3.2 DRAINAGE DESING IN BALARAJA FLYOVER

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

DAILY RAINFALL CENGKARENG STATION (TANGERANG)

No	Years	Rainfall Data (mm)
1	1993	101.00
2	1994	85.00
3	1995	80.00
4	1996	107.00
5	1997	103.00
6	1998	108.00
7	1999	98.00
8	2000	94.00
9	2001	84.00
10	2002	88.00
11	2003	115.00
12	2004	114.00
13	2005	129.00

DISTRIBUTION OF GUMBEL

No.	Years	Daily Rainfall Average (mm)	$(X - X_{ave})^2$	$(X - X_{ave})^3$	$(X - X_{ave})^4$
1	1993	101.000	19.041	83.089	362.572
2	1994	85.000	135.405	-1575.621	18334.503
3	1995	80.000	276.769	-4604.423	76600.855
4	1996	107.000	107.405	1113.106	11535.825
5	1997	103.000	40.496	257.701	1639.915
6	1998	108.000	129.132	1467.412	16675.133
7	1999	98.000	1.860	2.536	3.458
8	2000	94.000	6.950	-18.324	48.308
9	2001	84.000	159.678	-2017.745	25496.963
10	2002	88.000	74.587	-644.159	5563.187
11	2003	115.000	337.223	6192.643	113719.446
12	2004	114.000	301.496	5235.065	90899.758
13	2005	129.000	1047.405	33897.833	1097057.147
	Σ	1306.000	2637.446	39389.113	1457937.073

X Mean =	96.636	mm	
Standart Deviation =	11.351	mm	
Skewness Coefficient =	**3.740**	**Max rate :**	**1.140**
Kurtosis Coefficient=	**17.422**	**Max rate:**	**5.400**
Reduced Mean Y_N =	0.4952		
Reduced Standard Deviation S_N =	0.9496		
b =	90.717		
1/a =	11.954		

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	95.098
2	5	1.4999	108.646
3	10	2.2502	117.615
4	20	2.9606	126.107
5	25	3.1985	128.951
6	50	3.9019	137.360
7	100	4.6001	145.706

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	1993	101.000	2.004	0.000	0.000
2	1994	85.000	1.929	0.003	0.000
3	1995	80.000	1.903	0.006	0.000
4	1996	107.000	2.029	0.002	0.000
5	1997	103.000	2.013	0.001	0.000
6	1998	108.000	2.033	0.003	0.000
7	1999	98.000	1.991	0.000	0.000
8	2000	94.000	1.973	0.000	0.000
9	2001	84.000	1.924	0.003	0.000
10	2002	88.000	1.944	0.001	0.000
11	2003	115.000	2.061	0.006	0.000
12	2004	114.000	2.057	0.006	0.000
13	2005	129.000	2.111	0.016	0.002
	Σ	1306.000	25.974	0.048	0.002

Average = 1.982
Standart Deviation = 0.051
Skewness Coefficient= 2.432

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	1.9797	95.432
2	5	0.8228	2.0247	105.849
3	10	1.3102	2.0497	112.135
4	20	2.1664	2.0938	124.095
5	25	1.8537	2.0777	119.585
6	50	2.2185	2.0964	124.863
7	100	2.5547	2.1137	129.932

Log Pearson Type III

DISTRIBUTION OF LOG NORMAL

No.	Years	Daily Rainfall Average (mm)	Log X	(Log X - log X_{ave})	(Log X - log X_{ave})^2
1	1993	101.000	2.004	0.022	0.000
2	1994	85.000	1.929	-0.053	0.003
3	1995	80.000	1.903	-0.079	0.006
4	1996	107.000	2.029	0.047	0.002
5	1997	103.000	2.013	0.030	0.001
6	1998	108.000	2.033	0.051	0.003
7	1999	98.000	1.991	0.009	0.000
8	2000	94.000	1.973	-0.009	0.000
9	2001	84.000	1.924	-0.058	0.003
10	2002	88.000	1.944	-0.038	0.001
11	2003	115.000	2.061	0.078	0.006
12	2004	114.000	2.057	0.075	0.006
13	2005	129.000	2.111	0.128	0.016
	Σ	1306.000	25.974	0.203	0.048

Average = 1.982
Standart Deviation = 0.051
Variable Coefficient 0.026
Skewness Coefficient= 0.078 **Max rate : 0.078**
kurtosis Coefficient 3.011

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

Design Maximum Daily Rainfall on "T" Years Repeat Period

Return Period (years)	Y_T	Log X_T	XT (mm)
2	-0.0703	1.9788	95.231
5	0.8103	2.0240	105.692
10	1.3142	2.0499	112.188
20	1.7545	2.0726	118.190
25	1.8418	2.0771	119.418
50	2.2786	2.0995	125.754
100	2.6089	2.1165	130.767

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	173.412	109.2428	83.36787	68.81866	52.51847	40.07909	33.08456	27.3107	23.53565	20.84197	17.96106	15.9054	10.01977
5	192.340	121.1666	92.46746	76.3302	58.25085	44.45372	36.69573	30.29166	26.10456	23.11686	19.92151	17.64147	11.11343
10	203.860	128.4236	98.00554	80.90179	61.73962	47.11615	38.89352	32.1059	27.66802	24.50139	21.11465	18.69806	11.77904
20	225.495	142.0532	108.4069	89.48793	68.29207	52.1166	43.02131	35.51331	30.60444	27.10173	23.35556	20.68249	13.02915
25	217.301	136.891	104.4675	86.23602	65.8104	50.22273	41.45795	34.22279	29.4923	26.11687	22.50684	19.9309	12.55568
50	228.511	143.953	109.8566	90.68465	69.20534	52.81356	43.59663	35.98823	31.01372	27.46416	23.66789	20.95908	13.20339
100	237.620	149.691	114.2357	94.29948	71.96397	54.91879	45.33446	37.42277	32.24997	28.55892	24.61133	21.79454	13.7297

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	14.45101	18.20714	20.84197	22.93955	26.25923	30.05932	33.08456	36.41427	39.22609	41.68394	44.90266	47.7162	60.11864
5	16.02834	20.19444	23.11686	25.4434	29.12542	33.34029	36.69573	40.38888	43.5076	46.23373	49.80377	52.92441	66.68057
10	16.98831	21.40393	24.50139	26.96726	30.86981	35.33711	38.89352	42.80786	46.11337	49.00277	52.78663	56.09417	70.67422
20	18.79129	23.67554	27.10173	29.82931	34.14604	39.08745	43.02131	47.35108	51.0074	54.20345	58.3889	62.04747	78.17491
25	18.10843	22.81519	26.11687	28.74534	32.9052	37.66705	41.45795	45.63038	49.15384	52.23375	56.2671	59.79271	75.3341
50	19.04258	23.99215	27.46416	30.22822	34.60267	39.61017	43.59663	47.98431	51.68953	54.92832	59.16974	62.87723	79.22034
100	19.80165	24.94852	28.55892	31.43316	35.98199	41.18909	45.33446	49.89703	53.74995	57.11784	61.52833	65.38361	82.37818

Max Daily Rainfall Calculation for
BALARAJA Flyover

Return Period	Gumbel	Log Pearson	Log Normal	Result
2	95.098	95.432	95.231	95.432
5	108.646	105.849	105.692	105.849
10	117.615	112.135	112.188	112.188
20	126.107	124.095	118.190	124.095
25	128.951	119.585	119.418	119.585
50	137.360	124.863	125.754	125.754
100	145.706	129.932	130.767	130.767

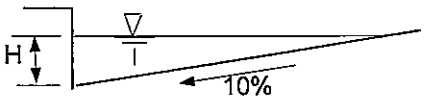
INTERVAL OF GUTTER INLET

- Section 0+180 - 0+300

Distance (Lo) =	**120**	**m**
Vertical Grades of Road (i)=	0.80%	
Road Width (L1) =	6	m
Super Elevation (m1) =	2.00%	(Pavement)
Super Elevation (m2) =	10.00%	(Gutter)
Rainfall intensity (Y) =	**105.85**	mm
(5 years return period)		
Coefficient of Run-off (C) =	0.9	(Concrete)

1) Catchments Area

Catchments Area (A= L0*L1) 720 m^2



2) Time Concentration

t1 = {2/3 x 3.28 x L1 x nd / (m1) ^ 0.5 } ^ 0.167 = 1.03 min. Friction Coefl 0.013

t2 = {2/3 x 3.28 x Lo x nd / (i) ^ 0.5 } ^ 0.167 = 1.84 min.

TC = t1 + t2 2.87 min. = 0.05 hour

3) Volume of Run-Off

Rainfall intensity

I = (Y /24) * (24 / TC) ^ 2/3 = 278.6 mm/ hour

Volume of Run-Off

Q = 1 / (3.6 x 10^6) x C x I x A = 0.0501 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) x $R^{2/3}$ x $i^{1/2}$

n = 0.02 (Concrete)

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

v = 3.53 $H^{2/3}$

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

Q1 = v x a = 17.6 $H^{8/3}$

Q = Q1

0.0501 = 17.6 $H^{8/3}$

H = 0.11 meter

4) Needed Number of Gutter Inlet

Dimension of Gutter Inlet

w = 50 cm

I = 15 cm

Coefficient lost of Gutter Inlet (C) = 80%

Area of Gutter Inlet

A = w x I / = 0.0375 m^2

Volume of Gutter Inlet

q = A x v = 0.024 m^3/sec.

N = Q / q = 2.0 < 3 each

d = L / N = 40 m

Design of Dimension and Distance for Gutter Inlet

	Maks Daily rainfall Return for Period 5 Year	mm/hour	:	105.84881			
1	Location :Balaraja FO		:				
	Position : Left and Right at grade						
	Beginning Sta.	meter	:	+180	+300	+400	+500
	End Sta.	meter	:	+300	+400	+500	+600
	Distance	meter	:	**120.00**	**100.00**	**100.00**	**100.00**
2	Design Road		:				
	a. Road Widht	meter	:	6	6	6	6
	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)			**0.80%**	**0.27%**	**0.40%**	**2%**
3	Coeffisient Road Friction (nd)		:	0.013	0.013	0.013	0.013
4	Concentration Time		:				
	d. T.1	minute	:	1.03	1.03	1.03	1.03
	e. T.2	minute	:	1.84	1.95	1.89	1.65
	f. Tc	minute	:	2.87	2.98	2.92	2.68
	Tc	hour		0.05	0.05	0.05	0.04
5	Coeffisient of Run-off (Concrete)			0.90	0.90	0.90	0.90
6	Catchments Area (=width *distance)	m^2	:	720	600	600	600
7	Coeffisient manning Friction		:	0.015	0.015	0.015	0.015
8	Rainfall Intensity for t = Tc	mm/hour	:	278.6	271.4	275.3	291.3
9	Volume of Run-off	m^3/sec		0.050	0.041	0.041	0.044
10	Hydraulic mean Depth factor			0.455	0.455	0.455	0.455
11	Velocity of Flow factor		:	3.53	2.05	2.49	5.57
12	Flow Area of Gutter factor			5	5	5	5
13	Q = (10 X 11)	m^3/sec	:	17.63	10.24	12.46	27.87
14	Possible hight water at gutter	meter	:	0.11	0.13	0.12	0.09
15	Possible velocity of flow at gutter	meter	:	0.81	0.51	0.60	1.11
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	0.02	0.02	0.03
	Total of Gutter Inlet	each		3	3	3	2
	Distance of Gutter Inlet	meter		40	33	33	50

Design of Dimension and Distance for Gutter Inlet

	Maks Daily rainfall Return for Period 5 Year	mm/hour	:	105.84881			
1	Location :Balaraja FO		:				
	Position : Left and Right at grade						
	Beginning Sta.	meter	:	+600	+720	+840	+40
	End Sta.	meter	:	+720	+840	+940	+120
	Distance	meter	:	**120.00**	**120.00**	**100.00**	**80.00**
2	Design Road		:				
	a. Road Widht	meter	:	6	6	6	6
	b. Super-elevation of Pavement (m1)		:	**2%**	**2%**	**2%**	**2%**
	c. Super-elevation of Gutter (m2)			**10%**	**10%**	**10%**	**10.00%**
	d. Vertical Grades of Road (i)			**0.30%**	**5.00%**	**0.80%**	**1.70%**
3	Coeffisient Road Friction (nd)		:	0.013	0.013	0.013	0.013
4	Concentration Time		:				
	d. T.1	minute	:	1.03	1.03	1.03	1.03
	e. T.2	minute	:	1.99	1.58	1.78	1.61
	f. Tc	minute	:	3.03	2.61	2.81	2.64
	Tc	hour		0.05	0.04	0.05	0.04
5	Coeffisient of Run-off (Concrete)			0.90	0.90	0.90	0.90
6	Catchments Area (=width *distance)	m^2	:	720	720	600	480
7	Coeffisient manning Friction		:	0.015	0.015	0.015	0.015
8	Rainfall Intensity for t = Tc	mm/hour	:	268.9	296.8	282.2	294.2
9	Volume of Run-off	m^3/sec		0.048	0.053	0.042	0.035
10	Hydraulic mean Depth factor			0.455	0.455	0.455	0.455
11	Velocity of Flow factor		:	2.16	8.81	3.53	5.14
12	Flow Area of Gutter factor			5	5	5	5
13	Q = (10 X 11)	m^3/sec	:	10.79	44.06	17.63	25.69
14	Possible hight water at gutter	meter	:	0.13	0.08	0.10	0.08
15	Possible velocity of flow at gutter	meter	:	0.56	1.64	0.78	0.99
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	0.05	0.02	0.03
	Total of Gutter Inlet	each		3	2	2	2
	Distance of Gutter Inlet	meter		40	60	50	40

Design Volume of Run-Off at Flyover (Balaraja)

Max. Daily rainfall for Return Period 5 Year	mm	:	105.8											
1 Location : Balaraja FO		:												
Position :			**Start**	**A1**	P1	**P2**	P3	P5	P6	P7	**P8**	P9	**A2**	**END**
Beginning Sta.	meter	:	+240	+399	+419	+439	+459	+484	+515	+540	+560	+580	+600	+620
End Sta.	meter	:	+399	+419	+439	+459	+484	+515	+540	+560	+580	+600	+620	+760
Distance	meter	:	159	20	20	20	25	31	25	20	20	20	20	140
2 Design Road		:												
a. Traffic width	meter	:	5.5	11	11	11	11	11	11	11	11	11	11	5.5
b. Super-elevation	%	:	2%	2%	2%	2%	2%	2%	2%	2%	2.5%	4%	5.7%	2%
c. Vertical Gradient of Flyover	%		4.45%	4.45%	4.45%	2%	0.70%	0.47%	0.47%	0.47%	3%	4.40%	5.70%	5.70%
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
4 Concentration Time		:												
a. T.1	minute	:	1.02	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.12	1.08	1.05	1.02
b. T.2	minute	:	1.67	1.18	1.18	1.26	1.43	1.53	1.48	1.42	1.22	1.18	1.16	1.60
c. Tc =T.1+T.2	minute	:	2.69	2.32	2.32	2.41	2.57	2.68	2.62	2.57	2.34	2.26	2.20	2.62
Tc	hour		0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
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
6 Catchments Area	m2	:	874.5	220	220	220	275	341	275	220	220	220	220	770
7 Rainfall Intensity for t = Tc	mm/hour	:	297.1	327.5	327.5	320.0	305.9	298.0	302.1	306.3	325.8	333.8	339.3	302.3
8 Volume of Run-Off for Section only	m3/sec	:	**0.065**	**0.018**	**0.018**	**0.018**	**0.021**	**0.025**	**0.021**	**0.017**	**0.018**	**0.018**	**0.019**	**0.058**
9 Volume of Run-Off for at grade leftside	m3/sec	:	**0.065**	**0.036**		**0.085**					**0.035**		**0.037**	**0.058**
10 Volume of Run-Off for at grade rightside	m3/sec	:	**0.065**											**0.058**

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

	Max. Daily rainfall for Return Period 5 Year	mm	:	105.849				
1	Location : Balaraja FO		:					
	Position : Right Frontage							
	Beginning Sta.	meter	:	+0	+120	+180	+420	+720	+840
	End Sta.	meter	:	+120	+180	+420	+720	+840	+940
	Distance	meter	:	120	60	240	300	120	100
2	Design Road		:						
	a. Traffic width	meter	:	6	6	6	6	6	6.5
	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	:	1.03	1.03	1.03	1.03	1.03	1.05
	b. Ground	minute	:	2.26	2.26	2.26	2.26	2.26	2.26
	c. T.1	minute	:	3.29	3.29	3.29	3.29	3.29	3.31
	d. T.2	minute	:	1.70	1.68	2.18	2.27	1.58	1.94
	e. Tc = T.1 + T.2	minute	:	5.00	4.97	5.47	5.56	4.87	5.24
	Tc	hour		0.08	0.08	0.09	0.09	0.08	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	:	720	360	1,440	1,800	720	650
	b. Ground	m^2	:	1,800	900	3,600	4,500	1,800	1,500
7	Coefficient manning Friction		:	0.02	0.02	0.02	0.02	0.02	0.02
8	Rainfall Intensity for t = Tc	mm/hour	:	196.13	196.81	184.60	182.49	199.50	189.90
9	Volume of Run-off on Section	m^3/sec	:	**0.082**	**0.041**	**0.155**	**0.192**	**0.084**	**0.068**
	Volume of Run-off from Upper Section	m^3/sec		**0.041**	-	-	**0.220**	**0.412**	**0.554**
	Volume of Run-off from Flyover	m^3/sec		-	-	**0.065**	-	**0.058**	-
	Total Volume of Run-off	m^3/sec		**0.124**	**0.041**	**0.220**	**0.412**	**0.554**	**0.622**
10	Design of Dimension (minimum)		:						
	a. Height of water level	meter	:	**0.15**	**0.10**	**0.40**	**0.69**	**0.32**	**0.62**
	b. Wide of Side Ditch	meter	:	**0.50**	**0.50**	**0.50**	**0.50**	**0.50**	**0.80**
11	Circumference Wet Area	meter	:	0.79	0.71	1.30	1.88	1.13	2.04
12	Ditch Wet Area	m^2		0.07	0.05	0.20	0.34	0.16	0.50
13	Hydraulic Radii Of Drain	meter	:	0.09	0.07	0.15	0.18	0.14	0.24
14	Ditch sloping		:	0.020	0.006	0.004	0.004	0.050	0.003
15	Flow of Velocity	m^2/sec		1.69	0.79	1.10	1.19	3.51	1.25
16	Design Volume of Ditch	m^3/sec		***0.124***	***0.041***	***0.220***	***0.412***	***0.555***	***0.622***
17	Free Board	meter		0.15	0.15	0.15	0.15	0.15	0.15
18	Highest of Ditch (=10a+17)	meter		0.30	0.25	0.55	0.84	0.47	0.77
			:						
	Wide of Side Ditch	meter		***0.50***	***0.50***	***0.50***	***0.50***	***0.50***	***0.80***
	Highest of Ditch	meter		***0.30***	***0.30***	***0.60***	***0.90***	***0.50***	***0.80***

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

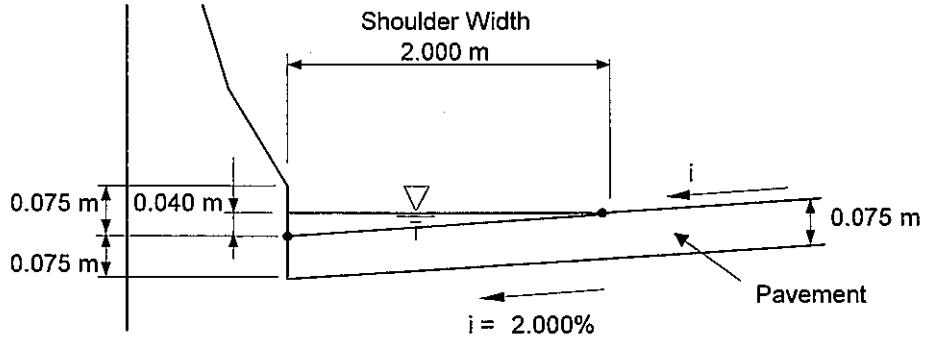
	Max. Daily rainfall for Return Period 5 Year	mm	:	105.849					
1	Location : Balaraja FO		:						
	Position : Left Frontage								
	Beginning Sta.	meter	:	+0	+120	+180	+420	+720	+840
	End Sta.	meter	:	+120	+180	+420	+720	+840	+940
	Distance	meter	:	120.00	60.00	240.00	300.00	120.00	100.00
2	Design Road		:						
	a. Traffic width	meter	:	6	6	6	6	6	6.5
	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	:	1.03	1.03	1.03	1.03	1.03	1.05
	b. Ground	minute	:	2.26	2.26	2.26	2.26	2.26	2.26
	c. T.1	minute	:	3.29	3.29	3.29	3.29	3.29	3.31
	d. T.2	minute	:	1.70	1.68	2.18	2.27	1.58	1.94
	e. Tc = T.1 + T.2	minute	:	5.00	4.97	5.47	5.56	4.87	5.24
	Tc	hour		0.08	0.08	0.09	0.09	0.08	0.09
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	:	720	360	1440	1800	720	650
	b. Ground	m^2	:	1800	900	3600	4500	1800	1500
7	Coefficient manning Friction		:	0.017	0.017	0.017	0.017	0.017	0.017
8	Rainfall Intensity for t = Tc	mm/hour	:	196.1	196.8	184.6	182.5	199.5	189.9
9	Volume of Run-off on Section	m^3/sec	:	**0.082**	**0.041**	**0.155**	**0.192**	**0.084**	**0.068**
	Volume of Run-off from Upper Section	m^3/sec		**0.041**	-	-	**0.256**	**0.604**	**0.746**
	Volume of Run-off from Flyover	m^3/sec		-	-	**0.101**	**0.157**	**0.058**	-
	Total Volume of Run-off	m^3/sec		**0.124**	**0.041**	**0.256**	**0.604**	**0.746**	**0.814**
10	Design of Dimension (minimum)		:						
	a. Height of water level	meter	:	**0.15**	**0.10**	**0.45**	**0.54**	**0.40**	**0.77**
	b. Wide of Side Ditch	meter	:	**0.50**	**0.50**	**0.50**	**0.80**	**0.50**	**0.80**
11	Circumference Wet Area	meter	:	0.79	0.71	1.41	1.89	1.30	2.34
12	Ditch Wet Area	m^2		0.07	0.05	0.23	0.43	0.20	0.62
13	Hydraulic Radii Of Drain	meter	:	0.09	0.07	0.16	0.23	0.15	0.26
14	Ditch sloping		:	0.02	0.01	0.00	0.00	0.05	0.003
15	Flow of Velocity	m^2/sec		1.69	0.79	1.13	1.39	3.75	1.32
16	Design Volume of Ditch	m^3/sec		***0.12***	***0.04***	***0.26***	***0.60***	***0.75***	***0.81***
17	Free Board	meter		0.15	0.15	0.15	0.15	0.15	0.15
18	Highest of Ditch (=10a+17)	meter		0.30	0.25	0.60	0.69	0.55	0.92
	Wide of Side Ditch	meter		**0.50**	**0.50**	**0.50**	**0.80**	**0.50**	**0.80**
	Highest of Ditch	meter		**0.30**	**0.30**	**0.70**	**0.70**	**0.60**	**1.00**

INTERVAL OF VERTICAL DRAIN OF BALARAJA FLYOVER

A. STEEL SUPERSTRUCTURE SECTION, P3 ~ P4 *w/ o Surface Down*

Total F.O. Width Wb = 13.00 m
Single Line Drainage System = 1
Double Line Drainage System = 2
Supper Elevation i = **2.00%**
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 = 0.000% ~ 1.435% **Ave. = 0.718%**
  Span Length L = **25.00 m**
  Catchments Area
  (Single Line Drainage) A1 = Wb x L / 1 = 325 m^2
  (Double Line Drainage) A2 = Wb x L / 2 = 163 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 = 0.0309 m^3/sec.
  (Double Line Drainage) Q2 = 0.0155 m^3/sec.
- Possible Through Volume of Run-Off along Shoulder
  Q' = v x a = 0.0164 m^3/sec.

				Applied w/ Surface Down
				0.0439
- Velocity of Flow				
$v = 1/n \times R^{2/3} \times I^{1/2}$ =	0.41065	m/sec.		0.60559
(Hydraulic mean Depth)	R = a / l =	0.0196		0.0351
(Wetted Perimeter)	l =	2.0404	m	2.0665
(Floow Area of Gutter)	a =	0.0400	m^2	0.0725
(Coefficient of Roughness)	n =	0.015		

3) Designed Number of Vertical Drain

N = Q / Q'

(Double Line Drainage)	N2 =	0.945	Each ==>	1	**Each**
		0.704		**1**	**w/ Surface Down**

4) Designed Interval of Vertical Drain

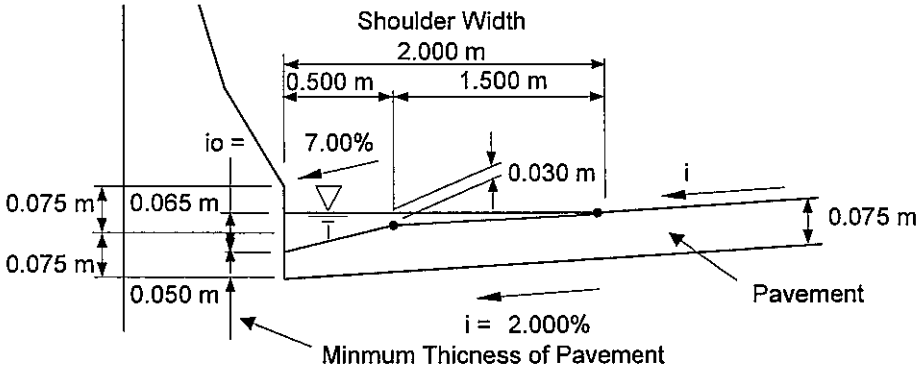
d = Q' / Q x L

(Double Line Drainage)	d2 =	13.269	m ==>	**13.2 m**	
		35.518		**35 m**	**w/ Surface Down**

C. STEEL SUPERSTRUCTURE SECTION, P4 ~ P5 *w/ Surface Down*

Total F.O. Width Wb = 13.00 m
Single Line Drainage System = 1
Double Line Drainage System = 2
Supper Elevation i = **2.00%**
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 = 0.103% ~ 0.472% **Ave. = 0.288%**
  Span Length L = **31.00 m**
  Catchments Area
  (Single Line Drainage) A1 = Wb x L / 1 = 403 m^2
  (Double Line Drainage) A2 = Wb x L / 2 = 202 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 = 0.0383 m^3/sec.
  (Double Line Drainage) Q2 = 0.0192 m^3/sec.
- Possible Through Volume of Run-Off along Shoulder
  Q' = v x a = 0.0278 m^3/sec.
- Velocity of Flow
  $v = 1/n \times R^{2/3} \times I^{1/2}$ = 0.38354 m/sec.
  (Hydraulic mean Depth) R = a / l = 0.0351
  (Wetted Perimeter) l = 2.0665 m
  (Floow Area of Gutter) a = 0.0725 m^2
  (Coefficient of Roughness) n = 0.015

3) Designed Number of Vertical Drain

N = Q / Q'
(Double Line Drainage) N2 = 0.691 Each ==> 1 **Each**

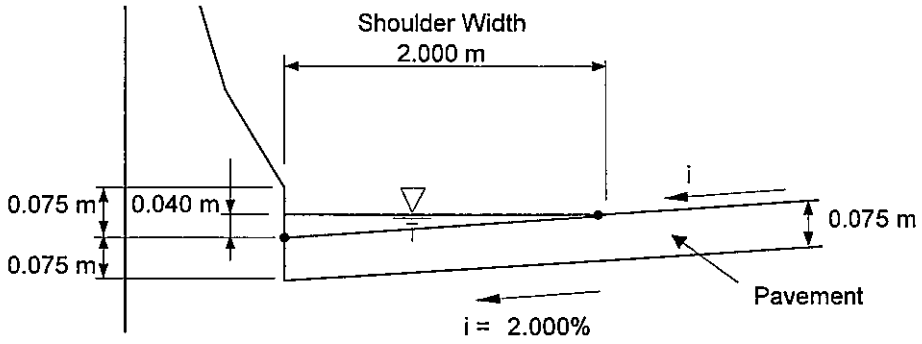
4) Designed Interval of Vertical Drain

d = Q' / Q x L
(Double Line Drainage) d2 = 44.885 m ==> **44 m**

D. STEEL SUPERSTRUCTURE SECTION, P5 ~ P6 *w/ o Surface Down*

Total F.O. Width Wb = 13.00 m
Single Line Drainage System = 1
Double Line Drainage System = 2
Supper Elevation i = **2.00%**
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 = 0.472% ~ 1.129% **Ave. = 0.801%**
  Span Length L = **25.00 m**
  Catchments Area
  (Single Line Drainage) A1 = Wb x L / 1 = 325 m^2
  (Double Line Drainage) A2 = Wb x L / 2 = 163 m^2

2) Volume of Run-Off

- Volume of Run-Off
  $Q = 1/(3.6 \times 10^6) \times C \times \gamma o \times A$

				Applied w/ Surface Down
(Single Line Drainage)	Q1 =	0.0309	m^3/sec.	
(Double Line Drainage)	Q2 =	0.0155	m^3/sec.	

- Possible Through Volume of Run-Off along Shoulder
  Q' = v x a = 0.0173 m^3/sec. 0.0464
- Velocity of Flow

$v = 1/n \times R^{2/3} \times I^{1/2}$ =	0.43374	m/sec.		0.63963
(Hydraulic mean Depth)	R = a / l =	0.0196		0.0351
(Wetted Perimeter)	l =	2.0404	m	2.0665
(Floow Area of Gutter)	a =	0.0400	m^2	0.0725
(Coefficient of Roughness)	n =	0.015		

3) Designed Number of Vertical Drain

N = Q / Q'

(Double Line Drainage)	N2 =	0.896	Each ==>	1	**Each**
		0.666		1	**w/ Surface Down**

4) Designed Interval of Vertical Drain

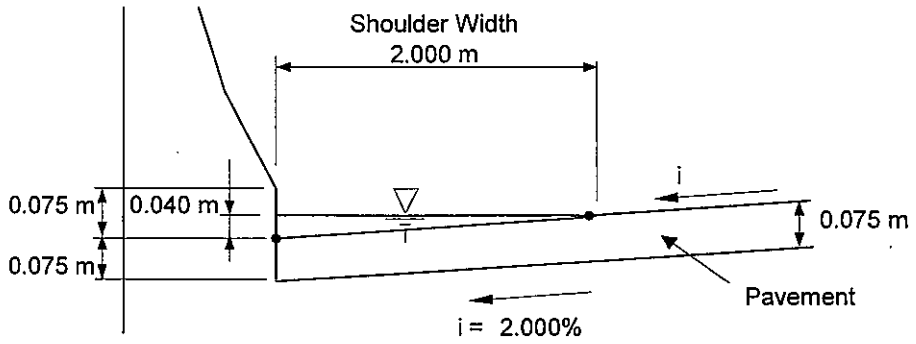
d = Q' / Q x L

(Double Line Drainage)	d2 =	13.997	m ==>	**13.9 m**	
		37.540		**37 m**	**w/ Surface Down**

E. PC SUPERSTRUCTURE SECTION, P6 ~ P7 *w/ o Surface Down*

Total F.O. Width Wb = 13.00 m
Single Line Drainage System = 1
Double Line Drainage System = 2
Supper Elevation i = **2.00%**
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 = 1.129% ~ 2.444% **Ave. = 1.787%**
  Span Length L = **20.00 m**
  Catchments Area
  (Single Line Drainage) A1 = Wb x L / 1 = 260 m^2
  (Double Line Drainage) A2 = Wb x L / 2 = 130 m^2

2) Volume of Run-Off

- Volume of Run-Off
  $Q = 1/(3.6 \times 10^6) \times C \times \gamma o \times A$

				Applied w/ Surface Down
(Single Line Drainage)	Q1 =	0.0247	m^3/sec.	
(Double Line Drainage)	Q2 =	0.0124	m^3/sec.	

- Possible Through Volume of Run-Off along Shoulder
  Q' = v x a = 0.0259 m^3/sec. 0.0693
- Velocity of Flow

$v = 1/n \times R^{2/3} \times I^{1/2}$ =	0.64785	m/sec.		0.95538
(Hydraulic mean Depth)	R = a / l =	0.0196		0.0351
(Wetted Perimeter)	l =	2.0404	m	2.0665
(Floow Area of Gutter)	a =	0.0400	m^2	0.0725
(Coefficient of Roughness)	n =	0.015		

3) Designed Number of Vertical Drain

N = Q / Q'

(Double Line Drainage)	N2 =	0.479	Each ==>	**1**	**Each**
		0.356		**1**	**w/ Surface Down**

4) Designed Interval of Vertical Drain

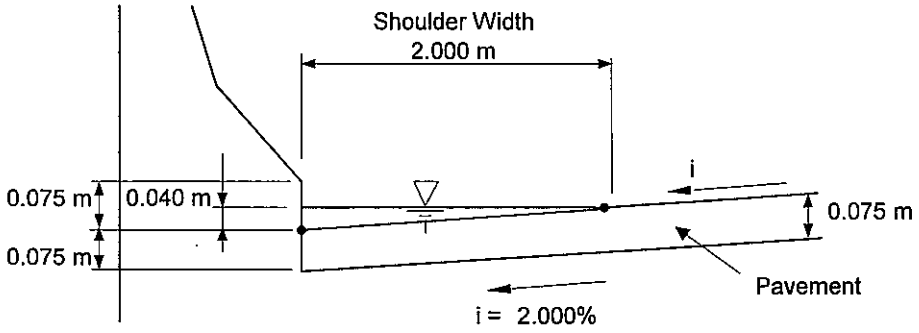
d = Q' / Q x L

(Double Line Drainage)	d2 =	20.972	m ==>	**20.9 m**	
		56.113		**56 m**	**w/ Surface Down**

F. APPROACH (A1)

Total F.O. Width Wb = 13.00 m
Single Line Drainage System = 1
Double Line Drainage System = 2
Supper Elevation i = **2.00%**
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 = **4.450%**
  Approach Length L = **156.00** **m**
  Catchments Area
  (Single Line Drainage) A1 = Wb x L / 1 = 2028 m^2
  (Double Line Drainage) A2 = Wb x L / 2 = 1014 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 = 0.1927 m^3/sec.
  (Double Line Drainage) Q2 = 0.0963 m^3/sec.
- Possible Through Volume of Run-Off along Shoulder
  Q' = v x a = 0.0409 m^3/sec.
- Velocity of Flow
  $v = 1/n \times R^{2/3} \times I^{1/2}$ = 1.02233 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 = 4.711 Each ==> **5** **Each**
(Double Line Drainage) N2 = 2.355 Each ==> **3** **Each**

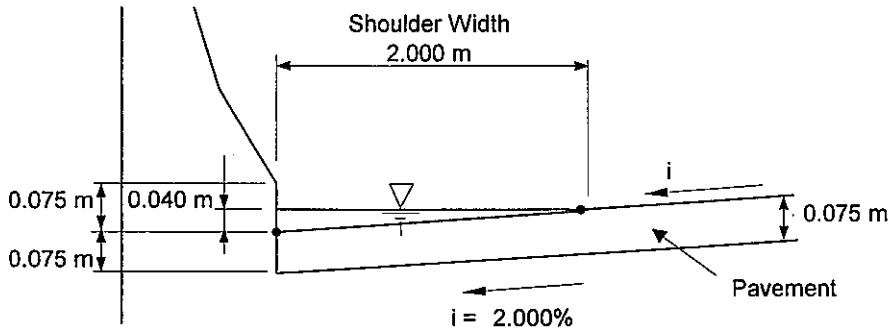
4) Designed Interval of Vertical Drain

d = L / N
(Single Line Drainage) d2 = 31.200 m ==> **31 m**
(Double Line Drainage) d1 = 52.000 m ==> **52 m**

G. APPROACH (A2)

Total F.O. Width Wb = 13.00 m
Single Line Drainage System = 1
Double Line Drainage System = 2
Supper Elevation i = **3.85%**
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 = **5.730%**
  Approach Length L = **140.00 m**
  Catchments Area
  (Single Line Drainage) A1 = Wb x L / 1 = 1820 m^2
  (Double Line Drainage) A2 = Wb x L / 2 = 910 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 = 0.1729 m^3/sec.
  (Double Line Drainage) Q2 = 0.0865 m^3/sec.
- Possible Through Volume of Run-Off along Shoulder
  Q' = v x a = 0.0464 m^3/sec.
- Velocity of Flow
  $v = 1/n \times R^{2/3} \times I^{1/2}$ = 1.16009 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 = 3.726 Each ==> **4 Each**
(Double Line Drainage) N2 = 1.864 Each ==> **2 Each**

4) Designed Interval of Vertical Drain

d = Q' / Q x L
(Single Line Drainage) d2 = 35.000 m ==> **35 m**
(Double Line Drainage) d1 = 70.000 m ==> **70 m**

3.3 DRAINAGE DESING IN NAGREG FLYOVER

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

DAILY RAINFALL CICALENGKA STATION (BANDUNG)

No	Years	Rainfall Data (mm)
1	1994	54.00
2	1995	53.00
3	1996	43.00
4	1997	61.00
5	1998	74.00
6	1999	42.00
7	2000	69.00
8	2001	46.00
9	2002	59.00
10	2003	76.00
11	2004	150.00

DISTRIBUTION OF GUMBEL

No.	Years	Daily Rainfall Average (mm)	$(X - X_{ave})^2$	$(X - X_{ave})^3$	$(X - X_{ave})^4$
1	1994	54.000	146.190	-1767.571	21371.540
2	1995	53.000	171.372	-2243.414	29368.328
3	1996	43.000	533.190	-12311.844	284291.664
4	1997	61.000	25.917	-131.943	671.709
5	1998	74.000	62.554	494.743	3912.968
6	1999	42.000	580.372	-13981.687	336831.543
7	2000	69.000	8.463	24.619	71.619
8	2001	46.000	403.645	-8109.588	162928.986
9	2002	59.000	50.281	-356.538	2528.178
10	2003	76.000	98.190	972.974	9641.292
11	2004	150.000	7040.736	590781.718	49571956.905
	Σ	727.000	9120.909	553371.471	50423574.733

X Mean =	66.091	mm	
Standart Deviation =	30.201	mm	
Skewness Coefficient =	**2.790**	**Max rate :**	**1.140**
Kurtosis Coefficient=	**12.026**	**Max rate:**	**5.400**
Reduced Mean Y_N =	0.4952		
Reduced Standard Deviation S_N =	0.9496		
b =	50.342		
1/a =	31.804		

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	61.998
2	5	1.4999	98.044
3	10	2.2502	121.906
4	20	2.9606	144.500
5	25	3.1985	152.066
6	50	3.9019	174.437
7	100	4.6001	196.642

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	54.000	1.732	0.003	0.000
2	1995	53.000	1.724	0.004	0.000
3	1996	43.000	1.633	0.025	-0.004
4	1997	61.000	1.785	0.000	0.000
5	1998	74.000	1.869	0.006	0.000
6	1999	42.000	1.623	0.028	-0.005
7	2000	69.000	1.839	0.002	0.000
8	2001	46.000	1.663	0.016	-0.002
9	2002	59.000	1.771	0.000	0.000
10	2003	76.000	1.881	0.008	0.001
11	2004	150.000	2.176	0.149	0.057
	Σ	727.000	19.697	0.242	0.047

Average = 1.791
Standart Deviation = 0.156
Skewness Coefficient= 1.744

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	1.7825	60.604
2	5	0.8228	1.9188	82.946
3	10	1.3102	1.9947	98.786
4	20	2.0059	2.1030	126.776
5	25	1.8537	2.0793	120.039
6	50	2.2185	2.1361	136.817
7	100	2.5547	2.1885	154.344

Log Pearson Type III

DISTRIBUTION OF LOG NORMAL

No.	Years	Daily Rainfall Average (mm)	Log X	(Log X - log X_{ave})	(Log X - log X_{ave})^2
1	1994	54.000	1.732	-0.058	0.003
2	1995	53.000	1.724	-0.066	0.004
3	1996	43.000	1.633	-0.157	0.025
4	1997	61.000	1.785	-0.005	0.000
5	1998	74.000	1.869	0.079	0.006
6	1999	42.000	1.623	-0.167	0.028
7	2000	69.000	1.839	0.048	0.002
8	2001	46.000	1.663	-0.128	0.016
9	2002	59.000	1.771	-0.020	0.000
10	2003	76.000	1.881	0.090	0.008
11	2004	150.000	2.176	0.385	0.149
	Σ	727.000	19.697	0.000	0.242

Average = 1.791
Standart Deviation = 0.156
Variable Coefficient 0.087
Skewness Coefficient= 0.262 **Max rate : 0.261**
kurtosis Coefficient 3.122

Result Formula,
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	1.7797	60.217
5	0.8103	1.9168	82.575
10	1.3142	1.9953	98.928
20	1.7545	2.0639	115.845
25	1.8418	2.0775	119.531
50	2.2786	2.1455	139.798
100	2.6089	2.1969	157.371

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	110.125	69.37463	52.94275	43.70328	33.35184	25.45222	21.01034	17.34366	14.94631	13.23569	11.40617	10.10072	6.363055
5	150.722	94.949	72.45965	59.81412	45.64672	34.83497	28.75563	23.73725	20.45614	18.11491	15.61096	13.82427	8.708742
10	179.764	113.2443	86.42156	71.33943	54.44217	41.54715	34.29642	28.31107	24.39774	21.60539	18.61896	16.488	10.38679
20	230.367	145.122	110.7488	91.42114	69.76739	53.24248	43.9507	36.2805	31.26559	27.68721	23.86011	21.12929	13.31062
25	218.126	137.411	104.8641	86.56342	66.06025	50.41341	41.61535	34.35272	29.60427	26.21603	22.59229	20.00657	12.60335
50	254.029	160.028	122.1245	100.8115	76.93361	58.71133	48.46514	40.00709	34.47706	30.53112	26.31092	23.29961	14.67783
100	285.962	180.145	137.476	113.484	86.60448	66.09159	54.5574	45.03614	38.81097	34.36901	29.61832	26.22846	16.5229

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	9.177113	11.56244	13.23569	14.56776	16.67592	19.08916	21.01034	23.12488	24.91052	26.47137	28.51542	30.30216	38.17833
5	12.56018	15.82483	18.11491	19.93804	22.82336	26.12623	28.75563	31.64967	34.09357	36.22983	39.0274	41.4728	52.25245
10	14.98034	18.87405	21.60539	23.77981	27.22109	31.16037	34.29642	37.74809	40.6629	43.21078	46.5474	49.464	62.32073
20	19.19724	24.187	27.68721	30.47371	34.88369	39.93186	43.9507	48.374	52.10932	55.37441	59.65028	63.38788	79.86372
25	18.17718	22.90181	26.21603	28.85447	33.03013	37.81006	41.61535	45.80362	49.34045	52.43206	56.48072	60.01972	75.62011
50	21.1691	26.67139	30.53112	33.60385	38.4668	44.0335	48.46514	53.34278	57.46177	61.06225	65.77731	69.89882	88.067
100	23.83014	30.0241	34.36901	37.82799	43.30224	49.56869	54.5574	60.04819	64.68496	68.73802	74.04579	78.68539	99.13738

Max Daily Rainfall Calculation for NAGREG Flyover

Return Period	Gumbel	Log Pearson	Log Normal	Result (mm)
2	61.998	60.604	60.217	60.604
5	98.044	82.946	82.575	82.946
10	121.906	98.786	98.928	98.928
20	144.500	126.776	115.845	126.776
25	152.066	120.039	119.531	120.039
50	174.437	136.817	139.798	139.798
100	196.642	154.344	157.371	157.371

INTERVAL OF GUTTER INLET

- Section 0+900 - 1+040

Distance (Lo) =	**140**	**m**
Vertical Grades of Road (i)=	2.40%	
Road Width (L1) =	5.5	m
Super Elevation (m1) =	2.00%	(Pavement)
Super Elevation (m2) =	10.00%	(Gutter)
Rainfall intensity (Y) =	**82.95**	mm
(5 years return period)		
Coefficient of Run-off (C) =	0.9	(Concrete)

1) Catchments Area

Catchments Area (A= L0*L1) 770 m^2

2) Time Concentration

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

t2 = {2/3 x 3.28 x Lo x nd / (i) ^ 0.5 } ^ 0.167 = 1.72 min.

TC = t1 + t2 2.74 min. = 0.05 hour

3) Volume of Run-Off

Rainfall intensity

$I = (Y /24) * (24 / TC) ^{2/3}$ = 225.3 mm/ hour

Volume of Run-Off

$Q = 1 / (3.6 \times 10^6) \times C \times I \times A$ = 0.0434 m^3/sec.

Possible Through Volume of Run-Off along Gutter

$Q1 = v \times a$ (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

$v = 6.11\ H^{2/3}$

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

$Q1 = v \times a = 30.5\ H^{8/3}$

Q = Q1

$0.0501 = 30.5\ H^{8/3}$

H = 0.09 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 = 0.036 m^3/sec.

N = Q / q = 1.2 < 2 each

d = L / N = 70 m

Design of Dimension and Distance for Gutter Inlet

	Maks Daily rainfall Return for Period 5 Year	mm/hour	:	82.945595			
1	Location :Nagreg FO		:				
	Position : Left and Right at grade						
	Beginning Sta.	meter	:	+900	+800	+662	+496
	End Sta.	meter	:	1+040	+900	+800	+604
	Distance	meter	:	**140.00**	**100.00**	**138.00**	**108.00**
2	Design Road		:				
	a. Road Widht	meter	:	6	6	6	6
	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)			**2.40%**	**1.70%**	**2.50%**	**1.90%**
3	Coeffisient Road Friction (nd)		:	0.013	0.013	0.013	0.013
4	Concentration Time		:				
	d. T.1	minute	:	1.03	1.03	1.03	1.03
	e. T.2	minute	:	1.72	1.67	1.71	1.68
	f. Tc	minute	:	2.75	2.70	2.74	2.71
	Tc	hour		0.05	0.05	0.05	0.05
5	Coeffisient of Run-off (Concrete)			0.90	0.90	0.90	0.90
6	Catchments Area (=width *distance)	m^2	:	840	600	828	648
7	Coeffisient manning Friction		:	0.015	0.015	0.015	0.015
8	Rainfall Intensity for t = Tc	mm/hour	:	224.5	227.0	225.0	226.7
9	Volume of Run-off	m^3/sec		0.047	0.034	0.047	0.037
10	Hydraulic mean Depth factor			0.455	0.455	0.455	0.455
11	Velocity of Flow factor		:	6.11	5.14	6.23	5.43
12	Flow Area of Gutter factor			5	5	5	5
13	Q = (10 X 11)	m^3/sec	:	30.53	25.69	31.16	27.16
14	Possible hight water at gutter	meter	:	**0.09**	**0.08**	**0.09**	**0.08**
15	Possible velocity of flow at gutter	meter	:	1.21	0.98	1.23	1.04
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		0.04	0.03	0.04	0.03
	Total of Gutter Inlet	each		2	2	2	2
	Distance of Gutter Inlet	meter		70	50	69	54

Design of Dimension and Distance for Gutter Inlet

	Maks Daily rainfall Return for Period 5 Year	mm/hour	:	82.945595			
1	Location :Nagreg FO		:				
	Position : Left and Right at grade						
	Beginning Sta.	meter	:	+400	+300	+225	+66
	End Sta.	meter	:	+496	+400	+300	+225
	Distance	meter	:	**96.00**	**100.00**	**75.00**	**159.00**
2	Design Road		:				
	a. Road Widht	meter	:	6	6	6	6
	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)			**2.00%**	**2.50%**	**5.30%**	**0.30%**
3	Coeffisient Road Friction (nd)		:	0.013	0.013	0.013	0.013
4	Concentration Time		:				
	d. T.1	minute	:	1.03	1.03	1.03	1.03
	e. T.2	minute	:	1.64	1.62	1.45	2.09
	f. Tc	minute	:	2.67	2.65	2.48	3.12
	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	:	576	600	450	954
7	Coeffisient manning Friction		:	0.015	0.015	0.015	0.015
8	Rainfall Intensity for t = Tc	mm/hour	:	228.9	230.0	240.4	206.3
9	Volume of Run-off	m^3/sec		0.033	0.035	0.027	0.049
10	Hydraulic mean Depth factor			0.455	0.455	0.455	0.455
11	Velocity of Flow factor		:	5.57	6.23	9.07	2.16
12	Flow Area of Gutter factor			5	5	5	5
13	Q = (10 X 11)	m^3/sec	:	27.87	31.16	45.37	10.79
14	Possible hight water at gutter	meter	:	**0.08**	**0.08**	**0.06**	**0.13**
15	Possible velocity of flow at gutter	meter	:	1.03	1.14	1.42	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		0.03	0.03	0.04	0.02
	Total of Gutter Inlet	each		2	2	1	3
	Distance of Gutter Inlet	meter		48	50	75	53

Tabel :

Design Volume of Run-Off at Flyover (Nagreg)

Maks Daily rainfall for Return Period 5 Year	mm	:	82.9455952											
1 Location : Nagreg FO		:												
Position :			**Start**	**A1**	**P1**	**P2**	P3	P4	P5	P6	P8	**P9**	**A2**	**END**
Beginning Sta.	meter	:	+139	+496	+516	+536	+556	+576	+601	+628	+655	+680	+700	+720
End Sta.	meter	:	+496	+516	+536	+556	+576	+601	+628	+655	+680	+700	+720	+875
Distance	meter	:	357.00	20.00	20.00	20.00	20.00	25.00	27.00	27.00	25.00	20.00	20.00	155.00
2 Design Road		:												
a. Traffic widht	meter	:	5.5	11	11	11	11	11	11	11	11	11	11	5.5
b. Super-elevation		:	3.9%	2.5%	4.1%	5.3%	4.1%	2.5%	2.0%	3.5%	5.1%	5.1%	3.5%	2.0%
c. Vertical Gradient of Flyover			5%	5%	5%	5%	5%	5%	2.50%	0.80%	0.80%	2.30%	3.20%	3.20%
3 Coeffisient 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
4 Concentration Time		:												
a. Traffic	minute	:	0.96	1.12	1.08	1.05	1.08	1.12	1.14	1.09	1.06	1.06	1.09	1.02
d. T.1	minute	:	0.96	1.12	1.08	1.05	1.08	1.12	1.14	1.09	1.06	1.06	1.09	1.02
e. T.2	minute	:	1.89	1.17	1.17	1.17	1.17	1.21	1.30	1.43	1.41	1.25	1.21	1.71
f. Tc	minute	:	2.86	2.29	2.25	2.22	2.25	2.34	2.45	2.52	2.47	2.30	2.30	2.73
Tc	hour		0.05	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.05
5 Coeffisient 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
6 Catchments Area	m2	:	1963.5	220	220	220	220	275	297	297	275	220	220	852.5
7 Rainfall Intensity for t = Tc	mm/hour	:	223.6	259.1	262.6	264.4	262.6	255.8	248.0	242.9	246.3	258.1	258.1	230.6
8 Volume of Run-Off for Section only	m3/sec	:	**0.110**	**0.014**	**0.014**	**0.002**	**0.014**	**0.018**	**0.018**	**0.018**	**0.017**	**0.014**	**0.014**	**0.049**
9 Volume of Run-Off for at grade leftside	m3/sec		**0.110**	**0.029**		**0.071**								**0.049**
10 Volume of Run-Off for at grade rightside	m3/sec		**0.110**									**0.031**	**0.014**	**0.049**

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

	Maks Daily rainfall for Return Period 5 Year	mm	:	82.9456		
1	Location : Nagreg FO		:			
	Position : Right Frontage					
	Beginning Sta.	meter	:	+900	+800	+662	+496
	End Sta.	meter	:	1+040	+900	+800	+604
	Distance	meter	:	140.00	100.00	138.00	108.00
2	Design Road		:			
	a. Traffic width	meter	:	5.5	5.5	5.5	5.5
	b. Ground width	meter	:	15	15	15	15
	Super-elevation		:			
	a. Traffic		:	0.02	0.02	0.02	0.02
	b. Ground		:	0.01	0.01	0.01	0.01
3	Coeffisient Road Friction (nd)		:			
	a. Traffic		:	0.013	0.013	0.013	0.013
	b. Ground		:	0.4	0.4	0.4	0.4
4	Concentration Time		:			
	a. Traffic	minute	:	1.02	1.02	1.02	1.02
	b. Ground	minute	:	2.26	2.26	2.26	2.26
	c. T.1	minute	:	3.28	3.28	3.28	3.28
	d. T.2	minute	:	1.72	1.67	1.71	1.68
	e. Tc = T.1 + T.2	minute	:	5.00	4.95	4.99	4.96
	Tc	hour		0.08	0.08	0.08	0.08
5	Coeffisient of Flow		:			
	a. Concrete Road and Asphalt		:	0.7	0.7	0.7	0.7
	b. Ground		:	0.5	0.5	0.5	0.5
	c. Average		:	0.60	0.60	0.60	0.60
6	Catchments Area (=width *distance)		:			
	a. Traffic	m^2	:	770	550	759	594
	b. Ground	m^2	:	2100	1500	2070	1620
7	Coeffisient manning Friction		:	0.017	0.017	0.017	0.017
8	Rainfall Intensity for t = Tc	mm/hour	:	153.6	154.6	153.8	154.5
9	Volume of Run-off on Section	m^3/sec	:	**0.073**	**0.053**	**0.073**	**0.057**
	Volume of Run-off from Upper Section	m^3/sec		**-**	**0.073**	**0.175**	**0.279**
	Volume of Run-off from Flyover	m^3/sec		**-**	**0.049**	**0.031**	**-**
	Total Volume of Run-off	m^3/sec		**0.073**	**0.175**	**0.279**	**0.336**
10	Design of Dimension (minimum)		:			
	a. Hight of water level	meter	:	**0.08**	**0.08**	**0.08**	**0.08**
	b. Wide of Side Ditch	meter	:	**0.60**	**0.60**	**0.60**	**0.60**
11	Circumference Wet Area	meter	:	0.77	0.75	0.76	0.75
12	Ditch Wet Area	m^2		0.05	0.05	0.05	0.05
13	Hydraulic Radii Of Drain	meter	:	0.07	0.06	0.06	0.06
14	Ditch sloping		:	**0.02**	**0.02**	**0.03**	**0.02**
15	Flow of Velocity	m^2/sec		1.47	1.17	1.48	1.24
16	Design Volume of Ditch	m^3/sec		***0.07***	***0.05***	***0.07***	***0.06***
17	Free Board	meter		0.15	0.15	0.15	0.15
18	Highest of Ditch (=10a+17)	meter		0.23	0.23	0.23	0.23
	Wide of Side Ditch	meter		**0.60**	**0.60**	**0.60**	**0.60**
	Highest of Ditch	meter		**0.30**	**0.30**	**0.30**	**0.30**

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

	Maks Daily rainfall for Return Period 5 Year	mm	:	82.9456		
1	Location : Nagreg FO		:			
	Position : Right Frontage					
	Beginning Sta.	meter	:	+400	+300	+225	+66
	End Sta.	meter	:	+620	+400	+300	+225
	Distance	meter	:	220.00	100.00	75.00	159.00
2	Design Road		:				
	a. Traffic width	meter	:	5.5	5.5	5.5	5.5
	b. Ground width	meter	:	15	15	15	15
	Super-elevation		:				
	a. Traffic		:	0.02	0.02	0.02	0.02
	b. Ground		:	0.01	0.01	0.01	0.01
3	Coeffisient Road Friction (nd)		:				
	a. Traffic		:	0.013	0.013	0.013	0.013
	b. Ground		:	0.4	0.4	0.4	0.4
4	Concentration Time		:				
	a. Traffic	minute	:	1.02	1.02	1.02	1.02
	b. Ground	minute	:	2.26	2.26	2.26	2.26
	c. T.1	minute	:	3.28	3.28	3.28	3.28
	d. T.2	minute	:	1.88	1.62	1.45	2.09
	e. Tc = T.1 + T.2	minute	:	5.16	4.90	4.73	5.37
	Tc	hour		0.09	0.08	0.08	0.09
5	Coeffisient of Flow		:				
	a. Concrete Road and Asphalt		:	0.7	0.7	0.7	0.7
	b. Ground		:	0.5	0.5	0.5	0.5
	c. Average		:	0.60	0.60	0.60	0.60
6	Catchments Area (=width *distance)		:				
	a. Traffic	m^2	:	1210	550	412.5	874.5
	b. Ground	m^2	:	3300	1500	1125	2385
7	Coeffisient manning Friction		:	0.017	0.017	0.017	0.017
8	Rainfall Intensity for t = Tc	mm/hour	:	150.3	155.7	159.4	146.4
9	Volume of Run-off on Section	m^3/sec	:	**0.11**	**0.05**	**0.04**	**0.08**
	Volume of Run-off from Upper Section	m^3/sec		-	**0.11**	**0.17**	**0.21**
	Volume of Run-off from Flyover	m^3/sec		-	-	-	**0.11**
	Total Volume of Run-off	m^3/sec		**0.11**	**0.17**	**0.21**	**0.40**
10	Design of Dimension (minimum)		:				
	a. Hight of water level	meter	:	**0.12**	**0.07**	**0.04**	**0.18**
	b. Wide of Side Ditch	meter	:	**0.60**	**0.60**	**0.60**	**0.60**
11	Circumference Wet Area	meter	:	0.84	0.73	0.69	0.96
12	Ditch Wet Area	m^2		0.07	0.04	0.03	0.11
13	Hydraulic Radii Of Drain	meter	:	0.08	0.05	0.04	0.11
14	Ditch sloping		:	**0.02**	**0.03**	**0.05**	**0.00**
15	Flow of Velocity	m^2/sec		1.59	1.33	1.53	0.74
16	Design Volume of Ditch	m^3/sec		***0.11***	***0.05***	***0.04***	***0.08***
17	Free Board	meter		0.15	0.15	0.15	0.15
18	Highest of Ditch (=10a+17)	meter		0.27	0.22	0.19	0.33
	Wide of Side Ditch	meter		**0.60**	**0.60**	**0.60**	**0.60**
	Highest of Ditch	meter		**0.30**	**0.30**	**0.20**	**0.40**

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

	Maks Daily rainfall for Return Period 5 Year	mm	:	82.9456		
1	Location : Nagreg FO		:			
	Position : Left Frontage					
	Beginning Sta.	meter	:	+900	+800	+662	+496
	End Sta.	meter	:	1+040	+900	+800	+604
	Distance	meter	:	140.00	100.00	138.00	108.00
2	Design Road		:				
	a. Traffic width	meter	:	5.5	5.5	5.5	5.5
	b. Ground width	meter	:	15	15	15	15
	Super-elevation		:				
	a. Traffic		:	0.02	0.02	0.02	0.02
	b. Ground		:	0.01	0.01	0.01	0.01
3	Coeffisient Road Friction (nd)		:				
	a. Traffic		:	0.013	0.013	0.013	0.013
	b. Ground		:	0.4	0.4	0.4	0.4
4	Concentration Time		:				
	a. Traffic	minute	:	1.02	1.02	1.02	1.02
	b. Ground	minute	:	2.26	2.26	2.26	2.26
	c. T.1	minute	:	3.28	3.28	3.28	3.28
	d. T.2	minute	:	1.72	1.67	1.71	1.68
	e. Tc = T.1 + T.2	minute	:	5.00	4.95	4.99	4.96
	Tc	hour		0.08	0.08	0.08	0.08
5	Coeffisient of Flow		:				
	a. Concrete Road and Asphalt		:	0.7	0.7	0.7	0.7
	b. Ground		:	0.5	0.5	0.5	0.5
	c. Average		:	0.60	0.60	0.60	0.60
6	Catchments Area (=width *distance)		:				
	a. Traffic	m^2	:	770	550	759	594
	b. Ground	m^2	:	2100	1500	2070	1620
7	Coeffisient manning Friction		:	0.017	0.017	0.017	0.017
8	Rainfall Intensity for t = Tc	mm/hour	:	153.6	154.6	153.8	154.5
9	Volume of Run-off on Section	m^3/sec	:	**0.07**	**0.05**	**0.07**	**0.06**
	Volume of Run-off from Upper Section	m^3/sec		-	**0.07**	**0.18**	**0.25**
	Volume of Run-off from Flyover	m^3/sec		-	**0.05**	-	-
	Total Volume of Run-off	m^3/sec		**0.07**	**0.18**	**0.25**	**0.30**
10	Design of Dimension (minimum)		:				
	a. Hight of water level	meter	:	**0.08**	**0.08**	**0.08**	**0.08**
	b. Wide of Side Ditch	meter	:	**0.60**	**0.60**	**0.60**	**0.60**
11	Circumference Wet Area	meter	:	0.77	0.75	0.76	0.75
12	Ditch Wet Area	m^2		0.05	0.05	0.05	0.05
13	Hydraulic Radii Of Drain	meter	:	0.07	0.06	0.06	0.06
14	Ditch sloping		:	**0.02**	**0.02**	**0.03**	**0.02**
15	Flow of Velocity	m^2/sec		1.47	1.17	1.48	1.24
16	Design Volume of Ditch	m^3/sec		***0.07***	***0.05***	***0.07***	***0.06***
17	Free Board	meter		0.15	0.15	0.15	0.15
18	Highest of Ditch (=10a+17)	meter		0.23	0.23	0.23	0.23
	Wide of Side Ditch	meter		**0.60**	**0.60**	**0.60**	**0.60**
	Highest of Ditch	meter		**0.30**	**0.30**	**0.30**	**0.30**

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

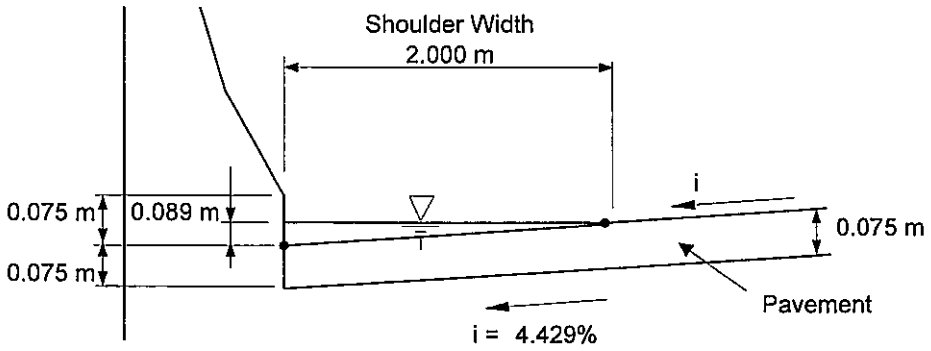
	Maks Daily rainfall for Return Period 5 Year	mm	:	82.9456		
1	Location : Nagreg FO		:			
	Position : Left Frontage					
	Beginning Sta.	meter	:	+400	+300	+225	+66
	End Sta.	meter	:	+620	+400	+300	+225
	Distance	meter	:	220.00	100.00	75.00	159.00
2	Design Road		:				
	a. Traffic width	meter	:	5.5	5.5	5.5	5.5
	b. Ground width	meter	:	15	15	15	15
	Super-elevation		:				
	a. Traffic		:	0.02	0.02	0.02	0.02
	b. Ground		:	0.01	0.01	0.01	0.01
3	Coeffisient Road Friction (nd)		:				
	a. Traffic		:	0.013	0.013	0.013	0.013
	b. Ground		:	0.4	0.4	0.4	0.4
4	Concentration Time		:				
	a. Traffic	minute	:	1.02	1.02	1.02	1.02
	b. Ground	minute	:	2.26	2.26	2.26	2.26
	c. T.1	minute	:	3.28	3.28	3.28	3.28
	d. T.2	minute	:	1.88	1.62	1.45	2.09
	e. Tc = T.1 + T.2	minute	:	5.16	4.90	4.73	5.37
	Tc	hour		0.09	0.08	0.08	0.09
5	Coeffisient of Flow		:				
	a. Concrete Road and Asphalt		:	0.7	0.7	0.7	0.7
	b. Ground		:	0.5	0.5	0.5	0.5
	c. Average		:	0.60	0.60	0.60	0.60
6	Catchments Area (=width *distance)		:				
	a. Traffic	m^2	:	1210	550	412.5	874.5
	b. Ground	m^2	:	3300	1500	1125	2385
7	Coeffisient manning Friction		:	0.017	0.017	0.017	0.017
8	Rainfall Intensity for t = Tc	mm/hour	:	150.3494	155.71	159.4396	146.442
9	Volume of Run-off on Section	m^3/sec	:	**0.11**	**0.05**	**0.04**	**0.08**
	Volume of Run-off from Upper Section	m^3/sec		-	**0.21**	**0.27**	**0.31**
	Volume of Run-off from Flyover	m^3/sec		**0.10**	-	-	**0.11**
	Total Volume of Run-off	m^3/sec		**0.21**	**0.27**	**0.31**	**0.50**
10	Design of Dimension (minimum)		:				
	a. Hight of water level	meter	:	**0.12**	**0.07**	**0.04**	**0.18**
	b. Wide of Side Ditch	meter	:	**0.60**	**0.60**	**0.60**	**0.60**
11	Circumference Wet Area	meter	:	0.84	0.73	0.69	0.96
12	Ditch Wet Area	m^2		0.07	0.04	0.03	0.11
13	Hydraulic Radii Of Drain	meter	:	0.09	0.05	0.04	0.11
14	Ditch sloping		:	**0.02**	**0.03**	**0.05**	**0.00**
15	Flow of Velocity	m^2/sec		1.60	1.33	1.54	0.74
16	Design Volume of Ditch	m^3/sec		***0.11***	***0.05***	***0.04***	***0.08***
17	Free Board	meter		0.15	0.15	0.15	0.15
18	Highest of Ditch (=10a+17)	meter		0.27	0.22	0.19	0.33
	Wide of Side Ditch	meter		**0.60**	**0.60**	**0.60**	**0.60**
	Highest of Ditch	meter		**0.30**	**0.30**	**0.20**	**0.40**

INTERVAL OF VERTICAL DRAIN OF NAGREG FLYOVER

A. STEEL SUPERSTRUCTURE SECTION, P6 ~ P7 *w/ o Surface Down*

Total F.O. Width Wb = 13.00 m
Single Line Drainage System = 1
Double Line Drainage System = 2
Supper Elevation i = 4.429% ~ 5.000%
Rainfall Intensity γ = 150 mm/hr
(5 years return period, 5 mins. Time concentration)
Design Rainfall Intensity γo = γ x k = **300** mm/hr
Coefficient of Run-off C = 0.9
Correction Factor of Falling k = 2

Section :



1) Catchments Area

- Vertical Gradient = 0.000% ~ 1.913% **Ave. = 0.957%**
  Span Length L = **23.00 m**
  Catchments Area
  (Single Line Drainage) A1 = Wb x L / 1 = 299 m^2
  (Double Line Drainage) A2 = Wb x L / 2 = 150 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 = 0.0224 m^3/sec.
  (Double Line Drainage) Q2 = 0.0113 m^3/sec.
- Possible Through Volume of Run-Off along Shoulder
  Q' = v x a = 0.0708 m^3/sec.
- Velocity of Flow
  $v = 1/n \times R^{2/3} \times I^{1/2}$ = 0.7955 m/sec.
  (Hydraulic mean Depth) R = a / l = 0.0426
  (Wetted Perimeter) l = 2.0910 m
  (Floow Area of Gutter) a = 0.0890 m^2
  (Coefficient of Roughness) n = 0.015

3) Designed Number of Vertical Drain

N = Q / Q'
(Single Line Drainage) N1 = 0.316 Each ==> **1 Each**

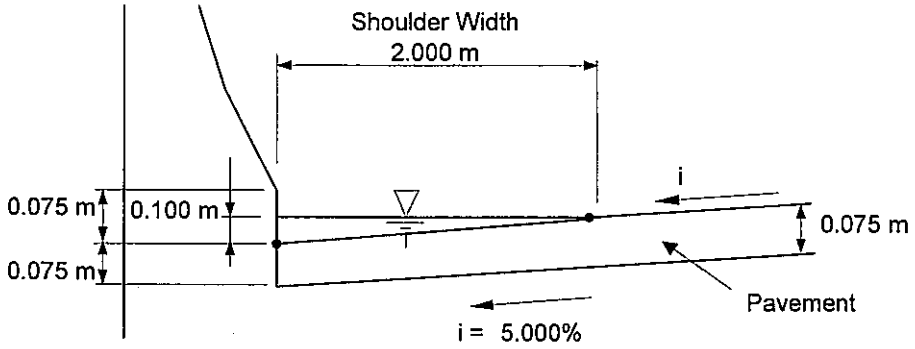
4) Designed Interval of Vertical Drain

d = Q' / Q x L
(Single Line Drainage) d1 = 72.696 m ==> **72 m**

B. STEEL SUPERSTRUCTURE SECTION, P7 ~ P8 *w/ o Surface Down*

Total F.O. Width Wb = 13.00 m
Single Line Drainage System = 1
Double Line Drainage System = 2
Supper Elevation i = **5.00%**
Rainfall Intensity γ = 150 mm/hr
(5 years return period, 5 mins. Time concentration)
Design Rainfall intensity γo = γ x k = **300** mm/hr
Coefficient of Run-off C = 0.9
Correction Factor of Falling k = 2

Section :



1) Catchments Area

- Vertical Gradient = 0.000% ~ 2.368% **Ave. = 1.184%**
  Span Length L = **25.00 m**
  Catchments Area
  (Single Line Drainage) A1 = Wb x L / 1 = 325 m^2
  (Double Line Drainage) A2 = Wb x L / 2 = 163 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 = 0.0244 m^3/sec.
  (Double Line Drainage) Q2 = 0.0122 m^3/sec.
- Possible Through Volume of Run-Off along Shoulder
  Q' = v x a = 0.0953 m^3/sec.
- Velocity of Flow
  $v = 1/n \times R^{2/3} \times I^{1/2}$ = 0.95277 m/sec.
  (Hydraulic mean Depth) R = a / I = 0.0476
  (Wetted Perimeter) I = 2.1025 m
  (Floow Area of Gutter) a = 0.1000 m^2
  (Coefficient of Roughness) n = 0.015

3) Designed Number of Vertical Drain

N = Q / Q'
(Single Line Drainage) N1 = 0.256 Each ==> **1 Each**

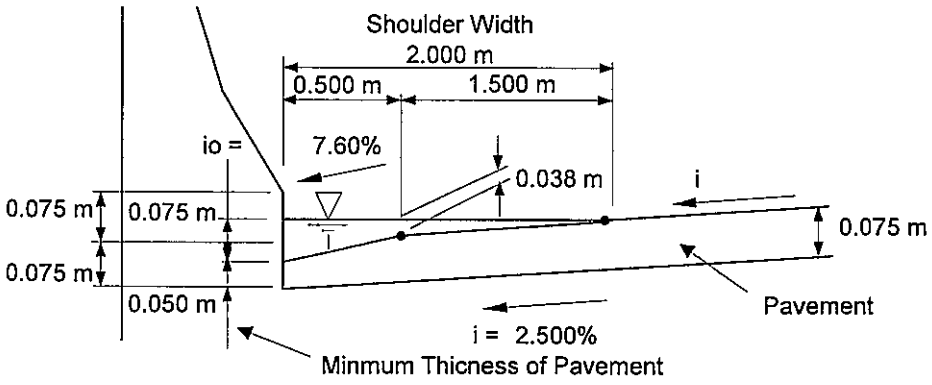
4) Designed Interval of Vertical Drain

d = Q' / Q x L
(Single Line Drainage) d1 = 97.643 m ==> **97 m**

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

Total F.O. Width Wb = 13.00 m
Single Line Drainage System = 1
Double Line Drainage System = 2
Supper Elevation i = 5.000% ~ 0.000%
Rainfall Intensity γ = 150 mm/hr
(5 years return period, 5 mins. Time concentration)
Design Rainfall intensity γo = γ x k = **300** mm/hr
Coefficient of Run-off C = 0.9
Correction Factor of Falling k = 2

Section :



1) Catchments Area

- Vertical Gradient = 4.136% ~ 0.000% **Ave. = 2.068%**
  Span Length L = **48.00 m**
  Catchments Area
  (Single Line Drainage) A1 = Wb x L / 1 = 624 m^2
  (Double Line Drainage) A2 = Wb x L / 2 = 312 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 = 0.0468 m^3/sec.
  (Double Line Drainage) Q2 = 0.0234 m^3/sec.
- Possible Through Volume of Run-Off along Shoulder
  Q' = v x a = 0.0959 m^3/sec.
- Velocity of Flow
  $v = 1/n \times R^{2/3} \times I^{1/2}$ = 1.13435 m/sec.
  (Hydraulic mean Depth) R = a / l = 0.0407
  (Wetted Perimeter) l = 2.0769 m
  (Floow Area of Gutter) a = 0.0845 m^2
  (Coefficient of Roughness) n = 0.015

3) Designed Number of Vertical Drain

N = Q / Q'
(Single Line Drainage) N1 = 0.488 Each ==> **1 Each**

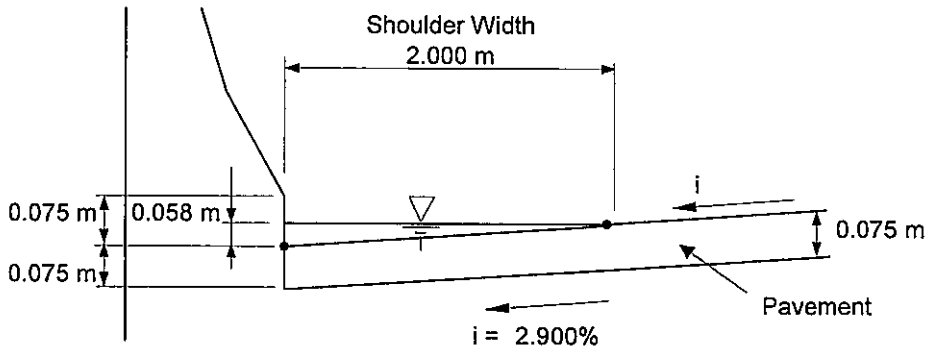
4) Designed Interval of Vertical Drain

d = Q' / Q x L
(Single Line Drainage) d1 = 98.359 m ==> **98 m**

D. APPROACH (A1)

Total F.O. Width	Wb =	13.00	m		
Single Line Drainage System =		1			
Double Line Drainage System =		2			
Supper Elevation	i =	2.000% ~	3.900%	**Ave. =**	2.900%
Rainfall Intensity	γ =	150	mm/hr		
(5 years return period, 5 mins. Time concentration)					
Design Rainfall intensity	γo =	γ x k =	**300**	mm/hr	
Coefficient of Run-off	C =	0.9			
Correction Factor of Falling	k =	2			

Section :



1) Catchments Area

- Vertical Gradient = **5.000%**

  Approach L = **355.00 m**

  Catchments Area

  (Single Line Drainage) A1 = Wb x L / 1 = 4615 m^2

  (Double Line Drainage) A2 = Wb x L / 2 = 2308 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 = 0.3461 m^3/sec.

  (Double Line Drainage) Q2 = 0.1731 m^3/sec.

- Possible Through Volume of Run-Off along Shoulder

  Q' = v x a = 0.0801 m^3/sec.

- Velocity of Flow

  $v = 1/n \times R^{2/3} \times i^{1/2}$ = 1.3811 m/sec.

  (Hydraulic mean Depth) R = a / l = 0.0282

  (Wetted Perimeter) l = 2.0588 m

  (Floow Area of Gutter) a = 0.0580 m^2

  (Coefficient of Roughness) n = 0.015

3) Designed Number of Vertical Drain

N = Q / Q'

(Single Line Drainage)	N1 =	4.321	Each ==>	**5**	**Each**
(Double Line Drainage)	N2 =	2.161	Each ==>	**3**	**Each**

4) Designed Interval of Vertical Drain

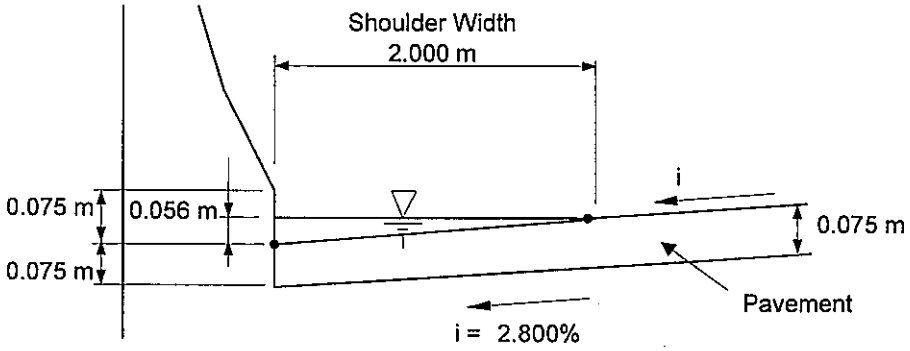
d = Q' / Q x L

(Single Line Drainage)	d1 =	71.000	m ==>	**71 m**
(Double Line Drainage)	d1 =	118.333	m ==>	**118 m**

E. APPROACH (A2)

Total F.O. Width Wb = 13.00 m
Single Line Drainage System = 1
Double Line Drainage System = 2
Supper Elevation i = **2.80%**
Rainfall Intensity γ = 150 mm/hr
(5 years return period, 5 mins. Time concentration)
Design Rainfall intensity γo = γ x k = **300** mm/hr
Coefficient of Run-off C = 0.9
Correction Factor of Falling k = 2

Section :



1) Catchments Area

- Vertical Gradient = **3.230%**
  Approach L = **155.00 m**
  Catchments Area
  (Single Line Drainage) A1 = Wb x L / 1 = 2015 m^2
  (Double Line Drainage) A2 = Wb x L / 2 = 1008 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 = 0.1511 m^3/sec.
  (Double Line Drainage) Q2 = 0.0756 m^3/sec.
- Possible Through Volume of Run-Off along Shoulder
  Q' = v x a = 0.0607 m^3/sec.
- Velocity of Flow
  $v = 1/n \times R^{2/3} \times I^{1/2}$ = 1.08365 m/sec.
  (Hydraulic mean Depth) R = a / l = 0.0272
  (Wetted Perimeter) l = 2.0568 m
  (Floow Area of Gutter) a = 0.0560 m^2
  (Coefficient of Roughness) n = 0.015

3) Designed Number of Vertical Drain

N = Q / Q'
(Single Line Drainage) N1 = 2.489 Each ==> **3 Each**
(Double Line Drainage) N2 = 1.245 Each ==> **2 Each**

4) Designed Interval of Vertical Drain

d = Q' / Q x L
(Single Line Drainage) d1 = 51.667 m ==> **51 m**
(Double Line Drainage) d1 = 77.500 m ==> **77 m**

3.4 DRAINAGE DESING IN GEBANG FLYOVER

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

DAILY RAINFALL LOSARI STATION (CIREBON)

No	Years	Rainfall Data (mm)
1	1994	90.00
2	1995	150.00
3	1996	75.00
4	1997	60.00
5	1998	60.00
6	1999	65.00
7	2000	75.00
8	2001	91.00
9	2002	137.00
10	2003	76.00
11	2004	67.00

DISTRIBUTION OF GUMBEL

No.	Years	Daily Rainfall Average (mm)	$(X - X_{ave})^2$	$(X - X_{ave})^3$	$(X - X_{ave})^4$
1	1994	90.000	16.000	64.000	256.000
2	1995	150.000	4096.000	262144.000	16777216.000
3	1996	75.000	121.000	-1331.000	14641.000
4	1997	60.000	676.000	-17576.000	456976.000
5	1998	60.000	676.000	-17576.000	456976.000
6	1999	65.000	441.000	-9261.000	194481.000
7	2000	75.000	121.000	-1331.000	14641.000
8	2001	91.000	25.000	125.000	625.000
9	2002	137.000	2601.000	132651.000	6765201.000
10	2003	76.000	100.000	-1000.000	10000.000
11	2004	67.000	361.000	-6859.000	130321.000
	Σ	946.000	9234.000	340050.000	24821334.000

X Mean =	86.000	mm	
Standart Deviation =	30.387	mm	
Skewness Coefficient =	**1.683**	**Max rate :**	**1.140**
Kurtosis Coefficient=	**5.776**	**Max rate:**	**5.400**
Reduced Mean Y_N =	0.4952		
Reduced Standard Deviation S_N =	0.9496		
b =	70.153		
1/a =	32.000		

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	81.882
2	5	1.4999	118.151
3	10	2.2502	142.161
4	20	2.9606	164.894
5	25	3.1985	172.506
6	50	3.9019	195.015
7	100	4.6001	217.358

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	90.000	1.954	0.002	0.000
2	1995	150.000	2.176	0.069	0.018
3	1996	75.000	1.875	0.002	0.000
4	1997	60.000	1.778	0.018	-0.002
5	1998	60.000	1.778	0.018	-0.002
6	1999	65.000	1.813	0.010	-0.001
7	2000	75.000	1.875	0.002	0.000
8	2001	91.000	1.959	0.002	0.000
9	2002	137.000	2.137	0.050	0.011
10	2003	76.000	1.881	0.001	0.000
11	2004	67.000	1.826	0.008	-0.001
	Σ	946.000	21.052	0.181	0.022

Average = 1.914
Standart Deviation = 0.135
Skewness Coefficient= 1.279

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	1.9068	80.686
2	5	0.8228	2.0245	105.809
3	10	1.3102	2.0901	123.051
4	20	1.8974	2.1691	147.595
5	25	1.8537	2.1632	145.609
6	50	2.2185	2.2123	163.030
7	100	2.5547	2.2575	180.920

Log Pearson Type III

DISTRIBUTION OF LOG NORMAL

No.	Years	Daily Rainfall Average (mm)	Log X	(Log X - log X_{nve})	(Log X - log X_{ave})^2
1	1994	90.000	1.954	0.040	0.002
2	1995	150.000	2.176	0.262	0.069
3	1996	75.000	1.875	-0.039	0.002
4	1997	60.000	1.778	-0.136	0.018
5	1998	60.000	1.778	-0.136	0.018
6	1999	65.000	1.813	-0.101	0.010
7	2000	75.000	1.875	-0.039	0.002
8	2001	91.000	1.959	0.045	0.002
9	2002	137.000	2.137	0.223	0.050
10	2003	76.000	1.881	-0.033	0.001
11	2004	67.000	1.826	-0.088	0.008
	Σ	946.000	21.052	0.000	0.181

Average = 1.914
Standart Deviation = 0.135
Variable Coefficient 0.070
Skewness Coefficient= 0.211 **Max rate : 0.211**
kurtosis Coefficient 3.079

Result Formula,
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	1.9044	80.241
5	0.8103	2.0228	105.401
10	1.3142	2.0906	123.205
20	1.7545	2.1498	141.204
25	1.8418	2.1616	145.077
50	2.2786	2.2204	166.093
100	2.6089	2.2648	183.980

Log Normal

LOG NORMAL

Max Daily Rainfall Calculation for
GEBANG Flyover

Return Period	Gumbel	Log Pearson	Log Normal	Result (mm)
2	81.882	80.686	80.241	80.686
5	118.151	105.809	105.401	105.809
10	142.161	123.051	123.205	123.205
20	164.894	147.595	141.204	147.595
25	172.506	145.609	145.077	145.609
50	195.015	163.030	166.093	166.093
100	217.358	180.920	183.980	183.980

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	146.616	92.36235	70.48567	58.18463	44.40319	33.88597	27.97225	23.09059	19.89887	17.62142	15.18568	13.44766	8.471493
5	192.268	121.1215	92.433	76.30176	58.22914	44.43715	36.68206	30.28037	26.09483	23.10825	19.91409	17.63489	11.10929
10	223.877	141.034	107.6291	88.84584	67.80207	51.74266	42.71263	35.2585	30.38485	26.90727	23.18798	20.53409	12.93567
20	268.197	168.9537	128.9358	106.4342	81.22447	61.98587	51.16821	42.23842	36.39997	32.23395	27.77838	24.59911	15.49647
25	264.590	166.681	127.2015	105.0026	80.13195	61.15213	50.47997	41.67029	35.91037	31.80039	27.40474	24.26824	15.28803
50	301.811	190.129	145.0958	119.7739	91.4046	69.75476	57.58129	47.53231	40.9621	36.27394	31.25993	27.6822	17.43869
100	334.315	210.605	160.7217	132.6729	101.2484	77.26696	63.78247	52.65127	45.37349	40.18044	34.62645	30.66341	19.31674

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	12.21801	15.39373	17.62142	19.39488	22.20159	25.41448	27.97225	30.78745	33.16478	35.24283	37.96419	40.34297	50.82896
5	16.02237	20.18692	23.10825	25.43392	29.11457	33.32786	36.68206	40.37383	43.49139	46.2165	49.78521	52.90468	66.65572
10	18.65646	23.50566	26.90727	29.61528	33.90103	38.807	42.71263	47.01133	50.64142	53.81454	57.96995	61.60227	77.61399
20	22.34977	28.15895	32.23395	35.47805	40.61223	46.4894	51.16821	56.3179	60.66662	64.4679	69.44594	73.79732	92.9788
25	22.04916	27.7802	31.80039	35.00085	40.06598	45.86409	50.47997	55.56039	59.85062	63.60077	68.51186	72.80471	91.72819
50	25.15094	31.6882	36.27394	39.92463	45.7023	52.31607	57.58129	63.37641	68.27016	72.54788	78.14983	83.04659	104.6321
100	27.85956	35.10084	40.18044	44.22429	50.62418	57.95022	63.78247	70.20169	75.62248	80.36087	86.56613	91.99024	115.9004

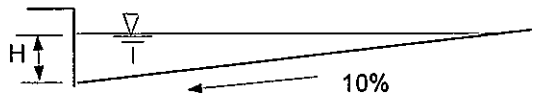
INTERVAL OF GUTTER INLET

- Section 0+100 - 0+200

Distance (Lo) =	**100**	m
Vertical Grades of Road (i)=	0.16%	
Road Width (L1) =	5	m
Super Elevation (m1) =	2.00%	(Pavement)
Super Elevation (m2) =	10.00%	(Gutter)
Rainfall intensity (Y) =	**105.85**	mm
(5 years return period)		
Coefficient of Run-off (C) =	0.9	(Concrete)

1) Catchments Area

Catchments Area (A= L0*L1) 500 m^2



2) Time Concentration

t1 = {2/3 x 3.28 x L1 x nd / (m1) ^ 0.5 } ^ 0.167 = 1.00 min. Friction Coefficient nd= 0.013

t2 = {2/3 x 3.28 x Lo x nd / (i) ^ 0.5 } ^ 0.167 = 2.04 min.

TC = t1 + t2 3.04 min. = 0.05 hour

3) Volume of Run-Off

Rainfall intensity

$I = (Y /24) * (24 / TC) ^{2/3}$ = 268.1 mm/ hour

Volume of Run-Off

$Q = 1 / (3.6 \times 10^6) \times C \times I \times A$ = 0.0335 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

$v = 1.58\ H^{2/3}$

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

$Q1 = v \times a$ = $7.9\ H^{8/3}$

Q = Q1

$0.0501 = 7.9\ H^{8/3}$

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 = 0.012 m^3/sec.

N = Q / q = 2.8 < 3 each

d = L / N = 33.333 m

Design of Dimension and Distance for Gutter Inlet

	Maks Daily rainfall Return for Period 5 Year	mm/hour	:	105.80937			
1	Location :Gebang FO		:				
	Position : Right at grade						
	Beginning Sta.	meter	:	+0	+100	+200	+320
	End Sta.	meter	:	+100	+200	+320	+416
	Distance	meter	:	**100.00**	**100.00**	**120.00**	**96.00**
2	Design Road		:				
	a. Road Widht	meter	:	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)			**0.32%**	**0.16%**	**0.17%**	**1.00%**
3	Coeffisient Road Friction (nd)		:	0.013	0.013	0.013	0.013
4	Concentration Time		:				
	d. T.1	minute	:	1.00	1.00	1.00	1.00
	e. T.2	minute	:	1.92	2.04	2.09	1.74
	f. Tc	minute	:	2.92	3.04	3.09	2.74
	Tc	hour		0.05	0.05	0.05	0.05
5	Coeffisient of Run-off (Concrete)			0.90	0.90	0.90	0.90
6	Catchments Area (=width *distance)	m^2	:	500	500	600	480
7	Coeffisient manning Friction		:	0.015	0.015	0.015	0.015
8	Rainfall Intensity for t = Tc	mm/hour	:	274.9	268.0	264.9	287.3
9	Volume of Run-off	m^3/sec		0.034	0.033	0.040	0.034
10	Hydraulic mean Depth factor			0.455	0.455	0.455	0.455
11	Velocity of Flow factor		:	2.23	1.58	1.62	3.94
12	Flow Area of Gutter factor			5	5	5	5
13	Q = (10 X 11)	m^3/sec	:	11.15	7.88	8.12	19.71
14	Possible hight water at gutter	meter	:	0.11	0.13	0.14	0.09
15	Possible velocity of flow at gutter	meter	:	0.53	0.40	0.43	0.81
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	0.01	0.01	0.02
	Total of Gutter Inlet	each		3	3	4	2
	Distance of Gutter Inlet	meter		33	33	30	48

Design of Dimension and Distance for Gutter Inlet

	Maks Daily rainfall Return for Period 5 Year	mm/hour	:	105.80937			
1	Location :Gebang FO		:				
	Position : Right at grade						
	Beginning Sta.	meter	:	+540	+595	+682	+962
	End Sta.	meter	:	+595	+682	+962	1+120
	Distance	meter	:	**55.00**	**87.00**	**280.00**	**158.00**
2	Design Road		:				
	a. Road Widht	meter	:	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)			**0.40%**	**0.14%**	**0.40%**	**0.03%**
3	Coeffisient Road Friction (nd)		:	0.013	0.013	0.013	0.013
4	Concentration Time		:				
	d. T.1	minute	:	1.00	1.00	1.00	1.00
	e. T.2	minute	:	1.71	2.01	2.24	2.53
	f. Tc	minute	:	2.71	3.01	3.24	3.53
	Tc	hour		0.05	0.05	0.05	0.06
5	Coeffisient of Run-off (Concrete)			0.90	0.90	0.90	0.90
6	Catchments Area (=width *distance)	m^2	:	275	435	1400	790
7	Coeffisient manning Friction		:	0.015	0.015	0.015	0.015
8	Rainfall Intensity for t = Tc	mm/hour	:	289.3	269.4	256.6	242.5
9	Volume of Run-off	m^3/sec		0.020	0.029	0.090	0.048
10	Hydraulic mean Depth factor			0.455	0.455	0.455	0.455
11	Velocity of Flow factor		:	2.49	1.47	2.49	0.68
12	Flow Area of Gutter factor			5	5	5	5
13	Q = (10 X 11)	m^3/sec	:	12.46	7.37	12.46	3.41
14	Possible hight water at gutter	meter	:	0.09	0.13	0.16	0.20
15	Possible velocity of flow at gutter	meter	:	0.50	0.37	0.73	0.23
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		0.01	0.01	0.02	0.01
	Total of Gutter Inlet	each		2	3	5	7
	Distance of Gutter Inlet	meter		27	29	56	22

Design of Dimension and Distance for Gutter Inlet

	Maks Daily rainfall Return for Period 5 Year	mm/hour	:	105.80937			
1	Location :Gebang FO		:				
	Position : Left at grade						
	Beginning Sta.	meter	:	+80	+180	+280	+388
	End Sta.	meter	:	+180	+280	+388	+460
	Distance	meter	:	**100.00**	**100.00**	**108.00**	**72.00**
2	Design Road		:				
	a. Road Widht	meter	:	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)			**0.56%**	**0.73%**	**0.58%**	**2.04%**
3	Coeffisient Road Friction (nd)		:	0.013	0.013	0.013	0.013
4	Concentration Time		:				
	d. T.1	minute	:	1.00	1.00	1.00	1.00
	e. T.2	minute	:	1.84	1.80	1.85	1.56
	f. Tc	minute	:	2.84	2.80	2.85	2.56
	Tc	hour		0.05	0.05	0.05	0.04
5	Coeffisient of Run-off (Concrete)			0.90	0.90	0.90	0.90
6	Catchments Area (=width *distance)	m^2	:	500	500	540	360
7	Coeffisient manning Friction		:	0.015	0.015	0.015	0.015
8	Rainfall Intensity for t = Tc	mm/hour	:	280.6	283.2	279.4	300.4
9	Volume of Run-off	m^3/sec		0.035	0.035	0.038	0.027
10	Hydraulic mean Depth factor			0.455	0.455	0.455	0.455
11	Velocity of Flow factor		:	2.95	3.37	3.00	5.63
12	Flow Area of Gutter factor			5	5	5	5
13	Q = (10 X 11)	m^3/sec	:	14.75	16.84	15.01	28.15
14	Possible hight water at gutter	meter	:	0.10	0.10	0.11	0.07
15	Possible velocity of flow at gutter	meter	:	0.65	0.72	0.67	0.99
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	0.02	0.02	0.03
	Total of Gutter Inlet	each		2	2	2	1
	Distance of Gutter Inlet	meter		50	50	54	72

Design of Dimension and Distance for Gutter Inlet

	Maks Daily rainfall Return for Period 5 Year	mm/hour	:	105.80937				
1	Location :Gebang FO		:					
	Position : Left at grade							
	Beginning Sta.	meter	:	+460	+580	+680	+760	+849
	End Sta.	meter	:	+580	+680	+760	+849	+925
	Distance	meter	:	**120.00**	**100.00**	**80.00**	**89.00**	**76.00**
2	Design Road		:					
	a. Road Widht	meter	:	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)			**0.74%**	**0.36%**	**0.68%**	**0.26%**	**0.47%**
3	Coeffisient Road Friction (nd)		:	0.013	0.013	0.013	0.013	0.013
4	Concentration Time		:					
	d. T.1	minute	:	1.00	1.00	1.00	1.00	1.00
	e. T.2	minute	:	1.85	1.90	1.74	1.92	1.78
	f. Tc	minute	:	2.85	2.91	2.74	2.92	2.78
	Tc	hour		0.05	0.05	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	:	600	500	400	445	380
7	Coeffisient manning Friction		:	0.015	0.015	0.015	0.015	0.015
8	Rainfall Intensity for t = Tc	mm/hour	:	279.7	276.1	287.0	275.2	284.3
9	Volume of Run-off	m^3/sec		0.042	0.035	0.029	0.031	0.027
10	Hydraulic mean Depth factor			0.455	0.455	0.455	0.455	0.455
11	Velocity of Flow factor		:	3.39	2.36	3.25	2.01	2.70
12	Flow Area of Gutter factor			5	5	5	5	5
13	Q = (10 X 11)	m^3/sec	:	16.95	11.82	16.25	10.05	13.51
14	Possible hight water at gutter	meter	:	0.11	0.11	0.09	0.11	0.10
15	Possible velocity of flow at gutter	meter	:	0.76	0.55	0.67	0.47	0.57
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	0.02	0.02	0.01	0.02
	Total of Gutter Inlet	each		2	3	2	3	2
	Distance of Gutter Inlet	meter		60	33	40	29	38

Design Volume of Run-Off at Flyover (Gebang)

Maks Daily rainfall for Return Period 5 Year	mm	:	105.8093678														
1 Location : Gebang FO		:															
Position :			Start	A1	P1	P2	P3	P4	P6	P7	P8	P9	P10	P11	P12	P13	A2	END
Beginning Sta.	meter	:	+148	+336	+356	+376	+396	+423	+459	+486	+513	+540	+567	+594	+621	+641	+661	+681
End Sta.	meter	:	+336	+356	+376	+396	+423	+459	+486	+513	+540	+567	+594	+621	+641	+661	+681	+906
Distance	meter	:	188.00	20.00	20.00	20.00	27.00	36.00	27.00	27.00	27.00	27.00	27.00	27.00	20.00	20.00	20.00	225.00
2 Design Road		:																
a. Traffic widht	meter	:	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75
b. Super-elevation		:	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
c. Vertical Gradient of Flyover			4.70%	4.70%	4.70%	2.80%	1.85%	0.70%	0.70%	1%	1%	1%	1%	1%	1%	1.70%	2.34%	4%
3 Coeffisient 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
4 Concentration Time		:																
a. T.1	minute	:	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08
e. T.2	minute	:	1.71	1.18	1.18	1.23	1.34	1.52	1.45	1.41	1.41	1.41	1.41	1.41	1.34	1.28	1.25	1.79
f. Tc	minute	:	2.79	2.25	2.25	2.31	2.41	2.60	2.53	2.48	2.48	2.48	2.48	2.48	2.42	2.36	2.32	2.86
Tc	hour		0.05	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.05
5 Coeffisient 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
6 Catchments Area	m2	:	1457	155	155	155	209.25	279	209.25	209.25	209.25	209.25	209.25	209.25	155	155	155	1743.75
7 Rainfall Intensity for t = Tc	mm/hour	:	289.9	334.2	334.2	329.1	319.1	303.8	309.5	313.1	313.1	313.1	313.1	313.1	319.0	324.2	327.4	284.7
8 Volume of Run-Off for Section only	m3/sec	:	0.106	0.013	0.013	0.013	0.017	0.021	0.016	0.016	0.016	0.016	0.016	0.016	0.012	0.013	0.013	0.124
9 Volume of Run-Off for at grade leftside	m3/sec																	
10 Volume of Run-Off for at grade rightside	m3/sec		0.106	0.077							0.082						0.054	0.124

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

	Maks Daily rainfall for Return Period 5 Year	mm	:	105.8094		
1	Location : Gebang FO		:			
	Position : Right Frontage					
	Beginning Sta.	meter	:	+60	+100	+380	+460
	End Sta.	meter	:	+100	+380	+430	+490
	Distance	meter	:	40.00	280.00	50.00	30.00
2	Design Road		:				
	a. Traffic width	meter	:	5	5	5	5
	b. Ground width	meter	:	15	15	15	15
	Super-elevation		:				
	a. Traffic		:	0.02	0.02	0.02	0.02
	b. Ground		:	0.01	0.01	0.01	0.01
3	Coefficient Road Friction (nd)		:				
	a. Traffic		:	0.013	0.013	0.013	0.013
	b. Ground		:	0.4	0.4	0.4	0.4
4	Concentration Time		:				
	a. Traffic	minute	:	1.00	1.00	1.00	1.00
	b. Ground	minute	:	2.26	2.26	2.26	2.26
	c. T.1	minute	:	3.26	3.26	3.26	3.26
	d. T.2	minute	:	1.61	2.30	1.70	1.36
	e. Tc = T.1 + T.2	minute	:	4.87	5.56	4.96	4.62
	Tc	hour		0.08	0.09	0.08	0.08
5	Coefficient of Flow		:				
	a. Concrete Road and Asphalt		:	0.7	0.7	0.7	0.7
	b. Ground		:	0.5	0.5	0.5	0.5
	c. Average		:	0.60	0.60	0.60	0.60
6	Catchments Area (=width *distance)		:				
	a. Traffic	m^2	:	200	1400	250	150
	b. Ground	m^2	:	600	4200	750	450
7	Coefficient manning Friction		:	0.017	0.017	0.017	0.017
8	Rainfall Intensity for t = Tc	mm/hour	:	199.3	182.5	197.0	206.6
9	Volume of Run-off on Section	m^3/sec	:	**0.03**	**0.17**	**0.03**	**0.02**
	Volume of Run-off from Upper Section	m^3/sec		**0.24**	**0.07**	**0.03**	**0.01**
	Volume of Run-off from Flyover	m^3/sec		-	-	-	-
	Total Volume of Run-off	m^3/sec		**0.26**	**0.24**	**0.07**	**0.03**
10	Design of Dimension (minimum)		:				
	a. Height of water level	meter	:	**0.061839**	**0.23688**	**0.07473**	**0.03317**
	b. Wide of Side Ditch	meter	:	**0.80**	**0.80**	**0.80**	**0.80**
11	Circumference Wet Area	meter	:	0.92	1.27	0.95	0.87
12	Ditch Wet Area	m^2		0.05	0.19	0.06	0.03
13	Hydraulic Radii Of Drain	meter	:	0.05	0.15	0.06	0.03
14	Ditch sloping		:	**0.004**	**0.003**	**0.004**	**0.019**
15	Flow of Velocity	m^2/sec		0.54	0.90	0.55	0.78
16	Design Volume of Ditch	m^3/sec		***0.03***	***0.17***	***0.03***	***0.02***
17	Free Board	meter		0.15	0.15	0.15	0.15
18	Highest of Ditch (=10a+17)	meter		0.21	0.39	0.22	0.18
	Wide of Side Ditch	meter		**0.80**	**0.80**	**0.80**	**0.80**
	Highest of Ditch	meter		**0.30**	**0.40**	**0.30**	**0.20**

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

	Maks Daily rainfall for Return Period 5 Year	mm	:	105.8094			
1	Location : Gebang FO		:				
	Position : Right Frontage						
	Beginning Sta.	meter	:	+490	+510	+620	+760	+960
	End Sta.	meter	:	+510	+620	+760	+960	1+060
	Distance	meter	:	20.00	110.00	140.00	200.00	100.00
2	Design Road		:					
	a. Traffic width	meter	:	5	5	5	5	5
	b. Ground width	meter	:	15	15	15	15	15
	Super-elevation		:					
	a. Traffic		:	0.02	0.02	0.02	0.02	0.02
	b. Ground		:	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
	b. Ground		:	0.4	0.4	0.4	0.4	0.4
4	Concentration Time		:					
	a. Traffic	minute	:	1.00	1.00	1.00	1.00	1.00
	b. Ground	minute	:	2.26	2.26	2.26	2.26	2.26
	c. T.1	minute	:	3.26	3.26	3.26	3.26	3.26
	d. T.2	minute	:	1.44	1.97	1.91	2.17	1.87
	e. Tc = T.1 + T.2	minute	:	4.70	5.23	5.17	5.43	5.14
	Tc	hour		0.08	0.09	0.09	0.09	0.09
5	Coefficient of Flow		:					
	a. Concrete Road and Asphalt		:	0.7	0.7	0.7	0.7	0.7
	b. Ground		:	0.5	0.5	0.5	0.5	0.5
	c. Average		:	0.60	0.60	0.60	0.60	0.60
6	Catchments Area (=width *distance)		:					
	a. Traffic	m^2	:	100	550	700	1000	500
	b. Ground	m^2	:	300	1650	2100	3000	1500
7	Coefficient manning Friction		:	0.017	0.017	0.017	0.017	0.017
8	Rainfall Intensity for t = Tc	mm/hour	:	204.3	190.2	191.6	185.3	192.4
9	Volume of Run-off on Section	m^3/sec	:	**0.01**	**0.07**	**0.09**	**0.12**	**0.06**
	Volume of Run-off from Upper Section	m^3/sec		**0.15**	-	**0.31**	**0.06**	-
	Volume of Run-off from Flyover	m^3/sec		-	**0.08**	**0.05**	**0.12**	-
	Total Volume of Run-off	m^3/sec		**0.17**	**0.15**	**0.46**	**0.31**	**0.06**
10	Design of Dimension (minimum)		:					
	a. Height of water level	meter	:	**0.04063**	**0.12949**	**0.115345**	**0.189469**	**0.10801**
	b. Wide of Side Ditch	meter	:	**0.80**	**0.80**	**0.80**	**0.80**	**0.80**
11	Circumference Wet Area	meter	:	0.88	1.06	1.03	1.18	1.02
12	Ditch Wet Area	m^2		0.03	0.10	0.09	0.15	0.09
13	Hydraulic Radii Of Drain	meter	:	0.04	0.10	0.09	0.13	0.09
14	Ditch sloping		:	**0.0043**	**0.003**	**0.007**	**0.003**	**0.0044**
15	Flow of Velocity	m^2/sec		0.42	0.68	0.98	0.82	0.75
16	Design Volume of Ditch	m^3/sec		***0.01***	***0.07***	***0.09***	***0.12***	***0.06***
17	Free Board	meter		0.15	0.15	0.15	0.15	0.15
18	Highest of Ditch (=10a+17)	meter		0.19	0.28	0.27	0.34	0.26
	Wide of Side Ditch	meter		**0.80**	**0.80**	**0.80**	**0.80**	**0.80**
	Highest of Ditch	meter		**0.20**	**0.30**	**0.30**	**0.40**	**0.30**

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

	Maks Daily rainfall for Return Period 5 Year	mm	:	105.8094		
1	Location : Gebang FO		:			
	Position :Left Frontage					
	Beginning Sta.	meter	:	+60	+100	+380	+460
	End Sta.	meter	:	+100	+380	+430	+490
	Distance	meter	:	40.00	280.00	50.00	30.00
2	Design Road		:				
	a. Traffic width	meter	:	5	5	5	5
	b. Ground width	meter	:	15	15	15	15
	Super-elevation		:				
	a. Traffic		:	0.02	0.02	0.02	0.02
	b. Ground		:	0.01	0.01	0.01	0.01
3	Coefficient Road Friction (nd)		:				
	a. Traffic		:	0.013	0.013	0.013	0.013
	b. Ground		:	0.4	0.4	0.4	0.4
4	Concentration Time		:				
	a. Traffic	minute	:	1.00	1.00	1.00	1.00
	b. Ground	minute	:	2.26	2.26	2.26	2.26
	c. T.1	minute	:	3.26	3.26	3.26	3.26
	d. T.2	minute	:	1.61	2.30	1.70	1.36
	e. Tc = T.1 + T.2	minute	:	4.87	5.56	4.96	4.62
	Tc	hour		0.08	0.09	0.08	0.08
5	Coefficient of Flow		:				
	a. Concrete Road and Asphalt		:	0.7	0.7	0.7	0.7
	b. Ground		:	0.5	0.5	0.5	0.5
	c. Average		:	0.60	0.60	0.60	0.60
6	Catchments Area (=width *distance)		:				
	a. Traffic	m^2	:	200	1400	250	150
	b. Ground	m^2	:	600	4200	750	450
7	Coefficient manning Friction		:	0.017	0.017	0.017	0.017
8	Rainfall Intensity for t = Tc	mm/hour	:	199.3	182.5	197.0	206.6
9	Volume of Run-off on Section	m^3/sec	:	**0.33**	**0.31**	**0.14**	**0.10**
	Volume of Run-off from Upper Section	m^3/sec		-	**0.33**	**0.64**	**0.15**
	Volume of Run-off from Flyover	m^3/sec		-	-	-	-
	Total Volume of Run-off	m^3/sec		**0.33**	**0.64**	**0.78**	**0.26**
10	Design of Dimension (minimum)		:				
	a. Height of water level	meter	:	**0.337448**	**0.36244**	**0.190937**	**0.091445**
	b. Wide of Side Ditch	meter	:	**0.80**	**0.80**	**0.80**	**0.80**
11	Circumference Wet Area	meter	:	1.47	1.52	1.18	0.98
12	Ditch Wet Area	m^2		0.27	0.29	0.15	0.07
13	Hydraulic Radii Of Drain	meter	:	0.18	0.19	0.13	0.07
14	Ditch sloping		:	**0.004**	**0.003**	**0.004**	**0.019**
15	Flow of Velocity	m^2/sec		1.24	1.06	0.90	1.42
16	Design Volume of Ditch	m^3/sec		***0.33***	***0.31***	***0.14***	***0.10***
17	Free Board	meter		0.15	0.15	0.15	0.15
18	Highest of Ditch (=10a+17)	meter		0.49	0.51	0.34	0.24
			:				
	Wide of Side Ditch	meter		**0.80**	**0.80**	**0.80**	**0.80**
	Highest of Ditch	meter		**0.50**	**0.60**	**0.40**	**0.30**

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

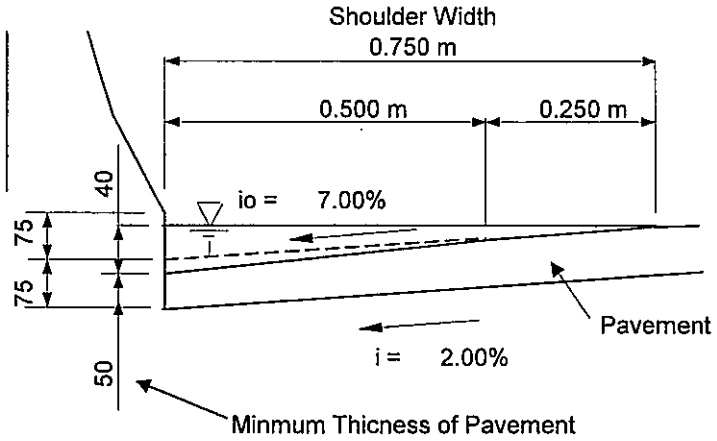
	Maks Daily rainfall for Return Period 5 Year	mm	:	105.8094			
1	Location : Gebang FO		:				
	Position : Left Frontage						
	Beginning Sta.	meter	:	+490	+510	+620	+760	+960
	End Sta.	meter	:	+510	+620	+760	+960	1+060
	Distance	meter	:	20.00	110.00	140.00	200.00	100.00
2	Design Road		:					
	a. Traffic width	meter	:	5	5	5	5	5
	b. Ground width	meter	:	15	15	15	15	15
	Super-elevation		:					
	a. Traffic		:	0.02	0.02	0.02	0.02	0.02
	b. Ground		:	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
	b. Ground		:	0.4	0.4	0.4	0.4	0.4
4	Concentration Time		:					
	a. Traffic	minute	:	1.00	1.00	1.00	1.00	1.00
	b. Ground	minute	:	2.26	2.26	2.26	2.26	2.26
	c. T.1	minute	:	3.26	3.26	3.26	3.26	3.26
	d. T.2	minute	:	1.44	1.97	1.91	2.17	1.87
	e. Tc = T.1 + T.2	minute	:	4.70	5.23	5.17	5.43	5.14
	Tc	hour		0.08	0.09	0.09	0.09	0.09
5	Coefficient of Flow		:					
	a. Concrete Road and Asphalt		:	0.7	0.7	0.7	0.7	0.7
	b. Ground		:	0.5	0.5	0.5	0.5	0.5
	c. Average		:	0.60	0.60	0.60	0.60	0.60
6	Catchments Area (=width *distance)		:					
	a. Traffic	m^2	:	100	550	700	1000	500
	b. Ground	m^2	:	300	1650	2100	3000	1500
7	Coefficient manning Friction		:	0.017	0.017	0.017	0.017	0.017
8	Rainfall Intensity for t = Tc	mm/hour	:	204.3	190.2	191.6	185.3	192.4
9	Volume of Run-off on Section	m^3/sec	:	**0.08**	**0.07**	**0.28**	**0.19**	**0.06**
	Volume of Run-off from Upper Section	m^3/sec		**0.07**	**0.00**	**0**	**0.28**	**0**
	Volume of Run-off from Flyover	m^3/sec		**0**	**0**	**0**	**0**	**0**
	Total Volume of Run-off	m^3/sec		**0.15**	**0.07**	**0.28**	**0.46**	**0.06**
10	Design of Dimension (minimum)		:					
	a. Height of water level	meter	:	**0.13**	**0.13**	**0.25**	**0.25**	**0.11**
	b. Wide of Side Ditch	meter	:	**0.80**	**0.80**	**0.80**	**0.80**	**0.80**
11	Circumference Wet Area	meter	:	1.06	1.06	1.30	1.31	1.02
12	Ditch Wet Area	m^2		0.10	0.10	0.20	0.20	0.09
13	Hydraulic Radii Of Drain	meter	:	0.10	0.10	0.15	0.16	0.09
14	Ditch sloping		:	**0.004**	**0.003**	**0.007**	**0.003**	**0.004**
15	Flow of Velocity	m^2/sec		0.81	0.68	1.40	0.92	0.75
16	Design Volume of Ditch	m^3/sec		***0.08***	***0.07***	***0.28***	***0.19***	***0.07***
17	Free Board	meter		0.15	0.15	0.15	0.15	0.15
18	Highest of Ditch (=10a+17)	meter		0.28	0.28	0.40	0.40	0.26
	Wide of Side Ditch	meter		**0.80**	**0.80**	**0.80**	**0.80**	**0.80**
	Highest of Ditch	meter		**0.30**	**0.30**	**0.40**	**0.50**	**0.30**

INTERVAL OF VERTICAL DRAIN OF GEBANG FLYOVER

A. PC SUPERSTRUCTURE SECTION, P1 ~ P2 *w/ Surface Down*

Total F.O. Width	Wb =	9.00	m
Single Line Drainage System =		1	
Double Line Drainage System =		2	
Supper Elevation	i =	**2.00%**	
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 = **4.700%**
  Span Length L = **20.00** **m**
  Catchments Area

(Single Line Drainage)	A1 = Wb x L / 1 =	180	m^2
(Double Line Drainage)	A2 = Wb x L / 2 =	90	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 =	0.0171	m^3/sec.
(Double Line Drainage)	Q2 =	0.0086	m^3/sec.

- Possible Through Volume of Run-Off along Shoulder
  Q' = v x a = 0.0105 m^3/sec.
- Velocity of Flow

  $v = 1/n \times R^{2/3} \times I^{1/2}$ = 0.88296 m/sec.

(Hydraulic mean Depth)	R = a / l =	0.0151	
(Wetted Perimeter)	l =	**0.7901**	m
(Floow Area of Gutter)	a =	**0.0119**	m^2
(Coefficient of Roughness)	n =	0.015	

3) Designed Number of Vertical Drain

N = Q / Q'

(Single Line Drainage)	N1 =	1.629	Each ==>	**2** **Each**

4) Designed Interval of Vertical Drain

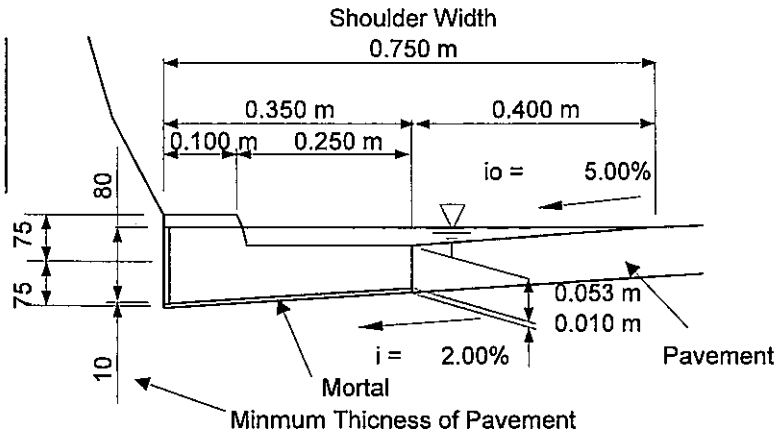
d = Q' / Q x L

(Single Line Drainage)	d1 =	12.281	m ==>	**12 m**

B. PC SUPERSTRUCTURE SECTION, P1 ~ P2 *w/ Steel Gutter Screen*

Total F.O. Width Wb = 9.00 m
Single Line Drainage System = 1
Double Line Drainage System = 2
Supper Elevation i = **2.00%**
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 = **4.700%**
  Span Length L = **20.00 m**
  Catchments Area
  (Single Line Drainage) A1 = Wb x L / 1 = 180 m^2
  (Double Line Drainage) A2 = Wb x L / 2 = 90 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 = 0.0171 m^3/sec.
  (Double Line Drainage) Q2 = 0.0086 m^3/sec.
- Possible Through Volume of Run-Off along Shoulder
  Q' = v x a = 0.0978 m^3/sec.
- Velocity of Flow
  $v = 1/n \times R^{2/3} \times I^{1/2}$ = 2.24218 m/sec.
  (Hydraulic mean Depth) R = a / l = 0.0493
  (Wetted Perimeter) l = **0.8836** m
  (Floow Area of Gutter) a = **0.0436** m^2
  (Coefficient of Roughness) n = **0.013**

3) Designed Number of Vertical Drain

N = Q / Q'
(Single Line Drainage) N1 = 0.175 Each ==> **1 Each**

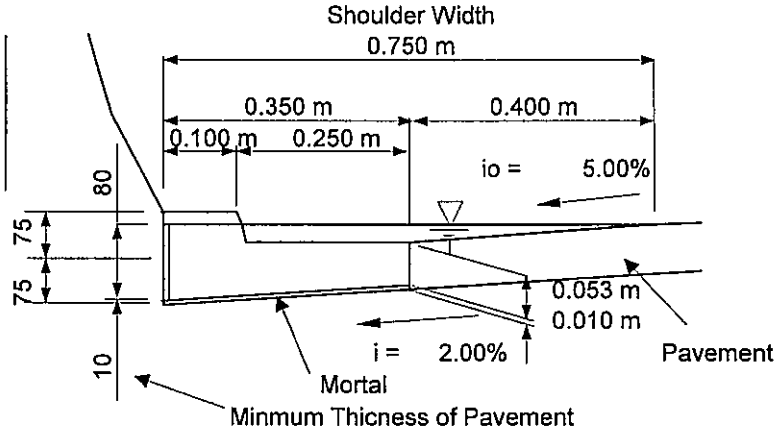
4) Designed Interval of Vertical Drain

d = Q' / Q x L
(Single Line Drainage) d1 = 114.386 m ==> **114 m**

C. PC SUPERSTRUCTURE SECTION, P2 ~ P3 *w/ Steel Gutter Screen*

Total F.O. Width Wb = 9.00 m
Single Line Drainage System = 1
Double Line Drainage System = 2
Supper Elevation i = **2.00%**
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 = 4.083% ~ 4.700% **Ave. = 4.392%**
  Span Length L = **20.00 m**
  Catchments Area
  (Single Line Drainage) A1 = Wb x L / 1 = 180 m^2
  (Double Line Drainage) A2 = Wb x L / 2 = 90 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 = 0.0171 m^3/sec.
  (Double Line Drainage) Q2 = 0.0086 m^3/sec.
- Possible Through Volume of Run-Off along Shoulder
  Q' = v x a = 0.0945 m^3/sec.
- Velocity of Flow
  $v = 1/n \times R^{2/3} \times I^{1/2}$ = 2.16747 m/sec.
  (Hydraulic mean Depth) R = a / l = 0.0493
  (Wetted Perimeter) l = **0.8836** m
  (Floow Area of Gutter) a = **0.0436** m^2
  (Coefficient of Roughness) n = **0.013**

3) Designed Number of Vertical Drain

N = Q / Q'
(Single Line Drainage) N1 = 0.181 Each ==> **1 Each**

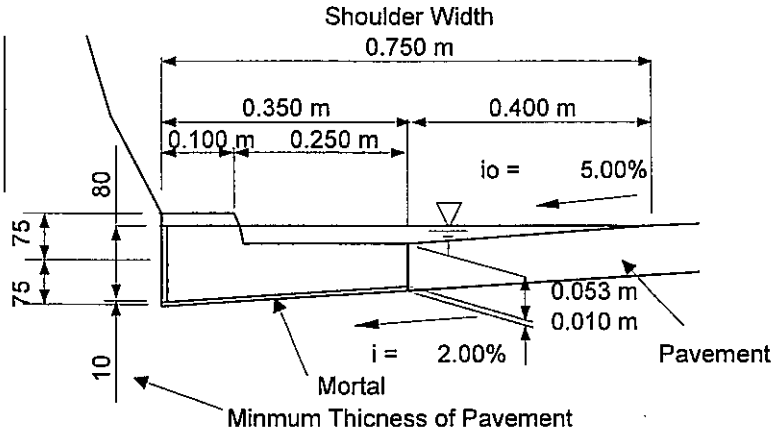
4) Designed Interval of Vertical Drain

d = Q' / Q x L
(Single Line Drainage) d1 = 110.526 m ==> **110 m**

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

Total F.O. Width Wb = 9.00 m
Single Line Drainage System = 1
Double Line Drainage System = 2
Supper Elevation i = **2.00%**
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 = 2.961% ~ 4.083% **Ave. = 3.522%**
  Span Length L = **20.00 m**
  Catchments Area
  (Single Line Drainage) A1 = Wb x L / 1 = 180 m^2
  (Double Line Drainage) A2 = Wb x L / 2 = 90 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 = 0.0171 m^3/sec.
  (Double Line Drainage) Q2 = 0.0086 m^3/sec.
- Possible Through Volume of Run-Off along Shoulder
  Q' = v x a = 0.0846 m^3/sec.
- Velocity of Flow
  $v = 1/n \times R^{2/3} \times I^{1/2}$ = 1.94096 m/sec.
  (Hydraulic mean Depth) R = a / l = 0.0493
  (Wetted Perimeter) l = **0.8836** m
  (Floow Area of Gutter) a = **0.0436** m^2
  (Coefficient of Roughness) n = **0.013**

3) Designed Number of Vertical Drain

N = Q / Q'
(Single Line Drainage) N1 = 0.202 Each ==> **1 Each**

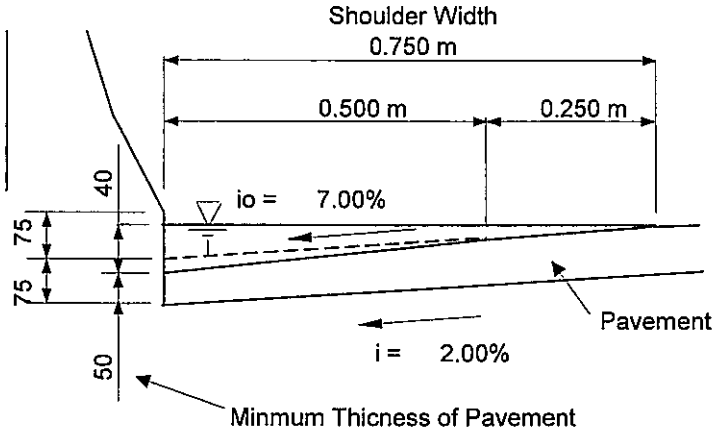
4) Designed Interval of Vertical Drain

d = Q' / Q x L
(Single Line Drainage) d1 = 98.947 m ==> **98 m**

E. STEEL SUPERSTRUCTURE SECTION, P4 ~ P5 *w/ Surface Down + Outer Ditch*

Total F.O. Width Wb = 9.00 m
Single Line Drainage System = 1
Double Line Drainage System = 2
Supper Elevation i = **2.00%**
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 = 0.000% ~ 2.961% **Ave. = 1.481%**
  Span Length L = **27.00 m**
  Catchments Area
  (Single Line Drainage) A1 = Wb x L / 1 = 243 m^2
  (Double Line Drainage) A2 = Wb x L / 2 = 122 m^2

2) Volume of Run-Off

- Volume of Run-Off
  $Q = 1/(3.6 \times 10^6) \times C \times \gamma o \times A$

				Applied Surface Down + Outer Ditch	
(Single Line Drainage)	Q1 =	0.0231	m^3/sec.		
(Double Line Drainage)	Q2 =	0.0116	m^3/sec.	0.0574	m^3/sec.

- Possible Through Volume of Run-Off along Shoulder
  Q' = v x a = 0.0059 m^3/sec.
- Velocity of Flow

$v = 1/n \times R^{2/3} \times I^{1/2}$ =	0.49565	m/sec.		1.09307	m/sec.
(Hydraulic mean Depth)	R = a / l =	0.0151		0.0399	
(Wetted Perimeter)	l =	**0.7901**	m	1.3171	m
(Floow Area of Gutter)	a =	**0.0119**	m^2	0.0525	m^2
(Coefficient of Roughness)	n =	0.015		0.013	

3) Designed Number of Vertical Drain

N = Q / Q'

(Single Line Drainage)	N1 =	3.915	Each ==>	**4**	**Each, Surface Down**
		0.402		**1**	**Each, Outer Ditch**

4) Designed Interval of Vertical Drain

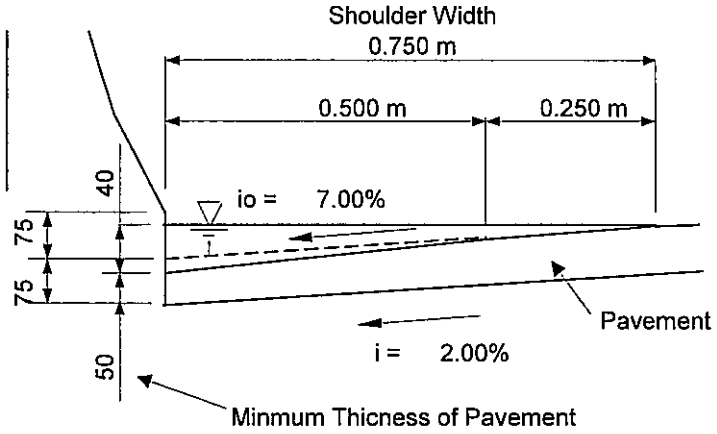
d = Q' / Q x L

(Single Line Drainage)	d1 =	6.896	m ==>	**6 m**	**Surface Down**
		67.091		**67 m**	**Outer Ditch**

F. STEEL SUPERSTRUCTURE SECTION, P7 ~ P12 *w/ Surface Down + Outer Ditch*

Total F.O. Width Wb = 9.00 m
Single Line Drainage System = 1
Double Line Drainage System = 2
Supper Elevation i = **2.00%**
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 = **0.910%**
  Span Length L = **27.00 m**
  Catchments Area
  (Single Line Drainage) A1 = Wb x L / 1 = 243 m^2
  (Double Line Drainage) A2 = Wb x L / 2 = 122 m^2

2) Volume of Run-Off

- Volume of Run-Off
  $Q = 1/(3.6 \times 10^6) \times C \times \gamma o \times A$

				Applied Surface Down + Outer Ditch	
(Single Line Drainage)	Q1 =	0.0231	m^3/sec.		
(Double Line Drainage)	Q2 =	0.0116	m^3/sec.	0.0450	m^3/sec.

- Possible Through Volume of Run-Off along Shoulder
  Q' = v x a = 0.0046 m^3/sec.
- Velocity of Flow

$v = 1/n \times R^{2/3} \times i^{1/2}$ =	0.38852	m/sec.		0.85683	m/sec.
(Hydraulic mean Depth)	R = a / l =	0.0151		0.0399	
(Wetted Perimeter)	l =	**0.7901**	m	1.3171	m
(Floow Area of Gutter)	a =	**0.0119**	m^2	0.0525	m^2
(Coefficient of Roughness)	n =	0.015		0.013	

3) Designed Number of Vertical Drain

N = Q / Q'

(Single Line Drainage)	N2 =	5.022	Each ==>	**6**	**Each**
		0.513		**1**	**Each, Outer Ditch**

4) Designed Interval of Vertical Drain

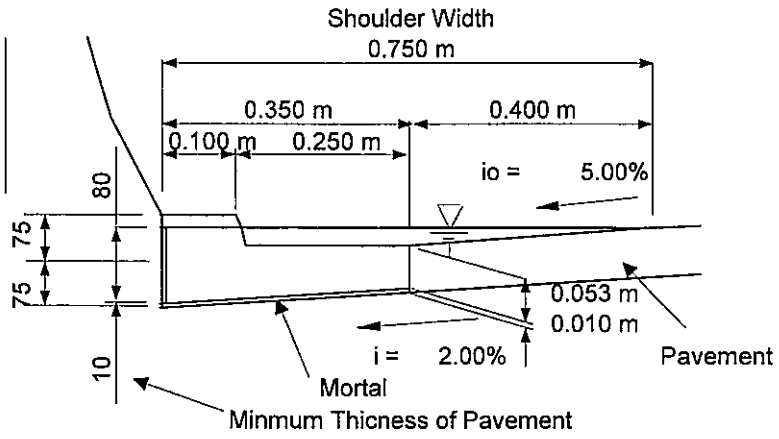
d = Q' / Q x L

(Single Line Drainage)	d2 =	5.377	m ==>	**5 m**	**Surface Down**
		52.597		**52 m**	**Outer Ditch**

G. STEEL SUPERSTRUCTURE SECTION, P7 ~ P12 *w/ Steel Gutter Screen*

Total F.O. Width Wb = 9.00 m
Single Line Drainage System = 1
Double Line Drainage System = 2
Supper Elevation i = **2.00%**
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 = **0.910%**
  Span Length L = **27.00 m**
  Catchments Area
  (Single Line Drainage) A1 = Wb x L / 1 = 243 m^2
  (Double Line Drainage) A2 = Wb x L / 2 = 122 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 = 0.0231 m^3/sec.
  (Double Line Drainage) Q2 = 0.0116 m^3/sec.
- Possible Through Volume of Run-Off along Shoulder
  Q' = v x a = 0.043 m^3/sec.
- Velocity of Flow
  $v = 1/n \times R^{2/3} \times I^{1/2}$ = 0.9866 m/sec.
  (Hydraulic mean Depth) R = a / l = 0.0493
  (Wetted Perimeter) l = **0.8836** m
  (Floow Area of Gutter) a = **0.0436** m^2
  (Coefficient of Roughness) n = **0.013**

3) Designed Number of Vertical Drain

N = Q / Q'
(Single Line Drainage) N2 = 0.537 Each ==> **1 Each**

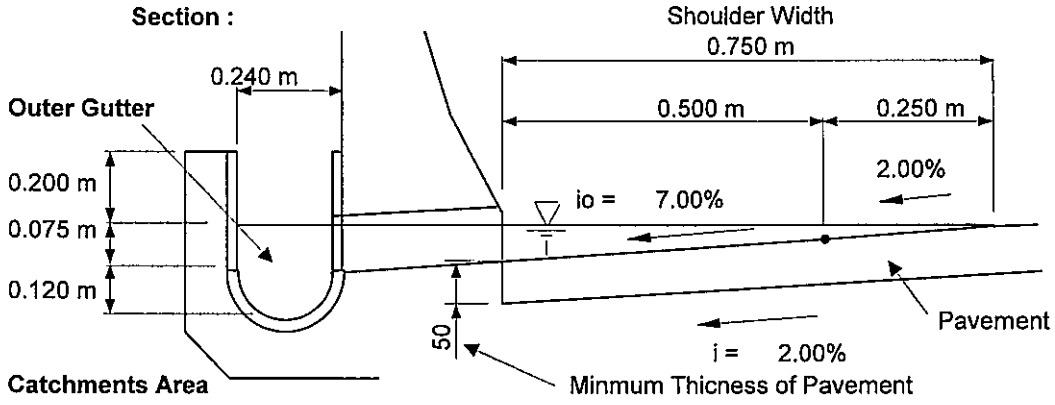
4) Designed Interval of Vertical Drain

d = Q' / Q x L
(Single Line Drainage) d2 = 50.260 m ==> **50 m**

H. STEEL SUPERSTRUCTURE SECTION, P7 ~ P12 *Surface Down + Outer Gutter*

Total F.O. Width Wb = 9.00 m
Single Line Drainage System = 1
Double Line Drainage System = 2
Supper Elevation i = **2.00%**
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 = **0.910%**
  Span Length L = **27.00 m**
  Catchments Area
  (Single Line Drainage) A1 = Wb x L / 1 = 243 m^2
  (Double Line Drainage) A2 = Wb x L / 2 = 122 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 = 0.0231 m^3/sec.
  (Double Line Drainage) Q2 = 0.0116 m^3/sec.
- Possible Through Volume of Run-Off along Shoulder
  Q' = v x a = 0.045 m^3/sec.
- Velocity of Flow
  $v = 1/n \times R^{2/3} \times I^{1/2}$ = 0.85683 m/sec.
  (Hydraulic mean Depth) R = a / l = 0.0399
  (Wetted Perimeter) l = 1.3171 m
  (Floow Area of Gutter) a = **0.0525** m^2
  (Coefficient of Roughness) n = **0.013**

3) Designed Number of Vertical Drain

N = Q / Q'
(Single Line Drainage) N2 = 0.513 Each ==> **1 Each**

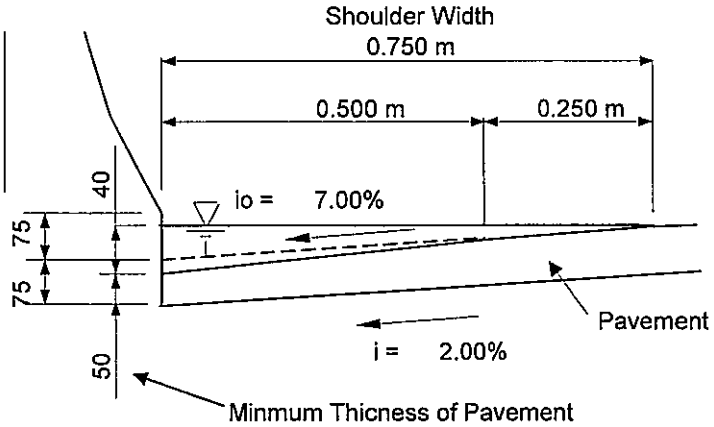
4) Designed Interval of Vertical Drain

d = Q' / Q x L
(Single Line Drainage) d2 = 52.597 m ==> **52 m**

I. STEEL SUPERSTRUCTURE SECTION, P4 ~ P6 *w/ Surface Down + Outer Ditch*

Total F.O. Width Wb = 9.00 m
Single Line Drainage System = 1
Double Line Drainage System = 2
Supper Elevation i = **2.00%**
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 = 2.961% ~ 0.000% **Ave. = 1.481%**
  Span Length L = **53.00 m**
  Catchments Area
  (Single Line Drainage) A1 = Wb x L / 1 = 477 m^2
  (Double Line Drainage) A2 = Wb x L / 2 = 239 m^2

2) Volume of Run-Off

- Volume of Run-Off
  $Q = 1/(3.6 \times 10^6) \times C \times \gamma o \times A$

				Applied Surface Down + Outer Ditch	
(Single Line Drainage)	Q1 =	0.0453	m^3/sec.		
(Double Line Drainage)	Q2 =	0.0227	m^3/sec.	0.0574	m^3/sec.

- Possible Through Volume of Run-Off along Shoulder
  Q' = v x a = 0.0059 m^3/sec.
- Velocity of Flow

$v = 1/n \times R^{2/3} \times I^{1/2}$ =	0.49565	m/sec.		1.09307	m/sec.
(Hydraulic mean Depth)	R = a / l =	0.0151		0.0399	
(Wetted Perimeter)	l =	**0.7901**	m	1.3171	m
(Floow Area of Gutter)	a =	**0.0119**	m^2	0.0525	m^2
(Coefficient of Roughness)	n =	0.015		0.013	

3) Designed Number of Vertical Drain

N = Q / Q'

(Single Line Drainage)	N1 =	7.678	Each ==>	**8**	**Each**
		0.789		**1**	**Each, Outer Ditch**

4) Designed Interval of Vertical Drain

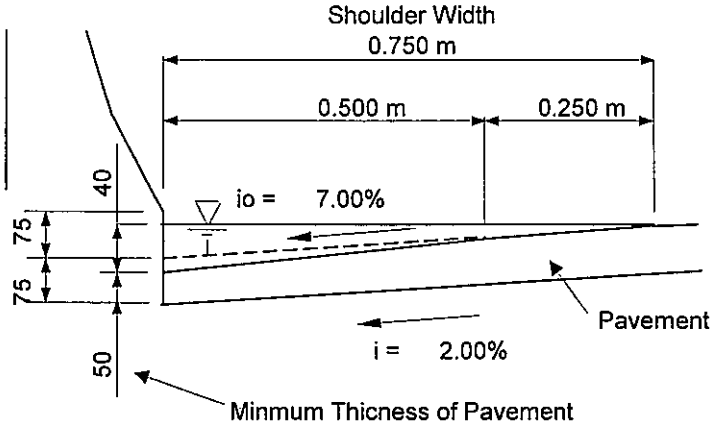
d = Q' / Q x L

(Single Line Drainage)	d1 =	6.903	m ==>	**6 m**	**Surface Down**
		67.157		**67 m**	**Outer Ditch**

J. STEEL SUPERSTRUCTURE SECTION, P5 ~ P6 *w/ Surface Down + Outer Ditch*

Total F.O. Width Wb = 9.00 m
Single Line Drainage System = 1
Double Line Drainage System = 2
Supper Elevation i = **2.00%**
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 = 0.000% ~ 0.573% **Ave. = 0.287%**
  Span Length L = **10.00 m**
  Catchments Area
  (Single Line Drainage) A1 = Wb x L / 1 = 90 m^2
  (Double Line Drainage) A2 = Wb x L / 2 = 45 m^2

2) Volume of Run-Off

- Volume of Run-Off
  $Q = 1/(3.6 \times 10^6) \times C \times \gamma o \times A$

				Applied Surface Down + Outer Ditch	
(Single Line Drainage)	Q1 =	0.0086	m^3/sec.		
(Double Line Drainage)	Q2 =	0.0043	m^3/sec.	0.0253	m^3/sec.

- Possible Through Volume of Run-Off along Shoulder
  Q' = v x a = 0.0026 m^3/sec. 0.0253 m^3/sec.
- Velocity of Flow

$v = 1/n \times R^{2/3} \times I^{1/2}$ =	0.21819	m/sec.		0.48119	m/sec.
(Hydraulic mean Depth)	R = a / l =	0.0151		0.0399	
(Wetted Perimeter)	l =	**0.7901**	m	1.3171	m
(Floow Area of Gutter)	a =	**0.0119**	m^2	0.0525	m^2
(Coefficient of Roughness)	n =	0.015		0.013	

3) Designed Number of Vertical Drain

N = Q / Q'

(Single Line Drainage)	N1 =	3.308	Each ==>	**4**	**Each**
		0.340		**1**	**Each, Outer Ditch**

4) Designed Interval of Vertical Drain

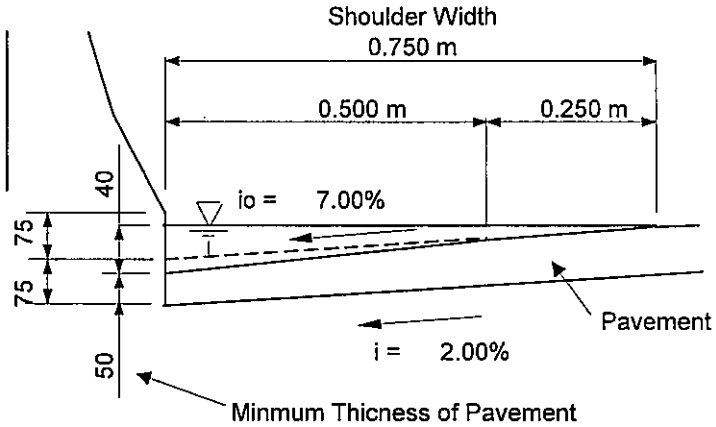
d = Q' / Q x L

(Single Line Drainage)	d1 =	3.023	m ==>	**3 m**	**Surface Down**
		29.419		**29 m**	**Outer Ditch**

K. STEEL SUPERSTRUCTURE SECTION, P5 ~ P7 *w/ Surface Down + Outer Ditch*

Total F.O. Width Wb = 9.00 m
Single Line Drainage System = 1
Double Line Drainage System = 2
Supper Elevation i = **2.00%**
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 = 0.000% ~ 0.910% **Ave. = 0.455%**
  Span Length L = **37.00 m**
  Catchments Area
  (Single Line Drainage) A1 = Wb x L / 1 = 333 m^2
  (Double Line Drainage) A2 = Wb x L / 2 = 167 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 = 0.0316 m^3/sec.
  (Double Line Drainage) Q2 = 0.0159 m^3/sec.

				Applied Surface Down + Outer Ditch	
- Possible Through Volume of Run-Off along Shoulder					
Q' = v x a =	0.0033	m^3/sec.		0.0318	m^3/sec.
- Velocity of Flow					
$v = 1/n \times R^{2/3} \times I^{1/2}$ =	0.27473	m/sec.		0.60587	m/sec.
(Hydraulic mean Depth)	R = a / l =	0.0151		0.0399	
(Wetted Perimeter)	l =	**0.7901**	m	1.3171	m
(Floow Area of Gutter)	a =	**0.0119**	m^2	0.0525	m^2
(Coefficient of Roughness)	n =	0.015		0.013	

3) Designed Number of Vertical Drain

N = Q / Q'

(Single Line Drainage)	N2 =	9.576	Each ==>	**10**	**Each**
		0.994		**1**	**Each, Outer Ditch**

4) Designed Interval of Vertical Drain

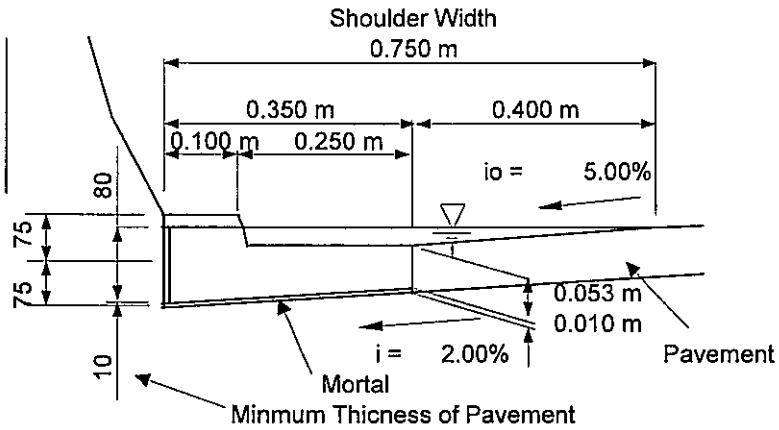
d = Q' / Q x L

(Single Line Drainage)	d2 =	3.864	m ==>	**3 m**	**Surface Down**
		37.234		**37 m**	**Outer Ditch**

L. PC SUPERSTRUCTURE SECTION, P12 ~ P13 *w/ Steel Gutter Screen*

Total F.O. Width Wb = 9.00 m
Single Line Drainage System = 1
Double Line Drainage System = 2
Supper Elevation i = **2.00%**
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 = 0.933% ~ 1.587% **Ave. = 1.260%**
  Span Length L = **20.00** m
  Catchments Area
  (Single Line Drainage) A1 = Wb x L / 1 = 180 m^2
  (Double Line Drainage) A2 = Wb x L / 2 = 90 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 = 0.0171 m^3/sec.
  (Double Line Drainage) Q2 = 0.0086 m^3/sec.
- Possible Through Volume of Run-Off along Shoulder
  Q' = v x a = 0.0506 m^3/sec.
- Velocity of Flow
  $v = 1/n \times R^{2/3} \times I^{1/2}$ = 1.16093 m/sec.
  (Hydraulic mean Depth) R = a / l = 0.0493
  (Wetted Perimeter) l = **0.8836** m
  (Floow Area of Gutter) a = **0.0436** m^2
  (Coefficient of Roughness) n = **0.013**

3) Designed Number of Vertical Drain

N = Q / Q'
(Single Line Drainage) N1 = 0.338 Each ==> **1** **Each**

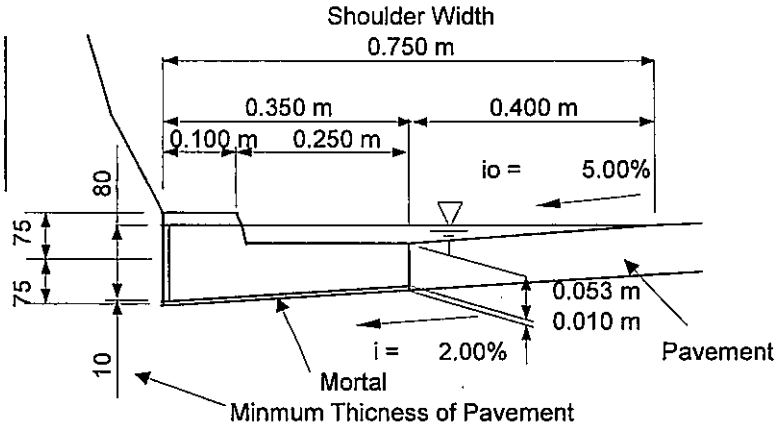
4) Designed Interval of Vertical Drain

d = Q' / Q x L
(Single Line Drainage) d1 = 59.181 m ==> **59 m**

M. PC SUPERSTRUCTURE SECTION, P13 ~ P14 *w/ Steel Gutter Screen*

Total F.O. Width Wb = 9.00 m
Single Line Drainage System = 1
Double Line Drainage System = 2
Supper Elevation i = **2.00%**
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 = 1.587% ~ 2.241% **Ave. = 1.914%**
  Span Length L = **20.00 m**
  Catchments Area
  (Single Line Drainage) A1 = Wb x L / 1 = 180 m^2
  (Double Line Drainage) A2 = Wb x L / 2 = 90 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 = 0.0171 m^3/sec.
  (Double Line Drainage) Q2 = 0.0086 m^3/sec.
- Possible Through Volume of Run-Off along Shoulder
  Q' = v x a = 0.0624 m^3/sec.
- Velocity of Flow
  $v = 1/n \times R^{2/3} \times I^{1/2}$ = 1.43084 m/sec.
  (Hydraulic mean Depth) R = a / l = 0.0493
  (Wetted Perimeter) l = **0.8836** m
  (Floow Area of Gutter) a = **0.0436** m^2
  (Coefficient of Roughness) n = **0.013**

3) Designed Number of Vertical Drain

N = Q / Q'
(Single Line Drainage) N1 = 0.274 Each ==> **1 Each**

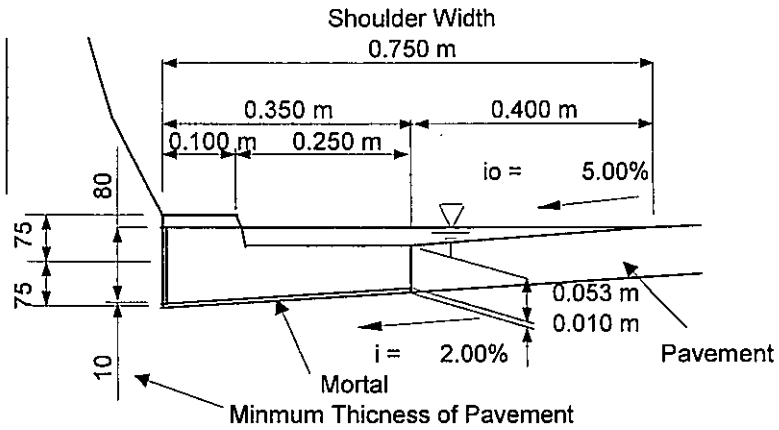
4) Designed Interval of Vertical Drain

d = Q' / Q x L
(Single Line Drainage) d1 = 72.982 m ==> **72 m**

N. PC SUPERSTRUCTURE SECTION, P14 ~ P15 *w/ Steel Gutter Screen*

Total F.O. Width Wb = 9.00 m
Single Line Drainage System = 1
Double Line Drainage System = 2
Supper Elevation i = **2.00%**
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 = 2.241% ~ 2.895% **Ave. = 2.568%**
  Span Length L = **20.00 m**
  Catchments Area
  (Single Line Drainage) A1 = Wb x L / 1 = 180 m^2
  (Double Line Drainage) A2 = Wb x L / 2 = 90 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 = 0.0171 m^3/sec.
  (Double Line Drainage) Q2 = 0.0086 m^3/sec.
- Possible Through Volume of Run-Off along Shoulder
  Q' = v x a = 0.0723 m^3/sec.
- Velocity of Flow
  $v = 1/n \times R^{2/3} \times I^{1/2}$ = 1.65737 m/sec.
  (Hydraulic mean Depth) R = a / l = 0.0493
  (Wetted Perimeter) l = **0.8836** m
  (Floow Area of Gutter) a = **0.0436** m^2
  (Coefficient of Roughness) n = **0.013**

3) Designed Number of Vertical Drain

N = Q / Q'
(Single Line Drainage) N1 = 0.237 Each ==> **1 Each**

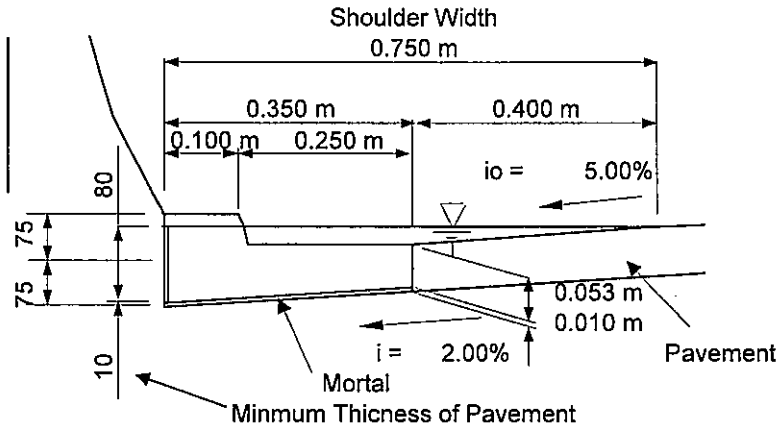
4) Designed Interval of Vertical Drain

d = Q' / Q x L
(Single Line Drainage) d1 = 84.561 m ==> **84 m**

O. PC SUPERSTRUCTURE SECTION, P15 ~ A2 *w/ Steel Gutter Screen*

Total F.O. Width	Wb =	9.00	m
Single Line Drainage System =		1	
Double Line Drainage System =		2	
Supper Elevation	i =	**2.00%**	
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 = 2.895% ~ 3.549% **Ave. = 3.222%**

Span Length L = **20.00** **m**

Catchments Area

(Single Line Drainage) A1 = Wb x L / 1 = 180 m^2

(Double Line Drainage) A2 = Wb x L / 2 = 90 m^2

2) Volume of Run-Off

- Volume of Run-Off

$Q = 1/(3.6 \times 10^6) \times C \times \gamma o \times A$

				Applied Surface Down	
(Single Line Drainage)	Q1 =	0.0171	m^3/sec.		
(Double Line Drainage)	Q2 =	0.0086	m^3/sec.		

- Possible Through Volume of Run-Off along Shoulder

Q' = v x a = 0.0809 m^3/sec. 0.0087 m^3/sec.

- Velocity of Flow

$v = 1/n \times R^{2/3} \times I^{1/2}$ =	1.85645	m/sec.		0.73107	m/sec.
(Hydraulic mean Depth)	R = a / l =	0.0493		0.0151	
(Wetted Perimeter)	l =	**0.8836**	m	0.7901	m
(Floow Area of Gutter)	a =	**0.0436**	m^2	0.0119	m^2
(Coefficient of Roughness)	n =	**0.013**		0.015	

3) Designed Number of Vertical Drain

N = Q / Q'

(Single Line Drainage)	N1 =	0.211	Each ==>	**1**	**Each**
		1.966		**2**	**Each, Outer Ditch**

4) Designed Interval of Vertical Drain

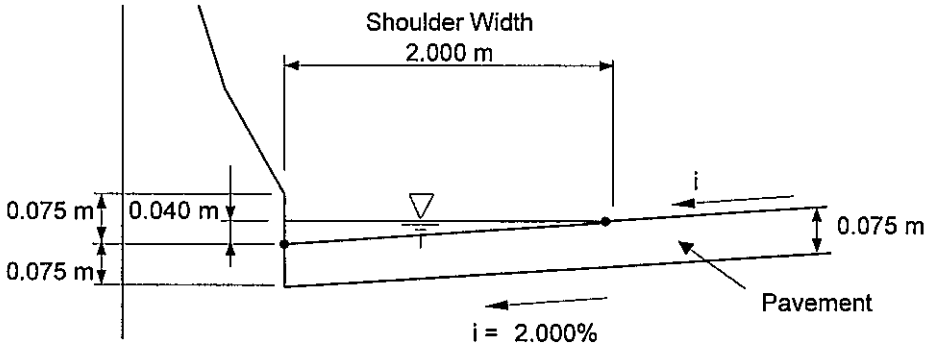
d = Q' / Q x L

(Single Line Drainage)	d1 =	94.620	m ==>	**94 m**	**Surface Down**
		10.175		**10 m**	**Outer Ditch**

P. APPROACH (A1)

Total F.O. Width Wb = 9.00 m
Single Line Drainage System = 1
Double Line Drainage System = 2
Supper Elevation i = **2.00%**
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 = **4.700%**
  Approach L = **168.00** m
  Catchments Area
  (Single Line Drainage) A1 = Wb x L / 1 = 1512 m^2
  (Double Line Drainage) A2 = Wb x L / 2 = 756 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 = 0.1436 m^3/sec.
  (Double Line Drainage) Q2 = 0.0718 m^3/sec.
- Possible Through Volume of Run-Off along Shoulder
  Q' = v x a = 0.042 m^3/sec.
- Velocity of Flow
  $v = 1/n \times R^{2/3} \times I^{1/2}$ = 1.05066 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 = 3.419 Each ==> **4 Each**

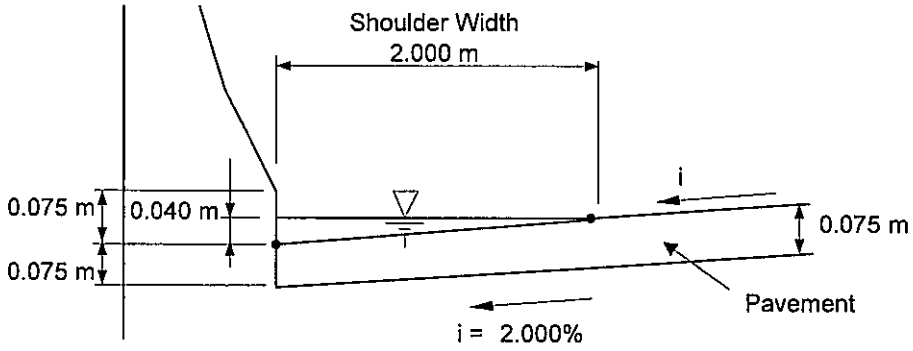
4) Designed Interval of Vertical Drain

d = Q' / Q x L
(Single Line Drainage) d1 = 42.000 m ==> **42 m**

Q. APPROACH (A2)

Total F.O. Width Wb = 9.00 m
Single Line Drainage System = 1
Double Line Drainage System = 2
Supper Elevation i = **2.00%**
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 = **4.180%**
  Approach L = **207.00 m**
  Catchments Area
  (Single Line Drainage) A1 = Wb x L / 1 = 1863 m^2
  (Double Line Drainage) A2 = Wb x L / 2 = 932 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 = 0.1770 m^3/sec.
  (Double Line Drainage) Q2 = 0.0885 m^3/sec.
- Possible Through Volume of Run-Off along Shoulder
  Q' = v x a = 0.0396 m^3/sec.
- Velocity of Flow
  $v = 1/n \times R^{2/3} \times I^{1/2}$ = 0.99083 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 = 4.470 Each ==> **5 Each**

4) Designed Interval of Vertical Drain

d = Q' / Q x L
(Single Line Drainage) d1 = 41.400 m ==> **41 m**

3.5 DRAINAGE DESING IN PETERONGAN FLYOVER

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

DAILY RAINFALL PETERONGAN STATION

No	Years	Rainfall Data (mm)
1	1994	140.00
2	1995	119.00
3	1996	90.00
4	1997	114.00
5	1998	115.00
6	1999	72.00
7	2000	78.00
8	2001	118.00
9	2002	108.00
10	2003	130.00
11	2004	104.00

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	1024.000	32768.000	1048576.000
2	1995	119.000	121.000	1331.000	14641.000
3	1996	90.000	324.000	-5832.000	104976.000
4	1997	114.000	36.000	216.000	1296.000
5	1998	115.000	49.000	343.000	2401.000
6	1999	72.000	1296.000	-46656.000	1679616.000
7	2000	78.000	900.000	-27000.000	810000.000
8	2001	118.000	100.000	1000.000	10000.000
9	2002	108.000	0.000	0.000	0.000
10	2003	130.000	484.000	10648.000	234256.000
11	2004	104.000	16.000	-64.000	256.000
	Σ	1188.000	4350.000	-33246.000	3906018.000

X Mean =	108.000	mm	
Standart Deviation =	20.857	mm	
Skewness Coefficient =	**-0.509**	**Max rate :**	**1.140**
Kurtosis Coefficient=	**4.096**	**Max rate:**	**5.400**
Reduced Mean Y_N =	0.4952		
Reduced Standard Deviation S_N =	0.9496		
b =	97.124		
1/a =	21.964		

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	105.173
2	5	1.4999	130.067
3	10	2.2502	146.546
4	20	2.9606	162.149
5	25	3.1985	167.374
6	50	3.9019	182.823
7	100	4.6001	198.158

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	0.015	0.002
2	1995	119.000	2.076	0.003	0.000
3	1996	90.000	1.954	0.005	0.000
4	1997	114.000	2.057	0.001	0.000
5	1998	115.000	2.061	0.001	0.000
6	1999	72.000	1.857	0.028	-0.005
7	2000	78.000	1.892	0.018	-0.002
8	2001	118.000	2.072	0.002	0.000
9	2002	108.000	2.033	0.000	0.000
10	2003	130.000	2.114	0.008	0.001
11	2004	104.000	2.017	0.000	0.000
	Σ	1188.000	22.279	0.081	-0.005

Average = 2.025
Standart Deviation = 0.090
Skewness Coefficient= -0.906

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	2.0207	104.877
2	5	0.8228	2.0992	125.669
3	10	1.3102	2.1430	138.986
4	20	1.3875	2.1499	141.224
5	25	1.8537	2.1917	155.505
6	50	2.2185	2.2245	167.683
7	100	2.5547	2.2547	179.745

Log Pearson Type III

DISTRIBUTION OF LOG NORMAL

No.	Years	Daily Rainfall Average (mm)	Log X	(Log X - log X_{ave})	(Log X - log X_{ave})^2
1	1994	140.000	2.146	0.121	0.015
2	1995	119.000	2.076	0.050	0.003
3	1996	90.000	1.954	-0.071	0.005
4	1997	114.000	2.057	0.032	0.001
5	1998	115.000	2.061	0.035	0.001
6	1999	72.000	1.857	-0.168	0.028
7	2000	78.000	1.892	-0.133	0.018
8	2001	118.000	2.072	0.046	0.002
9	2002	108.000	2.033	0.008	0.000
10	2003	130.000	2.114	0.089	0.008
11	2004	104.000	2.017	-0.008	0.000
	Σ	1188.000	22.279	0.000	0.081

Average = 2.025
Standart Deviation = 0.090
Variable Coefficient 0.044
Skewness Coefficient= 0.133
kurtosis Coefficient 3.031

Max rate : 0.133

Result Formula,
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	2.0191	104.491
5	0.8103	2.0981	125.345
10	1.3142	2.1433	139.101
20	1.7545	2.1828	152.350
25	1.8418	2.1907	155.125
50	2.2786	2.2299	169.778
100	2.6089	2.2595	181.769

Log Normal

LOG NORMAL

Max Daily Rainfall Calculation for
PETERONGAN Flyover

Return Period	Gumbel	Log Pearson	Log Normal	Result (mm)
2	105.173	104.877	104.491	104.877
5	130.067	125.669	125.345	125.669
10	146.546	138.986	139.101	139.101
20	162.149	141.224	152.350	152.350
25	167.374	155.505	155.125	155.505
50	182.823	167.683	169.778	169.778
100	198.158	179.745	181.769	181.769

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	190.575	120.0544	91.61867	75.62955	57.71614	44.04566	36.35889	30.0136	25.86494	22.90467	19.73864	17.47953	11.01142
5	228.355	143.8548	109.7818	90.62285	69.15818	52.77757	43.56692	35.9637	30.99258	27.44544	23.65176	20.94479	13.19439
10	252.763	159.231	121.516	100.3092	76.55028	58.4188	48.22365	39.80775	34.30528	30.379	26.17983	23.18351	14.6047
20	276.838	174.3972	133.09	109.8634	83.84143	63.98299	52.81679	43.5993	37.57274	33.27249	28.67337	25.39167	15.99575
25	282.571	178.009	135.846	112.1384	85.57763	65.30795	53.91053	44.50216	38.3508	33.9615	29.26714	25.91748	16.32699
50	308.508	194.348	148.3151	122.4314	93.43263	71.30244	58.85887	48.58693	41.87094	37.07876	31.95351	28.29639	17.82561
100	330.296	208.073	158.7896	131.0779	100.0312	76.33806	63.01568	52.0183	44.82801	39.69739	34.21018	30.29478	19.08452

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	15.88121	20.00907	22.90467	25.20985	28.85807	33.03425	36.35889	40.01814	43.10823	45.80933	49.34661	52.4386	66.06849
5	19.02961	23.9758	27.44544	30.20762	34.57909	39.58318	43.56692	47.9516	51.6543	54.89088	59.12941	62.83437	79.16635
10	21.06362	26.5385	30.379	33.43641	38.27514	43.8141	48.22365	53.077	57.17546	60.758	65.44957	69.55054	87.62819
20	23.06986	29.0662	33.27249	36.62112	41.92072	47.98724	52.81679	58.1324	62.62123	66.54499	71.68342	76.175	95.97448
25	23.54759	29.66811	33.9615	37.37947	42.78881	48.98096	53.91053	59.33621	63.918	67.92301	73.16784	77.75243	97.96193
50	25.70898	32.39128	37.07876	40.81046	46.71632	53.47683	58.85887	64.78257	69.78491	74.15753	79.88378	84.88918	106.9537
100	27.52463	34.67887	39.69739	43.69263	50.01558	57.25355	63.01568	69.35773	74.71335	79.39478	85.52544	90.88434	114.5071

INTERVAL OF GUTTER INLET

- Section 0+900 - 1+040

Distance (Lo) =	**107**	**m**
Vertical Grades of Road (i)=	0.19%	
Road Width (L1) =	5	m
Super Elevation (m1) =	2.00%	(Pavement)
Super Elevation (m2) =	10.00%	(Gutter)
Rainfall intensity (Y) =	**125.67**	mm
(5 years return period)		
Coefficient of Run-off (C) =	0.9	(Concrete)

1) Catchments Area

Catchments Area (A= L0*L1) 535 m^2

2) Time Concentration

t1 = {2/3 x 3.28 x L1 x nd / (m1) ^ 0.5 } ^ 0.167 = 1.00 min. Friction Coefficient nd= 0.013

t2 = {2/3 x 3.28 x Lo x nd / (i) ^ 0.5 } ^ 0.167 = 2.03 min.

TC = t1 + t2 3.03 min. = 0.05 hour

3) Volume of Run-Off

Rainfall intensity

$I = (Y /24) * (24 / TC) ^{2/3}$ = 318.7 mm/ hour

Volume of Run-Off

$Q = 1 / (3.6 \times 10^6) \times C \times I \times A$ = 0.0426 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

$v = 1.72\ H^{2/3}$

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

$Q1 = v \times a =$ 8.6 $H^{8/3}$

Q = Q1

$0.0501 = 8.6\ H^{8/3}$

H = 0.14 meter

4) Needed Number of Gutter Inlet

Dimension of Gutter Inlet

w = 50 cm

I = 15 cm

Coefficient lost of Gutter Inlet (C) = 80%

Area of Gutter Inlet

A = w x I / = 0.0375 m^2

Volume of Gutter Inlet

q = A x v = 0.014 m^3/sec.

N = Q / q = 3.1 < 4 each

d = L / N = 26.75 m

Design of Dimension and Distance for Gutter Inlet

	Maks Daily rainfall Return for Period 5 Year	mm/hour	:	125.66875			
1	Location :Peterongan FO		:				
	Position : Left and Right at grade						
	Beginning Sta.	meter	:	0+0	0+107	0+175	0+237
	End Sta.	meter	:	0+107	0+175	0+237	0+350
	Distance	meter	:	**107.00**	**68.00**	**62.00**	**113.00**
2	Design Road		:				
	a. Road Widht	meter	:	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)			**0.19%**	**1.56%**	**1.56%**	**0.20%**
3	Coeffisient Road Friction (nd)		:	0.013	0.013	0.013	0.013
4	Concentration Time		:				
	d. T.1	minute	:	1.00	1.00	1.00	1.00
	e. T.2	minute	:	2.03	1.58	1.56	2.04
	f. Tc	minute	:	3.03	2.58	2.56	3.04
	Tc	hour		0.05	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	:	535	340	310	565
7	Coeffisient manning Friction		:	0.015	0.015	0.015	0.015
8	Rainfall Intensity for t = Tc	mm/hour	:	318.7	354.9	357.1	318.0
9	Volume of Run-off	m^3/sec		0.04	0.03	0.03	0.04
10	Hydraulic mean Depth factor			0.455	0.455	0.455	0.455
11	Velocity of Flow factor		:	1.72	4.92	4.92	1.76
12	Flow Area of Gutter factor			5	5	5	5
13	Q = (10 X 11)	m^3/sec	:	8.59	24.61	24.61	8.81
14	Possible hight water at gutter	meter	:	0.14	0.08	0.08	0.14
15	Possible velocity of flow at gutter	meter	:	0.456	0.921	0.901	0.471
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		0.01	0.03	0.03	0.01
	Total of Gutter Inlet	each		4	2	2	4
	Distance of Gutter Inlet	meter		26	34	31	28

Design of Dimension and Distance for Gutter Inlet

	Maks Daily rainfall Return for Period 5 Year	mm/hour	:	125.66875			
1	Location :Peterongan FO		:				
	Position : Left and Right at grade						
	Beginning Sta.	meter	:	0+350	0+400	0+460	0+500
	End Sta.	meter	:	0+400	0+460	0+500	0+572
	Distance	meter	:	**50.00**	**60.00**	**40.00**	**72.00**
2	Design Road		:				
	a. Road Widht	meter	:	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)			**0.03%**	**1.60%**	**1.00%**	**0.60%**
3	Coeffisient Road Friction (nd)		:	0.013	0.013	0.013	0.013
4	Concentration Time		:				
	d. T.1	minute	:	1.00	1.00	1.00	1.00
	e. T.2	minute	:	2.09	1.54	1.50	1.73
	f. Tc	minute	:	3.09	2.54	2.50	2.73
	Tc	hour		0.05	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	:	250	300	200	360
7	Coeffisient manning Friction		:	0.015	0.015	0.015	0.015
8	Rainfall Intensity for t = Tc	mm/hour	:	314.8	358.2	362.3	342.0
9	Volume of Run-off	m^3/sec		0.02	0.03	0.02	0.03
10	Hydraulic mean Depth factor			0.455	0.455	0.455	0.455
11	Velocity of Flow factor		:	0.68	4.99	3.94	3.05
12	Flow Area of Gutter factor			5	5	5	5
13	Q = (10 X 11)	m^3/sec	:	3.41	24.93	19.71	15.26
14	Possible hight water at gutter	meter	:	0.14	0.08	0.07	0.10
15	Possible velocity of flow at gutter	meter	:	0.188	0.903	0.686	0.647
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		0.01	0.03	0.02	0.02
	Total of Gutter Inlet	each		4	1	1	2
	Distance of Gutter Inlet	meter		12	60	40	36

Design of Dimension and Distance for Gutter Inlet

	Maks Daily rainfall Return for Period 5 Year	mm/hour	:	125.66875			
1	Location :Peterongan FO		:				
	Position : Left and Right at grade						
	Beginning Sta.	meter	:	0+572	0+760	0+820	0+900
	End Sta.	meter	:	0+760	0+820	0+900	0+950
	Distance	meter	:	**188.00**	**60.00**	**80.00**	**50.00**
2	Design Road		:				
	a. Road Widht	meter	:	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)			**0.03%**	**0.15%**	**0.35%**	**1.37%**
3	Coeffisient Road Friction (nd)		:	0.013	0.013	0.013	0.013
4	Concentration Time		:				
	d. T.1	minute	:	1.00	1.00	1.00	1.00
	e. T.2	minute	:	2.60	1.88	1.84	1.52
	f. Tc	minute	:	3.61	2.88	2.84	2.52
	Tc	hour		0.06	0.05	0.05	0.04
5	Coeffisient of Run-off (Concrete)			0.90	0.90	0.90	0.90
6	Catchments Area (=width *distance)	m^2	:	940	300	400	250
7	Coeffisient manning Friction		:	0.015	0.015	0.015	0.015
8	Rainfall Intensity for t = Tc	mm/hour	:	284.0	329.7	332.9	360.7
9	Volume of Run-off	m^3/sec		0.07	0.02	0.03	0.02
10	Hydraulic mean Depth factor			0.455	0.455	0.455	0.455
11	Velocity of Flow factor		:	0.68	1.53	2.33	4.61
12	Flow Area of Gutter factor			5	5	5	5
13	Q = (10 X 11)	m^3/sec	:	3.41	7.63	11.66	23.07
14	Possible hight water at gutter	meter	:	0.23	0.12	0.11	0.07
15	Possible velocity of flow at gutter	meter	:	0.255	0.364	0.539	0.816
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		0.01	0.01	0.02	0.02
	Total of Gutter Inlet	each		9	3	3	1
	Distance of Gutter Inlet	meter		20	20	26	50

Design Volume of Run-Off at Flyover (Peterongan)

Max. Daily rainfall for Return Period 5 Year	mm	:	125.7														
1 Location : Balaraja FO		:															
Position :			**Start**	**A1**	**P1**	**P2**	**P3**	**P4**	**P5**	**P6**	**P7**	**P8**	**P9**	**P10**	**P11**	**A2**	**END**
Beginning Sta.	meter	:	+185	+343	+363	+383	+403	+423	+448	+464	+480	+505	+525	+545	+565	+585	+605
End Sta.	meter	:	+343	+363	+383	+403	+423	+448	+464	+480	+505	+525	+545	+565	+585	+605	+800
Distance	meter	:	158	20	20	20	20	25	16	16	25	20	20	20	20	20	195
2 Design Road		:															
a. Traffic width	meter	:	5.75	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	5.75
b. Super-elevation	%	:	2%	2%	2%	2%	2%	0%	2%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.0%	2%
c. Vertical Gradient of Flyover	%		4.60%	4.60%	4.60%	4.60%	4.60%	3.10%	0.50%	0.30%	1.4%	2.60%	3.75%	3.75%	3.75%	3.75%	3.75%
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
4 Concentration Time		:															
a. T.1	minute	:	1.03	1.15	1.15	1.15	1.15	1.48	1.15	1.13	1.13	1.13	1.13	1.13	1.13	1.15	1.03
b. T.2	minute	:	1.66	1.18	1.18	1.18	1.18	1.26	1.37	1.43	1.35	1.24	1.20	1.20	1.20	1.20	1.75
c. Tc =T.1+T.2	minute	:	2.69	2.33	2.33	2.33	2.33	2.74	2.52	2.56	2.48	2.37	2.33	2.33	2.33	2.35	2.78
Tc	hour		0.04	0.04	0.04	0.04	0.04	0.05	0.04	0.04	0.04	0.04	0.04	0.04	0.04	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
6 Catchments Area	m2	:	908.5	230	230	230	230	287.5	184	184	287.5	230	230	230	230	230	1121.25
7 Rainfall Intensity for t = Tc	mm/hour	:	352.6	388.3	388.3	388.3	388.3	348.0	368.6	364.9	372.2	384.3	388.4	388.4	388.4	386.0	345.0
8 Volume of Run-Off for Section only	m3/sec	:	**0.080**	**0.022**	**0.022**	**0.022**	**0.022**	**0.025**	**0.017**	**0.017**	**0.027**	**0.022**	**0.022**	**0.022**	**0.022**	**0.022**	**0.097**
9 Volume of Run-Off for at grade leftside	m3/sec	:	**0.080**									**0.066**					**0.097**
10 Volume of Run-Off for at grade rightside	m3/sec	:	**0.080**	**0.067**			**0.054**									**0.089**	**0.097**

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

	Max. Daily rainfall for Return Period 5 Year	mm	:	105.849			
1	Location : Peterongan FO		:				
	Position : Right Frontage						
	Beginning Sta.	meter	:	+0	+180	+505	+720
	End Sta.	meter	:	+167	+451	+720	+950
	Distance	meter	:	167	271	215	230
2	Design Road		:				
	a. Traffic width	meter	:	5	5	5	5
	b. Ground width	meter	:	15	15	15	15
	Super-elevation		:				
	a. Traffic		:	0.02	0.02	0.02	0.02
	b. Ground		:	0.01	0.01	0.01	0.01
3	Coefficient Road Friction (nd)		:				
	a. Traffic		:	0.013	0.013	0.013	0.013
	b. Ground		:	0.4	0.4	0.4	0.4
4	Concentration Time		:				
	a. Traffic	minute	:	1.00	1.00	1.00	1.00
	b. Ground	minute	:	2.26	2.26	2.26	2.26
	c. T.1	minute	:	3.26	3.26	3.26	3.26
	d. T.2	minute	:	1.99	2.17	2.16	2.18
	e. Tc = T.1 + T.2	minute	:	5.25	5.43	5.42	5.44
	Tc	hour		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
	b. Ground		:	0.50	0.50	0.50	0.50
	c. Average		:	0.60	0.60	0.60	0.60
6	Catchments Area (=width *distance)		:				
	a. Traffic	m^2	:	835	1,355	1,075	1,150
	b. Ground	m^2	:	2,505	4,065	3,225	3,450
7	Coefficient manning Friction		:	0.02	0.02	0.02	0.02
8	Rainfall Intensity for t = Tc	mm/hour	:	189.67	185.36	185.74	185.18
9	Volume of Run-off on Section	m^3/sec	:	**0.106**	**0.167**	**0.133**	**0.142**
	Volume of Run-off from Upper Section	m^3/sec			-	-	**0.222**
	Volume of Run-off from Flyover	m^3/sec		-	**0.211**	**0.089**	**0.097**
	Total Volume of Run-off	m^3/sec		**0.106**	**0.379**	**0.222**	**0.461**
10	Design of Dimension (minimum)		:				
	a. Height of water level	meter	:	**0.13**	**0.34**	**0.26**	**0.45**
	b. Wide of Side Ditch	meter	:	**0.80**	**0.80**	**0.80**	**0.80**
11	Circumference Wet Area	meter	:	1.07	1.48	1.33	1.70
12	Ditch Wet Area	m^2		0.11	0.27	0.21	0.36
13	Hydraulic Radii Of Drain	meter	:	0.10	0.18	0.16	0.21
14	Ditch sloping		:	0.006	0.006	0.004	0.004
15	Flow of Velocity	m^2/sec		0.98	1.40	1.06	1.28
16	Design Volume of Ditch	m^3/sec		***0.106***	***0.380***	***0.222***	***0.461***
17	Free Board	meter		0.15	0.15	0.15	0.15
18	Highest of Ditch (=10a+17)	meter		0.28	0.49	0.41	0.60
			:				
	Wide of Side Ditch	meter		***0.80***	***0.80***	***0.80***	***0.80***
	Highest of Ditch	meter		***0.30***	***0.50***	***0.50***	***0.60***

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

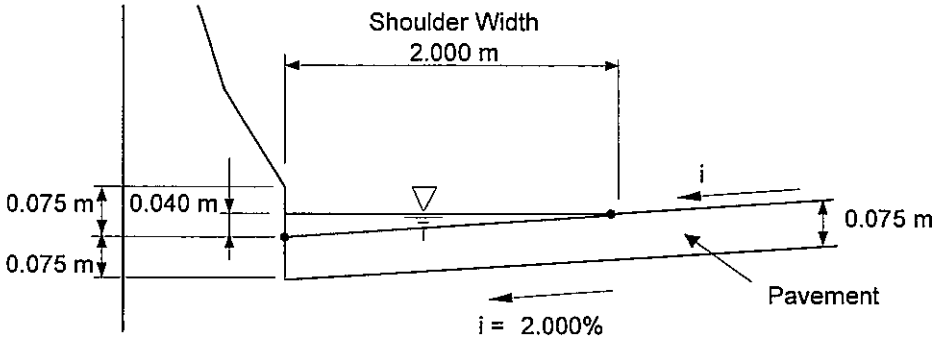
	Max. Daily rainfall for Return Period 5 Year	mm	:	105.849		
1	Location : Peterongan FO		:			
	Position : Right Frontage					
	Beginning Sta.	meter	:	+0	+180	+505	+720
	End Sta.	meter	:	+167	+451	+720	+950
	Distance	meter	:	167	271	215	230
2	Design Road		:				
	a. Traffic width	meter	:	5	5	5	5
	b. Ground width	meter	:	15	15	15	15
	Super-elevation		:				
	a. Traffic		:	0.02	0.02	0.02	0.02
	b. Ground		:	0.01	0.01	0.01	0.01
3	Coefficient Road Friction (nd)		:				
	a. Traffic		:	0.013	0.013	0.013	0.013
	b. Ground		:	0.4	0.4	0.4	0.4
4	Concentration Time		:				
	a. Traffic	minute	:	1.00	1.00	1.00	1.00
	b. Ground	minute	:	2.26	2.26	2.26	2.26
	c. T.1	minute	:	3.26	3.26	3.26	3.26
	d. T.2	minute	:	1.99	2.17	2.16	2.18
	e. Tc = T.1 + T.2	minute	:	5.25	5.43	5.42	5.44
	Tc	hour		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
	b. Ground		:	0.50	0.50	0.50	0.50
	c. Average		:	0.60	0.60	0.60	0.60
6	Catchments Area (=width *distance)		:				
	a. Traffic	m^2	:	835	1,355	1,075	1,150
	b. Ground	m^2	:	2,505	4,065	3,225	3,450
7	Coefficient manning Friction		:	0.02	0.02	0.02	0.02
8	Rainfall Intensity for t = Tc	mm/hour	:	189.67	185.36	185.74	185.18
9	Volume of Run-off on Section	m^3/sec	:	**0.106**	**0.167**	**0.133**	**0.142**
	Volume of Run-off from Upper Section	m^3/sec			-	-	**0.199**
	Volume of Run-off from Flyover	m^3/sec		-	**0.080**	**0.066**	**0.097**
	Total Volume of Run-off	m^3/sec		**0.106**	**0.248**	**0.199**	**0.437**
10	Design of Dimension (minimum)		:				
	a. Height of water level	meter	:	**0.13**	**0.25**	**0.24**	**0.43**
	b. Wide of Side Ditch	meter	:	**0.80**	**0.80**	**0.80**	**0.80**
11	Circumference Wet Area	meter	:	1.07	1.30	1.29	1.66
12	Ditch Wet Area	m^2		0.11	0.20	0.19	0.35
13	Hydraulic Radii Of Drain	meter	:	0.10	0.15	0.15	0.21
14	Ditch sloping		:	0.006	0.006	0.004	0.004
15	Flow of Velocity	m^2/sec		0.98	1.24	1.02	1.27
16	Design Volume of Ditch	m^3/sec		***0.106***	***0.249***	***0.199***	***0.437***
17	Free Board	meter		0.15	0.15	0.15	0.15
18	Highest of Ditch (=10a+17)	meter		0.28	0.40	0.39	0.58
			:				
	Wide of Side Ditch	meter		***0.80***	***0.80***	***0.80***	***0.80***
	Highest of Ditch	meter		***0.30***	***0.40***	***0.40***	***0.60***

INTERVAL OF VERTICAL DRAIN OF PETERONGAN FLYOVER

A. STEEL SUPERSTRUCTURE SECTION, P4 ~ P5 *w/ o Surface Down*

Total F.O. Width Wb = 13.00 m
Single Line Drainage System = 1
Double Line Drainage System = 2
Supper Elevation i = **2.00%**
Rainfall Intensity γ = 230 mm/hr
(5 years return period, 5 mins. Time concentration)
Design Rainfall intensity γo = γ x k = **460** mm/hr
Coefficient of Run-off C = 0.9
Correction Factor of Falling k = 2

Section :



1) Catchments Area

- Vertical Gradient = 1.093% ~ 2.485% **Ave. = 1.789%**
  Span Length L = **25.00 m**
  Catchments Area
  (Single Line Drainage) A1 = Wb x L / 1 = 325 m^2
  (Double Line Drainage) A2 = Wb x L / 2 = 163 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 = 0.0374 m^3/sec.
  (Double Line Drainage) Q2 = 0.0187 m^3/sec.
- Possible Through Volume of Run-Off along Shoulder
  Q' = v x a = 0.0259 m^3/sec.
- Velocity of Flow
  $v = 1/n \times R^{2/3} \times I^{1/2}$ = 0.64821 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 = 1.444 Each ==> **2 Each**

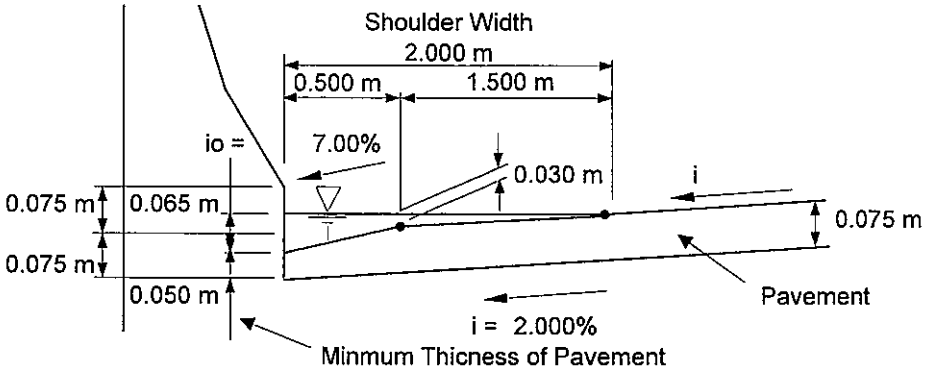
4) Designed Interval of Vertical Drain

d = Q' / Q x L
(Single Line Drainage) d1 = 17.313 m ==> **17 m**

B. STEEL SUPERSTRUCTURE SECTION, P4 ~ P5 *w/ Surface Down*

Total F.O. Width Wb = 13.00 m
Single Line Drainage System = 1
Double Line Drainage System = 2
Supper Elevation i = **2.00%**
Rainfall Intensity γ = 230 mm/hr
(5 years return period, 5 mins. Time concentration)
Design Rainfall intensity γo = γ x k = **460** mm/hr
Coefficient of Run-off C = 0.9
Correction Factor of Falling k = 2

Section :



1) Catchments Area

- Vertical Gradient = 1.093% ~ 2.485% **Ave. = 1.789%**
  Span Length L = **25.00 m**
  Catchments Area
  (Single Line Drainage) A1 = Wb x L / 1 = 325 m^2
  (Double Line Drainage) A2 = Wb x L / 2 = 163 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 = 0.0374 m^3/sec.
  (Double Line Drainage) Q2 = 0.0187 m^3/sec.
- Possible Through Volume of Run-Off along Shoulder
  Q' = v x a = 0.0693 m^3/sec.
- Velocity of Flow
  $v = 1/n \times R^{2/3} \times I^{1/2}$ = 0.95591 m/sec.
  (Hydraulic mean Depth) R = a / l = 0.0351
  (Wetted Perimeter) l = 2.0665 m
  (Floow Area of Gutter) a = 0.0725 m^2
  (Coefficient of Roughness) n = 0.015

3) Designed Number of Vertical Drain

N = Q / Q'
(Single Line Drainage) N1 = 0.540 Each ==> **1 Each**

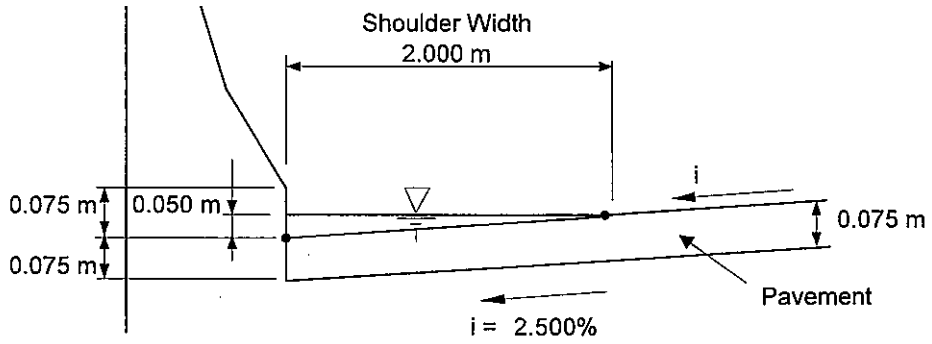
4) Designed Interval of Vertical Drain

d = Q' / Q x L
(Single Line Drainage) d1 = 46.324 m ==> **46 m**

C. STEEL SUPERSTRUCTURE SECTION, P5 ~ P6 *w/ o Surface Down*

Total F.O. Width Wb = 13.00 m
Single Line Drainage System = 1
Double Line Drainage System = 2
Supper Elevation i = **2.50%**
Rainfall Intensity γ = 230 mm/hr
(5 years return period, 5 mins. Time concentration)
Design Rainfall intensity γo = γ x k = **460** mm/hr
Coefficient of Run-off C = 0.9
Correction Factor of Falling k = 2

Section :



1) Catchments Area

- Vertical Gradient = 0.000% ~ 1.093% **Ave. = 0.547%**
  Span Length L = **20.00 m**
  Catchments Area
  (Single Line Drainage) A1 = Wb x L / 1 = 260 m^2
  (Double Line Drainage) A2 = Wb x L / 2 = 130 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 = 0.0299 m^3/sec.
  (Double Line Drainage) Q2 = 0.0150 m^3/sec.
- Possible Through Volume of Run-Off along Shoulder
  Q' = v x a = 0.0207 m^3/sec.
- Velocity of Flow
  $v = 1/n \times R^{2/3} \times I^{1/2}$ = 0.41479 m/sec.
  (Hydraulic mean Depth) R = a / I = 0.0244
  (Wetted Perimeter) I = 2.0506 m
  (Floow Area of Gutter) a = 0.0500 m^2
  (Coefficient of Roughness) n = 0.015

3) Designed Number of Vertical Drain

N = Q / Q'
(Single Line Drainage) N1 = 1.444 Each ==> **2 Each**

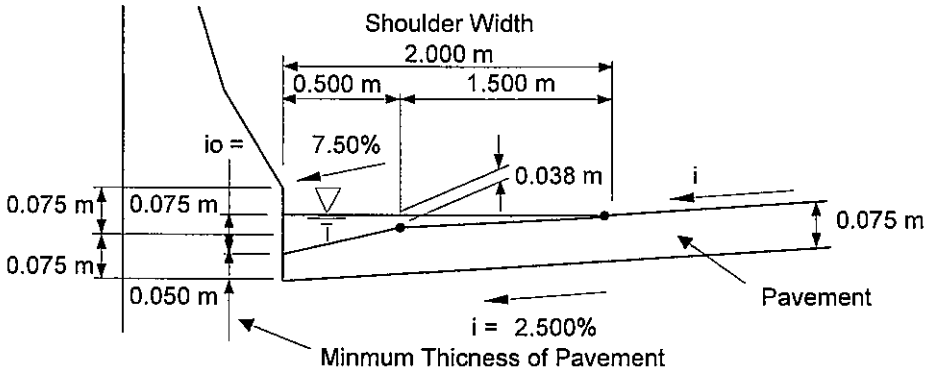
4) Designed Interval of Vertical Drain

d = Q' / Q x L
(Single Line Drainage) d1 = 13.846 m ==> **13.8 m**

D. STEEL SUPERSTRUCTURE SECTION, P5 ~ P6 *w/ Surface Down*

Total F.O. Width Wb = 13.00 m
Single Line Drainage System = 1
Double Line Drainage System = 2
Supper Elevation i = **2.50%**
Rainfall Intensity γ = 230 mm/hr
(5 years return period, 5 mins. Time concentration)
Design Rainfall intensity γo = γ x k = **460** mm/hr
Coefficient of Run-off C = 0.9
Correction Factor of Falling k = 2

Section :



1) Catchments Area

- Vertical Gradient = 0.000% ~ 1.093% **Ave. = 0.547%**
  Span Length L = **20.00 m**
  Catchments Area
  (Single Line Drainage) A1 = Wb x L / 1 = 260 m^2
  (Double Line Drainage) A2 = Wb x L / 2 = 130 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 = 0.0299 m^3/sec.
  (Double Line Drainage) Q2 = 0.0150 m^3/sec.
- Possible Through Volume of Run-Off along Shoulder
  Q' = v x a = 0.0493 m^3/sec.
- Velocity of Flow
  $v = 1/n \times R^{2/3} \times I^{1/2}$ = 0.5834 m/sec.
  (Hydraulic mean Depth) R = a / l = 0.0407
  (Wetted Perimeter) l = 2.0769 m
  (Floow Area of Gutter) a = 0.0845 m^2
  (Coefficient of Roughness) n = 0.015

3) Designed Number of Vertical Drain

N = Q / Q'
(Single Line Drainage) N1 = 0.606 Each ==> **1 Each**

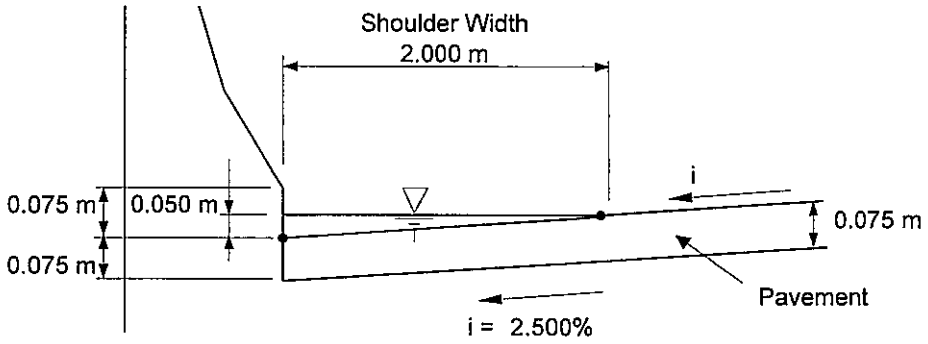
4) Designed Interval of Vertical Drain

d = Q' / Q x L
(Single Line Drainage) d1 = 32.977 m ==> **32 m**

E. STEEL SUPERSTRUCTURE SECTION, P5 ~ P6 *w/ Surface Down*

Total F.O. Width Wb = 13.00 m
Single Line Drainage System = 1
Double Line Drainage System = 2
Supper Elevation i = **2.50%**
Rainfall Intensity γ = 230 mm/hr
(5 years return period, 5 mins. Time concentration)
Design Rainfall intensity γo = γ x k = **460** mm/hr
Coefficient of Run-off C = 0.9
Correction Factor of Falling k = 2

Section :



1) Catchments Area

- Vertical Gradient = 0.000% ~ 0.688% **Ave. = 0.344%**
  Span Length L = **12.00 m**
  Catchments Area
  (Single Line Drainage) A1 = Wb x L / 1 = 156 m^2
  (Double Line Drainage) A2 = Wb x L / 2 = 78 m^2

2) Volume of Run-Off

- Volume of Run-Off
  $Q = 1/(3.6 \times 10^6) \times C \times \gamma o \times A$

				Applied w/ Surface Down
(Single Line Drainage)	Q1 =	0.0179	m^3/sec.	
(Double Line Drainage)	Q2 =	0.0090	m^3/sec.	

- Possible Through Volume of Run-Off along Shoulder
  Q' = v x a = 0.0164 m^3/sec. 0.0391
- Velocity of Flow

$v = 1/n \times R^{2/3} \times I^{1/2}$ =	0.32894	m/sec.		0.46265
(Hydraulic mean Depth)	R = a / I =	0.0244		0.0407
(Wetted Perimeter)	I =	2.0506	m	2.0769
(Floow Area of Gutter)	a =	0.0500	m^2	0.0845
(Coefficient of Roughness)	n =	0.015		

3) Designed Number of Vertical Drain

N = Q / Q'

(Single Line Drainage)	N1 =	1.091	Each ==>	**2**	**Each**
		0.458		**1**	**w/ Surface Down**

4) Designed Interval of Vertical Drain

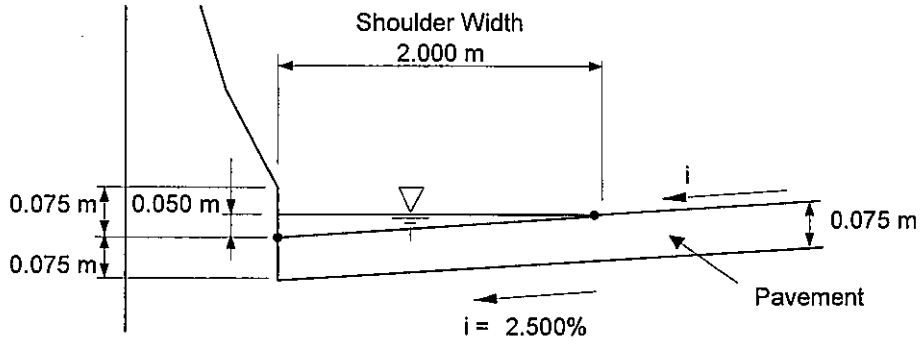
d = Q' / Q x L

(Single Line Drainage)	d1 =	10.994	m ==>	**10.9 m**	
		26.212		**26 m**	**w/ Surface Down**

F. STEEL SUPERSTRUCTURE SECTION, P6 ~ P7 *w/ Surface Down*

Total F.O. Width Wb = 13.00 m
Single Line Drainage System = 1
Double Line Drainage System = 2
Supper Elevation i = **2.50%**
Rainfall Intensity γ = 230 mm/hr
(5 years return period, 5 mins. Time concentration)
Design Rainfall Intensity γo = γ x k = **460** mm/hr
Coefficient of Run-off C = 0.9
Correction Factor of Falling k = 2

Section :



1) Catchments Area

- Vertical Gradient = 0.688% ~ 2.030% **Ave. = 1.359%**
  Span Length L = **25.00 m**
  Catchments Area
  (Single Line Drainage) A1 = Wb x L / 1 = 325 m^2
  (Double Line Drainage) A2 = Wb x L / 2 = 163 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 = 0.0374 m^3/sec.
  (Double Line Drainage) Q2 = 0.0187 m^3/sec.

Applied w/ Surface Down
0.0777

- Possible Through Volume of Run-Off along Shoulder
  Q' = v x a = 0.0327 m^3/sec.
- Velocity of Flow
  $v = 1/n \times R^{2/3} \times I^{1/2}$ = 0.6538 m/sec. 0.91956
  (Hydraulic mean Depth) R = a / l = 0.0244 0.0407
  (Wetted Perimeter) l = 2.0506 m 2.0769
  (Floow Area of Gutter) a = 0.0500 m^2 0.0845
  (Coefficient of Roughness) n = 0.015

3) Designed Number of Vertical Drain

N = Q / Q'
(Single Line Drainage) N1 = 1.144 Each ==> **2** **Each**
0.481 **1** **w/ Surface Down**

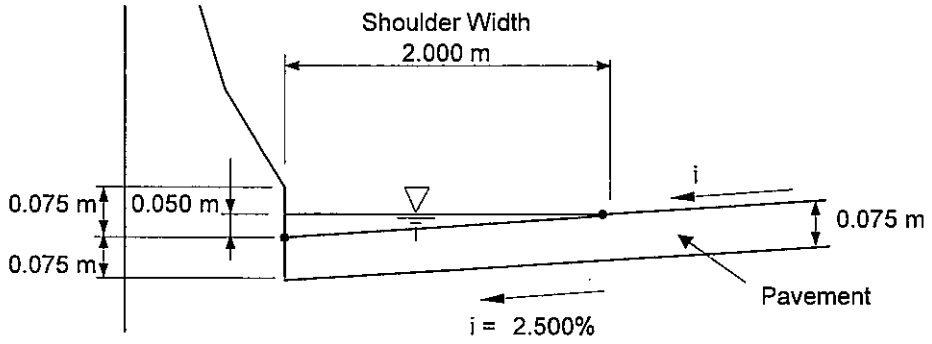
4) Designed Interval of Vertical Drain

d = Q' / Q x L
(Single Line Drainage) d1 = 21.858 m ==> **21.8 m**
51.939 **51 m** **w/ Surface Down**

G. PC SUPERSTRUCTURE SECTION, P7 ~ P8 *w/o Surface Down*

Total F.O. Width Wb = 13.00 m
Single Line Drainage System = 1
Double Line Drainage System = 2
Supper Elevation i = **2.50%**
Rainfall Intensity γ = 230 mm/hr
(5 years return period, 5 mins. Time concentration)
Design Rainfall intensity γo = γ x k = **460** mm/hr
Coefficient of Run-off C = 0.9
Correction Factor of Falling k = 2

Section :



1) Catchments Area

- Vertical Gradient = 2.030% ~ 3.193% **Ave. = 2.612%**
  Span Length L = **20.00 m**
  Catchments Area
  (Single Line Drainage) A1 = Wb x L / 1 = 260 m^2
  (Double Line Drainage) A2 = Wb x L / 2 = 130 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 = 0.0299 m^3/sec.
  (Double Line Drainage) Q2 = 0.0150 m^3/sec.
- Possible Through Volume of Run-Off along Shoulder
  Q' = v x a = 0.0453 m^3/sec.
- Velocity of Flow
  $v = 1/n \times R^{2/3} \times I^{1/2}$ = 0.9064 m/sec.
  (Hydraulic mean Depth) R = a / l = 0.0244
  (Wetted Perimeter) l = 2.0506 m
  (Floow Area of Gutter) a = 0.0500 m^2
  (Coefficient of Roughness) n = 0.015

3) Designed Number of Vertical Drain

N = Q / Q'
(Single Line Drainage) N1 = 0.660 Each ==> **1 Each**

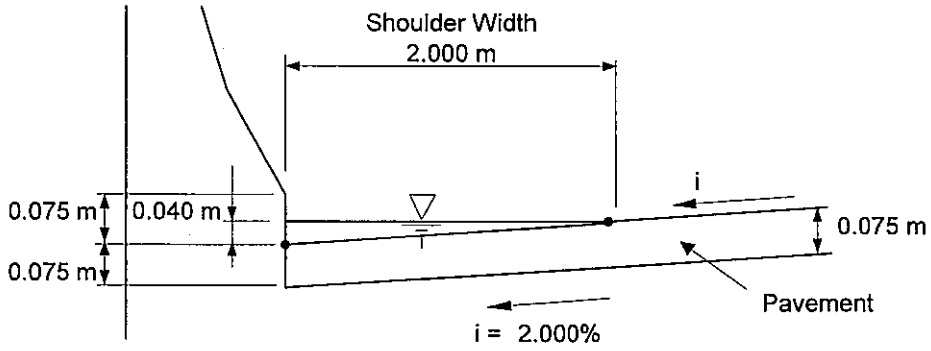
4) Designed Interval of Vertical Drain

d = Q' / Q x L
(Single Line Drainage) d1 = 30.301 m ==> **30.3 m**

H. APPROACH (A1)

Total F.O. Width Wb = 13.00 m
Single Line Drainage System = 1
Double Line Drainage System = 2
Supper Elevation i = **2.00%**
Rainfall Intensity γ = 230 mm/hr
(5 years return period, 5 mins. Time concentration)
Design Rainfall Intensity γo = γ x k = **460** mm/hr
Coefficient of Run-off C = 0.9
Correction Factor of Falling k = 2

Section :



1) Catchments Area

- Vertical Gradient = **4.300%**
  Approach L = **163.00 m**
  Catchments Area
  (Single Line Drainage) A1 = Wb x L / 1 = 2119 m^2
  (Double Line Drainage) A2 = Wb x L / 2 = 1060 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 = 0.2437 m^3/sec.
  (Double Line Drainage) Q2 = 0.1219 m^3/sec.
- Possible Through Volume of Run-Off along Shoulder
  Q' = v x a = 0.0402 m^3/sec.
- Velocity of Flow
  $v = 1/n \times R^{2/3} \times I^{1/2}$ = 1.00496 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 = 6.062 Each ==> **7 Each**
(Double Line Drainage) N2 = 3.032 Each ==> **4 Each**

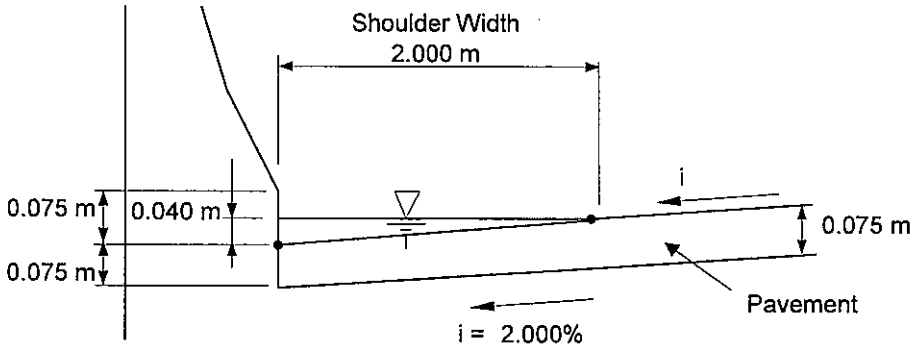
4) Designed Interval of Vertical Drain

d = Q' / Q x L
(Single Line Drainage) d1 = 23.286 m ==> **23 m**
(Double Line Drainage) d1 = 40.750 m ==> **40 m**

I. APPROACH (A2)

Total F.O. Width Wb = 13.00 m
Single Line Drainage System = 1
Double Line Drainage System = 2
Supper Elevation i = **2.00%**
Rainfall Intensity γ = 230 mm/hr
(5 years return period, 5 mins. Time concentration)
Design Rainfall intensity γo = γ x k = **460** mm/hr
Coefficient of Run-off C = 0.9
Correction Factor of Falling k = 2

Section :



1) Catchments Area

- Vertical Gradient = **3.700%**
  Approach L = **194.50 m**
  Catchments Area
  (Single Line Drainage) A1 = Wb x L / 1 = 2529 m^2
  (Double Line Drainage) A2 = Wb x L / 2 = 1264 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 = 0.2908 m^3/sec.
  (Double Line Drainage) Q2 = 0.1454 m^3/sec.
- Possible Through Volume of Run-Off along Shoulder
  Q' = v x a = 0.0373 m^3/sec.
- Velocity of Flow
  $v = 1/n \times R^{2/3} \times I^{1/2}$ = 0.93221 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 = 7.796 Each ==> **8 Each**

4) Designed Interval of Vertical Drain

d = Q' / Q x L
(Single Line Drainage) d1 = 24.313 m ==> **24 m**

3.6 DRAINAGE DESING IN TANGGULANGIN FLYOVER

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

DAILY RAINFALL SIDOARJO STATION

No	Years	Rainfall Data (mm)
1	1995	98.00
2	1996	131.00
3	1997	99.00
4	1998	143.00
5	1999	106.00
6	2000	95.00
7	2001	110.00
8	2002	90.00
9	2003	113.00
10	2004	89.00

DISTRIBUTION OF GUMBEL

No.	Years	Daily Rainfall Average (mm)	$(X - X_{ave})^2$	$(X - X_{ave})^3$	$(X - X_{ave})^4$
1	1995	98.000	88.360	-830.584	7807.490
2	1996	131.000	556.960	13144.256	310204.442
3	1997	99.000	70.560	-592.704	4978.714
4	1998	143.000	1267.360	45118.016	1606201.370
5	1999	106.000	1.960	-2.744	3.842
6	2000	95.000	153.760	-1906.624	23642.138
7	2001	110.000	6.760	17.576	45.698
8	2002	90.000	302.760	-5268.024	91663.618
9	2003	113.000	31.360	175.616	983.450
10	2004	89.000	338.560	-6229.504	114622.874
	Σ	1074.000	2818.400	43625.280	2160153.632

X Mean =	107.400	mm	
Standart Deviation =	17.696	mm	
Skewness Coefficient =	**1.093**	**Max rate :**	**1.140**
Kurtosis Coefficient=	**4.371**	**Max rate:**	**5.400**
Reduced Mean Y_N =	0.4952		
Reduced Standard Deviation S_N =	0.9496		
b =	98.172		
1/a =	18.635		

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	105.002
2	5	1.4999	126.123
3	10	2.2502	140.105
4	20	2.9606	153.344
5	25	3.1985	157.777
6	50	3.9019	170.885
7	100	4.6001	183.897

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	1995	98.000	1.991	0.001	0.000
2	1996	131.000	2.117	0.008	0.001
3	1997	99.000	1.996	0.001	0.000
4	1998	143.000	2.155	0.017	0.002
5	1999	106.000	2.025	0.000	0.000
6	2000	95.000	1.978	0.002	0.000
7	2001	110.000	2.041	0.000	0.000
8	2002	90.000	1.954	0.005	0.000
9	2003	113.000	2.053	0.001	0.000
10	2004	89.000	1.949	0.006	0.000
		1074.000	20.261	0.042	0.002

Average = 2.026
Standart Deviation = 0.068
Skewness Coefficient= 0.859

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	$\text{Log } X_T$	XT (mm)
1	2	-0.0524	2.0225	105.318
2	5	0.8228	2.0819	120.764
3	10	1.3102	2.1150	130.329
4	20	1.7995	2.1483	140.693
5	25	1.8537	2.1519	141.889
6	50	2.2185	2.1767	150.219
7	100	2.5547	2.1996	158.327

Log Pearson Type III

DISTRIBUTION OF LOG NORMAL

No.	Years	Daily Rainfall Average (mm)	Log X	(Log X - log X_{ave})	(Log X - log X_{ave})^2
1	1995	98.000	1.991	-0.035	0.001
2	1996	131.000	2.117	0.091	0.008
3	1997	99.000	1.996	-0.030	0.001
4	1998	143.000	2.155	0.129	0.017
5	1999	106.000	2.025	-0.001	0.000
6	2000	95.000	1.978	-0.048	0.002
7	2001	110.000	2.041	0.015	0.000
8	2002	90.000	1.954	-0.072	0.005
9	2003	113.000	2.053	0.027	0.001
10	2004	89.000	1.949	-0.077	0.006
	Σ	1074.000	20.261	0.000	0.042

Average = 2.026
Standart Deviation = 0.068
Variable Coefficient 0.034
Skewness Coefficient= 0.101
kurtosis Coefficient 3.018

Max rate : 0.101

Result Formula,
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	2.0213	105.024
5	0.8103	2.0811	120.529
10	1.3142	2.1153	130.410
20	1.7545	2.1452	139.705
25	1.8418	2.1511	141.626
50	2.2786	2.1808	151.638
100	2.6089	2.2032	159.674

Log Normal

LOG NORMAL

Max Daily Rainfall Calculation for
TANGGULANGIN Flyover

Return Period	Gumbel	Log Pearson	Log Normal	Result (mm)
2	105.002	105.318	105.024	105.318
5	126.123	120.764	120.529	120.764
10	140.105	130.329	130.410	130.410
20	153.344	140.693	139.705	140.693
25	157.777	141.889	141.626	141.889
50	170.885	150.219	151.638	151.638
100	183.897	158.327	159.674	159.674

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	191.375	120.5586	92.0034	75.94714	57.95851	44.23062	36.51158	30.13964	25.97356	23.00085	19.82153	17.55293	11.05766
5	219.443	138.2405	105.4973	87.08607	66.45911	50.7178	41.86662	34.56013	29.78302	26.37432	22.7287	20.12737	12.67945
10	236.971	149.2826	113.9239	94.04212	71.76757	54.7689	45.21073	37.32064	32.16195	28.48098	24.54416	21.73505	13.69223
20	255.655	161.0527	122.9062	101.4569	77.42607	59.08715	48.77537	40.26318	34.69776	30.72656	26.47934	23.44875	14.77179
25	257.829	162.422	123.951	102.3193	78.08427	59.58945	49.19001	40.60546	34.99272	30.98776	26.70444	23.64809	14.89736
50	275.544	173.582	132.4677	109.3497	83.44945	63.68385	52.56986	43.39546	37.39708	33.11694	28.53931	25.27295	15.92096
100	290.147	182.781	139.488	115.1448	87.87192	67.05883	55.35584	45.69524	39.37896	34.87199	30.05177	26.61231	16.76471

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	15.9479	20.09309	23.00085	25.31571	28.97926	33.17297	36.51158	40.18619	43.28926	46.0017	49.55383	52.6588	66.34594
5	18.28693	23.04009	26.37432	29.02869	33.22956	38.03835	41.86662	46.08018	49.63836	52.74863	56.82174	60.38211	76.07669
10	19.74761	24.88043	28.48098	31.34737	35.88378	41.07668	45.21073	49.76085	53.60325	56.96196	61.36041	65.20516	82.15336
20	21.3046	26.84212	30.72656	33.81895	38.71304	44.31536	48.77537	53.68424	57.82959	61.45311	66.19836	70.34626	88.63073
25	21.48571	27.0703	30.98776	34.10645	39.04213	44.69209	49.19001	54.14061	58.3212	61.97552	66.76111	70.94426	89.38417
50	22.962	28.93031	33.11694	36.44991	41.72473	47.76289	52.56986	57.86062	62.32846	66.23387	71.34828	75.81886	95.52578
100	24.17889	30.46349	34.87199	38.3816	43.93596	50.29412	55.35584	60.92699	65.63161	69.74399	75.12944	79.83694	100.5882

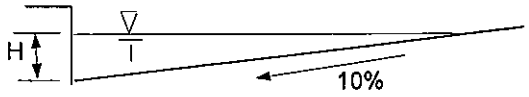
INTERVAL OF GUTTER INLET

- Section 0+900 - 1+040

Distance (Lo) =	**107**	**m**
Vertical Grades of Road (i)=	0.19%	
Road Width (L1) =	5	m
Super Elevation (m1) =	2.00%	(Pavement)
Super Elevation (m2) =	10.00%	(Gutter)
Rainfall intensity (Y) =	**120.76**	mm
(5 years return period)		
Coefficient of Run-off (C) =	0.9	(Concrete)

1) Catchments Area

Catchments Area (A= L0*L1) 535 m^2



2) Time Concentration

t1 = {2/3 x 3.28 x L1 x nd / (m1) ^ 0.5 } ^ 0.167 = 1.00 min. Friction Coefficient nd= 0.013

t2 = {2/3 x 3.28 x Lo x nd / (i) ^ 0.5 } ^ 0.167 = 2.03 min.

TC = t1 + t2 3.03 min. = 0.05 hour

3) Volume of Run-Off

Rainfall intensity

$I = (Y /24) * (24 / TC)^{2/3}$ = 306.3 mm/ hour

Volume of Run-Off

$Q = 1 / (3.6 \times 10^6) \times C \times I \times A$ = 0.0410 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

$v = 1.72\ H^{2/3}$

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

$Q1 = v \times a$ = $8.6\ H^{8/3}$

Q = Q1

$0.0501 = 8.6\ H^{8/3}$

H = 0.14 meter

4) Needed Number of Gutter Inlet

Dimension of Gutter Inlet

w = 50 cm

I = 15 cm

Coefficient lost of Gutter Inlet (C) = 80%

Area of Gutter Inlet

A = w x I / = 0.0375 m^2

Volume of Gutter Inlet

q = A x v = 0.014 m^3/sec.

N = Q / q = 3.0 < 3 each

d = L / N = 35.667 m

Design of Dimension and Distance for Gutter Inlet

	Maks Daily rainfall Return for Period 5 Year	mm/hour	:	120.76422			
1	Location :Tanggulangin FO		:				
	Position : Left at grade						
	Beginning Sta.	meter	:	0+268	0+380	0+460	0+520
	End Sta.	meter	:	0+380	0+460	0+520	0+563
	Distance	meter	:	**112.00**	**80.00**	**60.00**	**43.00**
2	Design Road		:				
	a. Road Widht	meter	:	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)			**0.25%**	**0.38%**	**0.60%**	**0.20%**
3	Coeffisient Road Friction (nd)		:	0.013	0.013	0.013	0.013
4	Concentration Time		:				
	d. T.1	minute	:	1.00	1.00	1.00	1.00
	e. T.2	minute	:	2.00	1.83	1.68	1.74
	f. Tc	minute	:	3.00	2.83	2.68	2.74
	Tc	hour		0.05	0.05	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	:	560	400	300	215
7	Coeffisient manning Friction		:	0.015	0.015	0.015	0.015
8	Rainfall Intensity for t = Tc	mm/hour	:	308.3	320.8	332.8	327.7
9	Volume of Run-off	m^3/sec		0.04	0.03	0.02	0.02
10	Hydraulic mean Depth factor			0.455	0.455	0.455	0.455
11	Velocity of Flow factor		:	1.97	2.42	3.05	1.75
12	Flow Area of Gutter factor			5	5	5	5
13	Q = (10 X 11)	m^3/sec	:	9.85	12.08	15.26	8.75
14	Possible hight water at gutter	meter	:	0.13	0.11	0.09	0.10
15	Possible velocity of flow at gutter	meter	:	0.507	0.549	0.614	0.371
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	0.02	0.02	0.01
	Total of Gutter Inlet	each		3	2	2	2
	Distance of Gutter Inlet	meter		37	40	30	21

Design of Dimension and Distance for Gutter Inlet

	Maks Daily rainfall Return for Period 5 Year	mm/hour	:	120.76422			
1	Location :Tanggulangin FO		:				
	Position : Left at grade						
	Beginning Sta.	meter	:	0+563	0+600	0+658	0+680
	End Sta.	meter	:	0+600	0+658	0+680	0+700
	Distance	meter	:	**37.00**	**58.00**	**22.00**	**20.00**
2	Design Road		:				
	a. Road Widht	meter	:	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)			**0.59%**	**0.18%**	**0.60%**	**0.09%**
3	Coeffisient Road Friction (nd)		:	0.013	0.013	0.013	0.013
4	Concentration Time		:				
	d. T.1	minute	:	1.00	1.00	1.00	1.00
	e. T.2	minute	:	1.55	1.84	1.42	1.63
	f. Tc	minute	:	2.55	2.84	2.42	2.64
	Tc	hour		0.04	0.05	0.04	0.04
5	Coeffisient of Run-off (Concrete)			0.90	0.90	0.90	0.90
6	Catchments Area (=width *distance)	m^2	:	185	290	110	100
7	Coeffisient manning Friction		:	0.015	0.015	0.015	0.015
8	Rainfall Intensity for t = Tc	mm/hour	:	343.9	319.7	356.2	336.3
9	Volume of Run-off	m^3/sec		0.02	0.02	0.01	0.01
10	Hydraulic mean Depth factor			0.455	0.455	0.455	0.455
11	Velocity of Flow factor		:	3.03	1.67	3.05	1.18
12	Flow Area of Gutter factor			5	5	5	5
13	Q = (10 X 11)	m^3/sec	:	15.14	8.36	15.26	5.91
14	Possible hight water at gutter	meter	:	0.08	0.11	0.06	0.09
15	Possible velocity of flow at gutter	meter	:	0.545	0.384	0.486	0.230
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	0.01	0.01	0.01
	Total of Gutter Inlet	each		1	3	1	2
	Distance of Gutter Inlet	meter		37	19	22	10

Design of Dimension and Distance for Gutter Inlet

	Maks Daily rainfall Return for Period 5 Year	mm/hour	:	120.76422			
1	Location :Tanggulangin FO		:				
	Position : Left at grade						
	Beginning Sta.	meter	:	0+700	0+792	0+920	0+974
	End Sta.	meter	:	0+792	0+920	0+974	0+991
	Distance	meter	:	**92.00**	**128.00**	**54.00**	**17.00**
2	Design Road		:				
	a. Road Widht	meter	:	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)			**0.06%**	**0.01%**	**0.60%**	**0.92%**
3	Coeffisient Road Friction (nd)		:	0.013	0.013	0.013	0.013
4	Concentration Time		:				
	d. T.1	minute	:	1.00	1.00	1.00	1.00
	e. T.2	minute	:	2.18	2.68	1.65	1.31
	f. Tc	minute	:	3.18	3.68	2.65	2.31
	Tc	hour		0.05	0.06	0.04	0.04
5	Coeffisient of Run-off (Concrete)			0.90	0.90	0.90	0.90
6	Catchments Area (=width *distance)	m^2	:	460	640	270	85
7	Coeffisient manning Friction		:	0.015	0.015	0.015	0.015
8	Rainfall Intensity for t = Tc	mm/hour	:	296.6	269.3	335.3	367.1
9	Volume of Run-off	m^3/sec		0.03	0.04	0.02	0.01
10	Hydraulic mean Depth factor			0.455	0.455	0.455	0.455
11	Velocity of Flow factor		:	0.97	0.39	3.05	3.78
12	Flow Area of Gutter factor			5	5	5	5
13	Q = (10 X 11)	m^3/sec	:	4.83	1.97	15.26	18.90
14	Possible hight water at gutter	meter	:	0.16	0.24	0.09	0.05
15	Possible velocity of flow at gutter	meter	:	0.280	0.152	0.599	0.539
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		0.01	0.00	0.02	0.02
	Total of Gutter Inlet	each		5	10	2	1
	Distance of Gutter Inlet	meter		18	12	27	17

Design of Dimension and Distance for Gutter Inlet

	Maks Daily rainfall Return for Period 5 Year	mm/hour	:	120.76422		
1	Location :Tanggulangin FO		:			
	Position : Left at grade					
	Beginning Sta.	meter	:	0+991	1+050	1+080
	End Sta.	meter	:	1+050	1+080	1+129
	Distance	meter	:	**59.00**	**30.00**	**49.00**
2	Design Road		:			
	a. Road Widht	meter	:	5	5	5
	b. Super-elevation of Pavement (m1)		:	**2%**	**2%**	**2%**
	c. Super-elevation of Gutter (m2)			**10%**	**10%**	**10%**
	d. Vertical Grades of Road (i)			**0.53%**	**0.67%**	**1.63%**
3	Coeffisient Road Friction (nd)		:	0.013	0.013	0.013
4	Concentration Time		:			
	d. T.1	minute	:	1.00	1.00	1.00
	e. T.2	minute	:	1.69	1.48	1.49
	f. Tc	minute	:	2.69	2.48	2.49
	Tc	hour		0.04	0.04	0.04
5	Coeffisient of Run-off (Concrete)			0.90	0.90	0.90
6	Catchments Area (=width *distance)	m^2	:	295	150	245
7	Coeffisient manning Friction		:	0.015	0.015	0.015
8	Rainfall Intensity for t = Tc	mm/hour	:	331.8	350.2	349.2
9	Volume of Run-off	m^3/sec		0.02	0.01	0.02
10	Hydraulic mean Depth factor			0.455	0.455	0.455
11	Velocity of Flow factor		:	2.87	3.23	5.03
12	Flow Area of Gutter factor			5	5	5
13	Q = (10 X 11)	m^3/sec	:	14.35	16.13	25.16
14	Possible hight water at gutter	meter	:	0.09	0.07	0.07
15	Possible velocity of flow at gutter	meter	:	0.583	0.545	0.859
16	Dimension of gutter inlet		:			
	a. Widht	meter	:	0.50	0.50	0.50
	b. Hight	meter	:	0.15	0.15	0.15
17	Area of gutter inlet	m^2		0.04	0.04	0.04
18	Coefficient lost of Gutter Inlet			80%	80%	80%
19	Volume of gutter inlet	m^3/sec		0.02	0.02	0.03
	Total of Gutter Inlet	each		2	1	1
	Distance of Gutter Inlet	meter		29	30	49

Design of Dimension and Distance for Gutter Inlet

	Maks Daily rainfall Return for Period 5 Year	mm/hour	:	120.76422			
1	Location :Tanggulangin FO		:				
	Position : Right at grade						
	Beginning Sta.	meter	:	0+268	0+358	0+420	0+466
	End Sta.	meter	:	0+358	0+420	0+466	0+500
	Distance	meter	:	**90.00**	**62.00**	**46.00**	**34.00**
2	Design Road		:				
	a. Road Widht	meter	:	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)			**0.20%**	**0.17%**	**0.30%**	**0.50%**
3	Coeffisient Road Friction (nd)		:	0.013	0.013	0.013	0.013
4	Concentration Time		:				
	d. T.1	minute	:	1.00	1.00	1.00	1.00
	e. T.2	minute	:	1.97	1.87	1.70	1.55
	f. Tc	minute	:	2.97	2.87	2.70	2.55
	Tc	hour		0.05	0.05	0.04	0.04
5	Coeffisient of Run-off (Concrete)			0.90	0.90	0.90	0.90
6	Catchments Area (=width *distance)	m^2	:	450	310	230	170
7	Coeffisient manning Friction		:	0.015	0.015	0.015	0.015
8	Rainfall Intensity for t = Tc	mm/hour	:	310.8	317.5	331.0	343.9
9	Volume of Run-off	m^3/sec		0.03	0.02	0.02	0.01
10	Hydraulic mean Depth factor			0.455	0.455	0.455	0.455
11	Velocity of Flow factor		:	1.76	1.62	2.16	2.79
12	Flow Area of Gutter factor			5	5	5	5
13	Q = (10 X 11)	m^3/sec	:	8.81	8.12	10.79	13.93
14	Possible hight water at gutter	meter	:	0.13	0.11	0.09	0.08
15	Possible velocity of flow at gutter	meter	:	0.442	0.381	0.442	0.502
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		0.01	0.01	0.01	0.02
	Total of Gutter Inlet	each		3	3	2	1
	Distance of Gutter Inlet	meter		30	20	23	34

Design of Dimension and Distance for Gutter Inlet

	Maks Daily rainfall Return for Period 5 Year	mm/hour	:	120.76422			
1	Location :Tanggulangin FO		:				
	Position : Right at grade						
	Beginning Sta.	meter	:	0+500	0+529	0+565	0+600
	End Sta.	meter	:	0+529	0+565	0+600	0+654
	Distance	meter	:	**29.00**	**36.00**	**35.00**	**54.00**
2	Design Road		:				
	a. Road Widht	meter	:	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)			**0.58%**	**0.25%**	**0.67%**	**0.22%**
3	Coeffisient Road Friction (nd)		:	0.013	0.013	0.013	0.013
4	Concentration Time		:				
	d. T.1	minute	:	1.00	1.00	1.00	1.00
	e. T.2	minute	:	1.49	1.66	1.52	1.79
	f. Tc	minute	:	2.49	2.66	2.52	2.79
	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	:	145	180	175	270
7	Coeffisient manning Friction		:	0.015	0.015	0.015	0.015
8	Rainfall Intensity for t = Tc	mm/hour	:	349.3	334.5	346.6	323.7
9	Volume of Run-off	m^3/sec		0.01	0.02	0.02	0.02
10	Hydraulic mean Depth factor			0.455	0.455	0.455	0.455
11	Velocity of Flow factor		:	3.00	1.97	3.23	1.85
12	Flow Area of Gutter factor			5	5	5	5
13	Q = (10 X 11)	m^3/sec	:	15.01	9.85	16.13	9.24
14	Possible hight water at gutter	meter	:	0.07	0.09	0.07	0.10
15	Possible velocity of flow at gutter	meter	:	0.512	0.390	0.565	0.408
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	0.01	0.02	0.01
	Total of Gutter Inlet	each		1	2	1	2
	Distance of Gutter Inlet	meter		29	18	35	27

Design of Dimension and Distance for Gutter Inlet

	Maks Daily rainfall Return for Period 5 Year	mm/hour	:	120.76422			
1	Location :Tanggulangin FO		:				
	Position : Right at grade						
	Beginning Sta.	meter	:	0+654	0+688	0+729	0+780
	End Sta.	meter	:	0+688	0+729	0+780	0+920
	Distance	meter	:	**34.00**	**41.00**	**51.00**	**140.00**
2	Design Road		:				
	a. Road Widht	meter	:	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)			**0.58%**	**0.28%**	**0.07%**	**0.02%**
3	Coeffisient Road Friction (nd)		:	0.013	0.013	0.013	0.013
4	Concentration Time		:				
	d. T.1	minute	:	1.00	1.00	1.00	1.00
	e. T.2	minute	:	1.53	1.68	1.95	2.56
	f. Tc	minute	:	2.53	2.68	2.95	3.57
	Tc	hour		0.04	0.04	0.05	0.06
5	Coeffisient of Run-off (Concrete)			0.90	0.90	0.90	0.90
6	Catchments Area (=width *distance)	m^2	:	170	205	255	700
7	Coeffisient manning Friction		:	0.015	0.015	0.015	0.015
8	Rainfall Intensity for t = Tc	mm/hour	:	345.6	332.8	311.8	274.9
9	Volume of Run-off	m^3/sec		0.01	0.02	0.02	0.05
10	Hydraulic mean Depth factor			0.455	0.455	0.455	0.455
11	Velocity of Flow factor		:	3.00	2.09	1.04	0.56
12	Flow Area of Gutter factor			5	5	5	5
13	Q = (10 X 11)	m^3/sec	:	15.01	10.43	5.21	2.79
14	Possible hight water at gutter	meter	:	0.07	0.09	0.12	0.22
15	Possible velocity of flow at gutter	meter	:	0.531	0.419	0.259	0.202
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	0.01	0.01	0.01
	Total of Gutter Inlet	each		1	2	3	8
	Distance of Gutter Inlet	meter		34	20	17	17

Design of Dimension and Distance for Gutter Inlet

	Maks Daily rainfall Return for Period 5 Year	mm/hour	:	120.76422			
1	Location :Tanggulangin FO		:				
	Position : Right at grade						
	Beginning Sta.	meter	:	0+920	0+974	0+991	1+081
	End Sta.	meter	:	0+974	0+991	1+081	1+129
	Distance	meter	:	**54.00**	**17.00**	**90.00**	**48.00**
2	Design Road		:				
	a. Road Widht	meter	:	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)			**0.03%**	**0.92%**	**0.58%**	**1.63%**
3	Coeffisient Road Friction (nd)		:	0.013	0.013	0.013	0.013
4	Concentration Time		:				
	d. T.1	minute	:	1.00	1.00	1.00	1.00
	e. T.2	minute	:	2.11	1.31	1.80	1.49
	f. Tc	minute	:	3.12	2.31	2.80	2.49
	Tc	hour		0.05	0.04	0.05	0.04
5	Coeffisient of Run-off (Concrete)			0.90	0.90	0.90	0.90
6	Catchments Area (=width *distance)	m^2	:	270	85	450	240
7	Coeffisient manning Friction		:	0.015	0.015	0.015	0.015
8	Rainfall Intensity for t = Tc	mm/hour	:	300.8	367.1	323.1	349.6
9	Volume of Run-off	m^3/sec		0.02	0.01	0.04	0.02
10	Hydraulic mean Depth factor			0.455	0.455	0.455	0.455
11	Velocity of Flow factor		:	0.68	3.78	3.00	5.03
12	Flow Area of Gutter factor			5	5	5	5
13	Q = (10 X 11)	m^3/sec	:	3.41	18.90	15.01	25.16
14	Possible hight water at gutter	meter	:	0.15	0.05	0.10	0.07
15	Possible velocity of flow at gutter	meter	:	0.190	0.539	0.666	0.855
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		0.01	0.02	0.02	0.03
	Total of Gutter Inlet	each		4	1	2	1
	Distance of Gutter Inlet	meter		13	17	45	48

Design Volume of Run-Off at Flyover (Balaraja)

	Max. Daily rainfall for Return Period 5 Year	mm	:	120.8									
1	Location : Tanggulangin FO		:										
	Position :			**Start**	**A1**	P1	**P2**	P3	P5	P6	P7	**P8**	A2	**END**
	Beginning Sta.	meter	:	+380	+542	+562	+582	+607	+632	+657	+682	+702	+722	+742
	End Sta.	meter	:	+542	+562	+582	+607	+632	+657	+682	+702	+722	+742	+911
	Distance	meter	:	163	20	20	25	25	25	25	20	20	20	169
2	Design Road		:											
	a. Traffic width	meter	:	5.75	12	12	12	12	12	12	12	12	12	5.75
	b. Super-elevation	%	:	2%	4%	5%	5%	2%	2%	4%	3%	2.8%	4%	2%
	c. Vertical Gradient of Flyover	%		5.00%	5.00%	5.00%	3.25%	1.45%	0.36%	2.12%	3.69%	4.87%	5.00%	5.00%
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
4	Concentration Time		:											
	a. T.1	minute	:	1.03	1.09	1.07	1.07	1.16	1.16	1.09	1.13	1.13	1.09	1.03
	b. T.2	minute	:	1.66	1.17	1.17	1.26	1.35	1.51	1.30	1.20	1.17	1.17	1.67
	c. Tc =T.1+T.2	minute	:	2.68	2.26	2.24	2.33	2.51	2.67	2.40	2.33	2.30	2.26	2.70
	Tc	hour		0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
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
6	Catchments Area	m2	:	934.375	240	240	300	300	300	300	240	240	240	971.75
7	Rainfall Intensity for t = Tc	mm/hour	:	339.2	380.3	382.6	372.7	355.3	340.3	365.8	373.1	376.1	380.5	338.3
8	Volume of Run-Off for Section only	m3/sec	:	**0.079**	**0.023**	**0.023**	**0.028**	**0.027**	**0.026**	**0.027**	**0.022**	**0.023**	**0.023**	**0.082**
9	Volume of Run-Off for at grade leftside	m3/sec	:	**0.079**			**0.055**							**0.082**
10	Volume of Run-Off for at grade rightside	m3/sec	:	**0.079**	**0.046**						**0.075**		**0.045**	**0.082**

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

	Max. Daily rainfall for Return Period 5 Year	mm	:	120.764			
1	Location : Tanggulangin FO		:				
	Position : Right Frontage						
	Beginning Sta.	meter	:	+268	+475	+624	+992	1+009
	End Sta.	meter	:	+465	+579	+992	1+009	1+130
	Distance	meter	:	197	104	368	17	121
2	Design Road		:					
	a. Traffic width	meter	:	6	6	6	6	6
	b. Ground width	meter	:	15	15	15	15	15
	Super-elevation		:					
	a. Traffic		:	0.02	0.02	0.02	0.02	0.02
	b. Ground		:	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
	b. Ground		:	0.4	0.4	0.4	0.4	0.4
4	Concentration Time		:					
	a. Traffic	minute	:	1.03	1.03	1.03	1.03	1.03
	b. Ground	minute	:	2.26	2.26	2.26	2.26	2.26
	c. T.1	minute	:	3.29	3.29	3.29	3.29	3.29
	d. T.2	minute	:	2.13	1.87	2.43	1.39	1.86
	e. Tc = T.1 + T.2	minute	:	5.42	5.17	5.72	4.68	5.16
	Tc	hour		0.09	0.09	0.10	0.08	0.09
5	Coefficient of Flow		:					
	a. Concrete Road and Asphalt		:	0.70	0.70	0.70	0.70	0.70
	b. Ground		:	0.50	0.50	0.50	0.50	0.50
	c. Average		:	0.60	0.60	0.60	0.60	0.60
6	Catchments Area (=width *distance)		:					
	a. Traffic	m^2	:	1,182	624	2,208	102	726
	b. Ground	m^2	:	2,955	1,560	5,520	255	1,815
7	Coefficient manning Friction		:	0.02	0.02	0.02	0.02	0.02
8	Rainfall Intensity for t = Tc	mm/hour	:	211.92	218.80	204.36	233.79	219.06
9	Volume of Run-off on Section	m^3/sec	:	**0.146**	**0.080**	**0.263**	**0.014**	**0.093**
	Volume of Run-off from Upper Section	m^3/sec		-	-	**0.107**	**0.093**	-
	Volume of Run-off from Flyover	m^3/sec		**0.079**	**0.046**	**0.203**	-	-
	Total Volume of Run-off	m^3/sec		**0.225**	**0.125**	**0.573**	**0.107**	**0.093**
10	Design of Dimension (minimum)		:					
	a. Height of water level	meter	:	**0.27**	**0.04**	**0.61**	**0.15**	**0.12**
	b. Wide of Side Ditch	meter	:	**0.80**	**0.80**	**0.80**	**0.80**	**0.80**
11	Circumference Wet Area	meter	:	1.33	0.89	2.02	1.09	1.04
12	Ditch Wet Area	m^2		0.21	0.03	0.49	0.12	0.09
13	Hydraulic Radii Of Drain	meter	:	0.16	0.04	0.24	0.11	0.09
14	Ditch sloping		:	0.004	0.005	0.003	0.005	0.007
15	Flow of Velocity	m^2/sec		1.06	0.46	1.18	0.91	0.98
16	Design Volume of Ditch	m^3/sec		***0.225***	***0.016***	***0.573***	***0.107***	***0.093***
17	Free Board	meter		0.15	0.15	0.15	0.15	0.15
18	Highest of Ditch (=10a+17)	meter		0.42	0.19	0.76	0.30	0.27
			:					
	Wide of Side Ditch	meter		***0.80***	***0.80***	***0.80***	***0.80***	***0.80***
	Highest of Ditch	meter		***0.50***	***0.20***	***0.80***	***0.30***	***0.30***

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

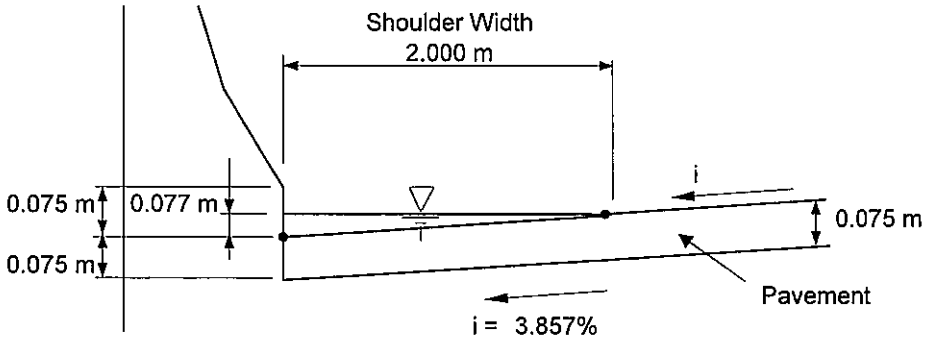
	Max. Daily rainfall for Return Period 5 Year	mm	:	120.764					
1	Location : Tanggulangin FO		:						
	Position : Right Frontage								
	Beginning Sta.	meter	:	+268	+463	+560	+612	+663	1+002
	End Sta.	meter	:	+455	+560	+611	+663	1+002	1+130
	Distance	meter	:	187	97	51	51	339	128
2	Design Road		:						
	a. Traffic width	meter	:	6	6	6	6	6	6.5
	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	:	1.03	1.03	1.03	1.03	1.03	1.05
	b. Ground	minute	:	2.26	2.26	2.26	2.26	2.26	2.26
	c. T.1	minute	:	3.29	3.29	3.29	3.29	3.29	3.31
	d. T.2	minute	:	2.10	1.82	1.61	1.66	2.37	1.78
	e. Tc = T.1 + T.2	minute	:	5.39	5.11	4.90	4.95	5.67	5.09
	Tc	hour		0.09	0.09	0.08	0.08	0.09	0.08
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	:	1,122	582	306	306	2,034	832
	b. Ground	m^2	:	2,805	1,455	765	765	5,085	1,920
7	Coefficient manning Friction		:	0.02	0.02	0.02	0.02	0.02	0.02
8	Rainfall Intensity for t = Tc	mm/hour	:	212.65	220.39	226.55	225.14	205.66	220.94
9	Volume of Run-off on Section	m^3/sec	:	**0.139**	**0.075**	**0.040**	**0.040**	**0.244**	**0.101**
	Volume of Run-off from Upper Section	m^3/sec		-	-	-	-	**0.101**	-
	Volume of Run-off from Flyover	m^3/sec		**0.079**	-	**0.055**	-	-	-
	Total Volume of Run-off	m^3/sec		**0.218**	**0.075**	**0.095**	**0.040**	**0.345**	**0.101**
10	Design of Dimension (minimum)		:						
	a. Height of water level	meter	:	**0.26**	**0.11**	**0.12**	**0.07**	**0.40**	**0.10**
	b. Wide of Side Ditch	meter	:	**0.80**	**0.80**	**0.80**	**0.80**	**0.80**	**0.80**
11	Circumference Wet Area	meter	:	1.31	1.02	1.03	0.94	1.59	1.00
12	Ditch Wet Area	m^2		0.20	0.09	0.09	0.06	0.32	0.08
13	Hydraulic Radii Of Drain	meter	:	0.16	0.08	0.09	0.06	0.20	0.08
14	Ditch sloping		:	0.004	0.006	0.007	0.005	0.003	0.013
15	Flow of Velocity	m^2/sec		1.07	0.87	0.98	0.63	1.09	1.25
16	Design Volume of Ditch	m^3/sec		***0.219***	***0.075***	***0.091***	***0.036***	***0.346***	***0.102***
17	Free Board	meter		0.15	0.15	0.15	0.15	0.15	0.15
18	Highest of Ditch (=10a+17)	meter		0.41	0.26	0.27	0.22	0.55	0.25
			:						
	Wide of Side Ditch	meter		***0.80***	***0.80***	***0.80***	***0.80***	***0.80***	***0.80***
	Highest of Ditch	meter		***0.50***	***0.30***	***0.30***	***0.30***	***0.60***	***0.30***

INTERVAL OF VERTICAL DRAIN OF TANGGULANGIN FLYOVER

A. STEEL SUPERSTRUCTURE SECTION, P2 ~ P3 *w/ o Surface Down*

Total F.O. Width Wb = 13.00 m
Single Line Drainage System = 1
Double Line Drainage System = 2
Supper Elevation i = 5.000% ~ 2.714%
Rainfall Intensity γ = 220 mm/hr
(5 years return period, 5 mins. Time concentration)
Design Rainfall intensity γo = γ x k = **440** mm/hr
Coefficient of Run-off C = 0.9
Correction Factor of Falling k = 2

Section :



1) Catchments Area

- Vertical Gradient = 4.143% ~ 2.357% **Ave. = 3.250%**
  Span Length L = **25.00 m**
  Catchments Area
  (Single Line Drainage) A1 = Wb x L / 1 = 325 m^2
  (Double Line Drainage) A2 = Wb x L / 2 = 163 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 = 0.0358 m^3/sec.
  (Double Line Drainage) Q2 = 0.0179 m^3/sec.
- Possible Through Volume of Run-Off along Shoulder
  Q' = v x a = 0.1028 m^3/sec.
- Velocity of Flow
  $v = 1/n \times R^{2/3} \times I^{1/2}$ = 1.3345 m/sec.
  (Hydraulic mean Depth) R = a / l = 0.037
  (Wetted Perimeter) l = 2.0785 m
  (Floow Area of Gutter) a = 0.0770 m^2
  (Coefficient of Roughness) n = 0.015

3) Designed Number of Vertical Drain

N = Q / Q'
(Single Line Drainage) N1 = 0.348 Each ==> **1 Each**

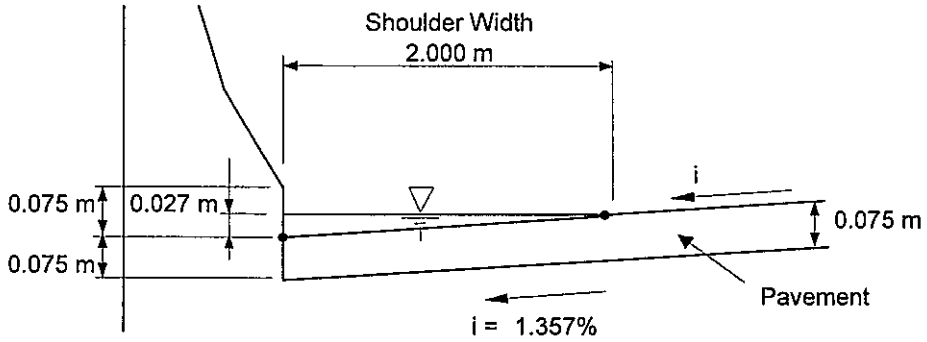
4) Designed Interval of Vertical Drain

d = Q' / Q x L
(Single Line Drainage) d1 = 71.788 m ==> **71 m**

B. STEEL SUPERSTRUCTURE SECTION, P3 ~ P5 *w/ o Surface Down*

Total F.O. Width Wb = 13.00 m
Single Line Drainage System = 1
Double Line Drainage System = 2
Supper Elevation i = 0.000% ~ 2.714%
Rainfall Intensity γ = 220 mm/hr
(5 years return period, 5 mins. Time concentration)
Design Rainfall intensity γo = γ x k = **440** mm/hr
Coefficient of Run-off C = 0.9
Correction Factor of Falling k = 2

Section :



1) Catchments Area

- Vertical Gradient = 2.357% ~ 0.571% **Ave. = 1.464%**
  Span Length L = **25.00** m
  Catchments Area
  (Single Line Drainage) A1 = Wb x L / 1 = 325 m^2
  (Double Line Drainage) A2 = Wb x L / 2 = 163 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 = 0.0358 m^3/sec.
  (Double Line Drainage) Q2 = 0.0179 m^3/sec.
- Possible Through Volume of Run-Off along Shoulder
  Q' = v x a = 0.0122 m^3/sec.
- Velocity of Flow
  $v = 1/n \times R^{2/3} \times I^{1/2}$ = 0.45281 m/sec.
  (Hydraulic mean Depth) R = a / l = 0.0133
  (Wetted Perimeter) l = 2.0272 m
  (Floow Area of Gutter) a = 0.0270 m^2
  (Coefficient of Roughness) n = 0.015

3) Designed Number of Vertical Drain

N = Q / Q'
(Single Line Drainage) N1 = 2.934 Each ==> **3 Each**

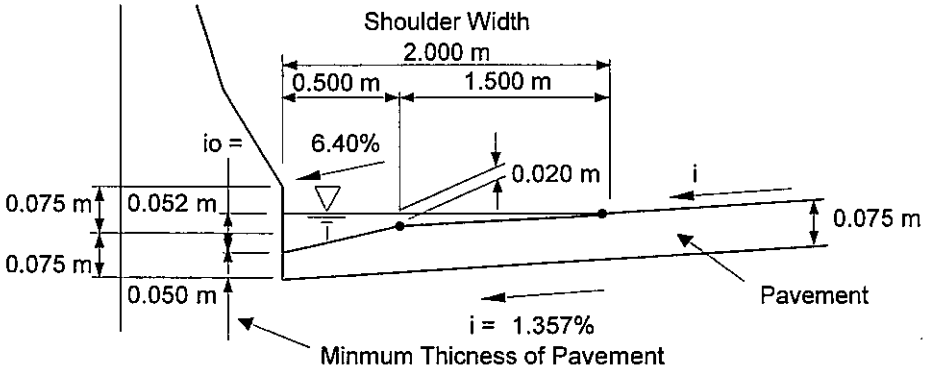
4) Designed Interval of Vertical Drain

d = Q' / Q x L
(Single Line Drainage) d1 = 8.520 m ==> **8 m**

C. STEEL SUPERSTRUCTURE SECTION, P3 ~ P5 *w/ Surface Down*

Total F.O. Width Wb = 13.00 m
Single Line Drainage System = 1
Double Line Drainage System = 2
Supper Elevation i = 0.000% ~ 2.714%
Rainfall Intensity γ = 220 mm/hr
(5 years return period, 5 mins. Time concentration)
Design Rainfall intensity γo = γ x k = **440** mm/hr
Coefficient of Run-off C = 0.9
Correction Factor of Falling k = 2

Section :



1) Catchments Area

- Vertical Gradient = 2.357% ~ 0.571% **Ave. = 1.464%**
  Span Length L = **33.00 m**
  Catchments Area
  (Single Line Drainage) A1 = Wb x L / 1 = 429 m^2
  (Double Line Drainage) A2 = Wb x L / 2 = 215 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 = 0.0472 m^3/sec.
  (Double Line Drainage) Q2 = 0.0237 m^3/sec.
- Possible Through Volume of Run-Off along Shoulder
  Q' = v x a = 0.0422 m^3/sec.
- Velocity of Flow
  $v = 1/n \times R^{2/3} \times I^{1/2}$ = 0.74025 m/sec.
  (Hydraulic mean Depth) R = a / l = 0.0278
  (Wetted Perimeter) l = 2.0532 m
  (Floow Area of Gutter) a = 0.0570 m^2
  (Coefficient of Roughness) n = 0.015

3) Designed Number of Vertical Drain

N = Q / Q'
(Single Line Drainage) N1 = 1.118 Each ==> **2 Each**

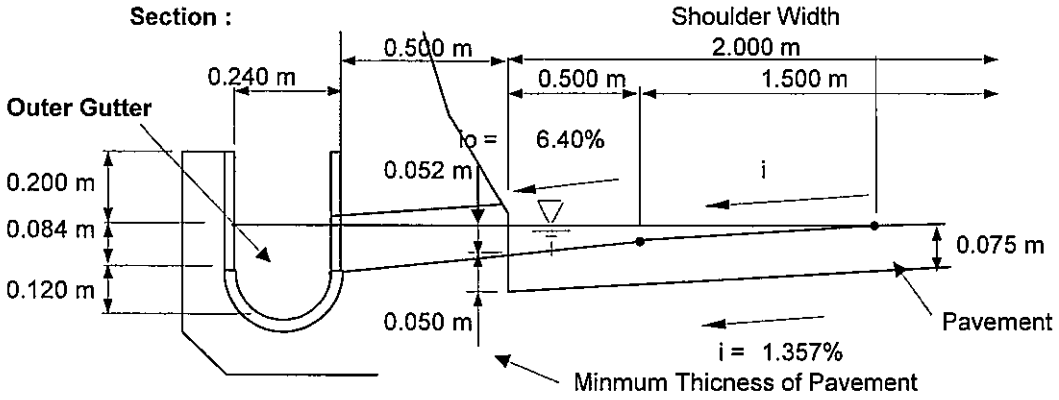
4) Designed Interval of Vertical Drain

d = Q' / Q x L
(Single Line Drainage) d1 = 29.504 m ==> **29 m**

D. STEEL SUPERSTRUCTURE SECTION, P3 ~ P5 *Surface Down + Outer Gutter*

Total F.O. Width Wb = 13.00 m
Single Line Drainage System = 1
Double Line Drainage System = 2
Supper Elevation i = 0.000% ~ 2.714%
Rainfall Intensity γ = 220 mm/hr
(5 years return period, 5 mins. Time concentration)
Design Rainfall intensity γo = γ x k = **440** mm/hr
Coefficient of Run-off C = 0.9
Correction Factor of Falling k = 2

Section :



1) Catchments Area

- Vertical Gradient = 2.357% ~ 0.571% **Ave. = 1.464%**
  Span Length L = **33.00** m
  Catchments Area
  (Single Line Drainage) A1 = Wb x L / 1 = 429 m^2
  (Double Line Drainage) A2 = Wb x L / 2 = 215 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 = 0.0472 m^3/sec.
  (Double Line Drainage) Q2 = 0.0237 m^3/sec.
- Possible Through Volume of Run-Off along Shoulder
  Q' = v x a = 0.0674 m^3/sec.
- Velocity of Flow
  $v = 1/n \times R^{2/3} \times I^{1/2}$ = 0.88458 m/sec.
  (Hydraulic mean Depth) R = a / l = 0.0293
  (Wetted Perimeter) l = 2.5982 m
  (Floow Area of Gutter) a = **0.0762** m^2
  (Coefficient of Roughness) n = **0.013**

3) Designed Number of Vertical Drain

N = Q / Q'
(Single Line Drainage) N2 = 0.700 Each ==> **1** **Each**

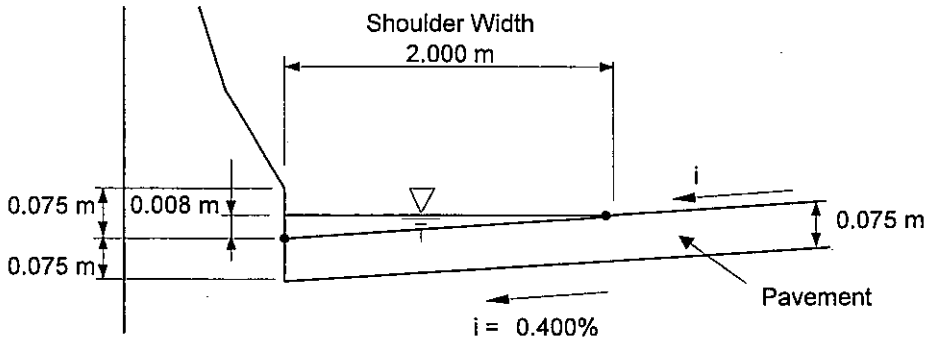
4) Designed Interval of Vertical Drain

d = Q' / Q x L
(Single Line Drainage) d2 = 47.123 m ==> **47 m**

E. STEEL SUPERSTRUCTURE SECTION, P4 ~ P5 *w/ o Surface Down*

Total F.O. Width Wb = 13.00 m
Single Line Drainage System = 1
Double Line Drainage System = 2
Supper Elevation i = 0.000% ~ 0.800%
Rainfall Intensity γ = 220 mm/hr
(5 years return period, 5 mins. Time concentration)
Design Rainfall intensity γo = γ x k = **440** mm/hr
Coefficient of Run-off C = 0.9
Correction Factor of Falling k = 2

Section :



1) Catchments Area

- Vertical Gradient = 0.571% ~ 0.000% **Ave. = 0.286%**
  Span Length L = **8.00 m**
  Catchments Area
  (Single Line Drainage) A1 = Wb x L / 1 = 104 m^2
  (Double Line Drainage) A2 = Wb x L / 2 = 52 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 = 0.0114 m^3/sec.
  (Double Line Drainage) Q2 = 0.0057 m^3/sec.
- Possible Through Volume of Run-Off along Shoulder
  Q' = v x a = 0.0007 m^3/sec.
- Velocity of Flow
  $v = 1/n \times R^{2/3} \times I^{1/2}$ = 0.08984 m/sec.
  (Hydraulic mean Depth) R = a / l = 0.004
  (Wetted Perimeter) l = 2.0080 m
  (Floow Area of Gutter) a = 0.0080 m^2
  (Coefficient of Roughness) n = 0.015

3) Designed Number of Vertical Drain

N = Q / Q'
(Single Line Drainage) N1 = 8.143 Each ==> **9 Each**

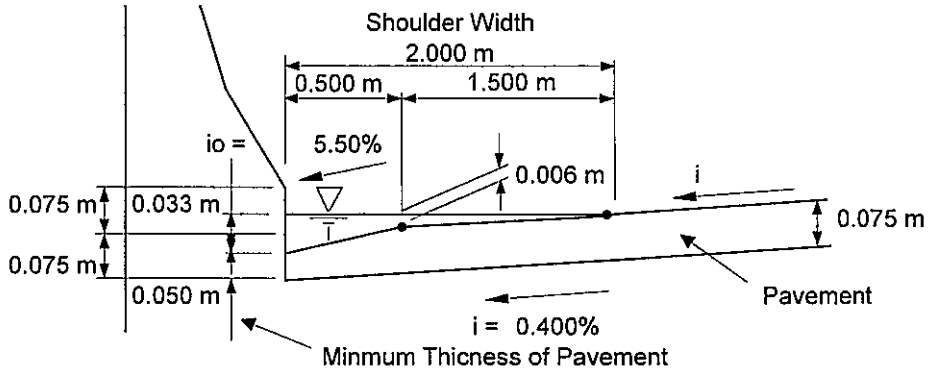
4) Designed Interval of Vertical Drain

d = Q' / Q x L
(Single Line Drainage) d1 = 0.982 m ==> **0.9 m**

F. STEEL SUPERSTRUCTURE SECTION, P4 ~ P5 *w/ Surface Down*

Total F.O. Width Wb = 13.00 m
Single Line Drainage System = 1
Double Line Drainage System = 2
Supper Elevation i = 0.000% ~ 0.800%
Rainfall Intensity γ = 220 mm/hr
(5 years return period, 5 mins. Time concentration)
Design Rainfall intensity γo = γ x k = **440** mm/hr
Coefficient of Run-off C = 0.9
Correction Factor of Falling k = 2

Section :



1) Catchments Area

- Vertical Gradient = 0.571% ~ 0.000% **Ave. = 0.286%**
  Span Length L = **8.00 m**
  Catchments Area
  (Single Line Drainage) A1 = Wb x L / 1 = 104 m^2
  (Double Line Drainage) A2 = Wb x L / 2 = 52 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 = 0.0114 m^3/sec.
  (Double Line Drainage) Q2 = 0.0057 m^3/sec.
- Possible Through Volume of Run-Off along Shoulder
  Q' = v x a = 0.0081 m^3/sec.
- Velocity of Flow
  $v = 1/n \times R^{2/3} \times I^{1/2}$ = 0.23572 m/sec.
  (Hydraulic mean Depth) R = a / l = 0.017
  (Wetted Perimeter) l = 2.0338 m
  (Floow Area of Gutter) a = 0.0345 m^2
  (Coefficient of Roughness) n = 0.015

3) Designed Number of Vertical Drain

N = Q / Q'
(Double Line Drainage) N2 = 0.704 Each ==> 1 **Each**

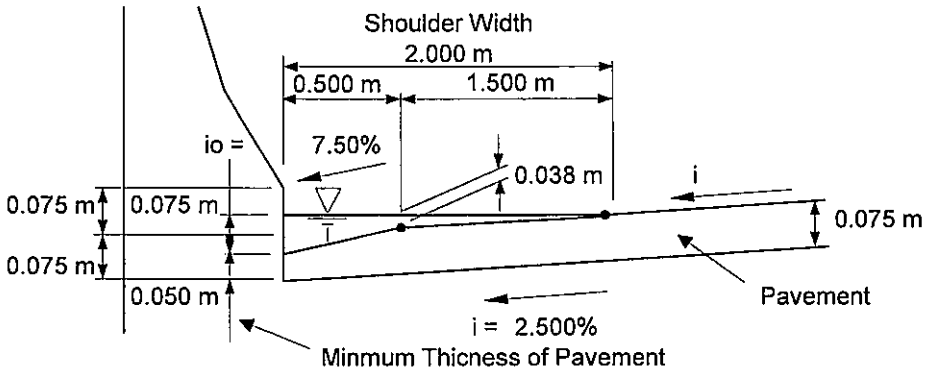
4) Designed Interval of Vertical Drain

d = Q' / Q x L
(Double Line Drainage) d2 = 11.368 m ==> **11 m**

G. STEEL SUPERSTRUCTURE SECTION, P4 ~ P6 *w/ Surface Down*

Total F.O. Width Wb = 13.00 m
Single Line Drainage System = 1
Double Line Drainage System = 2
Supper Elevation i = 0.000% ~ 5.000%
Rainfall Intensity γ = 220 mm/hr
(5 years return period, 5 mins. Time concentration)
Design Rainfall intensity γo = γ x k = **440** mm/hr
Coefficient of Run-off C = 0.9
Correction Factor of Falling k = 2

Section :



1) Catchments Area

- Vertical Gradient = 0.000% ~ 3.000% **Ave. = 1.500%**
  Span Length L = **50.00 m**
  Catchments Area
  (Single Line Drainage) A1 = Wb x L / 1 = 650 m^2
  (Double Line Drainage) A2 = Wb x L / 2 = 325 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 = 0.0715 m^3/sec.
  (Double Line Drainage) Q2 = 0.0358 m^3/sec.
- Possible Through Volume of Run-Off along Shoulder
  Q' = v x a = 0.0816 m^3/sec.
- Velocity of Flow
  $v = 1/n \times R^{2/3} \times I^{1/2}$ = 0.96609 m/sec.
  (Hydraulic mean Depth) R = a / l = 0.0407
  (Wetted Perimeter) l = 2.0769 m
  (Floow Area of Gutter) a = 0.0845 m^2
  (Coefficient of Roughness) n = 0.015

3) Designed Number of Vertical Drain

N = Q / Q'
(Single Line Drainage) N1 = 0.876 Each ==> **1 Each**

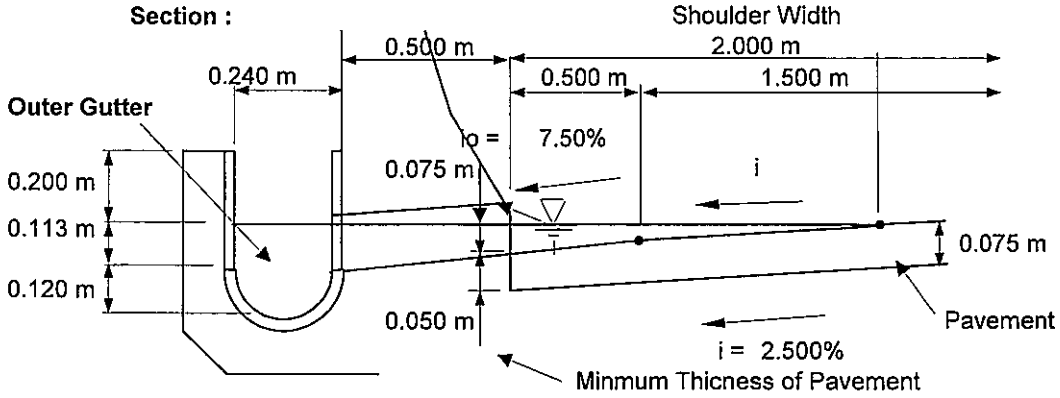
4) Designed Interval of Vertical Drain

d = Q' / Q x L
(Single Line Drainage) d1 = 57.063 m ==> **57 m**

H. STEEL SUPERSTRUCTURE SECTION, P4 ~ P6 *Surface Down + Outer Gutter*

Total F.O. Width Wb = 13.00 m
Single Line Drainage System = 1
Double Line Drainage System = 2
Supper Elevation i = 0.000% ~ 5.000%
Rainfall Intensity γ = 220 mm/hr
(5 years return period, 5 mins. Time concentration)
Design Rainfall intensity γo = γ x k = **440** mm/hr
Coefficient of Run-off C = 0.9
Correction Factor of Falling k = 2

Section :



1) Catchments Area

- Vertical Gradient = 0.000% ~ 3.000% **Ave. = 1.500%**
  Span Length L = **50.00 m**
  Catchments Area
  (Single Line Drainage) A1 = Wb x L / 1 = 650 m^2
  (Double Line Drainage) A2 = Wb x L / 2 = 325 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 = 0.0715 m^3/sec.
  (Double Line Drainage) Q2 = 0.0358 m^3/sec.
- Possible Through Volume of Run-Off along Shoulder
  Q' = v x a = 0.116 m^3/sec.
- Velocity of Flow
  $v = 1/n \times R^{2/3} \times I^{1/2}$ = 1.09454 m/sec.
  (Hydraulic mean Depth) R = a / l = 0.0396
  (Wetted Perimeter) l = 2.6799 m
  (Floow Area of Gutter) a = **0.1060** m^2
  (Coefficient of Roughness) n = **0.013**

3) Designed Number of Vertical Drain

N = Q / Q'
(Single Line Drainage) N2 = 0.616 Each ==> 1 **Each**

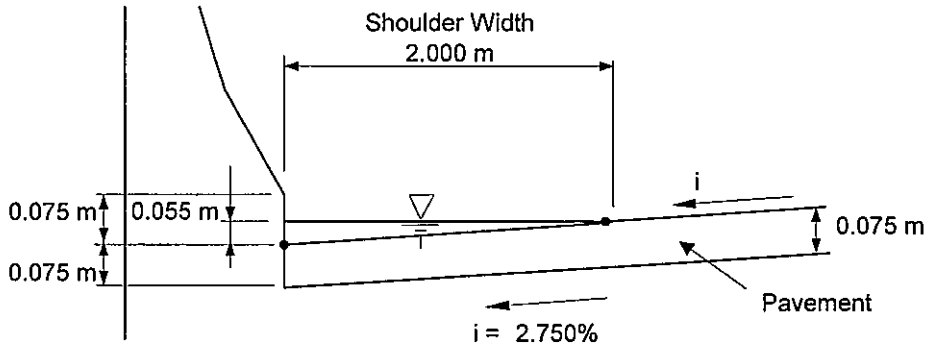
4) Designed Interval of Vertical Drain

d = Q' / Q x L
(Single Line Drainage) d2 = 81.119 m ==> **81 m**

I. APPROACH (A1)

Total F.O. Width Wb = 13.00 m
Single Line Drainage System = 1
Double Line Drainage System = 2
Supper Elevation i = 2.000% ~ 3.500% **Ave. =** 2.750%
Rainfall Intensity γ = 220 mm/hr
(5 years return period, 5 mins. Time concentration)
Design Rainfall intensity γo = γ x k = **440** mm/hr
Coefficient of Run-off C = 0.9
Correction Factor of Falling k = 2

Section :



1) Catchments Area

- Vertical Gradient = **5.000%**
  Approach L = **162.00 m**
  Catchments Area
  (Single Line Drainage) A1 = Wb x L / 1 = 2106 m^2
  (Double Line Drainage) A2 = Wb x L / 2 = 1053 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 = 0.2317 m^3/sec.
  (Double Line Drainage) Q2 = 0.1158 m^3/sec.
- Possible Through Volume of Run-Off along Shoulder
  Q' = v x a = 0.0734 m^3/sec.
- Velocity of Flow
  $v = 1/n \times R^{2/3} \times I^{1/2}$ = 1.33501 m/sec.
  (Hydraulic mean Depth) R = a / I = 0.0268
  (Wetted Perimeter) I = 2.0558 m
  (Floow Area of Gutter) a = 0.0550 m^2
  (Coefficient of Roughness) n = 0.015

3) Designed Number of Vertical Drain

N = Q / Q'
(Single Line Drainage) N1 = 3.157 Each ==> **4 Each**
(Double Line Drainage) N2 = 1.578 Each ==> **2 Each**

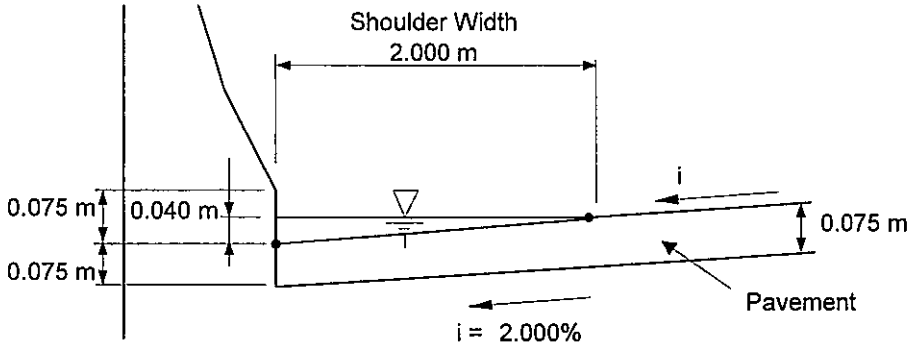
4) Designed Interval of Vertical Drain

d = Q' / Q x L
(Single Line Drainage) d1 = 40.500 m ==> **40 m**
(Double Line Drainage) d1 = 81.000 m ==> **81 m**

J. APPROACH (A2)

Total F.O. Width Wb = 13.00 m
Single Line Drainage System = 1
Double Line Drainage System = 2
Supper Elevation i = **2.00%**
Rainfall Intensity γ = 220 mm/hr
(5 years return period, 5 mins. Time concentration)
Design Rainfall intensity γo = γ x k = **440** mm/hr
Coefficient of Run-off C = 0.9
Correction Factor of Falling k = 2

Section :



1) Catchments Area

- Vertical Gradient = **5.000%**
  Approach L = **168.00 m**
  Catchments Area
  (Single Line Drainage) A1 = Wb x L / 1 = 2184 m^2
  (Double Line Drainage) A2 = Wb x L / 2 = 1092 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 = 0.2402 m^3/sec.
  (Double Line Drainage) Q2 = 0.1201 m^3/sec.
- Possible Through Volume of Run-Off along Shoulder
  Q' = v x a = 0.0433 m^3/sec.
- Velocity of Flow
  $v = 1/n \times R^{2/3} \times I^{1/2}$ = 1.08367 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 = 5.547 Each ==> **6 Each**
(Double Line Drainage) N2 = 2.774 Each ==> **3 Each**

4) Designed Interval of Vertical Drain

d = Q' / Q x L
(Single Line Drainage) d1 = 28.000 m ==> **28 m**
(Double Line Drainage) d1 = 56.000 m ==> **56 m**