

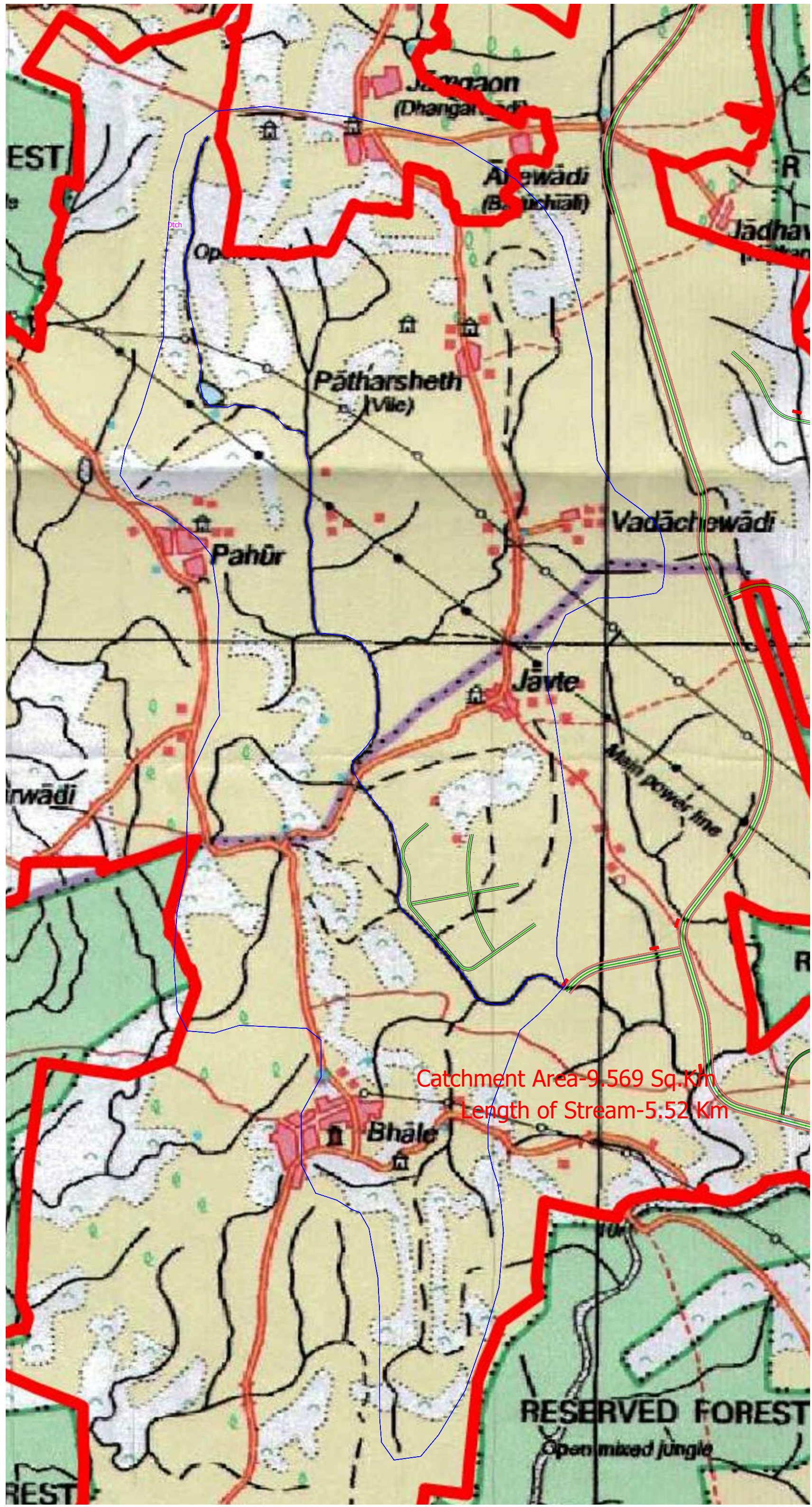
**Preparation of Master Plan & Preliminary Design
for Roads and Services/ Utilities for**

Dighi Port Industrial Area

under Delhi Mumbai Industrial Corridor (DMIC)

Volume 2D Hydology Annexure

September 2024



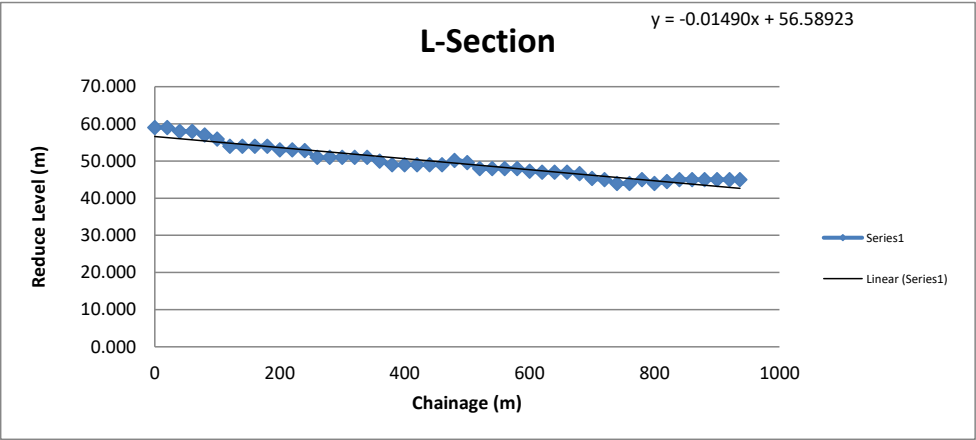
SUMMARY					
Sr.No	Chainage (km)	Discharge (Cumecs)			Design Discharge (Cumecs)
		By Modified Rational method (Bridges and Floods Wing Report, RBF-16)	By Rational Method (SP-13 Code)	By Area Velocity Method	
1	0+570 (AR-3)	242.361	165.778	-	242.361

Sr.No	Chainage (km)	Design Discharge (cumecs)	Design HFL (m)	Average Velocity (m/s)	Avg. depth (m)	LBL (m)	Proposed Waterway (m)	Vertical clearance Required (m)	Proposed Minimum Soffit level (m)
1	0+570 (AR-3)	242.361	51.879	4.82	2.70	49.00	25	0.90	52.779

*Note Scour Level shall be limited to Rock level found at site

Longitudnal Slope

Chainage (m)	RL (m)
0.00	59.000
20.00	59.000
40.00	58.000
60.00	58.000
80.00	57.032
100.00	55.948
120.00	54.000
140.00	54.000
160.00	54.000
180.00	54.000
200.00	53.000
220.00	53.000
240.00	52.821
260.00	51.000
280.00	51.000
300.00	51.000
320.00	51.000
340.00	51.000
360.00	50.000
380.00	49.000
400.00	49.000
420.00	49.000
440.00	49.000
460.00	49.000
480.00	50.173
500.00	49.585
520.00	48.000
540.00	48.000
560.00	48.000
580.00	48.000
600.00	47.280
620.00	47.000
640.00	47.000
660.00	47.000
680.00	46.638
700.00	45.297
720.00	45.000
740.00	44.000
760.00	44.000
780.00	45.000
800.00	44.000
820.00	44.500
840.00	45.000
860.00	45.000
880.00	45.000
900.00	45.000
920.00	45.000
936.77	45.000



DESIGN DISCHARGE CALCULATION

Name and number of subzone Subzone-5a-b
 Existing Chainage -
 Proposed chainage 0+570 (AR-3)
 River/Stream -
 Type Minor Bridge (Bridge on Parcel B Boundary)

(A) FLOOD ESTIMATION

(1) By Modified Rational method (Bridges and Floods Wing Report, RBF-16)

Catchment Area of River, A	=	9.569	km ²	3.694	Mile ²
Length of longest stream, L	=	5.52	km	3.425	Mile
Level Difference between source and bridge site, H	=	60.0	m	0.037	Mile
Slope (in percent)	=			1.088	
R	=	100 year 24 hour point rainfall			
	=	48.00	cm		(Refer Subzone Report 5a-b)
tc	=	Time of concentration			
	=	$0.9 \times L / (M \ 0.1 \times S \ 0.2)$			
	=	2.660	hr.		
F	=	Areal Reduction factor			
	=	0.86			
C	=	Runoff Coefficient			
	=	$0.415 \times (R \times F)^{0.2}$			
	=	0.87			
tc hr. ratio	=	0.58			
1 hr. ratio	=	0.416			Refer. RBF - 16 Report
Conversion Ratio, K	=	tc hr. ratio / 1 hr. ratio			
	=	1.39			
R100(24)	=	48	cm		
R100(1)	=	R100(24) x 1 hr. to 24 hr. rainfall ratio			
	=	19.97	cm		
	=	199.68	mm		
R100(tc)	=	K x R100(1)			
	=	277.44	mm		
I	=	100 year rainfall intensity (mm/hr) lasting for tc hr. duration			
	=	R100(tc)/tc			
	=	104.32	mm/hr.		
Design Flood					
Q	=	0.278 x C I A			
	=	242.36	m3/sec		

(2) By Rational Method (SP-13 Code)

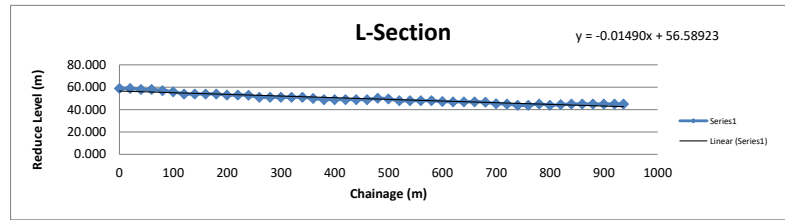
Area of catchment, A		956.9	Ha		
Length of longest stream, L		5.52	Km		
The fall in level from critical point to the structure, H		60.00	m		
Runoff Coefficient as per Terrain, P	=	0.5			
tc	=	$((0.87 \times (L^3/H))^{0.385})$			(Refer IRC SP-13)
	=	1.41	hr		
Now,					
F (100 year-24 hr rainfall)		480	mm		
One hour conversion ratio from report 5a		0.32			
F (100 year-1 hr rainfall)		153.6	mm		
T			hour		
Now,					
Ic	=	$(F/T) \times ((T+1)/(tc+1))$			(Refer SP-13) Where, F Total precipitation T Duration of time
	=	127.57	mm/hr		
	=	12.76	cm/hr		
f	=	0.970			Fig.4.2 ' f-curve ' from IRC:SP: 13
Q	=	$0.028 \times P \times f \times A \times I_c$			
	=	165.778	cumecs		

(B) Fixing of Design Discharge

Calculated Peak Discharge by					
i) By Modified Rational method (Bridges and Floods Wing Report, RBF-16)	=	242.36	cumecs		
ii) By Rational Method (SP-13 Code)	=	165.78	cumecs		

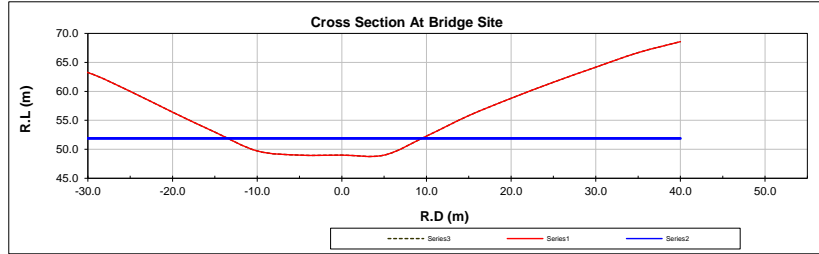
Therefore, The Reccomended Design Discharge, Qd (As per clause 106.3.2, IRC:5-2015) = 242.36 cumecs

(C) Calculation of Design Affluxed HFL w.r.t. Design Discharge
Design Discharge, Qd = 242.36 Cumecs



Average Bed Slope of River, S = 0.01490
Manning's Coefficient, n = 0.045

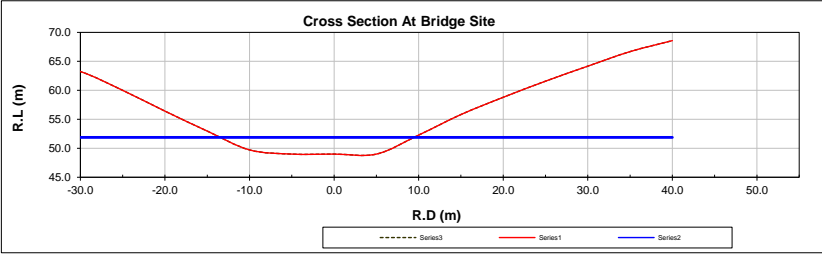
At Bridge Site



Distance	RL of Existing GL	RL of Modified GL	HFL	a	p	r=a/p	q
-40.00	65.610	65.610	51.879	-	-	-	-
-35.00	64.860	64.860	51.879				
-30.00	63.240	63.240	51.879				
-25.00	60.000	60.000	51.879				
-20.00	56.410	56.410	51.879				
-15.00	52.970	52.970	51.879				
-10.00	49.720	49.720	51.879	2.672	5.963	0.448	4.2427
-5.00	49.000	49.000	51.879	12.597	5.052	2.494	62.8318
0.00	49.000	49.000	51.879	14.397	5.000	2.879	79.0368
5.00	49.000	49.000	51.879	14.397	5.000	2.879	79.0368
10.00	52.280	52.280	51.879	6.197	5.980	1.036	17.2121
15.00	55.820	55.820	51.879				
20.00	58.800	58.800	51.879				
25.00	61.580	61.580	51.879				
30.00	64.170	64.170	51.879				
35.00	66.680	66.680	51.879				
40.00	68.580	68.580	51.879				
An1=				50.258		Q=	242.360

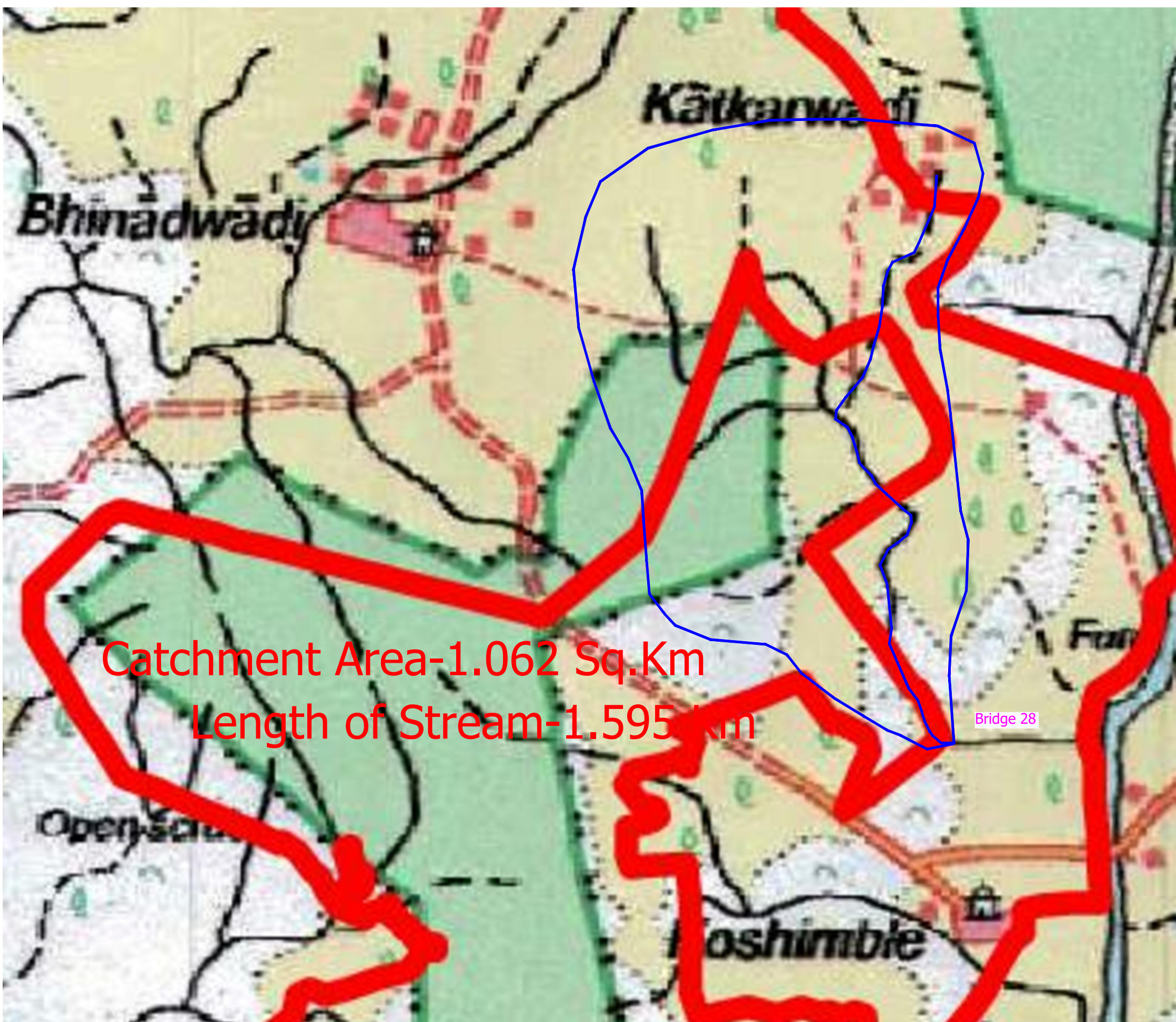
(D) Afflux Calculation

Determination of Obstructed Bridge Area



Distance	RL of Existing GL	RL of Modified GL	HFL	a	p	r=a/p	q	depth, d
-40.00	65.610	65.610	51.879	-	-	-	-	-
-35.00	64.860	64.860	51.879					
-30.00	63.240	63.240	51.879					
-25.00	60.000	60.000	51.879					
-20.00	56.410	56.410	51.879					
-15.00	52.970	52.970	51.879					
-10.00	49.720	49.720	51.879	2.672	5.963	0.448	4.2427	2.1593
-5.00	49.000	49.000	51.879	12.597	5.052	2.494	62.8318	2.8793
0.00	49.000	49.000	51.879	14.397	5.000	2.879	79.0368	2.8793
5.00	49.000	49.000	51.879	14.397	5.000	2.879	79.0368	2.8793
10.00	52.280	52.280	51.879	6.197	5.980	1.036	17.2121	
15.00	55.820	55.820	51.879					
20.00	58.800	58.800	51.879					
25.00	61.580	61.580	51.879					
30.00	64.170	64.170	51.879					
35.00	66.680	66.680	51.879					
40.00	68.580	68.580	51.879					
An2'=				50.258	sq m	Q=	242.360	Cumeecs
Average depth, d				=		2.699	m	
Lowest Bed Level				=		49.000	m	

Therefore,			
Discharge, Q	=	242.360	cumec
HFL (Without Afflux)	=	51.879	m
Average Depth, d	=	2.699	m
Area before constriction			
An1	=	50.258	sq m
Average velocity prior to constriction			
Vn1	=	Q/An1	
	=	4.822	m/s
Area after constriction			
An2*	=	50.258	sq m
An2	=	An2* - no's of piers * average width of piers * average depth (d)	
	=	50.258	sq m
Average Velocity after constriction			
Vn2	=	Q/An2	
	=	4.822	m/s
Afflux due to constriction (By Molesworth Formula)			
h	=	[(Vn1 ²)/17.88+0.015] [(An1/An2) ² -1]	
	=	0.000	m
(E) Recommendation			
Design Discharge, Qd	=	242.360	cumecs
Design Affluxed HFL	=	51.879	m
Average Velocity, Vn2	=	4.822	m/sec
(F) Hydraulic Adequacy			
Design Affluxed HFL	=	51.879	m
Required Vercile Clearance	=	0.90	m
Proposed Soffit Level	=	52.779	m



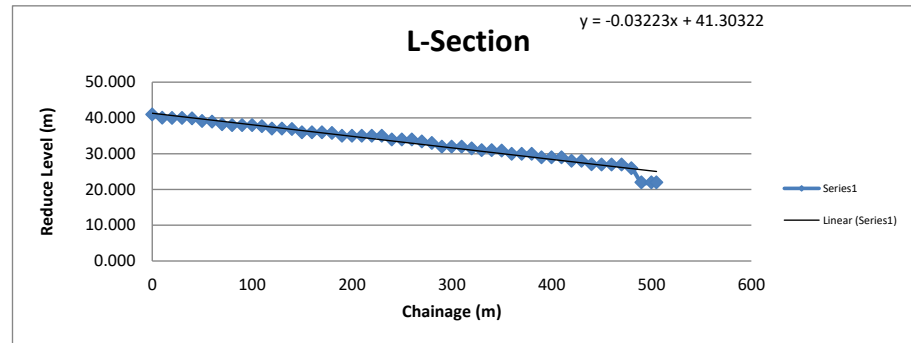
SUMMARY					
Sr.No	Chainage (km)	Discharge (Cumecs)			Design Discharge (Cumecs)
		By Modified Rational method (Bridges and Floods Wing Report, RBF-16)	By Rational Method (SP-13 Code)	By Area Velocity Method	
1	4+175-Br 28	56.771	39.886	-	56.771

Sr.No	Chainage (km)	Design Discharge (cumecs)	Design HFL (m)	Average Velocity (m/s)	Avg. depth (m)	LBL (m)	Proposed Waterway (m)	Vertical clearance Required (m)	Proposed Minimum Soffit level (m)
1	4+175-Br 28	56.771	33.337	4.47	0.93	32.00	15	0.90	34.237

*Note Scour Level shall be limited to Rock level found at site

Longitudnal Slope

Chainage (m)	RL (m)
0.00	41.000
10.00	40.045
20.00	40.000
30.00	40.000
40.00	39.861
50.00	39.159
60.00	39.000
70.00	38.242
80.00	38.000
90.00	38.000
100.00	38.000
110.00	37.713
120.00	37.000
130.00	37.000
140.00	36.891
150.00	36.000
160.00	36.000
170.00	36.000
180.00	35.815
190.00	35.000
200.00	35.000
210.00	35.000
220.00	35.000
230.00	35.000
240.00	34.000
250.00	34.000
260.00	34.000
270.00	33.450
280.00	33.000
290.00	32.000
300.00	32.000
310.00	32.000
320.00	31.465
330.00	31.000
340.00	31.000
350.00	30.908
360.00	30.000
370.00	30.000
380.00	30.000
390.00	29.000
400.00	29.000
410.00	29.000
420.00	28.000
430.00	28.000
440.00	27.054
450.00	27.000
460.00	27.000
470.00	27.000
480.00	25.935
490.00	22.000
500.00	22.000
505.00	22.000



DESIGN DISCHARGE CALCULATION

Name and number of subzone Subzone-5a-b
Existing Chainage
Proposed chainage 4+175-Br 28
River/Stream Br-28
Type Minor Bridge

(A) FLOOD ESTIMATION

(1) By Modified Rational method (Bridges and Floods Wing Report, RBF-16)

Catchment Area of River, A	=	1.062	km ²	0.410	Mile ²
Length of longest stream, L	=	1.60	km	0.990	Mile
Level Difference between source and bridge site, H	=	50.0	m	0.031	Mile
Slope (in percent)	=			3.135	
R	=	100 year 24 hour point rainfall			
	=	48.00	cm		(Refer Subzone Report 5a-b)
tc	=	Time of concentration			
	=	$0.9 \times L / (M \ 0.1 \times S \ 0.2)$			
	=	0.775	hr.		
F	=	Areal Reduction factor			
	=	0.81			
C	=	Runoff Coefficient			
	=	$0.415 \times (R \times F)^{0.2}$			
	=	0.86			
tc hr. ratio	=	0.36			
1 hr. ratio	=	0.416			Refer. RBF - 16 Report
Conversion Ratio, K	=	tc hr. ratio / 1 hr. ratio			
	=	0.87			
R100(24)	=	48	cm		
R100(1)	=	R100(24) x 1 hr. to 24 hr. rainfall ratio			
	=	19.97	cm		
	=	199.68	mm		
R100(tc)	=	K x R100(1)			
	=	172.80	mm		
I	=	100 year rainfall intensity (mm/hr) lasting for tc hr. duration			
	=	R100(tc)/tc			
	=	222.82	mm/hr.		
Design Flood					
Q	=	$0.278 \times C \ I \ A$			
	=	56.77	m3/sec		

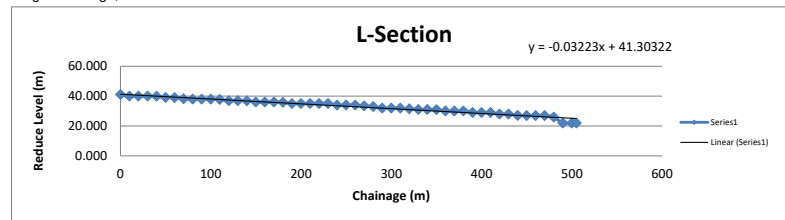
(2) By Rational Method (SP-13 Code)

Area of catchment, A		106.2	Ha		
Length of longest stream, L		1.60	Km		
The fall in level from critical point to the structure, H		50.00	m		
Runoff Coefficient as per Terrain, P	=	0.6			
tc	=	$((0.87 \times (L^3/H))^{0.385})$			(Refer IRC SP-13)
	=	0.36	hr		
Now,					
F (100 year-24 hr rainfall)		480	mm		
One hour conversion ratio from report 5a		0.32			
F (100 year-1 hr rainfall)		153.6	mm		
T			hour		
Now,					
Ic	=	$(F/T)X((T+1)/(tc+1))$			(Refer SP-13) Where,
	=	225.81	mm/hr		F Total precipitation
	=	22.58	cm/hr		T Duration of time
f	=	0.990			Fig.4.2 ' f-curve ' from IRC:SP: 13
Q	=	$0.028XPfXAxc$			
	=	39.886	cumecs		

(B) Fixing of Design Discharge

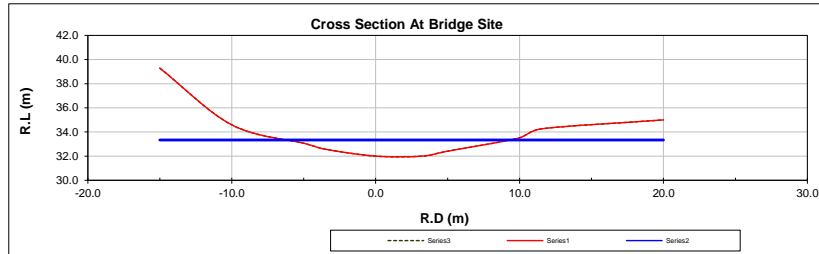
Calculated Peak Discharge by					
i) By Modified Rational method (Bridges and Floods Wing Report, RBF-16)	=	56.77	cumecs		
ii) By Rational Method (SP-13 Code)	=	39.89	cumecs		
Therefore, The Reccomended Design Discharge, Qd (As per clause 106.3.2, IRC:5-2015)	=	56.77	cumecs		

(C) Calculation of Design Affluxed HFL w.r.t. Design Discharge
 Design Discharge, Qd = 56.77 Cumecs



Average Bed Slope of River, S = 0.03223
 Manning's Coefficient, n = 0.04

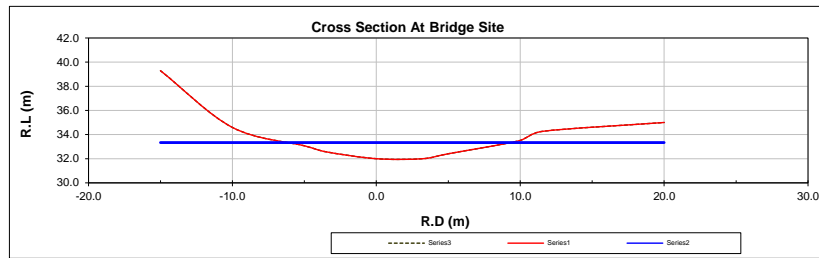
At Bridge Site



Distance	RL of Existing GL	RL of Modified GL	HFL	a	p	r=a/p	q
-15.00	39.290	39.290	33.337	-	-	-	-
-10.00	34.590	34.590	33.337				
-5.00	33.070	33.070	33.337				
-3.49	32.570	32.570	33.337	0.780	1.588	0.491	2.1773
0.00	32.000	32.000	33.337	3.676	3.539	1.039	16.9175
3.23	32.000	32.000	33.337	4.313	3.225	1.337	23.4941
5.00	32.410	32.410	33.337	2.010	1.822	1.103	9.6306
9.90	33.480	33.480	33.337	1.922	5.015	0.383	4.5514
11.57	34.270	34.270	33.337				
20.00	35.000	35.000	33.337				
An1=				12.700		Q=	56.771

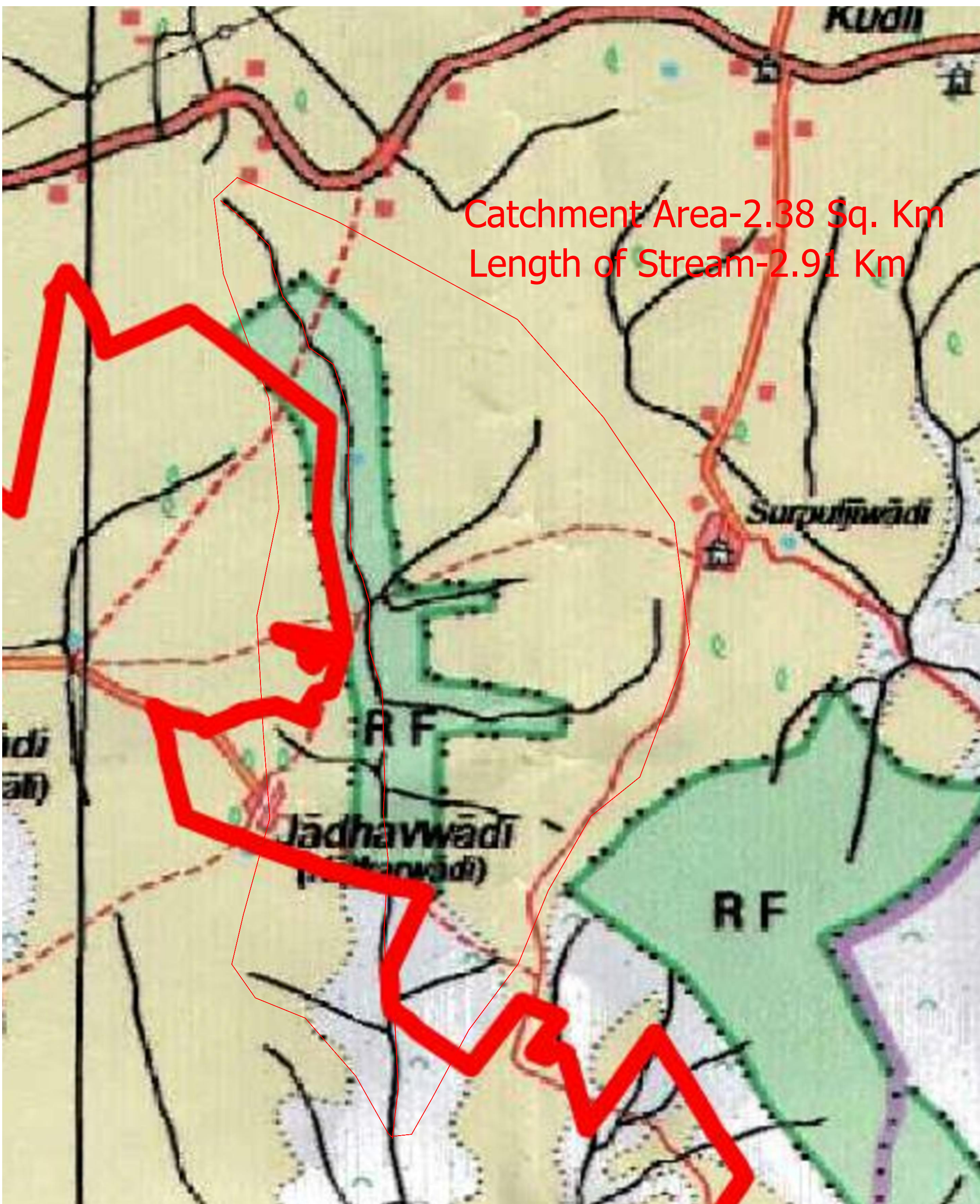
(D) Afflux Calculation

Determination of Obstructed Bridge Area



Distance	RL of Existing GL	RL of Modified GL	HFL	a	p	r=a/p	q	depth, d
-15.00	39.290	39.290	33.337	-	-	-	-	-
-10.00	34.590	34.590	33.337					
-5.00	33.070	33.070	33.337					0.2673
-3.49	32.570	32.570	33.337	0.780	1.588	0.491	2.1773	0.7673
0.00	32.000	32.000	33.337	3.676	3.539	1.039	16.9176	1.3373
3.23	32.000	32.000	33.337	4.313	3.225	1.337	23.4942	1.3373
5.00	32.410	32.410	33.337	2.010	1.822	1.103	9.6306	0.9273
9.90	33.480	33.480	33.337	1.922	5.015	0.383	4.5515	
11.57	34.270	34.270	33.337					
20.00	35.000	35.000	33.337					
An2=				12.700	sq m	Q=	56.771	Cumecs
Average depth, d				=		0.927	m	
Lowest Bed Level				=		32.000	m	

Therefore,			
Discharge, Q	=	56.771	cumec
HFL (Without Afflux)	=	33.337	m
Average Depth, d	=	0.927	m
Area before constriction			
An1	=	12.700	sq m
Average velocity prior to constriction			
Vn1	=	Q/An1	
	=	4.470	m/s
Area after constriction			
An2*	=	12.700	sq m
An2	=	An2* - no's of piers * average width of piers * average depth (d)	
	=	12.700	sq m
Average Velocity after constriction			
Vn2	=	Q/An2	
	=	4.470	m/s
Afflux due to constriction (By Molesworth Formula)			
h	=	[(Vn1 ²)/17.88+0.015] [(An1/An2) ² -1]	
	=	0.000	m
(E) Recommendation			
Design Discharge, Qd	=	56.771	cumecs
Design Affluxed HFL	=	33.337	m
Average Velocity, Vn2	=	4.470	m/sec
(F) Hydraulic Adequacy			
Design Affluxed HFL	=	33.337	m
Required Vortice Clearance	=	0.90	m
Proposed Soffit Level	=	34.237	m



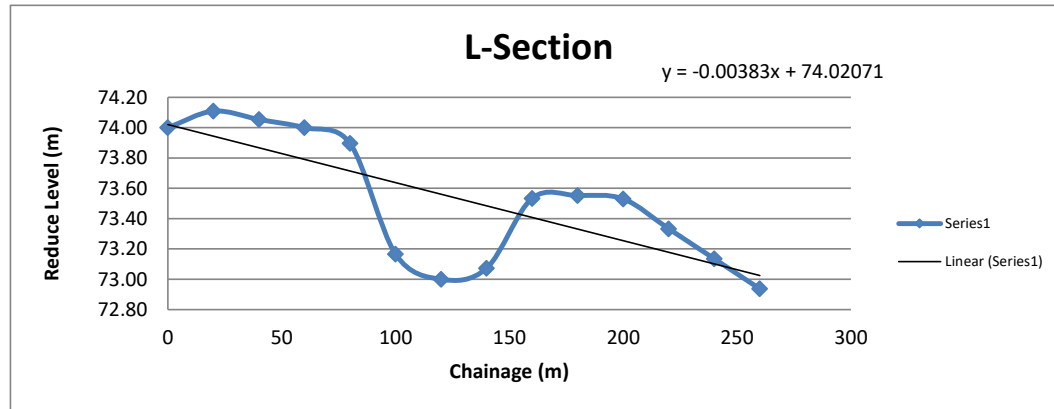
Catchment Area-2.38 Sq. Km
Length of Stream-2.91 Km

SUMMARY					
Sr.No	Chainage (km)	Discharge (Cumecs)			Design Discharge (Cumecs)
		Modified Rational Method (Cumecs)	By Rational Method (Cumecs)	By Area Velocity Method	
1	Br-5	52.186	82.797	-	82.797

Sr.No	Chainage (km)	Design Discharge (cumecs)	Design HFL (m)	Average Velocity (m/s)	Avg. depth (m)	LBL (m)	Proposed Waterway (m)	Vertical clearance Required (m)	Proposed Minimum Soffit level (m)
1	Br-5	82.797	75.256	2.14	1.62	74.00	25	0.9	76.156

Longitudnal Slope

Chainage (m)	RL (m)
0.00	74.00
20.00	74.11
40.00	74.05
60.00	74.00
80.00	73.90
100.00	73.17
120.00	73.00
140.00	73.07
160.00	73.53
180.00	73.55
200.00	73.53
220.00	73.33
240.00	73.14
260.00	72.94



DESIGN DISCHARGE CALCULATION

Name and number of subzone Subzone-5a-b
 Existing Chainage -
 Proposed chainage Br-5
 River/Stream -
 Type Minor Bridge

(A) FLOOD ESTIMATION

(1) Rational method (Bridges and Floods Wing Report, RBF-16)

Catchment Area of River, A = 2.380 km² 0.919 Mile²
 Length of longest stream, L = 2.91 km 1.806 Mile
 Level Difference between source and bridge site, H = 25.0 m 0.016 Mile
 Slope (in percent) = 0.860

R = 100 year 24 hour point rainfall
 = 48.00 cm (Refer Subzone Report 5a)
 tc = Time of concentration
 = $0.9 \times L / (M \ 0.1 \times S \ 0.2)$
 = 1.689 hr.
 F = Areal Reduction factor
 = 0.88
 C = Runoff Coefficient
 = $0.415 \times (R \times F)^{0.2}$
 = 0.88
 tc hr. ratio = 0.50
 1 hr. ratio = 0.416 Refer. RBF - 16 Report
 Conversion Ratio, K = tc hr. ratio / 1 hr. ratio
 = 1.21
 R100(24) = 48 cm
 R100(1) = R100(24) x 1 hr. to 24 hr. rainfall ratio
 = 19.97 cm
 = 199.68 mm
 R100(tc) = K x R100(1)
 = 240.96 mm
 I = 100 year rainfall intensity (mm/hr) lasting for tc hr. duration
 = R100(tc)/tc
 = 142.63 mm/hr.
 Design Flood
 Q = $0.278 \times C \ I \ A$
 = 82.80 m3/sec

(2) By Rational Method (SP-13 Code)

Area of catchment, A 238 Ha
 Length of longest stream, L 2.91 Km
 The fall in level from critical point to the structure, H 25.00 m

Runoff Coefficient as per Terrain, P = 0.5
 $tc = ((0.87 \times (L^3/H))^{0.385})$ (Refer IRC SP-13)
 0.94 hr

Now,
 F (100 year-24 hr rainfall) 480 mm
 One hour conversion ratio
 from report 5a 0.32
 F (100 year-1 hr rainfall) 153.6 mm
 T I hour

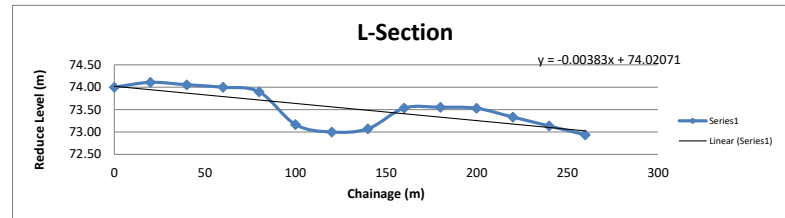
Now,
 $Ic = (F/T) \times ((T+1)/(tc+1))$ (Refer SP-13) Where, F Total precipitation
 = 158.20 mm/hr T Duration of time
 = 15.82 cm/hr
 f = 0.990 Fig.4.2 ' f-curve ' from IRC:SP: 13
 $Q = 0.028 \times P \times f \times A \times Ic$
 52.186 cumecs

(B) Fixing of Design Discharge

Calculated Peak Discharge by
 i) By Rational Method = 82.80 cumecs
 ii) By Rational Method (SP-13 Code) = 52.19 cumecs

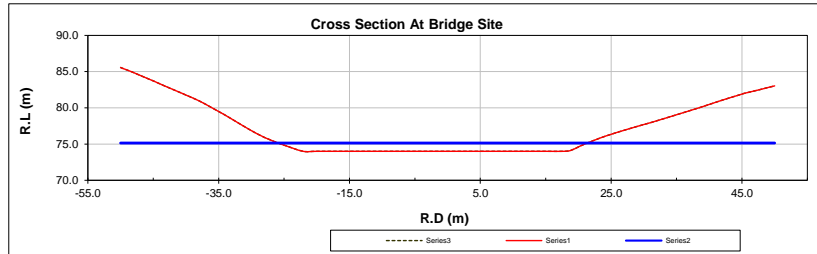
Therefore, The Recommended Design Discharge, Qd (As per clause 106.3.2, IRC:5-2015) = 82.80 cumecs

(C) Calculation of Design Affluxed HFL w.r.t. Design Discharge
Design Discharge, Qd = 82.80 Cumecs



Average Bed Slope of River, S = 0.00383
Manning's Coefficient, n = 0.04

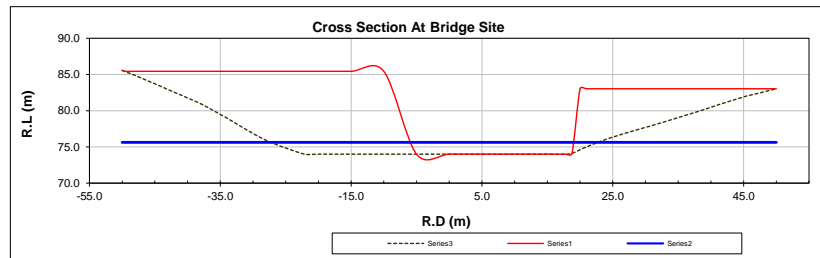
At Bridge Site



Distance	RL of Existing GL	RL of Modified GL	HFL	a	p	r=a/p	q
-50.00	85.570	85.570	75.143	-	-	-	-
-49.64	85.440	85.440	75.143				
-48.34	84.990	84.990	75.143				
-47.32	84.600	84.600	75.143				
-45.75	84.000	84.000	75.143				
-45.00	83.720	83.720	75.143				
-44.69	83.600	83.600	75.143				
-43.20	83.000	83.000	75.143				
-40.59	82.000	82.000	75.143				
-40.00	81.760	81.760	75.143				
-38.01	80.970	80.970	75.143				
-36.02	80.000	80.000	75.143				
-35.00	79.490	79.490	75.143				
-34.02	79.000	79.000	75.143				
-32.65	78.260	78.260	75.143				
-31.39	77.580	77.580	75.143				
-30.00	76.850	76.850	75.143				
-29.88	76.790	76.790	75.143				
-27.97	75.900	75.900	75.143				
-25.49	75.000	75.000	75.143				
-25.00	74.850	74.850	75.143	0.107	0.514	0.208	0.0582
-22.09	74.000	74.000	75.143	2.090	3.034	0.689	2.5215
-20.00	74.000	74.000	75.143	2.386	2.088	1.143	4.0340
-15.00	74.000	74.000	75.143	5.713	5.000	1.143	9.6599
-10.00	74.000	74.000	75.143	5.713	5.000	1.143	9.6599
-5.00	74.000	74.000	75.143	5.713	5.000	1.143	9.6599
0.00	74.000	74.000	75.143	5.713	5.000	1.143	9.6599
5.00	74.000	74.000	75.143	5.713	5.000	1.143	9.6599
10.00	74.000	74.000	75.143	5.713	5.000	1.143	9.6599
15.00	74.000	74.000	75.143	5.713	5.000	1.143	9.6599
17.71	74.000	74.000	75.143	3.091	2.705	1.143	5.2260
18.76	74.100	74.100	75.143	1.154	1.061	1.088	1.8879
20.00	74.610	74.610	75.143	0.976	1.340	0.728	1.2221
20.96	75.000	75.000	75.143	0.324	1.036	0.313	0.2310
23.36	75.850	75.850	75.143				
25.00	76.350	76.350	75.143				
26.74	76.840	76.840	75.143				
28.50	77.310	77.310	75.143				
30.00	77.700	77.700	75.143				
31.19	78.000	78.000	75.143				
34.84	79.000	79.000	75.143				
35.00	79.050	79.050	75.143				
38.42	80.000	80.000	75.143				
39.82	80.420	80.420	75.143				
40.00	80.470	80.470	75.143				
41.77	81.000	81.000	75.143				
43.48	81.480	81.480	75.143				
45.00	81.900	81.900	75.143				
45.35	82.000	82.000	75.143				
47.62	82.490	82.490	75.143				
48.86	82.780	82.780	75.143				
50.00	83.030	83.030	75.143				
An1=				50.116		Q=	82.800

(D) Afflux Calculation

Determination of Obstructed Bridge Area



Distance	RL of Existing GL	RL of Modified GL	HFL	a	p	r=a/p	q	depth, d
-50.00	85.570	85.570	75.630	-	-	-	-	-
-49.64	85.440	85.440	75.630					
-48.34	84.990	85.440	75.630					
-47.32	84.600	85.440	75.630					
-45.75	84.000	85.440	75.630					
-45.00	83.720	85.440	75.630					
-44.69	83.600	85.440	75.630					
-43.20	83.000	85.440	75.630					
-40.59	82.000	85.440	75.630					
-40.00	81.760	85.440	75.630					
-38.01	80.970	85.440	75.630					
-36.02	80.000	85.440	75.630					
-35.00	79.490	85.440	75.630					
-34.02	79.000	85.440	75.630					
-32.65	78.260	85.440	75.630					
-31.39	77.580	85.440	75.630					
-30.00	76.850	85.440	75.630					
-29.88	76.790	85.440	75.630					
-27.97	75.900	85.440	75.630					
-25.49	75.000	85.440	75.630					
-25.00	74.850	85.440	75.630					
-22.09	74.000	85.440	75.630					
-20.00	74.000	85.440	75.630					
-15.00	74.000	85.440	75.630					
-10.00	74.000	85.440	75.630					
-5.00	74.000	74.000	75.630					1.6300
0.00	74.000	74.000	75.630	8.150	5.000	1.630	17.4650	1.6300
5.00	74.000	74.000	75.630	8.150	5.000	1.630	17.4650	1.6300
10.00	74.000	74.000	75.630	8.150	5.000	1.630	17.4650	1.6300
15.00	74.000	74.000	75.630	8.150	5.000	1.630	17.4650	1.6300
17.71	74.000	74.000	75.630	4.409	2.705	1.630	9.4486	1.6300
18.76	74.100	74.100	75.630	1.669	1.061	1.573	3.4916	1.5300
20.00	74.610	83.030	75.630					
20.96	75.000	83.030	75.630					
23.36	75.850	83.030	75.630					
25.00	76.350	83.030	75.630					
26.74	76.840	83.030	75.630					
28.50	77.310	83.030	75.630					
30.00	77.700	83.030	75.630					
31.19	78.000	83.030	75.630					
34.84	79.000	83.030	75.630					
35.00	79.050	83.030	75.630					
38.42	80.000	83.030	75.630					
39.82	80.420	83.030	75.630					
40.00	80.470	83.030	75.630					
41.77	81.000	83.030	75.630					
43.48	81.480	83.030	75.630					
45.00	81.900	83.030	75.630					
45.35	82.000	83.030	75.630					
47.62	82.490	83.030	75.630					
48.86	82.780	83.030	75.630					
50.00	83.030	83.030	75.630					
An2=				38.678	sq m	Q=	82.800	Cumecs
Average depth, d				=		1.616	m	
Lowest Bed Level				=		74.000	m	

Therefore,			
Discharge, Q	=	82.800	cumec
HFL (Without Afflux)	=	75.143	m
Average Depth, d	=	1.616	m
Area before constriction			
An1	=	50.116	sq m
Average velocity prior to constriction			
Vn1	=	Q/An1	
	=	1.652	m/s
Area after constriction			
An2*	=	38.678	sq m
An2	=	An2* - no's of piers * average width of piers * average depth (d)	
	=	38.678	sq m
Average Velocity after constriction			
Vn2	=	Q/An2	
	=	2.141	m/s
Afflux due to constriction (By Molesworth Formula)			
h	=	[(Vn1 ²)/17.88+0.015] [(An1/An2) ² -1]	
	=	0.114	m
(E) Recommendation			
Design Discharge, Qd	=	82.800	cumecs
Design Affluxed HFL	=	75.256	m
Average Velocity, Vn2	=	2.141	m/sec
(F) Hydraulic Adequacy			
Design Affluxed HFL	=	75.256	m
Required Vortice Clearance	=	0.90	m
Proposed Soffit Level	=	76.156	m

(G)

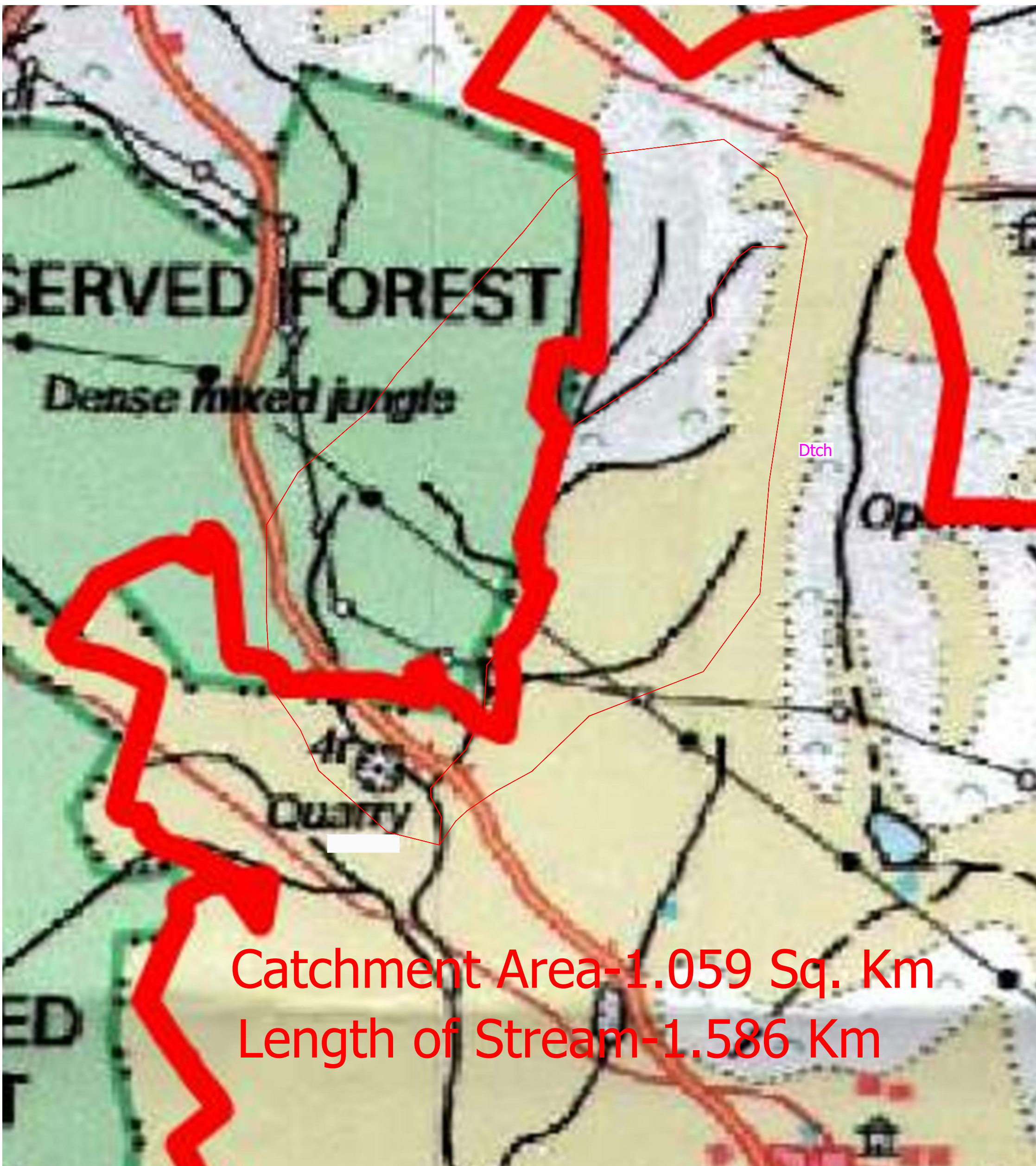
SCOUR DEPTH CALCULATION

Chainage	Br-5	km
HFL	75.26	m
Qd	82.80	cumec
Qdf=1.3*Qd	107.64	cumec
Effective Linear Waterway(Le)	10.00	m
Regime Width, W'=4.8*(Qd^0.5)	43.677	m
Db=Qdf/min(W',Le)	10.764	cumec/m

Abutment

Weighted Ksf*	Mean Scour Depth,Dsm=1.34*(Db2/Ksf)^1/3	Scour Depth,for Abutment,dsm=1.27xDsm	Scour Level=HFL-dsma	Observation	Recommened Scour Level (m)
Scour level limited toHard Rock Level found at site					

* Based on the data observed from the Geo technical report.



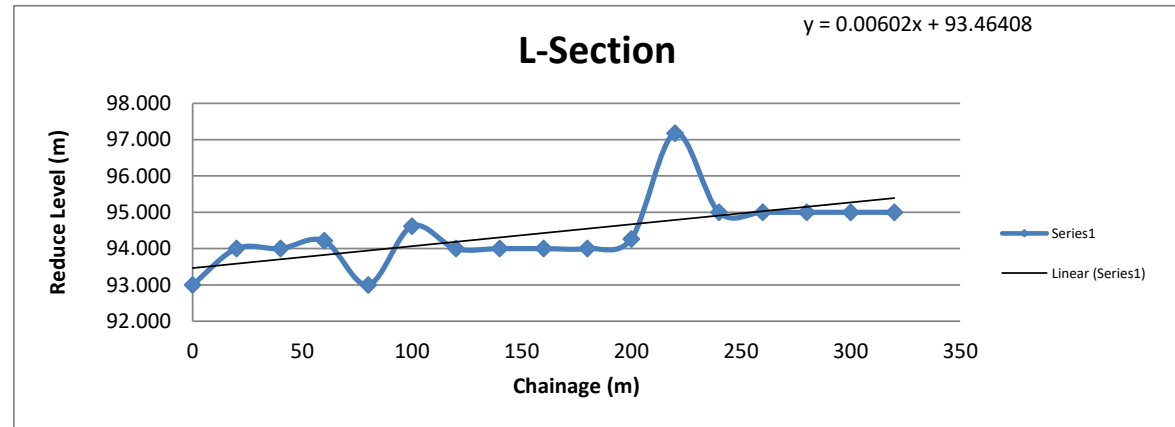
SUMMARY					
Sr.No	Chainage (km)	Discharge (Cumecs)			Design Discharge (Cumecs)
		By Modified Rational method (Bridges and Floods Wing Report, RBF-16)	By Rational Method (SP-13 Code)	By Area Velocity Method	
1	Br-33-SAR 2	49.546	35.350	-	49.546

Sr.No	Chainage (km)	Design Discharge (cumecs)	Design HFL (m)	Average Velocity (m/s)	Avg. depth (m)	LBL (m)	Proposed Waterway (m)	Vertical clearance Required (m)	Proposed Minimum Soffit level (m)
1	Br-33-SAR 2	49.546	98.834	2.84	2.58	96.25	15.00	0.90	99.734

*Note Scour Level shall be limited to Rock level found at site

Longitudnal Slope

Chainage (m)	RL (m)
0.00	93.000
20.00	94.000
40.00	94.000
60.00	94.214
80.00	93.000
100.00	94.615
120.00	94.000
140.00	94.000
160.00	94.000
180.00	94.000
200.00	94.266
220.00	97.179
240.00	95.000
260.00	95.000
280.00	95.000
300.00	95.000
320.00	95.000



DESIGN DISCHARGE CALCULATION

Name and number of subzone Subzone-5a-b
Existing Chainage
Proposed chainage Br-33-SAR 2
River/Stream -
Type Minor Bridge

(A) FLOOD ESTIMATION

(1) By Modified Rational method (Bridges and Floods Wing Report, RBF-16)

Catchment Area of River, A	=	1.059	km ²	0.409	Mile ²
Length of longest stream, L	=	1.586	km	0.985	Mile
Level Difference between source and bridge site, H	=	18.0	m	0.011	Mile
Slope (in percent)	=			1.135	
R	=	100 year 24 hour point rainfall			
	=	48.00	cm		(Refer Subzone Report 5a-b)
tc	=	Time of concentration			
	=	$0.9 \times L / (M \ 0.1 \times S \ 0.2)$			
	=	0.945	hr.		
F	=	Areal Reduction factor			
	=	0.81			
C	=	Runoff Coefficient			
	=	$0.415 \times (R \times F)^{0.2}$			
	=	0.86			
tc hr. ratio	=	0.384			
1 hr. ratio	=	0.416			Refer. RBF - 16 Report
Conversion Ratio, K	=	tc hr. ratio / 1 hr. ratio			
		0.92			
R100(24)	=	48	cm		
R100(1)	=	R100(24) x 1 hr. to 24 hr. rainfall ratio			
	=	19.97	cm		
	=	199.68	mm		
R100(tc)	=	K x R100(1)			
	=	184.32	mm		
I	=	100 year rainfall intensity (mm/hr) lasting for tc hr. duration			
	=	R100(tc)/tc			
	=	195.02	mm/hr.		
Design Flood					
Q	=	$0.278 \times C \ I \ A$			
	=	49.55	m3/sec		

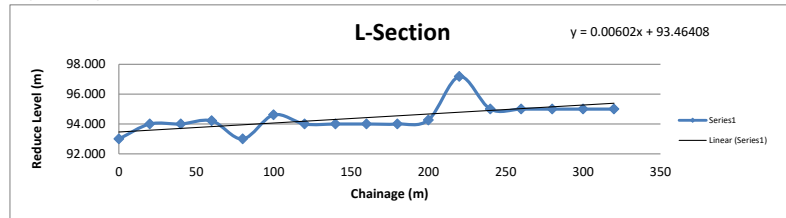
(2) By Rational Method (SP-13 Code)

Area of catchment, A		105.9	Ha		
Length of longest stream, L		1.59	Km		
The fall in level from critical point to the structure, H		18.00	m		
Runoff Coefficient as per Terrain, P	=	0.6			
tc	=	$((0.87 \times (L^3/H))^{0.385})$			(Refer IRC SP-13)
		0.53	hr		
Now,					
F (100 year-24 hr rainfall)		480	mm		
One hour conversion ratio from report 5a		0.32			
F (100 year-1 hr rainfall)		153.6	mm		
T			hour		
Now,					
Ic	=	$(F/T)X((T+1)/(tc+1))$			(Refer SP-13) Where,
	=	200.70	mm/hr		F Total precipitation
	=	20.07	cm/hr		T Duration of time
f	=	0.990			Fig.4.2 ' f-curve ' from IRC:SP: 13
Q	=	$0.028XPfXAxl_c$			
		35.350	cumecs		

(B) Fixing of Design Discharge

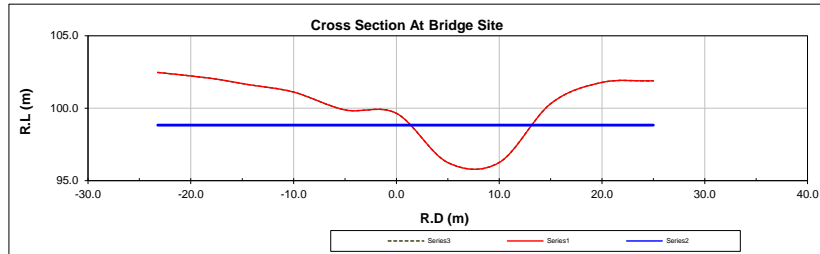
Calculated Peak Discharge by					
i) By Modified Rational method (Bridges and Floods Wing Report, RBF-16)	=	49.55	cumecs		
ii) By Rational Method (SP-13 Code)	=	35.35	cumecs		
Therefore, The Reccomended Design Discharge, Qd (As per clause 106.3.2, IRC:5-2015)	=	49.55	cumecs		

(C) Calculation of Design Affluxed HFL w.r.t. Design Discharge
 Design Discharge, Qd = 49.55 Cumecs



Average Bed Slope of River, S = 0.00602
 Manning's Coefficient, n = 0.04

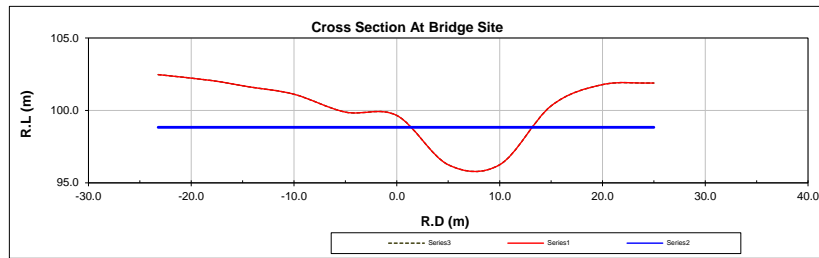
At Bridge Site



Distance	RL of Existing GL	RL of Modified GL	HFL	a	p	r=a/p	q
-23.22	102.470	102.470	98.834	-	-	-	-
-18.08	102.067	102.067	98.834				
-14.40	101.630	101.630	98.834				
-9.99	101.115	101.115	98.834				
-5.00	99.883	99.883	98.834				
0.00	99.650	99.650	98.834				
5.00	96.250	96.250	98.834	3.828	5.237	0.731	6.0245
10.00	96.250	96.250	98.834	11.190	4.331	2.584	40.8715
15.00	100.309	100.309	98.834	2.401	5.578	0.430	2.6546
20.00	101.781	101.781	98.834				
25.00	101.890	101.890	98.834				
An1=				17.419		Q=	49.551

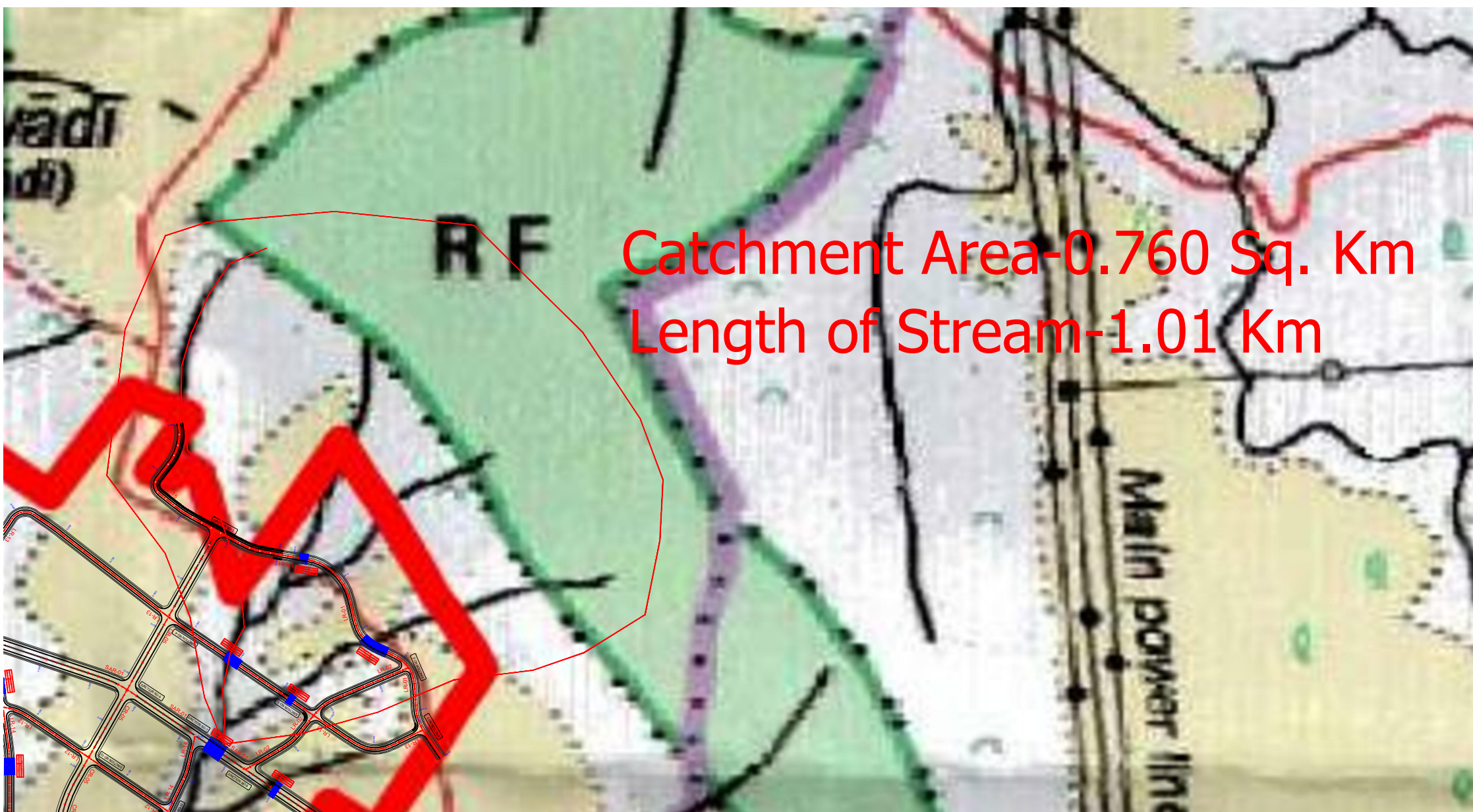
(D) Afflux Calculation

Determination of Obstructed Bridge Area



Distance	RL of Existing GL	RL of Modified GL	HFL	a	p	r=a/p	q	depth, d
-23.22	102.470	102.470	98.834	-	-	-	-	-
-18.08	102.067	102.067	98.834					
-14.40	101.630	101.630	98.834					
-9.99	101.115	101.115	98.834					
-5.00	99.883	99.883	98.834					
0.00	99.650	99.650	98.834					
5.00	96.250	96.250	98.834	3.828	5.237	0.731	6.0245	2.5839
10.00	96.250	96.250	98.834	11.190	4.331	2.584	40.8715	2.5839
15.00	100.309	100.309	98.834	2.401	5.578	0.430	2.6546	
20.00	101.781	101.781	98.834					
25.00	101.890	101.890	98.834					
An2=				17.419	sq m	Q=	49.551	Cumecs
Average depth, d				=		2.584	m	
Lowest Bed Level				=		96.250	m	

Therefore,			
Discharge, Q	=	49.551	cumec
HFL (Without Afflux)	=	98.834	m
Average Depth, d	=	2.584	m
Area before constriction			
An1	=	17.419	sq m
Average velocity prior to constriction			
Vn1	=	Q/An1	
	=	2.845	m/s
Area after constriction			
An2*	=	17.419	sq m
An2	=	An2* - no's of piers * average width of piers * average depth (d)	
	=	17.419	sq m
Average Velocity after constriction			
Vn2	=	Q/An2	
	=	2.845	m/s
Afflux due to constriction (By Molesworth Formula)			
h	=	[(Vn1 ²)/17.88+0.015] [(An1/An2) ² -1]	
	=	0.000	m
(E) Recommendation			
Design Discharge, Qd	=	49.551	cumecs
Design Affluxed HFL	=	98.834	m
Average Velocity, Vn2	=	2.845	m/sec
(F) Hydraulic Adequacy			
Design Affluxed HFL	=	98.834	m
Required Vortice Clearance	=	0.90	m
Proposed Soffit Level	=	99.734	m

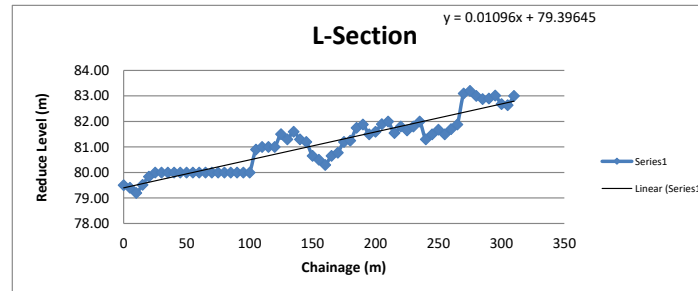


SUMMARY					
Sr.No	Chainage (km)	Discharge (Cumecs)			Design Discharge (Cumecs)
		Modified Rational Method (Cumecs)	By Rational Method (Cumecs)	By Area Velocity Method	
1	Br-6	28.997	47.330	-	47.330

Sr.No	Chainage (km)	Design Discharge (cumecs)	Design HFL (m)	Average Velocity (m/s)	Avg. depth (m)	LBL (m)	Proposed Waterway (m)	Vertical clearance Required (m)	Proposed Minimum Soffit level (m)
1	Br-6	47.330	82.529	2.55	0.92	81.00	15	0.9	83.429

Longitudnal Slope

Chainage (m)	RL (m)
0.00	79.50
5.00	79.40
10.00	79.20
15.00	79.52
20.00	79.84
25.00	80.00
30.00	80.00
35.00	80.00
40.00	80.00
45.00	80.00
50.00	80.00
55.00	80.00
60.00	80.00
65.00	80.00
70.00	80.00
75.00	80.00
80.00	80.00
85.00	80.00
90.00	80.00
95.00	80.00
100.00	80.00
105.00	80.90
110.00	81.00
115.00	81.00
120.00	81.00
125.00	81.51
130.00	81.30
135.00	81.60
140.00	81.30
145.00	81.20
150.00	80.65
155.00	80.50
160.00	80.30
165.00	80.65
170.00	80.78
175.00	81.20
180.00	81.25
185.00	81.75
190.00	81.88
195.00	81.50
200.00	81.60
205.00	81.90
210.00	82.00
215.00	81.55
220.00	81.80
225.00	81.65
230.00	81.80
235.00	82.00
240.00	81.30
245.00	81.50
250.00	81.68
255.00	81.50
260.00	81.70
265.00	81.88
270.00	83.10
275.00	83.20
280.00	83.00
285.00	82.88
290.00	82.90
295.00	83.02
300.00	82.68
305.00	82.64
310.00	83.00



DESIGN DISCHARGE CALCULATION

Name and number of subzone Subzone-5a-b
 Existing Chainage -
 Proposed chainage Br-6
 River/Stream -
 Type Minor Bridge

(A) FLOOD ESTIMATION

(1) Rational method (Bridges and Floods Wing Report, RBF-16)

Catchment Area of River, A = 0.760 km² 0.293 Mile²
 Length of longest stream, L = 1.01 km 0.629 Mile
 Level Difference between source and bridge site, H = 15.0 m 0.009 Mile
 Slope (in percent) = 1.481

R = 100 year 24 hour point rainfall
 = 48.00 cm (Refer Subzone Report 5a-b)
 tc = Time of concentration
 = $0.9 \times L / (M \ 0.1 \times S \ 0.2)$
 = 0.592 hr.
 F = Areal Reduction factor
 = 0.81
 C = Runoff Coefficient
 = $0.415 \times (R \times F)^{0.2}$
 = 0.86
 tc hr. ratio = 0.32
 1 hr. ratio = 0.416 Refer. RBF - 16 Report
 Conversion Ratio, K = tc hr. ratio / 1 hr. ratio
 = 0.77
 R100(24) = 48 cm
 R100(1) = R100(24) x 1 hr. to 24 hr. rainfall ratio
 = 19.97 cm
 = 199.68 mm
 R100(tc) = K x R100(1)
 = 153.60 mm
 I = 100 year rainfall intensity (mm/hr) lasting for tc hr. duration
 = R100(tc)/tc
 = 259.59 mm/hr.
 Design Flood
 Q = $0.278 \times C \ I \ A$
 = 47.33 m3/sec

(2) By Rational Method (SP-13 Code)

Area of catchment, A 76 Ha
 Length of longest stream, L 1.01 Km
 The fall in level from critical point to the structure, H 15.00 m

Runoff Coefficient as per Terrain, P = 0.6

$$tc = ((0.87 \times (L^3/H))^{0.385})$$
 (Refer IRC SP-13)
 0.34 hr

Now,
 F (100 year-24 hr rainfall) 480 mm
 One hour conversion ratio
 from report 5a 0.32
 F (100 year-1 hr rainfall) 153.6 mm
 T I hour

Now,

$$I_c = (F/T) \times ((T+1)/(tc+1))$$
 (Refer SP-13) Where, F Total precipitation
 = 229.40 mm/hr T Duration of time
 = 22.94 cm/hr
 f = 0.990 Fig.4.2 ' f-curve ' from IRC:SP: 13

$$Q = 0.028 \times P \times f \times A \times I_c$$

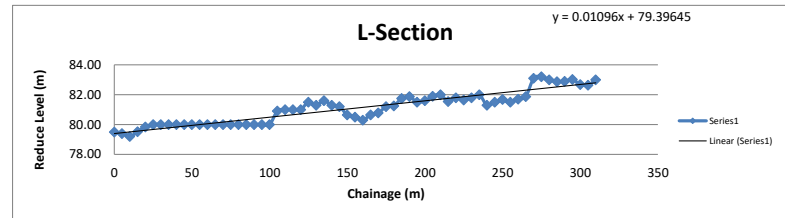
 28.97 cumecs

(B) Fixing of Design Discharge

Calculated Peak Discharge by
 i) By Rational Method = 47.33 cumecs
 ii) By Rational Method (SP-13 Code) = 29.00 cumecs

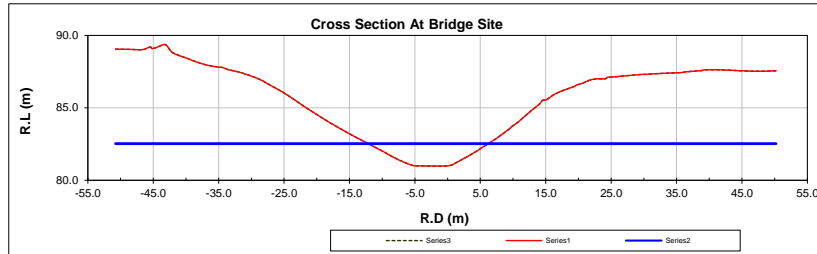
Therefore, The Recommended Design Discharge, Qd (As per clause 106.3.2, IRC:5-2015) = 47.33 cumecs

(C) Calculation of Design Affluxed HFL w.r.t. Design Discharge
Design Discharge, Qd = 47.33 Cumecs



Average Bed Slope of River, S = 0.010
Manning's Coefficient, n = 0.045

At Bridge Site

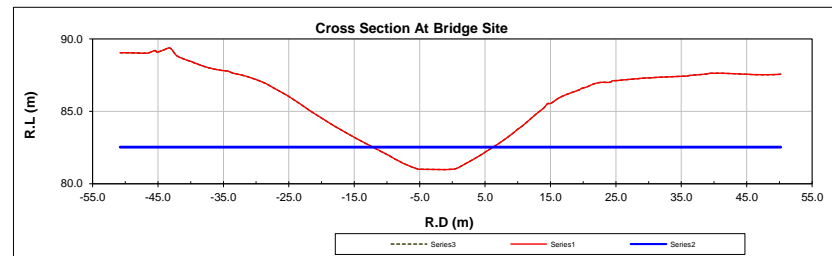


Distance	RL of Existing GL	RL of Modified GL	HFL	a	p	r=a/p	q
-50.77	89.050	89.050	82.529	-	-	-	-
-49.19	89.040	89.040	82.529				
-48.13	89.030	89.030	82.529				
-46.61	89.020	89.020	82.529				
-45.45	89.200	89.200	82.529				
-45.16	89.080	89.080	82.529				
-44.17	89.230	89.230	82.529				
-43.13	89.360	89.360	82.529				
-42.10	88.830	88.830	82.529				
-40.49	88.520	88.520	82.529				
-39.90	88.440	88.440	82.529				
-39.47	88.350	88.350	82.529				
-38.37	88.170	88.170	82.529				
-37.22	88.000	88.000	82.529				
-35.85	87.870	87.870	82.529				
-34.83	87.800	87.800	82.529				
-34.30	87.780	87.780	82.529				
-33.57	87.640	87.640	82.529				
-32.24	87.510	87.510	82.529				
-31.24	87.380	87.380	82.529				
-30.16	87.220	87.220	82.529				
-30.00	87.190	87.190	82.529				
-28.56	86.930	86.930	82.529				
-27.55	86.670	86.670	82.529				
-26.05	86.300	86.300	82.529				
-25.00	86.030	86.030	82.529				
-24.90	86.000	86.000	82.529				
-23.29	85.520	85.520	82.529				
-21.62	85.000	85.000	82.529				
-20.00	84.540	84.540	82.529				
-17.94	83.960	83.960	82.529				
-15.00	83.210	83.210	82.529				
-14.11	82.990	82.990	82.529				
-11.01	82.260	82.260	82.529				
-10.00	82.020	82.020	82.529	0.393	1.040	0.378	0.4568
-9.90	82.000	82.000	82.529	0.053	0.104	0.509	0.0749
-7.46	81.400	81.400	82.529	2.019	2.510	0.805	3.8812
-5.18	81.000	81.000	82.529	3.025	2.312	1.308	8.0421
-5.00	81.000	81.000	82.529	0.281	0.184	1.529	0.8293
0.00	81.000	81.000	82.529	7.643	5.000	1.529	22.5362
1.54	81.270	81.270	82.529	2.142	1.561	1.373	5.8784
4.40	82.000	82.000	82.529	2.555	2.952	0.866	5.1586
5.00	82.180	82.180	82.529	0.264	0.629	0.420	0.3297
6.22	82.530	82.530	82.529	0.212	1.270	0.167	0.1427
7.53	82.910	82.910	82.529				
9.41	83.540	83.540	82.529				
9.90	83.740	83.740	82.529				
10.73	84.000	84.000	82.529				
12.74	84.790	84.790	82.529				
13.92	85.210	85.210	82.529				
14.55	85.530	85.530	82.529				
15.06	85.550	85.550	82.529				
16.43	85.960	85.960	82.529				
18.07	86.270	86.270	82.529				
19.45	86.490	86.490	82.529				
19.70	86.580	86.580	82.529				
20.55	86.680	86.680	82.529				

21.60	86.890	86.890	82.529				
22.71	87.000	87.000	82.529				
24.02	87.000	87.000	82.529				
24.50	87.110	87.110	82.529				
25.08	87.120	87.120	82.529				
26.14	87.170	87.170	82.529				
27.40	87.220	87.220	82.529				
28.67	87.270	87.270	82.529				
29.69	87.310	87.310	82.529				
30.32	87.310	87.310	82.529				
31.04	87.340	87.340	82.529				
32.47	87.370	87.370	82.529				
33.98	87.400	87.400	82.529				
35.60	87.430	87.430	82.529				
35.95	87.440	87.440	82.529				
36.30	87.480	87.480	82.529				
37.67	87.530	87.530	82.529				
38.97	87.580	87.580	82.529				
39.20	87.620	87.620	82.529				
40.23	87.630	87.630	82.529				
41.23	87.630	87.630	82.529				
42.37	87.610	87.610	82.529				
43.60	87.590	87.590	82.529				
44.67	87.560	87.560	82.529				
45.25	87.560	87.560	82.529				
45.81	87.540	87.540	82.529				
47.05	87.530	87.530	82.529				
48.26	87.530	87.530	82.529				
49.32	87.540	87.540	82.529				
50.20	87.560	87.560	82.529				
An1=				18.588	Q=		47.330

(D) Afflux Calculation

Determination of Obstructed Bridge Area



Distance	RL of Existing GL	RL of Modified GL	HFL	a	p	r=a/p	q	depth, d
-50.77	89.050	89.050	82.529	-	-	-	-	-
-49.19	89.040	89.040	82.529					
-48.13	89.030	89.030	82.529					
-46.61	89.020	89.020	82.529					
-45.45	89.200	89.200	82.529					
-45.16	89.080	89.080	82.529					
-44.17	89.230	89.230	82.529					
-43.13	89.360	89.360	82.529					
-42.10	88.830	88.830	82.529					
-40.49	88.520	88.520	82.529					
-39.90	88.440	88.440	82.529					
-39.47	88.350	88.350	82.529					
-38.37	88.170	88.170	82.529					
-37.22	88.000	88.000	82.529					
-35.85	87.870	87.870	82.529					
-34.83	87.800	87.800	82.529					
-34.30	87.780	87.780	82.529					
-33.57	87.640	87.640	82.529					
-32.24	87.510	87.510	82.529					
-31.24	87.380	87.380	82.529					
-30.16	87.220	87.220	82.529					
-30.00	87.190	87.190	82.529					
-28.56	86.930	86.930	82.529					
-27.55	86.670	86.670	82.529					
-26.05	86.300	86.300	82.529					
-25.00	86.030	86.030	82.529					
-24.90	86.000	86.000	82.529					
-23.29	85.520	85.520	82.529					
-21.62	85.000	85.000	82.529					
-20.00	84.540	84.540	82.529					
-17.94	83.960	83.960	82.529					
-15.00	83.210	83.210	82.529					
-14.11	82.990	82.990	82.529					
-11.01	82.260	82.260	82.529					0.2685
-10.00	82.020	82.020	82.529	0.393	1.040	0.378	0.4568	0.5085
-9.90	82.000	82.000	82.529	0.053	0.104	0.509	0.0749	0.5285
-7.46	81.400	81.400	82.529	2.019	2.510	0.805	3.8813	1.1285
-5.18	81.000	81.000	82.529	3.025	2.312	1.308	8.0421	1.5285
-5.00	81.000	81.000	82.529	0.281	0.184	1.529	0.8293	1.5285
0.00	81.000	81.000	82.529	7.643	5.000	1.529	22.5362	1.5285
1.54	81.270	81.270	82.529	2.142	1.561	1.373	5.8784	1.2585
4.40	82.000	82.000	82.529	2.555	2.952	0.866	5.1586	0.5285
5.00	82.180	82.180	82.529	0.264	0.629	0.420	0.3297	0.3485
6.22	82.530	82.530	82.529	0.212	1.270	0.167	0.1427	
7.53	82.910	82.910	82.529					

9.41	83.540	83.540	82.529					
9.90	83.740	83.740	82.529					
10.73	84.000	84.000	82.529					
12.74	84.790	84.790	82.529					
13.92	85.210	85.210	82.529					
14.55	85.530	85.530	82.529					
15.06	85.550	85.550	82.529					
16.43	85.960	85.960	82.529					
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21.60	86.890	86.890	82.529					
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24.02	87.000	87.000	82.529					
24.50	87.110	87.110	82.529					
25.08	87.120	87.120	82.529					
26.14	87.170	87.170	82.529					
27.40	87.220	87.220	82.529					
28.67	87.270	87.270	82.529					
29.69	87.310	87.310	82.529					
30.32	87.310	87.310	82.529					
31.04	87.340	87.340	82.529					
32.47	87.370	87.370	82.529					
33.98	87.400	87.400	82.529					
35.60	87.430	87.430	82.529					
35.95	87.440	87.440	82.529					
36.30	87.480	87.480	82.529					
37.67	87.530	87.530	82.529					
38.97	87.580	87.580	82.529					
39.20	87.620	87.620	82.529					
40.23	87.630	87.630	82.529					
41.23	87.630	87.630	82.529					
42.37	87.610	87.610	82.529					
43.60	87.590	87.590	82.529					
44.67	87.560	87.560	82.529					
45.25	87.560	87.560	82.529					
45.81	87.540	87.540	82.529					
47.05	87.530	87.530	82.529					
48.26	87.530	87.530	82.529					
49.32	87.540	87.540	82.529					
50.20	87.560	87.560	82.529					
				An2*=	18.588	sq m	Q=	47.330 Cumecs
				Average depth, d	=	0.916	m	
				Lowest Bed Level	=	81.000	m	

Therefore,

Discharge, Q = 47.330 cumec

HFL (Without Afflux) = 82.529 m

Average Depth, d = 0.916 m

Area before constriction

An1 = 18.588 sq m

Average velocity prior to constriction

Vn1 = $\frac{Q}{An1}$ = 2.546 m/s

Area after constriction

An2* = 18.588 sq m

An2 = An2* - no's of piers * average width of piers * average depth (d)

= 18.588 sq m

Average Velocity after constriction

Vn2 = $\frac{Q}{An2}$ = 2.546 m/s

Afflux due to constriction (By Molesworth Formula)

h = $\frac{[(Vn1^2)/17.88+0.015]}{2} [(An1/An2)^2-1]$

= 0.000 m

(E) **Recommendation**

Design Discharge, Qd = 47.330 cumecs

Design Affluxed HFL = 82.529 m

Average Velocity, Vn2 = 2.546 m/sec

(F) **Hydraulic Adequacy**

Design Affluxed HFL = 82.529 m

Required Vortice Clearance = 0.90 m

Proposed Soffit Level = 83.429 m

(G)

SCOUR DEPTH CALCULATION

Chainage	Br-6	km
HFL	82.53	m
Qd	47.33	cumec
Qdf=1.3*Qd	61.53	cumec
Effective Linear Waterway(Le)	15.00	m
Regime Width, W'=4.8*(Qd^0.5)	33.022	m
Db=Qdf/min(W',Le)	4.102	cumec/m

Abutment

Weighted Ksf*	Mean Scour Depth,Dsm=1.34*(Db2/Ksf)^1/3	Scour Depth,for Abutment,dsm=1.27xDsm	Scour Level=HFL-dsma	Observation	Recommened Scour Level (m)
Scour level limited toHard Rock Level found at site					

* Based on the data observed from the Geo technical report.

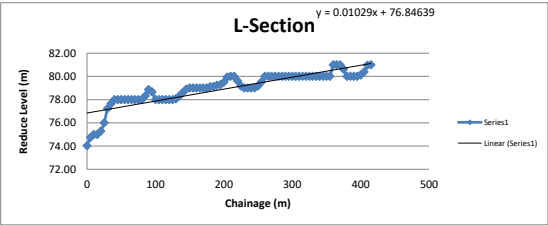
SUMMARY					
Sr.No	Chainage (km)	Discharge (Cumecs)			Design Discharge (Cumecs)
		Modified Rational Method (Cumecs)	By Rational Method (Cumecs)	By Area Velocity Method	
1	Br-14	33.932	41.306	-	41.306

Sr.No	Chainage (km)	Design Discharge (cumecs)	Design HFL (m)	Average Velocity (m/s)	Avg. depth (m)	LBL (m)	Proposed Waterway (m)	Vertical clearance Required (m)	Proposed Minimum Soffit level (m)
1	Br-14	41.306	80.592	2.17	0.92	79.48	20	0.9	81.492

*Note Scour Level limited to Hard Rock level found at site

Longitudnal Slope

Chainage (m)	RL (m)
0.00	74.03
5.00	74.75
10.00	75.00
15.00	75.00
20.00	75.28
25.00	76.00
30.00	77.23
35.00	77.64
40.00	78.00
45.00	78.00
50.00	78.00
55.00	78.00
60.00	78.00
65.00	78.00
70.00	78.00
75.00	78.00
80.00	78.00
85.00	78.32
90.00	78.87
95.00	78.66
100.00	78.01
105.00	78.00
110.00	78.00
115.00	78.00
120.00	78.00
125.00	78.00
130.00	78.07
135.00	78.31
140.00	78.61
145.00	78.90
150.00	79.00
155.00	79.00
160.00	79.00
165.00	79.00
170.00	79.00
175.00	79.00
180.00	79.11
185.00	79.14
190.00	79.24
195.00	79.28
200.00	79.50
205.00	79.94
210.00	80.00
215.00	80.00
220.00	79.63
225.00	79.16
230.00	79.00
235.00	79.00
240.00	79.00
245.00	79.02
250.00	79.17
255.00	79.52
260.00	80.00
265.00	80.00
270.00	80.00
275.00	80.00
280.00	80.00
285.00	80.00
290.00	80.00
295.00	80.00
300.00	80.00
305.00	80.00
310.00	80.000
315.00	80.000
320.00	80.000
325.00	80.000
330.00	80.000
335.00	80.000
340.00	80.000
345.00	80.000
350.00	80.000
355.00	80.000
360.00	81.000
365.00	81.000
370.00	81.000
375.00	80.624
380.00	80.000
385.00	80.000
390.00	80.000
395.00	80.000
400.00	80.113
405.00	80.374
410.00	80.959
414.931	81.000



DESIGN DISCHARGE CALCULATION

Name and number of subzone Subzone-5a-b
 Existing Chainage -
 Proposed chainage Br-14
 River/Stream -
 Type Minor Bridge

(A) FLOOD ESTIMATION

(1) Rational method (Bridges and Floods Wing Report, RBF-16)

Catchment Area of River, A = 1.300 km² 0.502 Mile²
 Length of longest stream, L = 3.30 km 2.049 Mile
 Level Difference between source and bridge site, H = 35.0 m 0.022 Mile
 Slope (in percent) = 1.061

R = 100 year 24 hour point rainfall
 = 48.00 cm (Refer Subzone Report 5a-b)
 tc = Time of concentration
 = $0.9 \times L / (M \ 0.1 \times S \ 0.2)$
 = 1.953 hr.
 F = Areal Reduction factor
 = 0.88
 C = Runoff Coefficient
 = $0.415 \times (R \times F)^{0.2}$
 = 0.88
 tc hr. ratio = 0.53
 1 hr. ratio = 0.416 Refer. RBF - 16 Report
 Conversion Ratio, K = tc hr. ratio / 1 hr. ratio
 = 1.27
 R100(24) = 48 cm
 R100(1) = R100(24) x 1 hr. to 24 hr. rainfall ratio
 = 19.97 cm
 = 199.68 mm
 R100(tc) = K x R100(1)
 = 254.40 mm
 I = 100 year rainfall intensity (mm/hr) lasting for tc hr. duration
 = R100(tc)/tc
 = 130.27 mm/hr.
 Design Flood
 Q = $0.278 \times C \ I \ A$
 = 41.31 m³/sec

(2) By Rational Method (SP-13 Code)

Area of catchment, A 130 Ha
 Length of longest stream, L 3.30 Km
 The fall in level from critical point to the structure, H 35.00 m

Runoff Coefficient as per Terrain, P = 0.6
 $tc = ((0.87 \times (L^3/H))^{0.385})$ (Refer IRC SP-13)
 = 0.96 hr

Now,
 F (100 year-24 hr rainfall) 480 mm
 One hour conversion ratio
 from report 5a 0.32
 F (100 year-1 hr rainfall) 153.6 mm
 T I hour

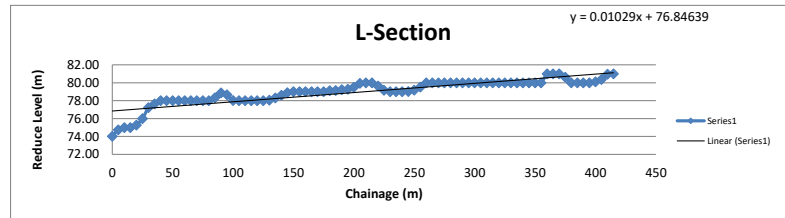
Now,
 $I_c = (F/T) \times ((T+1)/(tc+1))$ (Refer SP-13) Where, F Total precipitation
 = 156.94 mm/hr T Duration of time
 = 15.69 cm/hr
 f = 0.990 Fig.4.2 ' f-curve ' from IRC:SP: 13
 $Q = 0.028 \times P \times f \times A \times I_c$
 = 33.932 cumecs

(B) Fixing of Design Discharge

Calculated Peak Discharge by
 i) By Rational Method = 41.31 cumecs
 ii) By Rational Method (SP-13 Code) = 33.93 cumecs

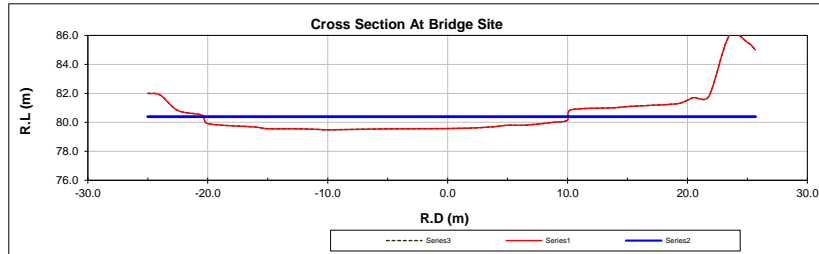
Therefore, The Recommended Design Discharge, Qd (As per clause 106.3.2, IRC:5-2015) = 41.31 cumecs

(C) Calculation of Design Affluxed HFL w.r.t. Design Discharge
Design Discharge, Qd = 41.31 Cumecs



Average Bed Slope of River, S = 0.01020
Manning's Coefficient, n = 0.045

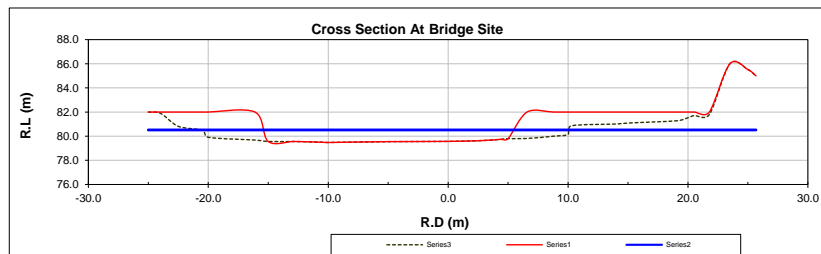
At Bridge Site



Distance	RL of Existing GL	RL of Modified GL	HFL	a	p	r=a/p	q
-25.01	82.000	82.000	80.391	-	-	-	-
-23.96	81.880	81.880	80.391				
-22.51	80.820	80.820	80.391				
-20.46	80.490	80.490	80.391				
-20.00	79.910	79.910	80.391	0.088	0.740	0.119	0.0475
-16.11	79.680	79.680	80.391	2.320	3.899	0.595	3.6836
-15.00	79.560	79.560	80.391	0.854	1.114	0.767	1.6061
-12.91	79.560	79.560	80.391	1.740	2.094	0.831	3.4526
-11.52	79.530	79.530	80.391	1.174	1.388	0.846	2.3574
-10.52	79.500	79.500	80.391	0.878	1.002	0.876	1.8033
-10.00	79.480	79.480	80.391	0.465	0.516	0.900	0.9730
-5.00	79.550	79.550	80.391	4.380	5.000	0.876	9.0007
0.00	79.570	79.570	80.391	4.155	5.000	0.831	8.2439
2.87	79.640	79.640	80.391	2.255	2.869	0.786	4.3089
4.37	79.740	79.740	80.391	1.050	1.501	0.700	1.8574
5.00	79.800	79.800	80.391	0.394	0.637	0.618	0.6414
6.58	79.810	79.810	80.391	0.925	1.578	0.586	1.4537
8.78	80.000	80.000	80.391	1.069	2.208	0.484	1.4801
10.00	80.150	80.150	80.391	0.386	1.231	0.314	0.4003
10.28	80.860	80.860	80.391				
14.04	81.010	81.010	80.391				
15.00	81.090	81.090	80.391				
19.11	81.280	81.280	80.391				
20.00	81.530	81.530	80.391				
20.55	81.710	81.710	80.391				
21.78	81.790	81.790	80.391				
23.50	86.000	86.000	80.391				
25.00	85.520	85.520	80.391				
25.67	85.000	85.000	80.391				
An1=				22.134		Q=	41.310

(D) Afflux Calculation

Determination of Obstructed Bridge Area



Distance	RL of Existing GL	RL of Modified GL	HFL	a	p	r=a/p	q	depth, d
-25.01	82.000	82.000	80.517	-	-	-	-	-
-23.96	81.880	82.000	80.517					
-22.51	80.820	82.000	80.517					
-20.46	80.490	82.000	80.517					
-20.00	79.910	82.000	80.517					
-16.11	79.680	82.000	80.517					
-15.00	79.560	79.560	80.517					0.9567
-12.91	79.560	79.560	80.517	2.003	2.094	0.957	4.3657	0.9567
-11.52	79.530	79.530	80.517	1.349	1.388	0.972	2.9693	0.9867
-10.52	79.500	79.500	80.517	1.004	1.002	1.001	2.2547	1.0167
-10.00	79.480	79.480	80.517	0.530	0.516	1.026	1.2095	1.0367
-5.00	79.550	79.550	80.517	5.009	5.000	1.002	11.2535	0.9667
0.00	79.570	79.570	80.517	4.784	5.000	0.957	10.4243	0.9467
2.87	79.640	79.640	80.517	2.615	2.869	0.911	5.5170	0.8767
4.37	79.740	79.740	80.517	1.238	1.501	0.825	2.4448	0.7767
5.00	79.800	79.800	80.517	0.473	0.637	0.743	0.8720	0.7167
6.58	79.810	82.000	80.517					
8.78	80.000	82.000	80.517					
10.00	80.150	82.000	80.517					
10.28	80.860	82.000	80.517					
14.04	81.010	82.000	80.517					
15.00	81.090	82.000	80.517					
19.11	81.280	82.000	80.517					
20.00	81.530	82.000	80.517					
20.55	81.710	82.000	80.517					
21.78	81.790	82.000	80.517					
23.50	86.000	86.000	80.517					
25.00	85.520	85.520	80.517					
25.67	85.000	85.000	80.517					
An2*=				19.005	sq m	Q=	41.311	Cumecs
Average depth, d				=		0.924	m	
Lowest Bed Level				=		79.480	m	

Therefore,

Discharge, Q = 41.311 cumec

HFL (Without Afflux) = 80.391 m

Average Depth, d = 0.924 m

Area before constriction

An1 = 22.134 sq m

Average velocity prior to constriction

Vn1 = Q/An1 = 1.866 m/s

Area after constriction

An2* = 19.005 sq m

An2 = An2* - no's of piers * average width of piers * average depth (d)

= 19.005 sq m

Average Velocity after constriction

Vn2 = Q/An2 = 2.174 m/s

Afflux due to constriction (By Molesworth Formula)

h = $[(Vn1^2)/17.88 + 0.015] [(An1/An2)^2 - 1]$

= 0.075 m

(E) **Recommendation**

Design Discharge, Qd = 41.311 cumecs

Design Affluxed HFL = 80.592 m

Average Velocity, Vn2 = 2.174 m/sec

(F) **Hydraulic Adequacy**

Design Affluxed HFL = 80.592 m

Required VEHICLE Clearance = 0.90 m

Proposed Soffit Level = 81.492 m

(G)

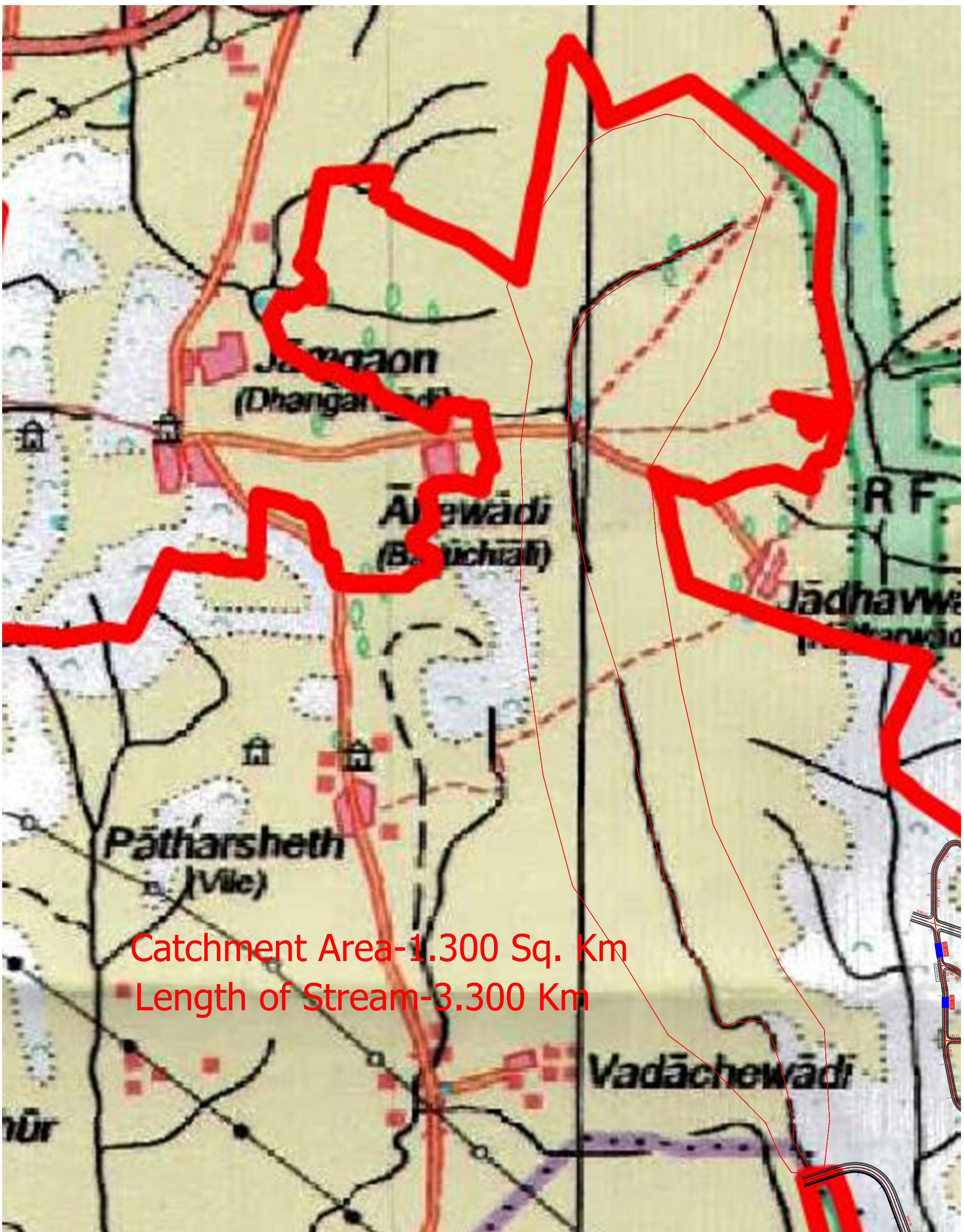
SCOUR DEPTH CALCULATION

Chainage	Br-14	km
HFL	80.59	m
Qd	41.31	cumec
Qdf=1.3*Qd	53.70	cumec
Effective Linear Waterway(Le)	20.00	m
Regime Width, W'=4.8*(Qd^0.5)	30.851	m
Db=Qdf/min(W',Le)	2.685	cumec/m

Abutment

Weighted Ksf*	Mean Scour Depth,Dsm=1.34*(Db2/Ksf)^1/3	Scour Depth,for Abutment,dsm=1.27xDsm	Scour Level=HFL-dsma	Observation	Recommened Scour Level (m)
Scour level limited toHard Rock Level found at site					

* Based on the data observed from the Geo technical report.



Catchment Area-1.300 Sq. Km
Length of Stream-3.300 Km

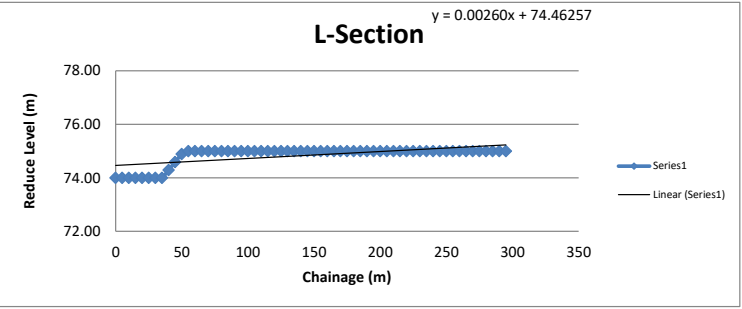
SUMMARY					
Sr.No	Chainage (km)	Discharge (Cumecs)			Design Discharge (Cumecs)
		Modified Rational Method (Cumecs)	By Rational Method (Cumecs)	By Area Velocity Method	
1	Br-15	32.970	47.894	-	47.894

Sr.No	Chainage (km)	Design Discharge (cumecs)	Design HFL (m)	Average Velocity (m/s)	Avg. depth (m)	LBL (m)	Proposed Waterway (m)	Vertical clearance Required (m)	Proposed Minimum Soffit level (m)
1	Br-15	47.894	76.556	1.71	1.85	74.56	18	0.9	77.456

* Note Scour Level limited to Hard Rock level found at site

Longitudnal Slope

Chainage (m)	RL (m)
0.00	74.00
5.00	74.00
10.00	74.00
15.00	74.00
20.00	74.00
25.00	74.00
30.00	74.00
35.00	74.00
40.00	74.29
45.00	74.59
50.00	74.89
55.00	75.00
60.00	75.00
65.00	75.00
70.00	75.00
75.00	75.00
80.00	75.00
85.00	75.00
90.00	75.00
95.00	75.00
100.00	75.00
105.00	75.00
110.00	75.00
115.00	75.00
120.00	75.00
125.00	75.00
130.00	75.00
135.00	75.00
140.00	75.00
145.00	75.00
150.00	75.00
155.00	75.00
160.00	75.00
165.00	75.00
170.00	75.00
175.00	75.00
180.00	75.00
185.00	75.00
190.00	75.00
195.00	75.00
200.00	75.00
205.00	75.00
210.00	75.00
215.00	75.00
220.00	75.00
225.00	75.00
230.00	75.00
235.00	75.00
240.00	75.00
245.00	75.00
250.00	75.00
255.00	75.00
260.00	75.00
265.00	75.00
270.00	75.00
275.00	75.00
280.00	75.00
285.00	75.00
290.00	75.00
295.00	75.00



DESIGN DISCHARGE CALCULATION

Name and number of subzone Subzone-5a-b
 Existing Chainage -
 Proposed chainage Br-15
 River/Stream -
 Type Minor Bridge

(A) FLOOD ESTIMATION

(1) Rational method (Bridges and Floods Wing Report, RBF-16)

Catchment Area of River, A = 0.976 km² 0.377 Mile²
 Length of longest stream, L = 1.59 km 0.990 Mile
 Level Difference between source and bridge site, H = 20.0 m 0.012 Mile
 Slope (in percent) = 1.255

R = 100 year 24 hour point rainfall
 = 48.00 cm (Refer Subzone Report 5a-b)
 tc = Time of concentration
 = $0.9 \times L / (M \ 0.1 \times S \ 0.2)$
 = 0.939 hr.
 F = Areal Reduction factor
 = 0.81
 C = Runoff Coefficient
 = $0.415 \times (R \times F)^{0.2}$
 = 0.86
 tc hr. ratio = 0.40
 1 hr. ratio = 0.416 Refer. RBF - 16 Report
 Conversion Ratio, K = tc hr. ratio / 1 hr. ratio
 = 0.96
 R100(24) = 48 cm
 R100(1) = R100(24) x 1 hr. to 24 hr. rainfall ratio
 = 19.97 cm
 = 199.68 mm
 R100(tc) = K x R100(1)
 = 192.00 mm
 I = 100 year rainfall intensity (mm/hr) lasting for tc hr. duration
 = R100(tc)/tc
 = 204.55 mm/hr.
 Design Flood
 Q = $0.278 \times C \ I \ A$
 = 47.89 m3/sec

(2) By Rational Method (SP-13 Code)

Area of catchment, A 97.6 Ha
 Length of longest stream, L 1.59 Km
 The fall in level from critical point to the structure, H 20.00 m

Runoff Coefficient as per Terrain, P = 0.6
 $tc = ((0.87 \times (L^3/H))^{0.385})$ (Refer IRC SP-13)
 = 0.51 hr

Now,
 F (100 year-24 hr rainfall) 480 mm
 One hour conversion ratio
 from report 5a 0.32
 F (100 year-1 hr rainfall) 153.6 mm
 T I hour

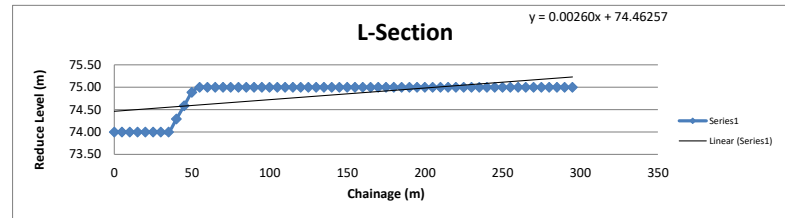
Now,
 $I_c = (F/T) \times ((T+1)/(tc+1))$ (Refer SP-13) Where, F Total precipitation
 = 203.11 mm/hr T Duration of time
 = 20.31 cm/hr
 f = 0.990 Fig.4.2 ' f-curve ' from IRC:SP: 13
 $Q = 0.028 \times P \times f \times A_{xlc}$
 = 32.970 cumecs

(B) Fixing of Design Discharge

Calculated Peak Discharge by
 i) By Rational Method = 47.894 cumecs
 ii) By Rational Method (SP-13 Code) = 32.970 cumecs

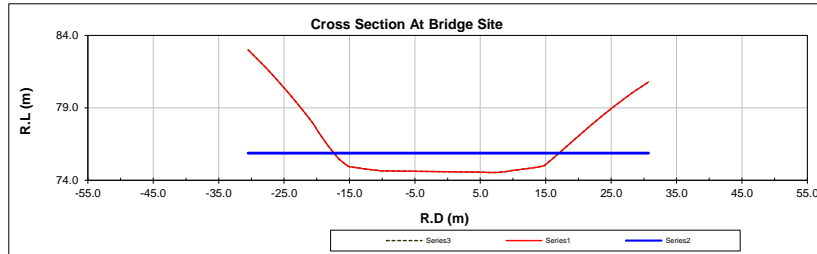
Therefore, The Recommended Design Discharge, Qd (As per clause 106.3.2, IRC:5-2015) = 47.894 cumecs

(C) Calculation of Design Affluxed HFL w.r.t. Design Discharge
 Design Discharge, Qd = 47.89 Cumecs



Average Bed Slope of River, S = 0.00260
 Manning's Coefficient, n = 0.045

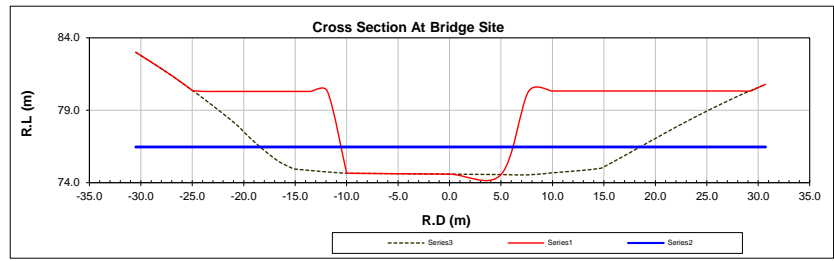
At Bridge Site



Distance	RL of Existing GL	RL of Modified GL	HFL	a	p	r=a/p	q
-30.49	83.000	83.000	75.873	-	-	-	-
-30.00	82.780	82.780	75.873				
-27.83	81.790	81.790	75.873				
-26.22	81.000	81.000	75.873				
-25.00	80.370	80.370	75.873				
-24.95	80.350	80.350	75.873				
-23.88	79.790	79.790	75.873				
-22.44	79.000	79.000	75.873				
-20.63	77.960	77.960	75.873				
-20.00	77.510	77.510	75.873				
-18.96	76.810	76.810	75.873				
-17.61	76.000	76.000	75.873				
-16.45	75.400	75.400	75.873	0.202	1.313	0.154	0.0659
-15.16	74.960	74.960	75.873	0.893	1.361	0.656	0.7637
-15.00	74.940	74.940	75.873	0.145	0.158	0.916	0.1549
-13.52	74.840	74.840	75.873	1.456	1.484	0.981	1.6289
-11.87	74.740	74.740	75.873	1.790	1.656	1.081	2.1372
-10.00	74.650	74.650	75.873	2.198	1.868	1.177	2.7767
-9.94	74.650	74.650	75.873	0.071	0.058	1.223	0.0919
-5.00	74.620	74.620	75.873	6.119	4.942	1.238	7.9947
0.00	74.590	74.590	75.873	6.341	5.000	1.268	8.4178
5.00	74.560	74.560	75.873	6.491	5.000	1.296	8.7523
7.68	74.540	74.540	75.873	3.545	2.679	1.323	4.8409
9.93	74.680	74.680	75.873	2.840	2.252	1.261	3.7550
10.00	74.680	74.680	75.873	0.087	0.073	1.193	0.1110
11.52	74.770	74.770	75.873	1.750	1.527	1.146	2.1715
12.89	74.850	74.850	75.873	1.453	1.369	1.061	1.7135
14.65	74.990	74.990	75.873	1.675	1.763	0.950	1.8341
15.00	75.090	75.090	75.873	0.293	0.366	0.801	0.2867
17.35	76.000	76.000	75.873	0.771	2.518	0.306	0.3965
19.25	76.760	76.760	75.873				
20.00	77.050	77.050	75.873				
21.80	77.760	77.760	75.873				
24.05	78.600	78.600	75.873				
25.00	78.940	78.940	75.873				
25.16	79.000	79.000	75.873				
28.11	80.000	80.000	75.873				
29.20	80.330	80.330	75.873				
30.00	80.570	80.570	75.873				
30.71	80.790	80.790	75.873				
An1=				38.120		Q=	47.893

(D) Afflux Calculation

Determination of Obstructed Bridge Area



Distance	RL of Existing GL	RL of Modified GL	HFL	a	p	r=a/p	q	depth, d
-30.49	83.000	83.000	76.467	-	-	-	-	-
-30.00	82.780	82.780	76.467					
-27.83	81.790	81.790	76.467					
-26.22	81.000	81.000	76.467					
-25.00	80.370	80.370	76.467					
-24.95	80.350	80.350	76.467					
-23.88	79.790	80.300	76.467					
-22.44	79.000	80.300	76.467					
-20.63	77.960	80.300	76.467					
-20.00	77.510	80.300	76.467					
-18.96	76.810	80.300	76.467					
-17.61	76.000	80.300	76.467					
-16.45	75.400	80.300	76.467					
-15.16	74.960	80.300	76.467					
-15.00	74.940	80.300	76.467					
-13.52	74.840	80.300	76.467					
-11.87	74.740	80.300	76.467					
-10.00	74.650	74.650	76.467					1.8168
-9.94	74.650	74.650	76.467	0.105	0.058	1.817	0.1778	1.8168
-5.00	74.620	74.620	76.467	9.053	4.942	1.832	15.3572	1.8468
0.00	74.590	74.590	76.467	9.309	5.000	1.862	15.9638	1.8768
5.00	74.560	74.560	76.467	9.459	5.000	1.892	16.3948	1.9068
7.68	74.540	80.300	76.467					
9.93	74.680	80.330	76.467					
10.00	74.680	80.330	76.467					
11.52	74.770	80.330	76.467					
12.89	74.850	80.330	76.467					
14.65	74.990	80.330	76.467					
15.00	75.090	80.330	76.467					
17.35	76.000	80.330	76.467					
19.25	76.760	80.330	76.467					
20.00	77.050	80.330	76.467					
21.80	77.760	80.330	76.467					
24.05	78.600	80.330	76.467					
25.00	78.940	80.330	76.467					
25.16	79.000	80.330	76.467					
28.11	80.000	80.330	76.467					
29.20	80.330	80.330	76.467					
30.00	80.570	80.570	76.467					
30.71	80.790	80.790	76.467					
An2²=				27.926	sq m	Q=	47.894	Cumecs
Average depth, d				=	1.853	m		
Lowest Bed Level				=	74.560	m		

Therefore,			
Discharge, Q	=	47.894	cumec
HFL (Without Afflux)	=	75.873	m
Average Depth, d	=	1.853	m
Area before constriction			
An1	=	38.120	sq m
Average velocity prior to constriction			
Vn1	=	Q/An1	
	=	1.256	m/s
Area after constriction			
An2*	=	27.926	sq m
An2	=	An2* - no's of piers * average width of piers * average depth (d)	
	=	27.926	sq m
Average Velocity after constriction			
Vn2	=	Q/An2	
	=	1.715	m/s
Afflux due to constriction (By Molesworth Formula)			
h	=	[(Vn1 ²)/17.88+0.015] [(An1/An2) ² -1]	
	=	0.089	m
(E) Recommendation			
Design Discharge, Qd	=	47.894	cumecs
Design Affluxed HFL	=	76.556	m
Average Velocity, Vn2	=	1.715	m/sec
(F) Hydraulic Adequacy			
Design Affluxed HFL	=	76.556	m
Required Vercile Clearance	=	0.90	m
Proposed Soffit Level	=	77.456	m

(G)

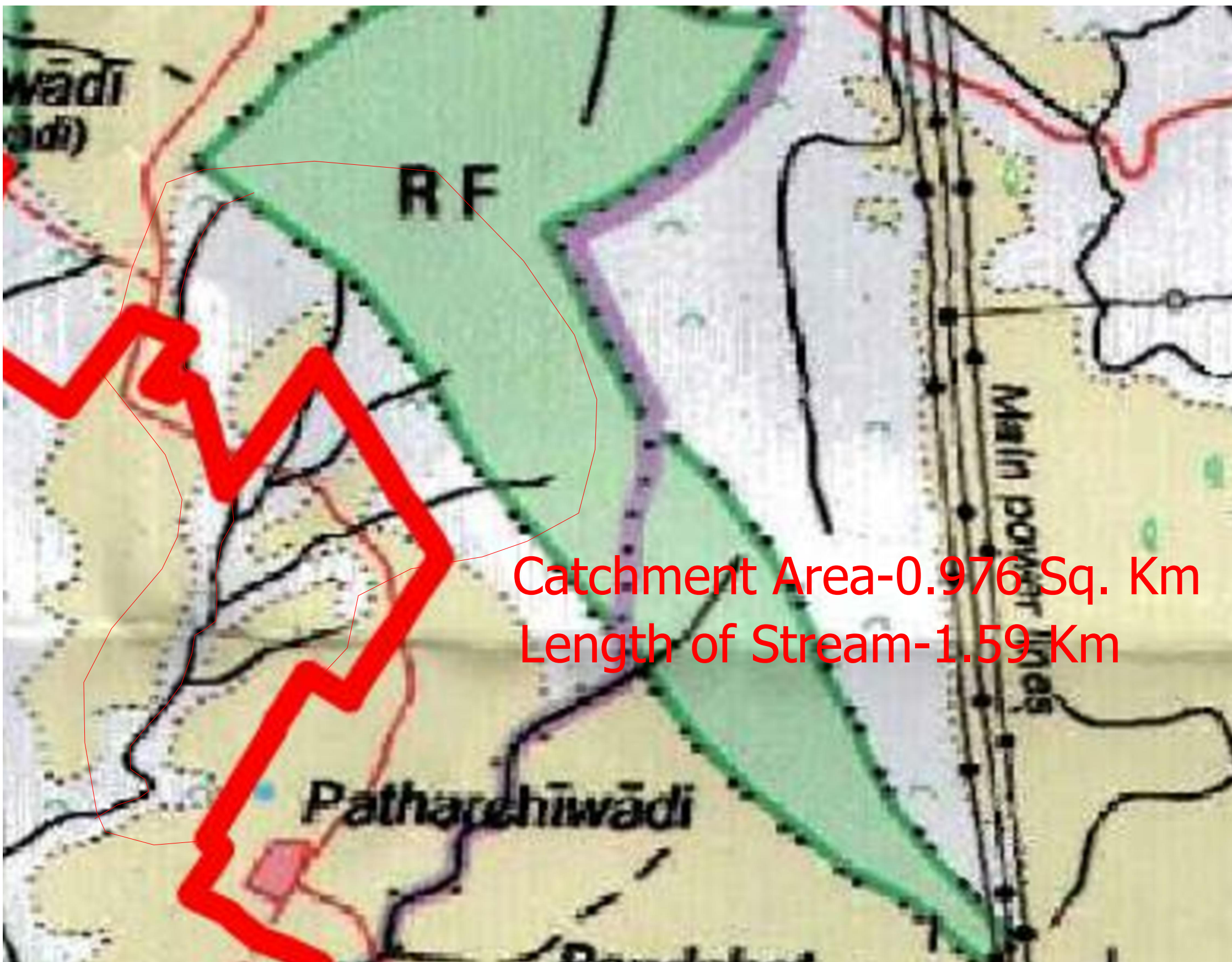
SCOUR DEPTH CALCULATION

Chainage	Br-15	km
HFL	76.56	m
Qd	47.89	cumec
Qdf=1.3*Qd	62.26	cumec
Effective Linear Waterway(Le)	18.00	m
Regime Width, W'=4.8*(Qd^0.5)	33.218	m
Db=Qdf/min(W',Le)	3.459	cumec/m

Abutment

Weighted Ksf*	Mean Scour Depth,Dsm=1.34*(Db2/Ksf)^1/3	Scour Depth,for Abutment,dsm=1.27xDsm	Scour Level=HFL-dsma	Observation	Recommened Scour Level (m)
Scour level limited toHard Rock Level found at site					

* Based on the data observed from the Geo technical report.



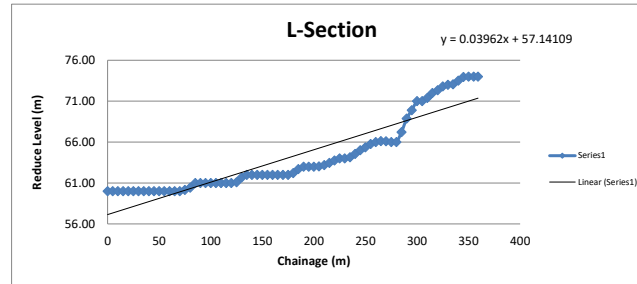
SUMMARY					
Sr.No	Chainage (km)	Discharge (Cumecs)			Design Discharge (Cumecs)
		Modified Rational Method (Cumecs)	By Rational Method (Cumecs)	By Area Velocity Method	
1	Br-16	75.243	116.495	-	116.495

Sr.No	Chainage (km)	Design Discharge (cumecs)	Design HFL (m)	Average Velocity (m/s)	Avg. depth (m)	LBL (m)	Proposed Waterway (m)	Vertical clearance Required (m)	Proposed Minimum Soffit level (m)
1	Br-16	116.495	65.426	4.23	0.88	64.00	35	0.9	66.326

* Note Scour Level limited to Hard Rock level found at site

Longitudnal Slope

Chainage (m)	RL (m)
0.00	60.00
5.00	60.00
10.00	60.00
15.00	60.00
20.00	60.00
25.00	60.00
30.00	60.00
35.00	60.00
40.00	60.00
45.00	60.00
50.00	60.00
55.00	60.00
60.00	60.00
65.00	60.00
70.00	60.00
75.00	60.16
80.00	60.42
85.00	61.00
90.00	61.00
95.00	61.00
100.00	61.00
105.00	61.00
110.00	61.00
115.00	61.00
120.00	61.00
125.00	61.09
130.00	61.69
135.00	62.00
140.00	62.00
145.00	62.00
150.00	62.00
155.00	62.00
160.00	62.00
165.00	62.00
170.00	62.00
175.00	62.00
180.00	62.20
185.00	62.70
190.00	63.00
195.00	63.00
200.00	63.00
205.00	63.02
210.00	63.18
215.00	63.47
220.00	63.75
225.00	64.00
230.00	64.00
235.00	64.15
240.00	64.55
245.00	65.00
250.00	65.36
255.00	65.77
260.00	66.01
265.00	66.11
270.00	66.10
275.00	66.00
280.00	66.00
285.00	67.22
290.00	68.87
295.00	69.90
300.00	71.00
305.00	71.00
310.00	71.41
315.00	72.00
320.00	72.35
325.00	72.81
330.00	73.00
335.00	73.07
340.00	73.51
345.00	73.96
350.00	74.00
355.00	74.00
359.17	74.00



DESIGN DISCHARGE CALCULATION

Name and number of subzone Subzone-5a-b
 Existing Chainage -
 Proposed chainage Br-16
 River/Stream -
 Type Minor Bridge

(A) FLOOD ESTIMATION

(1) Rational method (Bridges and Floods Wing Report, RBF-16)

Catchment Area of River, A = 4.289 km² 1.656 Mile²
 Length of longest stream, L = 4.04 km 2.511 Mile
 Level Difference between source and bridge site, H = 25.0 m 0.016 Mile
 Slope (in percent) = 0.618

R = 100 year 24 hour point rainfall
 = 48.00 cm (Refer Subzone Report 5a-b)
 tc = Time of concentration
 = $0.9 \times L / (M \ 0.1 \times S \ 0.2)$
 = 2.365 hr.
 F = Areal Reduction factor
 = 0.87
 C = Runoff Coefficient
 = $0.415 \times (R \times F)^{0.2}$
 = 0.88
 tc hr. ratio = 0.55
 1 hr. ratio = 0.416 Refer. RBF - 16 Report
 Conversion Ratio, K = tc hr. ratio / 1 hr. ratio
 = 1.32
 R100(24) = 48 cm
 R100(1) = R100(24) x 1 hr. to 24 hr. rainfall ratio
 = 19.97 cm
 = 199.68 mm
 R100(tc) = K x R100(1)
 = 264.00 mm
 I = 100 year rainfall intensity (mm/hr) lasting for tc hr. duration
 = R100(tc)/tc
 = 111.61 mm/hr.
 Design Flood
 Q = $0.278 \times C \ I \ A$
 = 116.50 m³/sec

(2) By Rational Method (SP-13 Code)

Area of catchment, A 428.9 Ha
 Length of longest stream, L 4.04 Km
 The fall in level from critical point to the structure, H 25.00 m

Runoff Coefficient as per Terrain, P = 0.5

$$tc = ((0.87 \times (L^3/H))^{0.385}) \quad \text{(Refer IRC SP-13)}$$
 1.38 hr

Now,
 F (100 year-24 hr rainfall) 480 mm
 One hour conversion ratio
 from report 5a 0.32
 F (100 year-1 hr rainfall) 153.6 mm
 T I hour

Now,

$$I_c = (F/T) \times ((T+1)/(tc+1)) \quad \text{(Refer SP-13)} \quad \text{Where,} \quad F \quad \text{Total precipitation}$$
 = 129.18 mm/hr
 = 12.92 cm/hr

$$f = 0.970 \quad \text{Fig.4.2 ' f-curve ' from IRC:SP: 13}$$

$$Q = 0.028 \times P \times f \times A \times I_c$$
 75.243 cumecs

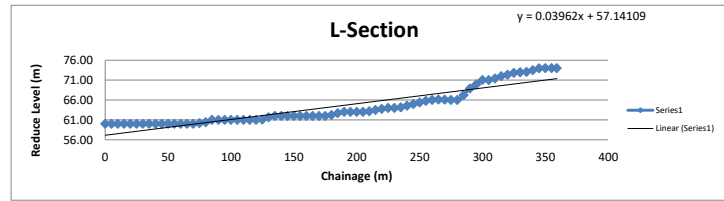
(B) Fixing of Design Discharge

Calculated Peak Discharge by
 i) By Rational Method = 116.50 cumecs
 ii) By Rational Method (SP-13 Code) = 75.24 cumecs

Therefore, The Recommended Design Discharge, Qd (As per clause 106.3.2, IRC:5-2015) = 116.50 cumecs

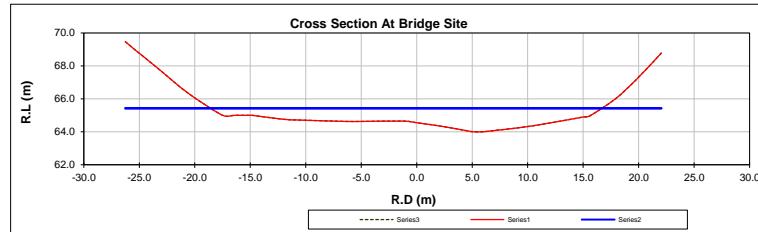
Skew Angle	15
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(C) Calculation of Design Affluxed HFL w.r.t. Design Discharge
Design Discharge, Qd = 116.50 Cumecs



Average Bed Slope of River, S = 0.03962
Manning's Coefficient, n = 0.045

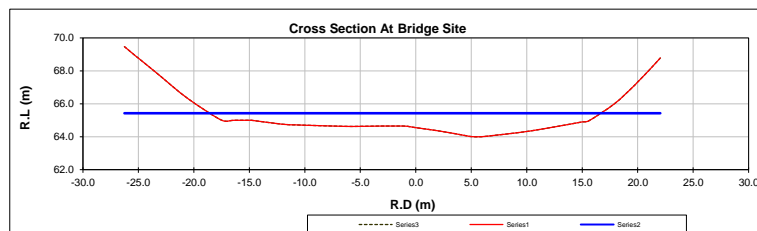
At Bridge Site



Distance	RL of Existing GL	RL of Modified GL	HFL	a	p	r=a/p	q
-26.258	69.470	69.470	65.426	-	-	-	-
-25.231	68.890	68.890	65.426	-	-	-	-
-25.000	68.770	68.770	65.426	-	-	-	-
-22.910	67.620	67.620	65.426	-	-	-	-
-21.255	66.680	66.680	65.426	-	-	-	-
-20.000	66.060	66.060	65.426	-	-	-	-
-19.813	65.970	65.970	65.426	-	-	-	-
-17.484	65.000	65.000	65.426	-	-	-	-
-16.407	65.000	65.000	65.426	0.443	1.040	0.426	1.1111
-15.000	65.000	65.000	65.426	0.579	1.359	0.426	1.4516
-14.816	65.000	65.000	65.426	0.076	0.178	0.426	0.1898
-12.042	64.760	64.760	65.426	1.464	2.690	0.544	4.3163
-10.862	64.720	64.720	65.426	0.782	1.140	0.686	2.6911
-10.000	64.700	64.700	65.426	0.596	0.833	0.716	2.1116
-6.435	64.630	64.630	65.426	2.622	3.444	0.761	9.6671
-5.000	64.630	64.630	65.426	1.104	1.386	0.796	4.1945
-1.164	64.650	64.650	65.426	2.914	3.705	0.786	10.9788
0.000	64.550	64.550	65.426	0.929	1.129	0.823	3.6098
1.306	64.430	64.430	65.426	1.181	1.267	0.932	4.9864
2.457	64.310	64.310	65.426	1.174	1.118	1.051	5.3685
3.499	64.190	64.190	65.426	1.184	1.013	1.169	5.8102
4.622	64.050	64.050	65.426	1.417	1.093	1.296	7.4517
5.000	64.010	64.010	65.426	0.510	0.367	1.389	2.8068
5.908	64.000	64.000	65.426	1.247	0.877	1.421	6.9702
7.038	64.080	64.080	65.426	1.513	1.094	1.383	8.3078
8.893	64.220	64.220	65.426	2.287	1.797	1.273	11.8798
10.000	64.320	64.320	65.426	1.236	1.074	1.152	6.0088
10.241	64.340	64.340	65.426	0.255	0.234	1.093	1.1975
11.765	64.510	64.510	65.426	1.474	1.481	0.995	6.4988
13.708	64.740	64.740	65.426	1.504	1.890	0.796	5.7124
15.000	64.900	64.900	65.426	0.757	1.258	0.602	2.3854
15.610	64.970	64.970	65.426	0.289	0.593	0.488	0.7938
17.903	66.000	66.000	65.426	-	-	-	-
19.535	67.000	67.000	65.426	-	-	-	-
20.000	67.320	67.320	65.426	-	-	-	-
20.976	68.000	68.000	65.426	-	-	-	-
22.041	68.780	68.780	65.426	-	-	-	-
An1=				27.538	Q=		116.500

(D) Afflux Calculation

Determination of Obstructed Bridge Area



Distance	RL of Existing GL	RL of Modified GL	HFL	a	p	r=a/p	q	depth, d
-26.258	69.470	69.470	65.426	-	-	-	-	-
-25.231	68.890	68.890	65.426	-	-	-	-	-
-25.000	68.770	68.770	65.426	-	-	-	-	-
-22.910	67.620	67.620	65.426	-	-	-	-	-
-21.255	66.680	66.680	65.426	-	-	-	-	-
-20.000	66.060	66.060	65.426	-	-	-	-	-
-19.813	65.970	65.970	65.426	-	-	-	-	-
-17.484	65.000	65.000	65.426	-	-	-	-	0.4263
-16.407	65.000	65.000	65.426	0.443	1.040	0.426	1.1111	0.4263
-15.000	65.000	65.000	65.426	0.579	1.359	0.426	1.4516	0.4263
-14.816	65.000	65.000	65.426	0.076	0.178	0.426	0.1898	0.4263
-12.042	64.760	64.760	65.426	1.464	2.690	0.544	4.3163	0.6663
-10.862	64.720	64.720	65.426	0.782	1.140	0.686	2.6911	0.7063
-10.000	64.700	64.700	65.426	0.596	0.833	0.716	2.1116	0.7263
-6.435	64.630	64.630	65.426	2.622	3.444	0.761	9.6671	0.7963
-5.000	64.630	64.630	65.426	1.104	1.386	0.796	4.1945	0.7963
-1.164	64.650	64.650	65.426	2.914	3.705	0.786	10.9788	0.7763
0.000	64.550	64.550	65.426	0.929	1.129	0.823	3.6098	0.8763
1.306	64.430	64.430	65.426	1.181	1.267	0.932	4.9864	0.9963
2.457	64.310	64.310	65.426	1.174	1.118	1.051	5.3685	1.1163
3.499	64.190	64.190	65.426	1.184	1.013	1.169	5.8102	1.2363
4.622	64.050	64.050	65.426	1.417	1.093	1.296	7.4517	1.3763
5.000	64.010	64.010	65.426	0.510	0.367	1.389	2.8068	1.4163
5.908	64.000	64.000	65.426	1.247	0.877	1.421	6.9702	1.4263
7.038	64.080	64.080	65.426	1.513	1.094	1.383	8.3078	1.3463
8.893	64.220	64.220	65.426	2.287	1.797	1.273	11.8798	1.2063
10.000	64.320	64.320	65.426	1.236	1.074	1.152	6.0088	1.1063
10.241	64.340	64.340	65.426	0.255	0.234	1.093	1.1975	1.0863
11.765	64.510	64.510	65.426	1.474	1.481	0.995	6.4988	0.9163
13.708	64.740	64.740	65.426	1.504	1.890	0.796	5.7124	0.6863
15.000	64.900	64.900	65.426	0.757	1.258	0.602	2.3854	0.5263
15.610	64.970	64.970	65.426	0.289	0.593	0.488	0.7938	0.4563
17.903	66.000	66.000	65.426	-	-	-	-	-
19.535	67.000	67.000	65.426	-	-	-	-	-
20.000	67.320	67.320	65.426	-	-	-	-	-
20.976	68.000	68.000	65.426	-	-	-	-	-
22.041	68.780	68.780	65.426	-	-	-	-	-
				An2*=	27.538	sq m	Q=	116.500
				Average depth, d	=	0.878	m	Cumecs
				Lowest Bed Level	=	64.000	m	

Therefore,			
Discharge, Q	=	116.500	cumec
HFL (Without Afflux)	=	65.426	m
Average Depth, d	=	0.878	m
Area before constriction			
An1	=	27.538	sq m
Average velocity prior to constriction			
Vn1	=	Q/An1	
	=	4.230	m/s
Area after constriction			
An2*	=	27.538	sq m
An2	=	An2* - no's of piers * average width of piers * average depth (d)	
	=	27.538	sq m
Average Velocity after constriction			
Vn2	=	Q/An2	
	=	4.230	m/s
Afflux due to constriction (By Molesworth Formula)			
h	=	[(Vn1^2)/17.88+0.015] [(An1/An2)^2-1]	
	=	0.000	m
(E) Recommendation			
Design Discharge, Qd	=	116.500	cumecs
Design Affluxed HFL	=	65.426	m
Average Velocity, Vn2	=	4.230	m/sec
(F) Hydraulic Adequacy			
Design Affluxed HFL	=	65.426	m
Required Vortice Clearance	=	0.90	m
Proposed Soffit Level	=	66.326	m

(G)

SCOUR DEPTH CALCULATION

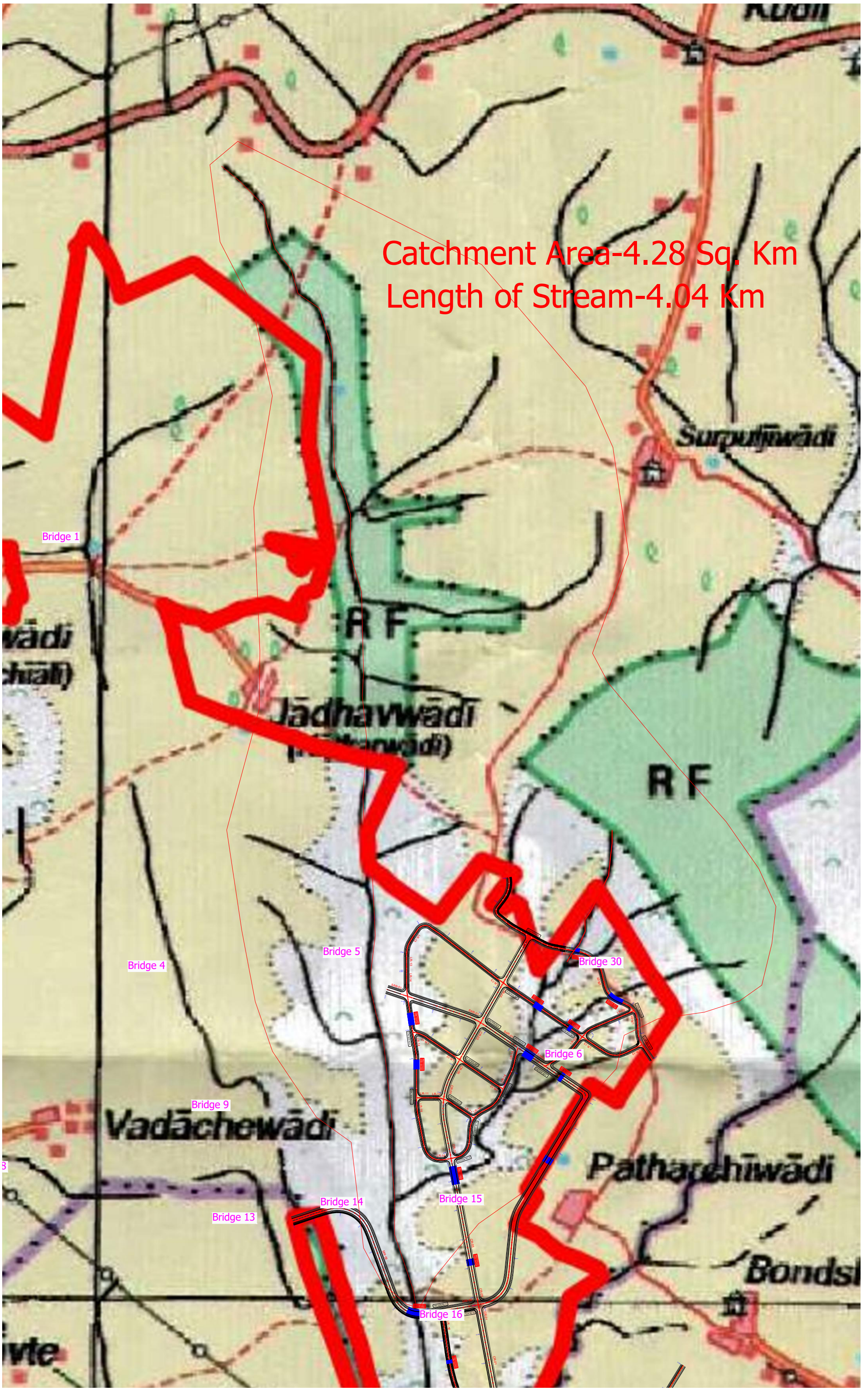
Chainage	Br-16	km
HFL	65.43	m
Qd	116.50	cumec
Qdf=1.3*Qd	151.45	cumec
Effective Linear Waterway(Le)	35.00	m
Regime Width, W'=4.8*(Qd^0.5)	51.809	m
Db=Qdf/min(W',Le)	4.327	cumec/m

Abutment

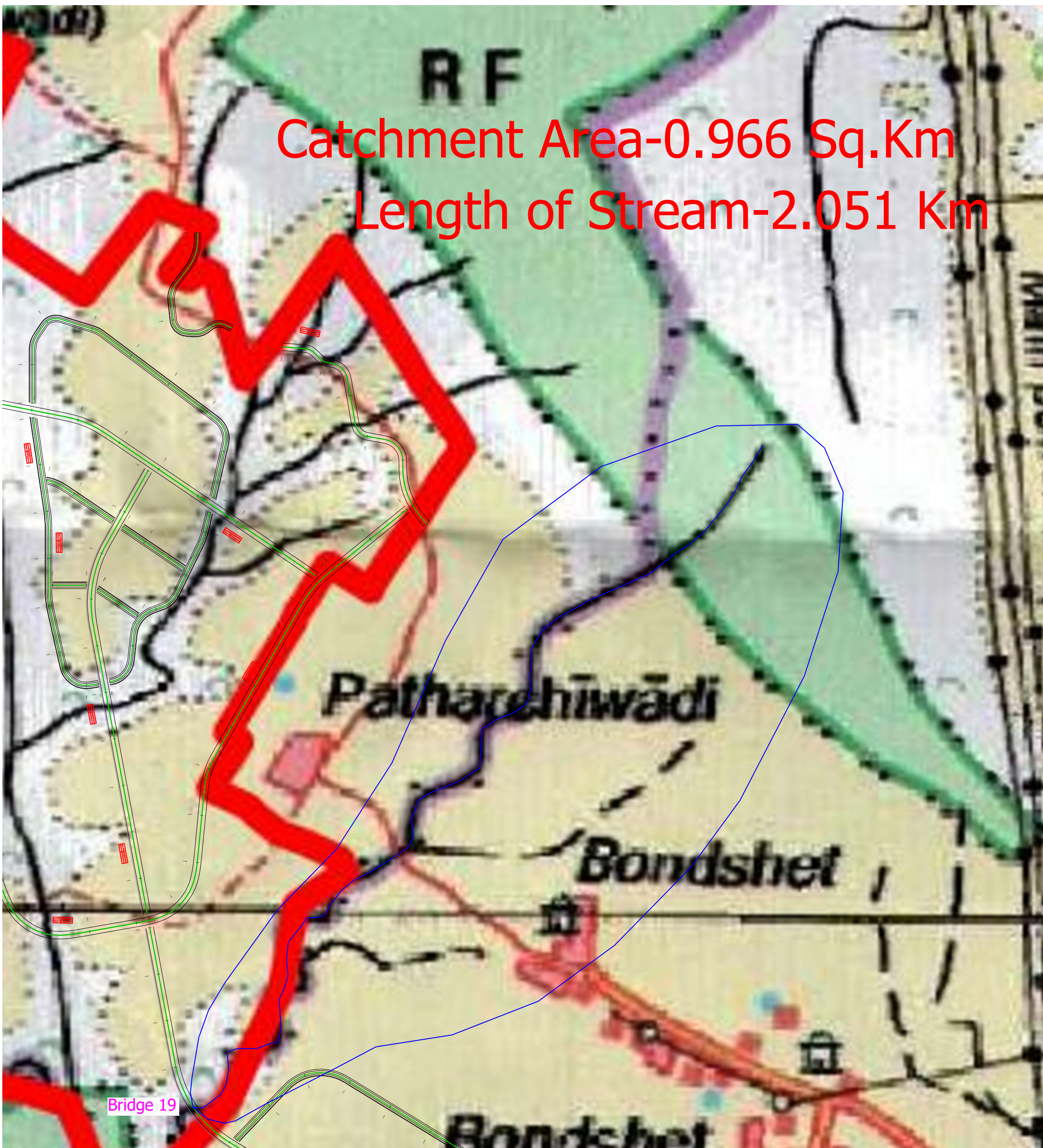
Weighted Ksf*	Mean Scour Depth,Dsm=1.34*(Db2/Ksf)^1/3	Scour Depth,for Abutment,dsm=1.27xDsm	Scour Level=HFL-dsma	Observation	Recommened Scour Level (m)
Scour level limited toHard Rock Level found at site					

* Based on the data observed from the Geo technical report.

Catchment Area-4.28 Sq. Km
Length of Stream-4.04 Km



Catchment Area-0.966 Sq.Km
Length of Stream-2.051 Km



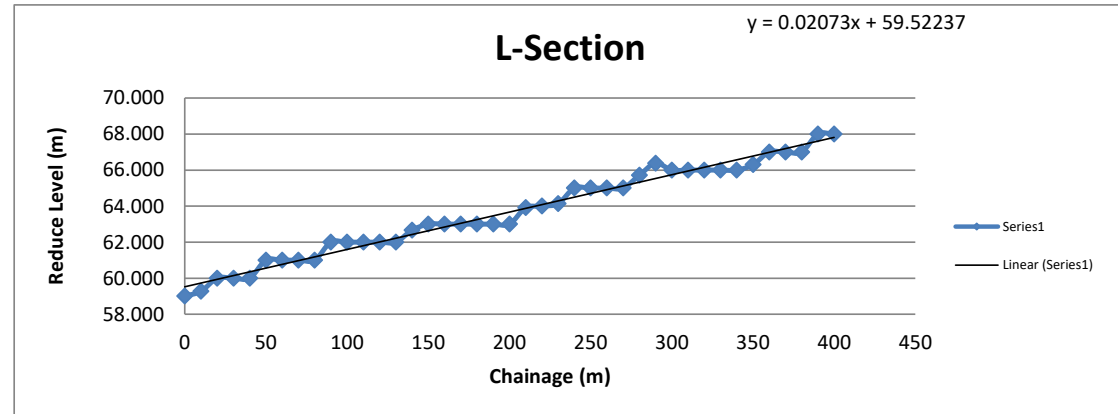
SUMMARY					
Sr.No	Chainage (km)	Discharge (Cumecs)			Design Discharge (Cumecs)
		By Modified Rational method (Bridges and Floods Wing Report, RBF-16)	By Rational Method (SP-13 Code)	By Area Velocity Method	
1	0+420-Br-19	45.084	27.756	-	45.084

Sr.No	Chainage (km)	Design Discharge (cumecs)	Design HFL (m)	Average Velocity (m/s)	Avg. depth (m)	LBL (m)	Proposed Waterway (m)	Vertical clearance Required (m)	Proposed Minimum Soffit level (m)
1	0+420-Br-19	45.084	66.459	3.32	1.12	65.00	16.00	0.90	67.359

*Note Scour Level shall be limited to Rock level found at site

Longitudnal Slope

Chainage (m)	RL (m)
0.00	59.000
10.00	59.274
20.00	60.000
30.00	60.000
40.00	60.000
50.00	61.000
60.00	61.000
70.00	61.000
80.00	61.000
90.00	62.000
100.00	62.000
110.00	62.000
120.00	62.000
130.00	62.000
140.00	62.664
150.00	63.000
160.00	63.000
170.00	63.000
180.00	63.000
190.00	63.000
200.00	63.000
210.00	63.908
220.00	64.000
230.00	64.140
240.00	65.000
250.00	65.000
260.00	65.000
270.00	65.000
280.00	65.711
290.00	66.382
300.00	66.000
310.00	66.000
320.00	66.000
330.00	66.000
340.00	66.000
350.00	66.296
360.00	67.000
370.00	67.000
380.00	67.000
390.00	68.000
400.00	68.000



DESIGN DISCHARGE CALCULATION

Name and number of subzone Subzone-5a-b
Existing Chainage
Proposed chainage 0+420-Br-19
River/Stream -
Type Minor Bridge

(A) FLOOD ESTIMATION

(1) By Modified Rational method (Bridges and Floods Wing Report, RBF-16)

Catchment Area of River, A	=	0.966	km ²	0.373	Mile ²
Length of longest stream, L	=	2.051	km	1.274	Mile
Level Difference between source and bridge site, H	=	50.0	m	0.031	Mile
Slope (in percent)	=			2.438	
R	=	100 year 24 hour point rainfall			
	=	48.00	cm		(Refer Subzone Report 5a-b)
tc	=	Time of concentration			
	=	$0.9 \times L / (M \ 0.1 \times S \ 0.2)$			
	=	1.059	hr.		
F	=	Areal Reduction factor			
	=	0.88			
C	=	Runoff Coefficient			
	=	$0.415 \times (R \times F)^{0.2}$			
	=	0.88			
tc hr. ratio	=	0.422			
1 hr. ratio	=	0.416			Refer. RBF - 16 Report
Conversion Ratio, K	=	tc hr. ratio / 1 hr. ratio			
	=	1.01			
R100(24)	=	48	cm		
R100(1)	=	R100(24) x 1 hr. to 24 hr. rainfall ratio			
	=	19.97	cm		
	=	199.68	mm		
R100(tc)	=	K x R100(1)			
	=	202.56	mm		
I	=	100 year rainfall intensity (mm/hr) lasting for tc hr. duration			
	=	R100(tc)/tc			
	=	191.34	mm/hr.		
Design Flood					
Q	=	$0.278 \times C \ I \ A$			
	=	45.08	m3/sec		

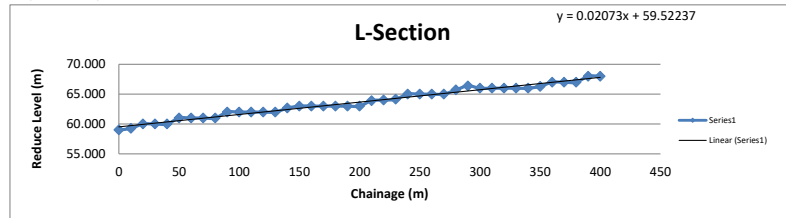
(2) By Rational Method (SP-13 Code)

Area of catchment, A		96.6	Ha		
Length of longest stream, L		2.05	Km		
The fall in level from critical point to the structure, H		50.00	m		
Runoff Coefficient as per Terrain, P	=	0.5			
tc	=	$((0.87 \times (L^3/H)))^{0.385}$			(Refer IRC SP-13)
	=	0.48	hr		
Now,					
F (100 year-24 hr rainfall)		480	mm		
One hour conversion ratio from report 5a		0.32			
F (100 year-1 hr rainfall)		153.6	mm		
T			hour		
Now,					
Ic	=	$(F/T) \times ((T+1)/(tc+1))$			(Refer SP-13) Where, F Total precipitation T Duration of time
	=	207.31	mm/hr		
	=	20.73	cm/hr		
f	=	0.990			Fig.4.2 ' f-curve ' from IRC:SP: 13
Q	=	$0.028 \times P \times f \times A \times I_c$			
	=	27.756	cumecs		

(B) Fixing of Design Discharge

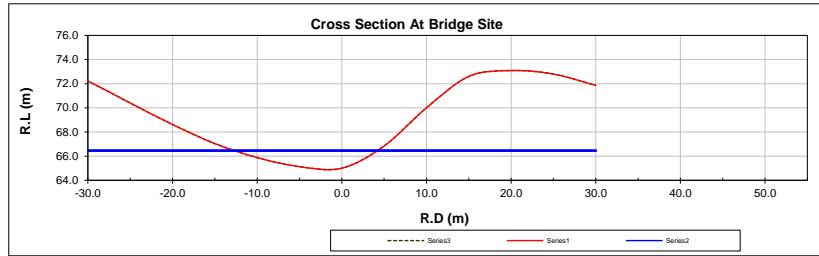
Calculated Peak Discharge by					
i) By Modified Rational method (Bridges and Floods Wing Report, RBF-16)	=	45.08	cumecs		
ii) By Rational Method (SP-13 Code)	=	27.76	cumecs		
Therefore, The Reccomended Design Discharge, Qd (As per clause 106.3.2, IRC:5-2015)	=	45.08	cumecs		

(C) Calculation of Design Affluxed HFL w.r.t. Design Discharge
 Design Discharge, Qd = 45.08 Cumecs



Average Bed Slope of River, S = 0.02073
 Manning's Coefficient, n = 0.045

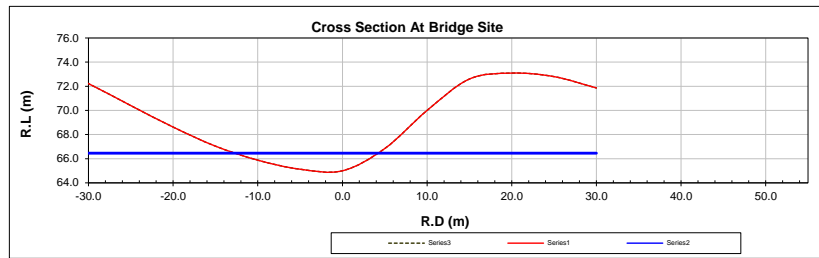
At Bridge Site



Distance	RL of Existing GL	RL of Modified GL	HFL	a	p	r=a/p	q
-35.00	73.830	73.830	66.459	-	-	-	-
-30.00	72.220	72.220	66.459				
-25.00	70.400	70.400	66.459				
-20.00	68.620	68.620	66.459				
-15.00	67.040	67.040	66.459				
-10.00	65.880	65.880	66.459				
-5.00	65.130	65.130	66.459	4.482	4.751	0.943	13.7939
0.00	65.000	65.000	66.459	6.550	4.700	1.393	26.1432
5.00	66.840	66.840	66.459	2.532	5.007	0.506	5.1428
10.00	70.000	70.000	66.459				
15.00	72.600	72.600	66.459				
20.00	73.090	73.090	66.459				
25.00	72.800	72.800	66.459				
30.00	71.860	71.860	66.459				
An1=				13.564		Q=	45.080

(D) Afflux Calculation

Determination of Obstructed Bridge Area



Distance	RL of Existing GL	RL of Modified GL	HFL	a	p	r=a/p	q	depth, d
-35.00	73.830	73.830	66.459	-	-	-	-	-
-30.00	72.220	72.220	66.459					
-25.00	70.400	70.400	66.459					
-20.00	68.620	68.620	66.459					
-15.00	67.040	67.040	66.459					
-10.00	65.880	65.880	66.459					0.5789
-5.00	65.130	65.130	66.459	4.482	4.751	0.943	13.7939	1.3289
0.00	65.000	65.000	66.459	6.550	4.700	1.393	26.1432	1.4589
5.00	66.840	66.840	66.459	2.532	5.007	0.506	5.1428	
10.00	70.000	70.000	66.459					
15.00	72.600	72.600	66.459					
20.00	73.090	73.090	66.459					
25.00	72.800	72.800	66.459					
30.00	71.860	71.860	66.459					
An2*=				13.564	sq m	Q=	45.080	Cumecs
Average depth, d				=		1.122	m	
Lowest Bed Level				=		65.000	m	

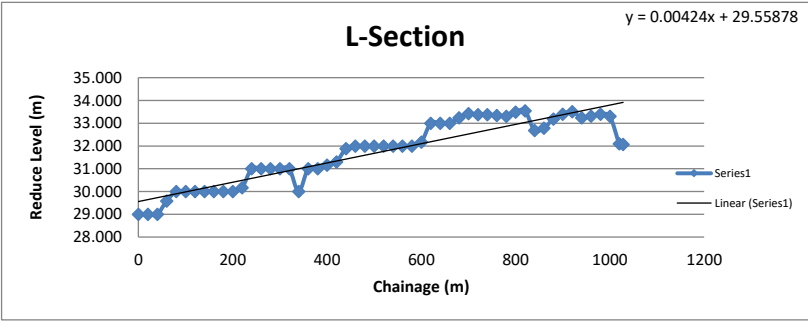
Therefore,			
Discharge, Q	=	45.080	cumec
HFL (Without Afflux)	=	66.459	m
Average Depth, d	=	1.122	m
Area before constriction			
An1	=	13.564	sq m
Average velocity prior to constriction			
Vn1	=	Q/An1	
	=	3.324	m/s
Area after constriction			
An2*	=	13.564	sq m
An2	=	An2* - no's of piers * average width of piers * average depth (d)	
	=	13.564	sq m
Average Velocity after constriction			
Vn2	=	Q/An2	
	=	3.324	m/s
Afflux due to constriction (By Molesworth Formula)			
h	=	[(Vn1 ²)/17.88+0.015] [(An1/An2) ² -1]	
	=	0.000	m
(E) Recommendation			
Design Discharge, Qd	=	45.080	cumecs
Design Affluxed HFL	=	66.459	m
Average Velocity, Vn2	=	3.324	m/sec
(F) Hydraulic Adequacy			
Design Affluxed HFL	=	66.459	m
Required Vercile Clearance	=	0.90	m
Proposed Soffit Level	=	67.359	m

SUMMARY						
Sr.No	River Name	Chainage (km)	Discharge (Cumecs)			Design Discharge (Cumecs)
			By SUH Method (Cumecs)	By Rational Method (Cumecs)	By Direct Flood Peak Formula by CWC (Cumecs)	
1	Kali river	Br-24	1108.02	Not Applicable	944.923	1108.024

Sr.No	Bridge Name	Chainage (km)	Design Discharge (cumecs)	Design HFL (m)	Average Velocity (m/s)	Avg. depth (m)	LBL (m)	Proposed Waterway (m)	Vertical clearance Required (m)	Proposed Soffit level (m)
1	Kali river	Br-24	1108.02	36.370	4.10	3.39	32.00	82.00	1.20	37.570

Longitudnal Slope

Chainage (m)	RL (m)
0.00	29.000
20.00	29.000
40.00	29.000
60.00	29.585
80.00	30.000
100.00	30.000
120.00	30.000
140.00	30.000
160.00	30.000
180.00	30.000
200.00	30.000
220.00	30.168
240.00	31.000
260.00	31.000
280.00	31.000
300.00	31.000
320.00	31.000
340.00	30.000
360.00	31.000
380.00	31.000
400.00	31.156
420.00	31.296
440.00	31.880
460.00	32.000
480.00	32.000
500.00	32.000
520.00	32.000
540.00	32.000
560.00	32.000
580.00	32.000
600.00	32.168
620.00	33.000
640.00	33.000
660.00	33.000
680.00	33.24
700.00	33.423
720.00	33.377
740.00	33.379
760.00	33.344
780.00	33.301
800.00	33.489
820.00	33.547
840.00	32.686
860.00	32.783
880.00	33.184
900.00	33.395
920.00	33.509
940.00	33.239
960.00	33.316
980.00	33.398
1000.00	33.306
1020.00	32.101
1028.09	32.067



DESIGN DISCHARGE CALCULATION

Name and number of subzone	West Coast Region-5a-b	
Location	-	
Proposed chainage	Br-24	
River/Stream	Kali river	
Type	Minor Bridge	
Skew Angle	0	Degree

(A) FLOOD ESTIMATION
1) Synthetic Unit Hydrograph Method

Catchment Area	108.32	Sq. Km
Length Of Stream	22.34	Km

SI No	Reduced Distance Starting From Bridge Site (Point of Study) (km)	Reduced Level of River Bed (m)	Length of Each Segment (L _i) (km)	Height Above Datum* (D _i)=Difference Between the Datum Line and its R.L (m)	(D _{i-1} + D _i) (m)	L _i x (D _{i-1} + D _i) (m*km)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	0.000	32.000	-	-	-	-
2	3.141	40.000	3.14	8.00	8.00	25.13
3	6.300	50.000	3.16	18.00	26.00	82.13
4	10.400	65.000	4.10	33.00	51.00	209.10
5	12.270	80.000	1.87	48.00	81.00	151.47
6	15.660	125.000	3.39	93.00	141.00	477.99
7	16.980	160.000	1.32	128.00	221.00	291.72
8	18.198	255.000	1.22	223.00	351.00	427.52
9	19.500	480.000	1.30	448.00	671.00	873.64
10	20.419	640.000	0.92	608.00	1056.00	970.46
11	21.603	700.000	1.18	668.00	1276.00	1510.78
12	22.340	820.000	0.74	788.00	1456.00	1073.07
SUM			22.34			6093.02

(*) **Reduced level of river bed at the point of study, i.e. 32m**

$$S = \frac{\text{Sum}(L_i \times (D_{i-1} + D_i))}{L^2}$$

$$= \frac{12.21}{22.34} \quad \text{m/km}$$

$$\text{Say } 12.21 \quad \text{m/km}$$

Step : - 2 Determination of Synthetic (1-hr) Unitgraph Parameterrs

Time from the center of Unit rainfall duration to the peak of Unit Hydrograph

$$t_p = \frac{1.5607 \times (q_p)^{-1.0814}}{2.270} \quad \text{hrs}$$

Peak discharge of hydrograph per unit area

$$q_p = \frac{0.9178 \times (L/S)^{-0.4313}}{0.707} \quad \text{cumecs per sq km}$$

Width of U. G. measured at 50% maximum discharge ordinate

$$W_{50} = \frac{1.925 \times [q_p]^{-1.0896}}{2.81} \quad \text{hrs}$$

Width of U. G. measured at 75% maximum discharge ordinate

$$W_{75} = \frac{1.0189 \times [q_p]^{-1.0443}}{1.46} \quad \text{hrs}$$

Width of the rising side of U. G. measured at 50% of maximum discharge ordinate

$$WR_{50} = \frac{0.5788 \times [q_p]^{-1.1072}}{0.85} \quad \text{hrs}$$

Width of the rising side of U. G. measured at 75% of maximum discharge ordinate

$$WR_{75} = \frac{0.3469 \times [q_p]^{-1.0538}}{0.50} \quad \text{hrs}$$

Base width of Unit Hydrograph

$$T_B = \frac{7.3801 \times [(t_p)^{0.7343}]}{13.47} \quad \text{hrs}$$

Time from start of rise to the peak of unit hydrograph

$$T_m = \frac{t_p + t_r/2}{2.77} \quad \text{hrs}$$

Peak discharge of Unit Hydrograph

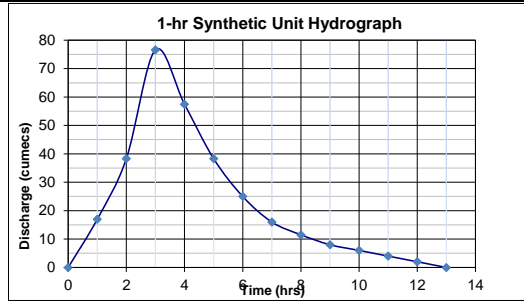
$$Q_p = \frac{q_p \times A}{76.62} \quad \text{cumecs}$$

say 76.62 cumecs

Step : - 3 Drawing of Synthetic Unitgraph

Estimated parameter of Unitgraph in step-2 were plotted to scale. The plotted points were joined to draw synthetic unitgraph. The discharge ordinates of unitgraph at $t_i = 1$ hr interval were summed up and compared with the volume of 1.00 cm direct runoff as calculated below

Time (in hrs)	1-hr Synthetic U.G. ordinates
0.0	0.00
1.0	17.00
2.0	38.31
3.0	76.62
4.0	57.46
5.0	38.31
6.0	25.00
7.0	16.00
8.0	11.50
9.0	8.00
10.0	6.00
11.0	4.00
12.0	2.00
13.0	0.00
Sum	300.19



cumecs1

$$\text{Sum}(Q_i) = (A \cdot d) / (t_r \cdot 0.36) = 300.88 \text{ cumecs} \quad \text{.....2}$$

Since $Eq-1 = Eq-2$, so unitgraph drawn is in order

Step : - 4 Estimation of design storm duration

The design storm duration

$$\begin{aligned} T_D &= 1.1 \cdot t_p \\ &= 2.50 \text{ hrs} \\ \text{Adopted} &= 2.00 \text{ hrs} \end{aligned}$$

Step : - 5 Estimation of point rainfall and areal rainfall

$$\begin{aligned} 100\text{-yr, 24-hr rainfall} &= 46.00 \text{ cm} && \text{(From Plate-10)} \\ \text{Ratio of 2-hr rainfall to 24-hr rainfall} &= 0.42 && \text{(From Figure-10)} \\ \text{So, 100-yr 2-hr point rainfall} &= 19.32 \text{ cm} \\ \text{Areal reduction factor corresponding to area 108.318 Sq. Km and } T_D=2 \text{ hrs} &= 0.790 && \text{(From Figure-11)} \\ \text{So, 100-yr 2-hr areal rainfall} &= 15.26 \text{ cm} \end{aligned}$$

Step : - 6 Time distribution of Areal Rainfall and Calculation of Rainfall Excess

This 100-yr 2-hrs areal rainfall is distributed as below - for 1 hr interval (from Fig-12)

Duration (hrs)	Distribution coefficient	Storm Rainfall (cm)	Hourly Rainfall Increment (cm)	Design Loss Rate (cm/hr)	Rainfall Excess (cms)
0	0.00	-	-	0.19	
1	0.82	12.52	12.52	0.19	12.33
2	1.00	15.26	2.75	0.19	2.56

Note: Design loss rate in this zone is recommended as 0.19 cm/hr
Design Loss rate for 1 hour 0.19 cm

Step : - 7 Estimation of base flow

$$\begin{aligned} \text{The design base flow } q_b &= 0.15 \text{ cumec per sq km} \\ \text{Total base flow } Q_b &= 16.25 \text{ cumecs} \end{aligned}$$

Step : - 8 Estimation of 100-yr Flood Peak

For the estimation of the peak discharge the effective rainfall units were re-arranged against the ordinates such that the maximum effective rainfall was placed against the maximum U.G. ordinates, the next lower value of effective rainfall against the the next lower value of U.G.

U.G. Ordinates (cumec)	1-hr effective rainfall (cm)	Direct Runoff (cumecs)
76.62	12.33	944.67
57.46	2.56	147.10

$$\begin{aligned} &= 1091.78 \text{ cumecs} \\ \text{Base Flow} &= 16.25 \text{ cumecs} \\ \text{100-yr peak flood} &= 1108.02 \text{ cumecs} \end{aligned}$$

(B) Fixing of Design Discharge

Calculated Peak Discharge by

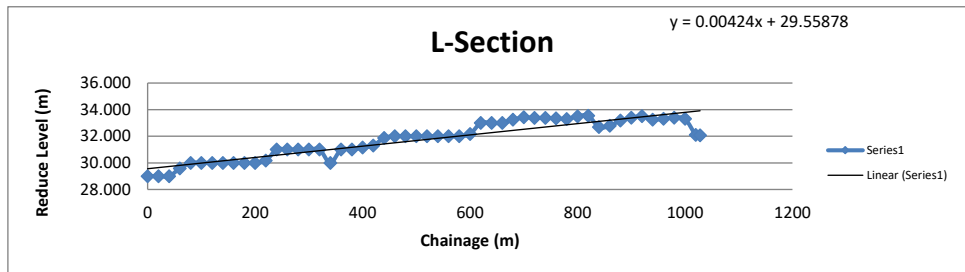
$$\text{i) Synthetic Unit Hydrograph Method} = 1108.02 \text{ cumecs}$$

$$\text{Therefore, The Recommended Design Discharge, } Q_d \text{ (As per clause 106.3.2, IRC:5-2015)} = 1108.02 \text{ cumecs}$$

Skew Angle	0	Degree
Design Discharge, Qd	1108.02	Cumecs

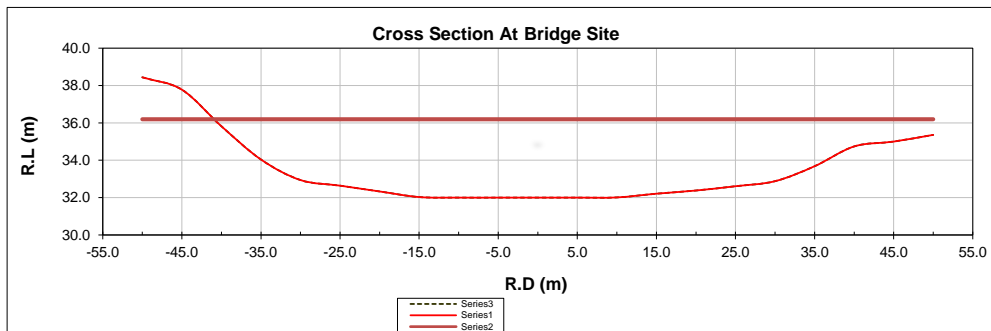
(C) Calculation of Design Affluxed HFL w.r.t. Design Discharge

Design Discharge, Qd = 1108.02 Cumecs



Average Bed Slope of River, S = 0.00424

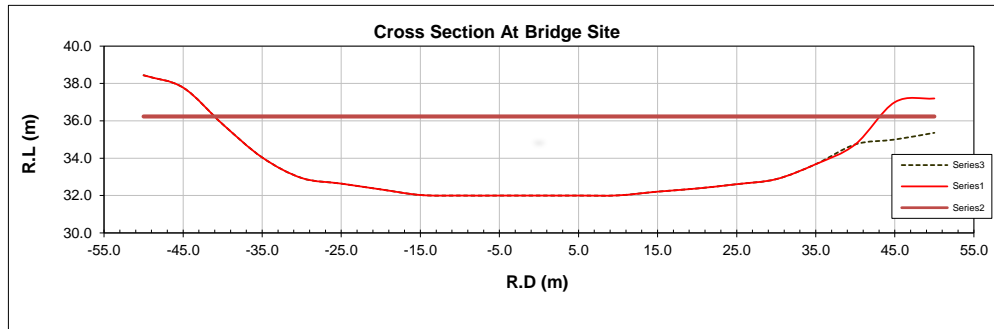
At Bridge Site



Distance	RL of Existing GL	RL of Modified GL	HFL	a	p	r=a/p	n	q
-50.00	38.440	38.440	36.194	-	-	-	-	-
-45.00	37.780	37.780	36.194				0.040	
-40.00	35.820	35.820	36.194				0.040	
-35.00	34.040	34.040	36.194	6.321	5.307	1.191	0.040	11.5607
-30.00	32.940	32.940	36.194	13.521	5.120	2.641	0.040	42.0535
-25.00	32.640	32.640	36.194	17.021	5.009	3.398	0.040	62.6259
-20.00	32.330	32.330	36.194	18.546	5.010	3.702	0.040	72.2484
-15.00	32.030	32.030	36.194	20.071	5.009	4.007	0.040	82.4256
-10.00	32.000	32.000	36.194	20.896	5.000	4.179	0.040	88.2540
-5.00	32.000	32.000	36.194	20.971	5.000	4.194	0.040	88.7837
0.00	32.000	32.000	36.194	20.971	5.000	4.194	0.040	88.7837
5.00	32.000	32.000	36.194	20.971	5.000	4.194	0.040	88.7837
10.00	32.010	32.010	36.194	20.946	5.000	4.189	0.040	88.6072
15.00	32.210	32.210	36.194	20.421	5.004	4.081	0.040	84.8916
20.00	32.380	32.380	36.194	19.496	5.003	3.897	0.040	78.5915
25.00	32.610	32.610	36.194	18.496	5.005	3.695	0.040	71.9654
30.00	32.880	32.880	36.194	17.246	5.007	3.444	0.040	64.0263
35.00	33.680	33.680	36.194	14.571	5.064	2.878	0.040	47.9866
40.00	34.740	34.740	36.194	9.921	5.111	1.941	0.040	25.1296
45.00	35.000	35.000	36.194	6.621	5.007	1.322	0.040	12.9847
50.00	35.360	35.360	36.194	5.071	5.013	1.012	0.040	8.3179
An1=				292.074		Q=		1108.020

(D) Afflux Calculation

Determination of Obstructed Bridge Area



Distance	RL of Existing GL	RL of Modified GL	HFL	a	p	r=a/p	n	q	depth, d	
-50.00	38.440	38.440	36.234	-	-	-		-	-	
-45.00	37.780	37.780	36.234				0.040			
-40.00	35.820	35.820	36.234				0.040		0.4142	
-35.00	34.040	34.040	36.234	6.521	5.307	1.229	0.040	12.177	2.1942	
-30.00	32.940	32.940	36.234	13.721	5.120	2.680	0.040	43.096	3.2942	
-25.00	32.640	32.640	36.234	17.221	5.009	3.438	0.040	63.858	3.5942	
-20.00	32.330	32.330	36.234	18.746	5.010	3.742	0.040	73.552	3.9042	
-15.00	32.030	32.030	36.234	20.271	5.009	4.047	0.040	83.800	4.2042	
-10.00	32.000	32.000	36.234	21.096	5.000	4.219	0.040	89.667	4.2342	
-5.00	32.000	32.000	36.234	21.171	5.000	4.234	0.040	90.200	4.2342	
0.00	32.000	32.000	36.234	21.171	5.000	4.234	0.040	90.200	4.2342	
5.00	32.000	32.000	36.234	21.171	5.000	4.234	0.040	90.200	4.2342	
10.00	32.010	32.010	36.234	21.146	5.000	4.229	0.040	90.022	4.2242	
15.00	32.210	32.210	36.234	20.621	5.004	4.121	0.040	86.282	4.0242	
20.00	32.380	32.380	36.234	19.696	5.003	3.937	0.040	79.940	3.8542	
25.00	32.610	32.610	36.234	18.696	5.005	3.735	0.040	73.267	3.6242	
30.00	32.880	32.880	36.234	17.446	5.007	3.484	0.040	65.269	3.3542	
35.00	33.680	33.680	36.234	14.771	5.064	2.917	0.040	49.090	2.5542	
40.00	34.740	34.740	36.234	10.121	5.111	1.980	0.040	25.980	1.4942	
45.00	35.000	37.000	36.234	1.821	5.487	0.332	0.040	1.421		
50.00	35.360	37.200	36.234				0.040			
An2*=						285.404	sq m	Q=		1108.020
Average depth, d						=	3.392	m		
Lowest Bed Level						=	32.000	m		

Therefore,

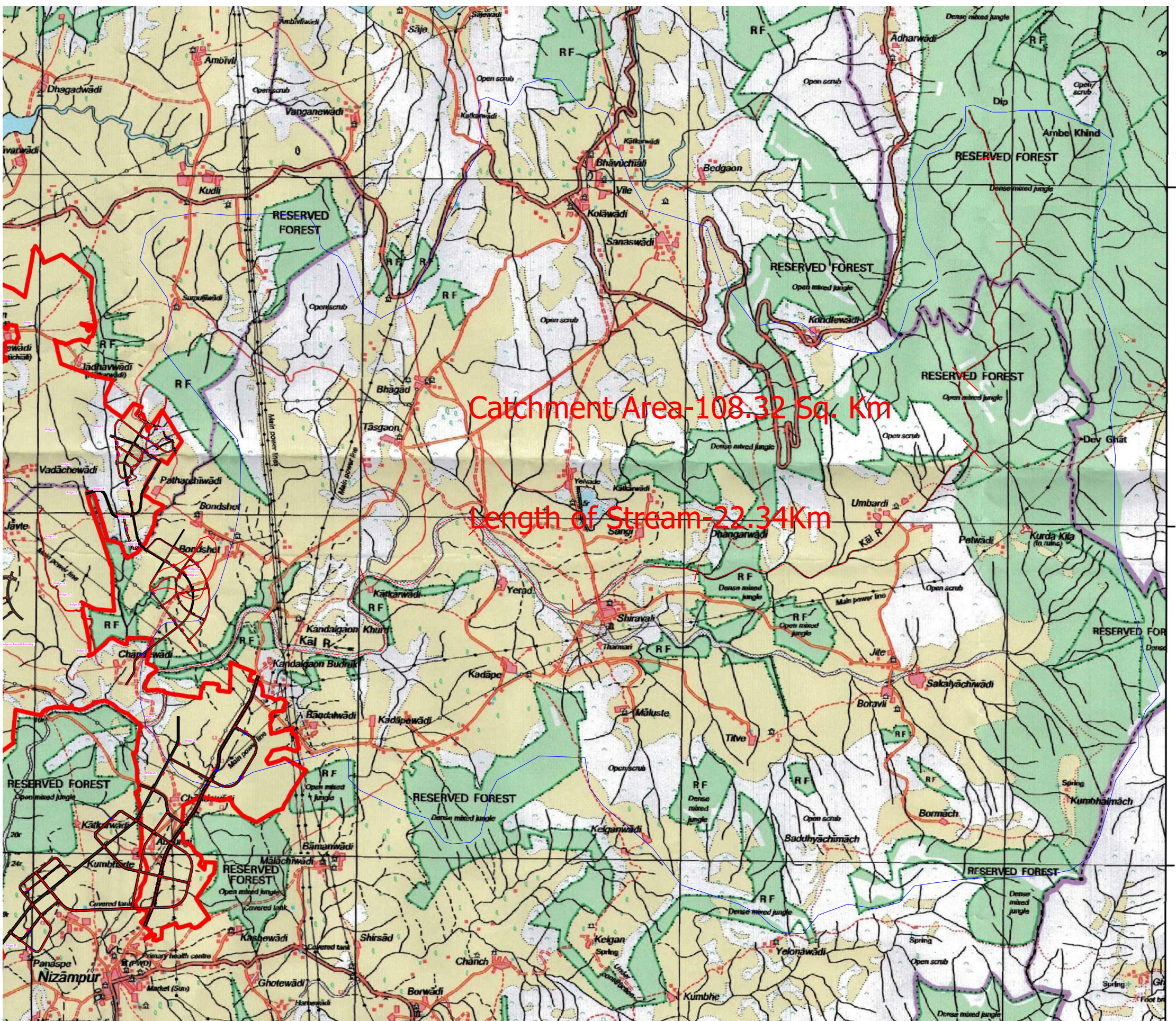
Discharge, Q	=	1108.020	cumec
HFL (Without Afflux)	=	36.234	m
Average Depth, d	=	3.392	m
Area before constriction			
An1	=	292.074	sq m
Average velocity prior to constriction			
Vn1	=	Q/An1	
	=	3.794	m/s
Area after constriction			
An2	=	An2* - (no's of abutment*average width of abutment+no's of piers * average width of piers) * average depth (d)	
	=	270.477	sq m
Average Velocity after constriction			
Vn2	=	Q/An2	
	=	4.097	m/s
Afflux due to constriction (By Molesworth Formula)			
h	=	[(Vn1^2)/17.88+0.015] [(An1/An2)^2-1]	
	=	0.136	m

(E) Recommendation

Design Discharge, Qd	=	1108.020	cumecs
Design Affluxed HFL	=	36.370	m
Average Velocity, Vn2	=	4.097	m/sec

(F) Hydraulic Adequacy

Design Affluxed HFL	=	36.370	m
Required Verticle Clearance	=	1.20	m
Proposed Soffit Level	=	37.570	m

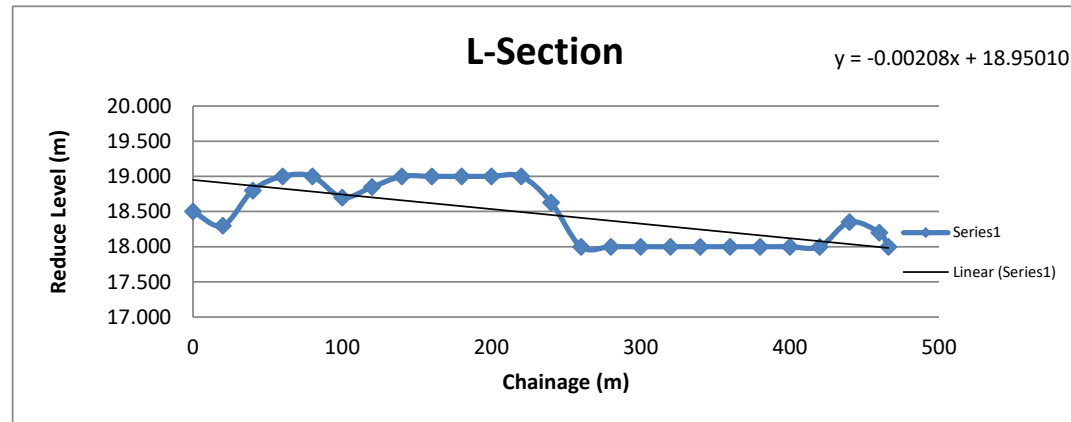


SUMMARY						
Sr.No	River Name	Chainage (km)	Discharge (Cumecs)			Design Discharge (Cumecs)
			By SUH Method (Cumecs)	By Rational Method (Cumecs)	By Direct Flood Peak Formula by CWC (Cumecs)	
1	Kali river	Br-27-SAR14	1304.98	Not Applicable	1104.818	1304.977

Sr.No	Bridge Name	Chainage (km)	Design Discharge (cumecs)	Design HFL (m)	Average Velocity (m/s)	Avg. depth (m)	LBL (m)	Proposed Waterway (m)	Vertical clearance Required (m)	Proposed Soffit level (m)
1	Kali river	Br-27-SAR14	1304.98	26.416	4.32	5.90	18.57	70.00	1.20	27.616

Longitudnal Slope

Chainage (m)	RL (m)
0.00	18.500
20.00	18.300
40.00	18.800
60.00	19.000
80.00	19.000
100.00	18.700
120.00	18.850
140.00	19.000
160.00	19.000
180.00	19.000
200.00	19.000
220.00	19.000
240.00	18.629
260.00	18.000
280.00	18.000
300.00	18.000
320.00	18.000
340.00	18.000
360.00	18.000
380.00	18.000
400.00	18.000
420.00	18.000
440.00	18.350
460.00	18.200
466.00	18.000



DESIGN DISCHARGE CALCULATION

Name and number of subzone	West Coast Region-5a-b	
Location	-	
Proposed chainage	Br-27-SAR14	
River/Stream	Kali river	
Type	Minor Bridge	
Skew Angle	0	Degree

(A) FLOOD ESTIMATION

1) Synthetic Unit Hydrograph Method

Catchment Area	137.16	Sq. Km
Length Of Stream	27.31	Km

SI No	Reduced Distance Starting From Bridge Site (Point of Study) (km)	Reduced Level of River Bed (m)	Length of Each Segment (L _i) (km)	Height Above Datum* (D _i)=Difference Between the Datum Line and its R.L. (m)	(D _{i-1} + D _i) (m)	L _i x (D _{i-1} + D _i) (m ² km)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	0.000	18.560	-	-	-	-
	1.350	25.000	1.35	6.44	6.44	8.69
	2.598	35.000	1.25	16.44	22.88	28.55
2	8.111	40.000	5.51	21.44	37.88	208.83
3	11.270	50.000	3.16	31.44	52.88	167.05
4	15.370	65.000	4.10	46.44	77.88	319.31
5	17.240	80.000	1.87	61.44	107.88	201.74
6	20.630	125.000	3.39	106.44	167.88	569.11
7	21.950	160.000	1.32	141.44	247.88	327.20
8	23.168	255.000	1.22	236.44	377.88	460.26
9	24.470	480.000	1.30	461.44	697.88	908.64
10	25.389	640.000	0.92	621.44	1082.88	995.17
11	26.573	700.000	1.18	681.44	1302.88	1542.61
12	27.310	820.000	0.74	801.44	1482.88	1092.88
SUM			27.31			6830.04

(*) Reduced level of river bed at the point of study, i.e. 18.56m

$$S = \frac{\sum (L_i \times (D_{i-1} + D_i))}{L^2}$$

m/km

Say 9.16 m/km

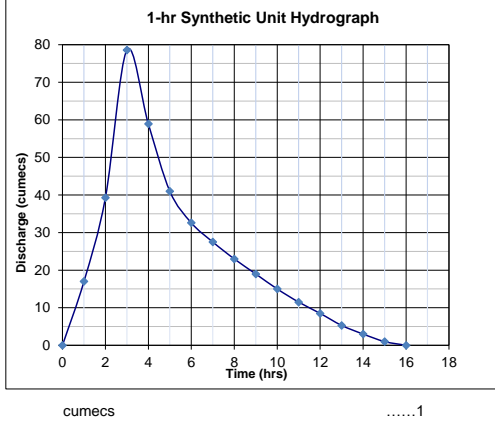
Step : - 2 Determination of Synthetic (1-hr) Unitgraph Parameterrrs

Time from the center of Unit rainfall duration to the peak of Unit Hydrograph	t _p = 1.5607*(q _p) ^{-1.0814}	
	= 2.851	hrs
Peak discharge of hydrograph per unit area	q _p = 0.9178*(L/S) ^{-0.4313}	
	= 0.573	cumecs per sq km
Width of U. G. measured at 50% maximum discharge ordinate	W ₅₀ = 1.925*[q _p] ^{-1.0896}	
	= 3.53	hrs
Width of U. G. measured at 75% maximum discharge ordinate	W ₇₅ = 1.0189*[q _p] ^{-1.0443}	
	= 1.82	hrs
Width of the rising side of U. G. measured at 50% of maximum discharge ordinate	W _{R50} = 0.5788*[q _p] ^{-1.1072}	
	= 1.07	hrs
Width of the rising side of U. G. measured at 75% of maximum discharge ordinate	W _{R75} = 0.3469*[q _p] ^{-1.0538}	
	= 0.62	hrs
Base width of Unit Hydrograph	T _B = 7.3801*[(t _p) ^{0.7343}]	
	= 15.93	
	= 16.00	hrs
Time from start of rise to the peak of unit hydrograph	T _m = t _p + t _r /2	
	= 3.35	hrs
	= 3.00	
Peak discharge of Unit Hydrograph	Q _p = q _p * A	
	= 78.58	cumecs
	say 78.58	cumecs

Step : - 3 Drawing of Synthetic Unitgraph

Estimated parameter of Unitgraph in step-2 were plotted to scale. The plotted points were joined to draw synthetic unitgraph. The discharge ordinates of unitgraph at $t_i = t_r = 1$ hr interval were summed up and compared with the volume of 1.00 cm direct runoff as calculated below

Time (in hrs)	1-hr Synthetic U.G. ordinates
0.0	0.00
1.0	17.00
2.0	39.29
3.0	78.58
4.0	58.94
5.0	41.00
6.0	32.60
7.0	27.50
8.0	23.00
9.0	19.00
10.0	15.00
11.0	11.50
12.0	8.50
13.0	5.30
14.0	3.00
15.0	1.00
16.0	0.00
Sum	381.21



$$\begin{aligned} \text{Sum}(Q_i) &= (A \cdot d) / (t_r^{0.36}) \\ &= 381.01 \text{ cumecs} \end{aligned} \quad \text{.....1}$$

Since Eq-1 = Eq-2, so unitgraph drawn is in order

Step : - 4 Estimation of design storm duration
The design storm duration

$$\begin{aligned} T_D &= 1.1 \cdot t_p \\ &= 3.14 \text{ hrs} \\ \text{Adopted} &= 3.00 \text{ hrs} \end{aligned}$$

Step : - 5 Estimation of point rainfall and areal rainfall

$$\begin{aligned} 100\text{-yr, 24-hr rainfall} &= 46.00 \text{ cm} && \text{(From Plate-10)} \\ \text{Ratio of 3-hr rainfall to 24-hr rainfall} &= 0.49 && \text{(From Figure-10)} \\ \text{So, 100-yr 3-hr point rainfall} &= 22.31 \text{ cm} && \\ \text{Areal reduction factor corresponding to area 137.162 Sq. Km and } T_D=3 \text{ hrs} &= 0.840 && \text{(From Figure-11)} \\ \text{So, 100-yr 3-hr areal rainfall} &= 18.74 \text{ cm} \end{aligned}$$

Step : - 6 Time distribution of Areal Rainfall and Calculation of Rainfall Excess

This 100-yr 3-hrs areal rainfall is distributed as below - for 1 hr interval (from Fig-12)

Duration (hrs)	Distribution coefficient	Storm Rainfall (cm)	Hourly Rainfall Increment (cm)	Design Loss Rate (cm/hr)	Rainfall Excess (cms)
0	0.00	-	-	0.19	-
1	0.68	12.74	12.74	0.19	12.55
2	0.90	16.87	4.12	0.19	3.93
3	1.00	18.74	1.87	0.19	1.68

Note: Design loss rate in this zone is recommended as 0.19 cm/hr
Design Loss rate for 1 hour 0.19 cm

Step : - 7 Estimation of base flow

$$\begin{aligned} \text{The design base flow } q_b &= 0.15 \text{ cumec per sq km} \\ \text{Total base flow } Q_b &= 20.57 \text{ cumecs} \end{aligned}$$

Step : - 8 Estimation of 100-yr Flood Peak

For the estimation of the peak discharge the effective rainfall units were re-arranged against the ordinates such that the maximum effective rainfall was placed against the maximum U.G. ordinates, the next lower value of effective rainfall against the the next lower value

U.G. Ordinates (cumec)	1-hr effective rainfall (cm)	Direct Runoff (cumecs)
78.58	12.55	986.45
58.94	3.93	231.78
39.29	1.68	66.17
		= 1284.40 cumecs
Base Flow		= 20.57 cumecs
100-yr peak flood		= 1304.98 cumecs

(B) Fixing of Design Discharge

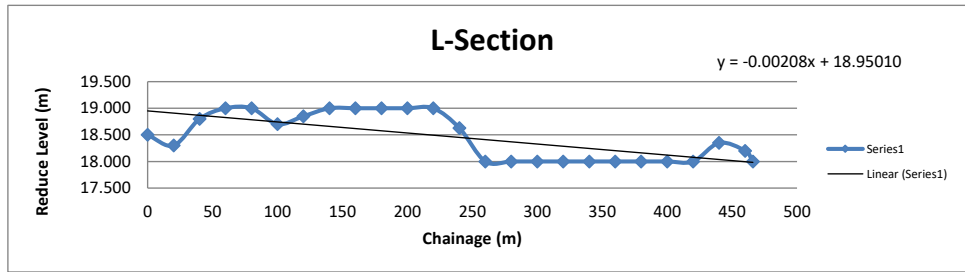
$$\begin{aligned} \text{Calculated Peak Discharge by} \\ \text{i) Synthetic Unit Hydrograph Method} &= 1304.98 \text{ cumecs} \end{aligned}$$

$$\text{Therefore, The Recommended Design Discharge, } Q_d \text{ (As per clause 106.3.2, IRC:5-2015)} = 1304.98 \text{ cumecs}$$

Design Discharge, Qd = 1304.98 Cumecs

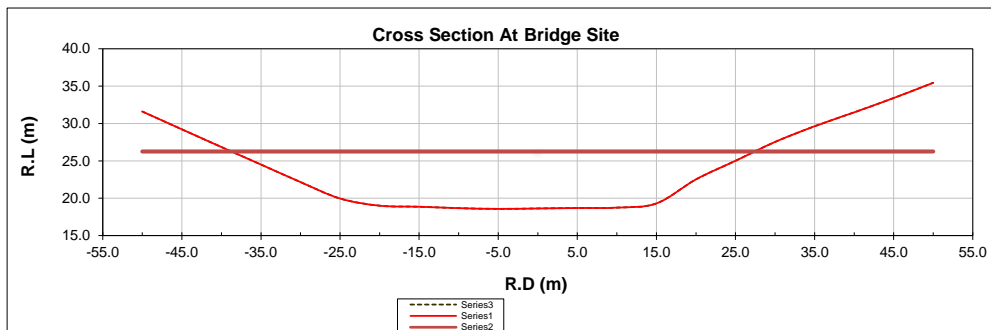
(C) Calculation of Design Affluxed HFL w.r.t. Design Discharge

Design Discharge, Qd = 1304.98 Cumecs



Average Bed Slope of River, S = 0.00208

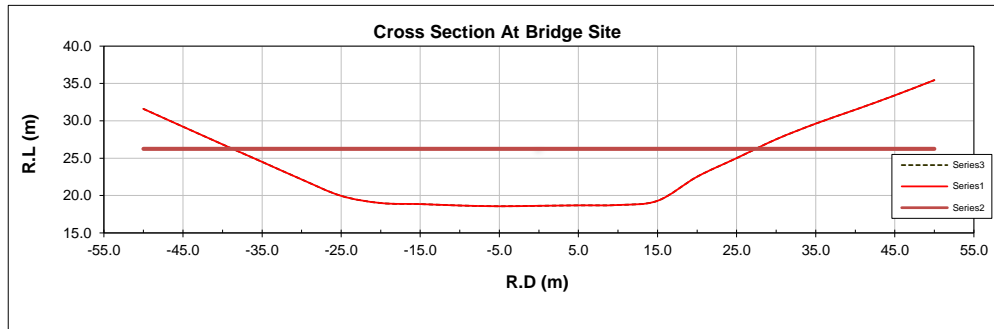
At Bridge Site



Distance	RL of Existing GL	RL of Modified GL	HFL	a	p	r=a/p	n	q
-50.00	31.600	31.600	26.255	-	-	-	-	-
-45.00	29.220	29.220	26.255				0.040	
-40.00	26.850	26.850	26.255				0.040	
-35.00	24.510	24.510	26.255	2.488	4.782	0.520	0.040	1.8352
-30.00	22.160	22.160	26.255	12.644	4.785	2.642	0.040	27.5525
-25.00	19.960	19.960	26.255	22.496	4.731	4.755	0.040	72.5259
-20.00	19.000	19.000	26.255	29.339	4.410	6.653	0.040	118.3298
-15.00	18.860	18.860	26.255	31.721	4.332	7.322	0.040	136.3712
-10.00	18.670	18.670	26.255	32.435	4.334	7.484	0.040	141.4985
-5.00	18.570	18.570	26.255	33.063	4.332	7.633	0.040	146.1445
0.00	18.630	18.630	26.255	33.150	4.331	7.654	0.040	146.7957
5.00	18.690	18.690	26.255	32.890	4.331	7.594	0.040	144.8829
10.00	18.740	18.740	26.255	32.652	4.331	7.539	0.040	143.1405
15.00	19.300	19.300	26.255	31.331	4.358	7.190	0.040	133.0707
20.00	22.520	22.520	26.255	23.146	5.151	4.493	0.040	71.8609
25.00	25.010	25.010	26.255	10.782	4.838	2.228	0.040	20.9727
30.00	27.530	27.530	26.255				0.040	
35.00	29.630	29.630	26.255				0.040	
40.00	31.490	31.490	26.255				0.040	
45.00	33.410	33.410	26.255				0.040	
50.00	35.450	35.450	26.255				0.040	
An1=				328.138		Q=		1304.981

(D) Afflux Calculation

Determination of Obstructed Bridge Area



Distance	RL of Existing GL	RL of Modified GL	HFL	a	p	r=a/p	n	q	depth, d
-50.00	31.600	31.600	26.255	-	-	-		-	-
-45.00	29.220	29.220	26.255				0.040		
-40.00	26.850	26.850	26.255				0.040		
-35.00	24.510	24.510	26.255	2.488	4.782	0.520	0.040	1.835	1.7445
-30.00	22.160	22.160	26.255	12.644	4.785	2.642	0.040	27.552	4.0945
-25.00	19.960	19.960	26.255	22.496	4.731	4.755	0.040	72.526	6.2945
-20.00	19.000	19.000	26.255	29.339	4.410	6.653	0.040	118.330	7.2545
-15.00	18.860	18.860	26.255	31.721	4.332	7.322	0.040	136.371	7.3945
-10.00	18.670	18.670	26.255	32.435	4.334	7.484	0.040	141.499	7.5845
-5.00	18.570	18.570	26.255	33.063	4.332	7.633	0.040	146.144	7.6845
0.00	18.630	18.630	26.255	33.150	4.331	7.654	0.040	146.796	7.6245
5.00	18.690	18.690	26.255	32.890	4.331	7.594	0.040	144.883	7.5645
10.00	18.740	18.740	26.255	32.652	4.331	7.539	0.040	143.140	7.5145
15.00	19.300	19.300	26.255	31.331	4.358	7.190	0.040	133.071	6.9545
20.00	22.520	22.520	26.255	23.146	5.151	4.493	0.040	71.861	3.7345
25.00	25.010	25.010	26.255	10.782	4.838	2.228	0.040	20.973	1.2445
30.00	27.530	27.530	26.255				0.040		
35.00	29.630	29.630	26.255				0.040		
40.00	31.490	31.490	26.255				0.040		
45.00	33.410	33.410	26.255				0.040		
50.00	35.450	35.450	26.255				0.040		
An2*=				328.138	sq m	Q=		1304.981	
Average depth, d				=	5.899		m		
Lowest Bed Level				=	18.570		m		

Therefore,

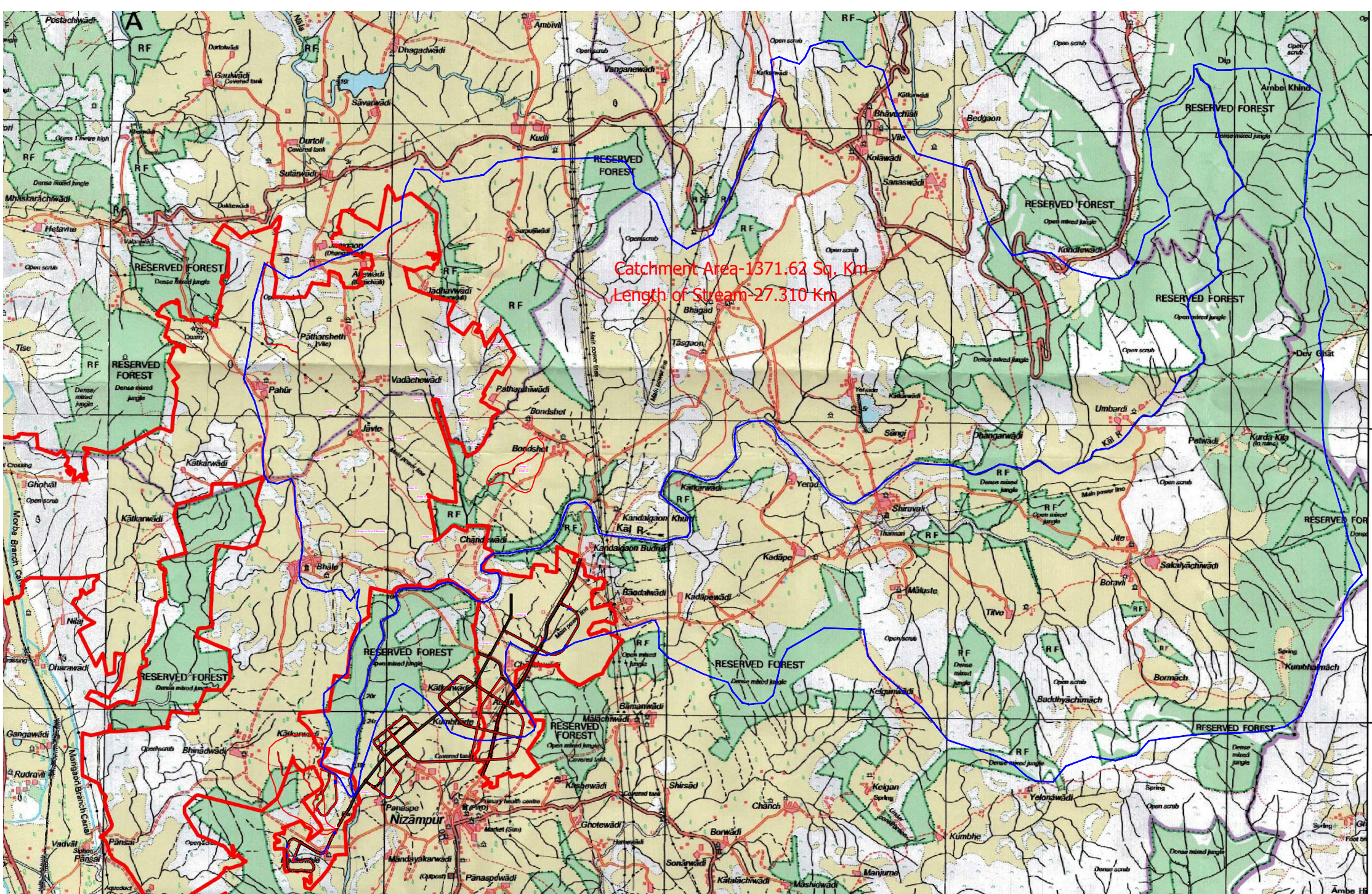
Discharge, Q	=	1304.981	cumec
HFL (Without Afflux)	=	26.255	m
Average Depth, d	=	5.899	m
Area before constriction			
An1	=	328.138	sq m
Average velocity prior to constriction			
Vn1	=	Q/An1	
	=	3.977	m/s
Area after constriction			
An2	=	An2* - (no's of abutment*average width of abutment+no's of piers * average width of piers) * average depth (d)	
	=	302.182	sq m
Average Velocity after constriction			
Vn2	=	Q/An2	
	=	4.319	m/s
Afflux due to constriction (By Molesworth Formula)			
h	=	[(Vn1^2)/17.88+0.015] [(An1/An2)^2-1]	
	=	0.161	m

(E) Recommendation

Design Discharge, Qd	=	1304.981	cumecs
Design Affluxed HFL	=	26.416	m
Average Velocity, Vn2	=	4.319	m/sec

(F) Hydraulic Adequacy

Design Affluxed HFL	=	26.416	m
Required Verticle Clearance	=	1.20	m
Proposed Soffit Level	=	27.616	m



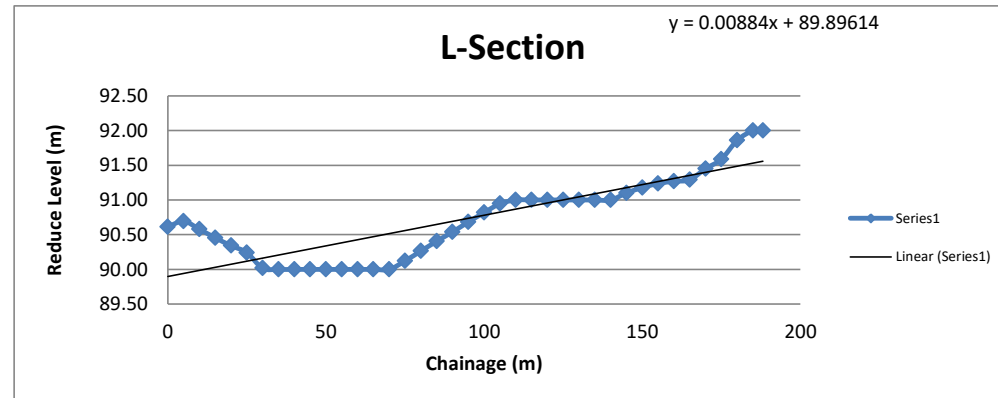
SUMMARY					
Sr.No	Chainage (km)	Discharge (Cumecs)			Design Discharge (Cumecs)
		Modified Rational Method (Cumecs)	By Rational Method (Cumecs)	By Area Velocity Method	
1	Br-29	5.814	10.184	-	10.184

Sr.No	Chainage (km)	Design Discharge (cumecs)	Design HFL (m)	Average Velocity (m/s)	Avg. depth (m)	LBL (m)	Proposed Waterway (m)	Vertical clearance Required (m)	Proposed Minimum Soffit level (m)
1	Br-29	10.184	91.517	1.74	0.67	91.00	10	0.6	92.117

* Note Scour Level limited to Hard Rock level found at site

Longitudnal Slope

Chainage (m)	RL (m)
0.00	90.61
5.00	90.69
10.00	90.58
15.00	90.46
20.00	90.34
25.00	90.24
30.00	90.02
35.00	90.00
40.00	90.00
45.00	90.00
50.00	90.00
55.00	90.00
60.00	90.00
65.00	90.00
70.00	90.00
75.00	90.12
80.00	90.26
85.00	90.41
90.00	90.54
95.00	90.68
100.00	90.82
105.00	90.95
110.00	91.00
115.00	91.00
120.00	91.00
125.00	91.00
130.00	91.00
135.00	91.00
140.00	91.00
145.00	91.10
150.00	91.18
155.00	91.24
160.00	91.27
165.00	91.29
170.00	91.45
175.00	91.59
180.00	91.86
185.00	92.00
188.14	92.00



DESIGN DISCHARGE CALCULATION

Name and number of subzone Subzone-5a-b
 Existing Chainage -
 Proposed chainage Br-29
 River/Stream -
 Type Minor Bridge

(A) FLOOD ESTIMATION

(1) Rational method (Bridges and Floods Wing Report, RBF-16)

Catchment Area of River, A = 0.143 km² 0.055 Mile²
 Length of longest stream, L = 0.55 km 0.343 Mile
 Level Difference between source and bridge site, H = 5.0 m 0.003 Mile
 Slope (in percent) = 0.906

R = 100 year 24 hour point rainfall
 = 48.00 cm (Refer Subzone Report 5a-b)
 tc = Time of concentration
 = $0.9 \times L / (M \times 0.1 \times S \times 0.2)$
 = 0.420 hr.
 F = Areal Reduction factor
 = 0.81
 C = Runoff Coefficient
 = $0.415 \times (R \times F)^{0.2}$
 = 0.86
 tc hr. ratio = 0.26
 1 hr. ratio = 0.416 Refer. RBF - 16 Report
 Conversion Ratio, K = tc hr. ratio / 1 hr. ratio
 = 0.63
 R100(24) = 48 cm
 R100(1) = R100(24) x 1 hr. to 24 hr. rainfall ratio
 = 19.97 cm
 = 199.68 mm
 R100(tc) = K x R100(1)
 = 124.80 mm
 I = 100 year rainfall intensity (mm/hr) lasting for tc hr. duration
 = R100(tc)/tc
 = 296.85 mm/hr.
 Design Flood
 Q = $0.278 \times C \times I \times A$
 = 10.18 m3/sec

(2) By Rational Method (SP-13 Code)

Area of catchment, A 14.3 Ha
 Length of longest stream, L 0.55 Km
 The fall in level from critical point to the structure, H 5.00 m

Runoff Coefficient as per Terrain, P = 0.6
 $tc = ((0.87 \times (L^3/H))^{0.385})$ (Refer IRC SP-13)
 0.26 hr

Now,
 F (100 year-24 hr rainfall) 480 mm
 One hour conversion ratio from report 5a 0.32
 F (100 year-1 hr rainfall) 153.6 mm
 T 1 hour

Now,
 $I_c = (F/T) \times ((T+1)/(tc+1))$ (Refer SP-13) Where, F Total precipitation
 = 244.44 mm/hr T Duration of time
 = 24.44 cm/hr
 f = 0.990 Fig.4.2 ' f-curve ' from IRC:SP: 13
 $Q = 0.028 \times P \times F \times A \times I_c$
 5.814 cumecs

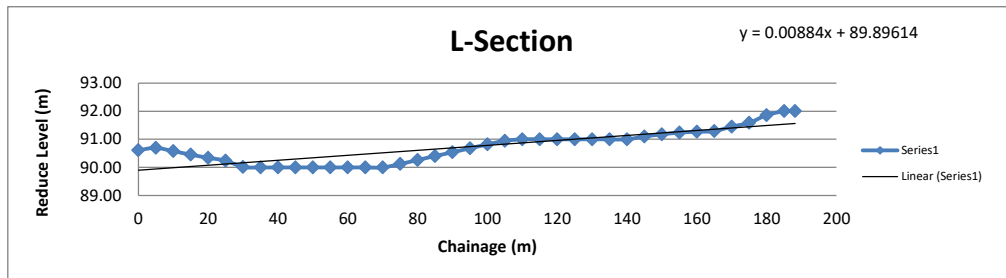
(B) Fixing of Design Discharge

Calculated Peak Discharge by
 i) By Rational Method = 10.18 cumecs
 ii) By Rational Method (SP-13 Code) = 5.81 cumecs

Therefore, The Recommended Design Discharge, Qd (As per clause 106.3.2, IRC:5-2015) = 10.18 cumecs

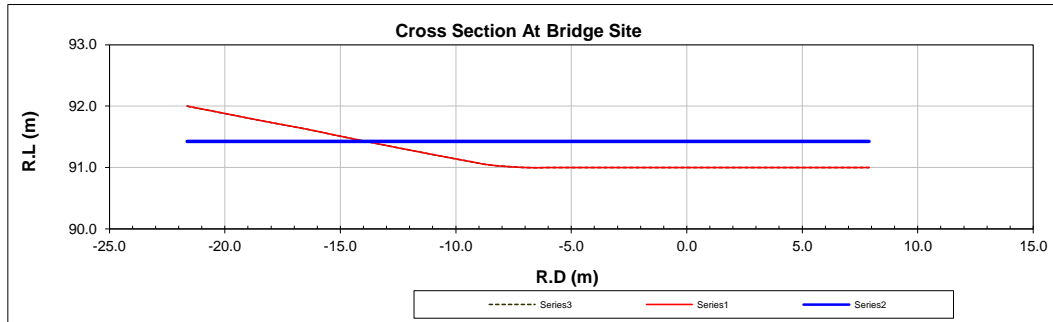
(C) Calculation of Design Affluxed HFL w.r.t. Design Discharge

Design Discharge, Qd = 10.18 Cumecs



Average Bed Slope of River, S = 0.00884
Manning's Coefficient, n = 0.04

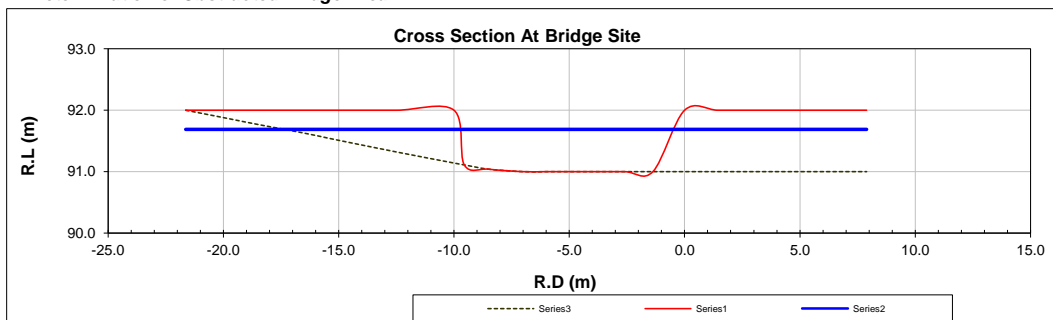
At Bridge Site



Distance	RL of Existing GL	RL of Modified GL	HFL	a	p	r=a/p	q
-21.63	92.000	92.000	91.426	-	-	-	-
-20.00	91.880	91.880	91.426				
-18.39	91.760	91.760	91.426				
-16.53	91.630	91.630	91.426				
-15.51	91.550	91.550	91.426				
-15.00	91.510	91.510	91.426				
-12.49	91.320	91.320	91.426	0.027	2.519	0.011	0.0031
-10.00	91.140	91.140	91.426	0.487	2.495	0.195	0.3852
-9.55	91.110	91.110	91.426	0.134	0.447	0.300	0.1413
-8.50	91.040	91.040	91.426	0.369	1.054	0.350	0.4307
-7.02	91.000	91.000	91.426	0.600	1.479	0.406	0.7723
-6.02	91.000	91.000	91.426	0.426	1.001	0.426	0.5669
-5.00	91.000	91.000	91.426	0.436	1.023	0.426	0.5794
-4.40	91.000	91.000	91.426	0.256	0.601	0.426	0.3404
-2.61	91.000	91.000	91.426	0.761	1.788	0.426	1.0126
-1.38	91.000	91.000	91.426	0.526	1.236	0.426	0.7000
0.00	91.000	91.000	91.426	0.585	1.375	0.426	0.7787
1.44	91.000	91.000	91.426	0.612	1.438	0.426	0.8144
2.90	91.000	91.000	91.426	0.622	1.462	0.426	0.8280
3.91	91.000	91.000	91.426	0.429	1.007	0.426	0.5703
4.97	91.000	91.000	91.426	0.450	1.058	0.426	0.5992
5.04	91.000	91.000	91.426	0.034	0.079	0.426	0.0447
6.72	91.000	91.000	91.426	0.713	1.675	0.426	0.9486
7.89	91.000	91.000	91.426	0.499	1.173	0.426	0.6643
An1=				7.967	Q=		10.180

(D) Afflux Calculation

Determination of Obstructed Bridge Area



Distance	RL of Existing GL	RL of Modified GL	HFL	a	p	r=a/p	q	depth, d
-21.63	92.000	92.000	91.688	-	-	-	-	-
-20.00	91.880	92.000	91.688					
-18.39	91.760	92.000	91.688					
-16.53	91.630	92.000	91.688					
-15.51	91.550	92.000	91.688					
-15.00	91.510	92.000	91.688					
-12.49	91.320	92.000	91.688					
-10.00	91.140	92.000	91.688					
-9.55	91.110	91.110	91.688	0.059	0.995	0.060	0.0213	0.5780
-8.50	91.040	91.040	91.688	0.645	1.054	0.612	1.0924	0.6480
-7.02	91.000	91.000	91.688	0.987	1.479	0.668	1.7731	0.6880
-6.02	91.000	91.000	91.688	0.689	1.001	0.688	1.2617	0.6880
-5.00	91.000	91.000	91.688	0.704	1.023	0.688	1.2894	0.6880
-4.40	91.000	91.000	91.688	0.414	0.601	0.688	0.7575	0.6880
-2.61	91.000	91.000	91.688	1.230	1.788	0.688	2.2537	0.6880
-1.38	91.000	91.000	91.688	0.850	1.236	0.688	1.5579	0.6880
0.00	91.000	92.000	91.688	0.259	1.700	0.152	0.1732	
1.44	91.000	92.000	91.688					
2.90	91.000	92.000	91.688					
3.91	91.000	92.000	91.688					
4.97	91.000	92.000	91.688					
5.04	91.000	92.000	91.688					
6.72	91.000	92.000	91.688					
7.89	91.000	92.000	91.688					
An2*=				5.837	sq m	Q=	10.180	Cumecs
Average depth, d				=		0.669	m	
Lowest Bed Level				=		91.000	m	

Therefore,

Discharge, Q = 10.180 cumec

HFL (Without Afflux) = 91.426 m

Average Depth, d = 0.669 m

Area before constriction

An1 = 7.967 sq m

Average velocity prior to constriction

Vn1 = $\frac{Q}{An1}$
= 1.278 m/s

Area after constriction

An2* = 5.837 sq m

An2 = An2* - no's of piers * average width of piers * average depth (d)

= 5.837 sq m

Average Velocity after constriction

Vn2 = $\frac{Q}{An2}$
= 1.744 m/s

Afflux due to constriction (By Molesworth Formula)

h = $\left[\frac{(Vn1^2)/17.88 + 0.015}{(An1/An2)^2 - 1} \right]$
= 0.092 m

(E) Recommendation

Design Discharge, Qd = 10.180 cumecs

Design Affluxed HFL = 91.517 m

Average Velocity, Vn2 = 1.744 m/sec

(F) Hydraulic Adequacy

Design Affluxed HFL = 91.517 m

Required Vetricle Clearance = 0.60 m

Proposed Soffit Level = 92.117 m

(G)

SCOUR DEPTH CALCULATION

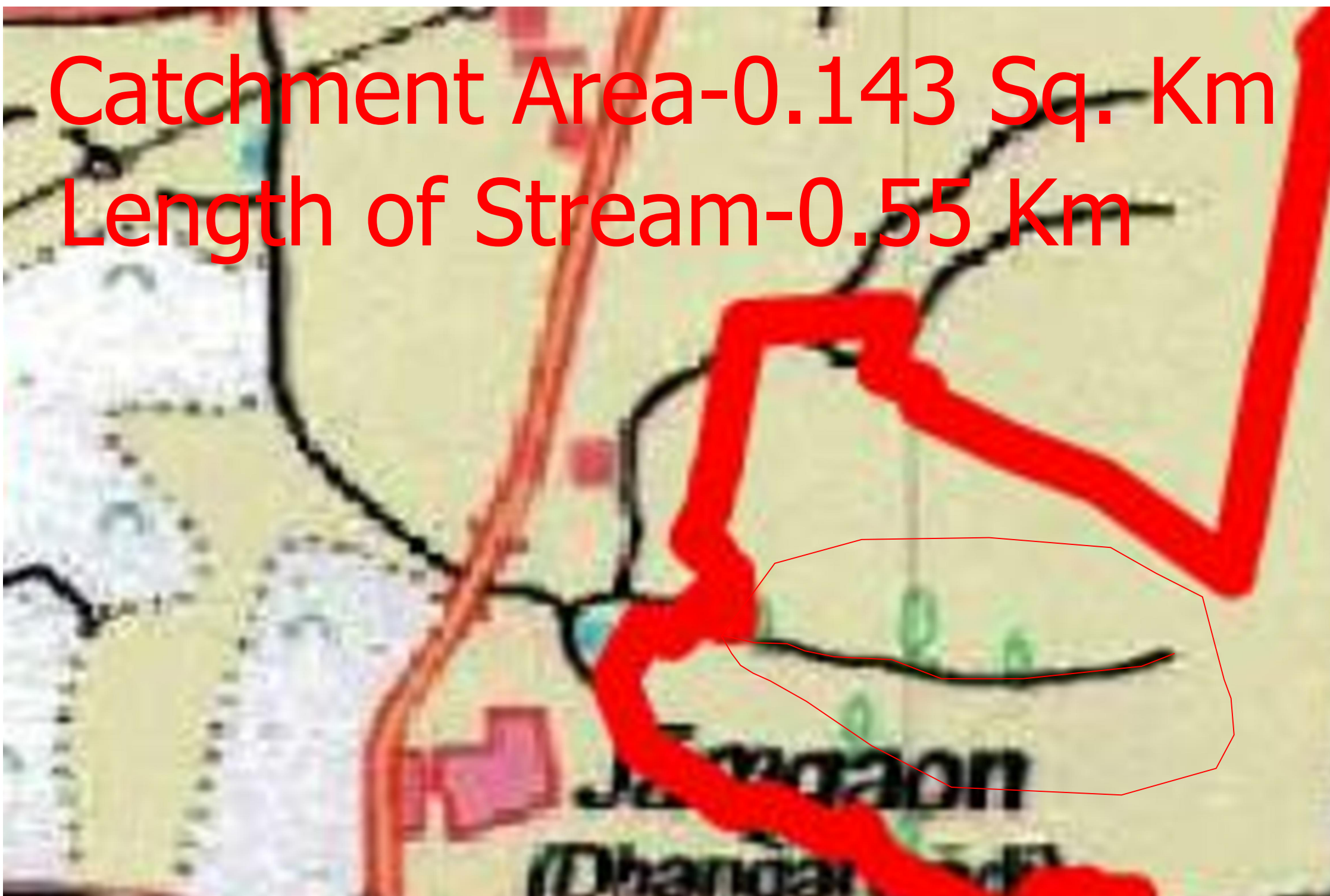
Chainage	Br-29	km
HFL	91.52	m
Qd	10.18	cumec
$Qdf=1.3*Qd$	13.23	cumec
Effective Linear Waterway(Le)	10.00	m
Regime Width, $W'=4.8*(Qd^{0.5})$	15.315	m
$Db=Qdf/min(W',Le)$	1.323	cumec/m

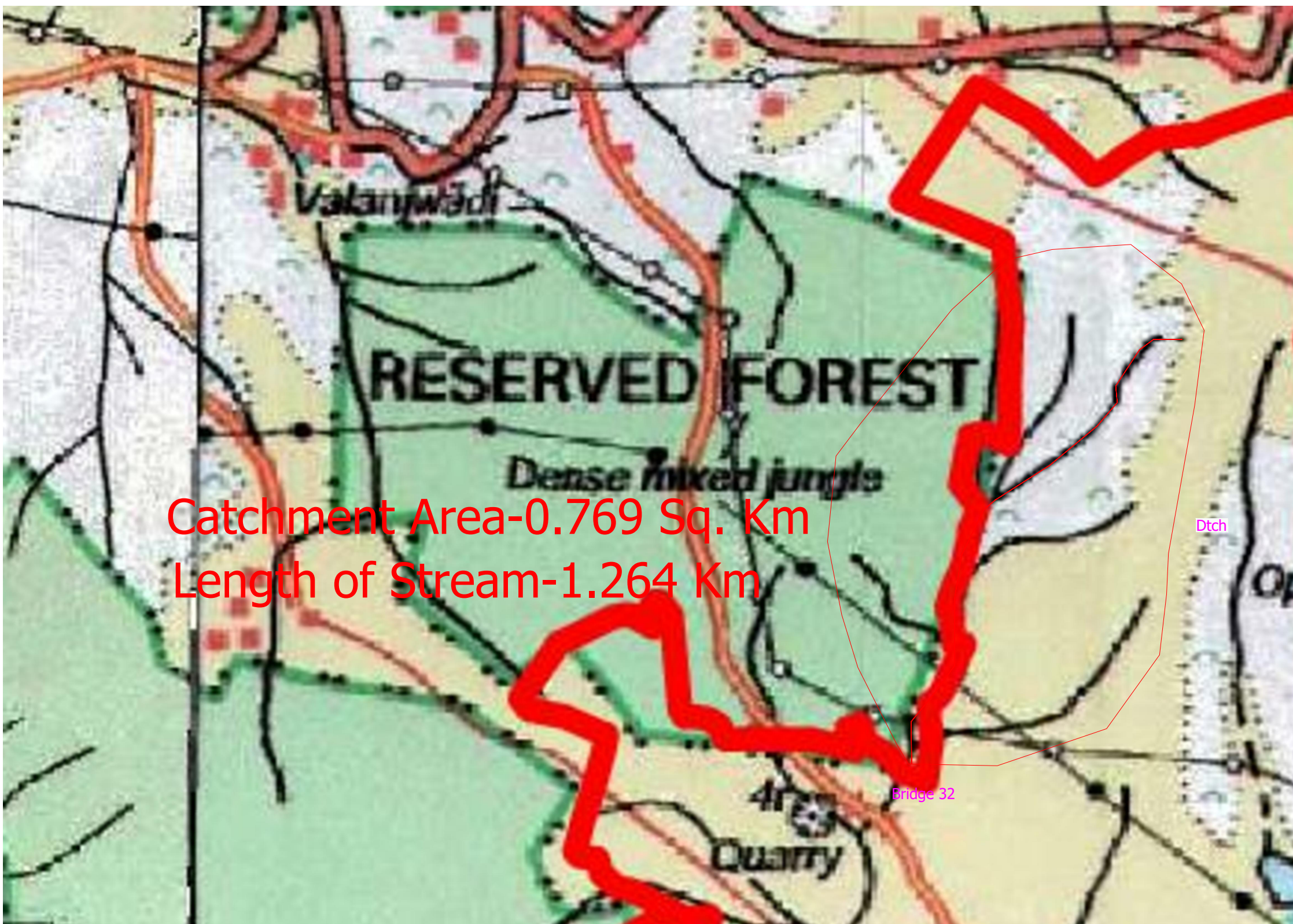
Abutment

Weighted Ksf*	Mean Scour Depth, $Dsm=1.34*(Db^2/Ksf)^{1/3}$	Scour Depth, for Abutment, $dsm=1.27xDsm$	Scour Level=HFL-dsma	Observation	Recommened Scour Level
Scour level limited to Hard Rock Level found at site					

* Based on the data observed from the Geo technical report.

Catchment Area-0.143 Sq. Km
Length of Stream-0.55 Km





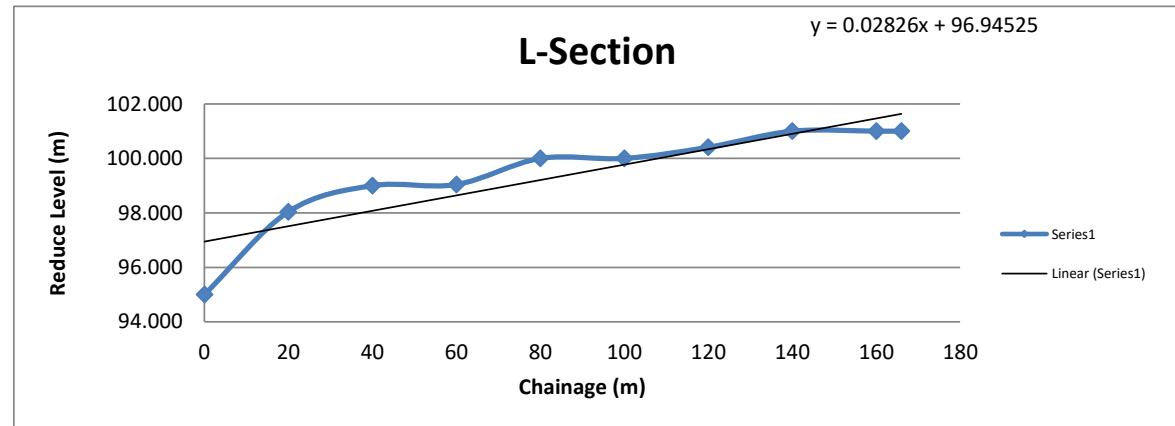
SUMMARY					
Sr.No	Chainage (km)	Discharge (Cumecs)			Design Discharge (Cumecs)
		By Modified Rational method (Bridges and Floods Wing Report, RBF-16)	By Rational Method (SP-13 Code)	By Area Velocity Method	
1	Br-32	41.357	27.324	-	41.357

Sr.No	Chainage (km)	Design Discharge (cumecs)	Design HFL (m)	Average Velocity (m/s)	Avg. depth (m)	LBL (m)	Proposed Waterway (m)	Vertical clearance Required (m)	Proposed Minimum Soffit level (m)
1	Br-32	41.357	100.978	3.36	0.76	100.00	20.00	0.90	101.878

*Note Scour Level shall be limited to Rock level found at site

Longitudnal Slope

Chainage (m)	RL (m)
0.00	95.000
20.00	98.042
40.00	99.000
60.00	99.041
80.00	100.000
100.00	100.000
120.00	100.409
140.00	101.000
160.00	101.000
166.00	101.000



DESIGN DISCHARGE CALCULATION

Name and number of subzone Subzone-5a-b
 Existing Chainage
 Proposed chainage Br-32
 River/Stream -
 Type Minor Bridge

(A) FLOOD ESTIMATION

(1) By Modified Rational method (Bridges and Floods Wing Report, RBF-16)

Catchment Area of River, A	=	0.769	km ²	0.297	Mile ²
Length of longest stream, L	=	1.264	km	0.785	Mile
Level Difference between source and bridge site, H	=	15.0	m	0.009	Mile
Slope (in percent)	=			1.187	
R	=	100 year 24 hour point rainfall			
	=	48.00	cm		(Refer Subzone Report 5a-b)
tc	=	Time of concentration			
	=	$0.9 \times L / (M \ 0.1 \times S \ 0.2)$			
	=	0.771	hr.		
F	=	Areal Reduction factor			
	=	0.81			
C	=	Runoff Coefficient			
	=	$0.415 \times (R \times F)^{0.2}$			
	=	0.86			
tc hr. ratio	=	0.360			
1 hr. ratio	=	0.416			Refer. RBF - 16 Report
Conversion Ratio, K	=	tc hr. ratio / 1 hr. ratio			
	=	0.87			
R100(24)	=	48	cm		
R100(1)	=	R100(24) x 1 hr. to 24 hr. rainfall ratio			
	=	19.97	cm		
	=	199.68	mm		
R100(tc)	=	K x R100(1)			
	=	172.80	mm		
I	=	100 year rainfall intensity (mm/hr) lasting for tc hr. duration			
	=	R100(tc)/tc			
	=	224.17	mm/hr.		
Design Flood					
Q	=	$0.278 \times C \ I \ A$			
	=	41.36	m3/sec		

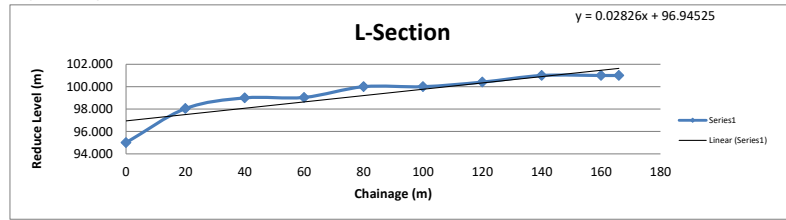
(2) By Rational Method (SP-13 Code)

Area of catchment, A		76.9	Ha		
Length of longest stream, L		1.26	Km		
The fall in level from critical point to the structure, H		15.00	m		
Runoff Coefficient as per Terrain, P	=	0.6			
tc	=	$((0.87 \times (L^3/H))^{0.385})$			(Refer IRC SP-13)
	=	0.44	hr		
Now,					
F (100 year-24 hr rainfall)		480	mm		
One hour conversion ratio from report 5a		0.32			
F (100 year-1 hr rainfall)		153.6	mm		
T			hour		
Now,					
Ic	=	$(F/T) \times ((T+1)/(tc+1))$			(Refer SP-13) Where, F Total precipitation T Duration of time
	=	213.64	mm/hr		
	=	21.36	cm/hr		
f	=	0.990			Fig.4.2 ' f-curve ' from IRC:SP: 13
Q	=	$0.028 \times P \times f \times A \times I_c$			
	=	27.324	cumecs		

(B) Fixing of Design Discharge

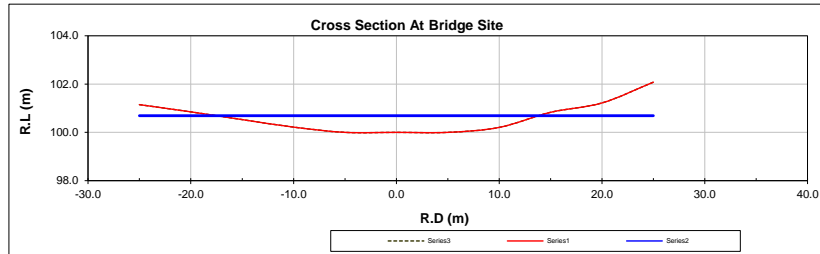
Calculated Peak Discharge by					
i) By Modified Rational method (Bridges and Floods Wing Report, RBF-16)	=	41.36	cumecs		
ii) By Rational Method (SP-13 Code)	=	27.32	cumecs		
Therefore, The Reccomended Design Discharge, Qd (As per clause 106.3.2, IRC:5-2015)	=	41.36	cumecs		

(C) Calculation of Design Affluxed HFL w.r.t. Design Discharge
 Design Discharge, Qd = 41.36 Cumecs



Average Bed Slope of River, S = 0.02826
 Manning's Coefficient, n = 0.04

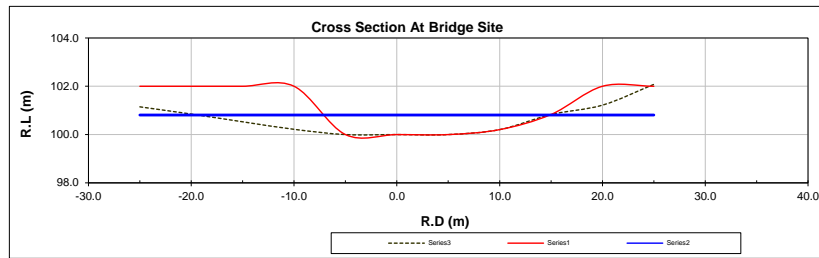
At Bridge Site



Distance	RL of Existing GL	RL of Modified GL	HFL	a	p	r=a/p	q
-25.00	101.148	101.148	100.690	-	-	-	-
-20.00	100.849	100.849	100.690	-	-	-	-
-15.00	100.529	100.529	100.690	0.005	4.708	0.001	0.0002
-10.00	100.217	100.217	100.690	1.490	4.708	0.316	2.9066
-5.00	100.000	100.000	100.690	2.732	4.703	0.581	7.9951
0.00	100.000	100.000	100.690	3.242	4.699	0.690	10.6397
5.00	100.000	100.000	100.690	3.242	4.699	0.690	10.6397
10.00	100.205	100.205	100.690	2.761	4.703	0.587	8.1336
15.00	100.831	100.831	100.690	0.808	4.735	0.171	1.0451
20.00	101.218	101.218	100.690				
25.00	102.078	102.078	100.690				
An1=				14.280		Q=	41.360

(D) Afflux Calculation

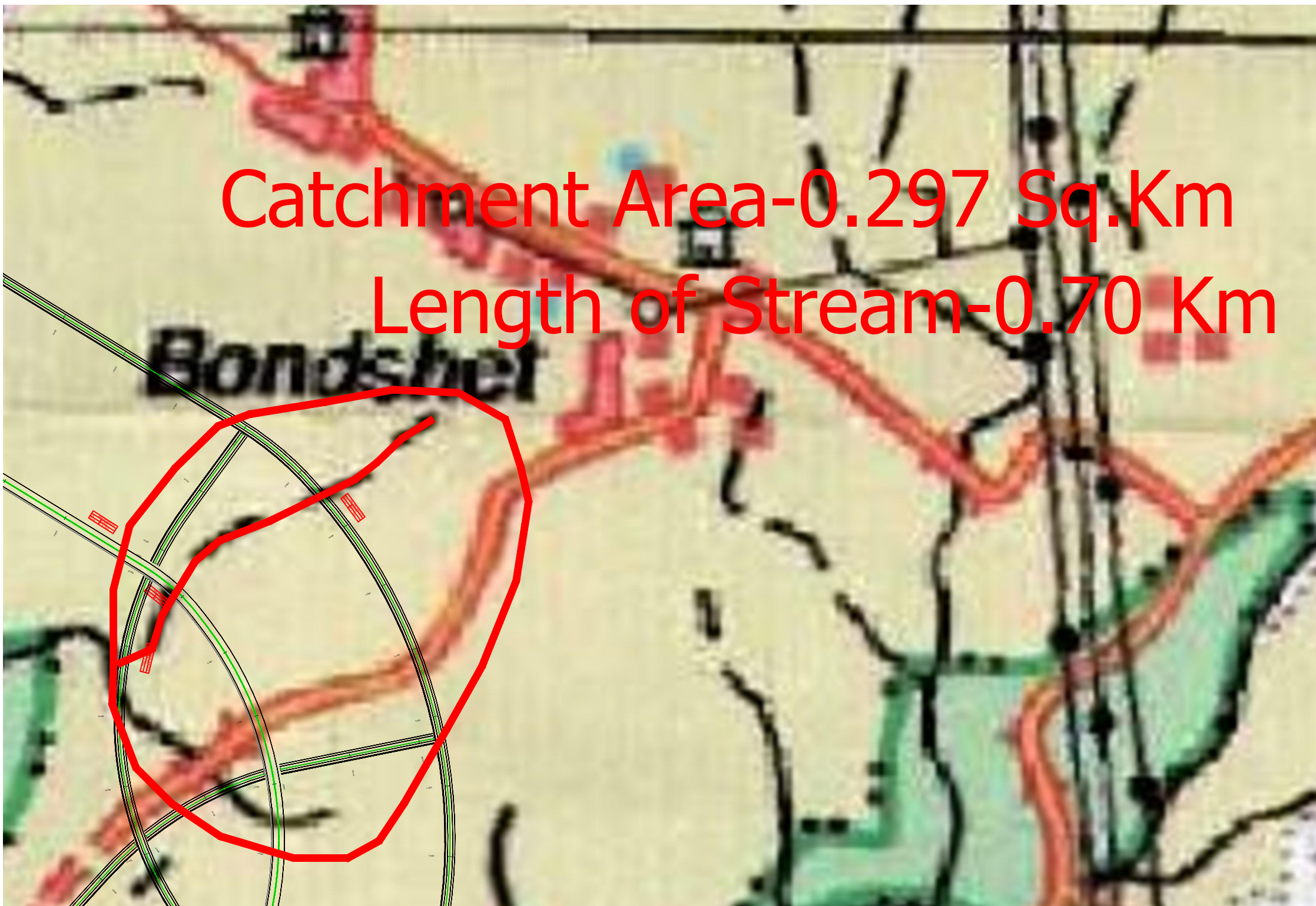
Determination of Obstructed Bridge Area



Distance	RL of Existing GL	RL of Modified GL	HFL	a	p	r=a/p	q	depth, d
-25.00	101.148	102.000	100.809	-	-	-	-	-
-20.00	100.849	102.000	100.809					
-15.00	100.529	102.000	100.809					
-10.00	100.217	102.000	100.809					
-5.00	100.000	100.000	100.809					0.8095
0.00	100.000	100.000	100.809	3.804	4.699	0.809	13.8843	0.8095
5.00	100.000	100.000	100.809	3.804	4.699	0.809	13.8843	0.8095
10.00	100.205	100.205	100.809	3.322	4.703	0.706	11.0734	0.6045
15.00	100.831	100.831	100.809	1.370	4.735	0.289	2.5174	
20.00	101.218	102.000	100.809					
25.00	102.078	102.000	100.809					
An2'=				12.299	sq m	Q=	41.359	Cumecs
Average depth, d				=		0.758	m	
Lowest Bed Level				=		100.000	m	

Therefore,				
Discharge, Q	=	41.359	cumec	
HFL (Without Afflux)	=	100.690	m	
Average Depth, d	=	0.758	m	
Area before constriction				
An1	=	14.280	sq m	
Average velocity prior to constriction				
Vn1	=	Q/An1		
	=	2.896	m/s	
Area after constriction				
An2*	=	12.299	sq m	
An2	=	An2* - no's of piers * average width of piers * average depth (d)		
	=	12.299	sq m	
Average Velocity after constriction				
Vn2	=	Q/An2		
	=	3.363	m/s	
Afflux due to constriction (By Molesworth Formula)				
h	=	[(Vn1^2)/17.88+0.015] [(An1/An2)^2-1]		
	=	0.169	m	
(E) Recommendation				
Design Discharge, Qd	=	41.359	cumecs	
Design Affluxed HFL	=	100.978	m	
Average Velocity, Vn2	=	3.363	m/sec	
(F) Hydraulic Adequacy				
Design Affluxed HFL	=	100.978	m	
Required Vortice Clearance	=	0.90	m	
Proposed Soffit Level	=	101.878	m	

Catchment Area-0.297 Sq.Km
Length of Stream-0.70 Km



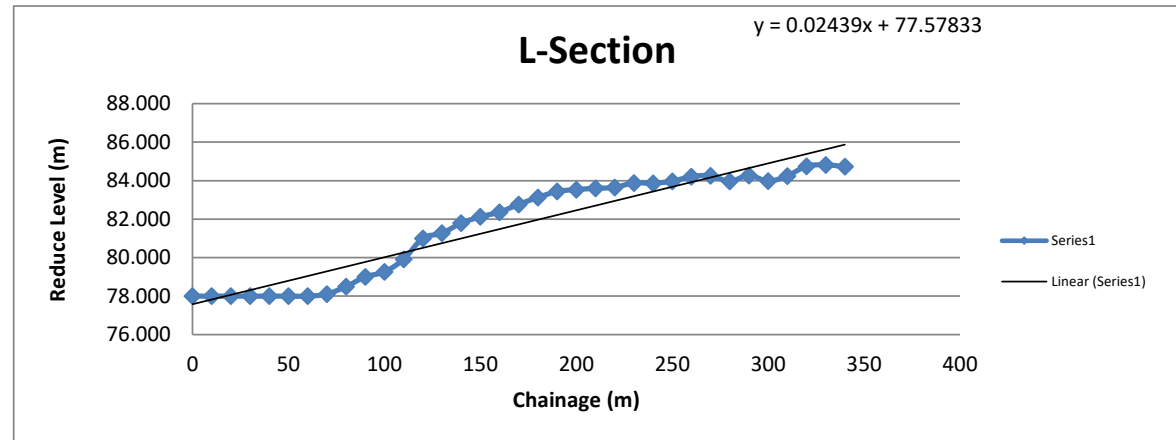
SUMMARY					
Sr.No	Chainage (km)	Discharge (Cumecs)			Design Discharge (Cumecs)
		By Modified Rational method (Bridges and Floods Wing Report, RBF-16)	By Rational Method (SP-13 Code)	By Area Velocity Method	
1	Br-34	21.978	12.787	-	21.978

Sr.No	Chainage (km)	Design Discharge (cumecs)	Design HFL (m)	Average Velocity (m/s)	Avg. depth (m)	LBL (m)	Proposed Waterway (m)	Vertical clearance Required (m)	Proposed Minimum Soffit level (m)
1	Br-34	21.978	79.925	2.45	0.54	79.19	17	0.60	80.525

*Note Scour Level shall be limited to Rock level found at site

Longitudnal Slope

Chainage (m)	RL (m)
0.00	78.000
10.00	78.000
20.00	78.000
30.00	78.000
40.00	78.000
50.00	78.000
60.00	78.000
70.00	78.104
80.00	78.493
90.00	79.000
100.00	79.261
110.00	79.911
120.00	81.000
130.00	81.270
140.00	81.789
150.00	82.121
160.00	82.366
170.00	82.766
180.00	83.126
190.00	83.439
200.00	83.538
210.00	83.598
220.00	83.650
230.00	83.880
240.00	83.863
250.00	83.971
260.00	84.211
270.00	84.253
280.00	83.968
290.00	84.273
300.00	83.979
310.00	84.245
320.00	84.751
330.00	84.820
340.00	84.728



DESIGN DISCHARGE CALCULATION

Name and number of subzone Subzone-5a-b
Existing Chainage
Proposed chainage 0+100
River/Stream Br-34
Type Minor Bridge

(A) FLOOD ESTIMATION

(1) By Modified Rational method (Bridges and Floods Wing Report, RBF-16)

Catchment Area of River, A	=	0.297	km ²	0.115	Mile ²
Length of longest stream, L	=	0.70	km	0.436	Mile
Level Difference between source and bridge site, H	=	20.0	m	0.012	Mile
Slope (in percent)	=			2.849	
R	=	100 year 24 hour point rainfall			
	=	48.00	cm		(Refer Subzone Report 5a-b)
tc	=	Time of concentration			
	=	$0.9 \times L / (M \ 0.1 \times S \ 0.2)$			
	=	0.395	hr.		
F	=	Areal Reduction factor			
	=	0.72			
C	=	Runoff Coefficient			
	=	$0.415 \times (R \times F)^{0.2}$			
	=	0.84			
tc hr. ratio	=	0.26			
1 hr. ratio	=	0.416			Refer. RBF - 16 Report
Conversion Ratio, K	=	tc hr. ratio / 1 hr. ratio			
	=	0.63			
R100(24)	=	48	cm		
R100(1)	=	R100(24) x 1 hr. to 24 hr. rainfall ratio			
	=	19.97	cm		
	=	199.68	mm		
R100(tc)	=	K x R100(1)			
	=	124.80	mm		
I	=	100 year rainfall intensity (mm/hr) lasting for tc hr. duration			
	=	R100(tc)/tc			
	=	315.80	mm/hr.		
Design Flood					
Q	=	$0.278 \times C \ I \ A$			
	=	21.98	m ³ /sec		

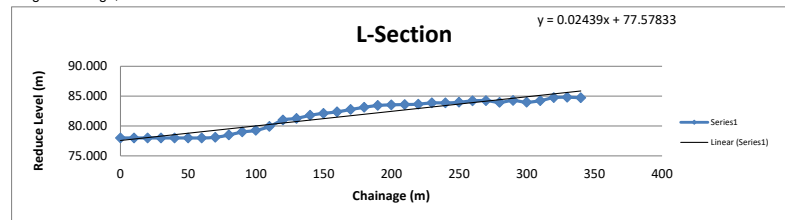
(2) By Rational Method (SP-13 Code)

Area of catchment, A		29.7	Ha		
Length of longest stream, L		0.70	Km		
The fall in level from critical point to the structure, H		20.00	m		
Runoff Coefficient as per Terrain, P	=	0.6			
tc	=	$((0.87 \times (L^3/H))^{0.385})$			(Refer IRC SP-13)
	=	0.20	hr		
Now,					
F (100 year-24 hr rainfall)		480	mm		
One hour conversion ratio from report 5a		0.32			
F (100 year-1 hr rainfall)		153.6	mm		
T			hour		
Now,					
Ic	=	$(F/T)X((T+1)/(tc+1))$			(Refer SP-13) Where, F Total precipitation
	=	256.26	mm/hr		T Duration of time
	=	25.63	cm/hr		
f	=	1.000			Fig.4.2 ' f-curve ' from IRC:SP: 13
Q	=	$0.028XPXfXAxc$			
	=	12.787	cumecs		

(B) Fixing of Design Discharge

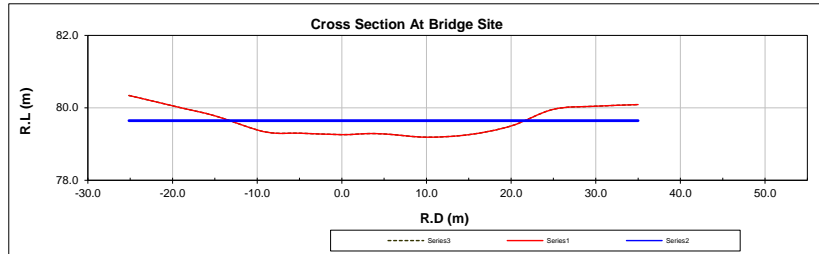
Calculated Peak Discharge by					
i) By Modified Rational method (Bridges and Floods Wing Report, RBF-16)	=	21.98	cumecs		
ii) By Rational Method (SP-13 Code)	=	12.79	cumecs		
Therefore, The Reccomended Design Discharge, Qd (As per clause 106.3.2, IRC:5-2015)	=	21.98	cumecs		

(C) Calculation of Design Affluxed HFL w.r.t. Design Discharge
 Design Discharge, Qd = 21.98 Cumecs



Average Bed Slope of River, S = 0.02490
 Manning's Coefficient, n = 0.04

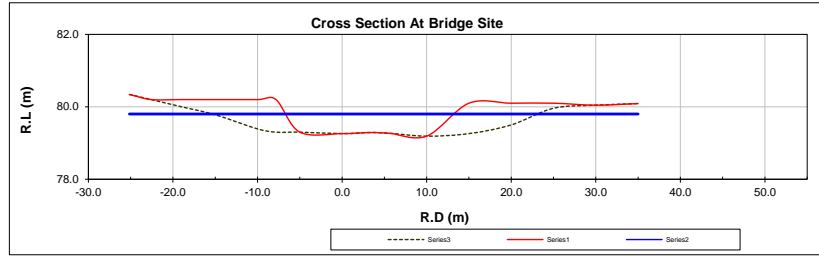
At Bridge Site



Distance	RL of Existing GL	RL of Modified GL	HFL	a	p	r=a/p	q
-25.15	80.341	80.341	79.646	-	-	-	-
-22.56	80.200	80.200	79.646				
-19.16	80.010	80.010	79.646				
-15.00	79.780	79.780	79.646				
-10.00	79.390	79.390	79.646	0.305	5.015	0.061	0.1856
-7.82	79.300	79.300	79.646	0.656	2.182	0.301	1.1614
-5.00	79.300	79.300	79.646	0.975	2.820	0.346	1.8962
0.00	79.260	79.260	79.646	1.830	5.000	0.366	3.6923
3.24	79.290	79.290	79.646	1.202	3.242	0.371	2.4488
5.59	79.270	79.270	79.646	0.857	2.343	0.366	1.7302
10.00	79.190	79.190	79.646	1.836	4.416	0.416	4.0357
15.00	79.260	79.260	79.646	2.105	5.000	0.421	4.6626
20.00	79.500	79.500	79.646	1.330	5.006	0.266	2.1672
25.00	79.960	79.960	79.646				
30.00	80.045	80.045	79.646				
35.00	80.090	80.090	79.646				
An1=				11.096		Q=	21.980

(D) Afflux Calculation

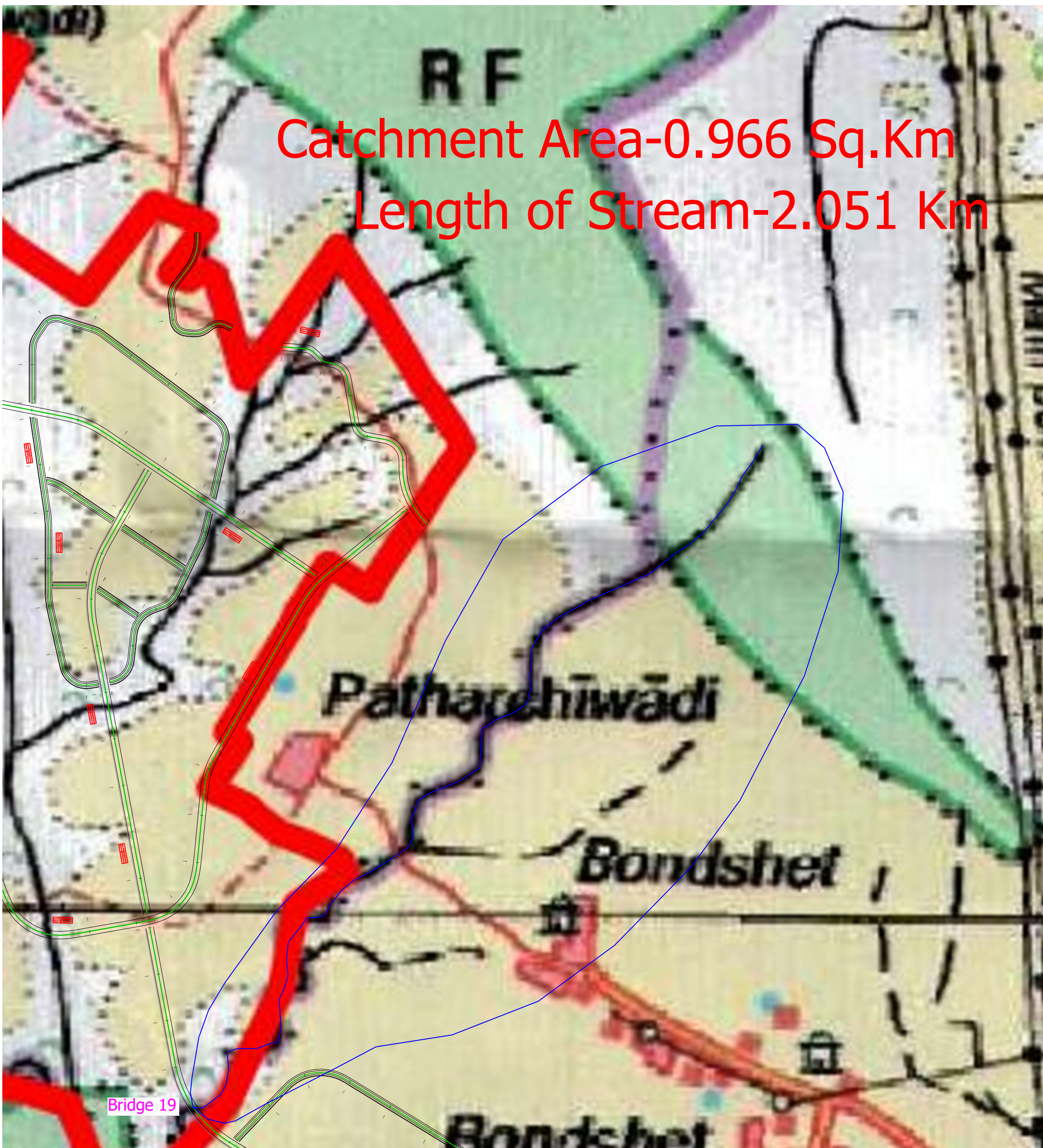
Determination of Obstructed Bridge Area



Distance	RL of Existing GL	RL of Modified GL	HFL	a	p	r=a/p	q	depth, d
-25.15	80.341	80.341	79.801	-	-	-	-	-
-22.56	80.200	80.200	79.801					
-19.16	80.010	80.200	79.801					
-15.00	79.780	80.200	79.801					
-10.00	79.390	80.200	79.801					
-7.82	79.300	80.200	79.801					
-5.00	79.300	79.300	79.801	0.145	2.960	0.049	0.0763	0.5013
0.00	79.260	79.260	79.801	2.607	5.000	0.521	6.6601	0.5413
3.24	79.290	79.290	79.801	1.706	3.242	0.526	4.3876	0.5113
5.59	79.270	79.270	79.801	1.221	2.343	0.521	3.1209	0.5313
10.00	79.190	79.190	79.801	2.522	4.416	0.571	6.8501	0.6113
15.00	79.260	80.100	79.801	0.762	5.082	0.154	0.8849	
20.00	79.500	80.100	79.801					
25.00	79.960	80.100	79.801					
30.00	80.045	80.045	79.801					
35.00	80.090	80.090	79.801					
An2'=				8.983	sq m	Q=	21.980	Cumecs
Average depth, d				=		0.539	m	
Lowest Bed Level				=		79.190	m	

Therefore,			
Discharge, Q	=	21.980	cumec
HFL (Without Afflux)	=	79.646	m
Average Depth, d	=	0.539	m
Area before constriction			
An1	=	11.096	sq m
Average velocity prior to constriction			
Vn1	=	Q/An1	
	=	1.981	m/s
Area after constriction			
An2*	=	8.983	sq m
An2	=	An2* - no's of piers * average width of piers * average depth (d)	
	=	8.983	sq m
Average Velocity after constriction			
Vn2	=	Q/An2	
	=	2.447	m/s
Afflux due to constriction (By Molesworth Formula)			
h	=	[(Vn1 ²)/17.88+0.015] [(An1/An2) ² -1]	
	=	0.123	m
(E) Recommendation			
Design Discharge, Qd	=	21.980	cumecs
Design Affluxed HFL	=	79.925	m
Average Velocity, Vn2	=	2.447	m/sec
(F) Hydraulic Adequacy			
Design Affluxed HFL	=	79.925	m
Required Vercile Clearance	=	0.60	m
Proposed Soffit Level	=	80.525	m

Catchment Area-0.966 Sq.Km
Length of Stream-2.051 Km



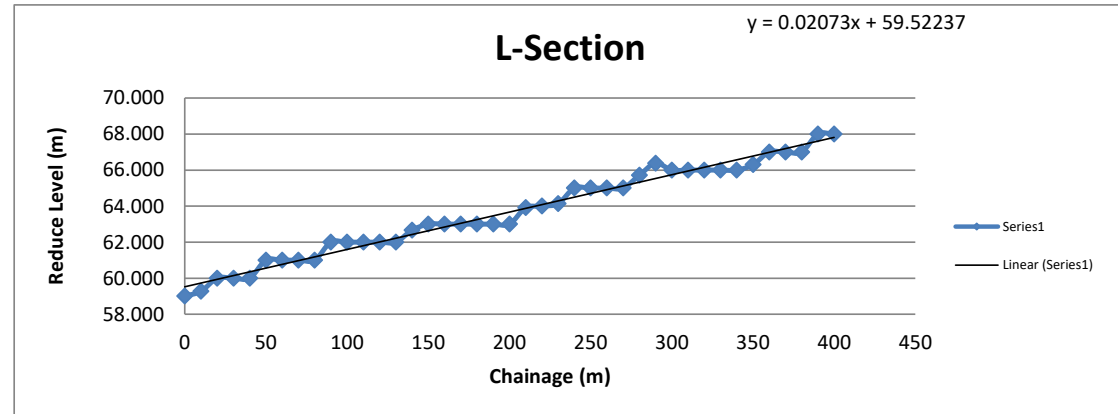
SUMMARY					
Sr.No	Chainage (km)	Discharge (Cumecs)			Design Discharge (Cumecs)
		By Modified Rational method (Bridges and Floods Wing Report, RBF-16)	By Rational Method (SP-13 Code)	By Area Velocity Method	
1	0+420-Br-19	45.084	27.756	-	45.084

Sr.No	Chainage (km)	Design Discharge (cumecs)	Design HFL (m)	Average Velocity (m/s)	Avg. depth (m)	LBL (m)	Proposed Waterway (m)	Vertical clearance Required (m)	Proposed Minimum Soffit level (m)
1	0+420-Br-19	45.084	66.459	3.32	1.12	65.00	16.00	0.90	67.359

*Note Scour Level shall be limited to Rock level found at site

Longitudnal Slope

Chainage (m)	RL (m)
0.00	59.000
10.00	59.274
20.00	60.000
30.00	60.000
40.00	60.000
50.00	61.000
60.00	61.000
70.00	61.000
80.00	61.000
90.00	62.000
100.00	62.000
110.00	62.000
120.00	62.000
130.00	62.000
140.00	62.664
150.00	63.000
160.00	63.000
170.00	63.000
180.00	63.000
190.00	63.000
200.00	63.000
210.00	63.908
220.00	64.000
230.00	64.140
240.00	65.000
250.00	65.000
260.00	65.000
270.00	65.000
280.00	65.711
290.00	66.382
300.00	66.000
310.00	66.000
320.00	66.000
330.00	66.000
340.00	66.000
350.00	66.296
360.00	67.000
370.00	67.000
380.00	67.000
390.00	68.000
400.00	68.000



DESIGN DISCHARGE CALCULATION

Name and number of subzone Subzone-5a-b
Existing Chainage
Proposed chainage 0+420-Br-19
River/Stream -
Type Minor Bridge

(A) FLOOD ESTIMATION

(1) By Modified Rational method (Bridges and Floods Wing Report, RBF-16)

Catchment Area of River, A	=	0.966	km ²	0.373	Mile ²
Length of longest stream, L	=	2.051	km	1.274	Mile
Level Difference between source and bridge site, H	=	50.0	m	0.031	Mile
Slope (in percent)	=			2.438	
R	=	100 year 24 hour point rainfall			
	=	48.00	cm		(Refer Subzone Report 5a-b)
tc	=	Time of concentration			
	=	$0.9 \times L / (M \ 0.1 \times S \ 0.2)$			
	=	1.059	hr.		
F	=	Areal Reduction factor			
	=	0.88			
C	=	Runoff Coefficient			
	=	$0.415 \times (R \times F)^{0.2}$			
	=	0.88			
tc hr. ratio	=	0.422			
1 hr. ratio	=	0.416			Refer. RBF - 16 Report
Conversion Ratio, K	=	tc hr. ratio / 1 hr. ratio			
	=	1.01			
R100(24)	=	48	cm		
R100(1)	=	R100(24) x 1 hr. to 24 hr. rainfall ratio			
	=	19.97	cm		
	=	199.68	mm		
R100(tc)	=	K x R100(1)			
	=	202.56	mm		
I	=	100 year rainfall intensity (mm/hr) lasting for tc hr. duration			
	=	R100(tc)/tc			
	=	191.34	mm/hr.		
Design Flood					
Q	=	$0.278 \times C \ I \ A$			
	=	45.08	m3/sec		

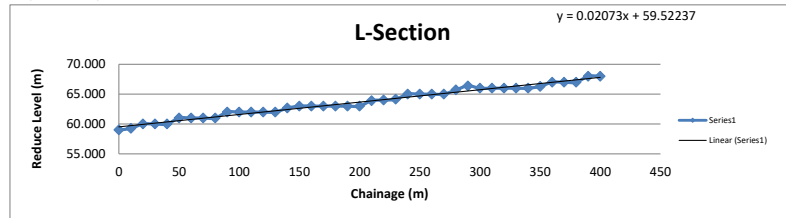
(2) By Rational Method (SP-13 Code)

Area of catchment, A		96.6	Ha		
Length of longest stream, L		2.05	Km		
The fall in level from critical point to the structure, H		50.00	m		
Runoff Coefficient as per Terrain, P	=	0.5			
tc	=	$((0.87 \times (L^3/H))^{0.385})$			(Refer IRC SP-13)
	=	0.48	hr		
Now,					
F (100 year-24 hr rainfall)		480	mm		
One hour conversion ratio from report 5a		0.32			
F (100 year-1 hr rainfall)		153.6	mm		
T			hour		
Now,					
Ic	=	$(F/T) \times ((T+1)/(tc+1))$			(Refer SP-13) Where,
	=	207.31	mm/hr		F Total precipitation
	=	20.73	cm/hr		T Duration of time
f	=	0.990			Fig.4.2 ' f-curve ' from IRC:SP: 13
Q	=	$0.028 \times P \times f \times A \times I_c$			
	=	27.756	cumecs		

(B) Fixing of Design Discharge

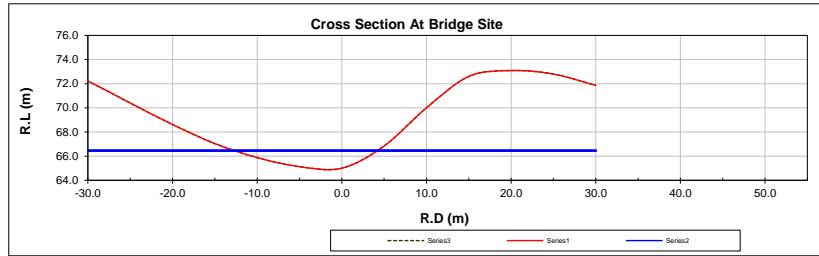
Calculated Peak Discharge by					
i) By Modified Rational method (Bridges and Floods Wing Report, RBF-16)	=	45.08	cumecs		
ii) By Rational Method (SP-13 Code)	=	27.76	cumecs		
Therefore, The Reccomended Design Discharge, Qd (As per clause 106.3.2, IRC:5-2015)	=	45.08	cumecs		

(C) Calculation of Design Affluxed HFL w.r.t. Design Discharge
 Design Discharge, Qd = 45.08 Cumecs



Average Bed Slope of River, S = 0.02073
 Manning's Coefficient, n = 0.045

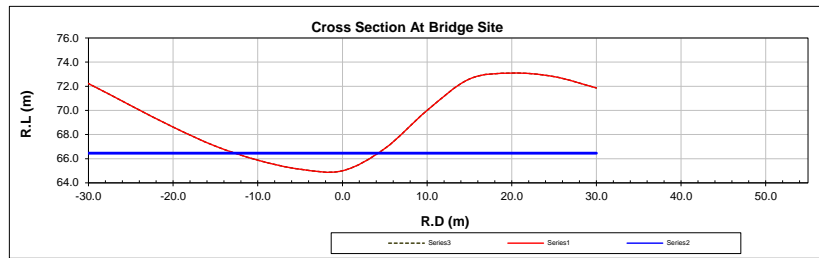
At Bridge Site



Distance	RL of Existing GL	RL of Modified GL	HFL	a	p	r=a/p	q
-35.00	73.830	73.830	66.459	-	-	-	-
-30.00	72.220	72.220	66.459				
-25.00	70.400	70.400	66.459				
-20.00	68.620	68.620	66.459				
-15.00	67.040	67.040	66.459				
-10.00	65.880	65.880	66.459				
-5.00	65.130	65.130	66.459	4.482	4.751	0.943	13.7939
0.00	65.000	65.000	66.459	6.550	4.700	1.393	26.1432
5.00	66.840	66.840	66.459	2.532	5.007	0.506	5.1428
10.00	70.000	70.000	66.459				
15.00	72.600	72.600	66.459				
20.00	73.090	73.090	66.459				
25.00	72.800	72.800	66.459				
30.00	71.860	71.860	66.459				
An1=				13.564		Q=	45.080

(D) Afflux Calculation

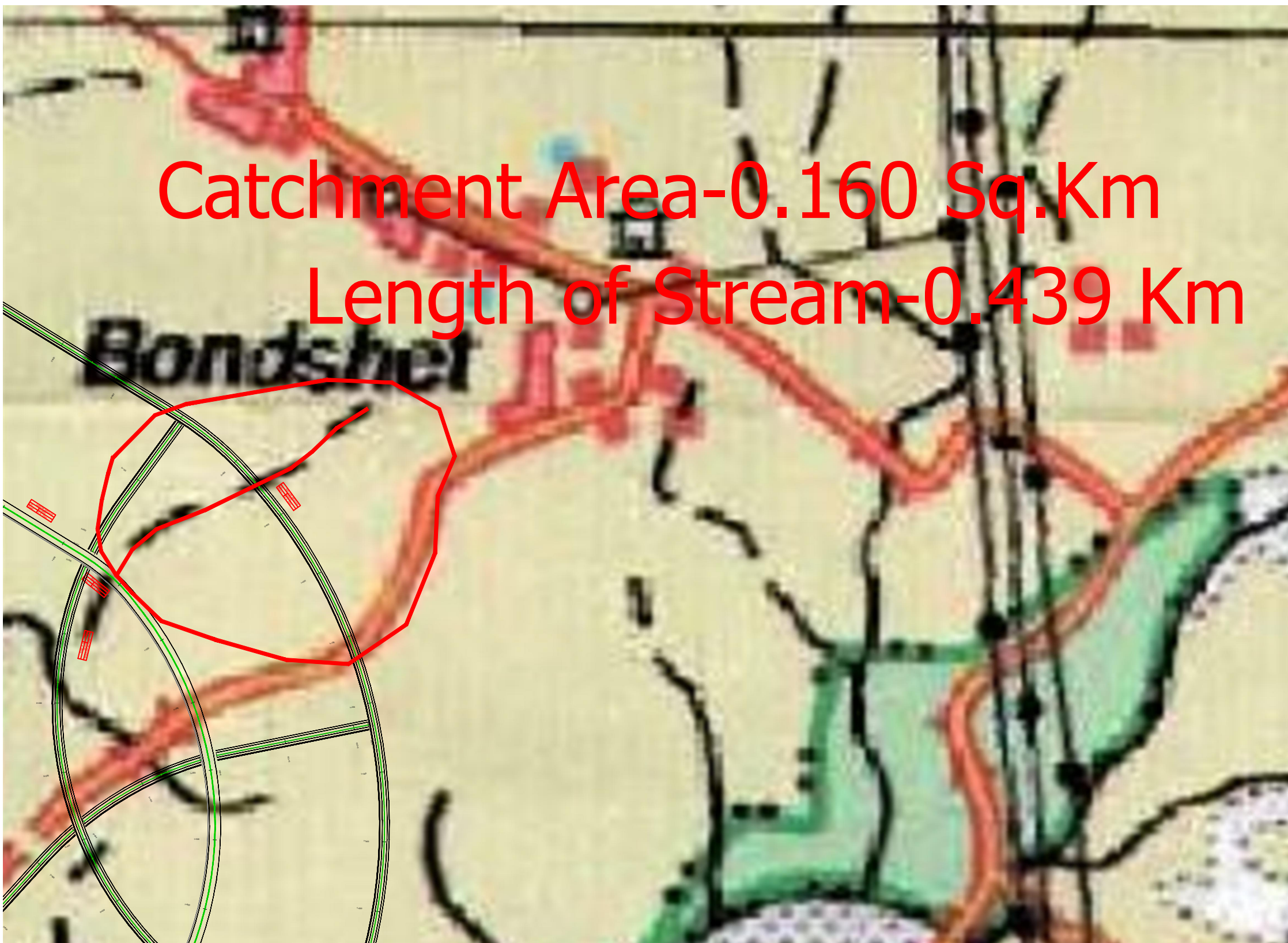
Determination of Obstructed Bridge Area



Distance	RL of Existing GL	RL of Modified GL	HFL	a	p	r=a/p	q	depth, d
-35.00	73.830	73.830	66.459	-	-	-	-	-
-30.00	72.220	72.220	66.459					
-25.00	70.400	70.400	66.459					
-20.00	68.620	68.620	66.459					
-15.00	67.040	67.040	66.459					
-10.00	65.880	65.880	66.459					0.5789
-5.00	65.130	65.130	66.459	4.482	4.751	0.943	13.7939	1.3289
0.00	65.000	65.000	66.459	6.550	4.700	1.393	26.1432	1.4589
5.00	66.840	66.840	66.459	2.532	5.007	0.506	5.1428	
10.00	70.000	70.000	66.459					
15.00	72.600	72.600	66.459					
20.00	73.090	73.090	66.459					
25.00	72.800	72.800	66.459					
30.00	71.860	71.860	66.459					
An2*=				13.564	sq m	Q=	45.080	Cumecs
Average depth, d				=		1.122	m	
Lowest Bed Level				=		65.000	m	

Therefore,			
Discharge, Q	=	45.080	cumec
HFL (Without Afflux)	=	66.459	m
Average Depth, d	=	1.122	m
Area before constriction			
An1	=	13.564	sq m
Average velocity prior to constriction			
Vn1	=	Q/An1	
	=	3.324	m/s
Area after constriction			
An2*	=	13.564	sq m
An2	=	An2* - no's of piers * average width of piers * average depth (d)	
	=	13.564	sq m
Average Velocity after constriction			
Vn2	=	Q/An2	
	=	3.324	m/s
Afflux due to constriction (By Molesworth Formula)			
h	=	$[(Vn1^2)/17.88+0.015] [(An1/An2)^2-1]$	
	=	0.000	m
(E) Recommendation			
Design Discharge, Qd	=	45.080	cumecs
Design Affluxed HFL	=	66.459	m
Average Velocity, Vn2	=	3.324	m/sec
(F) Hydraulic Adequacy			
Design Affluxed HFL	=	66.459	m
Required Vercile Clearance	=	0.90	m
Proposed Soffit Level	=	67.359	m

Catchment Area-0.160 Sq.Km
Length of Stream-0.439 Km



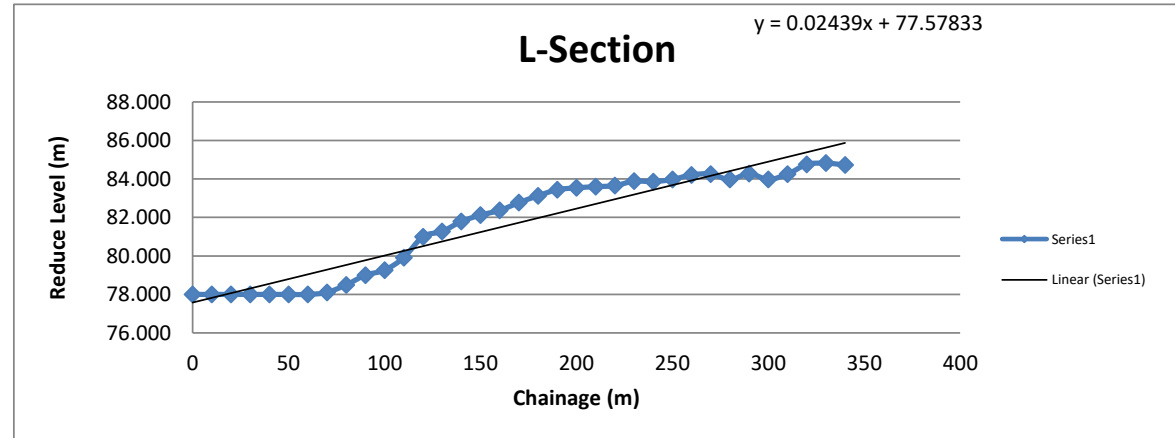
SUMMARY					
Sr.No	Chainage (km)	Discharge (Cumecs)			Design Discharge (Cumecs)
		By Modified Rational method (Bridges and Floods Wing Report, RBF-16)	By Rational Method (SP-13 Code)	By Area Velocity Method	
1	-	13.908	7.136	-	13.908

Sr.No	Chainage (km)	Design Discharge (cumecs)	Design HFL (m)	Average Velocity (m/s)	Avg. depth (m)	LBL (m)	Proposed Waterway (m)	Vertical clearance Required (m)	Proposed Minimum Soffit level (m)
1	-	13.908	84.005	2.61	0.74	83.00	12.00	0.60	84.605

*Note Scour Level shall be limited to Rock level found at site

Longitudnal Slope

Chainage (m)	RL (m)
0.00	78.000
10.00	78.000
20.00	78.000
30.00	78.000
40.00	78.000
50.00	78.000
60.00	78.000
70.00	78.104
80.00	78.493
90.00	79.000
100.00	79.261
110.00	79.911
120.00	81.000
130.00	81.270
140.00	81.789
150.00	82.121
160.00	82.366
170.00	82.766
180.00	83.126
190.00	83.439
200.00	83.538
210.00	83.598
220.00	83.650
230.00	83.880
240.00	83.863
250.00	83.971
260.00	84.211
270.00	84.253
280.00	83.968
290.00	84.273
300.00	83.979
310.00	84.245
320.00	84.751
330.00	84.820
340.00	84.728



DESIGN DISCHARGE CALCULATION

Name and number of subzone	Subzone-5a-b
Existing Chainage	Br-21
Proposed chainage	1+120
River/Stream	-
Type	Minor Bridge

(A) FLOOD ESTIMATION

(1) By Modified Rational method (Bridges and Floods Wing Report, RBF-16)

Catchment Area of River, A	=	0.160	km ²	0.062	Mile ²
Length of longest stream, L	=	0.439	km	0.273	Mile
Level Difference between source and bridge site, H	=	9.0	m	0.006	Mile
Slope (in percent)	=			2.050	
R	=	100 year 24 hour point rainfall			
	=	48.00	cm		(Refer Subzone Report 5a-b)
tc	=	Time of concentration			
	=	0.9 x L / (M 0.1 x S 0.2)			
	=	0.281	hr.		
F	=	Areal Reduction factor			
	=	0.72			
C	=	Runoff Coefficient			
	=	0.415 x (R x F) ^{0.2}			
	=	0.84			
tc hr. ratio	=	0.217			
1 hr. ratio	=	0.416			Refer. RBF - 16 Report
Conversion Ratio, K	=	tc hr. ratio / 1 hr. ratio			
	=	0.52			
R100(24)	=	48	cm		
R100(1)	=	R100(24) x 1 hr. to 24 hr. rainfall ratio			
	=	19.97	cm		
	=	199.68	mm		
R100(tc)	=	K x R100(1)			
	=	104.16	mm		
I	=	100 year rainfall intensity (mm/hr) lasting for tc hr. duration			
	=	R100(tc)/tc			
	=	370.96	mm/hr.		
Design Flood					
Q	=	0.278 x C I A			
	=	13.91	m3/sec		

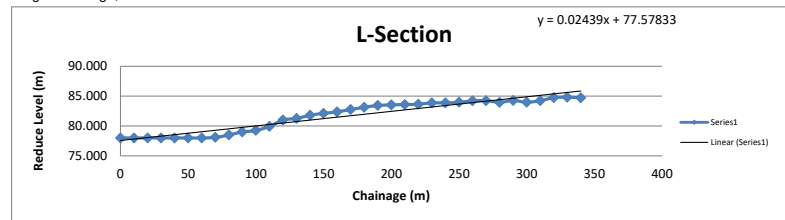
(2) By Rational Method (SP-13 Code)

Area of catchment, A		16	Ha		
Length of longest stream, L		0.44	Km		
The fall in level from critical point to the structure, H		9.00	m		
Runoff Coefficient as per Terrain, P	=	0.6			
tc	=	((0.87x(L ³ /H)) ^{0.385}			(Refer IRC SP-13)
	=	0.16	hr		
Now,					
F (100 year-24 hr rainfall)		480	mm		
One hour conversion ratio from report 5a		0.32			
F (100 year-1 hr rainfall)		153.6	mm		
T			hour		
Now,					
Ic	=	(F/T)X((T+1)/(tc+1))			(Refer SP-13) Where, F Total precipitation
	=	265.47	mm/hr		T Duration of time
	=	26.55	cm/hr		
f	=	1.000			Fig.4.2 ' f-curve ' from IRC:SP: 13
Q	=	0.028XPXfXAxlC			
	=	7.136	cumecs		

(B) Fixing of Design Discharge

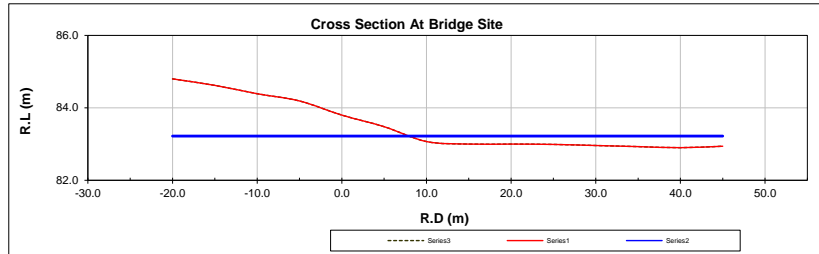
Calculated Peak Discharge by					
i) By Modified Rational method (Bridges and Floods Wing Report, RBF-16)	=	13.91	cumecs		
ii) By Rational Method (SP-13 Code)	=	7.14	cumecs		
Therefore, The Reccomended Design Discharge, Qd (As per clause 106.3.2, IRC:5-2015)	=	13.91	cumecs		

(C) Calculation of Design Affluxed HFL w.r.t. Design Discharge
 Design Discharge, Qd = 13.91 Cumecs



Average Bed Slope of River, S = 0.02439
 Manning's Coefficient, n = 0.04

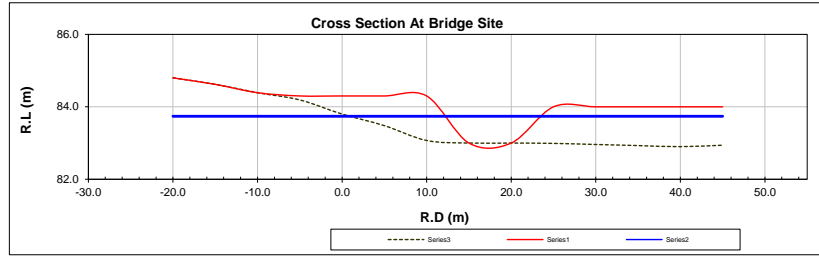
At Bridge Site



Distance	RL of Existing GL	RL of Modified GL	HFL	a	p	r=a/p	q
-20.00	84.800	84.800	83.221	-	-	-	-
-15.00	84.620	84.620	83.221				
-10.00	84.390	84.390	83.221				
-5.00	84.190	84.190	83.221				
0.00	83.800	83.800	83.221				
5.00	83.480	83.480	83.221				
10.00	83.070	83.070	83.221				
15.00	83.000	83.000	83.221	0.930	5.000	0.186	1.1820
20.00	83.000	83.000	83.221	1.105	5.000	0.221	1.5759
25.00	82.990	82.990	83.221	1.130	5.000	0.226	1.6358
30.00	82.960	82.960	83.221	1.230	5.000	0.246	1.8842
35.00	82.930	82.930	83.221	1.380	5.000	0.276	2.2827
40.00	82.900	82.900	83.221	1.530	5.000	0.306	2.7111
45.00	82.940	82.940	83.221	1.505	5.000	0.301	2.6377
An1=				8.807		Q=	13.909

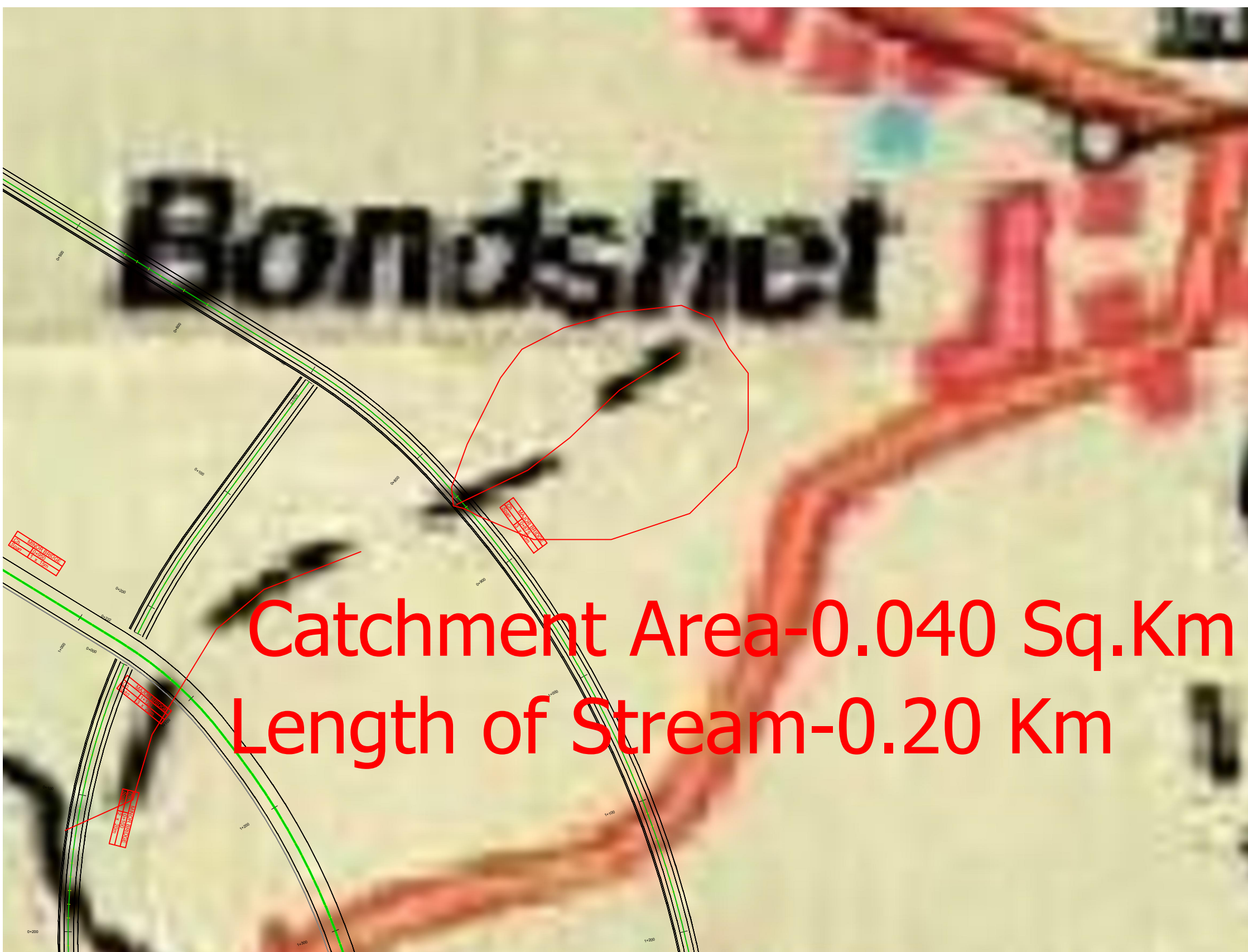
(D) Afflux Calculation

Determination of Obstructed Bridge Area



Distance	RL of Existing GL	RL of Modified GL	HFL	a	p	r=a/p	q	depth, d
-20.00	84.800	84.800	83.739	-	-	-	-	-
-15.00	84.620	84.620	83.739					
-10.00	84.390	84.390	83.739					
-5.00	84.190	84.300	83.739					
0.00	83.800	84.300	83.739					
5.00	83.480	84.300	83.739					
10.00	83.070	84.300	83.739					
15.00	83.000	83.000	83.739	0.446	5.166	0.086	0.3396	0.7391
20.00	83.000	83.000	83.739	3.696	5.000	0.739	11.7953	0.7391
25.00	82.990	84.000	83.739	1.196	5.099	0.234	1.7750	
30.00	82.960	84.000	83.739					
35.00	82.930	84.000	83.739					
40.00	82.900	84.000	83.739					
45.00	82.940	84.000	83.739					
An2²=				5.337	sq m	Q=	13.910	Cumecs
Average depth, d				=		0.739	m	
Lowest Bed Level				=		83.000	m	

Therefore,				
Discharge, Q	=	13.910	cumec	
HFL (Without Afflux)	=	83.221	m	
Average Depth, d	=	0.739	m	
Area before constriction				
An1	=	8.807	sq m	
Average velocity prior to constriction				
Vn1	=	Q/An1		
	=	1.579	m/s	
Area after constriction				
An2*	=	5.337	sq m	
An2	=	An2* - no's of piers * average width of piers * average depth (d)		
	=	5.337	sq m	
Average Velocity after constriction				
Vn2	=	Q/An2		
	=	2.606	m/s	
Afflux due to constriction (By Molesworth Formula)				
h	=	[(Vn1^2)/17.88+0.015] [(An1/An2)^2-1]		
	=	0.266	m	
(E) Recommendation				
Design Discharge, Qd	=	13.910	cumecs	
Design Affluxed HFL	=	84.005	m	
Average Velocity, Vn2	=	2.606	m/sec	
(F) Hydraulic Adequacy				
Design Affluxed HFL	=	84.005	m	
Required Vortice Clearance	=	0.60	m	
Proposed Soffit Level	=	84.605	m	



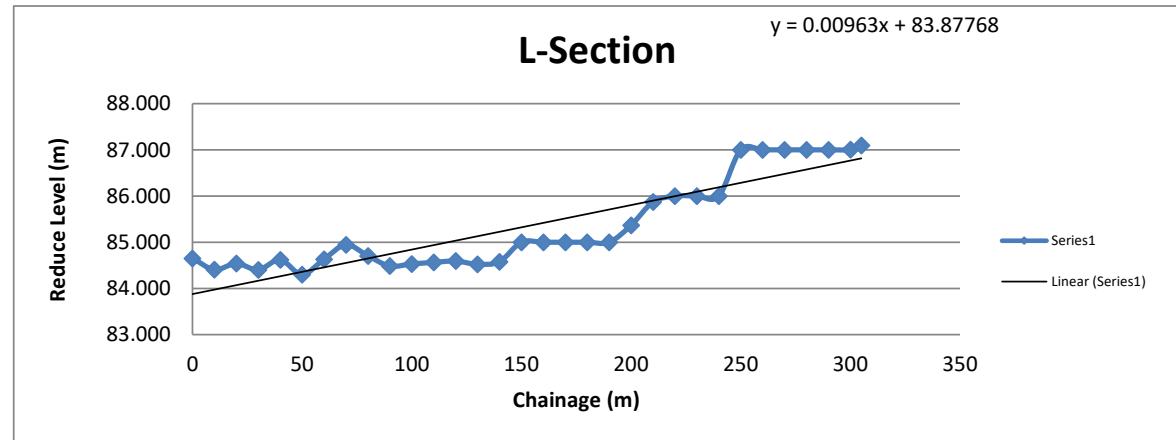
SUMMARY					
Sr.No	Chainage (km)	Discharge (Cumecs)			Design Discharge (Cumecs)
		By Modified Rational method (Bridges and Floods Wing Report, RBF-16)	By Rational Method (SP-13 Code)	By Area Velocity Method	
1	0+100-LR18-03	4.989	1.938	-	4.989

Sr.No	Chainage (km)	Design Discharge (cumecs)	Design HFL (m)	Average Velocity (m/s)	Avg. depth (m)	LBL (m)	Proposed Waterway (m)	Vertical clearance Required (m)	Proposed Minimum Soffit level (m)
1	0+100-LR18-03	4.989	85.759	1.71	0.58	85.00	8.00	0.60	86.359

*Note Scour Level shall be limited to Rock level found at site

Longitudnal Slope

Chainage (m)	RL (m)
0.00	84.652
10.00	84.408
20.00	84.538
30.00	84.405
40.00	84.618
50.00	84.301
60.00	84.634
70.00	84.945
80.00	84.705
90.00	84.485
100.00	84.529
110.00	84.564
120.00	84.592
130.00	84.523
140.00	84.579
150.00	85.000
160.00	85.000
170.00	85.000
180.00	85.000
190.00	85.000
200.00	85.365
210.00	85.870
220.00	86.000
230.00	86.000
240.00	86.000
250.00	87.000
260.00	87.000
270.00	87.000
280.00	87.000
290.00	87.000
300.00	87.004
305.00	87.095



DESIGN DISCHARGE CALCULATION

Name and number of subzone Subzone-5a-b
Existing Chainage
Proposed chainage 0+100-LR18-03
River/Stream -
Type Minor Bridge

(A) FLOOD ESTIMATION

(1) By Modified Rational method (Bridges and Floods Wing Report, RBF-16)

Catchment Area of River, A	=	0.040	km ²	0.015	Mile ²
Length of longest stream, L	=	0.20	km	0.122	Mile
Level Difference between source and bridge site, H	=	8.0	m	0.005	Mile
Slope (in percent)	=			4.061	
R	=	100 year 24 hour point rainfall			
	=	48.00	cm		(Refer Subzone Report 5a-b)
tc	=	Time of concentration			
	=	$0.9 \times L / (M \ 0.1 \times S \ 0.2)$			
	=	0.126	hr.		
F	=	Areal Reduction factor			
	=	0.72			
C	=	Runoff Coefficient			
	=	$0.415 \times (R \times F)^{0.2}$			
	=	0.84			
tc hr. ratio	=	0.14			
1 hr. ratio	=	0.416			Refer. RBF - 16 Report
Conversion Ratio, K	=	tc hr. ratio / 1 hr. ratio			
	=	0.34			
R100(24)	=	48	cm		
R100(1)	=	R100(24) x 1 hr. to 24 hr. rainfall ratio			
	=	19.97	cm		
	=	199.68	mm		
R100(tc)	=	K x R100(1)			
	=	67.20	mm		
I	=	100 year rainfall intensity (mm/hr) lasting for tc hr. duration			
	=	R100(tc)/tc			
	=	532.30	mm/hr.		
Design Flood					
Q	=	$0.278 \times C \ I \ A$			
	=	4.99	m ³ /sec		

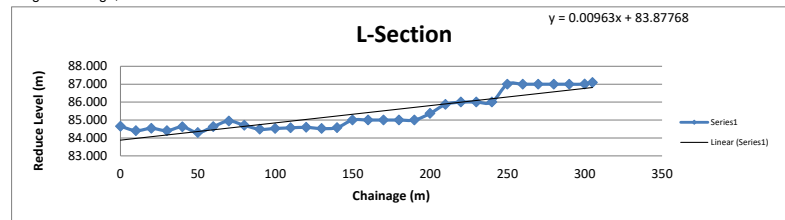
(2) By Rational Method (SP-13 Code)

Area of catchment, A	4	Ha
Length of longest stream, L	0.20	Km
The fall in level from critical point to the structure, H	8.00	m
Runoff Coefficient as per Terrain, P	=	0.6
tc	=	$((0.87 \times (L^3/H))^{0.385})$ (Refer IRC SP-13)
	=	0.07 hr
Now,		
F (100 year-24 hr rainfall)		480 mm
One hour conversion ratio from report 5a		0.32
F (100 year-1 hr rainfall)		153.6 mm
T		I hour
Now,		
Ic	=	$(F/T) \times ((T+1)/(tc+1))$ (Refer SP-13) Where, F Total precipitation
	=	288.40 mm/hr T Duration of time
	=	28.84 cm/hr
f	=	1.000 Fig.4.2 ' f-curve ' from IRC:SP: 13
Q	=	$0.028 \times P \times f \times A \times I_c$
	=	1.938 cumecs

(B) Fixing of Design Discharge

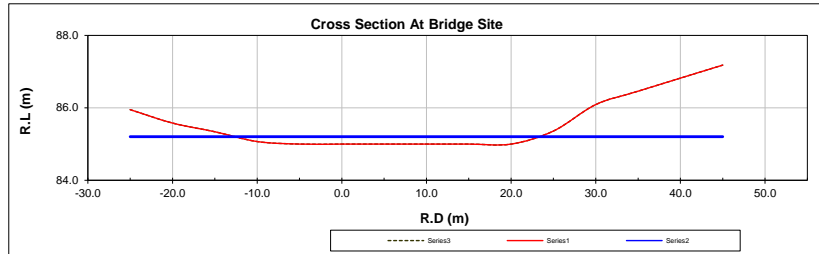
Calculated Peak Discharge by		
i) By Modified Rational method (Bridges and Floods Wing Report, RBF-16)	=	4.99 cumecs
ii) By Rational Method (SP-13 Code)	=	1.94 cumecs
Therefore, The Reccomended Design Discharge, Qd (As per clause 106.3.2, IRC:5-2015)	=	4.99 cumecs

(C) Calculation of Design Affluxed HFL w.r.t. Design Discharge
 Design Discharge, Qd = 4.99 Cumecs



Average Bed Slope of River, S = 0.00963
 Manning's Coefficient, n = 0.04

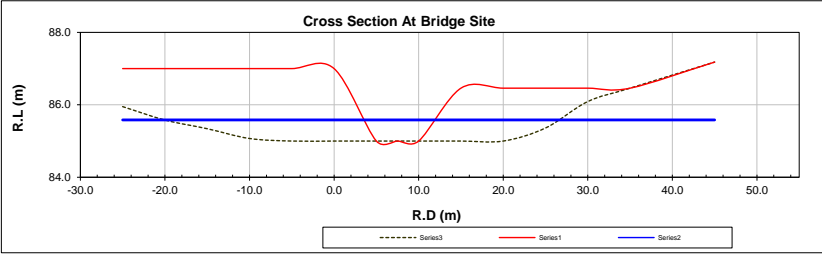
At Bridge Site



Distance	RL of Existing GL	RL of Modified GL	HFL	a	p	r=a/p	q
-25.00	85.950	85.950	85.204	-	-	-	-
-20.00	85.580	85.580	85.204				
-15.00	85.340	85.340	85.204				
-10.00	85.070	85.070	85.204				
-5.00	85.000	85.000	85.204	0.845	5.000	0.169	0.6331
0.00	85.000	85.000	85.204	1.020	5.000	0.204	0.8666
5.00	85.000	85.000	85.204	1.020	5.000	0.204	0.8666
10.00	85.000	85.000	85.204	1.020	5.000	0.204	0.8666
15.00	85.000	85.000	85.204	1.020	5.000	0.204	0.8666
20.00	85.000	85.000	85.204	1.020	5.000	0.204	0.8666
25.00	85.360	85.360	85.204	0.120	5.013	0.024	0.0243
30.00	86.090	86.090	85.204				
35.00	86.460	86.460	85.204				
45.00	87.180	87.180	85.204				
An1=				6.062		Q=	4.990

(D) Afflux Calculation

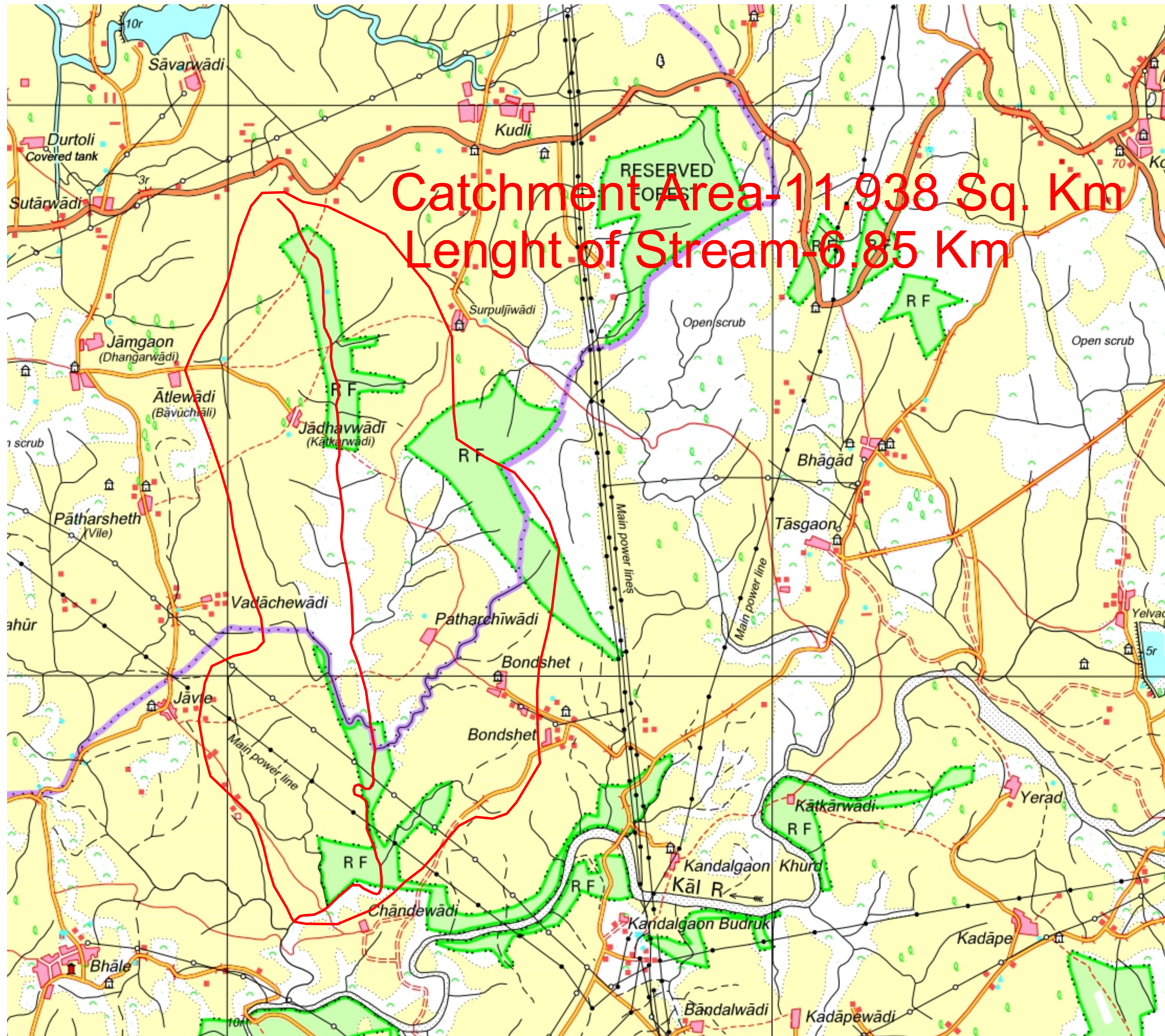
Determination of Obstructed Bridge Area



Distance	RL of Existing GL	RL of Modified GL	HFL	a	p	r=a/p	q	depth, d
-25.00	85.950	87.000	85.583	-	-	-	-	-
-20.00	85.580	87.000	85.583					
-15.00	85.340	87.000	85.583					
-10.00	85.070	87.000	85.583					
-5.00	85.000	87.000	85.583					
0.00	85.000	87.000	85.583					
5.00	85.000	85.000	85.583					0.5829
7.50	85.000	85.000	85.583					
10.00	85.000	85.000	85.583	2.915	5.000	0.583	4.9900	0.5829
15.00	85.000	86.460	85.583					
20.00	85.000	86.460	85.583					
25.00	85.360	86.460	85.583					
30.00	86.090	86.460	85.583					
35.00	86.460	86.460	85.583					
45.00	87.180	87.180	85.583					
An2²=				2.915	sq m	Q=	4.990	Cumecs
Average depth, d				=		0.583	m	
Lowest Bed Level				=		85.000	m	

Therefore,			
Discharge, Q	=	4.990	cumec
HFL (Without Afflux)	=	85.204	m
Average Depth, d	=	0.583	m
Area before constriction			
An1	=	6.062	sq m
Average velocity prior to constriction			
Vn1	=	Q/An1	
	=	0.823	m/s
Area after constriction			
An2*	=	2.915	sq m
An2	=	An2* - no's of piers * average width of piers * average depth (d)	
	=	2.915	sq m
Average Velocity after constriction			
Vn2	=	Q/An2	
	=	1.712	m/s
Afflux due to constriction (By Molesworth Formula)			
h	=	[(Vn1 ²)/17.88+0.015] [(An1/An2) ² -1]	
	=	0.176	m
(E) Recommendation			
Design Discharge, Qd	=	4.990	cumecs
Design Affluxed HFL	=	85.759	m
Average Velocity, Vn2	=	1.712	m/sec
(F) Hydraulic Adequacy			
Design Affluxed HFL	=	85.759	m
Required Vercile Clearance	=	0.60	m
Proposed Soffit Level	=	86.359	m

Catchment Area-11.938 Sq. Km
Lenght of Stream-6.85 Km



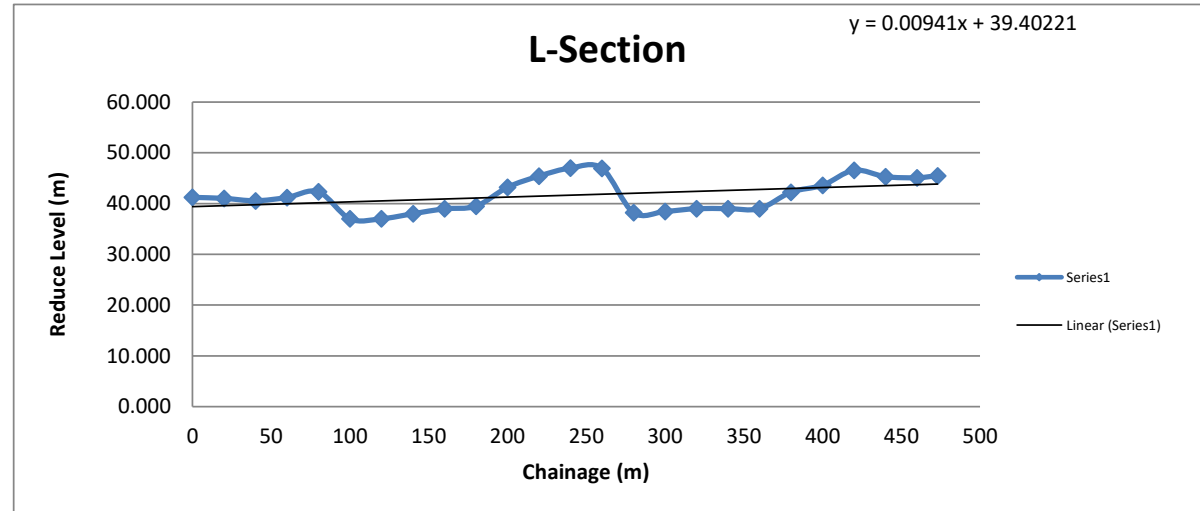
SUMMARY					
Sr.No	Chainage (km)	Discharge (Cumecs)			Design Discharge (Cumecs)
		Modified Rational Method (Cumecs)	By Rational Method (Cumecs)	By Area Velocity Method	
1	Br-23	213.931	242.175	-	242.175

Sr.No	Chainage (km)	Design Discharge (cumecs)	Design HFL (m)	Average Velocity (m/s)	Avg. depth (m)	LBL (m)	Proposed Waterway (m)	Vertical clearance Required (m)	Proposed Minimum Soffit level (m)
1	Br-23	242.175	40.735	4.89	2.68	37.00	26	0.9	41.635

* Note Scour level limited to Hard Rock Level found at site

Longitudnal Slope

Chainage (m)	RL (m)
0.00	41.230
20.00	41.030
40.00	40.560
60.00	41.200
80.00	42.320
100.00	37.000
120.00	37.008
140.00	38.000
160.00	38.980
180.00	39.498
200.00	43.208
220.00	45.416
240.00	47.011
260.00	46.945
280.00	38.225
300.00	38.457
320.00	39.000
340.00	39.000
360.00	39.000
380.00	42.261
400.00	43.606
420.00	46.573
440.00	45.300
460.00	45.100
473.00	45.500



DESIGN DISCHARGE CALCULATION

Name and number of subzone	Subzone-5a-b		
Existing Chainage	-		
Proposed chainage		Br-23	
River/Stream	-		
Type	Minor Bridge		

(A) FLOOD ESTIMATION

(1) Rational method (Bridges and Floods Wing Report, RBF-16)

Catchment Area of River, A	=	11.938	km ²	4.608	Mile ²
Length of longest stream, L	=	6.85	km	4.255	Mile
Level Difference between source and bridge site, H	=	64.0	m	0.040	Mile
Slope (in percent)	=		=	0.934	

R	=	100 year 24 hour point rainfall		
	=	48.00	cm	(Refer Subzone Report 5a-b)
tc	=	Time of concentration		
	=	$0.9 \times L / (M \ 0.1 \times S \ 0.2)$		
	=	3.332	hr.	
F	=	Areal Reduction factor		
	=	0.86		
C	=	Runoff Coefficient		
	=	$0.415 \times (R \times F)^{0.2}$		
	=	0.87		
tc hr. ratio	=	0.580		
1 hr. ratio	=	0.416		Refer. RBF - 16 Report
Conversion Ratio, K	=	tc hr. ratio / 1 hr. ratio		
		1.39		
R100(24)	=	48	cm	
R100(1)	=	R100(24) x 1 hr. to 24 hr. rainfall ratio		
	=	19.97	cm	
	=	199.68	mm	
R100(tc)	=	K x R100(1)		
	=	278.40	mm	
I	=	100 year rainfall intensity (mm/hr) lasting for tc hr. duration		
	=	R100(tc)/tc		
	=	83.55	mm/hr.	
Design Flood				
Q	=	$0.278 \times C \ I \ A$		
	=	242.18	m ³ /sec	

(2) By Rational Method (SP-13 Code)

Area of catchment, A	1193.8	Ha	
Length of longest stream, L	6.85	Km	
The fall in level from critical point to the structure, H	64.00	m	

Runoff Coefficient as per Terrain, P	=	0.6	
tc	=	$((0.87 \times (L^3/H))^{0.385})$	(Refer IRC SP-13)
		1.76	hr

Now,	F (100 year-24 hr rainfall)	480	mm	
	One hour conversion ratio from report 5a	0.32		
	F (100 year-1 hr rainfall)	153.6	mm	
	T		1	hour
Now,	lc	=	$(F/T) \times ((T+1)/(tc+1))$	(Refer SP-13) Where,
		=	111.11	mm/hr
		=	11.11	cm/hr
	f	=	0.960	Fig.4.2 ' f-curve ' from IRC:SP: 13
	Q	=	$0.028 \times P \times f \times A \times lc$	
			213.931	cumecs

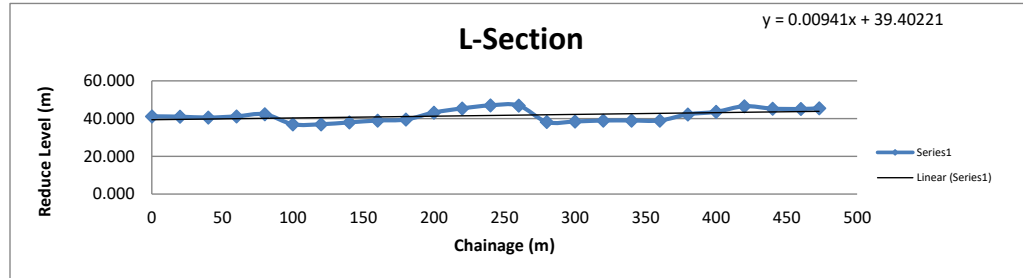
(B) Fixing of Design Discharge

Calculated Peak Discharge by		=	242.18 cumecs
i) By Rational Method		=	213.93 cumecs
ii) By Rational Method (SP-13 Code)		=	213.93 cumecs

Therefore, The Recommended Design Discharge, Qd (As per clause 106.3.2, IRC:5-2015)		=	242.18 cumecs
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(C) Calculation of Design Affluxed HFL w.r.t. Design Discharge

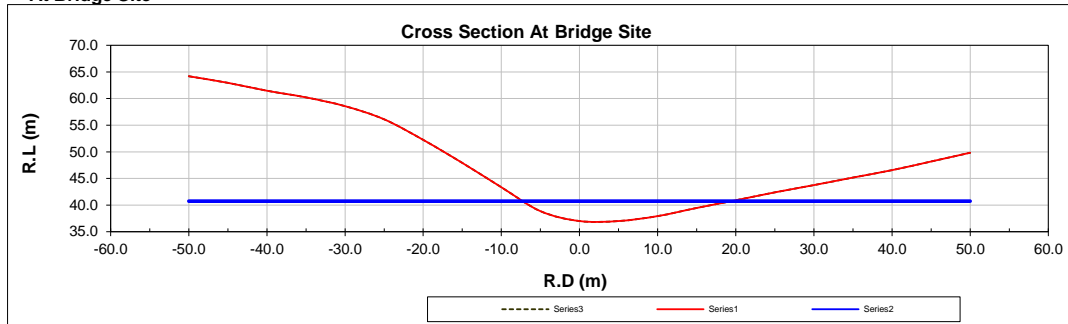
Design Discharge, Qd = 242.18 Cumecs



Average Bed Slope of River, S = 0.00941

Manning's Coefficient, n = 0.04

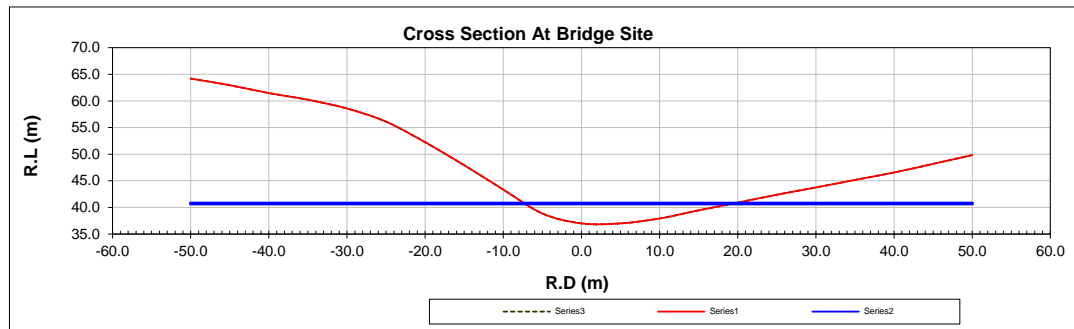
At Bridge Site



Distance	RL of Existing GL	RL of Modified GL	HFL	a	p	r=a/p	q
-50.00	64.19	64.190	40.735	-	-	-	-
-45.00	62.95	62.950	40.735				
-40.00	61.47	61.470	40.735				
-35.00	60.22	60.220	40.735				
-30.00	58.57	58.570	40.735				
-25.00	56.10	56.100	40.735				
-20.00	52.24	52.240	40.735				
-15.00	47.92	47.920	40.735				
-10.00	43.35	43.350	40.735				
-5.00	38.86	38.860	40.735				
0.00	37.00	37.000	40.735	11.202	4.262	2.629	51.7447
5.00	37.00	37.000	40.735	14.917	3.994	3.735	87.0790
10.00	37.93	37.930	40.735	13.060	4.063	3.215	68.9830
15.00	39.46	39.460	40.735	8.147	4.177	1.950	30.8414
20.00	40.90	40.900	40.735	2.215	4.157	0.533	3.5319
25.00	42.39	42.390	40.735				
30.00	43.75	43.750	40.735				
35.00	45.17	45.170	40.735				
40.00	46.56	46.560	40.735				
45.00	48.18	48.180	40.735				
50.00	49.83	49.830	40.735				
An1=				49.541		Q=	242.180

(D) Afflux Calculation

Determination of Obstructed Bridge Area



Distance	RL of Existing GL	RL of Modified GL	HFL	a	p	r=a/p	q	depth, d
-50.00	64.190	64.190	40.735	-	-	-	-	-
-45.00	62.950	62.950	40.735					
-40.00	61.470	61.470	40.735					
-35.00	60.220	60.220	40.735					
-30.00	58.570	58.570	40.735					
-25.00	56.100	56.100	40.735					
-20.00	52.240	52.240	40.735					
-15.00	47.920	47.920	40.735					
-10.00	43.350	43.350	40.735					
-5.00	38.860	38.860	40.735					1.8747
0.00	37.000	37.000	40.735	11.202	4.262	2.629	51.7447	3.7347
5.00	37.000	37.000	40.735	14.917	3.994	3.735	87.0790	3.7347
10.00	37.930	37.930	40.735	13.060	4.063	3.215	68.9830	2.8047
15.00	39.460	39.460	40.735	8.147	4.177	1.950	30.8414	1.2747
20.00	40.900	40.900	40.735	2.215	4.157	0.533	3.5319	
25.00	42.390	42.390	40.735					
30.00	43.750	43.750	40.735					
35.00	45.170	45.170	40.735					
40.00	46.560	46.560	40.735					
45.00	48.180	48.180	40.735					
50.00	49.830	49.830	40.735					
An2* =				49.541	sq m	Q =	242.180	Cumecs
Average depth, d				=		2.685	m	
Lowest Bed Level				=		37.000	m	

Therefore,

Discharge, Q	=	242.180	cumec
HFL (Without Afflux)	=	40.735	m
Average Depth, d	=	2.685	m
Area before constriction			
An1	=	49.541	sq m
Average velocity prior to constriction			
Vn1	=	Q/An1	
	=	4.888	m/s
Area after constriction			
An2*	=	49.541	sq m
An2	=	An2* - no's of piers * average width of piers * average depth (d)	
	=	49.541	sq m
Average Velocity after constriction			
Vn2	=	Q/An2	
	=	4.888	m/s
Afflux due to constriction (By Molesworth Formula)			
h	=	$[(Vn1^2)/17.88+0.015] [(An1/An2)^2-1]$	
	=	0.000	m

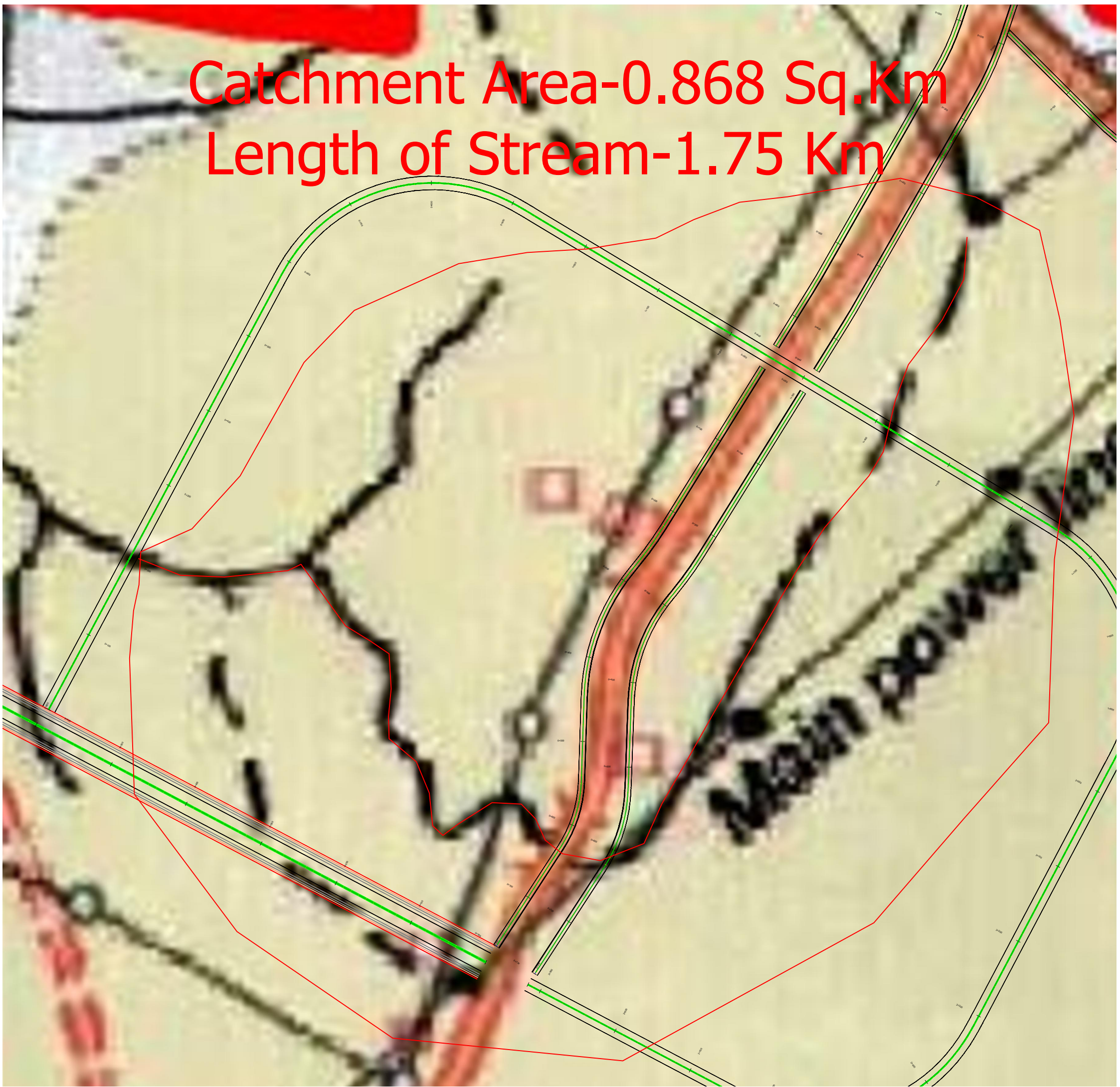
(E) Recommendation

Design Discharge, Qd	=	242.180	cumecs
Design Affluxed HFL	=	40.735	m
Average Velocity, Vn2	=	4.888	m/sec

(F) Hydraulic Adequacy

Design Affluxed HFL	=	40.735	m
Required Verticle Clearance	=	0.90	m
Proposed Soffit Level	=	41.635	m

Catchment Area-0.868 Sq.Km
Length of Stream-1.75 Km



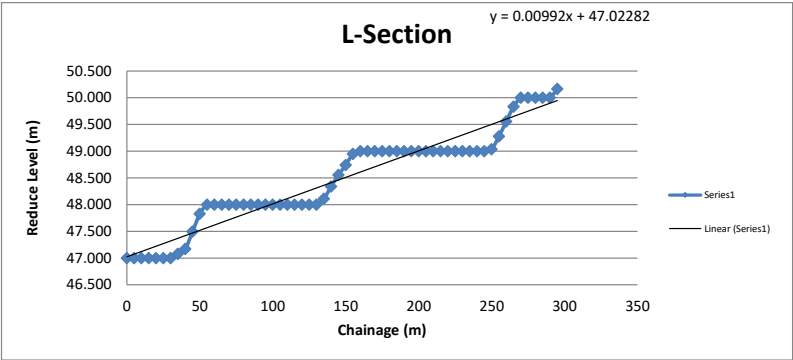
SUMMARY					
Sr.No	Chainage (km)	Discharge (Cumecs)			Design Discharge (Cumecs)
		By Modified Rational method (Bridges and Floods Wing Report, RBF-16)	By Rational Method (SP-13 Code)	By Area Velocity Method	
1	0+240 (SAR-13)	39.737	26.806	-	39.737

Sr.No	Chainage (km)	Design Discharge (cumecs)	Design HFL (m)	Average Velocity (m/s)	Avg. depth (m)	LBL (m)	Proposed Waterway (m)	Vertical clearance Required (m)	Proposed Minimum Soffit level (m)
1	0+240 (SAR-13)	39.737	50.185	2.43	0.96	49.00	20	0.90	51.085

*Note Scour Level shall be limited to Rock level found at site

Longitudnal Slope

Chainage (m)	RL (m)
0.00	47.000
5.00	47.000
10.00	47.000
15.00	47.000
20.00	47.000
25.00	47.000
30.00	47.000
35.00	47.078
40.00	47.169
45.00	47.494
50.00	47.828
55.00	48.000
60.00	48.000
65.00	48.000
70.00	48.000
75.00	48.000
80.00	48.000
85.00	48.000
90.00	48.000
95.00	48.000
100.00	48.000
105.00	48.000
110.00	48.000
115.00	48.000
120.00	48.000
125.00	48.000
130.00	48.000
135.00	48.109
140.00	48.339
145.00	48.554
150.00	48.741
155.00	48.949
160.00	49.000
165.00	49.000
170.00	49.000
175.00	49.000
180.00	49.000
185.00	49.000
190.00	49.000
195.00	49.000
200.00	49.000
205.00	49.000
210.00	49.000
215.00	49.000
220.00	49.000
225.00	49.000
230.00	49.000
235.00	49.000
240.00	49.000
245.00	49.000
250.00	49.038
255.00	49.277
260.00	49.555
265.00	49.832
270.00	50.000
275.00	50.000
280.00	50.000
285.00	50.000
290.00	50.000
295.00	50.165



DESIGN DISCHARGE CALCULATION

Name and number of subzone Subzone-5a-b
Existing Chainage -
Proposed chainage 0+240 (SAR-13)
River/Stream -
Type Minor Bridge

(A) FLOOD ESTIMATION

(1) By Modified Rational method (Bridges and Floods Wing Report, RBF-16)

Catchment Area of River, A	=	0.868	km ²	0.335	Mile ²
Length of longest stream, L	=	1.75	km	1.087	Mile
Level Difference between source and bridge site, H	=	15.0	m	0.009	Mile
Slope (in percent)	=			0.857	
R	=	100 year 24 hour point rainfall			
	=	48.00	cm		(Refer Subzone Report 5a-b)
tc	=	Time of concentration			
	=	$0.9 \times L / (M \ 0.1 \times S \ 0.2)$			
	=	1.125	hr.		
F	=	Areal Reduction factor			
	=	0.88			
C	=	Runoff Coefficient			
	=	$0.415 \times (R \times F)^{0.2}$			
	=	0.88			
tc hr. ratio	=	0.44			
1 hr. ratio	=	0.416			Refer. RBF - 16 Report
Conversion Ratio, K	=	tc hr. ratio / 1 hr. ratio			
	=	1.06			
R100(24)	=	48	cm		
R100(1)	=	R100(24) x 1 hr. to 24 hr. rainfall ratio			
	=	19.97	cm		
	=	199.68	mm		
R100(tc)	=	K x R100(1)			
	=	211.20	mm		
I	=	100 year rainfall intensity (mm/hr) lasting for tc hr. duration			
	=	R100(tc)/tc			
	=	187.69	mm/hr.		
Design Flood					
Q	=	$0.278 \times C \ I \ A$			
	=	39.74	m3/sec		

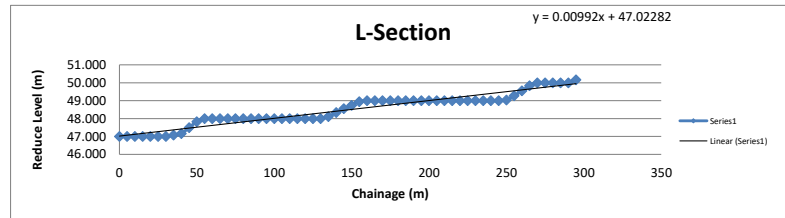
(2) By Rational Method (SP-13 Code)

Area of catchment, A		86.8	Ha		
Length of longest stream, L		1.75	Km		
The fall in level from critical point to the structure, H		15.00	m		
Runoff Coefficient as per Terrain, P	=	0.6			
tc	=	$((0.87 \times (L^3/H))^{0.385})$			(Refer IRC SP-13)
	=	0.64	hr		
Now,					
F (100 year-24 hr rainfall)		480	mm		
One hour conversion ratio from report 5a		0.32			
F (100 year-1 hr rainfall)		153.6	mm		
T			hour		
Now,					
Ic	=	$(F/T) \times ((T+1)/(tc+1))$			(Refer SP-13) Where, F Total precipitation T Duration of time
	=	187.58	mm/hr		
	=	18.76	cm/hr		
f	=	0.980			Fig.4.2 ' f-curve ' from IRC:SP: 13
Q	=	$0.028 \times P \times f \times A \times I_c$			
	=	26.806	cumecs		

(B) Fixing of Design Discharge

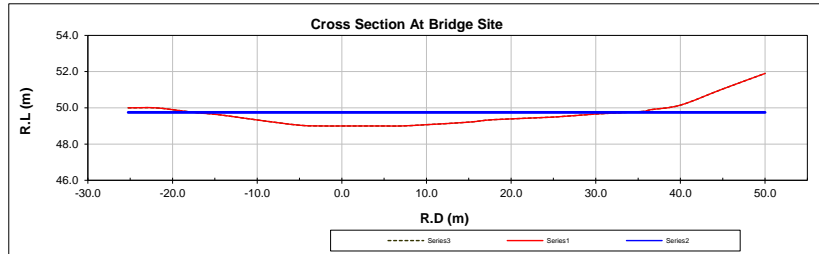
Calculated Peak Discharge by					
i) By Modified Rational method (Bridges and Floods Wing Report, RBF-16)	=	39.74	cumecs		
ii) By Rational Method (SP-13 Code)	=	26.81	cumecs		
Therefore, The Reccomended Design Discharge, Qd (As per clause 106.3.2, IRC:5-2015)	=	39.74	cumecs		

(C) Calculation of Design Affluxed HFL w.r.t. Design Discharge
 Design Discharge, Qd = 39.74 Cumecs



Average Bed Slope of River, S = 0.00992
 Manning's Coefficient, n = 0.04

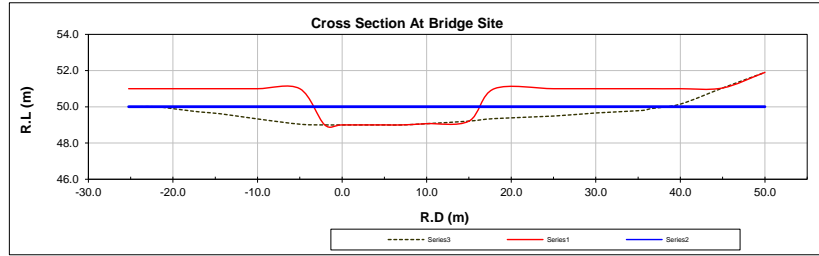
At Bridge Site



Distance	RL of Existing GL	RL of Modified GL	HFL	a	p	r=a/p	q
-25.24	50.000	50.000	49.750	-	-	-	-
-22.00	50.000	50.000	49.750				
-18.85	49.830	49.830	49.750				
-16.69	49.710	49.710	49.750				
-14.46	49.620	49.620	49.750	0.188	2.228	0.085	0.0903
-10.00	49.330	49.330	49.750	1.226	4.472	0.274	1.2874
-5.00	49.040	49.040	49.750	2.823	5.008	0.564	4.7964
-2.05	49.000	49.000	49.750	2.152	2.950	0.730	4.3431
0.00	49.000	49.000	49.750	1.537	2.050	0.750	3.1574
5.00	49.000	49.000	49.750	3.748	5.000	0.750	7.7010
7.05	49.000	49.000	49.750	1.539	2.053	0.750	3.1620
10.00	49.070	49.070	49.750	2.106	2.948	0.714	4.1905
15.00	49.210	49.210	49.750	3.048	5.002	0.609	5.4550
18.00	49.350	49.350	49.750	1.409	3.003	0.469	2.1178
25.00	49.490	49.490	49.750	2.307	7.001	0.330	2.7408
30.00	49.660	49.660	49.750	0.873	5.003	0.174	0.6788
35.53	49.800	49.800	49.750	0.108	5.528	0.020	0.0196
36.53	49.900	49.900	49.750				
40.00	50.150	50.150	49.750				
45.00	51.040	51.040	49.750				
50.00	51.900	51.900	49.750				
An1=				23.064		Q=	39.740

(D) Afflux Calculation

Determination of Obstructed Bridge Area



Distance	RL of Existing GL	RL of Modified GL	HFL	a	p	r=a/p	q	depth, d
-25.24	50.000	51.000	50.007	-	-	-	-	-
-22.00	50.000	51.000	50.007					
-18.85	49.830	51.000	50.007					
-16.69	49.710	51.000	50.007					
-14.46	49.620	51.000	50.007					
-10.00	49.330	51.000	50.007					
-5.00	49.040	51.000	50.007					
-2.05	49.000	49.000	50.007	0.021	3.564	0.006	0.0016	1.0070
0.00	49.000	49.000	50.007	2.064	2.050	1.007	5.1639	1.0070
5.00	49.000	49.000	50.007	5.035	5.000	1.007	12.5948	1.0070
7.05	49.000	49.000	50.007	2.067	2.053	1.007	5.1714	1.0070
10.00	49.070	49.070	50.007	2.864	2.948	0.972	6.9970	0.9370
15.00	49.210	49.210	50.007	4.335	5.002	0.867	9.8112	0.7970
18.00	49.350	51.000	50.007					
25.00	49.490	51.000	50.007					
30.00	49.660	51.000	50.007					
35.53	49.800	51.000	50.007					
36.53	49.900	51.000	50.007					
40.00	50.150	51.000	50.007					
45.00	51.040	51.040	50.007					
50.00	51.900	51.900	50.007					
An2=				16.386	sq m	Q=	39.740	Cumecs
Average depth, d				=		0.960	m	
Lowest Bed Level				=		49.000	m	

Therefore,			
Discharge, Q	=	39.740	cumec
HFL (Without Afflux)	=	49.750	m
Average Depth, d	=	0.960	m
Area before constriction			
An1	=	23.064	sq m
Average velocity prior to constriction			
Vn1	=	Q/An1	
	=	1.723	m/s
Area after constriction			
An2*	=	16.386	sq m
An2	=	An2* - no's of piers * average width of piers * average depth (d)	
	=	16.386	sq m
Average Velocity after constriction			
Vn2	=	Q/An2	
	=	2.425	m/s
Afflux due to constriction (By Molesworth Formula)			
h	=	[(Vn1 ²)/17.88+0.015] [(An1/An2) ² -1]	
	=	0.178	m
(E) Recommendation			
Design Discharge, Qd	=	39.740	cumecs
Design Affluxed HFL	=	50.185	m
Average Velocity, Vn2	=	2.425	m/sec
(F) Hydraulic Adequacy			
Design Affluxed HFL	=	50.185	m
Required Vercile Clearance	=	0.90	m
Proposed Soffit Level	=	51.085	m



Catchment Area-0.270 Sq.Km
Length of Stream-0.70 Km

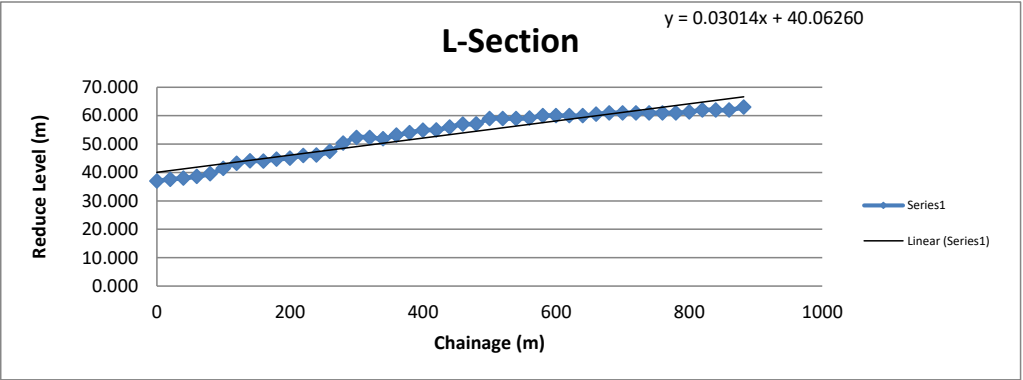
SUMMARY					
Sr.No	Chainage (km)	Discharge (Cumecs)			Design Discharge (Cumecs)
		By Modified Rational method (Bridges and Floods Wing Report, RBF-16)	By Rational Method (SP-13 Code)	By Area Velocity Method	
1	Br-26	26.833	11.992	-	26.833

Sr.No	Chainage (km)	Design Discharge (cumecs)	Design HFL (m)	Average Velocity (m/s)	Avg. depth (m)	LBL (m)	Proposed Waterway (m)	Vertical clearance Required (m)	Proposed Minimum Soffit level (m)
1	Br-26	26.833	59.641	2.75	0.59	59.00	14	0.60	60.241

*Note Scour Level shall be limited to Rock level found at site

Longitudnal Slope

Chainage (m)	RL (m)
0.00	37.000
20.00	37.606
40.00	38.000
60.00	38.585
80.00	39.529
100.00	41.476
120.00	43.195
140.00	44.074
160.00	44.036
180.00	44.684
200.00	45.000
220.00	46.000
240.00	46.106
260.00	47.412
280.00	50.320
300.00	52.321
320.00	52.348
340.00	51.920
360.00	53.151
380.00	54.000
400.00	54.910
420.00	55.000
440.00	56.000
460.00	57.000
480.00	57.106
500.00	58.969
520.00	59.000
540.00	59.000
560.00	59.176
580.00	60.000
600.00	60.000
620.00	60.000
640.00	60.000
660.00	60.496
680.00	61.000
700.00	61.000
720.00	61.000
740.00	61.000
760.00	61.000
780.00	61.000
800.00	61.319
820.00	62.000
840.00	62.000
860.00	62.000
881.97	63.000



DESIGN DISCHARGE CALCULATION

Name and number of subzone Subzone-5a-b
Existing Chainage -
Proposed chainage Br-26
River/Stream -
Type Minor Bridge

(A) FLOOD ESTIMATION

(1) By Modified Rational method (Bridges and Floods Wing Report, RBF-16)

Catchment Area of River, A	=	0.270	km ²	0.104	Mile ²
Length of longest stream, L	=	0.59	km	0.365	Mile
Level Difference between source and bridge site, H	=	20.0	m	0.012	Mile
Slope (in percent)	=			3.401	
R	=	100 year 24 hour point rainfall			
	=	48.00	cm		(Refer Subzone Report 5a-b)
tc	=	Time of concentration			
	=	$0.9 \times L / (M \ 0.1 \times S \ 0.2)$			
	=	0.323	hr.		
F	=	Areal Reduction factor			
	=	0.72			
C	=	Runoff Coefficient			
	=	$0.415 \times (R \times F)^{0.2}$			
	=	0.84			
tc hr. ratio	=	0.29			
1 hr. ratio	=	0.416			Refer. RBF - 16 Report
Conversion Ratio, K	=	tc hr. ratio / 1 hr. ratio			
	=	0.69			
R100(24)	=	48	cm		
R100(1)	=	R100(24) x 1 hr. to 24 hr. rainfall ratio			
	=	19.97	cm		
	=	199.68	mm		
R100(tc)	=	K x R100(1)			
	=	136.80	mm		
I	=	100 year rainfall intensity (mm/hr) lasting for tc hr. duration			
	=	R100(tc)/tc			
	=	424.13	mm/hr.		
Design Flood					
Q	=	$0.278 \times C \ I \ A$			
	=	26.83	m ³ /sec		

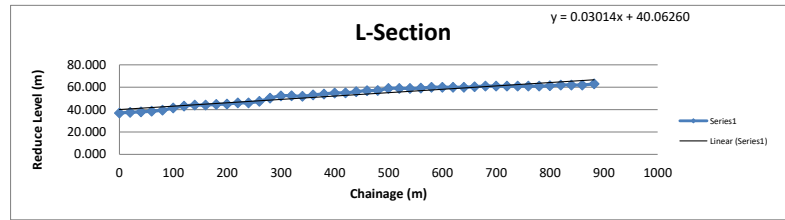
(2) By Rational Method (SP-13 Code)

Area of catchment, A	27	Ha		
Length of longest stream, L	0.59	Km		
The fall in level from critical point to the structure, H	20.00	m		
Runoff Coefficient as per Terrain, P	=	0.6		
tc	=	$((0.87 \times (L^3/H))^{0.385})$		(Refer IRC SP-13)
	=	0.16	hr	
Now,				
F (100 year-24 hr rainfall)		480	mm	
One hour conversion ratio from report 5a		0.32		
F (100 year-1 hr rainfall)		153.6	mm	
T			I	hour
Now,				
Ic	=	$(F/T)X((T+1)/(tc+1))$		(Refer SP-13) Where, F Total precipitation T Duration of time
	=	264.38	mm/hr	
	=	26.44	cm/hr	
f	=	1.000		Fig.4.2 ' f-curve ' from IRC:SP: 13
Q	=	$0.028XPXfXAxc$		
	=	11.992	cumecs	

(B) Fixing of Design Discharge

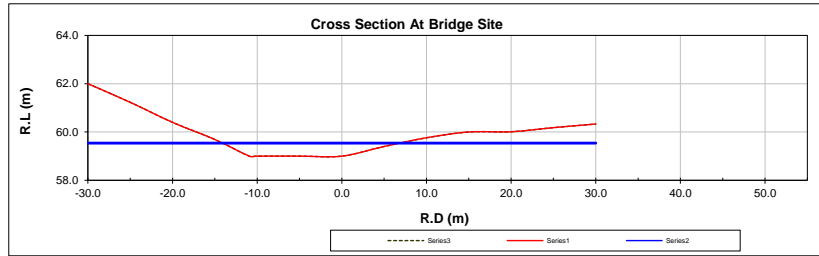
Calculated Peak Discharge by				
i) By Modified Rational method (Bridges and Floods Wing Report, RBF-16)	=	26.83	cumecs	
ii) By Rational Method (SP-13 Code)	=	11.99	cumecs	
Therefore, The Reccomended Design Discharge, Qd (As per clause 106.3.2, IRC:5-2015)	=	26.83	cumecs	

(C) Calculation of Design Affluxed HFL w.r.t. Design Discharge
 Design Discharge, Qd = 26.83 Cumecs



Average Bed Slope of River, S = 0.03010
 Manning's Coefficient, n = 0.04

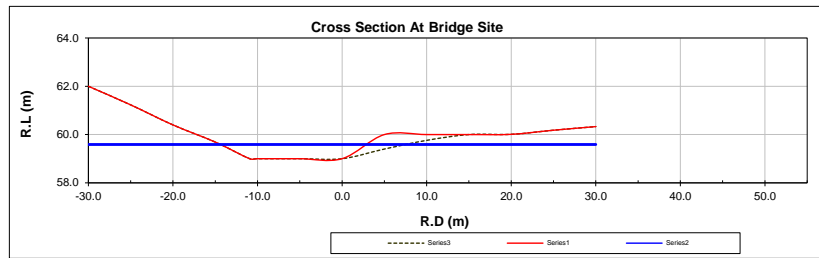
At Bridge Site



Distance	RL of Existing GL	RL of Modified GL	HFL	a	p	r=a/p	q
-30.00	62.000	62.000	59.540	-	-	-	-
-25.00	61.230	61.230	59.540				
-20.00	60.400	60.400	59.540				
-15.00	59.690	59.690	59.540				
-10.93	59.000	59.000	59.540	0.792	4.125	0.192	1.1433
-10.00	59.000	59.000	59.540	0.504	0.933	0.540	1.4479
-5.00	59.000	59.000	59.540	2.699	5.000	0.540	7.7596
0.00	59.000	59.000	59.540	2.699	5.000	0.540	7.7596
5.00	59.400	59.400	59.540	1.699	5.016	0.339	3.5798
10.00	59.760	59.760	59.540				
15.00	60.000	60.000	59.540				
20.00	60.010	60.010	59.540				
25.00	60.180	60.180	59.540				
30.00	60.330	60.330	59.540				
An1=				8.392		Q=	21.690

(D) Afflux Calculation

Determination of Obstructed Bridge Area



Distance	RL of Existing GL	RL of Modified GL	HFL	a	p	r=a/p	q	depth, d
-30.00	62.000	62.000	59.589	-	-	-	-	-
-25.00	61.230	61.230	59.589					
-20.00	60.400	60.400	59.589					
-15.00	59.690	59.690	59.589					
-10.93	59.000	59.000	59.589	0.993	4.125	0.241	1.6679	0.5893
-10.00	59.000	59.000	59.589	0.550	0.933	0.589	1.6761	0.5893
-5.00	59.000	59.000	59.589	2.946	5.000	0.589	8.9822	0.5893
0.00	59.000	59.000	59.589	2.946	5.000	0.589	8.9822	0.5893
5.00	59.400	60.000	59.589	0.446	5.099	0.088	0.3817	
10.00	59.760	60.000	59.589					
15.00	60.000	60.000	59.589					
20.00	60.010	60.010	59.589					
25.00	60.180	60.180	59.589					
30.00	60.330	60.330	59.589					
An2²=				7.882	sq m	Q=	21.690	Cumecs
Average depth, d				=		0.589	m	
Lowest Bed Level				=		59.000	m	

Therefore,			
Discharge, Q	=	21.690	cumec
HFL (Without Afflux)	=	59.540	m
Average Depth, d	=	0.589	m
Area before constriction			
An1	=	8.392	sq m
Average velocity prior to constriction			
Vn1	=	Q/An1	
	=	2.585	m/s
Area after constriction			
An2*	=	7.882	sq m
An2	=	An2* - no's of piers * average width of piers * average depth (d)	
	=	7.882	sq m
Average Velocity after constriction			
Vn2	=	Q/An2	
	=	2.752	m/s
Afflux due to constriction (By Molesworth Formula)			
h	=	[(Vn1 ²)/17.88+0.015] [(An1/An2) ² -1]	
	=	0.052	m
(E) Recommendation			
Design Discharge, Qd	=	21.690	cumecs
Design Affluxed HFL	=	59.641	m
Average Velocity, Vn2	=	2.752	m/sec
(F) Hydraulic Adequacy			
Design Affluxed HFL	=	59.641	m
Required Vercile Clearance	=	0.60	m
Proposed Soffit Level	=	60.241	m



GEOTECHNICAL INVESTIGATION FOR DMIDC - DIGHI PORT INDUSTRIAL AREA

Laboratory California Bearing Ratio Test Report

Prepared by



P. N. Shidhore Civil Engineers (I) Pvt. Ltd.

Prabhakar Apt, B Wing,
3rd Floor, Gaondevi Chowk,
Kalyan – 421301, Maharashtra
Email: info@pnsco.in, pnsco@yahoo.com

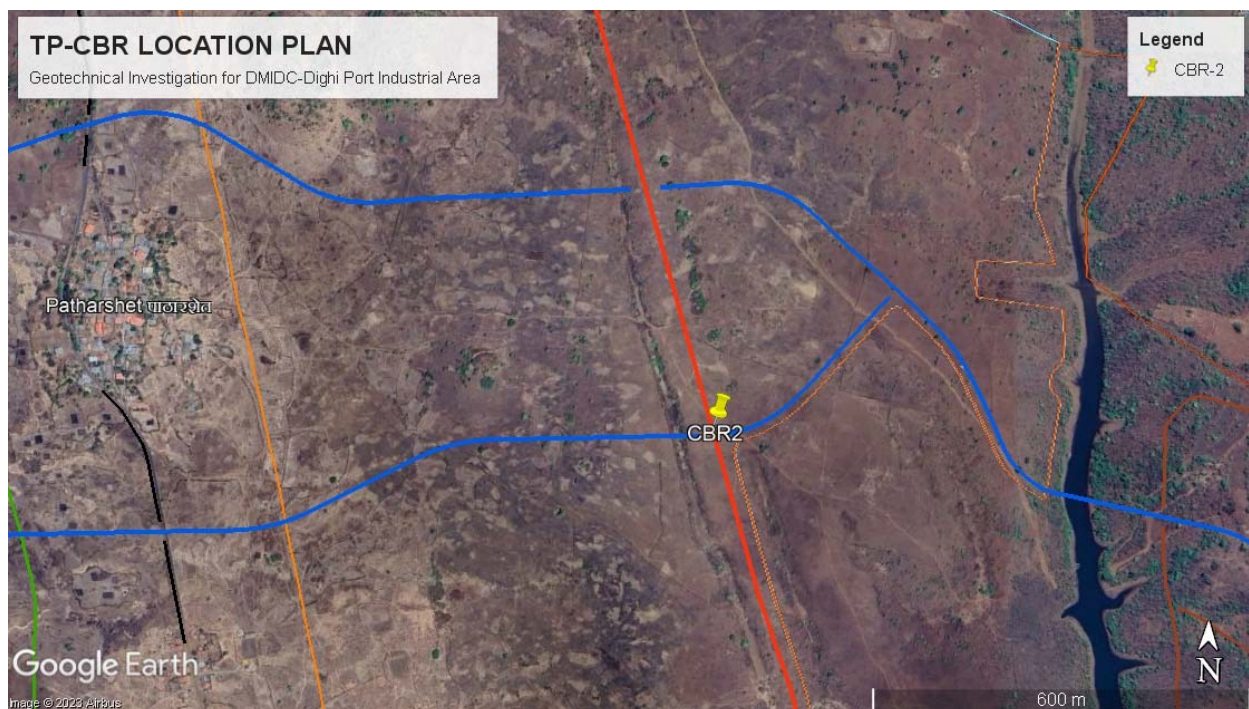
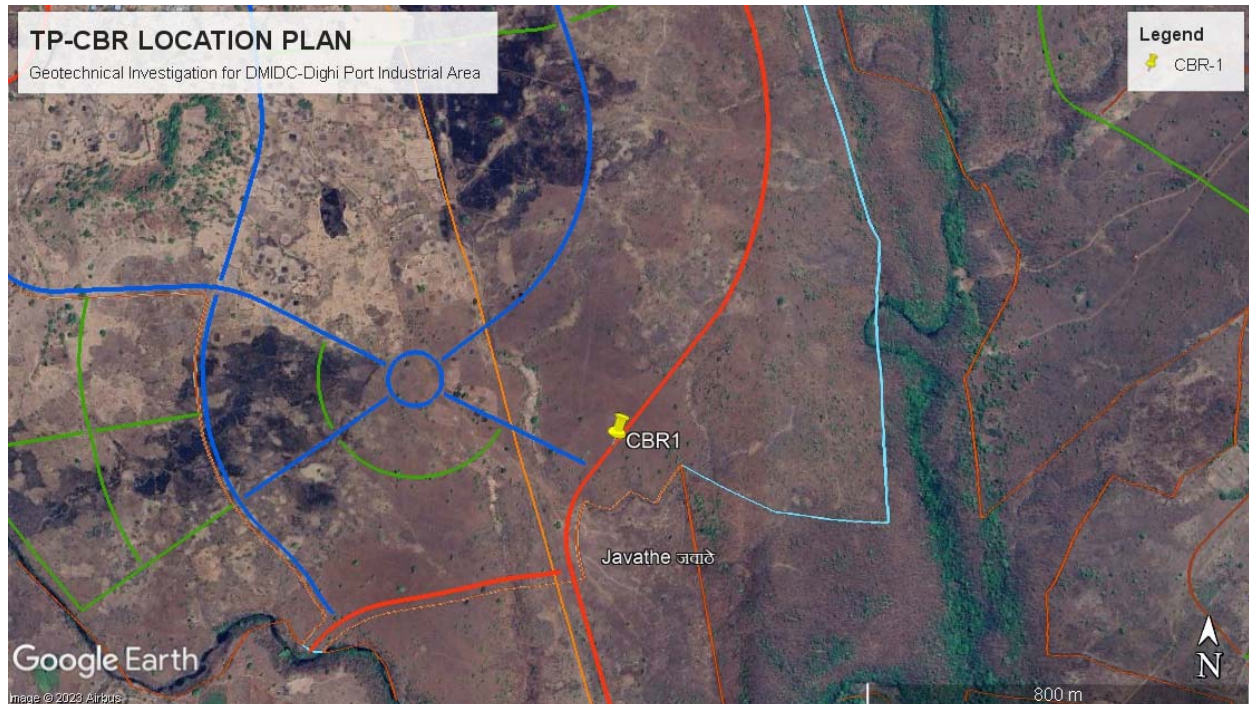
Laboratory California Bearing Ratio Test Report

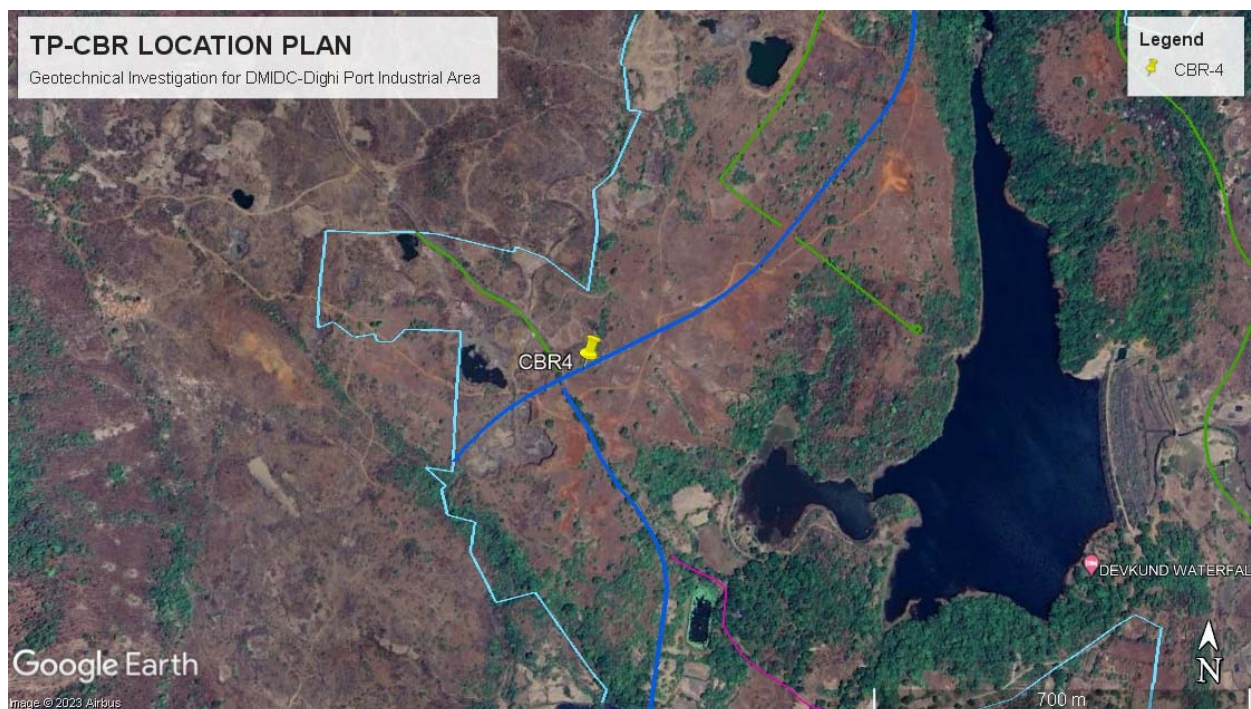
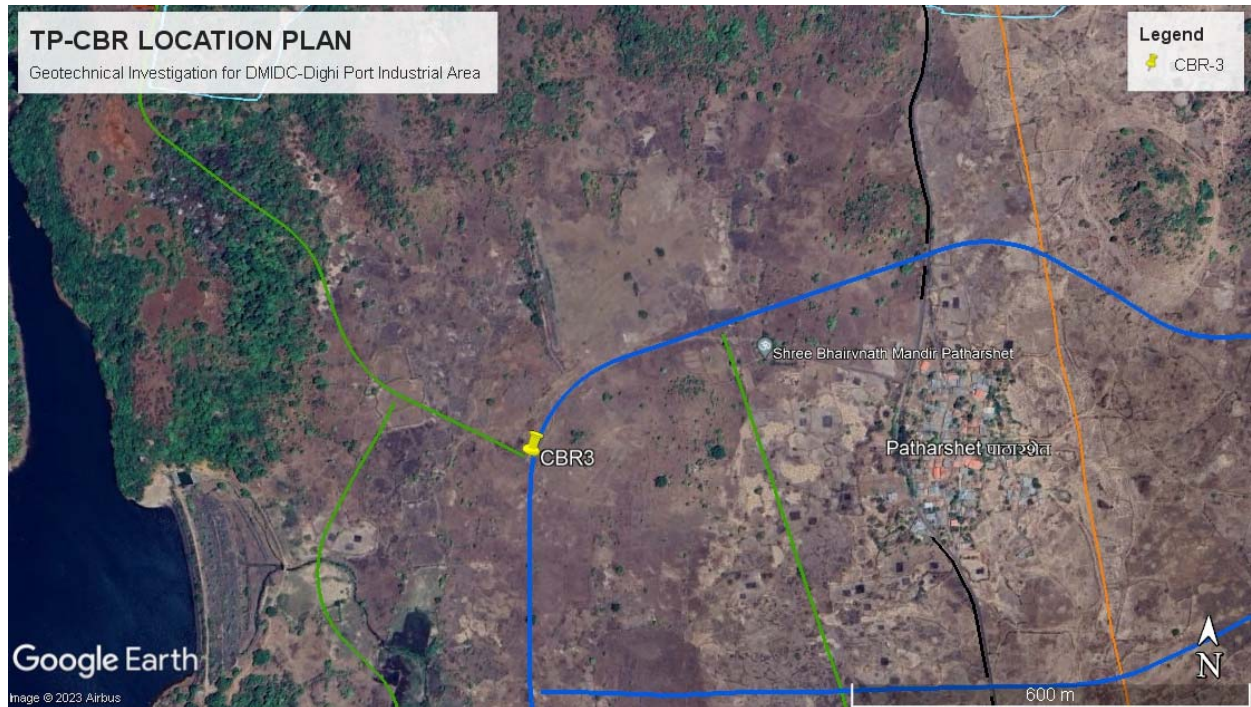
The National Industrial Corridor Development Corporation with the State of Maharashtra is developing a state-of-the-art Industrial city near Mangaon, Raigad District. For this purpose, Egis Consulting India Pvt. Limited has been awarded the work for the Detailed Master Plan and Preliminary Engineering Design. As a part of the Preliminary Engineering design, Geotechnical survey work is being undertaken for the design of bridge structures. For this purpose, Egis has appointed PNSCO in March 2023. This report presents results of the laboratory California Bearing Ratio Test for the proposed roads.

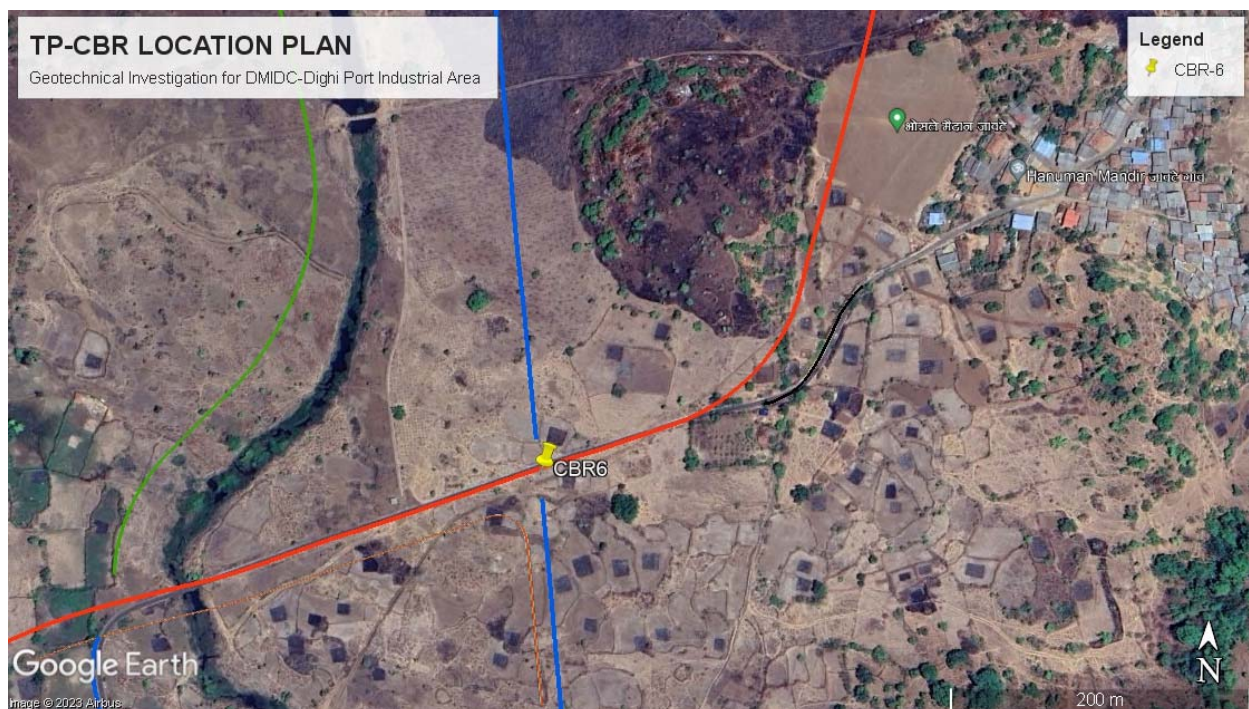
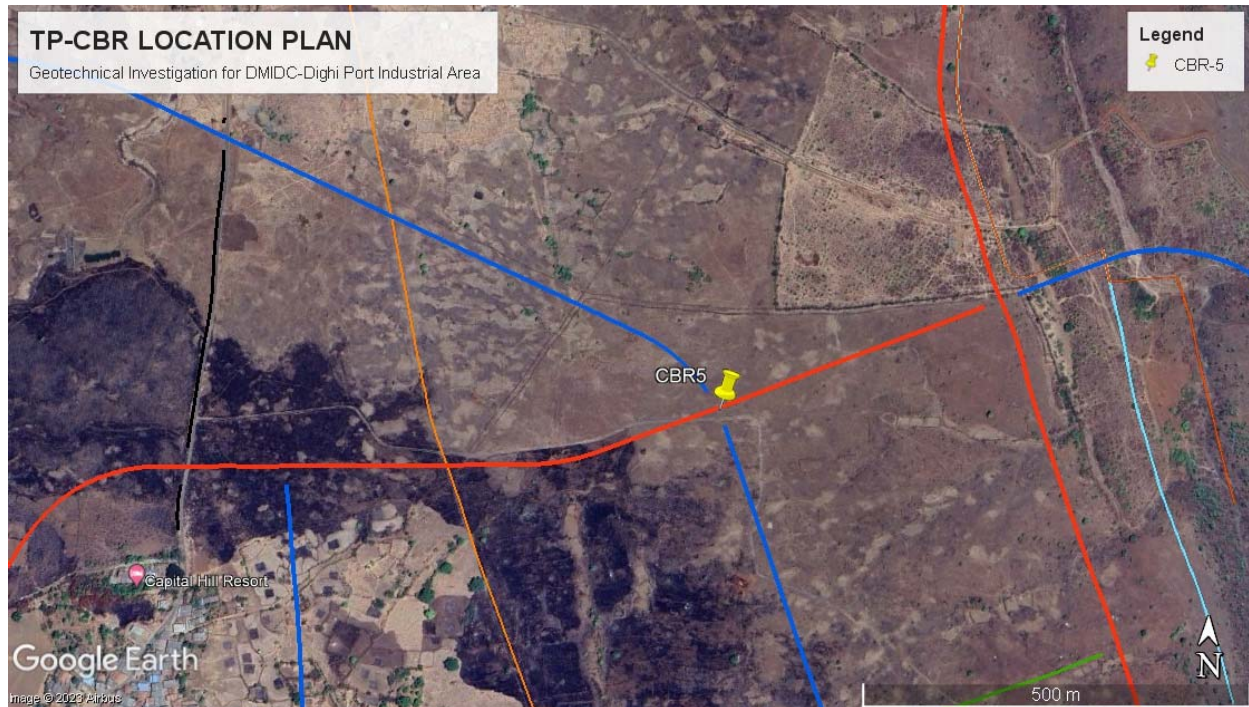
Total 11 trial pits have been excavated up to 1.00mtr. Collected the soil samples from each trial pit and conducted the lab CBR Test, reports attached below.

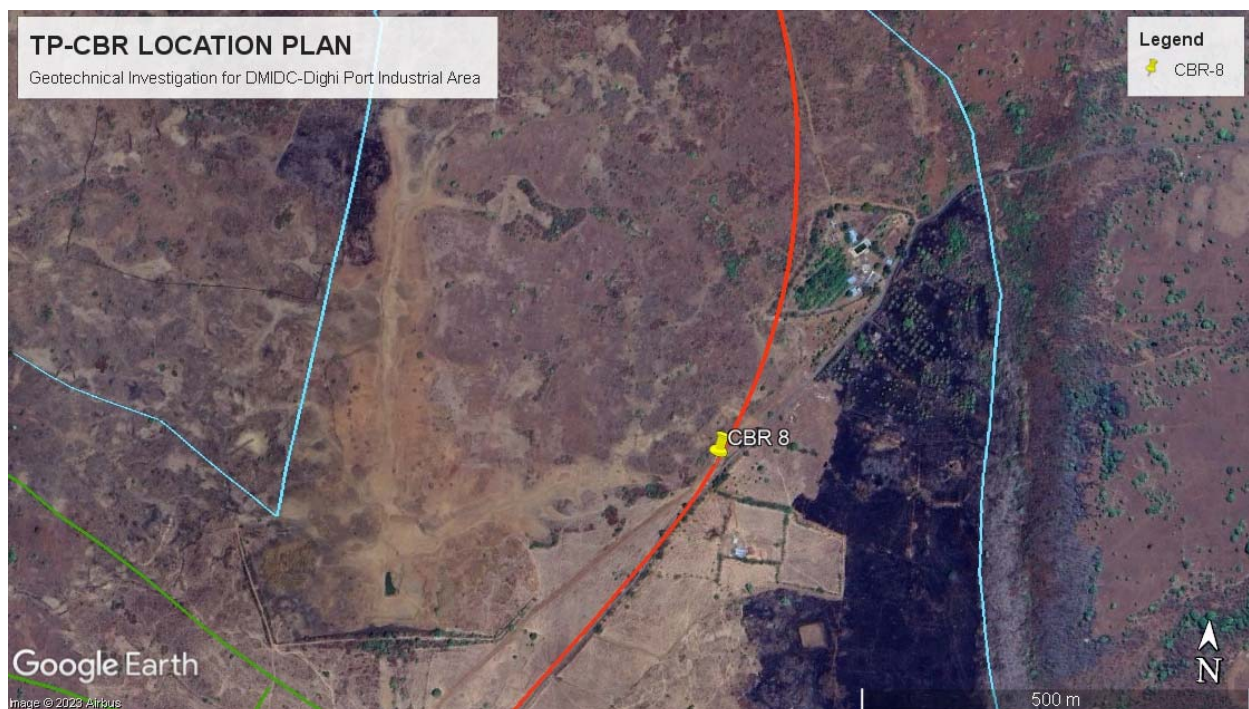
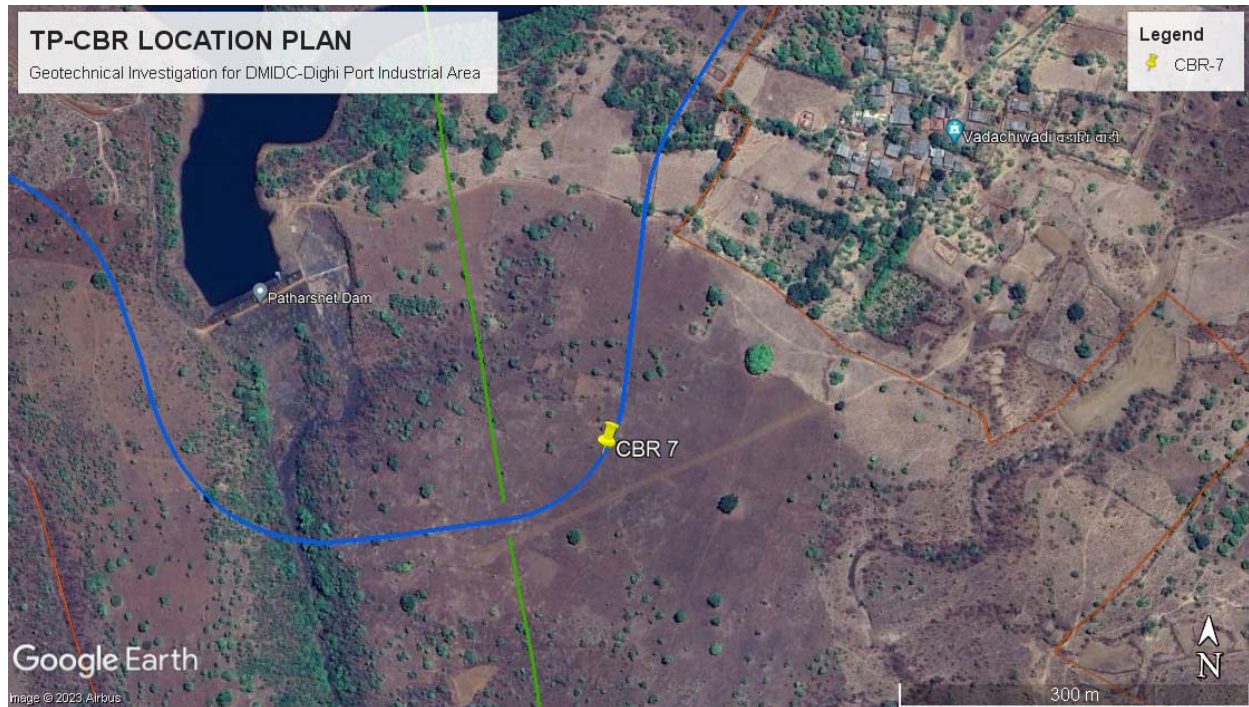
Subsurface profile at this site generally consists of residual soil includes pebbles, cobbles etc.

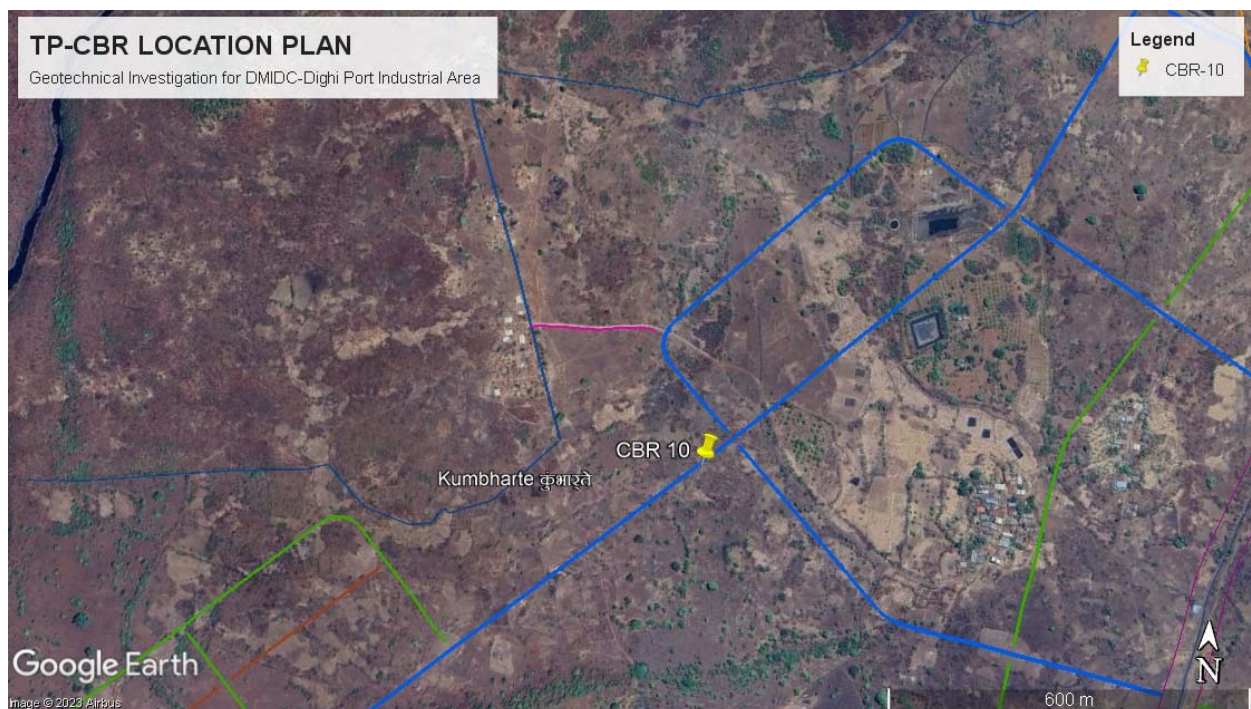
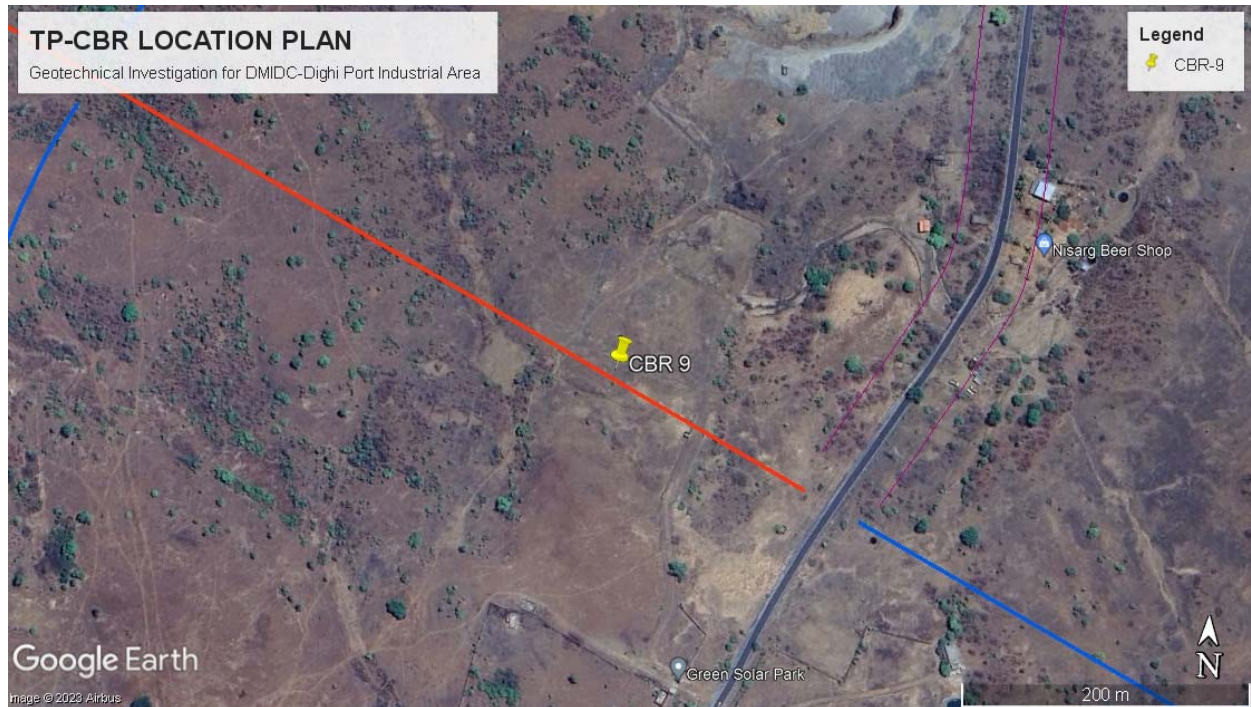
LOCATION PLAN















SOIL TEST DATA SHEET

Report No. :-	SRGeo/Lab/PNS10206/Rep-11/R0		
Project :-	Geotechnical Investigation for DMIDC-Dighi Port Industrial Area, Indapur.		
Principal Client :-	M/s. EGIS Consulting Engineers Pvt. Ltd.		
Client:-	M/s. P. N. Shidore Civil Engineers (I) Pvt. Ltd.		
Location:-	----	DATE:	14.06.2023

Trial PIt No. / Sample ID :	Depth* (m)	Sample Type *	Modified Proctor Compaction Test IS : 2720 (Part 8) -1970		Soil Classification (IS: 1498-1970)	Mechanical Analysis (IS: 2720 - Part-4 : 1985)				Consistency Limits (IS: 2720- Part-5 : 1985)			Free Swell Index % (IS:2720 - Part-40 : 1977)	Lab.CBR Test Unsoaked (IS: 2720 - Part-16 : 1987)		Lab.CBR Test Soaked (IS: 2720 - Part-16 : 1987)		Specific Gravity (IS:2720 Part-03)	Remarks
			Maximum Dry Density (MDD) gm/ cm3	Optimum Moisture Content (OMC) %		Gravel %	Sand %	Silt %	Clay %	Liquid %	Plastic %	Plasticity Index, I _p %		Penetration at 2.5 mm in %	Penetration at 5 mm in %	Penetration at 2.5 mm in %	Penetration at 5 mm in %		
TP-01-CBR-01	0.00-1.00	DS-01	1.87	16.90	CI	7	39	24	30	40	24	16	40	15.3	13.6	11.4	10.2	2.63	
TP-02-CBR-02	0.00-1.00	DS-01	1.61	22.80	CH	11	27	24	38	57	29	28	45	13.2	11.8	9.0	8.4	2.60	
TP-03-CBR-03	0.00-0.50	DS-01	1.73	20.25	CI	12	33	25	30	42	23	19	40	14.1	12.2	11.4	10.0	2.64	
TP-04-CBR-04	0.00-0.60	DS-01	1.57	25.81	CH	4	12	35	49	56	27	29	45	12.6	11.4	8.7	8.2	2.59	
TP-05-CBR-05	0.00-1.00	DS-01	2.06	13.70	SC	5	66	17	12	34	20	14	25	18.6	16.6	13.8	13.0	2.59	

CHEM : Chemical Analysis	Tuu : Triaxial Test (Unconsolidated Undrained)	SP : Swelling Pressure or Swelling Potential Test	φ : Angle of Internal Friction
COMP : Compaction Test	Tcu : Triaxial Test (Consolidated Undrained)	SPT : Standard Penetration Test Sample	Cu : Undrained Cohesion
DS : Direct Shear	Tcd : Triaxial Test (Consolidated Drained)	UDS : Undisturbed Soil Sample	φ' : Effective Angle of Internal Friction
K : Permeability Test	NP : Non Plastic	VL : Laboratory Vane Shear Test	Cu' : Effective Cohesion
FSI : Free Swell Test	SL : Shrinkage Limit Test	UC : Unconfined Compression Test	NPD : Not Possible

S & R Geotechniques Pvt. Ltd.

JOB NO : PNSI0206

(Pooja Patil - Report Engineer)
Prepared By

(Atul Bopche - Dy. Technical Manager)
Reviewed By



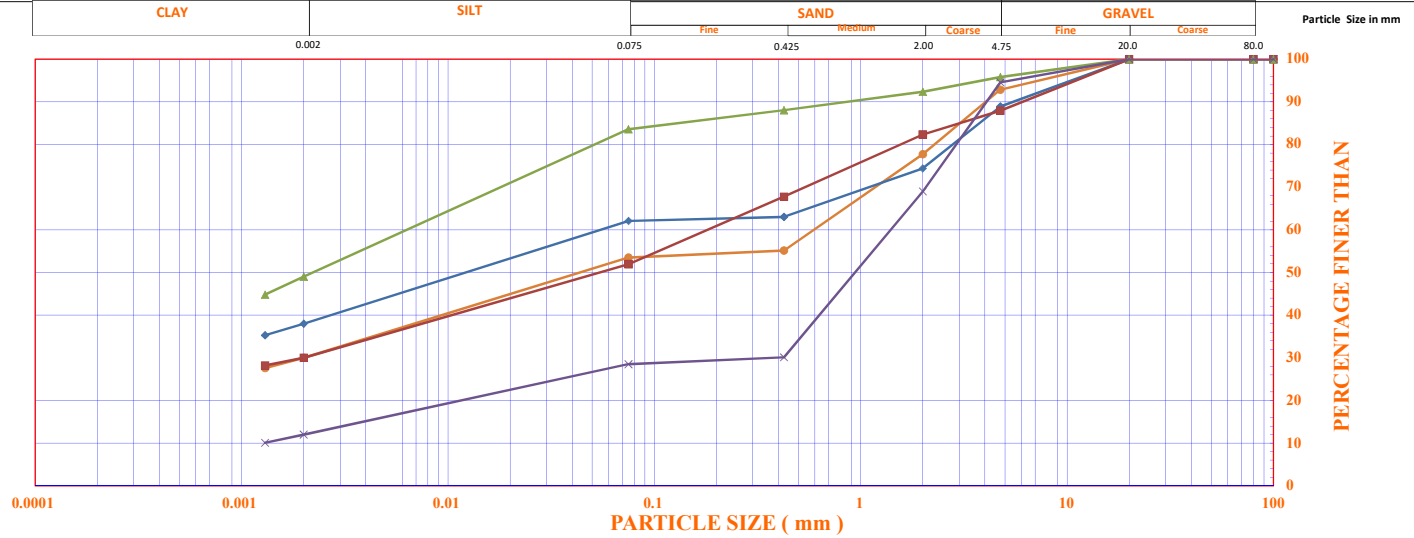
(Atul Chaudhari - Technical Manager)
Authorized By

GRAIN SIZE DISTRIBUTION CURVE (IS 2720: PART 4)

Project :- Geotechnical Investigation for DMIDC-Dighi Port Industrial Area, Indapur.

Location:- ----

S & R Geotechniques Pvt. Ltd.



JOB NO : PNSIO206

Symbol	Trial Pit No. / Sample ID ::	Depth* (m)	Classification (IS 1498)	Gravel	Sand	Silt	Clay	$\phi_{75\%}$	$\phi_{50\%}$	$\phi_{25\%}$	Coeff. of Uniformity, $C_u = D_{60} / D_{10}$	Coeff. Of Curvature $C_c = D_{30}^2 / (D_{60} * D_{10})$	Liquid Limit, W_L	Plastic Limit, W_p	Plasticity Index, I_p	Remarks
				%	%	%	%	mm	mm	mm						
—●—	TP-01-CBR-01	0.00-1.00	CI	7	39	24	30	---	---	---	---	---	40	24	16	DS-01
—■—	TP-02-CBR-02	0.00-1.00	CH	11	27	24	38	---	---	---	---	---	57	29	28	DS-01
—▲—	TP-03-CBR-03	0.00-0.50	CI	12	33	25	30	---	---	---	---	---	42	23	19	DS-01
—*—	TP-04-CBR-04	0.00-0.60	CH	4	12	35	49	---	---	---	---	---	56	27	29	DS-01
—◆—	TP-05-CBR-05	0.00-1.00	SC	5	66	17	12	---	---	---	---	---	34	20	14	DS-01

[Signature]

(Pooja Patil - Report Engineer)
Prepared By

[Signature]

(Atul Bopche - Dy. Technical Manager)
Reviewed By



[Signature]

(Atul Chaudhari - Technical Manager)
Authorised By



SOIL TEST DATA SHEET

Report No. :-	SRGeo/Lab/PNS10206/Rep-11/R0																
Project :-	Geotechnical Investigation for DMIDC-Dighi Port Industrial Area, Indapur.																
Principal Client :-	M/s. EGIS Consulting Engineers Pvt. Ltd.																
Client:-	M/s. P. N. Shidore Civil Engineers (I) Pvt. Ltd.																
Location:-	---														DATE: 14.06.2023		

Trial Pit No. / Sample ID :	Depth* (m)	Sample Type *	Modified Proctor Compaction Test (IS : 2720 (Part 8) -1970)		Soil Classification (IS: 1498-1970)	Mechanical Analysis (IS: 2720 - Part-4 : 1985)				Consistency Limits (IS: 2720- Part-5 : 1985)			Free Swell Index % (IS:2720 - Part-40 : 1977)	Lab.CBR Test Unsoaked (IS: 2720 - Part-16 : 1987)		Lab.CBR Test Soaked (IS: 2720 - Part-16 : 1987)		Specific Gravity (IS:2720 Part-03)	Remarks
			Maximum Dry Density (MDD) gm/ cm3	Optimum Moisture Content (OMC) %		Gravel %	Sand %	Silt %	Clay %	Liquid %	Plastic %	Plasticity Index, I _p %		Penetration at 2.5 mm in %	Penetration at 5 mm in %	Penetration at 2.5 mm in %	Penetration at 5 mm in %		
TP-06-CBR-06	0.00-0.70	DS-01	1.74	18.80	CI	5	32	27	36	41	22	19	36	14.4	12.4	11.7	10.6	2.62	

CHEM : Chemical Analysis	Tuu : Triaxial Test (Unconsolidated Undrained)	SP : Swelling Pressure or Swelling Potential Test	φ : Angle of Internal Friction
COMP : Compaction Test	Tcu : Triaxial Test (Consolidated Undrained)	SPT : Standard Penetration Test Sample	Cu : Undrained Cohesion
DS : Direct Shear	Tcd : Triaxial Test (Consolidated Drained)	UDS : Undisturbed Soil Sample	φ' : Effective Angle of Internal Friction
K : Permeability Test	NP : Non Plastic	VL : Laboratory Vane Shear Test	Cu' : Effective Cohesion
FSI : Free Swell Test	SL : Shrinkage Limit Test	UC : Unconfined Compression Test	NPO : Not Possible

S & R Geotechniques Pvt. Ltd.

JOB NO : PNS10206

(Pooja Patil - Report Engineer)
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Reviewed By



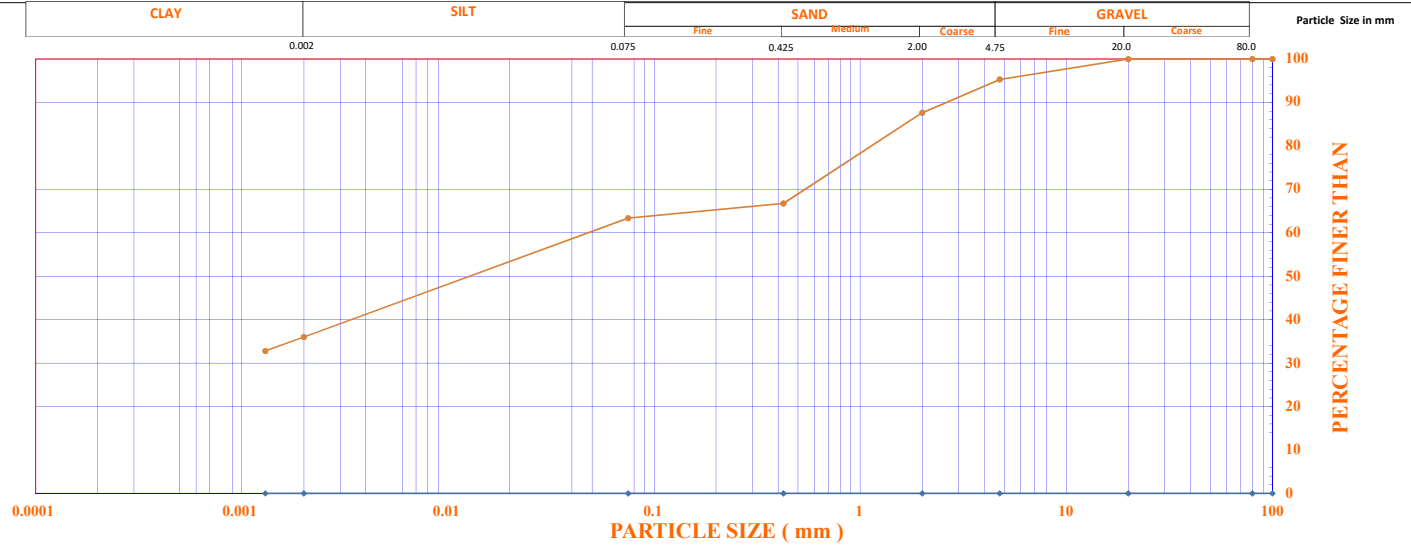
(Atul Chaudhari - Technical Manager)
Authorized By

GRAIN SIZE DISTRIBUTION CURVE (IS 2720: PART 4)

Project :- Geotechnical Investigation for DMIDC-Dighi Port Industrial Area, Indapur.

Location:- ---

S & R Geotechniques Pvt. Ltd.



JOB NO : PNSIO206

Symbol	Trial Pit No. / Sample ID :	Depth* (m)	Classification (IS 1498)	Gravel	Sand	Silt	Clay	$\Phi_{15\%}$	$\Phi_{30\%}$	$\Phi_{60\%}$	Coeff. of Uniformity, $C_u = D_{60} / D_{10}$	Coeff. Of Curvature $C_c = D_{30}^2 / (D_{60} * D_{10})$	Liquid Limit, W_L	Plastic Limit, W_p	Plasticity Index, I_p	Remarks
				%	%	%	%	mm	mm	mm						
◆◆◆	TP-06-CBR-06	0.00-0.70	CI	5	32	27	36	---	---	---	---	---	41	22	19	DS-01
◆◆◆																
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◆◆◆																

(Signature)

(Pooja Patil - Report Engineer)
Prepared By

(Signature)

(Atul Bopche - Dy. Technical Manager)
Reviewed By



(Signature)

(Atul Chaudhari - Technical Manager)
Authorised By

PROCTOR DENSITY TEST RESULTS

IS - 2720 , PART:8

Project : Geotechnical Investigation for DMIDC-Dighi Port Industrial Area, Indapur.

Principal Client :- M/s. EGIS Consulting Engineers Pvt. Ltd.

Date: 08.06.2023

Client:- M/s. P. N. Shidore Civil Engineers (I) Pvt. Ltd.

Trial Pit No. TP-01-CBR-01

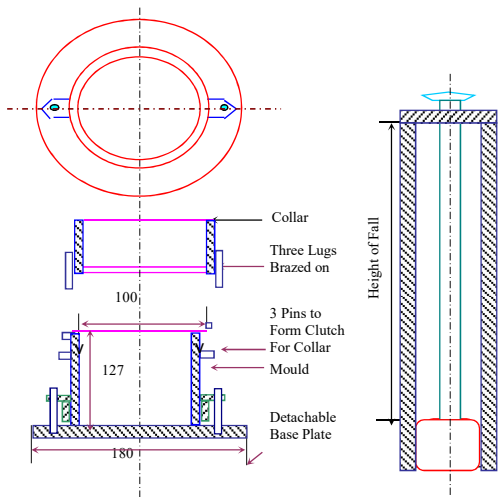
Weight of Hammer : $4.9\text{kg} \pm 25\text{gm}$

Depth of Sample : 0.00-1.00 - DS-01

Height of Fall : $450\text{mm} \pm 0.5\text{mm}$

Type of Test : **Modified Procter Test**

No. of Layers : 5



Proctor Test Apparatus

Rammer

OBSERVATION TABLE

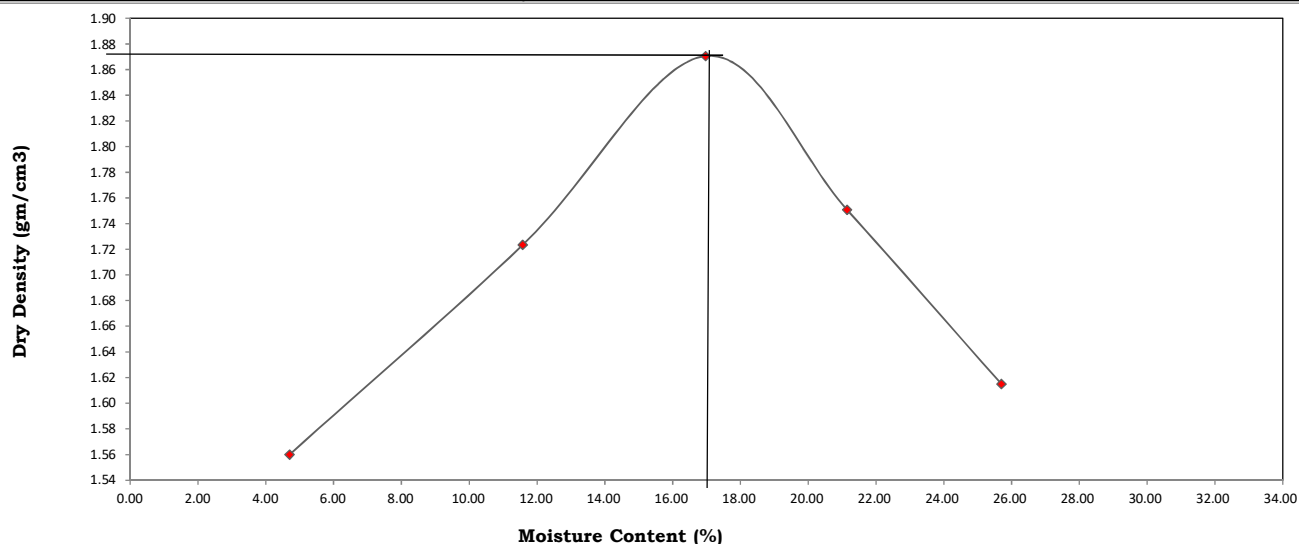
Sr.No.	Water Content %	Dry Density gm/cm ³
1	4.70	1.56
2	11.58	1.72
3	16.97	1.87
4	21.15	1.75
5	25.70	1.61

Maximum Dry Density (gm/cm³)=

1.87

Optimum Moisture Content (%)=

16.90



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JOB NO.

PNSI0206

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(Pooja Patil - Sr Test Engineer)
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(Atul Bopche - Dy. Tech Manager)
Reviewed By



[Signature]

(Atul Chaudhari-Technical Manager)
Authorised By

PROCTOR DENSITY TEST RESULTS

IS - 2720 , PART:8

Project : Geotechnical Investigation for DMIDC-Dighi Port Industrial Area, Indapur.

Principal Client :- M/s. EGIS Consulting Engineers Pvt. Ltd.

Date: 08.06.2023

Client:- M/s. P. N. Shidore Civil Engineers (I) Pvt. Ltd.

Trial Pit No. TP-02-CBR-02

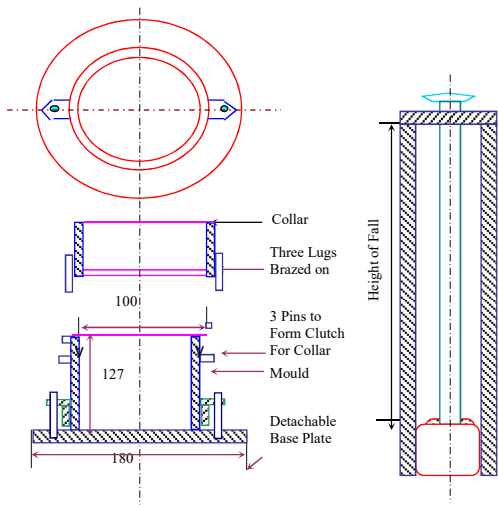
Weight of Hammer : $4.9\text{kg} \pm 25\text{gm}$

Depth of Sample : 0.00-1.00 - DS-01

Height of Fall : $450\text{mm} \pm 0.5\text{mm}$

Type of Test : **Modified Procter Test**

No. of Layers : 5



Proctor Test Apparatus

Rammer

OBSERVATION TABLE

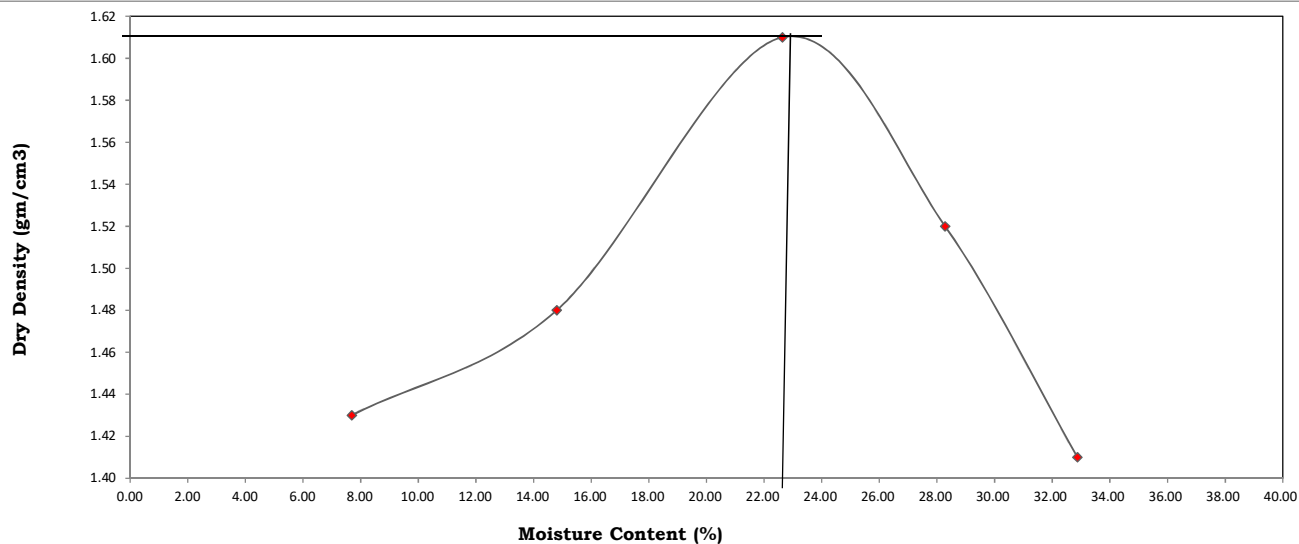
Sr.No.	Water Content %	Dry Density gm/cm ³
1	7.69	1.43
2	14.80	1.48
3	22.63	1.61
4	28.28	1.52
5	32.87	1.41

Maximum Dry Density (gm/cm³)=

1.61

Optimum Moisture Content (%)=

22.80



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JOB NO.

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Reviewed By



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(Atul Chaudhari-Technical Manager)
Authorised By

PROCTOR DENSITY TEST RESULTS

IS - 2720 , PART:8

Project : Geotechnical Investigation for DMIDC-Dighi Port Industrial Area, Indapur.

Principal Client :- M/s. EGIS Consulting Engineers Pvt. Ltd.

Date: 08.06.2023

Client:- M/s. P. N. Shidore Civil Engineers (I) Pvt. Ltd.

Trial Pit No. TP-03-CBR-03

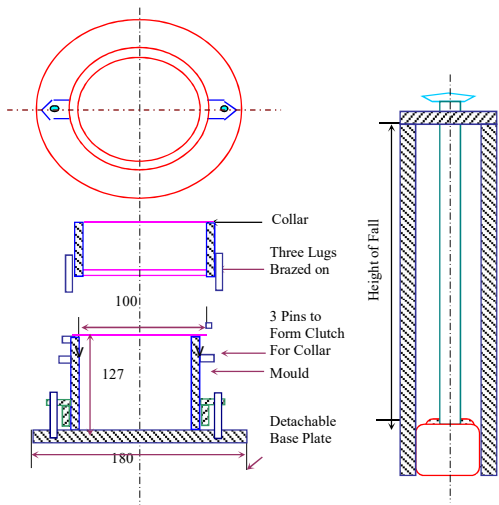
Weight of Hammer : $4.9\text{kg} \pm 25\text{gm}$

Depth of Sample : 0.00-1.00 - DS-01

Height of Fall : $450\text{mm} \pm 0.5\text{mm}$

Type of Test : **Modified Procter Test**

No. of Layers : 5



Proctor Test Apparatus

Rammer

OBSERVATION TABLE

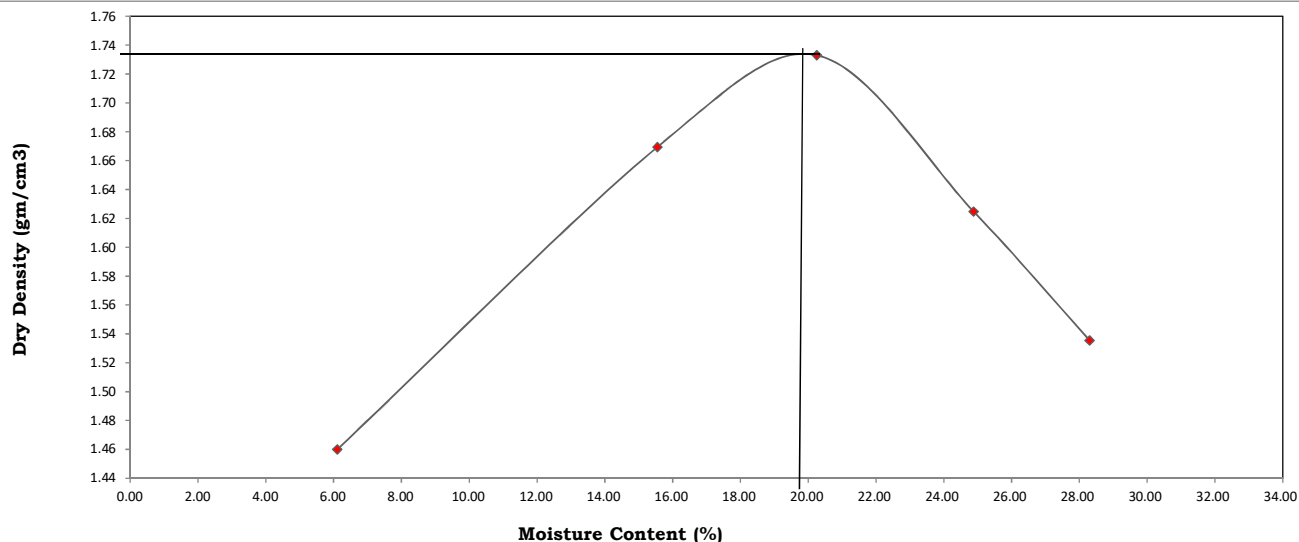
Sr.No.	Water Content %	Dry Density gm/cm ³
1	6.11	1.46
2	15.55	1.67
3	20.25	1.73
4	24.88	1.62
5	28.30	1.54

Maximum Dry Density (gm/cm³)=

1.73

Optimum Moisture Content (%)=

19.80



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JOB NO.

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Reviewed By



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(Atul Chaudhari-Technical Manager)
Authorised By

PROCTOR DENSITY TEST RESULTS

IS - 2720 , PART:8

Project : Geotechnical Investigation for DMIDC-Dighi Port Industrial Area, Indapur.

Principal Client :- M/s. EGIS Consulting Engineers Pvt. Ltd.

Date: 08.06.2023

Client:- M/s. P. N. Shidore Civil Engineers (I) Pvt. Ltd.

Trial Pit No. TP-04-CBR-04

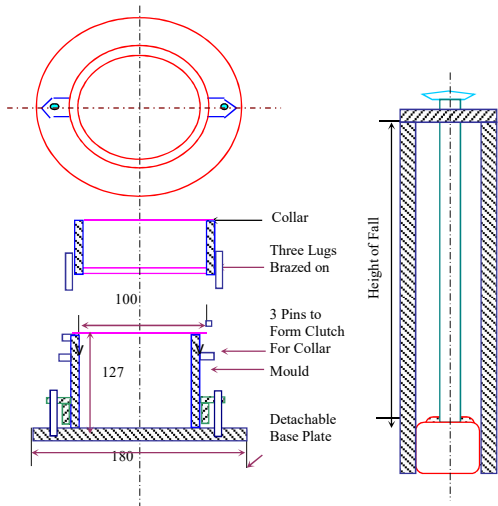
Weight of Hammer : $4.9\text{kg} \pm 25\text{gm}$

Depth of Sample : 0.00-1.00 - DS-01

Height of Fall : $450\text{mm} \pm 0.5\text{mm}$

Type of Test : **Modified Procter Test**

No. of Layers : 5



Proctor Test Apparatus

Rammer

OBSERVATION TABLE

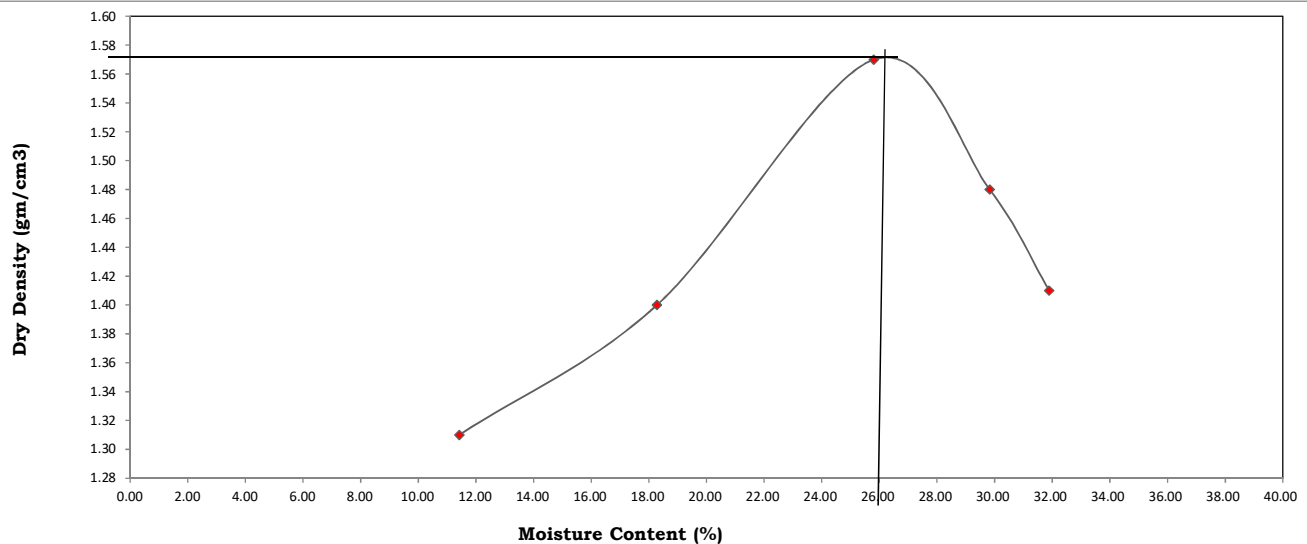
Sr.No.	Water Content %	Dry Density gm/cm ³
1	11.42	1.31
2	18.28	1.40
3	25.81	1.57
4	29.82	1.48
5	31.89	1.41

Maximum Dry Density (gm/cm³)=

1.57

Optimum Moisture Content (%)=

26.00



S&R GEOTECHNIQUES PVT. LTD.

JOB NO.

PNSI0206

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(Pooja Patil - Sr Test Engineer)
Prepared By

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(Atul Bopche - Dy. Tech Manager)
Reviewed By



[Signature]

(Atul Chaudhari-Technical Manager)
Authorised By

PROCTOR DENSITY TEST RESULTS

IS - 2720 , PART:8

Project : Geotechnical Investigation for DMIDC-Dighi Port Industrial Area, Indapur.

Principal Client :- M/s. EGIS Consulting Engineers Pvt. Ltd.

Date: 08.06.2023

Client:- M/s. P. N. Shidore Civil Engineers (I) Pvt. Ltd.

Trial Pit No. TP-05-CBR-05

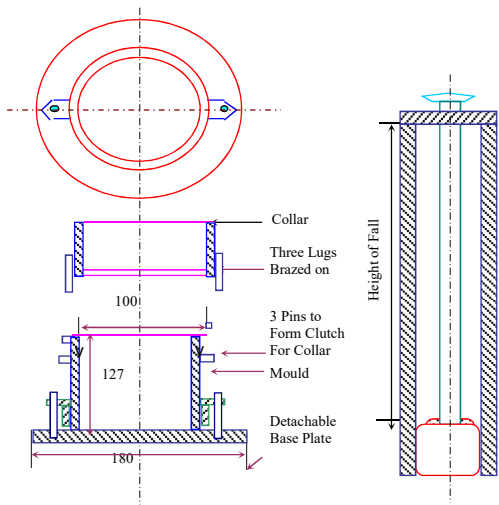
Weight of Hammer : $4.9\text{kg} \pm 25\text{gm}$

Depth of Sample : 0.00-1.00 - DS-01

Height of Fall : $450\text{mm} \pm 0.5\text{mm}$

Type of Test : **Modified Procter Test**

No. of Layers : 5



Proctor Test Apparatus

Rammer

OBSERVATION TABLE

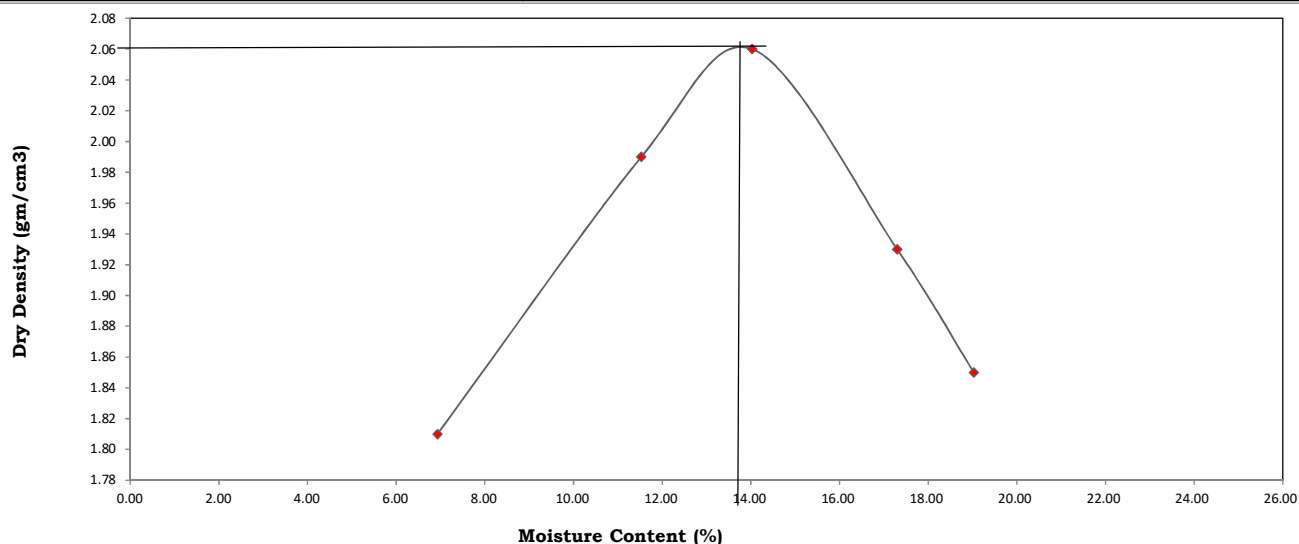
Sr.No.	Water Content %	Dry Density gm/cm ³
1	6.93	1.81
2	11.53	1.99
3	14.03	2.06
4	17.30	1.93
5	19.03	1.85

Maximum Dry Density (gm/cm³)=

2.06

Optimum Moisture Content (%)=

13.70



S&R GEOTECHNIQUES PVT. LTD.

JOB NO.

PNSI0206

[Signature]

(Pooja Patil - Sr Test Engineer)
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(Atul Bopche - Dy. Tech Manager)
Reviewed By



[Signature]

(Atul Chaudhari-Technical Manager)
Authorised By

PROCTOR DENSITY TEST RESULTS

IS - 2720 , PART:8

Project : Geotechnical Investigation for DMIDC-Dighi Port Industrial Area, Indapur.

Principal Client :- M/s. EGIS Consulting Engineers Pvt. Ltd.

Date: 08.06.2023

Client:- M/s. P. N. Shidore Civil Engineers (I) Pvt. Ltd.

Trial Pit No. TP-06-CBR-06

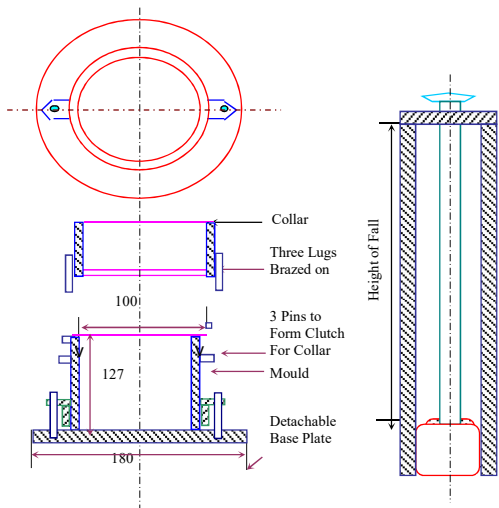
Weight of Hammer : $4.9\text{kg} \pm 25\text{gm}$

Depth of Sample : 0.00-0.70 - DS-01

Height of Fall : $450\text{mm} \pm 0.5\text{mm}$

Type of Test : **Modified Procter Test**

No. of Layers : 5



Proctor Test Apparatus

Rammer

OBSERVATION TABLE

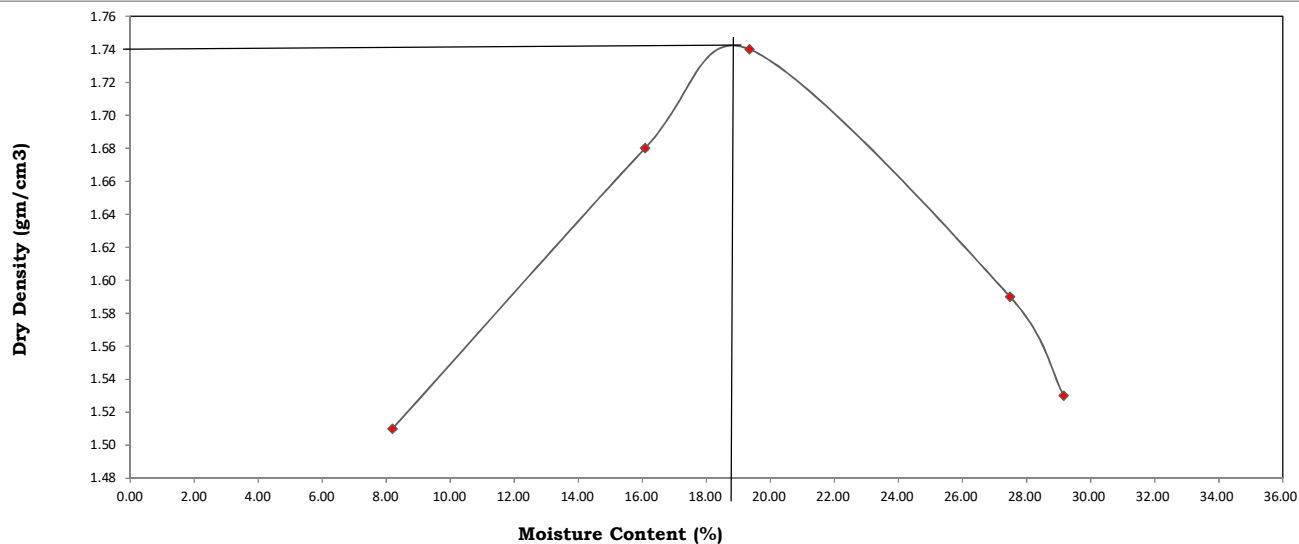
Sr.No.	Water Content %	Dry Density gm/cm ³
1	8.19	1.51
2	16.08	1.68
3	19.34	1.74
4	27.48	1.59
5	29.16	1.53

Maximum Dry Density (gm/cm³)=

1.74

Optimum Moisture Content (%)=

18.80



S&R GEOTECHNIQUES PVT. LTD.

JOB NO.

PNSI0206

[Signature]

(Pooja Patil - Sr Test Engineer)
Prepared By

[Signature]

(Atul Bopche - Dy. Tech Manager)
Reviewed By



[Signature]

(Atul Chaudhari-Technical Manager)
Authorised By

CALIFORNIA BEARING RATIO

As Per IS 2720:Part-16

Project : Geotechnical Investigation for DMIDC-Dighi Port Industrial Area, Indapur.

Principal Client : M/s. EGIS Consulting Engineers Pvt. Ltd.

Client : M/s. P. N. Shidore Civil Engineers (I) Pvt. Ltd.

Date: 13.06.2023

Trial Pit No. : TP-01

Reference No. of Proving Ring : 30-2018

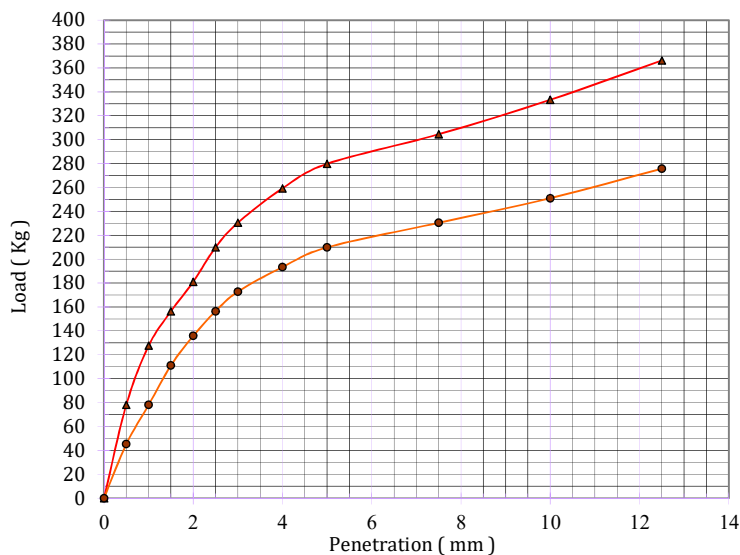
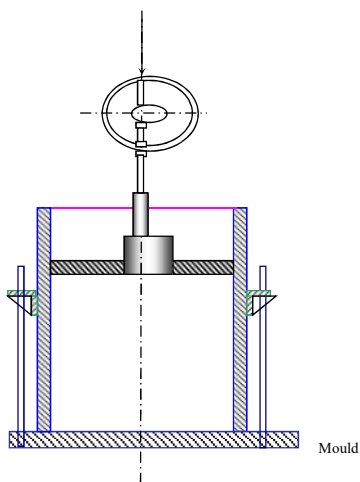
Depth of Sample : 0.00-1.00 DS-1

Load Factor (Kg/Div.) : 4.1150

Type of Test : Modified Proctor Test

Maximum Dry Density (gm/cm³): 1.87

Optimum Moisture Content % : 16.90



CALIFORNIA BEARING RATIO OBSERVATION

Penetration mm	Dial Gauge Reading Div.	Observed Load Kg	Corrected Load Kg	Dial Gauge Reading Div.	Observed Load Kg	Corrected Load Kg	Standard Load Kg	California Bearing Ratio		Remarks
	Unsoaked	Unsoaked	Unsoaked	Soaked	Soaked	Soaked		% Unsoaked	% Soaked	
0	0	0.00		0	0.00					
0.5	19	78.19		11	45.27					
1	31	127.57		19	78.19					
1.5	38	156.37		27	111.11					
2	44	181.06		33	135.80					
2.5	51	209.87	209.87	38	156.37	156.37	1370	15.3	11.4	
3	56	230.44		42	172.83					
4	63	259.25		47	193.41					
5	68	279.82	279.82	51	209.87	209.87	2055	13.6	10.2	
7.5	74	304.51		56	230.44					
10	81	333.32		61	251.02					
12.5	89	366.24		67	275.71					

S&R GEOTECHNIQUES PVT. LTD.

JOB NO.

PNSI0206



(Pooja Patil - Sr Test Engineer)
Prepared By



(Atul Bopche - Dy. Technical Manager)
Reviewed By




(Atul Chaudhari - Technical Manager)
Authorised By

CALIFORNIA BEARING RATIO

As Per IS 2720:Part-16

Project : Geotechnical Investigation for DMIDC-Dighi Port Industrial Area, Indapur.

Principal Client : M/s. EGIS Consulting Engineers Pvt. Ltd.

Client : M/s. P. N. Shidore Civil Engineers (I) Pvt. Ltd.

Date: 13.06.2023

Trial Pit No. : TP-02

Reference No. of Proving Ring : 30-2018

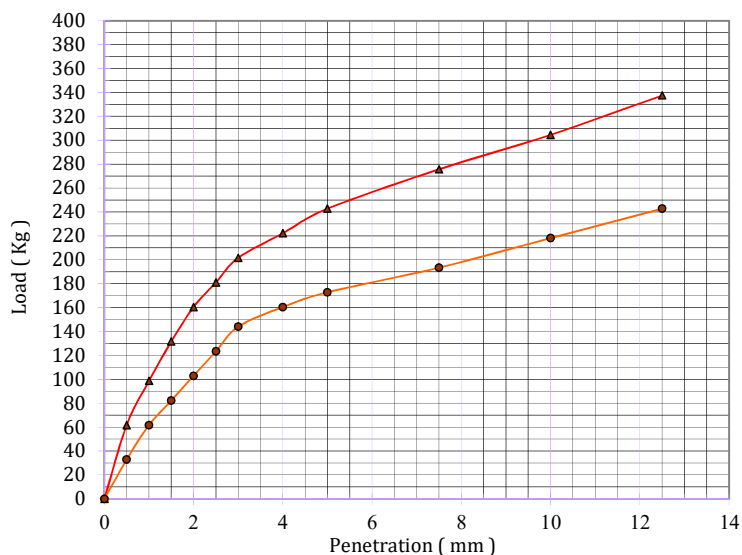
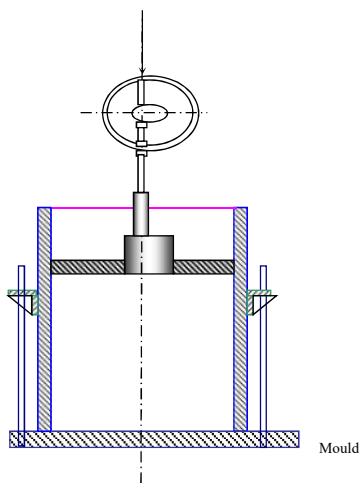
Depth of Sample : 0.00-1.00 DS-1

Load Factor (Kg/Div.) : 4.1150

Type of Test : Modified Proctor Test

Maximum Dry Density (gm/cm³): 1.61

Optimum Moisture Content % : 22.80



CALIFORNIA BEARING RATIO OBSERVATION

Penetration mm	Dial Gauge Reading	Observed Load	Corrected Load	Dial Gauge Reading	Observed Load	Corrected Load	Standard Load Kg	California Bearing Ratio		Remarks
	Div.	Kg	Kg	Div.	Kg	Kg		%	%	
	Unsoaked	Unsoaked	Unsoaked	Soaked	Soaked	Soaked		Unsoaked	Soaked	
0	0	0.00		0	0.00					
0.5	15	61.73		8	32.92					
1	24	98.76		15	61.73					
1.5	32	131.68		20	82.30					
2	39	160.49		25	102.88					
2.5	44	181.06	181.06	30	123.45	123.45	1370	13.2	9.0	
3	49	201.64		35	144.03					
4	54	222.21		39	160.49					
5	59	242.79	242.79	42	172.83	172.83	2055	11.8	8.4	
7.5	67	275.71		47	193.41					
10	74	304.51		53	218.10					
12.5	82	337.43		59	242.79					

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Reviewed By



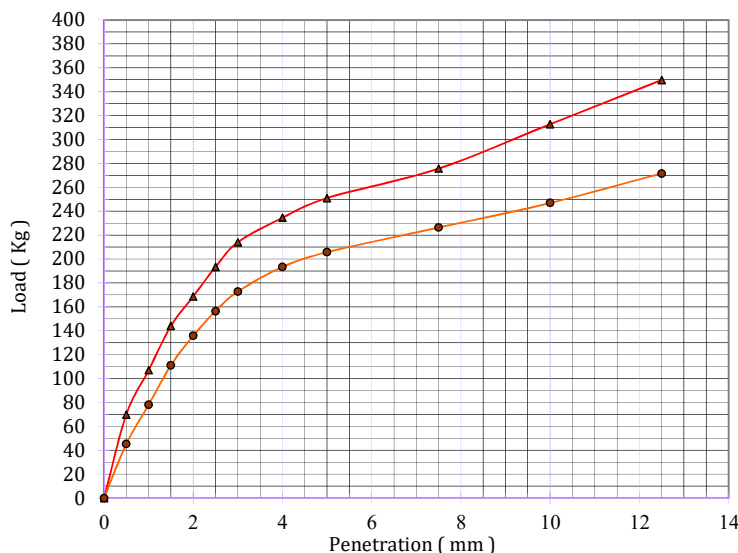
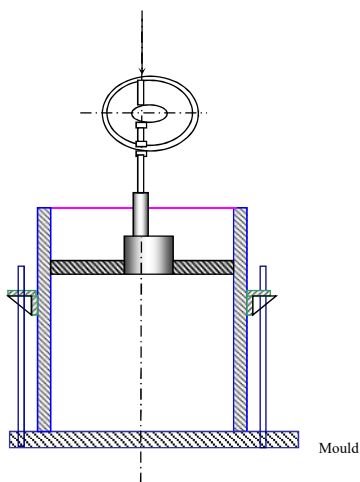
(Signature)

(Atul Chaudhari - Technical Manager)
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CALIFORNIA BEARING RATIO

As Per IS 2720:Part-16

Project : Geotechnical Investigation for DMIDC-Dighi Port Industrial Area, Indapur.
Principal Client : M/s. EGIS Consulting Engineers Pvt. Ltd.
Client : M/s. P. N. Shidore Civil Engineers (I) Pvt. Ltd. Date: 13.06.2023
Trial Pit No. : TP-03 Reference No. of Proving Ring : 30-2018
Depth of Sample : 0.00-0.50 DS-1 Load Factor (Kg/Div.) : 4.1150
Type of Test : Modified Proctor Test Maximum Dry Density (gm/cm3): 1.73
Optimum Moisture Content % : 20.25



CALIFORNIA BEARING RATIO OBSERVATION

Penetration mm	Dial Gauge Reading Div.	Observed Load Kg	Corrected Load Kg	Dial Gauge Reading Div.	Observed Load Kg	Corrected Load Kg	Standard Load Kg	California Bearing Ratio		Remarks
	Unsoaked	Unsoaked	Unsoaked	Soaked	Soaked	Soaked		% Unsoaked	% Soaked	
0	0	0.00		0	0.00					
0.5	17	69.96		11	45.27					
1	26	106.99		19	78.19					
1.5	35	144.03		27	111.11					
2	41	168.72		33	135.80					
2.5	47	193.41	193.41	38	156.37	156.37	1370	14.1	11.4	
3	52	213.98		42	172.83					
4	57	234.56		47	193.41					
5	61	251.02	251.02	50	205.75	205.75	2055	12.2	10.0	
7.5	67	275.71		55	226.33					
10	76	312.74		60	246.90					
12.5	85	349.78		66	271.59					

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Reviewed By



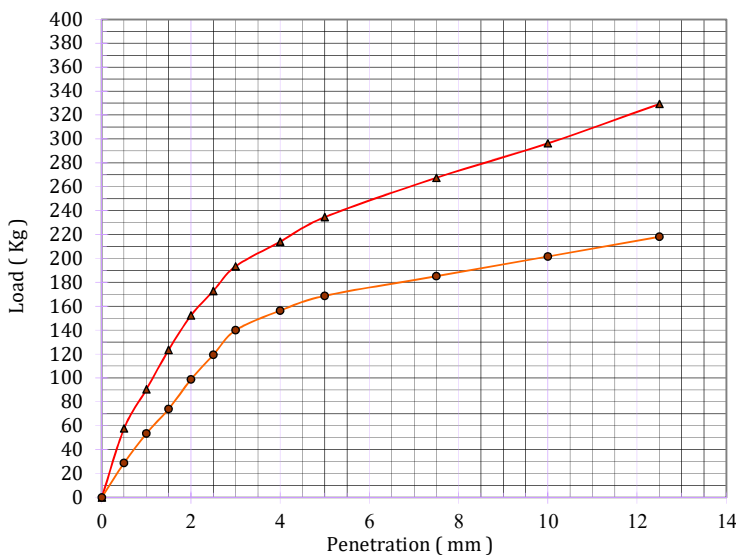
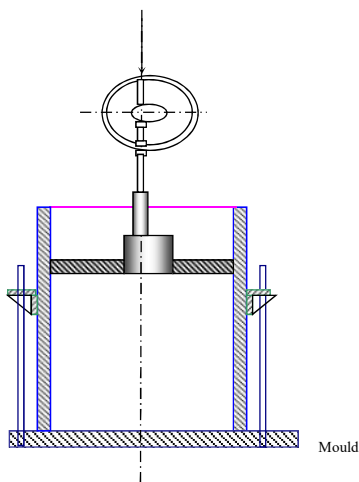
(Signature)

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CALIFORNIA BEARING RATIO

As Per IS 2720:Part-16

Project : Geotechnical Investigation for DMIDC-Dighi Port Industrial Area, Indapur.
Principal Client : M/s. EGIS Consulting Engineers Pvt. Ltd.
Client : M/s. P. N. Shidore Civil Engineers (I) Pvt. Ltd. Date: 13.06.2023
Trial Pit No. : TP-04 Reference No. of Proving Ring : 30-2018
Depth of Sample : 0.00-0.60 DS-1 Load Factor (Kg/Div.) : 4.1150
Type of Test : Modified Proctor Test Maximum Dry Density (gm/cm³): 1.57
Optimum Moisture Content % : 25.81



CALIFORNIA BEARING RATIO OBSERVATION

Penetration mm	Dial Gauge Reading	Observed Load Kg	Correcte d Load Kg	Dial Gauge Reading	Observed Load Kg	Correcte d Load Kg	Standard Load Kg	California Bearing Ratio		Remarks
	Div.	Kg	Kg	Div.	Kg	Kg		%	%	
	<i>Unsoaked</i>	<i>Unsoaked</i>	<i>Unsoaked</i>	<i>Soaked</i>	<i>Soaked</i>	<i>Soaked</i>		<i>Unsoaked</i>	<i>Soaked</i>	
0	0	0.00		0	0.00					
0.5	14	57.61		7	28.81					
1	22	90.53		13	53.50					
1.5	30	123.45		18	74.07					
2	37	152.26		24	98.76					
2.5	42	172.83	172.83	29	119.34	119.34	1370	12.6	8.7	
3	47	193.41		34	139.91					
4	52	213.98		38	156.37					
5	57	234.56	234.56	41	168.72	168.72	2055	11.4	8.2	
7.5	65	267.48		45	185.18					
10	72	296.28		49	201.64					
12.5	80	329.20		53	218.10					

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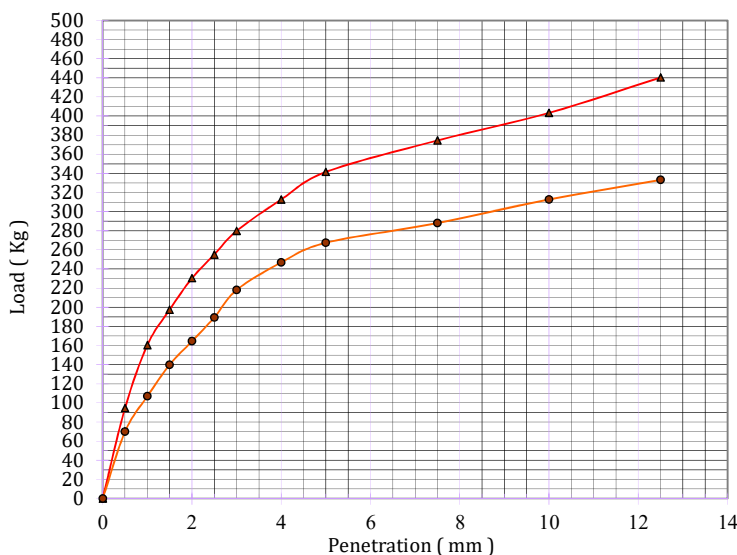
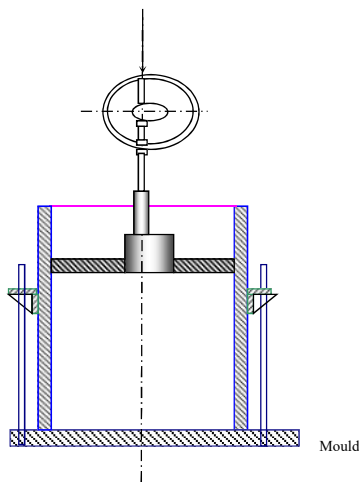
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CALIFORNIA BEARING RATIO

As Per IS 2720:Part-16

Project : Geotechnical Investigation for DMIDC-Dighi Port Industrial Area, Indapur.
Principal Client : M/s. EGIS Consulting Engineers Pvt. Ltd.
Client : M/s. P. N. Shidore Civil Engineers (I) Pvt. Ltd. Date: 13.06.2023
Trial Pit No. : TP-05 Reference No. of Proving Ring : 30-2018
Depth of Sample : 0.00-1.00 DS-1 Load Factor (Kg/Div.) : 4.1150
Type of Test : Modified Proctor Test Maximum Dry Density (gm/cm³): 2.06
Optimum Moisture Content % : 13.70



CALIFORNIA BEARING RATIO OBSERVATION

Penetration mm	Dial Gauge Reading Div.	Observed Load Kg	Corrected Load Kg	Dial Gauge Reading Div.	Observed Load Kg	Corrected Load Kg	Standard Load Kg	California Bearing Ratio		Remarks
	Unsoaked	Unsoaked	Unsoaked	Soaked	Soaked	Soaked		% Unsoaked	% Soaked	
0	0	0.00		0	0.00					
0.5	23	94.65		17	69.96					
1	39	160.49		26	106.99					
1.5	48	197.52		34	139.91					
2	56	230.44		40	164.60					
2.5	62	255.13	255.13	46	189.29	189.29	1370	18.6	13.8	
3	68	279.82		53	218.10					
4	76	312.74		60	246.90					
5	83	341.55	341.55	65	267.48	267.48	2055	16.6	13.0	
7.5	91	374.47		70	288.05					
10	98	403.27		76	312.74					
12.5	107	440.31		81	333.32					

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JOB NO.

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(Pooja Patil - Sr Test Engineer)
Prepared By



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Reviewed By

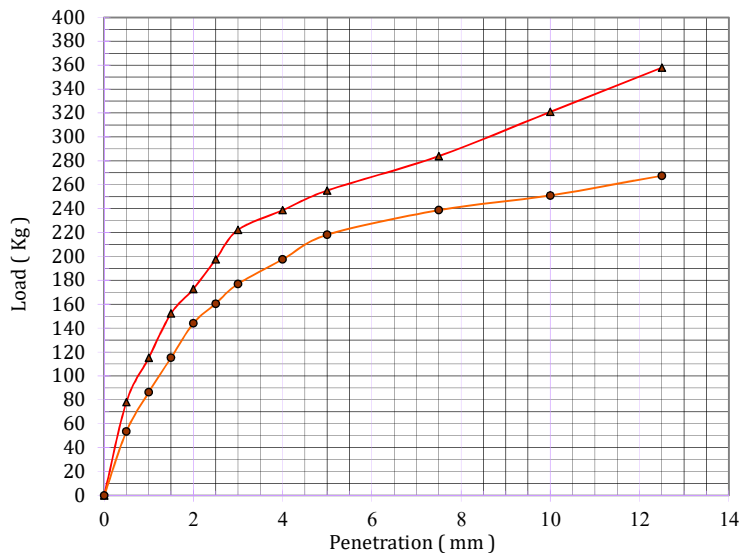
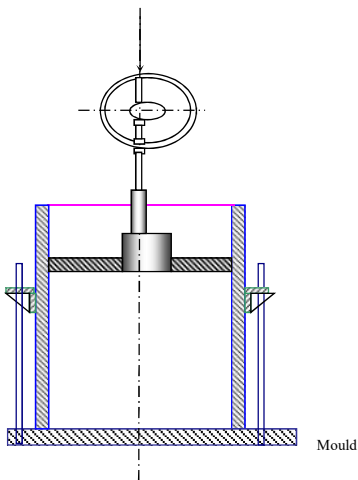



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CALIFORNIA BEARING RATIO

As Per IS 2720:Part-16

Project : Geotechnical Investigation for DMIDC-Dighi Port Industrial Area, Indapur.
Principal Client : M/s. EGIS Consulting Engineers Pvt. Ltd.
Client : M/s. P. N. Shidore Civil Engineers (I) Pvt. Ltd. Date: 13.06.2023
Trial Pit No. : TP-05 Reference No. of Proving Ring : 30-2018
Depth of Sample : 0.00-1.00 DS-1 Load Factor (Kg/Div.) : 4.1150
Type of Test : Modified Proctor Test Maximum Dry Density (gm/cm³): 1.74
Optimum Moisture Content % : 18.80



CALIFORNIA BEARING RATIO OBSERVATION

Penetration mm	Dial Gauge Reading	Observed Load	Corrected Load	Dial Gauge Reading	Observed Load	Corrected Load	Standard Load Kg	California Bearing Ratio		Remarks
	Div.	Kg	Kg	Div.	Kg	Kg		% Unsoaked	% Soaked	
0	0	0.00		0	0.00					
0.5	19	78.19		13	53.50					
1	28	115.22		21	86.42					
1.5	37	152.26		28	115.22					
2	42	172.83		35	144.03					
2.5	48	197.52	197.52	39	160.49	160.49	1370	14.4	11.7	
3	54	222.21		43	176.95					
4	58	238.67		48	197.52					
5	62	255.13	255.13	53	218.10	218.10	2055	12.4	10.6	
7.5	69	283.94		58	238.67					
10	78	320.97		61	251.02					
12.5	87	358.01		65	267.48					

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JOB NO.

PNSI0206

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(Atul Chaudhari - Technical Manager)
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SOIL TEST DATA SHEET

Report No. :-	SRGeo/Lab/PNS10206/Rep-12/R0
Project :-	Geotechnical Investigation for DMIDC-Dighi Port Industrial Area, Indapur.
Principal Client :-	M/s. EGIS Consulting Engineers Pvt. Ltd.
Client:-	M/s. P. N. Shidore Civil Engineers (I) Pvt. Ltd.

Location:-	----	DATE:	15.06.2023
-------------------	------	--------------	------------

* Trial Pit No. / Sample ID :	* Depth (m)	* Sample Type	Modified Proctor Compaction Test : 2720 (Part 8) -1970		Soil Classification (IS: 1498-1970)	Mechanical Analysis (IS: 2720 - Part-4 : 1985)				Consistency Limits (IS: 2720- Part-5 : 1985)			Free Swell Index % (IS:2720 - Part-40 : 1977)	Lab.CBR Test Unsoaked (IS: 2720 - Part-16 : 1987)		Lab.CBR Test Soaked (IS: 2720 - Part-16 : 1987)		Specific Gravity (IS:2720 Part-03)	Remarks
			Maximum Dry Density (MDD) gm/ cm ³	Optimum Moisture Content (OMC) %		Gravel %	Sand %	Silt %	Clay %	Liquid %	Plastic %	Plasticity Index, I _p %		Penetration at 2.5 mm in %	Penetration at 5 mm in %	Penetration at 2.5 mm in %	Penetration at 5 mm in %		
TP-07-CBR-07	0.00-1.00	DS-01	1.75	21.50	SC	17	43	20	20	41	24	17	27	15.3	13.4	12.3	11.4	2.64	
TP-08-CBR-08	0.00-1.00	DS-01	1.95	21.20	SC	26	27	22	25	44	26	18	30	17.7	16.2	13.2	12.6	2.65	
TP-09-CBR-09	0.00-0.50	DS-01	1.95	21.30	SC	34	35	17	14	43	25	18	27	18.3	16	13.5	13.0	2.65	
TP-10-CBR-10	0.00-0.60	DS-01	1.85	21.70	SC	5	48	21	26	45	26	19	27	17.7	15.4	12.6	11.4	2.64	
TP-11-CBR-11	0.00-1.00	DS-01	1.61	25.30	CH	8	33	25	34	53	27	26	40	13.5	12.2	9.0	8.6	2.62	

CHEM : Chemical Analysis	Tuu : Triaxial Test (Unconsolidated Undrained)	SP : Swelling Pressure or Swelling Potential Test	φ : Angle of Internal Friction
COMP : Compaction Test	Tcu : Triaxial Test (Consolidated Undrained)	SPT : Standard Penetration Test Sample	Cu : Undrained Cohesion
DS : Direct Shear	Tcd : Triaxial Test (Consolidated Drained)	UDS : Undisturbed Soil Sample	φ' : Effective Angle of Internal Friction
K : Permeability Test	NP : Non Plastic	VL : Laboratory Vane Shear Test	Cu' : Effective Cohesion
FSI : Free Swell Test	SL : Shrinkage Limit Test	UC : Unconfined Compression Test	NPO : Not Possible

S & R Geotechniques Pvt. Ltd.

JOB NO : PNSI0206

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(Pooja Patil - Report Engineer)
Prepared By

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Reviewed By



(Signature)

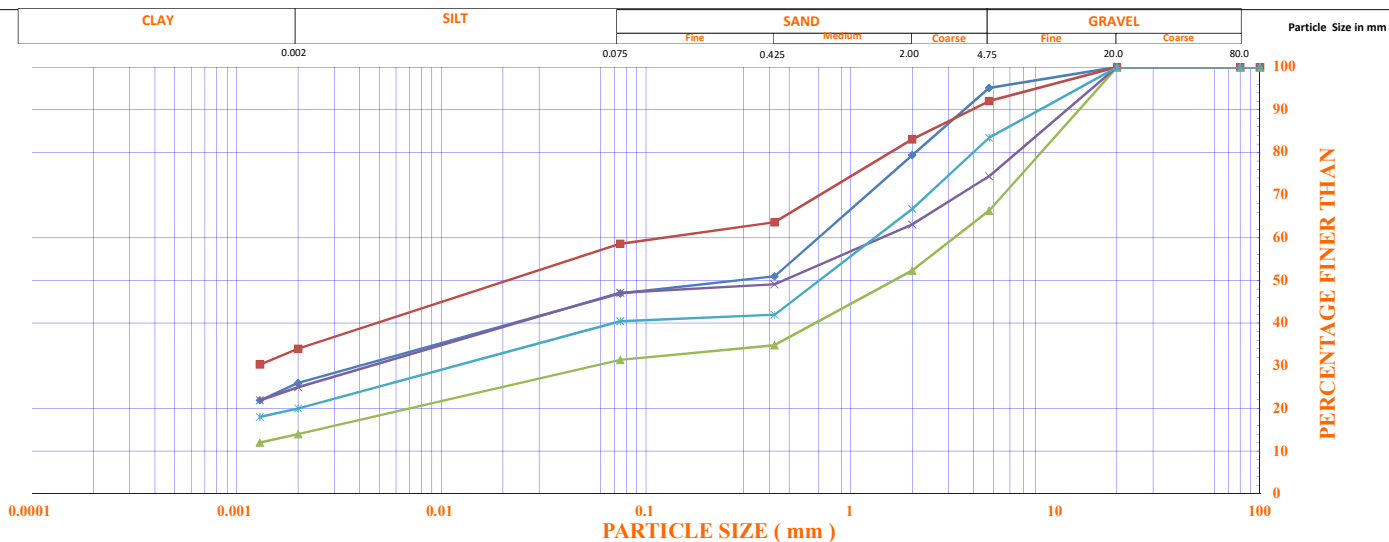
(Atul Chaudhari - Technical Manager)
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GRAIN SIZE DISTRIBUTION CURVE (IS 2720: PART 4)

Project :- Geotechnical Investigation for DMIDC-Dighi Port Industrial Area, Indapur.

Location:- ----

S & R Geotechniques Pvt. Ltd.



JOB NO : PNSI0206

Symbol	* Trial Pit No. / Sample ID :	* Depth (m)	Classification (IS 1498)	Gravel	Sand	Silt	Clay	$\phi_{10\%}$	$\phi_{30\%}$	$\phi_{60\%}$	Coeff. of Uniformity, $C_u = D_{60} / D_{10}$	Coeff. Of Curvature $C_c = D_{30}^2 / (D_{60} \cdot D_{10})$	Liquid Limit, W_L	Plastic Limit, W_P	Plasticity Index, I_p	Remarks
				%	%	%	%	mm	mm	mm						
●-●-	TP-07-CBR-07	0.00-1.00	SC	17	43	20	20	---	---	---	---	---	41	24	17	DS-01
■-■-	TP-08-CBR-08	0.00-1.00	SC	26	27	22	25	---	---	---	---	---	44	26	18	DS-01
▲-▲-	TP-09-CBR-09	0.00-0.50	SC	34	35	17	14	---	---	---	---	---	43	25	18	DS-01
-	TP-10-CBR-10	0.00-0.60	SC	5	48	21	26	---	---	---	---	---	45	26	19	DS-01
◆-◆	TP-11-CBR-11	0.00-1.00	CH	8	33	25	34	---	---	---	---	---	53	27	26	DS-01

[Signature]

(Pooja Patil - Report Engineer)
Prepared By

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(Atul Bopche - Dy. Technical Manager)
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Authorised By

PROCTOR DENSITY TEST RESULTS

IS - 2720 , PART:8

Project : Geotechnical Investigation for DMIDC-Dighi Port Industrial Area, Indapur.

Principal Client :- M/s. EGIS Consulting Engineers Pvt. Ltd.

Date: 10.06.2023

Client:- M/s. P. N. Shidore Civil Engineers (I) Pvt. Ltd.

Trial Pit No. TP-07-CBR-07

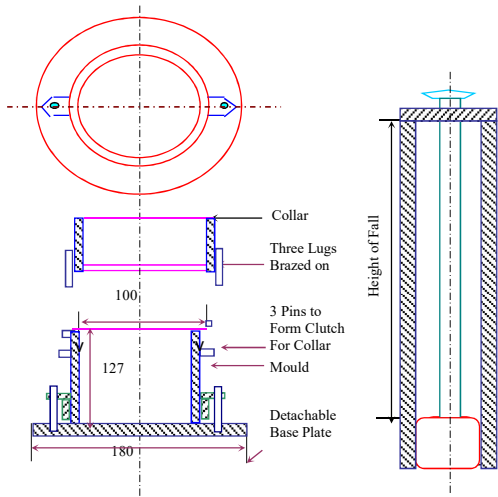
Weight of Hammer : $4.9\text{kg} \pm 25\text{gm}$

Depth of Sample : 0.00-1.00 - DS-01

Height of Fall : $450\text{mm} \pm 0.5\text{mm}$

Type of Test : **Modified Procter Test**

No. of Layers : 5



Proctor Test Apparatus

Rammer

OBSERVATION TABLE

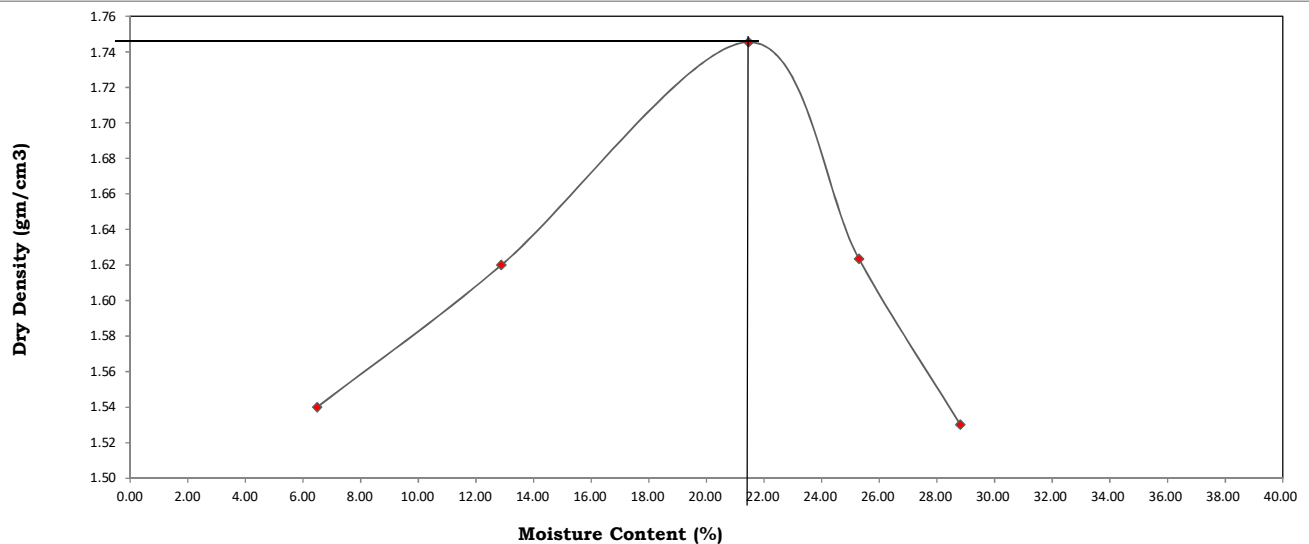
Sr.No.	Water Content %	Dry Density gm/cm ³
1	6.49	1.54
2	12.88	1.62
3	21.46	1.75
4	25.29	1.62
5	28.81	1.53

Maximum Dry Density (gm/cm³)=

1.75

Optimum Moisture Content (%)=

21.50



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JOB NO.

PNSI0206

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(Pooja Patil - Sr Test Engineer)
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Reviewed By



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Authorised By

PROCTOR DENSITY TEST RESULTS

IS - 2720 , PART:8

Project : Geotechnical Investigation for DMIDC-Dighi Port Industrial Area, Indapur.

Principal Client :- M/s. EGIS Consulting Engineers Pvt. Ltd.

Date: 10.06.2023

Client:- M/s. P. N. Shidore Civil Engineers (I) Pvt. Ltd.

Trial Pit No. TP-08-CBR-08

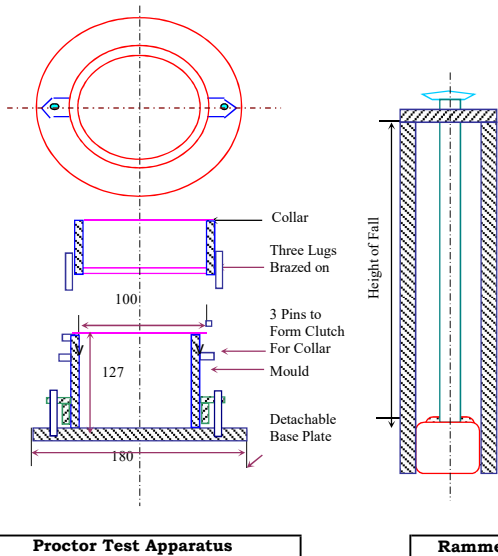
Weight of Hammer : $4.9\text{kg} \pm 25\text{gm}$

Depth of Sample : 0.00-1.00 - DS-01

Height of Fall : $450\text{mm} \pm 0.5\text{mm}$

Type of Test : **Modified Procter Test**

No. of Layers : 5



OBSERVATION TABLE

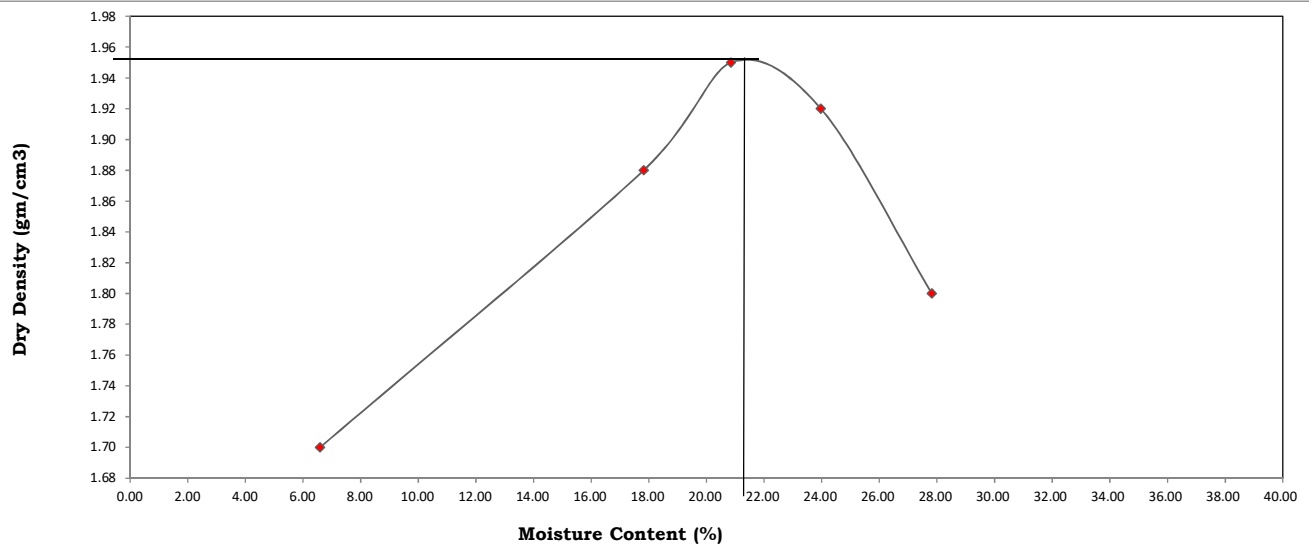
Sr.No.	Water Content %	Dry Density gm/cm ³
1	6.59	1.70
2	17.82	1.88
3	20.85	1.95
4	23.97	1.92
5	27.82	1.80

Maximum Dry Density (gm/cm³)=

1.95

Optimum Moisture Content (%)=

21.20



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Reviewed By



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Authorised By

PROCTOR DENSITY TEST RESULTS

IS - 2720 , PART:8

Project : Geotechnical Investigation for DMIDC-Dighi Port Industrial Area, Indapur.

Principal Client :- M/s. EGIS Consulting Engineers Pvt. Ltd.

Date: 10.06.2023

Client:- M/s. P. N. Shidore Civil Engineers (I) Pvt. Ltd.

Trial Pit No. TP-09-CBR-09

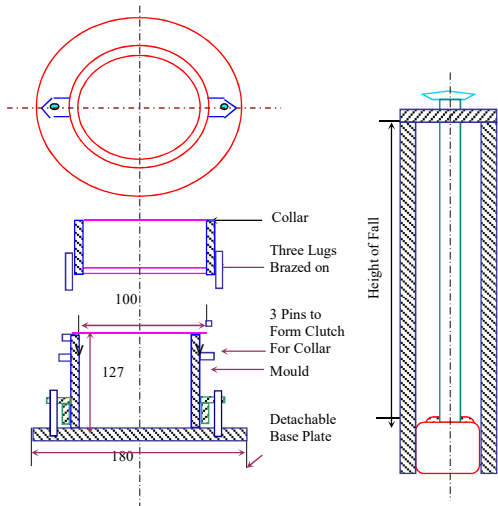
Weight of Hammer : $4.9\text{kg} \pm 25\text{gm}$

Depth of Sample : 0.00-0.50 - DS-01

Height of Fall : $450\text{mm} \pm 0.5\text{mm}$

Type of Test : **Modified Procter Test**

No. of Layers : 5



Proctor Test Apparatus

Rammer

OBSERVATION TABLE

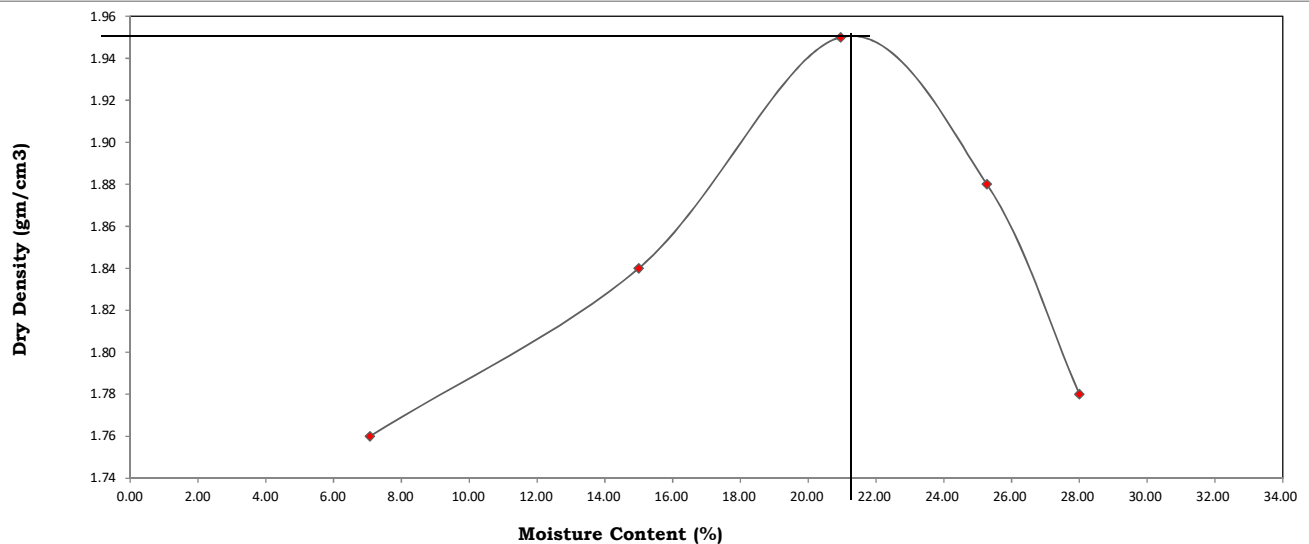
Sr.No.	Water Content %	Dry Density gm/cm ³
1	7.07	1.76
2	15.00	1.84
3	20.96	1.95
4	25.27	1.88
5	28.00	1.78

Maximum Dry Density (gm/cm³)=

1.95

Optimum Moisture Content (%)=

21.30



S&R GEOTECHNIQUES PVT. LTD.

JOB NO.

PNSI0206

[Signature]

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(Atul Bopche - Dy. Tech Manager)
Reviewed By



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(Atul Chaudhari-Technical Manager)
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PROCTOR DENSITY TEST RESULTS

IS - 2720 , PART:8

Project : Geotechnical Investigation for DMIDC-Dighi Port Industrial Area, Indapur.

Principal Client :- M/s. EGIS Consulting Engineers Pvt. Ltd.

Date: 10.06.2023

Client:- M/s. P. N. Shidore Civil Engineers (I) Pvt. Ltd.

Trial Pit No. TP-10-CBR-10

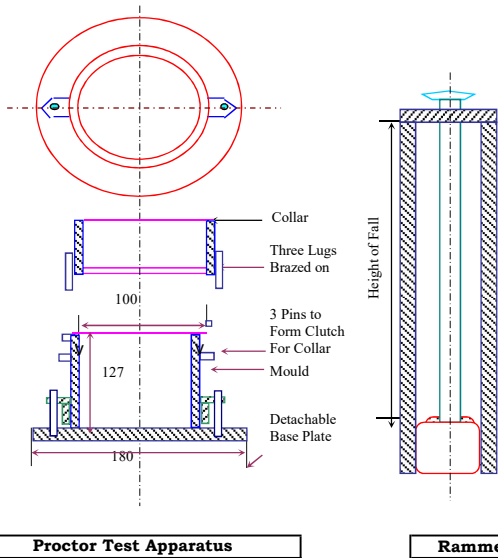
Weight of Hammer : $4.9\text{kg} \pm 25\text{gm}$

Depth of Sample : 0.00-0.60 - DS-01

Height of Fall : $450\text{mm} \pm 0.5\text{mm}$

Type of Test : **Modified Procter Test**

No. of Layers : 5



OBSERVATION TABLE

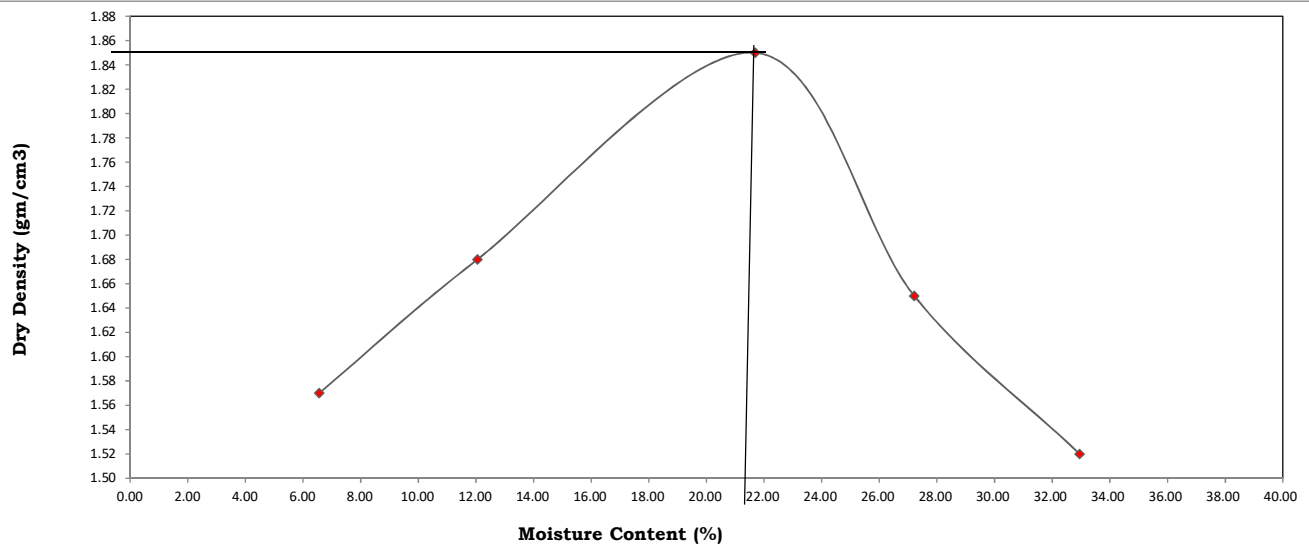
Sr.No.	Water Content %	Dry Density gm/cm ³
1	6.56	1.57
2	12.05	1.68
3	21.69	1.85
4	27.21	1.65
5	32.95	1.52

Maximum Dry Density (gm/cm³)=

1.85

Optimum Moisture Content (%)=

21.70



S&R GEOTECHNIQUES PVT. LTD.

JOB NO.

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Atul Chaudhari

(Atul Chaudhari-Technical Manager)
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PROCTOR DENSITY TEST RESULTS

IS - 2720 , PART:8

Project : Geotechnical Investigation for DMIDC-Dighi Port Industrial Area, Indapur.

Principal Client :- M/s. EGIS Consulting Engineers Pvt. Ltd.

Date: 10.06.2023

Client:- M/s. P. N. Shidore Civil Engineers (I) Pvt. Ltd.

Trial Pit No. : TP-11-CBR-11

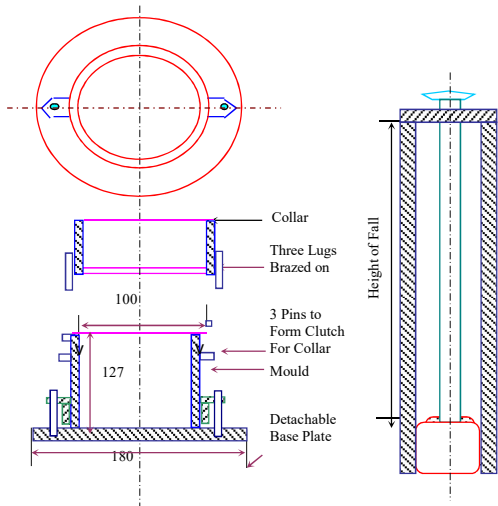
Weight of Hammer : $4.9\text{kg} \pm 25\text{gm}$

Depth of Sample : 0.00-1.00 - DS-01

Height of Fall : $450\text{mm} \pm 0.5\text{mm}$

Type of Test : **Modified Proctor Test**

No. of Layers : 5



Proctor Test Apparatus

Rammer

OBSERVATION TABLE

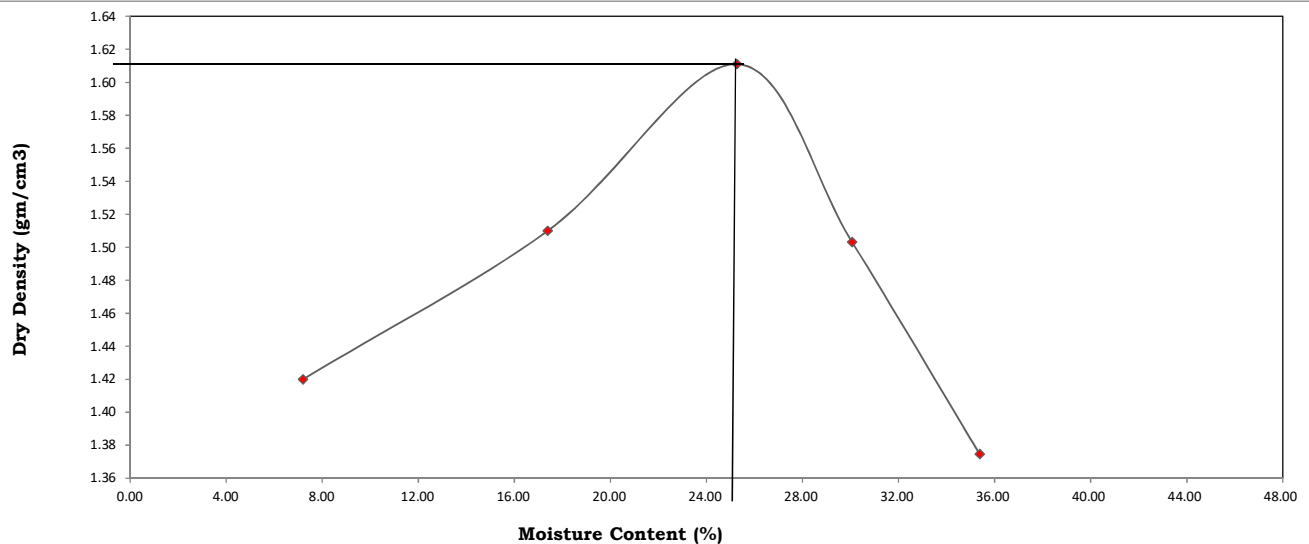
Sr.No.	Water Content %	Dry Density gm/cm ³
1	7.20	1.42
2	17.39	1.51
3	25.26	1.61
4	30.06	1.50
5	35.38	1.37

Maximum Dry Density (gm/cm³)=

1.61

Optimum Moisture Content (%)=

25.30



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CALIFORNIA BEARING RATIO

As Per IS 2720:Part-16

Project : Geotechnical Investigation for DMIDC-Dighi Port Industrial Area, Indapur.

Principal Client : M/s. EGIS Consulting Engineers Pvt. Ltd.

Client : M/s. P. N. Shidore Civil Engineers (I) Pvt. Ltd.

DATE : 14.06.2023

Trial Pit No. : TP-07-CBR-07

Reference No. of Proving Ring : 30-2018

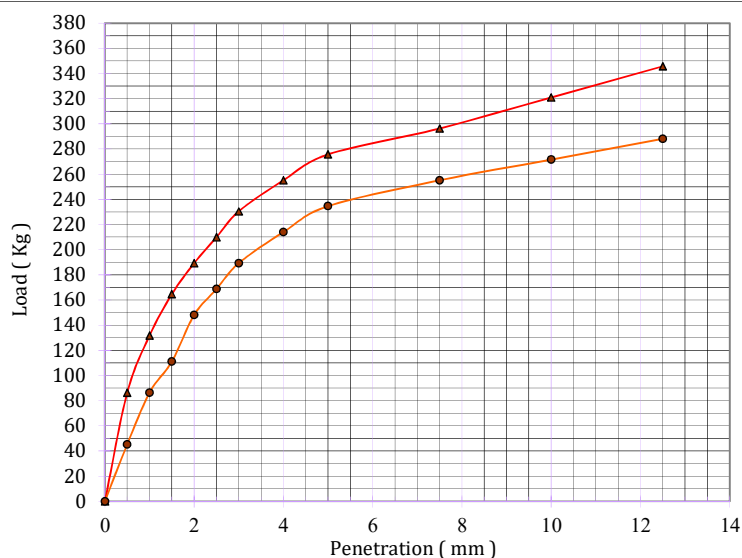
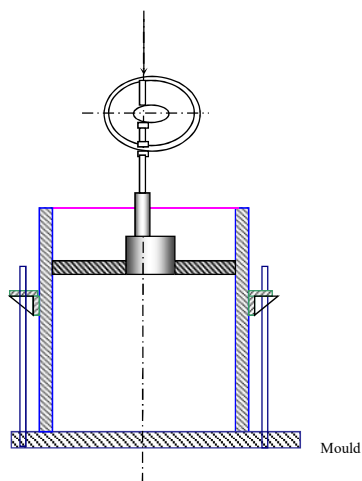
Depth of Sample : 0.00-1.00 DS-1

Load Factor (Kg/Div.) : 4.1150

Type of Test : Modified Proctor Test

Maximum Dry Density (gm/cm³): 1.75

Optimum Moisture Content % : 21.50



CALIFORNIA BEARING RATIO OBSERVATION

Penetration mm	Dial Gauge Reading Div.	Observed Load Kg	Corrected Load Kg	Dial Gauge Reading Div.	Observed Load Kg	Corrected Load Kg	Standard Load Kg	California Bearing Ratio		Remarks
								%	%	
	<i>Unsoaked</i>	<i>Unsoaked</i>	<i>Unsoaked</i>	<i>Soaked</i>	<i>Soaked</i>	<i>Soaked</i>		<i>Unsoaked</i>	<i>Soaked</i>	
0	0	0.00		0	0.00					
0.5	21	86.42		11	45.27					
1	32	131.68		21	86.42					
1.5	40	164.60		27	111.11					
2	46	189.29		36	148.14					
2.5	51	209.87	209.87	41	168.72	168.72	1370	15.3	12.3	
3	56	230.44		46	189.29					
4	62	255.13		52	213.98					
5	67	275.71	275.71	57	234.56	234.56	2055	13.4	11.4	
7.5	72	296.28		62	255.13					
10	78	320.97		66	271.59					
12.5	84	345.66		70	288.05					

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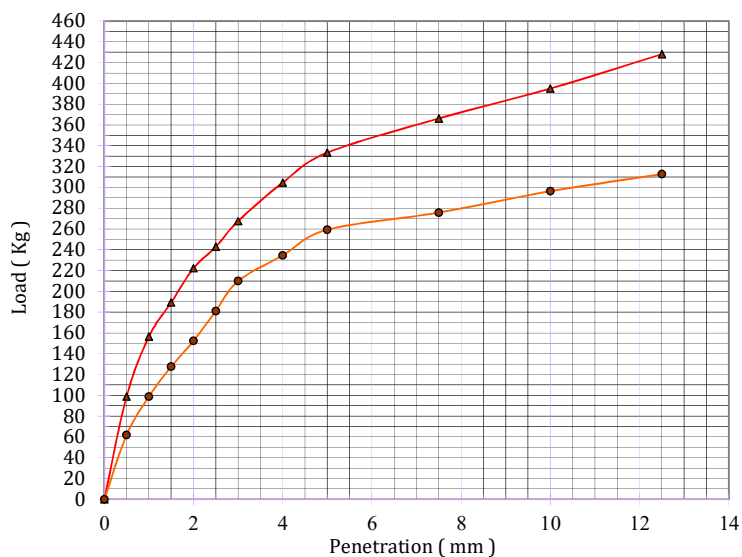
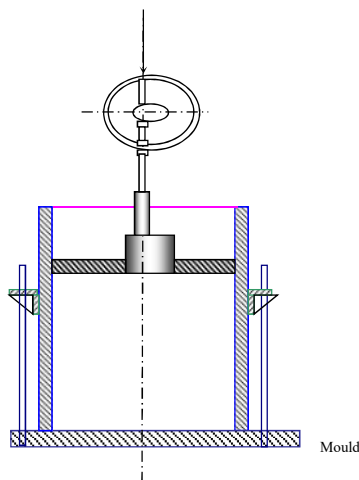
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(Atul Chaudhari - Technical Manager)
Authorised By

CALIFORNIA BEARING RATIO

As Per IS 2720:Part-16

Project : Geotechnical Investigation for DMIDC-Dighi Port Industrial Area, Indapur.
Principal Client : M/s. EGIS Consulting Engineers Pvt. Ltd.
Client : M/s. P. N. Shidore Civil Engineers (I) Pvt. Ltd. DATE :14.06.2023
Trial Pit No. : TP-08-CBR-08 Reference No. of Proving Ring : 30-2018
Depth of Sample : 0.00-1.00 DS-1 Load Factor (Kg/Div.) : 4.1150
Type of Test : Modified Proctor Test Maximum Dry Density (gm/cm³): 1.95
Optimum Moisture Content % : 21.20



CALIFORNIA BEARING RATIO OBSERVATION

Penetration mm	Dial Gauge Reading Div.	Observed Load Kg	Corrected Load Kg	Dial Gauge Reading Div.	Observed Load Kg	Corrected Load Kg	Standard Load Kg	California Bearing Ratio		Remarks
	Unsoaked	Unsoaked	Unsoaked	Soaked	Soaked	Soaked		% Unsoaked	% Soaked	
0	0	0.00		0	0.00					
0.5	24	98.76		15	61.73					
1	38	156.37		24	98.76					
1.5	46	189.29		31	127.57					
2	54	222.21		37	152.26					
2.5	59	242.79	242.79	44	181.06	181.06	1370	17.7	13.2	
3	65	267.48		51	209.87					
4	74	304.51		57	234.56					
5	81	333.32	333.32	63	259.25	259.25	2055	16.2	12.6	
7.5	89	366.24		67	275.71					
10	96	395.04		72	296.28					
12.5	104	427.96		76	312.74					

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PNS10206

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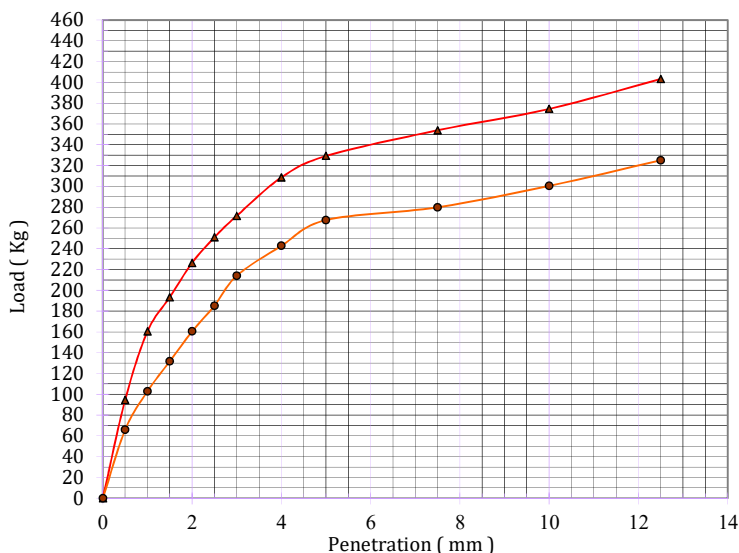
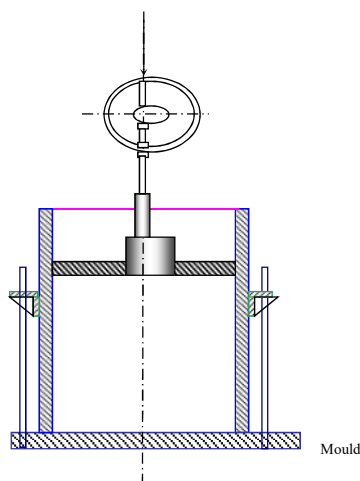
Atul Chaudhari

(Atul Chaudhari - Technical Manager)
Authorised By

CALIFORNIA BEARING RATIO

As Per IS 2720:Part-16

Project	: Geotechnical Investigation for DMIDC-Dighi Port Industrial Area, Indapur.		
Principal Client	: M/s. EGIS Consulting Engineers Pvt. Ltd.		
Client	: M/s. P. N. Shidore Civil Engineers (I) Pvt. Ltd.	DATE	: 14.06.2023
Trial Pit No.	: TP-09-CBR-09	Reference No. of Proving Ring	: 30-2018
Depth of Sample	: 0.00-0.50 DS-1	Load Factor (Kg/Div.)	: 4.1150
Type of Test	: Modified Proctor Test	Maximum Dry Density (gm/cm ³):	1.95
		Optimum Moisture Content % :	21.30



CALIFORNIA BEARING RATIO OBSERVATION

Penetration mm	Dial Gauge Reading	Observed Load	Corrected Load	Dial Gauge Reading	Observed Load	Corrected Load	Standard Load Kg	California Bearing Ratio		Remarks
	Div.	Kg	Kg	Div.	Kg	Kg		%	%	
	Unsoaked	Unsoaked	Unsoaked	Soaked	Soaked	Soaked		Unsoaked	Soaked	
0	0	0.00		0	0.00					
0.5	23	94.65		16	65.84					
1	39	160.49		25	102.88					
1.5	47	193.41		32	131.68					
2	55	226.33		39	160.49					
2.5	61	251.02	251.02	45	185.18	185.18	1370	18.3	13.5	
3	66	271.59		52	213.98					
4	75	308.63		59	242.79					
5	80	329.20	329.20	65	267.48	267.48	2055	16.0	13.0	
7.5	86	353.89		68	279.82					
10	91	374.47		73	300.40					
12.5	98	403.27		79	325.09					

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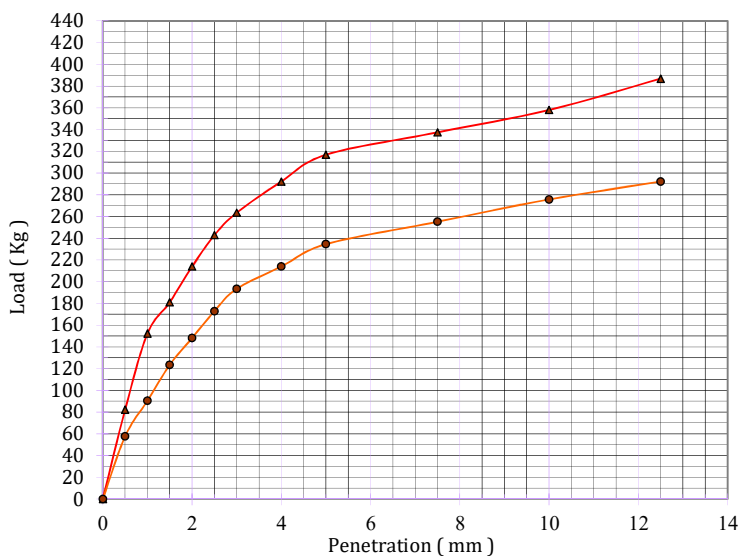
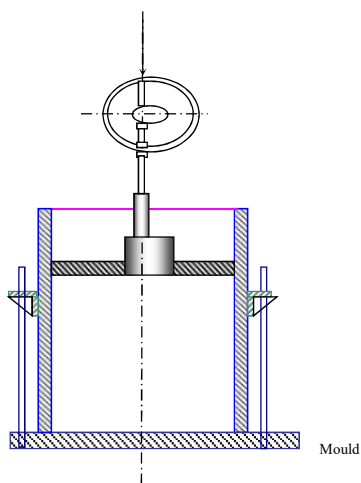



(Atul Chaudhari - Technical Manager)
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CALIFORNIA BEARING RATIO

As Per IS 2720:Part-16

Project	: Geotechnical Investigation for DMIDC-Dighi Port Industrial Area, Indapur.		
Principal Client	: M/s. EGIS Consulting Engineers Pvt. Ltd.		
Client	: M/s. P. N. Shidore Civil Engineers (I) Pvt. Ltd.	DATE	: 14.06.2023
Trial Pit No.	: TP-10-CBR-10	Reference No. of Proving Ring	: 30-2018
Depth of Sample	: 0.00-0.60 DS-1	Load Factor (Kg/Div.)	: 4.1150
Type of Test	: Modified Proctor Test	Maximum Dry Density (gm/cm ³):	1.85
		Optimum Moisture Content %	: 21.70



CALIFORNIA BEARING RATIO OBSERVATION

Penetration mm	Dial Gauge Reading Div.	Observed Load Kg	Corrected Load Kg	Dial Gauge Reading Div.	Observed Load Kg	Corrected Load Kg	Standard Load Kg	California Bearing Ratio		Remarks
	Unsoaked	Unsoaked	Unsoaked	Soaked	Soaked	Soaked		% Unsoaked	% Soaked	
0	0	0.00		0	0.00					
0.5	20	82.30		14	57.61					
1	37	152.26		22	90.53					
1.5	44	181.06		30	123.45					
2	52	213.98		36	148.14					
2.5	59	242.79	242.79	42	172.83	172.83	1370	17.7	12.6	
3	64	263.36		47	193.41					
4	71	292.17		52	213.98					
5	77	316.86	316.86	57	234.56	234.56	2055	15.4	11.4	
7.5	82	337.43		62	255.13					
10	87	358.01		67	275.71					
12.5	94	386.81		71	292.17					

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PNSI0206



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Prepared By



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Reviewed By

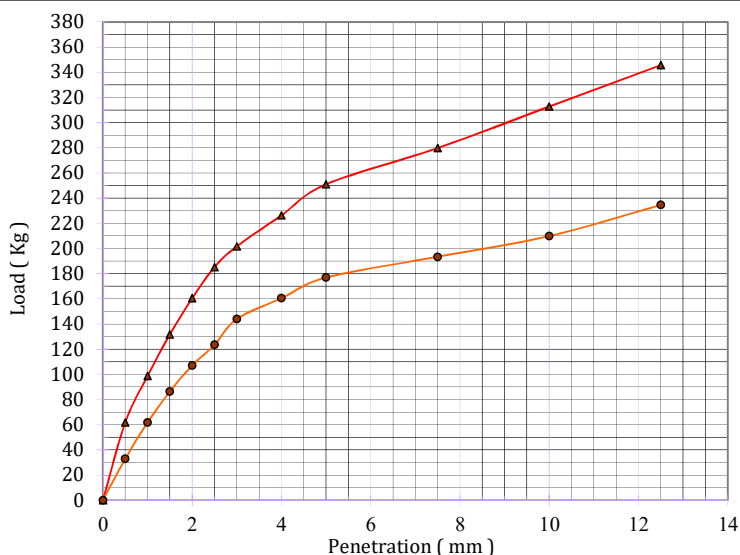
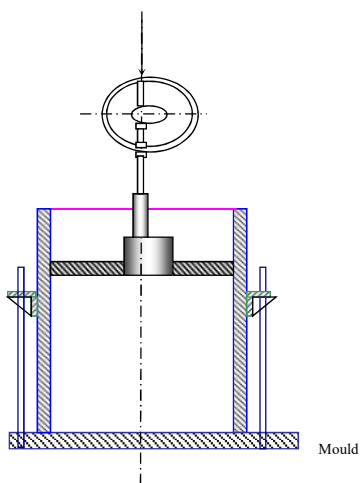



(Atul Chaudhari - Technical Manager)
Authorised By

CALIFORNIA BEARING RATIO

As Per IS 2720:Part-16

Project : Geotechnical Investigation for DMIDC-Dighi Port Industrial Area, Indapur.
Principal Client : M/s. EGIS Consulting Engineers Pvt. Ltd.
Client : M/s. P. N. Shidore Civil Engineers (I) Pvt. Ltd. DATE :14.06.2023
Trial Pit No. : TP-11-CBR-11 Reference No. of Proving Ring : 30-2018
Depth of Sample : 0.00-1.00 DS-1 Load Factor (Kg/Div.) : 4.1150
Type of Test : Modified Proctor Test Maximum Dry Density (gm/cm³): 1.61
Optimum Moisture Content % : 25.30



CALIFORNIA BEARING RATIO OBSERVATION

Penetration mm	Dial Gauge Reading Div.	Observed Load Kg	Corrected Load Kg	Dial Gauge Reading Div.	Observed Load Kg	Corrected Load Kg	Standard Load Kg	California Bearing Ratio		Remarks
	<i>Unsoaked</i>	<i>Unsoaked</i>	<i>Unsoaked</i>	<i>Soaked</i>	<i>Soaked</i>	<i>Soaked</i>		% <i>Unsoaked</i>	% <i>Soaked</i>	
0	0	0.00		0	0.00					
0.5	15	61.73		8	32.92					
1	24	98.76		15	61.73					
1.5	32	131.68		21	86.42					
2	39	160.49		26	106.99					
2.5	45	185.18	185.18	30	123.45	123.45	1370	13.5	9.0	
3	49	201.64		35	144.03					
4	55	226.33		39	160.49					
5	61	251.02	251.02	43	176.95	176.95	2055	12.2	8.6	
7.5	68	279.82		47	193.41					
10	76	312.74		51	209.87					
12.5	84	345.66		57	234.56					

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JOB NO.

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Reviewed By



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