

TABLE OF CONTENTS

Chapter Number	Description	Page
	TITLE PAGE	I
	APROVAL PAGE.....	Ii
	DECLARATION.....	Iii
	PROCESS VERBAUX (BERITA ACARA).....	Iv
	ABSTRACT	V
	ABSTRAK	Vi
	MOTTO	Vii
	ACKNOWLEDGEMENT.....	viii
	DEDICATION.....	Ix
	TABLE OF CONTENTS	X
	LIST OF TABLES	Xi
	TABLE OF FIGURES.....	Xii
	TABLE OF ABBREVIATION	xiii
I	INTRODUCTION	1
1.1	Background.....	1
1.2	History of road network in Indonesia	1
1.3	Problem limitation	3

1.4	Objectives of the study	3
1.5	Scope of the study	3
II	LITERATURE REVIEW	4
2.1	Introduction.....	4
2.2	Toll road.....	4
2.3	Typical cross section of standard safety toll road.....	4
2.3.1	Cross – section elements.....	5
2.3.1.1	Pavement surface characteristic.....	5
2.3.1.2	Friction.....	7
2.3.1.3	Unevenness	7
2.3.1.4	Light reflection characteristics.....	8
2.3.1.5	Drainage.....	8
2.3.1.6	Camber.....	8
2.3.1.7	Width of carriage way.....	9
2.3.1.8	Shoulder.....	9
2.3.2	Sight distance.....	9
2.3.2.1	Types of sight distance	10
2.3.2.2	Stopping sight distance	10
2.3.2.3	Overtaking sight distance.....	11
2.3.2.4	Overtaking zones	12
2.3.2.5	Sight distance at intersections.....	12
2.3.3	Horizontal alignment	13

2.3.3.1	Horizontal curve	15
2.3.3.2	Radius of horizontal curve	15
2.3.3.3	Analysis of super – elevation	15
2.3.3.4	Extra widening	16
2.3.3.5	Horizontal transition curve	17
2.3.4	Vertical alignment	17
2.3.4.1	Gradient	18
2.3.4.2	Summit curve	18
2.3.4.3	Valley curve	20
2.3.5	Intersection	21
2.3.5.1	Interchange	22
2.3.5.2	Channelized intersection	22
2.4	ASHTOO 1993 flexible pavement design procedure	24
2.4.1	Traffic	24
2.4.2	Reliability	26
2.5	Environmental effect	28
2.5.1	Performance criteria	28
2.5.1.1	Serviceability	28
2.5.1.2	Allowing rutting	30
2.5.1.3	Aggregate loss	30
2.5.2	Material properties for structure design	30
2.5.2.1	Effective modulus of subgrade reaction	31
2.5.2.2	Pavement layer material characterization	32

2.5.3	Layer coefficients	32
2.5.4	Pavement structural characteristic	36
2.5.4.1	Drainage.....	36
2.6	Pavement material.....	37
2.6.1	Prepared roadbed	37
2.6.1.1	Sub base course.....	37
2.6.1.2	Base course	38
2.6.1.3	Drainage layer.....	39
2.6.1.4	Filter material.....	39
2.6.1.5	Surface course.....	39
2.7	Summary of literature review	41
III	LITERATURE REVIEW	42
3.1	Introduction.....	42
3.2	Flexible pavement.....	42
3.2.1	Determine require structure number	44
3.2.2	Stage construction.....	44
3.2.3	Selection of layer thickness.....	46
3.2.4	Layered design analysis	47
3.3	Design of flexible pavement	48
IV	DESIGN AND CALCULATION	49

4.1	Introduction.....	49
4.2	Design Requirement	49
4.2.1	Time constraints.....	49
4.2.2	Traffic	49
4.2.2.1	Calculation of equivalent single axle load.....	50
4.2.3	Reliability.....	53
4.2.4	Environmental impacts	53
4.3	Serviceability	54
4.4	Pavement layer material characterization	55
4.4.1	Resilient modulus	55
4.5	Layer coefficient	56
4.6	Drainage coefficient.....	58
4.7	Development of initial stage of a design alternative.....	59
4.8	Determination of structural layer thickness for initial structure	59
V	CONCLUSIONS AND RECOMMENDATION	80
5.1	Conclusions	80
5.2	Recommendations	80
	REFERENCES	81
	APPENDICES.....	83

LIST OF TABLES

Table Number	Description	Page
2.1	Standard design of safety toll roads.....	6
2.2	IRC values for camber.....	8
2.3	IRC values for desirable carriage way.....	9
2.4	Acceleration values of the fast vehicle	12
2.5	Suggested levels of reliability for various functional classification	27
2.6	Serviceability index	29
2.7	Drainage levels from the pavement structure	37
4.1	Average daily traffic year 2018	50
4.2	Number of Equivalency (E) of axle load.....	50
4.3	Load configuration for 8,16 Ton ESAL	51
4.4	Worksheet for calculating 8.16 ton (ESAL) applications	52
4.5	Data of Soil.....	55
4.6	Resilient Modulus (M_R).....	56
4.7	Drainage levels from the pavement structure	58
4.8	The quality of drainage based on humidity levels	58
4.11	SN required.....	76
4.12	Result of thickness.....	76
4.13	The design result of thickness layers with all type of subgrade soil	79

TABLE OF FIGURES

Figure Number	Description	Page
1.1	Maps of north route road in java island.....	2
1.2	Typical existing toll road in Indonesia	2
2.1	Full circle.....	13
2.2	Spiral – circle – spiral.....	14
2.3	Spiral – spiral.....	14
2.4	Super elevation	16
2.5	Types of summit curve	19
2.6	Summit curve details	19
2.7	Type of valley curve	20
2.8	Valley curve details	21
2.9	Three-legged intersection	23
2.10	Four-legged intersection.....	23
2.11	Clover-leaf intersection	24
2.12	Example plot of cumulative 8.16 ton ESAL traffic versus time	25
2.13	Chart to determine coefficient of surface layer	34
2.14	Chart above foundation layer coefficient a2	35
2.15	Chart above coefficient subgrade a3	36
3.1	Flowchart calculation of the design of toll road.....	43
3.2	Design chart for flexible pavemenet based on using mean values for each input.....	45

3.3	Procedure for determining thickness of layers using a layered analysis approach.....	47
4.1	Plot of cumulative 8.16ton-esal traffic versus time.....	53
4.2	Chart to determine coefficient of surface layer	56
4.3	Chart above foundation layer coefficient a2	57
4.4	Chart above foundation layer coefficient a3	57
4.5	Design chart SN3 for flexible pavement	64
4.6	Design chart SN2 for flexible pavement	65
4.7	Design chart SN3 for flexible pavement	66
4.8	Design chart SN3 for flexible pavement	67
4.9	Design chart SN2 for flexible pavement	68
4.10	Design chart SN3 for flexible pavement	69
4.11	Design chart SN3 for flexible pavement	70
4.12	Design chart SN2 for flexible pavement	71
4.13	Design chart SN3 for flexible pavement	72
4.14	Design chart SN3 for flexible pavement	73
4.15	Design chart SN2 for flexible pavement	74
4.16	Design chart SN3 for flexible pavement	75
4.17	Procedure for determining thickness of layer using a layered analysis approach.....	76
4.18	Flexible pavement layers using subgrade CBR 3%	77
4.19	Flexible pavement layers using subgrade CBR 5%	77
4.20	Flexible pavement layers using subgrade CBR 6%	78
4.21	Flexible pavement layers using subgrade CBR 8%	78

LIST OF ABBREVIATION

ASSTHO	= American Association of State Highway and Transportation Officials
ASTM	= American Standard Testing and Material
CBR	= California Bearing Ratio
DD	= Directional distribution factor
DL	= Line distribution factor
E	= Equivalent
EAc	= Asphalt concrete
Egs	= Base
ESAL	= Equivalent single axle load
EsB	= Sub base
FR	= Reliability factor
G_r	= Growth factor
i	= Traffic growth
M_R	= Effective resilient modulus of roadbed material
n	= Year to -
PSI	= Percent serviceability index
R	= Reliability
SN	= structural number
So	= Standard deviation
ST	= Surface treatment
W18	= Estimated future traffic for the performance period
$a_{1,2,3}$	= Layer coefficient representative surface base and sub base courses, respectively
$D_{1,2,3}$	= Actual thickness (in inches) of surface, base and sub base courses, respectively
$m_{1,2,3}$	= Drainage coefficient for base and sub base layer, respectively
Δ PSI Po –Pt	= Design serviceability loss
Δ PSIW	= Graph of cumulative environmental loss versus time