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| RESEARCH ARTICLE

Geometric Evaluation and Analysis of Road Pavement on the Buper - Kemp Road Section, Wolker Waena

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| ABSTRACT
The topography in Jayapura regency is generally an area consisting of mountains and valleys that have various elevations, and the transportation facilities are also diverse. Geometric evaluation on the Camp road section. Wolker – Buper Waena conducted a topographic survey of existing roads. To obtain geometric data, then geometric evaluation is carried out based on RSNI T-14-2004 (Guidelines for Geometric Planning of Urban Roads) and Inter-City Geometric Planning Procedures, Department of PU, Directorate General of Highways, 1997. Road pavement analysis based on the Road Pavement Design Manual of the Ministry of PU No. 04/SE/DB/2017 and the Regulation of the Minister of PU No. 04/SE/M/2010.The conclusion of the study on geometric evaluation of horizontal alinyemen roads on the bends PI – 10 and PI – 11 did not meet the standard provisions. Similarly, vertical alinyemen exceeds the maximum limit of road slump, which is 10%. The slump is at sta 0+450 – 0+650 and sta 0+800 – 1+400. Thus, it needs re-planning. Analysis of road pavement at the Cbr point of the field > 6%, the basic soil strength class SG6. Basic soil improvement foundation structure stabilization segment or preferred heap material (compaction of ≤ layer 200 mm loose thickness), no need for improvement. Then for the field Cbr < 2.5%, the basic soil strength class SG1 with a support layer of 700 mm. For a field Cbr of 2.5%, the base soil strength class is SG2.5 with a minimum soil improvement thickness of 175 mm. For field Cbr, 3 % uses basic soil strength class SG3 with a minimum thickness of soil improvement of 150 mm. For a field Cbr of 4%, a base soil strength grade of SG4 with a minimum soil improvement thickness of 100 mm. The pavement layer design obtained AC WC = 40 mm, AC BC = 60 mm and LPA Class A adjusts the minimum thickness of soil improvement of each segment.

| KEYWORDS
Topography, Geometric, Horizontal Alinyemen, Vertical Alinyemen, CBR

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1. Introduction
Road geometrics is part of road planning which is focused on physical form planning so that it fulfills the basic function of the road, namely providing optimum service to traffic flow and access to houses. In these plans, the basis of geometric planning is the nature of the movement and size of the vehicle, the nature of the driver in controlling the motion of his vehicle and the characteristics of traffic flow. Elements used for geometric planning include horizontal alinyemen / road traffic, mainly focused on road axis planning, vertical alinyemen / longitudinal cross-section of the road and cross-section of the road. So that planning for horizontal alinyemen and vertical alinyemen provides a comfortable effect for road users.

The topography in Jayapura regency is generally an area consisting of mountains and valleys that have various elevations, and the transportation facilities are also diverse. One of them is on the Camp road section. Wolker – Buper Waena. On the newly opened road section, the planned road traffic has relatively steep inclines and descents that can endanger road users. So it is necessary to carry out geometric evaluation and road pavement planning so that comfort can be felt by road users. The geometric evaluation used on the Camp road section. Wolker – Buper Waena is focused on vertical and horizontal alinyemen based on *RSNI T-14-2004*

(Urban Road Geometric Planning Guidelines) and Intercity Geometric Planning Procedures, Pu Department, Directorate General of Highways, 1997.

Geometric evaluation on the Camp's road section. Wolker – Buper Waena was carried out by conducting topographic surveys of existing roads to obtain geometric data, then geometric evaluation was carried out by referring to RSNI T-14-2004 (Urban Road Geometric Planning Guidelines) and Inter-City Geometric Planning Procedures, Dapartemen PU, Directorate General of Highways, 1997. Planning of a thick layer of road pavement based on the Road Pavement Design Manual of the Ministry of PU No. 04/SE/Db/2017 and PU Ministerial Regulation No. 04/SE/M/2010.

2. Bibliography Review

2.1 Road Geometric Planning

Road geometric planning is also part of road planning which is focused on Geometric planning as part of overall road planning. Reviewed as a whole, geometric planning must be able to guarantee the safety and comfort of road users. To be able to produce a good road plan and approach the actual situation requires.

2.2 Road Classification

Road classification is an important aspect that must first be identified before designing roads because the design criteria of a road plan determined from the design standards are determined by the classification of road plans. In principle, the classification of roads in design standards (both for inner city roads and out-of-town roads) is based on the classification of roads according to applicable laws and government regulations.

a. Classification according to the function of the road
b. Classification according to road class
c. Classification according to road terrain

2.3 Road Geometric Planning Parameters

In road geometric planning, there are several planning parameters that must be understood, such as vehicle plan, plan speed, road volume and capacity, and the level of service provided by the road. These parameters are a determination of the level of comfort and safety produced by the geometric shape of the road.

a. Plan vehicles
A Plan Vehicle is a vehicle whose dimensions and turning radius are used as a reference in geometric planning.

b. Plan speed
Plan speed (Vr) is the speed chosen as the basis of road geometric planning, which allows the vehicle to move safely and comfortably in sunny weather conditions, quiet traffic and meaningless side road influences.

c. Traffic volume
Average daily traffic volume (VLHR) is an estimate of the daily traffic volume at the end of the year of the traffic plan expressed in passenger car units per day (smp/day).

d. Visibility
Visibility is the distance required by a driver while driving in such a way that if the driver sees a dangerous obstruction, the driver can do something to avoid the danger safely. Two Visibility Distances are distinguished, namely, Stop Visibility (Jh) and Preemptive Visibility (Jd).

2.4 Alinyemen Horizontal

Alinyemen is a projection of the axis of the road on the horizontal plane. The horizontal alinyemen consists of a straight part of a curved part (also called a bend). In general, the placement of horizontal alinyemen should be able to guarantee safety and comfort for road users.

2.5 Vertical Alinyemen Requirements

A vertical alinyemen is a projection of the axis of a road on a vertical plane through the axis of the road. The vertical alinyemen consists of a vertical ramp section and a vertical curved section (Sukirman, 1994). Judging from the starting point of planning, the vertical ramp section can be either a positive ramp (ramp), a negative ramp (child), or a zero ramp (flat).

2.6 Bending Pavement

According to Sukirman (1999), *flexible* pavement is a pavement that uses asphalt as a binding material. Its pavement layers are shouldering and spreading the traffic load to the bottom soil. The construction of bending pavement consists of layers laid on compacted bottom soil. These layers serve to accept the traffic load and spread it to the layer below.

2.7 Bending Pavement Planning

According to Sukirman (1999), bending pavement construction materials are divided into 3, namely:

a. Basic soil according to Sukirman (1999), road pavement is placed on the bottom soil; thus, the overall quality and durability of pavement construction cannot be separated from the nature of the basic soil. The material used in the base soil can come from the work site or in the surrounding area. For good carrying capacity and the ability to maintain volume during the service life, the bottom soil must be compacted to the level of density needed.
b. Aggregates according to Sukirman (1999), aggregates/rocks are the main components of road pavement layers, containing 90-95% aggregate based on weight percentage or 75-85% aggregate based on volume percentage. On the surface layer, an aggregate with good quality and properties is needed because this layer directly receives a traffic load which is then spread to the layer below.
c. Asphalt is defined as an adhesive material, black or brown in color

Old, with the main element of bitumen. Asphalt can be obtained in nature or is a residue from petroleum refining. Bitumen is often also called asphalt. Asphalt is a material that, at room temperature, is solid; it's rather dense and thermoplastic. So the asphalt will melt if heated to a certain temperature and re-freeze if the temperature goes down. Together with aggregate, asphalt is a mixture-forming material of road pavement. The abundance of asphalt in pavement mixtures ranges from 4-10% by weight of the mixture or 10-15% by volume of the mixture.

Pavement layers serve to support traffic loads during the service life without causing significant damage. Thus, some consideration of factors that can affect the performance of pavement construction is required, such as:

1. Road function 3. Traffic 5. Pavement coated material
2. Plan lifespan 4. Basic Soil Properties

In bending road pavement planning refer to the 2017 Road Pavement Manual Method. The Road Pavement Design Manual Method 2017 is one of the methods used for planning bending pavements and rigid pavements for new roads, road widening, and reconstruction, as well as explaining the factors to consider in the selection of pavement structures, including design details, drainage and construction requirements. This method is used to produce a preliminary design that later the results can be examined and made into a flexible and rigid pavement design.

3. Research Methodology

3.1 Data Collection Techniques

Based on the research framework, it can be detailed the steps to be taken:

1. Survey of Research Location Conditions

The purpose of this survey is to find out the original condition of the location that the author discusses in the compiled thesis.

The data obtained are in the form of the following:

a. Geometric original conditions
b. Road documentation retrieval
c. Road environmental conditions
d. Topographic conditions
e. Data tanah (DCP)

These data will later become primary data.

3.2 Data Analysis Methods

To get good planning, it is necessary to analyze the data that has been obtained in order to help in the redesign of the Buper - Camp road section. Wolker Waena. The data in the calculations that need to be analyzed include the following:

1. Visibility Calculation

Analysis and calculation of visibility, including:

a. Stopping visibility
b. Visibility precedes

2. Horizontal Alinyemen Calculation
Analysis and calculations on Horizontal Alinyemen, including: centrifugal force, the radius of bend, degree of curvature, transitional arch, horizontal curved shape, free side bend and superelevation.

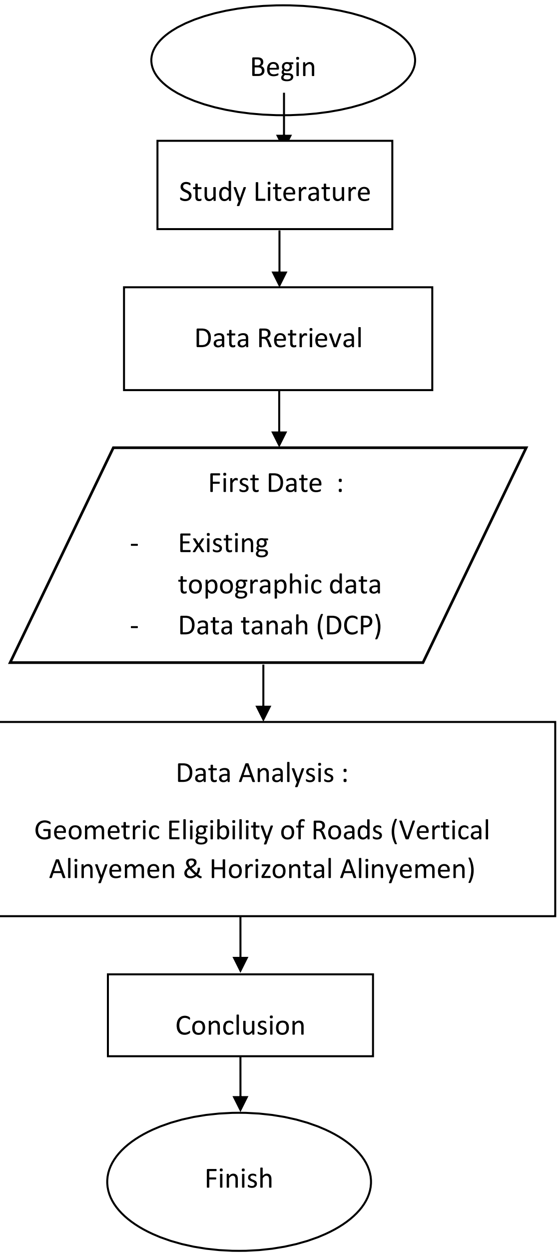
3. Vertical Alinyemen Calculation
Analysis and calculations on Vertical Alinyemen, including: vertical alnyemen slump, convex, and concave vertical arch.

4. Soil Data Calculation (DCP)
Analysis and calculation of Soil Data, including: cumulative penetration, DCP value and field CBR.

5. Results of Analysis or Calculation
From the results of analysis and calculation, the size or dimensions will be obtained.
a. The magnitude of the dimensions of the Horizontal Alinyemen.
b. The magnitude of the dimensions of the Vertical Alinyemen.
c. The magnitude of the volume of excavations and deposits (Cut and Fill).
d. The magnitude of the dimensions of the lining and the width of the road pavement

The results of the calculation will be compared with the standards used as a reference in order to evaluate the Buper - Camp road section. Wolker Waena.

3.3 Research Flowchart



4. Design and Discussion

4.1 Road Network System Identification

In planning a road, it is necessary to first identify the road network system around the road section to be planned. Things that need to be identified are in the form of land use, travel patterns of road users and travel patterns of goods. The identification carried out is used as the basis of geometric road planning, where based on the data from the identification can help in determining the length of the route, road width, and other supporting facilities.

4.2 Analysis of Meshn Terrain

In analyzing the geometry of the road, it is also necessary to classify the terrain of the road based on the slump of the road section under review. The determination of the road terrain is based on Table 2.2. The following is a classification of road terrain based on the slump.

Table 4.1 Road terrain classification

Stasion	Elevation (m)	Height Difference (m)	Distance (m)	Slump (%)	Information
0 + 000	262,000				
		1,29	50	3	Hill
0 + 050	263,285				
		0,84	50	2	FLAT
0 + 100	262,445				
		3,98	50	8	Hill
0 + 150	266,429				
		3,98	50	8	Hill
0 + 200	270,413				
		2,64	50	5	Hill
0 + 250	273,051				
		1,29	50	3	Hill
0 + 300	274,342				
		0,32	50	1	FLAT
0 + 350	274,662				
		3,80	50	8	Hill
0 + 400	270,861				
		3,80	50	8	Hill
0 + 450	267,06				
		3,80	50	8	Hill
0 + 500	263,259				
		5,21	50	10	Hill
0 + 550	258,05				

		6,62	50	13	Hill
0 + 600	251,434				
		1,12	50	2	FLAT
0 + 650	250,316				
		1,12	50	2	FLAT
0 + 700	249,199				
		1,12	50	2	FLAT
0 + 750	248,081				
		1,12	50	2	FLAT
0 + 800	246,964				
		1,12	50	2	FLAT
0 + 850	245,846				
		1,12	50	2	FLAT
0 + 900	244,728				
		8,85	50	18	Hill
0 + 950	235,875				
		8,85	50	18	Hill
1 + 000	227,022				
		8,85	50	18	Hill
1 + 050	218,17				
		10,45	50	21	Hill
1 + 100	207,717				
		11,81	50	24	Hill
1 + 150	195,909				
		11,81	50	24	Hill

1 + 200	184,1				
		11,81	50	24	Hill
1 + 250	172,292				
		11,81	50	24	Hill
1 + 300	160,484				
		11,81	50	24	Hill
1 + 350	148,676				
		2,46	50	5	Hill
1 + 400	146,216				
		2,16	50	4	Hill
1 + 450	144,06				
		2,16	50	4	Hill
1 + 500	141,905				
		2,15	50	4	Hill
1 + 550	139,751				
		1,28	50	3	Hill
1 + 600	138,472				
		1,28	50	3	Hill
1 + 650	137,19				
		1,28	50	3	Hill
1 + 700	135,915				
		1,28	50	3	Hill
1 + 750	134,636				
		1,28	50	3	Hill
1 + 800	133,357				

		1,28	50	3	Hill
1 + 850	132,078				
		1,28	50	3	Hill
1 + 900	130,8				
		1,28	50	3	Hill
1 + 950	129,521				
		1,28	50	3	Hill
2 + 000	128,242				
		1,28	50	3	Hill
2 + 050	126,963				
		2,87	50	6	Hill
2 + 100	124,095				
		2,98	50	6	Hill
2 + 150	121,111				
		0,35	50	1	FLAT
2 + 200	120,758				
		0,29	50	1	FLAT
2 + 250	120,468				
		0,17	50	0,35	FLAT
2 + 280	120,293				
Average Slump				7,34	

5. Conclusion

Based on the results of the analysis and evaluation that has been carried out on the Buper - Camp road section. Wolker Waena, then it can be concluded that:

Geometric evaluation of the horizontal alinyemen road section of the Buper – Camp road section. Wolker Waena at the corners of PI – 10 and PI – 11 does not meet the standard provisions issued by the Directorate General of Wildlife Development, namely "Geometric Planning Procedures for Intercity Roads No. 038/T/BM/1997" because using a Switching Arch does not correspond to comfort and safety. Similarly, vertical alinyemen exceeds the maximum limit of road slump, which is 10%. The slump is at Sta 0+450

– 0+650 and Sta 0+800 – 1+400. So to overcome this problem, it is necessary to re-plan the PI – 10 and PI – 11 bends of the existing road so that the bends use a Transitional Arch that is in accordance with comfort and safety so that the Buper – Camp road section. Wolker Waena is more comfortable to walk through.

Analysis of road pavements on the Buper – Camp road section. Wolker Waena, by using the standard reference of the Road Pavement Design Manual of the Ministry of PU No. 04 / SE / Db / 2017 and the Regulation of the Minister of PU No. 04 / SE / M / 2010 from the analysis of the foundation design for the base soil in the field, Cbr > 6% using the basic soil strength class SG6. With the description of the structure of the foundation of the basic soil, improvement can be either segment stabilization or preferred stockpile material (compaction of the ≤ layer 200 mm of loose thickness); the minimum thickness does not need an increase. Then for field Cbr < 2.5 % using the basic soil strength class SG1 with a support layer of 1000 – 300 = 700 mm if the original soil is compacted in dry conditions at sta 0 + 200 – 0 + 300. For 2.5% field Cbr using base soil strength class SG2.5 with a minimum soil improvement thickness of 175 mm at sta 1+300. For the Cbr field, 3 % using basic ground strength class SG3, With a minimum soil improvement thickness of 150 mm at sta 0+100,1+400,1+900 and 2+200. For field Cbr, 4 % using the basic soil strength class is SG4 with a minimum thickness of soil improvement of 100 mm at sta 0+800. Cbr 5 % uses basic soil strength class SG5 with a description of the foundation structure of the basic soil improvement can be segment stabilization or preferred heap material (compaction of the ≤ layer 200 mm loose thickness); the minimum thickness does not need to increase.

The pavement layer thickness design from the analysis obtained the pavement layer AC WC = 40 mm, AC BC = 60 mm and LPA Class A adjusts based on the minimum thickness of soil improvement of each segment.

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