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Geometric Calculations on The Halong PHB Road Section in Ambon City

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ABSTRACT

One of the roads that has high accessibility and is in an accident-prone condition is the Upper Halong PHB road, because the terrain of the road has quite a lot of bends, descents and quite high inclines which can interfere with the visibility of road users, and it is feared that this could cause problems. problems such as accidents among users of this road section. The aim of this research is to calculate horizontal alignments and vertical alignments to be able to determine the geometric optimality of efficient roads in terms of fast and precise timing. The planning method uses the 2021 Bina Marga method, which is determined based on the geometric planning guidelines for road number 20/SE/Db/2021 . Types of data consisting of primary data and secondary data. for primary data, road condition data and topographic survey data (Measurements) and for secondary data, planned speed data. The analysis results show that the horizontal alignment has 32 types of bends, namely bend 1 to bend 3 with a full circle (FC) bend type, bend 4 with a spiral-spiral (SS) bend type, bend 5 with a spiral-circle-spiral (SCS) bend type. , bend 6 to 14 is a Full circle (FC) type bend, corner 15 is a Spiral-circle-spiral type bend, bend 16 to 30 is a Full circle (FC) type bend, corner 31 is a Spiral-circle-spiral (SCS) type bend, and There are 32 Full Circle (FC) bends, then the vertical alignment has 16 vertical curves, with 9 convex verticals and 7 concave verticals.

1. INTRODUCTION

Judging from its location, the Upper Halong PHB Road section is located in Halong Village, Teluk Ambon Bagualah District, Maluku Province, which connects the Halong SPBU Interchange with the Advertisement Interchange, with a length of 01+950 Km. One of the roads that has high accessibility and is in an accident-prone condition is the Upper Halong PHB road, because the terrain of the road has quite a lot of bends, descents and quite high inclines which can interfere with the visibility of road users, and it is feared that this could cause problems. problems such as accidents for users of this road section. as happened on September 21 2021, an accident occurred when a public transportation to Toisapu was unable to cross the ramp on the Upper Halong PHB road and rolled over onto a motorbike (Siwalimanews 2021).

Geometric road planning is the complete route planning of a road section, including several elements that are adapted to the completeness and data that exist or are available from the results of field surveys and have been analyzed, and refer to applicable regulations (Hendarsin L. Shierly, 2000). The basis for geometric planning is the nature of movement and size of the vehicle, the nature of the driver in controlling the vehicle and the characteristics of traffic flow.

Based on the explanation above, which is the background for conducting research in order to create an optimal road geometry, the author tries to apply a program (AutoCad Civil 3D) in carrying out geometric planning so as to get optimal results in carrying out the road planning.

2. LITERATURE REVIEW

2.1. General

Geometric roads are building road bodies above the ground surface both vertically and horizontally with the assumption that the ground surface is uneven. Geometric road planning is to produce road infrastructure that is safe and comfortable for road users. The Highways Regulations are one of the references for carrying out geometric planning of roads that apply in Indonesia (Teguh Triyono, Arif Mudianto, Heny Purawanti, 2015)

2.2. Road Classification

Road classification indicates the required operating standards and is a useful aid to planners. In Indonesia, based on highway geometric planning regulations issued by Bina Marga, roads are divided into classes whose designation is based on their function.

2.3. Road Terrain Classification

The road terrain on which the road is built is classified. Each terrain classification has characteristics, both in terms of

physical form, geometric elements and operational aspects of road users, and these characteristics are synergistic with each other.
The formula for calculating field orientation:

$$\text{Total} = \frac{\sum \%\, piece}{number\ of\ pieces}$$

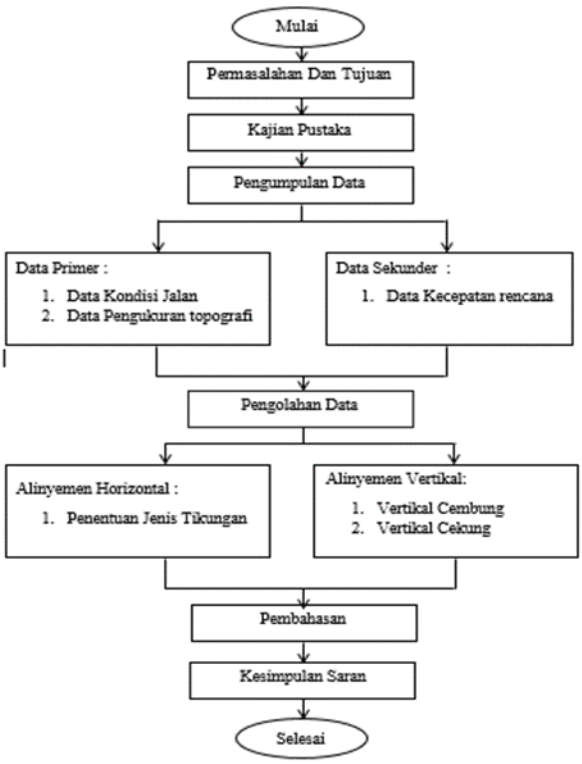
2.4. Planning Speed

Almost all planning of highway sections is influenced by design speed. A design speed must be in accordance with the characteristics of the terrain, the type of highway concerned and the cost. Shapes such as curves, road slopes (superelevation) are directly influenced by design speed. Meanwhile, other forms such as pavement width, road shoulders and side clearance are indirectly influenced or have a relationship with design speed but affect vehicle speed.

2.5. Visibility

What is meant by visibility distance is the length of the part of the road in front of the driver that can still be seen clearly measured from the driver's position.

3. METHODOLOGY



Source : Fridolin, 2022

Figure 1. Research Flow Chart

Figure 1 shows the research flow consisting of road condition data, topographic measurement data using a theodolite, plan speed data. Data processing calculates the value of horizontal alignment, namely determining the type of bend, and vertical alignment, namely convex vertical and concave vertical.

3.1. Data Type

1. Primary data

   Primary Data is data obtained by yourself in the form of the location of the project to be reviewed.
   In this research, what is called primary data is:
   a. Road condition data
   b. Topographic survey data (Measurements)
2. Secondary Data

   Secondary data is data obtained indirectly, for example from previous research references, references from literature books or obtained from related parties which includes research.
   In this research, what is called secondary data is.
   a. Plan Speed Data

3.2. Data Collection Technique

Data collection using methods Observation is processing data from measurement results using a theodolite measuring instrument, and the Literature Study method is processing written data on books, journals and reports that are related to the problem to be solved.

4. RESULTS AND DISCUSSION

4.1. General Image of Research Location

The research location is on the Jalan PHB Halong Atas which is located in Halong Village, Teluk Ambon Bagualah District, which connects the Halong SPBU Interchange with the Advertisement Interchange, with a length of 01+975 Km.

4.2. Data Analysis

Road data is used to determine research results. Road data obtained from the study location includes:

1. Location: Upper Halong Village, Ambon City
2. Section: Jl. PHB Upper Halong
3.Stationary (STA) : 0 + 000 KM – 1 + 975 KM
4.Section Length : 1 + 975 KM
5.Planning Speed
   a.Average : 30 Km/Hour
   b. Convex : 10 km/hour
   c. Concave : 40 km/hour

6. Road Status : Secondary Environment

4.2.1 Name

Full names of authors are required. The middle name can be abbreviated.

4.3. Horizontal Alignment

4.3.1. Turn 1 Full Circle (FC)

The following data is determined:

VD = 30 km/h
Δ = 20.568°
R = 50 m (Adjusting to existing road alignment conditions)
e max = 0.14 m/m (e max = V2 mean path / 127R
e = 4 %
f = 0.17 (based on 2021 BM road geometric design guidelines)
R_{min} = 35 m (based on 2021 BM road geometric design guidelines)

a. Calculate the Tc value

Tc = R tan Δ/2
=50 tons 21/2
=9.07212 m

b. Calculating the Lc value

Lc = (Δ/360) x 2πR

= (20.57 / 360) x 2 x 3 x 50
= 17.9399 m

c. Calculating Ec

Ec = (R/ cos Δ/2) – R
= (50 / cos 20.57 / 2) – 50
= 0.81637 m

Thus, the data for the full circle (FC) curve above is:

VD = 30 km/h
Δ = 21 0
R = 50 m
Ec = 0.82 m
Tc = 9.07 m
Lc = 17.94m

d = A – PI1
= 39.1825
Check = NOT OK
d = PI1 – PI2
= 56.4046
Check = OK

4.3.2 Turn 4 Spiral – Spiral (S-S)

Calculate and plan the type of bend

Known: R = 25 m
VD = 10 km/h

Road class type: collector

Δ = 35.44°
c = 0.4 to 0.8...(speed shift coefficient)
planned using a spiral-spiral bend type.
Calculate cornering speed
Vt = √(127.R.(e + fm))
For Vr = 10, then fm = 0.186
So :
Vt = √(127 . 25 .(0.10 +0.186))
= 30.11 km/h

Safe conditions: Vt > Vr
30.11 > 10 **SAFE..!!!**

Calculating Bend Superelevation

D $= \frac{1432,4}{R} = \frac{1432,4}{25} = 57,296°$
ϑs = 1/2 .D = 1/2 .35
= 17,72°
L $= \frac{D}{360}$. 2Pr $= \frac{35,44}{360}$. 2p. 25
= 15,46 m
Ls = 1/2 . L = 1/2 . 15,46
= 7,73 m

e and Lsmin are influenced by D, according to the PDGJ 2021 BM Guidelines

e = 0.080
Ls_{min} = 22 m
Safe condition : Lsmin < Ls
22 > 7.73 **DANGER..!!**
$R_{min} = Vr^2/(127 .(e + fm))$
= 100/(127 .(0.080 + 0.186))
= 2.966 m
The spiral-spiral bend condition is Δc = Lc = 0
Safe condition: R > Rmin
25 > 2,966 **SAFE...!!**

4.3.3. Turn 5 Spiral-Circle-Spiral (S-C-S)

Is known :

R = 25 m
VD = 20 km / h
Type of road class
Δ = 51.434°
c = 0.4 to 0.8 ..(speed shift coefficient)

planned to use the Spirasl-Circle-Spiral (S-C-S) bend type

Calculate cornering speed

Vt = √(127.R.(e + fm))
For VD = 20 km/hour, then fm = 0.179
So :
Vt = √(127 . 25 .(0.100 +0.179))
= 29.76 km/h

Calculating bend superelevation

$e = ((Vr)^2)/(127.R) – fm = ((20)^2)/(127.25) – 0.179 = -0.053 ≈ -5.3\%$

Lsmin = 0.022 . ((Vr)3)/(R.c) - 2.727 . (Vr .e)/c
= 0.022 . ((20)3)/(25 .0.5) – 2.727 . (20 .-0.053)/0.5
= 19,863

Ls is obtained from the table, influenced by Vr and e Ls = 22m

Safe condition: Lsmin < Ls
19,863 < 22 **SAFE...!!**

ϑs = (90° . Ls)/(p.R) = (90° . 22)/(p.25) = 25.21°
Δc = Δ - 2ϑs
= 51 – 2 . 25,21
= 1.014°
Lc = ΔL/(360°) . 2pR = 1.014/(360°) . 2p . 25
= 0.442°
L = Lc + 2Ls = 0.442 + 2 . 22
= 44.442 m

From Table... we get p* and k*

p* = 0.0549549
k* = 0.4934084

p = p* . Ls
= 0.0549549 . 22.00
= 1.209
k = k* . Ls
= 0.4934084 . 22.0
= 10.855
Ts = (Rp) . Tg 1/2 Δ + k
= (25 + 1.209) . Tg (1/2 . 51) + 10.855
= 23.478 m
Es = ((R + p))/(cos1/2) – R
= ((25 + 1.209))/0.9999 – 25 = 1.2116 m
D = 1432.4/R = 1432.4/25 = 57.296

Conclusion :

Because ..Lc < 20	that is	0.422 < 20
L < 2Ts		44.442 < 46.9562
DC > 0		1.014 > 0

So: FALSE...

4.4. Vertical Alignment

4.4.1. Convex Vertical Curve

Calculating the convex vertical alignment 1 at sta. 1 + 34.45

Brother: g1 = 18.7 %
g2 = 8.55 %

Vr = 10 km/hour

<u>PPV point</u>

Elevation PPV = 31.92 m

PPV distance = 0 + 113.16 m

Algebraic difference ramps (A) = g1 - g2 = 18.7 + 8.55 = 10.15%

Geometric planning by knowing A and Vr obtains Lv = 60m

Vertical shift from PPV point to curved part = Lv

Ev = (A.Lv)/800 = (10.15 . 60)/800 = 0.761 m

PPV point'

Elevation PPv' = PPV – Ev
= 31.92 – 00.761 = 31.16

Distance PPV' = 1 + 113.2 m

PLV Distance

Elevation PLV = PPV – (g1% . ½ . Lv)
= 31.92 - (18.72 % . ½ .60)
= 26.31 m

Distance PLV = PPv – ½ . Lv
= 0 + 113.2 + ½ . 60 = 0 + 83.16 m

PTV distance

Elevation PTV = PPV + (g2% . ½ . Lv)
= 31.92 - (8.55% . ½ . 60) = 34.49 m

PTV Distance = PPV + ½ . Lv
= 0 + 113.2 + ½ . 60 = 0 + 143.2 m

Points P and Q

x = ¼ . Lv
= ¼ . 60 = 15,000 m

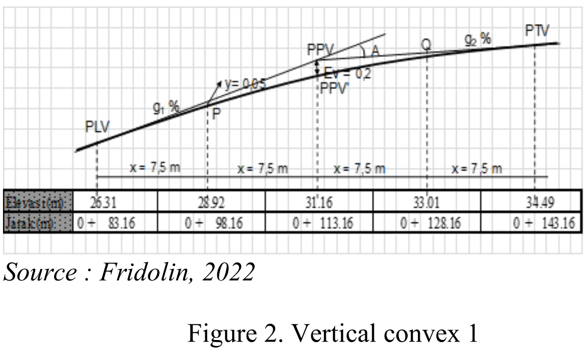
y = (A . 〖x〗^2)/(200 Lv) = (10.15 . 225.00)/(200 . 60) = 0.190 m

Elevation P = PPV – (g1 % . x) – y
= 31.92 – (18.70 % . 15,000) – 0.190 = 28.92 m

Distance P = PPV – x
= 0 + 113.2 – 15,000 = 0 – 98.16

Elevation Q = PPV + (g2 % . x) – y
= 31.92 – (8.55 % . 15,000) – 0.190
= 33.01 m

Distance Q = PPV + x
= 0 + 113.2 + 15,000 = 0 + 128.16 m



Source : Fridolin, 2022

Figure 2. Vertical convex 1

4.4.2. Concave Vertical Curve

Calculate the concave vertical alignment 1 at sta 1 + 58.42

Brother: g1 = 8.55 %
g2 = 22.62 %
Vr = 40 km/hour

<u>PPV point</u>

Elevation PPV = 33.97 m

PPV distance = 0 + 198.8 m

Algebraic difference ramps (A) = g1 - g2 = 8.55 + 22.62 = -14.77 %

Geometric planning by knowing A and Vr obtains Lv = 0.9 m

Vertical shift from PPV point to curved part = Lv

Ev = (A.Lv)/800 = (-14.77 . 0.9)/800 = -0.016 m

PPV point'

Elevation PPv' = PPV – Ev
= 33.97 – -0.016 = 33.99 m

Distance PPV' = 0 + 34.0 m

PLV distance

Elevation PLV = PPV – (g1% . ½ . Lv)
= 33.97 - (8.55 % . ½ .0.9)
= 33.93 m

Distance PLV = PPv – ½ . Lv
= 0 + 198.8 + ½ . 0.9
= 0 + 198.4 m

PTV Distance

Elevation PTV = PPV + (g2% . ½ . Lv)
= 33.97 - (22.62 % . ½ . 0.9)
= 34.07 m

PTV Distance = PPV + ½ . Lv
= 0 + 198.83 + ½ . 0.9 = 0 + 199.3 m

Points P and Q

x = ¼ . Lv
= ¼ . 0.9 = 0.225 m

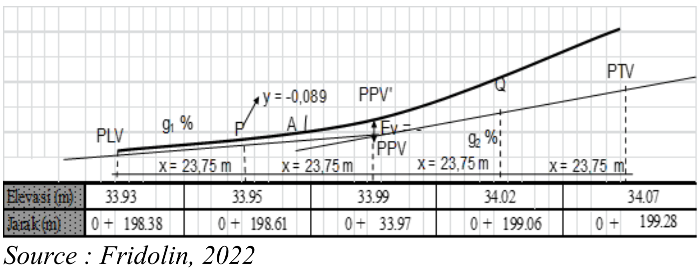
y = (A . 〖x〗^2)/(200 Lv)
= (-14.77 . 0.05)/(200 . 0.9) = -0.004 m

Elevation P = PPV – (g1 % . x) – y
= 33.97 – (8.55 % . 0.225) – 0.164
= 33.95 m

Distance P = PPV – x
= 0 + 198.8 – 0.225 = 0 – 198.61

Elevation Q = PPV + (g2 % . x) – y
= 33.97 – (22.62% . 0.225) – 1,164
= 34.02 m

Distance Q = PPV + x
= 0 + 198.8 + 0.225 = 0 + 199.06 m



Source : Fridolin, 2022

Figure 3. Vertical convex 1

5. CLOSING

5.1. Conclusion

Based on primary data from topographic measurements obtained from survey results using a theodolite and processed using Civil 3D 2018 software, it can be concluded as follows: The results of the research on the Upper Halong Phb Road Section are that the length is 1,975 km, the average design speed = 30 km/hour. And the horizontal alignment consists of

3 S-C-S bends (Spiral-Circle-Spiral), 1 SS bend (Spiral-Spiral), 28 FC bends (full circle) and a vertical alignment consisting of 9 convex verticals and 7 concave verticals.

5.2. Suggestion

Suggestions that can be given as material for research consideration are:
To provide safety and comfort for users of the Upper Halong PHB road section, it is recommended that traffic signs be prepared, because this section has high accessibility and is prone to accidents.

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