JOURNAL OF RESEARCH AND INOVATION IN CIVIL ENGINEERING AS APPLIED SCIENCE (RIGID)
Vol. 4 No. 1 (2024) 27 - 39 ISSN Media Elektronik: 2828-3732

Analysis and Design in Kuningan Regency

(Case Study of The Road Section of Sukadana Kuningan - Karangwuni Cirebon)

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Abstract

Kuningan Regency is one of the areas that has tourism potential with mountainous geographical conditions with various natural beauties and natural springs. Therefore, Kuningan Regency requires good and planned management in order to achieve optimal results. One of the supporting facilities for tourism in Kuningan Regency is road access that must be developed. In supporting the Government Program related to Regional Development Potential and in accordance with the Regional Spatial Plan of Kuningan Regency Year 2011-2031 regarding the development of road networks to support the tourism sector. So it is necessary to plan road development, which is intended to facilitate relations from one region to another. Where the Road Network has a very important function, namely as a transportation infrastructure in the accessibility and mobility of goods and services which is the lifeblood for encouraging economic growth, social, cultural and national stability, as well as efforts to equalize and spread the building.On the horizontal alignment of the Sukadana Kuningan - Karangwuni Cirebon road section there are 8 bend points. Including 6 Full-Cricle bend points and 6 Spiral-Circle-Spiral bend points. The vertical alignment of the Sukadana Kuningan - Karangwuni Cirebon road section has 22 arch points consisting of 11 concave vertical points and 13 convex vertical points. Making vertical arches aims to balance the number of excavations and embankments at the existing location. The amount of excavation in this road section plan is 530656.5m3 while the amount of embankment is 1859787.22m3.. The type of pavement used is flexible pavement with a thickness of 40 cm top grade LPA, 6 cm AC-BC and 4 cm AC-WC. There is 1 bridge with a length of 80 m. The construction of the Ciawigebang Ring Road section in Kuningan Regency costs Rp. 351,385,080,000.00, - (Three Hundred Five Hundred One Million Three Hundred Eighteen Thousand Five Million Eight Hundred Thousand Thousand Rupiah) and can be completed within 1 year..

Keywords: PDGJ 2021, MDP Revision 2017

Diterima Redaksi : 28-01-2025 | Selesai Revisi : 31-01-2025 | Diterbitkan Online : 31-01-2025

1. Introduction

Kuningan Regency is one of the areas that has tourism potential with mountainous geographical conditions with various natural beauties and natural springs. Therefore, Kuningan Regency requires good and planned management in order to achieve optimal results. One of the supporting facilities for tourism in Kuningan Regency is road access that must be developed.

From the planning of the Sukadana (Kuningan) - Karangwuni (Cirebon) road construction, as stated in the Kuningan Regency Regional Regulation No. 26 of 2011 concerning the Regional Spatial Plan for Kuningan Regency 2011-2031, Article 13 Paragraph 7 is intended to connect Ciawigebang sub-district (Sukadana) with Sedong sub-district (Karangwuni). The purpose of building this road is to save travel time and distance between regions, because compared to taking the existing local road which is 11 km with ± 31 minutes. This road section is an alternative route from Kuningan to Cirebon Regency and vice versa. Therefore, this road section needs to improve its performance in order to be able to support and accommodate community activities.

Problems encountered in Geometric Planning of Roads and Pavement of Sukadana (Kuningan) - Karangwuni (Cirebon) Road Section: 1) How to plan the Geometrics of Sukadana (Kuningan) - Karangwuni (Cirebon) Road to produce a road that is in accordance with the function and class of the road, safe to pass and speed up travel time, 2) How to plan road pavement, and 3) How to plan the cost budget (RAB) needed.

The problems faced in the Geometric Planning of Roads and Pavement of Sukadana Road, Kuningan Regency - Karangwuni, Kuningan Regency are: a) How to plan road geometrics in the Analysis and Design Study of Sukadana Road, Kuningan Regency - Karangwuni, Kuningan Regency? b) How to plan the thickness of pavement on the Analysis and Design Study of Sukadana Road, Kuningan Regency - Karangwuni, Kuningan Regency? And c) How much is the Budget Plan needed for Research Analysis and Design of the Ciawigebang Ring Road Section Based on the Basic Unit Price of Activities (HSPK) Kuningan Regency?

Problem Limitation in this research is a) Only focuses on Geometric Planning, Pavement Planning and Budget Plan, b) Road geometric planning using AutoCAD Civil 3D software based on the 2021 Road Geometric Pavement Design Rules, c) The pavement used is flexible pavement based on the 2017 Pavement Design Manual, d) The Cost Budget Calculation only includes preparatory work and structural work based on the Kuningan Regency Basic Unit Price (HSPK) in 2023, e) Not conducting direct data surveys but by conducting reviews from relevant agencies, namely the Kuningan Regency Public Works and Spatial Planning Office and other sources, namely internet media and books [5], and f) It does not discuss the structural calculation of road complementary buildings but only technical drawings.

Research objectives Analysis and Design of Ciawigebang Ring Road Section: 1) Road Geometric Planning in Ciawigebang Ring Road Analysis and Design Study, 2) Pavement Thickness Planning in Analysis and Design Study of Ciawigebang Ring Road, 3) Planning the Budget Plan required for Research Analysis and Design of the Ciawigebang Ring Road Section Based on the Basic Unit Price of Activities (HSPK) Kuningan Regency.

2. Method

The research location is in Kuningan Regency along ± 7 km, West Java. Oleced - Maleber Cilimus road corridor. The starting point of this road corridor is in Oleced Village, Lebakwangi District and the end point is in Mekarsari Village, Maleber District.

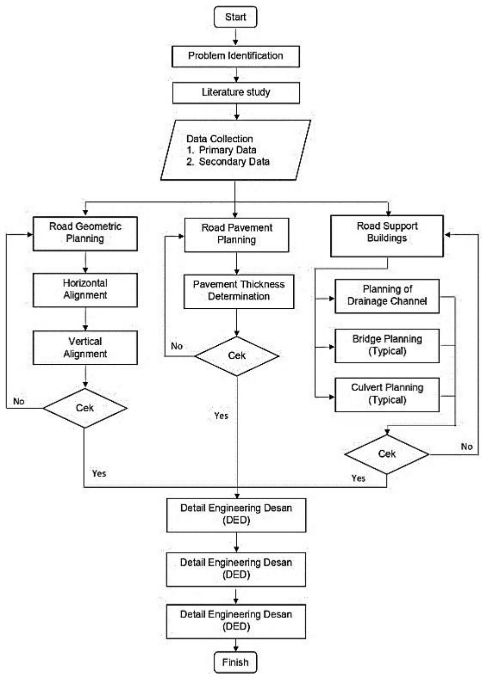


Figure 1. Planning Flowchart
Source: Author's Research Results

Figure 2. Planning Location Planning Location

Source: Google Earth

3. Results and Discussion

3.1 Road Tracks

Determination of the road trajectory is carried out according to the 1:100,000 scale topographic map which is then enlarged to 1:25,000, first planned several alternative road trajectory options by taking into account the existing contour conditions and other contours that can affect road trajectory planning [1]. Some alternative road trajectory options can be seen in the following table 1. Assessment based on several parameters in determining the trase plan obtained 1 trase plan with the highest points with 6 points, namely Trase Plan 1.

Table 1. Alternative Road Trajectory Options

PARAMETERS		TRASE 1	TRASE 2	TRASE 3
Plan Trace Length		7+615,53 m	**7+535.83 m**	8+247.59m
Number of Bends		**7**	**7**	8
Number of Bridges		**1**	**1**	**1**
Culverts		**16**	18	17
Elevation	Maximum	**165**	**165**	**165**
	Minimal	**105**	**105**	**105**
Road Crossing		**4**	5	5
Land Acquisition		**2739,59**	19339,624	29668,448
Existing Contour Elevation Difference		60	60	**60**
POINT		6	5	4
SELECTED TRASE		**YES**	NOT	NOT

***Description:** *Points are taken from the smallest value*

Horizontal Alignment

This is an example of calculating the horizontal alignment in PI.4:

Distance calculation

$$d_{4-5} = \sqrt{(X_5 - X_4)^2 + (Y_5 - Y_4)^2}$$

$$= \sqrt{(234232{,}598\ -\ 2332664{,}597)^2 + (9220942{,}359\ -\ 5221341{,}432)^2} \qquad = 1051{,}076\ m$$

Calculation of azimuth angle

$$\propto_{PI.4} = arc\ \tan\left(\frac{X_5 - X_4}{Y_5 - Y_4}\right) \qquad = arc\ \tan\left(\frac{234232{,}598 - 2332664{,}597}{9220942{,}359 - 5221341{,}432}\right) \qquad = 11231°$$

Calculation of deflection angle

$$\Delta_{PI.4} = \alpha_{PI.4} - \alpha_{PI.5} \qquad = 112{,}31 - 154{,}75 \qquad = 42{,}44°$$

Plan radius of curvature calculation

$$R_{min} = \frac{V_D{}^2}{127(e_{max} - f_{min})} \qquad = \frac{60^2}{127(8\% + 0{,}15)} \qquad = 123{,}25\ m$$

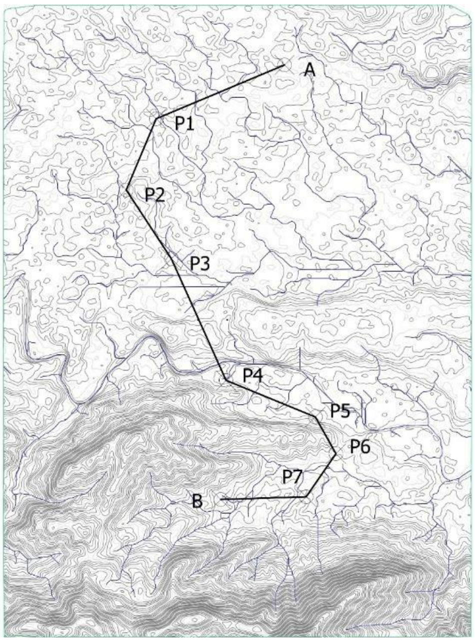


Figure 3. Trajectory Plan 1

Source: Author's Research Results

Calculation of transitional arch length (Ls)

- Based on Suverelevation Runoff

$$L_s = 43{,}46\ m$$

- Based on driving comfort

$$L_{smin} = 2\sqrt{24(P_{min})R} \qquad = 2\sqrt{24\ x\ 0{,}2\ x\ 175} = 28{,}98\ m$$

- Based on Shortt's formula

$$L_{smin} = \frac{0{,}0214\ V_D{}^3}{R_c\ x\ C} = \frac{0{,}0214\ x\ 60^3}{175\ x\ 1{,}2} = 22{,}01\ m$$

Based on the three L_s formulas above, the largest L_s value is selected, which is 43.46 m ~ 44 m.

Checck L_s

$$L_s \leq 0{,}5\ (6\ seconds\ x\ V_D)$$

$$44\ m \leq 0{,}5\ x\ 6\ (\frac{60\ x\ 1000}{3600})$$

$44\ m \leq 50\ m$ → NOT GOOD

Since the largest L_s value exceeds the requirement, the L_s value used is 44 m.

Calculation of bend displacement value If p > 25 then the bend is SCS type.

$p = \frac{44^2}{24\ x\ 75} = 0{,}461\ m\ \geq 0{,}25\ m$ → OK (S-C-S)

Transition bend angle calculation

$$\theta_s = \frac{90\ L_s}{\pi\ R_c} = \frac{90\ x\ 44}{\pi\ x\ 175} = 7{,}203°$$

Calculation of perpendicular distance from point TS to point SC

$$X_s = L_s - \frac{L_s{}^3}{40\ R_c{}^2} = 44 - \frac{44^3}{40\ x\ 175^2} = 43\ m$$

Calculation of perpendicular distance to point SC on the curve

$$Y_s = \frac{{L_s}^2}{6\,R_c} = \frac{44^2}{6\,x\,175} = 1{,}84\text{ m}$$

Calculation of distance from TS point to bend shift point

$$k = X_s - R_c \sin\theta_s = 43 - (175\,x\sin(7{,}203)) = 21{,}99\;m$$

Calculation of tangent length from point P1 to TS

$$T_s = (R_c + p)\tan\frac{1}{2}\Delta + k = (175 + 1{,}84)\tan\left(\frac{42{,}44}{2}\right) + 21{,}99 = 91{,}92\;m$$

Calculation of distance from PI to circular arc

$E_s = (R_C + p)$ seconds$1/2\Delta - R_C$ = (175 + 1.84) x seconds (42,44/2) -175 = 13,88 m

Circular arch bend angle calculation

$\theta_C = (\Delta - 2\theta_S)$ = (42,44 - 2 x 7,203) = 29,06°

Calculating the arc length of a circle

$$L_c = \frac{2\pi}{360}\,x\,\theta_c\,x\,R_c = \frac{2\pi}{360}\,x\,29{,}06\,x\,175 = 88{,}75\;m$$

$$L_c \le 6\;seconds\;x\;V_D$$

$$100\;m \le 6\left(\frac{60\;x\;1000}{3600}\right)$$

$88{,}75\;m \le 100\;m$ → NOT MET

$$L_c > 20\;m$$

$88{,}75\;m > 20\;m$ → MET

Calculation of total arch length

$L_{total} = L_C + 2L_S$ = 88.75 + 2 x 44 = 176,75 m

Distance between bends Length of P1.5

$$T_{sP1.5} = 1051{,}706\;m$$

Distance between bends = $881{,}1\;m$

Distance between bends $\ge 20\;m$

$881{,}1 \ge 20\;m$ → OK

Widen the bend path

Vehicle type = 3-axle truck

P = 6,6 m

A = 1,25 m

Number of lanes = 2

Width of front protrusion

$$T_d = \sqrt{R^2 + A(2P + A) - R} = \sqrt{175^2 + 1{,}25(2\,x\,6{,}6 + 1{,}25) - 175} = 0{,}05\;m$$

Total pavement width of the bend [2]

$$B = b + R - \sqrt{R^2 - P^2} = 2{,}49 + 175 - \sqrt{175^2 - 6{,}60^2} = 2{,}61\;m$$

Additional width due to driving difficulties

$$Z = 0{,}104\;x\;\frac{V}{\sqrt{R}} = 0{,}104\;x\;\frac{60}{\sqrt{175}} = 0{,}47\;m$$

Sidewalk width at corners

$B_t = n(B + C) + (n - 1)T_d + Z$ = 2(2,61 + 0,8) + (2 - 1) x 0,05 + 0,47 = = 7,35 m

Additional sidewalk width at corners

$\Delta b = B_t - B_n = 7{,}35 - 7 = 0{,}35$ m

Check if there is additional widening at the corners

$\Delta b \leq 0{,}5$ m → $0{,}35 \text{ m} \leq 0{,}5$ m

From the calculation results, it was found that the bend widening of 0.35 m was smaller than the requirement of 0.5 so that for bend point P1.4 no widening was needed at the bend. The following are the results of the depiction of each bend in AutoCAD Civil 3D [3].

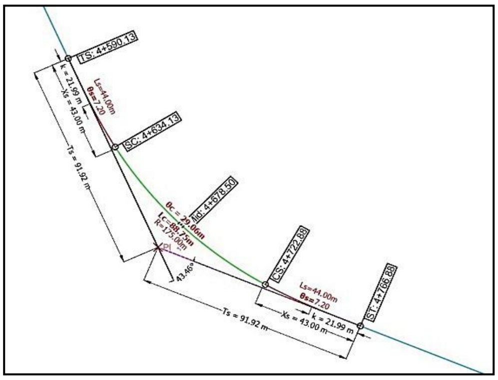


Figure 11. Pl $bend_4$, Spiral-Circle-Spiral
Source: Author's Research Results

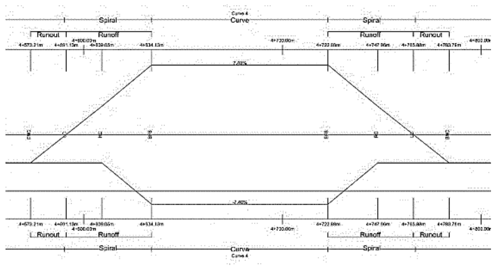


Figure 12. Superelevation Diagram Pl_4 Spiral-Circle-Spiral Curve
Source: Author's Research Results

In the planning of the Oleced - Maleber road in Kuningan Regency, 7 bends are used. There is 1 F-C type bend and 6 S-C-S type bends in the following table.

Table 3. Bend Planning Data

Point	Coordinates		Distance Between PIs (m)	Azimuth α (°)	Bend Angle Δ (°)	Type Bend
	X	Y				
A	233896,4232	9224773,69				
			1513,980	247,26		
PI 1	232500,088	9224188,553			44,46	S-C-S
			841,21	202,81		
PI 2	232174,001	9223413,118			56,07	S-C-S
			894,39	146,73		
PI 3	232664,597	9222665,294			9,04	FC
			1451,68	155,78		
PI 4	233260,228	9221341,432			43,46	S-C-S
			1051,076	112,31		
PI 5	234232,598	9220942,359			42,44	S-C-S
			441,504	154,75		
PI 6	234420,895	9220543,022			56,87	S-C-S
			550,164	211,63		
PI 7	234132,409	9220074,561			56,55	S-C-S
			929,733	268,18		
B	233203,147	9220044,955				

Source: Author's Research Results

Table 4. Recapitulation of Horizontal Alignment Calculation Results

NO. PI	PI-01	PI-02	PI-03	PI-04	PI-05	PI06	PI-07
V (Km/jam)	60	60	60	60	60	60	60
TYPE	S-C-S	S-C-S	F-C	S-C-S	S-C-S	S-C-S	S-C-S
STA	1+514	2+355	3+250	4+701	5+752	6+194	6+744
X	232500,088	232174,001	232664,597	233260,228	234232,598	234420,895	234132,409
Y	9224188,553	9223413,118	9222665,294	9221341,432	9220942,359	9220543,022	9220074,561
Δ (°)	44,46	56,07	9,04	43,46	42,44	56,87	56,55
R (m)	140	140	500	175	140	140	140
Ts/Tc (m)	80,96	98,38	39,54	91,92	78,09	99,64	99,13
Lc (m)	61,63	90,01	78,91	88,75	56,70	91,96	91,18
Ls (m)	46,67	46,08	48,99	43,17	46,08	46,08	46,08
Ltotal (m)	155,63	184,01	0,00	176,75	150,70	185,96	185,18
θ_s (m)	9,62	9,62	0,00	7,20	9,62	9,62	9,62
Es (m)	11,95	19,36	0,00	13,88	10,89	19,96	91,18
E_{max} (%)	8%	8%	8%	8%	8%	8%	8%
Pelebaran	Tidak Butuh	Tidak Butuh	Tidak Butuh	Tidak Butuh	Tidak Butuh	Tidak Butuh	Tidak Butuh

Source: Author's Research Results

Vertical Alignment

The following are the vertical intersection points (PVIs) in vertical alignment planning.

The following is an example of the vertical alignment calculation on PVI 10:

Longitudinal slope

$$g_2 = \frac{Evaluasi_{akhir} - Evaluasi_{awal}}{STA_{akhir} - STA_{awal}} x100\%$$

$$= \frac{131{,}030 - 126{,}550}{7117{,}943 - 6695{,}099} x\ 100\% = 1{,}06\%$$

Positive→ **Concave**

Critical slope length

g1 = 0,31%

Critical slope length = 900 m

Control the critical slope length: 539,71 ≤ 900 m➔ **OK**

g2 = 1,06%

Critical slope length = 900 m Control the critical slope length:

422,84 ≤ 900 m➔ **OK**

Table 5. Vertical Alignment Data

Point	Station	Height (m)	Type
Initial STA	0	153,090	
PVI 1	761,624	148,430	Sag
PVI 2	1510,542	153,730	Crest
PVI 3	2342,522	140,680	Sag
PVI 4	2779,576	132,370	Sag
PVI 5	3521,498	127,640	Crest
PVI 6	4353,537	115,000	Sag
PVI 7	4675,120	115,000	Sag
PVI 8	5444,617	120,000	Sag
PVI 9	6200,000	124,870	Crest
PVI 10	6695,099	126,550	Sag
PVI 11	7117,943	131,030	Sag
Final STA	7615,532	148,110	Crest

Source: Author's Research Results

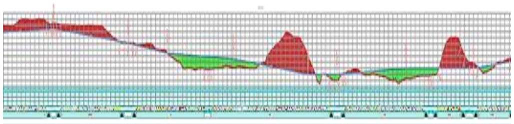


Figure 13. Longitudinal Profile
Source: Author's Research Results

Determine the minimum stopping sight distance $(J)_{PH}$
Plan speed (V_D) PV10 = 10 km/hour

So we get J_{PH} of 85 m and K_{ref} of 18.
Length of concave vertical arch
To calculate the length of a concave vertical arch, it is calculated based on the following four conditions:

Based on stopping sight distance
$(J)_{PH}$ = K x A = 18 x 0.748 = 13.468

Based on passenger comfort
K = 5,663 m
L = K x A = 5,663 x 0,748 = 4,237 m

Based on appearance factors
L = K_{min} x A = 30 x 0.748 = 22.447 m

Based on drainage factors
L = $K_{max}\, x\, A = 51\, x\, 0.748 = 8.159\, m$

Based on the four formulas, the largest L value of 38.159 m was selected.

Table 6. Vertical Curve Design Based on JPH

V_D (km/h)	**J_{PH} (m)**	**K**
20	20	3
30	35	6
40	50	9
50	65	13
60	85	18
70	105	23
80	130	30
90	160	38
100	185	45
110	220	55
120	150	63

Source: Road Geometric Design Guidelines, 2021 [4]

Arch shift value

$$E_V = \frac{A\ x\ L}{800} = \frac{0{,}748\ x\ 38{,}159}{800} = 0{,}036\ m$$

Vertical arch placement

STA PVI10 = 6695,099 m

STA PLV = STA PVI10 - ½ x L

= 6695,1 - ½ x 38,159

= 6676,020 m

STA PTV = STA PVI10 + ½ x L

= 6695,1 - ½ x 38,159

= 6714,180 m

Height of vertical arch

Elevation PVI10 = 126,550

PLV height = PVI10 Altitude – $\left(\frac{g_1\ x\ L}{2}\right)$

= PVI10 Altitude - $(\frac{0{,}31\ x\ 38{,}159}{2})$

= 126,491 m

Height of PTV = PVI10 Altitude – $\left(\frac{g_1\ x\ L}{2}\right)$

= PVI10 Altitude - $(\frac{0{,}31\ x\ 38{,}159}{2})$

= 126,752 m

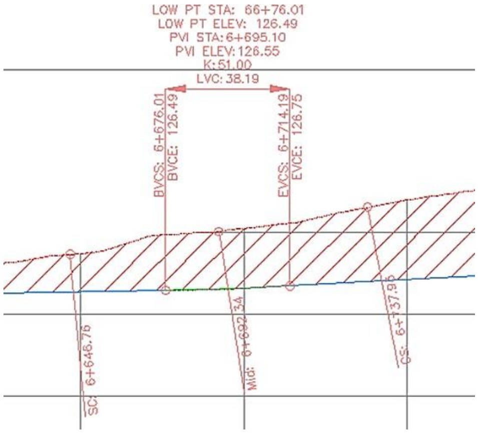


Figure 14: Example of Concave Curve PVI.10
Source: Author's Research Results

3.2 Flexible Pavement Thickness Planning

Table 7. Pavement Thickness Planning Data

Planned road	Class III A Road (Collector)
Pavement Thickness	2/2 TT
Road opened	Year 2026
Construction implementation begins	Year 2023
Implementation period	1 Year
Sidewalk type	Flexural Pavement
Pavement Layer Settings	– Surface Course – Base Layer – Sub Base Course – LPA Class A
Soil CBR value	5,72%

*Description: *) CBR value data taken from the Kuningan Regency Bina Marga Office*
Source: Author's Research Results

Pavement planning in this study uses a type of flexible pavement. The method used refers to the 2017 Flexural Pavement Design Manual in accordance with the Minister of Highways Regulation No.02/M/BM/2017 [6]. The following steps are required in conducting pavement planning:

Determining the Plan Life

Pavement Type	Pavement Elements	Plan Life (year) [(1)]
Flexural pavement	Asphalt layers and graded layers.	20
	Road foundation	40
	All pavements for areas where *overlay is* not possible, such as: urban roads, *underpasses,* bridges, tunnels.	
	Cement Treated Based (CTB)	
Rigid pavement	Upper foundation layer, lower foundation layer, cement concrete layer, and road foundation.	
Road without cover	All elements (including road foundations)	Minimum 10

Figure 15: Plan Life of New Pavement
Source: Pavement Design Manual, 2017 [7]

Calculating ESA4 and ESA5 Values

Traffic Growth Factor

	Java	Sumatra	Kalimantan	Indonesia Average
Arterial and Urban	4,80	4,83	5,14	4,75
Rural collector	3,50	3,50	3,50	3,50
Village road	1,00	1,00	1,00	1,00

Figure 16. Traffic Growth Rate Factor (i) %
Source: Pavement Design Manual, 2017 [7]

Based on the table above, the type of flexible pavement that uses asphalt layers and graded layers has a Plan Life (UR) = 20 Years.

Based on the above table, a traffic growth factor (i) = 3.50% was used for rural collector roads in Java. Thus, the value of the cumulative traffic growth multiplier (R) over the plan life (20 years) can be obtained:

$$R = \frac{(1 + 0{,}001i)^{UR} - 1}{0{,}01i} = \frac{(1 + 0{,}001\ x\ 3{,}5)^{20} - 1}{0{,}001\ x\ 3{,}5} = 28{,}280$$

Lane Distribution Factor (DL)

In the planning of the Oleced - Maleber Road Section, a 2-lane 2- way road will be made with 1 lane in each direction. So the DL value is:

Number of Lanes each direction	Commercial vehicles **in the design lane** (% of commercial vehicle population)
1	100
2	80
3	60
4	50

Figure 17. Lane Distribution Factor (DL)
Source: Pavement Design Manual, 2017

Vehicle type	Sumatra				Java				Kalimantan				Sulawesi				Bali, Nusa Tenggara, Maluku and Papua			
	Actual load		Normal		Actual load		Normal		Actual load		Normal		Actual load		Normal		Actual load		Normal	
	VDF 4	VDF 5	VDF 4	VDF 5	VDF 4	VDF 5	VDF 4	VDF 5	VDF 4	VDF 5	VDF 4	VDF 5	VDF 4	VDF 5	VDF 4	VDF 5	VDF 4	VDF 5	VDF 4	VDF 5
5B	1.0	1,0	1,0	1,0	1,0	1,0	1.0	1,0	1,0	1,0	1,0	1,0	1.0	1,0	1,0	1,0	1,0	1,0	1,0	1,0
6A	0.55	0.5	0.55	0.5	0.55	0.5	0.55	0.5	0.55	0.5	0.55	0.5	0.55	0.5	0.55	0.5	0.55	0.5	0.55	0.5
6B	4,5	7,4	3,4	4,6	5,3	9,2	4,0	5,1	4,8	8,5	3,4	4,7	4,9	9,0	2,9	4,0	3,0	4,0	2,5	3,0
7A1	10,1	18,4	5,4	7,4	8,2	14,4	4,7	6,4	9,9	18,3	4,1	5,3	7,2	11,4	4,9	6,7	-	-	-	-
7A2	10,5	20,0	4,3	5,6	10,2	19,0	4,3	5,6	9,6	17,7	4,2	5,4	9,4	19,1	3,8	4,8	4,9	9,7	3,9	6,0
7B1	-	-	-	-	11,8	18,2	9,4	13,0	-	-	-	-	-	-	-	-	-	-	-	-
7B2	-	-	-	-	13,7	21,8	12,6	17,8	-	-	-	-	-	-	-	-	-	-	-	-
7C1	15,9	29,5	7.0	9,6	11,0	19,8	7,4	9,7	11,7	20,4	7,0	10,2	13,2	25,5	6,5	8,8	8,0	11,9	6,5	8,8
7C2A	19,8	39,0	6,1	8,1	17,7	33,0	7,6	10,2	8,2	14,7	4,0	5,2	20,2	42,0	6,6	8,5	-	-	-	-
7C2B	20,7	42,8	6,1	8,0	13,4	24,2	6,5	8,5	-	-	-	-	17,0	28,8	9,3	13,5	-	-	-	-
7C3	24,5	51,7	6,4	8,0	18,1	34,4	6,1	7,7	13,5	22,9	9,8	15,0	28,7	59,6	6,9	8,8	-	-	-	-

Figure 18. VDF Value of Each Type of Commercial Vehicle
Source: Pavement Design Manual, 2017

<u>Determination of ESA4 and ESA5</u>
Cumulative Equivalent Single Axle Load (CESAL) is the cumulative sum of the design traffic axle loads on the design lanes over the plan life, determined as follows:
The determination of ESA4 and ESA5 values for class 6 vehicles is as follows:

$$ESA4 = (\sum LHR \times VDF) \times 365 \times DL \times DD \times R = (100 \times 0{,}55) \times 365 \times 0{,}5 \times 1 \times 28{,}280 = 517974{,}6442$$

$$ESA5 = (\sum LHR \times VDF) \times 365 \times DL \times DD \times R = (100 \times 0{,}5) \times 365 \times 0{,}5 \times 1 \times 28{,}280 = 517974{,}6442$$

Table 8. CESA Calculation Results

Vehicle Class	LHR 2023	LHR 2026	VDF5 NORMAL	365	DD	DL	R	ESA5 Normal (2026-2046)
1	9646	11739	-	-	-	-	-	-
2	2262	2753	-	-	-	-	-	-
3	329	400	-	-	-	-	-	-
4	602	733	-	-	-	-	-	-
5a	11	13	-	-	-	-	-	-
5b	82	100	1,0	365	0,5	1,0	28,280	517974,644
6a	245	298	0,5	365	0,5	1,0	28,280	768230,578
7a1	12	15	6,4	365	0,5	1,0	28,280	489221,462
7b1	2	3	13	365	0,5	1,0	28,280	198746,219
7c1	4	4	9,7	365	0,5	1,0	28,280	222442,883
8	1	1	-	-	-	-	-	-
							CESA	**2196615,789**

Source: Author's Research Results

<u>Determination of Pavement Structure Type</u>

Pavement Structure	Design Chart	ESA (million) in 20 years (rank 4 unless otherwise specified)				
		0 - 0,5	0,1 - 4	>4 - 10	>10 - 30	>30 - 200
Rigid pavement with heavy traffic (on soil with CBR ≥ 2.5%)	4	-	-	2	2	2
Low-traffic rigid pavement (rural and urban areas)	4A	-	1, 2	-	-	-
Modified AC WC or modified SMA with CTB (ESA rank 5)	3	-	-	-	2	2
AC with CTB (ESA rank 5)	3	-	-	-	2	2
AC ≥ 100 mm thick with graded foundation layer (ESA rank 5)	3B	-	1, 2	1, 2	2	2
AC or thin HRS over a graded foundation layer (ESA rank 5)	3A	-	1, 2	-	-	-
Burda or Burtu with Class A LFA or native rock	5	3	3	-	-	-
Soil Cement Foundation Layer	6	1	1	-	-	-
Pavement without cover (Japat, gravel road)	7	1	-	-	-	-

Notes:
Difficulty level:
1 - small - medium contractors
2 - Large contractor with sufficient resources
3 - requires specialized skills and expertise - contractors, Burtu/Burda specialists

Figure 19: Selection of Pavement Type
Source: Pavement Design Manual, 2017

With the value of CESA = 2196615.789, the pavement structure that can be used is AC ≥ 100m thick with a graded foundation layer.

Determination of Subgrade Segments with California Bearing Ratio (CBR) Values

Table 9: CBR value CBR value

No.	CBR	Same or Larger Amount	(%) that is Equal or Greater			
1	3,90	12	12/12 * 100%	=	100	%
2	5,40	11	11/12 * 100%	=	92	%
3	5,80	10	10/12 * 100%	=	83	%
4	5,90	9	9/12 * 100%	=	75	%
5	6,70	8	8/12 * 100%	=	67	%
6	6,90	7	7/12 * 100%	=	58	%
7	7,20	6	6/12 * 100%	=	50	%
8	7,60	5	5/12 * 100%	=	42	%
9	7,70	4	4/12 * 100%	=	33	%
10	9,00	3	3/12 * 100%	=	25	%
11	10,20	2	2/12 * 100%	=	17	%
12	11,70	1	1/12 * 100%	=	8	%

Source: Bina Marga Office of Kuningan Regency

Based on the table above, the 90% value is in the 2nd and 3rd data, so interpolation is used to determine the right value:

$$CBR\ 90\% = \left(\frac{90-83}{92-83}\right)\ x\ (5{,}80 - 5{,}40) + 5{,}40 = 5{,}72\ \%$$

It can also be depicted through the graph below:

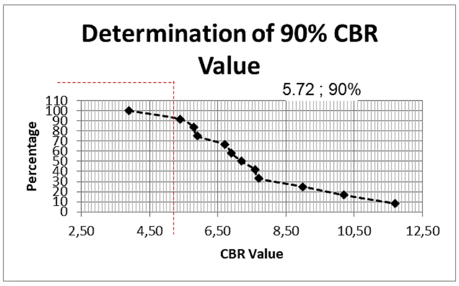
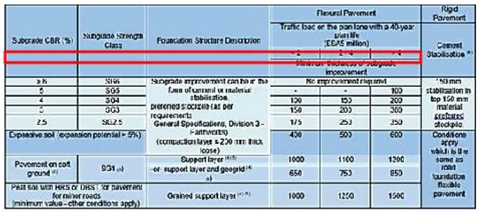


Figure 20. CBR Value Chart CBR Value Chart
Source: Author's Research Results



Subgrade CBR (%)	Subgrade Strength Class	Foundation Structure Description	Flexural Pavement: Traffic load on the plan lane with a 40-year plan life (ESA5 million) < 2	2 - 4	> 4	Rigid Pavement: Cement Stabilisation
			Minimum thickness of subgrade improvement			
≥ 6	SG6	Subgrade improvement can be in the form of cement or material stabilisation, preferred stockpile (as per requirements General Specifications, Division 3 - Earthworks) (compaction layer ≤ 200 mm thick loose)	No improvement required			150 mm stabilisation in top 150 mm material prepared stockpile
5	SG5		-	-	100	
4	SG4		100	150	200	
3	SG3		150	200	300	
2.5	SG2.5		175	250	350	
Expansive soil (expansion potential > 5%)			400	500	600	Conditions apply which is the same as road foundation flexible pavement
Pavement on soft ground	SG1	Support layer	1000	1100	1200	
		-or- support layer and geogrid	650	750	850	
Peat soil with HRS or DBST for pavement for minor roads (minimum value - other conditions apply)		Grained support layer	1000	1250	1500	

Figure 21. Support Layer
Source: Pavement Design Manual, 2017

With CBR value = 5.72%, according to Design Chart - 2, it is categorized as SG5. And with CESA value = 2196615.789 (< 2 Million), there is no need for soil improvement.

Determination of Pavement Structure Thickness

	STRUKTUR PERKERASAN							
	FFF1	FFF2	FFF3	FFF4	FFF5	FFF6	FFF7	FFF8
	Solusi yang dipilih			Lihat Catatan 2				
Kumulatif beban sumbu 20 tahun pada lajur rencana (10^6 ESA5)	< 2	≥ 2 - 7	> 7 - 10	> 10 - 20	> 20 - 30	> 30 - 50	> 50 - 100	> 100 - 200
KETEBALAN LAPIS PERKERASAN (mm)								
AC WC	40	40	40	40	40	40	40	40
AC BC	60	60	60	60	60	60	60	60
AC Base	0	80	105	145	160	180	210	245
LFA Kelas A	400	300	300	300	300	300	300	300
Catatan	1	2		3				

Figure 22: Flexural Pavement Design Asphalt with Graded Foundation Layer
Source: Pavement Design Manual, 2017

Based on the design chart table above, it is found that the thickness of the pavement structure of the road section with a CESA5 value of 10-20 million, the pavement structure is type FFF2. The pavement structure is as follows:

WC AIR CONDITIONING : 4 cm

AC BC : 6 cm

AC base : 8 cm

LP Class A : 30 cm

3.3 Cost Budget Planning

The construction of the Ciawigebang Ring Road (Oleced - Maleber) in Kuningan Regency requires a cost of Rp. 390,733,900,000, - (Three Hundred Seven Million Ten Million Rupiahs) and can be completed within 1 year. RAB calculation has been adjusted to the volume of work [8][9][10].

Table 10. Recapitulation of Budget Plan Costs Recapitulation of Budget Plan Costs

NO.	URAIAN PEKERJAAN	KODE	VOLUME	SATUAN	HARGA SATUAN	JUMLAH HARGA	BOBOT (%)
BAB I : UMUM							
1	Pengukuran	1.1	1.00	Ls	Rp. 6,000,000.00	Rp. 6,000,000.00	0.0019
2	Pembuatan Papan Nama Proyek	1.2	1.00	Ls	Rp. 625,000.00	Rp. 625,000.00	0.0002
3	Pekerjaan Direksi Keet	1.3	1.00	Ls	Rp. 1,250,000.00	Rp. 1,250,000.00	0.0004
4	Administrasi dan Dokumentasi	1.4	1.00	Ls	Rp. 1,250,000.00	Rp. 1,250,000.00	0.0004
					JUMLAH BAB I : UMUM	**Rp. 9,125,000.00**	0.0029
BAB II : PEKERJAAN PERSIAPAN							
1	Mobilisasi dan Demobilisasi	2.1	1.00	Ls	Rp. 25,000,000.00	Rp. 25,000,000.00	0.0079
2	Pembersihan Semak dan Pengupasan Tanah	2.2	103,056.75	M^2	Rp. 1,118.15	Rp. 115,232,389.73	0.0364
3	Persiapan Badan Jalan	2.3	68,704.50	M^2	Rp. 1,118.43	Rp. 76,841,345.70	0.0243
					JUMLAH BAB II : PEKERJAAN PERSIAPAN	**Rp. 217,073,735.43**	0.0686
BAB III : PEKERJAAN TANAH						Rp.	
1	Galian Tanah	3.1	530,656.50	M^3	Rp. 196,640.02	Rp. 104,348,303,711.82	32.9629
2	Timbunan Tanah	3.2	1,859,787.22	M^3	Rp. 85,195.50	Rp. 158,445,494,662.36	50.0518
					JUMLAH BAB III : PEKERJAAN TANAH	**Rp. 262,793,798,374.18**	83.0147
BAB IV : PEKERJAAN DRAINASE							
1	Galian Drainase	4.1	7,735.37	M^3	Rp. 31,472.91	Rp. 243,454,623.17	0.0769
2	Pekerjaan Drainase Samping Jalan (Uditch DS-5)	4.2	13,004.00	Unit	Rp. 2,587,589.16	Rp. 33,649,009,430.14	10.6295
					JUMLAH BAB IV : PEKERJAAN DRAINASE	**Rp. 33,892,464,053.30**	10.7064
BAB V : PEKERJAAN STRUKTUR							
1	Gorong-Gorong (Box Culvert 2.0m x 2.0m)	5.2	121.00	Unit	Rp. 11,503,261.96	Rp. 1,391,894,697.58	0.4397
					JUMLAH BAB V : PEKERJAAN STRUKTUR	**Rp. 1,391,894,697.58**	0.4397
BAB VI : PEKERJAAN PERKERASAN							
1	Lapis Pondasi Atas kelas A (30 cm)	6.1	22,817.04	M^3	Rp. 367,710.52	Rp. 8,390,065,688.89	2.6504
2	Lapis Resap Pengikat (Prime Coat)	6.2	57,711.78	M^3	Rp. 12,635.97	Rp. 729,244,520.10	0.2304
3	Lapis Resap Perekat (Tack Coat)	6.3	19,237.26	M^3	Rp. 11,870.28	Rp. 228,351,671.38	0.0721
4	Lapis Permukaan (AC-BC, 6 cm)	6.4	3,798.21	M^3	Rp. 1,365,039.89	Rp. 5,184,708,161.88	1.6378
5	Lapis Permukaan (AC-WC, 4 cm)	6.5	2,532.18	M^3	Rp. 1,373,468.24	Rp. 3,477,868,808.82	1.0986
					JUMLAH BAB VI : PEKERJAAN PERKERASAN	**Rp. 18,010,238,851.07**	5.6893
BAB VII : PEKERJAAN PELENGKAP							
1	Marka	7.1	1,701.55	M^2	Rp. 141,283.31	Rp. 240,401,045.05	0.0759
2	Rambu	7.2	32.00	Unit	Rp. 132,093.84	Rp. 4,227,002.78	0.0013
3	Patok	7.3	6.00	Unit	Rp. 651,294.33	Rp. 3,907,765.97	0.0012
					JUMLAH BAB VII : PEKERJAAN PELENGKAP	**Rp. 248,535,813.80**	0.0785
REKAPITULASI							
BAB I : UMUM						**Rp. 9,125,000.00**	0.0029
BAB II : PEKERJAAN PERSIAPAN						**Rp. 217,073,735.43**	0.0686
BAB III : PEKERJAAN TANAH						**Rp. 262,793,798,374.18**	83.0147
BAB IV : PEKERJAAN DRAINASE						**Rp. 33,892,464,053.30**	10.7064
BAB V : PEKERJAAN STRUKTUR						**Rp. 1,391,894,697.58**	0.4397
BAB VI : PEKERJAAN PERKERASAN						**Rp. 18,010,238,851.07**	5.6893
BAB VII : PEKERJAAN PELENGKAP						**Rp. 248,535,813.80**	0.0785
					JUMLAH	**Rp. 316,563,130,525.36**	100.0000
					PPn 11 %	**Rp. 34,821,944,357.79**	
					JUMLAH TOTAL	**Rp. 351,385,074,883.15**	
					DIBULATKAN	**Rp. 351,385,080,000.00**	
TIGA RATUS LIMA PULUH SATU MILYAR TIGA RATUS DELAPAN PULUH LIMA JUTA DELAPAN PULUH RIBU RUPIAH							

Source: Author's Research Results

4. Closing

4.1 Conclusions

1 The Sukadana Kuningan - Karangwuni road section is planned to have 6870.453 meters. Road geometric planning refers to the 2021 Ministry of Highways Road Geometric Design Guidelines method using Autocad Civil 3D software.

2 On the horizontal alignment of the Sukadana Kuningan - Karangwuni Cirebon road section there are 8 bend points. Including 6 Full-Cricle bend points and 6 Spiral-Circle-Spiral bend points.

3 The vertical alignment of the Sukadana Kuningan – Karangwuni Cirebon road section has 22 arch points consisting of 11 concave vertical points and 13 convex vertical points. Making vertical arches aims to balance the number of excavations and embankments at the existing location. The amount of excavation in this road section plan is 530656.5m3 while the amount of embankment is 1859787.22m3.

4 Pavement planning on the Sukadana Kuningan - Karangwuni Cirebon road section using Flexible Pavement refers to the 2017 Ministry of Highways Pavement Design Manual method. Based on the amount of LHR plan, the type and thickness of pavement is obtained as follows:

WC AIR CONDITIONING : 4 cm

AC BC : 6 cm

LP Class A : 40 cm

5 The construction of the Sukadana Kuningan - Karangwuni Cirebon clear section requires an ordinary fund of Rp. 351,385,080,000.00, - (Three Hundred Fifty One Billion Three Hundred Eighty-Five Million Eighty- Four Thousand Rupiah)

4.2 Saran

1. After carrying out the preparation of this final project, there are several things and suggestions that need to be considered, including:
2. The selection of the best trajectory should consider the existing topographic conditions, not just the parameter values. This can help the planning process in the long run.
3. Making bends on horizontal alignments as much as possible has a small angle (Δ) so that the plan speed used can be maximized.

4. The use of the plan speed should be adjusted to the needs of the horizontal curve to minimize the "danger" in AutoCAD Civil 3D software.
5. Use references that are appropriate to the planning objectives and topic. Use references that are not too old, so that the characteristics of the data and problems are not too different.
6. More understanding and skills are needed in the use of supporting software, especially AutoCAD Civil 3D and Microsoft Excel for calculations in planning a plan.

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