डेडीकेटेड फ्रेट कोरीडोर

DESIGN AND CONSTRUCTION OF CIVIL, STRUCTURES AND TRACK WORKS FOR DOUBLE LINE RAILWAY INVOLVING FORMATION IN EMBANKMENTS/CUTTINGS, BALLAST ON FORMATION, TRACK WORKS, BRIDGES, STRUCTURES, BUILDINGS, YARDS, INTEGRATION WITH IR EXISTING RAILWAY SYSTEM AND TESTING & COMMISSIONING ON DESIGN-BUILD LUMP SUM BASIS FOR DADRI - KHURJA SECTION OF EASTERN DEDICATED FREIGHT CORRIDOR
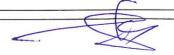
Contract Package: 302
ICB No. HQ/EN/EC/D-B/DADRI - KHURJA
PART - 4 - REFERENCE DOCUMENT
HYDROLOGICAL DATA - VOLUME - 4

DADRI TO KHURJA
From Km. 1413.856 to Km. 1367.000

HYDROLOGICAL DATA

Hydraulic Data for Contract Package 302

Sr. No.	Chainage	IR KM	Bridge No.	Page No
Major Bridges				
1	1372/364.451	1372/12-14	176	0001-0004
2	1407/484.357	1407/15-17	211	0005-0008
Minor Bridges				
3	1370/919.880	1370/33-35	173	0009-0012
4	1371/364.405	1371/11-13	174	0013-0016
5	1372/000.	1371/31 to 1372/1	175	0017-0020
6	1373/790.876	1373/25-27	177	0021-0024
7	1375/273.706	1375/7-9	178	0025-0028
8	1376/769.566	1376/25-27	179	0029-0032
9	1378/999.607	1378/0-1	180	0033-0036
10	1380/058.619	1380/1-3	181	0037-0040
11	1382/549.306	1382/17-19	182	0041-0044
12	1382/813.941	1382/25-27	183	0045-0048
13	1383/150.066	1383/5-7	184	0049-0052
14	1384/494.346	1384/19-21	186	0053-0056
15	1385/046.883	1385/0-1	187	0057-0060
16	1385/853.99	1385/27-29	188	0061-0064
17	1385/993.073	1385/33-35	189	0065-0068
18	1387/135.712	1387/5-7	190	0069-0072
19	1102.34	Wair Detour	WR 1	0073-0076
20	1764.43	Wair Detour	WR 2	0077-0080
21	2036.02	Wair Detour	WR 3	0081-0084
22	2139.02	Wair Detour	WR 4	0085-0088
23	1392/287.728	1392/9-11	195	0089-0092
24	1392/953.232	1392/29-31	196	0093-0096
25	1393/529.341	1393/17-19	197	0097-0100
26	1394/215.978	1394/7-9	198	0101-0104
27	1396/218.33	1396/5-7	199	0105-0108
28	1396/662.05	1396/19-21	200	0109-0112
29	1396/964.577	1396/29-31	201	0113-0116
30	1397/594.452	1397/17-19	202	0117-0120
31	1398/458.491	1398/11-13	203	0121-0124
32	1398/629.52	1398/19-21	204	0125-0128
33	1399/059.833	1398/35-37	205	0129-0132
34	1400/211.428	1400/7-9	206	0133-0136
35	1400/707.719	1400/23-25	208	0137-0140
36	1401/649.621	1401/19-21	209	0141-0144
37	1405/321.581	1405/9-11	210	0145-0148
38	1408/069.519	1408/0-1	212	0149-0152

| 39 | 1408/611.855 | 1405/17-19 | 213 | 0153-0156 |
| 40 | 1408/984.954 | 1408/29-31 | 214 | 0157-0160 |

MAJOR BRIDGES

Estimation of Design Discharge for Major Bridges Using Simplified Equations.

Bridge No. Br. No.176

		No. of Spans	Width of Span	
1	Proposed Bridge Type	4	9.15	
2	Topography		plain	
3	Catchment Area A		26.35	Sq.Km
4	Length of Longest Stream L		10.15	Km
5	Height Of farthest point		196.35	m
6	Height of Point of Interest		193.70	m
7	Height Diff		2.65	m
8	Nature of Soil		Sandy Soil / Sandy Laom/ arid Areas	
9	Avg. Bed Level		193.697	m
10	O.H.F.L.		195.118	m
11	50 years Rainfall for	6.00 Hrs. =	225	mm
12	50 years Rainfall for	12.00 Hrs. =	255	mm
13	Area of Cross Section under consideration		43.92	Sq M
14	Wetted Perimeter of the Section		46.20	R. M.

Step : 1   **Preparation of catchment Area Plan :**

The point of interest (Railway Bridge Site) was located on the Survey of India toposheet
and catchment boundary was marked using the contours along the ridge line and also
from the spot levels in the plains.A catchment area showing the rivers, contours .
and spot levels was prepared.
Stream slope has been derived from data taken at site on U/S and D/S of river

Computation of Eqivalant slope

Sr. No.	Dist. From bridge site (km)	Bed Level (m)	Length of each river segmanent (Li)	Ht.above Datum (Di) (m)	$[D_{(i-1)} + D_i]$	Li x [D(i - 1) + Di]
1	2	3	4	5	6	7
1	0.000	193.697	0.00	0.00	0.00	0.00
2	12.250	196.050	12.25	2.35	2.35	28.82
3						
4						
5						
6						
7						
8						
9						
10						
	12.250					
					Total	28.82

2.353

Equivalent Slope (Se) = $\sum Li \times [D(i-1) + Di] / L^2$

= 28.82 / (12.25 x 12.25)
= 0.19   m / Km

Calculate t d as per Table No. 1 , Simplified Equations for Various Sub Zones.
(Technical Monogram No. 58 , Hand Book For Estimation of Design Discharge For Railway Bridges.)

$$t_d = 0.345 [L / Sqrt S_e]^{1.012}$$

t_d =   0.345 x [10.15 / Sqrt 0.19] $^{1.012}$

t_d =   8.3 Hrs.
Say   9.00

From Isopluvial maps for Subzone 1 (d)

50-year 6 h Point rainfall =	22.50	Cm
50-year 12 h Point rainfall =	25.50	Cm
Therefore		
50-year 9 h Point rainfall =	**24.00**	Cm

Design discharge by " Regression equation "

$$Q_{50} = 6.214 \ A^{0.701} \ Se^{0.484} \ R_{50 \ (t \ d)}^{0.202}$$

$$Q_{50} = 6.214 \times 26.35 \wedge 0.701 \times 0.19 \wedge 0.484 \times 24 \wedge 0.202$$

$$Q_{50} = \boxed{52.64} \ CuM / S$$

5   Checking for adequacy of Waterway Provided

a   Discharge   =   52.64   CuM / S

b   Avg. Velovcity calculated using Manning's Formula

Area of cross section of Nalla / River at Bridge site =	43.92	SqM
Wetted Perimeter of cross section of Nalla / River at Bridge site =	46.200	M
"n" for Manning's Formula is assumed =	0.045	
"Slope of Bed" for Manning's Formula is =	1000	

Hydraulic Mean Depth = $\dfrac{\text{Area of cross Section}}{\text{Wetted Perimeter}}$

Hydraulic Mean Depth = $\dfrac{43.92}{46.2}$

Hydraulic Mean Depth =   0.95

From Manning's Formula we have velocity of flow =

$$V = (1/ n)(\text{Hydraulic Mean Depth})^{2/3} (1/ \text{slope of Bed })^{1/2}$$

$$V = (1 / 0.045) \quad (0.95)^{2/3} (1/ \quad 1000 \ )^{1/2}$$

V =   22.22   x0.97   x0.0316

V =   0.68   m / sec

c   Avg. Waterway Required   = $\dfrac{Q}{V}$

                                        = $\dfrac{52.644}{0.68}$

                                        =   **77.418 Sq.m**

d   Proposed Opening   =   4 x 9.15

e	Height of Water	=	$\dfrac{\text{Avg. Waterway}}{\text{Total Width}}$		
		=	$\dfrac{77.418}{36.6}$		
		=	**2.12**	m	
f	Avg. Bed Level	=	193.697		
h	**Min. Formation Required**		B.L +	Ht of water	+ Vertical Clearance
		=	193.70	+2.120	+ 0.651
		=	196.468		

Min Vertical Clearance reqd (Para 312(1) IRBM)

Verical Clearance

Discharge in Cumecs	Vertical Clearance in mm	Reqd. vertical Clearance
0 - 30	600	
31 - 300	600 - 1200 (pro-rata)	651
301 - 3000	1500	
Above 3000	1800	
		651

k	**Formation level adopted**	=	**197.768**

Provided formation Level is O.K.

Estimation of Design Discharge for Major Bridges Using Simplified Equations.

Bridge No. Br. No.211

		No. of Spans	Width of Span	
1	Proposed Bridge Type	3	9.15	
2	Topography		plain	
3	Catchment Area A		28.40	Sq.Km
4	Length of Longest Stream L		14.00	Km
5	Height Of farthest point		205.50	m
6	Height of Point of Interest		202.95	m
7	Height Diff		2.55	m
8	Nature of Soil		Sandy Soil / Sandy Laom/ arid Areas	
9	Avg. Bed Level		202.95	m
10	O.H.F.L.		203.450	m
11	50 years Rainfall for 6.00 Hrs. =		225 mm	
12	50 years Rainfall for 12.00 Hrs. =		255 mm	
13	Area of Cross Section under consideration		38.43	Sq M
14	Wetted Perimeter of the Section		34.65	R. M.

Step : 1   **Preparation of catchment Area Plan :**

The point of interest (Railway Bridge Site) was located on the Survey of India toposheet
and catchment boundary was marked using the contours along the ridge line and also
from the spot levels in the plains.A catchment area showing the rivers, contours .
and spot levels was prepared.
Stream slope has been derived from data taken at site on U/S and D/S of river

Computation of Eqivalant slope

Sr. No.	Dist. From bridge site (km)	Bed Level (m)	Length of each river segmanent (Li)	Ht.above Datum (Di) (m)	$[D_{(i-1)} + D_i]$	Li x [D(i - 1) + Di]
1	2	3	4	5	6	7
1	0.000	202.949	0.00	0.00	0.00	0.00
2	12.250	205.500	12.25	2.55	2.55	31.25
3						
4						
5						
6						
7						
8						
9						
10						
	12.250					
					Total	31.25

2.551

Equivalent Slope (Se) = $\sum Li \times [D(i - 1) + Di] / L^2$

$$= 31.25 \ / \ (12.25 \times 12.25)$$
$$= 0.21 \qquad m \ / \ Km$$

Calculate t d as per Table No. 1 , Simplified Equations for Various Sub Zones.
(Technical Monogram No. 58 , Hand Book For Estimation of Design Discharge For Railway Bridges.)

$$t_d = 0.345 \ [\ L \ / \ Sqrt \ S_e \ ]^{1.012}$$

$$t_d = \quad 0.345 \ \times \ [\ 14 \ / \ Sqrt \ 0.21 \ ]^{1.012}$$

$$t_d = \quad 11.03 \ Hrs.$$
Say   12.00

From Isopluvial maps for Subzone 1 (d)

50-year 6 h Point rainfall =	22.50	Cm
50-year 12 h Point rainfall =	25.50	Cm
Therefore		
50-year 12 h Point rainfall =	**25.50**	Cm

Design discharge by " Regression equation "

$$Q_{50} = 6.214 \ A^{0.701} \ Se^{0.484} \ R_{50 \ (t \ d)}^{0.202}$$

$$Q_{50} = \quad 6.214 \times 28.4 \wedge 0.701 \times 0.21 \wedge 0.484 \times 25.5 \wedge 0.202$$

$$Q_{50} = \quad \boxed{58.41} \ \text{CuM / S}$$

5 Checking for adequacy of Waterway Provided

a Discharge = 58.41 CuM / S

b Avg. Velovcity calculated using Manning's Formula

Area of cross section of Nalla / River at Bridge site =	38.43	SqM
Wetted Perimeter of cross section of Nalla / River at Bridge site =	34.650	M
"n" for Manning's Formula is assumed =	0.045	
"Slope of Bed" for Manning's Formula is =	1000	

Hydraulic Mean Depth = $\dfrac{\text{Area of cross Section}}{\text{Wetted Perimeter}}$

Hydraulic Mean Depth = $\dfrac{38.43}{34.65}$

Hydraulic Mean Depth = 1.11

From Manning's Formula we have velocity of flow =

$$V = (1/ n)(\text{Hydraulic Mean Depth})^{2/3} (1/ \text{slope of Bed})^{1/2}$$

$$V = (1 / 0.045) \quad (1.11) \quad ^{2/3} (1/ \quad 1000 \quad) \quad ^{1/2}$$

$$V = \quad 22.22 \quad \times 1.07 \quad \times 0.0316$$

$$V = \quad 0.75 \quad m / sec$$

c Avg. Waterway Required = $\dfrac{Q}{V}$

= $\dfrac{58.406}{0.75}$

= **77.875 Sq.m**

d Proposed Opening = 3 x 9.15

e	Height of Water	=	Avg. Waterway	
			Total Width	

$$= \frac{77.875}{27.45}$$

$$= \mathbf{2.84} \quad m$$

f	Avg. Bed Level	=	202.949

h	**Min. Formation Required**		B.L +	Ht of water + Vertical Clearance
		=	202.95	+2.840 + 0.664
		=	206.453	

Min Vertical Clearance reqd (Para 312(1) IRBM)

Verical Clearance

Discharge in Cumecs	Vertical Clearance in mm	Reqd. vertical Clearance
0 - 30	600	
31 - 300	600 - 1200 (pro-rata)	664
301 - 3000	1500	
Above 3000	1800	
		664

k	**Formation level adopted**	=	**206.985**

Provided formation Level is O.K.

MINOR BRIDGES

Dedicated freight corridor Corporation of India.

Estimation of Design Discharge for Railway Bridge. Br. No. 173

A	Topography		
B	Catchment Area	0.0571	Sq Km
C	Length of Longest Stream	0.300	Km
D	Height Of farthest point	197.921	M
E	Height of Point of Interest	194.721	M
F	Height Diff of 10 & 11	3.200	M
G	Nature of Soil	Sandy Soil / Sandy Laom.....	
H	Avg. Bed Level	194.721	M
I	Observed HFL	195.450	M

0003

1 **Using Improved Rational Formula**

Q-50 = 0.278 x C x I x A
Where
Q-50 = 50 Years Design Flood Discharge
c = Runoff Coefficient
I = 50 Years Rainfall Intensity lasting for tc hour duration where tc = time of concentration

a = Catchment Area

2 **Run off coefficient**

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	C = 0.249(R x F) ^ 0.2
b Alluvium/silty/coastal area	C = 0.332(R x F) ^ 0.2
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	C = 0.415(R x F) ^ 0.2
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine & plateau	C = 0.456(R x F) ^ 0.2
e Hilly soil / plateau/barren	C = 0.498(R x F) ^ 0.2

Where
R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor depending upon catchment Area & duration rainfall from table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 Min	60 To 100 Min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

$$= [0.3 \times 0.3 \times 0.3 / 3.200]^{0.345}$$

= **0.1926 hr.**

= 0.1926 hr. x 60

= **11.5530 Min**

Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , $C = 0.249(R \times F)^{0.2}$

$$R = 300.00 \text{ mm}$$
$$F = 0.72$$
$$C = 0.249 \times (R \times F)^{0.2}$$
$$= \mathbf{0.8511}$$

But as per Annexture 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3   Calculation of Intensity of Rainfall (I)

a   tc h Ratio   =   *0.1213*   From Fig. 4 of RBF - 16

b   1h Ratio =   =   0.34   From Fig. 4 of RBF - 16

c   Coefficient K   = $\dfrac{\text{tc h Ratio}}{\text{1h Ratio}}$

$$= \frac{0.1213}{0.34}$$

$$= \mathbf{0.3567}$$

d
I   R-50 (24)   =   300.00   mm

ii   R-50 (1)   =   R-50 (24) x 1 h to 24 h Rainfall Ratio.

    =   300 x 0.34

    =   **102.00 mm**

iii   R-50 (tc)   =   K x R-50 (1)

    =   0.3567 x102.00

    =   **36.3825 mm**

iv   Int. of rainfall (I)   = $\dfrac{\text{R-50 (tc)}}{\text{tc}}$

$$= \frac{36.38}{0.1926}$$

    =   **188.9508 mm/hr.**

4   Design Flood Discharge =

    Q-50   =   0.278 x C xI x A

    =   x 0.278   x 0.8511   x 188.9508   x 0.0571.

    =   **2.5528 cum/sec**

3

5 Checking for adequacy of Waterway Provided

a	Discharge	=	2.5528 cum/sec		

c Avg. Waterway Required $= \dfrac{Q}{V}$

$$= \dfrac{2.5528}{1.75}$$

$$= \textbf{1.4587 Sq.m}$$

d	Proposed Opening	=	1	2	1.2

e Height of Water $= \dfrac{\text{Avg. Waterway}}{\text{Total Width}}$

$$= \dfrac{1.4587}{2}$$

$$= \textbf{0.7290} \quad \text{m}$$

f Avg. Bed Level = 194.721

h **Min. Formation Required**   B.L +   Ht of water + free Board

= 194.7210   +0.7290   +0.8210

= 196.2710

k **Formation level adopted**   = 196.2710

Provided formation Level is O.K.

4

Dedicated freight corridor Corporation of India.

Estimation of Design Discharge for Railway Bridge. Br. No. 174

A	Topography		
B	Catchment Area	0.0882	Sq Km
C	Length of Longest Stream	0.350	Km
D	Height Of farthest point	197.558	M
E	Height of Point of Interest	194.658	M
F	Height Diff of 10 & 11	2.900	M
G	Nature of Soil	Sandy Soil / Sandy Laom.....	
H	Avg. Bed Level	194.658	M
I	Observed HFL	195.744	M

1   Using Improved Rational Formula

$$Q\text{-}50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

   c = Runoff Coefficient

   I = 50 Years Rainfall Intensity lasting for tc hour duration where tc = time of concentration

   a = Catchment Area

2   Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountane & plateau	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R =   50 Year 24 hour point rainfall (cm)

F =   Areal Reduction factor depending upon catchment Area & duration rainfall from table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 Min	60 To 100 Min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

$$= [0.35 \times 0.35 \times 0.35 / 2.900]^{0.345}$$

=   **0.2337 hr.**

=   0.2337 hr. x 60

=   **14.0196 Min**

Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , $C = 0.249(R \times F)^{0.2}$

$$R = 300.00 \text{ mm}$$
$$F = 0.72$$
$$C = 0.249 \times (R \times F)^{0.2}$$
$$= \mathbf{0.8511}$$

But as per Annexture 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3   **Calculation of Intensity of Rainfall (I)**

a   tc h Ratio   =   *0.1418*   From Fig. 4 of RBF - 16

b   1h Ratio =   =   0.34   From Fig. 4 of RBF - 16

c   Coefficient K   = $\dfrac{\text{tc h Ratio}}{\text{1h Ratio}}$

                         = $\dfrac{0.1418}{0.34}$

                         =   **0.4171**

d

I   R-50 (24)   =   300.00   mm

ii   R-50 (1)   =   R-50 (24) x 1 h to 24 h Rainfall Ratio.

                         =   300 x 0.34

                         =   **102.00 mm**

iii   R-50 (tc)   =   K x R-50 (1)

                         =   0.4171 x102.00

                         =   **42.5489 mm**

iv   Int. of rainfall (I)   = $\dfrac{\text{R-50 (tc)}}{\text{tc}}$

                         = $\dfrac{42.55}{0.2337}$

                         =   **182.0980 mm/hr.**

4   **Design Flood Discharge =**

     Q-50   =   0.278 x C xl x A

                     =   x 0.278   x 0.8511   x 182.0980   x 0.0882

                     =   **3.8001 cum/sec**

5 Checking for adequacy of Waterway Provided

a   Discharge   =   3.8001 cum/sec

c   Avg. Waterway Required = $\dfrac{Q}{V}$

                            = $\dfrac{3.8001}{1.75}$

                            =   **2.1715 Sq.m**

d   Proposed Opening   =   1   2   1.2

e   Height of Water   = $\dfrac{\text{Avg. Waterway}}{\text{Total Width}}$

                            = $\dfrac{2.1715}{2}$

                            =   **1.0860   m**

f   Avg. Bed Level   =   194.658

h   **Min. Formation Required**   B.L   +   Ht of water   + free Board

                            =   194.6580   +1.0860   +1.0780

                            =   196.8220

k   **Formation level adopted**   =   196.8220

Provided formation Level is O.K.

8

Dedicated freight corridor Corporation of India.

Estimation of Design Discharge for Railway Bridge. Br. No. 175

A	Topography		
B	Catchment Area	0.5225	Sq Km
C	Length of Longest Stream	1.375	Km
D	Height Of farthest point	197.539	M
E	Height of Point of Interest	194.689	M
F	Height Diff of 10 & 11	2.850	M
G	Nature of Soil	Sandy Soil / Sandy Laom.....	
H	Avg. Bed Level	194.689	M
I	Observed HFL	195.965	M

1 **Using Improved Rational Formula**

$$Q\text{-}50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

c = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for tc hour duration where tc = time of concentration

a = Catchment Area

2 **Run off coefficient**

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine & plateau	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor depending upon catchment Area & duration rainfall from table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 Min	60 To 100 Min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13 0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

$$= [1.375 \times 1.375 \times 1.375 / 2.850]^{0.345}$$

= **0.9688 hr.**

= 0.9688 hr. x 60

= **58.1264 Min**

10

Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , $C = 0.249(R \times F)^{0.2}$

$$R \quad = \quad 300.00 \text{ mm}$$
$$F \quad = \quad 0.81$$
$$C = 0.249 \times (R \times F)^{0.2}$$
$$= \quad \mathbf{0.8922}$$

But as per Annexture 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3   Calculation of Intensity of Rainfall (I)

a   tc h Ratio   =   0.3338   From Fig. 4 of RBF - 16

b   1h Ratio =   =   0.34   From Fig. 4 of RBF - 16

c   Coefficient K   = $\dfrac{\text{tc h Ratio}}{\text{1h Ratio}}$

                  = $\dfrac{0.3338}{0.34}$

                  =   **0.9816**

d
I   R-50 (24)   =   300.00   mm

ii   R-50 (1)   =   R-50 (24) x 1 h to 24 h Rainfall Ratio.

                  =   300 x 0.34

                  =   **102.00 mm**

iii   R-50 (tc)   =   K x R-50 (1)

                  =   0.9816 x102.00

                  =   **100.1264 mm**

iv   Int. of rainfall (I)   = $\dfrac{\text{R-50 (tc)}}{\text{tc}}$

                  = $\dfrac{100.13}{0.9688}$

                  =   **103.3539 mm/hr.**

4   Design Flood Discharge =

Q-50   =   0.278 x C xI x A

      =   x 0.278   x 0.8922   x 103.3539   x 0.5225

      =   **13.3937 cum/sec**

11

5 Checking for adequacy of Waterway Provided

a Discharge = 13.3937 cum/sec

c Avg. Waterway Required = $\dfrac{Q}{V}$

= $\dfrac{13.3937}{1.75}$

= **7.6535 Sq.m**

d Proposed Opening = 1   6   2

e Height of Water = $\dfrac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\dfrac{7.6535}{6}$

= **1.2760**   m

f Avg. Bed Level = 194.689

h **Min. Formation Required**   B.L + Ht of water + free Board

= 194.6890   +1.2760 +1.4740

= 197.4390

k **Formation level adopted** = 197.4390

Provided formation Level is O.K.

Dedicated freight corridor Corporation of India.

Estimation of Design Discharge for Railway Bridge. Br. No. 177

A	Topography	
B	Catchment Area	0.0926 Sq Km
C	Length of Longest Stream	0.410 Km
D	Height Of farthest point	197.298 M
E	Height of Point of Interest	194.508 M
F	Height Diff of 10 & 11	2.790 M
G	Nature of Soil	Sandy Soil / Sandy Laom.....
H	Avg. Bed Level	194.508 M
I	Observed HFL	196.321 M

1 **Using Improved Rational Formula**

$$Q\text{-}50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

  c = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for tc hour duration where tc = time of concentration

  a = Catchment Area

2 **Run off coefficient**

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine & plateau	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R =   50 Year 24 hour point rainfall (cm)

F =   Areal Reduction factor depending upon catchment Area & duration rainfall from table below

	Duration of Rainfall		
Catchment Area in Sq. Km.	< 30 Min	30 to 60 Min	60 To 100 Min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

$$= [0.41 \times 0.41 \times 0.41 / 2.790]^{0.345}$$

= **0.2789 hr.**

= 0.2789 hr. x 60

= **16.7359 Min**

14

Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , $C = 0.249(R \times F)^{0.2}$

$$R \quad = \quad 300.00 \text{ mm}$$
$$F \quad = \quad 0.72$$
$$C = 0.249 \times (R \times F)^{0.2}$$
$$= \quad \textbf{0.8511}$$

But as per Annexture 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3   Calculation of Intensity of Rainfall (I)

a   tc h Ratio   =   *0.1616*   From Fig. 4 of RBF - 16

b   1h Ratio =   =   0.34   From Fig. 4 of RBF - 16

c   Coefficient K   = $\dfrac{\text{tc h Ratio}}{\text{1h Ratio}}$

                                = $\dfrac{0.1616}{0.34}$

                                =   **0.4752**

d

I   R-50 (24)   =   300.00   mm

ii   R-50 (1)   =   R-50 (24) x 1 h to 24 h Rainfall Ratio.

                                =   300 x 0.34

                                =   **102.00 mm**

iii   R-50 (tc)   =   K x R-50 (1)

                                =   0.4752 x102.00

                                =   **48.4718 mm**

iv   Int. of rainfall (I)   = $\dfrac{\text{R-50 (tc)}}{\text{tc}}$

                                = $\dfrac{48.47}{0.2789}$

                                =   **173.7766 mm/hr.**

4   Design Flood Discharge =

    Q-50   =   0.278 x C xI x A

                    =   x 0.278   x 0.8511   x 173.7766   x 0.0926

                    =   **3.8074 cum/sec**

15

5   **Checking for adequacy of Waterway Provided**

a   Discharge   =   3.8074 cum/sec

c   Avg. Waterway Required   = $\dfrac{Q}{V}$

     = $\dfrac{3.8074}{1.75}$

     = **2.1757 Sq.m**

d   Proposed Opening   =   1   1.2   2

e   Height of Water   = $\dfrac{\text{Avg. Waterway}}{\text{Total Width}}$

     = $\dfrac{2.1757}{1.2}$

     = **1.8130**   **m**

f   Avg. Bed Level   =   194.508

h   **Min. Formation Required**   B.L +   Ht of water   + free Board

     =   194.5080   +1.8130   +1.4060

     =   197.7270

k   **Formation level adopted**   =   197.7270

Provided formation Level is O.K.

16

Dedicated freight corridor Corporation of India.

Estimation of Design Discharge for Railway Bridge. Br. No. 178

A	Topography	
B	Catchment Area	0.0914 Sq Km
C	Length of Longest Stream	0.545 Km
D	Height Of farthest point	197.823 M
E	Height of Point of Interest	195.523 M
F	Height Diff of 10 & 11	2.300 M
G	Nature of Soil	Sandy Soil / Sandy Laom.....
H	Avg. Bed Level	195.523 M
I	Observed HFL	196.450 M

1 Using Improved Rational Formula

Q-50 = 0.278 x C x I x A
Where
Q-50 = 50 Years Design Flood Discharge
   c = Runoff Coefficient
   I = 50 Years Rainfall Intensity lasting for tc hour duration where tc = time of concentration

   a = Catchment Area

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine & plateau	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where
R =   50 Year 24 hour point rainfall (cm)

F =   Areal Reduction factor depending upon catchment Area & duration rainfall from table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 Min	60 To 100 Min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

tc   = $[L^3 / H]^{0.345}$

    = $[0.545 \times 0.545 \times 0.545 / 2.300]^{0.345}$

    =   **0.4003 hr.**

    =   0.4003 hr. x 60

    =   **24.0174 Min**

Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , $C = 0.249(R \times F)^{0.2}$

$$R = 300.00 \text{ mm}$$
$$F = 0.72$$
$$C = 0.249 \times (R \times F)^{0.2}$$
$$= \mathbf{0.8511}$$

But as per Annexture 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3   Calculation of Intensity of Rainfall (I)

a   tc h Ratio   =   *0.2001*   From Fig. 4 of RBF - 16

b   1h Ratio =   =   0.34   From Fig. 4 of RBF - 16

c   Coefficient K   = $\dfrac{\text{tc h Ratio}}{\text{1h Ratio}}$

= $\dfrac{0.2001}{0.34}$

=   **0.5885**

d
I   R-50 (24)   =   300.00   mm

ii   R-50 (1)   =   R-50 (24) x 1 h to 24 h Rainfall Ratio.

=   300 x 0.34

=   **102.00 mm**

iii   R-50 (tc)   =   K x R-50 (1)

=   0.5885 x102.00

=   **60.0261 mm**

iv   Int. of rainfall (I)   = $\dfrac{\text{R-50 (tc)}}{\text{tc}}$

= $\dfrac{60.03}{0.4003}$

=   **149.9567 mm/hr.**

4   Design Flood Discharge =

Q-50   =   0.278 x C xI x A

=   x 0.278   x 0.8511   x 149.9567   x 0.0914

=   **3.2429 cum/sec**

19

5 Checking for adequacy of Waterway Provided

a	Discharge	=	3.2429 cum/sec

c Avg. Waterway Required = $\dfrac{Q}{V}$

$$= \dfrac{3.2429}{1.75}$$

$$= \textbf{1.8531 Sq.m}$$

d	Proposed Opening	=	1	2	1.2

e Height of Water = $\dfrac{\text{Avg. Waterway}}{\text{Total Width}}$

$$= \dfrac{1.8531}{2}$$

$$= \textbf{0.9270}\quad\text{m}$$

f Avg. Bed Level = 195.523

h Min. Formation Required   B.L +   Ht of water + free Board

$$= \quad 195.5230 \qquad +0.9270 \quad +1.4480$$

$$= \quad 197.8980$$

k Formation level adopted = 197.8980

Provided formation Level is O.K.

Dedicated freight corridor Corporation of India.

Estimation of Design Discharge for Railway Bridge. Br. No. 179

A	Topography	
B	Catchment Area	0.0542 Sq Km
C	Length of Longest Stream	0.450 Km
D	Height Of farthest point	198.829 M
E	Height of Point of Interest	196.079 M
F	Height Diff of 10 & 11	2.750 M
G	Nature of Soil	Sandy Soil / Sandy Laom.....
H	Avg. Bed Level	196.079 M
I	Observed HFL	196.694 M

1   **Using Improved Rational Formula**

$Q\text{-}50 = 0.278 \times C \times I \times A$

Where

$Q\text{-}50$ = 50 Years Design Flood Discharge

c = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for tc hour duration where tc = time of concentration

a = Catchment Area

2   **Run off coefficient**

Description of the catchment	Formula for C
a	Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b	Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c	Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d	Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine & plateau	$C = 0.456(R \times F)^{0.2}$
e	Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R =   50 Year 24 hour point rainfall (cm)

F =   Areal Reduction factor depending upon catchment Area & duration rainfall from table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 Min	60 To 100 Min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$tc = [L^3 / H]^{0.345}$

$= [0.45 \times 0.45 \times 0.45 / 2.750]^{0.345}$

= **0.3087 hr.**

= 0.3087 hr. x 60

= **18.5207 Min**

22

22

0030

Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , $C = 0.249(R \times F)^{0.2}$

$$R = 300.00 \text{ mm}$$
$$F = 0.72$$
$$C = 0.249 \times (R \times F)^{0.2}$$
$$= \mathbf{0.8511}$$

But as per Annexture 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3   Calculation of Intensity of Rainfall (I)

a   tc h Ratio   =   *0.1726*   From Fig. 4 of RBF - 16

b   1h Ratio =   =   0.34   From Fig. 4 of RBF - 16

c   Coefficient K   = $\dfrac{\text{tc h Ratio}}{\text{1h Ratio}}$

                         = $\dfrac{0.1726}{0.34}$

                         =   **0.5077**

d
I   R-50 (24)   =   300.00   mm

ii R-50 (1)   =   R-50 (24) x 1 h to 24 h Rainfall Ratio.

                         =   300 x 0.34

                         =   **102.00 mm**

iii R-50 (tc)   =   K x R-50 (1)

                         =   0.5077 x102.00

                         =   **51.7810 mm**

iv Int. of rainfall (I) = $\dfrac{\text{R-50 (tc)}}{\text{tc}}$

                         = $\dfrac{51.78}{0.3087}$

                         =   **167.7511 mm/hr.**

4   Design Flood Discharge =

    Q-50   =   0.278 x C xl x A

                         =   x 0.278   x 0.8511   x 167.7511   x 0.0542

                         =   **2.1512 cum/sec**

23

5 Checking for adequacy of Waterway Provided

a Discharge = 2.1512 cum/sec

c Avg. Waterway Required = $\dfrac{Q}{V}$

= $\dfrac{2.1512}{1.75}$

= **1.2293 Sq.m**

d Proposed Opening = 1   2   1.2

e Height of Water = $\dfrac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\dfrac{1.2293}{2}$

= **0.6150   m**

f Avg. Bed Level = 196.079

h **Min. Formation Required**   B.L   +   Ht of water   + free Board

= 196.0790   +0.6150   +1.1160

= 197.8100

k **Formation level adopted** = 197.8100

Provided formation Level is O.K.

24

Dedicated freight corridor Corporation of India.

Estimation of Design Discharge for Railway Bridge. Br. No. 180

A	Topography		
B	Catchment Area	0.0390 Sq Km	
C	Length of Longest Stream	0.380 Km	
D	Height Of farthest point	200.153 M	
E	Height of Point of Interest	197.063 M	
F	Height Diff of 10 & 11	3.090 M	
G	Nature of Soil	Sandy Soil / Sandy Laom.....	
H	Avg. Bed Level	197.063 M	
I	Observed HFL	197.855 M	

1   Using Improved Rational Formula

$$Q\text{-}50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

c = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for tc hour duration where tc = time of concentration

a = Catchment Area

2   Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastai area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine & plateau	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R =   50 Year 24 hour point rainfall (cm)

F =   Areal Reduction factor depending upon catchment Area & duration rainfall from table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 Min	60 To 100 Min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

$$= [0.38 \times 0.38 \times 0.38 / 3.090]^{0.345}$$

= **0.2489 hr.**

= 0.2489 hr. x 60

= **14.9345 Min**

Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas ,   C = 0.249(R x F) ^ 0.2

$$R = 300.00 \text{ mm}$$
$$F = 0.72$$
$$C = 0.249 \times (R \times F)^{0.2}$$
$$= \mathbf{0.8511}$$

But as per Annexture 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3   Calculation of Intensity of Rainfall (I)

a   tc h Ratio   =   0.1495   From Fig. 4 of RBF - 16

b   1h Ratio =   =   0.34   From Fig. 4 of RBF - 16

c   Coefficient K   = $\dfrac{\text{tc h Ratio}}{\text{1h Ratio}}$

                          = $\dfrac{0.1495}{0.34}$

                          =   **0.4396**

d
I   R-50 (24)   =   300.00   mm

ii   R-50 (1)   =   R-50 (24) x 1 h to 24 h Rainfall Ratio.

                          =   300 x 0.34

                          =   **102.00 mm**

iii   R-50 (tc)   =   K x R-50 (1)

                          =   0.4396 x102.00

                          =   **44.8363 mm**

iv   Int. of rainfall (I) = $\dfrac{\text{R-50 (tc)}}{\text{tc}}$

                          = $\dfrac{44.84}{0.2489}$

                          =   **180.1314 mm/hr.**

4   Design Flood Discharge =

Q-50   =   0.278 x C xI x A

                          =   x 0.278   x 0.8511   x 180.1314   x 0.0390

                          =   **1.6622 cum/sec**

27

5 Checking for adequacy of Waterway Provided

a   Discharge = 1.6622 cum/sec

c   Avg. Waterway Required = $\dfrac{Q}{V}$

= $\dfrac{1.6622}{1.75}$

= **0.9498 Sq.m**

d   Proposed Opening = 1   1.2   1.2

e   Height of Water = $\dfrac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\dfrac{0.9498}{1.2}$

= **0.7920**   m

f   Avg. Bed Level = 197.063

h   **Min. Formation Required**   B.L +   Ht of water   + free Board

= 197.0630   +0.7920   +0.7580

= 198.6130

k   **Formation level adopted** = 198.6130

Provided formation Level is O.K.

Dedicated freight corridor Corporation of India.

Estimation of Design Discharge for Railway Bridge. Br. No. 181

A	Topography		
B	Catchment Area	0.1567	Sq Km
C	Length of Longest Stream	0.500	Km
D	Height Of farthest point	199.192	M
E	Height of Point of Interest	196.792	M
F	Height Diff of 10 & 11	2.400	M
G	Nature of Soil	Sandy Soil / Sandy Laom.....	
H	Avg. Bed Level	196.792	M
I	Observed HFL	198.450	M

1   Using Improved Rational Formula

$$Q\text{-}50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

c = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for tc hour duration where tc = time of concentration

a = Catchment Area

2   **Run off coefficient**

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine & plateau	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R =   50 Year 24 hour point rainfall (cm)

F =   Areal Reduction factor depending upon catchment Area & duration rainfall from table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 Min	60 To 100 Min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

tc   = $[L^3 / H]^{0.345}$

    = $[0.5 \times 0.5 \times 0.5 / 2.400]^{0.345}$

    =   **0.3608 hr.**

    =   0.3608 hr. x 60

    =   **21.6477 Min**

30

Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , $C = 0.249(R \times F)^{0.2}$

$$R \quad = \quad 300.00 \text{ mm}$$
$$F \quad = \quad 0.72$$
$$C = 0.249 \times (R \times F)^{0.2}$$
$$= \quad \mathbf{0.8511}$$

But as per Annexture 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3   Calculation of Intensity of Rainfall (I)

a   tc h Ratio   = 0.1882 From Fig. 4 of RBF - 16

b   1h Ratio =   =   0.34   From Fig. 4 of RBF - 16

c   Coefficient K   = $\dfrac{\text{tc h Ratio}}{\text{1h Ratio}}$

                          = $\dfrac{0.1882}{0.34}$

                          =   **0.5536**

d
I   R-50 (24)   =   300.00   mm

ii   R-50 (1)   =   R-50 (24) x 1 h to 24 h Rainfall Ratio.

                         =   300 x 0.34

                         =   **102.00 mm**

iii   R-50 (tc)   =   K x R-50 (1)

                          =   0.5536 x102.00

                          =   **56.4716 mm**

iv   Int. of rainfall (I)   = $\dfrac{\text{R-50 (tc)}}{\text{tc}}$

                          = $\dfrac{56.47}{0.3608}$

                          =   **156.5197 mm/hr.**

4   Design Flood Discharge =

Q-50   =   0.278 x C xI x A

              =   x 0.278   x 0.8511   x 156.5197   x 0.1567

              =   **5.8031 cum/sec**

31

5 Checking for adequacy of Waterway Provided

a Discharge   =   5.8031 cum/sec

c Avg. Waterway Required   = $\dfrac{Q}{V}$

     = $\dfrac{5.8031}{1.75}$

     =   **3.3161 Sq.m**

d Proposed Opening   =   1   2   2

e Height of Water   = $\dfrac{\text{Avg. Waterway}}{\text{Total Width}}$

     = $\dfrac{3.3161}{2}$

     =   **1.6580**   m

f Avg. Bed Level   =   196.792

h **Min. Formation Required**   B.L   +   Ht of water   + free Board

     =   196.7920   +1.6580   +0.7760

     =   199.2260

k **Formation level adopted**   =   199.2260

Provided formation Level is O.K.

Dedicated freight corridor Corporation of India.

Estimation of Design Discharge for Railway Bridge.   Br. No. 182

A	Topography		
B	Catchment Area	0.0376	Sq Km
C	Length of Longest Stream	0.400	Km
D	Height Of farthest point	201.508	M
E	Height of Point of Interest	198.908	M
F	Height Diff of 10 & 11	2.600	M
G	Nature of Soil	Sandy Soil / Sandy Laom.....	
H	Avg. Bed Level	198.908	M
I	Observed HFL	199.350	M

1   **Using Improved Rational Formula**

   Q-50 = 0.278 x C x I x A
   Where
   Q-50 = 50 Years Design Flood Discharge
      c = Runoff Coefficient
      I = 50 Years Rainfall Intensity lasting for tc hour duration where tc = time of concentration

      a = Catchment Area

2   **Run off coefficient**

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	C = 0.249(R x F) ^ 0.2
b Alluvium/silty/coastal area	C = 0.332(R x F) ^ 0.2
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	C = 0.415(R x F) ^ 0.2
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine & plateau	C = 0.456(R x F) ^ 0.2
e Hilly soil / plateau/barren	C = 0.498(R x F) ^ 0.2

   Where
   R =   50 Year 24 hour point rainfall (cm)

   F =   Areal Reduction factor depending upon catchment Area & duration rainfall
                  from table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 Min	60 To 100 Min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

   Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

   for estimating the time of concentration(tc) as per bhatnagar formula

   $$tc = [L^3/H]^{0.345}$$

   $$= [0.4 \times 0.4 \times 0.4 / 2.600]^{0.345}$$

   = **0.2786 hr.**

   = 0.2786 hr. x 60

   = **16.7154 Min**

Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , $C = 0.249(R \times F)^{0.2}$

$$R = 300.00 \text{ mm}$$
$$F = 0.72$$
$$C = 0.249 \times (R \times F)^{0.2}$$
$$= \mathbf{0.8511}$$

But as per Annexture 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3   Calculation of Intensity of Rainfall (I)

a   tc h Ratio   =   *0.1614*   From Fig. 4 of RBF - 16

b   1h Ratio =   =   0.34   From Fig. 4 of RBF - 16

c   Coefficient K   = $\dfrac{\text{tc h Ratio}}{\text{1h Ratio}}$

          = $\dfrac{0.1614}{0.34}$

          =   **0.4748**

d
l   R-50 (24)   =   300.00   mm

ii   R-50 (1)   =   R-50 (24) x 1 h to 24 h Rainfall Ratio.

          =   300 x 0.34

          =   **102.00 mm**

iii   R-50 (tc)   =   K x R-50 (1)

          =   0.4748 x102.00

          =   **48.4309 mm**

iv   Int. of rainfall (I)   = $\dfrac{\text{R-50 (tc)}}{\text{tc}}$

          = $\dfrac{48.43}{0.2786}$

          =   **173.8426 mm/hr.**

4   **Design Flood Discharge =**

Q-50   =   0.278 x C xI x A

          =   x 0.278   x 0.8511   x 173.8426   x 0.0376

          =   **1.5466 cum/sec**

35

5 Checking for adequacy of Waterway Provided

a Discharge = 1.5466 cum/sec

c Avg. Waterway Required = $\dfrac{Q}{V}$

= $\dfrac{1.5466}{1.75}$

= **0.8838 Sq.m**

d Proposed Opening = 1   2   1.2

e Height of Water = $\dfrac{\text{Avg. Waterway}}{\cdot \text{ Total Width}}$

= $\dfrac{0.8838}{2}$

= **0.4420**   m

f Avg. Bed Level = 198.908

h **Min. Formation Required**   B.L +   Ht of water + free Board

= 198.9080   +0.4420 +1.1080

= 200.4580

k **Formation level adopted** = 200.4580

Provided formation Level is O.K.

36

Dedicated freight corridor Corporation of India.

Estimation of Design Discharge for Railway Bridge. Br. No. 183

A	Topography		
B	Catchment Area	0.0418	Sq Km
C	Length of Longest Stream	0.425	Km
D	Height Of farthest point	201.450	M
E	Height of Point of Interest	198.950	M
F	Height Diff of 10 & 11	2.500	M
G	Nature of Soil	Sandy Soil / Sandy Laom.....	
H	Avg. Bed Level	198.950	M
I	Observed HFL	199.750	M

1   Using Improved Rational Formula

        Q-50 = 0.278 x C x I x A
        Where
        Q-50 = 50 Years Design Flood Discharge
          c = Runoff Coefficient
          I = 50 Years Rainfall Intensity lasting for tc hour duration where tc = time of concentration

          a = Catchment Area

2   **Run off coefficient**

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	C = 0.249(R x F) ^ 0.2
b Alluvium/silty/coastal area	C = 0.332(R x F) ^ 0.2
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	C = 0.415(R x F) ^ 0.2
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine & plateau	C = 0.456(R x F) ^ 0.2
e Hilly soil / plateau/barren	C = 0.498(R x F) ^ 0.2

Where
R =   50 Year 24 hour point rainfall (cm)

F =   Areal Reduction factor depending upon catchment Area & duration rainfall from table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 Min	60 To 100 Min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

$$= [0.425 \times 0.425 \times 0.425 / 2.500]^{0.345}$$

$$= \textbf{0.3007 hr.}$$

$$= 0.3007 \text{ hr.} \times 60$$

$$= \textbf{18.0403 Min}$$

38

Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas ,   C = 0.249(R x F) ^ 0.2

$$R = 300.00 \text{ mm}$$
$$F = 0.72$$
$$C = 0.249 \times (R \times F)^{0.2}$$
$$= \mathbf{0.8511}$$

But as per Annexture 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3   Calculation of Intensity of Rainfall (I)

a   tc h Ratio   =   *0.1702*   From Fig. 4 of RBF - 16

b   1h Ratio =   =   0.34   From Fig. 4 of RBF - 16

c   Coefficient K   = $\dfrac{\text{tc h Ratio}}{\text{1h Ratio}}$

          = $\dfrac{0.1702}{0.34}$

          =   **0.5006**

d
I   R-50 (24)   =   300.00   mm

ii   R-50 (1)   =   R-50 (24) x 1 h to 24 h Rainfall Ratio.

          =   300 x 0.34

          =   **102.00 mm**

iii   R-50 (tc)   =   K x R-50 (1)

          =   0.5006 x102.00

          =   **51.0605 mm**

iv   Int. of rainfall (I)   = $\dfrac{\text{R-50 (tc)}}{\text{tc}}$

          = $\dfrac{51.06}{0.3007}$

          =   **169.8212 mm/hr.**

4   Design Flood Discharge =

Q-50   =   0.278 x C xI x A

          =   x 0.278   x 0.8511   x 169.8212   x 0.0418

          =   **1.6796 cum/sec**

39

5 **Checking for adequacy of Waterway Provided**

a	Discharge	=	1.6796 cum/sec		

c Avg. Waterway Required = $\dfrac{Q}{V}$

= $\dfrac{1.6796}{1.75}$

= **0.9598 Sq.m**

d	Proposed Opening	=	1	1.2	1.2

e Height of Water = $\dfrac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\dfrac{0.9598}{1.2}$

= **0.8000** m

f Avg. Bed Level = 198.950

h **Min. Formation Required**   B.L +   Ht of water + free Board

= 198.9500   +0.8000   +0.8280

= 200.5780

k **Formation level adopted** = 200.5780

Provided formation Level is O.K.

Dedicated freight corridor Corporation of India.

Estimation of Design Discharge for Railway Bridge. Br. No. 184

A	Topography		
B	Catchment Area	0.0699	Sq Km
C	Length of Longest Stream	0.610	Km
D	Height Of farthest point	201.845	M
E	Height of Point of Interest	198.745	M
F	Height Diff of 10 & 11	3.100	M
G	Nature of Soil	Sandy Soil / Sandy Laom.....	
H	Avg. Bed Level	198.745	M
I	Observed HFL	199.450	M

1   Using Improved Rational Formula

   Q-50 = 0.278 x C x I x A
   Where
   Q-50 = 50 Years Design Flood Discharge
      c = Runoff Coefficient
      I = 50 Years Rainfall Intensity lasting for tc hour duration where tc = time of concentration

      a = Catchment Area

2   Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine & plateau	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where
R =   50 Year 24 hour point rainfall (cm)

F =   Areal Reduction factor depending upon catchment Area & duration rainfall from table below

	Duration of Rainfall		
Catchment Area in Sq. Km.	< 30 Min	30 to 60 Min	60 To 100 Min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

$$= [0.61 \times 0.61 \times 0.61 / 3.100]^{0.345}$$

=   **0.4058 hr.**

=   0.4058 hr. x 60

=   **24.3471 Min**

Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , $C = 0.249(R \times F)^{0.2}$

$$R = 300.00 \text{ mm}$$
$$F = 0.72$$
$$C = 0.249 \times (R \times F)^{0.2}$$
$$= 0.8511$$

But as per Annexture 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3   Calculation of Intensity of Rainfall (I)

a   tc h Ratio   =   *0.2017*   From Fig. 4 of RBF - 16

b   1h Ratio =   =   0.34   From Fig. 4 of RBF - 16

c   Coefficient K   = $\dfrac{\text{tc h Ratio}}{\text{1h Ratio}}$

$$= \frac{0.2017}{0.34}$$

$$= 0.5933$$

d
I   R-50 (24)   =   300.00   mm

ii   R-50 (1)   =   R-50 (24) x 1 h to 24 h Rainfall Ratio.

$$= 300 \times 0.34$$

$$= 102.00 \text{ mm}$$

iii   R-50 (tc)   =   K x R-50 (1)

$$= 0.5933 \times 102.00$$

$$= 60.5207 \text{ mm}$$

iv   Int. of rainfall (I)   = $\dfrac{\text{R-50 (tc)}}{\text{tc}}$

$$= \frac{60.52}{0.4058}$$

$$= 149.1445 \text{ mm/hr.}$$

4   Design Flood Discharge =

Q-50   =   0.278 x C xI x A

    =   x 0.278   x 0.8511   x 149.1445   x 0.0699

    =   2.4667 cum/sec

43

5 Checking for adequacy of Waterway Provided

a	Discharge	=	2.4667 cum/sec		

c Avg. Waterway Required $= \dfrac{Q}{V}$

$= \dfrac{2.4667}{1.75}$

$=$ **1.4095 Sq.m**

d Proposed Opening $=$ 1   2   1.2

e Height of Water $= \dfrac{\text{Avg. Waterway}}{\text{Total Width}}$

$= \dfrac{1.4095}{2}$

$=$ **0.7050   m**

f Avg. Bed Level $=$ 198.745

h **Min. Formation Required**   B.L   +   Ht of water   + free Board

$=$ 198.7450   +0.7050   +1.3820

$=$ 200.8320

k **Formation level adopted** $=$ 200.8320

Provided formation Level is O.K.

44

Dedicated freight corridor Corporation of India.

Estimation of Design Discharge for Railway Bridge. Br. No. 186

A	Topography		
B	Catchment Area	0.0568	Sq Km
C	Length of Longest Stream	0.475	Km
D	Height Of farthest point	202.446	M
E	Height of Point of Interest	199.396	M
F	Height Diff of 10 & 11	3.050	M
G	Nature of Soil	Sandy Soil / Sandy Laom.....	
H	Avg. Bed Level	199.396	M
I	Observed HFL	200.460	M

1   Using Improved Rational Formula

Q-50 = 0.278 x C x I x A
Where
Q-50 = 50 Years Design Flood Discharge
    c = Runoff Coefficient
    I = 50 Years Rainfall Intensity lasting for tc hour duration where tc = time of concentration

    a = Catchment Area

2   Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine & plateau	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where
R =   50 Year 24 hour point rainfall (cm)

F =   Areal Reduction factor depending upon catchment Area & duration rainfall from table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 Min	60 To 100 Min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note.- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

tc   = $[L^3 / H]^{0.345}$

= $[0.475 \times 0.475 \times 0.475 / 3.050]^{0.345}$

=   **0.3150 hr.**

=   0.3150 hr. x 60

=   **18.8993 Min**

46

Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas ,   C = 0.249(R x F) ^ 0.2

$$R \quad = \quad 300.00 \text{ mm}$$
$$F \quad = \quad 0.72$$
$$C = 0.249 \times (R \times F)^{0.2}$$
$$= \quad \mathbf{0.8511}$$

But as per Annexture 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3   Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	*0.1745*	From Fig. 4 of RBF - 16
b	1h Ratio =	=	0.34	From Fig. 4 of RBF - 16

c   Coefficient K   = $\dfrac{\text{tc h Ratio}}{\text{1h Ratio}}$

= $\dfrac{0.1745}{0.34}$

= **0.5132**

d

i   R-50 (24)   =   300.00   mm

ii   R-50 (1)   =   R-50 (24) x 1 h to 24 h Rainfall Ratio.

=   300 x 0.34

=   **102.00 mm**

iii   R-50 (tc)   =   K x R-50 (1)

=   0.5132 x102.00

=   **52.3489 mm**

iv   Int. of rainfall (I)   = $\dfrac{\text{R-50 (tc)}}{\text{tc}}$

= $\dfrac{52.35}{0.3150}$

=   **166.1931 mm/hr.**

4   Design Flood Discharge =

Q-50   =   0.278 x C xI x A

=   x 0.278   x 0.8511   x 166.1931   x 0.0568

=   **2.2335 cum/sec**

47

5 Checking for adequacy of Waterway Provided

a	Discharge	=	2.2335 cum/sec

c Avg. Waterway Required = $\dfrac{Q}{V}$

= $\dfrac{2.2335}{1.75}$

= **1.2763 Sq.m**

d	Proposed Opening	=	1	1.2	1.2

e Height of Water = $\dfrac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\dfrac{1.2763}{1.2}$

= **1.0640   m**

f	Avg. Bed Level	=	199.396

h **Min. Formation Required**   B.L +   Ht of water + free Board

= 199.3960   +1.0640 +0.7610

= 201.2210

k **Formation level adopted** = 201.2210

Provided formation Level is O.K.

Dedicated freight corridor Corporation of India.

Estimation of Design Discharge for Railway Bridge. Br. No. 187

A	Topography		
B	Catchment Area	0.0226	Sq Km
C	Length of Longest Stream	0.500	Km
D	Height Of farthest point	202.017	M
E	Height of Point of Interest	199.617	M
F	Height Diff of 10 & 11	2.400	M
G	Nature of Soil	Sandy Soil / Sandy Laom.....	
H	Avg. Bed Level	199.617	M
I	Observed HFL	199.856	M

1 Using Improved Rational Formula

$$Q\text{-}50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

   c = Runoff Coefficient

   I = 50 Years Rainfall Intensity lasting for tc hour duration where tc = time of concentration

   a = Catchment Area

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine & plateau	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R =   50 Year 24 hour point rainfall (cm)

F =   Areal Reduction factor depending upon catchment Area & duration rainfall from table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 Min	60 To 100 Min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

tc   = $[L^3 / H]^{0.345}$

    = $[0.5 \times 0.5 \times 0.5 / 2.400]^{0.345}$

    =   **0.3608 hr.**

    =   0.3608 hr. x 60

    =   **21.6477 Min**

Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas ,   C = 0.249(R x F) ^ 0.2

$$R = 300.00 \text{ mm}$$
$$F = 0.72$$
$$C = 0.249 \times (R \times F)^{0.2}$$
$$= \mathbf{0.8511}$$

But as per Annexture 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3   Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	*0.1882*	From Fig. 4 of RBF - 16
b	1h Ratio =	=	0.34	From Fig. 4 of RBF - 16

c   Coefficient K   = $\dfrac{\text{tc h Ratio}}{\text{1h Ratio}}$

$$= \frac{0.1882}{0.34}$$

$$= \mathbf{0.5536}$$

d

i   R-50 (24)   =   300.00   mm

ii   R-50 (1)   =   R-50 (24) x 1 h to 24 h Rainfall Ratio.

$$= 300 \times 0.34$$

$$= \mathbf{102.00 \text{ mm}}$$

iii   R-50 (tc)   =   K x R-50 (1)

$$= 0.5536 \times 102.00$$

$$= \mathbf{56.4716 \text{ mm}}$$

iv   Int. of rainfall (I)   = $\dfrac{\text{R-50 (tc)}}{\text{tc}}$

$$= \frac{56.47}{0.3608}$$

$$= \mathbf{156.5197 \text{ mm/hr.}}$$

4   Design Flood Discharge =

Q-50   =   0.278 x C xI x A

$$= \text{x } 0.278 \quad \text{x } 0.8511 \quad \text{x } 156.5197 \quad \text{x } 0.0226$$

$$= \mathbf{0.8370 \text{ cum/sec}}$$

51

5 Checking for adequacy of Waterway Provided

a   Discharge   =   0.8370 cum/sec

c   Avg. Waterway Required   = $\dfrac{Q}{V}$

      = $\dfrac{0.8370}{1.75}$

      =   **0.4783 Sq.m**

d   Proposed Opening   =   1   2   1.2

e   Height of Water   = $\dfrac{\text{Avg. Waterway}}{\text{Total Width}}$

      = $\dfrac{0.4783}{2}$

      =   **0.2390**   m

f   Avg. Bed Level   =   199.617

h   **Min. Formation Required**   B.L +   Ht of water + free Board

      =   199.6170   +0.2390   +1.5160

      =   201.3720

k   **Formation level adopted**   =   201.3720

Provided formation Level is O.K.

Dedicated freight corridor Corporation of India.

Estimation of Design Discharge for Railway Bridge. Br. No. 188

A	Topography	
B	Catchment Area	0.1332 Sq Km
C	Length of Longest Stream	0.495 Km
D	Height Of farthest point	201.947 M
E	Height of Point of Interest	199.097 M
F	Height Diff of 10 & 11	2.850 M
G	Nature of Soil	Sandy Soil / Sandy Laom.....
H	Avg. Bed Level	199.097 M
I	Observed HFL	200.550 M

1   Using Improved Rational Formula

   Q-50 = 0.278 x C x I x A
   Where
   Q-50 = 50 Years Design Flood Discharge
      c = Runoff Coefficient
      I = 50 Years Rainfall Intensity lasting for tc hour duration where tc = time of concentration

      a = Catchment Area

2   Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	C = 0.249(R x F) ^ 0.2
b Alluvium/silty/coastal area	C = 0.332(R x F) ^ 0.2
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	C = 0.415(R x F) ^ 0.2
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine & plateau	C = 0.456(R x F) ^ 0.2
e Hilly soil / plateau/barren	C = 0.498(R x F) ^ 0.2

   Where
   R =   50 Year 24 hour point rainfall (cm)

   F =   Areal Reduction factor depending upon catchment Area & duration rainfall
                     from table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 Min	60 To 100 Min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

   Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

   for estimating the time of concentration(tc) as per bhatnagar formula

   $$tc   =   [L^3 / H]^{0.345}$$

   $$=   [0.495 \times 0.495 \times 0.495 / 2.850]^{0.345}$$

   =   **0.3365 hr.**

   =   0.3365 hr. x 60

   =   **20.1905 Min**

Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas ,   C = 0.249(R x F) ^ 0.2

$$R = 300.00 \text{ mm}$$
$$F = 0.72$$
$$C = 0.249 \text{ x } (R \text{ x } F)^{0.2}$$
$$= \mathbf{0.8511}$$

But as per Annexture 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3   Calculation of Intensity of Rainfall (I)

a   tc h Ratio   =   *0.1810*   From Fig. 4 of RBF - 16

b   1h Ratio =   =   0.34   From Fig. 4 of RBF - 16

c   Coefficient K   = $\dfrac{\text{tc h Ratio}}{\text{1h Ratio}}$

$$= \dfrac{0.1810}{0.34}$$

$$= \mathbf{0.5322}$$

d

I   R-50 (24)   =   300.00   mm

ii   R-50 (1)   =   R-50 (24) x 1 h to 24 h Rainfall Ratio.

$$= 300 \text{ x } 0.34$$

$$= \mathbf{102.00 \text{ mm}}$$

iii   R-50 (tc)   =   K x R-50 (1)

$$= 0.5322 \text{ x} 102.00$$

$$= \mathbf{54.2857 \text{ mm}}$$

iv   Int. of rainfall (I)   = $\dfrac{\text{R-50 (tc)}}{\text{tc}}$

$$= \dfrac{54.29}{0.3365}$$

$$= \mathbf{161.3209 \text{ mm/hr.}}$$

4   Design Flood Discharge =

Q-50   =   0.278 x C xI x A

$$= \text{ x } 0.278 \quad \text{ x } 0.8511 \quad \text{ x } 161.3209 \quad \text{ x } 0.1332$$

$$= \mathbf{5.0842 \text{ cum/sec}}$$

5 Checking for adequacy of Waterway Provided

a   Discharge   =   5.0842 cum/sec

c   Avg. Waterway Required   = $\dfrac{Q}{V}$

= $\dfrac{5.0842}{1.75}$

=   **2.9053 Sq.m**

d   Proposed Opening   =   1   2   2

e   Height of Water   = $\dfrac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\dfrac{2.9053}{2}$

=   **1.4530   m**

f   Avg. Bed Level   =   199.097

h   **Min. Formation Required**   B.L   +   Ht of water   + free Board

=   199.0970   +1.4530   +0.8970

=   201.4470

k   **Formation level adopted**   =   201.4470

Provided formation Level is O.K.

Dedicated freight corridor Corporation of India.

Estimation of Design Discharge for Railway Bridge. Br. No. 189

A	Topography		
B	Catchment Area	0.1540	Sq Km
C	Length of Longest Stream	0.710	Km
D	Height Of farthest point	201.624	M
E	Height of Point of Interest	199.074	M
F	Height Diff of 10 & 11	2.550	M
G	Nature of Soil	Sandy Soil / Sandy Laom.....	
H	Avg. Bed Level	199.074	M
I	Observed HFL	200.540	M

1   **Using Improved Rational Formula**

        Q-50 = 0.278 x C x I x A
        Where
        Q-50 = 50 Years Design Flood Discharge
          c = Runoff Coefficient
          I = 50 Years Rainfall Intensity lasting for tc hour duration where tc = time of concentration

          a = Catchment Area

2   **Run off coefficient**

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	C = 0.249(R x F) ^ 0.2
b Alluvium/silty/coastal area	C = 0.332(R x F) ^ 0.2
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	C = 0.415(R x F) ^ 0.2
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine & plateau	C = 0.456(R x F) ^ 0.2
e Hilly soil / plateau/barren	C = 0.498(R x F) ^ 0.2

Where
R =   50 Year 24 hour point rainfall (cm)

F =   Areal Reduction factor depending upon catchment Area & duration rainfall from table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 Min	60 To 100 Min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

$$= [0.71 \times 0.71 \times 0.71 / 2.550]^{0.345}$$

$$= \textbf{0.5079 hr.}$$

$$= 0.5079 \text{ hr.} \times 60$$

$$= \textbf{30.4753 Min}$$

58

Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas ,   C = 0.249(R x F) ^ 0.2

$$R = 300.00 \text{ mm}$$
$$F = 0.81$$
$$C = 0.249 \times (R \times F)^{0.2}$$
$$= \mathbf{0.8922}$$

But as per Annexture 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3   Calculation of Intensity of Rainfall (I)

a   tc h Ratio   =   *0.2274*   From Fig. 4 of RBF - 16

b   1h Ratio =   =   0.34   From Fig. 4 of RBF - 16

c   Coefficient K   = $\dfrac{\text{tc h Ratio}}{\text{1h Ratio}}$

　　　　　　　　　　= $\dfrac{0.2274}{0.34}$

　　　　　　　　　　=   **0.6688**

d
I   R-50 (24)   =   300.00   mm

ii   R-50 (1)   =   R-50 (24) x 1 h to 24 h Rainfall Ratio.

　　　　　　　　　=   300 x 0.34

　　　　　　　　　=   **102.00 mm**

iii R-50 (tc)   =   K x R-50 (1)

　　　　　　　　　=   0.6688 x102.00

　　　　　　　　　=   **68.2129 mm**

iv   Int. of rainfall (I)   = $\dfrac{\text{R-50 (tc)}}{\text{tc}}$

　　　　　　　　　　　= $\dfrac{68.21}{0.5079}$

　　　　　　　　　　　=   **134.2983 mm/hr.**

4   Design Flood Discharge =

Q-50   =   0.278 x C xI x A

　　　　　=   x 0.278   x 0.8922   x 134.2983   x 0.1540

　　　　　=   **5.1295 cum/sec**

59

5 Checking for adequacy of Waterway Provided

a Discharge = 5.1295 cum/sec

c Avg. Waterway Required = $\dfrac{Q}{V}$

= $\dfrac{5.1295}{1.75}$

= **2.9311 Sq.m**

d Proposed Opening = 1   2   2

e Height of Water = $\dfrac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\dfrac{2.9311}{2}$

= **1.4660   m**

f Avg. Bed Level = 199.074

h **Min. Formation Required**   B.L   +   Ht of water   + free Board

= 199.0740   +1.4660   +0.9190

= 201.4590

k **Formation level adopted** = 201.4590

Provided formation Level is O.K.

Dedicated freight corridor Corporation of India.

Estimation of Design Discharge for Railway Bridge. Br. No. 190

A	Topography		
B	Catchment Area	0.0270	Sq Km
C	Length of Longest Stream	0.275	Km
D	Height Of farthest point	202.768	M
E	Height of Point of Interest	199.938	M
F	Height Diff of 10 & 11	2.830	M
G	Nature of Soil	Sandy Soil / Sandy Laom.....	
H	Avg. Bed Level	199.938	M
I	Observed HFL	200.519	M

1   **Using Improved Rational Formula**

$$Q\text{-}50 = 0.278 \times C \times I \times A$$
Where
Q-50 = 50 Years Design Flood Discharge
c = Runoff Coefficient
I = 50 Years Rainfall Intensity lasting for tc hour duration where tc = time of concentration

a = Catchment Area

2   **Run off coefficient**

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine & plateau	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where
R =   50 Year 24 hour point rainfall (cm)

F =   Areal Reduction factor depending upon catchment Area & duration rainfall from table below

	Duration of Rainfall		
Catchment Area in Sq. Km.	< 30 Min	30 to 60 Min	60 To 100 Min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

$$= [0.275 \times 0.275 \times 0.275 / 2.830]^{0.345}$$

=   **0.1836 hr.**

=   0.1836 hr. x 60

=   **11.0152 Min**

0070

Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas ,   C = 0.249(R x F) ^ 0.2

$$R = 300.00 \text{ mm}$$
$$F = 0.72$$
$$C = 0.249 \times (R \times F)^{0.2}$$
$$= \mathbf{0.8511}$$

But as per Annexture 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3   Calculation of Intensity of Rainfall (I)

a   tc h Ratio   =   *0.1168*   From Fig. 4 of RBF - 16

b   1h Ratio =   =   0.34   From Fig. 4 of RBF - 16

c   Coefficient K   = $\dfrac{\text{tc h Ratio}}{\text{1h Ratio}}$

              = $\dfrac{0.1168}{0.34}$

              =   **0.3435**

d
l   R-50 (24)   =   300.00   mm

ii   R-50 (1)   =   R-50 (24) x 1 h to 24 h Rainfall Ratio.

              =   300 x 0.34

              =   **102.00 mm**

iii   R-50 (tc)   =   K x R-50 (1)

              =   0.3435 x102.00

              =   **35.0381 mm**

iv   Int. of rainfall (I)   = $\dfrac{\text{R-50 (tc)}}{tc}$

              = $\dfrac{35.04}{0.1836}$

              =   **190.8524 mm/hr.**

4   Design Flood Discharge =

Q-50   =   0.278 x C xI x A

              =   x 0.278   x 0.8511   x 190.8524   x 0.0270

              =   **1.2192 cum/sec**

63

5   Checking for adequacy of Waterway Provided

a   Discharge   =   1.2192 cum/sec

c   Avg. Waterway Required   = $\dfrac{Q}{V}$

                                                   = $\dfrac{1.2192}{1.75}$

                                                   =   **0.6967 Sq.m**

d   Proposed Opening   =   1   1.2   1.2

e   Height of Water   = $\dfrac{\text{Avg. Waterway}}{\text{Total Width}}$

                                                   = $\dfrac{0.6967}{1.2}$

                                                   =   **0.5810   m**

f   Avg. Bed Level   =   199.938

h   **Min. Formation Required**   B.L   +   Ht of water   + free Board

                                                   =   199.9380   +0.5810   +1.2550

                                                   =   201.7740

k   **Formation level adopted**   =   201.7740

Provided formation Level is O.K.

Dedicated freight corridor Corporation of India.

Estimation of Design Discharge for Railway Bridge. Br. No. WR1

A	Topography		
B	Catchment Area	0.8862	Sq Km
C	Length of Longest Stream	0.850	Km
D	Height Of farthest point	202.948	M
E	Height of Point of Interest	200.848	M
F	Height Diff of 10 & 11	2.100	M
G	Nature of Soil	Sandy Soil / Sandy Laom.....	
H	Avg. Bed Level	200.848	M
I	Observed HFL	203.400	M

1 Using Improved Rational Formula

$$Q\text{-}50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

   c = Runoff Coefficient

   I = 50 Years Rainfall Intensity lasting for tc hour duration where tc = time of concentration

   a = Catchment Area

2 Run off coefficient

Description of the catchment	Formula for C
a	Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b	Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c	Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d	Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine & plateau	$C = 0.456(R \times F)^{0.2}$
e	Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R =   50 Year 24 hour point rainfall (cm)

F =   Areal Reduction factor depending upon catchment Area & duration rainfall from table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 Min	60 To 100 Min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

tc   = $[L^3 / H]^{0.345}$

   = $[0.85 \times 0.85 \times 0.85 / 2.100]^{0.345}$

   =   **0.6543 hr.**

   =   0.6543 hr. x 60

   =   **39.2585 Min**

66

Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , $C = 0.249(R \times F)^{0.2}$

$$R = 300.00 \text{ mm}$$
$$F = 0.81$$
$$C = 0.249 \times (R \times F)^{0.2}$$
$$= 0.8922$$

But as per Annexture 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a   tc h Ratio   =   0.2659   From Fig. 4 of RBF - 16

b   1h Ratio =   =   0.34   From Fig. 4 of RBF - 16

c   Coefficient K   = $\dfrac{\text{tc h Ratio}}{\text{1h Ratio}}$

                          = $\dfrac{0.2659}{0.34}$

                          =   0.7819

d
I   R-50 (24)   =   300.00   mm

ii   R-50 (1)   =   R-50 (24) x 1 h to 24 h Rainfall Ratio.

                         =   300 x 0.34

                         =   102.00 mm

iii R-50 (tc)   =   K x R-50 (1)

                         =   0.7819 x102.00

                         =   79.7585 mm

iv   Int. of rainfall (I) = $\dfrac{\text{R-50 (tc)}}{\text{tc}}$

                         = $\dfrac{79.76}{0.6543}$

                         =   121.8973 mm/hr.

4   Design Flood Discharge =

    Q-50   =   0.278 x C xl x A

                         =   x 0.278   x 0.8922   x 121.8973   x 0.8862

                         =   26.7925 cum/sec

5   Checking for adequacy of Waterway Provided

a   Discharge   =   26.7925 cum/sec

c   Avg. Waterway Required   = $\dfrac{Q}{V}$

                                     = $\dfrac{26.7925}{1.75}$

                                     =   **15.3100 Sq.m**

d   Proposed Opening   =   1   6   4

e   Height of Water   = $\dfrac{\text{Avg. Waterway}}{\text{Total Width}}$

                                     = $\dfrac{15.3100}{6}$

                                     =   **2.5520   m**

f   Avg. Bed Level   =   200.848

h   **Min. Formation Required**   B.L   +   Ht of water   + free Board

                                     =   200.8480   +2.5520   +4.5670

                                     =   207.9670

k   **Formation level adopted**   =   207.9670

Provided formation Level is O.K.

68

Dedicated freight corridor Corporation of India.

Estimation of Design Discharge for Railway Bridge. Br. No. WR2

A	Topography	
B	Catchment Area	0.3257 Sq Km
C	Length of Longest Stream	0.600 Km
D	Height Of farthest point	204.422 M
E	Height of Point of Interest	201.172 M
F	Height Diff of 10 & 11	3.250 M
G	Nature of Soil	Sandy Soil / Sandy Laom.....
H	Avg. Bed Level	201.172 M
I	Observed HFL	204.500 M

0077

1 Using Improved Rational Formula

$Q\text{-}50 = 0.278 \times C \times I \times A$
Where
$Q\text{-}50 = $ 50 Years Design Flood Discharge
$\quad c = $ Runoff Coefficient
$\quad I = $ 50 Years Rainfall Intensity lasting for tc hour duration where tc = time of concentration

$\quad a = $ Catchment Area

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loarn/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine & plateau	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where
R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor depending upon catchment Area & duration rainfall from table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 Min	60 To 100 Min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.73	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

$$= [0.6 \times 0.6 \times 0.6 / 3.250]^{0.345}$$

$$= \textbf{0.3925 hr.}$$

$$= 0.3925 \text{ hr.} \times 60$$

$$= \textbf{23.5471 Min}$$

Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas ,   C = 0.249(R x F) ^ 0.2

$$R = 300.00 \text{ mm}$$
$$F = 0.72$$
$$C = 0.249 \times (R \times F)^{0.2}$$
$$= \mathbf{0.8511}$$

But as per Annexture 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3   Calculation of Intensity of Rainfall (I)

a   tc h Ratio   =   *0.1977*   From Fig. 4 of RBF - 16

b   1h Ratio =   =   0.34   From Fig. 4 of RBF - 16

c   Coefficient K   = $\dfrac{\text{tc h Ratio}}{\text{1h Ratio}}$

= $\dfrac{0.1977}{0.34}$

=   **0.5816**

d

I   R-50 (24)   =   300.00   mm

ii   R-50 (1)   =   R-50 (24) x 1 h to 24 h Rainfall Ratio.

=   300 x 0.34

=   **102.00 mm**

iii   R-50 (tc)   =   K x R-50 (1)

=   0.5816 x102.00

=   **59.3207 mm**

iv   Int. of rainfall (I)   = $\dfrac{\text{R-50 (tc)}}{\text{tc}}$

= $\dfrac{59.32}{0.3925}$

=   **151.1539 mm/hr.**

4   Design Flood Discharge =

Q-50   =   0.278 x C xI x A

=   x 0.278   x 0.8511   x 151.1539   x 0.3257

=   **11.6483 cum/sec**

71

5   Checking for adequacy of Waterway Provided

a   Discharge   =   11.6483 cum/sec

c   Avg. Waterway Required   = $\dfrac{Q}{V}$

       = $\dfrac{11.6483}{1.75}$

       =   **6.6562 Sq.m**

d   Proposed Opening   =   1   2   4

e   Height of Water   = $\dfrac{\text{Avg. Waterway}}{\text{Total Width}}$

       = $\dfrac{6.6562}{2}$

       =   **3.3280**   m

f   Avg. Bed Level   =   201.172

h   **Min. Formation Required**   B.L   +   Ht of water   + free Board

       =   201.1720   +3.3280   +3.4850

       =   207.9850

k   **Formation level adopted**   =   207.9850

Provided formation Level is O.K.

Dedicated freight corridor Corporation of India.

Estimation of Design Discharge for Railway Bridge. Br. No. WR3

A	Topography		
B	Catchment Area	0.1416	Sq Km
C	Length of Longest Stream	0.490	Km
D	Height Of farthest point	204.301	M
E	Height of Point of Interest	201.351	M
F	Height Diff of 10 & 11	2.950	M
G	Nature of Soil	Sandy Soil / Sandy Laom.....	
H	Avg. Bed Level	201.351	M
I	Observed HFL	203.950	M

1   **Using Improved Rational Formula**

$$Q\text{-}50 = 0.278 \times C \times I \times A$$
Where
Q-50 = 50 Years Design Flood Discharge
   c = Runoff Coefficient
   I = 50 Years Rainfall Intensity lasting for tc hour duration where tc = time of concentration

   a = Catchment Area

2   **Run off coefficient**

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine & plateau	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where
R =   50 Year 24 hour point rainfall (cm)

F =   Areal Reduction factor depending upon catchment Area & duration rainfall from table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 Min	60 To 100 Min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the caothment

for estimating the time of concentration(tc) as per bhatnagar formula

tc   = $[L^3 / H]^{0.345}$

      = $[0.49 \times 0.49 \times 0.49 / 2.950]^{0.345}$

      =   **0.3291 hr.**

      =   0.3291 hr. x 60

      =   **19.7431 Min**

Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , $C = 0.249(R \times F)^{0.2}$

$$R = 300.00 \text{ mm}$$
$$F = 0.72$$
$$C = 0.249 \times (R \times F)^{0.2}$$
$$= \mathbf{0.8511}$$

But as per Annexture 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a tc h Ratio   =   0.1787   From Fig. 4 of RBF - 16

b 1h Ratio =   =   0.34   From Fig. 4 of RBF - 16

c Coefficient K   = $\dfrac{\text{tc h Ratio}}{\text{1h Ratio}}$

$$= \dfrac{0.1787}{0.34}$$

$$= \mathbf{0.5256}$$

d

I R-50 (24)   =   300.00   mm

ii R-50 (1)   =   R-50 (24) x 1 h to 24 h Rainfall Ratio.

$$= 300 \times 0.34$$

$$= \mathbf{102.00 \text{ mm}}$$

iii R-50 (tc)   =   K x R-50 (1)

$$= 0.5256 \times 102.00$$

$$= \mathbf{53.6147 \text{ mm}}$$

iv Int. of rainfall (I)   = $\dfrac{\text{R-50 (tc)}}{\text{tc}}$

$$= \dfrac{53.61}{0.3291}$$

$$= \mathbf{162.9369 \text{ mm/hr.}}$$

4 Design Flood Discharge =

Q-50   =   0.278 x C xI x A

$$= \quad \times 0.278 \quad \times 0.8511 \quad \times 162.9369 \quad \times 0.1416$$

$$= \mathbf{5.4589 \text{ cum/sec}}$$

5 Checking for adequacy of Waterway Provided

a Discharge   =   5.4589 cum/sec

c Avg. Waterway Required   = $\dfrac{Q}{V}$

                               = $\dfrac{5.4589}{1.75}$

                               =   **3.1194 Sq.m**

d Proposed Opening   =   1   1.2   3

e Height of Water   = $\dfrac{\text{Avg. Waterway}}{\text{Total Width}}$

                               = $\dfrac{3.1194}{1.2}$

                               =   **2.5990**   m

f Avg. Bed Level   =   201.351

h **Min. Formation Required**   B.L   +   Ht of water   + free Board

                               =   201.3510   +2.5990   +2.6930

                               =   206.6430

k **Formation level adopted**   =   206.6430

Provided formation Level is O.K.

Dedicated freight corridor Corporation of India.

Estimation of Design Discharge for Railway Bridge. Br. No. WR4

A	Topography	
B	Catchment Area	0.2343 Sq Km
C	Length of Longest Stream	0.480 Km
D	Height Of farthest point	203.873 M
E	Height of Point of Interest	201.123 M
F	Height Diff of 10 & 11	2.750 M
G	Nature of Soil	Sandy Soil / Sandy Laom.....
H	Avg. Bed Level	201.123 M
I	Observed HFL	203.700 M

1   Using Improved Rational Formula

Q-50 = 0.278 x C x I x A
Where
Q-50 = 50 Years Design Flood Discharge
   c = Runoff Coefficient
   I = 50 Years Rainfall Intensity lasting for tc hour duration where tc = time of concentration

   a = Catchment Area

2   Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine & plateau	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where
R =   50 Year 24 hour point rainfall (cm)

F =   Areal Reduction factor depending upon catchment Area & duration rainfall from table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 Min	60 To 100 Min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

$$= [0.48 \times 0.48 \times 0.48 / 2.750]^{0.345}$$

=   **0.3300 hr.**

=   0.3300 hr. x 60

=   **19.8000 Min**

Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas ,   C = 0.249(R x F) ^ 0.2

$$R = 300.00 \text{ mm}$$
$$F = 0.72$$
$$C = 0.249 \times (R \times F)^{0.2}$$
$$= \mathbf{0.8511}$$

But as per Annexture 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3   Calculation of Intensity of Rainfall (I)

a   tc h Ratio   =   *0.1790*   From Fig. 4 of RBF - 16

b   1h Ratio =   =   0.34   From Fig. 4 of RBF - 16

c   Coefficient K   = $\dfrac{\text{tc h Ratio}}{\text{1h Ratio}}$

                            = $\dfrac{0.1790}{0.34}$

                            =   **0.5265**

d
I   R-50 (24)   =   300.00   mm

ii   R-50 (1)   =   R-50 (24) x 1 h to 24 h Rainfall Ratio.

                            =   300 x 0.34

                            =   **102.00 mm**

iii R-50 (tc)   =   K x R-50 (1)

                            =   0.5265 x102.00

                            =   **53.7001 mm**

iv   Int. of rainfall (I)   = $\dfrac{\text{R-50 (tc)}}{\text{tc}}$

                            = $\dfrac{53.70}{0.3300}$

                            =   **162.7272 mm/hr.**

4   Design Flood Discharge =

Q-50   =   0.278 x C xI x A

                            =   x 0.278   x 0.8511   x 162.7272   x 0.2343

                            =   **9.0211 cum/sec**

5 Checking for adequacy of Waterway Provided

a	Discharge	=	9.0211 cum/sec

c Avg. Waterway Required = $\dfrac{Q}{V}$

$$= \dfrac{9.0211}{1.75}$$

$$= \mathbf{5.1549\ Sq.m}$$

d	Proposed Opening	=	1	2	3

e Height of Water = $\dfrac{\text{Avg. Waterway}}{\text{Total Width}}$

$$= \dfrac{5.1549}{2}$$

$$= \mathbf{2.5770}\quad \mathbf{m}$$

f	Avg. Bed Level	=	201.123

h **Min. Formation Required**   B.L +   Ht of water   + free Board

	=	201.1230	+2.5770	+1.8400
	=	205.5400		

k **Formation level adopted**   =   205.5400

Provided formation Level is O.K.

Dedicated freight corridor Corporation of India.

Estimation of Design Discharge for Railway Bridge. Br. No. 195

A	Topography		
B	Catchment Area	0.1211	Sq Km
C	Length of Longest Stream	0.500	Km
D	Height Of farthest point	204.103	M
E	Height of Point of Interest	201.803	M
F	Height Diff of 10 & 11	2.300	M
G	Nature of Soil	Sandy Soil / Sandy Laom.....	
H	Avg. Bed Level	201.803	M
I	Observed HFL	203.076	M

1   **Using Improved Rational Formula**

$$Q\text{-}50 = 0.278 \times C \times I \times A$$
Where
Q-50 = 50 Years Design Flood Discharge
c = Runoff Coefficient
I = 50 Years Rainfall Intensity lasting for tc hour duration where tc = time of concentration

a = Catchment Area

2   **Run off coefficient**

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F) ^ 0.2$
b Alluvium/silty/coastal area	$C = 0.332(R \times F) ^ 0.2$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F) ^ 0.2$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine & plateau	$C = 0.456(R \times F) ^ 0.2$
e Hilly soil / plateau/barren	$C = 0.498(R \times F) ^ 0.2$

Where
R =   50 Year 24 hour point rainfall (cm)

F =   Areal Reduction factor depending upon catchment Area & duration rainfall from table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 Min	60 To 100 Min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

$$= [0.5 \times 0.5 \times 0.5 / 2.300]^{0.345}$$

=   **0.3661 hr.**

=   0.3661 hr. x 60

=   **21.9679 Min**

Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas ,   C = 0.249(R x F) ^ 0.2

$$R \quad = \quad 300.00 \text{ mm}$$
$$F \quad = \quad 0.72$$
$$C = 0.249 \times (R \times F)^{0.2}$$
$$= \quad \mathbf{0.8511}$$

But as per Annexture 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3   Calculation of Intensity of Rainfall (I)

a   tc h Ratio   =   *0.1898*   From Fig. 4 of RBF - 16

b   1h Ratio =   =   0.34   From Fig. 4 of RBF - 16

c   Coefficient K   = $\dfrac{\text{tc h Ratio}}{\text{1h Ratio}}$

                        = $\dfrac{0.1898}{0.34}$

                        =   **0.5584**

d
l   R-50 (24)   =   300.00   mm

ii   R-50 (1)   =   R-50 (24) x 1 h to 24 h Rainfall Ratio.

                        =   300 x 0.34

                        =   **102.00 mm**

iii   R-50 (tc)   =   K x R-50 (1)

                        =   0.5584 x102.00

                        =   **56.9519 mm**

iv   Int. of rainfall (I)   = $\dfrac{\text{R-50 (tc)}}{\text{tc}}$

                        = $\dfrac{56.95}{0.3661}$

                        =   **155.5501 mm/hr.**

4   Design Flood Discharge =

Q-50   =   0.278 x C xI x A

                =   x 0.278   x 0.8511   x 155.5501   x 0.1211

                =   **4.4570 cum/sec**

5   Checking for adequacy of Waterway Provided

a	Discharge	=	4.4570 cum/sec	

c   Avg. Waterway Required   = $\dfrac{Q}{V}$

= $\dfrac{4.4570}{1.75}$

=   **2.5469 Sq.m**

d	Proposed Opening	=	1	2	2

e   Height of Water   = $\dfrac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\dfrac{2.5469}{2}$

=   **1.2730   m**

f	Avg. Bed Level	=	201.803

h   **Min. Formation Required**   B.L   +   Ht of water   + free Board

=   201.8030   +1.2730   +1.2740

=   204.3500

k   **Formation level adopted**   =   204.3500

Provided formation Level is O.K.

Dedicated freight corridor Corporation of India.

Estimation of Design Discharge for Railway Bridge. Br. No. 196

A	Topography		
B	Catchment Area	0.0392	Sq Km
C	Length of Longest Stream	0.400	Km
D	Height Of farthest point	205.730	M
E	Height of Point of Interest	203.171	M
F	Height Diff of 10 & 11	2.559	M
G	Nature of Soil	Sandy Soil / Sandy Laom.....	
H	Avg. Bed Level	203.171	M
I	Observed HFL	203.938	M

1 **Using Improved Rational Formula**

$$Q\text{-}50 = 0.278 \times C \times I \times A$$

Where

$Q\text{-}50$ = 50 Years Design Flood Discharge

   c = Runoff Coefficient

  $I =$ 50 Years Rainfall Intensity lasting for tc hour duration where tc = time of concentration

   a = Catchment Area

2 **Run off coefficient**

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine & plateau	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

$R =$ 50 Year 24 hour point rainfall (cm)

$F =$ Areal Reduction factor depending upon catchment Area & duration rainfall from table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 Min	60 To 100 Min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

$$= [0.4 \times 0.4 \times 0.4 / 2.559]^{0.345}$$

$$= \mathbf{0.2801 \ hr.}$$

$$= 0.2801 \ hr. \times 60$$

$$= \mathbf{16.8073 \ Min}$$

Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas ,   C = 0.249(R x F) ^ 0.2

$$R = 300.00 \text{ mm}$$
$$F = 0.72$$
$$C = 0.249 \times (R \times F)^{0.2}$$
$$= \mathbf{0.8511}$$

But as per Annexture 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3   Calculation of Intensity of Rainfall (I)

a   tc h Ratio   =   *0.1620*   From Fig. 4 of RBF - 16

b   1h Ratio =   =   0.34   From Fig. 4 of RBF - 16

c   Coefficient K   = $\dfrac{\text{tc h Ratio}}{\text{1h Ratio}}$

= $\dfrac{0.1620}{0.34}$

=   **0.4766**

d
I   R-50 (24)   =   300.00   mm

ii   R-50 (1)   =   R-50 (24) x 1 h to 24 h Rainfall Ratio.

=   300 x 0.34

=   **102.00 mm**

iii   R-50 (tc)   =   K x R-50 (1)

=   0.4766 x102.00

=   **48.6147 mm**

iv   Int. of rainfall (I)   = $\dfrac{\text{R-50 (tc)}}{\text{tc}}$

= $\dfrac{48.61}{0.2801}$

=   **173.5481 mm/hr.**

4   **Design Flood Discharge =**

Q-50   =   0.278 x C xl x A

=   x 0.278   x 0.8511   x 173.5481   x 0.0392

=   **1.6097 cum/sec**

87

5   **Checking for adequacy of Waterway Provided**

a   Discharge   =   1.6097 cum/sec

c   Avg. Waterway Required   = $\dfrac{Q}{V}$

                                       = $\dfrac{1.6097}{1.75}$

                                       =   **0.9198 Sq.m**

d   Proposed Opening   =   1   1.2   1.2

e   Height of Water   = $\dfrac{\text{Avg. Waterway}}{\text{Total Width}}$

                                       = $\dfrac{0.9198}{1.2}$

                                       =   **0.7670**   m

f   Avg. Bed Level   =   203.171

h   **Min. Formation Required**   B.L   +   Ht of water   + free Board

                                       =   203.1710   +0.7670   +0.7830

                                       =   204.7210

k   **Formation level adopted**   =   204.7210

Provided formation Level is O.K.

Dedicated freight corridor Corporation of India.

Estimation of Design Discharge for Railway Bridge.   Br. No. 197

A	Topography		
B	Catchment Area	0.0231	Sq Km
C	Length of Longest Stream	0.385	Km
D	Height Of farthest point	205.238	M
E	Height of Point of Interest	203.088	M
F	Height Diff of 10 & 11	2.150	M
G	Nature of Soil	Sandy Soil / Sandy Laom.....	
H	Avg. Bed Level	203.088	M
I	Observed HFL	203.537	M

1   **Using Improved Rational Formula**

   Q-50 = 0.278 x C x I x A
   Where
   Q-50 = 50 Years Design Flood Discharge
     c = Runoff Coefficient
     I = 50 Years Rainfall Intensity lasting for tc hour duration where tc = time of concentration

     a = Catchment Area

2   **Run off coefficient**

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	C = 0.249(R x F) ^ 0.2
b Alluvium/silty/coastal area	C = 0.332(R x F) ^ 0.2
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	C = 0.415(R x F) ^ 0.2
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine & plateau	C = 0.456(R x F) ^ 0.2
e Hilly soil / plateau/barren	C = 0.498(R x F) ^ 0.2

Where
R =   50 Year 24 hour point rainfall (cm)

F =   Areal Reduction factor depending upon catchment Area & duration rainfall
             from table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 Min	60 To 100 Min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

$$= [0.385 \times 0.385 \times 0.385 / 2.150]^{0.345}$$

= **0.2859 hr.**

= 0.2859 hr. x 60

= **17.1558 Min**

Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas ,   C = 0.249(R x F) ^ 0.2

$$R = 300.00 \text{ mm}$$
$$F = 0.72$$
$$C = 0.249 \times (R \times F)^{0.2}$$
$$= \mathbf{0.8511}$$

But as per Annexture 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3   Calculation of Intensity of Rainfall (I)

a   tc h Ratio   =   *0.1644*   From Fig. 4 of RBF - 16

b   1h Ratio =   =   0.34   From Fig. 4 of RBF - 16

c   Coefficient K   = $\dfrac{\text{tc h Ratio}}{\text{1h Ratio}}$

                          = $\dfrac{0.1644}{0.34}$

                          =   **0.4834**

d
I   R-50 (24)   =   300.00   mm

ii   R-50 (1)   =   R-50 (24) x 1 h to 24 h Rainfall Ratio.

                          =   300 x 0.34

                          =   **102.00 mm**

iii   R-50 (tc)   =   K x R-50 (1)

                          =   0.4834 x102.00

                          =   **49.3117 mm**

iv   Int. of rainfall (I)   = $\dfrac{\text{R-50 (tc)}}{\text{tc}}$

                          = $\dfrac{49.31}{0.2859}$

                          =   **172.4604 mm/hr.**

4   Design Flood Discharge =

     Q-50   =   0.278 x C xI x A

                        =   x 0.278   x 0.8511   x 172.4604   x 0.0231

                        =   **0.9426 cum/sec**

5 Checking for adequacy of Waterway Provided

a Discharge = 0.9426 cum/sec

c Avg. Waterway Required = $\dfrac{Q}{V}$

= $\dfrac{0.9426}{1.75}$

= **0.5386 Sq.m**

d Proposed Opening = 1   1.2   1.2

e Height of Water = $\dfrac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\dfrac{0.5386}{1.2}$

= **0.4490**   m

f Avg. Bed Level = 203.088

h **Min. Formation Required**   B.L   +   Ht of water   + free Board

= 203.0880   +0.4490   +1.1010

= 204.6380

k **Formation level adopted** = 204.6380

Provided formation Level is O.K.

Dedicated freight corridor Corporation of India.

Estimation of Design Discharge for Railway Bridge. Br. No. 198

A	Topography		
B	Catchment Area	0.0367	Sq Km
C	Length of Longest Stream	0.350	Km
D	Height Of farthest point	205.201	M
E	Height of Point of Interest	202.799	M
F	Height Diff of 10 & 11	2.402	M
G	Nature of Soil	Sandy Soil / Sandy Laom.....	
H	Avg. Bed Level	202.799	M
I	Observed HFL	203.368	M

1   **Using Improved Rational Formula**

Q-50 = 0.278 x C x I x A
Where
Q-50 = 50 Years Design Flood Discharge
    c = Runoff Coefficient
    I = 50 Years Rainfall Intensity lasting for tc hour duration where tc = time of concentration

    a = Catchment Area

2   **Run off coefficient**

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F) \wedge 0.2$
b Alluvium/silty/coastal area	$C = 0.332(R \times F) \wedge 0.2$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F) \wedge 0.2$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine & plateau	$C = 0.456(R \times F) \wedge 0.2$
e Hilly soil / plateau/barren	$C = 0.498(R \times F) \wedge 0.2$

Where
R =   50 Year 24 hour point rainfall (cm)

F =   Areal Reduction factor depending upon catchment Area & duration rainfall from table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 Min	60 To 100 Min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

tc = $[L^3 / H]^{0.345}$

= $[0.35 \times 0.35 \times 0.35 / 2.402]^{0.345}$

=   **0.2494 hr.**

=   0.2494 hr. x 60

=   **14.9611 Min**

Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , $C = 0.249(R \times F)^{0.2}$

$$R \quad = \quad 300.00 \text{ mm}$$
$$F \quad = \quad 0.72$$
$$C = 0.249 \times (R \times F)^{0.2}$$
$$= \quad \mathbf{0.8511}$$

But as per Annexture 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3   **Calculation of Intensity of Rainfall (I)**

a   tc h Ratio   =   *0.1497*   From Fig. 4 of RBF - 16

b   1h Ratio =   =   0.34   From Fig. 4 of RBF - 16

c   Coefficient K   = $\dfrac{\text{tc h Ratio}}{\text{1h Ratio}}$

   = $\dfrac{0.1497}{0.34}$

   =   **0.4402**

d

I   R-50 (24)   =   300.00   mm

ii   R-50 (1)   =   R-50 (24) x 1 h to 24 h Rainfall Ratio.

   =   300 x 0.34

   =   **102.00 mm**

iii   R-50 (tc)   =   K x R-50 (1)

   =   0.4402 x102.00

   =   **44.9028 mm**

iv   Int. of rainfall (I)   = $\dfrac{\text{R-50 (tc)}}{\text{tc}}$

   = $\dfrac{44.90}{0.2494}$

   =   **180.0780 mm/hr.**

4   **Design Flood Discharge =**

   Q-50   =   0.278 x C xI x A

   =   x 0.278   x 0.8511   x 180.0780   x 0.0367

   =   **1.5637 cum/sec**

95

5 Checking for adequacy of Waterway Provided

a	Discharge	=	1.5637 cum/sec		

c Avg. Waterway Required = $\dfrac{Q}{V}$

= $\dfrac{1.5637}{1.75}$

= **0.8935 Sq.m**

d	Proposed Opening	=	1	2	1.2

e Height of Water = $\dfrac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\dfrac{0.8935}{2}$

= **0.4470** m

f	Avg. Bed Level	=	202.799

h **Min. Formation Required**   B.L +   Ht of water + free Board

= 202.7990   +0.4470   +1.1380

= 204.3840

k **Formation level adopted** = 204.5060

Provided formation Level is O.K.

Dedicated freight corridor Corporation of India.

Estimation of Design Discharge for Railway Bridge. Br. No. 199

A	Topography	
B	Catchment Area	0.0296 Sq Km
C	Length of Longest Stream	0.315 Km
D	Height Of farthest point	205.650 M
E	Height of Point of Interest	203.031 M
F	Height Diff of 10 & 11	2.619 M
G	Nature of Soil	Sandy Soil / Sandy Laom.....
H	Avg. Bed Level	203.031 M
I	Observed HFL	203.647 M

1   **Using Improved Rational Formula**

Q-50 = 0.278 x C x I x A
Where
Q-50 = 50 Years Design Flood Discharge
    c = Runoff Coefficient
    I = 50 Years Rainfall Intensity lasting for tc hour duration where tc = time of concentration

    a = Catchment Area

2   **Run off coefficient**

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	C = 0.249(R x F) ^ 0.2
b Alluvium/silty/coastal area	C = 0.332(R x F) ^ 0.2
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	C = 0.415(R x F) ^ 0.2
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine & plateau	C = 0.456(R x F) ^ 0.2
e Hilly soil / plateau/barren	C = 0.498(R x F) ^ 0.2

Where
R =   50 Year 24 hour point rainfall (cm)

F =   Areal Reduction factor depending upon catchment Area & duration rainfall from table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 Min	60 To 100 Min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

$$= [0.315 \times 0.315 \times 0.315 / 2.619]^{0.345}$$

$$= \mathbf{0.2170 \ hr.}$$

$$= 0.2170 \ hr. \times 60$$

$$= \mathbf{13.0210 \ Min}$$

Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas ,   C = 0.249(R x F) ^ 0.2

$$R = 300.00 \text{ mm}$$
$$F = 0.72$$
$$C = 0.249 \times (R \times F)^{0.2}$$
$$= \mathbf{0.8511}$$

But as per Annexture 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3   Calculation of Intensity of Rainfall (I)

a   tc h Ratio   =   0.1335   From Fig. 4 of RBF - 16

b   1h Ratio =   =   0.34   From Fig. 4 of RBF - 16

c   Coefficient K   = $\dfrac{\text{tc h Ratio}}{\text{1h Ratio}}$

                              = $\dfrac{0.1335}{0.34}$

                              =   **0.3927**

d

I   R-50 (24)   =   300.00   mm

ii   R-50 (1)   =   R-50 (24) x 1 h to 24 h Rainfall Ratio.

                              =   300 x 0.34

                              =   **102.00 mm**

iii   R-50 (tc)   =   K x R-50 (1)

                              =   0.3927 x102.00

                              =   **40.0526 mm**

iv   Int. of rainfall (I)   = $\dfrac{\text{R-50 (tc)}}{\text{tc}}$

                              = $\dfrac{40.05}{0.2170}$

                              =   **184.5593 mm/hr.**

4   **Design Flood Discharge =**

     Q-50   =   0.278 x C xI x A

                   =   x 0.278   x 0.8511   x 184.5593   x 0.0296

                   =   **1.2926 cum/sec**

5 Checking for adequacy of Waterway Provided

a	Discharge	=	1.2926 cum/sec	

c Avg. Waterway Required = $\dfrac{Q}{V}$

$$= \dfrac{1.2926}{1.75}$$

$$= \mathbf{0.7386 \ Sq.m}$$

d	Proposed Opening	=	1	1.2		1.2

e Height of Water = $\dfrac{\text{Avg. Waterway}}{\text{Total Width}}$

$$= \dfrac{0.7386}{1.2}$$

$$= \mathbf{0.6160} \quad \mathbf{m}$$

f	Avg. Bed Level	=	203.031

h **Min. Formation Required**   B.L +   Ht of water + free Board

$$= \quad 203.0310 \qquad +0.6160 \quad +0.9340$$

$$= \quad 204.5810$$

k **Formation level adopted**   =   204.5810

Provided formation Level is O.K.

Dedicated freight corridor Corporation of India.

Estimation of Design Discharge for Railway Bridge. Br. No. 200

A	Topography		
B	Catchment Area	0.0719	Sq Km
C	Length of Longest Stream	0.300	Km
D	Height Of farthest point	204.980	M
E	Height of Point of Interest	202.830	M
F	Height Diff of 10 & 11	2.150	M
G	Nature of Soil	Sandy Soil / Sandy Laom.....	
H	Avg. Bed Level	202.830	M
I	Observed HFL	203.724	M

1   **Using Improved Rational Formula**

$$Q\text{-}50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

c = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for tc hour duration where tc = time of concentration

a = Catchment Area

2   **Run off coefficient**

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine & plateau	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R =   50 Year 24 hour point rainfall (cm)

F =   Areal Reduction factor depending upon catchment Area & duration rainfall from table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 Min	60 To 100 Min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0 68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

tc   = $[L^3 / H]^{0.345}$

      = $[0.3 \times 0.3 \times 0.3 / 2.150]^{0.345}$

      =   **0.2209 hr.**

      =   0.2209 hr. x 60

      =   **13.2520 Min**

Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas ,   C = 0.249(R x F) ^ 0.2

$$R = 300.00 \text{ mm}$$
$$F = 0.72$$
$$C = 0.249 \times (R \times F)^{0.2}$$
$$= \mathbf{0.8511}$$

But as per Annexture 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3   Calculation of Intensity of Rainfall (I)

a   tc h Ratio   =   *0.1354*   From Fig. 4 of RBF - 16

b   1h Ratio =   =   0.34   From Fig. 4 of RBF - 16

c   Coefficient K   = $\dfrac{\text{tc h Ratio}}{\text{1h Ratio}}$

                                            = $\dfrac{0.1354}{0.34}$

                                            =   **0.3983**

d
I   R-50 (24)   =   300.00   mm

ii   R-50 (1)   =   R-50 (24) x 1 h to 24 h Rainfall Ratio.

                                      =   300 x 0.34

                                      =   **102.00 mm**

iii   R-50 (tc)   =   K x R-50 (1)

                                      =   0.3983 x102.00

                                      =   **40.6299 mm**

iv   Int. of rainfall (I)   = $\dfrac{\text{R-50 (tc)}}{\text{tc}}$

                                                   = $\dfrac{40.63}{0.2209}$

                                                   =   **183.9571 mm/hr.**

4   Design Flood Discharge =

Q-50   =   0.278 x C xI x A

                  =   x 0.278   x 0.8511   x 183.9571   x 0.0719

                  =   **3.1295 cum/sec**

103

5 Checking for adequacy of Waterway Provided

a   Discharge   =   3.1295 cum/sec

c   Avg. Waterway Required   = $\dfrac{Q}{V}$

                                     = $\dfrac{3.1295}{1.75}$

                                     =   **1.7883 Sq.m**

d   Proposed Opening   =   1   2   1.2

e   Height of Water   = $\dfrac{\text{Avg. Waterway}}{\text{Total Width}}$

                                     = $\dfrac{1.7883}{2}$

                                     =   **0.8940**   m

f   Avg. Bed Level   =   202.830

h   **Min. Formation Required**   B.L   +   Ht of water   + free Board

                                     =   202.8300   +0.8940   +0.8580

                                     =   204.5820

k   **Formation level adopted**   =   204.5820

Provided formation Level is O.K.

Dedicated freight corridor Corporation of India.

Estimation of Design Discharge for Railway Bridge. Br. No. 201

A	Topography	
B	Catchment Area	0.0353 Sq Km
C	Length of Longest Stream	0.280 Km
D	Height Of farthest point	205.331 M
E	Height of Point of Interest	203.055 M
F	Height Diff of 10 & 11	2.276 M
G	Nature of Soil	Sandy Soil / Sandy Laom.....
H	Avg. Bed Level	203.055 M
I	Observed HFL	203.800 M

1 **Using Improved Rational Formula**

   Q-50 = 0.278 x C x I x A
   Where
   Q-50 = 50 Years Design Flood Discharge
       c = Runoff Coefficient
     I = 50 Years Rainfall Intensity lasting for tc hour duration where tc = time of concentration

       a = Catchment Area

2 **Run off coefficient**

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	C = 0.249(R x F) ^ 0.2
b Alluvium/silty/coastal area	C = 0.332(R x F) ^ 0.2
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	C = 0.415(R x F) ^ 0.2
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine & plateau	C = 0.456(R x F) ^ 0.2
e Hilly soil / plateau/barren	C = 0.498(R x F) ^ 0.2

   Where
   R =   50 Year 24 hour point rainfall (cm)

   F =   Areal Reduction factor depending upon catchment Area & duration rainfall
                from table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 Min	60 To 100 Min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13 0 to 25.0 Sq. Km	0.68	0.78	0.85

   Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

   for estimating the time of concentration(tc) as per bhatnagar formula

   tc = $[L^3 / H]^{0.345}$

       = $[0.28 \times 0.28 \times 0.28 / 2.276]^{0.345}$

       =   **0.2016 hr.**

       =   0.2016 hr. x 60

       =   **12.0986 Min**

0111

Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas ,   C = 0.249(R x F) ^ 0.2

$$R = 300.00 \text{ mm}$$
$$F = 0.72$$
$$C = 0.249 \times (R \times F)^{0.2}$$
$$= \mathbf{0.8511}$$

But as per Annexture 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3   Calculation of Intensity of Rainfall (I)

a   tc h Ratio   =   *0.1258*   From Fig. 4 of RBF - 16

b   1h Ratio =   =   0.34   From Fig. 4 of RBF - 16

c   Coefficient K   = $\dfrac{\text{tc h Ratio}}{\text{1h Ratio}}$

                          = $\dfrac{0.1258}{0.34}$

                          =   **0.3701**

d
I   R-50 (24)   =   300.00   mm

ii   R-50 (1)   =   R-50 (24) x 1 h to 24 h Rainfall Ratio.

                          =   300 x 0.34

                          =   **102.00 mm**

iii   R-50 (tc)   =   K x R-50 (1)

                          =   0.3701 x102.00

                          =   **37.7465 mm**

iv   Int. of rainfall (I) = $\dfrac{\text{R-50 (tc)}}{\text{tc}}$

                          = $\dfrac{37.75}{0.2016}$

                          =   **187.1943 mm/hr.**

4   Design Flood Discharge =

Q-50   =   0.278 x C xI x A

                          =   x 0.278   x 0.8511   x 187.1943   x 0.0353

                          =   **1.5635 cum/sec**

107

5 Checking for adequacy of Waterway Provided

a   Discharge   =   1.5635 cum/sec

c   Avg. Waterway Required   = $\dfrac{Q}{V}$

                                 = $\dfrac{1.5635}{1.75}$

                                 =   **0.8934 Sq.m**

d   Proposed Opening   =   1   1.2   1.2

e   Height of Water   = $\dfrac{\text{Avg. Waterway}}{\text{Total Width}}$

                                 = $\dfrac{0.8934}{1.2}$

                                 =   **0.7450   m**

f   Avg. Bed Level   =   203.055

h   **Min. Formation Required**   B.L +   Ht of water   + free Board

                                 =   203.0550   +0.7450   +0.8050

                                 =   204.6050

k   **Formation level adopted**   =   204.6050

Provided formation Level is O.K.

Dedicated freight corridor Corporation of India.

Estimation of Design Discharge for Railway Bridge. Br. No. 202

A	Topography		
B	Catchment Area	0.0878	Sq Km
C	Length of Longest Stream	0.475	Km
D	Height Of farthest point	205.299	M
E	Height of Point of Interest	202.799	M
F	Height Diff of 10 & 11	2.500	M
G	Nature of Soil	Sandy Soil / Sandy Laom.....	
H	Avg. Bed Level	202.799	M
I	Observed HFL	203.755	M

1 **Using Improved Rational Formula**

$$Q\text{-}50 = 0.278 \times C \times I \times A$$
Where
Q-50 = 50 Years Design Flood Discharge
  c = Runoff Coefficient
  I = 50 Years Rainfall Intensity lasting for tc hour duration where tc = time of concentration

  a = Catchment Area

2 **Run off coefficient**

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine & plateau	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where
R =   50 Year 24 hour point rainfall (cm)

F =   Areal Reduction factor depending upon catchment Area & duration rainfall from table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 Min	60 To 100 Min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note. Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

$$= [0.475 \times 0.475 \times 0.475 / 2.500]^{0.345}$$

= **0.3374 hr.**

= 0.3374 hr. x 60

= **20.2414 Min**

110

Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , $C = 0.249(R \times F)^{0.2}$

$$R = 300.00 \text{ mm}$$
$$F = 0.72$$
$$C = 0.249 \times (R \times F)^{0.2}$$
$$= \mathbf{0.8511}$$

But as per Annexture 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a tc h Ratio   =   *0.1812*   From Fig. 4 of RBF - 16

b 1h Ratio =   =   0.34   From Fig. 4 of RBF - 16

c Coefficient K   = $\dfrac{\text{tc h Ratio}}{\text{1h Ratio}}$

        = $\dfrac{0.1812}{0.34}$

        =   **0.5330**

d

I R-50 (24)   =   300.00   mm

ii R-50 (1)   =   R-50 (24) x 1 h to 24 h Rainfall Ratio.

        =   300 x 0.34

        =   **102.00 mm**

iii R-50 (tc)   =   K x R-50 (1)

        =   0.5330 x102.00

        =   **54.3621 mm**

iv Int. of rainfall (I)   = $\dfrac{\text{R-50 (tc)}}{tc}$

        = $\dfrac{54.36}{0.3374}$

        =   **161.1416 mm/hr.**

4 Design Flood Discharge =

Q-50   =   0.278 x C xI x A

        =   x 0.278   x 0.8511   x 161.1416   x 0.0878

        =   **3.3476 cum/sec**

111

5   Checking for adequacy of Waterway Provided

a	Discharge	=	3.3476 cum/sec

c   Avg. Waterway Required   = $\dfrac{Q}{V}$

   = $\dfrac{3.3476}{1.75}$

   =   **1.9129 Sq.m**

d	Proposed Opening	=	1	2	1.2

e   Height of Water   = $\dfrac{\text{Avg. Waterway}}{\text{Total Width}}$

   = $\dfrac{1.9129}{2}$

   =   **0.9560   m**

f   Avg. Bed Level   =   202.799

h   **Min. Formation Required**   B.L   +   Ht of water   + free Board

   =   202.7990   +0.9560   +0.9850

   =   204.7400

k   **Formation level adopted**   =   204.7400

Provided formation Level is O.K.

Dedicated freight corridor Corporation of India.

Estimation of Design Discharge for Railway Bridge. Br. No. 203

A	Topography		
B	Catchment Area	0.0531	Sq Km
C	Length of Longest Stream	0.430	Km
D	Height Of farthest point	205.385	M
E	Height of Point of Interest	203.385	M
F	Height Diff of 10 & 11	2.000	M
G	Nature of Soil	Sandy Soil / Sandy Laom.....	
H	Avg. Bed Level	203.385	M
I	Observed HFL	203.970	M

113

1   **Using Improved Rational Formula**

$$Q\text{-}50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

c = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for tc hour duration where tc = time of concentration

a = Catchment Area

2   **Run off coefficient**

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine & plateau	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R =   50 Year 24 hour point rainfall (cm)

F =   Areal Reduction factor depending upon catchment Area & duration rainfall from table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 Min	60 To 100 Min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

tc   = $[L^3 / H]^{0.345}$

      = $[0.43 \times 0.43 \times 0.43 / 2.000]^{0.345}$

      =   **0.3287 hr.**

      =   0.3287 hr. x 60

      =   **19.7213 Min**

Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , $C = 0.249(R \times F)^{0.2}$

$$R = 300.00 \text{ mm}$$
$$F = 0.72$$
$$C = 0.249 \times (R \times F)^{0.2}$$
$$= \mathbf{0.8511}$$

But as per Annexture 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3   Calculation of Intensity of Rainfall (I)

a   tc h Ratio   =   *0.1786*   From Fig. 4 of RBF - 16

b   1h Ratio =   =   0.34   From Fig. 4 of RBF - 16

c   Coefficient K   = $\dfrac{\text{tc h Ratio}}{\text{1h Ratio}}$

                             = $\dfrac{0.1786}{0.34}$

                             =   **0.5253**

d

I   R-50 (24)   =   300.00   mm

ii   R-50 (1)   =   R-50 (24) x 1 h to 24 h Rainfall Ratio.

                             =   300 x 0.34

                             =   **102.00 mm**

iii   R-50 (tc)   =   K x R-50 (1)

                             =   0.5253 x102.00

                             =   **53.5820 mm**

iv   Int. of rainfall (I)   = $\dfrac{\text{R-50 (tc)}}{\text{tc}}$

                             = $\dfrac{53.58}{0.3287}$

                             =   **163.0176 mm/hr.**

4   Design Flood Discharge =

     Q-50   =   0.278 x C xI x A

                             =   x 0.278   x 0.8511   x 163.0176   x 0.0531

                             =   **2.0481 cum/sec**

115

5 Checking for adequacy of Waterway Provided

a Discharge = 2.0481 cum/sec

c Avg. Waterway Required = $\dfrac{Q}{V}$

                            = $\dfrac{2.0481}{1.75}$

                            = **1.1703 Sq.m**

d Proposed Opening = 1   2   1.2

e Height of Water = $\dfrac{\text{Avg. Waterway}}{\text{Total Width}}$

                            = $\dfrac{1.1703}{2}$

                            = **0.5850** m

f Avg. Bed Level = 203.385

h **Min. Formation Required**   B.L + Ht of water + free Board

                            = 203.3850   +0.5850   +0.9650

                            = 204.9350

k **Formation level adopted** = 204.9350

Provided formation Level is O.K.

116

Dedicated freight corridor Corporation of India.

Estimation of Design Discharge for Railway Bridge. Br. No. 204

A	Topography		
B	Catchment Area	0.0340	Sq Km
C	Length of Longest Stream	0.350	Km
D	Height Of farthest point	206.354	M
E	Height of Point of Interest	203.554	M
F	Height Diff of 10 & 11	2.800	M
G	Nature of Soil	Sandy Soil / Sandy Laom.....	
H	Avg. Bed Level	203.554	M
I	Observed HFL	204.250	M

1 **Using Improved Rational Formula**

Q-50 = 0.278 x C x I x A
Where
Q-50 = 50 Years Design Flood Discharge
   c = Runoff Coefficient
   I = 50 Years Rainfall Intensity lasting for tc hour duration where tc = time of concentration

   a = Catchment Area

2 **Run off coefficient**

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine & plateau	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where
R =   50 Year 24 hour point rainfall (cm)

F =   Areal Reduction factor depending upon catchment Area & duration rainfall from table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 Min	60 To 100 Min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

$$= [0.35 \times 0.35 \times 0.35 / 2.800]^{0.345}$$

= **0.2365 hr.**

= 0.2365 hr. x 60

= **14.1903 Min**

118

Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas ,   C = 0.249(R x F) ^ 0.2

$$R = 300.00 \text{ mm}$$
$$F = 0.72$$
$$C = 0.249 \times (R \times F)^{0.2}$$
$$= \mathbf{0.8511}$$

But as per Annexture 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3   **Calculation of Intensity of Rainfall (I)**

a   tc h Ratio   =   *0.1433*   From Fig. 4 of RBF - 16

b   1h Ratio =   =   0.34   From Fig. 4 of RBF - 16

c   Coefficient K   = $\dfrac{\text{tc h Ratio}}{\text{1h Ratio}}$

                    = $\dfrac{0.1433}{0.34}$

                    =   **0.4213**

d

I   R-50 (24)   =   300.00   mm

ii   R-50 (1)   =   R-50 (24) x 1 h to 24 h Rainfall Ratio.

                    =   300 x 0.34

                    =   **102.00 mm**

iii   R-50 (tc)   =   K x R-50 (1)

                    =   0.4213 x102.00

                    =   **42.9758 mm**

iv   Int. of rainfall (I)   = $\dfrac{\text{R-50 (tc)}}{\text{tc}}$

                    = $\dfrac{42.98}{0.2365}$

                    =   **181.7118 mm/hr.**

4   **Design Flood Discharge =**

Q-50   =   0.278 x C xI x A

            =   x 0.278   x 0.8511   x 181.7118   x 0.0340

            =   **1.4618 cum/sec**

119

5 Checking for adequacy of Waterway Provided

a   Discharge = 1.4618 cum/sec

c   Avg. Waterway Required = $\dfrac{Q}{V}$

   = $\dfrac{1.4618}{1.75}$

   = **0.8353 Sq.m**

d   Proposed Opening = 1   1.2   1.2

e   Height of Water = $\dfrac{\text{Avg. Waterway}}{\text{Total Width}}$

   = $\dfrac{0.8353}{1.2}$

   = **0.6960** m

f   Avg. Bed Level = 203.554

h   **Min. Formation Required**   B.L +   Ht of water   + free Board

   = 203.5540   +0.6960   +0.8540

   = 205.1040

k   **Formation level adopted** = 205.1040

Provided formation Level is O.K.

Dedicated freight corridor Corporation of India.

Estimation of Design Discharge for Railway Bridge. Br. No. 205

A	Topography		
B	Catchment Area	0.0742	Sq Km
C	Length of Longest Stream	0.500	Km
D	Height Of farthest point	206.751	M
E	Height of Point of Interest	204.051	M
F	Height Diff of 10 & 11	2.700	M
G	Nature of Soil	Sandy Soil / Sandy Laom.....	
H	Avg. Bed Level	204.051	M
I	Observed HFL	204.850	M

121

1 Using Improved Rational Formula

Q-50 = 0.278 x C x I x A

Where

Q-50 = 50 Years Design Flood Discharge

c = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for tc hour duration where tc = time of concentration

a = Catchment Area

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine & plateau	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor depending upon catchment Area & duration rainfall from table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 Min	60 To 100 Min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

tc = $[L^3 / H]^{0.345}$

= $[0.5 \times 0.5 \times 0.5 / 2.700]^{0.345}$

= **0.3464 hr.**

= 0.3464 hr. x 60

= **20.7857 Min**

122

Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , $C = 0.249(R \times F)^{0.2}$

$$R = 300.00 \text{ mm}$$
$$F = 0.72$$
$$C = 0.249 \times (R \times F)^{0.2}$$
$$= \mathbf{0.8511}$$

But as per Annexture 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3   Calculation of Intensity of Rainfall (I)

a   tc h Ratio   =   *0.1839*   From Fig. 4 of RBF - 16

b   1h Ratio =   =   0.34   From Fig. 4 of RBF - 16

c   Coefficient K   = $\dfrac{\text{tc h Ratio}}{\text{1h Ratio}}$

$$= \dfrac{0.1839}{0.34}$$

$$= \mathbf{0.5410}$$

d

I   R-50 (24)   =   300.00   mm

ii   R-50 (1)   =   R-50 (24) x 1 h to 24 h Rainfall Ratio.

$$= 300 \times 0.34$$

$$= \mathbf{102.00 \text{ mm}}$$

iii   R-50 (tc)   =   K x R-50 (1)

$$= 0.5410 \times 102.00$$

$$= \mathbf{55.1786 \text{ mm}}$$

iv   Int. of rainfall (I)   = $\dfrac{\text{R-50 (tc)}}{\text{tc}}$

$$= \dfrac{55.18}{0.3464}$$

$$= \mathbf{159.2785 \text{ mm/hr.}}$$

4   **Design Flood Discharge =**

Q-50   =   0.278 x C xI x A

       =   x 0.278   x 0.8511   x 159.2785   x 0.0742

       =   **2.7963 cum/sec**

123

5 Checking for adequacy of Waterway Provided

a Discharge = 2.7963 cum/sec

c Avg. Waterway Required = $\dfrac{Q}{V}$

= $\dfrac{2.7963}{1.75}$

= **1.5979 Sq.m**

d Proposed Opening = 1   2   1.2

e Height of Water = $\dfrac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\dfrac{1.5979}{2}$

= **0.7990**   **m**

f Avg. Bed Level = 204.051

h **Min. Formation Required**   B.L   +   Ht of water   + free Board

= 204.0510   +0.7990   +0.7510

= 205.6010

k **Formation level adopted** = 205.6010

Provided formation Level is O.K.

Dedicated freight corridor Corporation of India.

Estimation of Design Discharge for Railway Bridge. Br. No. 206

A	Topography	
B	Catchment Area	0.2314 Sq Km
C	Length of Longest Stream	0.650 Km
D	Height Of farthest point	206.013 M
E	Height of Point of Interest	203.563 M
F	Height Diff of 10 & 11	2.450 M
G	Nature of Soil	Sandy Soil / Sandy Laom.....
H	Avg. Bed Level	203.563 M
I	Observed HFL	205.750 M

1 Using Improved Rational Formula

$$Q\text{-}50 = 0.278 \times C \times I \times A$$

Where

$Q\text{-}50$ = 50 Years Design Flood Discharge

c = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for tc hour duration where tc = time of concentration

a = Catchment Area

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine & plateau	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor depending upon catchment Area & duration rainfall from table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 Min	60 To 100 Min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3/H]^{0.345}$$

$$= [0.65 \times 0.65 \times 0.65 / 2.450]^{0.345}$$

$$= \mathbf{0.4700\ hr.}$$

$$= 0.4700\ hr. \times 60$$

$$= \mathbf{28.2003\ Min}$$

Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas ,   C = 0.249(R x F) ^ 0.2

$$R = 300.00 \text{ mm}$$
$$F = 0.72$$
$$C = 0.249 \times (R \times F)^{0.2}$$
$$= \mathbf{0.8511}$$

But as per Annexture 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.2190	From Fig. 4 of RBF - 16
b	1h Ratio =	=	0.34	From Fig. 4 of RBF - 16

c   Coefficient K $= \dfrac{\text{tc h Ratio}}{\text{1h Ratio}}$

$$= \dfrac{0.2190}{0.34}$$

$$= \mathbf{0.6441}$$

d

i   R-50 (24)   =   300.00   mm

ii   R-50 (1)   =   R-50 (24) x 1 h to 24 h Rainfall Ratio.

$$= 300 \times 0.34$$

$$= \mathbf{102.00 \text{ mm}}$$

iii   R-50 (tc)   =   K x R-50 (1)

$$= 0.6441 \times 102.00$$

$$= \mathbf{65.7003 \text{ mm}}$$

iv   Int. of rainfall (I) $= \dfrac{\text{R-50 (tc)}}{\text{tc}}$

$$= \dfrac{65.70}{0.4700}$$

$$= \mathbf{139.7862 \text{ mm/hr.}}$$

4   Design Flood Discharge =

Q-50   =   0.278 x C xI x A

$$= \times 0.278 \quad \times 0.8511 \quad \times 139.7862 \quad \times 0.2314$$

$$= \mathbf{7.6534 \text{ cum/sec}}$$

127

5   Checking for adequacy of Waterway Provided

a	Discharge	=	7.6534 cum/sec

c   Avg. Waterway Required   = $\dfrac{Q}{V}$

= $\dfrac{7.6534}{1.75}$

=   **4.3734 Sq.m**

d	Proposed Opening	=	1 2 3

e   Height of Water   = $\dfrac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\dfrac{4.3734}{2}$

=   **2.1870   m**

f	Avg. Bed Level	=	203.563

h   **Min. Formation Required**   B.L   +   Ht of water   + free Board

=   203.5630   +2.1870   +1.2930

=   207.0430

k   **Formation level adopted**   =   207.0430

Provided formation Level is O.K.

Dedicated freight corridor Corporation of India.

Estimation of Design Discharge for Railway Bridge. Br. No. 208

A	Topography		
B	Catchment Area	0.1709	Sq Km
C	Length of Longest Stream	0.540	Km
D	Height Of farthest point	205.642	M
E	Height of Point of Interest	203.242	M
F	Height Diff of 10 & 11	2.400	M
G	Nature of Soil	Sandy Soil / Sandy Laom.....	
H	Avg. Bed Level	203.242	M
I	Observed HFL	204.991	M

1   **Using Improved Rational Formula**

   Q-50 = 0.278 x C x I x A
   Where
   Q-50 = 50 Years Design Flood Discharge
      c = Runoff Coefficient
      I = 50 Years Rainfall Intensity lasting for tc hour duration where tc = time of concentration

      a = Catchment Area

2   **Run off coefficient**

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	C = 0.249(R x F) ^ 0.2
b Alluvium/silty/coastal area	C = 0.332(R x F) ^ 0.2
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	C = 0.415(R x F) ^ 0.2
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine & plateau	C = 0.456(R x F) ^ 0.2
e Hilly soil / plateau/barren	C = 0.498(R x F) ^ 0.2

   Where
   R =   50 Year 24 hour point rainfall (cm)

   F =   Areal Reduction factor depending upon catchment Area & duration rainfall from table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 Min	60 To 100 Min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

   Note:- Rainfall Duration shall be equal to the calculated tc for the cacthment

   for estimating the time of concentration(tc) as per bhatnagar formula

   $$tc = [L^3 / H]^{0.345}$$

   $$= [0.54 \times 0.54 \times 0.54 / 2.400]^{0.345}$$

   = **0.3907 hr.**

   = 0.3907 hr. x 60

   = **23.4426 Min**

Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas ,   C = 0.249(R x F) ^ 0.2

$$R = 300.00 \text{ mm}$$
$$F = 0.72$$
$$C = 0.249 \times (R \times F)^{0.2}$$
$$= \mathbf{0.8511}$$

But as per Annexture 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3   Calculation of Intensity of Rainfall (I)

a   tc h Ratio   =   0.1972   From Fig. 4 of RBF - 16

b   1h Ratio =   =   0.34   From Fig. 4 of RBF - 16

c   Coefficient K   = $\dfrac{\text{tc h Ratio}}{\text{1h Ratio}}$

                             = $\dfrac{0.1972}{0.34}$

                             =   **0.5800**

d
I   R-50 (24)   =   300.00   mm

ii   R-50 (1)   =   R-50 (24) x 1 h to 24 h Rainfall Ratio.

                             =   300 x 0.34

                             =   **102.00 mm**

iii R-50 (tc)   =   K x R-50 (1)

                             =   0.5800 x102.00

                             =   **59.1639 mm**

iv   Int. of rainfall (I)   = $\dfrac{\text{R-50 (tc)}}{\text{tc}}$

                             = $\dfrac{59.16}{0.3907}$

                             =   **151.4266 mm/hr.**

4   Design Flood Discharge =

     Q-50   =   0.278 x C xI x A

                             =   x 0.278   x 0.8511   x 151.4266   x 0.1709

                             =   **6.1231 cum/sec**

5 Checking for adequacy of Waterway Provided

a   Discharge   =   6.1231 cum/sec

c   Avg. Waterway Required   = $\dfrac{Q}{V}$

                                 = $\dfrac{6.1231}{1.75}$

                                 =   **3.4989 Sq.m**

d   Proposed Opening   =   1   2   2

e   Height of Water   = $\dfrac{\text{Avg. Waterway}}{\text{Total Width}}$

                                 = $\dfrac{3.4989}{2}$

                                 =   **1.7490   m**

f   Avg. Bed Level   =   203.242

h   **Min. Formation Required**   B.L   +   Ht of water   + free Board

                                 =   203.2420   +1.7490   +1.3140

                                 =   206.3050

k   **Formation level adopted**   =   206.3050

Provided formation Level is O.K.

Dedicated freight corridor Corporation of India.

Estimation of Design Discharge for Railway Bridge. Br. No. 209

A	Topography	
B	Catchment Area	0.1492 Sq Km
C	Length of Longest Stream	0.455 Km
D	Height Of farthest point	206.033 M
E	Height of Point of Interest	202.783 M
F	Height Diff of 10 & 11	3.250 M
G	Nature of Soil	Sandy Soil / Sandy Laom.....
H	Avg. Bed Level	202.783 M
I	Observed HFL	204.507 M

1   **Using Improved Rational Formula**

$$Q\text{-}50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

c = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for tc hour duration where tc = time of concentration

a = Catchment Area

2   **Run off coefficient**

Description of the catchment	Formula for C
a	Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b	Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c	Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d	Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine & plateau	$C = 0.456(R \times F)^{0.2}$
e	Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R =   50 Year 24 hour point rainfall (cm)

F =   Areal Reduction factor depending upon catchment Area & duration rainfall from table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 Min	60 To 100 Min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

tc = $[L^3 / H]^{0.345}$

= $[0.455 \times 0.455 \times 0.455 / 3.250]^{0.345}$

= **0.2947 hr.**

= 0.2947 hr. x 60

= **17.6845 Min**

Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , $C = 0.249(R \times F)^{0.2}$

$$R = 300.00 \text{ mm}$$
$$F = 0.72$$
$$C = 0.249 \times (R \times F)^{0.2}$$
$$= \mathbf{0.8511}$$

But as per Annexture 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3   Calculation of Intensity of Rainfall (I)

a   tc h Ratio   =   0.1679   From Fig. 4 of RBF - 16

b   1h Ratio =   =   0.34   From Fig. 4 of RBF - 16

c   Coefficient K   = $\dfrac{\text{tc h Ratio}}{\text{1h Ratio}}$

                          = $\dfrac{0.1679}{0.34}$

                          =   **0.4938**

d
I   R-50 (24)   =   300.00   mm

ii   R-50 (1)   =   R-50 (24) x 1 h to 24 h Rainfall Ratio.

                          =   300 x 0.34

                          =   **102.00 mm**

iii R-50 (tc)   =   K x R-50 (1)

                          =   0.4938 x102.00

                          =   **50.3690 mm**

iv   Int. of rainfall (I) = $\dfrac{\text{R-50 (tc)}}{\text{tc}}$

                          = $\dfrac{50.37}{0.2947}$

                          =   **170.8918 mm/hr.**

4   Design Flood Discharge =

     Q-50   =   0.278 x C xI x A

                          =   x 0.278   x 0.8511   x 170.8918   x 0.1492

                          =   **6.0328 cum/sec**

135

5 Checking for adequacy of Waterway Provided

a Discharge   =   6.0328 cum/sec

c Avg. Waterway Required   = $\dfrac{Q}{V}$

                                      = $\dfrac{6.0328}{1.75}$

                                      =   **3.4473 Sq.m**

d Proposed Opening   =   1   2   2

e Height of Water   = $\dfrac{\text{Avg. Waterway}}{\text{Total Width}}$

                                      = $\dfrac{3.4473}{2}$

                                      =   **1.7240**   m

f Avg. Bed Level   =   202.783

h **Min. Formation Required**   B.L   +   Ht of water   + free Board

                                      =   202.7830   +1.7240   +1.3450

                                      =   205.8520

k **Formation level adopted**   =   205.8520

Provided formation Level is O.K.

136

0141

Dedicated freight corridor Corporation of India.

Estimation of Design Discharge for Railway Bridge. Br. No. 210

A	Topography	
B	Catchment Area	0.0646 Sq Km
C	Length of Longest Stream	0.360 Km
D	Height Of farthest point	206.910 M
E	Height of Point of Interest	204.110 M
F	Height Diff of 10 & 11	2.800 M
G	Nature of Soil	Sandy Soil / Sandy Laom.....
H	Avg. Bed Level	204.110 M
I	Observed HFL	204.900 M

1   Using Improved Rational Formula

$$Q\text{-}50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

c = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for tc hour duration where tc = time of concentration

a = Catchment Area

2   Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine & plateau	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R =   50 Year 24 hour point rainfall (cm)

F =   Areal Reduction factor depending upon catchment Area & duration rainfall from table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 Min	60 To 100 Min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

$$= [0.36 \times 0.36 \times 0.36 / 2.800]^{0.345}$$

= **0.2435 hr.**

= 0.2435 hr. x 60

= **14.6102 Min**

Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , $C = 0.249(R \times F)^{0.2}$

$$R \quad = \quad 300.00 \text{ mm}$$
$$F \quad = \quad 0.72$$
$$C = 0.249 \times (R \times F)^{0.2}$$
$$= \quad \textbf{0.8511}$$

But as per Annexture 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3   Calculation of Intensity of Rainfall (I)

a   tc h Ratio   =   *0.1468*   From Fig. 4 of RBF - 16

b   1h Ratio =   =   0.34   From Fig. 4 of RBF - 16

c   Coefficient K   = $\dfrac{\text{tc h Ratio}}{\text{1h Ratio}}$

                          = $\dfrac{0.1468}{0.34}$

                          =   **0.4316**

d
I   R-50 (24)   =   300.00   mm

ii   R-50 (1)   =   R-50 (24) x 1 h to 24 h Rainfall Ratio.

                          =   300 x 0.34

                          =   **102.00 mm**

iii   R-50 (tc)   =   K x R-50 (1)

                          =   0.4316 x102.00

                          =   **44.0254 mm**

iv   Int. of rainfall (I)   = $\dfrac{\text{R-50 (tc)}}{\text{tc}}$

                          = $\dfrac{44.03}{0.2435}$

                          =   **180.8005 mm/hr.**

4   Design Flood Discharge =

     Q-50   =   0.278 x C xI x A

                          =   x 0.278   x 0.8511   x 180.8005   x 0.0646

                          =   **2.7635 cum/sec**

139

5   Checking for adequacy of Waterway Provided

a   Discharge   =   2.7635 cum/sec

c   Avg. Waterway Required   = $\dfrac{Q}{V}$

                                 = $\dfrac{2.7635}{1.75}$

                                 =   **1.5791 Sq.m**

d   Proposed Opening   =   1   2   1.2

e   Height of Water   = $\dfrac{\text{Avg. Waterway}}{\text{Total Width}}$

                                 = $\dfrac{1.5791}{2}$

                                 =   **0.7900**   **m**

f   Avg. Bed Level   =   204.110

h   **Min. Formation Required**   B.L   +   Ht of water   + free Board

                                 =   204.1100   +0.7900   +0.7600

                                 =   205.6600

k   **Formation level adopted**   =   205.6600

Provided formation Level is O.K.

Dedicated freight corridor Corporation of India.

Estimation of Design Discharge for Railway Bridge. Br. No. 212

A	Topography		
B	Catchment Area	0.0551	Sq Km
C	Length of Longest Stream	0.300	Km
D	Height Of farthest point	205.775	M
E	Height of Point of Interest	202.783	M
F	Height Diff of 10 & 11	2.992	M
G	Nature of Soil	Sandy Soil / Sandy Laom.....	
H	Avg. Bed Level	202.783	M
I	Observed HFL	203.950	M

141

0140

1   **Using Improved Rational Formula**

$$Q\text{-}50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

   c = Runoff Coefficient

  I = 50 Years Rainfall Intensity lasting for tc hour duration where tc = time of concentration

   a = Catchment Area

2   **Run off coefficient**

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine & plateau	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R =   50 Year 24 hour point rainfall (cm)

F =   Areal Reduction factor depending upon catchment Area & duration rainfall from table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 Min	60 To 100 Min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

$$= [0.3 \times 0.3 \times 0.3 / 2.992]^{0.345}$$

$$= \mathbf{0.1971 \ hr.}$$

$$= 0.1971 \ hr. \times 60$$

$$= \mathbf{11.8240 \ Min}$$

142

Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas ,   C = 0.249(R x F) ^ 0.2

$$R = 300.00 \text{ mm}$$
$$F = 0.72$$
$$C = 0.249 \times (R \times F)^{0.2}$$
$$= \mathbf{0.8511}$$

But as per Annexture 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3   **Calculation of Intensity of Rainfall (I)**

a   tc h Ratio   =   *0.1235*   From Fig. 4 of RBF - 16

b   1h Ratio =   =   0.34   From Fig. 4 of RBF - 16

c   Coefficient K   =   tc h Ratio
                                      1h Ratio

                             =   0.1235
                                      0.34

                             =   **0.3633**

d
I   R-50 (24)   =   300.00   mm

ii   R-50 (1)   =   R-50 (24) x 1 h to 24 h Rainfall Ratio.

                             =   300 x 0.34

                             =   **102.00 mm**

iii R-50 (tc)   =   K x R-50 (1)

                             =   0.3633 x102.00

                             =   **37.0600 mm**

iv   Int. of rainfall (I)   =   R-50 (tc)
                                      tc

                             =   37.06
                                      0.1971

                             =   **188.0579 mm/hr.**

4   **Design Flood Discharge =**

     Q-50   =   0.278 x C xI x A

                             =   x 0.278   x 0.8511   x 188.0579   x 0.0551

                             =   **2.4517 cum/sec**

143

5 Checking for adequacy of Waterway Provided

a Discharge = 2.4517 cum/sec

c Avg. Waterway Required = $\dfrac{Q}{V}$

= $\dfrac{2.4517}{1.75}$

= **1.4010 Sq.m**

d Proposed Opening = 1   1.2   1.2

e Height of Water = $\dfrac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\dfrac{1.4010}{1.2}$

= **1.1670   m**

f Avg. Bed Level = 202.783

h **Min. Formation Required**   B.L +   Ht of water + free Board

= 202.7830   +1.1670   +2.4920

= 206.4420

k **Formation level adopted** = 206.4420

Provided formation Level is O.K.

Dedicated freight corridor Corporation of India.

Estimation of Design Discharge for Railway Bridge. Br. No. 213

A	Topography		
B	Catchment Area	0.1639	Sq Km
C	Length of Longest Stream	0.450	Km
D	Height Of farthest point	205.133	M
E	Height of Point of Interest	202.783	M
F	Height Diff of 10 & 11	2.350	M
G	Nature of Soil	Sandy Soil / Sandy Laom.....	
H	Avg. Bed Level	202.783	M
I	Observed HFL	204.596	M

1   Using Improved Rational Formula

$$Q\text{-}50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

   c = Runoff Coefficient

   I = 50 Years Rainfall Intensity lasting for tc hour duration where tc = time of concentration

   a = Catchment Area

2   Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine & plateau	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R =   50 Year 24 hour point rainfall (cm)

F =   Areal Reduction factor depending upon catchment Area & duration rainfall from table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 Min	60 To 100 Min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

$$= [0.45 \times 0.45 \times 0.45 / 2.350]^{0.345}$$

=   **0.3259 hr.**

=   0.3259 hr. x 60

=   **19.5527 Min**

146

Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas ,   C = 0.249(R x F) ^ 0.2

$$R \quad = \quad 300.00 \text{ mm}$$
$$F \quad = \quad 0.72$$
$$C = 0.249 \times (R \times F)^{0.2}$$
$$= \quad \mathbf{0.8511}$$

But as per Annexture 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3   Calculation of Intensity of Rainfall (I)

a   tc h Ratio   =   *0.1778*   From Fig. 4 of RBF - 16

b   1h Ratio =   =   0.34   From Fig. 4 of RBF - 16

c   Coefficient K   = $\dfrac{\text{tc h Ratio}}{\text{1h Ratio}}$

                          = $\dfrac{0.1778}{0.34}$

                          =   **0.5228**

d
I   R-50 (24)   =   300.00   mm

ii   R-50 (1)   =   R-50 (24) x 1 h to 24 h Rainfall Ratio.

                          =   300 x 0.34

                          =   **102.00 mm**

iii   R-50 (tc)   =   K x R-50 (1)

                          =   0.5228 x102.00

                          =   **53.3291 mm**

iv   Int. of rainfall (I)   = $\dfrac{\text{R-50 (tc)}}{\text{tc}}$

                          = $\dfrac{53.33}{0.3259}$

                          =   **163.6469 mm/hr.**

4   Design Flood Discharge =

Q-50   =   0.278 x C xI x A

                    =   x 0.278   x 0.8511   x 163.6469   x 0.1639

                    =   **6.3462 cum/sec**

147

5   **Checking for adequacy of Waterway Provided**

a   Discharge   =   6.3462 cum/sec

c   Avg. Waterway Required   = $\dfrac{Q}{V}$

                                = $\dfrac{6.3462}{1.75}$

                                =   **3.6264 Sq.m**

d   Proposed Opening   =   1   2   2

e   Height of Water   = $\dfrac{\text{Avg. Waterway}}{\text{Total Width}}$

                                = $\dfrac{3.6264}{2}$

                                =   **1.8130**   **m**

f   Avg. Bed Level   =   202.783

h   **Min. Formation Required**   B.L   +   Ht of water   + free Board

                                =   202.7830   +1.8130   +2.0280

                                =   206.6240

k   **Formation level adopted**   =   206.6240

Provided formation Level is O.K.

148

Dedicated freight corridor Corporation of India.

Estimation of Design Discharge for Railway Bridge. Br. No. 214

A	Topography	
B	Catchment Area	0.0811 Sq Km
C	Length of Longest Stream	0.390 Km
D	Height Of farthest point	205.533 M
E	Height of Point of Interest	202.783 M
F	Height Diff of 10 & 11	2.750 M
G	Nature of Soil	Sandy Soil / Sandy Laom.....
H	Avg. Bed Level	202.783 M
I	Observed HFL	203.750 M

149

1 **Using Improved Rational Formula**

$$Q\text{-}50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

c = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for tc hour duration where tc = time of concentration

a = Catchment Area

2 **Run off coefficient**

Description of the catchment	Formula for C
a	Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b	Aliuvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c	Red soil /Clayey loam/ gray or brown aliuvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d	Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine & plateau	$C = 0.456(R \times F)^{0.2}$
e	Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R =   50 Year 24 hour point rainfall (cm)

F =   Areal Reduction factor depending upon catchment Area & duration rainfall from table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 Min	60 To 100 Min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfail Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

$$= [0.39 \times 0.39 \times 0.39 / 2.750]^{0.345}$$

=   **0.2662 hr.**

=   0.2662 hr. x 60

=   **15.9710 Min**

Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas ,   C = 0.249(R x F) ^ 0.2

$$R = 300.00 \text{ mm}$$
$$F = 0.72$$
$$C = 0.249 \times (R \times F)^{0.2}$$
$$= 0.8511$$

But as per Annexture 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3   Calculation of Intensity of Rainfall (I)

a   tc h Ratio   =   0.1565   From Fig. 4 of RBF - 16

b   1h Ratio =   =   0.34   From Fig. 4 of RBF - 16

c   Coefficient K   = $\dfrac{\text{tc h Ratio}}{\text{1h Ratio}}$

                          = $\dfrac{0.1565}{0.34}$

                          =   **0.4602**

d

I   R-50 (24)   =   300.00   mm

ii   R-50 (1)   =   R-50 (24) x 1 h to 24 h Rainfall Ratio.

                          =   300 x 0.34

                          =   **102.00 mm**

iii R-50 (tc)   =   K x R-50 (1)

                          =   0.4602 x102.00

                          =   **46.9421 mm**

iv   Int. of rainfall (I) = $\dfrac{\text{R-50 (tc)}}{\text{tc}}$

                          = $\dfrac{46.94}{0.2662}$

                          =   **176.3520 mm/hr.**

4   Design Flood Discharge =

Q-50   =   0.278 x C xI x A

                  =   x 0.278   x 0.8511   x 176.3520   x 0.0811

                  =   **3.3840 cum/sec**

151

5 Checking for adequacy of Waterway Provided

a Discharge = 3.3840 cum/sec

c Avg. Waterway Required = $\dfrac{Q}{V}$

   = $\dfrac{3.3840}{1.75}$

   = **1.9337 Sq.m**

d Proposed Opening = 1 2 1.2

e Height of Water = $\dfrac{\text{Avg. Waterway}}{\text{Total Width}}$

   = $\dfrac{1.9337}{2}$

   = **0.9670** m

f Avg. Bed Level = 202.783

h **Min. Formation Required** B.L + Ht of water + free Board

   = 202.7830 +0.9670 +3.0450

   = 206.7950

k **Formation level adopted** = 206.7950

Provided formation Level is O.K.