579	211.400	61.995	50.754
1+785	Embankment	114.510	10.043	9.043	25.200	35.564	204.800	60.255	49.814
1+985	Embankment	100.650	8.888	7.888	22.313	31.522	182.000	53.325	42.584
2+35	Embankment	100.590	8.883	7.883	22.300	31.504	181.600	53.295	42.854

3.3.3 Existing Ground and Road Profile Diagram

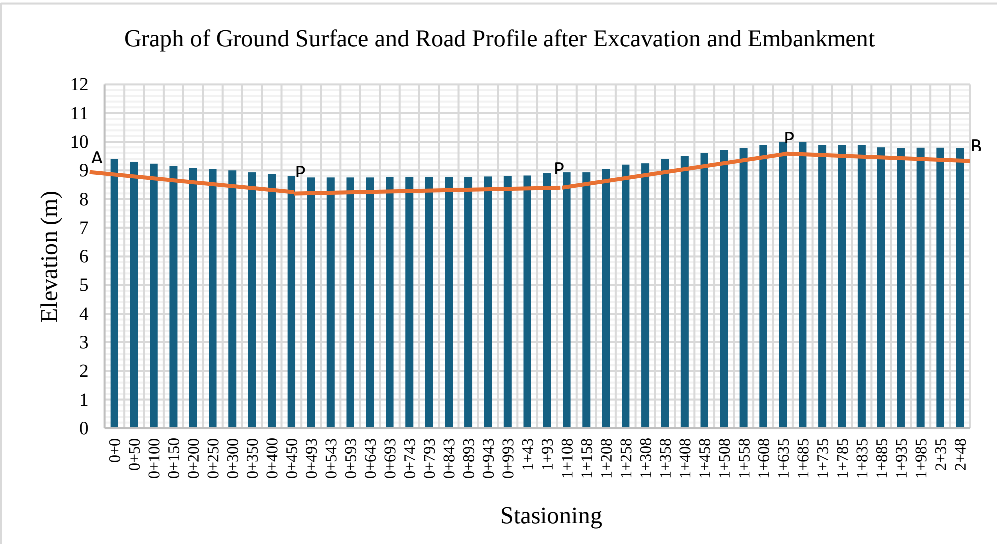

Figure 11. Ground Surface and Road Profile after Excavation and Embankment

3.4 Drainage

Road drainage is an infrastructure system designed to drain and control surface water and groundwater so that it does not flood the road. This system serves to maintain the strength and durability of the road pavement by preventing water from entering the road structure layers, which can cause damage such as cracks, potholes, or surface subsidence. Road drainage typically consists of curbs, culverts, cross drains, and other complementary structures tailored to local topography and rainfall conditions, ensuring the road remains safe, comfortable, and functional throughout its service life.

- Calculate Debit Q

  $Q = 0.278 \times C \times I \times A$

- Check Speed

  $V = \frac{Q}{A}$

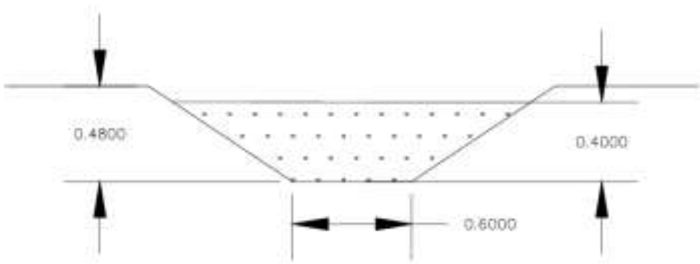

Figure 12. Drainage System (Author. 2025)

4. Conclusion

Based on the results and discussion of this study, it can be concluded that: 1). The Subang-Ciasem road section is classified as flat terrain with a design speed of 80 km/h. Based on projections. The end-of-life traffic volume will reach 7,470 vehicles per day. indicating the need for capacity expansion and geometric improvements to support traffic flow and road user safety. 2). The analysis results produced three main curves with a Spiral–Circle–Spiral (S–C–S) type. a minimum radius of 229 meters. and a maximum superelevation of 8%. The horizontal and vertical designs have been adjusted to the 2021 Bina Marga standards. resulting in a safe and comfortable route with an average vertical curve length of 66.67 meters. 3). The trapezoidal soil drainage system with a capacity of 0.5 m^3/second is considered effective for draining rainwater without the risk of sedimentation. Overall. The design results show that the Subang-Ciasem road meets technical standards, is safe, efficient, and sustainable, and has the potential to improve accessibility, safety, and economic growth in the region.

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