

GEOMETRIC REDESIGN, FLEXIBLE PAVEMENT DESIGN, AND COST ESTIMATE (RAB) FOR THE GUNUNG TUA–AEK GODANG ROAD SECTION, STA 6+800–STA 21+900

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Abstract

The geometric redesign, flexible pavement design, and Cost Budget Plan (RAB) for the Gunung Tua–Aek Godang Road Section from STA 6+800 to STA 21+900 in North Padang Lawas Regency were carried out to improve road safety, driving comfort, and traffic flow. This study aimed to design the road geometry based on the 2021 Road Geometric Design Guidelines (PDGJ), design the flexible pavement using the 2024 Bina Marga Pavement Design Manual (MDPJ), and estimate the construction cost based on the 2024 Unit Price Analysis (AHSP). The data used in this study included Average Daily Traffic (ADT), topographic data, and subgrade soil data (CBR). The geometric design results identified a total of 18 horizontal curves that comply with the requirements of the 2021 PDGJ. Based on the 2024 MDPJ, the proposed flexible pavement structure consists of a 4 cm Asphalt Concrete Wearing Course (AC-WC), 6 cm Asphalt Concrete Binder Course (AC-BC), 8 cm Asphalt Concrete Base (AC-Base), 20 cm Class A Aggregate Base Course, 15 cm Class B Aggregate Subbase Course, and 20 cm Selected Fill (LFA). The designed pavement structure is capable of accommodating the projected traffic loads throughout the design service life in accordance with the 2024 MDPJ. The estimated total construction cost was IDR 98,140,652,856.

Keywords: geometric design; flexible pavement; cost estimate; ADT; RAB

INTRODUCTION

Roads are one of the key land transportation infrastructures that play an important role in supporting economic growth, community mobility, the distribution of goods and services, and equitable regional development. Roads that meet technical standards are essential to create a transportation system that is safe, comfortable, smooth, and efficient. In accordance with Law No. 2 of 2022, the Second Amendment to Law No. 38 of 2004 concerning Roads, roads have a strategic function in supporting economic, social, cultural, defense, and security activities, as well as improving community welfare (Government of the Republic of Indonesia, 2022). The development and improvement of road quality are among the government's efforts to enhance interregional connectivity and facilitate the movement of people and goods. Good road infrastructure improves accessibility, accelerates logistics distribution, and supports regional economic growth (Ministry of Public Works and Housing, 2020). Therefore, every road development or improvement project should be planned based on applicable technical standards to achieve an optimal level of service.

The Gunung Tua–Aek Godang Road is one of the national road sections serving as a primary collector road that connects several important areas in North Sumatra Province, particularly North Padang Lawas Regency and its surrounding areas. This road plays an important role in supporting community mobility, the distribution of agricultural products, trading activities, and interregional connectivity. The high traffic activity on this road requires geometric conditions and pavement structures that meet technical requirements to provide safety, comfort, and smooth traffic flow for road users (Directorate General of Highways, 2021). Based on field observations along the Gunung Tua–Aek Godang Road, STA 6+800–STA 21+900, several problems were still found that affect road performance. In addition, several sections of the road pavement have experienced deterioration in the form of cracking, deformation, and surface settlement. These damages are suspected to be caused by increasing traffic

volume, repeated vehicle loading, and declining pavement structural capacity to withstand traffic loads throughout its service life (Directorate General of Highways, 2024). These conditions indicate that the Gunung Tua–Aek Godang Road requires redesign so that it can provide a level of service appropriate to current and future traffic demand. Geometric redesign is required to produce a road alignment that meets safety, comfort, and traffic-flow requirements in accordance with the 2021 Road Geometric Design Guidelines (PDGJ). Meanwhile, the flexible pavement thickness is designed based on the 2024 Pavement Design Manual (MDPJ) so that the pavement structure can optimally accommodate traffic loads throughout the design life (Directorate General of Highways, 2021; Directorate General of Highways, 2024). In addition to technical aspects, the preparation of a Cost Estimate (RAB) is necessary as a basis for estimating the cost requirements of the work effectively and efficiently. The RAB is prepared based on the 2024 Unit Price Analysis for Public Works (AHSP), so that the planning results can serve as a reference for road improvement implementation (Ministry of Public Works and Housing, 2024).



Figure 1. Pavement and Curve Conditions

Source: Documentation in the thesis

Research Questions

1. What are the horizontal and vertical geometric designs for the Gunung Tua–Aek Godang Road using the Road Geometric Design Guidelines 13/P/BM/2021 (PDGJ 2021)?
2. What is the required flexible pavement thickness for the Gunung Tua–Aek Godang Road in accordance with the 2024 Pavement Design Manual method?
3. What is the Cost Estimate (RAB) for the Gunung Tua–Aek Godang Road using the 2024 Unit Price Analysis (AHSP)?

Objectives

1. To obtain the results of the geometric redesign of the Gunung Tua–Aek Godang Road.
2. To obtain the designed flexible pavement thickness for the Gunung Tua–Aek Godang Road.
3. To obtain the Cost Estimate (RAB) for the flexible pavement and drainage works on the Gunung Tua–Aek Godang Road.

LITERATURE REVIEW

Road Network and Design Parameters

A road network is the integrated whole of interconnected roads classified into primary and secondary network systems. The management of these systems follows regional spatial planning and considers connectivity within and between urban and rural areas. Government Regulation of the Republic of Indonesia No. 34 of 2006 concerning Roads describes the road network system as follows Primary road networks are arranged according to spatial planning and the distribution of goods and services with the aim of developing areas at the national level. Primary road networks connect national, regional, local, and neighborhood activity centers. Based on Government Regulation of the Republic of Indonesia No. 34 of 2006 concerning Roads, roads are classified by function into four categories:

Collector roads are road types that collect and distribute traffic from environmental and local roads toward arterial or main roads. Collector roads play an important role in connecting various areas and facilitating population mobility. Collector roads are divided into primary collector roads and secondary collector roads.

Several planning parameters must be understood in geometric road design, including design speed, road traffic volume and capacity, and the level of service provided by the road. These parameters determine the comfort and safety produced by a particular road geometric design.

A design vehicle is a vehicle whose dimensions and turning radius are used as references in geometric road design. Design vehicles are grouped into three categories:

Small vehicles, represented by passenger cars;

Medium vehicles, represented by three-axle tandem trucks or two-axle large buses;

Large vehicles, represented by tractor-semitrailers.

Design Average Daily Traffic Volume (VLHR) is the estimated daily traffic volume at the end of the design year, expressed in passenger car units (pcu/day). Design Hourly Volume (VJR) is the estimated traffic volume during the peak hour of the design year, expressed in passenger car units (pcu/hour). It can be calculated using the following formula:

The design speed (VR) on a road section is the speed selected as the basis for geometric design that allows vehicles to travel safely and comfortably under clear weather, light traffic, and insignificant roadside interference conditions. For difficult terrain, the VR of a road segment may be reduced, provided that the reduction does not exceed 20 km/h. The VR for each road function can be determined from Table 2.4.

Flexible Pavement and Cost Planning

Road pavement is a layer or road body constructed using special materials that are structurally superior to the subgrade. A pavement structure is the hardened part of a road construction consisting of specific layers with defined thickness, strength, stiffness, and stability so that traffic loads can be transferred to the subgrade. Pavement functions to provide service to transportation facilities and, throughout its service period, is expected to remain free from significant damage. This study refers to the 2024 Bina Marga Pavement Design Manual. The guideline is the latest method for pavement layer thickness design and has been refined from previous methods.

Design Life (UR)

Traffic

Pavement Type

Subgrade Segment

Design CBR for Subgrade Stabilization

Flexible Pavement Foundation Structure

The pavement structure that meets the design requirements can be selected based on the design traffic load and the materials used, as follows.

Unit Price of Work (HSP)

Unit Price Analysis of Work (AHSP)

Work Volume Calculation

Cost Estimate Calculation

Cost Recapitulation

The design methods used in the thesis were selected based on relevant national guidelines, while traffic, topographic, CBR, work-volume, and unit-price data formed the basis for processing the data through to the preparation of the cost estimate.

METHOD

Study Location

The study was conducted on the Gunung Tua–Aek Godang Road, Padang Bolak District, North Padang Lawas Regency, North Sumatra Province (STA 6+800–STA 21+900). This road connects regencies, so good road access is required to support economic activity in the area. The location map of the road project is shown in Figure 3.1 below.



Figure 2. Research Location Map

Source: Google Earth

Preparation and Data Collection

The preparation stage consists of a series of activities carried out before the collection, processing, and analysis of research data. This stage aims to ensure that all research requirements are properly prepared so that the study can be conducted effectively, systematically, and in accordance with the established objectives. At this stage, the research plan is prepared, the method is determined, references are collected from books, journals, and relevant standards or guidelines, secondary data are identified, and data completeness is checked for use in the analysis stage. Preparation also includes arranging the software and supporting equipment used in the analysis. Preparation also includes arranging the software and supporting equipment used in the geometric design, flexible pavement design, and cost estimate process. Therefore, the following preparation activities were carried out:

- Completing references or literature reviews related to the topic;
- Determining the data required for the preparation of the thesis;
- Determining the institutions from which data would be collected;
- Preparing the administrative requirements for data collection;
- Conducting a survey at the designated research location to obtain an overview of field conditions;
- Problem Identification

At this stage, the researcher directly visited the field to observe the actual condition of the research object and obtain a general overview of site conditions.

Solving the road problems at the study location requires careful analysis of the data collected for each parameter used in addressing the problems. The data collection methods used in preparing this thesis were as follows:

- Average Daily Traffic (ADT) data were obtained through direct field surveys.
- These data were required to determine the soil bearing capacity value used in pavement design.
- These data were required to determine the total price and Cost Estimate.

Technical Planning

Technical planning involves developing product designs from alternative solutions. Each design detail must refer to the literature or selected design method used as the applicable design guideline, technical specifications, and governing legal basis. The products designed in this study are:

- Road geometric design in accordance with the Road Geometric Design Guidelines (PDGJ 13/P/BM/2021).
- Flexible pavement thickness design using the Bina Marga Pavement Design Manual (MDPJ 2024).
- Drainage dimension design using the Drainage System Planning Guideline (Pd T-02-2006-B).
- Cost Estimate using the 2024 Unit Price Analysis of Work (AHSP).

RESULTS AND DISCUSSION

Technical Data and Traffic Growth

Existing road data are technical data describing the physical conditions and characteristics of the Gunung Tua–Aek Godang Road, which is the planning location. The existing data include road length, road width, lane width,

shoulder width, and existing geometric conditions. These data are used as the basis for evaluation and redesign in accordance with applicable requirements.

Table 1. Road Technical Data

No.	Parameter	Data
1	Road section name	Gunung Tua – Aek Godang
2	Location	North Padang Lawas Regency
3	Starting STA	6 + 800
4	Ending STA	21+900
5	Length of reviewed section	15.10 km
6	Pavement width	7.00 m
7	Number of lanes	2 lanes
8	Width of each lane	3.50 m
9	Road type	2/2 TT

Source: Survey and analysis results

The initial traffic volume was obtained from primary data collected through vehicle counting surveys on the Gunung Tua–Aek Godang Road. The Average Daily Traffic (ADT) data were then analyzed for traffic traveling from Gunung Tua to Aek Godang and in the opposite direction. The data from both directions were used to describe the traffic conditions and characteristics on the reviewed road section.

Based on the calculations, the traffic growth rate was 4.73% (Appendix). This value refers to the Gross Regional Domestic Product (GRDP) growth data for South Tapanuli Regency. GRDP growth was used as the basis for estimating traffic growth because GRDP is an indicator reflecting the economic development of a region, which is related to transportation activity. Considering the concept of selecting the review time frame described above, the feasibility analysis period used in accordance with medium-term planning for a road network system is 2026–2047.

Table 2. ADT Growth on the Gunung Tua–Aek Godang Road

Vehicle Category / Reference Year	Projected Traffic Volume / Reference Year					
	2026	2027	2032	2037	2042	2047
Light Vehicles (PC)	1,788	1,873	2,345	2,959	3,721	4,678
Medium Heavy Vehicles (MHV)	66	69	87	109	137	173
Large Bus (LB)	12	13	16	20	25	31
Large Truck (LT)	641	617	844	1,061	1,334	1,676
Motorcycles (MC)	301	315	396	498	626	785
Non-motorized Vehicles (UM)	0	0	0	0	0	0
TOTAL	2,808	2,941	3,697	4,647	5,843	7,343

Source: Analysis results

Planning-Hour Volume, Capacity, and Degree of Saturation

The following presents the results of the planning-hour volume (VJP) calculation for the Gunung Tua-Aek Godang Road in 2026.

$VJP = VLHR \times K/F$ (Formula II.1) Where:

Traffic volume factor (K) = 10%

Variation factor (F) = 0.8

Based on the Road Geometric Design Guidelines (PDGJ) No. 13/P/BM/2021, the reviewed road is a two-way undivided road (2/2 TT) with a collector function. Therefore, the total carriageway width is 6 meters with a 1-meter shoulder width. The road capacity is calculated using the following formula:

$C = CO \times FCW \times FCSP$

CO = 3000 pcu/hour for both directions (Table II.13)

FCW = 0.91 (Table 2.14)

FCSP = 1 (Table 2.15)

FCSF = 0.95 (Table 2.16)

$C = 3000 \text{ pcu/hour} \times 0.91 \times 1 \times 0.95$

$C = 2593.5$

The road service requirement is assessed using the degree of saturation, defined as the ratio of volume to capacity, which should not exceed 0.800. Based on Table IV.7, the vehicle volume for 2026 on the Gunung Tua-Aek Godang Road is calculated using Formula II.15 as follows:

$DS = V/C$

V = 503 pcu/hour, Gunung Tua-Aek Godang Road, both directions

C = 2593.5 pcu/hour, total capacity in both directions on the Gunung Tua-Aek Godang Road

$DS = 503 : 2593.5 = 0.2063$

Based on the analysis of the road degree of saturation, traffic density on the Gunung Tua-Aek Godang Road from 2026 to 2031 remains adequate because it does not exceed the specified VCR value of 0.800. However, inspection and maintenance should still be carried out on this road to maintain its level of service because the planned service period has been reached.

Table 3. Degree of Saturation Analysis for the Gunung Tua-Aek Godang Road

Calculation Item / Reference Year	Projected Traffic Volume / Reference Year					
	2026	2027	2032	2037	2042	2047
VJP (pcu/hour)	533	588	704	886	1117	1407
Capacity (C)	2594	2594	2594	2594	2594	2594
VCR (DS)	0.206	0.215	0.271	0.342	0.431	0.494
(VCR ≤ 0.80) --> OK	OK	OK	OK	OK	OK	OK

Source: Analysis results

GEOMETRIC DESIGN

Horizontal Alignment

The coordinate data used to determine the road alignment are secondary data presented in Table 4.1 below.

Table 4.8. Alignment Coordinates and Angles

The total calculated distance between points is

$\Sigma d = d1 + d2 + d3 + \dots + d22 = 4145.677007 \text{ m}$

From the table above, the average transverse gradient can be determined as follows:

Based on the calculations, the average transverse gradient was 6.97%. Referring to the 2021 Road Geometric Design Guidelines (PDGJ), the Gunung Tua-Aek Godang Road is classified as hilly terrain because the terrain gradient is within the range of 3%–25%.

The Gunung Tua-Aek Godang Road is an intercity collector road located in hilly terrain. Based on the 2021 Road Geometric Design Guidelines (PDGJ), the geometric design parameters used in calculating the Full Circle curve at PI8 are as follows:

VR = 30 km/h

$$\Delta 8 = 5.32^\circ$$

$$RC = 100 \text{ m} \geq R_{\min} = 26.0006$$

$$RC = 100 \text{ m}$$

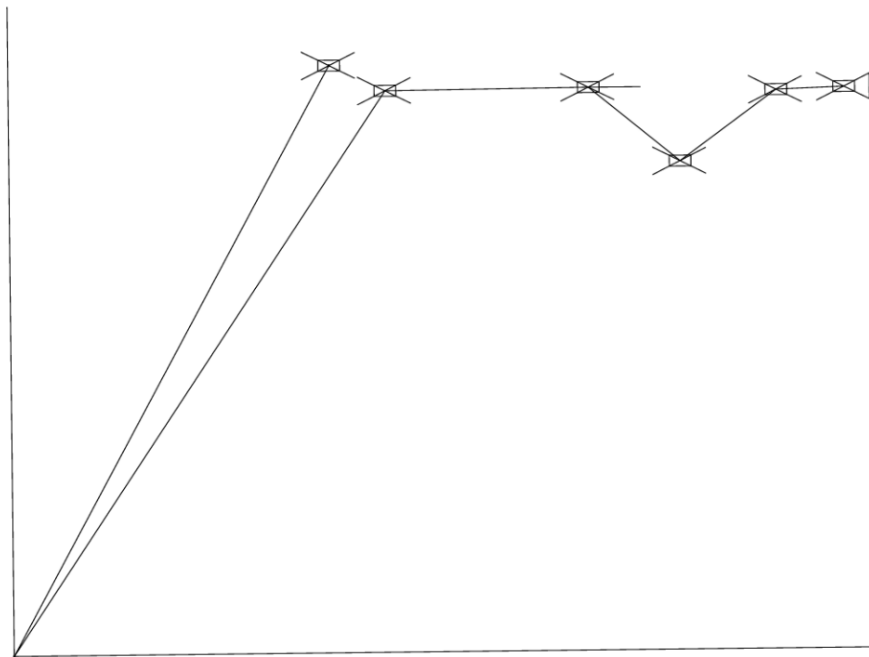


Figure 3. Road Alignment Sketch

Table 4. Calculated Curve Design Results for Segment 1

No. PI	PI1	PI2	PI3	PI4	PI5	PI6
Type	SCS	SCS	SCS	SCS	SCS	FC
X	552039.090	552581.252	552121.662	552098.40	552194.73	552099.393
Y	156360.840	156064.148	156412.456	156636.716	156766.89	156870.053
Δ	68.61	114.150	46.920	42.420	79.240	36.65
R _{design}	50	50	50	50	50	60
V _r	30	40	40	40	40	40
L _s /L _c	59.874	99.615	40.945	16.667	69.150	16.667
k	29.547	47.761	20.354	8.326	33.959	8.328
P	3.252	10.254	1.455	0.233	4.454	0.194
T _s /T _c	65.880	140.810	42.684	27.820	79.039	28.264
E _s /E _c	14.466	60.855	6.092	3.883	20.692	3.409

Source: Analysis results

GEOMETRIC DESIGN

Vertical Alignment

The following are the existing-ground and design-ground elevations obtained from the design of the Gunung Tua–Aek Godang Road:

Table 4.11. Existing Ground and Design Elevations

Longitudinal gradient calculation

Algebraic difference in gradient (A)

The Gunung Tua–Aek Godang Road is an intercity collector road located in hilly terrain; therefore, the design speed was set at $VR = 40 \text{ km/h}$.

$$A = g_3 - g_2 = (-5.68\%) - (-6.80\%) = 1.13\% = (\text{sag})$$

Because the value of A is positive, a sag vertical curve is used. Referring to Figure 2.12, with a design speed VR of 40 km/h and a grade difference of 1.13%, the resulting vertical curve length (Ls) is 30 meters.

$$Ev = A \cdot Lv / 800$$

= 0.042, positive sign (+) = Sag

Based on the road function and hilly terrain conditions, a design speed of 40 km/h was used with an elevation of 248.55 meters.

$A = g_3 - g_2 = (-5.68\%) - (-9.15\%) = 3.48\% = (\text{crest})$

= -0.130, negative sign (-) = Crest

The vertical alignment results were interpreted from the existing-ground and design-ground elevation data and the differences in gradients used to determine the length and type of vertical curves. These calculations form part of the geometric checks for the designed road section.

FLEXIBLE PAVEMENT DESIGN

The pavement thickness design in this study was conducted for a flexible pavement type with reference to the Pavement Design Manual No. 03/M/BM/2024. The calculations followed the procedures specified in the guideline to obtain pavement layer thicknesses that satisfy the design requirements.

The design life of a pavement is determined according to the type and elements of the road pavement. The Gunung Tua-Aek Godang Road is designed as a flexible pavement with asphalt pavement layers. Table 4.15 presents the traffic data used for designing the road section.

$R = 32.138$

i : Traffic Growth Rate Factor = 4.73%

UR : Design Life (years) = 20 years (Table 4.10)

Traffic loading on the design lane is expressed as cumulative standard axle loads (ESA), taking into account the directional distribution factor (DD) and the lane distribution factor for commercial vehicles (DL). The commercial vehicle lane distribution factor (DL) is given in Table 4.16. For two-way roads, the directional distribution factor (DD) is generally taken as 0.50 (Bina Marga, 2024).

In pavement design, traffic loads are converted into standard loads (ESA) using the Vehicle Damage Factor (VDF). The VDF values are presented in Table 4.12.

The traffic data used for the design were obtained from surveys.

To obtain the ESA value for each vehicle type, the following formula is used: $ADT \times VDF \times 365 \times DD \times DL \times R$.

From the ESA4 calculation, a value of approximately 12.780 million (12,780,517.47) was obtained for a design life of 20 years. The selected pavement type can be seen in Table 4.20.

Pavement thickness was determined based on the 2024 Pavement Design Manual (MDPJ) using the ESA5 value obtained from the calculations. The resulting ESA45 value was 15,410.98452 for a 20-year design life and a subgrade CBR value of 11.07%. This value was then used as the basis for selecting the pavement structure in accordance with the 2024 Pavement Design Manual. The resulting flexible pavement structure uses asphalt concrete (AC) layers with aggregate foundation layers capable of accommodating the required traffic loads throughout the design life.

In addition to meeting technical requirements, the selected pavement structure also considers construction cost efficiency without reducing pavement quality and performance. Therefore, this alternative structure was selected as the basis for the design in this study. The arrangement and thickness of each pavement layer used in the study are presented in the following table:

Subgrade Support

Average CBR value = 16.33%

= 4.10%

Road function (collector; therefore, f value) = 1.282%

= $16.33\% - (1.282 \times 4.10\%)$

= 11.07%

Table 5. CBR Value Recapitulation

NO.	STA.	R/S	CBR (%)	CBR – avg	(CBR – avg)^2
1	6+800	R/S	12.55	-3.77	14.21
2	7+0	R/S	15.14	-1.18	1.39
3	7+200	R/S	31.07	14.75	217.56
4	7+400	R/S	11.90	-4.42	19.54
5	7+600	R/S	13.39	-2.93	8.58
6	7+800	R/S	15.07	-1.25	1.56
7	8+0	R/S	16.61	0.29	0.08
8	8+200	R/S	16.73	0.41	0.17
9	8+400	R/S	18.95	2.63	6.92
10	13+800	R/S	11.29	-5.03	25.30
11	14+0	R/S	12.99	-3.33	11.09
12	15+300	R/S	20.50	4.18	17.47
13	15+500	R/S	17.51	1.19	1.42
14	16+100	R/S	14.73	-1.59	2.53
15	16+300	R/S	18.22	1.90	3.61
16	20+900	R/S	15.53	-0.79	0.62
17	21+100	R/S	17.83	1.51	2.28
18	21+300	R/S	16.07	-0.25	0.06
19	21+500	R/S	14.88	-1.44	2.07
20	21+700	R/S	15.69	-0.16	0.40
21	12+900	R/S	16.16	0.09	0.03
Total	Total	Total	342.81	0.09	336.90

Source: Analysis results

FLEXIBLE PAVEMENT DESIGN

Final Pavement Structure

Based on the calculations using MDPJ 2024, a flexible pavement structure with asphalt layers and aggregate foundation layers was obtained. The layer thicknesses are:

1. AC-WC = 40 mm
2. AC-BC = 60 mm
3. AC Base = 80 mm
4. Class A Aggregate Base Course = 200 mm
5. Class B Aggregate Subbase Course = 150 mm
6. Selected Fill (LFA) = 200 mm

Each pavement layer performs a complementary function in carrying and distributing vehicle loads. The AC-WC layer serves as the surface layer, while the AC-BC layer serves as the binder layer between the surface and foundation layers. The AC Base functions as an asphalt-bound base layer that helps distribute vehicle loads to the layers below and increases the structural strength of the pavement. The load is then transferred to the Class A aggregate base, Class B aggregate subbase, and Selected Fill (LFA) until it reaches the subgrade. With this arrangement, vehicle loads can be distributed more evenly, allowing pavement performance to be maintained throughout the design life.

GEOMETRIC REDESIGN, FLEXIBLE PAVEMENT DESIGN, AND COST ESTIMATE (RAB) FOR THE GUNUNG TUA–AEK GODANG ROAD SECTION, STA 6+800–STA 21+900

Adi Syahputra Pasaribu et al

Bagan Desain-3A Desain perkerasan lentur – aspal dengan lapis fondasi agregat (aspal pen 60/70 dan PG70)

	STRUKTUR PERKERASAN								
	FFF(1) 1	FFF(1) 2	FFF(1) 3	FFF(1) 4	FFF(1) 5	FFF(1) 6	FFF(1) 7	FFF(1) 8	FFF(1) 9
	Untuk beban rencana < 30 juta ESA5 menggunakan Aspal Pen 60-70					Untuk beban rencana ≥ 30 juta ESA5 direkomendasikan menggunakan Aspal PG70 ⁽¹⁾			
Beban rencana 20 tahun (10 ⁶ ESA5)	< 2	> 2 - 5	> 5 - 10	> 10 - 15	> 15 - 30	> 30 - 50	> 50 - 100	> 100 - 150	> 150 - 200
Tebal Perkerasan (mm)									
AC WC	60 ⁽²⁾	40	40	40	40	40	40	50	40
AC BC	-	65	75	75	60	60	75	80	60
AC Base ⁽³⁾	-	80	80	-	-	-	-	-	-
	-	-	-	100	80	85	100	100	80
	-	-	-	-	80	100	100	100	80
Lapis Fondasi Agregat Kelas A ⁽⁴⁾	200	200	200	200	200	200	200	200	200
Lapis Fondasi Agregat Kelas B	150	150	150	150	150	150	150	150	150
Timbunan Pilihan Berbutir Kasar atau LFA Kelas C atau Stabilisasi Semen ⁽⁵⁾	-	-	200	200	200	200	200	200	200

(1) Khusus untuk AC WC dan AC BC.
 (2) Tumbukan Marshall sebanyak 2 x 50 tumbukan.
 (3) Khusus untuk AC Base dengan lalu lintas rencana di atas 30 juta ESA5 dapat tidak menggunakan aspal PG70.
 (4) Untuk perkerasan dengan jumlah lajur lebih dari 2 per arahnya, tebal lapis fondasi agregat kelas A minimal 300 mm.
 (5) Dapat menggunakan timbunan pilihan butir kasar yang mempunyai CBR minimum 30% dengan PI 6 - 15 dan ukuran butir maksimum 50 mm atau LFA Kelas C atau stabilisasi semen (UCS 10 kg/cm²). Bilamana untuk ketiga jenis material atau alat yang diperlukan untuk stabilisasi tidak bisa terpenuhi, maka lapisan ini dapat diganti menjadi LFA Kelas B dengan ketebalan 200 mm bila harganya sama atau lebih rendah dari ketiga material tersebut.

Figure 4. Flexible Pavement Design—Asphalt with Aggregate Foundation Layers

Source: Pavement Design Manual (MDPJ 2024)

COST ESTIMATE

The Cost Estimate (RAB) was calculated after the work volume for each work item had been obtained. The calculated work volumes were multiplied by the respective unit prices based on the Unit Price Analysis of Work (AHSP) to obtain the total cost required for road construction.

Work volumes were calculated by grouping work items according to the divisions specified in the Unit Price Analysis of Work. The divisions used in calculating the work volumes for the Gunung Tua–Aek Godang Road, North Padang Lawas Regency, were as follows:

Table 6. Recapitulation of Estimated Work Costs

Division No.	Description	Amount	Remarks
1	General	51,974,917	Work cost
5	Granular Pavement	44,748,141,300	Work cost
6	Asphalt Pavement	41,169,183,312	Work cost
9	Daily and Miscellaneous Works	1,656,283,378	Work cost
	Total Work Cost	87,625,582,907	(A), including general costs and profit
	VAT 12%	10,515,069,949	(B)
	Total RAB	98,140,652,856	(A)+(B)

Source: Analysis results

Based on the calculations, the road construction work consists of general works, granular pavement works, asphalt pavement works, and daily and miscellaneous works. The costs of all work items were summed to obtain a total work cost of IDR 87,625,582,907. A 12% Value Added Tax (VAT) was then added, resulting in a total Cost Estimate (RAB) of IDR 98,140,652,856. The RAB value indicates that construction costs are dominated by pavement works because these works require relatively large quantities of materials, labor, and equipment compared with other work items. Therefore, the RAB should be prepared carefully so that the resulting estimate can serve as a basis for road construction implementation.

Based on these calculations, the Cost Estimate (RAB) is considered consistent with the 2024 Unit Price Analysis of Work (AHSP), so the resulting cost estimate can be used as a reference for planning the construction budget for the Gunung Tua–Aek Godang Road, STA 6+800–STA 21+900. Based on the 2024 Unit Price Analysis of Work (AHSP), the total Cost Estimate (RAB) for the Gunung Tua–Aek Godang Road, STA 6+800–STA 21+900, is IDR 98,140,652,856 after adding 12% Value Added Tax (VAT).

DISCUSSION

The Cost Estimate (RAB) should preferably be adjusted to the unit prices prevailing at the construction location so that the estimated project cost is more representative. The flexible pavement thickness design for the Gunung Tua-Aek Godang Road, STA 6+800-STA 21+900, refers to the 2024 Pavement Design Manual (MDPJ). The design data include average daily traffic (ADT), traffic growth rate, design life, CESA value, and subgrade bearing capacity (CBR). Based on the analysis, average daily traffic (ADT) was 2,808 vehicles/day with a traffic growth rate of 4.73%, which was subsequently used as the basis for determining the pavement structure.

Each pavement layer performs a complementary function in carrying and distributing vehicle loads. The AC-WC layer serves as the surface layer, while the AC-BC layer serves as the binder layer between the surface and foundation layers. The AC Base serves as an asphalt-bound base layer that helps distribute vehicle loads to the lower layers and increases pavement structural strength. The load is then transferred to the Class A aggregate base, Class B aggregate subbase, and Selected Fill (LFA) until it reaches the subgrade. With this arrangement, vehicle loads can be distributed evenly so that pavement performance is maintained throughout the design life.

Based on the design results, the planned flexible pavement structure complies with the requirements of the 2024 Pavement Design Manual (MDPJ), and is therefore expected to provide good road service and reduce the potential for traffic-load-related pavement damage. The preparation of the Cost Estimate (RAB) for the Gunung Tua-Aek Godang Road, STA 6+800-STA 21+900, refers to the 2024 Unit Price Analysis of Work (AHSP). The RAB calculation was based on the road geometric design and flexible pavement thickness design obtained previously. The data used include the volume of each work item, material unit prices, labor wages, and the equipment required for construction.

Based on the calculations, the road construction work consists of general works, granular pavement works, asphalt pavement works, and daily and miscellaneous works. The costs of all work items were summed to obtain a total work cost of IDR 87,625,582,907. A 12% Value Added Tax (VAT) was then added, resulting in a total Cost Estimate (RAB) of IDR 98,140,652,856. The RAB value shows that construction costs are dominated by pavement works because these works require substantial amounts of materials, labor, and equipment compared with other work items. Therefore, the RAB must be prepared carefully so that the estimate can serve as a basis for road construction. Based on the calculations, the Cost Estimate (RAB) is considered consistent with the 2024 Unit Price Analysis of Work (AHSP), so the resulting estimate can be used as a reference for budgeting the construction of the Gunung Tua-Aek Godang Road, STA 6+800-STA 21+900.

CONCLUSION

Based on the design, calculations, and analysis conducted in the study entitled “Geometric Redesign, Flexible Pavement Design, and Cost Estimate (RAB) for the Gunung Tua-Aek Godang Road, STA 6+800-STA 21+900,” the following conclusions were obtained: Based on the road geometric redesign in accordance with PDGJ No. 13/P/BM/2021, 18 curve points (PI) were obtained across 4 segments, consisting of 14 Spiral-Circle-Spiral (SCS) curves and 4 Full Circle (FC) curves. The horizontal and vertical alignments also met the geometric requirements, thereby providing safety and comfort for road users.

Based on the pavement design using MDPJ 2024 with a 20-year design life, the flexible pavement structure obtained is:

1. AC-WC = 40 mm
2. AC-BC = 60 mm
3. AC Base = 80 mm
4. Class A Aggregate Base Course = 200 mm
5. Class B Aggregate Subbase Course = 150 mm
6. Selected Fill (LFA) = 200 mm

Based on the 2024 Unit Price Analysis of Work (AHSP), the total Cost Estimate (RAB) for construction of the Gunung Tua-Aek Godang Road, STA 6+800-STA 21+900, is IDR 98,140,652,856 after adding 12% Value Added Tax (VAT).

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