INTERNATIONAL JOURNAL ON ADVANCED TECHNOLOGY, ENGINEERING, AND INFORMATION SYSTEM
(IJATEIS)
VOLUME 1 ISSUE 3 (2022)

STUDY OF THE CAUSES OF ROAD DAMAGE TO CAPTAIN HARUN TOHIR STREET, GRESIK EAST JAVA

Ardhi Ramadhani[1*], Haris Muhammadun[2], Wateno Oetomo[3]
[1,2,3]Faculty of Engineering, University 17 Agustus 1945 Surabaya
E-mail: [1)] 1472000050@untag-sby.ac.id

Abstract

This study aims to make a study and technical planning of the road following the traffic of heavy vehicle loads through the Harun Tohir road. Road maintenance is an activity to maintain, repair, add or replace existing physical buildings so that their functions can be maintained or enhanced for a longer period. This maintenance guideline is intended to regulate the procedures for carrying out rigid pavement maintenance activities, and maintain stable serviceability conditions, to provide safety and comfort to road users. This guideline for the maintenance of rigid pavements includes descriptions of the types of damage that commonly occur in rigid pavements, their possible causes, follow-up consequences, recommendations for handling, and methods.

Keywords: Heavy Vehicle Load Traffic, Road Damage, Road Technical Planning

1. INTRODUCTION

Gresik as a city that is the centre of the economic lifeblood of one of the regions in East Java, is a city that is growing rapidly both in terms of population and economic growth, so it is required to have a high level of accessibility and be supported by the provision of easy, cheap and fast transportation. Gresik, an industrial and logistics centre city, must be supported by qualified land transportation media. One of the land transportation media is the road.

Roads are land transportation infrastructure covering all parts of the road, including complementary buildings and equipment intended for traffic, which are at ground level, above ground level, above water level and below ground and water level, except railroads, lorry roads and cable roads (Government Regulation Of The Republic Of Indonesia Number 34 Of 2006) (Kantharia, 2019). Roads are a means of land transportation, such as trucks, to send or deliver goods from Gresik City. The existence of roads will facilitate and accelerate the flow of mobility of goods and services, thereby creating reduced logistics costs (Fauziyah, 2021). According to Rahayu (2019), highways can facilitate a nation's economic growth, economic equity; smooth traffic; regional GRDP (Gross Domestic Regional Product) growth, and so on.

The Harun Thohir road section is where heavy vehicles pass through, which is the access road to and from the Port area in Gresik. Harun Thohir road has a length of 1.850 meters, connecting the port with the city road. Harun Thohir street plays a vital role as a means for land vehicles such as trucks and cars from ships to downtown Gresik or other areas. Therefore, it is necessary to carry out road maintenance in the form of pavement to prevent damage to the Harun Thohir road.

Road pavement is a pavement layer that is the place where the wheels of the vehicle run, which functions to support the load caused by the objects above it (Assogba et al., 2021). Pavement is a mixture of materials and binders to form a layer that vehicles can pass (Sucipto, 2021). Road pavement is made of aggregate and asphalt or cement (Portland cement) as a binder to harden a certain construction layer with a certain thickness, strength, stiffness and stability so that it can distribute the traffic load safely to reach the road base (Ramadhan, 2014). With the dense activity and vital role of Harun Thohir Street, it is necessary to repair the damaged old pavement to facilitate the movement of passengers and goods. Therefore, the improvement of road pavement must comply with predetermined standards.

The purpose of the Road Pavement Improvement activity on the Harun Thohir road section is to make a road technical study and plan following the heavy vehicle traffic that passes through the road section. The general objective of the Road Pavement Improvement activity on the Harun Thohir road section is to make a technical road plan following the traffic of heavy vehicle loads passing through the road section.

The specific objectives of the Pavement Improvement activity on the HARUN TOHIR road are analyzing the structure of the old concrete pavement, planning to upgrade the pavement, and planning roadside drains as needed.

2. BASIC THEORY

2.1. Road

Roads are land transportation infrastructure covering all parts of the road, including complementary buildings and equipment intended for traffic, which are at ground level, above ground level, above water level and below ground and water level, except railroads, lorry roads and cable roads (Government Regulation Of The Republic Of Indonesia Number 34 Of 2006). Roads are dirt paths above the earth's surface that are deliberately made by humans with their shapes, dimensions and construction so that who can use them to channel the traffic of people, animals and vehicles that transport goods from one place to another quickly and easy (Eustoliano et al, 2015). Based on the functional classification, roads can be divided into Arterial Roads, Collector Roads, and Local Roads.

2.2. Road Pavement

Road pavement is a pavement layer that is the place where the wheels of the vehicle run, which functions to support the load caused by the objects above it. Pavement is a mixture of materials and binders to form a layer that vehicles can pass (Sucipto, 2021). Road pavement is made of aggregate and asphalt or cement (Portland cement) as a binder to harden a certain construction layer with a certain thickness, strength, stiffness and stability so that it can distribute the traffic load safely to reach the road base (Behiry, 2013). The main role of the road surface itself is to distribute or distribute the wheel load over a larger area of the roadbed than the contact area of the wheels with the road surface, thereby reducing the maximum stress that occurs on the road surface. The base of the road. The road surface must have the strength to withstand traffic loads. The pavement surface must be smooth, but the pavement must be slip-resistant. Pavements are built considering various factors such as structural requirements, economy, durability, comfort and experience.

2.3. Project Delay Factors

Damage that requires maintenance work can be classified into three categories:

1) Damage due to initial work, including supervision weaknesses, design weaknesses and poor material quality
2) Damage due to use and time, including surface wear, weather (cracks) and traffic abrasion, Installation of utilities (electricity, telephone cables, etc.), and Road marking. Cat's eyes etc., and joint fragility.
3) Damage due to special causes, including traffic accidents, potholes and landslides

2.4. Form and Type Damage

The types of damage commonly occurring on rigid pavements can be grouped into several similar types based on the damage model. The identification of each type of damage is as follows:

1) Deformation: The types of damage classified as deformation are depression, falling, pumping and rocking.
2) Cracks on rigid pavements have various forms, ranging from single to interconnected cracks. Generally, the types of cracks are block, corner, diagonal, longitudinal), transverse (transversal) and irregular (meandering)
3) Damage to the filler joints (joint seal defects)
4) Gopal
5) Damage to the edge of the slab (edge drop-off)
6) Damage to the surface texture (surface texture defect), this damage can be grouped into aggregate wear (scaling) and roughness (polished aggregate).
7) Hole
8) Insufficient drainage of the pavement surface.

2.5. Cross Section of Road

The cross-section of the road is the cross-section perpendicular to the road axis. On the cross-section of the road, you can see the sections of the road. The main road sections can be grouped as follows: (a). Parts that are directly useful for traffic and road support facilities, including traffic lanes, shoulders, sidewalks, road medians, road markings, roundabouts, signs, pedestrian bridges, bus stops, signalized and unsignalized intersections, and vehicle parking; (b). Useful parts for road drainage, including side channel, carriageway cross-slope, shoulder cross-slope, and slope; (c). Complementary road parts, including Kereb and Edge Crossings; (d). The road construction section includes the road pavement layer, upper foundation layer, lower foundation layer, and subgrade soil layer (e). Road benefit area (*damaja*); (f). Road property (*damija*); and (g). Road control area (*Madawaska*).

2.6. Road Pavement Design Concept

The concept of road design can be broadly divided into two groups: the design of new roads and the improvement of old roads (Rogers & Enright, 2016). The priority in designing new roads is balancing the existing regional spatial planning. Development consistency does not change existing land use. In fact, by placing the location of the road appropriately, efforts are made to help improve the existing land use. Road and pavement design criteria must follow the existing pattern and the patterns that will develop (Southworth & Ben-Joseph, 2013). Traffic predictions and predictions of the development of transportation patterns must be directed at the system to be built. The design criteria and parameters will differ according to the objectives and conditions. Generally, using the original basic data, with some modifications to parts that no longer meet the requirements. This category includes the design of roads for road improvement, road maintenance, road rehabilitation, road reconstruction and resurfacing programs.

2.7. Road Pavement Design Criteria

In pavement design, using any method, there are always 3 (three) design parameters: Traffic loading, Plan age, and Road standard & class (Pereira & Pais, 2017). The design age is determined following the planned road management program, for example, a. New Road Construction, for a service life of 20 years. b. Road Improvement, for a service life of 10 years and c. Road Maintenance for five years. Road Classification by Road Class ((for inter-city roads) and (for urban roads) and (for Regency roads)).

3. RESEARCH METHOD

Planning for improving concrete pavement on the Harun Tohir road section goes through the following stages: preliminary survey stage, primary and secondary data collection stage and field identification, data analysis stage, design stage, budget planning stage, and technical specifications and work method preparation stage implementation.

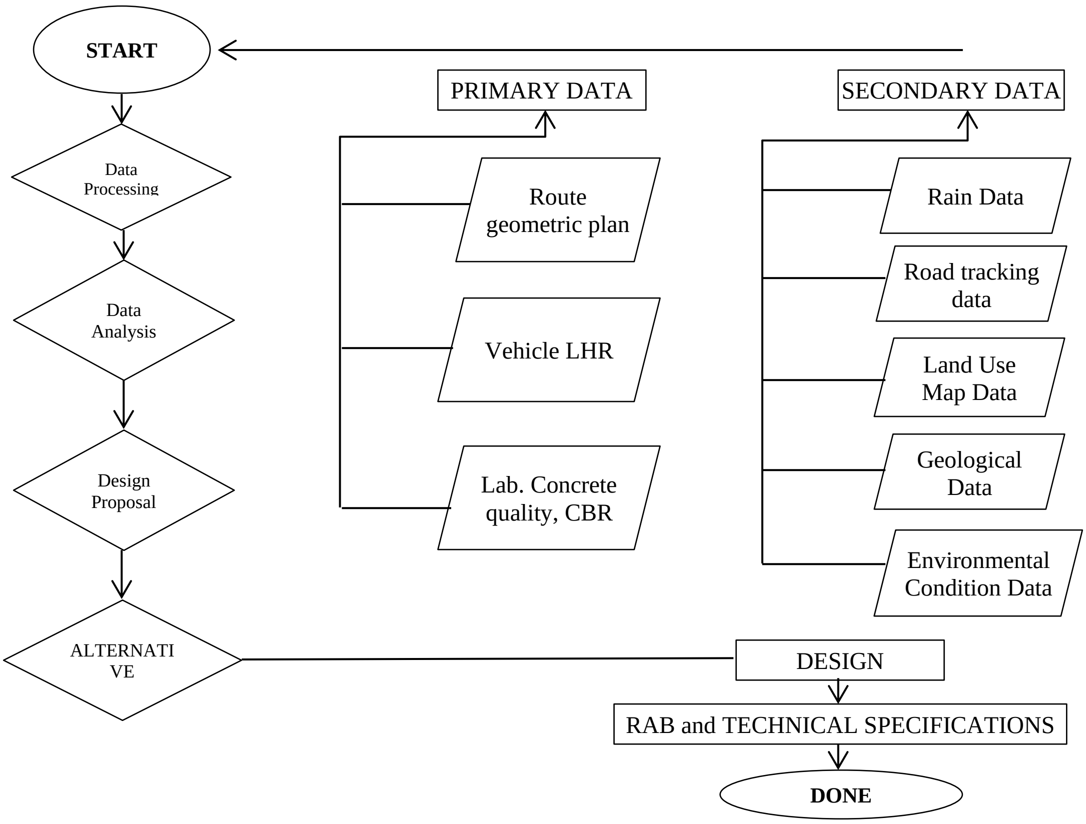

Figure 1 Study Stages

4. RESULTS AND DISCUSSION

4.1. Rigid Pavement Maintenance and Damage Problems

Road maintenance is an activity to maintain, repair, add or replace existing physical buildings so that their functions can be maintained or enhanced for a longer period. Road maintenance is a routine activity to maintain existing physical buildings to continue functioning as planned. This maintenance guideline is intended to regulate the procedures for carrying out rigid pavement maintenance activities and maintain stable serviceability conditions to provide safety and comfort to road users. This guideline for the maintenance of rigid pavements includes descriptions of the types of damage commonly occurring, their possible causes, follow-up consequences, recommendations for handling and methods.

Damage that requires maintenance work can be classified into three categories, namely: (1) Damage due to initial work, including weaknesses in supervision, design weaknesses, and poor material quality; (2) Damage due to use and time, including surface wear, weather (cracks) and traffic abrasion, Installation of utilities (electricity, telephone cables, etc.), Road marking. Cat's eye etc., Joint fragility; (3) Damage due to special causes, including traffic accidents, potholes, landslides. Rigid pavements are structurally stronger than flexible pavements. However, if maintenance is neglected, it can cause road conditions that are difficult to repair compared to asphalt pavements. Every maintenance officer is required to detect the cause of damage and ways of repair.

4.2. Existing Concrete Pavement Analysis at 4 Point Location

The existing road pavement thickness is as follows:

Role of Roads : Local Roads
Road Type : 2 lanes, 2 directions not divided (2/2 TB)
Planned Lifespan : 10 years
Traffic Growth : 6 %
Pavement : Rigid

Planned Concrete Quality:
Concrete will be used with a compressive strength of 28 days of 392 kg/cm2
f'c = 392 / 10.2 = 38.43 MPa
fr = 0.62 √(f'c) = 3.844 MPa

Planned Traffic Load:

Table 1 Planned Traffic Load

Type of Vehicle	Total Vehicle	Unit Vehicle
Light vehicle 2 tons (1 + 1)	-	
Small truck 6 tons (2 + 4)	1.200	Vehicle /2 track/2 direction
Large 2 axle truck 13 ton (5 + 8)	840	Vehicle /2 track/2 direction
20 ton 3 axle tandem truck (6 + 7.7)	560	Vehicle /2 track/2 direction
30 ton 5 axle tandem truck (6 + 7.7+5+5)	320	Vehicle /2 track/2 direction
40 ton 5 axle tandem truck (6 + 7.7 + 10 + 10)	320	Vehicle /2 track/2 direction
50 ton 6 axle tandem truck (6 + 7.7 + 10 + 10 + 10)	160	Vehicle /2 track/2 direction
Total	**3.400**	Vehicle /2 track/2 direction

(Source : data processed by researchers)

4.3. Analysis of the Number of Vehicle Axes that pass in a day

Table 2 Number of Vehicle Axes that pass in a day

Transportation type	Amount		Axis Load					Axis Configuration				
	Vehicle	Axis	Front	Middle	Back 1	Back 2	Back 3	Front	Middle	Back 1	Back 2	Back 3
Light Vehicles 2 tons (1+1)	-	-	-	-	-			-	-	-	-	-
Small Truck 6 tons (2+4)	1.200	2.400	2		4			STRT	-	STRT	-	-
Big Truck 2 Axis 13 tons (5+8)	840	1.680	3		8			STRT	-	STRG	-	-

Tandem truck 3 axis 20 tons (6+7.7)	560	1.120	6		14			STRT	-	SGRG	-	-
Tandem truck 5 axis 30 tons (6+7.7+5+5)	320	1.280	6	14	5	5		STRT	SGRG	STRT	STRT	-
Tandem truck 5 axis 40 tons (6+7.7+10+10)	320	1.280	6	14	10	10		STRT	SGRG	STRG	STRG	-
Tandem truck 6 axis 50 tons (6+7.7+10+10 +10)	160	800	6	14	10	10	10	STRT	SGRG	STRG	STRG	STRG
	3.400	8.560										

Information:

STRT = Single Axle Single Wheel
STRG = Double Wheel Single Axis
SGRG = Double Axle Double Wheel

Commercial vehicle (weight):

JKSN = 365 x JSKNH x R

$$R = \frac{(1+i)^n - 1}{e_{\log(1+i)}} = \frac{(1+0,06)^{10} - 1}{e_{\log(1+0,06)}} = 13,59$$

Then : JSKN = 365 x 8.560 x 13,59 = 34.920.864 unit

4.4. The Number of Reps Weight

Table 3 Number of Reps Weight

Axis Configuration	Axis Load (ton)	Axis Configuration Percentage (%)		JKSN	cd	Reps Number During Plan Age
STRT	2	1.200	8.560	118.339.774,40	0,50	8.294.844
STRT	3	840	8.560	118.339.774,40	0,50	5.806.391
STRT	4	1.200	8.560	118.339.774,40	0,50	8.294.844
STRT	5	320	8.560	118.339.774,40	0,50	2.211.958
STRT	5	320	8.560	118.339.774,40	0,50	2.211.958
STRT	6	560	8.560	118.339.774,40	0,50	3.870.927
STRT	6	320	8.560	118.339.774,40	0,50	2.211.958
STRT	6	320	8.560	118.339.774,40	0,50	2.211.958
STRT	6	160	8.560	118.339.774,40	0,50	1.105.979
STRG	8	840	8.560	118.339.774,40	0,50	5.806.391
STRG	10	320	8.560	118.339.774,40	0,50	2.211.958
STRG	10	320	8.560	118.339.774,40	0,50	2.211.958
STRG	10	160	8.560	118.339.774,40	0,50	1.105.979
STRG	10	160	8.560	118.339.774,40	0,50	1.105.979
STRG	10	160	8.560	118.339.774,40	0,50	1.105.979
SGRG	14	560	8.560	118.339.774,40	0,50	3.870.927
SGRG	14	320	8.560	118.339.774,40	0,50	2.211.958
SGRG	14	320	8.560	118.339.774,40	0,50	2.211.958
SGRG	14	160	8.560	118.339.774,40	0,50	1.105.979

Base Soil Strength:
CBR value representing = 5 %
From the graph in the figure obtained k = 38 kPa / mm for CBR 5 %
Concrete Plate Strength Control (Concrete slab thickness = 25 cm)
The total percentage of fatigue that occurs is required ≤ 100%

4.5. Road Pavement Planning

Table 4 Road Pavement Planning

2014 Traffic Data		
Light vehicles 2 tons (1 + 1)	=	540 Vehicles
Small trucks 6 tons (2 + 4)	=	1.200 Vehicles
Big 2 axle truck 13 tons (5 + 8)	=	840 Vehicles
20 ton 3 axle tandem truck (6 + 7.7)	=	560 Vehicles
30 ton 5 axle tandem truck (6 + 7.7+5+5)	=	320 Vehicles
40 ton 5 axle tandem truck (6 + 7.7+10+10)	=	320 Vehicles
50 ton 6 axle tandem truck (6 + 7.7+10+10+10)	=	160 Vehicles
Total	**=**	**3.940 Vehicles/day**

(Source: data processed by researchers)

Traffic growth for 10 years is predicted to be = 6 %

4.5.1. Calculation Analysis Using the Highways Method

Pavement Material:
Asphalt (MS 744) (a1) = 0,4
Existing concrete (a2) = 0,14
Class B aggregate (CBR 50) (a3) = 0,12

Table 5 LHR 2024

LHR In 2024, the end of the plan (1+i)^n		
Light vehicles 2 tons (1 + 1)	=	967 Vehicles
Small trucks 6 tons (2 + 4)	=	2.149 Vehicles
Big 2 axle truck 13 tons (5 + 8)	=	1.504 Vehicles
20 ton 3 axle tandem truck (6 + 7.7)	=	1.003 Vehicles
30 ton 5 axle tandem truck (6 + 7.7+5+5)	=	573 Vehicles
40 ton 5 axle tandem truck (6 + 7.7+10+10)	=	573 Vehicles
50 ton 6 axle tandem truck (6 + 7.7+10+10+10)	=	287 Vehicles

(Source: data processed by researchers)

4.5.2. Equivalent Value of Each Vehicle

Table 6 Equivalence Calculation

Light vehicles 2 tons (1 + 1)	= 0,0002 + 0,0002	= 0,0004
Small trucks 6 tons (2 + 4)	= 0,0036 + 0,0577	= 0,0613
Big 2 axle truck 13 tons (5 + 8)	= 0,1410 + 0,9238	= 1,0648
20 ton 3 axle tandem truck (6 + 7.7)	= 0,2923 + 0,7452	= 1,0375
30 ton 5 axle tandem truck (6 + 7.7+5+5)	= 0,2923 + 0,7452 + 0,1410 + 0,14	= 1,3195
40 ton 5 axle tandem truck (6 + 7.7+10+10)	= 0,2923 + 0,7452 + 2,2555 + 2,26	= 5,5485
50 ton 6 axle tandem truck (6 + 7.7+10+10+10)	= 0,2923 + 0,7452 + 2,2555 + 2,26 + 2,2555	= 7,8040

First Equivalent Cross (LEP) of (2014)
C x LHR x E

Light vehicles 2 tons (1 + 1)	= 0,50	x 540	x	0,0004	=	0,11
Small trucks 6 tons (2 + 4)	= 0,50	x 1.200	x	0,0613	=	36,78
Big 2 axle truck 13 tons (5 + 8)	= 0,50	x 840	x	1,0648	=	447,22
20 ton 3 axle tandem truck (6 + 7.7)	= 0,50	x 560	x	1,0375	=	290,50
30 ton 5 axle tandem truck (6 + 7.7+5+5)	= 0,50	x 320	x	1,3195	=	211,12
40 ton 5 axle tandem truck (6 + 7.7+10+10)	= 0,50	x 320	x	5,5485	=	887,76
50 ton 6 axle tandem truck (6 + 7.7+10+10+10)	= 0,50	x 160	x	7,8040	=	624,32
						2.497,80

Final Equivalent Cross (LEA) 10th year (2024)
C x LHR x E

Light vehicles 2 tons (1 + 1)	= 0,50	x 967	x	0,0004	=	0,19
Small trucks 6 tons (2 + 4)	= 0,50	x 2.149	x	0,0613	=	56,78
Big 2 axle truck 13 tons (5 + 8)	= 0,50	x 1.504	x	1,0648	=	800,90
20 ton 3 axle tandem truck (6 + 7.7)	= 0,50	x 1.003	x	1,0375	=	520,24
30 ton 5 axle tandem truck (6 + 7.7+5+5)	= 0,50	x 573	x	1,3195	=	378,08
40 ton 5 axle tandem truck (6 + 7.7+10+10)	= 0,50	x 573	x	5,5485	=	1.589,84
50 ton 6 axle tandem truck (6 + 7.7+10+10+10)	= 0,50	x 287	x	7,8040	=	1.118,06
						4.473,19

Middle Equivalent Cross LET

LET	= 0,5 (LEP + LEA10)	=	0,50 x (2.498 + 4.473)	= 3.485,50

Cross Equivalent Plans LER

LER	= LET x UR/10	=	3.485 x .10/10	= 3.485,50

ITP
CBR Subgrade = 6,07 % DDT = 5,2 IP = 2,0 FR = 1,0
LER = 3.485 (Ipo = 3,9 - 3,5)

Pavement Thickness
Planned D2=25cm
ITP = a1.D1 + a2.D2 + a3.D3
9,9 = 0,4 d1 + 0,14 d2 + 0,12 d3
9,9 = 0,4 d1 + 0,14 (25) + 0,12 (20)
9,9 = 0,4 d1 + 5,90
0,4 d1 = 9,9 – 5,90
0,4 d1 = 4,00
d1 = 10,00 cm

Table 7 Road Pavement Planning

New surface layer (asphalt) AC-WC = 4 CM New surface layer (asphalt) AC-BC = 6 CM	D1	10 cm
Existing concrete	D2	25 cm
LBR (CBR 50)	D3	20 cm

(Source: data processed by researchers)

4.6. Drainage Calculation

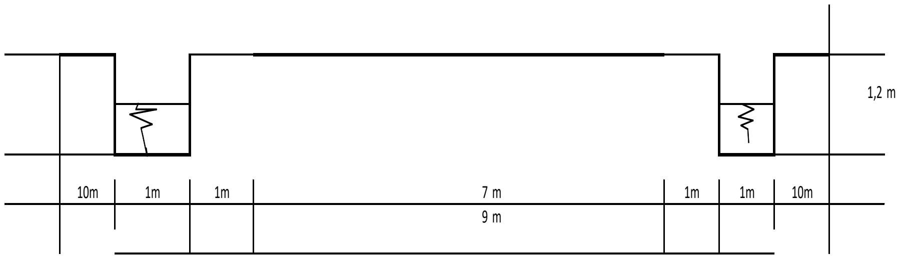

Figure 2 Drainage Design Plan

Road pavement catchment area (A1) = 11x1800 = 21.150,00 m2
Ran off coefficient (C1) = 0,95

Grass catchment area (A2) = 10x1800x2 = 36.000,00 m2
Ran off coefficient (C2) = 0,33

$$C\ \text{Average} = \frac{C1.A1 + C2.A2}{A1+A2}$$

$$= \frac{0{,}95 \quad 21.150{,}00 \quad + \quad 0{,}33 \quad 36.000{,}00}{21.150{,}00 + 36.000{,}00}$$

= 0,56

A total = 57.150,00 m2 = 0,057150 km2

Q=1/3,6 x C x I x A
Q= = 0,888125 m3/dt
n= = 0,02
Channel Dimensions
Wet cross-sectional area
A=Q/V = 1,77625 m2 (left and right)

Figure 3 Planned Dimension Calculation

Planned Dimensions of the right and the left bank of the road:
Channel Cross-Sectional area 1.0 m x 1.2 m 2 units = 2,4 m^2 > 1,77 m^2 (OK)

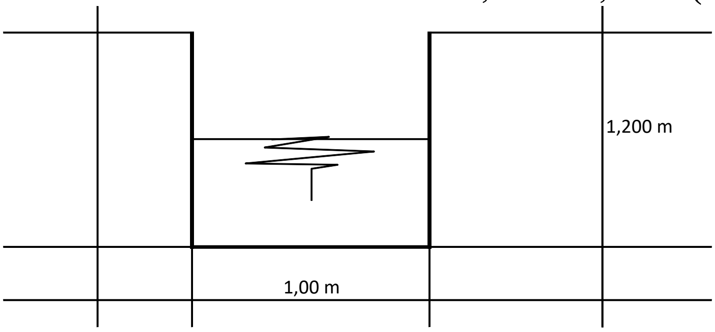

Figure 4 Planned Dimension of the Right and Left Bank of Road

5. CONCLUSION

Based on the calculation results, it can be concluded as follows:

1) The road pavement plan consists of a base layer of CBR 50 with a thickness of 20 cm, a concrete pavement with a thickness of 25 cm, and a surface layer of 10 cm consisting of an AC BC layer of 6 cm and an AC WC layer of 4 cm.
2) Drainage with a square cross-section. The dimensions of the base width are 1.0 m and 1.2 meters high, totalling two units built on the right and left sides of the road

REFERENCES

Assogba, O. C., Tan, Y., Sun, Z., Lushinga, N., & Bin, Z. (2021). Effect of vehicle speed and overload on dynamic response of semi-rigid base asphalt pavement. *Road Materials and Pavement Design*, *22*(3), 572–602.

Behiry, A. E. A. E.-M. (2013). Utilization of cement treated recycled concrete aggregates as base or subbase layer in Egypt. *Ain Shams Engineering Journal*, *4*(4), 661–673.

Eustoliano, Sumanjaya, & ... (2015). Planning Of Connecting Roads Emerera District And Hatolian Sub-Distrite. *Universitas Warmadewa*, *4*, 10–16.

Fauziyah, W. E. (2021). Policy Implementation for the Development of the South Ring Road (Ring Road) in Tuban Regency. *Upn Veteran Jawa Timur*.

Government Regulation Of The Republic Of Indonesia Number 34 Of 2006. (2006). *Government Regulation Of The Republic Of Indonesia Number 34 Of 2006 Concerning Roads With*. Indonesia Goverment.

Kantharia, R. (2019). *4 Types of Ship Launching Methods*. Marineinsight.Com.

Pereira, P., & Pais, J. (2017). Main flexible pavement and mix design methods in Europe and challenges for the development of an European method. *Journal of Traffic and Transportation Engineering (English Edition)*, *4*(4), 316–346.

Rahayu, I. T. (2019). The need for Standardization Guidelines and Criteria in Building Roads and Bridges for Infrastructure and Interests The National Defense. In *Ministry of Defense of the Republic of Indonesia*.

Ramadhan, G. B. (2014). Comparison Of Graded Ac-Wc Characteristics Meetings And Gaps With Asphalt Binding Materials Retona Blend E-55 And Starbit E-55. *Universitas*

Islam Indonesia.

Rogers, M., & Enright, B. (2016). *Highway engineering*. John Wiley & Sons.

Southworth, M., & Ben-Joseph, E. (2013). *Streets and the Shaping of Towns and Cities*. Island Press.

Sucipto, & Sucipto. (2021). Asphalt Mixture Characteristics Analysis Using Glass Powder. *Journal of Civil Engineering and Planning*, *2*(1).