NO.

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

MINISTRY OF PUBLIC WORKS
REPUBLIC OF INDONESIA

DETAILED DESIGN STUDY
OF
NORTH JAVA CORRIDOR FLYOVER PROJECT
IN THE REPUBLIC OF INDONESIA

FINAL REPORT
DESIGN REPORT
(HIGHWAY AND DRAINAGE)

DECEMBER 2006

KATAHIRA & ENGINEERS INTERNATIONAL

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DETAILED DESIGN STUDY
OF
NORTH JAVA CORRIDOR FLYOVER PROJECT
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HIGHWAY AND DRAINAGE DESIGN REPORT

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1. HIGHWAY HORIZONTAL ALIGNMENT AND CURVE REPORT

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Horizontal Alignment Station and Curve Report.
Alignment: MERAK-1
Desc:
Desc.  Station           Spiral/Curve Data          Northing        Easting
-----------------------------------------------------------------------------

-----------------------------------------------------------------------------
PI     0+500                                    9344631.6238    610285.4066
           Length:          32.6078   Course:     179-29-24.38

-----------------------------------------------------------------------------
PI     0+532.608                                9344599.0173    610285.6968
           Length:         138.3002   Course:     131-09-44.88
            Delta:      48-19-39.50
-----------------------------------------------------------------------------
                         Tangent Data
       0+500                                    9344631.6238    610285.4066
       0+510.175                                9344621.4494    610285.4972
           Length:          10.1748   Course:     179-29-24.38
-----------------------------------------------------------------------------
                         Circular Curve Data
TC     0+510.175                                9344621.4494    610285.4972
CC                                              9344621.8944    610335.4952
CT     0+552.349                                9344584.2520    610302.5854
            Delta:      48-19-39.50     Type:             LEFT
           Radius:          50.0000      DOC:     114-35-29.61
           Length:          42.1738  Tangent:          22.4330
          Mid-Ord:           4.3811 External:           4.8018
            Chord:          40.9347   Course:     155-19-34.63
               Es:           4.8018

-----------------------------------------------------------------------------
PI     0+668.216                                9344507.9887    610389.8156
           Length:         212.7103   Course:     132-23-10.93
            Delta:       1-13-26.05
-----------------------------------------------------------------------------
                         Tangent Data
       0+552.349                                9344584.2520    610302.5854
       0+641.513                                9344525.5641    610369.7127
           Length:          89.1648   Course:     131-09-44.88
-----------------------------------------------------------------------------
                         Circular Curve Data
TC     0+641.513                                9344525.5641    610369.7127
CC                                              9342643.4485    608724.2217
CT     0+694.916                                9344489.9878    610409.5384
            Delta:      01-13-26.05     Type:            RIGHT
           Radius:        2500.0000      DOC:      02-17-30.59
           Length:          53.4028  Tangent:          26.7024
          Mid-Ord:           0.1426 External:           0.1426
            Chord:          53.4018   Course:     131-46-27.90
               Es:           0.1426

-----------------------------------------------------------------------------
PI-3     0+880.924                                9344364.5950    610546.927
           Length:          60.1528   Course:     149-29-54.35
            Delta:      17-06-43.42
-----------------------------------------------------------------------------
                         Tangent Data
       0+694.916                                9344489.9878    610409.5384
       0+820.771                                9344405.1456    610502.4969
           Length:         125.8550   Course:     132-23-10.93
-----------------------------------------------------------------------------
```

Spiral Curve Data: CLOTHOID

TS	0+820.771			9344405.146	610502.497
SC	0+850.771			9344384.558	610524.313
	Length:	30.0000	L Tan:	20.0026	
	Radius:	300.0000	S Tan:	10.0024	
	Theta:	2-51-53.24	P:	0.1250	
	X:	29.9925	K:	14.9988	
	Y:	0.4999	A:	94.8683	
	Chord:	29.9967	Course:	133-20-28.60	
	Ts:	60.153			

Circular Curve Data

SC	0+850.771			9344384.5576	610524.3128
CC				9344173.3575	610311.2530
SC	0+910.370			9344338.355	610561.8042
	Delta:	11-22-56.94	Type:	RIGHT	
	Radius:	300.0000	DOC:	19-05-54.94	
	Length:	59.5985	Tangent:	29.8977	
	Mid-Ord:	1.4788	External:	1.4861	
	Chord:	59.5006	Course:	140-56-32.64	
	Es:	3.5027			

Spiral Curve Data: CLOTHOID

SC	0+910.370			9344338.3546	610561.8042
SPI				9344330.0009	610567.3054
TC	0+940.370			9344312.7664	610577.4580
	Length:	30.0000	L Tan:	20.0026	
	Radius:	300.0000	S Tan:	10.0024	
	Theta:	2-51-53.24	P:	0.1250	
	X:	29.9925	K:	14.9988	
	Y:	0.4999	A:	94.8683	
	Chord:	29.9967	Course:	148-32-36.67	
	Ts:	60.1528			

PI	0+940.370			9344312.7664	610577.4580
	Length:	5.2992	Course:	149-29-54.38	
	Delta:	0-00-00.03			

PI	0+945.669			9344308.2005	610580.1477
	Length:	44.4890	Course:	149-29-54.35	
	Delta:	0-00-00.03			

Tangent Data

	0+940.370			9344312.7664	610577.4580
	0+945.669			9344308.2005	610580.1477
	Length:	5.2992	Course:	149-29-54.38	

PI-4	0+990.158			9344269.8682	610602.729
	Length:	126.2146	Course:	171-26-36.29	
	Delta:	21-56-41.94			

Spiral Curve Data: CLOTHOID

TS	0+945.669			9344308.2005	610580.1487
SPI				9344290.5025	610590.5732
SC	0+976.463			9344281.162	610594.854
	Length:	30.794	L Tan:	20.5405	
	Radius:	150.0000	S Tan:	10.2749	
	Theta:	5-52-52.19	P:	0.2633	
	X:	30.7613	K:	15.3914	
	Y:	1.0528	A:	67.9636	

	Chord:	30.7793	Course:	151-27-31.11	
	Ts:	44.4890			

Circular Curve Data

SC	0+976.463			9344281.1618	610594.8538
CC				9344218.6711	610458.4906
SC	1+003.518			9344255.686	610603.852
	Delta:	10-20-03.27	Type:	RIGHT	
	Radius:	150.0000	DOC:	38-11-49.87	
	Length:	27.0550	Tangent:	13.5643	
	Mid-Ord:	0.6096	External:	0.6121	
	Chord:	27.0183	Course:	160-32-48.17	
	Es:	3.0547			

Spiral Curve Data: CLOTHOID

SC	1+003.518			9344255.6858	610603.8519
SPI				9344245.9858	610606.3219
TC	1+033.518			9344226.1981	610609.2992
	Length:	30.0000	L Tan:	20.0105	
	Radius:	150.0000	S Tan:	10.0095	
	Theta:	5-43-46.48	P:	0.2499	
	X:	29.9700	K:	14.9950	
	Y:	0.9993	A:	67.0820	
	Chord:	29.9867	Course:	169-32-01.38	
	Ts:	44.1626			

PI-5	1+115.571			9344145.0584	610621.50876
	Length:	82.0529	Course:	132-36-07.67	
	Delta:	38-50-28.61			

Spiral Curve Data: CLOTHOID

TS	1+033.518			9344226.1981	610609.2992
SPI				9344206.4142	610612.2759
SC	1+063.518			9344196.6679	610614.5404
	Length:	30.0000	L Tan:	20.0065	
	Radius:	190.0000	S Tan:	10.0059	
	Theta:	4-31-24.06	P:	0.1973	
	X:	29.9813	K:	14.9969	
	Y:	0.7891	A:	75.4983	
	Chord:	29.9917	Course:	169-56-08.55	
	Ts:	82.0530			

Circular Curve Data

SC	1+063.518			9344196.6679	610614.5404
CC				9344239.6669	610799.6109
SC	1+162.320			9344110.3918	610660.3702
	Delta:	29-47-40.52	Type:	LEFT	
	Radius:	190.0000	DOC:	30-09-20.42	
	Length:	98.8026	Tangent:	50.5455	
	Mid-Ord:	6.3862	External:	6.6084	
	Chord:	97.6931	Course:	152-01-21.96	
	Es:	11.6719			

Spiral Curve Data: CLOTHOID

SC	1+162.320			9344110.3918	610660.3702
SPI				9344103.0590	610667.1782
TC	1+192.320			9344089.5165	610681.9044
	Length:	29.9999	L Tan:	20.0065	
	Radius:	190.0000	S Tan:	10.0059	
	Theta:	4-31-24.04	P:	0.1973	
	X:	29.9813	K:	14.9969	
	Y:	0.7891	A:	75.4983	

Chord: 29.9916 Course: 134-06-35.40
Ts: 82.0529

PI 1+192.320 9344089.5165 610681.9044
Length: 57.4963 Course: 132-36-07.67
Delta: 0-00-00.00

PI 1+249.817 9344050.5971 610724.2258
Length: 20.1961 Course: 132-36-07.67
Delta: 0-00-00.00

Tangent Data
1+192.320 9344089.5165 610681.9044
1+249.817 9344050.5971 610724.2258
Length: 57.4963 Course: 132-36-07.67

PI 1+270.013 9344036.9263 610739.0916
Length: 181.4989 Course: 134-08-41.65
Delta: 1-32-33.98

Circular Curve Data
TC 1+249.817 9344050.5971 610724.2258
CC 9342946.4892 609708.8708
CT 1+290.206 9344022.8602 610753.5839
Delta: 01-32-33.98 Type: RIGHT
Radius: 1500.0000 DOC: 03-49-10.99
Length: 40.3897 Tangent: 20.1961
Mid-Ord: 0.1359 External: 0.1360
Chord: 40.3885 Course: 133-22-24.66
Es: 0.1360

PI 1+451.509 9343910.5168 610869.3317
Length: 55.4253 Course: 138-25-46.75
Delta: 4-17-05.10

Tangent Data
1+290.206 9344022.8602 610753.5839
1+425.323 9343928.7549 610850.5409
Length: 135.1166 Course: 134-08-41.65

Circular Curve Data
TC 1+425.323 9343928.7549 610850.5409
CC 9343426.4484 610363.0082
CT 1+477.671 9343890.9258 610886.7073
Delta: 04-17-05.10 Type: RIGHT
Radius: 700.0000 DOC: 08-11-06.40
Length: 52.3481 Tangent: 26.1863
Mid-Ord: 0.4893 External: 0.4896
Chord: 52.3359 Course: 136-17-14.20
Es: 0.4896

PI 1+506.910 9343869.0508 610906.1086
Length: 37.6744 Course: 159-08-31.43
Delta: 20-42-44.68

Circular Curve Data
TC 1+477.671 9343890.9258 610886.7073
CC 9343784.7595 610767.0046

MERAK 1

CT	1+535.511			9343841.7278		610916.5192
	Delta:	20-42-44.68	Type:	RIGHT		
	Radius:	160.0000	DOC:	35-48-35.50		
	Length:	57.8400	Tangent:	29.2391		
	Mid-Ord:	2.6065	External:	2.6497		
	Chord:	57.5255	Course:	148-47-09.09		
	Es:	2.6497				

PI	1+543.946		9343833.8453	610919.5226

Tangent Data

1+535.511			9343841.7278	610916.5192
1+543.946			9343833.8453	610919.5226
Length:	8.4353	Course:	159-08-31.43	

MERAK-1 FLYOVER

Location		:	Merak							
Design Speed	(Vr)	:	**30**	km/hr						
PI-1, Sta			0+532,608							
Radii of Curve	(R_r)	:	50	m						
Super Elevation	(e_r)	:	5,4	%	From table RSNI T-14-2004/P29 (to interpolation)					
Horizontal Curve length	(L_{ch})	:	26	m	R_1	50	e_1	5,4	L_{h1}	26
					R_2	40	e_2	5,8	L_{h2}	28
Spiral length (Ls)					(R_1-R_2)	10	Δe	-0,4	$(L_{h1}-L_{h2})$	-2
$Ls=Vr*t/3.6 \rightarrow t=2sec.$		:	16,67	m						
$Ls=W*\Delta^{-1}*(e_r+e_n)$		:	38,10	m	Δ	1/143	0,00699	Δ^{-1}	143	
					W	3,6				
Widening (w)			0	m	From table RSNI T-14-2004/P37 (to interpolation)					
					w_1	0				
					w_2	0				
					(w_1-w_2)	0				

Design Speed	(Vr)	:	**60**	km/hr						
PI-2, Sta			0+668,216							
Radii of Curve	(R_r)	:	2500	m						
Super Elevation	(e_r)	:	2,00	%	From table RSNI T-14-2004/P29 (to interpolation)					
Horizontal Curve length	(L_{ch})	:	0	m	R_1	2500	e_1	2	L_{h1}	0
					R_2	2000	e_2	2	L_{h2}	0
Spiral length (Ls)					(R_1-R_2)	500	Δe	0	$(L_{h1}-L_{h2})$	0
$Ls=Vr*t/3.6 \rightarrow t=2sec.$			33,33	m						
$Ls=W*\Delta^{-1}*(e_r+e_n)$			20,59	m	Δ	1/143	0,00699	Δ^{-1}	143	
					W	3,6				
Widening (w)			0,20	m	From table RSNI T-14-2004/P37 (to interpolation)					
					w_1	0,2				
					w_2	0,2				
					(w_1-w_2)	0				

Design Speed	(Vr)	:	**60**	km/hr						
PI-3, Sta			0+880,924							
Radii of Curve	(R_r)	:	300	m						
Super Elevation	(e_r)	:	4,6	%	From table RSNI T-14-2004/P29 (to interpolation)					
Horizontal Curve length	(L_{ch})	:	28	m	R_1	300	e_1	4,6	L_{h1}	28
					R_2	250	e_2	5	L_{h2}	30
Spiral length (Ls)					(R_1-R_2)	50	Δe	-0,4	$(L_{h1}-L_{h2})$	-2
$Ls=Vr*t/3.6 \rightarrow t=2sec.$			33,33	m						
$Ls=W*\Delta^{-1}*(e_r+e_n)$			33,98	m	Δ	1/143	0,00699	Δ^{-1}	143	
					W	3,6				
Widening (w)			0,5	m	From table RSNI T-14-2004/P37 (to interpolation)					
					w_1	0,5				
					w_2	0,6				
					(w_1-w_2)	0,1				

Design Speed	(Vr)	:	**60**	km/hr
PI-4, Sta			0+990,158	
Radii of Curve	(R_r)	:	150	m

Super Elevation	(e_r)	:	6	%	From table RSNI T-14-2004/P29 (to interpolation)					
Horizontal Curve length	(L_{ch})	:	36	m	R_1	150	e_1	6	L_{h1}	36
					R_2	140	e_2	6	L_{h2}	36
Spiral length (Ls)					(R_1-R_2)	10	Δe	0	$(L_{h1}-L_{h2})$	0
$Ls=Vr*t/3.6 \rightarrow t=2sec.$			33,33	m						
$Ls=W*\Delta^{-1}*(e_r+e_n)$			41,18	m	Δ	1/143	0,00699	Δ^{-1}	143	
					W	3,6				
Widening (w)			0,3	m	From table RSNI T-14-2004/P37 (to interpolation)					
					w_1	0,3				
					w_2	0,5				
					(w_1-w_2)	0,2				

Design Speed	(Vr)	:	60	km/hr						
PI-5, Sta			1+115,571							
Radii of Curve	(R_r)	:	190	m						
Super Elevation	(e_r)	:	5,62	%	From table RSNI T-14-2004/P29 (to interpolation)					
Horizontal Curve length	(L_{ch})	:	33,8	m	R_1	200	e_1	5,5	L_{h1}	33
					R_2	175	e_2	5,8	L_{h2}	35
Spiral length (Ls)					(R_1-R_2)	25	Δe	-0,3	$(L_{h1}-L_{h2})$	-2
$Ls=Vr*t/3.6 \rightarrow t=2sec.$			33,33	m						
$Ls=W*\Delta^{-1}*(e_r+e_n)$			39,23	m	Δ	1/143	0,00699	Δ^{-1}	143	
					W	3,6				
Widening (w)			0	m	From table RSNI T-14-2004/P37 (to interpolation)					
					w_1	0				
					w_2	0				
					(w_1-w_2)	0				

Design Speed	(Vr)	:	60	km/hr						
PI-6, Sta			1+270,013							
Radii of Curve	(R_r)	:	1500	m						
Super Elevation	(e_r)	:	2	%	From table RSNI T-14-2004/P29 (to interpolation)					
Horizontal Curve length	(L_{ch})	:	0	m	R_1	1500	e_1	2	L_{h1}	0
					R_2	1400	e_2	2	L_{h2}	0
Spiral length (Ls)					(R_1-R_2)	100	Δe	0	$(L_{h1}-L_{h2})$	0
$Ls=Vr*t/3.6 \rightarrow t=2sec.$			33,33	m						
$Ls=W*\Delta^{-1}*(e_r+e_n)$			20,59	m	Δ	1/143	0,00699	Δ^{-1}	143	
					W	3,6				
Widening (w)			0,1	m	From table RSNI T-14-2004/P37 (tp interpolation)					
					w_1	0,1				
					w_2	0,1				
					(w_1-w_2)	0				

Design Speed	(Vr)	:	40	km/hr						
PI-7, Sta			1+451,509							
Radii of Curve	(R_r)	:	700	m						
Super Elevation	(e_r)	:	2	%	From table RSNI T-14-2004/P29 (to interpolation)					
Horizontal Curve length	(L_{ch})	:	10	m	R_1	700	e_1	2	L_{h1}	10
					R_2	600	e_2	2	L_{h2}	10
Spiral length (Ls)					(R_1-R_2)	100	Δe	0	$(L_{h1}-L_{h2})$	0
$Ls=Vr*t/3.6 \rightarrow t=2sec.$			22,22	m						

$Ls=W*\Delta^{-1}*(e_r+e_n)$			20,59	m	Δ	1/143	0,00699	Δ^{-1}		143		
					W	3,6						
Widening (w)			0	m	From table RSNI T-14-2004/P37 (tp interpolation)							
					w_1	0						
					w_2	0						
					(w_1-w_2)	0						
Design Speed	(Vr)	:	40	km/hr								
PI-8, Sta			1+506,910									
Radii of Curve	(R_r)	:	160	m								
Super Elevation	(e_r)	:	4,28	%	From table RSNI T-14-2004/P29 (to interpolation)							
Horizontal Curve length	(L_{ch})	:	22,2	m	R_1	175	e_1	4,1	L_{h1}		21	
					R_2	150	e_2	4,4	L_{h2}		23	
Spiral length (Ls)					(R_1-R_2)	25	Δe	-0,3	$(L_{h1}-L_{h2})$		-2	
$Ls=Vr*t/3.6 \rightarrow t=2sec.$			22,22	m								
$Ls=W*\Delta^{-1}*(e_r+e_n)$			32,33	m	Δ	1/143	0,00699	Δ^{-1}		143		
					W	3,6						
Widening (w)			0	m	From table RSNI T-14-2004/P37 (tp interpolation)							
					w_1	0						
					w_2	0						
					(w_1-w_2)	0						

Horizontal Alignment Station and Curve Report.
Alignment: MERAK-2
Desc:

```
Desc.  Station          Spiral/Curve Data            Northing          Easting
-------------------------------------------------------------------------------

-------------------------------------------------------------------------------
PI     0+000                                        9344405.9658     610303.8987
             Length:          180.2852  Course:     113-02-39.79

-------------------------------------------------------------------------------
PI     0+180.285                                    9344335.3942     610469.7975
             Length:          250.7279  Course:     141-40-05.31
              Delta:       28-37-25.52
-------------------------------------------------------------------------------
                         Tangent Data
       0+000                                        9344405.9658     610303.8987
       0+127.133                                    9344356.2003     610420.8868
             Length:          127.1331  Course:     113-02-39.79
-------------------------------------------------------------------------------
                         Circular Curve Data
TC     0+127.133                                    9344356.2003     610420.8868
CC                                                  9344172.1599     610342.5980
SC     0+192.049                                    9344321.6236     610475.4912
              Delta:       18-35-49.18    Type:            RIGHT
             Radius:          200.0000     DOC:      28-38-52.40
             Length:           64.9158 Tangent:          32.7459
            Mid-Ord:            2.6280 External:          2.6630
              Chord:           64.6312  Course:     122-20-34.38
                 Es:            6.9424
-------------------------------------------------------------------------------
                         Spiral Curve Data: CLOTHOID
SC     0+192.049                                    9344321.6236     610475.4912
SPI                                                 9344306.0740     610492.9796
TC     0+262.049                                    9344269.4083     610521.9696
             Length:           70.0000   L Tan:          46.7417
             Radius:          200.0000   S Tan:          23.4016
              Theta:       10-01-36.34       P:           1.0197
                  X:           69.7859       K:          34.9643
                  Y:            4.0744       A:         118.3216
              Chord:           69.9048  Course:     138-19-36.32
                 Ts:           84.1194

-------------------------------------------------------------------------------
PI     0+428.657                                    9344138.7153     610625.3028
             Length:           74.9657  Course:     132-36-07.67
              Delta:        9-03-57.64
-------------------------------------------------------------------------------
                         Tangent Data
       0+262.049                                    9344269.4083     610521.9696
       0+381.089                                    9344176.0298     610595.7999
             Length:          119.0398  Course:     141-40-05.31
-------------------------------------------------------------------------------
                         Circular Curve Data
TC     0+381.089                                    9344176.0298     610595.7999
CC                                                  9344548.1590     611066.4589
CT     0+476.028                                    9344106.5158     610660.3169
              Delta:       09-03-57.64    Type:             LEFT
             Radius:          600.0000     DOC:      09-32-57.47
             Length:           94.9391 Tangent:          47.5688
            Mid-Ord:            1.8768 External:          1.8827
              Chord:           94.8400  Course:     137-08-06.49
```

MERAK 2

	Es:	1.8827		
PI	0+503.425		9344087.9708	610680.4829
	Tangent Data			
	0+476.028		9344106.5158	610660.3169
	0+503.425		9344087.9708	610680.4829
	Length:	27.3969	Course: 132-36-07.67	

MERAK-2 FLYOVER

Design Speed	(Vr)	:	60	km/hr								
PI-1, Sta			0+180,285	A								
Radii of Curve	(R_r)	:	200	m								
Super Elevation	(e_r)	:	5,5	%	From table RSNI T-14-2004/P29 (to interpolation)							
Horizontal Curve length	(L_{ch})	:	33	m		R_1	200	e_1	5,5	L_{h1}	33	
						R_2	175	e_2	5,8	L_{h2}	35	
Spiral length (Ls)						$(R_1 - R_2)$	25	Δe	-0,3	$(L_{h1} - L_{h2})$	-2	
$Ls=Vr*t/3.6 \rightarrow t=2sec.$			33,33	m								
$Ls=W*\Delta^{-1}*(e_r+e_n)$			38,61	m		Δ	3,6	0,00699	Δ^{-1}	143		
						W	3,6					
Widening (w)			0	m	From table RSNI T-14-2004/P37 (tp interpolation)							
						w_1	0					
						w_2	0					
						(w_1-w_2)	0					

Design Speed	(Vr)	:	60	km/hr								
PI-2, Sta			0+428,657	A								
Radii of Curve	(R_r)	:	600	m								
Super Elevation	(e_r)	:	3,1	%	From table RSNI T-14-2004/P29 (to interpolation)							
Horizontal Curve length	(L_{ch})	:	19	m		R_1	600	e_1	3,1	L_{h1}	19	
						R_2	500	e_2	3,5	L_{h2}	21	
Spiral length (Ls)						$(R_1 - R_2)$	100	Δe	-0,4	$(L_{h1} - L_{h2})$	-2	
$Ls=Vr*t/3.6 \rightarrow t=2sec.$			33,33	m								
$Ls=W*\Delta^{-1}*(e_r+e_n)$			26,25	m		Δ	3,6	0,00699	Δ^{-1}	143		
						W	3,6					
Widening (w)			0	m	From table RSNI T-14-2004/P37 (tp interpolation)							
						w_1	0					
						w_2	0					
						(w_1-w_2)	0					

```
Horizontal Alignment Station and Curve Report.
Alignment: BALARAJA
Desc:
Desc.  Station          Spiral/Curve Data          Northing          Easting
-------------------------------------------------------------------------------

-------------------------------------------------------------------------------
PI     0+069.157                                  9315050.887       661483.335
           Length:          186.401   Course:          38-14-08

-------------------------------------------------------------------------------
PI-1     0+255.558                                  9315197.300       661598.698
           Length:          366.511   Course:          46-51-29
            Delta:          8-37-21
-------------------------------------------------------------------------------
                         Tangent Data
       0+069.157                                  9315050.887       661483.335
       0+210.326                                  9315161.771       661570.704
           Length:          141.169   Course:          38-14-08
-------------------------------------------------------------------------------
                         Circular Curve Data
TC     0+210.326                                  9315161.771       661570.704
RP                                                9314790.433       662041.987
CT     0+300.619                                  9315228.230       661631.702
            Delta:         08-37-21     Type:            RIGHT
           Radius:          600.000      DOC:          09-32-57
           Length:           90.294  Tangent:            45.232
          Mid-Ord:            1.698 External:             1.703
            Chord:           90.208   Course:          42-32-49
               Es:            1.703

-------------------------------------------------------------------------------
PI-2     0+621.898                                  9315447.923       661866.127
           Length:          121.741   Course:         101-16-29
            Delta:         54-25-00
-------------------------------------------------------------------------------
                         Tangent Data
       0+300.619                                  9315228.230       661631.702
       0+561.205                                  9315406.421       661821.842
           Length:          260.586   Course:          46-51-29
-------------------------------------------------------------------------------
                         Spiral Curve Data: CLOTHOID
TS     0+561.205                                  9315406.421       661821.842
SPI                                               9315426.256       661843.008
SC     0+604.525                                  9315432.772       661856.023
           Length:           43.320    L Tan:            29.007
           Radius:           75.000    S Tan:            14.556
            Theta:         16-32-49        P:             1.039
                X:           42.960        K:            21.600
                Y:            4.145        A:            57.000
            Chord:           43.160   Course:          52-22-11
               Ts:           60.693
-------------------------------------------------------------------------------
                         Circular Curve Data
SC     0+604.525                                  9315432.772       661856.023
RP                                                9315365.708       661889.599
SC     0+632.436                                  9315440.391       661882.707
            Delta:         21-19-21     Type:            RIGHT
           Radius:           75.000      DOC:          76-23-40
           Length:           27.911  Tangent:            14.119
          Mid-Ord:            1.295 External:             1.317
            Chord:           27.750   Course:          74-03-59
```

```
                Es:          10.500
------------------------------------------------------------------------------
                        Spiral Curve Data: CLOTHOID
SC      0+632.436                                  9315440.391      661882.707
SPI                                                9315441.728      661897.202
TC      0+675.756                                  9315436.057      661925.649
            Length:         43.320    L Tan:            29.007
            Radius:         75.000    S Tan:            14.556
             Theta:       16-32-49        P:             1.039
                 X:         42.960        K:            21.600
                 Y:          4.145        A:            57.000
             Chord:         43.160   Course:          95-45-47
                Ts:         60.693

------------------------------------------------------------------------------
PI-3      0+736.804                                  9315424.121      661985.519
            Length:        145.195   Course:          99-31-59
             Delta:        1-44-30
------------------------------------------------------------------------------
                        Tangent Data
        0+675.756                                  9315436.057      661925.649
        0+721.604                                  9315427.093      661970.612
            Length:         45.848   Course:         101-16-29
------------------------------------------------------------------------------
                        Circular Curve Data
TC      0+721.604                                  9315427.093      661970.612
RP                                                 9316407.794      662166.126
CT      0+752.002                                  9315421.604      662000.509
             Delta:       01-44-30      Type:             LEFT
            Radius:       1000.000       DOC:          05-43-46
            Length:         30.398   Tangent:           15.200
           Mid-Ord:          0.116  External:            0.116
             Chord:         30.397    Course:        100-24-14
                Es:          0.116

------------------------------------------------------------------------------
PI-4      0+881.998                                  9315400.074      662128.709
            Length:         80.107   Course:          87-20-23
             Delta:       12-11-36
------------------------------------------------------------------------------
                        Tangent Data
        0+752.002                                  9315421.604      662000.509
        0+801.890                                  9315413.341      662049.708
            Length:         49.888   Course:          99-31-59
------------------------------------------------------------------------------
                        Circular Curve Data
TC      0+801.890                                  9315413.341      662049.708
RP                                                 9316152.984      662173.921
CT      0+961.500                                  9315403.792      662208.730
             Delta:       12-11-36      Type:             LEFT
            Radius:        750.000       DOC:          07-38-22
            Length:        159.609   Tangent:           80.107
           Mid-Ord:          4.242  External:            4.266
             Chord:        159.308    Course:         93-26-11
                Es:          4.266

------------------------------------------------------------------------------
PI      0+961.500                                  9315403.792      662208.730
```

BALARAJA FLYOVER

Location		:	Balaraja							
Design Speed	(*Vr*)	:	40	km/hr						
PI-1, Sta			0+255,558							
Radii of Curve	(R_r)	:	600	m						
Super Elevation	(e_r)	:	2	%	From table RSNI T-14-2004/P29 (to interpolation)					
Horizontal Curve length	(L_{ch})	:	10	m	R_1	600	e_1	2	L_{h1}	10
					R_2	600	e_2	2	L_{h2}	10
Spiral length (*Ls*)					(R_1-R_2)	0	Δe	0	$(L_{h1}-L_{h2})$	0
*Ls=Vr*t/3.6 →t=2sec.*			22,22	m						
$Ls=W*\Delta^{-1}*(e_r+e_n)$			20,592	m	Δ	1/143	0,00699	Δ^{-1}	143	
					W	3,6				
Widening (*w*)			0	m	From table RSNI T-14-2004/P37 (to interpolation)					
					w_1	0				
					w_2	0				
					(w_1-w_2)	0				

Design Speed	(*Vr*)	:	40	km/hr						
PI-2, Sta			0+621,898							
Radii of Curve	(R_r)	:	75	m						
Super Elevation	(e_r)	:	5,7	%	From table RSNI T-14-2004/P29 (to interpolation)					
Horizontal Curve length	(L_{ch})	:	29,5	m	R_1	80	e_1	5,6	L_{h1}	29
					R_2	70	e_2	5,8	L_{h2}	30
Spiral length (*Ls*)					(R_1-R_2)	10	Δe	-0,2	$(L_{h1}-L_{h2})$	-1
*Ls=Vr*t/3.6 →t=2sec.*			22,22	m						
$Ls=W*\Delta^{-1}*(e_r+e_n)$			39,6396	m	Δ	1/143	0,00699	Δ^{-1}	143	
					W	3,6				
Widening (*w*)			0,95	m	From table RSNI T-14-2004/P37 (to interpolation)					
					w_1	0,9				
					w_2	1				
					(w_1-w_2)	0,1				

Design Speed	(*Vr*)	:	40	km/hr						
PI-3, Sta			0+736,804							
Radii of Curve	(R_r)	:	1000	m						
Super Elevation	(e_r)	:	2	%	From table RSNI T-14-2004/P29 (to interpolation)					
Horizontal Curve length	(L_{ch})	:	0	m	R_1	1000	e_1	2	L_{h1}	0
					R_2	1000	e_2	2	L_{h2}	0
Spiral length (*Ls*)					(R_1-R_2)	0	Δe	0	$(L_{h1}-L_{h2})$	0
*Ls=Vr*t/3.6 →t=2sec.*			22,22	m						
$Ls=W*\Delta^{-1}*(e_r+e_n)$			20,592	m	Δ	1/143	0,00699	Δ^{-1}	143	
					W	3,6				
Widening (*w*)			0	m	From table RSNI T-14-2004/P37 (to interpolation)					
					w_1	0				
					w_2	0				
					(w_1-w_2)	0				

Design Speed	(*Vr*)	:	40	km/hr
PI-4, Sta			0+881,998	
Radii of Curve	(R_r)	:	750	m

Location		:	Balaraja									
Design Speed	(*Vr*)	:	**40**	km/hr								
Super Elevation	(e_r)	:	2	%	From table RSNI T-14-2004/P29 (to interpolation)							
Horizontal Curve length	(L_{ch})	:	5	m		R_1	800	e_1	2	L_{h1}	0	
						R_2	700	e_2	2	L_{h2}	10	
Spiral length (*Ls*)						(R_1-R_2)	100	Δe	0	$(L_{h1}-L_{h2})$	-10	
Ls=Vr*t/3.6 →t=2sec.			22,22	m								
Ls=WΔ^{-1}*(e_r+e_n)*			20,592	m		Δ	1/143	0,00699	Δ^{-1}	143		
						W	3,6					
Widening (*w*)			0	m	From table RSNI T-14-2004/P37 (to interpolation)							
						w_1	0					
						w_2	0					
						(w_1-w_2)	0					

```
Horizontal Alignment Station and Curve Report.
Alignment: NAGREG
Desc:
Desc.  Station          Spiral/Curve Data           Northing         Easting
-------------------------------------------------------------------------------

-------------------------------------------------------------------------------
PI     0+000                                        9223089.853      818990.710
           Length:          137.950   Course:           119-07-43

-------------------------------------------------------------------------------
PI     0+137.950                                    9223022.703      819111.213
           Length:           72.728   Course:           114-37-55
            Delta:          4-29-48
-------------------------------------------------------------------------------
                        Tangent Data
       0+000                                        9223089.853      818990.710
       0+128.135                                    9223027.481      819102.640
           Length:          128.135   Course:           119-07-43
-------------------------------------------------------------------------------
                        Circular Curve Data
TC     0+128.135                                    9223027.481      819102.640
RP                                                  9223245.863      819224.332
CT     0+147.755                                    9223018.612      819120.135
            Delta:         04-29-48      Type:             LEFT
           Radius:          250.000       DOC:          22-55-06
           Length:           19.620   Tangent:             9.815
          Mid-Ord:            0.192  External:             0.193
            Chord:           19.615    Course:          116-52-49
               Es:            0.193

-------------------------------------------------------------------------------
PI     0+210.668                                    9222992.391      819177.324
           Length:          197.722   Course:            98-26-43
            Delta:         16-11-12
-------------------------------------------------------------------------------
                        Tangent Data
       0+147.755                                    9223018.612      819120.135
       0+168.007                                    9223010.171      819138.545
           Length:           20.253   Course:           114-37-55
-------------------------------------------------------------------------------
                        Circular Curve Data
TC     0+168.007                                    9223010.171      819138.545
RP                                                  9223282.872      819263.582
CT     0+252.760                                    9222986.125      819219.522
            Delta:         16-11-12      Type:             LEFT
           Radius:          300.000       DOC:          19-05-55
           Length:           84.753   Tangent:            42.661
          Mid-Ord:            2.988  External:             3.018
            Chord:           84.472    Course:          106-32-19
               Es:            3.018

-------------------------------------------------------------------------------
PI     0+407.821                                    9222963.352      819372.901
           Length:           62.866   Course:           112-46-40
            Delta:         14-19-57
-------------------------------------------------------------------------------
                        Tangent Data
       0+252.760                                    9222986.125      819219.522
       0+344.956                                    9222972.585      819310.717
           Length:           92.195   Course:            98-26-43
-------------------------------------------------------------------------------
```

Circular Curve Data

TC	0+344.956				9222972.585	819310.717
RP					9222478.007	819237.284
CT	0+470.031				9222939.013	819430.865
		Delta:	14-19-57	Type:	RIGHT	
		Radius:	500.000	DOC:	11-27-33	
		Length:	125.075	Tangent:	62.866	
		Mid-Ord:	3.906	External:	3.937	
		Chord:	124.749	Course:	105-36-42	
		Es:	3.937			

PI	0+470.031				9222939.013	819430.865
		Length:	41.290	Course:	112-46-40	
		Delta:	0-00-00			

PI	0+511.321				9222923.027	819468.934
		Length:	36.811	Course:	112-46-40	
		Delta:	0-00-00			

Tangent Data

	0+470.031				9222939.013	819430.865
	0+511.321				9222923.027	819468.934
		Length:	41.290	Course:	112-46-40	

PI	0+548.132				9222908.776	819502.875
		Length:	36.811	Course:	96-15-17	
		Delta:	16-31-23			

Spiral Curve Data: CLOTHOID

TS	0+511.321				9222923.027	819468.934
SPI					9222915.280	819487.384
SC	0+541.321				9222912.346	819496.954
		Length:	30.000	L Tan:	20.010	
		Radius:	150.000	S Tan:	10.010	
		Theta:	5-43-46	P:	0.250	
		X:	29.970	K:	14.995	
		Y:	0.999	A:	67.082	
		Chord:	29.987	Course:	110-52-06	
		Ts:	36.811			

Circular Curve Data

SC	0+541.321				9222912.346	819496.954
RP					9223055.754	819540.931
SC	0+554.578				9222909.024	819509.784
		Delta:	05-03-50	Type:	LEFT	
		Radius:	150.000	DOC:	38-11-50	
		Length:	13.257	Tangent:	6.633	
		Mid-Ord:	0.146	External:	0.147	
		Chord:	13.253	Course:	104-30-59	
		Es:	1.825			

Spiral Curve Data: CLOTHOID

SC	0+554.578				9222909.024	819509.784
SPI					9222906.945	819519.575
TC	0+584.578				9222904.765	819539.467
		Length:	30.000	L Tan:	20.010	
		Radius:	150.000	S Tan:	10.010	
		Theta:	5-43-46	P:	0.250	
		X:	29.970	K:	14.995	
		Y:	0.999	A:	67.082	

```
                                   NAGREG
           Chord:           29.987  Course:         98-09-52
              Ts:           36.811

--------------------------------------------------------------------------------
PI     0+584.578                           9222904.765       819539.467
          Length:            7.046  Course:         96-15-18
           Delta:         0-00-00

--------------------------------------------------------------------------------
PI     0+591.624                           9222903.997       819546.471
          Length:           76.869  Course:         96-15-17
           Delta:         0-00-00
--------------------------------------------------------------------------------
                         Tangent Data
       0+584.578                           9222904.765       819539.467
       0+591.624                           9222903.997       819546.471
          Length:            7.046  Course:         96-15-18

--------------------------------------------------------------------------------
PI     0+668.494                           9222895.622       819622.883
          Length:          212.990  Course:        134-12-33
           Delta:        37-57-15
--------------------------------------------------------------------------------
                         Spiral Curve Data: CLOTHOID
TS     0+591.624                           9222903.997       819546.471
SPI                                        9222901.090       819572.999
SC     0+631.624                           9222898.041       819585.998
          Length:           40.000   L Tan:           26.687
          Radius:          165.000   S Tan:           13.352
           Theta:          6-56-42       P:            0.404
               X:           39.941       K:           19.990
               Y:            1.614       A:           81.240
           Chord:           39.974  Course:         98-34-10
              Ts:           76.869
--------------------------------------------------------------------------------
                         Circular Curve Data
SC     0+631.624                           9222898.041       819585.998
RP                                         9222737.400       819548.321
SC     0+700.925                           9222868.716       819648.227
           Delta:         24-03-52    Type:            RIGHT
          Radius:          165.000     DOC:         34-43-29
          Length:           69.300 Tangent:           35.169
         Mid-Ord:            3.625 External:           3.706
           Chord:           68.792  Course:        115-13-55
              Es:            9.910
--------------------------------------------------------------------------------
                         Spiral Curve Data: CLOTHOID
SC     0+700.925                           9222868.716       819648.227
SPI                                        9222860.631       819658.853
TC     0+740.925                           9222842.023       819677.983
          Length:           40.000   L Tan:           26.687
          Radius:          165.000   S Tan:           13.352
           Theta:          6-56-42       P:            0.404
               X:           39.941       K:           19.990
               Y:            1.614       A:           81.240
           Chord:           39.974  Course:        131-53-40
              Ts:           76.869

--------------------------------------------------------------------------------
PI     0+877.045                           9222747.109       819775.554
          Length:          141.308  Course:        150-53-10
           Delta:         16-40-37
--------------------------------------------------------------------------------
```

```
                       Tangent Data
      0+740.925                                    9222842.023        819677.983
      0+825.746                                    9222782.879        819738.782
           Length:              84.821   Course:         134-12-33
---------------------------------------------------------------------------------
                       Circular Curve Data
TC    0+825.746                                    9222782.879        819738.782
RP                                                 9222531.999        819494.735
CT    0+927.619                                    9222702.291        819800.514
            Delta:           16-40-37      Type:             RIGHT
           Radius:            350.000       DOC:          16-22-13
           Length:            101.874  Tangent:             51.299
          Mid-Ord:              3.700 External:              3.740
            Chord:            101.514    Course:         142-32-51
               Es:              3.740

---------------------------------------------------------------------------------
PI    1+017.628                                    9222623.654        819844.307
           Length:             33.148    Course:         145-12-42
            Delta:            5-40-28
---------------------------------------------------------------------------------
                       Tangent Data
      0+927.619                                    9222702.291        819800.514
      0+992.849                                    9222645.303        819832.251
           Length:             65.229    Course:         150-53-10
---------------------------------------------------------------------------------
                       Circular Curve Data
TC    0+992.849                                    9222645.303        819832.251
RP                                                 9222888.577        820269.078
CT    1+042.367                                    9222603.304        819858.445
            Delta:           05-40-28      Type:              LEFT
           Radius:            500.000       DOC:          11-27-33
           Length:             49.518  Tangent:             24.779
          Mid-Ord:              0.613 External:              0.614
            Chord:             49.498    Course:         148-02-56
               Es:              0.614

---------------------------------------------------------------------------------
PI    1+050.736                                    9222596.431        819863.220
           Length:             10.000    Course:         144-06-21
            Delta:            1-06-21
---------------------------------------------------------------------------------
                       Tangent Data
      1+042.367                                    9222603.304        819858.445
      1+050.736                                    9222596.431        819863.220
           Length:              8.368    Course:         145-12-42

---------------------------------------------------------------------------------
PI    1+060.735                                    9222588.330        819869.083
           Length:             10.000    Course:         143-52-21
            Delta:            0-13-59
---------------------------------------------------------------------------------
                       Tangent Data
      1+050.736                                    9222596.431        819863.220
      1+060.735                                    9222588.330        819869.083
           Length:             10.000    Course:         144-06-21

---------------------------------------------------------------------------------
PI    1+070.735                                    9222580.253        819874.978
           Length:             10.000    Course:         143-04-18
            Delta:            0-48-03
---------------------------------------------------------------------------------
                       Tangent Data
```

```
      1+060.735                                  9222588.330       819869.083
      1+070.735                                  9222580.253       819874.978
          Length:          10.000    Course:         143-52-21

-------------------------------------------------------------------------------
PI    1+080.735                                  9222572.259       819880.986
          Length:          10.000    Course:         141-57-53
           Delta:         1-06-25
-------------------------------------------------------------------------------
                    Tangent Data
      1+070.735                                  9222580.253       819874.978
      1+080.735                                  9222572.259       819880.986
          Length:          10.000    Course:         143-04-18

-------------------------------------------------------------------------------
PI    1+090.735                                  9222564.383       819887.148
          Length:           9.999    Course:         140-59-32
           Delta:         0-58-21
-------------------------------------------------------------------------------
                    Tangent Data
      1+080.735                                  9222572.259       819880.986
      1+090.735                                  9222564.383       819887.148
          Length:          10.000    Course:         141-57-53

-------------------------------------------------------------------------------
PI    1+100.734                                  9222556.614       819893.441
          Length:           9.999    Course:         140-46-09
           Delta:         0-13-23
-------------------------------------------------------------------------------
                    Tangent Data
      1+090.735                                  9222564.383       819887.148
      1+100.734                                  9222556.614       819893.441
          Length:           9.999    Course:         140-59-32

-------------------------------------------------------------------------------
PI    1+110.733                                  9222548.868       819899.765
          Length:           9.996    Course:         139-48-29
           Delta:         0-57-40
-------------------------------------------------------------------------------
                    Tangent Data
      1+100.734                                  9222556.614       819893.441
      1+110.733                                  9222548.868       819899.765
          Length:           9.999    Course:         140-46-09

-------------------------------------------------------------------------------
PI    1+120.729                                  9222541.232       819906.216
          Length:          10.000    Course:         138-06-00
           Delta:         1-42-29
-------------------------------------------------------------------------------
                    Tangent Data
      1+110.733                                  9222548.868       819899.765
      1+120.729                                  9222541.232       819906.216
          Length:           9.996    Course:         139-48-29

-------------------------------------------------------------------------------
PI    1+130.729                                  9222533.789       819912.894
          Length:           9.996    Course:         137-36-00
           Delta:         0-30-00
-------------------------------------------------------------------------------
                    Tangent Data
      1+120.729                                  9222541.232       819906.216
      1+130.729                                  9222533.789       819912.894
          Length:          10.000    Course:         138-06-00
```

```
--------------------------------------------------------------------------------
PI      1+140.725                                9222526.408        819919.635
           Length:             9.999   Course:          133-41-41
            Delta:           3-54-19
--------------------------------------------------------------------------------
                         Tangent Data
        1+130.729                                9222533.789        819912.894
        1+140.725                                9222526.408        819919.635
           Length:             9.996   Course:          137-36-00

--------------------------------------------------------------------------------
PI      1+150.724                                9222519.501        819926.864
           Length:            10.000   Course:          132-17-27
            Delta:           1-24-14
--------------------------------------------------------------------------------
                         Tangent Data
        1+140.725                                9222526.408        819919.635
        1+150.724                                9222519.501        819926.864
           Length:             9.999   Course:          133-41-41

--------------------------------------------------------------------------------
PI      1+160.724                                9222512.772        819934.261
           Length:             4.796   Course:          132-03-06
            Delta:           0-14-21
--------------------------------------------------------------------------------
                         Tangent Data
        1+150.724                                9222519.501        819926.864
        1+160.724                                9222512.772        819934.261
           Length:            10.000   Course:          132-17-27

--------------------------------------------------------------------------------
PI      1+165.520                                9222509.559        819937.823
--------------------------------------------------------------------------------
                         Tangent Data
        1+160.724                                9222512.772        819934.261
        1+165.520                                9222509.559        819937.823
           Length:             4.796   Course:          132-03-06
```

NAGREG FLYOVER

Location		:	Nagreg							
Design Speed	(Vr)	:	**50**	km/hr						
PI-1, Sta			0+137,950							
Radii of Curve	(R_r)	:	250	m						
Super Elevation	(e_r)	:	4,2	%	From table RSNI T-14-2004/P29 (to interpolation)					
Horizontal Curve length	(L_{ch})	:	23	m	R_1	250	e_1	4,2	L_{h1}	23
					R_2	175	e_2	4,7	L_{h2}	26
Spiral length (Ls)					$(R_1\text{-}R_2)$	75	Δe	-0,5	$(L_{h1}\text{-}L_{h2})$	-3
$Ls=Vr*t/3.6 \rightarrow t=2sec.$			27,778	m						
$Ls=W*\Delta^{-1}*(e_r+e_n)$			33,480	m	Δ	1/150	0	Δ^{-1}	150	
					W	4				
Widening (w)			0,100	m	From table RSNI T-14-2004/P37 (to interpolation)					
					w_1	0				
					w_2	0				
					$(w_1\text{-}w_2)$	0				
Design Speed	(Vr)	:	**50**	km/hr						
PI-2, Sta			0+210,668							
Radii of Curve	(R_r)	:	300	m						
Super Elevation	(e_r)	:	3,9	%	From table RSNI T-14-2004/P29 (to interpolation)					
Horizontal Curve length	(L_{ch})	:	22	m	R_1	300	e_1	3,9	L_{h1}	22
					R_2	250	e_2	4,2	L_{h2}	23
Spiral length (Ls)					$(R_1\text{-}R_2)$	50	Δe	-0,3	$(L_{h1}\text{-}L_{h2})$	-1
$Ls=Vr*t/3.6 \rightarrow t=2sec.$			27,778	m						
$Ls=W*\Delta^{-1}*(e_r+e_n)$			31,860	m	Δ	1/150	0	Δ^{-1}	150	
					W	4				
Widening (w)			0,000	m	From table RSNI T-14-2004/P37 (to interpolation)					
					w_1	0				
					w_2	0				
					$(w_1\text{-}w_2)$	0				
Design Speed	(Vr)	:	**50**	km/hr						
PI-3, Sta			0+407,821							
Radii of Curve	(R_r)	:	500	m						
Super Elevation	(e_r)	:	2,8	%	From table RSNI T-14-2004/P29 (to interpolation)					
Horizontal Curve length	(L_{ch})	:	15	m	R_1	500	e_1	2,8	L_{h1}	15
					R_2	400	e_2	3,3	L_{h2}	18
Spiral length (Ls)					$(R_1\text{-}R_2)$	100	Δe	-0,5	$(L_{h1}\text{-}L_{h2})$	-3
$Ls=Vr*t/3.6 \rightarrow t=2sec.$			27,778	m						
$Ls=W*\Delta^{-1}*(e_r+e_n)$			25,920	m	Δ	1/150	0	Δ^{-1}	150	
					W	4				
Widening (w)			0,000	m	From table RSNI T-14-2004/P37 (to interpolation)					
					w_1	0				
					w_2	0				
					$(w_1\text{-}w_2)$	0				
Design Speed	(Vr)	:	**50**	km/hr						
PI-4, Sta			0+548,132							
Radii of Curve	(R_r)	:	150	m						
Super Elevation	(e_r)	:	5,3	%	From table RSNI T-14-2004/P29 (to interpolation)					
Horizontal Curve length	(L_{ch})	:	29	m	R_1	150	e_1	5,3	L_{h1}	29
					R_2	140	e_2	5,4	L_{h2}	30

Location		:	Nagreg							
Design Speed	(*Vr*)	:	**50**	km/hr						
Spiral length (*Ls*)					(R_1-R_2)	10	Δe	-0,1	$(L_{h1}-L_{h2})$	-1
Ls=Vr*t/3.6 →t=2sec.			27,778	m						
$Ls=W*\Delta^{-1}*(e_r+e_n)$			39,420	m	Δ	1/150	0	Δ^{-1}	150	
					W	4				
Widening (*w*)			0,000	m	From table RSNI T-14-2004/P37 (to interpolation)					
					w_1	0				
					w_2	0				
					(w_1-w_2)	0				
Design Speed	(*Vr*)	:	**50**	km/hr						
PI-5, Sta			0+668,494							
Radii of Curve	(R_r)	:	165	m						
Super Elevation	(e_r)	:	5,1	%	From table RSNI T-14-2004/P29 (to interpolation)					
Horizontal Curve length	(L_{ch})	:	28,4	m	R_1	175	e_1	5,0	L_{h1}	28
					R_2	150	e_2	5,3	L_{h2}	29
Spiral length (*Ls*)					(R_1-R_2)	25	Δe	-0,3	$(L_{h1}-L_{h2})$	-1
Ls=Vr*t/3.6 →t=2sec.			27,778	m						
$Ls=W*\Delta^{-1}*(e_r+e_n)$			38,448	m	Δ	1/150	0	Δ^{-1}	150	
					W	4				
Widening (*w*)			0,000	m	From table RSNI T-14-2004/P37 (tp interpolation)					
					w_1	0				
					w_2	0				
					(w_1-w_2)	0				
Design Speed	(*Vr*)	:	**50**	km/hr						
PI-6, Sta			0+877,045							
Radii of Curve	(R_r)	:	350	m						
Super Elevation	(e_r)	:	3,6	%	From table RSNI T-14-2004/P29 (to interpolation)					
Horizontal Curve length	(L_{ch})	:	20	m	R_1	400	e_1	3,3	L_{h1}	18
					R_2	300	e_2	3,9	L_{h2}	22
Spiral length (*Ls*)					(R_1-R_2)	100	Δe	-0,6	$(L_{h1}-L_{h2})$	-4
Ls=Vr*t/3.6 →t=2sec.			27,778	m						
$Ls=W*\Delta^{-1}*(e_r+e_n)$			30,240	m	Δ	1/150	0	Δ^{-1}	150	
					W	4				
Widening (*w*)			0,000	m	From table RSNI T-14-2004/P37 (to interpolation)					
					w_1	0				
					w_2	0				
					(w_1-w_2)	0				
Design Speed	(*Vr*)	:	**40**	km/hr						
PI-7, Sta			1+017,628							
Radii of Curve	(R_r)	:	500	m						
Super Elevation	(e_r)	:	2,1	%	From table RSNI T-14-2004/P29 (to interpolation)					
Horizontal Curve length	(L_{ch})	:	11	m	R_1	500	e_1	2	L_{h1}	11
					R_2	400	e_2	3	L_{h2}	13
Spiral length (*Ls*)					(R_1-R_2)	100	Δe	0	$(L_{h1}-L_{h2})$	-2
Ls=Vr*t/3.6 →t=2sec.			22,222	m						
$Ls=W*\Delta^{-1}*(e_r+e_n)$			22,140	m	Δ	1/150	0	Δ^{-1}	150	
					W	4				
Widening (*w*)			0,000	m	From table RSNI T-14-2004/P37 (to interpolation)					
					w_1	0				

Location		:	Nagreg			
Design Speed	(*Vr*)	:	50	km/hr		
					w_2	0
					(w_1-w_2)	0

GEBANG

```
Horizontal Alignment Station and Curve Report.
Alignment: GEBANG
Desc:
Desc.  Station        Spiral/Curve Data          Northing        Easting
---------------------------------------------------------------------------

---------------------------------------------------------------------------
PI     0+000                                  9245903.4971    248317.9459
           Length:             61.500   Course:       91-04-46

---------------------------------------------------------------------------
PI     0+061.500                              9245902.3385    248379.4351
           Length:            229.228   Course:      104-25-05
            Delta:           13-20-19
---------------------------------------------------------------------------
                          Tangent Data
       0+000                                  9245903.4971    248317.9459
       0+003.035                              9245903.4400    248320.9802
           Length:              3.035   Course:       91-04-46
---------------------------------------------------------------------------
                          Circular Curve Data
TC     0+003.035                              9245903.4400    248320.9802
RP                                            9245403.5287    248311.5604
CT     0+119.437                              9245887.7808    248436.0589
            Delta:           13-20-19     Type:          RIGHT
           Radius:            500.000      DOC:       11-27-33
           Length:            116.402  Tangent:         58.465
         Mid-Ord:              3.384 External:          3.407
            Chord:            116.139   Course:       97-44-56
               Es:              3.407

---------------------------------------------------------------------------
PI     0+290.199                              9245845.2615    248601.4432
           Length:            134.001   Course:      102-10-09
            Delta:            2-14-56
---------------------------------------------------------------------------
                          Tangent Data
       0+119.437                              9245887.7808    248436.0589
       0+237.203                              9245858.4573    248550.1164
           Length:            117.767   Course:      104-25-05
---------------------------------------------------------------------------
                          Circular Curve Data
TC     0+237.203                              9245858.4573    248550.1164
RP                                            9248473.4188    249222.4083
CT     0+343.182                              9245834.0899    248653.2483
            Delta:           02-14-56     Type:           LEFT
           Radius:           2700.000      DOC:       02-07-19
           Length:            105.978  Tangent:         52.996
         Mid-Ord:              0.520 External:          0.520
            Chord:            105.971   Course:      103-17-37
               Es:              0.520

---------------------------------------------------------------------------
PI     0+424.187                              9245817.0139    248732.4336
           Length:            234.433   Course:      106-13-32
            Delta:            4-03-23
---------------------------------------------------------------------------
                          Tangent Data
       0+343.182                              9245834.0899    248653.2483
       0+371.068                              9245828.2115    248680.5079
           Length:             27.886   Course:      102-10-09
---------------------------------------------------------------------------
```

GEBANG

Circular Curve Data

```
TC      0+371.068                              9245828.2115      248680.5079
RP                                             9244361.9177      248364.3079
CT      0+477.262                              9245802.1714      248783.4372
             Delta:        04-03-23     Type:            RIGHT
            Radius:        1500.000      DOC:         03-49-11
            Length:         106.194  Tangent:           53.119
           Mid-Ord:           0.940 External:            0.940
             Chord:         106.172   Course:        104-11-51
                Es:           0.940

-------------------------------------------------------------------------------
PI      0+658.576                              9245751.5087      248957.5291
            Length:         180.687   Course:        111-24-45
             Delta:         5-11-13
-------------------------------------------------------------------------------
```

Tangent Data

```
        0+477.262                              9245802.1714      248783.4372
        0+604.222                              9245766.6963      248905.3400
            Length:         126.960   Course:        106-13-32
-------------------------------------------------------------------------------
```

Circular Curve Data

```
TC      0+604.222                              9245766.6963      248905.3400
RP                                             9244614.4934      248570.0366
CT      0+712.856                              9245731.6652      249008.1315
             Delta:        05-11-13     Type:            RIGHT
            Radius:        1200.000      DOC:         04-46-29
            Length:         108.634  Tangent:           54.354
           Mid-Ord:           1.229 External:            1.230
             Chord:         108.597   Course:        108-49-08
                Es:           1.230

-------------------------------------------------------------------------------
PI      0+839.188                              9245685.5438      249125.7441
            Length:         175.769   Course:        112-57-22
             Delta:         1-32-38
-------------------------------------------------------------------------------
```

Tangent Data

```
        0+712.856                              9245731.6652      249008.1315
        0+785.297                              9245705.2186      249075.5721
            Length:          72.441   Course:        111-24-45
-------------------------------------------------------------------------------
```

Circular Curve Data

```
TC      0+785.297                              9245705.2186      249075.5721
RP                                             9241981.3126      247615.2557
CT      0+893.074                              9245664.5245      249175.3679
             Delta:        01-32-38     Type:            RIGHT
            Radius:        4000.000      DOC:         01-25-57
            Length:         107.777  Tangent:           53.892
           Mid-Ord:           0.363 External:            0.363
             Chord:         107.774   Course:        112-11-04
                Es:           0.363

-------------------------------------------------------------------------------
PI      1+014.951                              9245616.9888      249287.5931
            Length:         127.761   Course:        113-42-50
             Delta:         0-45-28
-------------------------------------------------------------------------------
```

Tangent Data

```
        0+893.074                              9245664.5245      249175.3679
        0+988.500                              9245627.3054      249263.2371
            Length:          95.427   Course:        112-57-22
-------------------------------------------------------------------------------
```

GEBANG

Circular Curve Data

TC	0+988.500				9245627.3054	249263.2371
RP					9241944.0935	247703.1249
CT	1+041.401				9245606.3511	249311.8105
	Delta:	00-45-28	Type:	RIGHT		
	Radius:	4000.000	DOC:	01-25-57		
	Length:	52.901	Tangent:	26.451		
	Mid-Ord:	0.087	External:	0.087		
	Chord:	52.900	Course:	113-20-06		
	Es:	0.087				

PI	1+142.711	9245565.6071	249404.5663

Tangent Data

1+041.401			9245606.3511	249311.8105
1+142.711			9245565.6071	249404.5663
Length:	101.310	Course:	113-42-50	

Page 3

GEBANG FLYOVER

Location		:	Gebang							
Design Speed	(Vr)	:	**40**	km/hr						
PI-1, Sta			0+061,50							
Radii of Curve	(R_r)	:	500	m						
Super elevation	(e_r)	:	2,1	%	From table RSNI T-14-2004/P29 (to interpolation)					
Horizontal Curve length	(L_{ch})	:	11	m	R_1	500	e_1	2,1	L_{h1}	11
					R_2	400	e_2	2,5	L_{h2}	13
Spiral length (Ls)					$(R_1\text{-}R_2)$	100	Δe	-0,4	$(L_{h1}\text{-}L_{h2})$	-2
$Ls=Vr^*t/3.6 \rightarrow t=2sec.$			22,222	m						
$Ls=W^*\Delta^{-1}{}^*(e_r+e_n)$			29,520	m	Δ	1/200	0,005	Δ^{-1}	200	
					W	3,6				
Widening (w)			0	m	From table RSNI T-14-2004/P37 (to interpolation)					
					w_1	0				
					w_2	0				
					$(w_1\text{-}w_2)$	0				

Design Speed	(Vr)	:	**60**	km/hr						
PI-2, Sta			0+290,199							
Radii of Curve	(R_r)	:	2700	m						
Super elevation	(e_r)	:	2	%	From table RSNI T-14-2004/P29 (to interpolation)					
Horizontal Curve length	(L_{ch})	:	0	m	R_1	3000	e_1	2	L_{h1}	0
					R_2	2500	e_2	2	L_{h2}	0
Spiral length (Ls)					$(R_1\text{-}R_2)$	500	Δe	0	$(L_{h1}\text{-}L_{h2})$	0
$Ls=Vr^*t/3.6 \rightarrow t=2sec.$			33,333	m						
$Ls=W^*\Delta^{-1}{}^*(e_r+e_n)$			28,800	m	Δ	1/200	0,005	Δ^{-1}	200	
					W	3,6				
Widening (w)			0	m	From table RSNI T-14-2004/P37 (to interpolation)					
					w_1	0				
					w_2	0				
					$(w_1\text{-}w_2)$	0				

Design Speed	(Vr)	:	**60**	km/hr						
PI-3, Sta			0+424,187							
Radii of Curve	(R_r)	:	1500	m						
Super elevation	(e_r)	:	2	%	From table RSNI T-14-2004/P29 (to interpolation)					
Horizontal Curve length	(L_{ch})	:	0	m	R_1	1500	e_1	NC	L_{h1}	0
					R_2	1500	e_2	NC	L_{h2}	0
Spiral length (Ls)					$(R_1\text{-}R_2)$	0	Δe	0	$(L_{h1}\text{-}L_{h2})$	0
$Ls=Vr^*t/3.6 \rightarrow t=2sec.$			33,333	m						
$Ls=W^*\Delta^{-1}{}^*(e_r+e_n)$			28,800	m	Δ	1/200	0,005	Δ^{-1}	200	
					W	3,6				
Widening (w)			0	m	From table RSNI T-14-2004/P37 (to interpolation)					
					w_1	0				
					w_2	0				
					$(w_1\text{-}w_2)$	0				

Design Speed	(Vr)	:	**60**	km/hr
PI-4, Sta			0+658,576	
Radii of Curve	(R_r)	:	1200	m

Location		:	Gebang							
Design Speed	(Vr)	:	40	km/hr						
Super elevation	(e_r)	:	2	%	From table RSNI T-14-2004/P29 (to interpolation)					
Horizontal Curve length	(L_{ch})	:	12	m	R_1	1200	e_1	RC	L_{h1}	12
					R_2	1200	e_2	RC	L_{h2}	12
Spiral length (Ls)					$(R_1$-$R_2)$	0	Δe	0	$(L_{h1}$-$L_{h2})$	0
$Ls=Vr*t/3.6 \rightarrow t=2sec.$			33,333	m						
$Ls=W*\Delta^{-1}*(e_r+e_n)$			28,800	m	Δ	1/200	0,005	Δ^{-1}	200	
					W	3,6				
Widening (w)			0	m	From table RSNI T-14-2004/P37 (tp interpolation)					
					w_1	0				
					w_2	0				
					(w_1-w_2)	0				

Design Speed	(Vr)	:	60	km/hr						
PI-5, Sta			0+839,188							
Radii of Curve	(R_r)	:	4000	m						
Super elevation	(e_r)	:	2	%	From table RSNI T-14-2004/P29 (to interpolation)					
Horizontal Curve length	(L_{ch})	:	0	m	R_1	4000	e_1	NC	L_{h1}	0
					R_2	4000	e_2	NC	L_{h2}	0
Spiral length (Ls)					$(R_1$-$R_2)$	0	Δe	0	$(L_{h1}$-$L_{h2})$	0
$Ls=Vr*t/3.6 \rightarrow t=2sec.$			33,333	m						
$Ls=W*\Delta^{-1}*(e_r+e_n)$			28,800	m	Δ	1/200	0,005	Δ^{-1}	200	
					W	3,6				
Widening (w)			0	m	From table RSNI T-14-2004/P37 (tp interpolation)					
					w_1	0				
					w_2	0				
					(w_1-w_2)	0				

Design Speed	(Vr)	:	40	km/hr						
PI-6, Sta			1+014,951							
Radii of Curve	(R_r)	:	4000	m						
Super elevation	(e_r)	:	2	%	From table RSNI T-14-2004/P29 (to interpolation)					
Horizontal Curve length	(L_{ch})	:	0	m	R_1	6000	e_1	2	L_{h1}	0
$Lh=0.278*Vr*t \rightarrow t=6sec.$		:	66,72	m	R_2	3000	e_2	2	L_{h2}	0
Spiral length (Ls)					$(R_1$-$R_2)$	3000	Δe	0	$(L_{h1}$-$L_{h2})$	0
$Ls=Vr*t/3.6 \rightarrow t=2sec.$			22,222	m						
$Ls=W*\Delta^{-1}*(e_r+e_n)$			28,800	m	Δ	1/200	0,005	Δ^{-1}	200	
					W	3,6				
Widening (w)			0	m	From table RSNI T-14-2004/P37 (tp interpolation)					
					w_1	0				
					w_2	0				
					(w_1-w_2)	0				

PETERONGAN

```
Horizontal Alignment Station and Curve Report.
Alignment: FO-01MEI
Desc: PETERONGAN FO
Desc.  Station          Spiral/Curve Data           Northing          Easting
--------------------------------------------------------------------------------

--------------------------------------------------------------------------------
PI     -0+020.471                                   9166445.992       640936.098
            Length:              112.194   Course:        109-29-35

--------------------------------------------------------------------------------
PI     0+091.723                                    9166408.554       641041.861
            Length:              418.897   Course:        116-44-01
             Delta:              7-14-26
--------------------------------------------------------------------------------
                        Tangent Data
       -0+020.471                                   9166445.992       640936.098
       -0+003.182                                   9166440.223       640952.396
            Length:               17.289   Course:        109-29-35
--------------------------------------------------------------------------------
                        Circular Curve Data
TC     -0+003.182                                   9166440.223       640952.396
CC                                                  9165026.199       640451.860
CT     0+186.375                                    9166365.862       641126.621
             Delta:             07-14-26      Type:           RIGHT
            Radius:             1500.000       DOC:        03-49-11
            Length:              189.557   Tangent:          94.905
          Mid-Ord:                 2.993  External:           2.999
             Chord:              189.431    Course:       113-06-48
                Es:                2.999

--------------------------------------------------------------------------------
PI-2     0+510.367                                    9166220.117       641415.981
            Length:              201.494   Course:        126-31-17
             Delta:              9-47-16
--------------------------------------------------------------------------------
                        Tangent Data
       0+186.375                                    9166365.862       641126.621
       0+441.868                                    9166250.931       641354.804
            Length:              255.492   Course:        116-44-01
--------------------------------------------------------------------------------
                        Circular Curve Data
TC     0+441.868                                    9166250.931       641354.804
CC                                                  9165536.444       640994.931
CT     0+578.533                                    9166179.352       641471.029
             Delta:             09-47-16      Type:           RIGHT
            Radius:              800.000       DOC:        07-09-43
            Length:              136.665   Tangent:          68.499
          Mid-Ord:                 2.917  External:           2.927
             Chord:              136.499    Course:       121-37-39
                Es:                2.927

--------------------------------------------------------------------------------
PI-3     0+711.528                                    9166100.203       641577.909
            Length:              238.040   Course:        131-39-55
             Delta:              5-08-38
--------------------------------------------------------------------------------
                        Tangent Data
       0+578.533                                    9166179.352       641471.029
       0+666.608                                    9166126.936       641541.810
            Length:               88.076   Course:        126-31-17
--------------------------------------------------------------------------------
```

PETERONGAN

Circular Curve Data

TC	0+666.608			9166126.936	641541.810
CC				9165323.301	640946.687
CT	0+756.387			9166070.342	641611.465
	Delta:	05-08-38	Type:	RIGHT	
	Radius:	1000.000	DOC:	05-43-46	
	Length:	89.779	Tangent:	44.920	
	Mid-Ord:	1.007	External:	1.008	
	Chord:	89.749	Course:	129-05-36	
	Es:	1.008			

PI	0+949.507			9165941.959	641755.734

Tangent Data

0+756.387			9166070.342	641611.465
0+949.507			9165941.959	641755.734
Length:	193.120	Course:	131-39-55	

Page 2

PETERONGAN FLYOVER

Location		:	Peterongan								
Design Speed	(*Vr*)	:	40	km/hr							
PI-1, Sta			0+091,723								
Radii of Curve	(R_r)	:	1500	m							
Super Elevation	(e_r)	:	2	%	From table RSNI T-14-2004/P29 (to interpolation)						
Horizontal Curve length	(L_{ch})	:	0	m	R_1	1500	e_1	2	L_{h1}	0	
					R_2	1400	e_2	2	L_{h2}	0	
Spiral length (*Ls*)					$(R_1\text{-}R_2)$	100	Δe	0	$(L_{h1}\text{-}L_{h2})$	0	
$Ls=Vr*t/3.6 \rightarrow t=2sec.$			22,222	m							
$Ls=W*\Delta^{-1}*(e_r+e_n)$			24,048	m	Δ	1/167	0,00599	Δ^{-1}	167		
					W	3,6					
Widening (*w*)			0	m	From table RSNI T-14-2004/P37 (to interpolation)						
					w_1	0					
					w_2	0					
					$(w_1\text{-}w_2)$	0					

Design Speed	(*Vr*)	:	60	km/hr						
PI-2, Sta			0+510,367							
Radii of Curve	(R_r)	:	800	m						
Super Elevation	(e_r)	:	2,5	%	From table RSNI T-14-2004/P29 (to interpolation)					
Horizontal Curve length	(L_{ch})	:	15	m	R_1	800	e_1	2,5	L_{h1}	15
					R_2	800	e_2	2,5	L_{h2}	15
Spiral length (*Ls*)					$(R_1\text{-}R_2)$	0	Δe	0	$(L_{h1}\text{-}L_{h2})$	0
$Ls=Vr*t/3.6 \rightarrow t=2sec.$			33,333	m						
$Ls=W*\Delta^{-1}*(e_r+e_n)$			27,054	m	Δ	1/167	0,00599	Δ^{-1}	167	
					W	3,6				
Widening (*w*)			0	m	From table RSNI T-14-2004/P37 (to interpolation)					
					w_1	0				
					w_2	0				
					$(w_1\text{-}w_2)$	0				

Design Speed	(*Vr*)	:	60	km/hr						
PI-3, Sta			0+711,528							
Radii of Curve	(R_r)	:	1000	m						
Super Elevation	(e_r)	:	2,1	%	From table RSNI T-14-2004/P29 (to interpolation)					
Horizontal Curve length	(L_{ch})	:	13	m	R_1	1000	e_1	2,1	L_{h1}	13
					R_2	1000	e_2	2,1	L_{h2}	13
Spiral length (*Ls*)					$(R_1\text{-}R_2)$	0	Δe	0	$(L_{h1}\text{-}L_{h2})$	0
$Ls=Vr*t/3.6 \rightarrow t=2sec.$			33,33	m						
$Ls=W*\Delta^{-1}*(e_r+e_n)$			24,6492	m	Δ	1/167	0,00599	Δ^{-1}	167	
					W	3,6				
Widening (*w*)			0	m	From table RSNI T-14-2004/P37 (to interpolation)					
					w_1	0				
					w_2	0				
					$(w_1\text{-}w_2)$	0				

TANGGULANGIN

```
Horizontal Alignment Station and Curve Report.
Alignment: TANGGULANGIN_ALT-2
Desc:
Desc.  Station          Spiral/Curve Data           Northing          Easting
-----------------------------------------------------------------------------

-----------------------------------------------------------------------------
PI     0+000                                       9168934.353       688323.973
           Length:          12.282   Course:            12-34-33

-----------------------------------------------------------------------------
PI     0+012.282                                   9168946.341       688326.647
           Length:         266.229   Course:            11-28-46
            Delta:         1-05-47
-----------------------------------------------------------------------------
                        Circular Curve Data
TC     0+000                                       9168934.353       688323.973
RP                                                 9169213.861       687071.037
CT     0+024.564                                   9168958.377       688329.092
            Delta:        01-05-47     Type:                LEFT
           Radius:        1283.735      DOC:            04-27-48
           Length:          24.564  Tangent:              12.282
         Mid-Ord:            0.059 External:               0.059
            Chord:          24.563   Course:            12-01-39
               Es:           0.059

-----------------------------------------------------------------------------
PI     0+278.510                                   9169207.244       688379.631
           Length:         297.484   Course:             9-10-10
            Delta:         2-18-36
-----------------------------------------------------------------------------
                        Tangent Data
       0+024.564                                   9168958.377       688329.092
       0+238.187                                   9169167.727       688371.606
           Length:         213.623   Course:            11-28-46
-----------------------------------------------------------------------------
                        Circular Curve Data
TC     0+238.187                                   9169167.727       688371.606
RP                                                 9169565.758       686411.613
CT     0+318.823                                   9169247.053       688386.057
            Delta:        02-18-36     Type:                LEFT
           Radius:        2000.000      DOC:            02-51-53
           Length:          80.637  Tangent:              40.324
         Mid-Ord:            0.406 External:               0.406
            Chord:          80.631   Course:            10-19-28
               Es:           0.406

-----------------------------------------------------------------------------
PI     0+575.983                                   9169500.926       688427.036
           Length:         116.808   Course:            27-03-52
            Delta:        17-53-42
-----------------------------------------------------------------------------
                        Tangent Data
       0+318.823                                   9169247.053       688386.057
       0+520.963                                   9169446.609       688418.268
           Length:         202.140   Course:             9-10-10
-----------------------------------------------------------------------------
                        Spiral Curve Data: CLOTHOID
TS     0+520.963                                   9169446.609       688418.268
SPI                                                9169466.357       688421.456
SC     0+550.963                                   9169476.120       688423.639
           Length:          30.000    L Tan:              20.004
```

Radius:	250.000	S Tan:	10.003
Theta:	3-26-16	P:	0.150
X:	29.989	K:	14.998
Y:	0.600	A:	86.603
Chord:	29.995	Course:	10-18-55
Ts:	55.020		

Circular Curve Data

SC	0+550.963	9169476.120	688423.639
RP		9169421.554	688667.612
SC	0+591.269	9169514.576	688435.563

Delta:	09-14-15	Type:	RIGHT
Radius:	250.000	DOC:	22-55-06
Length:	40.306	Tangent:	20.197
Mid-Ord:	0.812	External:	0.814
Chord:	40.262	Course:	17-13-33
Es:	3.331		

Spiral Curve Data: CLOTHOID

SC	0+591.269	9169514.576	688435.563
SPI		9169528.681	688441.217
TC	0+636.821	9169555.735	688455.040

Length:	45.552	L Tan:	30.381
Radius:	250.000	S Tan:	15.196
Theta:	5-13-11	P:	0.346
X:	45.514	K:	22.769
Y:	1.382	A:	106.714
Chord:	45.535	Course:	25-19-28
Ts:	61.548		

PI	0+692.080	9169604.943	688480.183

Length:	188.889	Course:	11-56-15
Delta:	15-07-36		

Spiral Curve Data: CLOTHOID

TS	0+636.821	9169555.735	688455.040
SPI		9169582.789	688468.863
SC	0+682.372	9169596.894	688474.517

Length:	45.552	L Tan:	30.381
Radius:	250.000	S Tan:	15.196
Theta:	5-13-11	P:	0.346
X:	45.514	K:	22.769
Y:	1.382	A:	106.714
Chord:	45.535	Course:	25-19-28
Ts:	55.260		

Circular Curve Data

SC	0+682.372	9169596.894	688474.517
RP		9169689.916	688242.468
SC	0+710.599	9169623.631	688483.520

Delta:	06-28-09	Type:	LEFT
Radius:	250.000	DOC:	22-55-06
Length:	28.227	Tangent:	14.129
Mid-Ord:	0.398	External:	0.399
Chord:	28.212	Course:	18-36-36
Es:	2.445		

Spiral Curve Data: CLOTHOID

SC	0+710.599	9169623.631	688483.520
SPI		9169633.276	688486.173
TC	0+740.599	9169652.847	688490.310

Length:	30.000	L Tan:	20.004

Radius:	250.000	S Tan:	10.003
Theta:	3-26-16	P:	0.150
X:	29.989	K:	14.998
Y:	0.600	A:	86.603
Chord:	29.995	Course:	13-05-01
Ts:	48.963		

PI	0+880.525			9169789.747	688519.253
	Length:	137.051	Course:	0-12-51	
	Delta:	11-43-25			

Tangent Data

0+740.599			9169652.847	688490.310
0+829.193			9169739.525	688508.636
Length:	88.593	Course:	11-56-15	

Circular Curve Data

TC	0+829.193			9169739.525	688508.636
RP				9169842.948	688019.449
CT	0+931.499			9169841.079	688519.445
	Delta:	11-43-25	Type:	LEFT	
	Radius:	500.000	DOC:	11-27-33	
	Length:	102.307	Tangent:	51.333	
	Mid-Ord:	2.614	External:	2.628	
	Chord:	102.128	Course:	6-04-33	
	Es:	2.628			

PI	1+017.218			9169926.797	688519.766
	Length:	113.030	Course:	10-09-30	
	Delta:	9-56-40			

Tangent Data

0+931.499			9169841.079	688519.445
0+973.718			9169883.298	688519.603
Length:	42.219	Course:	0-12-51	

Circular Curve Data

TC	0+973.718			9169883.298	688519.603
RP				9169881.429	689019.600
CT	1+060.499			9169969.615	688527.438
	Delta:	09-56-40	Type:	RIGHT	
	Radius:	500.000	DOC:	11-27-33	
	Length:	86.781	Tangent:	43.500	
	Mid-Ord:	1.882	External:	1.889	
	Chord:	86.672	Course:	5-11-11	
	Es:	1.889			

PI	1+130.029	9170038.055	688539.701

Tangent Data

1+060.499			9169969.615	688527.438
1+130.029			9170038.055	688539.701
Length:	69.530	Course:	10-09-30	

TANGGULANGINFLYOVER

Location		:	Tanggulangin							
Design Speed	(*Vr*)	:	40	km/hr						
PI-1, Sta			0+012,282							
Radii of Curve	(R_r)	:	1283,735	m						
Super Elevation	(e_r)	:	2	%	From table RSNI T-14-2004/P29 (to interpolation)					
Horizontal Curve length	(L_{ch})	:	0	m	R_1	1300	e_1	2	L_{h1}	0
					R_2	1200	e_2	2	L_{h2}	0
Spiral length (*Ls*)					$(R_1$-$R_2)$	100	Δe	0	$(L_{h1}$-$L_{h2})$	0
*Ls=Vr*t/3.6 →t=2sec.*			22,222	m						
*Ls=W*Δ⁻¹*(e r+e n)*			21,600	m	Δ	1/150	0,00667	Δ^{-1}	150	
					W	3,6				
Widening (*w*)			0	m	From table RSNI T-14-2004/P37 (to interpolation)					
					w_1	0				
					w_2	0				
					$(w_1$-$w_2)$	0				

Design Speed	(*Vr*)	:	40	km/hr						
PI-2, Sta			0+278,510							
Radii of Curve	(R_r)	:	2000	m						
Super Elevation	(e_r)	:	2	%	From table RSNI T-14-2004/P29 (to interpolation)					
Horizontal Curve length	(L_{ch})	:	0	m	R_1	2000	e_1	2	L_{h1}	0
					R_2	1500	e_2	2	L_{h2}	0
Spiral length (*Ls*)					$(R_1$-$R_2)$	500	Δe	0	$(L_{h1}$-$L_{h2})$	0
*Ls=Vr*t/3.6 →t=2sec.*			22,222	m						
*Ls=W*Δ⁻¹*(e r+e n)*			21,600	m	Δ	1/150	0,00667	Δ^{-1}	150	
					W	3,6				
Widening (*w*)			0	m	From table RSNI T-14-2004/P37 (to interpolation)					
					w_1	0				
					w_2	0				
					$(w_1$-$w_2)$	0				

Design Speed	(*Vr*)	:	50	km/hr						
PI-3, Sta			0+575,983							
Radii of Curve	(R_r)	:	250	m						
Super Elevation	(e_r)	:	4,2	%	From table RSNI T-14-2004/P29 (to interpolation)					
Horizontal Curve length	(L_{ch})	:	23	m	R_1	250	e_1	4,2	L_{h1}	23
					R_2	200	e_2	4,7	L_{h2}	26
Spiral length (*Ls*)					$(R_1$-$R_2)$	50	Δe	-0,5	$(L_{h1}$-$L_{h2})$	-3
*Ls=Vr*t/3.6 →t=2sec.*			27,778	m						
*Ls=W*Δ⁻¹*(e r+e n)*			33,480	m	Δ	1/150	0,00667	Δ^{-1}	150	
					W	3,6				
Widening (*w*)			0,1	m	From table RSNI T-14-2004/P37 (to interpolation)					
					w_1	0,1				
					w_2	0,1				
					$(w_1$-$w_2)$	0				

Design Speed	(*Vr*)	:	50	km/hr
PI-4, Sta			0+692,080	

Location		:	Tanggulangin									
Design Speed	(*Vr*)	:	40	km/hr								
Radii of Curve	(R_r)	:	250	m								
Super Elevation	(e_r)	:	4,20	%	From table RSNI T-14-2004/P29 (to interpolation)							
Horizontal Curve length	(L_{ch})	:	23,00	m	R_1	250	e_1	4,2	L_{h1}		23	
					R_2	200	e_2	4,7	L_{h2}		26	
Spiral length (*Ls*)					(R_1-R_2)	50	Δe	-0,5	$(L_{h1}-L_{h2})$		-3	
$Ls=Vr*t/3.6 \rightarrow t=2sec.$			27,778	m								
$Ls=W*\Delta^{-1}*(e_r+e_n)$			33,480	m	Δ	1/150	0,00667	Δ^{-1}	150			
					W	3,6						
Widening (*w*)			0	m	From table RSNI T-14-2004/P37 (tp interpolation)							
					w_1	0						
					w_2	0						
					(w_1-w_2)	0						

Design Speed	(*Vr*)	:	50	km/hr						
PI-5, Sta			0+880,525							
Radii of Curve	(R_r)	:	500	m						
Super Elevation	(e_r)	:	2,80	%	From table RSNI T-14-2004/P29 (to interpolation)					
Horizontal Curve length	(L_{ch})	:	15,00	m	R_1	500	e_1	2,8	L_{h1}	15
					R_2	400	e_2	3,3	L_{h2}	18
Spiral length (*Ls*)					(R_1-R_2)	100	Δe	-0,5	$(L_{h1}-L_{h2})$	-3
$Ls=Vr*t/3.6 \rightarrow t=2sec.$			27,778	m						
$Ls=W*\Delta^{-1}*(e_r+e_n)$			25,920	m	Δ	1/150	0,00667	Δ^{-1}	150	
					W	3,6				
Widening (*w*)			0	m	From table RSNI T-14-2004/P37 (tp interpolation)					
					w_1	0				
					w_2	0				
					(w_1-w_2)	0				

Design Speed	(*Vr*)	:	40	km/hr						
PI-6, Sta			1+017,218							
Radii of Curve	(R_r)	:	500	m						
Super Elevation	(e_r)	:	2,10	%	From table RSNI T-14-2004/P29 (to interpolation)					
Horizontal Curve length	(L_{ch})	:	11,00	m	R_1	500	e_1	2,1	L_{h1}	11
					R_2	400	e_2	2,5	L_{h2}	13
Spiral length (*Ls*)					(R_1-R_2)	100	Δe	-0,4	$(L_{h1}-L_{h2})$	-2
$Ls=Vr*t/3.6 \rightarrow t=2sec.$			22,222	m						
$Ls=W*\Delta^{-1}*(e_r+e_n)$			22,140	m	Δ	1/150	0,00667	Δ^{-1}	150	
					W	3,6				
Widening (*w*)			0	m	From table RSNI T-14-2004/P37 (tp interpolation)					
					w_1	0				
					w_2	0				
					(w_1-w_2)	0				

2. PAVEMENT THICKNESS DESIGN REPORT

2.1 SUMMARY

SUMMARY OF PAVEMENT THICKNESS DESIGN

LOCATION	Structure Number (SN)	THICKNEES LAYER PAVEMENT (CM)								
		Option 1 (Agg Class A only)				Option 2 (Agg Class A and Agg Class B)				
		AC - WC	AC - BC	AC - Base	Agg A	AC - WC	AC - BC	AC - Base	Agg A	Agg B
MERAK	7.272	4	6	10	87	4	6	10	40	55
BALARAJA	5.377	4	6	10	50	4	6	10	30	25
NAGREG	5.728	4	6	10	58	4	6	10	30	35
GEBANG	7.237	4	6	10	86	4	6	10	40	55
PETERONGAN	5.890	4	6	10	60	4	6	10	30	35
TANGGULANGIN	6.050	4	6	10	63	4	6	10	30	40

SUMMARY OF PAVEMENT THICKNESS DESIGN
THICKNEES PAVEMENT DESIGN (FLEXIBLE) OF ABUTTMENT SECTION

LOCATION	Structure Number (SN)	THICKNEES LAYER PAVEMENT (CM)								
		Option 1 (Agg Class A only)				Option 2 (Agg Class A and Agg Class B)				
		AC - WC	AC - BC	AC - Base	Agg A	AC - WC	AC - BC	AC - Base	Agg A	Agg B
MERAK	5.785	4	6	10	58	4	6	10	30	35
BALARAJA	5.508	4	6	10	53	4	6	10	30	30
NAGREG	6.040	4	6	10	63	4	6	10	30	40
GEBANG	5.508	4	6	10	53	4	6	10	30	30
PETERONGAN	6.180	4	6	10	66	4	6	10	30	45
TANGGULANGIN	5.240	4	6	10	59	4	6	10	30	35

2.2 PAVEMENT THICKNESS DESIGN IN MERAK FLYOVER

TRAFFIC ANALYSIS MERAK FLYOVER (AT GRADE)

(1/4)

No.	Year	Daily Traffic Volume (Vehicle./day/1 lane)								
		Sedan	Oplet, Mini Bus	Pickup, Micro Truck	Small Bus	Large Bus	Truck 2w	Truck 3w	Semi Trailer	Total
	2008	2464	3695	765	324	926	2182	512	174	11042

No.	Year	Daily Traffic Volume (Vehicle./day/1 lane)								
		Sedan	Oplet, Mini Bus	Pickup, Micro Truck	Small Bus	Large Bus	Truck 2w	Truck 3w	Semi Trailer	Total
	2005	2164	3200	670	280	800	1876	440	153	9583
	2006	2260	3357	700	294	840	1973	463	160	10047
	2007	2360	3522	732	309	882	2075	487	167	10534
1	**2008**	**2464**	**3695**	**765**	**324**	**926**	**2182**	**512**	**174**	**11042**
2	2009	2573	3876	800	340	972	2295	538	182	11576
3	2010	2687	4066	836	357	1020	2413	566	190	12135
4	2011	2777	4229	862	371	1059	2516	590	196	12600
5	2012	2870	4399	889	385	1099	2624	615	203	13084
6	2013	2966	4576	917	400	1141	2736	641	210	13587
7	2014	3065	4760	946	415	1185	2853	668	217	14109
8	2015	3167	4951	976	431	1230	2975	697	224	14651
9	2016	3237	5165	1003	446	1274	3116	730	231	15202
10	2017	3309	5388	1031	462	1319	3264	765	238	15776

No.	Year	DAILY ESA								TOTAL DAILY ESA	TOTAL ESA DESIGN LANE (DAILY ESA*0.8)	ESA PER YEAR (10^6)	ESA CUMULATIVE (10^6)
		Sedan 0.0012	Oplet, Mini Bus 0.2165	Pickup, Micro Truck 0.2458	Small Bus 0.2458	Large Bus 1.0413	Truck 2w 2.9918	Truck 3w 5.3443	Semi Trailer 4.1269				
1	2008	2.96	800.0	188.0	188.0	337.4	2770.4	11661.3	2113.0	18061.0	14449	5.274	5.274
2	2009	3.09	839.2	196.6	196.6	354.0	2908.0	12265.2	2220.3	18983.0	15186	5.543	10.817
3	2010	3.22	880.3	205.5	205.5	371.7	3051.6	12895.8	2335.8	19949.5	15960	5.825	16.642
4	2011	3.33	915.6	211.9	211.9	386.3	3168.3	13446.3	2434.9	20778.4	16623	6.067	22.709
5	2012	3.44	952.4	218.5	218.5	400.9	3288.0	14023.4	2538.0	21643.2	17315	6.320	29.029
6	2013	3.56	990.7	225.4	225.4	416.5	3413.6	14622.0	2645.3	22542.6	18034	6.582	35.612
7	2014	3.68	1030.5	232.5	232.5	432.1	3545.3	15247.3	2756.8	23480.8	18785	6.856	42.468
8	2015	3.80	1071.9	239.9	239.9	448.8	3679.9	15899.3	2876.4	24459.9	19568	7.142	49.610
9	2016	3.88	1118.2	246.5	246.5	464.4	3811.6	16652.8	3012.6	25556.6	20445	7.463	57.073
10	2017	3.97	1166.5	253.4	253.4	481.1	3946.2	17443.8	3157.1	26705.5	21364	7.798	64.871
10	2017	4.0	1166.5	253.4	253.4	481.1	3946.2	17443.8	3157.1	26705.5	21364	7.798	64.87

MERAK FLYOVER (AT GRADE)
CALCULATION OF STRUCTURAL NUMBER (SN) TOTAL, DESIGN LIFE = 10 YEARS

USED FORMULA

log (ESA $Kumulative_{18}$) ((Zr*So)+((9.36*LOG(SN+1))-0.2)+(Gt/(0.4+(1094/((SN+1)^5.19))))
+((2.32*(LOG(Mr))-8.07)))

Gt = log((P_0-P_t)/(4.2-1.5))

Loss of Serviceability due to swelling = 0.00335*Vr*P8(1-e^(-at))

PARAMETER

Reliability	90 %	(Table 2.2, page II-9, AASHTO 1993)
During construction		
n	1	
$R_{overall}$	90 %	
$R_{stage} = (R_{overall})^{1/n}$	0.90	(Section 4.5, page I-63, AASHTO 1993)
Standar Normal Deviate Z_R	-1.282	(Table 4-1, page I-62 AASHTO 1993)
Standar Error (So)	0.45	(Section 4.5, page I-63, AASHTO 1993)
Initial Seviceability, P_0	4.2	(Section 4.5, page I-63, AASHTO 1993)
Final Seviceability, P_t	2.5	(Section 4.5, page I-63, AASHTO 1993)
CBR Subgrade	3.23 %	
Resilient Modulus of Subgrade (Mr)	4845	(Mr = 1500CBR)

Loss of Serviceability due to roadbed swelling

Potential vertical rise (Vr)	=	0.75	using PI = 36.64 and minimum moisture conditions - 5 ft thickness
Design Life, t	=	10	
Swell Rate Constant (θ)	=	0.12	
Probability of Swell (P)	=	100 %	
Loss of Serviceability	=	0.176	
Serviceability factor (Gt)	=	-0.201	
Design Life	=	10	
ESA $Cumulative_{18}$	=	6.487E+07	
Structural Number (Asumption)	=	**7.271675247**	
ESA Cumulative	=	6.487E+07	

MERAK FLYOVER (AT GRADE)
CALCULATION OF STRUCTURAL NUMBER (SN) ASPHALT LAYER

USED FORMULA

log (ESA Cumulative$_{18}$) ((Zr*So)+((9.36*LOG(SN+1))-0.2)+(Gt/(0.4+(1094/((SN+1)^5.19))))
+((2.32*(LOG(Mr))-8.07)))

Gt = log((P$_0$-P$_t$)/(4.2-1.5))

Loss of Serviceability due to swelling = 0.00335*Vr*P8(1-e^(-at))

PARAMETER

Reliability	90 %	(Table 2.2, page II-9, AASHTO 1993)
During Construction		
n	1	
$R_{overall}$	90	
$R_{stage} = (R_{overall})^{1/n}$	0.90	(Section 4.5, page I-63, AASHTO 1993)
Standard of Normal Deviate Z_R	-1.282	(Table 4-1, page I-62 AASHTO 1993)
Standard Error (So)	0.45	(Section 4.5, page I-63, AASHTO 1993)
Initial Seviceability, P_0	4.2	(Section 4.5, page I-63, AASHTO 1993)
Final Seviceability, P_t	2.5	(Section 4.5, page I-63, AASHTO 1993)
CBR Subbase	80 %	
Resilient Modulus of Subgrade (Mr)	120000	

Loss of Serviceability due to roadbed swelling

Potential vertical rise (Vr) =	0.75	using PI = 36.64 and minimum moisture conditions - 5 ft thickness
Design Life, t =	10	
Swell Rate Constant (θ) =	0.12	
Probability of Swell (P) =	100 %	
Loss of Serviceability =	0.176	
Serviceability factor (Gt) =	-0.201	
Design Life =	10	
ESA Cumulative$_{18}$ =	6.487E+07	
Structural Number (Asumption) =	**2.389**	
ESA Cumulative =	6.487E+07	

MERAK FLYOVER (AT GRADE)
DETERMINE THICKNEES DESIGN

FLEXIBLE PAVEMENT (DL = 10 YEAR)

Design Life = 10 year

Structural coefisient (a) :

1. Structural Number AC/Wearing Course (MS 1100 kg) per cm	=	0.410
2. Structural Number AC/Binder Course (MS 1100 kg) per cm	=	0.410
3. Structural Number AC Base (MS 900 kg) per cm	=	0.300
4. Structural Number Subbase (kelas A) per cm	=	0.132

Formula for SN value from granular materials

Base : $0.249 * \log(E_{BS}) - 0.977$

Subbase : $0.227 * \log(E_{SB}) - 0.839$

	CBR	Mr	E
Sub grade	5 %	7500 psi	19000 psi
Subbase	80 %	120000 psi	

Drainage coefisient for Base Course, good condition (assumption)
Present of time Pavement to moisture level > 25% 1.00

Result Calculation

	SN_3 (inch)	SN_2 (inch)	SN_2 (asphalt layer) (inch)	Wearing (AC) (cm)	Binder (AC) (cm)	AC Base (cm)	Subbase (Class A) (cm)
Thicknees Every Layer :	**7.272**	**-**	**2.389**	**4**	**6**	**10**	**86.13678**

Thicknees of Subbase (Class A) = 87 cm

SN = $a_{11}D_{11} + a_{12}D_{12} + a_2D_2 + a_3D_3$

(0.410*6) + (0.410*8) + (0.300*10) + (0.132*50)

= 18.58 cm

SN = 7.317 inch > 7.272 inch OK!

TRAFFIC ANALYSIS MERAK FLYOVER (FLYOVER)

No.	Year	Daily Traffic Volume (Vehicle./day/1 lane)								
		Sedan	Oplet, Mini Bus	Pickup, Micro Truck	Small Bus	Large Bus	Truck 2w	Truck 3w	Semi Trailer	Total
	2008	1460	1431	1208	55	184	1133	452	172	6095

No.	Year	Daily Traffic Volume (Vehicle./day/1 lane)								
		Sedan	Oplet, Mini Bus	Pickup, Micro Truck	Small Bus	Large Bus	Truck 2w	Truck 3w	Semi Trailer	Total
	2005	1215	80	374	10	11	940	480	316	3426
	2006	1269	84	391	10	12	989	505	330	3590
	2007	1325	88	409	10	13	1040	531	344	3760
1	**2008**	**1384**	**92**	**427**	**10**	**14**	**1094**	**558**	**359**	**3938**
2	2009	1445	97	446	10	15	1150	587	375	4125
3	2010	1509	102	466	10	16	1209	617	391	4320
4	2011	1559	106	481	10	17	1261	643	404	4481
5	2012	1611	110	496	10	18	1315	671	418	4649
6	2013	1665	114	511	10	19	1371	700	432	4822
7	2014	1721	119	527	10	20	1430	730	447	5004
8	2015	1778	124	543	10	21	1491	761	462	5190
9	2016	1817	129	558	10	22	1562	797	477	5372
10	2017	1857	135	574	10	23	1636	835	492	5562

No.	Year	DAILY ESA								TOTAL DAILY ESA	TOTAL ESA DESIGN LANE (DAILY ESA*0.8)	ESA PER YEAR (10^6)	ESA CUMULATIVE (10^6)
		Sedan 0.0012	Oplet, Mini Bus 0.2165	Pickup, Micro Truck 0.2458	Small Bus 0.2458	Large Bus 1.0413	Truck 2w 2.9918	Truck 3w 5.3443	Semi Trailer 4.1269				
1	2008	1.66	19.9	105.0	105.0	10.4	41.9	5846.7	2302.8	8433.3	6747	2.463	2.463
2	2009	1.73	21.0	109.6	109.6	10.4	44.9	6145.9	2422.5	8865.7	7093	2.589	5.051
3	2010	1.81	22.1	114.5	114.5	10.4	47.9	6461.3	2546.3	9318.8	7455	2.721	7.772
4	2011	1.87	22.9	118.2	118.2	10.4	50.9	6739.2	2653.6	9715.3	7772	2.837	10.609
5	2012	1.93	23.8	121.9	121.9	10.4	53.9	7027.8	2769.1	10130.8	8105	2.958	13.567
6	2013	2.00	24.7	125.6	125.6	10.4	56.8	7327.0	2888.8	10561.0	8449	3.084	16.651
7	2014	2.07	25.8	129.5	129.5	10.4	59.8	7642.3	3012.6	11012.1	8810	3.216	19.867
8	2015	2.13	26.8	133.5	133.5	10.4	62.8	7968.4	3140.6	11478.1	9182	3.352	23.218
9	2016	2.18	27.9	137.2	137.2	10.4	65.8	8347.8	3289.1	12017.6	9614	3.509	26.728
10	2017	2.23	29.2	141.1	141.1	10.4	68.8	8743.3	3446.0	12582.1	10066	3.674	30.402
10	2017	2.2	29.2	141.1	141.1	10.4	68.8	8743.3	3446.0	12582.1	10066	3.674	30.40

MERAK FLYOVER (FLYOVER)
CALCULATION OF STRUCTURAL NUMBER (SN) TOTAL, DESIGN LIFE = 10 YEARS

USED FORMULA

log (ESA $Kumulative_{18}$) ((Zr*So)+((9.36*LOG(SN+1))-0.2)+(Gt/(0.4+(1094/((SN+1)^5.19)))) +((2.32*(LOG(Mr))-8.07)))

Gt = log((P_0-P_t)/(4.2-1.5))

Loss of Serviceability due to swelling = 0.00335*Vr*P8(1-e^(-at))

PARAMETER

Reliability	90 %	(Table 2.2, page II-9, AASHTO 1993)
During construction		
n	1	
$R_{overall}$	90 %	
$R_{stage} = (R_{overall})^{1/n}$	0.90	(Section 4.5, page I-63, AASHTO 1993)
Standar Normal Deviate Z_R	-1.282	(Table 4-1, page I-62 AASHTO 1993)
Standar Error (So)	0.45	(Section 4.5, page I-63, AASHTO 1993)
Initial Seviceability, P_0	4.2	(Section 4.5, page I-63, AASHTO 1993)
Final Seviceability, P_t	2.5	(Section 4.5, page I-63, AASHTO 1993)
CBR Subgrade	5 %	
Resilient Modulus of Subgrade (Mr)	7500	(Mr = 1500CBR)

Loss of Serviceability due to roadbed swelling

Potential vertical rise (Vr) =	0.75	using PI = 36.64 and minimum moisture conditions - 5 ft thickness
Design Life, t =	10	
Swell Rate Constant (θ) =	0.12	
Probability of Swell (P) =	100 %	
Loss of Serviceability =	0.176	
Serviceability factor (Gt) =	-0.201	
Design Life =	10	
ESA $Cumulative_{18}$ =	3.040E+07	
Structural Number (Asumption) =	**5.784937644**	
ESA Cumulative =	3.040E+07	

MERAK FLYOVER (FLYOVER)
CALCULATION OF STRUCTURAL NUMBER (SN) ASPHALT LAYER

USED FORMULA

log (ESA $Cumulative_{18}$) ((Zr*So)+((9.36*LOG(SN+1))-0.2)+(Gt/(0.4+(1094/((SN+1)^5.19))))
+((2.32*(LOG(Mr))-8.07)))

Gt = $\log((P_0-P_t)/(4.2-1.5))$

Loss of Serviceability due to swelling = 0.00335*Vr*P8(1-e^(-at))

PARAMETER

Reliability	90	%	(Table 2.2, page II-9, AASHTO 1993)
During Construction			
n	1		
$R_{overall}$	90		
$R_{stage} = (R_{overall})^{1/n}$	0.90		(Section 4.5, page I-63, AASHTO 1993)
Standard of Normal Deviate Z_R	-1.282		(Table 4-1, page I-62 AASHTO 1993)
Standard Error (So)	0.45		(Section 4.5, page I-63, AASHTO 1993)
Initial Seviceability, P_0	4.2		(Section 4.5, page I-63, AASHTO 1993)
Final Seviceability, P_t	2.5		(Section 4.5, page I-63, AASHTO 1993)
CBR Subbase	80	%	
Resilient Modulus of Subgrade (Mr)	120000		

Loss of Serviceability due to roadbed swelling

Potential vertical rise (Vr)	=	0.75		using PI = 36.64 and minimum moisture conditions - 5 ft thickness
Design Life, t	=	10		
Swell Rate Constant (θ)	=	0.12		
Probability of Swell (P)	=	100	%	
Loss of Serviceability	=	0.176		
Serviceability factor (Gt)	=	-0.201		
Design Life	=	10		
ESA $Cumulative_{18}$	=	3.040E+07		
Structural Number (Asumption)	=	**2.104**		
ESA Cumulative	=	3.040E+07		

MERAK FLYOVER (FLYOVER)
DETERMINE THICKNEES DESIGN

FLEXIBLE PAVEMENT (DL = 10 YEAR)

Design Life = 10 year

Structural coefisient (a) :

1. Structural Number AC/Wearing Course (MS 1100 kg) per cm = 0.410
2. Structural Number AC/Binder Course (MS 1100 kg) per cm = 0.410
3. Structural Number AC Base (MS 900 kg) per cm = 0.300
4. Structural Number Subbase (kelas A) per cm = 0.132

Formula for SN value from granular materials

Base : **$0.249 * \log(E_{BS}) - 0.977$**

Subbase : **$0.227 * \log(E_{SB}) - 0.839$**

	CBR	Mr	E
Sub grade	5 %	7500 psi	19000 psi
Subbase	80 %	120000 psi	

Drainage coefisient for Base Course, good condition (assumption)
Present of time Pavement to moisture level > 25% 1.00

Result Calculation

	SN_3 (inch)	SN_2 (inch)	SN_2 (asphalt layer) (inch)	Wearing (AC) (cm)	Binder (AC) (cm)	AC Base (cm)	Subbase (Class A) (cm)
Thicknees Every Layer :	**5.785**	**-**	**2.104**	**4**	**6**	**10**	**57.52835**

Thicknees of Subbase (Class A) = 58 cm

SN = $a_{11}D_{11} + a_{12}D_{12} + a_2D_2 + a_3D_3$
(0.410*6) + (0.410*8) + (0.300*10) + (0.132*52.5)
= 14.76 cm
SN = 5.809 inch > 5.785 inch OK!

2.3 PAVEMENT THICKNESS DESIGN IN BALARAJA FLYOVER

TRAFFIC ANALYSIS BALARAJA FLYOVER (AT GRADE)

No.	Year	Daily Traffic Volume (Vehicle./day/1 lane)								
		Passenger Car	Oplet, Mini Bus	Pickup, Micro Truck	Small Bus	Large Bus	Truck 2w	Truck 3w	Semi Trailer	Total
	2008	1201	7732	1069	744	764	741	284	126	12661

No.	Year	Daily Traffic Volume (Vehicle./day/1 lane)								
		PC	Oplet, Mini Bus	Pickup, Micro Truck	Small Bus	Large Bus	Truck 2w	Truck 3w	Semi Trailer	Total
	2005	1054	6696	937	644	661	637	244	111	10984
	2006	1101	7025	979	676	694	670	257	116	11518
	2007	1150	7370	1023	709	728	705	270	121	12076
1	**2008**	**1201**	**7732**	**1069**	**744**	**764**	**741**	**284**	**126**	**12661**
2	2009	1254	8112	1117	781	802	779	299	132	13276
3	2010	1309	8510	1167	820	842	819	314	138	13919
4	2011	1353	8852	1203	851	874	854	327	143	14457
5	2012	1398	9208	1241	884	907	891	341	148	15018
6	2013	1445	9578	1280	918	942	929	356	153	15601
7	2014	1493	9963	1320	953	978	969	371	158	16205
8	2015	1543	10364	1361	989	1015	1010	387	163	16832
9	2016	1577	10812	1399	1024	1051	1058	405	168	17494
10	2017	1612	11279	1438	1060	1088	1108	424	173	18182

No.	Year	DAILY ESA								TOTAL DAILY ESA	TOTAL ESA DESIGN LANE (DAILY ESA*0.5)	ESA PER YEAR (10^6)	ESA CUMULATIVE (10^6)
		PC 0.0012	Oplet, Mini Bus 0.2165	Pickup, Micro Truck 0.2458	Small Bus 0.2458	Large Bus 1.0413	Truck 2w 2.9918	Truck 3w 5.3443	Semi Trailer 4.1269				
1	**2008**	**1.44**	**1674.0**	**262.8**	**262.8**	**774.7**	**2285.7**	**3960.1**	**1172.0**	**10393.6**	**5197**	**1.897**	**1.897**
2	2009	1.50	1756.2	274.6	274.6	813.3	2399.4	4163.2	1233.9	10916.7	5458	1.992	3.889
3	2010	1.57	1842.4	286.8	286.8	853.9	2519.1	4377.0	1295.8	11463.5	5732	2.092	5.981
4	2011	1.62	1916.5	295.7	295.7	886.1	2614.8	4564.0	1349.5	11924.0	5962	2.176	8.157
5	2012	1.68	1993.5	305.0	305.0	920.5	2713.6	4761.8	1407.3	12408.4	6204	2.265	10.422
6	2013	1.73	2073.6	314.6	314.6	955.9	2818.3	4964.9	1469.2	12912.8	6456	2.357	12.778
7	2014	1.79	2157.0	324.5	324.5	992.4	2926.0	5178.6	1531.1	13435.7	6718	2.452	15.230
8	2015	1.85	2243.8	334.5	334.5	1029.8	3036.7	5397.7	1597.1	13976.1	6988	2.551	17.781
9	2016	1.89	2340.8	343.9	343.9	1066.3	3144.4	5654.3	1671.4	14566.8	7283	2.658	20.440
10	2017	1.93	2441.9	353.5	353.5	1103.8	3255.1	5921.5	1749.8	15180.9	7590	2.771	23.210
10	**2017**	**1.9**	**2441.9**	**353.5**	**353.5**	**1103.8**	**3255.1**	**5921.5**	**1749.8**	**15180.9**	**7590**	**2.771**	**23.21**

BALARAJA FLYOVER (AT GRADE) (2/4)

CALCULATION OF STRUCTURAL NUMBER (SN) TOTAL, DESIGN LIFE = 10 YEARS

USED FORMULA

log (ESA Kumulative$_{18}$) ((Zr*So)+((9.36*LOG(SN+1))-0.2)+(Gt/(0.4+(1094/((SN+1)^5.19))))
+((2.32*(LOG(Mr))-8.07)))

Gt = log((P$_0$-P$_t$)/(4.2-1.5))

Loss of Serviceability due to swelling = 0.00335*Vr*P8(1-e^(-at))

PARAMETER

Reliability	90 %	(Table 2.2, page II-9, AASHTO 1993)
During construction		
n	1	
$R_{overall}$	90 %	
$R_{stage} = (R_{overall})^{1/n}$	0.90	(Section 4.5, page I-63, AASHTO 1993)
Standar Normal Deviate Z_R	-1.282	(Table 4-1, page I-62 AASHTO 1993)
Standar Error (So)	0.45	(Section 4.5, page I-63, AASHTO 1993)
Initial Seviceability, P_0	4.2	(Section 4.5, page I-63, AASHTO 1993)
Final Seviceability, P_t	2.5	(Section 4.5, page I-63, AASHTO 1993)
CBR Subgrade	5.61 %	
Resilient Modulus of Subgrade (Mr)	8415	(Mr = 1500CBR)

Loss of Serviceability due to roadbed swelling

Potential vertical rise (Vr) =	0.75	using PI = 36.64 and minimum moisture conditions - 5 ft thickness
Design Life, t =	10	
Swell Rate Constant (θ) =	0.12	
Probability of Swell (P) =	100 %	
Loss of Serviceability =	0.176	
Serviceability factor (Gt) =	-0.201	
Design Life =	10	
ESA Cumulative$_{18}$ =	2.321E+07	
Structural Number (Asumption) =	**5.377080433**	
ESA Cumulative =	2.321E+07	

BALARAJA FLYOVER (AT GRADE)
CALCULATION OF STRUCTURAL NUMBER (SN) ASPHALT LAYER

USED FORMULA

log (ESA Cumulative$_{18}$) ((Zr*So)+((9.36*LOG(SN+1))-0.2)+(Gt/(0.4+(1094/((SN+1)^5.19))))
+((2.32*(LOG(Mr))-8.07)))

Gt = log((P_0-P_t)/(4.2-1.5))

Loss of Serviceability due to swelling = 0.00335*Vr*P8(1-e^(-at))

PARAMETER

Reliability	90 %	(Table 2.2, page II-9, AASHTO 1993)
During Construction		
n	1	
$R_{overall}$	90	
$R_{stage} = (R_{overall})^{1/n}$	0.90	(Section 4.5, page I-63, AASHTO 1993)
Standard of Normal Deviate Z_R	-1.282	(Table 4-1, page I-62 AASHTO 1993)
Standard Error (So)	0.45	(Section 4.5, page I-63, AASHTO 1993)
Initial Seviceability, P_0	4.2	(Section 4.5, page I-63, AASHTO 1993)
Final Seviceability, P_t	2.5	(Section 4.5, page I-63, AASHTO 1993)
CBR Subbase	80 %	
Resilient Modulus of Subgrade (Mr)	120000	

Loss of Serviceability due to roadbed swelling

Potential vertical rise (Vr) =	0.75	using PI = 36.64 and minimum moisture conditions - 5 ft thickness
Design Life, t =	10	
Swell Rate Constant (θ) =	0.12	
Probability of Swell (P) =	100 %	
Loss of Serviceability =	0.176	
Serviceability factor (Gt) =	-0.201	
Design Life =	10	
ESA Cumulative$_{18}$ =	2.321E+07	
Structural Number (Asumption) =	**2.010**	
ESA Cumulative =	2.321E+07	

BALARAJA FLYOVER (AT GRADE)
DETERMINE THICKNEES DESIGN

FLEXIBLE PAVEMENT (DL = 10 YEAR)

Design Life = 10 year

Structural coefisient (a) :

1. Structural Number AC/Wearing Course (MS 1100 kg) per cm = 0.410
2. Structural Number AC/Binder Course (MS 1100 kg) per cm = 0.410
3. Structural Number AC Base (MS 900 kg) per cm = 0.300
4. Structural Number Subbase (kelas A) per cm = 0.132

Formula for SN value from granular materials

Base : **$0.249 * \log(E_{BS}) - 0.977$**

Subbase : **$0.227 * \log(E_{SB}) - 0.839$**

	CBR	Mr	E
Sub grade	5 %	7500 psi	19000 psi
Subbase	80 %	120000 psi	

Drainage coefisient for Base Course, good condition (assumption)
Present of time Pavement to moisture level > 25% 1.00

Result Calculation

	SN_3 (inch)	SN_2 (inch)	SN_2 (asphalt layer) (inch)	Wearing (AC) (cm)	Binder (AC) (cm)	AC Base (cm)	Subbase (Class A) (cm)
Thicknees Every Layer :	**5.377**	**-**	**2.010**	**4**	**6**	**10**	**49.68018**

Thicknees of Subbase (Class A) = 50 cm

SN = $a_{11}D_{11} + a_{12}D_{12} + a_2D_2 + a_3D_3$

(0.410*6) + (0.410*8) + (0.300*10) + (0.132*50)

= 13.70 cm

SN = 5.394 inch > 5.377 inch OK!

TRAFFIC ANALYSIS BALARAJA FLYOVER (FLYOVER)

No.	Year	Daily Traffic Volume (Vehicle./day/1 lane)								
		Passenger Car	Oplet, Mini Bus	Pickup, Micro Truck	Small Bus	Large Bus	Truck 2w	Truck 3w	Semi Trailer	Total
	2008	1460	1431	1208	55	184	1133	452	172	6095

No.	Year	Daily Traffic Volume (Vehicle./day/1 lane)								
		PC	Oplet, Mini Bus	Pickup, Micro Truck	Small Bus	Large Bus	Truck 2w	Truck 3w	Semi Trailer	Total
	2005	1282	1239	1058	48	159	974	389	151	5300
	2006	1339	1300	1106	50	167	1024	409	158	5553
	2007	1398	1364	1156	52	175	1077	430	165	5817
1	**2008**	**1460**	**1431**	**1208**	**55**	**184**	**1133**	**452**	**172**	**6095**
2	2009	1525	1501	1263	58	193	1191	475	180	6386
3	2010	1592	1575	1320	61	203	1252	500	188	6691
4	2011	1645	1638	1361	63	211	1306	521	194	6939
5	2012	1700	1704	1403	65	219	1362	543	201	7197
6	2013	1757	1773	1447	67	227	1420	566	208	7465
7	2014	1816	1844	1492	70	236	1481	590	215	7744
8	2015	1877	1918	1539	73	245	1544	615	222	8033
9	2016	1918	2001	1582	76	254	1617	644	229	8321
10	2017	1960	2087	1626	79	263	1694	675	236	8620

No.	Year	DAILY ESA								TOTAL DAILY ESA	TOTAL ESA DESIGN LANE (DAILY ESA*0.5)	ESA PER YEAR (10^6)	ESA CUMULATIVE (10^6)
		PC 0.0012	Oplet, Mini Bus 0.2165	Pickup, Micro Truck 0.2458	Small Bus 0.2458	Large Bus 1.0413	Truck 2w 2.9918	Truck 3w 5.3443	Semi Trailer 4.1269				
1	**2008**	**1.75**	**309.8**	**296.9**	**296.9**	**57.3**	**550.5**	**6055.1**	**1865.4**	**9433.6**	**4717**	**1.722**	**1.722**
2	2009	1.83	325.0	310.4	310.4	60.4	577.4	6365.1	1960.3	9910.8	4955	1.809	3.530
3	2010	1.91	341.0	324.5	324.5	63.5	607.3	6691.1	2063.5	10417.2	5209	1.901	5.432
4	2011	1.97	354.6	334.5	334.5	65.6	631.3	6979.7	2150.1	10852.3	5426	1.981	7.412
5	2012	2.04	368.9	344.9	344.9	67.7	655.2	7278.9	2240.9	11303.4	5652	2.063	9.475
6	2013	2.11	383.9	355.7	355.7	69.8	679.1	7588.9	2335.8	11770.9	5885	2.148	11.623
7	2014	2.18	399.2	366.7	366.7	72.9	706.1	7914.9	2434.9	12263.6	6132	2.238	13.861
8	2015	2.25	415.2	378.3	378.3	76.0	733.0	8251.6	2538.0	12772.7	6386	2.331	16.192
9	2016	2.30	433.2	388.9	388.9	79.1	759.9	8641.7	2657.7	13351.7	6676	2.437	18.629
10	2017	2.35	451.8	399.7	399.7	82.3	786.8	9053.2	2785.7	13961.5	6981	2.548	21.177
10	**2017**	**2.4**	**451.8**	**399.7**	**399.7**	**82.3**	**786.8**	**9053.2**	**2785.7**	**13961.5**	**6981**	**2.548**	**21.18**

BALARAJA FLYOVER (FLYOVER)

CALCULATION OF STRUCTURAL NUMBER (SN) TOTAL, DESIGN LIFE = 10 YEARS

USED FORMULA

log (ESA $Kumulative_{18}$) ((Zr*So)+((9.36*LOG(SN+1))-0.2)+(Gt/(0.4+(1094/((SN+1)^5.19))))
+((2.32*(LOG(Mr))-8.07)))

Gt = log((P_0-P_t)/(4.2-1.5))

Loss of Serviceability due to swelling = 0.00335*Vr*P8(1-e^(-at))

PARAMETER

Reliability	90 %	(Table 2.2, page II-9, AASHTO 1993)
During construction		
n	1	
$R_{overall}$	90 %	
$R_{stage} = (R_{overall})^{1/n}$	0.90	(Section 4.5, page I-63, AASHTO 1993)
Standar Normal Deviate Z_R	-1.282	(Table 4-1, page I-62 AASHTO 1993)
Standar Error (So)	0.45	(Section 4.5, page I-63, AASHTO 1993)
Initial Seviceability, P_0	4.2	(Section 4.5, page I-63, AASHTO 1993)
Final Seviceability, P_t	2.5	(Section 4.5, page I-63, AASHTO 1993)
CBR Subgrade	5 %	
Resilient Modulus of Subgrade (Mr)	7500	(Mr = 1500CBR)

Loss of Serviceability due to roadbed swelling

Potential vertical rise (Vr) =	0.75	using PI = 36.64 and minimum moisture conditions - 5 ft thickness
Design Life, t =	10	
Swell Rate Constant (θ) =	0.12	
Probability of Swell (P) =	100 %	
Loss of Serviceability =	0.176	
Serviceability factor (Gt) =	-0.201	
Design Life =	10	
ESA $Cumulative_{18}$ =	2.118E+07	
Structural Number (Asumption) =	**5.508499978**	
ESA Cumulative =	2.118E+07	

CALCULATION OF STRUCTURAL NUMBER (SN) ASPHALT LAYER

USED FORMULA

log (ESA $Cumulative_{18}$) ((Zr*So)+((9.36*LOG(SN+1))-0.2)+(Gt/(0.4+(1094/((SN+1)^5.19))))
+((2.32*(LOG(Mr))-8.07)))

Gt = $\log((P_0-P_t)/(4.2-1.5))$

Loss of Serviceability due to swelling = 0.00335*Vr*P8(1-e^(-at))

PARAMETER

Reliability	90 %	(Table 2.2, page II-9, AASHTO 1993)
During Construction		
n	1	
$R_{overall}$	90	
$R_{stage} = (R_{overall})^{1/n}$	0.90	(Section 4.5, page I-63, AASHTO 1993)
Standard of Normal Deviate Z_R	-1.282	(Table 4-1, page I-62 AASHTO 1993)
Standard Error (So)	0.45	(Section 4.5, page I-63, AASHTO 1993)
Initial Seviceability, P_0	4.2	(Section 4.5, page I-63, AASHTO 1993)
Final Seviceability, P_t	2.5	(Section 4.5, page I-63, AASHTO 1993)
CBR Subbase	80 %	
Resilient Modulus of Subgrade (Mr)	120000	

Loss of Serviceability due to roadbed swelling

Potential vertical rise (Vr)	=	0.75	using PI = 36.64 and minimum moisture conditions - 5 ft thickness
Design Life, t	=	10	
Swell Rate Constant (θ)	=	0.12	
Probability of Swell (P)	=	100 %	
Loss of Serviceability	=	0.176	
Serviceability factor (Gt)	=	-0.201	
Design Life	=	10	
ESA $Cumulative_{18}$	=	2.118E+07	
Structural Number (Asumption)	=	**1.979**	
ESA Cumulative	=	2.118E+07	

BALARAJA FLYOVER (FLYOVER)
DETERMINE THICKNEES DESIGN

FLEXIBLE PAVEMENT (DL = 10 YEAR)

Design Life = 10 year

Structural coefisient (a) :

1. Structural Number AC/Wearing Course (MS 1100 kg) per cm = 0.410
2. Structural Number AC/Binder Course (MS 1100 kg) per cm = 0.410
3. Structural Number AC Base (MS 900 kg) per cm = 0.300
4. Structural Number Subbase (kelas A) per cm = 0.132

Formula for SN value from granular materials

Base : **$0.249 * \log(E_{BS}) - 0.977$**

Subbase : **$0.227 * \log(E_{SB}) - 0.839$**

	CBR	Mr	E
Sub grade	5 %	7500 psi	19000 psi
Subbase	80 %	120000 psi	

Drainage coefisient for Base Course, good condition (assumption)
Present of time Pavement to moisture level > 25% 1.00

Result Calculation

	SN_3 (inch)	SN_2 (inch)	SN_2 (asphalt layer) (inch)	Wearing (AC) (cm)	Binder (AC) (cm)	AC Base (cm)	Subbase (Class A) (cm)
Thicknees Every Layer :	**5.508**	**-**	**1.979**	**4**	**6**	**10**	**52.20901**

Thicknees of Subbase (Class A) = 52.5 cm

SN = $a_{11}D_{11} + a_{12}D_{12} + a_2D_2 + a_3D_3$

(0.410*6) + (0.410*8) + (0.300*10) + (0.132*52.5)

= 14.03 cm

SN = 5.524 inch > 5.508 inch OK!

2.4 PAVEMENT THICKNESS DESIGN IN NAGREG FLYOVER

TRAFFIC ANALYSIS NAGREG FLYOVER (AT GRADE)

No.	Year	Daily Traffic Volume (Vehicle./day/1 lane)								
		Passenger Car	Oplet, Mini Bus	Pickup, Micro Truck	Small Bus	Large Bus	Truck 2w	Truck 3w	Semi Trailer	Total
	2008	1970	2504	677	529	1045	663	154	81	7623

No.	Year	Daily Traffic Volume (Vehicle./day/1 lane)								
		PC	Oplet, Mini Bus	Pickup, Micro Truck	Small Bus	Large Bus	Truck 2w	Truck 3w	Semi Trailer	Total
	2005	1731	2168	594	457	904	569	133	72	6628
	2006	1807	2275	620	480	949	599	139	75	6944
	2007	1887	2387	648	504	996	630	146	78	7276
1	**2008**	**1970**	**2504**	**677**	**529**	**1045**	**663**	**154**	**81**	**7623**
2	2009	2057	2627	708	555	1097	697	162	85	7988
3	2010	2148	2756	740	582	1151	733	170	89	8369
4	2011	2220	2867	763	604	1195	764	177	92	8682
5	2012	2294	2982	787	627	1241	797	185	95	9008
6	2013	2371	3102	812	651	1288	831	193	98	9346
7	2014	2450	3227	837	676	1337	867	201	101	9696
8	2015	2532	3357	863	702	1388	904	210	104	10060
9	2016	2588	3502	887	727	1437	947	220	107	10415
10	2017	2645	3653	912	753	1488	992	230	110	10783

No.	Year	DAILY ESA								TOTAL DAILY ESA	TOTAL ESA DESIGN LANE (DAILY ESA*0.5)	ESA PER YEAR (10^6)	ESA CUMULATIVE (10^6)
		PC 0.0012	Oplet, Mini Bus 0.2165	Pickup, Micro Truck 0.2458	Small Bus 0.2458	Large Bus 1.0413	Truck 2w 2.9918	Truck 3w 5.3443	Semi Trailer 4.1269				
1	2008	2.36	542.1	166.4	166.4	550.8	3126.4	3543.3	635.5	8733.4	4367	1.594	1.594
2	2009	2.47	568.7	174.0	174.0	577.9	3282.0	3725.0	668.6	9172.7	4586	1.674	3.268
3	2010	2.58	596.7	181.9	181.9	606.0	3443.6	3917.4	701.6	9631.6	4816	1.758	5.026
4	2011	2.66	620.7	187.5	187.5	628.9	3575.2	4083.0	730.5	10016.1	5008	1.828	6.854
5	2012	2.75	645.6	193.4	193.4	652.9	3712.8	4259.4	763.5	10423.8	5212	1.902	8.756
6	2013	2.85	671.6	199.6	199.6	677.9	3853.4	4441.1	796.5	10842.5	5421	1.979	10.735
7	2014	2.94	698.6	205.7	205.7	703.9	4000.0	4633.5	829.5	11280.0	5640	2.059	12.793
8	2015	3.04	726.8	212.1	212.1	731.0	4152.6	4831.2	866.6	11735.6	5868	2.142	14.935
9	2016	3.11	758.2	218.0	218.0	757.0	4299.2	5061.1	907.9	12222.5	6111	2.231	17.166
10	2017	3.17	790.9	224.2	224.2	784.1	4451.8	5301.5	949.2	12729.0	6365	2.323	19.489
10	**2017**	**3.2**	**790.9**	**224.2**	**224.2**	**784.1**	**4451.8**	**5301.5**	**949.2**	**12729.0**	**6365**	**2.323**	**19.49**

NAGREG FLYOVER (AT GRADE)

CALCULATION OF STRUCTURAL NUMBER (SN) TOTAL, DESIGN LIFE = 10 YEARS

USED FORMULA

log (ESA Kumulative$_{18}$) ((Zr*So)+((9.36*LOG(SN+1))-0.2)+(Gt/(0.4+(1094/((SN+1)^5.19))))
+((2.32*(LOG(Mr))-8.07)))

Gt = log((P_0-P_t)/(4.2-1.5))

Loss of Serviceability due to swelling = 0.00335*Vr*P8(1-e^(-at))

PARAMETER

Reliability	90 %	(Table 2.2, page II-9, AASHTO 1993)
During construction		
n	1	
$R_{overall}$	90 %	
$R_{stage} = (R_{overall})^{1/n}$	0.90	(Section 4.5, page I-63, AASHTO 1993)
Standar Normal Deviate Z_R	-1.282	(Table 4-1, page I-62 AASHTO 1993)
Standar Error (So)	0.45	(Section 4.5, page I-63, AASHTO 1993)
Initial Seviceability, P_0	4.2	(Section 4.5, page I-63, AASHTO 1993)
Final Seviceability, P_t	2.5	(Section 4.5, page I-63, AASHTO 1993)
CBR Subgrade	4.26 %	
Resilient Modulus of Subgrade (Mr)	6390	(Mr = 1500CBR)

Loss of Serviceability due to roadbed swelling

Potential vertical rise (Vr)	=	0.75	using PI = 36.64 and minimum moisture conditions - 5 ft thickness
Design Life, t	=	10	
Swell Rate Constant (θ)	=	0.12	
Probability of Swell (P)	=	100 %	
Loss of Serviceability	=	0.176	
Serviceability factor (Gt)	=	-0.201	
Design Life	=	10	
ESA Cumulative$_{18}$	=	1.949E+07	
Structural Number (Asumption)	=	**5.728481419**	
ESA Cumulative	=	1.949E+07	

NAGREG FLYOVER (AT GRADE)

CALCULATION OF STRUCTURAL NUMBER (SN) ASPHALT LAYER

USED FORMULA

log (ESA $Cumulative_{18}$) ((Zr*So)+((9.36*LOG(SN+1))-0.2)+(Gt/(0.4+(1094/((SN+1)^5.19)))) +((2.32*(LOG(Mr))-8.07)))

Gt = $\log((P_0-P_t)/(4.2-1.5))$

Loss of Serviceability due to swelling = 0.00335*Vr*P8(1-e^(-at))

PARAMETER

Reliability	90 %	(Table 2.2, page II-9, AASHTO 1993)
During Construction		
n	1	
$R_{overall}$	90	
$R_{stage} = (R_{overall})^{1/n}$	0.90	(Section 4.5, page I-63, AASHTO 1993)
Standard of Normal Deviate Z_R	-1.282	(Table 4-1, page I-62 AASHTO 1993)
Standard Error (So)	0.45	(Section 4.5, page I-63, AASHTO 1993)
Initial Seviceability, P_0	4.2	(Section 4.5, page I-63, AASHTO 1993)
Final Seviceability, P_t	2.5	(Section 4.5, page I-63, AASHTO 1993)
CBR Subbase	80 %	
Resilient Modulus of Subgrade (Mr)	120000	

Loss of Serviceability due to roadbed swelling

Potential vertical rise (Vr)	=	0.75	using PI = 36.64 and minimum moisture conditions - 5 ft thickness
Design Life, t	=	10	
Swell Rate Constant (θ)	=	0.12	
Probability of Swell (P)	=	100 %	
Loss of Serviceability	=	0.176	
Serviceability factor (Gt)	=	-0.201	
Design Life	=	10	
ESA $Cumulative_{18}$	=	1.949E+07	
Structural Number (Asumption)	=	**1.951**	
ESA Cumulative	=	1.949E+07	

NAGREG FLYOVER (AT GRADE)
DETERMINE THICKNEES DESIGN

FLEXIBLE PAVEMENT (DL = 10 YEAR)

Design Life = 10 year

Structural coefisient (a) :

1. Structural Number AC/Wearing Course (MS 1100 kg) per cm = 0.410
2. Structural Number AC/Binder Course (MS 1100 kg) per cm = 0.410
3. Structural Number AC Base (MS 900 kg) per cm = 0.300
4. Structural Number Subbase (kelas A) per cm = 0.132

Formula for SN value from granular materials

Base : **$0.249 * \log(E_{BS}) - 0.977$**

Subbase : **$0.227 * \log(E_{SB}) - 0.839$**

	CBR	Mr	E
Sub grade	5 %	7500 psi	19000 psi
Subbase	80 %	120000 psi	

Drainage coefisient for Base Course, good condition (assumption)
Present of time Pavement to moisture level > 25% 1.00

Result Calculation

	SN_3 (inch)	SN_2 (inch)	SN_2 (asphalt layer) (inch)	Wearing (AC) (cm)	Binder (AC) (cm)	AC Base (cm)	Subbase (Class A) (cm)
Thicknees Every Layer :	**5.728**	**-**	**1.951**	**4**	**6**	**10**	**56.44199**

Thicknees of Subbase (Class A) = 57.5 cm

SN = $a_{11}D_{11} + a_{12}D_{12} + a_2D_2 + a_3D_3$
(0.410*6) + (0.410*8) + (0.300*10) + (0.132*57.5)
= 14.69 cm
SN = 5.783 inch > 5.728 inch OK!

TRAFFIC ANALYSIS NAGREG FLYOVER (FLYOVER)

No.	Year	Daily Traffic Volume (Vehicle./day/1 lane)								
		Passenger Car	Oplet, Mini Bus	Pickup, Micro Truck	Small Bus	Large Bus	Truck 2w	Truck 3w	Semi Trailer	Total
	2008	6192	473	2152	194	551	2491	579	156	12788

No.	Year	Daily Traffic Volume (Vehicle./day/1 lane)								
		PC	Oplet, Mini Bus	Pickup, Micro Truck	Small Bus	Large Bus	Truck 2w	Truck 3w	Semi Trailer	Total
	2005	5438	410	1884	168	477	2142	498	137	11155
	2006	5679	430	1970	176	500	2253	524	143	11675
	2007	5930	451	2059	185	525	2369	551	149	12219
1	**2008**	**6192**	**473**	**2152**	**194**	**551**	**2491**	**579**	**156**	**12788**
2	2009	6466	496	2249	204	578	2620	609	163	13385
3	2010	6752	520	2351	214	607	2755	640	170	14009
4	2011	6978	541	2424	222	630	2873	667	176	14511
5	2012	7211	563	2500	230	654	2996	696	182	15032
6	2013	7452	586	2578	239	679	3124	726	188	15572
7	2014	7701	610	2658	248	705	3258	757	194	16131
8	2015	7958	635	2741	257	732	3397	789	201	16710
9	2016	8134	662	2817	266	758	3558	826	208	17229
10	2017	8314	691	2895	275	785	3727	865	215	17767

No.	Year	DAILY ESA								TOTAL DAILY ESA	TOTAL ESA DESIGN LANE (DAILY ESA*0.5)	ESA PER YEAR (10^6)	ESA CUMULATIVE (10^6)
		PC 0.0012	Oplet, Mini Bus 0.2165	Pickup, Micro Truck 0.2458	Small Bus 0.2458	Large Bus 1.0413	Truck 2w 2.9918	Truck 3w 5.3443	Semi Trailer 4.1269				
1	2008	7.43	102.4	529.0	529.0	202.0	1648.5	13312.7	2389.5	18720.4	9360	3.416	3.416
2	2009	7.76	107.4	552.8	552.8	212.4	1729.3	14002.1	2513.3	19677.8	9839	3.591	7.008
3	2010	8.10	112.6	577.9	577.9	222.8	1816.0	14723.5	2641.2	20680.1	10340	3.774	10.782
4	2011	8.37	117.1	595.8	595.8	231.2	1884.8	15354.2	2752.6	21540.0	10770	3.931	14.713
5	2012	8.65	121.9	614.5	614.5	239.5	1956.6	16011.5	2872.3	22439.5	11220	4.095	18.808
6	2013	8.94	126.9	633.7	633.7	248.9	2031.4	16695.6	2996.1	23375.2	11688	4.266	23.074
7	2014	9.24	132.1	653.3	653.3	258.2	2109.2	17411.7	3124.1	24351.2	12176	4.444	27.518
8	2015	9.55	137.5	673.7	673.7	267.6	2190.0	18154.6	3256.1	25362.8	12681	4.629	32.147
9	2016	9.76	143.3	692.4	692.4	277.0	2267.8	19015.0	3408.8	26506.5	13253	4.837	36.984
10	2017	9.98	149.6	711.6	711.6	286.4	2348.6	19918.2	3569.8	27705.7	13853	5.056	42.041
10	**2017**	**10.0**	**149.6**	**711.6**	**711.6**	**286.4**	**2348.6**	**19918.2**	**3569.8**	**27705.7**	**13853**	**5.056**	**42.04**

NAGREG FLYOVER (FLYOVER)

CALCULATION OF STRUCTURAL NUMBER (SN) TOTAL, DESIGN LIFE = 10 YEARS

USED FORMULA

log (ESA $Kumulative_{18}$) ((Zr*So)+((9.36*LOG(SN+1))-0.2)+(Gt/(0.4+(1094/((SN+1)^5.19))))
+((2.32*(LOG(Mr))-8.07)))

Gt = $\log((P_0-P_t)/(4.2-1.5))$

Loss of Serviceability due to swelling = 0.00335*Vr*P8(1-e^(-at))

PARAMETER

Reliability	90 %	(Table 2.2, page II-9, AASHTO 1993)
During construction		
n	1	
$R_{overall}$	90 %	
$R_{stage} = (R_{overall})^{1/n}$	0.90	(Section 4.5, page I-63, AASHTO 1993)
Standar Normal Deviate Z_R	-1.282	(Table 4-1, page I-62 AASHTO 1993)
Standar Error (So)	0.45	(Section 4.5, page I-63, AASHTO 1993)
Initial Seviceability, P_0	4.2	(Section 4.5, page I-63, AASHTO 1993)
Final Seviceability, P_t	2.5	(Section 4.5, page I-63, AASHTO 1993)
CBR Subgrade	5 %	
Resilient Modulus of Subgrade (Mr)	7500	(Mr = 1500CBR)

Loss of Serviceability due to roadbed swelling

Potential vertical rise (Vr) =	0.75	using PI = 36.64 and minimum moisture conditions - 5 ft thickness
Design Life, t =	10	
Swell Rate Constant (θ) =	0.12	
Probability of Swell (P) =	100 %	
Loss of Serviceability =	0.176	
Serviceability factor (Gt) =	-0.201	
Design Life =	10	
ESA $Cumulative_{18}$ =	4.204E+07	
Structural Number (Asumption) =	**6.039990718**	
ESA Cumulative =	4.204E+07	

CALCULATION OF STRUCTURAL NUMBER (SN) ASPHALT LAYER

USED FORMULA

log (ESA $Cumulative_{18}$) ((Zr*So)+((9.36*LOG(SN+1))-0.2)+(Gt/(0.4+(1094/((SN+1)^5.19))))
+((2.32*(LOG(Mr))-8.07)))

Gt = log((P_0-P_t)/(4.2-1.5))

Loss of Serviceability due to swelling = 0.00335*Vr*P8(1-e^(-at))

PARAMETER

Reliability	90 %	(Table 2.2, page II-9, AASHTO 1993)
During Construction		
n	1	
$R_{overall}$	90	
$R_{stage} = (R_{overall})^{1/n}$	0.90	(Section 4.5, page I-63, AASHTO 1993)
Standard of Normal Deviate Z_R	-1.282	(Table 4-1, page I-62 AASHTO 1993)
Standard Error (So)	0.45	(Section 4.5, page I-63, AASHTO 1993)
Initial Seviceability, P_0	4.2	(Section 4.5, page I-63, AASHTO 1993)
Final Seviceability, P_t	2.5	(Section 4.5, page I-63, AASHTO 1993)
CBR Subbase	80 %	
Resilient Modulus of Subgrade (Mr)	120000	

Loss of Serviceability due to roadbed swelling

Potential vertical rise (Vr)	=	0.75	using PI = 36.64 and minimum moisture conditions - 5 ft thickness
Design Life, t	=	10	
Swell Rate Constant (θ)	=	0.12	
Probability of Swell (P)	=	100 %	
Loss of Serviceability	=	0.176	
Serviceability factor (Gt)	=	-0.201	
Design Life	=	10	
ESA $Cumulative_{18}$	=	4.204E+07	
Structural Number (Asumption)	=	**2.222**	
ESA Cumulative	=	4.204E+07	

NAGREG FLYOVER (FLYOVER)
DETERMINE THICKNEES DESIGN

FLEXIBLE PAVEMENT (DL = 10 YEAR)

Design Life = 10 year

Structural coefisient (a) :

1. Structural Number AC/Wearing Course (MS 1100 kg) per cm = 0.410
2. Structural Number AC/Binder Course (MS 1100 kg) per cm = 0.410
3. Structural Number AC Base (MS 900 kg) per cm = 0.300
4. Structural Number Subbase (kelas A) per cm = 0.132

Formula for SN value from granular materials

Base : **$0.249 * \log(E_{BS}) - 0.977$**

Subbase : **$0.227 * \log(E_{SB}) - 0.839$**

	CBR	Mr	E
Sub grade	5 %	7500 psi	19000 psi
Subbase	80 %	120000 psi	

Drainage coefisient for Base Course, good condition (assumption)
Present of time Pavement to moisture level > 25% 1.00

Result Calculation

	SN_3 (inch)	SN_2 (inch)	SN_2 (asphalt layer) (inch)	Wearing (AC) (cm)	Binder (AC) (cm)	AC Base (cm)	Subbase (Class A) (cm)
Thicknees Every Layer :	**6.040**	-	**2.222**	**4**	**6**	**10**	**62.43619**

Thicknees of Subbase (Class A) = 62.5 cm

SN = $a_{11}D_{11} + a_{12}D_{12} + a_2D_2 + a_3D_3$

(0.410*6) + (0.410*8) + (0.300*10) + (0.132*85)

= 15.35 cm

SN = 6.043 inch > 6.040 inch OK!

2.5 PAVEMENT THICKNESS DESIGN IN GEBANG FLYOVER

TRAFFIC ANALYSIS GEBANG FLYOVER (AT GRADE)

No.	Year	Daily Traffic Volume (Vehicle./day)								
		Sedan	Oplet, Mini Bus	Pickup, Micro Truck	Small Bus	Large Bus	Truck 2w	Truck 3w	Semi Trailer	Total
	2008	360	864	367	26	1242	327	236	183	5041

No.	Year	Daily Traffic Volume (Vehicle./day)								
		Sedan	Oplet, Mini Bus	Pickup, Micro Truck	Small Bus	Large Bus	Truck 2w	Truck 3w	Semi Trailer	Total
	2005	316	748	321	23	1074	281	203	161	4390
	2006	330	785	336	24	1127	296	213	168	4597
	2007	345	824	351	25	1183	311	224	175	4814
1	2008	360	864	367	26	1242	327	236	183	5041
2	2009	376	906	384	27	1303	344	248	191	5278
3	2010	393	950	401	28	1367	362	261	199	5527
4	2011	406	988	414	29	1419	377	272	206	5729
5	2012	420	1028	427	30	1473	393	284	213	5939
6	2013	434	1069	440	31	1529	410	296	220	6157
7	2014	448	1112	454	32	1587	428	309	228	6382
8	2015	463	1157	468	33	1648	446	322	236	6615
9	2016	473	1207	481	34	1707	467	337	244	6833
10	2017	483	1259	494	35	1768	489	353	252	7060

No.	Year	DAILY ESA								TOTAL DAILY ESA	TOTAL ESA DESIGN LANE (DAILY ESA)	ESA PER YEAR (10^6)	ESA CUMULATIVE (10^6)
		Sedan 0.0012	Oplet, Mini Bus 0.2165	Pickup, Micro Truck 0.2458	Small Bus 0.2458	Large Bus 1.0413	Truck 2w 2.9918	Truck 3w 5.3443	Semi Trailer 4.1269				
1	2008	0.43	187.1	90.2	90.2	27.1	3715.8	1747.6	973.9	6832.3	6832	2.494	2.494
2	2009	0.45	196.1	94.4	94.4	28.1	3898.3	1838.4	1023.5	7173.7	7174	2.618	5.112
3	2010	0.47	205.7	98.6	98.6	29.2	4089.8	1934.6	1077.1	7534.0	7534	2.750	7.862
4	2011	0.49	213.9	101.8	101.8	30.2	4245.4	2014.8	1122.5	7830.8	7831	2.858	10.720
5	2012	0.50	222.6	105.0	105.0	31.2	4406.9	2100.3	1172.0	8143.5	8143	2.972	13.693
6	2013	0.52	231.4	108.2	108.2	32.3	4574.5	2191.2	1221.6	8467.7	8468	3.091	16.783
7	2014	0.54	240.7	111.6	111.6	33.3	4748.0	2287.4	1275.2	8808.4	8808	3.215	19.998
8	2015	0.56	250.5	115.0	115.0	34.4	4930.5	2383.6	1328.9	9158.4	9158	3.343	23.341
9	2016	0.57	261.3	118.2	118.2	35.4	5107.0	2495.8	1390.8	9527.3	9527	3.477	26.819
10	2017	0.58	272.6	121.4	121.4	36.4	5289.5	2613.4	1456.8	9912.1	9912	3.618	30.437
10	2017	0.6	272.6	121.4	121.4	36.4	5289.5	2613.4	1456.8	9912.1	4956	1.809	30.44

GEBANG FLYOVER (AT GRADE)
CALCULATION OF STRUCTURAL NUMBER (SN) TOTAL, DESIGN LIFE = 10 YEARS

USED FORMULA

log (ESA Kumulative$_{18}$) ((Zr*So)+((9.36*LOG(SN+1))-0.2)+(Gt/(0.4+(1094/((SN+1)^5.19))))
+((2.32*(LOG(Mr))-8.07)))

Gt = log((P_0-P_t)/(4.2-1.5))

Loss of Serviceability due to swelling = 0.00335*Vr*P8(1-e^(-at))

PARAMETER

Reliability	90 %	(Table 2.2, page II-9, AASHTO 1993)
During construction		
n	1	
$R_{overall}$	90 %	
$R_{stage} = (R_{overall})^{1/n}$	0.90	(Section 4.5, page I-63, AASHTO 1993)
Standar Normal Deviate Z_R	-1.282	(Table 4-1, page I-62 AASHTO 1993)
Standar Error (So)	0.45	(Section 4.5, page I-63, AASHTO 1993)
Initial Seviceability, P_0	4.2	(Section 4.5, page I-63, AASHTO 1993)
Final Seviceability, P_t	2.5	(Section 4.5, page I-63, AASHTO 1993)
CBR Subgrade	2.37 %	
Resilient Modulus of Subgrade (Mr)	3555	(Mr = 1500CBR)

Loss of Serviceability due to roadbed swelling

Potential vertical rise (Vr)	=	0.75	using PI = 36.64 and minimum moisture conditions - 5 ft thickness
Design Life, t	=	10	
Swell Rate Constant (θ)	=	0.12	
Probability of Swell (P)	=	100 %	
Loss of Serviceability	=	0.176	
Serviceability factor (Gt)	=	-0.201	
Design Life	=	10	
ESA Cumulative$_{18}$	=	3.044E+07	
Structural Number (Asumption)	=	7.236862713	
ESA Cumulative	=	3.044E+07	

GEBANG FLYOVER (AT GRADE)
CALCULATION OF STRUCTURAL NUMBER (SN) ASPHALT LAYER

USED FORMULA

log (ESA $Cumulative_{18}$) ((Zr*So)+((9.36*LOG(SN+1))-0.2)+(Gt/(0.4+(1094/((SN+1)^5.19))))
+((2.32*(LOG(Mr))-8.07)))

Gt = log((P_0-P_t)/(4.2-1.5))

Loss of Serviceability due to swelling = 0.00335*Vr*P8(1-e^(-at))

PARAMETER

Reliability	90 %	(Table 2.2, page II-9, AASHTO 1993)
During Construction		
n	1	
$R_{overall}$	90	
$R_{stage} = (R_{overall})^{1/n}$	0.90	(Section 4.5, page I-63, AASHTO 1993)
Standard of Normal Deviate Z_R	-1.282	(Table 4-1, page I-62 AASHTO 1993)
Standard Error (So)	0.45	(Section 4.5, page I-63, AASHTO 1993)
Initial Seviceability, P_0	4.2	(Section 4.5, page I-63, AASHTO 1993)
Final Seviceability, P_t	2.5	(Section 4.5, page I-63, AASHTO 1993)
CBR Subbase	80 %	
Resilient Modulus of Subgrade (Mr)	120000	

Loss of Serviceability due to roadbed swelling

Potential vertical rise (Vr) =	0.75	using PI = 36.64 and minimum moisture conditions - 5 ft thickness
Design Life, t =	10	
Swell Rate Constant (θ) =	0.12	
Probability of Swell (P) =	100 %	
Loss of Serviceability =	0.176	
Serviceability factor (Gt) =	-0.201	
Design Life =	10	
ESA $Cumulative_{18}$ =	3.044E+07	
Structural Number (Asumption) =	**2.104**	
ESA Cumulative =	3.044E+07	

DETERMINE THICKNEES DESIGN IN GEBANG FLYOVER (AT GRADE)

FLEXIBLE PAVEMENT (DL = 10 YEAR)

Design Life = 10,year

Structural coefisient (a) :

1. Structural Number AC/Wearing Course (MS 1100 kg) per cm = 0.410
2. Structural Number AC/Binder Course (MS 1100 kg) per cm = 0.410
3. Structural Number AC Base (MS 900 kg) per cm = 0.300
4. Structural Number Subbase (kelas A) per cm = 0.132

Formula for SN value from granular materials

Base : **$0.249 * \log(E_{BS}) - 0.977$**

Subbase : **$0.227 * \log(E_{SB}) - 0.839$**

	CBR	Mr	E
Sub grade	5 %	7500 psi	19000 psi
Subbase	80 %	120000 psi	

Drainage coefisient for Base Course, good condition (assumption)
Present of time Pavement to moisture level > 25% 1.00

Result Calculation

	SN_3 (inch)	SN_2 (inch)	SN_2 (asphalt layer) (inch)	Wearing (AC) (cm)	Binder (AC) (cm)	AC Base (cm)	Subbase (Class A) (cm)
Thicknees Every Layer :	**7.237**	**-**	**2.104**	**4**	**6**	**10**	**85.4669**

Thicknees of Subbase (Class A) = 86 cm

SN = $a_{11}D_{11} + a_{12}D_{12} + a_2D_2 + a_3D_3$
(0.410*6) + (0.410*8) + (0.300*10) + (0.132*76)
= 18.45 cm
SN = 7.265 inch > 7.237 inch OK!

TRAFFIC ANALYSIS GEBANG FLYOVER (FLYOVER)

No.	Year	Daily Traffic Volume (Vehicle./day/1 lane)								
		Passenger Car	Oplet, Mini Bus	Pickup, Micro Truck	Small Bus	Large Bus	Truck 2w	Truck 3w	Semi Trailer	Total
	2008	1533	189	1565	54	1145	1595	1150	1058	8289

No.	Year	Daily Traffic Volume (Vehicle./day/1 lane)								
		PC	Oplet, Mini Bus	Pickup, Micro Truck	Small Bus	Large Bus	Truck 2w	Truck 3w	Semi Trailer	Total
	2005	1347	164	1370	47	991	1372	989	931	7211
	2006	1406	172	1432	49	1040	1443	1040	972	7554
	2007	1468	180	1497	51	1091	1517	1094	1014	7912
1	**2008**	**1533**	**189**	**1565**	**54**	**1145**	**1595**	**1150**	**1058**	8289
2	2009	1601	198	1636	57	1202	1677	1209	1104	8684
3	2010	1672	208	1710	60	1261	1764	1271	1152	9098
4	2011	1728	216	1763	62	1309	1839	1325	1191	9433
5	2012	1786	225	1818	64	1359	1918	1382	1232	9784
6	2013	1846	234	1875	66	1411	2000	1441	1274	10147
7	2014	1908	243	1934	69	1465	2086	1503	1318	10526
8	2015	1972	253	1994	72	1521	2175	1567	1363	10917
9	2016	2016	264	2049	75	1575	2278	1641	1407	11305
10	2017	2061	275	2106	78	1631	2386	1719	1453	11709

No.	Year	DAILY ESA								TOTAL DAILY ESA	TOTAL ESA DESIGN LANE (DAILY ESA*0.8)	ESA PER YEAR (10^6)	ESA CUMULATIVE (10^6)
		PC 0.0012	Oplet, Mini Bus 0.2165	Pickup, Micro Truck 0.2458	Small Bus 0.2458	Large Bus 1.0413	Truck 2w 2.9918	Truck 3w 5.3443	Semi Trailer 4.1269				
1	2008	1.84	40.9	384.7	384.7	56.2	3425.6	8524.2	4745.9	17564.0	14051	5.129	5.129
2	2009	1.92	42.9	402.1	402.1	59.4	3596.1	8962.4	4989.4	18456.4	14765	5.389	10.518
3	2010	2.01	45.0	420.3	420.3	62.5	3772.7	9427.3	5245.3	19395.4	15516	5.663	16.181
4	2011	2.07	46.8	433.3	433.3	64.6	3916.3	9828.2	5468.1	20192.7	16154	5.896	22.078
5	2012	2.14	48.7	446.9	446.9	66.6	4065.9	10250.4	5703.4	21030.8	16825	6.141	28.219
6	2013	2.22	50.7	460.9	460.9	68.7	4221.4	10688.6	5946.9	21900.2	17520	6.395	34.614
7	2014	2.29	52.6	475.4	475.4	71.8	4383.0	11148.2	6202.7	22811.4	18249	6.661	41.274
8	2015	2.37	54.8	490.1	490.1	75.0	4550.5	11623.9	6466.9	23753.6	19003	6.936	48.211
9	2016	2.42	57.2	503.6	503.6	78.1	4712.1	12174.3	6772.2	24803.6	19843	7.243	55.453
10	2017	2.47	59.5	517.7	517.7	81.2	4879.6	12751.5	7094.1	25903.8	20723	7.564	63.017
10	2017	2.5	59.5	517.7	517.7	81.2	4879.6	12751.5	7094.1	25903.8	20723	7.564	63.02

GEBANG FLYOVER (FLYOVER)
CALCULATION OF STRUCTURAL NUMBER (SN) TOTAL, DESIGN LIFE = 10 YEARS

USED FORMULA

log (ESA Kumulative$_{18}$) ((Zr*So)+((9.36*LOG(SN+1))-0.2)+(Gt/(0.4+(1094/((SN+1)^5.19))))+((2.32*(LOG(Mr))-8.07)))

Gt = log((P_0-P_t)/(4.2-1.5))

Loss of Serviceability due to swelling = 0.00335*Vr*P8(1-e^(-at))

PARAMETER

Reliability	90 %	(Table 2.2, page II-9, AASHTO 1993)
During construction		
n	1	
$R_{overall}$	90 %	
$R_{stage} = (R_{overall})^{1/n}$	0.90	(Section 4.5, page I-63, AASHTO 1993)
Standar Normal Deviate Z_R	-1.282	(Table 4-1, page I-62 AASHTO 1993)
Standar Error (So)	0.45	(Section 4.5, page I-63, AASHTO 1993)
Initial Seviceability, P_0	4.2	(Section 4.5, page I-63, AASHTO 1993)
Final Seviceability, P_t	2.5	(Section 4.5, page I-63, AASHTO 1993)
CBR Subgrade	8 %	
Resilient Modulus of Subgrade (Mr)	12000	(Mr = 1500CBR)

Loss of Serviceability due to roadbed swelling

Potential vertical rise (Vr) =	0.75	using PI = 36.64 and minimum moisture conditions - 5 ft thickness
Design Life, t =	10	
Swell Rate Constant (θ) =	0.12	
Probability of Swell (P) =	100 %	
Loss of Serviceability =	0.176	
Serviceability factor (Gt) =	-0.201	
Design Life =	10	
ESA Cumulative$_{18}$ =	6.302E+07	
Structural Number (Asumption) =	**5.508489707**	
ESA Cumulative =	6.302E+07	

GEBANG FLYOVER (FLYOVER)
CALCULATION OF STRUCTURAL NUMBER (SN) ASPHALT LAYER

USED FORMULA

log (ESA $Cumulative_{18}$)   ((Zr*So)+((9.36*LOG(SN+1))-0.2)+(Gt/(0.4+(1094/((SN+1)^5.19))))+((2.32*(LOG(Mr))-8.07)))

Gt = $\log((P_0-P_t)/(4.2-1.5))$

Loss of Serviceability due to swelling = 0.00335*Vr*P8(1-e^(-at))

PARAMETER

Reliability	90	%	(Table 2.2, page II-9, AASHTO 1993)
During Construction			
n	1		
$R_{overall}$	90		
$R_{stage} = (R_{overall})^{1/n}$	0.90		(Section 4.5, page I-63, AASHTO 1993)
Standard of Normal Deviate Z_R	-1.282		(Table 4-1, page I-62 AASHTO 1993)
Standard Error (So)	0.45		(Section 4.5, page I-63, AASHTO 1993)
Initial Seviceability, P_0	4.2		(Section 4.5, page I-63, AASHTO 1993)
Final Seviceability, P_t	2.5		(Section 4.5, page I-63, AASHTO 1993)
CBR Subbase	80	%	
Resilient Modulus of Subgrade (Mr)	120000		

Loss of Serviceability due to roadbed swelling

Potential vertical rise (Vr)	=	0.75		using PI = 36.64 and minimum moisture conditions - 5 ft thickness
Design Life, t	=	10		
Swell Rate Constant (θ)	=	0.12		
Probability of Swell (P)	=	100	%	
Loss of Serviceability	=	0.176		
Serviceability factor (Gt)	=	-0.201		
Design Life	=	10		
ESA $Cumulative_{18}$	=	6.302E+07		
Structural Number (Asumption)	=	**2.377**		
ESA Cumulative	=	6.302E+07		

GEBANG FLYOVER (FLYOVER)
DETERMINE THICKNEES DESIGN IN GEBANG FLYOVER (FLYOVER)

FLEXIBLE PAVEMENT (DL = 10 YEAR)

Design Life = 10 year

Structural coefisient (a) :

1. Structural Number AC/Wearing Course (MS 1100 kg) per cm = 0.410
2. Structural Number AC/Binder Course (MS 1100 kg) per cm = 0.410
3. Structural Number AC Base (MS 900 kg) per cm = 0.300
4. Structural Number Subbase (kelas A) per cm = 0.132

Formula for SN value from granular materials

Base : **$0.249 * \log(E_{BS}) - 0.977$**
Subbase : **$0.227 * \log(E_{SB}) - 0.839$**

	CBR	Mr	E
Sub grade	5 %	7500 psi	19000 psi
Subbase	80 %	120000 psi	

Drainage coefisient for Base Course, good condition (assumption)
Present of time Pavement to moisture level > 25% 1.00

Result Calculation

	SN_3 (inch)	SN_2 (inch)	SN_2 (asphalt layer) (inch)	Wearing (AC) (cm)	Binder (AC) (cm)	AC Base (cm)	Subbase (Class A) (cm)
Thicknees Every Layer :	**5.508**	-	**2.377**	**4**	**6**	**10**	**52.20882**

Thicknees of Subbase (Class A) = 52.5 cm

SN = $a_{11}D_{11} + a_{12}D_{12} + a_2D_2 + a_3D_3$
(0.410*6) + (0.410*8) + (0.300*10) + (0.132*70)
= 14.03 cm
SN = 5.524 inch > 5.508 inch OK!

2.6 PAVEMENT THICKNESS DESIGN IN PETERONGAN FLYOVER

TRAFFIC ANALYSIS PETERONGAN FLYOVER (AT GRADE)

No.	Year	Daily Traffic Volume (Vehicle./day/1 lane)								
		Passenger Car	Oplet, Mini Bus	Pickup, Micro Truck	Small Bus	Large Bus	Truck 2w	Truck 3w	Semi Trailer	Total
	2008	1742	644	628	54	874	679	181	239	5041

No.	Year	Daily Traffic Volume (Vehicle./day/1 lane)								
		PC	Oplet, Mini Bus	Pickup, Micro Truck	Small Bus	Large Bus	Truck 2w	Truck 3w	Semi Trailer	Total
	2005	1529	558	550	46	757	584	156	210	4390
	2006	1597	585	575	49	794	614	164	219	4597
	2007	1668	614	601	51	833	646	172	229	4814
1	**2008**	**1742**	**644**	**628**	**54**	**874**	**679**	**181**	**239**	**5041**
2	2009	1819	676	656	57	917	714	190	249	5278
3	2010	1899	709	686	60	962	751	200	260	5527
4	2011	1962	738	707	62	999	783	209	269	5729
5	2012	2028	768	729	64	1037	817	218	278	5939
6	2013	2096	799	752	66	1077	852	227	288	6157
7	2014	2166	831	775	69	1118	888	237	298	6382
8	2015	2238	864	799	72	1161	926	247	308	6615
9	2016	2287	901	821	75	1202	970	259	318	6833
10	2017	2338	940	844	78	1245	1016	271	328	7060

No.	Year	DAILY ESA								TOTAL DAILY ESA	TOTAL ESA DESIGN LANE (DAILY ESA*0.5)	ESA PER YEAR (10^6)	ESA CUMULATIVE (10^6)
		PC 0.0012	Oplet, Mini Bus 0.2165	Pickup, Micro Truck 0.2458	Small Bus 0.2458	Large Bus 1.0413	Truck 2w 2.9918	Truck 3w 5.3443	Semi Trailer 4.1269				
1	2008	2.09	139.4	154.4	154.4	56.2	2614.8	3628.8	747.0	7497.1	3749	1.368	1.368
2	2009	2.18	146.4	161.2	161.2	59.4	2743.5	3815.8	784.1	7873.8	3937	1.437	2.805
3	2010	2.28	153.5	168.6	168.6	62.5	2878.1	4013.6	825.4	8272.6	4136	1.510	4.315
4	2011	2.35	159.8	173.8	173.8	64.6	2988.8	4184.6	862.5	8610.2	4305	1.571	5.886
5	2012	2.43	166.3	179.2	179.2	66.6	3102.5	4366.3	899.7	8962.2	4481	1.636	7.522
6	2013	2.52	173.0	184.8	184.8	68.7	3222.2	4553.3	936.8	9326.2	4663	1.702	9.224
7	2014	2.60	179.9	190.5	190.5	71.8	3344.8	4745.7	978.1	9704.0	4852	1.771	10.995
8	2015	2.69	187.1	196.4	196.4	75.0	3473.5	4948.8	1019.3	10099.1	5050	1.843	12.838
9	2016	2.74	195.1	201.8	201.8	78.1	3596.1	5184.0	1068.9	10528.5	5264	1.921	14.759
10	2017	2.81	203.5	207.5	207.5	81.2	3724.8	5429.8	1118.4	10975.4	5488	2.003	16.762
10	**2017**	**2.8**	**203.5**	**207.5**	**207.5**	**81.2**	**3724.8**	**5429.8**	**1118.4**	**10975.4**	**5488**	**2.003**	**16.76**

PETERONGAN FLYOVER (AT GRADE)

CALCULATION OF STRUCTURAL NUMBER (SN) TOTAL, DESIGN LIFE = 10 YEARS

USED FORMULA

log (ESA Kumulative$_{18}$) ((Zr*So)+((9.36*LOG(SN+1))-0.2)+(Gt/(0.4+(1094/((SN+1)^5.19))))+((2.32*(LOG(Mr))-8.07)))

Gt = log((P$_0$-P$_t$)/(4.2-1.5))

Loss of Serviceability due to swelling = 0.00335*Vr*P8(1-e^(-at))

PARAMETER

Reliability	90 %	(Table 2.2, page II-9, AASHTO 1993)
During construction		
n	1	
$R_{overall}$	90 %	
$R_{stage} = (R_{overall})^{1/n}$	0.90	(Section 4.5, page I-63, AASHTO 1993)
Standar Normal Deviate Z_R	-1.282	(Table 4-1, page I-62 AASHTO 1993)
Standar Error (So)	0.45	(Section 4.5, page I-63, AASHTO 1993)
Initial Seviceability, P_0	4.2	(Section 4.5, page I-63, AASHTO 1993)
Final Seviceability, P_t	2.5	(Section 4.5, page I-63, AASHTO 1993)
CBR Subgrade	3.65 %	
Resilient Modulus of Subgrade (Mr)	5475	(Mr = 1500CBR)

Loss of Serviceability due to roadbed swelling

Potential vertical rise (Vr)	=	0.75	using PI = 36.64 and minimum moisture conditions - 5 ft thickness
Design Life, t	=	10	
Swell Rate Constant (θ)	=	0.12	
Probability of Swell (P)	=	100 %	
Loss of Serviceability	=	0.176	
Serviceability factor (Gt)	=	-0.201	
Design Life	=	10	
ESA Cumulative$_{18}$	=	1.676E+07	
Structural Number (Asumption)	=	**5.890063749**	
ESA Cumulative	=	1.676E+07	

PETERONGAN FLYOVER (AT GRADE)
CALCULATION OF STRUCTURAL NUMBER (SN) ASPHALT LAYER

USED FORMULA

log (ESA Cumulative$_{18}$) ((Zr*So)+((9.36*LOG(SN+1))-0.2)+(Gt/(0.4+(1094/((SN+1)^5.19))))
+((2.32*(LOG(Mr))-8.07)))

Gt = log((P_0-P_t)/(4.2-1.5))

Loss of Serviceability due to swelling = 0.00335*Vr*P8(1-e^(-at))

PARAMETER

Reliability	90 %	(Table 2.2, page II-9, AASHTO 1993)
During Construction		
n	1	
$R_{overall}$	90	
$R_{stage} = (R_{overall})^{1/n}$	0.90	(Section 4.5, page I-63, AASHTO 1993)
Standard of Normal Deviate Z_R	-1.282	(Table 4-1, page I-62 AASHTO 1993)
Standard Error (So)	0.45	(Section 4.5, page I-63, AASHTO 1993)
Initial Seviceability, P_0	4.2	(Section 4.5, page I-63, AASHTO 1993)
Final Seviceability, P_t	2.5	(Section 4.5, page I-63, AASHTO 1993)
CBR Subbase	80 %	
Resilient Modulus of Subgrade (Mr)	120000	

Loss of Serviceability due to roadbed swelling

Potential vertical rise (Vr) =	0.75	using PI = 36.64 and minimum moisture conditions - 5 ft thickness
Design Life, t =	10	
Swell Rate Constant (θ) =	0.12	
Probability of Swell (P) =	100 %	
Loss of Serviceability =	0.176	
Serviceability factor (Gt) =	-0.201	
Design Life =	10	
ESA Cumulative$_{18}$ =	1.676E+07	
Structural Number (Asumption) =	**1.901**	
ESA Cumulative =	1.676E+07	

PETERONGAN FLYOVER (AT GRADE)
DETERMINE THICKNEES DESIGN

FLEXIBLE PAVEMENT (DL = 10 YEAR)

Design Life = 10 year

Structural coefisient (a) :

1. Structural Number AC/Wearing Course (MS 1100 kg) per cm = 0.410
2. Structural Number AC/Binder Course (MS 1100 kg) per cm = 0.410
3. Structural Number AC Base (MS 900 kg) per cm = 0.300
4. Structural Number Subbase (kelas A) per cm = 0.132

Formula for SN value from granular materials

Base : **$0.249 * \log(E_{BS}) - 0.977$**

Subbase : **$0.227 * \log(E_{SB}) - 0.839$**

	CBR	Mr	E
Sub grade	5 %	7500 psi	19000 psi
Subbase	80 %	120000 psi	

Drainage coefisient for Base Course, good condition (assumption)
Present of time Pavement to moisture level > 25% 1.00

Result Calculation

	SN_3 (inch)	SN_2 (inch)	SN_2 (asphalt layer) (inch)	Wearing (AC) (cm)	Binder (AC) (cm)	AC Base (cm)	Subbase (Class A) (cm)
Thicknees Every Layer :	**5.890**	**-**	**1.901**	**4**	**6**	**10**	**59.55123**

Thicknees of Subbase (Class A) = 60 cm

SN = $a_{11}D_{11} + a_{12}D_{12} + a_2D_2 + a_3D_3$

(0.410*6) + (0.410*8) + (0.300*10) + (0.132*60)

= 15.02 cm

SN = 5.913 inch > 5.890 inch OK!

TRAFFIC ANALYSIS PETERONGAN FLYOVER (FLYOVER)

No.	Year	Daily Traffic Volume (Vehicle./day/1 lane)								
		Passenger Car	Oplet, Mini Bus	Pickup, Micro Truck	Small Bus	Large Bus	Truck 2w	Truck 3w	Semi Trailer	Total
	2008	5353	141	1930	26	700	2956	816	1238	13160

No.	Year	Daily Traffic Volume (Vehicle./day/1 lane)								
		PC	Oplet, Mini Bus	Pickup, Micro Truck	Small Bus	Large Bus	Truck 2w	Truck 3w	Semi Trailer	Total
	2005	4701	122	1690	23	606	2542	702	1088	11474
	2006	4909	128	1767	24	636	2673	738	1136	12011
	2007	5126	134	1847	25	667	2811	776	1186	12572
1	2008	5353	141	1930	26	700	2956	816	1238	13160
2	2009	5590	148	2017	27	735	3109	858	1292	13776
3	2010	5837	155	2108	28	771	3269	902	1348	14418
4	2011	6032	161	2174	29	800	3409	941	1394	14940
5	2012	6233	167	2242	30	831	3555	981	1442	15481
6	2013	6441	174	2312	31	863	3707	1023	1491	16042
7	2014	6656	181	2384	32	896	3866	1067	1542	16624
8	2015	6878	188	2458	33	930	4031	1113	1595	17226
9	2016	7030	196	2526	34	963	4222	1166	1647	17784
10	2017	7185	204	2596	35	997	4422	1221	1700	18360

No.	Year	DAILY ESA								TOTAL DAILY ESA	TOTAL ESA DESIGN LANE (DAILY ESA*0.5)	ESA PER YEAR (10^6)	ESA CUMULATIVE (10^6)
		PC 0.0012	Oplet, Mini Bus 0.2165	Pickup, Micro Truck 0.2458	Small Bus 0.2458	Large Bus 1.0413	Truck 2w 2.9918	Truck 3w 5.3443	Semi Trailer 4.1269				
1	2008	6.42	30.5	474.4	474.4	27.1	2094.3	15797.8	3367.6	22272.4	11136	4.065	4.065
2	2009	6.71	32.0	495.8	495.8	28.1	2199.0	16615.4	3540.9	23413.7	11707	4.273	8.338
3	2010	7.00	33.6	518.1	518.1	29.2	2306.7	17470.5	3722.5	24605.7	12303	4.491	12.828
4	2011	7.24	34.9	534.4	534.4	30.2	2393.4	18218.7	3883.4	25636.6	12818	4.679	17.507
5	2012	7.48	36.2	551.1	551.1	31.2	2486.2	18999.0	4048.5	26710.7	13355	4.875	22.382
6	2013	7.73	37.7	568.3	568.3	32.3	2581.9	19811.3	4221.8	27829.3	13915	5.079	27.460
7	2014	7.99	39.2	586.0	586.0	33.3	2680.7	20661.1	4403.4	28997.6	14499	5.292	32.753
8	2015	8.25	40.7	604.2	604.2	34.4	2782.4	21542.9	4593.2	30210.2	15105	5.513	38.266
9	2016	8.44	42.4	620.9	620.9	35.4	2881.1	22563.6	4812.0	31584.8	15792	5.764	44.030
10	2017	8.62	44.2	638.1	638.1	36.4	2982.8	23632.5	5038.9	33019.7	16510	6.026	50.056
10	2017	8.6	44.2	638.1	638.1	36.4	2982.8	23632.5	5038.9	33019.7	16510	6.026	50.06

CALCULATION OF STRUCTURAL NUMBER (SN) TOTAL, DESIGN LIFE = 10 YEARS

USED FORMULA

log (ESA $Kumulative_{18}$) ((Zr*So)+((9.36*LOG(SN+1))-0.2)+(Gt/(0.4+(1094/((SN+1)^5.19))))
+((2.32*(LOG(Mr))-8.07)))

Gt = log((P_0-P_t)/(4.2-1.5))

Loss of Serviceability due to swelling = 0.00335*Vr*P8(1-e^(-at))

PARAMETER

Reliability	90 %	(Table 2.2, page II-9, AASHTO 1993)
During construction		
n	1	
$R_{overall}$	90 %	
$R_{stage} = (R_{overall})^{1/n}$	0.90	(Section 4.5, page I-63, AASHTO 1993)
Standar Normal Deviate Z_R	-1.282	(Table 4-1, page I-62 AASHTO 1993)
Standar Error (So)	0.45	(Section 4.5, page I-63, AASHTO 1993)
Initial Seviceability, P_0	4.2	(Section 4.5, page I-63, AASHTO 1993)
Final Seviceability, P_t	2.5	(Section 4.5, page I-63, AASHTO 1993)
CBR Subgrade	5 %	
Resilient Modulus of Subgrade (Mr)	7500	(Mr = 1500CBR)

Loss of Serviceability due to roadbed swelling

Potential vertical rise (Vr)	=	0.75	using PI = 36.64 and minimum moisture conditions - 5 ft thickness
Design Life, t	=	10	
Swell Rate Constant (θ)	=	0.12	
Probability of Swell (P)	=	100 %	
Loss of Serviceability	=	0.176	
Serviceability factor (Gt)	=	-0.201	
Design Life	=	10	
ESA $Cumulative_{18}$	=	5.006E+07	
Structural Number (Asumption)	=	**6.180279342**	
ESA Cumulative	=	5.006E+07	

PETERONGAN FLYOVER (FLYOVER)

CALCULATION OF STRUCTURAL NUMBER (SN) ASPHALT LAYER

USED FORMULA

log (ESA Cumulative$_{18}$) ((Zr*So)+((9.36*LOG(SN+1))-0.2)+(Gt/(0.4+(1094/((SN+1)^5.19)))) +((2.32*(LOG(Mr))-8.07)))

Gt = log((P_0-P_t)/(4.2-1.5))

Loss of Serviceability due to swelling = 0.00335*Vr*P8(1-e^(-at))

PARAMETER

Reliability	90 %	(Table 2.2, page II-9, AASHTO 1993)
During Construction		
n	1	
$R_{overall}$	90	
$R_{stage} = (R_{overall})^{1/n}$	0.90	(Section 4.5, page I-63, AASHTO 1993)
Standard of Normal Deviate Z_R	-1.282	(Table 4-1, page I-62 AASHTO 1993)
Standard Error (So)	0.45	(Section 4.5, page I-63, AASHTO 1993)
Initial Seviceability, P_0	4.2	(Section 4.5, page I-63, AASHTO 1993)
Final Seviceability, P_t	2.5	(Section 4.5, page I-63, AASHTO 1993)
CBR Subbase	80 %	
Resilient Modulus of Subgrade (Mr)	120000	

Loss of Serviceability due to roadbed swelling

Potential vertical rise (Vr)	=	0.75	using PI = 36.64 and minimum moisture conditions - 5 ft thickness
Design Life, t	=	10	
Swell Rate Constant (θ)	=	0.12	
Probability of Swell (P)	=	100 %	
Loss of Serviceability	=	0.176	
Serviceability factor (Gt)	=	-0.201	
Design Life	=	10	
ESA Cumulative$_{18}$	=	5.006E+07	
Structural Number (Asumption)	=	**2.288**	
ESA Cumulative	=	5.006E+07	

PETERONGAN FLYOVER (FLYOVER)
DETERMINE THICKNEES DESIGN

FLEXIBLE PAVEMENT (DL = 10 YEAR)

Design Life = 10 year

Structural coefisient (a) :

1. Structural Number AC/Wearing Course (MS 1100 kg) per cm = 0.410
2. Structural Number AC/Binder Course (MS 1100 kg) per cm = 0.410
3. Structural Number AC Base (MS 900 kg) per cm = 0.300
4. Structural Number Subbase (kelas A) per cm = 0.132

Formula for SN value from granular materials

Base : **$0.249 * \log(E_{BS}) - 0.977$**

Subbase : **$0.227 * \log(E_{SB}) - 0.839$**

	CBR	Mr	E
Sub grade	5 %	7500 psi	19000 psi
Subbase	80 %	120000 psi	

Drainage coefisient for Base Course, good condition (assumption)
Present of time Pavement to moisture level > 25% 1.00

Result Calculation

	SN_3 (inch)	SN_2 (inch)	SN_2 (asphalt layer) (inch)	Wearing (AC) (cm)	Binder (AC) (cm)	AC Base (cm)	Subbase (Class A) (cm)
Thicknees Every Layer :	**6.180**	**-**	**2.288**	**4**	**6**	**10**	**65.13568**

Thicknees of Subbase (Class A) = 65.5 cm

SN = $a_{11}D_{11} + a_{12}D_{12} + a_2D_2 + a_3D_3$

(0.410*6) + (0.410*8) + (0.300*10) + (0.132*65.5)

= 15.75 cm

SN = 6.199 inch > 6.180 inch OK!

2.7 PAVEMENT THICKNESS DESIGN IN TANGULANGIN FLYOVER

TRAFFIC ANALYSIS TANGGULANGIN FLYOVER (AT GRADE)

(1/4)

No.	Year	Daily Traffic Volume (Vehicle./day/1 lane)								
		Passenger Car	Oplet, Mini Bus	Pickup, Micro Truck	Small Bus	Large Bus	Truck 2w	Truck 3w	Semi Trailer	Total
	2008	1620	3661	760	26	0	565	108	21	6761

No.	Year	Daily Traffic Volume (Vehicle./day/1 lane)								
		PC	Oplet, Mini Bus	Pickup, Micro Truck	Small Bus	Large Bus	Truck 2w	Truck 3w	Semi Trailer	Total
	2005	1422	3171	665	22	0	486	93	18	5879
	2006	1485	3327	696	24	0	511	98	19	6160
	2007	1551	3490	727	25	0	537	103	20	6453
1	**2008**	**1620**	**3661**	**760**	**26**	**0**	**565**	**108**	**21**	**6761**
2	2009	1692	3841	794	27	0	594	114	22	7084
3	2010	1767	4030	830	28	0	625	120	23	7423
4	2011	1826	4192	856	29	0	652	125	24	7704
5	2012	1887	4361	883	30	0	680	130	25	7996
6	2013	1950	4536	911	31	0	709	136	26	8299
7	2014	2015	4718	939	32	0	739	142	27	8612
8	2015	2082	4908	968	33	0	771	148	28	8938
9	2016	2128	5120	995	34	0	808	155	29	9269
10	2017	2175	5341	1023	35	0	846	162	30	9612

No.	Year	DAILY ESA								TOTAL	TOTAL ESA	ESA	ESA
		PC	Oplet, Mini Bus	Pickup, Micro Truck	Small Bus	Large Bus	Truck 2w	Truck 3w	Semi Trailer	DAILY ESA	DESIGN LANE	PER YEAR	CUMULATIVE
		0.0012	0.2165	0.2458	0.2458	1.0413	2.9918	5.3443	4.1269		(DAILY ESA*0.5)	(10^6)	(10^6)
1	**2008**	**1.94**	**792.6**	**186.8**	**186.8**	**27.1**	**0.0**	**3019.5**	**445.7**	**4660.5**	**2330**	**0.851**	**0.851**
2	2009	2.03	831.6	195.2	195.2	28.1	0.0	3174.5	470.5	4897.0	2449	0.894	1.744
3	2010	2.12	872.5	204.0	204.0	29.2	0.0	3340.2	495.2	5147.2	2574	0.939	2.684
4	2011	2.19	907.6	210.4	210.4	30.2	0.0	3484.5	515.9	5361.1	2681	0.978	3.662
5	2012	2.26	944.2	217.0	217.0	31.2	0.0	3634.1	536.5	5582.4	2791	1.019	4.681
6	2013	2.34	982.0	223.9	223.9	32.3	0.0	3789.1	561.3	5814.9	2907	1.061	5.742
7	2014	2.42	1021.4	230.8	230.8	33.3	0.0	3949.4	586.0	6054.3	3027	1.105	6.847
8	2015	2.50	1062.6	237.9	237.9	34.4	0.0	4120.5	610.8	6306.5	3153	1.151	7.998
9	2016	2.55	1108.5	244.6	244.6	35.4	0.0	4318.2	639.7	6593.4	3297	1.203	9.201
10	2017	2.61	1156.3	251.5	251.5	36.4	0.0	4521.3	668.6	6888.1	3444	1.257	10.458
10	**2017**	**2.6**	**1156.3**	**251.5**	**251.5**	**36.4**	**0.0**	**4521.3**	**668.6**	**6888.1**	**3444**	**1.257**	**10.46**

TANGGULANGIN FLYOVER (AT GRADE)
CALCULATION OF STRUCTURAL NUMBER (SN) TOTAL, DESIGN LIFE = 10 YEARS

USED FORMULA

log (ESA $Kumulative_{18}$) ((Zr*So)+((9.36*LOG(SN+1))-0.2)+(Gt/(0.4+(1094/((SN+1)^5.19))))
+((2.32*(LOG(Mr))-8.07)))

Gt = log((P_0-P_t)/(4.2-1.5))

Loss of Serviceability due to swelling = 0.00335*Vr*P8(1-e^(-at))

PARAMETER

Reliability	90 %	(Table 2.2, page II-9, AASHTO 1993)
During construction		
n	1	
$R_{overall}$	90 %	
$R_{stage} = (R_{overall})^{1/n}$	0.90	(Section 4.5, page I-63, AASHTO 1993)
Standar Normal Deviate Z_R	-1.282	(Table 4-1, page I-62 AASHTO 1993)
Standar Error (So)	0.45	(Section 4.5, page I-63, AASHTO 1993)
Initial Seviceability, P_0	4.2	(Section 4.5, page I-63, AASHTO 1993)
Final Seviceability, P_t	2.5	(Section 4.5, page I-63, AASHTO 1993)
CBR Subgrade	2.73 %	
Resilient Modulus of Subgrade (Mr)	4095	(Mr = 1500CBR)

Loss of Serviceability due to roadbed swelling

Potential vertical rise (Vr) =	0.75	using PI = 36.64 and minimum moisture conditions - 5 ft thickness
Design Life, t =	10	
Swell Rate Constant (θ) =	0.12	
Probability of Swell (P) =	100 %	
Loss of Serviceability =	0.176	
Serviceability factor (Gt) =	-0.201	
Design Life =	10	
ESA $Cumulative_{18}$ =	1.046E+07	
Structural Number (Asumption) =	**6.050246894**	
ESA Cumulative =	1.046E+07	

TANGGULANGIN FLYOVER (AT GRADE)
CALCULATION OF STRUCTURAL NUMBER (SN) ASPHALT LAYER

USED FORMULA

log (ESA $Cumulative_{18}$) ((Zr*So)+((9.36*LOG(SN+1))-0.2)+(Gt/(0.4+(1094/((SN+1)^5.19))))+((2.32*(LOG(Mr))-8.07)))

Gt = $\log((P_0-P_t)/(4.2-1.5))$

Loss of Serviceability due to swelling = 0.00335*Vr*P8(1-e^(-at))

PARAMETER

Reliability	90 %	(Table 2.2, page II-9, AASHTO 1993)
During Construction		
n	1	
$R_{overall}$	90	
$R_{stage} = (R_{overall})^{1/n}$	0.90	(Section 4.5, page I-63, AASHTO 1993)
Standard of Normal Deviate Z_R	-1.282	(Table 4-1, page I-62 AASHTO 1993)
Standard Error (So)	0.45	(Section 4.5, page I-63, AASHTO 1993)
Initial Seviceability, P_0	4.2	(Section 4.5, page I-63, AASHTO 1993)
Final Seviceability, P_t	2.5	(Section 4.5, page I-63, AASHTO 1993)
CBR Subbase	80 %	
Resilient Modulus of Subgrade (Mr)	120000	

Loss of Serviceability due to roadbed swelling

Potential vertical rise (Vr) =	0.75	using PI = 36.64 and minimum moisture conditions - 5 ft thickness
Design Life, t =	10	
Swell Rate Constant (θ) =	0.12	
Probability of Swell (P) =	100 %	
Loss of Serviceability =	0.176	
Serviceability factor (Gt) =	-0.201	
Design Life =	10	
ESA $Cumulative_{18}$ =	1.046E+07	
Structural Number (Asumption) =	**1.752**	
ESA Cumulative =	1.046E+07	

TANGGULANGIN FLYOVER (AT GRADE)
DETERMINE THICKNEES DESIGN

FLEXIBLE PAVEMENT (DL = 10 YEAR)

Design Life = 10 year

Structural coefisient (a) :

1. Structural Number AC/Wearing Course (MS 1100 kg) per cm = 0.410
2. Structural Number AC/Binder Course (MS 1100 kg) per cm = 0.410
3. Structural Number AC Base (MS 900 kg) per cm = 0.300
4. Structural Number Subbase (kelas A) per cm = 0.132

Formula for SN value from granular materials

Base : **$0.249 * \log(E_{BS}) - 0.977$**

Subbase : **$0.227 * \log(E_{SB}) - 0.839$**

	CBR	Mr	E
Sub grade	5 %	7500 psi	19000 psi
Subbase	80 %	120000 psi	

Drainage coefisient for Base Course, good condition (assumption)
Present of time Pavement to moisture level > 25% 1.00

Result Calculation

	SN_3 (inch)	SN_2 (inch)	SN_2 (asphalt layer) (inch)	Wearing (AC) (cm)	Binder (AC) (cm)	AC Base (cm)	Subbase (Class A) (cm)
Thicknees Every Layer :	**6.050**	**-**	**1.752**	**4**	**6**	**10**	**62.63354**

Thicknees of Subbase (Class A) = 63 cm

SN = $a_{11}D_{11} + a_{12}D_{12} + a_2D_2 + a_3D_3$

(0.410*6) + (0.410*8) + (0.300*10) + (0.132*63)

= 15.42 cm

SN = 6.069 inch > 6.050 inch OK!

TRAFFIC ANALYSIS TANGGULANGIN FLYOVER (FLYOVER)

No.	Year	Daily Traffic Volume (Vehicle./day/1 lane)								
		Passenger Car	Oplet, Mini Bus	Pickup, Micro Truck	Small Bus	Large Bus	Truck 2w	Truck 3w	Semi Trailer	Total
	2008	4608	698	2163	22	22	2968	571	77	11129

No.	Year	Daily Traffic Volume (Vehicle./day/1 lane)								
		PC	Oplet, Mini Bus	Pickup, Micro Truck	Small Bus	Large Bus	Truck 2w	Truck 3w	Semi Trailer	Total
	2005	4047	604	1894	19	20	2553	491	68	9695
	2006	4226	634	1980	20	20	2684	516	71	10151
	2007	4413	665	2069	21	21	2822	543	74	10628
1	**2008**	**4608**	**698**	**2163**	**22**	**22**	**2968**	**571**	**77**	**11129**
2	2009	4812	732	2261	23	23	3121	600	80	11652
3	2010	5025	768	2363	24	24	3282	631	83	12200
4	2011	5193	799	2437	25	25	3422	658	86	12645
5	2012	5366	831	2513	26	26	3568	686	89	13105
6	2013	5545	864	2591	27	27	3721	715	92	13582
7	2014	5730	899	2672	28	28	3880	746	95	14078
8	2015	5921	935	2755	29	29	4046	778	98	14591
9	2016	6052	975	2832	30	30	4238	815	101	15073
10	2017	6186	1017	2911	31	31	4439	854	104	15573

No.	Year	DAILY ESA								TOTAL DAILY ESA	TOTAL ESA DESIGN LANE (DAILY ESA*0.5)	ESA PER YEAR (10^6)	ESA CUMULATIVE (10^6)
		PC	Oplet, Mini Bus	Pickup, Micro Truck	Small Bus	Large Bus	Truck 2w	Truck 3w	Semi Trailer				
		0.0012	0.2165	0.2458	0.2458	1.0413	2.9918	5.3443	4.1269				
1	**2008**	**5.53**	**151.1**	**531.7**	**531.7**	**22.9**	**65.8**	**15861.9**	**2356.5**	**19527.0**	**9764**	**3.564**	**3.564**
2	2009	5.77	158.5	555.8	555.8	23.9	68.8	16679.6	2476.1	20524.2	10262	3.746	7.309
3	2010	6.03	166.3	580.8	580.8	25.0	71.8	17540.0	2604.1	21574.8	10787	3.937	11.247
4	2011	6.23	173.0	599.0	599.0	26.0	74.8	18288.2	2715.5	22481.8	11241	4.103	15.350
5	2012	6.44	179.9	617.7	617.7	27.1	77.8	19068.5	2831.1	23426.1	11713	4.275	19.625
6	2013	6.65	187.1	636.9	636.9	28.1	80.8	19886.1	2950.7	24413.2	12207	4.455	24.080
7	2014	6.88	194.6	656.8	656.8	29.2	83.8	20735.9	3078.7	25442.5	12721	4.643	28.724
8	2015	7.11	202.4	677.2	677.2	30.2	86.8	21623.0	3210.7	26514.6	13257	4.839	33.563
9	2016	7.26	211.1	696.1	696.1	31.2	89.8	22649.1	3363.4	27744.1	13872	5.063	38.626
10	2017	7.42	220.2	715.5	715.5	32.3	92.7	23723.3	3524.4	29031.4	14516	5.298	43.924
10	**2017**	**7.4**	**220.2**	**715.5**	**715.5**	**32.3**	**92.7**	**23723.3**	**3524.4**	**29031.4**	**14516**	**5.298**	**43.92**

TANGGULANGIN FLYOVER (FLYOVER) (2/4)
CALCULATION OF STRUCTURAL NUMBER (SN) TOTAL, DESIGN LIFE = 10 YEARS

USED FORMULA

log (ESA Kumulative$_{18}$) ((Zr*So)+((9.36*LOG(SN+1))-0.2)+(Gt/(0.4+(1094/((SN+1)^5.19))))
+((2.32*(LOG(Mr))-8.07)))

Gt = log((P_0-P_t)/(4.2-1.5))

Loss of Serviceability due to swelling = 0.00335*Vr*P8(1-e^(-at))

PARAMETER

Reliability	90 %	(Table 2.2, page II-9, AASHTO 1993)
During construction		
n	1	
$R_{overall}$	90 %	
$R_{stage} = (R_{overall})^{1/n}$	0.90	(Section 4.5, page I-63, AASHTO 1993)
Standar Normal Deviate Z_R	-1.282	(Table 4-1, page I-62 AASHTO 1993)
Standar Error (So)	0.45	(Section 4.5, page I-63, AASHTO 1993)
Initial Seviceability, P_0	4.2	(Section 4.5, page I-63, AASHTO 1993)
Final Seviceability, P_t	2.5	(Section 4.5, page I-63, AASHTO 1993)
CBR Subgrade	8 %	
Resilient Modulus of Subgrade (Mr)	12000	(Mr = 1500CBR)

Loss of Serviceability due to roadbed swelling

Potential vertical rise (Vr)	=	0.75	using PI = 36.64 and minimum moisture conditions - 5 ft thickness
Design Life, t	=	10	
Swell Rate Constant (θ)	=	0.12	
Probability of Swell (P)	=	100 %	
Loss of Serviceability	=	0.176	
Serviceability factor (Gt)	=	-0.201	
Design Life	=	10	
ESA Cumulative$_{18}$	=	4.392E+07	
Structural Number (Asumption)	=	**5.240108177**	
ESA Cumulative	=	4.392E+07	

TANGGULANGIN FLYOVER (FLYOVER)
CALCULATION OF STRUCTURAL NUMBER (SN) ASPHALT LAYER

USED FORMULA

log (ESA Cumulative$_{18}$) ((Zr*So)+((9.36*LOG(SN+1))-0.2)+(Gt/(0.4+(1094/((SN+1)^5.19))))
+((2.32*(LOG(Mr))-8.07)))

Gt = log((P$_0$-P$_t$)/(4.2-1.5))

Loss of Serviceability due to swelling = 0.00335*Vr*P8(1-e^(-at))

PARAMETER

Reliability	90 %	(Table 2.2, page II-9, AASHTO 1993)
During Construction		
n	1	
$R_{overall}$	90	
$R_{stage} = (R_{overall})^{1/n}$	0.90	(Section 4.5, page I-63, AASHTO 1993)
Standard of Normal Deviate Z_R	-1.282	(Table 4-1, page I-62 AASHTO 1993)
Standard Error (So)	0.45	(Section 4.5, page I-63, AASHTO 1993)
Initial Seviceability, P_0	4.2	(Section 4.5, page I-63, AASHTO 1993)
Final Seviceability, P_t	2.5	(Section 4.5, page I-63, AASHTO 1993)
CBR Subbase	80 %	
Resilient Modulus of Subgrade (Mr)	120000	

Loss of Serviceability due to roadbed swelling

Potential vertical rise (Vr)	=	0.75	using PI = 36.64 and minimum moisture conditions - 5 ft thickness
Design Life, t	=	10	
Swell Rate Constant (θ)	=	0.12	
Probability of Swell (P)	=	100 %	
Loss of Serviceability	=	0.176	
Serviceability factor (Gt)	=	-0.201	
Design Life	=	10	
ESA Cumulative$_{18}$	=	4.392E+07	
Structural Number (Asumption)	=	**2.238**	
ESA Cumulative	=	4.392E+07	

TANGGULANGIN FLYOVER (FLYOVER)
DETERMINE THICKNEES DESIGN

FLEXIBLE PAVEMENT (DL = 10 YEAR)

Design Life = 10 year

Structural coefisient (a) :

1. Structural Number AC/Wearing Course (MS 1100 kg) per cm = 0.410
2. Structural Number AC/Binder Course (MS 1100 kg) per cm = 0.410
3. Structural Number AC Base (MS 900 kg) per cm = 0.300
4. Structural Number Subbase (kelas A) per cm = 0.132

Formula for SN value from granular materials

Base : **$0.249 * \log(E_{BS}) - 0.977$**

Subbase : **$0.227 * \log(E_{SB}) - 0.839$**

	CBR	Mr	E
Sub grade	5 %	7500 psi	19000 psi
Subbase	80 %	120000 psi	

Drainage coefisient for Base Course, good condition (assumption)
Present of time Pavement to moisture level > 25% 1.00

Result Calculation

	SN_3 (inch)	SN_2 (inch)	SN_2 (asphalt layer) (inch)	Wearing (AC) (cm)	Binder (AC) (cm)	AC Base (cm)	Subbase (Class A) (cm)
Thicknees Every Layer :	**5.240**	**-**	**2.238**	**4**	**6**	**10**	**47.04451**

Thicknees of Subbase (Class A) = 50 cm

SN = $a_{11}D_{11} + a_{12}D_{12} + a_2D_2 + a_3D_3$

(0.410*6) + (0.410*8) + (0.300*10) + (0.132*63.5)

= 13.70 cm

SN = 5.394 inch > 5.240 inch OK!

3. DRAINAGE DESIGN REPORT

3.1 DRAINAGE DESING IN MERAK FLYOVER

DAILY RAINFALL
INTERVAL OF GUTTER INLET
DIMENSHON OF SIDE DITCH
DRAINAGE DESIGN AT VIADUCT
DRAINAGE DESIGN AT APPROACH

DAILY RAINFALL SERANG STATION (BANTEN)

No	Years	Rainfall Data (mm)
1	1994	140.00
2	1995	84.00
3	1996	109.00
4	1997	88.00
5	1998	77.00
6	1999	104.00
7	2000	84.00
8	2001	75.00
9	2002	94.00
10	2003	53.00
11	2004	107.00

DISTRIBUTION OF GUMBEL

No.	Years	Daily Rainfall Average (mm)	$(X - X_{ave})^2$	$(X - X_{ave})^3$	$(X - X_{ave})^4$
1	1994	140.000	2277.893	108717.600	5188794.524
2	1995	84.000	68.438	-566.169	4683.762
3	1996	109.000	279.802	4680.319	78288.965
4	1997	88.000	18.256	-78.004	333.289
5	1998	77.000	233.256	-3562.458	54408.454
6	1999	104.000	137.529	1612.839	18914.205
7	2000	84.000	68.438	-566.169	4683.762
8	2001	75.000	298.347	-5153.268	89010.997
9	2002	94.000	2.983	5.153	8.901
10	2003	53.000	1542.347	-60572.177	2378834.600
11	2004	107.000	216.893	3194.236	47042.383
	Σ	1015.000	5144.182	47711.901	7865003.842

X Mean =	92.273	mm		
Standart Deviation =	22.681	mm		
Skewness Coefficient =	**0.568**		**Syarat :**	**1.140**
Kurtosis Coefficient=	**5.897**		**Syarat :**	**5.400**
Reduced Mean Y_N =	0.4952			
Reduced Standard Deviation S_N =	0.9496			
b =	80.445			
1/a =	23.885			

Result Formula

$53.920 + 12.941\ Y_T$

Design Maximum Daily Rainfall on "T" Years Repeat Period

No.	Return Period (years)	Yt	XT (mm)
1	2	0.3665	89.199
2	5	1.4999	116.270
3	10	2.2502	134.190
4	20	2.9606	151.158
5	25	3.1985	156.840
6	50	3.9019	173.640
7	100	4.6001	190.317

GUMBEL

DISTRIBUTION OF PEARSON

No.	Years	Daily Rainfall Average (mm)	Log X	$(\text{Log X} - \log X_{ave})^2$	$(\text{Log X} - \log X_{ave})^3$
1	1994	140.000	2.146	0.037	0.007
2	1995	84.000	1.924	0.001	0.000
3	1996	109.000	2.037	0.007	0.001
4	1997	88.000	1.944	0.000	0.000
5	1998	77.000	1.886	0.004	0.000
6	1999	104.000	2.017	0.004	0.000
7	2000	84.000	1.924	0.001	0.000
8	2001	75.000	1.875	0.006	0.000
9	2002	94.000	1.973	0.000	0.000
10	2003	53.000	1.724	0.052	-0.012
11	2004	107.000	2.029	0.006	0.000
		1015.000	21.482	0.119	-0.004

Average =	1.953
Standart Deviation =	0.109
Skewness Coefficient=	-0.450

Result Formula,

$\text{Log } X_T = \log X_{ave} + Y_T . S_D$

Design Maximum Daily Rainfall on "T" Years Repeat Period

No.	Return Period (years)	Y_T	Log X_T	XT (mm)
1	2	-0.0524	1.9472	88.549
2	5	0.8228	2.0428	110.351
3	10	1.3102	2.0960	124.742
4	20	1.4939	2.1161	130.640
5	25	1.8537	2.1554	143.012
6	50	2.2185	2.1952	156.756
7	100	2.5547	2.2319	170.585

Log Pearson Type III

DISTRIBUTION OF LOG NORMAL

No.	Years	CH. HARIAN RATA-RATA (mm)	Log X	(Log X - log X_{ave})	(Log X - log $X_{ave})^2$
1	1994	140.000	2.146	0.193	0.037
2	1995	84.000	1.924	-0.029	0.001
3	1996	109.000	2.037	0.085	0.007
4	1997	88.000	1.944	-0.008	0.000
5	1998	77.000	1.886	-0.066	0.004
6	1999	104.000	2.017	0.064	0.004
7	2000	84.000	1.924	-0.029	0.001
8	2001	75.000	1.875	-0.078	0.006
9	2002	94.000	1.973	0.020	0.000
10	2003	53.000	1.724	-0.229	0.052
11	2004	107.000	2.029	0.076	0.006
	Jumlah	1015.000	21.482	0.000	0.119

Average = 1.953
Standart Deviation = 0.109
Variable Coefficient 0.056
Skewness Coefficient= 0.168 **Max rate : 0.168**
kurtosis Coefficient 3.050

Result Formula,
$\text{Log } X_T = \log X_{ave} + Y_T.S_D$

Design Maximum Daily Rainfall on "T" Years Repeat Period

Return Period (years)	Y_T	Log X_T	XT (mm)
2	-0.0703	1.9452	88.152
5	0.8103	2.0414	110.005
10	1.3142	2.0965	124.868
20	1.7545	2.1445	139.489
25	1.8418	2.1541	142.587
50	2.2786	2.2018	159.144
100	2.6089	2.2379	172.925

Log Normal

LOG NORMAL

EQUIVALENT AVERAGE INTENSITY OF COMPUTED EXTREME VALUES

Return Period (Year)	5 mins	10 mins	15 mins	20 mins	30 mins	45 mins	60 mins	80 mins	100 mins	120 mins	150 mins	3 hrs	6 hrs
2	160.904	101.3629	77.35437	63.85462	48.7302	37.1881	30.6981	25.34072	21.83797	19.33859	16.66549	14.75811	9.297025
5	200.521	126.3203	96.40044	79.57681	60.72847	46.3445	38.25654	31.58008	27.21489	24.10011	20.76885	18.39183	11.58612
10	226.900	142.9383	109.0824	90.04552	68.71759	52.44134	43.28937	35.73459	30.79513	27.27059	23.50109	20.81136	13.11033
20	253.468	159.6748	121.8547	100.5888	76.76365	58.58163	48.35807	39.91871	34.4009	30.46368	26.2528	23.24814	14.64541
25	259.870	163.708	124.9326	103.1296	78.70262	60.06134	49.57955	40.92701	35.26983	31.23316	26.91592	23.83536	15.01534
50	289.183	182.174	139.0247	114.7623	87.58006	66.83609	55.17198	45.54347	39.24817	34.75617	29.95196	26.52392	16.70902
100	314.226	197.950	151.064	124.7006	95.16438	72.62401	59.9498	49.48747	42.64701	37.76601	32.54576	28.82086	18.156

COMPUTED EXTREME VALUE OF PRECIPITATION

Return Period (Year)	5 mins	10 mins	15 mins	20 mins	30 mins	45 mins	60 mins	80 mins	100 mins	120 mins	150 mins	180 mins	360 mins
2	13.40863	16.89382	19.33859	21.28487	24.3651	27.89108	30.6981	33.78763	36.39662	38.67718	41.66373	44.27432	55.78215
5	16.71008	21.05339	24.10011	26.5256	30.36424	34.75837	38.25654	42.10677	45.35814	48.20022	51.92211	55.17548	69.51675
10	18.90837	23.82306	27.27059	30.01517	34.35879	39.331	43.28937	47.64612	51.32522	54.54119	58.75271	62.43407	78.662
20	21.12233	26.61247	30.46368	33.52961	38.38183	43.93622	48.35807	53.22494	57.33483	60.92735	65.632	69.74441	87.87245
25	21.65586	27.28468	31.23316	34.37654	39.35131	45.04601	49.57955	54.56935	58.78305	62.46631	67.2898	71.50608	90.09201
50	24.09858	30.36231	34.75617	38.25411	43.79003	50.12707	55.17198	60.72462	65.41362	69.51234	74.8799	79.57176	100.2541
100	26.18549	32.99165	37.76601	41.56687	47.58219	54.46801	59.9498	65.98329	71.07835	75.53202	81.3644	86.46258	108.936

Max Daily Rainfall Calculation for MERAK Flyover

Return Period	Gumbel	Log Pearson	Log Normal	Terpakai
2	89.199	88.549	88.152	88.549
5	116.270	110.351	110.005	110.351
10	134.190	124.742	124.868	124.868
20	151.158	130.640	139.489	139.489
25	156.840	143.012	142.587	143.012
50	173.640	156.756	159.144	159.144
100	190.317	170.585	172.925	172.925

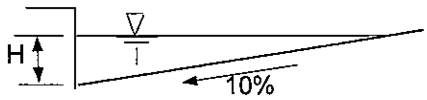
INTERVAL OF GUTTER INLET

- Section 0+580- 0+702

Distance (Lo) =	**122 m**	
Vertical Grades of Road (i)=	0.31%	
Road Width (L1) =	5.5 m	
Super Elevation (m1) =	2.00%	(Pavement)
Super Elevation (m2) =	10.00%	(Gutter)
Rainfall intensity (Y) =	**110.35** mm	
(5 years return period)		
Coefficient of Run-off (C) =	0.9	(Concrete)

1) Catchments Area

Catchments Area (A= L0*L1) 671 m^2



2) Time Concentration

t1 = {2/3 x 3.28 x L1 x nd / (m1) ^ 0.5} ^ 0.167 = 1.02 min. Friction Coefl 0.013

t2 = {2/3 x 3.28 x Lo x nd / (i) ^ 0.5} ^ 0.167 = 1.99 min.

TC = t1 + t2 3.01 min. = 0.05 hour

3) Volume of Run-Off

Rainfall intensity

I = (Y /24) * (24 / TC) ^ 2/3 = 281.2 mm/ hour

Volume of Run-Off

Q = 1 / (3.6 x 10^6) x C x I x A = 0.0472 m^3/sec.

Possible Through Volume of Run-Off along Gutter

Q1 = v x a (m^3/sec.)

Velocity of Flow (v)

$v = (1 / n) \times R^{2/3} \times i^{1/2}$

n = 0.02 (Concrete)

R = H / {2 x (1 + m2) } = 0.455 H

v = 2.20 $H^{2/3}$

a = H^2 / (2 *m2)= 5 H^2

Q1 = v x a = 11.0 $H^{8/3}$

Q = Q1

0.0501 = 11.0 $H^{8/3}$

H = 0.13 meter

4) Needed Number of Gutter Inlet

Dimension of Gutter Inlet

w = 50 cm

l = 15 cm

Coefficient lost of Gutter Inlet (C) = 80%

Area of Gutter Inlet

A = w x l / = 0.0375 m^2

Volume of Gutter Inlet

q = A x v = 0.017 m^3/sec.

N = Q / q = 2.8 < 3 each

d = L / N = 40.6667 m

Design of Dimension and Distance for Gutter Inlet

	Maks Daily rainfall Return for Period 5 Year	mm/hour	:	110.35096			
1	Location :Merak FO		:				
	Position : Left and Right at grade						
	Beginning Sta.	meter	:	+500	+523	+560	+580
	End Sta.	meter	:	+523	+560	+580	+702
	Distance	meter	:	**23.00**	**37.00**	**20.00**	**122.00**
2	Design Road		:				
	a. Road Widht	meter	:	5.5	5.5	5.5	5.5
	b. Super-elevation of Pavement (m1)		:	**2%**	**2%**	**2%**	**2%**
	c. Super-elevation of Gutter (m2)			**10%**	**10%**	**10%**	**10%**
	d. Vertical Grades of Road (i)			**1.51%**	**2.28%**	**1.60%**	**0.31%**
3	Coeffisient Road Friction (nd)		:	0.013	0.013	0.013	0.013
4	Concentration Time		:				
	d. T.1	minute	:	1.02	1.02	1.02	1.02
	e. T.2	minute	:	1.32	1.38	1.29	1.99
	f. Tc	minute	:	2.34	2.40	2.30	3.01
	Tc	hour		0.04	0.04	0.04	0.05
5	Coeffisient of Run-off (Concrete)			0.90	0.90	0.90	0.90
6	Catchments Area (=width *distance)	m^2	:	126.5	203.5	110	671
7	Coeffisient manning Friction		:	0.015	0.015	0.015	0.015
8	Rainfall Intensity for t = Tc	mm/hour	:	332.8	327.1	336.3	281.2
9	Volume of Run-off	m^3/sec		0.011	0.017	0.009	0.047
10	Hydraulic mean Depth factor			0.455	0.455	0.455	0.455
11	Velocity of Flow factor		:	4.84	5.95	4.99	2.19
12	Flow Area of Gutter factor			5	5	5	5
13	Q = (10 X 11)	m^3/sec	:	24.22	29.76	24.93	10.97
14	Possible hight water at gutter	meter	:	0.05	0.06	0.05	0.13
15	Possible velocity of flow at gutter	meter	:	0.70	0.92	0.69	0.56
16	Dimension of gutter inlet		:				
	a. Widht	meter	:	0.50	0.50	0.50	0.50
	b. Hight	meter	:	0.15	0.15	0.15	0.15
17	Area of gutter inlet	m^2		0.04	0.04	0.04	0.04
18	Coefficient lost of Gutter Inlet			80%	80%	80%	80%
19	Volume of gutter inlet	m^3/sec		0.02	0.03	0.02	0.02
	Total of Gutter Inlet	each		1	1	1	3
	Distance of Gutter Inlet	meter		23	37	20	40

Design of Dimension and Distance for Gutter Inlet

	Maks Daily rainfall Return for Period 5 Year	mm/hour	:	110.35096				
1	Location :Merak FO		:					
	Position : Left and Right at grade							
	Beginning Sta.	meter	:	+702	+821	+953	1+011	1+048
	End Sta.	meter	:	+821	+953	1+011	1+048	1+123
	Distance	meter	:	**119.00**	**132.00**	**58.00**	**37.00**	**75.00**
2	Design Road		:					
	a. Road Widht	meter	:	5.5	5.5	5.5	5.5	5.5
	b. Super-elevation of Pavement (m1)		:	**2%**	**2%**	**2%**	**2%**	**2%**
	c. Super-elevation of Gutter (m2)			**10%**	**10%**	**10%**	**10%**	**10%**
	d. Vertical Grades of Road (i)			**0.03%**	**0.51%**	**0.02%**	**2.89%**	**1.39%**
3	Coeffisient Road Friction (nd)		:	0.013	0.013	0.013	0.013	0.013
4	Concentration Time		:					
	d. T.1	minute	:	1.02	1.02	1.02	1.02	1.02
	e. T.2	minute	:	2.41	1.94	2.21	1.36	1.62
	f. Tc	minute	:	3.43	2.95	3.23	2.37	2.64
	Tc	hour		0.06	0.05	0.05	0.04	0.04
5	Coeffisient of Run-off (Concrete)			0.90	0.90	0.90	0.90	0.90
6	Catchments Area (=width *distance)	m^2	:	654.5	726	319	203.5	412.5
7	Coeffisient manning Friction		:	0.015	0.015	0.015	0.015	0.015
8	Rainfall Intensity for t = Tc	mm/hour	:	257.8	284.7	268.3	329.6	307.1
9	Volume of Run-off	m^3/sec		0.042	0.052	0.021	0.017	0.032
10	Hydraulic mean Depth factor			0.455	0.455	0.455	0.455	0.455
11	Velocity of Flow factor		:	0.68	2.81	0.56	6.70	4.65
12	Flow Area of Gutter factor			5	5	5	5	5
13	Q = (10 X 11)	m^3/sec	:	3.41	14.07	2.79	33.50	23.23
14	Possible hight water at gutter	meter	:	0.19	0.12	0.16	0.06	0.08
15	Possible velocity of flow at gutter	meter	:	0.23	0.69	0.16	1.00	0.89
16	Dimension of gutter inlet		:					
	a. Widht	meter	:	0.50	0.50	0.50	0.50	0.50
	b. Hight	meter	:	0.15	0.15	0.15	0.15	0.15
17	Area of gutter inlet	m^2		0.04	0.04	0.04	0.04	0.04
18	Coefficient lost of Gutter Inlet			80%	80%	80%	80%	80%
19	Volume of gutter inlet	m^3/sec		0.01	0.02	0.00	0.03	0.03
	Total of Gutter Inlet	each		7	3	5	1	2
	Distance of Gutter Inlet	meter		17	44	11	37	37

Design of Dimension and Distance for Gutter Inlet

	Maks Daily rainfall Return for Period 5 Year	mm/hour	:	110.35096				
1	Location :Merak FO		:					
	Position : Left and Right at grade							
	Beginning Sta.	meter	:	1+123	1+229	1+285	1+320	1+399
	End Sta.	meter	:	1+229	1+285	1+320	1+399	1+449
	Distance	meter	:	**106.00**	**56.00**	**35.00**	**79.00**	**50.00**
2	Design Road		:					
	a. Road Widht	meter	:	5.5	5.5	5.5	5.5	5.5
	b. Super-elevation of Pavement (m1)		:	**2%**	**2%**	**2%**	**2%**	**2%**
	c. Super-elevation of Gutter (m2)			**10%**	**10%**	**10%**	**10%**	**10%**
	d. Vertical Grades of Road (i)			**0.84%**	**0.21%**	**1.20%**	**0.06%**	**1.02%**
3	Coeffisient Road Friction (nd)		:	0.013	0.013	0.013	0.013	0.013
4	Concentration Time		:					
	d. T.1	minute	:	1.02	1.02	1.02	1.02	1.02
	e. T.2	minute	:	1.79	1.81	1.45	2.13	1.56
	f. Tc	minute	:	2.81	2.83	2.46	3.14	2.57
	Tc	hour		0.05	0.05	0.04	0.05	0.04
5	Coeffisient of Run-off (Concrete)			0.90	0.90	0.90	0.90	0.90
6	Catchments Area (=width *distance)	m^2	:	583	308	192.5	434.5	275
7	Coeffisient manning Friction		:	0.015	0.015	0.015	0.015	0.015
8	Rainfall Intensity for t = Tc	mm/hour	:	294.5	293.4	321.5	273.2	312.3
9	Volume of Run-off	m^3/sec		0.043	0.023	0.015	0.030	0.021
10	Hydraulic mean Depth factor			0.455	0.455	0.455	0.455	0.455
11	Velocity of Flow factor		:	3.61	1.81	4.32	0.97	3.98
12	Flow Area of Gutter factor			5	5	5	5	5
13	Q = (10 X 11)	m^3/sec	:	18.06	9.03	21.59	4.83	19.90
14	Possible hight water at gutter	meter	:	0.10	0.11	0.07	0.15	0.08
15	Possible velocity of flow at gutter	meter	:	0.80	0.40	0.71	0.27	0.72
16	Dimension of gutter inlet		:					
	a. Widht	meter	:	0.50	0.50	0.50	0.50	0.50
	b. Hight	meter	:	0.15	0.15	0.15	0.15	0.15
17	Area of gutter inlet	m^2		0.04	0.04	0.04	0.04	0.04
18	Coefficient lost of Gutter Inlet			80%	80%	80%	80%	80%
19	Volume of gutter inlet	m^3/sec		0.02	0.01	0.02	0.01	0.02
	Total of Gutter Inlet	each		2	2	1	4	1
	Distance of Gutter Inlet	meter		53	28	35	19	50

Design of Dimension and Distance for Gutter Inlet

	Maks Daily rainfall Return for Period 5 Year	mm/hour	:	110.35096			
1	Location :Merak FO		:				
	Position : Left and Right at grade						
	Beginning Sta.	meter	:	+500	+523	+560	+580
	End Sta.	meter	:	+523	+560	+580	+702
	Distance	meter	:	**23.00**	**37.00**	**20.00**	**122.00**
2	Design Road		:				
	a. Road Widht	meter	:	5.5	5.5	5.5	5.5
	b. Super-elevation of Pavement (m1)		:	**2%**	**2%**	**2%**	**2%**
	c. Super-elevation of Gutter (m2)			**10%**	**10%**	**10%**	**10%**
	d. Vertical Grades of Road (i)			**1.51%**	**2.28%**	**1.60%**	**0.31%**
3	Coeffisient Road Friction (nd)		:	0.013	0.013	0.013	0.013
4	Concentration Time		:				
	d. T.1	minute	:	1.02	1.02	1.02	1.02
	e. T.2	minute	:	1.32	1.38	1.29	1.99
	f. Tc	minute	:	2.34	2.40	2.30	3.01
	Tc	hour		0.04	0.04	0.04	0.05
5	Coeffisient of Run-off (Concrete)			0.90	0.90	0.90	0.90
6	Catchments Area (=width *distance)	m^2	:	126.5	203.5	110	671
7	Coeffisient manning Friction		:	0.015	0.015	0.015	0.015
8	Rainfall Intensity for t = Tc	mm/hour	:	332.8	327.1	336.3	281.2
9	Volume of Run-off	m^3/sec		0.011	0.017	0.009	0.047
10	Hydraulic mean Depth factor			0.455	0.455	0.455	0.455
11	Velocity of Flow factor		:	4.84	5.95	4.99	2.19
12	Flow Area of Gutter factor			5	5	5	5
13	Q = (10 X 11)	m^3/sec	:	24.22	29.76	24.93	10.97
14	Possible hight water at gutter	meter	:	0.05	0.06	0.05	0.13
15	Possible velocity of flow at gutter	meter	:	0.70	0.92	0.69	0.56
16	Dimension of gutter inlet		:				
	a. Widht	meter	:	0.50	0.50	0.50	0.50
	b. Hight	meter	:	0.15	0.15	0.15	0.15
17	Area of gutter inlet	m^2		0.04	0.04	0.04	0.04
18	Coefficient lost of Gutter Inlet			80%	80%	80%	80%
19	Volume of gutter inlet	m^3/sec		0.02	0.03	0.02	0.02
	Total of Gutter Inlet	each		1	1	1	3
	Distance of Gutter Inlet	meter		23	37	20	40

Design of Dimension and Distance for Gutter Inlet

	Maks Daily rainfall Return for Period 5 Year	mm/hour	:	110.35096				
1	Location :Merak FO		:					
	Position : Left and Right at grade							
	Beginning Sta.	meter	:	+702	+821	+920	1+011	1+048
	End Sta.	meter	:	+821	+920	1+013	1+048	1+128
	Distance	meter	:	**119.00**	**99.00**	**93.00**	**37.00**	**80.00**
2	Design Road		:					
	a. Road Widht	meter	:	5.5	5.5	5.5	5.5	5.5
	b. Super-elevation of Pavement (m1)		:	**2%**	**2%**	**2%**	**2%**	**2%**
	c. Super-elevation of Gutter (m2)			**10%**	**10%**	**10%**	**10%**	**10%**
	d. Vertical Grades of Road (i)			**0.03%**	**0.51%**	**0.02%**	**2.89%**	**1.39%**
3	Coeffisient Road Friction (nd)		:	0.013	0.013	0.013	0.013	0.013
4	Concentration Time		:					
	d. T.1	minute	:	1.02	1.02	1.02	1.02	1.02
	e. T.2	minute	:	2.41	1.85	2.40	1.36	1.64
	f. Tc	minute	:	3.43	2.86	3.41	2.37	2.66
	Tc	hour		0.06	0.05	0.06	0.04	0.04
5	Coeffisient of Run-off (Concrete)			0.90	0.90	0.90	0.90	0.90
6	Catchments Area (=width *distance)	m^2	:	654.5	544.5	511.5	203.5	440
7	Coeffisient manning Friction		:	0.015	0.015	0.015	0.015	0.015
8	Rainfall Intensity for t = Tc	mm/hour	:	257.8	290.7	258.7	329.6	305.7
9	Volume of Run-off	m^3/sec		0.042	0.040	0.033	0.017	0.034
10	Hydraulic mean Depth factor			0.455	0.455	0.455	0.455	0.455
11	Velocity of Flow factor		:	0.68	2.81	0.56	6.70	4.65
12	Flow Area of Gutter factor			5	5	5	5	5
13	Q = (10 X 11)	m^3/sec	:	3.41	14.07	2.79	33.50	23.23
14	Possible hight water at gutter	meter	:	0.19	0.11	0.19	0.06	0.09
15	Possible velocity of flow at gutter	meter	:	0.23	0.65	0.18	1.00	0.91
16	Dimension of gutter inlet		:					
	a. Widht	meter	:	0.50	0.50	0.50	0.50	0.50
	b. Hight	meter	:	0.15	0.15	0.15	0.15	0.15
17	Area of gutter inlet	m^2		0.04	0.04	0.04	0.04	0.04
18	Coefficient lost of Gutter Inlet			80%	80%	80%	80%	80%
19	Volume of gutter inlet	m^3/sec		0.01	0.02	0.01	0.03	0.03
	Total of Gutter Inlet	each		7	3	6	1	2
	Distance of Gutter Inlet	meter		17	33	15	37	40

Design of Dimension and Distance for Gutter Inlet

	Maks Daily rainfall Return for Period 5 Year	mm/hour	:	110.35096				
1	Location :Merak FO		:					
	Position : Left and Right at grade							
	Beginning Sta.	meter	:	1+128	1+219	1+253	1+339	1+449
	End Sta.	meter	:	1+219	1+253	1+339	1+449	1+545
	Distance	meter	:	**91.00**	**34.00**	**86.00**	**110.00**	**96.00**
2	Design Road		:					
	a. Road Widht	meter	:	5.5	5.5	5.5	5.5	5.5
	b. Super-elevation of Pavement (m1)		:	**2%**	**2%**	**2%**	**2%**	**2%**
	c. Super-elevation of Gutter (m2)			**10%**	**10%**	**10%**	**10%**	**10%**
	d. Vertical Grades of Road (i)			**0.84%**	**0.21%**	**0.81%**	**0.06%**	**1.40%**
3	Coeffisient Road Friction (nd)		:	0.013	0.013	0.013	0.013	0.013
4	Concentration Time		:					
	d. T.1	minute	:	1.02	1.02	1.02	1.02	1.02
	e. T.2	minute	:	1.75	1.66	1.74	2.25	1.69
	f. Tc	minute	:	2.76	2.68	2.75	3.26	2.71
	Tc	hour		0.05	0.04	0.05	0.05	0.05
5	Coeffisient of Run-off (Concrete)			0.90	0.90	0.90	0.90	0.90
6	Catchments Area (=width *distance)	m^2	:	500.5	187	473	605	528
7	Coeffisient manning Friction		:	0.015	0.015	0.015	0.015	0.015
8	Rainfall Intensity for t = Tc	mm/hour	:	297.7	303.8	298.5	266.4	302.0
9	Volume of Run-off	m^3/sec		0.037	0.014	0.035	0.040	0.040
10	Hydraulic mean Depth factor			0.455	0.455	0.455	0.455	0.455
11	Velocity of Flow factor		:	3.61	1.81	3.55	0.97	4.66
12	Flow Area of Gutter factor			5	5	5	5	5
13	Q = (10 X 11)	m^3/sec	:	18.06	9.03	17.74	4.83	23.32
14	Possible hight water at gutter	meter	:	0.10	0.09	0.10	0.17	0.09
15	Possible velocity of flow at gutter	meter	:	0.77	0.36	0.75	0.29	0.95
16	Dimension of gutter inlet		:					
	a. Widht	meter	:	0.50	0.50	0.50	0.50	0.50
	b. Hight	meter	:	0.15	0.15	0.15	0.15	0.15
17	Area of gutter inlet	m^2		0.04	0.04	0.04	0.04	0.04
18	Coefficient lost of Gutter Inlet			80%	80%	80%	80%	80%
19	Volume of gutter inlet	m^3/sec		0.02	0.01	0.02	0.01	0.03
	Total of Gutter Inlet	each		2	2	2	5	2
	Distance of Gutter Inlet	meter		45	17	43	22	48

Design Volume of Run-Off at Flyover (Merak)

Max. Daily rainfall for Return Period 5 Year	mm	:	110.4																
1 Location : Merak FO		:																	
Position :			Start	A1	P1	P2	P3	P4	P5	P6	P7	P8	P10	P11	P12	P13	P14	P15	A2	END
Beginning Sta.	meter	:	+702	+863	+883	+903	+923	+943	+963	+983	1+003	1+023	1+048	1+073	1+098	1+123	1+148	1+168	1+188	1+208
End Sta.	meter	:	+863	+883	+903	+923	+943	+963	+983	1+003	1+023	1+048	1+073	1+098	1+123	1+148	1+168	1+188	1+208	1+410
Distance	meter	:	161	20	20	20	20	20	20	20	20	25	25	25	25	25	20	20	20	203
2 Design Road		:																		
a. Traffic width	meter	:	4.5	5.75	5.75	5.75	5.75	5.75	5.75	5.75	5.75	5.75	5.75	5.75	5.75	5.75	5.75	5.75	5.75	5.75
b. Super-elevation	%	:	2.00%	4.60%	4.60%	4.60%	4.70%	5.00%	5.45%	5.85%	5.45%	0.85%	5.20%	5.40%	5.60%	5.60%	5.27%	3.74%	2.00%	2.00%
c. Vertical Gradient of Flyover	%	:	4.50%	4.50%	3.20%	2.35%	1.51%	0.62%	0.30%	0.30%	0.30%	0.30%	0.03%	0.63%	1.30%	1.96%	2.56%	3.10%	3.63%	4.50%
3 Coefficient Road Friction (nd)		:																		
a. Traffic		:	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013
4 Concentration Time		:																		
a. T.1	minute	:	0.98	0.96	0.96	0.96	0.95	0.95	0.94	0.94	0.94	1.10	0.95	0.94	0.94	0.94	0.95	0.97	1.03	1.03
b. T.2	minute	:	1.67	1.18	1.21	1.25	1.29	1.39	1.48	1.48	1.48	1.54	1.86	1.44	1.36	1.31	1.24	1.22	1.20	1.74
c. Tc =T.1+T.2	minute	:	2.65	2.14	2.17	2.20	2.25	2.34	2.42	2.42	2.42	2.64	2.81	2.39	2.30	2.25	2.18	2.19	2.23	2.76
Tc	hour		0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.05	0.04	0.04	0.04	0.04	0.04	0.04	0.05
5 Coefficient of Flow		:																		
a. Concrete Road and Asphalt		:	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
6 Catchments Area	m2	:	722.25	115	115	115	115	115	115	115	115	143.75	143.75	143.75	143.75	143.75	115	115	115	1164.375
7 Rainfall Intensity for t = Tc	mm/hour	:	312.3	361.2	357.4	354.0	349.2	339.6	332.1	332.6	332.1	313.7	300.8	335.4	343.9	348.5	356.1	355.2	351.4	304.1
8 Volume of Run-Off for Section only	m3/sec	:	0.056	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.011	0.011	0.012	0.012	0.013	0.010	0.010	0.010	0.089
9 Volume of Run-Off for at grade leftside	m3/sec	:	0.056	0.021		0.010	0.039				0.021		0.011						0.055	0.089
10 Volume of Run-Off for at grade rightside	m3/sec	:																		

Design Dimension of Side Ditch (Merak, At-grade, Right side)

Max. Daily rainfall for Return Period 5 Year	mm	:	110.351					
1 Location : Merak FO		:						
Position : Right Frontage								
Beginning Sta.	meter	:	+520	+820	1+105	1+200	1+300	1+410
End Sta.	meter	:	+820	1+025	1+200	1+300	1+410	1+540
Distance	meter	:	300	205	95	100	110	130
2 Design Road		:						
a. Traffic width	meter	:	6.00	5.50	5.50	5.50	5.50	6.00
b. Ground width	meter	:	15	15	15	15	15	15
Super-elevation		:						
a. Traffic		:	0.02	0.02	0.02	0.02	0.02	0.02
b. Ground		:	0.01	0.01	0.01	0.01	0.01	0.01
3 Coefficient Road Friction (nd)		:						
a. Traffic		:	0.013	0.013	0.013	0.013	0.013	0.013
b. Ground		:	0.4	0.4	0.4	0.4	0.4	0.4
4 Concentration Time		:						
a. Traffic	minute	:	1.03	1.02	1.02	1.02	1.02	1.03
b. Ground	minute	:	2.26	2.26	2.26	2.26	2.26	2.26
c. T.1	minute	:	3.29	3.28	3.28	3.28	3.28	3.29
d. T.2	minute	:	2.33	2.13	1.86	1.83	1.97	1.97
e. Tc = T.1 + T.2	minute	:	5.62	5.41	5.14	5.10	5.24	5.27
Tc	hour		0.09	0.09	0.09	0.09	0.09	0.09
5 Coefficient of Flow		:						
a. Concrete Road and Asphalt		:	0.70	0.70	0.70	0.70	0.70	0.70
b. Ground		:	0.50	0.50	0.50	0.50	0.50	0.50
c. Average		:	0.60	0.60	0.60	0.60	0.60	0.60
6 Catchments Area (=width *distance)		:						
a. Traffic	m^2	:	1,800	1,128	523	550	605	780
b. Ground	m^2	:	4,500	3,075	1,425	1,500	1,650	1,950
7 Coefficient manning Friction		:	0.02	0.02	0.02	0.02	0.02	0.02
8 Rainfall Intensity for t = Tc	mm/hour	:	189.00	193.89	200.57	201.54	197.92	197.35
9 Volume of Run-off on Section	m^3/sec	:	**0.198**	**0.136**	**0.065**	**0.069**	**0.074**	**0.090**
Volume of Run-off from Upper Section	m^3/sec		**0.136**	**-**	**-**	**0.130**	**0.199**	**0.331**
Volume of Run-off from Flyover	m^3/sec		**-**	**-**	**0.065**	**-**	**0.058**	**-**
Total Volume of Run-off	m^3/sec		**0.334**	**0.136**	**0.130**	**0.199**	**0.331**	**0.421**
10 Design of Dimension (minimum)		:						
a. Height of water level	meter	:	**0.39**	**0.18**	**0.17**	**0.21**	**0.38**	**0.41**
b. Wide of Side Ditch	meter	:	**0.80**	**0.80**	**0.80**	**0.80**	**0.80**	**0.80**
11 Circumference Wet Area	meter	:	1.57	1.17	1.15	1.21	1.57	1.63
12 Ditch Wet Area	m^2		0.31	0.15	0.14	0.17	0.31	0.33
13 Hydraulic Radii Of Drain	meter	:	0.20	0.13	0.12	0.14	0.20	0.20
14 Ditch sloping		:	0.003	0.004	0.004	0.006	0.003	0.004
15 Flow of Velocity	m^2/sec		1.08	0.93	0.93	1.20	1.08	1.28
16 Design Volume of Ditch	m^3/sec		***0.334***	***0.136***	***0.130***	***0.199***	***0.332***	***0.422***
17 Free Board	meter		0.15	0.15	0.15	0.15	0.15	0.15
18 Highest of Ditch (=10a+17)	meter		0.54	0.33	0.32	0.36	0.53	0.56
		:						
Wide of Side Ditch	meter		***0.80***	***0.80***	***0.80***	***0.80***	***0.80***	***0.80***
Highest of Ditch	meter		***0.60***	***0.40***	***0.40***	***0.40***	***0.60***	***0.60***

Design Dimension of Side Ditch (Merak, At-grade, Left side)

	Max. Daily rainfall for Return Period 5 Year	mm	:	110.351					
1	Location : Merak FO		:						
	Position : Left Frontage								
	Beginning Sta.	meter	:	+520	+570	+820	1+010	1+025	1+075
	End Sta.	meter	:	+570	+820	1+010	1+025	1+075	1+135
	Distance	meter	:	50.00	250.00	190.00	15.00	50.00	60.00
2	Design Road		:						
	a. Traffic width	meter	:	7	7	5.5	5.5	5.5	5.5
	b. Ground width	meter	:	15	15	15	15	15	15
	Super-elevation		:						
	a. Traffic		:	0.02	0.02	0.02	0.02	0.02	0.02
	b. Ground		:	0.01	0.01	0.01	0.01	0.01	0.01
3	Coefficient Road Friction (nd)		:						
	a. Traffic		:	0.013	0.013	0.013	0.013	0.013	0.013
	b. Ground		:	0.4	0.4	0.4	0.4	0.4	0.4
4	Concentration Time		:						
	a. Traffic	minute	:	1.06	1.06	1.02	1.02	1.02	1.02
	b. Ground	minute	:	2.26	2.26	2.26	2.26	2.26	2.26
	c. T.1	minute	:	3.32	3.32	3.28	3.28	3.28	3.28
	d. T.2	minute	:	1.56	2.26	1.99	1.20	1.65	1.68
	e. Tc = T.1 + T.2	minute	:	4.88	5.57	5.26	4.48	4.93	4.95
	Tc	hour		0.08	0.09	0.09	0.07	0.08	0.08
5	Coefficient of Flow		:						
	a. Concrete Road and Asphalt		:	0.7	0.7	0.7	0.7	0.7	0.7
	b. Ground		:	0.5	0.5	0.5	0.5	0.5	0.5
	c. Average		:	0.6	0.6	0.6	0.6	0.6	0.6
6	Catchments Area (=width *distance)		:						
	a. Traffic	m^2	:	350	1750	1045	82.5	275	330
	b. Ground	m^2	:	750	3750	2850	225	750	900
7	Coefficient manning Friction		:	0.017	0.017	0.017	0.017	0.017	0.017
8	Rainfall Intensity for t = Tc	mm/hour	:	207.7	190.0	197.5	219.9	206.3	205.6
9	Volume of Run-off on Section	m^3/sec	:	**0.038**	**0.174**	**0.128**	**0.011**	**0.035**	**0.042**
	Volume of Run-off from Upper Section	m^3/sec			**0.056**	-		**0.060**	
	Volume of Run-off from Flyover	m^3/sec		-	-	**0.056**	**0.049**	**0.021**	-
	Total Volume of Run-off	m^3/sec		**0.038**	**0.231**	**0.185**	**0.060**	**0.116**	**0.042**
10	Design of Dimension (minimum)		:						
	a. Height of water level	meter	:	**0.06**	**0.30**	**0.18**	**0.06**	**0.15**	**0.08**
	b. Wide of Side Ditch	meter	:	**0.80**	**0.80**	**0.80**	**0.80**	**0.80**	**0.80**
11	Circumference Wet Area	meter	:	0.92	1.39	1.16	0.93	1.11	0.96
12	Ditch Wet Area	m^2		0.05	0.24	0.14	0.05	0.12	0.06
13	Hydraulic Radii Of Drain	meter	:	0.05	0.17	0.12	0.05	0.11	0.07
14	Ditch sloping		:	0.010	0.003	0.008	0.02	0.01	0.006
15	Flow of Velocity	m^2/sec		0.81	0.98	1.29	1.18	0.95	0.74
16	Design Volume of Ditch	m^3/sec		***0.04***	***0.23***	***0.18***	***0.06***	***0.12***	***0.05***
17	Free Board	meter		0.15	0.15	0.15	0.15	0.15	0.15
18	Highest of Ditch (=10a+17)	meter		0.21	0.45	0.33	0.21	0.30	0.23
	Wide of Side Ditch	meter		**0.80**	**0.80**	**0.80**	**0.80**	**0.80**	**0.80**
	Highest of Ditch	meter		**0.30**	**0.50**	**0.40**	**0.30**	**0.40**	**0.30**

Design Dimension of Side Ditch (Merak, At-grade, Left side)

Max. Daily rainfall for Return Period 5 Year	mm	:	110.351		
1 Location : Merak FO		:			
Position : Left Frontage					
Beginning Sta.	meter	:	1+135	1+270	1+410
End Sta.	meter	:	1+270	1+410	1+540
Distance	meter	:	135.00	140.00	130.00
2 Design Road		:			
a. Traffic width	meter	:	5.5	5.5	5.5
b. Ground width	meter	:	15	15	15
Super-elevation		:			
a. Traffic		:	0.02	0.02	0.02
b. Ground		:	0.01	0.01	0.01
3 Coefficient Road Friction (nd)		:			
a. Traffic		:	0.013	0.013	0.013
b. Ground		:	0.4	0.4	0.4
4 Concentration Time		:			
a. Traffic	minute	:	1.02	1.02	1.02
b. Ground	minute	:	2.26	2.26	2.26
c. T.1	minute	:	3.28	3.28	3.28
d. T.2	minute	:	1.87	2.00	1.97
e. Tc = T.1 + T.2	minute	:	5.15	5.28	5.25
Tc	hour		0.09	0.09	0.09
5 Coefficient of Flow		:			
a. Concrete Road and Asphalt		:	0.7	0.7	0.7
b. Ground		:	0.5	0.5	0.5
c. Average		:	0.6	0.6	0.6
6 Catchments Area (=width *distance)		:			
a. Traffic	m^2	:	742.5	770	715
b. Ground	m^2	:	2025	2100	1950
7 Coefficient manning Friction		:	0.017	0.017	0.017
8 Rainfall Intensity for t = Tc	mm/hour	:	200.3	197.1	197.7
9 Volume of Run-off on Section	m^3/sec	:	**0.092**	**0.094**	**0.088**
Volume of Run-off from Upper Section	m^3/sec			-	**0.149**
Volume of Run-off from Flyover	m^3/sec		-	**0.055**	
Total Volume of Run-off	m^3/sec		**0.092**	**0.149**	**0.237**
10 Design of Dimension (minimum)		:			
a. Height of water level	meter	:	**0.11**	**0.20**	**0.27**
b. Wide of Side Ditch	meter	:	**0.80**	**0.80**	**0.80**
11 Circumference Wet Area	meter	:	1.02	1.19	1.34
12 Ditch Wet Area	m^2		0.09	0.16	0.22
13 Hydraulic Radii Of Drain	meter	:	0.09	0.13	0.16
14 Ditch sloping		:	0.008	0.004	0.004
15 Flow of Velocity	m^2/sec		1.03	0.96	1.10
16 Design Volume of Ditch	m^3/sec		***0.09***	***0.15***	***0.24***
17 Free Board	meter		0.15	0.15	0.15
18 Highest of Ditch (=10a+17)	meter		0.26	0.35	0.42
Wide of Side Ditch	meter		**0.80**	**0.80**	**0.80**
Highest of Ditch	meter		**0.30**	**0.40**	**0.50**

INTERVAL OF VERTICAL DRAIN OF GEBANG FLYOVER

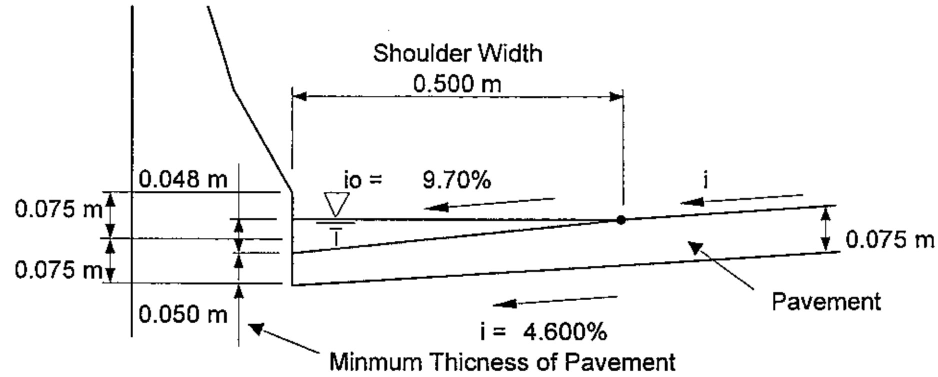
A. PC SUPERSTRUCTURE SECTION, A1 ~ P4 *w/ Surface Down*

Total F.O. Width	Wb =	6.75	m
Single Line Drainage System =		1	
Double Line Drainage System =		2	
Supper Elevation	i =	4.600%	
Rainfall Intensity	γ =	190	mm/hr

(5 years return period, 5 mins. Time concentration)

Design Rainfall intensity	γo =	γ x k =	**380**	mm/hr
Coefficient of Run-off	C =	0.9		
Correction Factor of Falling k =		2		

Section :



1) Catchments Area

- Vertical Gradient = 4.395% ~ 3.555% **Ave. = 3.975%**

  Span Length L = **20.00 m**

  Catchments Area

  (Single Line Drainage) A1 = Wb x L / 1 = 135 m^2

  (Double Line Drainage) A2 = Wb x L / 2 = 68 m^2

2) Volume of Run-Off

- Volume of Run-Off

  Q = 1 /(3.6 x 10^6)x C x γo x A

  (Single Line Drainage) Q1 = 0.0128 m^3/sec.

  (Double Line Drainage) Q2 = 0.0065 m^3/sec.

- Possible Through Volume of Run-Off along Shoulder

  Q' = v x a = 0.0124 m^3/sec.

- Velocity of Flow

  v = 1 / n x $R^{2/3}$ x $I^{1/2}$ = 1.03725 m/sec.

  (Hydraulic mean Depth) R = a / l = 0.0218

  (Wetted Perimeter) l = 0.5503 m

  (Floow Area of Gutter) a = 0.012 m^2

  (Coefficient of Roughness) n = 0.015

3) Designed Number of Vertical Drain

N = Q / Q'

(Single Line Drainage) N1 = 1.032 Each ==> **2 Each**

4) Designed Interval of Vertical Drain

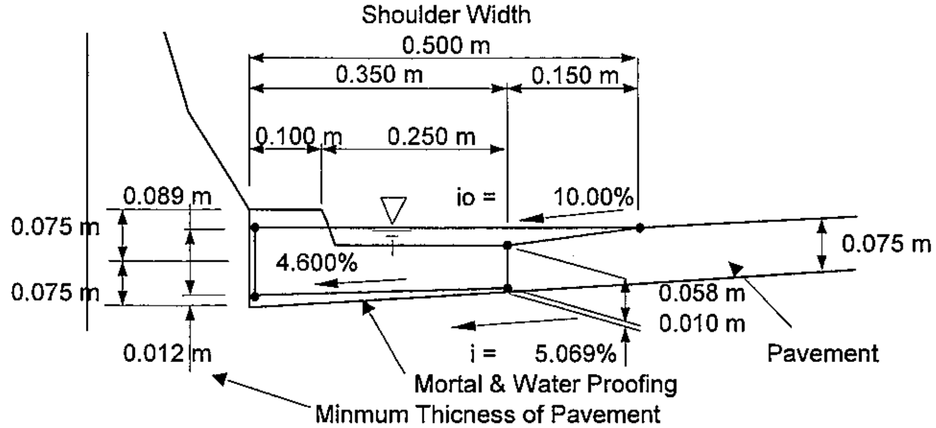
d = Q' / Q x L

(Single Line Drainage) d1 = 19.375 m ==> **19 m**

B. PC SUPERSTRUCTURE SECTION, P3 ~ P4 ***w/ Steel Screen Gutter***

Total F.O. Width	Wb =	6.75	m	
Single Line Drainage System =		1		
Double Line Drainage System =		2		
Supper Elevation	i =	4.857% ~	5.281%	
Rainfall Intensity	γ =	190	mm/hr	
(5 years return period, 5 mins. Time concentration)				
Design Rainfall intensity	γo =	γ x k =	**380**	mm/hr
Coefficient of Run-off	C =	0.9		
Correction Factor of Falling k =		2		

Section :



1) Catchments Area

- Vertical Gradient = 1.875% ~ 1.035% **Ave. = 1.455%**

  Span Length L = **20.00 m**

  Catchments Area

  (Single Line Drainage) A1 = Wb x L / 1 = 135 m^2

  (Double Line Drainage) A2 = Wb x L / 2 = 68 m^2

2) Volume of Run-Off

- Volume of Run-Off

  Q = 1 /(3.6 x 10^6)x C x γo x A

  (Single Line Drainage) Q1 = 0.0128 m^3/sec.

  (Double Line Drainage) Q2 = 0.0065 m^3/sec.

- Possible Through Volume of Run-Off along Shoulder

  Q' = v x a = 0.0552 m^3/sec.

- Velocity of Flow

  v = 1 / n x $R^{2/3}$ x $I^{1/2}$ = 1.30401 m/sec.

  (Hydraulic mean Depth) R = a / l = 0.0653

  (Wetted Perimeter) l = 0.6482 m

  (Floow Area of Gutter) a = 0.0423 m^2

  (Coefficient of Roughness) n = 0.015

3) Designed Number of Vertical Drain

N = Q / Q'

(Single Line Drainage) N1 = 0.232 Each ==> **1 Each**

4) Designed Interval of Vertical Drain

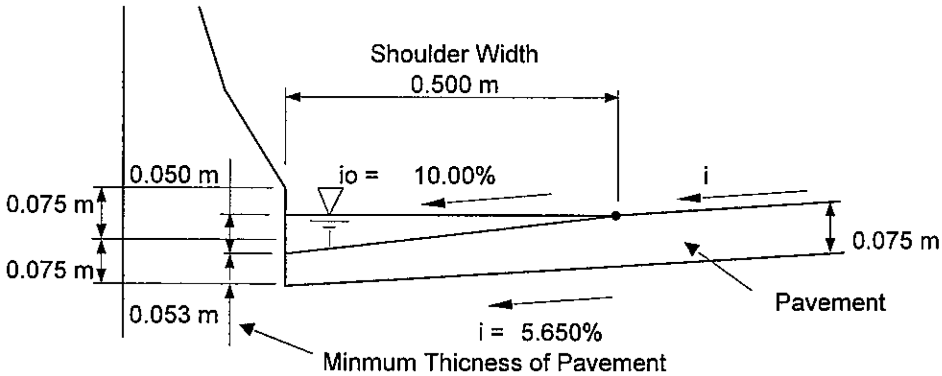
d = Q' / Q x L

(Single Line Drainage) d1 = 86.250 m ==> **86 m**

C. PC SUPERSTRUCTURE SECTION, P5 ~ P7 ***w/ Surface Down***

Total F.O. Width	Wb =	6.75	m	
Single Line Drainage System =		1		
Double Line Drainage System =		2		
Supper Elevation	i =	5.300% ~	6.000%	
Rainfall Intensity	γ =	200	mm/hr	
(5 years return period, 5 mins. Time concentration)				
Design Rainfall intensity	γo =	γ x k =	**400**	mm/hr
Coefficient of Run-off	C =	0.9		
Correction Factor of Falling k =		2		

Section :



1) Catchments Area

- Vertical Gradient = **0.300%**
  Span Length L = **20.00 m**
  Catchments Area
  (Single Line Drainage) A1 = Wb x L / 1 = 135 m^2
  (Double Line Drainage) A2 = Wb x L / 2 = 68 m^2

2) Volume of Run-Off

- Volume of Run-Off
  Q = $1 / (3.6 \times 10^6) \times C \times \gamma o \times A$
  (Single Line Drainage) Q1 = 0.0135 m^3/sec.
  (Double Line Drainage) Q2 = 0.0068 m^3/sec.
- Possible Through Volume of Run-Off along Shoulder
  Q' = v x a = 0.0036 m^3/sec.
- Velocity of Flow
  v = $1 / n \times R^{2/3} \times I^{1/2}$ = 0.29188 m/sec.
  (Hydraulic mean Depth) R = a / l = 0.0226
  (Wetted Perimeter) l = 0.5525 m
  (Floow Area of Gutter) a = 0.0125 m^2
  (Coefficient of Roughness) n = 0.015

3) Designed Number of Vertical Drain

N = Q / Q'
(Single Line Drainage) N1 = 3.750 Each ==> **4 Each**

4) Designed Interval of Vertical Drain

d = Q' / Q x L
(Single Line Drainage) d1 = 5.333 m ==> **5.3 m**

D. STEEL SUPERSTRUCTURE SECTION, P5 ~ P7 ***w/ Surface Down + Outer Gutter***

Total F.O. Width	Wb =	6.75	m	
Single Line Drainage System =		1		
Double Line Drainage System =		2		
Supper Elevation	i =	5.300% ~	6.000%	
Rainfall Intensity	γ =	200	mm/hr	
(5 years return period, 5 mins. Time concentration)				
Design Rainfall intensity	γo =	γ x k =	**400**	mm/hr
Coefficient of Run-off	C =	0.9		
Correction Factor of Falling k =		2		

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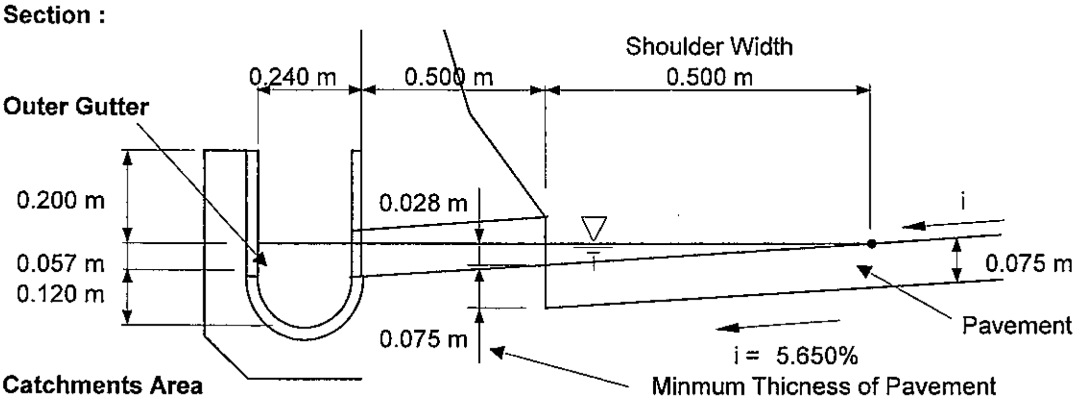

1) Catchments Area

- Vertical Gradient = **0.300%**
  Span Length L = **20.00** m
  Catchments Area
  (Single Line Drainage) A1 = Wb x L / 1 = 135 m^2
  (Double Line Drainage) A2 = Wb x L / 2 = 68 m^2

2) Volume of Run-Off

- Volume of Run-Off
  Q = $1 / (3.6 \times 10^6) \times C \times \gamma o \times A$
  (Single Line Drainage) Q1 = 0.0135 m^3/sec.
  (Double Line Drainage) Q2 = 0.0068 m^3/sec.
- Possible Through Volume of Run-Off along Shoulder
  Q' = v x a = 0.0166 m^3/sec.
- Velocity of Flow
  v = $1 / n \times R^{2/3} \times I^{1/2}$ = 0.45595 m/sec.
  (Hydraulic mean Depth) R = a / l = 0.0356
  (Wetted Perimeter) l = 1.0197 m
  (Floow Area of Gutter) a = **0.0363** m^2
  (Coefficient of Roughness) n = **0.013**

3) Designed Number of Vertical Drain

N = Q / Q'
(Single Line Drainage) N2 = 0.813 Each ==> **1** **Each**

4) Designed Interval of Vertical Drain

d = Q' / Q x L
(Single Line Drainage) d2 = 24.593 m ==> **24 m**

E. STEEL SUPERSTRUCTURE SECTION, P8 ~ P9 ***w/ Surface Down + Outer Gutter***

Total F.O. Width	Wb =	6.75	m
Single Line Drainage System =		1	
Double Line Drainage System =		2	
Supper Elevation	i =	0.000% ~	2.000%
Rainfall Intensity	γ =	200	mm/hr

(5 years return period, 5 mins. Time concentration)

Design Rainfall intensity	γo =	γ x k =	**400**	mm/hr
Coefficient of Run-off	C =	0.9		
Correction Factor of Falling	k =	2		

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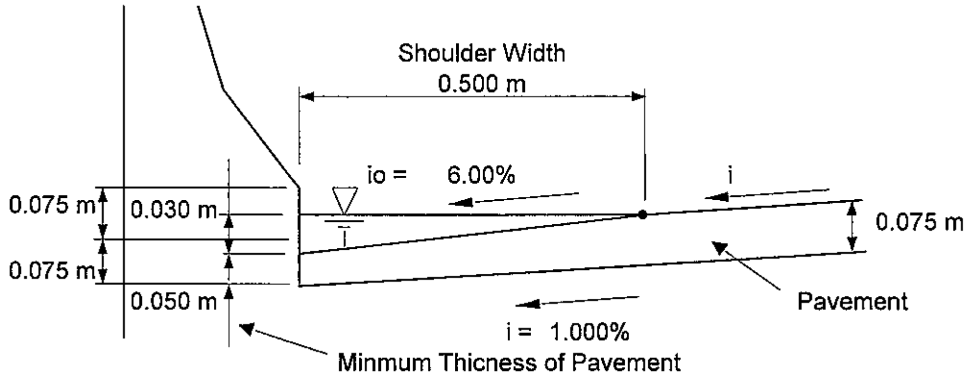

1) Catchments Area

- Vertical Gradient = **0.300%**
  Span Length L = **13.00 m**
  Catchments Area
  (Single Line Drainage) A1 = Wb x L / 1 = 88 m^2
  (Double Line Drainage) A2 = Wb x L / 2 = 44 m^2

2) Volume of Run-Off

- Volume of Run-Off
  Q = $1/(3.6 \times 10^6) \times C \times \gamma o \times A$
  (Single Line Drainage) Q1 = 0.0088 m^3/sec.
  (Double Line Drainage) Q2 = 0.0044 m^3/sec.
- Possible Through Volume of Run-Off along Shoulder
  Q' = v x a = 0.0016 m^3/sec.
- Velocity of Flow

				Applied Surface Down + Outer Ditch	
Q' = v x a =		0.0016	m^3/sec.	0.0166	m^3/sec.
v = $1/n \times R^{2/3} \times I^{1/2}$ =		0.21312	m/sec.	0.45595	m/sec.
(Hydraulic mean Depth)	R = a / I =	0.0141		0.0356	
(Wetted Perimeter)	I =	0.5309	m	1.0197	m
(Floow Area of Gutter)	a =	0.0075	m^2	0.0363	m^2
(Coefficient of Roughness)	n =	0.015		0.013	

3) Designed Number of Vertical Drain

N = Q / Q'

(Single Line Drainage)	N1 =	5.500	Each ==>	**6**	**Each**
		0.530		**1**	**w/ Outer Ditch**

4) Designed Interval of Vertical Drain

d = Q' / Q x L

(Single Line Drainage)	d1 =	2.364	m ==>	**2.3 m**	
		24.523		**24 m**	**w/ Outer Ditch**

F. STEEL SUPERSTRUCTURE SECTION, P8 ~ P9 *w/ Surface Down*

Total F.O. Width	Wb =	6.75	m	
Single Line Drainage System =		1		
Double Line Drainage System =		2		
Supper Elevation	i =	0.000% ~	1.600%	
Rainfall Intensity	γ =	200	mm/hr	
(5 years return period, 5 mins. Time concentration)				
Design Rainfall intensity	γo =	γ x k =	**400**	mm/hr
Coefficient of Run-off	C =	0.9		
Correction Factor of Falling	k =	2		

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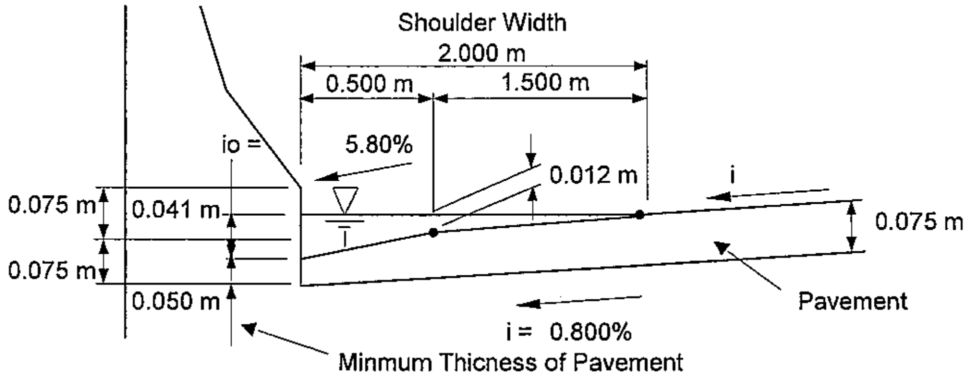


1) Catchments Area

- Vertical Gradient = **0.300%**
  Span Length L = **12.00 m**
  Catchments Area
  (Single Line Drainage) A1 = Wb x L / 1 = 81 m^2
  (Double Line Drainage) A2 = Wb x L / 2 = 41 m^2

2) Volume of Run-Off

- Volume of Run-Off
  Q = 1 /(3.6 x 10^6)x C x γo x A
  (Single Line Drainage) Q1 = 0.0081 m^3/sec.
  (Double Line Drainage) Q2 = 0.0041 m^3/sec.
- Possible Through Volume of Run-Off along Shoulder
  Q' = v x a = 0.0124 m^3/sec.
- Velocity of Flow

					Applied w/o Surface Down
Q' = v x a =		0.0124	m^3/sec.		0.0023
v = 1 / n x $R^{2/3}$ x $I^{1/2}$ =		0.28233	m/sec.		0.14484
(Hydraulic mean Depth)	R =	a / I =		0.0215	0.0079
(Wetted Perimeter)	I =	2.0419	m		2.0161
(Floow Area of Gutter)	a =	0.044	m^2		0.016
(Coefficient of Roughness)	n =	0.015			

3) Designed Number of Vertical Drain

N = Q / Q'

(Single Line Drainage)	N1 =	0.653	Each ==>	**1**	**Each**
		3.522		**4**	**w/o Surface Down**

4) Designed Interval of Vertical Drain

d = Q' / Q x L

(Single Line Drainage)	d1 =	18.370	m ==>	**18.3 m**	
		3.407		**3 m**	**w/o Surface Down**

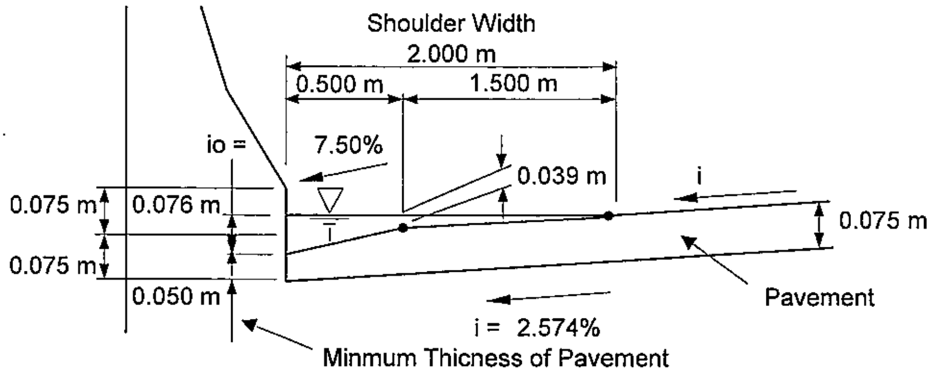
G. STEEL SUPERSTRUCTURE SECTION, P9 ~ P10 *w/ o Surface Down*

Total F.O. Width	Wb =	6.75	m
Single Line Drainage System =		1	
Double Line Drainage System =		2	
Supper Elevation	i =	1.600% ~	3.548%
Rainfall Intensity	γ =	200	mm/hr

(5 years return period, 5 mins. Time concentration)

Design Rainfall intensity	γo =	γ x k =	**400**	mm/hr
Coefficient of Run-off	C =	0.9		
Correction Factor of Falling	k =	2		

Section :



1) Catchments Area Minmum Thicness of Pavement

- Vertical Gradient = 0.000% ~ 0.300% **Ave. = 0.150%**

Span Length L = **14.00 m**

Catchments Area

(Single Line Drainage) A1 = Wb x L / 1 = 95 m^2

(Double Line Drainage) A2 = Wb x L / 2 = 47 m^2

2) Volume of Run-Off

- Volume of Run-Off

Q = 1 /(3.6 x 10^6)x C x γo x A

(Single Line Drainage) Q1 = 0.0095 m^3/sec.

(Double Line Drainage) Q2 = 0.0047 m^3/sec.

Applied w/o Surface Down

- Possible Through Volume of Run-Off along Shoulder

Q' = v x a = 0.1363 m^3/sec. 0.0587

- Velocity of Flow

v = $1 / n \times R^{2/3} \times I^{1/2}$ =		1.5881 m/sec.			1.13944
(Hydraulic mean Depth)	R =	a / l =		0.0413	0.0251
(Wetted Perimeter)	l =	2.0779	m		2.0521
(Floow Area of Gutter)	a =	0.0858	m^2		0.0515
(Coefficient of Roughness)	n =	0.015			

3) Designed Number of Vertical Drain

N = Q / Q'

(Single Line Drainage)	N1 =	0.070	Each ==>	**1**	**Each**
		0.162		**1**	**w/o Surface Down**

4) Designed Interval of Vertical Drain

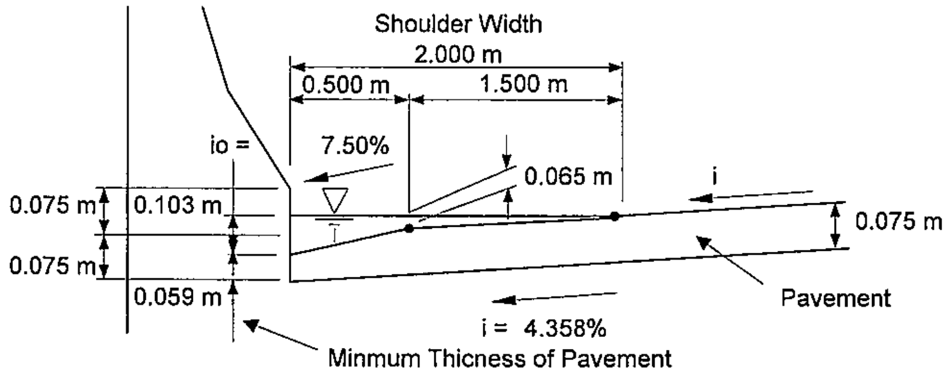
d = Q' / Q x L

(Single Line Drainage)	d1 =	286.947	m ==>	**286.9 m**	
		123.579		**123 m**	**w/o Surface Down**

H. STEEL SUPERSTRUCTURE SECTION, P9 ~ P10 ***w/ o Surface Down***

Total F.O. Width	Wb =	6.75	m	
Single Line Drainage System =		1		
Double Line Drainage System =		2		
Supper Elevation	i =	3.548% ~	5.168%	
Rainfall Intensity	γ =	200	mm/hr	
(5 years return period, 5 mins. Time concentration)				
Design Rainfall intensity	γo =	γ x k =	**400**	mm/hr
Coefficient of Run-off	C =	0.9		
Correction Factor of Falling k =		2		

Section :



1) Catchments Area

- Vertical Gradient = 0.000% ~ 0.300% **Ave. = 0.150%**
  Span Length L = **12.00 m**
  Catchments Area
  (Single Line Drainage) A1 = Wb x L / 1 = 81 m^2
  (Double Line Drainage) A2 = Wb x L / 2 = 41 m^2

2) Volume of Run-Off

- Volume of Run-Off
  Q = 1 /(3.6 x 10^6)x C x γo x A
  (Single Line Drainage) Q1 = 0.0081 m^3/sec.
  (Double Line Drainage) Q2 = 0.0041 m^3/sec.
- Possible Through Volume of Run-Off along Shoulder

			Applied w/o Surface Down
Q' = v x a =	0.0455 m^3/sec.		0.0271
Velocity of Flow			
v = 1 / n x $R^{2/3}$ x $I^{1/2}$ =	0.38107 m/sec.		0.31049
(Hydraulic mean Depth)	R = a / l =	0.0567	0.0417
(Wetted Perimeter)	l = 2.1058 m		2.0891
(Floow Area of Gutter)	a = 0.1193 m^2		0.0872
(Coefficient of Roughness)	n = 0.015		

3) Designed Number of Vertical Drain

N = Q / Q'

(Single Line Drainage)	N1 =	0.178	Each ==>	1	**Each**
		0.299		1	**w/o Surface Down**

4) Designed Interval of Vertical Drain

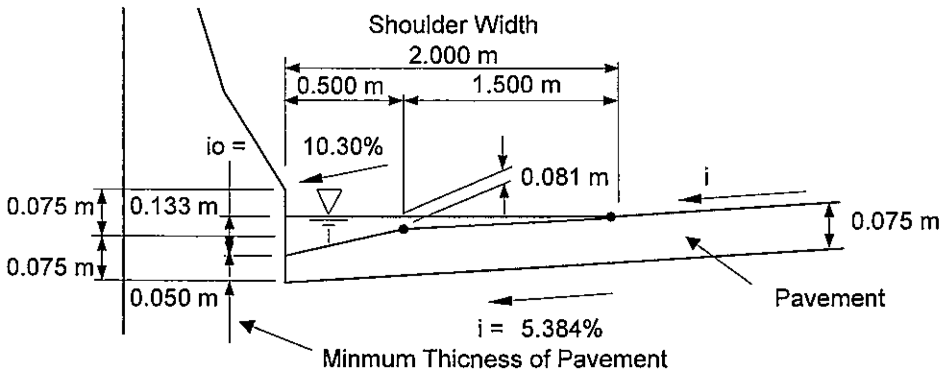
d = Q' / Q x L

(Single Line Drainage)	d1 =	67.407	m ==>	**67.4 m**	
		40.148		**40 m**	**w/o Surface Down**

I. STEEL SUPERSTRUCTURE SECTION, P10 ~ P11 ***w/ o Surface Down***

Total F.O. Width	Wb =	6.75	m	
Single Line Drainage System =		1		
Double Line Drainage System =		2		
Supper Elevation	i =	5.168% ~	5.600%	
Rainfall Intensity	γ =	200	mm/hr	
(5 years return period, 5 mins. Time concentration)				
Design Rainfall intensity γo =		γ x k =	**400**	mm/hr
Coefficient of Run-off	C =	0.9		
Correction Factor of Falling k =		2		

Section :



1) Catchments Area

- Vertical Gradient = 0.300% ~ 1.633% **Ave. = 0.967%**

  Span Length L = **25.00 m**

  Catchments Area

  (Single Line Drainage) A1 = Wb x L / 1 = 169 m^2

  (Double Line Drainage) A2 = Wb x L / 2 = 84 m^2

2) Volume of Run-Off

- Volume of Run-Off

  Q = 1 /(3.6 x 10^6)x C x γo x A

  (Single Line Drainage) Q1 = 0.0169 m^3/sec.

  (Double Line Drainage) Q2 = 0.0084 m^3/sec.

- Possible Through Volume of Run-Off along Shoulder

  Q' = v x a = 0.1735 m^3/sec.

- Velocity of Flow

				Applied w/o Surface Down
Q' = v x a		0.1735	m^3/sec.	0.0971
v = 1 / n x $R^{2/3}$ x $I^{1/2}$ =		1.13145	m/sec.	0.90158
(Hydraulic mean Depth)	R =	a / I =	0.0717	0.0510
(Wetted Perimeter)	I =	2.1378	m	2.1106
(Floow Area of Gutter)	a =	0.1533	m^2	0.1077
(Coefficient of Roughness)	n =	0.015		

3) Designed Number of Vertical Drain

N = Q / Q'

(Single Line Drainage)	N1 =	0.097	Each ==>	1	**Each**
		0.174		1	**w/o Surface Down**

4) Designed Interval of Vertical Drain

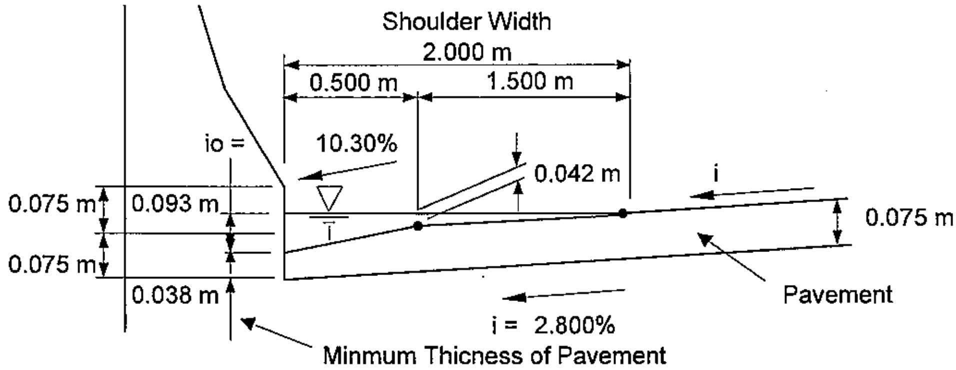
d = Q' / Q x L

(Single Line Drainage)	d1 =	256.657	m ==>	**256.6 m**	
		143.639		**143 m**	**w/o Surface Down**

J. STEEL SUPERSTRUCTURE SECTION, P12 ~ P13 ***w/ o Surface Down***

Total F.O. Width	Wb =	18.68m ~	10.61m	**Ave. =**	14.65m
Single Line Drainage System =		1			
Double Line Drainage System =		2			
Supper Elevation	i =	**5.60%**			
Rainfall Intensity	γ =	200	mm/hr		
(5 years return period, 5 mins. Time concentration)					
Design Rainfall intensity	γo =	γ x k =	**400**	mm/hr	
Coefficient of Run-off	C =	0.9			
Correction Factor of Falling k =		2			

Section :



1) Catchments Area

- Vertical Gradient = 1.633% ~ 2.300% **Ave. = 1.967%**
  Span Length L = **25.00 m**
  Catchments Area
  (Single Line Drainage) A1 = Wb x L / 1 = 366 m^2
  (Double Line Drainage) A2 = Wb x L / 2 = 183 m^2

2) Volume of Run-Off

- Volume of Run-Off
  Q = 1 /(3.6 x 10^6)x C x γo x A
  (Single Line Drainage) Q1 = 0.0366 m^3/sec.
  (Double Line Drainage) Q2 = 0.0183 m^3/sec.
- Possible Through Volume of Run-Off along Shoulder
  Q' = v x a = 0.1303 m^3/sec.
- Velocity of Flow

					Applied w/o Surface Down
Q' = v x a =		0.1303	m^3/sec.		0.0474
v = 1 / n x $R^{2/3}$ x $I^{1/2}$ =		1.25882	m/sec.		0.84565
(Hydraulic mean Depth)	R =	a / I =		0.0494	0.0272
(Wetted Perimeter)	I =	2.0962	m		2.0568
(Floow Area of Gutter)	a =	0.1035	m^2		0.0560
(Coefficient of Roughness)	n =	0.015			

3) Designed Number of Vertical Drain

N = Q / Q'

(Single Line Drainage)	N1 =	0.281	Each ==>	**1**	**Each**
		0.772		**1**	**w/o Surface Down**

4) Designed Interval of Vertical Drain

d = Q' / Q x L

(Single Line Drainage)	d1 =	89.003	m ==>	**89.0 m**	
		32.377		**32 m**	**w/o Surface Down**

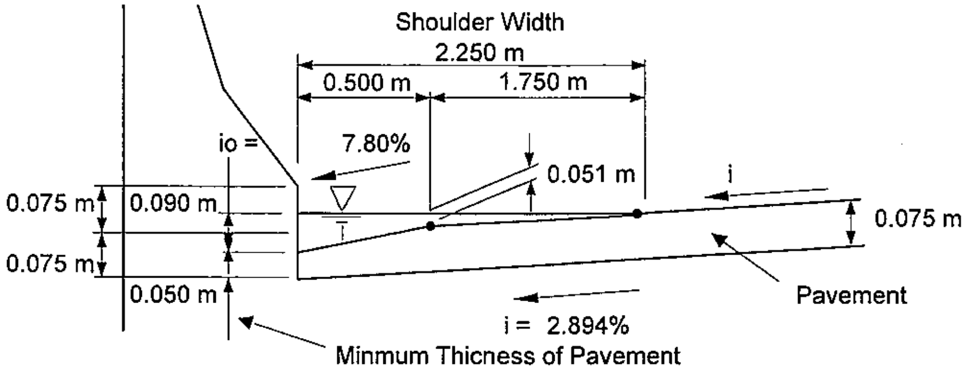
K. STEEL SUPERSTRUCTURE SECTION, PB4 ~ PB5 ***w/ o Surface Down***

Total F.O. Width	Wb =	7.00	m	
Single Line Drainage System =		1		
Double Line Drainage System =		2		
Supper Elevation	i =	2.688% ~	3.100%	
Rainfall Intensity	γ =	200	mm/hr	

(5 years return period, 5 mins. Time concentration)

Design Rainfall intensity	γo =	γ x k =	**400**	mm/hr
Coefficient of Run-off	C =	0.9		
Correction Factor of Falling k =		2		

Section :



1) Catchments Area

- Vertical Gradient = 0.316% ~ 2.354% **Ave. = 1.335%**
  Span Length L = **30.00 m**
  Catchments Area
  (Single Line Drainage) A1 = Wb x L / 1 = 210 m^2
  (Double Line Drainage) A2 = Wb x L / 2 = 105 m^2

2) Volume of Run-Off

- Volume of Run-Off
  Q = 1 /(3.6 x 10^6)x C x γo x A
  (Single Line Drainage) Q1 = 0.0210 m^3/sec.
  (Double Line Drainage) Q2 = 0.0105 m^3/sec.
- Possible Through Volume of Run-Off along Shoulder
  Q' = v x a = 0.1171 m^3/sec.
- Velocity of Flow
  v = 1 / n x $R^{2/3}$ x $I^{1/2}$ = 1.02723 m/sec.

				Applied w/o Surface Down
Q' = v x a		0.1171	m^3/sec.	0.0564
v = 1 / n x $R^{2/3}$ x $I^{1/2}$ =		1.02723	m/sec.	0.76991
(Hydraulic mean Depth)	R =	a / l =	0.0487	0.0316
(Wetted Perimeter)	l =	2.3423	m	2.3161
(Floow Area of Gutter)	a =	0.114	m^2	0.0733
(Coefficient of Roughness)	n =	0.015		

3) Designed Number of Vertical Drain

N = Q / Q'

(Single Line Drainage)	N1 =	0.179	Each ==>	**1**	**Each**
		0.372		**1**	**w/o Surface Down**

4) Designed Interval of Vertical Drain

d = Q' / Q x L

(Single Line Drainage)	d1 =	167.286	m ==>	**167.2 m**	
		80.571		**80 m**	**w/o Surface Down**

L. STEEL SUPERSTRUCTURE SECTION, PB5 ~ PB6 *w/ o Surface Down*

Total F.O. Width	Wb =	7.00	m
Single Line Drainage System =		1	
Double Line Drainage System =		2	
Supper Elevation	i =	**3.10%**	
Rainfall Intensity	γ =	200	mm/hr

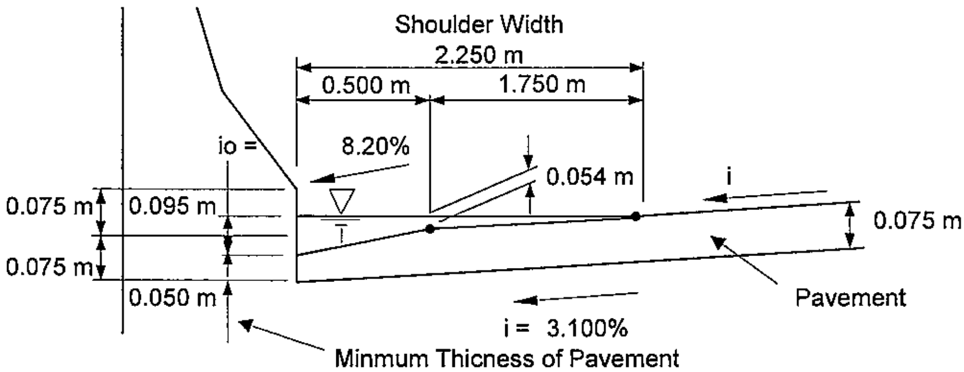
(5 years return period, 5 mins. Time concentration)

Design Rainfall intensity γo = γ x k = **400** mm/hr

Coefficient of Run-off C = 0.9

Correction Factor of Falling k = 2

Section :



1) Catchments Area

- Vertical Gradient = 0.000% ~ 1.633% **Ave. = 0.817%**
  Span Length L = **26.00 m**
  Catchments Area
  (Single Line Drainage) A1 = Wb x L / 1 = 182 m^2
  (Double Line Drainage) A2 = Wb x L / 2 = 91 m^2

2) Volume of Run-Off

- Volume of Run-Off
  Q = 1 /(3.6 x 10^6)x C x γo x A
  (Single Line Drainage) Q1 = 0.0182 m^3/sec.
  (Double Line Drainage) Q2 = 0.0091 m^3/sec.
- Possible Through Volume of Run-Off along Shoulder
  Q' = v x a = 0.1002 m^3/sec.
- Velocity of Flow

			Applied w/o Surface Down
Q' = v x a =		0.1002 m^3/sec.	0.0495
v = 1 / n x $R^{2/3}$ x $I^{1/2}$ =		0.83195 m/sec.	0.62994
(Hydraulic mean Depth)	R = a / l =	0.0513	0.0338
(Wetted Perimeter)	l =	2.3475 m	2.3208
(Floow Area of Gutter)	a =	0.1204 m^2	0.0785
(Coefficient of Roughness)	n =	0.015	

3) Designed Number of Vertical Drain

N = Q / Q'

(Single Line Drainage) N1 = 0.182 Each ==> **1 Each**

0.368 **1 w/o Surface Down**

4) Designed Interval of Vertical Drain

d = Q' / Q x L

(Single Line Drainage) d1 = 143.143 m ==> **143.1 m**

70.714 **70 m w/o Surface Down**

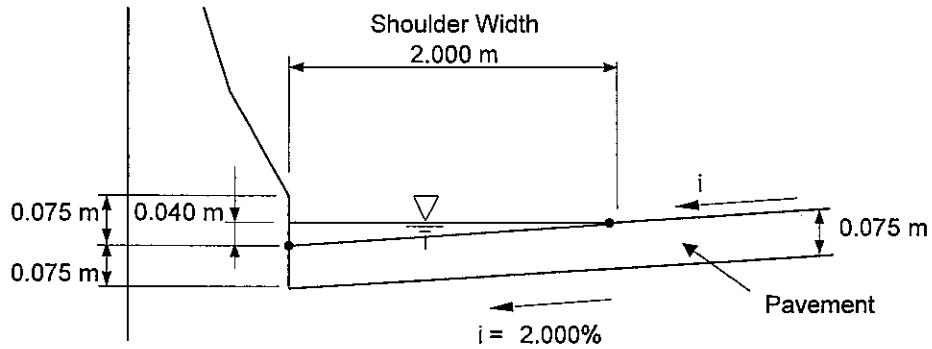
M. APPROACH (A1)

Total F.O. Width	Wb =	6.75	m
Single Line Drainage System =		1	
Double Line Drainage System =		2	
Supper Elevation	i =	**2.00%**	
Rainfall Intensity	γ =	200	mm/hr

(5 years return period, 5 mins. Time concentration)

Design Rainfall intensity	γo =	γ x k =	**400**	mm/hr
Coefficient of Run-off	C =	0.9		
Correction Factor of Falling k =		2		

Section :



1) Catchments Area

- Vertical Gradient = **4.500%**

Approach L = **160.00 m**

Catchments Area

(Single Line Drainage) A1 = Wb x L / 1 = 1080 m^2

(Double Line Drainage) A2 = Wb x L / 2 = 540 m^2

2) Volume of Run-Off

- Volume of Run-Off

Q = 1 /(3.6 x 10^6)x C x γo x A

(Single Line Drainage) Q1 = 0.1080 m^3/sec.

(Double Line Drainage) Q2 = 0.0540 m^3/sec.

- Possible Through Volume of Run-Off along Shoulder

Q' = v x a = 0.0411 m^3/sec.

- Velocity of Flow

v = $1 / n \times R^{2/3} \times I^{1/2}$ = 1.02806 m/sec.

(Hydraulic mean Depth) R = a / I = 0.0196

(Wetted Perimeter) I = 2.0404 m

(Floow Area of Gutter) a = 0.0400 m^2

(Coefficient of Roughness) n = 0.015

3) Designed Number of Vertical Drain

N = Q / Q'

(Single Line Drainage) N1 = 2.628 Each ==> **3 Each**

4) Designed Interval of Vertical Drain

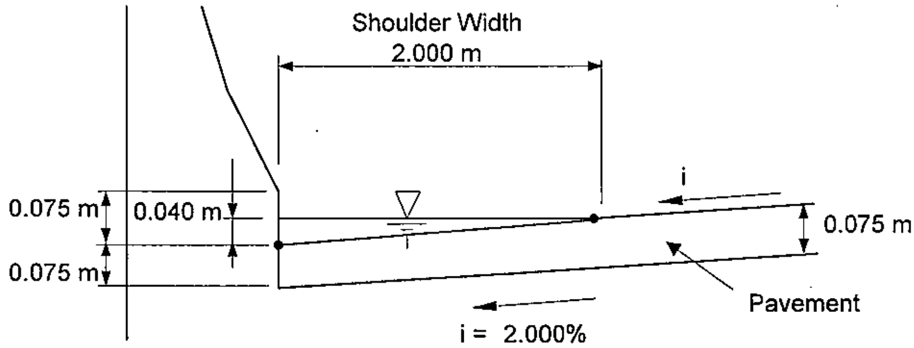
d = Q' / Q x L

(Single Line Drainage) d1 = 53.333 m ==> **53 m**

N. APPROACH (A2)

Total F.O. Width Wb = 6.75 m
Single Line Drainage System = 1
Double Line Drainage System = 2
Supper Elevation i = **2.00%**
Rainfall Intensity γ = 200 mm/hr
(5 years return period, 5 mins. Time concentration)
Design Rainfall intensity γo = γ x k = **400** mm/hr
Coefficient of Run-off C = 0.9
Correction Factor of Falling k = 2

Section :



1) **Catchments Area**
- Vertical Gradient = **4.500%**
  Approach L = **202.50 m**
  Catchments Area
  (Single Line Drainage) A1 = Wb x L / 1 = 1367 m^2
  (Double Line Drainage) A2 = Wb x L / 2 = 683 m^2

2) **Volume of Run-Off**
- Volume of Run-Off
  Q = 1 /(3.6 x 10^6)x C x γo x A
  (Single Line Drainage) Q1 = 0.1367 m^3/sec.
  (Double Line Drainage) Q2 = 0.0683 m^3/sec.
- Possible Through Volume of Run-Off along Shoulder
  Q' = v x a = 0.0411 m^3/sec.
- Velocity of Flow
  v = 1 / n x $R^{2/3}$ x $I^{1/2}$ = 1.02806 m/sec.
  (Hydraulic mean Depth) R = a / l = 0.0196
  (Wetted Perimeter) l = 2.0404 m
  (Floow Area of Gutter) a = 0.0400 m^2
  (Coefficient of Roughness) n = 0.015

3) **Designed Number of Vertical Drain**
  N = Q / Q'
  (Single Line Drainage) N1 = 3.326 Each ==> **4 Each**

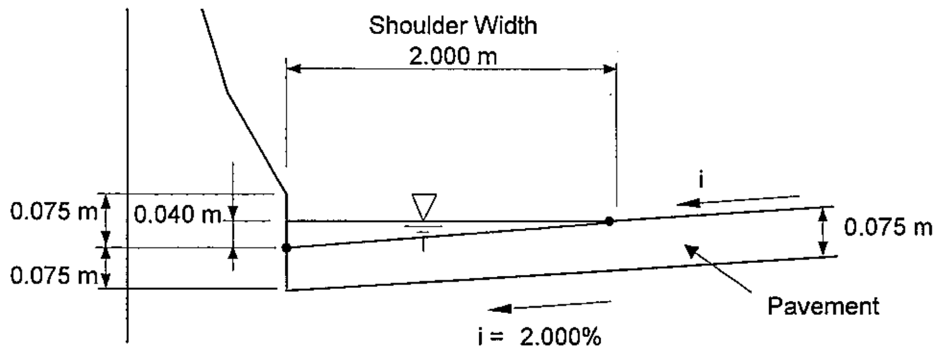
4) **Designed Interval of Vertical Drain**

  d = Q' / Q x L
  (Single Line Drainage) d1 = 50.625 m ==> **50 m**

O. APPROACH (A3)

Total F.O. Width Wb = 6.75 m
Single Line Drainage System = 1
Double Line Drainage System = 2
Supper Elevation i = **2.00%**
Rainfall Intensity γ = 200 mm/hr
(5 years return period, 5 mins. Time concentration)
Design Rainfall intensity γo = γ x k = **400** mm/hr
Coefficient of Run-off C = 0.9
Correction Factor of Falling k = 2

Section :



1) Catchments Area

- Vertical Gradient = **4.500%**
  Approach L = **174.00 m**
  Catchments Area
  (Single Line Drainage) A1 = Wb x L / 1 = 1175 m^2
  (Double Line Drainage) A2 = Wb x L / 2 = 587 m^2

2) Volume of Run-Off

- Volume of Run-Off
  Q = 1 /(3.6 x 10^6)x C x γo x A
  (Single Line Drainage) Q1 = 0.1175 m^3/sec.
  (Double Line Drainage) Q2 = 0.0587 m^3/sec.
- Possible Through Volume of Run-Off along Shoulder
  Q' = v x a = 0.0411 m^3/sec.
- Velocity of Flow
  v = 1 / n x $R^{2/3}$ x $I^{1/2}$ = 1.02806 m/sec.
  (Hydraulic mean Depth) R = a / l = 0.0196
  (Wetted Perimeter) l = 2.0404 m
  (Floow Area of Gutter) a = 0.0400 m^2
  (Coefficient of Roughness) n = 0.015

3) Designed Number of Vertical Drain

N = Q / Q'
(Single Line Drainage) N1 = 2.859 Each ==> **3 Each**

4) Designed Interval of Vertical Drain

d = Q' / Q x L
(Single Line Drainage) d1 = 58.000 m ==> **58 m**