

LOCAL ROAD PROJECT DESIGN DANAU JURUG – PANTAI TEBING CLUAK'AN

Final Project Report

As one of the requirements to obtain a bachelor's degree at
Universitas Atma Jaya Yogyakarta



Written By:

STANLY ARIA LOUIS (181317545)

AMOS TRISTAN DANANJAYA (211318522)

**INTERNATIONAL CIVIL ENGINEERING PROGRAM
DEPARTMENT OF CIVIL ENGINEERING
FACULTY OF ENGINEERING
UNIVERSITAS ATMA JAYA YOGYAKARTA**

2025

ABSTRACT

The design of a local road connecting Danau Jurug to Pantai Tebing Cluak'an was undertaken to address the critical need for transportation infrastructure that supports regional accessibility, economic development, and traffic safety. This study integrates geometric design, pavement design, and geotechnical engineering into a cohesive planning framework. The primary objective of this project is to develop a technically sound and economically feasible roadway by analyzing multiple alignment alternatives, assessing subgrade conditions, predicting settlement, and ensuring long-term structural performance.

The research began with the selection of the optimal road alignment using the Analytic Hierarchy Process (AHP) in Autodesk Civil 3D. Four alternatives were compared based on criteria including geometric suitability, earthwork efficiency, slope stability, and cost-effectiveness. Alignment 4 was selected as the final alignment due to its favorable balance of horizontal and vertical geometry, minimal earthwork volume, and adaptability to natural terrain contours. The horizontal alignment incorporated appropriate curve radii and superelevation to accommodate vehicle dynamics and safety. Vertical alignment was designed using parabolic curves, ensuring smooth transitions and sufficient sight distances in both crest and sag curves.

In the pavement design phase, the projected traffic volume and Equivalent Standard Axle Loads (ESALs) were calculated using traffic growth data and Vehicle Damage Factor (VDF) in accordance with Bina Marga standards. The selected pavement structure consists of a surface course, base course, and subbase layer, designed to distribute loads effectively and resist deformation. The California Bearing Ratio (CBR) values obtained from field tests were used to determine pavement thickness. The mechanistic-empirical method was employed to ensure the design meets both performance and durability targets over the pavement's intended lifespan.

Geotechnical investigation was conducted to assess the subgrade bearing capacity, settlement potential, and slope stability. Field tests including Cone Penetration Test (CPT) and Standard Penetration Test (SPT) were performed along the selected alignment. Analytical and empirical methods—namely Terzaghi and Hansen approaches—were used to evaluate soil bearing capacity. The results indicated that most segments of the alignment have sufficient capacity, while weaker zones were reinforced through replacement or improvement of subgrade materials. Additionally, embankment loading was analyzed to estimate immediate and consolidation settlements. Results showed that settlements remained within acceptable limits, ensuring the long-term performance of the pavement structure.

Slope stability analysis was carried out using the Ordinary Method and the Simplified Bishop Method in GeoStudio software. The calculated safety factor values exceeded the minimum requirement of 1.5, indicating stable slope conditions for both cut and fill sections. In particular, the slope along embankment zones was carefully designed with appropriate compaction and geometry to mitigate the risk of sliding or erosion. Where necessary, slope reinforcements were recommended to maintain safety in areas with weak soil or high-water content.

The comprehensive nature of the design addresses the core research problems defined in the project: determining optimal alignment in complex terrain, improving

traffic load prediction, evaluating subgrade response, ensuring slope stability, and managing settlement. These components were analyzed within a clearly defined scope, focusing on preliminary design stages and excluding construction details or special soil conditions.

In conclusion, the “Local Road Project Design Danau Jurug – Pantai Tebing Cluak’an” demonstrates an integrated civil engineering approach that combines design optimization with field-based geotechnical evaluation. The methodology employed in this project not only ensures structural integrity and road safety but also provides a scalable template for similar local road development projects in varied terrain. The outcome of this project is a resilient and sustainable road design that aligns with both national standards and local context.

Keywords: Road, Design, Geotechnical, Gunungkidul, Geometric, Pavement, Soil

STATEMENT

We, the undersigned,

Student Name 1 : Stanly Aria Louis

Student Number : 181317545

Student Name 2 : Amos Tristan Dananjaya

Student Number : 211318522

Declare that the final project with the title:

LOCAL ROAD PROJECT DESIGN DANAU JURUG – PANTAI TEBING
CLUAK'AN

is an original work and not a plagiarism of someone else's work. We, the undersigned,
have contributed to this final project in equal proportions. Thus, we make this statement
as a complement to the final document of this project.

Yogyakarta, 23rd June 2025



Stanly Aria Louis



Amos Tristan Dananjaya

VALIDATION SHEET

Final Project Report

LOCAL ROAD PROJECT DESIGN DANAU JURUG – PANTAI TEBING CLUAK'AN

Written by:

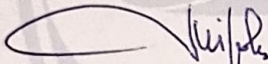
Stanly Aria Louis (181317545)

Amos Tristan Dananjaya (211318522)

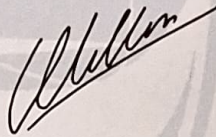
Checked and approved by

Supervisor Lecturer 2
Yogyakarta, 21st July 2025

Supervisor Lecturer 1
Yogyakarta, 21st July 2025


Dr. Ir. J. Dwijoko Anusanto, M. T. IPU.

NIDN: 0505056601


Ir. William Wijaya, S.T., M. Eng.

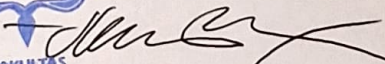
NIDN: 0529039402

Confirmed by,

Head Department of Civil Engineering

Yogyakarta, 21st July 2025




Prof. Ir. Yoyong Arfiadi, M. Eng., Ph. D.

NIDN: 0515015901

VALIDATION SHEET

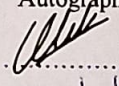
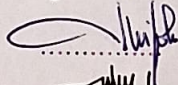
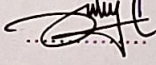
Final Project Report

HIGHWAY PROJECT DESIGN DANAU JURUG – PANTAI TEBING CLUAK'AN

By:

	
Stanly Aria Louis 181317545	Amos Tristan Dananjaya 211318522

Has been tested and approved by:

Name	:	Autograph	Date
Head	: Ir. William Wijaya, S.T., M.Eng.		21/07/2025
Secretary	: Dr. Ir. J. Dwijoko Anusanto, M.T., IPU		21/07/2025
Examiner	: Dr.Eng. Ir. Luky Handoko, S.T., M.Eng, IPM		21/07/2025

PREFACE

Praise be to God Almighty for His blessings and mercy so that we can complete the Final Project Design Infrastructure report. In preparing this report we faced several difficulties in terms of designing and preparing reports. However, thanks to existence assistance from the lecturer and the teaching assistants and lecturers' mentor who has taken the time to guide us. Therefore, we express our deepest gratitude to:

1. God Almighty because of His blessings and grace we can carrying out the Final Project of Road Planning and compiling Assignments End of road planning well and completely.
2. Mr. Prof. Dr. Ir. A.M. Ade Lisantono, M.Eng., IPU, ASEAN Eng as Dean of the Faculty of Engineering in Universitas Atma Jaya Yogyakarta.
3. Mr. Prof. Ir. Yoyong Arfiadi, M.Eng., Ph.D. as Head Department of Civil Engineering, in Universitas Atma Jaya Yogyakarta.
4. Ms. Dr.-Ing. Ir. Agustina Kiky Anggraini, S.T., M.Eng. as Head of Study Program of Civil Engineering in Universitas Atma Jaya Yogyakarta
5. Mr. Dr. Ir. J. Dwijoko Ansusanto, M.T. IPU, as teaching lecturer Road Design and as supervisor group 2 who assisted in preparing the report.
6. Mr. Ir. William Wijaya, S.T., M.Eng., as teaching lecturer planning Soil Bearing Capacity and Slope Stability.

We realize that the task we have created is still far from perfect. Therefore, we really need constructive criticism and suggestions for the perfection of this task. Hopefully this final project of road planning will be successful and provide benefits for us and all parties who read this assignment.

Yogyakarta, 23rd June 2025

Authors

TABLE OF CONTENT

ABSTRACT	i
STATEMENT	iii
VALIDATION SHEET	iv
VALIDATION SHEET	v
PREFACE	vi
TABLE OF CONTENT	vii
LIST OF TABLES	xi
LIST OF FIGURES	xiii
1. CHAPTER I INTRODUCTION	1
1.1. Background	1
1.2. Purposes	1
1.3. Research Problem.....	2
1.4. Scope of Problem	2
2. CHAPTER II THEORETICAL REVIEW.....	3
2.1. Road Classification	3
2.1.1. Classification According to Road Function	7
2.1.2. Classification According to Road Terrain.....	7
2.1.3. Classification According to Road Class.....	8
2.1.4. Classification According to Road Development Authority	8
2.2. Road Segments.....	10
2.2.1. Road Use Space (Rumaja)	12
2.2.2. Road Ownership Space (Rumija).....	12
2.2.3. Road Monitoring Space.....	12
2.3. Geometric Design Parameter	13
2.3.1. Planned Vehicles	13
2.3.2. Planned Speed	14
2.3.3. Traffic Volume.....	14
2.4. Alignment Election	16
2.4.1. Fundamental Scale of Pairwise Comparison.....	16
2.4.2. Random Consistency Index.....	16
2.4.3. Consistency Ratio (CR) Formula	17
2.5. Horizontal Alignment.....	17
2.5.1. Introduction	17
2.5.2. Formula and Factor	18

2.5.3.	Degree of Curvature (D)	19
2.5.4.	Side Friction Factor.....	19
2.4.5.	Maximum Superelevation	20
2.4.6.	Maximum Degree of Curvature	20
2.4.7.	Superelevation.....	20
2.4.8.	Sharp Curves Without Superelevation	21
2.4.9.	Influence of Grade.....	21
2.4.10.	Spiral Curves.....	21
2.6.	Vertical Alignment.....	22
2.6.1.	Features of Vehicle Performance on Grades.....	23
2.6.2.	Grade Limits for Planning.....	23
2.6.3.	Critical Length of a Grade for Design.....	23
2.6.4.	Vertical Curve	23
2.6.5.	Properties of Vertical Curves	24
2.6.6.	Types of Vertical Curves	24
2.6.7.	Parabolic Curve Equation	26
2.7.	Soil Work	27
2.7.1.	Soil Work Specifications.....	27
2.7.2.	Embankment Work	28
2.8.	Pavement Design.....	29
2.8.1.	Methodology and Fundamentals	29
2.8.2.	Benefits of Mechanistic Approaches	30
2.8.3.	Model of Pavement Structure.....	30
2.8.4.	Crucial Stress in Pavement Function	30
2.8.5.	Flexible Pavement Design Procedure Using Empirical Mechanistic Methods	31
2.9.	Soil Investigation	31
2.9.1.	Cone Penetration Test	32
2.9.2.	Standard Penetration Test	33
2.10.	Soil Settlement	36
2.10.1.	Immediate Settlement.....	36
2.10.2.	Consolidation Settlement	38
2.11.	Soil Bearing Capacity	39
2.11.1.	Analytical Method.....	39
2.11.2.	Empirical Method.....	46
2.12.	Slope Stability	47
3.	CHAPTER III ROADWAY PLANNING	48

3.1.	Planning Criteria	48
3.2.	Horizontal Alignment.....	48
3.2.1.	Alternative Road Route.....	49
3.2.2.	Elective Route	51
3.2.3.	Determining Stationing	53
3.2.4.	Bends Planning	53
3.3.	Vertical Alignment.....	62
3.3.1.	Stationing Elevation.....	62
3.3.2.	Bends Stationing	71
3.3.3.	Vertical Intersection Points	73
3.3.4.	Stopping Visibility	76
3.4.	Soil Work	82
3.4.1.	Cut.....	82
3.4.2.	Fill	82
3.4.3.	Data Collection.....	83
4.	CHAPTER IV PAVEMENT DESIGN.....	60
4.1.	Technical Requirement	60
4.1.1.	Pavement Design Life	60
4.1.2.	Data of California Bearing Ratio and Daily Traffic.....	61
4.1.3.	Subgrade Segments with Uniform Bearing Capacity	66
4.2.	Determining Pavement Layer and Loads	67
5.	CHAPTER V SOIL INVESTIGATION	70
5.1.	Soil Investigation	70
5.1.1.	CPT (Cone Penetration Test)	70
5.1.2.	SPT (Standard Penetration Test).....	79
5.1.3.	Stratigraphy of the Soil	84
5.2.	Settlement Analysis.....	84
5.2.1.	Axial Load.....	84
5.2.2.	Immediate Settlement.....	85
5.2.3.	Consolidation Settlement	86
5.2.4.	Embankments and New Axial Load Calculation	88
5.3.	Soil Bearing Capacity Analysis	89
5.3.1.	Analytical Bearing Capacity	89
5.3.2.	Empirical Bearing Capacity	93
5.3.3.	Analytical and Empirical Recap.....	94
5.4.	Slope Stability	94
5.4.1.	Ordinary Method.....	95

5.4.2.	Simplified Bishop Method	97
5.4.3.	Recap of Safety Factor	99
5.4.4.	Critical Height.....	100
6.	CHAPTER VI CONCLUSION.....	102
6.1.	Road Alignment Optimization	102
6.2.	Traffic Load Estimation for Pavement Design	102
6.3.	Settlement due to Embankment Load	102
6.4.	Soil Bearing Capacity and Subgrade Response	102
6.5.	Slope and Embankment Stability	103
6.6.	Conclusion	103
7.	REFERENCES.....	104
8.	ATTACHMENT	8-110

LIST OF TABLES

Table 2.1. Classification Criteria for Terrain	8
Table 2.2. Classification According to Road Class	8
Table 2.3. Vehicle Planning	14
Table 2.4. Planning Speed.....	14
Table 2.5. Traffic Volume.....	15
Table 2.6. Passenger Car Equivalent.....	15
Table 2.7. Matrix Comparison	16
Table 2.8. Random Consistency Index	17
Table 2.9. Grade Limits for Planning.....	23
Table 2.10. Split Tube Sampling Tool	34
Table 2.11. Hammer Efficiency for SPT	35
Table 2.12. SPT Coefficient Table.....	36
Table 2.13. Correlations for Compression Index	38
Table 2.14. Terzaghi Bearing Capacity Factor	40
Table 2.15. Depth Factor.....	42
Table 2.16. Load Slope Factor	42
Table 2.17. Foundation Shape Factor	43
Table 2.18. Base Slope Factor	43
Table 2.19. Surface Slope Factor	43
Table 2.20. Hansen Bearing Capacity Factor.....	44
Table 2.21. Safety Factor Criteria	47
Table 3.1. Pairwise Comparison Matrix Between Road Criteria.....	51
Table 3.2. Priority Weights of Road Criteria	52
Table 3.3. Score of Each Alternative	52
Table 3.4. Normalized Score of Each Alternative	52
Table 3.5. Stationing of the Road.....	53
Table 3.6. Design Road Criteria.....	54
Table 3.7 Curve Angle Formula.....	55
Table 3.8. Calculation of Curve Angle	55
Table 3.9. Design Criteria for Planned Speeds	56
Table 3.10. Horizontal Alignment 1	57
Table 3.11. Horizontal Alignment 2	58
Table 3.12. Horizontal Alignment 3	59
Table 3.13 Maximum Relative Gradient.....	60
Table 3.14 Adjustments Factor of Number of Lanes.....	61
Table 3.15 Superelevation Runoff	62
Table 3.16. Stationing Elevation Left	63
Table 3.17. Stationing Elevation Right.....	66
Table 3.18. Elevation Existing	69
Table 3.19 Type of Road Terrain Based on Terrain Slope	71
Table 3.20. Superelevation Stationing	72
Table 3.21. Vertical Intersection Point	75
Table 3.22. Convex Curve Length	77
Table 3.23 Stop Sight Distance & K.....	78
Table 3.24. Concave Curve Length	80
Table 3.25. Cut and Fill Volume.....	87
Table 4.1. Planned Life for Pavement.....	60
Table 4.2. CBR Data of all Samples	61

Table 4.3. Data of Daily Traffic.....	62
Table 4.4. Values of ESA4 and ESA5 According to The Planned Lifespan	62
Table 4.5. VDF Value of the Commercial Vehicle.....	63
Table 4.6. The Traffic Growth Rate Factor.....	64
Table 4.7. Selection of Road Pavement Type	65
Table 4.8. Adjustment Factors for Subgrade Modulus Due to Seasonal Variations.....	66
Table 4.9. Minimum Design for Foundation	66
Table 4.10. VDF 4 & VDF F 5 for D.I.Y.	68
Table 4.11. VDF Flexible for D.I.Y.....	68
Table 4.12. Traffic Load	69
Table 4.13. Selected Pavement Layer	69
Table 5.1 CPT Test Results.....	70
Table 5.2. CPT Calculation Results for STA 1+000 to 1+500	74
Table 5.3 Soil Classification on Sta 1+000 to 1+500	77
Table 5.4. SPT Test Results (SPT 3.0).....	80
Table 5.5. Soil Test Results.....	81
Table 5.6. SPT Calculation Results	83
Table 5.7. Axial Load on the Road	85
Table 5.8. Immediate Settlement Calculation 1	85
Table 5.9. Immediate Settlement Calculation 2	86
Table 5.10. Consolidation Settlement	87
Table 5.11. New Axial Load and Height of Embankments Recap	88
Table 5.12. Terzaghi Bearing Capacity Calculation	90
Table 5.13. Hansen Bearing Capacity Calculation	92
Table 5.14. Soil Bearing Capacity Recap	94
Table 5.15. Data of Soils in Slope	94
Table 5.16. Ordinary Method Calculation	96
Table 5.17. Bishop Method Calculation	98
Table 5.18. Recap of Calculated Safety Factors	99

LIST OF FIGURES

Figure 2.1. Flexible Pavement on Original Soil Surface	4
Figure 2.2. Flexible Pavement in Embankments	4
Figure 2.3. Flexible Pavement in Excavations	5
Figure 2.4. Rigid Pavement on Original Soil Surface	6
Figure 2.5. Rigid Pavement in Embankments	6
Figure 2.6. Rigid Pavement in Excavations	7
Figure 2.7. Road Shoulder	12
Figure 2.8. Road Space	13
Figure 2.9. Centrifugal Force	18
Figure 2.10. Types of Convex Curve and Concave Curve	24
Figure 2.11. Convex Curve	25
Figure 2.12. Concave Curve	25
Figure 2.13. Vertical Curve.....	26
Figure 2.14. Parabolic Curve	26
Figure 2.15. Double Cone Details	33
Figure 2.16. Split Tube Sampling Tool	34
Figure 2.17. Diagram of μ_1 and μ_0	37
Figure 3.1. Area Overview.....	48
Figure 3.2. Road Alignment 1.....	49
Figure 3.3. Road Alignment 2.....	50
Figure 3.4. Road Alignment 3.....	50
Figure 3.5. Road Alignment 4.....	51
Figure 3.6. Azimuth Angle.....	55
Figure 3.7 Road Superelevation.....	72
Figure 3.8. Length of Grade.....	73
Figure 3.9. L for Convex Curve Length.....	78
Figure 3.10. Passing Sight Distance & K.....	79
Figure 3.11. L for Passing Sight Distance.....	79
Figure 3.12. L for Headlight Sight Distance	80
Figure 3.13. L for Passenger Comfort.....	81
Figure 3.14. Design Control.....	82
Figure 5.1. Begemann Soil Classification for CPT.....	79
Figure 5.2. Soil Stratigraphy	84
Figure 5.3. GeoStudio SF Result for Ordinary Method	97
Figure 5.4. GeoStudio SF Result for Bishop Method	99
Figure 5.5. Slope Section for H Critical.....	100