डेडीकेटेड फ्रेट कोरीडोर

DESIGN AND CONSTRUCTION OF CIVIL, STRUCTURES AND TRACK WORKS, INVOLVING FORMATION IN EMBANKMENT /CUTTING, BALLAST ON FORMATION, TRACK WORKS, BRIDGES, STRUCTURES, BUILDINGS, YARDS & INTEGRATION WITH INDIAN RAILWAY'S EXISTING RAILWAY SYSTEM AND TESTING & COMMISSIONING ON DESIGN-BUILD LUMP SUM BASIS OF KHURJA-PILKHANI SECTION (APPROXIMATELY 222 ROUTE KM OF SINGLE LINE) OF EASTERN DEDICATED FREIGHT CORRIDOR

**CIVIL, STRUCTURES AND TRACK WORKS**

CONTRACT PACKAGE NO: 303

ICB No.: **HQ/EN/EC/D-B/Khurja-Pilkhani Section**

# PART-4 – REFERENCE DOCUMENT

# HYDRAULIC DATA – VOLUME 4

# KHURJA TO PILKHANI

## From Km. 1367.0 (ALJN-GZB) to Km 187.5 (SRE-UMB)

## HYDRAULIC DATA

## (PARALLEL SECTIONS)

## PART. 1/3

**EMPLOYER: DEDICATED FREIGHT CORRIDOR CORPORATION OF INDIA LTD**
**(A GOVERNMENT OF INDIA ENTERPRISE)**
**MINISTRY OF RAILWAYS**

COUNTRY: **INDIA**

**KHURJA - PILKHANI SECTION**
**HYDRAULIC DATA**
**PARALLEL PORTION**

| Sr. No. | Bridge No | DFCC Chainage | IR Km | Page No. | |
|---|---|---|---|---|---|
| | | | | From | To |
| **Khurja - Hafizpur Section** | | | | | |
| **Major Bridges** | | | | | |
| 1 | 11 | 6950 | 6/35-7/0 | 1 | 11 |
| 2 | 85 | 33710 | 33/10-11 | 12 | 22 |
| **Minor Bridges** | | | | | |
| 3 | 3 | -0.084 | 3.116 | 23 | 26 |
| 4 | 4 | 3813 | 3.813 | 27 | 30 |
| 5 | 5 | 3938 | 3.938 | 31 | 34 |
| 6 | 6 | 4366 | 4.366 | 35 | 38 |
| 7 | 7 | 5513 | 5.513 | 39 | 42 |
| 8 | 8 | 5698 | 5.698 | 43 | 46 |
| 9 | 9 | 5948 | 5.948 | 47 | 50 |
| 10 | 10 | 6050 | 6.050 | 51 | 54 |
| 11 | 12 | 7072 | 7.072 | 55 | 58 |
| 12 | 13 | 7170 | 7.170 | 59 | 62 |
| 13 | 14 | 7212 | 7.212 | 63 | 66 |
| 14 | 15 | 8090 | 8.090 | 67 | 70 |
| 15 | 16 | 8340 | 8.340 | 71 | 74 |
| 16 | 17 | 8543 | 8.543 | 75 | 78 |
| 17 | 19 | 9207 | 9.207 | 79 | 82 |
| 18 | 20 | 9993 | 9.993 | 83 | 86 |
| 19 | 21 | 11104 | 11.104 | 87 | 90 |
| 20 | 22 | 11588 | 11.588 | 91 | 94 |
| 21 | 23 | 12292 | 12.292 | 95 | 98 |
| 22 | 24 | 12328 | 12.328 | 99 | 102 |
| 23 | 25 | 12576 | 12.576 | 103 | 106 |
| 24 | 26 | 12688 | 12.688 | 107 | 110 |
| 25 | 27 | 12981 | 12.981 | 111 | 114 |
| 26 | 28 | 13275 | 13.275 | 115 | 118 |
| 27 | 29 | 13416 | 13.416 | 119 | 122 |
| 28 | 30 | 13739 | 13.739 | 123 | 126 |
| 29 | 31 | 14383 | 14.383 | 127 | 130 |
| 30 | 33 | 14727 | 14.727 | 131 | 134 |
| 31 | 34 | 14995 | 14.995 | 135 | 138 |
| 32 | 35 | 15305 | 15.305 | 139 | 142 |
| 33 | 37 | 16458 | 16.458 | 143 | 146 |
| 34 | 38 | 16890 | 16.890 | 147 | 150 |
| 35 | 39 | 17170 | 17.170 | 151 | 154 |
| 36 | 40 | 17232 | 17.232 | 155 | 158 |
| 37 | 41 | 17327 | 17.327 | 159 | 162 |
| 38 | 42 | 17622 | 17.622 | 163 | 166 |
| 39 | 44 | 18290 | 18.290 | 167 | 170 |
| 40 | 45 | 18335 | 18.335 | 171 | 174 |
| 41 | 46 | 18683 | 18.683 | 175 | 178 |
| 42 | 47 | 19231 | 19.231 | 179 | 182 |
| 43 | 48 | 19403 | 19.403 | 183 | 186 |
| 44 | 50 | 19908 | 19.908 | 187 | 190 |
| 45 | 51 | 20305 | 20.305 | 191 | 194 |
| 46 | 52 | 20853 | 20.853 | 195 | 198 |
| 47 | 53 | 21235 | 21.235 | 199 | 202 |
| 48 | 54 | 21625 | 21.625 | 203 | 206 |
| 49 | 55 | 21775 | 21.775 | 207 | 210 |
| 50 | 56 | 22018 | 22.018 | 211 | 214 |
| 51 | 58 | 23033 | 23.033 | 215 | 218 |
| 52 | 61 | 24040 | 24.04 | 219 | 222 |
| 53 | 62 | 24350 | 24.350 | 223 | 226 |
| 54 | 63 | 24558 | 24.558 | 227 | 230 |
| 55 | 64 | 24599 | 24.599 | 231 | 234 |
| 56 | 66 | 24763 | 24.763 | 235 | 238 |
| 57 | 67 | 25075 | 25.075 | 239 | 242 |
| 58 | 68 | 25405 | 25.405 | 243 | 246 |
| 59 | 70 | 25901 | 25.901 | 247 | 250 |
| 60 | 71 | 26163 | 26.163 | 251 | 254 |
| 61 | 72 | 26525 | 26.525 | 255 | 258 |
| 62 | 73 | 26675 | 26.675 | 259 | 262 |
| 63 | 74 | 27207 | 27.207 | 263 | 266 |
| 64 | 75 | 28878 | 28.878 | 267 | 270 |
| 65 | 76 | 29540 | 29.540 | 271 | 274 |
| 66 | 77 | 29992 | 29.992 | 275 | 278 |
| 67 | 78 | 30555 | 30.555 | 279 | 282 |
| 68 | 79 | 30426 | 30.426 | 283 | 286 |
| 69 | 80 | 30913 | 30.913 | 287 | 290 |
| 70 | 81 | 31428 | 31.428 | 291 | 294 |
| 71 | 82 | 31760 | 31.760 | 295 | 298 |

| | | | | | |
|---|---|---|---|---|---|
| 72 | 83 | 32506 | 32.506 | 299 | 302 |
| 73 | 84 | 32956 | 32.956 | 303 | 306 |
| 74 | 86 | 34403 | 34.403 | 307 | 310 |
| 75 | 87 | 35680 | 35.680 | 311 | 314 |
| 76 | 88 | 36643 | 36.643 | 315 | 318 |
| 77 | 89 | 37625 | 37.625 | 319 | 322 |
| 78 | 90 | 38670 | 38.670 | 323 | 326 |
| 79 | 91 | 39030 | 39.030 | 327 | 330 |
| 80 | 92 | 39740 | 39.740 | 331 | 334 |
| 81 | 93 | 40240 | 40.240 | 335 | 338 |
| 82 | 94 | 41003 | 41.003 | 339 | 342 |
| 83 | 95 | 41182 | 41.182 | 343 | 346 |
| 84 | 96 | 41433 | 41.433 | 347 | 350 |
| 85 | 97 | 41739 | 41.739 | 351 | 354 |
| 86 | 98 | 42308 | 42.308 | 355 | 358 |
| 87 | 99 | 42483 | 42.483 | 359 | 362 |
| 88 | 100 | 42780 | 42.780 | 363 | 366 |
| 89 | 101 | 42975 | 42.975 | 367 | 370 |
| 90 | 102 | 43232 | 43.232 | 371 | 374 |
| 91 | 103 | 43470 | 43.470 | 375 | 378 |
| 92 | 104 | 43638 | 43.638 | 379 | 382 |
| 93 | 105 | 44055 | 44.055 | 383 | 386 |
| 94 | 106 | 44857 | 44.857 | 387 | 390 |
| 95 | 107 | 45068 | 45.068 | 391 | 394 |
| 96 | 108 | 45295 | 45.295 | 395 | 398 |
| 97 | 109 | 45455 | 45.455 | 399 | 402 |
| 98 | 110 | 45590 | 45.590 | 403 | 406 |
| 99 | 111 | 45902 | 45.902 | 407 | 410 |
| 100 | 112 | 46118 | 46.118 | 411 | 414 |
| 101 | 113 | 46341 | 46.341 | 415 | 418 |
| 102 | 114 | 46676 | 46.676 | 419 | 422 |
| 103 | 115 | 46859 | 46.859 | 423 | 426 |
| 104 | 116 | 47236 | 47.236 | 427 | 430 |
| 105 | 117 | 47581 | 47.581 | 431 | 434 |
| 106 | 118 | 47694 | 47.694 | 435 | 438 |
| 107 | 119 | 47914 | 47.914 | 439 | 442 |
| 108 | 120 | 48404 | 48.404 | 443 | 446 |
| **Meerut - Saharanpur Section** | | | | | |
| **Minor Bridges** | | | | | |
| 109 | 134 | 86926 | 86.926 | 447 | 450 |
| 110 | 135 | 88604 | 88.604 | 451 | 454 |
| 111 | 136 | 89534 | 89.534 | 455 | 458 |
| 112 | 137 | 90429 | 90.429 | 459 | 462 |
| 113 | 140 | 91848 | 91.848 | 463 | 466 |
| 114 | 141 | 92241 | 92.241 | 467 | 470 |
| 115 | 142 | 92502 | 92.502 | 471 | 474 |
| 116 | 143 | 92700 | 92.7 | 475 | 478 |
| 117 | 144 | 94585 | 94.585 | 479 | 482 |
| 118 | 145 | 95153 | 95.153 | 483 | 486 |
| 119 | 146 | 95892 | 95.892 | 487 | 490 |
| 120 | 148 | 96946 | 96.946 | 491 | 494 |
| 121 | 149 | 97783 | 97.783 | 495 | 498 |
| 122 | 150 | 98921 | 98.921 | 499 | 502 |
| 123 | 151 | 99442 | 99.442 | 503 | 506 |
| 124 | 152 | 99667 | 99.667 | 507 | 510 |
| 125 | 153 | 99909 | 99.909 | 511 | 514 |
| 126 | 155 | 103868 | 103.868 | 515 | 518 |
| 127 | 156 | 104742 | 104.742 | 519 | 522 |
| 128 | 157 | 105501 | 105.501 | 523 | 526 |
| 129 | 158 | 106138 | 106.138 | 527 | 530 |
| 130 | 159 | 106764 | 106.764 | 531 | 534 |
| 131 | 162 | 108161 | 108.161 | 535 | 538 |
| 132 | 163 | 110820 | 110.82 | 539 | 542 |
| 133 | 164 | 111112 | 111.112 | 543 | 546 |
| **Talheri - Pilkhani Section** | | | | | |
| **Minor Bridges** | | | | | |
| 134 | 201B | 82268 | 153.548 | 547 | 550 |
| 135 | 202 | 82923 | 154.203 | 551 | 554 |

# KHURJA – HAFIZPUR SECTION

# MAJOR BRIDGES

## Dedicated Freight Corridor Corporation Of India.

**Estimation of Design Discharge for Railway Bridge No-11 at KM 6/35-7/0**

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | Formation Level Provided | | | | 198.458 | M |
| | | | No. of Spans | *Width of Span* | | |
| 2 | Proposed Bridge Type | | 3 | 6 | | |
| 3 | Topography | | | Undulation | | |
| 4 | Catchment Area A | | | 62.677 | Sq.Km | |
| 5 | Length of Longest Stream L | | | 19.685 | Km | |
| 7 | Height Of farthest point | | | 225.68 | m | |
| 8 | Height of Point of Interest | | | 194.708 | m | |
| 9 | Height Diff | | | 30.972 | m | |
| 10 | Nature of Soil | | | Hilly | | |
| 11 | Avg. Bed Level | | | 194.708 | m | |
| 12 | O.H.F.L. | | | 195.958 | m | |
| 13 | 50 years Rainfall for | 12 | Hrs. = | 291 | mm | |
| 14 | 50 years Rainfall for | 24 | Hrs. = | 300 | mm | |
| 15 | Area of Cross Section under consideration | | | 22.5 | Sq M | |
| 16 | Wetted Perimeter of the Section | | | 25.5 | R. M. | |

**Dedicated Freight Corridor Corporation Of India.**

**Estimation of Design Discharge for Railway Bridge No-11 at KM 6/35-7/0**

**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 ) + Di ] | [D(i - 1 ) + Di ] multiplied by col. 4 |
|---|---|---|---|---|---|---|
| **1** | **2** | **3** | **4** | **5** | **6** | ***7*** |
| 1 | 0.00 | 194.71 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2 | 8.00 | 209.50 | 8.00 | 14.79 | 14.79 | 118.34 |
| 3 | 15.00 | 218.75 | 7.00 | 24.04 | 38.83 | 271.84 |
| 4 | 19.69 | 225.68 | 4.69 | 30.97 | 55.01 | 257.75 |
| 5 | | | | | | 0.00 |
| 6 | | | | | | 0.00 |
| 7 | | | | | | 0.00 |
| | | | | | | 647.93 |

19.69 225.68

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

= 1.67 m / Km

**Step : 2 Preparation of Physiographic Parameters.**

1) Catchment area upto Bridge location ( A ) 62.68 sq.km

2) Length of longest stream ( L ) 19.69 km.

3) Equivalent Stream Slope ( Se ) 1.670 m/km

**Step : 3 Determination of synthetic ( 1 hr ) Unitgraph Parameter.**

( b ) Determination of time from the center of the unit rain fall duration to the peak of unit hydrograph in hours.

tp = $0.314(L/sqrtSe)^{1.012}$

4.94 hrs

say 4.50

( a ) Peak discharge of unit hydrograph per unit area in cumecs per sq.km.

qp = $1.664 /(tp)^{0.965}$

0.390 cumecs/sq.km.

say 0.390

( c ) $W_{50}$ : Width of Unit Graph measured at 50% max discharge ordinate $q_p$ in hrs.

$W_{50} = 2.534/(qp)^{0.976}$

6.35 hrs

( d ) $W_{75}$ : Width of Unit Graph measured at 75% max discharge ordinate $q_p$ in hrs.

$W_{75} = 1.478/(q p)^{0.860}$

3.32 hrs

( e ) $W_{R50}$ : Width of rising side of unit graph measured at 50% max. discharge ordinate $q_p$ in hrs .

$W_{R50} = 1.091/(q p)^{0.750}$

2.21 hrs

( f ) $W_{R75}$ : Width of rising side of unit graph measured at 75% max. discharge ordinate $q_p$ in hrs .

$W_{R75} = 0.672/(q p)^{0.719}$

1.32

( g ) $T_B$ : Base width of Unit Hydrograph in hours.

$T_B = 5.526(t p)^{0.866}$

20.33

( h ) $T_m$ : Time from the start of rise to the peak of unit hydrograph in hrs.

$T_m = t p + t r / 2$

= 5.00 hrs

( I ) $Q_p$ : Peak discharge of unit hydrograph in cu mt / sec.

$Q_p = q_p \times A$

24.44 cumecs

## Dedicated Freight Corridor Corporation Of India.

**Estimation of Design Discharge for Railway Bridge No-11 at KM 6/35-7/0**

**Step-4** **Drawing of Synthetic Unitgraph**

Estimated parameters of unit graph in step-3 were plotted to scale on a graph paper as shown in fig. The plotted points were joined to draw synthetic unitgraph. The discharge ordinates ( Qi )of the unitgraph at ti = tr = 1 hr interval were summed up and multiplied by tr (=1) I.e.< Qi x ti m/s and compared with the volume of 1.00 cm. direct runoff depth over the catchment with the formula < Q ix ti = Axd/tix0.36

Qi x ti = A x d / ti x 0.36

| | | | | |
|---|---|---|---|---|
| where | A = | catchment area in Sq.Km | 62.68 | |
| | d = | depth in cm. | | 1 |
| | ti = | tr ( unit duration of the unitgraph ) | | 1 |
| | < Qixti = | 174.10 | | |

| | | | |
|---|---|---|---|
| **Alternatly,** | As per RDSO monograph - 50 | | |
| Volume of Runoff | = 2.78*A | 174.20 | |
| Adopt higher value | = | 174.20 | |

**Step - 5** **Estimation of Design Storm Duration**

The Design Storm Duration ($T_d$) =1.1*$t_p$

4.95 hrs

say 5.00 hrs

**Step - 6** **Estimation of Point Rainfall and Areal Rainfall**

1) Calculating 50 years 5hr point Rainfall

| | | | | |
|---|---|---|---|---|
| 50 year 12h point rainfall = | 291 | mm | 12 | hrs. |
| 50 year 24h point rainfall = | 300 | mm | 24 | hrs. |
| By intrepolation 50 years 5h point rainfall = | | | 29.175 | cm |
| As ,for T D= | | | **5.00** | hrs. |

The value of conversion factor 1.000

50 years 5hr point Rainfall 29.18

Hourly block values of areal rainfall are obtained as below

| Hours | Cu % of storm duration | Cu% of total rainfall | td hour time distribution | td hour storm distribution ( from graph) | td hour storm distribution col 5 x 29.18/100 | Hourly Storm |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1 | 4.16 | 14 | 4.16 | 14 | 4.08 | 4.08 |
| 2 | 8.33 | 26 | 8.33 | 26 | 7.59 | 3.50 |
| 3 | 12.50 | 34 | 12.50 | 34 | 9.92 | 2.33 |
| 4 | 16.67 | 42 | 16.67 | 42 | 12.25 | 2.33 |
| 5 | 20.83 | 48 | 20.83 | 48 | 14.00 | 1.75 |
| 6 | 25.00 | 54 | 25.00 | 54 | 15.75 | 1.75 |
| 7 | 29.16 | 58 | 29.16 | 58 | 16.92 | 1.17 |
| 8 | 33.33 | 63 | 33.33 | 63 | 18.38 | 1.46 |
| 9 | 37.50 | 67 | 37.50 | 67 | 19.55 | 1.17 |
| 10 | 41.46 | 70 | 41.46 | 70 | 20.42 | 0.88 |
| 11 | 45.83 | 74 | 45.83 | 74 | 21.59 | 1.17 |
| 12 | 50.00 | 77 | 50.00 | 77 | 22.46 | 0.88 |
| 13 | 54.16 | 80 | 54.16 | 80 | 23.34 | 0.88 |
| 14 | 58.33 | 83 | 58.33 | 83 | 24.22 | 0.88 |
| 15 | 62.50 | 85 | 62.50 | 85 | 24.80 | 0.58 |
| 16 | 66.67 | 87 | 66.67 | 87 | 25.38 | 0.58 |
| 17 | 70.83 | 89 | 70.83 | 89 | 25.97 | 0.58 |
| 18 | 75.00 | 91 | 75.00 | 91 | 26.55 | 0.58 |
| 19 | 79.16 | 93 | 79.16 | 93 | 27.13 | 0.58 |
| 20 | 83.33 | 95 | 83.33 | 95 | 27.72 | 0.58 |
| 21 | 87.50 | 96 | 87.50 | 96 | 28.01 | 0.29 |
| 22 | 91.66 | 98 | 91.66 | 98 | 28.59 | 0.58 |
| 23 | 95.83 | 99 | 95.83 | 99 | 28.88 | 0.29 |
| 24 | 100.00 | 100 | 100.00 | 100 | 29.18 | 0.29 |

**Dedicated Freight Corridor Corporation Of India.**

**Estimation of Design Discharge for Railway Bridge No-11 at KM 6/35-7/0**

**Step - 8**

| | Hourly storm( cm.) | Loss rate ( cm/h) | Effective rainfall |
|---|---|---|---|
| 1 | 4.08 | 0.25 | 3.83 |
| 2 | 3.50 | 0.25 | 3.25 |
| 3 | 2.33 | 0.25 | 2.08 |
| 4 | 1.75 | 0.25 | 1.50 |
| 5 | 1.46 | 0.25 | 1.21 |
| 6 | 1.17 | 0.25 | 0.92 |
| 7 | 0.88 | 0.25 | 0.63 |
| 8 | 0.58 | 0.25 | 0.33 |
| 9 | 0.29 | 0.25 | 0.04 |

a)

| | UH ordinate $m^3/s$ | Discharge ordinate cm. | Discharge ordinate col 2 x col3 |
|---|---|---|---|
| 1 | 2 | 3 | 4 |
| 1 | 24.44 | 3.83 | 93.61 |
| 2 | 22.00 | 3.25 | 71.50 |
| 3 | 20.10 | 2.08 | 41.81 |
| 4 | 18.33 | 1.50 | 27.50 |
| 5 | 14.50 | 1.21 | 17.55 |
| 6 | 13.20 | 0.92 | 12.14 |
| 7 | 12.50 | 0.63 | 7.88 |
| 8 | 11.00 | 0.33 | 3.63 |
| 9 | 10.00 | 0.04 | 0.40 |
| | | **Total** | 276.00 |

b) Add base flow

Base flow rate = 0.045A

0.45 x 62.677 $m^3/s$

= 2.820465

Design discharge = 276.0022 + 2.820465

278.82 $m^3/s$

**Step 9 -** **Computation of design Flood Hydrograph**

The 1 - hr effective rainfall sequence shown in col. (3) of Table in Step - 9 was reversed to obtain the critical sequence as shown below:

| Time | SUH ordinate | Rainfall excess | Rainfall excess in critical order |
|---|---|---|---|
| 0 | 0.00 | | |
| 1 | 4.20 | | |
| 2 | 8.60 | | |
| 3 | 13.20 | 1.17 | 0.29 |
| 4 | 20.10 | 2.33 | 0.58 |
| 5 | 24.44 | 4.08 | 0.88 |
| 6 | 22.00 | 3.5 | 1.46 |
| 7 | 18.33 | 1.75 | 1.75 |
| 8 | 14.50 | 1.46 | 3.5 |
| 9 | 12.50 | 0.88 | 4.08 |
| 10 | 11.00 | 0.58 | 2.33 |
| 11 | 10.00 | 0.29 | 1.17 |
| 12 | 8.90 | | |
| 13 | 7.85 | | |
| 14 | 6.60 | | |
| 15 | 5.70 | | |
| 16 | 4.60 | | |
| 17 | 3.50 | | |
| 18 | 2.50 | | |
| 19 | 1.50 | | |
| 20 | 0.40 | | |
| 20.33 | 0.00 | | |

**Dedicated Freight Corridor Corporation Of India.**

**Estimation of Design Discharge for Railway Bridge No-11 at KM 6/35-7/0**

3.0 Velocity calculation and check.

Bed Level provided 194.708

Velocity calculation.(V)

For calculating the velocity of the storm water flow,first of all cross-section of the river bed/nala is to be studied.Simultaneously wetted perimeter can be found out and hydraulic mean depth should be calculated as follows

$$R = \frac{A}{P}$$

R= Hydraulic mean depth in meter
A= C/S area in sq.m.
P = Wetted Peremeter

$$R = \frac{A}{P}$$

Where R = Hydraulic Mean Depth In Meter
A = C/S Area In Sqm = 22.500
P = Wetted Peremeter = 25.500

$$R = \frac{A}{P}$$

$$= 0.88$$

Velocity

$$V = \frac{(R)^{2/3} * (S)^{1/2}.}{n}$$

Where V = Velocity In m/sec
R = Hydraulic Mean Depth 0.88
S = Energy Slope or Bed Slope 0.00167
n = Rugosity Coefficient 0.045

V = 0.83 m/sec

Checking for adequacy of Waterway Provided

Discharge = A * V | 18.675 | Cum/sec

Calculated flood discharge from unit Hydrograph | 315.340 |

Let us assume CHFL @ | 195.958 | The revised sectional properties will be as under

A = C/S Area In Sqm = 22.500
P = Wetted PerImeter = 25.500

$$R = \frac{A}{P}$$

$$= 0.88$$

**Dedicated Freight Corridor Corporation Of India.**

**Estimation of Design Discharge for Railway Bridge No-11 at KM 6/35-7/0**

Velocity $\frac{(R)^{2/3} * (S)^{1/2.}}{n}$

Where V = Velocity In m/sec
R = Hydraulic Mean Depth In Meter 0.88
S = Energy Slope or Bed Slope 0.00167
n = Rugosity Coefficient 0.045

V = 0.83 m/sec

0.83

Discharge A X V 18.68 Cum/sec

Calculated flood discharge from unit Hydrograph 315.340

Calculation of afflux

Approximate Area of pier

| Pier No. | Area | Pier No. | Area |
|---|---|---|---|
| P1 | 3.00 | | |
| P2 | 3.00 | | |
| Total | 5.99 | Total | 0.00 |

TOTAL AREA OF PIERS a = 16.51

$V^2$ 0.6889

$A^2$ 506.25

$a^2$ 272.51

AFFLUX = $(V^2/17.88+0.01524) \times ((A^2/a^2)-1)$

= 0.047

Total discharge = 18.68 Cum/sec

width of opng. 18

Ht. of Water 1.04 m

Vertical clearance = 1

Girder Height = 0.6

Formation Required CHFL/OHFL+Afflux+Girder height+V.C

= 197.61

Formation provided **198.458**

**Bridge No-11 at KM 6/35-7/0** COMPUTATION OF FLOOD HYDROGRAPH

| Time | SUH ord. | Direct surface runoff in $m^3$ /s due to rainfall excess increment in cm. of | | | | | | | | | Total Sur. flow. | Base flow | D.flood hydrograph |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| h | m 3 /s | 0.29 | 0.58 | 0.88 | 1.46 | 1.75 | 3.5 | 4.08 | 2.33 | 1.17 | $m^3$ / s | $m^3$ / s | $m^3$ / s |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 0 | 0.00 | 0.00 | | | | | | | | | 0.00 | 2.82 | 2.82 |
| 1 | 4.20 | 1.22 | 0.00 | | | | | | | | 1.22 | 2.82 | 4.04 |
| 2 | 8.60 | 2.49 | 2.44 | 0.00 | | | | | | | 4.93 | 2.82 | 7.75 |
| 3 | 13.20 | 3.83 | 4.99 | 3.70 | 0.00 | | | | | | 12.52 | 2.82 | 15.34 |
| 4 | 20.10 | 5.83 | 7.66 | 7.57 | 6.13 | 0.00 | | | | | 27.19 | 2.82 | 30.01 |
| 5 | 24.44 | 7.09 | 11.66 | 11.62 | 12.56 | 7.35 | 0.00 | | | | 50.28 | 2.82 | 53.10 |
| 6 | 22.00 | 6.38 | 14.18 | 17.69 | 19.27 | 15.05 | 14.70 | 0.00 | | | 87.27 | 2.82 | 90.09 |
| 7 | 18.33 | 5.32 | 12.76 | 21.51 | 29.35 | 23.10 | 30.10 | 17.14 | 0.00 | | 139.28 | 2.82 | 142.10 |
| 8 | 14.50 | 4.21 | 10.63 | 19.36 | 35.68 | 35.18 | 46.20 | 35.09 | 9.79 | 0.00 | 196.14 | 2.82 | 198.96 |
| 9 | 12.50 | 3.63 | 8.41 | 16.13 | 32.12 | 42.77 | 70.35 | 53.86 | 20.04 | 4.91 | 252.22 | 2.82 | 255.04 |
| 10 | 11.00 | 3.19 | 7.25 | 12.76 | 26.76 | 38.50 | 85.54 | 82.01 | 30.76 | 10.06 | 296.83 | 2.82 | 299.65 |
| 11 | 10.00 | 2.90 | 6.38 | 11.00 | 21.17 | 32.08 | 77.00 | 99.72 | 46.83 | 15.44 | 312.52 | 2.82 | 315.34 |
| 12 | 8.90 | 2.58 | 5.80 | 9.68 | 18.25 | 25.38 | 64.16 | 89.76 | 56.95 | 23.52 | 296.08 | 2.82 | 298.90 |
| 13 | 7.85 | 2.28 | 5.16 | 8.80 | 16.06 | 21.88 | 50.75 | 74.79 | 51.26 | 28.59 | 259.57 | 2.82 | 262.39 |
| 14 | 6.60 | 1.91 | 4.55 | 7.83 | 14.60 | 19.25 | 43.75 | 59.16 | 42.71 | 25.74 | 219.50 | 2.82 | 222.32 |
| 15 | 5.70 | 1.65 | 3.83 | 6.91 | 12.99 | 17.50 | 38.50 | 51.00 | 33.79 | 21.45 | 187.62 | 2.82 | 190.44 |
| 16 | 4.60 | 1.33 | 3.31 | 5.81 | 11.46 | 15.58 | 35.00 | 44.88 | 29.13 | 16.97 | 163.47 | 2.82 | 166.29 |
| 17 | 3.50 | 1.02 | 2.67 | 5.02 | 9.64 | 13.74 | 31.15 | 40.80 | 25.63 | 14.63 | 144.30 | 2.82 | 147.12 |
| 18 | 2.50 | 0.73 | 2.03 | 4.05 | 8.32 | 11.55 | 27.48 | 36.31 | 23.30 | 12.87 | 126.64 | 2.82 | 129.46 |
| 19 | 1.50 | 0.44 | 1.45 | 3.08 | 6.72 | 9.98 | 23.10 | 32.03 | 20.74 | 11.70 | 109.24 | 2.82 | 112.06 |
| 20 | 0.40 | 0.12 | 0.87 | 2.20 | 5.11 | 8.05 | 19.95 | 26.93 | 18.29 | 10.41 | 91.93 | 2.82 | 94.75 |
| 20.33 | 0.00 | 0.00 | 0.23 | 1.32 | 3.65 | 6.13 | 16.10 | 23.26 | 15.38 | 9.18 | 75.25 | 2.82 | 78.07 |
| | | | 0.00 | 0.35 | 2.19 | 4.38 | 12.25 | 18.77 | 13.28 | 7.72 | 58.94 | 2.82 | 61.76 |
| | | | | 0.00 | 0.58 | 2.63 | 8.75 | 14.28 | 10.72 | 6.67 | 43.63 | 2.82 | 46.45 |
| | | | | | 0.00 | 0.70 | 5.25 | 10.20 | 8.16 | 5.38 | 29.69 | 2.82 | 32.51 |
| | | | | | | 0.00 | 1.40 | 6.12 | 5.83 | 4.10 | 17.45 | 2.82 | 20.27 |
| | | | | | | | 0.00 | 1.63 | 3.50 | 2.93 | 8.06 | 2.82 | 10.88 |
| | | | | | | | | 0.00 | 0.93 | 1.76 | 2.69 | 2.82 | 5.51 |
| | | | | | | | | | 0.00 | 0.47 | 0.47 | 2.82 | 3.29 |
| | | | | | | | | | | 0.00 | 0.00 | 2.82 | 2.82 |
| | | | | | | | | | | | | | 315.34 |

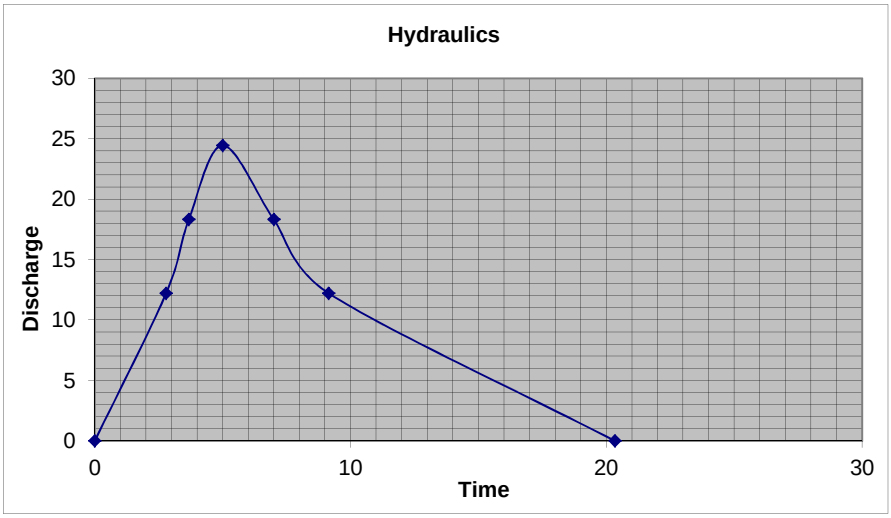
**Bridge No-11 at KM 6/35-7/0**

| | |
|---|---|
| 0 | 0 |
| w r50 | 2.21 |
| w r75 | 1.32 |
| tp | 5.00 |
| w75 | 3.32 |
| w50 | 6.35 |
| Qp | 24.44 |

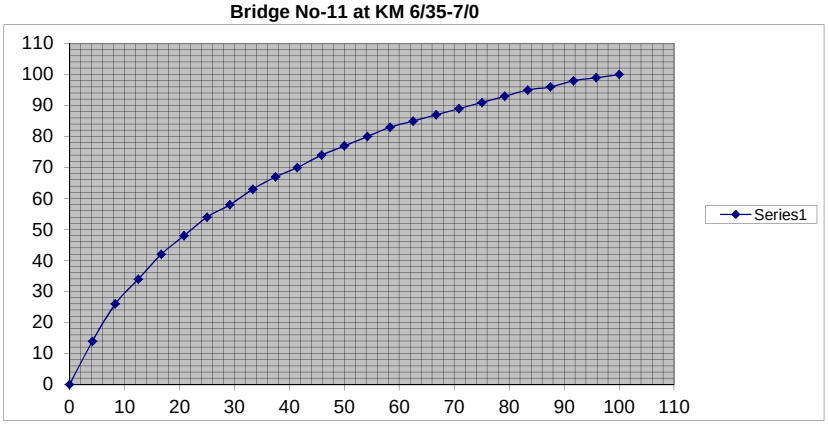
| x hrs | y discharge |
|---|---|
| 0.00 | 0.00 |
| 2.79 | 12.22 |
| 3.68 | 18.33 |
| 5.00 | 24.44 |
| 7.00 | 18.33 |
| 9.14 | 12.22 |
| 20.33 | 0.00 |

tb 20.33

| | |
|---|---|
| 0 | 0 |
| 1 | 4.2 |
| 2 | 8.6 |
| 3 | 13.2 |
| 4 | 20.1 |
| 5 | 24.44 |
| 6 | 22 |
| 7 | 18.33 |
| 8 | 14.5 |
| 9 | 12.5 |
| 10 | 11 |
| 11 | 10 |
| 12 | 8.9 |
| 13 | 7.85 |
| 14 | 6.6 |
| 15 | 5.7 |
| 16 | 4.6 |
| 17 | 3.5 |
| 18 | 2.5 |
| 19 | 1.5 |
| 20 | 0.4 |
| 20.33 | 0 |



| | |
|---|---|
| 0 | 0 |
| 4.16 | 14 |
| 8.33 | 26 |
| 12.50 | 34 |
| 16.67 | 42 |
| 20.83 | 48 |
| 25.00 | 54 |
| 29.16 | 58 |
| 33.33 | 63 |
| 37.50 | 67 |
| 41.46 | 70 |
| 45.83 | 74 |
| 50.00 | 77 |
| 54.16 | 80 |
| 58.33 | 83 |
| 62.50 | 85 |
| 66.67 | 87 |
| 70.83 | 89 |
| 75.00 | 91 |
| 79.16 | 93 |
| 83.33 | 95 |
| 87.50 | 96 |
| 91.66 | 98 |
| 95.83 | 99 |
| 100.00 | 100 |




| | | | |
|---|---|---|---|
| A | 81665409.18 | | 81.66541 |
| P | 66061.6948 | | 66.06169 |
| | | | |
| A | 71618940.63 | | 71.61894 |
| P | 65235.7281 | | 65.23573 |
| | | | |
| | A | | 153.2843 |
| | P | | 131.2974 |
| | | | |
| | wetted peri | 34688.28 | |
| | | 35485.91 | |
| | | 70174.2 | 70.1742 |

## Dedicated Freight Corridor Corporation Of India.

### Estimation of Design Discharge for Railway Bridge No-85 at CH 33/10-11

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | Formation Level Provided | | | | 205.001 | M |
| | | | No. of Spans | *Width of Span* | | |
| 2 | Proposed Bridge Type | | 3 | 6 | | |
| 3 | Topography | | | | Undulation | |
| 4 | Catchment Area A | | | | 71.222 | Sq.Km |
| 5 | Length of Longest Stream L | | | | 24.179 | Km |
| 7 | Height Of farthest point | | | | 228.295 | m |
| 8 | Height of Point of Interest | | | | 199.036 | m |
| 9 | Height Diff | | | | 29.259 | m |
| 10 | Nature of Soil | | | | Hilly | |
| 11 | Avg. Bed Level | | | | 199.036 | m |
| 12 | O.H.F.L. | | | | 202.501 | m |
| 13 | 50 years Rainfall for | 12 | Hrs. | = | 291 | mm |
| 14 | 50 years Rainfall for | 24 | Hrs. | = | 300 | mm |
| 15 | Area of Cross Section under consideration | | | | 62.37 | Sq M |
| 16 | Wetted Perimeter of the Section | | | | 38.79 | R. M. |

## Dedicated Freight Corridor Corporation Of India.

**Estimation of Design Discharge for Railway Bridge No-85 at CH 33/10-11**

**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 ) + Di ] | [D(i - 1 ) + Di ] multiplied by col. 4 |
|---|---|---|---|---|---|---|
| **1** | **2** | **3** | **4** | **5** | **6** | ***7*** |
| 1 | 0.00 | 199.04 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2 | 8.00 | 209.50 | 8.00 | 10.46 | 10.46 | 83.72 |
| 3 | 16.00 | 218.75 | 8.00 | 19.71 | 30.18 | 241.43 |
| 4 | 24.18 | 228.29 | 8.18 | 29.25 | 48.97 | 400.51 |
| 5 | | | | | | 0.00 |
| 6 | | | | | | 0.00 |
| 7 | | | | | | 0.00 |
| | | | | | | 725.66 |

24.18 228.30

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

= 1.24 m / Km

**Step : 2** **Preparation of Physiographic Parameters.**

1) Catchment area upto Bridge location ( A ) 71.22 sq.km

2) Length of longest stream ( L ) 24.18 km.

3) Equivalent Stream Slope ( Se ) 1.240 m/km

**Step : 3** **Determination of synthetic ( 1 hr ) Unitgraph Parameter.**

( b ) Determination of time from the center of the unit rain fall duration to the peak of unit hydrograph in hours.

tp = $0.314(L/\sqrt{Se})^{1.012}$

7.07 hrs
say 7.50

( a ) Peak discharge of unit hydrograph per unit area in cumecs per sq.km.

qp = $1.664 /(tp)^{0.965}$

0.238 cumecs/sq.km.
say 0.240

( c ) $W_{50}$ : Width of Unit Graph measured at 50% max discharge ordinate $q_p$ in hrs.

$W_{50} = 2.534/(qp)^{0.976}$

10.20 hrs

( d ) $W_{75}$ : Width of Unit Graph measured at 75% max discharge ordinate $q_p$ in hrs.

$W_{75} = 1.478/(q\,p)^{0.860}$

5.04 hrs

( e ) $W_{R50}$ : Width of rising side of unit graph measured at 50% max. discharge ordinate $q_p$ in hrs .

$W_{R50} = 1.091/(q\,p)^{0.750}$

3.18 hrs

( f ) $W_{R75}$ : Width of rising side of unit graph measured at 75% max. discharge ordinate $q_p$ in hrs .

$W_{R75} = 0.672/(q\,p)^{0.719}$

1.87

( g ) $T_B$ : Base width of Unit Hydrograph in hours.

$T_B = 5.526(t\,p)^{0.866}$

31.64

( h ) $T_m$ : Time from the start of rise to the peak of unit hydrograph in hrs.

$T_m = t\,p + t\,r / 2$

= 8.00 hrs

( I ) $Q_p$ : Peak discharge of unit hydrograph in cu mt / sec.

$Q_p = q_p \times A$

17.09 cumecs

## Dedicated Freight Corridor Corporation Of India.

**Estimation of Design Discharge for Railway Bridge No-85 at CH 33/10-11**

**Step-4** **Drawing of Synthetic Unitgraph**

Estimated parameters of unit graph in step-3 were plotted to scale on a graph paper as shown in fig. The plotted points were joined to draw synthetic unitgraph. The discharge ordinates ( Qi )of the unitgraph at ti = tr = 1 hr interval were summed up and multiplied by tr (=1) I.e.< Qi x ti m/s and compared with the volume of 1.00 cm. direct runoff depth over the catchment with the formula < Q ix ti = Axd/tix0.36

Qi x ti = A x d / ti x 0.36

| | | | | |
|---|---|---|---|---|
| where | A = | catchment area in Sq.Km | 71.22 | |
| | d = | depth in cm. | | 1 |
| | ti = | tr ( unit duration of the unitgraph ) | | 1 |
| | < Qixti = | 197.84 | | |

**Alternatly,** As per RDSO monograph - 50

Volume of Runoff = 2.78*A 198.00

Adopt higher value = 198.00

**Step - 5** **Estimation of Design Storm Duration**

The Design Storm Duration ($T_d$) =1.1*$t_p$

8.25 hrs

say 8.00 hrs

**Step - 6** **Estimation of Point Rainfall and Areal Rainfall**

1) Calculating 50 years 8hr point Rainfall

| | | | | |
|---|---|---|---|---|
| 50 year 12h point rainfall = | 291 | mm | 12 | hrs. |
| 50 year 24h point rainfall = | 300 | mm | 24 | hrs. |
| By intrepolation 50 years 8h point rainfall = | | | 29.175 | cm |
| As ,for T D= | | | **8.00** | hrs. |
| The value of conversion factor | | 1.000 | | |
| 50 years 8hr point Rainfall | | 29.18 | | |

Hourly block values of areal rainfall are obtained as below

| Hours | Cu % of storm duration | Cu% of total rainfall | td hour time distribution | td hour storm distribution ( from graph) | td hour storm distribution col 5 x 29.18/100 | Hourly Storm |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1 | 4.16 | 14 | 4.16 | 14 | 4.08 | 4.08 |
| 2 | 8.33 | 26 | 8.33 | 26 | 7.59 | 3.50 |
| 3 | 12.50 | 34 | 12.50 | 34 | 9.92 | 2.33 |
| 4 | 16.67 | 42 | 16.67 | 42 | 12.25 | 2.33 |
| 5 | 20.83 | 48 | 20.83 | 48 | 14.00 | 1.75 |
| 6 | 25.00 | 54 | 25.00 | 54 | 15.75 | 1.75 |
| 7 | 29.16 | 58 | 29.16 | 58 | 16.92 | 1.17 |
| 8 | 33.33 | 63 | 33.33 | 63 | 18.38 | 1.46 |
| 9 | 37.50 | 67 | 37.50 | 67 | 19.55 | 1.17 |
| 10 | 41.46 | 70 | 41.46 | 70 | 20.42 | 0.88 |
| 11 | 45.83 | 74 | 45.83 | 74 | 21.59 | 1.17 |
| 12 | 50.00 | 77 | 50.00 | 77 | 22.46 | 0.88 |
| 13 | 54.16 | 80 | 54.16 | 80 | 23.34 | 0.88 |
| 14 | 58.33 | 83 | 58.33 | 83 | 24.22 | 0.88 |
| 15 | 62.50 | 85 | 62.50 | 85 | 24.80 | 0.58 |
| 16 | 66.67 | 87 | 66.67 | 87 | 25.38 | 0.58 |
| 17 | 70.83 | 89 | 70.83 | 89 | 25.97 | 0.58 |
| 18 | 75.00 | 91 | 75.00 | 91 | 26.55 | 0.58 |
| 19 | 79.16 | 93 | 79.16 | 93 | 27.13 | 0.58 |
| 20 | 83.33 | 95 | 83.33 | 95 | 27.72 | 0.58 |
| 21 | 87.50 | 96 | 87.50 | 96 | 28.01 | 0.29 |
| 22 | 91.66 | 98 | 91.66 | 98 | 28.59 | 0.58 |
| 23 | 95.83 | 99 | 95.83 | 99 | 28.88 | 0.29 |
| 24 | 100.00 | 100 | 100.00 | 100 | 29.18 | 0.29 |

## Dedicated Freight Corridor Corporation Of India.

**Estimation of Design Discharge for Railway Bridge No-85 at CH 33/10-11**

**Step - 8**

| | Hourly storm( cm.) | Loss rate ( cm/h) | Effective rainfall |
|---|---|---|---|
| 1 | 4.08 | 0.25 | 3.83 |
| 2 | 3.50 | 0.25 | 3.25 |
| 3 | 2.33 | 0.25 | 2.08 |
| 4 | 1.75 | 0.25 | 1.50 |
| 5 | 1.46 | 0.25 | 1.21 |
| 6 | 1.17 | 0.25 | 0.92 |
| 7 | 0.88 | 0.25 | 0.63 |
| 8 | 0.58 | 0.25 | 0.33 |
| 9 | 0.29 | 0.25 | 0.04 |

a)

| | UH ordinate $m^3/s$ | Discharge ordinate cm. | Discharge ordinate col 2 x col3 |
|---|---|---|---|
| 1 | 2 | 3 | 4 |
| 1 | 17.09 | 3.83 | 65.45 |
| 2 | 16.10 | 3.25 | 52.33 |
| 3 | 15.60 | 2.08 | 32.45 |
| 4 | 14.50 | 1.50 | 21.75 |
| 5 | 13.00 | 1.21 | 15.73 |
| 6 | 12.50 | 0.92 | 11.50 |
| 7 | 11.60 | 0.63 | 7.31 |
| 8 | 10.20 | 0.33 | 3.37 |
| 9 | 9.30 | 0.04 | 0.37 |
| | | **Total** | 210.25 |

b) Add base flow

Base flow rate = 0.045A

0.45 x 71.222 $m^3/s$

= 3.20499

Design discharge = 210.2537 + 3.20499

213.46 $m^3/s$

**Step 9 -** **Computation of design Flood Hydrograph**

The 1 - hr effective rainfall sequence shown in col. (3) of Table in Step - 9 was reversed to obtain the critical sequence as shown below:

| Time | SUH ordinate | Rainfall excess | Rainfall excess in critical order |
|---|---|---|---|
| 0 | 0.00 | | |
| 1 | 1.80 | | |
| 2 | 3.40 | | |
| 3 | 5.20 | | |
| 4 | 7.00 | | |
| 5 | 9.00 | | |
| 6 | 12.50 | 1.17 | 0.29 |
| 7 | 15.60 | 2.33 | 0.58 |
| 8 | 17.09 | 4.08 | 0.88 |
| 9 | 16.10 | 3.5 | 1.46 |
| 10 | 14.50 | 1.75 | 1.75 |
| 11 | 13.00 | 1.46 | 3.5 |
| 12 | 11.60 | 0.88 | 4.08 |
| 13 | 10.20 | 0.58 | 2.33 |
| 14 | 9.30 | 0.29 | 1.17 |
| 15 | 8.55 | | |
| 16 | 8.00 | | |
| 17 | 7.40 | | |
| 18 | 6.90 | | |
| 19 | 6.40 | | |
| 20 | 5.80 | | |
| 21 | 5.30 | | |
| 22 | 4.80 | | |
| 23 | 4.30 | | |
| 24 | 3.90 | | |
| 25 | 3.20 | | |
| 26 | 2.90 | | |
| 27 | 2.30 | | |
| 28 | 1.80 | | |
| 29 | 1.30 | | |
| 30 | 0.85 | | |
| 31 | 0.40 | | |
| 31.64 | 0.00 | | |

3.0 Velocity calculation and check.

Bed Level provided 199.036

Velocity calculation.(V)

For calculating the velocity of the storm water flow,first of all cross-section of the river bed/nala is to be studied.Simultaneously wetted perimeter can be found out and hydraulic mean depth should be calculated as follows

$$R = \frac{A}{P}$$

R= Hydraulic mean depth in meter
A= C/S area in sq.m.
P = Wetted Peremeter

$$R = \frac{A}{P}$$

Where R = Hydraulic Mean Depth In Meter
A = C/S Area In Sqm = 62.370
P = Wetted Peremeter = 38.790

$$R = \frac{A}{P}$$

= 1.61

Velocity

$$V = \frac{(R)^{2/3} * (S)^{1/2}.}{n}$$

Where V = Velocity In m/sec
R = Hydraulic Mean Depth 1.61
S = Energy Slope or Bed Slope 0.00124
n = Rugosity Coefficient 0.045

V = 1.07 m/sec

Checking for adequacy of Waterway Provided

Discharge = A * V 66.736 Cum/sec
Calculated flood discharge from unit Hydrograph 243.455

Let us assume CHFL @ 202.501 The revised sectional properties will be as under

A = C/S Area In Sqm = 62.370
P = Wetted PerImeter = 38.790

$$R = \frac{A}{P}$$

= 1.61

## Dedicated Freight Corridor Corporation Of India.

**Estimation of Design Discharge for Railway Bridge No-85 at CH 33/10-11**

Velocity $\frac{(R)^{2/3} * (S)^{1/2.}}{n}$

Where V = Velocity In m/sec
R = Hydraulic Mean Depth In Mete 1.61
S = Energy Slope or Bed Slope 0.00124
n = Rugosity Coefficient 0.045

V = 1.07 m/sec
1.07

Discharge A X V 66.74 Cum/sec
Calculated flood discharge from unit Hydrograph 243.455

Calculation of afflux

Approximate Area of pier

| Pier No. | Area | Pier No. | Area |
|---|---|---|---|
| P1 | 3.00 | | |
| P2 | 3.00 | | |
| Total | 5.99 | Total | 0.00 |

TOTAL AREA OF PIERS a = 56.38
$V^2$ = 1.1449
$A^2$ = 3890.02
$a^2$ = 3178.48

AFFLUX = $(V^2/17.88+0.01524) \times ((A^2/a^2)-1)$

= 0.018

Total discharge = 66.74 Cum/sec
width of opng. 18
Ht. of Water 3.71 m

Vertical clearance = 1
Girder Height = 0.6

Formation Required CHFL/OHFL+Afflux+Girder height+V.C

= 204.12

Formation provided **205.001**

COMPUTATION OF FLOOD HYDROGRAPH

**Bridge No-85 at CH 33/10-11**

| Time | SUH ord. | Direct surface runoff in $m^3$ /s due to rainfall excess increment in cm. of | | | | | | | | | Total Sur. flow. | Base flow | D.flood hydrograph |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| h | m 3 /s | 0.29 | 0.58 | 0.88 | 1.46 | 1.75 | 3.5 | 4.08 | 2.33 | 1.17 | $m^3$ / s | $m^3$ / s | $m^3$ / s |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 0 | 0.00 | 0.00 | | | | | | | | | 0.00 | 3.20 | 3.20 |
| 1 | 1.80 | 0.52 | 0.00 | | | | | | | | 0.52 | 3.20 | 3.72 |
| 2 | 3.40 | 0.99 | 1.04 | 0.00 | | | | | | | 2.03 | 3.20 | 5.23 |
| 3 | 5.20 | 1.51 | 1.97 | 1.58 | 0.00 | | | | | | 5.06 | 3.20 | 8.26 |
| 4 | 7.00 | 2.03 | 3.02 | 2.99 | 2.63 | 0.00 | | | | | 10.67 | 3.20 | 13.87 |
| 5 | 9.00 | 2.61 | 4.06 | 4.58 | 4.96 | 3.15 | 0.00 | | | | 19.36 | 3.20 | 22.56 |
| 6 | 12.50 | 3.63 | 5.22 | 6.16 | 7.59 | 5.95 | 6.30 | 0.00 | | | 34.85 | 3.20 | 38.05 |
| 7 | 15.60 | 4.52 | 7.25 | 7.92 | 10.22 | 9.10 | 11.90 | 7.34 | 0.00 | | 58.25 | 3.20 | 61.45 |
| 8 | 17.09 | 4.96 | 9.05 | 11.00 | 13.14 | 12.25 | 18.20 | 13.87 | 4.19 | 0.00 | 86.66 | 3.20 | 89.86 |
| 9 | 16.10 | 4.67 | 9.91 | 13.73 | 18.25 | 15.75 | 24.50 | 21.22 | 7.92 | 2.11 | 118.06 | 3.20 | 121.26 |
| 10 | 14.50 | 4.21 | 9.34 | 15.04 | 22.78 | 21.88 | 31.50 | 28.56 | 12.12 | 3.98 | 149.41 | 3.20 | 152.61 |
| 11 | 13.00 | 3.77 | 8.41 | 14.17 | 24.95 | 27.30 | 43.75 | 36.72 | 16.31 | 6.08 | 181.46 | 3.20 | 184.66 |
| 12 | 11.60 | 3.36 | 7.54 | 12.76 | 23.51 | 29.91 | 54.60 | 51.00 | 20.97 | 8.19 | 211.84 | 3.20 | 215.04 |
| 13 | 10.20 | 2.96 | 6.73 | 11.44 | 21.17 | 28.18 | 59.82 | 63.65 | 29.13 | 10.53 | 233.61 | 3.20 | 236.81 |
| 14 | 9.30 | 2.70 | 5.92 | 10.21 | 18.98 | 25.38 | 56.35 | 69.73 | 36.35 | 14.63 | 240.25 | 3.20 | 243.45 |
| 15 | 8.55 | 2.48 | 5.39 | 8.98 | 16.94 | 22.75 | 50.75 | 65.69 | 39.82 | 18.25 | 231.05 | 3.20 | 234.25 |
| 16 | 8.00 | 2.32 | 4.96 | 8.18 | 14.89 | 20.30 | 45.50 | 59.16 | 37.51 | 20.00 | 212.82 | 3.20 | 216.02 |
| 17 | 7.40 | 2.15 | 4.64 | 7.52 | 13.58 | 17.85 | 40.60 | 53.04 | 33.79 | 18.84 | 192.01 | 3.20 | 195.21 |
| 18 | 6.90 | 2.00 | 4.29 | 7.04 | 12.48 | 16.28 | 35.70 | 47.33 | 30.29 | 16.97 | 172.38 | 3.20 | 175.58 |
| 19 | 6.40 | 1.86 | 4.00 | 6.51 | 11.68 | 14.96 | 32.55 | 41.62 | 27.03 | 15.21 | 155.42 | 3.20 | 158.62 |
| 20 | 5.80 | 1.68 | 3.71 | 6.07 | 10.80 | 14.00 | 29.93 | 37.94 | 23.77 | 13.57 | 141.47 | 3.20 | 144.67 |
| 21 | 5.30 | 1.54 | 3.36 | 5.63 | 10.07 | 12.95 | 28.00 | 34.88 | 21.67 | 11.93 | 130.03 | 3.20 | 133.23 |
| 22 | 4.80 | 1.39 | 3.07 | 5.10 | 9.34 | 12.08 | 25.90 | 32.64 | 19.92 | 10.88 | 120.32 | 3.20 | 123.52 |
| 23 | 4.30 | 1.25 | 2.78 | 4.66 | 8.47 | 11.20 | 24.15 | 30.19 | 18.64 | 10.00 | 111.34 | 3.20 | 114.54 |
| 24 | 3.90 | 1.13 | 2.49 | 4.22 | 7.74 | 10.15 | 22.40 | 28.15 | 17.24 | 9.36 | 102.88 | 3.20 | 106.08 |
| 25 | 3.20 | 0.93 | 2.26 | 3.78 | 7.01 | 9.28 | 20.30 | 26.11 | 16.08 | 8.66 | 94.41 | 3.20 | 97.61 |
| 26 | 2.90 | 0.84 | 1.86 | 3.43 | 6.28 | 8.40 | 18.55 | 23.66 | 14.91 | 8.07 | 86.00 | 3.20 | 89.20 |
| 27 | 2.30 | 0.67 | 1.68 | 2.82 | 5.69 | 7.53 | 16.80 | 21.62 | 13.51 | 7.49 | 77.81 | 3.20 | 81.01 |
| 28 | 1.80 | 0.52 | 1.33 | 2.55 | 4.67 | 6.83 | 15.05 | 19.58 | 12.35 | 6.79 | 69.67 | 3.20 | 72.87 |
| 29 | 1.30 | 0.38 | 1.04 | 2.02 | 4.23 | 5.60 | 13.65 | 17.54 | 11.18 | 6.20 | 61.84 | 3.20 | 65.04 |
| 30 | 0.85 | 0.25 | 0.75 | 1.58 | 3.36 | 5.08 | 11.20 | 15.91 | 10.02 | 5.62 | 53.77 | 3.20 | 56.97 |
| 31 | 0.40 | 0.12 | 0.49 | 1.14 | 2.63 | 4.03 | 10.15 | 13.06 | 9.09 | 5.03 | 45.74 | 3.20 | 48.94 |
| 31.64 | 0.00 | 0.00 | 0.23 | 0.75 | 1.90 | 3.15 | 8.05 | 11.83 | 7.46 | 4.56 | 37.93 | 3.20 | 41.13 |
| | | | 0.00 | 0.35 | 1.24 | 2.28 | 6.30 | 9.38 | 6.76 | 3.74 | 30.05 | 3.20 | 33.25 |
| | | | | 0.00 | 0.58 | 1.49 | 4.55 | 7.34 | 5.36 | 3.39 | 22.71 | 3.20 | 25.91 |
| | | | | | 0.00 | 0.70 | 2.98 | 5.30 | 4.19 | 2.69 | 15.86 | 3.20 | 19.06 |
| | | | | | | 0.00 | 1.40 | 3.47 | 3.03 | 2.11 | 10.01 | 3.20 | 13.21 |
| | | | | | | | 0.00 | 1.63 | 1.98 | 1.52 | 5.13 | 3.20 | 8.33 |
| | | | | | | | | 0.00 | 0.93 | 0.99 | 1.92 | 3.20 | 5.12 |
| | | | | | | | | | 0.00 | 0.47 | 0.47 | 3.20 | 3.67 |
| | | | | | | | | | | 0.00 | 0.00 | 3.20 | 3.20 |
| | | | | | | | | | | | | | 243.45 |

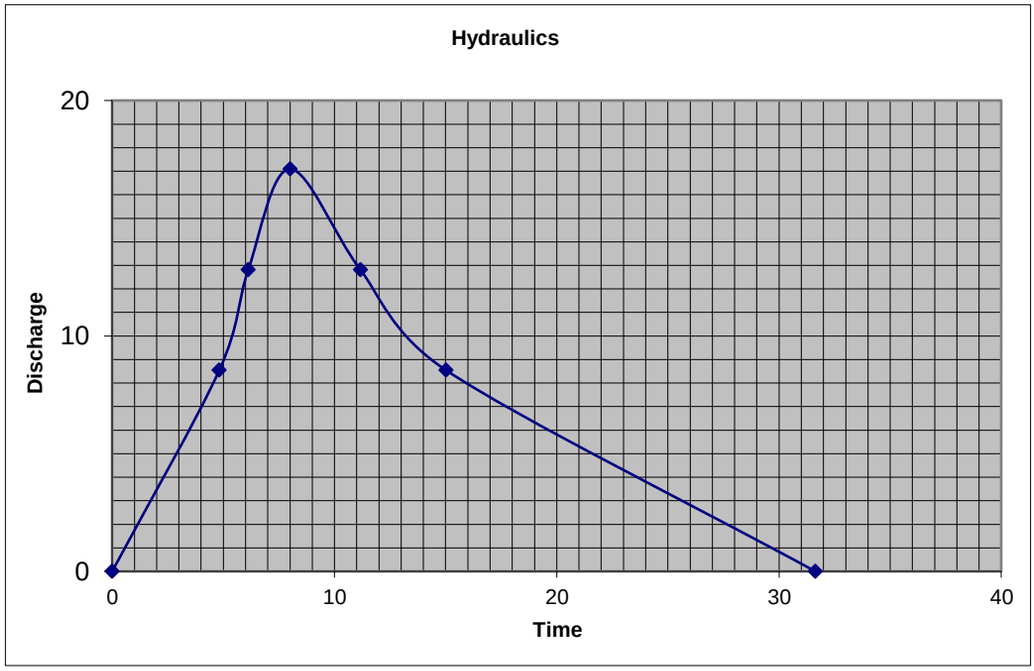
**Bridge No-85 at CH 33/10-11**

| | |
|---|---|
| 0 | 0 |
| w r50 | 3.18 |
| w r75 | 1.87 |
| tp | 8.00 |
| w75 | 5.04 |
| w50 | 10.20 |
| Qp | 17.09 |

| x hrs | y discharge |
|---|---|
| 0.00 | 0.00 |
| 4.82 | 8.55 |
| 6.13 | 12.82 |
| 8.00 | 17.09 |
| 11.17 | 12.82 |
| 15.02 | 8.55 |
| 31.64 | 0.00 |

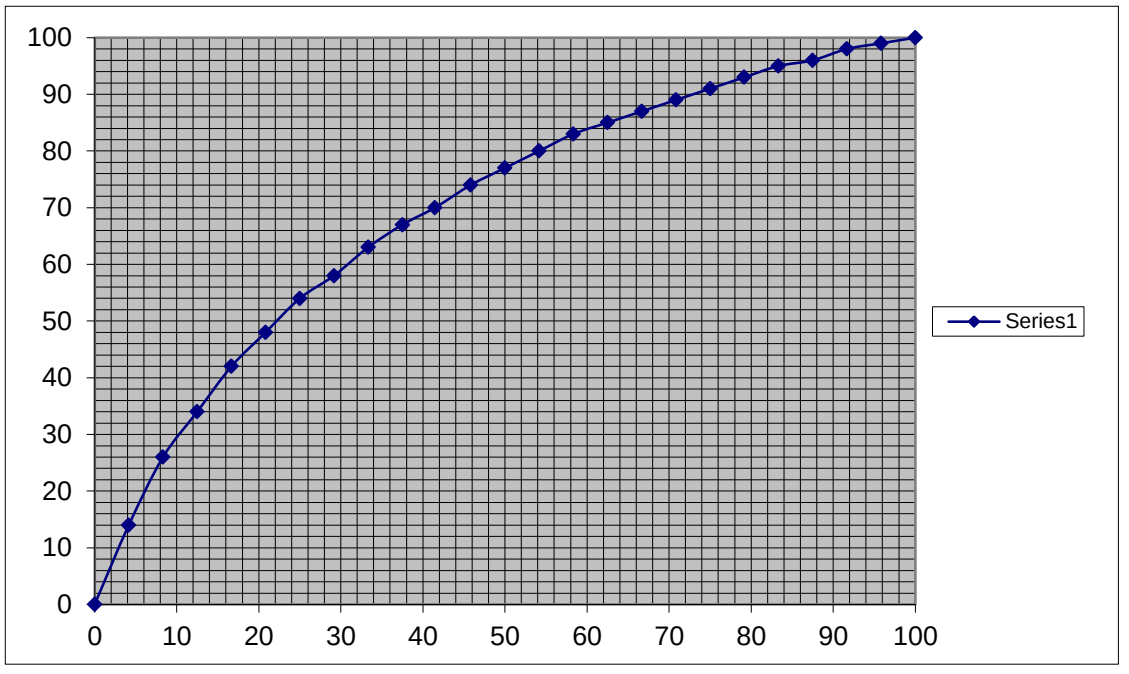
tb 31.64

| | |
|---|---|
| 0 | 0 |
| 1 | 1.8 |
| 2 | 3.4 |
| 3 | 5.2 |
| 4 | 7 |
| 5 | 9 |
| 6 | 12.5 |
| 7 | 15.6 |
| 8 | 17.09 |
| 9 | 16.1 |
| 10 | 14.5 |
| 11 | 13 |
| 12 | 11.6 |
| 13 | 10.2 |
| 14 | 9.3 |
| 15 | 8.55 |
| 16 | 8 |
| 17 | 7.4 |
| 18 | 6.9 |
| 19 | 6.4 |
| 20 | 5.8 |
| 21 | 5.3 |
| 22 | 4.8 |
| 23 | 4.3 |
| 24 | 3.9 |
| 25 | 3.2 |
| 26 | 2.9 |
| 27 | 2.3 |
| 28 | 1.8 |
| 29 | 1.3 |
| 30 | 0.85 |
| 31 | 0.4 |
| 31.64 | 0 |



**Bridge No-85 at CH 33/10-11**

| | |
|---|---|
| 0 | 0 |
| 4.16 | 14 |
| 8.33 | 26 |
| 12.50 | 34 |
| 16.67 | 42 |
| 20.83 | 48 |
| 25.00 | 54 |
| 29.16 | 58 |
| 33.33 | 63 |
| 37.50 | 67 |
| 41.46 | 70 |
| 45.83 | 74 |
| 50.00 | 77 |
| 54.16 | 80 |
| 58.33 | 83 |
| 62.50 | 85 |
| 66.67 | 87 |
| 70.83 | 89 |
| 75.00 | 91 |
| 79.16 | 93 |
| 83.33 | 95 |
| 87.50 | 96 |
| 91.66 | 98 |
| 95.83 | 99 |
| 100.00 | 100 |




| | | |
|---|---|---|
| A | 81665409 | 81.66541 |
| P | 66061.695 | 66.06169 |
| A | 71618941 | 71.61894 |
| P | 65235.728 | 65.23573 |
| A | | 153.2843 |
| P | | 131.2974 |
| wetted peri | 34688.28 | |
| | 35485.91 | |
| | 70174.2 | 70.1742 |

# MINOR BRIDGES

**Dedicated freight corridor Corporation of India.**

**Br. No. 3 IR KM-3.116 (Khurja-Hafizpur)**

Estimation of Design Discharge for Railway Bridge

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.1739 | Sq Km |
| C | Length of Longest Stream | 0.300 | Km |
| D | Height Of farthest point | 199.064 | M |
| E | Height of Point of Interest | 195.864 | M |
| F | Height Diff of 10 & 11 | 3.20 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 195.864 | M |
| I | Observed HFL | 196.975 | M |

**Br. No. 3 IR KM-3.116 (Khurja-Hafizpur)**

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

= $[ 0.3 \times 0.3 \times 0.3 / 3.20 ]^{0.345}$

= **0.1926 hr.**

= 0.1926 hr. x 60

= **11.5530 Min**

**Br. No. 3 IR KM-3.116 (Khurja-Hafizpur)**

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

R = 300.00 mm

F = 0.72

$C = 0.249 \times ( R \times F )^{0.2}$

= **0.8511**

**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 = $\frac{\text{tc h Ratio}}{\text{1h Ratio}}$

= $\frac{0.1213}{0.34}$

= **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) = $\frac{\text{R-50 (tc)}}{\text{tc}}$

= $\frac{36.38}{0.1926}$

= **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 0.1739

= **7.7745 cum/sec**

**Br. No. 3 IR KM-3.116 (Khurja-Hafizpur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 7.7745 cum/sec

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

= $\frac{7.7745}{1.75}$

= **4.4426 Sq.m**

d Proposed Opening = 1 4 1.2

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

= $\frac{4.4426}{4}$

= **1.1110 m**

f Avg. Bed Level = 195.864

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

= 195.8640 +1.1110 +4.1560

= 201.1310

k **Formation level adopted** = 201.1310

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-4 IR KM 3.813 (Khurja-Hafizpur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.1183 | Sq Km |
| C | Length of Longest Stream | 0.468 | Km |
| D | Height Of farthest point | 198.731 | M |
| E | Height of Point of Interest | 196.111 | M |
| F | Height Diff of 10 & 11 | 2.62 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 196.111 | M |
| I | Observed HFL | 197.200 | M |

**BR NO-4 IR KM 3.813 (Khurja-Hafizpur)**

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

= $[ 0.468 \times 0.468 \times 0.468 / 2.62 ]^{0.345}$

= **0.3269 hr.**

= 0.3269 hr. x 60

= **19.6129 Min**

**BR NO-4 IR KM 3.813 (Khurja-Hafizpur)**

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

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

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

a tc h Ratio = *0.1781* From Fig. 4 of RBF - 16

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

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

= $\frac{0.1781}{0.34}$

= **0.5237**

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 )

= 0.5237 x102.00

= **53.4193 mm**

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

= $\frac{53.42}{0.3269}$

= **163.4209 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 163.4209 x 0.1183

= **4.5742 cum/sec**

**BR NO-4 IR KM 3.813 (Khurja-Hafizpur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 4.5742 cum/sec

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

= $\frac{4.5742}{1.75}$

= **2.6138 Sq.m**

d Proposed Opening = 2 1.2 1.2

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

= $\frac{2.6138}{2.4}$

= **1.0890 m**

f Avg. Bed Level = 196.111

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

= 196.1110 +1.0890 +1.1350

= 198.3350

k **Formation level adopted** = 198.3350

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO 5 IR KM 3.938 (Khurja-Hafizpur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0512 | Sq Km |
| C | Length of Longest Stream | 0.237 | Km |
| D | Height Of farthest point | 198.521 | M |
| E | Height of Point of Interest | 196.021 | M |
| F | Height Diff of 10 & 11 | 2.50 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 196.021 | M |
| I | Observed HFL | 197.150 | M |

**BR NO 5 IR KM 3.938 (Khurja-Hafizpur)**

**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

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

$= [ 0.237 \times 0.237 \times 0.237 / 2.50 ]^{0.345}$

= **0.1643 hr.**

= 0.1643 hr. x 60

= **9.8566 Min**

**BR NO 5 IR KM 3.938 (Khurja-Hafizpur)**

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

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

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

a tc h Ratio = *0.1071* From Fig. 4 of RBF - 16

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

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

= $\frac{0.1071}{0.34}$

= **0.3151**

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 )

= 0.3151 x102.00

= **32.1415 mm**

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

= $\frac{32.14}{0.1643}$

= **195.6550 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 195.6550 x 0.0512

= **2.3702 cum/sec**

**BR NO 5 IR KM 3.938 (Khurja-Hafizpur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 2.3702 cum/sec

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

= $\frac{2.3702}{1.75}$

= **1.3544 Sq.m**

d Proposed Opening = 1 1.2 1.2

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

= $\frac{1.3544}{1.2}$

= **1.1290 m**

f Avg. Bed Level = 196.021

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

= 196.0207 +1.1290 +0.7700

= 197.9197

k **Formation level adopted** = 197.9200

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-6 IR KM 4.366 (Khurja-Hafizpur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0381 | Sq Km |
| C | Length of Longest Stream | 0.352 | Km |
| D | Height Of farthest point | 198.621 | M |
| E | Height of Point of Interest | 196.101 | M |
| F | Height Diff of 10 & 11 | 2.52 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 196.101 | M |
| I | Observed HFL | 196.875 | M |

**BR NO-6 IR KM 4.366 (Khurja-Hafizpur)**

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

= $[ 0.352 \times 0.352 \times 0.352 / 2.52 ]^{0.345}$

= **0.2467 hr.**

= 0.2467 hr. x 60

= **14.8027 Min**

**BR NO-6 IR KM 4.366 (Khurja-Hafizpur)**

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

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

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

a tc h Ratio = *0.1484* From Fig. 4 of RBF - 16

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

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

= $\frac{0.1484}{0.34}$

= **0.4363**

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 )

= 0.4363 x102.00

= **44.5066 mm**

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

= $\frac{44.51}{0.2467}$

= **180.3998 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 180.3998 x 0.0381

= **1.6262 cum/sec**

**BR NO-6 IR KM 4.366 (Khurja-Hafizpur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.6262 cum/sec

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

= $\frac{1.6262}{1.75}$

= **0.9293 Sq.m**

d Proposed Opening = 1 1.2 1.2

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

= $\frac{0.9293}{1.2}$

= **0.7740 m**

f Avg. Bed Level = 196.101

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

= 196.1010 +0.7740 +0.7860

= 197.6610

k **Formation level adopted** = 197.6610

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**Br. No. 7 IR KM 5.513 (Khurja-Hafizpur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0757 | Sq Km |
| C | Length of Longest Stream | 0.290 | Km |
| D | Height Of farthest point | 197.671 | M |
| E | Height of Point of Interest | 195.311 | M |
| F | Height Diff of 10 & 11 | 2.36 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 195.311 | M |
| I | Observed HFL | 196.900 | M |

**Br. No. 7 IR KM 5.513 (Khurja-Hafizpur)**

**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

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

$= [ 0.29 \times 0.29 \times 0.29 / 2.36 ]^{0.345}$

= **0.2065 hr.**

= 0.2065 hr. x 60

= **12.3902 Min**

**Br. No. 7 IR KM 5.513 (Khurja-Hafizpur)**

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

R = 300.00 mm

F = 0.72

$C = 0.249 \times ( R \times F )^{0.2}$

= **0.8511**

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

a tc h Ratio = *0.1283* From Fig. 4 of RBF - 16

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

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

= $\frac{0.1283}{0.34}$

= **0.3772**

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 )

= 0.3772 x102.00

= **38.4755 mm**

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

= $\frac{38.48}{0.2065}$

= **186.3189 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 186.3189 x 0.0757

= **3.3372 cum/sec**

**Br. No. 7 IR KM 5.513 (Khurja-Hafizpur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 3.3372 cum/sec

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

= $\frac{3.3372}{1.75}$

= **1.9070 Sq.m**

d Proposed Opening = 1 1.2 2

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

= $\frac{1.9070}{1.2}$

= **1.5890 m**

f Avg. Bed Level = 195.311

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

= 195.3110 +1.5890 +0.7610

= 197.6610

k **Formation level adopted** = 197.6610

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-8 IR KM 5.6698 (Khurja-Hafizpur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.3026 | Sq Km |
| C | Length of Longest Stream | 0.500 | Km |
| D | Height Of farthest point | 198.303 | M |
| E | Height of Point of Interest | 195.403 | M |
| F | Height Diff of 10 & 11 | 2.90 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 195.403 | M |
| I | Observed HFL | 197.050 | M |

**BR NO-8 IR KM 5.6698 (Khurja-Hafizpur)**

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

= $[ 0.5 \times 0.5 \times 0.5 / 2.90 ]^{0.345}$

= **0.3380 hr.**

= 0.3380 hr. x 60

= **20.2795 Min**

**BR NO-8 IR KM 5.6698 (Khurja-Hafizpur)**

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

R = 300.00 mm

F = 0.72

$C = 0.249 \times ( R \times F )^{0.2}$

= **0.8511**

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

a tc h Ratio = *0.1814* From Fig. 4 of RBF - 16

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

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

= $\frac{0.1814}{0.34}$

= **0.5335**

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 )

= 0.5335 x102.00

= **54.4193 mm**

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

= $\frac{54.42}{0.3380}$

= **161.0076 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 161.0076 x 0.3026

= **11.5277 cum/sec**

**BR NO-8 IR KM 5.6698 (Khurja-Hafizpur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 11.5277 cum/sec

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

= $\frac{11.5277}{1.75}$

= **6.5873 Sq.m**

d Proposed Opening = 1 4 2

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

= $\frac{6.5873}{4}$

= **1.6470 m**

f Avg. Bed Level = 195.403

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

= 195.4030 +1.6470 +0.8530

= 197.9030

k **Formation level adopted** = 197.9030

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-9 IR KM 5.948 (Khurja-Hafizpur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0557 | Sq Km |
| C | Length of Longest Stream | 0.200 | Km |
| D | Height Of farthest point | 199.098 | M |
| E | Height of Point of Interest | 196.648 | M |
| F | Height Diff of 10 & 11 | 2.45 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 196.648 | M |
| I | Observed HFL | 197.425 | M |

**BR NO-9 IR KM 5.948 (Khurja-Hafizpur)**

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

= $[ 0.2 \times 0.2 \times 0.2 / 2.45 ]^{0.345}$

= **0.1388 hr.**

= 0.1388 hr. x 60

= **8.3264 Min**

**BR NO-9 IR KM 5.948 (Khurja-Hafizpur)**

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

R = 300.00 mm

F = 0.72

$C = 0.249 \times ( R \times F )^{0.2}$

= **0.8511**

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

a tc h Ratio = *0.0955* From Fig. 4 of RBF - 16

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

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

= $\frac{0.0955}{0.34}$

= **0.2809**

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 )

= 0.2809 x102.00

= **28.6527 mm**

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

= $\frac{28.65}{0.1388}$

= **206.4723 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 206.4723 x 0.0557

= **2.7211 cum/sec**

**BR NO-9 IR KM 5.948 (Khurja-Hafizpur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 2.7211 cum/sec

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

= $\frac{2.7211}{1.75}$

= **1.5549 Sq.m**

d Proposed Opening = 1 2 1.2

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

= $\frac{1.5549}{2}$

= **0.7770 m**

f Avg. Bed Level = 196.648

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

= 196.6476 +0.7770 +0.7900

= 198.2146

k **Formation level adopted** = 198.2150

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-10 IR KM 6.050 (Khurja-Hafizpur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.2246 | Sq Km |
| C | Length of Longest Stream | 0.600 | Km |
| D | Height Of farthest point | 198.479 | M |
| E | Height of Point of Interest | 195.829 | M |
| F | Height Diff of 10 & 11 | 2.65 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 195.829 | M |
| I | Observed HFL | 196.945 | M |

**BR NO-10 IR KM 6.050 (Khurja-Hafizpur)**

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

= $[ 0.6 \times 0.6 \times 0.6 / 2.65 ]^{0.345}$

= **0.4211 hr.**

= 0.4211 hr. x 60

= **25.2649 Min**

**BR NO-10 IR KM 6.050 (Khurja-Hafizpur)**

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

R = 300.00 mm

F = 0.72

$C = 0.249 \times ( R \times F )^{0.2}$

= **0.8511**

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

a tc h Ratio = *0.2063* From Fig. 4 of RBF - 16

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

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

= $\frac{0.2063}{0.34}$

= **0.6068**

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 )

= 0.6068 x102.00

= **61.8974 mm**

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

= $\frac{61.90}{0.4211}$

= **146.9961 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 146.9961 x 0.2246

= **7.8116 cum/sec**

**BR NO-10 IR KM 6.050 (Khurja-Hafizpur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 7.8116 cum/sec

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

= $\frac{7.8116}{1.75}$

= **4.4638 Sq.m**

d Proposed Opening = 1 4 1.2

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

= $\frac{4.4638}{4}$

= **1.1160 m**

f Avg. Bed Level = 195.829

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

= 195.8290 +1.1160 +1.2290

= 198.1740

k **Formation level adopted** = 198.1740

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-12 IR KM 7.072 (Khurja-Hafizpur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.3654 | Sq Km |
| C | Length of Longest Stream | 0.700 | Km |
| D | Height Of farthest point | 198.897 | M |
| E | Height of Point of Interest | 196.047 | M |
| F | Height Diff of 10 & 11 | 2.85 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 196.047 | M |
| I | Observed HFL | 197.750 | M |

**BR NO-12 IR KM 7.072 (Khurja-Hafizpur)**

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

= $[ 0.7 \times 0.7 \times 0.7 / 2.85 ]^{0.345}$

= **0.4817 hr.**

= 0.4817 hr. x 60

= **28.9006 Min**

**BR NO-12 IR KM 7.072 (Khurja-Hafizpur)**

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

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

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

a tc h Ratio = *0.2213* From Fig. 4 of RBF - 16

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

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

= $\frac{0.2213}{0.34}$

= **0.6510**

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 )

= 0.6510 x102.00

= **66.4006 mm**

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

= $\frac{66.40}{0.4817}$

= **137.8532 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 137.8532 x 0.3654

= **11.9182 cum/sec**

**BR NO-12 IR KM 7.072 (Khurja-Hafizpur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 11.9182 cum/sec

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

= $\frac{11.9182}{1.75}$

= **6.8104 Sq.m**

d Proposed Opening = 1 4 2

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

= $\frac{6.8104}{4}$

= **1.7030 m**

f Avg. Bed Level = 196.047

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

= 196.0470 +1.7030 +0.7970

= 198.5470

k **Formation level adopted** = 198.5470

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-13 IR KM 7.170 (Khurja-Hafizpur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0327 | Sq Km |
| C | Length of Longest Stream | 0.205 | Km |
| D | Height Of farthest point | 200.058 | M |
| E | Height of Point of Interest | 197.138 | M |
| F | Height Diff of 10 & 11 | 2.92 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 197.138 | M |
| I | Observed HFL | 197.910 | M |

**BR NO-13 IR KM 7.170 (Khurja-Hafizpur)**

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

= $[ 0.205 \times 0.205 \times 0.205 / 2.92 ]^{0.345}$

= **0.1340 hr.**

= 0.1340 hr. x 60

= **8.0401 Min**

**BR NO-13 IR KM 7.170 (Khurja-Hafizpur)**

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

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

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

a tc h Ratio = *0.0936* From Fig. 4 of RBF - 16

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

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

= $\frac{0.0936}{0.34}$

= **0.2753**

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 )

= 0.2753 x102.00

= **28.0801 mm**

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

= $\frac{28.08}{0.1340}$

= **209.5514 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 209.5514 x 0.0327

= **1.6213 cum/sec**

**BR NO-13 IR KM 7.170 (Khurja-Hafizpur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.6213 cum/sec

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

= $\frac{1.6213}{1.75}$

= **0.9265 Sq.m**

d Proposed Opening = 1 1.2 1.2

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

= $\frac{0.9265}{1.2}$

= **0.7720 m**

f Avg. Bed Level = 197.138

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

= 197.1380 +0.7720 +0.7780

= 198.6880

k **Formation level adopted** = 198.6880

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-14 IR KM 7.212 (Khurja-Hafizpur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0283 | Sq Km |
| C | Length of Longest Stream | 0.175 | Km |
| D | Height Of farthest point | 200.889 | M |
| E | Height of Point of Interest | 197.249 | M |
| F | Height Diff of 10 & 11 | 3.64 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 197.249 | M |
| I | Observed HFL | 197.995 | M |

**BR NO-14 IR KM 7.212 (Khurja-Hafizpur)**

**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

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

$= [0.175 \times 0.175 \times 0.175 / 3.64]^{0.345}$

= **0.1054 hr.**

= 0.1054 hr. x 60

= **6.3258 Min**

**BR NO-14 IR KM 7.212 (Khurja-Hafizpur)**

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

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

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

a tc h Ratio = *0.0822* From Fig. 4 of RBF - 16

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

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

= $\frac{0.0822}{0.34}$

= **0.2417**

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 )

= 0.2417 x102.00

= **24.6516 mm**

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

= $\frac{24.65}{0.1054}$

= **233.8195 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 233.8195 x 0.0283

= **1.5656 cum/sec**

**BR NO-14 IR KM 7.212 (Khurja-Hafizpur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.5656 cum/sec

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

= $\frac{1.5656}{1.75}$

= **0.8946 Sq.m**

d Proposed Opening = 1 1.2 1.2

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

= $\frac{0.8946}{1.2}$

= **0.7460 m**

f Avg. Bed Level = 197.249

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

= 197.2490 +0.7460 +0.8040

= 198.7990

k **Formation level adopted** = 198.7990

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-14 IR KM 8.090 (Khurja-Hafizpur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0296 | Sq Km |
| C | Length of Longest Stream | 0.161 | Km |
| D | Height Of farthest point | 200.161 | M |
| E | Height of Point of Interest | 197.651 | M |
| F | Height Diff of 10 & 11 | 2.51 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 197.651 | M |
| I | Observed HFL | 198.415 | M |

**BR NO-14 IR KM 8.090 (Khurja-Hafizpur)**

**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

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

$= [0.161 \times 0.161 \times 0.161 / 2.51]^{0.345}$

= **0.1099 hr.**

= 0.1099 hr. x 60

= **6.5967 Min**

**BR NO-14 IR KM 8.090 (Khurja-Hafizpur)**

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

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

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

a tc h Ratio = *0.0840* From Fig. 4 of RBF - 16

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

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

= $\frac{0.0840}{0.34}$

= **0.2470**

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 )

= 0.2470 x102.00

= **25.1935 mm**

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

= $\frac{25.19}{0.1099}$

= **229.1454 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 229.1454 x 0.0296

= **1.6048 cum/sec**

**BR NO-14 IR KM 8.090 (Khurja-Hafizpur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.6048 cum/sec

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

= $\frac{1.6048}{1.75}$

= **0.9170 Sq.m**

d Proposed Opening = 1 1.2 1.2

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

= $\frac{0.9170}{1.2}$

= **0.7640 m**

f Avg. Bed Level = 197.651

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

= 197.6510 +0.7640 +0.7860

= 199.2010

k **Formation level adopted** = 199.2010

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-16 IR KM 8.340 (Khurja-Hafizpur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0380 | Sq Km |
| C | Length of Longest Stream | 0.400 | Km |
| D | Height Of farthest point | 199.788 | M |
| E | Height of Point of Interest | 196.928 | M |
| F | Height Diff of 10 & 11 | 2.86 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 196.928 | M |
| I | Observed HFL | 197.680 | M |

**BR NO-16 IR KM 8.340 (Khurja-Hafizpur)**

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

= $[ 0.4 \times 0.4 \times 0.4 / 2.86 ]^{0.345}$

= **0.2696 hr.**

= 0.2696 hr. x 60

= **16.1747 Min**

**BR NO-16 IR KM 8.340 (Khurja-Hafizpur)**

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

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

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

a tc h Ratio = *0.1578* From Fig. 4 of RBF - 16

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

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

= $\frac{0.1578}{0.34}$

= **0.4642**

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 )

= 0.4642 x102.00

= **47.3495 mm**

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

= $\frac{47.35}{0.2696}$

= **175.6425 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 175.6425 x 0.0380

= **1.5792 cum/sec**

**BR NO-16 IR KM 8.340 (Khurja-Hafizpur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.5792 cum/sec

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

= $\frac{1.5792}{1.75}$

= **0.9024 Sq.m**

d Proposed Opening = 1 1.2 1.2

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

= $\frac{0.9024}{1.2}$

= **0.7520 m**

f Avg. Bed Level = 196.928

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

= 196.9280 +0.7520 +0.7980

= 198.4780

k **Formation level adopted** = 198.4780

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-17 IR KM 8.543 (Khurja-Hafizpur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0366 | Sq Km |
| C | Length of Longest Stream | 0.382 | Km |
| D | Height Of farthest point | 199.063 | M |
| E | Height of Point of Interest | 196.333 | M |
| F | Height Diff of 10 & 11 | 2.73 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 196.333 | M |
| I | Observed HFL | 197.065 | M |

**BR NO-17 IR KM 8.543 (Khurja-Hafizpur)**

**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

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

$= [0.382 \times 0.382 \times 0.382 / 2.73]^{0.345}$

= **0.2612 hr.**

= 0.2612 hr. x 60

= **15.6715 Min**

**BR NO-17 IR KM 8.543 (Khurja-Hafizpur)**

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

R = 300.00 mm

F = 0.72

$C = 0.249 \times ( R \times F )^{0.2}$

= **0.8511**

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

a tc h Ratio = *0.1545* From Fig. 4 of RBF - 16

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

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

= $\frac{0.1545}{0.34}$

= **0.4543**

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 )

= 0.4543 x102.00

= **46.3430 mm**

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

= $\frac{46.34}{0.2612}$

= **177.4290 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 177.4290 x 0.0366

= **1.5365 cum/sec**

**BR NO-17 IR KM 8.543 (Khurja-Hafizpur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.5365 cum/sec

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

= $\frac{1.5365}{1.75}$

= **0.8780 Sq.m**

d Proposed Opening = 1 1.2 1.2

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

= $\frac{0.8780}{1.2}$

= **0.7320 m**

f Avg. Bed Level = 196.333

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

= 196.3330 +0.7320 +0.8180

= 197.8830

k **Formation level adopted** = 197.8830

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-19 IR KM 9.207 (Khurja-Hafizpur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0326 | Sq Km |
| C | Length of Longest Stream | 0.200 | Km |
| D | Height Of farthest point | 198.715 | M |
| E | Height of Point of Interest | 196.225 | M |
| F | Height Diff of 10 & 11 | 2.49 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 196.225 | M |
| I | Observed HFL | 196.985 | M |

**BR NO-19 IR KM 9.207 (Khurja-Hafizpur)**

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

= $[ 0.2 \times 0.2 \times 0.2 / 2.49 ]^{0.345}$

= **0.1380 hr.**

= 0.1380 hr. x 60

= **8.2800 Min**

**BR NO-19 IR KM 9.207 (Khurja-Hafizpur)**

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

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

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

a tc h Ratio = *0.0952* From Fig. 4 of RBF - 16

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

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

= $\frac{0.0952}{0.34}$

= **0.2800**

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 )

= 0.2800 x102.00

= **28.5599 mm**

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

= $\frac{28.56}{0.1380}$

= **206.9567 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 206.9567 x 0.0326

= **1.5963 cum/sec**

**BR NO-19 IR KM 9.207 (Khurja-Hafizpur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.5963 cum/sec

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

= $\frac{1.5963}{1.75}$

= **0.9122 Sq.m**

d Proposed Opening = 1 1.2 1.2

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

= $\frac{0.9122}{1.2}$

= **0.7600 m**

f Avg. Bed Level = 196.225

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

= 196.2250 +0.7600 +0.7900

= 197.7750

k **Formation level adopted** = 197.7750

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-20 IR KM-9.993 (Khurja-Hafizpur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.6453 | Sq Km |
| C | Length of Longest Stream | 0.610 | Km |
| D | Height Of farthest point | 197.705 | M |
| E | Height of Point of Interest | 195.275 | M |
| F | Height Diff of 10 & 11 | 2.43 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 195.275 | M |
| I | Observed HFL | 196.850 | M |

**BR NO-20 IR KM-9.993 (Khurja-Hafizpur)**

**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

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

$= [ 0.61 \times 0.61 \times 0.61 / 2.43 ]^{0.345}$

= **0.4413 hr.**

= 0.4413 hr. x 60

= **26.4809 Min**

**BR NO-20 IR KM-9.993 (Khurja-Hafizpur)**

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

R = 300.00 mm

F = 0.72

$C = 0.249 \times ( R \times F )^{0.2}$

= **0.8511**

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

a tc h Ratio = *0.2124* From Fig. 4 of RBF - 16

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

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

= $\frac{0.2124}{0.34}$

= **0.6247**

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 )

= 0.6247 x102.00

= **63.7214 mm**

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

= $\frac{63.72}{0.4413}$

= **144.3787 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 144.3787 x 0.6453

= **22.0440 cum/sec**

**BR NO-20 IR KM-9.993 (Khurja-Hafizpur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 22.0440 cum/sec

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

= $\frac{22.0440}{1.75}$

= **12.5966 Sq.m**

d Proposed Opening = 2 4 2

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

= $\frac{12.5966}{8}$

= **1.5750 m**

f Avg. Bed Level = 195.275

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

= 195.2750 +1.5750 +0.9250

= 197.7750

k **Formation level adopted** = 197.7750

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-21 IR KM 11.104 (Khurja-Hafizpur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.3687 | Sq Km |
| C | Length of Longest Stream | 0.200 | Km |
| D | Height Of farthest point | 197.683 | M |
| E | Height of Point of Interest | 194.483 | M |
| F | Height Diff of 10 & 11 | 3.20 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 194.483 | M |
| I | Observed HFL | 197.160 | M |

**BR NO-21 IR KM 11.104 (Khurja-Hafizpur)**

**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

| | 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

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

$= [ 0.2 \times 0.2 \times 0.2 / 3.20 ]^{0.345}$

= **0.1266 hr.**

= 0.1266 hr. x 60

= **7.5935 Min**

**BR NO-21 IR KM 11.104 (Khurja-Hafizpur)**

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

R = 300.00 mm

F = 0.72

$C = 0.249 \times ( R \times F )^{0.2}$

= **0.8511**

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

a tc h Ratio = *0.0906* From Fig. 4 of RBF - 16

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

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

= $\frac{0.0906}{0.34}$

= **0.2665**

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 )

= 0.2665 x102.00

= **27.1869 mm**

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

= $\frac{27.19}{0.1266}$

= **214.8179 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 214.8179 x 0.3687

= **18.7400 cum/sec**

**BR NO-21 IR KM 11.104 (Khurja-Hafizpur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 18.7400 cum/sec

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

= $\frac{18.7400}{1.75}$

= **10.7086 Sq.m**

d Proposed Opening = 2 2 3

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

= $\frac{10.7086}{4}$

= **2.6770 m**

f Avg. Bed Level = 194.483

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

= 194.4830 +2.6770 +0.8230

= 197.9830

k **Formation level adopted** = 197.9830

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR No-22 IR KM-11.588 (Khurja-Hafizpur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0338 | Sq Km |
| C | Length of Longest Stream | 0.200 | Km |
| D | Height Of farthest point | 198.998 | M |
| E | Height of Point of Interest | 196.738 | M |
| F | Height Diff of 10 & 11 | 2.26 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 196.738 | M |
| I | Observed HFL | 197.515 | M |

**BR No-22 IR KM-11.588 (Khurja-Hafizpur)**

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

= $[ 0.2 \times 0.2 \times 0.2 / 2.26 ]^{0.345}$

= **0.1427 hr.**

= 0.1427 hr. x 60

= **8.5615 Min**

**BR No-22 IR KM-11.588 (Khurja-Hafizpur)**

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

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

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

a tc h Ratio = *0.0971* From Fig. 4 of RBF - 16

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

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

= $\frac{0.0971}{0.34}$

= **0.2855**

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 )

= 0.2855 x102.00

= **29.1230 mm**

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

= $\frac{29.12}{0.1427}$

= **204.0974 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 204.0974 x 0.0338

= **1.6322 cum/sec**

**BR No-22 IR KM-11.588 (Khurja-Hafizpur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.6322 cum/sec

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

= $\frac{1.6322}{1.75}$

= **0.9327 Sq.m**

d Proposed Opening = 1 1.2 1.2

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

= $\frac{0.9327}{1.2}$

= **0.7770 m**

f Avg. Bed Level = 196.738

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

= 196.7380 +0.7770 +0.7730

= 198.2880

k **Formation level adopted** = 198.2880

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-23 IR KM-12.292 (Khurja-Hafizpur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0542 | Sq Km |
| C | Length of Longest Stream | 0.200 | Km |
| D | Height Of farthest point | 200.350 | M |
| E | Height of Point of Interest | 197.450 | M |
| F | Height Diff of 10 & 11 | 2.90 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 197.450 | M |
| I | Observed HFL | 198.225 | M |

**BR NO-23 IR KM-12.292 (Khurja-Hafizpur)**

**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

| | 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

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

$= [0.2 \times 0.2 \times 0.2 / 2.90]^{0.345}$

= **0.1309 hr.**

= 0.1309 hr. x 60

= **7.8558 Min**

**BR NO-23 IR KM-12.292 (Khurja-Hafizpur)**

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

R = 300.00 mm

F = 0.72

$C = 0.249 \times ( R \times F )^{0.2}$

= **0.8511**

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

a tc h Ratio = *0.0924* From Fig. 4 of RBF - 16

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

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

= $\frac{0.0924}{0.34}$

= **0.2717**

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 )

= 0.2717 x102.00

= **27.7116 mm**

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

= $\frac{27.71}{0.1309}$

= **211.6522 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 211.6522 x 0.0542

= **2.7142 cum/sec**

**BR NO-23 IR KM-12.292 (Khurja-Hafizpur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 2.7142 cum/sec

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

= $\frac{2.7142}{1.75}$

= **1.5510 Sq.m**

d Proposed Opening = 1 2 1.2

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

= $\frac{1.5510}{2}$

= **0.7750 m**

f Avg. Bed Level = 197.450

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

= 197.4500 +0.7750 +0.7750

= 199.0000

k **Formation level adopted** = 199.0000

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-24 IR KM 12.328 (Khurja-Hafizpur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0279 | Sq Km |
| C | Length of Longest Stream | 0.150 | Km |
| D | Height Of farthest point | 200.196 | M |
| E | Height of Point of Interest | 197.486 | M |
| F | Height Diff of 10 & 11 | 2.71 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 197.486 | M |
| I | Observed HFL | 198.240 | M |

**BR NO-24 IR KM 12.328 (Khurja-Hafizpur)**

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

= $[ 0.15 \times 0.15 \times 0.15 / 2.71 ]^{0.345}$

= **0.0995 hr.**

= 0.0995 hr. x 60

= **5.9708 Min**

**BR NO-24 IR KM 12.328 (Khurja-Hafizpur)**

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

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

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

a tc h Ratio = *0.0796* From Fig. 4 of RBF - 16

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

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

= $\frac{0.0796}{0.34}$

= **0.2341**

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 )

= 0.2341 x102.00

= **23.8831 mm**

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

= $\frac{23.88}{0.0995}$

= **239.9997 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 239.9997 x 0.0279

= **1.5843 cum/sec**

**BR NO-24 IR KM 12.328 (Khurja-Hafizpur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.5843 cum/sec

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

= $\frac{1.5843}{1.75}$

= **0.9053 Sq.m**

d Proposed Opening = 1 1.2 1.2

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

= $\frac{0.9053}{1.2}$

= **0.7540 m**

f Avg. Bed Level = 197.486

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

= 197.4860 +0.7540 +0.7960

= 199.0360

k **Formation level adopted** = 199.0360

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-25 IR KM 12.576 (Khurja-Hafizpur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0359 | Sq Km |
| C | Length of Longest Stream | 0.200 | Km |
| D | Height Of farthest point | 200.252 | M |
| E | Height of Point of Interest | 197.632 | M |
| F | Height Diff of 10 & 11 | 2.62 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 197.632 | M |
| I | Observed HFL | 198.475 | M |

**BR NO-25 IR KM 12.576 (Khurja-Hafizpur)**

**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

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

$= [0.2 \times 0.2 \times 0.2 / 2.62]^{0.345}$

= **0.1356 hr.**

= 0.1356 hr. x 60

= **8.1359 Min**

**BR NO-25 IR KM 12.576 (Khurja-Hafizpur)**

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

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

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

a tc h Ratio = *0.0942* From Fig. 4 of RBF - 16

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

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

= $\frac{0.0942}{0.34}$

= **0.2772**

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 )

= 0.2772 x102.00

= **28.2717 mm**

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

= $\frac{28.27}{0.1356}$

= **208.4970 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 208.4970 x 0.0359

= **1.7710 cum/sec**

**BR NO-25 IR KM 12.576 (Khurja-Hafizpur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.7710 cum/sec

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

= $\frac{1.7710}{1.75}$

= **1.0120 Sq.m**

d Proposed Opening = 1 1.2 1.2

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

= $\frac{1.0120}{1.2}$

= **0.8430 m**

f Avg. Bed Level = 197.632

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

= 197.6320 +0.8430 +0.8110

= 199.2860

k **Formation level adopted** = 199.2860

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-26 IR KM 12.688 (Khurja-Hafizpur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.3642 | Sq Km |
| C | Length of Longest Stream | 0.595 | Km |
| D | Height Of farthest point | 198.803 | M |
| E | Height of Point of Interest | 195.803 | M |
| F | Height Diff of 10 & 11 | 3.00 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 195.803 | M |
| I | Observed HFL | 197.650 | M |

**BR NO-26 IR KM 12.688 (Khurja-Hafizpur)**

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

= $[ 0.595 \times 0.595 \times 0.595 / 3.00 ]^{0.345}$

= **0.4000 hr.**

= 0.4000 hr. x 60

= **23.9977 Min**

**BR NO-26 IR KM 12.688 (Khurja-Hafizpur)**

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

R = 300.00 mm

F = 0.72

$C = 0.249 \times ( R \times F )^{0.2}$

= **0.8511**

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

a tc h Ratio = *0.2000* From Fig. 4 of RBF - 16

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

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

= $\frac{0.2000}{0.34}$

= **0.5882**

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 )

= 0.5882 x102.00

= **59.9965 mm**

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

= $\frac{60.00}{0.4000}$

= **150.0057 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 150.0057 x 0.3642

= **12.9263 cum/sec**

**BR NO-26 IR KM 12.688 (Khurja-Hafizpur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 12.9263 cum/sec

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

= $\frac{12.9263}{1.75}$

= **7.3865 Sq.m**

d Proposed Opening = 1 4 2

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

= $\frac{7.3865}{4}$

= **1.8470 m**

f Avg. Bed Level = 195.803

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

= 195.8030 +1.8470 +1.7490

= 199.3990

k **Formation level adopted** = 199.3990

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-27 IR KM 12.981 (Khurja-Hafizpur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0366 | Sq Km |
| C | Length of Longest Stream | 0.165 | Km |
| D | Height Of farthest point | 199.090 | M |
| E | Height of Point of Interest | 196.300 | M |
| F | Height Diff of 10 & 11 | 2.79 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 196.300 | M |
| I | Observed HFL | 197.250 | M |

**BR NO-27 IR KM 12.981 (Khurja-Hafizpur)**

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

= $[ 0.165 \times 0.165 \times 0.165 / 2.79 ]^{0.345}$

= **0.1087 hr.**

= 0.1087 hr. x 60

= **6.5240 Min**

**BR NO-27 IR KM 12.981 (Khurja-Hafizpur)**

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

R = 300.00 mm

F = 0.72

$C = 0.249 \times ( R \times F )^{0.2}$

= **0.8511**

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

a tc h Ratio = *0.0835* From Fig. 4 of RBF - 16

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

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

= $\frac{0.0835}{0.34}$

= **0.2456**

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 )

= 0.2456 x102.00

= **25.0480 mm**

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

= $\frac{25.05}{0.1087}$

= **230.3619 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 230.3619 x 0.0366

= **1.9949 cum/sec**

**BR NO-27 IR KM 12.981 (Khurja-Hafizpur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.9949 cum/sec

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

= $\frac{1.9949}{1.75}$

= **1.1399 Sq.m**

d Proposed Opening = 1 1.2 1.2

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

= $\frac{1.1399}{1.2}$

= **0.9500 m**

f Avg. Bed Level = 196.300

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

= 196.3000 +0.9500 +2.4450

= 199.6950

k **Formation level adopted** = 199.6950

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-28 IR KM13.275 (Khurja-Hafizpur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0512 | Sq Km |
| C | Length of Longest Stream | 0.250 | Km |
| D | Height Of farthest point | 200.511 | M |
| E | Height of Point of Interest | 198.061 | M |
| F | Height Diff of 10 & 11 | 2.45 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 198.061 | M |
| I | Observed HFL | 199.174 | M |

**BR NO-28 IR KM13.275 (Khurja-Hafizpur)**

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

= $[ 0.25 \times 0.25 \times 0.25 / 2.45 ]^{0.345}$

= **0.1748 hr.**

= 0.1748 hr. x 60

= **10.4896 Min**

**BR NO-28 IR KM13.275 (Khurja-Hafizpur)**

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

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

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

a tc h Ratio = *0.1124* From Fig. 4 of RBF - 16

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

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

= $\frac{0.1124}{0.34}$

= **0.3306**

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 )

= 0.3306 x102.00

= **33.7239 mm**

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

= $\frac{33.72}{0.1748}$

= **192.9000 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 192.9000 x 0.0512

= **2.3368 cum/sec**

**BR NO-28 IR KM13.275 (Khurja-Hafizpur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 2.3368 cum/sec

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

= $\frac{2.3368}{1.75}$

= **1.3353 Sq.m**

d Proposed Opening = 1 1.2 1.2

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

= $\frac{1.3353}{1.2}$

= **1.1130 m**

f Avg. Bed Level = 198.061

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

= 198.0610 +1.1130 +1.5430

= 200.7170

k **Formation level adopted** = 200.7170

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-29 IR KM13.416 (Khurja-Hafizpur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0420 | Sq Km |
| C | Length of Longest Stream | 0.200 | Km |
| D | Height Of farthest point | 201.873 | M |
| E | Height of Point of Interest | 198.943 | M |
| F | Height Diff of 10 & 11 | 2.93 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 198.943 | M |
| I | Observed HFL | 199.946 | M |

**BR NO-29 IR KM13.416 (Khurja-Hafizpur)**

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

= $[ 0.2 \times 0.2 \times 0.2 / 2.93 ]^{0.345}$

= **0.1305 hr.**

= 0.1305 hr. x 60

= **7.8279 Min**

**BR NO-29 IR KM13.416 (Khurja-Hafizpur)**

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

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

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

a tc h Ratio = *0.0922* From Fig. 4 of RBF - 16

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

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

= $\frac{0.0922}{0.34}$

= **0.2711**

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 )

= 0.2711 x102.00

= **27.6559 mm**

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

= $\frac{27.66}{0.1305}$

= **211.9781 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 211.9781 x 0.0420

= **2.1065 cum/sec**

**BR NO-29 IR KM13.416 (Khurja-Hafizpur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 2.1065 cum/sec

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

= $\frac{2.1065}{1.75}$

= **1.2037 Sq.m**

d Proposed Opening = 1 1.2 1.2

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

= $\frac{1.2037}{1.2}$

= **1.0030 m**

f Avg. Bed Level = 198.943

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

= 198.9430 +1.0030 +1.3480

= 201.2940

k **Formation level adopted** = 201.2940

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-30 IR KM 13.739 (Khurja-Hafizpur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.4683 | Sq Km |
| C | Length of Longest Stream | 0.600 | Km |
| D | Height Of farthest point | 200.727 | M |
| E | Height of Point of Interest | 197.177 | M |
| F | Height Diff of 10 & 11 | 3.55 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 197.177 | M |
| I | Observed HFL | 199.600 | M |

**BR NO-30 IR KM 13.739 (Khurja-Hafizpur)**

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

= $[ 0.6 \times 0.6 \times 0.6 / 3.55 ]^{0.345}$

= **0.3807 hr.**

= 0.3807 hr. x 60

= **22.8407 Min**

**BR NO-30 IR KM 13.739 (Khurja-Hafizpur)**

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

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

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

a tc h Ratio = *0.1942* From Fig. 4 of RBF - 16

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

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

= $\frac{0.1942}{0.34}$

= **0.5712**

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 )

= 0.5712 x102.00

= **58.2610 mm**

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

= $\frac{58.26}{0.3807}$

= **153.0454 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 153.0454 x 0.4683

= **16.9578 cum/sec**

**BR NO-30 IR KM 13.739 (Khurja-Hafizpur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 16.9578 cum/sec

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

= $\frac{16.9578}{1.75}$

= **9.6902 Sq.m**

d Proposed Opening = 1 4 3

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

= $\frac{9.6902}{4}$

= **2.4230 m**

f Avg. Bed Level = 197.177

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

= 197.1770 +2.4230 +3.0120

= 202.6120

k **Formation level adopted** = 202.6120

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-31 IR KM 14.383 (Khurja-Hafizpur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0854 | Sq Km |
| C | Length of Longest Stream | 0.365 | Km |
| D | Height Of farthest point | 203.051 | M |
| E | Height of Point of Interest | 200.641 | M |
| F | Height Diff of 10 & 11 | 2.41 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 200.641 | M |
| I | Observed HFL | 202.350 | M |

**BR NO-31 IR KM 14.383 (Khurja-Hafizpur)**

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

= $[ 0.365 \times 0.365 \times 0.365 / 2.41 ]^{0.345}$

= **0.2601 hr.**

= 0.2601 hr. x 60

= **15.6073 Min**

**BR NO-31 IR KM 14.383 (Khurja-Hafizpur)**

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

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

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

a tc h Ratio = *0.1540* From Fig. 4 of RBF - 16

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

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

= $\frac{0.1540}{0.34}$

= **0.4531**

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 )

= 0.4531 x102.00

= **46.2147 mm**

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

= $\frac{46.21}{0.2601}$

= **177.6654 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 177.6654 x 0.0854

= **3.5899 cum/sec**

**BR NO-31 IR KM 14.383 (Khurja-Hafizpur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 3.5899 cum/sec

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

= $\frac{3.5899}{1.75}$

= **2.0514 Sq.m**

d Proposed Opening = 1 1.2 2

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

= $\frac{2.0514}{1.2}$

= **1.7090 m**

f Avg. Bed Level = 200.641

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

= 200.6410 +1.7090 +2.4820

= 204.8320

k **Formation level adopted** = 204.8320

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-33 IR KM 14.727 (Khurja-Hafizpur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.1623 | Sq Km |
| C | Length of Longest Stream | 0.375 | Km |
| D | Height Of farthest point | 204.666 | M |
| E | Height of Point of Interest | 202.266 | M |
| F | Height Diff of 10 & 11 | 2.40 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 202.266 | M |
| I | Observed HFL | 203.875 | M |

**BR NO-33 IR KM 14.727 (Khurja-Hafizpur)**

**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

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

$= [ 0.375 \times 0.375 \times 0.375 / 2.40 ]^{0.345}$

= **0.2679 hr.**

= 0.2679 hr. x 60

= **16.0731 Min**

**BR NO-33 IR KM 14.727 (Khurja-Hafizpur)**

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

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

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

a tc h Ratio = *0.1572* From Fig. 4 of RBF - 16

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

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

= $\frac{0.1572}{0.34}$

= **0.4622**

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 )

= 0.4622 x102.00

= **47.1463 mm**

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

= $\frac{47.15}{0.2679}$

= **175.9941 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 175.9941 x 0.1623

= **6.7584 cum/sec**

**BR NO-33 IR KM 14.727 (Khurja-Hafizpur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 6.7584 cum/sec

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

= $\frac{6.7584}{1.75}$

= **3.8619 Sq.m**

d Proposed Opening = 2 1.2 2

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

= $\frac{3.8619}{2.4}$

= **1.6090 m**

f Avg. Bed Level = 202.266

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

= 202.2660 +1.6090 +0.8290

= 204.7040

k **Formation level adopted** = 204.7040

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-34 IR KM 14.995 (Khurja-Hafizpur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0821 | Sq Km |
| C | Length of Longest Stream | 0.250 | Km |
| D | Height Of farthest point | 202.366 | M |
| E | Height of Point of Interest | 199.026 | M |
| F | Height Diff of 10 & 11 | 3.34 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 199.026 | M |
| I | Observed HFL | 200.855 | M |

**BR NO-34 IR KM 14.995 (Khurja-Hafizpur)**

**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

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

$= [0.25 \times 0.25 \times 0.25 / 3.34]^{0.345}$

= **0.1571 hr.**

= 0.1571 hr. x 60

= **9.4260 Min**

**BR NO-34 IR KM 14.995 (Khurja-Hafizpur)**

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

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

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

a tc h Ratio = *0.1035* From Fig. 4 of RBF - 16

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

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

= $\frac{0.1035}{0.34}$

= **0.3046**

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 )

= 0.3046 x102.00

= **31.0650 mm**

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

= $\frac{31.07}{0.1571}$

= **197.7407 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 197.7407 x 0.0821

= **3.8412 cum/sec**

**BR NO-34 IR KM 14.995 (Khurja-Hafizpur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 3.8412 cum/sec

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

= $\frac{3.8412}{1.75}$

= **2.1950 Sq.m**

d Proposed Opening = 1 1.2 2

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

= $\frac{2.1950}{1.2}$

= **1.8290 m**

f Avg. Bed Level = 199.026

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

= 199.0260 +1.8290 +2.6980

= 203.5530

k **Formation level adopted** = 203.5530

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-35 IR KM 15.305 (Khurja-Hafizpur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0871 | Sq Km |
| C | Length of Longest Stream | 0.275 | Km |
| D | Height Of farthest point | 202.137 | M |
| E | Height of Point of Interest | 199.087 | M |
| F | Height Diff of 10 & 11 | 3.05 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 199.087 | M |
| I | Observed HFL | 200.970 | M |

**BR NO-35 IR KM 15.305 (Khurja-Hafizpur)**

**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

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

$= [0.275 \times 0.275 \times 0.275 / 3.05]^{0.345}$

= **0.1789 hr.**

= 0.1789 hr. x 60

= **10.7344 Min**

**BR NO-35 IR KM 15.305 (Khurja-Hafizpur)**

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

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

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

a tc h Ratio = *0.1145* From Fig. 4 of RBF - 16

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

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

= $\frac{0.1145}{0.34}$

= **0.3366**

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 )

= 0.3366 x102.00

= **34.3360 mm**

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

= $\frac{34.34}{0.1789}$

= **191.9216 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 191.9216 x 0.0871

= **3.9552 cum/sec**

**BR NO-35 IR KM 15.305 (Khurja-Hafizpur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 3.9552 cum/sec

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

= $\frac{3.9552}{1.75}$

= **2.2601 Sq.m**

d Proposed Opening = 1 1.2 2

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

= $\frac{2.2601}{1.2}$

= **1.8830 m**

f Avg. Bed Level = 199.087

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

= 199.0870 +1.8830 +1.6140

= 202.5840

k **Formation level adopted** = 202.5840

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-37 IR KM 16.458 (Khurja-Hafizpur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0462 | Sq Km |
| C | Length of Longest Stream | 0.310 | Km |
| D | Height Of farthest point | 202.885 | M |
| E | Height of Point of Interest | 200.015 | M |
| F | Height Diff of 10 & 11 | 2.87 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 200.015 | M |
| I | Observed HFL | 200.985 | M |

**BR NO-37 IR KM 16.458 (Khurja-Hafizpur)**

**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

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

$= [0.31 \times 0.31 \times 0.31 / 2.87]^{0.345}$

= **0.2068 hr.**

= 0.2068 hr. x 60

= **12.4091 Min**

**BR NO-37 IR KM 16.458 (Khurja-Hafizpur)**

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

R = 300.00 mm

F = 0.72

$C = 0.249 \times ( R \times F )^{0.2}$

= **0.8511**

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

a tc h Ratio = *0.1284* From Fig. 4 of RBF - 16

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

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

= $\frac{0.1284}{0.34}$

= **0.3777**

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 )

= 0.3777 x102.00

= **38.5228 mm**

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

= $\frac{38.52}{0.2068}$

= **186.2635 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 186.2635 x 0.0462

= **2.0361 cum/sec**

**BR NO-37 IR KM 16.458 (Khurja-Hafizpur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 2.0361 cum/sec

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

= $\frac{2.0361}{1.75}$

= **1.1635 Sq.m**

d Proposed Opening = 1 1.2 1.2

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

= $\frac{1.1635}{1.2}$

= **0.9700 m**

f Avg. Bed Level = 200.015

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

= 200.0150 +0.9700 +0.9370

= 201.9220

k **Formation level adopted** = 201.9220

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-38 IR KM 16.890 (Khurja-Hafizpur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.4654 | Sq Km |
| C | Length of Longest Stream | 0.360 | Km |
| D | Height Of farthest point | 201.058 | M |
| E | Height of Point of Interest | 197.858 | M |
| F | Height Diff of 10 & 11 | 3.20 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 197.858 | M |
| I | Observed HFL | 200.725 | M |

**BR NO-38 IR KM 16.890 (Khurja-Hafizpur)**

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

= $[ 0.36 \times 0.36 \times 0.36 / 3.20 ]^{0.345}$

= **0.2325 hr.**

= 0.2325 hr. x 60

= **13.9524 Min**

**BR NO-38 IR KM 16.890 (Khurja-Hafizpur)**

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

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

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

a tc h Ratio = *0.1413* From Fig. 4 of RBF - 16

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

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

= $\frac{0.1413}{0.34}$

= **0.4155**

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 )

= 0.4155 x102.00

= **42.3809 mm**

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

= $\frac{42.38}{0.2325}$

= **182.2526 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 182.2526 x 0.4654

= **20.0690 cum/sec**

**BR NO-38 IR KM 16.890 (Khurja-Hafizpur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 20.0690 cum/sec

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

= $\frac{20.0690}{1.75}$

= **11.4680 Sq.m**

d Proposed Opening = 1 4 3

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

= $\frac{11.4680}{4}$

= **2.8670 m**

f Avg. Bed Level = 197.858

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

= 197.8580 +2.8670 +1.1970

= 201.9220

k **Formation level adopted** = 201.9220

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-39 IR KM 17.170 (Khurja-Hafizpur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0611 | Sq Km |
| C | Length of Longest Stream | 0.409 | Km |
| D | Height Of farthest point | 201.772 | M |
| E | Height of Point of Interest | 199.272 | M |
| F | Height Diff of 10 & 11 | 2.50 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 199.272 | M |
| I | Observed HFL | 200.455 | M |

**BR NO-39 IR KM 17.170 (Khurja-Hafizpur)**

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

= $[ 0.409 \times 0.409 \times 0.409 / 2.50 ]^{0.345}$

= **0.2890 hr.**

= 0.2890 hr. x 60

= **17.3379 Min**

**BR NO-39 IR KM 17.170 (Khurja-Hafizpur)**

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

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

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

a tc h Ratio = *0.1656* From Fig. 4 of RBF - 16

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

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

= $\frac{0.1656}{0.34}$

= **0.4870**

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 )

= 0.4870 x102.00

= **49.6757 mm**

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

= $\frac{49.68}{0.2890}$

= **171.9094 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 171.9094 x 0.0611

= **2.4852 cum/sec**

**BR NO-39 IR KM 17.170 (Khurja-Hafizpur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 2.4852 cum/sec

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

= $\frac{2.4852}{1.75}$

= **1.4201 Sq.m**

d Proposed Opening = 1 1.2 1.2

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

= $\frac{1.4201}{1.2}$

= **1.1830 m**

f Avg. Bed Level = 199.272

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

= 199.2720 +1.1830 +1.4670

= 201.9220

k **Formation level adopted** = 201.9220

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-40 IR KM 17.232 (Khurja-Hafizpur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0348 | Sq Km |
| C | Length of Longest Stream | 0.245 | Km |
| D | Height Of farthest point | 203.672 | M |
| E | Height of Point of Interest | 200.372 | M |
| F | Height Diff of 10 & 11 | 3.30 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 200.372 | M |
| I | Observed HFL | 201.150 | M |

**BR NO-40 IR KM 17.232 (Khurja-Hafizpur)**

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

= $[ 0.245 \times 0.245 \times 0.245 / 3.30 ]^{0.345}$

= **0.1545 hr.**

= 0.1545 hr. x 60

= **9.2694 Min**

**BR NO-40 IR KM 17.232 (Khurja-Hafizpur)**

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

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

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

a tc h Ratio = *0.1022* From Fig. 4 of RBF - 16

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

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

= $\frac{0.1022}{0.34}$

= **0.3007**

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 )

= 0.3007 x102.00

= **30.6735 mm**

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

= $\frac{30.67}{0.1545}$

= **198.5472 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 198.5472 x 0.0348

= **1.6348 cum/sec**

**BR NO-40 IR KM 17.232 (Khurja-Hafizpur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.6348 cum/sec

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

= $\frac{1.6348}{1.75}$

= **0.9342 Sq.m**

d Proposed Opening = 1 1.2 1.2

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

= $\frac{0.9342}{1.2}$

= **0.7780 m**

f Avg. Bed Level = 200.372

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

= 200.3720 +0.7780 +0.7720

= 201.9220

k **Formation level adopted** = 201.9220

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-41 IR KM 17.327 (Khurja-Hafizpur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0728 | Sq Km |
| C | Length of Longest Stream | 0.225 | Km |
| D | Height Of farthest point | 201.662 | M |
| E | Height of Point of Interest | 198.922 | M |
| F | Height Diff of 10 & 11 | 2.74 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 198.922 | M |
| I | Observed HFL | 200.560 | M |

**BR NO-41 IR KM 17.327 (Khurja-Hafizpur)**

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

= $[ 0.225 \times 0.225 \times 0.225 / 2.74 ]^{0.345}$

= **0.1508 hr.**

= 0.1508 hr. x 60

= **9.0497 Min**

**BR NO-41 IR KM 17.327 (Khurja-Hafizpur)**

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

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

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

a tc h Ratio = *0.1004* From Fig. 4 of RBF - 16

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

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

= $\frac{0.1004}{0.34}$

= **0.2953**

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 )

= 0.2953 x102.00

= **30.1244 mm**

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

= $\frac{30.12}{0.1508}$

= **199.7255 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 199.7255 x 0.0728

= **3.4403 cum/sec**

**BR NO-41 IR KM 17.327 (Khurja-Hafizpur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 3.4403 cum/sec

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

= $\frac{3.4403}{1.75}$

= **1.9659 Sq.m**

d Proposed Opening = 1 1.2 2

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

= $\frac{1.9659}{1.2}$

= **1.6380 m**

f Avg. Bed Level = 198.922

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

= 198.9220 +1.6380 +1.3620

= 201.9220

k **Formation level adopted** = 201.9220

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-42 IR KM 17.622 (Khurja-Hafizpur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.1376 | Sq Km |
| C | Length of Longest Stream | 0.450 | Km |
| D | Height Of farthest point | 202.522 | M |
| E | Height of Point of Interest | 199.572 | M |
| F | Height Diff of 10 & 11 | 2.95 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 199.572 | M |
| I | Observed HFL | 201.150 | M |

**BR NO-42 IR KM 17.622 (Khurja-Hafizpur)**

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

= $[ 0.45 \times 0.45 \times 0.45 / 2.95 ]^{0.345}$

= **0.3013 hr.**

= 0.3013 hr. x 60

= **18.0775 Min**

**BR NO-42 IR KM 17.622 (Khurja-Hafizpur)**

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

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

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

a tc h Ratio = *0.1704* From Fig. 4 of RBF - 16

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

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

= $\frac{0.1704}{0.34}$

= **0.5011**

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 )

= 0.5011 x102.00

= **51.1162 mm**

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

= $\frac{51.12}{0.3013}$

= **169.6572 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 169.6572 x 0.1376

= **5.5235 cum/sec**

**BR NO-42 IR KM 17.622 (Khurja-Hafizpur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 5.5235 cum/sec

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

= $\frac{5.5235}{1.75}$

= **3.1563 Sq.m**

d Proposed Opening = 1 2 2

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

= $\frac{3.1563}{2}$

= **1.5780 m**

f Avg. Bed Level = 199.572

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

= 199.5720 +1.5780 +0.7720

= 201.9220

k **Formation level adopted** = 201.9220

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-44 IR KM 18.290 (Khurja-Hafizpur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.3224 | Sq Km |
| C | Length of Longest Stream | 0.510 | Km |
| D | Height Of farthest point | 202.929 | M |
| E | Height of Point of Interest | 199.349 | M |
| F | Height Diff of 10 & 11 | 3.58 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 199.349 | M |
| I | Observed HFL | 201.145 | M |

**BR NO-44 IR KM 18.290 (Khurja-Hafizpur)**

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

= $[ 0.51 \times 0.51 \times 0.51 / 3.58 ]^{0.345}$

= **0.3208 hr.**

= 0.3208 hr. x 60

= **19.2485 Min**

**BR NO-44 IR KM 18.290 (Khurja-Hafizpur)**

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

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

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

a tc h Ratio = *0.1762* From Fig. 4 of RBF - 16

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

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

= $\frac{0.1762}{0.34}$

= **0.5184**

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 )

= 0.5184 x102.00

= **52.8727 mm**

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

= $\frac{52.87}{0.3208}$

= **164.8109 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 164.8109 x 0.3224

= **12.5721 cum/sec**

**BR NO-44 IR KM 18.290 (Khurja-Hafizpur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 12.5721 cum/sec

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

= $\frac{12.5721}{1.75}$

= **7.1841 Sq.m**

d Proposed Opening = 1 4 2

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

= $\frac{7.1841}{4}$

= **1.7960 m**

f Avg. Bed Level = 199.349

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

= 199.3490 +1.7960 +0.7770

= 201.9220

k **Formation level adopted** = 201.9220

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-45 IR KM 18.335 (Khurja-Hafizpur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0358 | Sq Km |
| C | Length of Longest Stream | 0.200 | Km |
| D | Height Of farthest point | 203.248 | M |
| E | Height of Point of Interest | 200.278 | M |
| F | Height Diff of 10 & 11 | 2.97 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 200.278 | M |
| I | Observed HFL | 201.135 | M |

**BR NO-45 IR KM 18.335 (Khurja-Hafizpur)**

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

= $[ 0.2 \times 0.2 \times 0.2 / 2.97 ]^{0.345}$

= **0.1299 hr.**

= 0.1299 hr. x 60

= **7.7914 Min**

**BR NO-45 IR KM 18.335 (Khurja-Hafizpur)**

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

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

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

a tc h Ratio = *0.0919* From Fig. 4 of RBF - 16

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

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

= $\frac{0.0919}{0.34}$

= **0.2704**

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 )

= 0.2704 x102.00

= **27.5828 mm**

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

= $\frac{27.58}{0.1299}$

= **212.4092 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 212.4092 x 0.0358

= **1.7992 cum/sec**

**BR NO-45 IR KM 18.335 (Khurja-Hafizpur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.7992 cum/sec

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

= $\frac{1.7992}{1.75}$

= **1.0281 Sq.m**

d Proposed Opening = 1 1.2 1.2

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

= $\frac{1.0281}{1.2}$

= **0.8570 m**

f Avg. Bed Level = 200.278

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

= 200.2780 +0.8570 +0.7870

= 201.9220

k **Formation level adopted** = 201.9220

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO 46 IR KM 18.683 (Khurja-Hafizpur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0668 | Sq Km |
| C | Length of Longest Stream | 0.200 | Km |
| D | Height Of farthest point | 202.292 | M |
| E | Height of Point of Interest | 199.572 | M |
| F | Height Diff of 10 & 11 | 2.72 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 199.572 | M |
| I | Observed HFL | 201.150 | M |

**BR NO 46 IR KM 18.683 (Khurja-Hafizpur)**

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

= $[ 0.2 \times 0.2 \times 0.2 / 2.72 ]^{0.345}$

= **0.1339 hr.**

= 0.1339 hr. x 60

= **8.0314 Min**

**BR NO 46 IR KM 18.683 (Khurja-Hafizpur)**

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

R = 300.00 mm

F = 0.72

$C = 0.249 \times ( R \times F )^{0.2}$

= **0.8511**

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

a tc h Ratio = *0.0935* From Fig. 4 of RBF - 16

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

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

= $\frac{0.0935}{0.34}$

= **0.2751**

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 )

= 0.2751 x102.00

= **28.0628 mm**

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

= $\frac{28.06}{0.1339}$

= **209.6482 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 209.6482 x 0.0668

= **3.3135 cum/sec**

**BR NO 46 IR KM 18.683 (Khurja-Hafizpur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 3.3135 cum/sec

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

= $\frac{3.3135}{1.75}$

= **1.8934 Sq.m**

d Proposed Opening = 1 1.2 2

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

= $\frac{1.8934}{1.2}$

= **1.5780 m**

f Avg. Bed Level = 199.572

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

= 199.5720 +1.5780 +0.7720

= 201.9220

k **Formation level adopted** = 201.9220

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-47 IR KM 19.231 (Khurja-Hafizpur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0762 | Sq Km |
| C | Length of Longest Stream | 0.310 | Km |
| D | Height Of farthest point | 202.142 | M |
| E | Height of Point of Interest | 199.572 | M |
| F | Height Diff of 10 & 11 | 2.57 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 199.572 | M |
| I | Observed HFL | 201.160 | M |

**BR NO-47 IR KM 19.231 (Khurja-Hafizpur)**

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

= $[ 0.31 \times 0.31 \times 0.31 / 2.57 ]^{0.345}$

= **0.2148 hr.**

= 0.2148 hr. x 60

= **12.8909 Min**

**BR NO-47 IR KM 19.231 (Khurja-Hafizpur)**

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

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

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

a tc h Ratio = *0.1324* From Fig. 4 of RBF - 16

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

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

= $\frac{0.1324}{0.34}$

= **0.3895**

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 )

= 0.3895 x102.00

= **39.7273 mm**

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

= $\frac{39.73}{0.2148}$

= **184.9084 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 184.9084 x 0.0762

= **3.3338 cum/sec**

**BR NO-47 IR KM 19.231 (Khurja-Hafizpur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 3.3338 cum/sec

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

= $\frac{3.3338}{1.75}$

= **1.9050 Sq.m**

d Proposed Opening = 1 1.2 2

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

= $\frac{1.9050}{1.2}$

= **1.5880 m**

f Avg. Bed Level = 199.572

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

= 199.5720 +1.5880 +0.7620

= 201.9220

k **Formation level adopted** = 201.9220

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-48 IR KM 19.403 (Khurja-Hafizpur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0385 | Sq Km |
| C | Length of Longest Stream | 0.350 | Km |
| D | Height Of farthest point | 202.872 | M |
| E | Height of Point of Interest | 200.372 | M |
| F | Height Diff of 10 & 11 | 2.50 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 200.372 | M |
| I | Observed HFL | 201.155 | M |

**BR NO-48 IR KM 19.403 (Khurja-Hafizpur)**

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

= $[ 0.35 \times 0.35 \times 0.35 / 2.50 ]^{0.345}$

= **0.2459 hr.**

= 0.2459 hr. x 60

= **14.7561 Min**

**BR NO-48 IR KM 19.403 (Khurja-Hafizpur)**

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

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

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

a tc h Ratio = *0.1480* From Fig. 4 of RBF - 16

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

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

= $\frac{0.1480}{0.34}$

= **0.4352**

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 )

= 0.4352 x102.00

= **44.3903 mm**

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

= $\frac{44.39}{0.2459}$

= **180.4957 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 180.4957 x 0.0385

= **1.6442 cum/sec**

**BR NO-48 IR KM 19.403 (Khurja-Hafizpur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.6442 cum/sec

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

= $\frac{1.6442}{1.75}$

= **0.9395 Sq.m**

d Proposed Opening = 1 1.2 1.2

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

= $\frac{0.9395}{1.2}$

= **0.7830 m**

f Avg. Bed Level = 200.372

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

= 200.3720 +0.7830 +0.7670

= 201.9220

k **Formation level adopted** = 201.9220

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-50 IR KM 19.908 (Khurja-Hafizpur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0367 | Sq Km |
| C | Length of Longest Stream | 0.300 | Km |
| D | Height Of farthest point | 203.362 | M |
| E | Height of Point of Interest | 200.372 | M |
| F | Height Diff of 10 & 11 | 2.99 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 200.372 | M |
| I | Observed HFL | 201.150 | M |

**BR NO-50 IR KM 19.908 (Khurja-Hafizpur)**

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

= $[ 0.3 \times 0.3 \times 0.3 / 2.99 ]^{0.345}$

= **0.1971 hr.**

= 0.1971 hr. x 60

= **11.8267 Min**

**BR NO-50 IR KM 19.908 (Khurja-Hafizpur)**

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

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

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

a tc h Ratio = *0.1236* From Fig. 4 of RBF - 16

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

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

= $\frac{0.1236}{0.34}$

= **0.3634**

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 )

= 0.3634 x102.00

= **37.0669 mm**

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

= $\frac{37.07}{0.1971}$

= **188.0496 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 188.0496 x 0.0367

= **1.6329 cum/sec**

**BR NO-50 IR KM 19.908 (Khurja-Hafizpur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.6329 cum/sec

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

= $\frac{1.6329}{1.75}$

= **0.9331 Sq.m**

d Proposed Opening = 1 1.2 1.2

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

= $\frac{0.9331}{1.2}$

= **0.7780 m**

f Avg. Bed Level = 200.372

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

= 200.3720 +0.7780 +0.7720

= 201.9220

k **Formation level adopted** = 201.9220

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-51 IR KM 20.305 (Khurja-Hafizpur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0683 | Sq Km |
| C | Length of Longest Stream | 0.195 | Km |
| D | Height Of farthest point | 201.822 | M |
| E | Height of Point of Interest | 199.562 | M |
| F | Height Diff of 10 & 11 | 2.26 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 199.562 | M |
| I | Observed HFL | 201.150 | M |

**BR NO-51 IR KM 20.305 (Khurja-Hafizpur)**

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

= $[ 0.195 \times 0.195 \times 0.195 / 2.26 ]^{0.345}$

= **0.1390 hr.**

= 0.1390 hr. x 60

= **8.3401 Min**

**BR NO-51 IR KM 20.305 (Khurja-Hafizpur)**

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

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

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

a tc h Ratio = *0.0956* From Fig. 4 of RBF - 16

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

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

= $\frac{0.0956}{0.34}$

= **0.2812**

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 )

= 0.2812 x102.00

= **28.6801 mm**

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

= $\frac{28.68}{0.1390}$

= **206.3299 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 206.3299 x 0.0683

= **3.3343 cum/sec**

**BR NO-51 IR KM 20.305 (Khurja-Hafizpur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 3.3343 cum/sec

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

= $\frac{3.3343}{1.75}$

= **1.9053 Sq.m**

d Proposed Opening = 1 1.2 2

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

= $\frac{1.9053}{1.2}$

= **1.5880 m**

f Avg. Bed Level = 199.562

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

= 199.5620 +1.5880 +0.7720

= 201.9220

k **Formation level adopted** = 201.9220

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-52 IR KM 20.853 (Khurja-Hafizpur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.1468 | Sq Km |
| C | Length of Longest Stream | 0.500 | Km |
| D | Height Of farthest point | 202.462 | M |
| E | Height of Point of Interest | 199.562 | M |
| F | Height Diff of 10 & 11 | 2.90 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 199.562 | M |
| I | Observed HFL | 201.160 | M |

**BR NO-52 IR KM 20.853 (Khurja-Hafizpur)**

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

= $[ 0.5 \times 0.5 \times 0.5 / 2.90 ]^{0.345}$

= **0.3380 hr.**

= 0.3380 hr. x 60

= **20.2795 Min**

**BR NO-52 IR KM 20.853 (Khurja-Hafizpur)**

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

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

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

a tc h Ratio = *0.1814* From Fig. 4 of RBF - 16

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

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

= $\frac{0.1814}{0.34}$

= **0.5335**

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 )

= 0.5335 x102.00

= **54.4193 mm**

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

= $\frac{54.42}{0.3380}$

= **161.0076 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 161.0076 x 0.1468

= **5.5924 cum/sec**

**BR NO-52 IR KM 20.853 (Khurja-Hafizpur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 5.5924 cum/sec

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

= $\frac{5.5924}{1.75}$

= **3.1957 Sq.m**

d Proposed Opening = 1 2 2

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

= $\frac{3.1957}{2}$

= **1.5980 m**

f Avg. Bed Level = 199.562

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

= 199.5620 +1.5980 +0.7620

= 201.9220

k **Formation level adopted** = 201.9220

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-53 IR KM 21.235 (Khurja-Hafizpur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0379 | Sq Km |
| C | Length of Longest Stream | 0.320 | Km |
| D | Height Of farthest point | 203.112 | M |
| E | Height of Point of Interest | 200.362 | M |
| F | Height Diff of 10 & 11 | 2.75 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 200.362 | M |
| I | Observed HFL | 201.150 | M |

**BR NO-53 IR KM 21.235 (Khurja-Hafizpur)**

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

= $[ 0.32 \times 0.32 \times 0.32 / 2.75 ]^{0.345}$

= **0.2169 hr.**

= 0.2169 hr. x 60

= **13.0140 Min**

**BR NO-53 IR KM 21.235 (Khurja-Hafizpur)**

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

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

**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 = $\frac{\text{tc h Ratio}}{\text{1h Ratio}}$

= $\frac{0.1335}{0.34}$

= **0.3925**

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 )

= 0.3925 x102.00

= **40.0351 mm**

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

= $\frac{40.04}{0.2169}$

= **184.5782 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 184.5782 x 0.0379

= **1.6552 cum/sec**

**BR NO-53 IR KM 21.235 (Khurja-Hafizpur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.6552 cum/sec

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

= $\frac{1.6552}{1.75}$

= **0.9458 Sq.m**

d Proposed Opening = 1 1.2 1.2

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

= $\frac{0.9458}{1.2}$

= **0.7880 m**

f Avg. Bed Level = 200.362

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

= 200.3620 +0.7880 +0.7720

= 201.9220

k **Formation level adopted** = 201.9220

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-54 IR KM 21.265 (Khurja-Hafizpur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0347 | Sq Km |
| C | Length of Longest Stream | 0.225 | Km |
| D | Height Of farthest point | 203.162 | M |
| E | Height of Point of Interest | 200.362 | M |
| F | Height Diff of 10 & 11 | 2.80 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 200.362 | M |
| I | Observed HFL | 201.145 | M |

**BR NO-54 IR KM 21.265 (Khurja-Hafizpur)**

**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

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

$= [0.225 \times 0.225 \times 0.225 / 2.80]^{0.345}$

= **0.1497 hr.**

= 0.1497 hr. x 60

= **8.9824 Min**

**BR NO-54 IR KM 21.265 (Khurja-Hafizpur)**

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

R = 300.00 mm

F = 0.72

$C = 0.249 \times ( R \times F )^{0.2}$

= **0.8511**

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

a tc h Ratio = *0.0999* From Fig. 4 of RBF - 16

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

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

= $\frac{0.0999}{0.34}$

= **0.2938**

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 )

= 0.2938 x102.00

= **29.9647 mm**

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

= $\frac{29.96}{0.1497}$

= **200.1569 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 200.1569 x 0.0347

= **1.6433 cum/sec**

**BR NO-54 IR KM 21.265 (Khurja-Hafizpur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.6433 cum/sec

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

= $\frac{1.6433}{1.75}$

= **0.9390 Sq.m**

d Proposed Opening = 1 1.2 1.2

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

= $\frac{0.9390}{1.2}$

= **0.7830 m**

f Avg. Bed Level = 200.362

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

= 200.3620 +0.7830 +0.7770

= 201.9220

k **Formation level adopted** = 201.9220

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-55 IR KM 21.775 (Khurja-Hafizpur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0360 | Sq Km |
| C | Length of Longest Stream | 0.250 | Km |
| D | Height Of farthest point | 203.062 | M |
| E | Height of Point of Interest | 200.362 | M |
| F | Height Diff of 10 & 11 | 2.70 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 200.362 | M |
| I | Observed HFL | 201.150 | M |

**BR NO-55 IR KM 21.775 (Khurja-Hafizpur)**

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

= $[ 0.25 \times 0.25 \times 0.25 / 2.70 ]^{0.345}$

= **0.1691 hr.**

= 0.1691 hr. x 60

= **10.1438 Min**

**BR NO-55 IR KM 21.775 (Khurja-Hafizpur)**

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

R = 300.00 mm

F = 0.72

$C = 0.249 \times ( R \times F )^{0.2}$

= **0.8511**

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

a tc h Ratio = *0.1095* From Fig. 4 of RBF - 16

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

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

= $\frac{0.1095}{0.34}$

= **0.3222**

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 )

= 0.3222 x102.00

= **32.8594 mm**

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

= $\frac{32.86}{0.1691}$

= **194.3624 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 194.3624 x 0.0360

= **1.6555 cum/sec**

**BR NO-55 IR KM 21.775 (Khurja-Hafizpur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.6555 cum/sec

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

= $\frac{1.6555}{1.75}$

= **0.9460 Sq.m**

d Proposed Opening = 1 1.2 1.2

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

= $\frac{0.9460}{1.2}$

= **0.7880 m**

f Avg. Bed Level = 200.362

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

= 200.3620 +0.7880 +0.7720

= 201.9220

k **Formation level adopted** = 201.9220

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-56 IR KM 22.018 (Khurja-Hafizpur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0624 | Sq Km |
| C | Length of Longest Stream | 0.290 | Km |
| D | Height Of farthest point | 203.282 | M |
| E | Height of Point of Interest | 200.362 | M |
| F | Height Diff of 10 & 11 | 2.92 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 200.362 | M |
| I | Observed HFL | 201.160 | M |

**BR NO-56 IR KM 22.018 (Khurja-Hafizpur)**

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

= $[ 0.29 \times 0.29 \times 0.29 / 2.92 ]^{0.345}$

= **0.1919 hr.**

= 0.1919 hr. x 60

= **11.5127 Min**

**BR NO-56 IR KM 22.018 (Khurja-Hafizpur)**

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

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

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

a tc h Ratio = *0.1209* From Fig. 4 of RBF - 16

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

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

= $\frac{0.1209}{0.34}$

= **0.3557**

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 )

= 0.3557 x102.00

= **36.2817 mm**

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

= $\frac{36.28}{0.1919}$

= **189.0875 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 189.0875 x 0.0624

= **2.7917 cum/sec**

**BR NO-56 IR KM 22.018 (Khurja-Hafizpur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 2.7917 cum/sec

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

= $\frac{2.7917}{1.75}$

= **1.5953 Sq.m**

d Proposed Opening = 1 2 1.2

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

= $\frac{1.5953}{2}$

= **0.7980 m**

f Avg. Bed Level = 200.362

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

= 200.3620 +0.7980 +0.7620

= 201.9220

k **Formation level adopted** = 201.9220

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-58 23.033 IR KM (Khurja-Hafizpur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0752 | Sq Km |
| C | Length of Longest Stream | 0.550 | Km |
| D | Height Of farthest point | 203.217 | M |
| E | Height of Point of Interest | 200.367 | M |
| F | Height Diff of 10 & 11 | 2.85 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 200.367 | M |
| I | Observed HFL | 201.150 | M |

**BR NO-58 23.033 IR KM (Khurja-Hafizpur)**

**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

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

$= [0.55 \times 0.55 \times 0.55 / 2.85]^{0.345}$

= **0.3753 hr.**

= 0.3753 hr. x 60

= **22.5167 Min**

**BR NO-58 23.033 IR KM (Khurja-Hafizpur)**

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

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

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

a tc h Ratio = *0.1926* From Fig. 4 of RBF - 16

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

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

= $\frac{0.1926}{0.34}$

= **0.5664**

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 )

= 0.5664 x102.00

= **57.7751 mm**

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

= $\frac{57.78}{0.3753}$

= **153.9525 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 153.9525 x 0.0752

= **2.7392 cum/sec**

**BR NO-58 23.033 IR KM (Khurja-Hafizpur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 2.7392 cum/sec

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

= $\frac{2.7392}{1.75}$

= **1.5653 Sq.m**

d Proposed Opening = 1 2 1.2

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

= $\frac{1.5653}{2}$

= **0.7830 m**

f Avg. Bed Level = 200.367

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

= 200.3670 +0.7830 +0.7720

= 201.9220

k **Formation level adopted** = 201.9220

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-61 IR KM 24.04 (Khurja-Hafizpur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0374 | Sq Km |
| C | Length of Longest Stream | 0.300 | Km |
| D | Height Of farthest point | 203.014 | M |
| E | Height of Point of Interest | 200.364 | M |
| F | Height Diff of 10 & 11 | 2.65 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 200.364 | M |
| I | Observed HFL | 201.150 | M |

**BR NO-61 IR KM 24.04 (Khurja-Hafizpur)**

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

= $[ 0.3 \times 0.3 \times 0.3 / 2.65 ]^{0.345}$

= **0.2055 hr.**

= 0.2055 hr. x 60

= **12.3297 Min**

**BR NO-61 IR KM 24.04 (Khurja-Hafizpur)**

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

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

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

a tc h Ratio = *0.1277* From Fig. 4 of RBF - 16

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

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

= $\frac{0.1277}{0.34}$

= **0.3757**

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 )

= 0.3757 x102.00

= **38.3242 mm**

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

= $\frac{38.32}{0.2055}$

= **186.4972 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 186.4972 x 0.0374

= **1.6503 cum/sec**

**BR NO-61 IR KM 24.04 (Khurja-Hafizpur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.6503 cum/sec

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

= $\frac{1.6503}{1.75}$

= **0.9430 Sq.m**

d Proposed Opening = 1 1.2 1.2

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

= $\frac{0.9430}{1.2}$

= **0.7860 m**

f Avg. Bed Level = 200.364

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

= 200.3640 +0.7860 +0.7720

= 201.9220

k **Formation level adopted** = 201.9220

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-62 IR KM 24.350 (Khurja-Hafizpur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0352 | Sq Km |
| C | Length of Longest Stream | 0.240 | Km |
| D | Height Of farthest point | 203.106 | M |
| E | Height of Point of Interest | 200.366 | M |
| F | Height Diff of 10 & 11 | 2.74 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 200.366 | M |
| I | Observed HFL | 201.145 | M |

**BR NO-62 IR KM 24.350 (Khurja-Hafizpur)**

**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

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

$= [ 0.24 \times 0.24 \times 0.24 / 2.74 ]^{0.345}$

= **0.1612 hr.**

= 0.1612 hr. x 60

= **9.6749 Min**

**BR NO-62 IR KM 24.350 (Khurja-Hafizpur)**

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

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

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

a tc h Ratio = *0.1056* From Fig. 4 of RBF - 16

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

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

= $\frac{0.1056}{0.34}$

= **0.3107**

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 )

= 0.3107 x102.00

= **31.6872 mm**

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

= $\frac{31.69}{0.1612}$

= **196.5120 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 196.5120 x 0.0352

= **1.6367 cum/sec**

**BR NO-62 IR KM 24.350 (Khurja-Hafizpur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.6367 cum/sec

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

= $\frac{1.6367}{1.75}$

= **0.9353 Sq.m**

d Proposed Opening = 1 1.2 1.2

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

= $\frac{0.9353}{1.2}$

= **0.7790 m**

f Avg. Bed Level = 200.366

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

= 200.3660 +0.7790 +0.7770

= 201.9220

k **Formation level adopted** = 201.9220

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**Br. No. 63**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0733 | Sq Km |
| C | Length of Longest Stream | 0.315 | Km |
| D | Height Of farthest point | 203.568 | M |
| E | Height of Point of Interest | 200.368 | M |
| F | Height Diff of 10 & 11 | 3.20 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 200.368 | M |
| I | Observed HFL | 201.140 | M |

**Br. No. 63**

**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

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

$= [0.315 \times 0.315 \times 0.315 / 3.20]^{0.345}$

= **0.2025 hr.**

= 0.2025 hr. x 60

= **12.1514 Min**

**Br. No. 63**

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

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

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

a tc h Ratio = *0.1263* From Fig. 4 of RBF - 16

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

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

= $\frac{0.1263}{0.34}$

= **0.3714**

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 )

= 0.3714 x102.00

= **37.8785 mm**

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

= $\frac{37.88}{0.2025}$

= **187.0329 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 187.0329 x 0.0733

= **3.2438 cum/sec**

**Br. No. 63**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 3.2438 cum/sec

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

= $\frac{3.2438}{1.75}$

= **1.8536 Sq.m**

d Proposed Opening = 2 1.2 1.2

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

= $\frac{1.8536}{2.4}$

= **0.7720 m**

f Avg. Bed Level = 200.368

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

= 200.3680 +0.7720 +0.7820

= 201.9220

k **Formation level adopted** = 201.9220

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-64 IR KM 24.599 (Khurja-Hafizpur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0381 | Sq Km |
| C | Length of Longest Stream | 0.355 | Km |
| D | Height Of farthest point | 203.088 | M |
| E | Height of Point of Interest | 200.368 | M |
| F | Height Diff of 10 & 11 | 2.72 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 200.368 | M |
| I | Observed HFL | 201.145 | M |

**BR NO-64 IR KM 24.599 (Khurja-Hafizpur)**

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

= $[ 0.355 \times 0.355 \times 0.355 / 2.72 ]^{0.345}$

= **0.2424 hr.**

= 0.2424 hr. x 60

= **14.5449 Min**

**BR NO-64 IR KM 24.599 (Khurja-Hafizpur)**

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

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

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

a tc h Ratio = *0.1462* From Fig. 4 of RBF - 16

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

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

= $\frac{0.1462}{0.34}$

= **0.4300**

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 )

= 0.4300 x102.00

= **43.8623 mm**

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

= $\frac{43.86}{0.2424}$

= **180.9386 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 180.9386 x 0.0381

= **1.6311 cum/sec**

**BR NO-64 IR KM 24.599 (Khurja-Hafizpur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.6311 cum/sec

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

= $\frac{1.6311}{1.75}$

= **0.9321 Sq.m**

d Proposed Opening = 1 1.2 1.2

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

= $\frac{0.9321}{1.2}$

= **0.7770 m**

f Avg. Bed Level = 200.368

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

= 200.3680 +0.7770 +0.7770

= 201.9220

k **Formation level adopted** = 201.9220

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-66 IR KM 24.763 (Khurja-Hafizpur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0387 | Sq Km |
| C | Length of Longest Stream | 0.400 | Km |
| D | Height Of farthest point | 203.599 | M |
| E | Height of Point of Interest | 200.369 | M |
| F | Height Diff of 10 & 11 | 3.23 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 200.369 | M |
| I | Observed HFL | 201.145 | M |

**BR NO-66 IR KM 24.763 (Khurja-Hafizpur)**

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

= $[ 0.4 \times 0.4 \times 0.4 / 3.23 ]^{0.345}$

= **0.2585 hr.**

= 0.2585 hr. x 60

= **15.5099 Min**

**BR NO-66 IR KM 24.763 (Khurja-Hafizpur)**

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

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

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

a tc h Ratio = *0.1534* From Fig. 4 of RBF - 16

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

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

= $\frac{0.1534}{0.34}$

= **0.4512**

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 )

= 0.4512 x102.00

= **46.0198 mm**

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

= $\frac{46.02}{0.2585}$

= **178.0277 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 178.0277 x 0.0387

= **1.6301 cum/sec**

**BR NO-66 IR KM 24.763 (Khurja-Hafizpur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.6301 cum/sec

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

= $\frac{1.6301}{1.75}$

= **0.9315 Sq.m**

d Proposed Opening = 1 1.2 1.2

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

= $\frac{0.9315}{1.2}$

= **0.7760 m**

f Avg. Bed Level = 200.369

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

= 200.3690 +0.7760 +0.7770

= 201.9220

k **Formation level adopted** = 201.9220

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-67 IR KM 25.075 (Khurja-HafizPur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0386 | Sq Km |
| C | Length of Longest Stream | 0.375 | Km |
| D | Height Of farthest point | 203.031 | M |
| E | Height of Point of Interest | 200.371 | M |
| F | Height Diff of 10 & 11 | 2.66 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 200.371 | M |
| I | Observed HFL | 201.145 | M |

**BR NO-67 IR KM 25.075 (Khurja-HafizPur)**

**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

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

$= [0.375 \times 0.375 \times 0.375 / 2.66]^{0.345}$

= **0.2585 hr.**

= 0.2585 hr. x 60

= **15.5128 Min**

**BR NO-67 IR KM 25.075 (Khurja-HafizPur)**

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

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

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

a tc h Ratio = *0.1534* From Fig. 4 of RBF - 16

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

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

= $\frac{0.1534}{0.34}$

= **0.4512**

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 )

= 0.4512 x102.00

= **46.0255 mm**

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

= $\frac{46.03}{0.2585}$

= **178.0165 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 178.0165 x 0.0386

= **1.6258 cum/sec**

**BR NO-67 IR KM 25.075 (Khurja-HafizPur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.6258 cum/sec

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

= $\frac{1.6258}{1.75}$

= **0.9290 Sq.m**

d Proposed Opening = 1 1.2 1.2

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

= $\frac{0.9290}{1.2}$

= **0.7740 m**

f Avg. Bed Level = 200.371

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

= 200.3710 +0.7740 +0.7770

= 201.9220

k **Formation level adopted** = 201.9220

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO- 68 IR KM 25.405 (Khurja-HafizPur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0398 | Sq Km |
| C | Length of Longest Stream | 0.415 | Km |
| D | Height Of farthest point | 202.833 | M |
| E | Height of Point of Interest | 200.183 | M |
| F | Height Diff of 10 & 11 | 2.65 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 200.183 | M |
| I | Observed HFL | 200.955 | M |

**BR NO- 68 IR KM 25.405 (Khurja-HafizPur)**

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

= $[ 0.415 \times 0.415 \times 0.415 / 2.65 ]^{0.345}$

= **0.2875 hr.**

= 0.2875 hr. x 60

= **17.2509 Min**

**BR NO- 68 IR KM 25.405 (Khurja-HafizPur)**

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

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

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

a tc h Ratio = *0.1650* From Fig. 4 of RBF - 16

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

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

= $\frac{0.1650}{0.34}$

= **0.4853**

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 )

= 0.4853 x102.00

= **49.5018 mm**

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

= $\frac{49.50}{0.2875}$

= **172.1714 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 172.1714 x 0.0398

= **1.6213 cum/sec**

**BR NO- 68 IR KM 25.405 (Khurja-HafizPur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.6213 cum/sec

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

= $\frac{1.6213}{1.75}$

= **0.9265 Sq.m**

d Proposed Opening = 1 1.2 1.2

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

= $\frac{0.9265}{1.2}$

= **0.7720 m**

f Avg. Bed Level = 200.183

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

= 200.1830 +0.7720 +0.7860

= 201.7410

k **Formation level adopted** = 201.7410

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-70 IR KM 25.901(Khurja-HafizPur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0752 | Sq Km |
| C | Length of Longest Stream | 0.310 | Km |
| D | Height Of farthest point | 201.832 | M |
| E | Height of Point of Interest | 199.112 | M |
| F | Height Diff of 10 & 11 | 2.72 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 199.112 | M |
| I | Observed HFL | 200.685 | M |

**BR NO-70 IR KM 25.901(Khurja-HafizPur)**

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

= $[ 0.31 \times 0.31 \times 0.31 / 2.72 ]^{0.345}$

= **0.2107 hr.**

= 0.2107 hr. x 60

= **12.6411 Min**

**BR NO-70 IR KM 25.901(Khurja-HafizPur)**

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

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

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

a tc h Ratio = *0.1303* From Fig. 4 of RBF - 16

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

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

= $\frac{0.1303}{0.34}$

= **0.3834**

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 )

= 0.3834 x102.00

= **39.1027 mm**

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

= $\frac{39.10}{0.2107}$

= **185.5982 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 185.5982 x 0.0752

= **3.3023 cum/sec**

**BR NO-70 IR KM 25.901(Khurja-HafizPur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 3.3023 cum/sec

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

= $\frac{3.3023}{1.75}$

= **1.8870 Sq.m**

d Proposed Opening = 1 1.2 2

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

= $\frac{1.8870}{1.2}$

= **1.5730 m**

f Avg. Bed Level = 199.112

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

= 199.1120 +1.5730 +0.7830

= 201.4680

k **Formation level adopted** = 201.4680

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-71IR KM 26.163 (Khurja-HafizPur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0801 | Sq Km |
| C | Length of Longest Stream | 0.450 | Km |
| D | Height Of farthest point | 201.987 | M |
| E | Height of Point of Interest | 199.017 | M |
| F | Height Diff of 10 & 11 | 2.97 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 199.017 | M |
| I | Observed HFL | 200.550 | M |

**BR NO-71IR KM 26.163 (Khurja-HafizPur)**

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

= $[ 0.45 \times 0.45 \times 0.45 / 2.97 ]^{0.345}$

= **0.3006 hr.**

= 0.3006 hr. x 60

= **18.0354 Min**

**BR NO-71IR KM 26.163 (Khurja-HafizPur)**

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

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

**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 = $\frac{\text{tc h Ratio}}{\text{1h Ratio}}$

= $\frac{0.1702}{0.34}$

= **0.5005**

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 )

= 0.5005 x102.00

= **51.0531 mm**

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

= $\frac{51.05}{0.3006}$

= **169.8432 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 169.8432 x 0.0801

= **3.2189 cum/sec**

**BR NO-71IR KM 26.163 (Khurja-HafizPur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 3.2189 cum/sec

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

= $\frac{3.2189}{1.75}$

= **1.8394 Sq.m**

d Proposed Opening = 1 1.2 2

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

= $\frac{1.8394}{1.2}$

= **1.5330 m**

f Avg. Bed Level = 199.017

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

= 199.0170 +1.5330 +0.8170

= 201.3670

k **Formation level adopted** = 201.3670

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-72 IR KM 26.525 (Khurja-HafizPur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.1471 | Sq Km |
| C | Length of Longest Stream | 0.620 | Km |
| D | Height Of farthest point | 202.829 | M |
| E | Height of Point of Interest | 198.929 | M |
| F | Height Diff of 10 & 11 | 3.90 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 198.929 | M |
| I | Observed HFL | 200.450 | M |

**BR NO-72 IR KM 26.525 (Khurja-HafizPur)**

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

= $[ 0.62 \times 0.62 \times 0.62 / 3.90 ]^{0.345}$

= **0.3812 hr.**

= 0.3812 hr. x 60

= **22.8749 Min**

**BR NO-72 IR KM 26.525 (Khurja-HafizPur)**

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

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

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

a tc h Ratio = *0.1944* From Fig. 4 of RBF - 16

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

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

= $\frac{0.1944}{0.34}$

= **0.5717**

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 )

= 0.5717 x102.00

= **58.3124 mm**

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

= $\frac{58.31}{0.3812}$

= **152.9512 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 152.9512 x 0.1471

= **5.3234 cum/sec**

**BR NO-72 IR KM 26.525 (Khurja-HafizPur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 5.3234 cum/sec

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

= $\frac{5.3234}{1.75}$

= **3.0419 Sq.m**

d Proposed Opening = 1 2 2

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

= $\frac{3.0419}{2}$

= **1.5210 m**

f Avg. Bed Level = 198.929

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

= 198.9290 +1.5210 +0.8290

= 201.2790

k **Formation level adopted** = 201.2790

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-73 IR KM 26.675 (Khurja-HafizPur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.1850 | Sq Km |
| C | Length of Longest Stream | 0.550 | Km |
| D | Height Of farthest point | 201.164 | M |
| E | Height of Point of Interest | 198.464 | M |
| F | Height Diff of 10 & 11 | 2.70 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 198.464 | M |
| I | Observed HFL | 200.375 | M |

**BR NO-73 IR KM 26.675 (Khurja-HafizPur)**

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

= $[ 0.55 \times 0.55 \times 0.55 / 2.70 ]^{0.345}$

= **0.3823 hr.**

= 0.3823 hr. x 60

= **22.9407 Min**

**BR NO-73 IR KM 26.675 (Khurja-HafizPur)**

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

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

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

a tc h Ratio = *0.1947* From Fig. 4 of RBF - 16

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

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

= $\frac{0.1947}{0.34}$

= **0.5727**

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 )

= 0.5727 x102.00

= **58.4110 mm**

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

= $\frac{58.41}{0.3823}$

= **152.7706 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 152.7706 x 0.1850

= **6.6871 cum/sec**

**BR NO-73 IR KM 26.675 (Khurja-HafizPur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 6.6871 cum/sec

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

= $\frac{6.6871}{1.75}$

= **3.8212 Sq.m**

d Proposed Opening = 1 2 2

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

= $\frac{3.8212}{2}$

= **1.9110 m**

f Avg. Bed Level = 198.464

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

= 198.4640 +1.9110 +0.8050

= 201.1800

k **Formation level adopted** = 201.1800

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-74 IR KM 27.207 (Khurja-HafizPur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.7325 | Sq Km |
| C | Length of Longest Stream | 0.825 | Km |
| D | Height Of farthest point | 201.436 | M |
| E | Height of Point of Interest | 196.586 | M |
| F | Height Diff of 10 & 11 | 4.85 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 196.586 | M |
| I | Observed HFL | 200.025 | M |

**BR NO-74 IR KM 27.207 (Khurja-HafizPur)**

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

= $[ 0.825 \times 0.825 \times 0.825 / 4.85 ]^{0.345}$

= **0.4753 hr.**

= 0.4753 hr. x 60

= **28.5168 Min**

**BR NO-74 IR KM 27.207 (Khurja-HafizPur)**

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

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

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

a tc h Ratio = *0.2201* From Fig. 4 of RBF - 16

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

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

= $\frac{0.2201}{0.34}$

= **0.6472**

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 )

= 0.6472 x102.00

= **66.0168 mm**

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

= $\frac{66.02}{0.4753}$

= **138.9011 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 138.9011 x 0.7325

= **24.0735 cum/sec**

**BR NO-74 IR KM 27.207 (Khurja-HafizPur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 24.0735 cum/sec

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

= $\frac{24.0735}{1.75}$

= **13.7563 Sq.m**

d Proposed Opening = 2 2 4

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

= $\frac{13.7563}{4}$

= **3.4390 m**

f Avg. Bed Level = 196.586

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

= 196.5860 +3.4390 +0.9610

= 200.9860

k **Formation level adopted** = 200.9860

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-75 IR KM 28.878 (Khurja-HafizPur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.3858 | Sq Km |
| C | Length of Longest Stream | 0.485 | Km |
| D | Height Of farthest point | 203.049 | M |
| E | Height of Point of Interest | 199.149 | M |
| F | Height Diff of 10 & 11 | 3.90 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 199.149 | M |
| I | Observed HFL | 201.375 | M |

**BR NO-75 IR KM 28.878 (Khurja-HafizPur)**

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

= $[ 0.485 \times 0.485 \times 0.485 / 3.90 ]^{0.345}$

= **0.2957 hr.**

= 0.2957 hr. x 60

= **17.7409 Min**

**BR NO-75 IR KM 28.878 (Khurja-HafizPur)**

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

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

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

a tc h Ratio = *0.1683* From Fig. 4 of RBF - 16

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

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

= $\frac{0.1683}{0.34}$

= **0.4949**

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 )

= 0.4949 x102.00

= **50.4819 mm**

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

= $\frac{50.48}{0.2957}$

= **170.7302 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 170.7302 x 0.3858

= **15.5847 cum/sec**

**BR NO-75 IR KM 28.878 (Khurja-HafizPur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 15.5847 cum/sec

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

= $\frac{15.5847}{1.75}$

= **8.9055 Sq.m**

d Proposed Opening = 1 4 3

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

= $\frac{8.9055}{4}$

= **2.2260 m**

f Avg. Bed Level = 199.149

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

= 199.1490 +2.2260 +1.3240

= 202.6990

k **Formation level adopted** = 202.6990

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-76 IR KM 29.540 (Khurja-HafizPur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.1044 | Sq Km |
| C | Length of Longest Stream | 0.425 | Km |
| D | Height Of farthest point | 202.532 | M |
| E | Height of Point of Interest | 200.162 | M |
| F | Height Diff of 10 & 11 | 2.37 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 200.162 | M |
| I | Observed HFL | 201.350 | M |

**BR NO-76 IR KM 29.540 (Khurja-HafizPur)**

**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

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

$= [0.425 \times 0.425 \times 0.425 / 2.37]^{0.345}$

= **0.3063 hr.**

= 0.3063 hr. x 60

= **18.3758 Min**

**BR NO-76 IR KM 29.540 (Khurja-HafizPur)**

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

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

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

a tc h Ratio = *0.1719* From Fig. 4 of RBF - 16

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

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

= $\frac{0.1719}{0.34}$

= **0.5055**

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 )

= 0.5055 x102.00

= **51.5637 mm**

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

= $\frac{51.56}{0.3063}$

= **168.3642 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 168.3642 x 0.1044

= **4.1589 cum/sec**

**BR NO-76 IR KM 29.540 (Khurja-HafizPur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 4.1589 cum/sec

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

= $\frac{4.1589}{1.75}$

= **2.3765 Sq.m**

d Proposed Opening = 1 2 2

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

= $\frac{2.3765}{2}$

= **1.1880 m**

f Avg. Bed Level = 200.162

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

= 200.1620 +1.1880 +1.3490

= 202.6990

k **Formation level adopted** = 202.6990

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-77 IR KM 29.992 (Khurja-HafizPur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0353 | Sq Km |
| C | Length of Longest Stream | 0.250 | Km |
| D | Height Of farthest point | 203.969 | M |
| E | Height of Point of Interest | 201.149 | M |
| F | Height Diff of 10 & 11 | 2.82 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 201.149 | M |
| I | Observed HFL | 201.925 | M |

**BR NO-77 IR KM 29.992 (Khurja-HafizPur)**

**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

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

$= [0.25 \times 0.25 \times 0.25 / 2.82]^{0.345}$

= **0.1665 hr.**

= 0.1665 hr. x 60

= **9.9927 Min**

**BR NO-77 IR KM 29.992 (Khurja-HafizPur)**

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

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

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

a tc h Ratio = *0.1083* From Fig. 4 of RBF - 16

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

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

= $\frac{0.1083}{0.34}$

= **0.3184**

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 )

= 0.3184 x102.00

= **32.4818 mm**

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

= $\frac{32.48}{0.1665}$

= **195.0330 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 195.0330 x 0.0353

= **1.6290 cum/sec**

**BR NO-77 IR KM 29.992 (Khurja-HafizPur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.6290 cum/sec

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

= $\frac{1.6290}{1.75}$

= **0.9309 Sq.m**

d Proposed Opening = 1 1.2 1.2

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

= $\frac{0.9309}{1.2}$

= **0.7760 m**

f Avg. Bed Level = 201.149

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

= 201.1490 +0.7760 +0.7740

= 202.6990

k **Formation level adopted** = 202.6990

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-78 IR KM 30.555 (Khurja-HafizPur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0325 | Sq Km |
| C | Length of Longest Stream | 0.300 | Km |
| D | Height Of farthest point | 204.296 | M |
| E | Height of Point of Interest | 201.276 | M |
| F | Height Diff of 10 & 11 | 3.02 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 201.276 | M |
| I | Observed HFL | 201.965 | M |

**BR NO-78 IR KM 30.555 (Khurja-HafizPur)**

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

= $[ 0.3 \times 0.3 \times 0.3 / 3.02 ]^{0.345}$

= **0.1964 hr.**

= 0.1964 hr. x 60

= **11.7861 Min**

**BR NO-78 IR KM 30.555 (Khurja-HafizPur)**

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

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

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

a tc h Ratio = *0.1232* From Fig. 4 of RBF - 16

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

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

= $\frac{0.1232}{0.34}$

= **0.3624**

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 )

= 0.3624 x102.00

= **36.9652 mm**

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

= $\frac{36.97}{0.1964}$

= **188.1806 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 188.1806 x 0.0325

= **1.4471 cum/sec**

**BR NO-78 IR KM 30.555 (Khurja-HafizPur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.4471 cum/sec

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

= $\frac{1.4471}{1.75}$

= **0.8269 Sq.m**

d Proposed Opening = 1 1.2 1.2

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

= $\frac{0.8269}{1.2}$

= **0.6890 m**

f Avg. Bed Level = 201.276

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

= 201.2760 +0.6890 +0.8610

= 202.8260

k **Formation level adopted** = 202.8260

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-79 IR KM 30.426 (Khurja-HafizPur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0330 | Sq Km |
| C | Length of Longest Stream | 0.210 | Km |
| D | Height Of farthest point | 204.165 | M |
| E | Height of Point of Interest | 201.405 | M |
| F | Height Diff of 10 & 11 | 2.76 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 201.405 | M |
| I | Observed HFL | 202.170 | M |

**BR NO-79 IR KM 30.426 (Khurja-HafizPur)**

**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

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

$= [0.21 \times 0.21 \times 0.21 / 2.76]^{0.345}$

= **0.1401 hr.**

= 0.1401 hr. x 60

= **8.4049 Min**

**BR NO-79 IR KM 30.426 (Khurja-HafizPur)**

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

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

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

a tc h Ratio = *0.0960* From Fig. 4 of RBF - 16

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

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

= $\frac{0.0960}{0.34}$

= **0.2824**

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 )

= 0.2824 x102.00

= **28.8099 mm**

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

= $\frac{28.81}{0.1401}$

= **205.6641 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 205.6641 x 0.0330

= **1.6058 cum/sec**

**BR NO-79 IR KM 30.426 (Khurja-HafizPur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.6058 cum/sec

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

= $\frac{1.6058}{1.75}$

= **0.9176 Sq.m**

d Proposed Opening = 1 1.2 1.2

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

= $\frac{0.9176}{1.2}$

= **0.7650 m**

f Avg. Bed Level = 201.405

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

= 201.4050 +0.7650 +0.7850

= 202.9550

k **Formation level adopted** = 202.9550

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-80 IR KM 30.913 (Khurja-HafizPur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.5875 | Sq Km |
| C | Length of Longest Stream | 0.750 | Km |
| D | Height Of farthest point | 202.932 | M |
| E | Height of Point of Interest | 198.982 | M |
| F | Height Diff of 10 & 11 | 3.95 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 198.982 | M |
| I | Observed HFL | 201.785 | M |

**BR NO-80 IR KM 30.913 (Khurja-HafizPur)**

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

= $[ 0.75 \times 0.75 \times 0.75 / 3.95 ]^{0.345}$

= **0.4622 hr.**

= 0.4622 hr. x 60

= **27.7341 Min**

**BR NO-80 IR KM 30.913 (Khurja-HafizPur)**

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

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

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

a tc h Ratio = *0.2174* From Fig. 4 of RBF - 16

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

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

= $\frac{0.2174}{0.34}$

= **0.6395**

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 )

= 0.6395 x102.00

= **65.2341 mm**

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

= $\frac{65.23}{0.4622}$

= **141.1277 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 141.1277 x 0.5875

= **19.6176 cum/sec**

**BR NO-80 IR KM 30.913 (Khurja-HafizPur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 19.6176 cum/sec

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

= $\frac{19.6176}{1.75}$

= **11.2101 Sq.m**

d Proposed Opening = 1 4 3

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

= $\frac{11.2101}{4}$

= **2.8030 m**

f Avg. Bed Level = 198.982

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

= 198.9820 +2.8030 +1.4960

= 203.2810

k **Formation level adopted** = 203.2810

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-81 IR KM 31.428 (Khurja-HafizPur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 1.2937 | Sq Km |
| C | Length of Longest Stream | 1.285 | Km |
| D | Height Of farthest point | 203.193 | M |
| E | Height of Point of Interest | 199.343 | M |
| F | Height Diff of 10 & 11 | 3.85 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 199.343 | M |
| I | Observed HFL | 201.900 | M |

**BR NO-81 IR KM 31.428 (Khurja-HafizPur)**

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

= $[ 1.285 \times 1.285 \times 1.285 / 3.85 ]^{0.345}$

= **0.8142 hr.**

= 0.8142 hr. x 60

= **48.8520 Min**

**BR NO-81 IR KM 31.428 (Khurja-HafizPur)**

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

R = 300.00 mm
F = 0.81
C = 0.249 x ( R x F ) $^{0.2}$
= **0.8922**

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

a tc h Ratio = *0.3028* From Fig. 4 of RBF - 16

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

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

= $\frac{0.3028}{0.34}$

= **0.8907**

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 )

= 0.8907 x102.00

= **90.8520 mm**

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

= $\frac{90.85}{0.8142}$

= **111.5845 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8922 x 111.5845 x 1.2937

= **35.8034 cum/sec**

**BR NO-81 IR KM 31.428 (Khurja-HafizPur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 35.8034 cum/sec

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

= $\frac{35.8034}{1.75}$

= **20.4591 Sq.m**

d Proposed Opening = 2 4 3

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

= $\frac{20.4591}{8}$

= **2.5570 m**

f Avg. Bed Level = 199.343

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

= 199.3430 +2.5570 +1.7260

= 203.6260

k **Formation level adopted** = 203.6260

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-82 IR KM 31.760 (Khurja-HafizPur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.1595 | Sq Km |
| C | Length of Longest Stream | 0.400 | Km |
| D | Height Of farthest point | 203.143 | M |
| E | Height of Point of Interest | 200.243 | M |
| F | Height Diff of 10 & 11 | 2.90 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 200.243 | M |
| I | Observed HFL | 202.140 | M |

**BR NO-82 IR KM 31.760 (Khurja-HafizPur)**

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

= $[ 0.4 \times 0.4 \times 0.4 / 2.90 ]^{0.345}$

= **0.2683 hr.**

= 0.2683 hr. x 60

= **16.0974 Min**

**BR NO-82 IR KM 31.760 (Khurja-HafizPur)**

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

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

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

a tc h Ratio = *0.1573* From Fig. 4 of RBF - 16

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

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

= $\frac{0.1573}{0.34}$

= **0.4627**

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 )

= 0.4627 x102.00

= **47.1948 mm**

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

= $\frac{47.19}{0.2683}$

= **175.9095 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 175.9095 x 0.1595

= **6.6386 cum/sec**

**BR NO-82 IR KM 31.760 (Khurja-HafizPur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 6.6386 cum/sec

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

= $\frac{6.6386}{1.75}$

= **3.7935 Sq.m**

d Proposed Opening = 1 2 2

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

= $\frac{3.7935}{2}$

= **1.8970 m**

f Avg. Bed Level = 200.243

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

= 200.2429 +1.8970 +1.7100

= 203.8499

k **Formation level adopted** = 203.8500

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-83 IR KM 32.506 (Khurja-HafizPur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.1879 | Sq Km |
| C | Length of Longest Stream | 0.600 | Km |
| D | Height Of farthest point | 204.690 | M |
| E | Height of Point of Interest | 201.990 | M |
| F | Height Diff of 10 & 11 | 2.70 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 201.990 | M |
| I | Observed HFL | 203.550 | M |

**BR NO-83 IR KM 32.506 (Khurja-HafizPur)**

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

= $[ 0.6 \times 0.6 \times 0.6 / 2.70 ]^{0.345}$

= **0.4184 hr.**

= 0.4184 hr. x 60

= **25.1025 Min**

**BR NO-83 IR KM 32.506 (Khurja-HafizPur)**

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

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

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

a tc h Ratio = *0.2055* From Fig. 4 of RBF - 16

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

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

= $\frac{0.2055}{0.34}$

= **0.6044**

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 )

= 0.6044 x102.00

= **61.6538 mm**

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

= $\frac{61.65}{0.4184}$

= **147.3648 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 147.3648 x 0.1879

= **6.5516 cum/sec**

**BR NO-83 IR KM 32.506 (Khurja-HafizPur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 6.5516 cum/sec

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

= $\frac{6.5516}{1.75}$

= **3.7438 Sq.m**

d Proposed Opening = 2 1.2 2

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

= $\frac{3.7438}{2.4}$

= **1.5600 m**

f Avg. Bed Level = 201.990

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

= 201.9900 +1.5600 +0.7990

= 204.3490

k **Formation level adopted** = 204.3490

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-84 IR KM 32.956 (Khurja-HafizPur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0449 | Sq Km |
| C | Length of Longest Stream | 0.575 | Km |
| D | Height Of farthest point | 206.051 | M |
| E | Height of Point of Interest | 203.081 | M |
| F | Height Diff of 10 & 11 | 2.97 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 203.081 | M |
| I | Observed HFL | 203.850 | M |

**BR NO-84 IR KM 32.956 (Khurja-HafizPur)**

**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

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

$= [0.575 \times 0.575 \times 0.575 / 2.97]^{0.345}$

= **0.3874 hr.**

= 0.3874 hr. x 60

= **23.2438 Min**

**BR NO-84 IR KM 32.956 (Khurja-HafizPur)**

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

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

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

a tc h Ratio = *0.1962* From Fig. 4 of RBF - 16

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

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

= $\frac{0.1962}{0.34}$

= **0.5771**

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 )

= 0.5771 x102.00

= **58.8656 mm**

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

= $\frac{58.87}{0.3874}$

= **151.9520 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 151.9520 x 0.0449

= **1.6143 cum/sec**

**BR NO-84 IR KM 32.956 (Khurja-HafizPur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.6143 cum/sec

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

= $\frac{1.6143}{1.75}$

= **0.9225 Sq.m**

d Proposed Opening = 1 1.2 1.2

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

= $\frac{0.9225}{1.2}$

= **0.7690 m**

f Avg. Bed Level = 203.081

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

= 203.0810 +0.7690 +0.7910

= 204.6410

k **Formation level adopted** = 204.6410

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-86 IR KM 34.403 (Khurja-HafizPur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 1.7451 | Sq Km |
| C | Length of Longest Stream | 1.375 | Km |
| D | Height Of farthest point | 206.345 | M |
| E | Height of Point of Interest | 200.795 | M |
| F | Height Diff of 10 & 11 | 5.55 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 200.795 | M |
| I | Observed HFL | 204.300 | M |

**BR NO-86 IR KM 34.403 (Khurja-HafizPur)**

**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

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

$= [1.375 \times 1.375 \times 1.375 / 5.55]^{0.345}$

= **0.7698 hr.**

= 0.7698 hr. x 60

= **46.1863 Min**

**BR NO-86 IR KM 34.403 (Khurja-HafizPur)**

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

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

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

a tc h Ratio = *0.2909* From Fig. 4 of RBF - 16

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

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

= $\frac{0.2909}{0.34}$

= **0.8557**

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 )

= 0.8557 x102.00

= **87.2795 mm**

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

= $\frac{87.28}{0.7698}$

= **113.3835 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8922 x 113.3835 x 1.7451

= **49.0746 cum/sec**

**BR NO-86 IR KM 34.403 (Khurja-HafizPur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 49.0746 cum/sec

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

= $\frac{49.0746}{1.75}$

= **28.0426 Sq.m**

d Proposed Opening = 2 4 4

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

= $\frac{28.0426}{8}$

= **3.5050 m**

f Avg. Bed Level = 200.795

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

= 200.7950 +3.5050 +1.0550

= 205.3550

k **Formation level adopted** = 205.3550

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-87 IR KM 35.680 (Khurja-HafizPur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0325 | Sq Km |
| C | Length of Longest Stream | 0.200 | Km |
| D | Height Of farthest point | 207.294 | M |
| E | Height of Point of Interest | 204.114 | M |
| F | Height Diff of 10 & 11 | 3.18 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 204.114 | M |
| I | Observed HFL | 204.900 | M |

**BR NO-87 IR KM 35.680 (Khurja-HafizPur)**

**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

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

$= [0.2 \times 0.2 \times 0.2 / 3.18]^{0.345}$

= **0.1268 hr.**

= 0.1268 hr. x 60

= **7.6099 Min**

**BR NO-87 IR KM 35.680 (Khurja-HafizPur)**

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

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

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

a tc h Ratio = *0.0907* From Fig. 4 of RBF - 16

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

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

= $\frac{0.0907}{0.34}$

= **0.2669**

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 )

= 0.2669 x102.00

= **27.2198 mm**

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

= $\frac{27.22}{0.1268}$

= **214.6131 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 214.6131 x 0.0325

= **1.6503 cum/sec**

**BR NO-87 IR KM 35.680 (Khurja-HafizPur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.6503 cum/sec

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

= $\frac{1.6503}{1.75}$

= **0.9430 Sq.m**

d Proposed Opening = 1 1.2 1.2

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

= $\frac{0.9430}{1.2}$

= **0.7860 m**

f Avg. Bed Level = 204.114

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

= 204.1140 +0.7860 +0.7500

= 205.6500

k **Formation level adopted** = 205.6500

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-88 IR KM 36.643 (Khurja-HafizPur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0316 | Sq Km |
| C | Length of Longest Stream | 0.185 | Km |
| D | Height Of farthest point | 207.238 | M |
| E | Height of Point of Interest | 204.318 | M |
| F | Height Diff of 10 & 11 | 2.92 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 204.318 | M |
| I | Observed HFL | 205.100 | M |

**BR NO-88 IR KM 36.643 (Khurja-HafizPur)**

**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

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

$= [0.185 \times 0.185 \times 0.185 / 2.92]^{0.345}$

= **0.1205 hr.**

= 0.1205 hr. x 60

= **7.2296 Min**

**BR NO-88 IR KM 36.643 (Khurja-HafizPur)**

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

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

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

a tc h Ratio = *0.0882* From Fig. 4 of RBF - 16

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

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

= $\frac{0.0882}{0.34}$

= **0.2594**

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 )

= 0.2594 x102.00

= **26.4593 mm**

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

= $\frac{26.46}{0.1205}$

= **219.5901 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 219.5901 x 0.0316

= **1.6418 cum/sec**

**BR NO-88 IR KM 36.643 (Khurja-HafizPur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.6418 cum/sec

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

= $\frac{1.6418}{1.75}$

= **0.9382 Sq.m**

d Proposed Opening = 1 1.2 1.2

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

= $\frac{0.9382}{1.2}$

= **0.7820 m**

f Avg. Bed Level = 204.318

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

= 204.3180 +0.7820 +0.7690

= 205.8690

k **Formation level adopted** = 205.8690

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-89 IR KM 37.625 (Khurja-HafizPur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0355 | Sq Km |
| C | Length of Longest Stream | 0.250 | Km |
| D | Height Of farthest point | 208.309 | M |
| E | Height of Point of Interest | 204.989 | M |
| F | Height Diff of 10 & 11 | 3.32 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 204.989 | M |
| I | Observed HFL | 205.780 | M |

**BR NO-89 IR KM 37.625 (Khurja-HafizPur)**

**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

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

$= [ 0.25 \times 0.25 \times 0.25 / 3.32 ]^{0.345}$

= **0.1574 hr.**

= 0.1574 hr. x 60

= **9.4455 Min**

**BR NO-89 IR KM 37.625 (Khurja-HafizPur)**

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

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

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

a tc h Ratio = *0.1037* From Fig. 4 of RBF - 16

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

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

= $\frac{0.1037}{0.34}$

= **0.3050**

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 )

= 0.3050 x102.00

= **31.1138 mm**

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

= $\frac{31.11}{0.1574}$

= **197.6413 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 197.6413 x 0.0355

= **1.6601 cum/sec**

**BR NO-89 IR KM 37.625 (Khurja-HafizPur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.6601 cum/sec

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

= $\frac{1.6601}{1.75}$

= **0.9486 Sq.m**

d Proposed Opening = 1 1.2 1.2

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

= $\frac{0.9486}{1.2}$

= **0.7910 m**

f Avg. Bed Level = 204.989

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

= 204.9890 +0.7910 +0.7660

= 206.5460

k **Formation level adopted** = 206.5460

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-90 IR KM 38.670 (Khurja-HafizPur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0341 | Sq Km |
| C | Length of Longest Stream | 0.225 | Km |
| D | Height Of farthest point | 208.424 | M |
| E | Height of Point of Interest | 205.754 | M |
| F | Height Diff of 10 & 11 | 2.67 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 205.754 | M |
| I | Observed HFL | 206.520 | M |

**BR NO-90 IR KM 38.670 (Khurja-HafizPur)**

**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

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

$= [0.225 \times 0.225 \times 0.225 / 2.67]^{0.345}$

= **0.1522 hr.**

= 0.1522 hr. x 60

= **9.1309 Min**

**BR NO-90 IR KM 38.670 (Khurja-HafizPur)**

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

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

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

a tc h Ratio = *0.1011* From Fig. 4 of RBF - 16

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

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

= $\frac{0.1011}{0.34}$

= **0.2973**

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 )

= 0.2973 x102.00

= **30.3273 mm**

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

= $\frac{30.33}{0.1522}$

= **199.2834 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 199.2834 x 0.0341

= **1.6079 cum/sec**

**BR NO-90 IR KM 38.670 (Khurja-HafizPur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.6079 cum/sec

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

= $\frac{1.6079}{1.75}$

= **0.9188 Sq.m**

d Proposed Opening = 1 1.2 1.2

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

= $\frac{0.9188}{1.2}$

= **0.7660 m**

f Avg. Bed Level = 205.754

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

= 205.7540 +0.7660 +0.7940

= 207.3140

k **Formation level adopted** = 207.3140

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-91 IR KM 39.030 (Khurja-HafizPur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0331 | Sq Km |
| C | Length of Longest Stream | 0.210 | Km |
| D | Height Of farthest point | 209.128 | M |
| E | Height of Point of Interest | 205.848 | M |
| F | Height Diff of 10 & 11 | 3.28 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 205.848 | M |
| I | Observed HFL | 206.635 | M |

**BR NO-91 IR KM 39.030 (Khurja-HafizPur)**

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

= $[ 0.21 \times 0.21 \times 0.21 / 3.28 ]^{0.345}$

= **0.1320 hr.**

= 0.1320 hr. x 60

= **7.9190 Min**

**BR NO-91 IR KM 39.030 (Khurja-HafizPur)**

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

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

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

a tc h Ratio = *0.0928* From Fig. 4 of RBF - 16

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

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

= $\frac{0.0928}{0.34}$

= **0.2729**

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 )

= 0.2729 x102.00

= **27.8381 mm**

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

= $\frac{27.84}{0.1320}$

= **210.9206 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 210.9206 x 0.0331

= **1.6519 cum/sec**

**BR NO-91 IR KM 39.030 (Khurja-HafizPur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.6519 cum/sec

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

= $\frac{1.6519}{1.75}$

= **0.9439 Sq.m**

d Proposed Opening = 1 1.2 1.2

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

= $\frac{0.9439}{1.2}$

= **0.7870 m**

f Avg. Bed Level = 205.848

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

= 205.8480 +0.7870 +0.7740

= 207.4090

k **Formation level adopted** = 207.4090

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-92 IR KM 39.740 (Khurja-HafizPur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0414 | Sq Km |
| C | Length of Longest Stream | 0.350 | Km |
| D | Height Of farthest point | 208.815 | M |
| E | Height of Point of Interest | 205.895 | M |
| F | Height Diff of 10 & 11 | 2.92 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 205.895 | M |
| I | Observed HFL | 206.745 | M |

**BR NO-92 IR KM 39.740 (Khurja-HafizPur)**

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

= $[ 0.35 \times 0.35 \times 0.35 / 2.92 ]^{0.345}$

= **0.2331 hr.**

= 0.2331 hr. x 60

= **13.9864 Min**

**BR NO-92 IR KM 39.740 (Khurja-HafizPur)**

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

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

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

a tc h Ratio = *0.1416* From Fig. 4 of RBF - 16

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

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

= $\frac{0.1416}{0.34}$

= **0.4163**

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 )

= 0.4163 x102.00

= **42.4659 mm**

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

= $\frac{42.47}{0.2331}$

= **182.1743 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 182.1743 x 0.0414

= **1.7845 cum/sec**

**BR NO-92 IR KM 39.740 (Khurja-HafizPur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.7845 cum/sec

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

= $\frac{1.7845}{1.75}$

= **1.0197 Sq.m**

d Proposed Opening = 1 1.2 1.2

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

= $\frac{1.0197}{1.2}$

= **0.8500 m**

f Avg. Bed Level = 205.895

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

= 205.8950 +0.8500 +0.8500

= 207.5950

k **Formation level adopted** = 207.5950

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-93 IR KM 40.240 (Khurja-HafizPur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0706 | Sq Km |
| C | Length of Longest Stream | 0.265 | Km |
| D | Height Of farthest point | 208.627 | M |
| E | Height of Point of Interest | 205.367 | M |
| F | Height Diff of 10 & 11 | 3.26 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 205.367 | M |
| I | Observed HFL | 206.915 | M |

**BR NO-93 IR KM 40.240 (Khurja-HafizPur)**

**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

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

$= [0.265 \times 0.265 \times 0.265 / 3.26]^{0.345}$

= **0.1683 hr.**

= 0.1683 hr. x 60

= **10.0960 Min**

**BR NO-93 IR KM 40.240 (Khurja-HafizPur)**

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

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

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

a tc h Ratio = *0.1091* From Fig. 4 of RBF - 16

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

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

= $\frac{0.1091}{0.34}$

= **0.3210**

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 )

= 0.3210 x102.00

= **32.7401 mm**

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

= $\frac{32.74}{0.1683}$

= **194.5721 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 194.5721 x 0.0706

= **3.2502 cum/sec**

**BR NO-93 IR KM 40.240 (Khurja-HafizPur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 3.2502 cum/sec

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

= $\frac{3.2502}{1.75}$

= **1.8573 Sq.m**

d Proposed Opening = 1 1.2 2

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

= $\frac{1.8573}{1.2}$

= **1.5480 m**

f Avg. Bed Level = 205.367

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

= 205.3670 +1.5480 +0.8120

= 207.7270

k **Formation level adopted** = 207.7270

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-94 IR KM 41.003 (Khurja-HafizPur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0594 | Sq Km |
| C | Length of Longest Stream | 0.174 | Km |
| D | Height Of farthest point | 208.318 | M |
| E | Height of Point of Interest | 205.478 | M |
| F | Height Diff of 10 & 11 | 2.84 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 205.478 | M |
| I | Observed HFL | 206.985 | M |

**BR NO-94 IR KM 41.003 (Khurja-HafizPur)**

**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

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

$= [ 0.174 \times 0.174 \times 0.174 / 2.84 ]^{0.345}$

= **0.1142 hr.**

= 0.1142 hr. x 60

= **6.8505 Min**

**BR NO-94 IR KM 41.003 (Khurja-HafizPur)**

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

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

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

a tc h Ratio = *0.0857* From Fig. 4 of RBF - 16

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

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

= $\frac{0.0857}{0.34}$

= **0.2520**

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 )

= 0.2520 x102.00

= **25.7011 mm**

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

= $\frac{25.70}{0.1142}$

= **225.1013 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 225.1013 x 0.0594

= **3.1637 cum/sec**

**BR NO-94 IR KM 41.003 (Khurja-HafizPur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 3.1637 cum/sec

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

= $\frac{3.1637}{1.75}$

= **1.8078 Sq.m**

d Proposed Opening = 1 1.2 2

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

= $\frac{1.8078}{1.2}$

= **1.5070 m**

f Avg. Bed Level = 205.478

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

= 205.4780 +1.5070 +0.8530

= 207.8380

k **Formation level adopted** = 207.8380

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-95 IR KM 41.182 (Khurja-HafizPur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0315 | Sq Km |
| C | Length of Longest Stream | 0.220 | Km |
| D | Height Of farthest point | 208.548 | M |
| E | Height of Point of Interest | 206.278 | M |
| F | Height Diff of 10 & 11 | 2.27 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 206.278 | M |
| I | Observed HFL | 206.980 | M |

**BR NO-95 IR KM 41.182 (Khurja-HafizPur)**

**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

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

$= [0.22 \times 0.22 \times 0.22 / 2.27]^{0.345}$

= **0.1572 hr.**

= 0.1572 hr. x 60

= **9.4347 Min**

**BR NO-95 IR KM 41.182 (Khurja-HafizPur)**

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

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

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

a tc h Ratio = *0.1036* From Fig. 4 of RBF - 16

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

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

= $\frac{0.1036}{0.34}$

= **0.3048**

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 )

= 0.3048 x102.00

= **31.0868 mm**

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

= $\frac{31.09}{0.1572}$

= **197.6958 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 197.6958 x 0.0315

= **1.4734 cum/sec**

**BR NO-95 IR KM 41.182 (Khurja-HafizPur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.4734 cum/sec

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

= $\frac{1.4734}{1.75}$

= **0.8419 Sq.m**

d Proposed Opening = 1 1.2 1.2

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

= $\frac{0.8419}{1.2}$

= **0.7020 m**

f Avg. Bed Level = 206.278

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

= 206.2780 +0.7020 +0.8580

= 207.8380

k **Formation level adopted** = 207.8380

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-96 IR KM 41.433 (Khurja-HafizPur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0321 | Sq Km |
| C | Length of Longest Stream | 0.250 | Km |
| D | Height Of farthest point | 208.938 | M |
| E | Height of Point of Interest | 206.278 | M |
| F | Height Diff of 10 & 11 | 2.66 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 206.278 | M |
| I | Observed HFL | 206.980 | M |

**BR NO-96 IR KM 41.433 (Khurja-HafizPur)**

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

= $[ 0.25 \times 0.25 \times 0.25 / 2.66 ]^{0.345}$

= **0.1699 hr.**

= 0.1699 hr. x 60

= **10.1961 Min**

**BR NO-96 IR KM 41.433 (Khurja-HafizPur)**

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

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

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

a tc h Ratio = *0.1100* From Fig. 4 of RBF - 16

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

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

= $\frac{0.1100}{0.34}$

= **0.3234**

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 )

= 0.3234 x102.00

= **32.9903 mm**

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

= $\frac{32.99}{0.1699}$

= **194.1344 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 194.1344 x 0.0321

= **1.4745 cum/sec**

**BR NO-96 IR KM 41.433 (Khurja-HafizPur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.4745 cum/sec

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

= $\frac{1.4745}{1.75}$

= **0.8426 Sq.m**

d Proposed Opening = 1 1.2 1.2

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

= $\frac{0.8426}{1.2}$

= **0.7020 m**

f Avg. Bed Level = 206.278

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

= 206.2780 +0.7020 +0.8580

= 207.8380

k **Formation level adopted** = 207.8380

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-97 IR KM 41.739 (Khurja-HafizPur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0317 | Sq Km |
| C | Length of Longest Stream | 0.255 | Km |
| D | Height Of farthest point | 209.558 | M |
| E | Height of Point of Interest | 206.278 | M |
| F | Height Diff of 10 & 11 | 3.28 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 206.278 | M |
| I | Observed HFL | 206.980 | M |

**BR NO-97 IR KM 41.739 (Khurja-HafizPur)**

**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

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

$= [ 0.255 \times 0.255 \times 0.255 / 3.28 ]^{0.345}$

= **0.1614 hr.**

= 0.1614 hr. x 60

= **9.6815 Min**

**BR NO-97 IR KM 41.739 (Khurja-HafizPur)**

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

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

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

a tc h Ratio = *0.1057* From Fig. 4 of RBF - 16

b 1h Ratio = = 0.34 From Fig. 4 of RBF - 16

c Coefficient K = $\frac{\text{tc h Ratio}}{\text{1h Ratio}}$

= $\frac{0.1057}{0.34}$

= **0.3108**

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 )

= 0.3108 x102.00

= **31.7038 mm**

iv Int. of rainfall (I) = $\frac{\text{R-50 (tc)}}{\text{tc}}$

= $\frac{31.70}{0.1614}$

= **196.4802 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 196.4802 x 0.0317

= **1.4737 cum/sec**

**BR NO-97 IR KM 41.739 (Khurja-HafizPur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.4737 cum/sec

c Avg. Waterway Required = $\frac{Q}{V}$

= $\frac{1.4737}{1.75}$

= **0.8421 Sq.m**

d Proposed Opening = 1 1.2 1.2

e Height of Water = $\frac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\frac{0.8421}{1.2}$

= **0.7020 m**

f Avg. Bed Level = 206.278

h **Min. Formation Required** B.L + Ht of water + free Board

= 206.2780 +0.7020 +0.8580

= 207.8380

k **Formation level adopted** = 207.8380

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-98 IR KM 42.308 (Khurja-HafizPur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0321 | Sq Km |
| C | Length of Longest Stream | 0.220 | Km |
| D | Height Of farthest point | 209.059 | M |
| E | Height of Point of Interest | 206.389 | M |
| F | Height Diff of 10 & 11 | 2.67 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 206.389 | M |
| I | Observed HFL | 207.115 | M |

**BR NO-98 IR KM 42.308 (Khurja-HafizPur)**

**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

$tc = [L^3 / H]^{0.345}$

$= [0.22 \times 0.22 \times 0.22 / 2.67]^{0.345}$

= **0.1487 hr.**

= 0.1487 hr. x 60

= **8.9210 Min**

**BR NO-98 IR KM 42.308 (Khurja-HafizPur)**

**Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , C = 0.249(R x F) ^ 0.2**

R = 300.00 mm
F = 0.72
$C = 0.249 \times ( R \times F )^{0.2}$
= **0.8511**

**3 Calculation of Intensity of Rainfall ( I )**

a tc h Ratio = *0.0995* From Fig. 4 of RBF - 16

b 1h Ratio = = 0.34 From Fig. 4 of RBF - 16

c Coefficient K = $\frac{\text{tc h Ratio}}{\text{1h Ratio}}$

= $\frac{0.0995}{0.34}$

= **0.2926**

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 )

= 0.2926 x102.00

= **29.8420 mm**

iv Int. of rainfall (I) = $\frac{\text{R-50 (tc)}}{\text{tc}}$

= $\frac{29.84}{0.1487}$

= **200.7090 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 200.7090 x 0.0321

= **1.5244 cum/sec**

**BR NO-98 IR KM 42.308 (Khurja-HafizPur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.5244 cum/sec

c Avg. Waterway Required = $\frac{Q}{V}$

= $\frac{1.5244}{1.75}$

= **0.8711 Sq.m**

d Proposed Opening = 1 1.2 1.2

e Height of Water = $\frac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\frac{0.8711}{1.2}$

= **0.7260 m**

f Avg. Bed Level = 206.389

h **Min. Formation Required** B.L + Ht of water + free Board

= 206.3890 +0.7260 +0.8340

= 207.9490

k **Formation level adopted** = 207.9490

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-99 IR KM 42.483 (Khurja-HafizPur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.1355 | Sq Km |
| C | Length of Longest Stream | 0.460 | Km |
| D | Height Of farthest point | 208.483 | M |
| E | Height of Point of Interest | 205.713 | M |
| F | Height Diff of 10 & 11 | 2.77 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 205.713 | M |
| I | Observed HFL | 207.235 | M |

**BR NO-99 IR KM 42.483 (Khurja-HafizPur)**

**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 = $[ L^3 / H ]^{0.345}$

= $[ 0.46 \times 0.46 \times 0.46 / 2.77 ]^{0.345}$

= **0.3150 hr.**

= 0.3150 hr. x 60

= **18.8995 Min**

**BR NO-99 IR KM 42.483 (Khurja-HafizPur)**

**Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , C = 0.249(R x F) ^ 0.2**

R = 300.00 mm
F = 0.72
$C = 0.249 \times ( R \times F )^{0.2}$
= **0.8511**

**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 = $\frac{\text{tc h Ratio}}{\text{1h Ratio}}$

= $\frac{0.1745}{0.34}$

= **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

= **52.3492 mm**

iv Int. of rainfall (I) = $\frac{\text{R-50 (tc)}}{\text{tc}}$

= $\frac{52.35}{0.3150}$

= **166.1924 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 166.1924 x 0.1355

= **5.3281 cum/sec**

**BR NO-99 IR KM 42.483 (Khurja-HafizPur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 5.3281 cum/sec

c Avg. Waterway Required = $\frac{Q}{V}$

= $\frac{5.3281}{1.75}$

= **3.0446 Sq.m**

d Proposed Opening = 1 2 2

e Height of Water = $\frac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\frac{3.0446}{2}$

= **1.5220 m**

f Avg. Bed Level = 205.713

h **Min. Formation Required** B.L + Ht of water + free Board

= 205.7130 +1.5220 +0.8370

= 208.0720

k **Formation level adopted** = 208.0720

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-100 IR KM 42.780 (Khurja-HafizPur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0357 | Sq Km |
| C | Length of Longest Stream | 0.230 | Km |
| D | Height Of farthest point | 209.564 | M |
| E | Height of Point of Interest | 206.544 | M |
| F | Height Diff of 10 & 11 | 3.02 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 206.544 | M |
| I | Observed HFL | 207.350 | M |

**BR NO-100 IR KM 42.780 (Khurja-HafizPur)**

**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

$tc = [L^3 / H]^{0.345}$

$= [0.23 \times 0.23 \times 0.23 / 3.02]^{0.345}$

= **0.1492 hr.**

= 0.1492 hr. x 60

= **8.9524 Min**

**BR NO-100 IR KM 42.780 (Khurja-HafizPur)**

**Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , C = 0.249(R x F) ^ 0.2**

R = 300.00 mm
F = 0.72
C = 0.249 x ( R x F ) $^{0.2}$
= **0.8511**

**3 Calculation of Intensity of Rainfall ( I )**

a tc h Ratio = *0.0997* From Fig. 4 of RBF - 16

b 1h Ratio = = 0.34 From Fig. 4 of RBF - 16

c Coefficient K = $\frac{\text{tc h Ratio}}{\text{1h Ratio}}$

= $\frac{0.0997}{0.34}$

= **0.2932**

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 )

= 0.2932 x102.00

= **29.9047 mm**

iv Int. of rainfall (I) = $\frac{\text{R-50 (tc)}}{\text{tc}}$

= $\frac{29.90}{0.1492}$

= **200.4258 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 200.4258 x 0.0357

= **1.6930 cum/sec**

**BR NO-100 IR KM 42.780 (Khurja-HafizPur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.6930 cum/sec

c Avg. Waterway Required = $\frac{Q}{V}$

= $\frac{1.6930}{1.75}$

= **0.9674 Sq.m**

d Proposed Opening = 1 1.2 1.2

e Height of Water = $\frac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\frac{0.9674}{1.2}$

= **0.8060 m**

f Avg. Bed Level = 206.544

h **Min. Formation Required** B.L + Ht of water + free Board

= 206.5438 +0.8060 +0.7890

= 208.1388

k **Formation level adopted** = 208.1390

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-101 IR KM 42.975 (Khurja-HafizPur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0370 | Sq Km |
| C | Length of Longest Stream | 0.310 | Km |
| D | Height Of farthest point | 209.149 | M |
| E | Height of Point of Interest | 206.579 | M |
| F | Height Diff of 10 & 11 | 2.57 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 206.579 | M |
| I | Observed HFL | 207.350 | M |

**BR NO-101 IR KM 42.975 (Khurja-HafizPur)**

**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 = $[ L^3 / H ]^{0.345}$

= $[ 0.31 \times 0.31 \times 0.31 / 2.57 ]^{0.345}$

= **0.2148 hr.**

= 0.2148 hr. x 60

= **12.8909 Min**

**BR NO-101 IR KM 42.975 (Khurja-HafizPur)**

**Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , C = 0.249(R x F) ^ 0.2**

R = 300.00 mm
F = 0.72
$C = 0.249 \times ( R \times F )^{0.2}$
= **0.8511**

**3 Calculation of Intensity of Rainfall ( I )**

a tc h Ratio = *0.1324* From Fig. 4 of RBF - 16

b 1h Ratio = = 0.34 From Fig. 4 of RBF - 16

c Coefficient K = $\frac{\text{tc h Ratio}}{\text{1h Ratio}}$

= $\frac{0.1324}{0.34}$

= **0.3895**

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 )

= 0.3895 x102.00

= **39.7273 mm**

iv Int. of rainfall (I) = $\frac{\text{R-50 (tc)}}{\text{tc}}$

= $\frac{39.73}{0.2148}$

= **184.9084 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 184.9084 x 0.0370

= **1.6188 cum/sec**

**BR NO-101 IR KM 42.975 (Khurja-HafizPur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.6188 cum/sec

c Avg. Waterway Required = $\frac{Q}{V}$

= $\frac{1.6188}{1.75}$

= **0.9250 Sq.m**

d Proposed Opening = 1 1.2 1.2

e Height of Water = $\frac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\frac{0.9250}{1.2}$

= **0.7710 m**

f Avg. Bed Level = 206.579

h **Min. Formation Required** B.L + Ht of water + free Board

= 206.5790 +0.7710 +0.7890

= 208.1390

k **Formation level adopted** = 208.1390

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-102 IR KM 43.232 (Khurja-HafizPur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0392 | Sq Km |
| C | Length of Longest Stream | 0.245 | Km |
| D | Height Of farthest point | 209.763 | M |
| E | Height of Point of Interest | 206.473 | M |
| F | Height Diff of 10 & 11 | 3.29 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 206.473 | M |
| I | Observed HFL | 207.350 | M |

**BR NO-102 IR KM 43.232 (Khurja-HafizPur)**

**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

$tc = [ L^3 / H ]^{0.345}$

$= [ 0.245 \times 0.245 \times 0.245 / 3.29 ]^{0.345}$

= **0.1547 hr.**

= 0.1547 hr. x 60

= **9.2791 Min**

**BR NO-102 IR KM 43.232 (Khurja-HafizPur)**

**Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , C = 0.249(R x F) ^ 0.2**

R = 300.00 mm
F = 0.72
$C = 0.249 \times ( R \times F )^{0.2}$
= **0.8511**

**3 Calculation of Intensity of Rainfall ( I )**

a tc h Ratio = *0.1023* From Fig. 4 of RBF - 16

b 1h Ratio = = 0.34 From Fig. 4 of RBF - 16

c Coefficient K = $\frac{\text{tc h Ratio}}{\text{1h Ratio}}$

= $\frac{0.1023}{0.34}$

= **0.3010**

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 )

= 0.3010 x102.00

= **30.6977 mm**

iv Int. of rainfall (I) = $\frac{\text{R-50 (tc)}}{\text{tc}}$

= $\frac{30.70}{0.1547}$

= **198.4959 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 198.4959 x 0.0392

= **1.8410 cum/sec**

**BR NO-102 IR KM 43.232 (Khurja-HafizPur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.8410 cum/sec

c Avg. Waterway Required = $\frac{Q}{V}$

= $\frac{1.8410}{1.75}$

= **1.0520 Sq.m**

d Proposed Opening = 1 1.2 1.2

e Height of Water = $\frac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\frac{1.0520}{1.2}$

= **0.8770 m**

f Avg. Bed Level = 206.473

h **Min. Formation Required** B.L + Ht of water + free Board

= 206.4730 +0.8770 +0.7890

= 208.1390

k **Formation level adopted** = 208.1390

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-103 IR KM 43.470 (Khurja-HafizPur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0375 | Sq Km |
| C | Length of Longest Stream | 0.330 | Km |
| D | Height Of farthest point | 209.079 | M |
| E | Height of Point of Interest | 206.579 | M |
| F | Height Diff of 10 & 11 | 2.50 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 206.579 | M |
| I | Observed HFL | 207.350 | M |

**BR NO-103 IR KM 43.470 (Khurja-HafizPur)**

**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 = $[ L^3 / H ]^{0.345}$

= $[ 0.33 \times 0.33 \times 0.33 / 2.50 ]^{0.345}$

= **0.2314 hr.**

= 0.2314 hr. x 60

= **13.8843 Min**

**BR NO-103 IR KM 43.470 (Khurja-HafizPur)**

**Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , C = 0.249(R x F) ^ 0.2**

R = 300.00 mm
F = 0.72
$C = 0.249 \times ( R \times F )^{0.2}$
= **0.8511**

**3 Calculation of Intensity of Rainfall ( I )**

a tc h Ratio = *0.1407* From Fig. 4 of RBF - 16

b 1h Ratio = = 0.34 From Fig. 4 of RBF - 16

c Coefficient K = $\frac{\text{tc h Ratio}}{\text{1h Ratio}}$

= $\frac{0.1407}{0.34}$

= **0.4138**

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 )

= 0.4138 x102.00

= **42.2107 mm**

iv Int. of rainfall (I) = $\frac{\text{R-50 (tc)}}{\text{tc}}$

= $\frac{42.21}{0.2314}$

= **182.4105 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 182.4105 x 0.0375

= **1.6185 cum/sec**

**BR NO-103 IR KM 43.470 (Khurja-HafizPur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.6185 cum/sec

c Avg. Waterway Required = $\frac{Q}{V}$

= $\frac{1.6185}{1.75}$

= **0.9249 Sq.m**

d Proposed Opening = 1 1.2 1.2

e Height of Water = $\frac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\frac{0.9249}{1.2}$

= **0.7710 m**

f Avg. Bed Level = 206.579

h **Min. Formation Required** B.L + Ht of water + free Board

= 206.5790 +0.7710 +0.7890

= 208.1390

k **Formation level adopted** = 208.1390

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-104 IR KM 43.638 (Khurja-HafizPur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0369 | Sq Km |
| C | Length of Longest Stream | 0.280 | Km |
| D | Height Of farthest point | 209.361 | M |
| E | Height of Point of Interest | 206.621 | M |
| F | Height Diff of 10 & 11 | 2.74 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 206.621 | M |
| I | Observed HFL | 207.409 | M |

**BR NO-104 IR KM 43.638 (Khurja-HafizPur)**

**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

$tc = [L^3 / H]^{0.345}$

$= [0.28 \times 0.28 \times 0.28 / 2.74]^{0.345}$

= **0.1891 hr.**

= 0.1891 hr. x 60

= **11.3484 Min**

**BR NO-104 IR KM 43.638 (Khurja-HafizPur)**

**Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , C = 0.249(R x F) ^ 0.2**

R = 300.00 mm
F = 0.72
$C = 0.249 \times ( R \times F )^{0.2}$
= **0.8511**

**3 Calculation of Intensity of Rainfall ( I )**

a tc h Ratio = *0.1196* From Fig. 4 of RBF - 16

b 1h Ratio = = 0.34 From Fig. 4 of RBF - 16

c Coefficient K = $\frac{\text{tc h Ratio}}{\text{1h Ratio}}$

= $\frac{0.1196}{0.34}$

= **0.3517**

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 )

= 0.3517 x102.00

= **35.8711 mm**

iv Int. of rainfall (I) = $\frac{\text{R-50 (tc)}}{\text{tc}}$

= $\frac{35.87}{0.1891}$

= **189.6532 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 189.6532 x 0.0369

= **1.6558 cum/sec**

**BR NO-104 IR KM 43.638 (Khurja-HafizPur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.6558 cum/sec

c Avg. Waterway Required = $\frac{Q}{V}$

= $\frac{1.6558}{1.75}$

= **0.9462 Sq.m**

d Proposed Opening = 1 1.2 1.2

e Height of Water = $\frac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\frac{0.9462}{1.2}$

= **0.7880 m**

f Avg. Bed Level = 206.621

h **Min. Formation Required** B.L + Ht of water + free Board

= 206.6210 +0.7880 +0.7750

= 208.1840

k **Formation level adopted** = 208.1840

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-105 IR KM 44.055 (Khurja-HafizPur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0367 | Sq Km |
| C | Length of Longest Stream | 0.255 | Km |
| D | Height Of farthest point | 209.497 | M |
| E | Height of Point of Interest | 206.867 | M |
| F | Height Diff of 10 & 11 | 2.63 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 206.867 | M |
| I | Observed HFL | 207.665 | M |

**BR NO-105 IR KM 44.055 (Khurja-HafizPur)**

**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

$tc = [L^3 / H]^{0.345}$

$= [0.255 \times 0.255 \times 0.255 / 2.63]^{0.345}$

= **0.1741 hr.**

= 0.1741 hr. x 60

= **10.4481 Min**

**BR NO-105 IR KM 44.055 (Khurja-HafizPur)**

**Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , C = 0.249(R x F) ^ 0.2**

R = 300.00 mm
F = 0.72
$C = 0.249 \times ( R \times F )^{0.2}$
= **0.8511**

**3 Calculation of Intensity of Rainfall ( I )**

a tc h Ratio = *0.1121* From Fig. 4 of RBF - 16

b 1h Ratio = = 0.34 From Fig. 4 of RBF - 16

c Coefficient K = $\frac{\text{tc h Ratio}}{\text{1h Ratio}}$

= $\frac{0.1121}{0.34}$

= **0.3296**

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 )

= 0.3296 x102.00

= **33.6201 mm**

iv Int. of rainfall (I) = $\frac{\text{R-50 (tc)}}{\text{tc}}$

= $\frac{33.62}{0.1741}$

= **193.0699 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 193.0699 x 0.0367

= **1.6765 cum/sec**

**BR NO-105 IR KM 44.055 (Khurja-HafizPur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.6765 cum/sec

c Avg. Waterway Required = $\frac{Q}{V}$

= $\frac{1.6765}{1.75}$

= **0.9580 Sq.m**

d Proposed Opening = 1 1.2 1.2

e Height of Water = $\frac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\frac{0.9580}{1.2}$

= **0.7980 m**

f Avg. Bed Level = 206.867

h **Min. Formation Required** B.L + Ht of water + free Board

= 206.8670 +0.7980 +0.7620

= 208.4270

k **Formation level adopted** = 208.4270

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-106 IR KM 44.857 (Khurja-HafizPur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0433 | Sq Km |
| C | Length of Longest Stream | 0.310 | Km |
| D | Height Of farthest point | 209.420 | M |
| E | Height of Point of Interest | 206.950 | M |
| F | Height Diff of 10 & 11 | 2.47 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 206.950 | M |
| I | Observed HFL | 207.850 | M |

**BR NO-106 IR KM 44.857 (Khurja-HafizPur)**

**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

| | 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

$tc = [L^3 / H]^{0.345}$

$= [0.31 \times 0.31 \times 0.31 / 2.47]^{0.345}$

= **0.2178 hr.**

= 0.2178 hr. x 60

= **13.0686 Min**

**BR NO-106 IR KM 44.857 (Khurja-HafizPur)**

**Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , C = 0.249(R x F) ^ 0.2**

R = 300.00 mm
F = 0.72
$C = 0.249 \times ( R \times F )^{0.2}$
= **0.8511**

**3 Calculation of Intensity of Rainfall ( I )**

a tc h Ratio = *0.1339* From Fig. 4 of RBF - 16

b 1h Ratio = = 0.34 From Fig. 4 of RBF - 16

c Coefficient K = $\frac{\text{tc h Ratio}}{\text{1h Ratio}}$

= $\frac{0.1339}{0.34}$

= **0.3938**

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 )

= 0.3938 x102.00

= **40.1716 mm**

iv Int. of rainfall (I) = $\frac{\text{R-50 (tc)}}{\text{tc}}$

= $\frac{40.17}{0.2178}$

= **184.4337 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 184.4337 x 0.0433

= **1.8895 cum/sec**

**BR NO-106 IR KM 44.857 (Khurja-HafizPur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.8895 cum/sec

c Avg. Waterway Required = $\frac{Q}{V}$

= $\frac{1.8895}{1.75}$

= **1.0797 Sq.m**

d Proposed Opening = 1 1.2 1.2

e Height of Water = $\frac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\frac{1.0797}{1.2}$

= **0.9000 m**

f Avg. Bed Level = 206.950

h **Min. Formation Required** B.L + Ht of water + free Board

= 206.9500 +0.9000 +0.7560

= 208.6060

k **Formation level adopted** = 208.6060

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-107 IR KM 45.068 (Khurja-HafizPur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0342 | Sq Km |
| C | Length of Longest Stream | 0.275 | Km |
| D | Height Of farthest point | 210.346 | M |
| E | Height of Point of Interest | 207.056 | M |
| F | Height Diff of 10 & 11 | 3.29 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 207.056 | M |
| I | Observed HFL | 207.800 | M |

**BR NO-107 IR KM 45.068 (Khurja-HafizPur)**

**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

$tc = [L^3 / H]^{0.345}$

$= [0.275 \times 0.275 \times 0.275 / 3.29]^{0.345}$

= **0.1743 hr.**

= 0.1743 hr. x 60

= **10.4575 Min**

**BR NO-107 IR KM 45.068 (Khurja-HafizPur)**

**Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , C = 0.249(R x F) ^ 0.2**

R = 300.00 mm
F = 0.72
$C = 0.249 \times ( R \times F )^{0.2}$
= **0.8511**

**3 Calculation of Intensity of Rainfall ( I )**

a tc h Ratio = *0.1121* From Fig. 4 of RBF - 16

b 1h Ratio = = 0.34 From Fig. 4 of RBF - 16

c Coefficient K = $\frac{\text{tc h Ratio}}{\text{1h Ratio}}$

= $\frac{0.1121}{0.34}$

= **0.3298**

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 )

= 0.3298 x102.00

= **33.6438 mm**

iv Int. of rainfall (I) = $\frac{\text{R-50 (tc)}}{\text{tc}}$

= $\frac{33.64}{0.1743}$

= **193.0315 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 193.0315 x 0.0342

= **1.5620 cum/sec**

**BR NO-107 IR KM 45.068 (Khurja-HafizPur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.5620 cum/sec

c Avg. Waterway Required = $\frac{Q}{V}$

= $\frac{1.5620}{1.75}$

= **0.8926 Sq.m**

d Proposed Opening = 1 1.2 1.2

e Height of Water = $\frac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\frac{0.8926}{1.2}$

= **0.7440 m**

f Avg. Bed Level = 207.056

h **Min. Formation Required** B.L + Ht of water + free Board

= 207.0560 +0.7440 +0.8060

= 208.6060

k **Formation level adopted** = 208.6060

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-108 IR KM 45.295 (Khurja-HafizPur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0389 | Sq Km |
| C | Length of Longest Stream | 0.230 | Km |
| D | Height Of farthest point | 210.230 | M |
| E | Height of Point of Interest | 206.910 | M |
| F | Height Diff of 10 & 11 | 3.32 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 206.910 | M |
| I | Observed HFL | 207.800 | M |

**BR NO-108 IR KM 45.295 (Khurja-HafizPur)**

**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

| | 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

$tc = [L^3 / H]^{0.345}$

$= [0.23 \times 0.23 \times 0.23 / 3.32]^{0.345}$

= **0.1444 hr.**

= 0.1444 hr. x 60

= **8.6646 Min**

**BR NO-108 IR KM 45.295 (Khurja-HafizPur)**

**Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , C = 0.249(R x F) ^ 0.2**

R = 300.00 mm
F = 0.72
$C = 0.249 \times ( R \times F )^{0.2}$
= **0.8511**

**3 Calculation of Intensity of Rainfall ( I )**

a tc h Ratio = *0.0978* From Fig. 4 of RBF - 16

b 1h Ratio = = 0.34 From Fig. 4 of RBF - 16

c Coefficient K = $\frac{\text{tc h Ratio}}{\text{1h Ratio}}$

= $\frac{0.0978}{0.34}$

= **0.2875**

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 )

= 0.2875 x102.00

= **29.3291 mm**

iv Int. of rainfall (I) = $\frac{\text{R-50 (tc)}}{\text{tc}}$

= $\frac{29.33}{0.1444}$

= **203.0968 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 203.0968 x 0.0389

= **1.8693 cum/sec**

**BR NO-108 IR KM 45.295 (Khurja-HafizPur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.8693 cum/sec

c Avg. Waterway Required = $\frac{Q}{V}$

= $\frac{1.8693}{1.75}$

= **1.0682 Sq.m**

d Proposed Opening = 1 1.2 1.2

e Height of Water = $\frac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\frac{1.0682}{1.2}$

= **0.8900 m**

f Avg. Bed Level = 206.910

h **Min. Formation Required** B.L + Ht of water + free Board

= 206.9100 +0.8900 +0.8060

= 208.6060

k **Formation level adopted** = 208.6060

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-109 IR KM 45.455 (Khurja-HafizPur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.4624 | Sq Km |
| C | Length of Longest Stream | 0.900 | Km |
| D | Height Of farthest point | 207.080 | M |
| E | Height of Point of Interest | 204.180 | M |
| F | Height Diff of 10 & 11 | 2.90 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 204.180 | M |
| I | Observed HFL | 206.915 | M |

**BR NO-109 IR KM 45.455 (Khurja-HafizPur)**

**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

$tc = [L^3 / H]^{0.345}$

$= [0.9 \times 0.9 \times 0.9 / 2.90]^{0.345}$

= **0.6210 hr.**

= 0.6210 hr. x 60

= **37.2619 Min**

**BR NO-109 IR KM 45.455 (Khurja-HafizPur)**

**Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , C = 0.249(R x F) ^ 0.2**

R = 300.00 mm
F = 0.81
C = 0.249 x ( R x F ) $^{0.2}$
= **0.8922**

**3 Calculation of Intensity of Rainfall ( I )**

a tc h Ratio = *0.2592* From Fig. 4 of RBF - 16

b 1h Ratio = = 0.34 From Fig. 4 of RBF - 16

c Coefficient K = $\frac{\text{tc h Ratio}}{\text{1h Ratio}}$

= $\frac{0.2592}{0.34}$

= **0.7624**

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 )

= 0.7624 x102.00

= **77.7619 mm**

iv Int. of rainfall (I) = $\frac{\text{R-50 (tc)}}{\text{tc}}$

= $\frac{77.76}{0.6210}$

= **125.2141 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8922 x 125.2141 x 0.4624

= **14.3601 cum/sec**

**BR NO-109 IR KM 45.455 (Khurja-HafizPur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 14.3601 cum/sec

c Avg. Waterway Required = $\frac{Q}{V}$

= $\frac{14.3601}{1.75}$

= **8.2058 Sq.m**

d Proposed Opening = 1 3 3

e Height of Water = $\frac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\frac{8.2058}{3}$

= **2.7350 m**

f Avg. Bed Level = 204.180

h **Min. Formation Required** B.L + Ht of water + free Board

= 204.1800 +2.7350 +1.6910

= 208.6060

k **Formation level adopted** = 208.6060

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-110 IR KM 45.590 (Khurja-HafizPur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.1794 | Sq Km |
| C | Length of Longest Stream | 0.275 | Km |
| D | Height Of farthest point | 209.056 | M |
| E | Height of Point of Interest | 206.206 | M |
| F | Height Diff of 10 & 11 | 2.85 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 206.206 | M |
| I | Observed HFL | 207.750 | M |

**BR NO-110 IR KM 45.590 (Khurja-HafizPur)**

**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

$tc = [L^3 / H]^{0.345}$

$= [0.275 \times 0.275 \times 0.275 / 2.85]^{0.345}$

= **0.1831 hr.**

= 0.1831 hr. x 60

= **10.9885 Min**

**BR NO-110 IR KM 45.590 (Khurja-HafizPur)**

**Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , C = 0.249(R x F) ^ 0.2**

R = 300.00 mm
F = 0.72
$C = 0.249 \times ( R \times F )^{0.2}$
= **0.8511**

**3 Calculation of Intensity of Rainfall ( I )**

a tc h Ratio = *0.1166* From Fig. 4 of RBF - 16

b 1h Ratio = = 0.34 From Fig. 4 of RBF - 16

c Coefficient K = $\frac{\text{tc h Ratio}}{\text{1h Ratio}}$

= $\frac{0.1166}{0.34}$

= **0.3429**

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 )

= 0.3429 x102.00

= **34.9713 mm**

iv Int. of rainfall (I) = $\frac{\text{R-50 (tc)}}{\text{tc}}$

= $\frac{34.97}{0.1831}$

= **190.9519 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 190.9519 x 0.1794

= **8.1054 cum/sec**

**BR NO-110 IR KM 45.590 (Khurja-HafizPur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 8.1054 cum/sec

c Avg. Waterway Required = $\frac{Q}{V}$

= $\frac{8.1054}{1.75}$

= **4.6317 Sq.m**

d Proposed Opening = 1 3 2

e Height of Water = $\frac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\frac{4.6317}{3}$

= **1.5440 m**

f Avg. Bed Level = 206.206

h **Min. Formation Required** B.L + Ht of water + free Board

= 206.2060 +1.5440 +0.8560

= 208.6060

k **Formation level adopted** = 208.6060

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-111 IR KM 45.902 (Khurja-HafizPur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0369 | Sq Km |
| C | Length of Longest Stream | 0.265 | Km |
| D | Height Of farthest point | 210.134 | M |
| E | Height of Point of Interest | 207.044 | M |
| F | Height Diff of 10 & 11 | 3.09 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 207.044 | M |
| I | Observed HFL | 207.850 | M |

**BR NO-111 IR KM 45.902 (Khurja-HafizPur)**

**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

$tc = [L^3 / H]^{0.345}$

$= [0.265 \times 0.265 \times 0.265 / 3.09]^{0.345}$

= **0.1714 hr.**

= 0.1714 hr. x 60

= **10.2843 Min**

**BR NO-111 IR KM 45.902 (Khurja-HafizPur)**

**Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , C = 0.249(R x F) ^ 0.2**

R = 300.00 mm
F = 0.72
$C = 0.249 \times ( R \times F )^{0.2}$
= **0.8511**

**3 Calculation of Intensity of Rainfall ( I )**

a tc h Ratio = *0.1107* From Fig. 4 of RBF - 16

b 1h Ratio = = 0.34 From Fig. 4 of RBF - 16

c Coefficient K = $\frac{\text{tc h Ratio}}{\text{1h Ratio}}$

= $\frac{0.1107}{0.34}$

= **0.3256**

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 )

= 0.3256 x102.00

= **33.2108 mm**

iv Int. of rainfall (I) = $\frac{\text{R-50 (tc)}}{\text{tc}}$

= $\frac{33.21}{0.1714}$

= **193.7562 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 193.7562 x 0.0369

= **1.6916 cum/sec**

**BR NO-111 IR KM 45.902 (Khurja-HafizPur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.6916 cum/sec

c Avg. Waterway Required = $\frac{Q}{V}$

= $\frac{1.6916}{1.75}$

= **0.9666 Sq.m**

d Proposed Opening = 1 1.2 1.2

e Height of Water = $\frac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\frac{0.9666}{1.2}$

= **0.8060 m**

f Avg. Bed Level = 207.044

h **Min. Formation Required** B.L + Ht of water + free Board

= 207.0436 +0.8060 +0.7560

= 208.6056

k **Formation level adopted** = 208.6060

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-112 IR KM 46.118 (Khurja-HafizPur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0365 | Sq Km |
| C | Length of Longest Stream | 0.250 | Km |
| D | Height Of farthest point | 209.536 | M |
| E | Height of Point of Interest | 207.056 | M |
| F | Height Diff of 10 & 11 | 2.48 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 207.056 | M |
| I | Observed HFL | 207.850 | M |

**BR NO-112 IR KM 46.118 (Khurja-HafizPur)**

**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 = $[ L^3 / H ]^{0.345}$

= $[ 0.25 \times 0.25 \times 0.25 / 2.48 ]^{0.345}$

= **0.1741 hr.**

= 0.1741 hr. x 60

= **10.4456 Min**

**BR NO-112 IR KM 46.118 (Khurja-HafizPur)**

**Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , C = 0.249(R x F) ^ 0.2**

R = 300.00 mm
F = 0.72
$C = 0.249 \times ( R \times F )^{0.2}$
= **0.8511**

**3 Calculation of Intensity of Rainfall ( I )**

a tc h Ratio = *0.1120* From Fig. 4 of RBF - 16

b 1h Ratio = = 0.34 From Fig. 4 of RBF - 16

c Coefficient K = $\frac{\text{tc h Ratio}}{\text{1h Ratio}}$

= $\frac{0.1120}{0.34}$

= **0.3295**

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 )

= 0.3295 x102.00

= **33.6140 mm**

iv Int. of rainfall (I) = $\frac{\text{R-50 (tc)}}{\text{tc}}$

= $\frac{33.61}{0.1741}$

= **193.0804 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 193.0804 x 0.0365

= **1.6675 cum/sec**

**BR NO-112 IR KM 46.118 (Khurja-HafizPur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.6675 cum/sec

c Avg. Waterway Required = $\frac{Q}{V}$

= $\frac{1.6675}{1.75}$

= **0.9529 Sq.m**

d Proposed Opening = 1 1.2 1.2

e Height of Water = $\frac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\frac{0.9529}{1.2}$

= **0.7940 m**

f Avg. Bed Level = 207.056

h **Min. Formation Required** B.L + Ht of water + free Board

= 207.0560 +0.7940 +0.7560

= 208.6060

k **Formation level adopted** = 208.6060

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-113 IR KM 46.341 (Khurja-HafizPur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0404 | Sq Km |
| C | Length of Longest Stream | 0.220 | Km |
| D | Height Of farthest point | 209.830 | M |
| E | Height of Point of Interest | 206.910 | M |
| F | Height Diff of 10 & 11 | 2.92 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 206.910 | M |
| I | Observed HFL | 207.835 | M |

**BR NO-113 IR KM 46.341 (Khurja-HafizPur)**

**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

$tc = [ L^3 / H ]^{0.345}$

$= [ 0.22 \times 0.22 \times 0.22 / 2.92 ]^{0.345}$

= **0.1442 hr.**

= 0.1442 hr. x 60

= **8.6497 Min**

**BR NO-113 IR KM 46.341 (Khurja-HafizPur)**

**Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , C = 0.249(R x F) ^ 0.2**

R = 300.00 mm
F = 0.72
$C = 0.249 \times ( R \times F )^{0.2}$
= **0.8511**

**3 Calculation of Intensity of Rainfall ( I )**

a tc h Ratio = *0.0977* From Fig. 4 of RBF - 16

b 1h Ratio = = 0.34 From Fig. 4 of RBF - 16

c Coefficient K = $\frac{\text{tc h Ratio}}{\text{1h Ratio}}$

= $\frac{0.0977}{0.34}$

= **0.2872**

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 )

= 0.2872 x102.00

= **29.2994 mm**

iv Int. of rainfall (I) = $\frac{\text{R-50 (tc)}}{\text{tc}}$

= $\frac{29.30}{0.1442}$

= **203.2396 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 203.2396 x 0.0404

= **1.9427 cum/sec**

**BR NO-113 IR KM 46.341 (Khurja-HafizPur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.9427 cum/sec

c Avg. Waterway Required = $\frac{Q}{V}$

= $\frac{1.9427}{1.75}$

= **1.1101 Sq.m**

d Proposed Opening = 1 1.2 1.2

e Height of Water = $\frac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\frac{1.1101}{1.2}$

= **0.9250 m**

f Avg. Bed Level = 206.910

h **Min. Formation Required** B.L + Ht of water + free Board

= 206.9100 +0.9250 +0.7710

= 208.6060

k **Formation level adopted** = 208.6060

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-114 IR KM 46.676 (Khurja-HafizPur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0763 | Sq Km |
| C | Length of Longest Stream | 0.340 | Km |
| D | Height Of farthest point | 209.864 | M |
| E | Height of Point of Interest | 206.894 | M |
| F | Height Diff of 10 & 11 | 2.97 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 206.894 | M |
| I | Observed HFL | 207.840 | M |

**BR NO-114 IR KM 46.676 (Khurja-HafizPur)**

**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

$tc = [ L^3 / H ]^{0.345}$

$= [ 0.34 \times 0.34 \times 0.34 / 2.97 ]^{0.345}$

= **0.2249 hr.**

= 0.2249 hr. x 60

= **13.4937 Min**

**BR NO-114 IR KM 46.676 (Khurja-HafizPur)**

**Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , C = 0.249(R x F) ^ 0.2**

R = 300.00 mm
F = 0.72
$C = 0.249 \times ( R \times F )^{0.2}$
= **0.8511**

**3 Calculation of Intensity of Rainfall ( I )**

a tc h Ratio = *0.1374* From Fig. 4 of RBF - 16

b 1h Ratio = = 0.34 From Fig. 4 of RBF - 16

c Coefficient K = $\frac{\text{tc h Ratio}}{\text{1h Ratio}}$

= $\frac{0.1374}{0.34}$

= **0.4043**

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 )

= 0.4043 x102.00

= **41.2342 mm**

iv Int. of rainfall (I) = $\frac{\text{R-50 (tc)}}{\text{tc}}$

= $\frac{41.23}{0.2249}$

= **183.3487 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 183.3487 x 0.0763

= **3.3100 cum/sec**

**BR NO-114 IR KM 46.676 (Khurja-HafizPur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 3.3100 cum/sec

c Avg. Waterway Required = $\frac{Q}{V}$

= $\frac{3.3100}{1.75}$

= **1.8914 Sq.m**

d Proposed Opening = 1 2 1.2

e Height of Water = $\frac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\frac{1.8914}{2}$

= **0.9460 m**

f Avg. Bed Level = 206.894

h **Min. Formation Required** B.L + Ht of water + free Board

= 206.8940 +0.9460 +0.7660

= 208.6060

k **Formation level adopted** = 208.6060

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-115 IR KM 46.859 (Khurja-HafizPur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0337 | Sq Km |
| C | Length of Longest Stream | 0.215 | Km |
| D | Height Of farthest point | 209.878 | M |
| E | Height of Point of Interest | 207.148 | M |
| F | Height Diff of 10 & 11 | 2.73 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 207.148 | M |
| I | Observed HFL | 207.920 | M |

**BR NO-115 IR KM 46.859 (Khurja-HafizPur)**

**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

$tc = [L^3 / H]^{0.345}$

$= [0.215 \times 0.215 \times 0.215 / 2.73]^{0.345}$

= **0.1441 hr.**

= 0.1441 hr. x 60

= **8.6447 Min**

**BR NO-115 IR KM 46.859 (Khurja-HafizPur)**

**Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , C = 0.249(R x F) ^ 0.2**

R = 300.00 mm
F = 0.72
$C = 0.249 \times ( R \times F )^{0.2}$
= **0.8511**

**3 Calculation of Intensity of Rainfall ( I )**

a tc h Ratio = *0.0976* From Fig. 4 of RBF - 16

b 1h Ratio = = 0.34 From Fig. 4 of RBF - 16

c Coefficient K = $\frac{\text{tc h Ratio}}{\text{1h Ratio}}$

= $\frac{0.0976}{0.34}$

= **0.2872**

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 )

= 0.2872 x102.00

= **29.2894 mm**

iv Int. of rainfall (I) = $\frac{\text{R-50 (tc)}}{\text{tc}}$

= $\frac{29.29}{0.1441}$

= **203.2885 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 203.2885 x 0.0337

= **1.6209 cum/sec**

**BR NO-115 IR KM 46.859 (Khurja-HafizPur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.6209 cum/sec

c Avg. Waterway Required = $\frac{Q}{V}$

= $\frac{1.6209}{1.75}$

= **0.9262 Sq.m**

d Proposed Opening = 1 1.2 1.2

e Height of Water = $\frac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\frac{0.9262}{1.2}$

= **0.7720 m**

f Avg. Bed Level = 207.148

h **Min. Formation Required** B.L + Ht of water + free Board

= 207.1480 +0.7720 +0.7780

= 208.6980

k **Formation level adopted** = 208.6980

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-116 IR KM 47.236 (Khurja-HafizPur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0460 | Sq Km |
| C | Length of Longest Stream | 0.260 | Km |
| D | Height Of farthest point | 210.184 | M |
| E | Height of Point of Interest | 207.194 | M |
| F | Height Diff of 10 & 11 | 2.99 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 207.194 | M |
| I | Observed HFL | 208.200 | M |

**BR NO-116 IR KM 47.236 (Khurja-HafizPur)**

**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 = $[ L^3 / H ]^{0.345}$

= $[ 0.26 \times 0.26 \times 0.26 / 2.99 ]^{0.345}$

= **0.1700 hr.**

= 0.1700 hr. x 60

= **10.1986 Min**

**BR NO-116 IR KM 47.236 (Khurja-HafizPur)**

**Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , C = 0.249(R x F) ^ 0.2**

R = 300.00 mm
F = 0.72
$C = 0.249 \times ( R \times F )^{0.2}$
= **0.8511**

**3 Calculation of Intensity of Rainfall ( I )**

a tc h Ratio = *0.1100* From Fig. 4 of RBF - 16

b 1h Ratio = = 0.34 From Fig. 4 of RBF - 16

c Coefficient K = $\frac{\text{tc h Ratio}}{\text{1h Ratio}}$

= $\frac{0.1100}{0.34}$

= **0.3235**

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 )

= 0.3235 x102.00

= **32.9966 mm**

iv Int. of rainfall (I) = $\frac{\text{R-50 (tc)}}{\text{tc}}$

= $\frac{33.00}{0.1700}$

= **194.1236 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 194.1236 x 0.0460

= **2.1128 cum/sec**

**BR NO-116 IR KM 47.236 (Khurja-HafizPur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 2.1128 cum/sec

c Avg. Waterway Required = $\frac{Q}{V}$

= $\frac{2.1128}{1.75}$

= **1.2073 Sq.m**

d Proposed Opening = 1 1.2 1.2

e Height of Water = $\frac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\frac{1.2073}{1.2}$

= **1.0060 m**

f Avg. Bed Level = 207.194

h **Min. Formation Required** B.L + Ht of water + free Board

= 207.1937 +1.0060 +0.8180

= 209.0177

k **Formation level adopted** = 209.0180

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-117 IR KM 47.581 (Khurja-HafizPur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0366 | Sq Km |
| C | Length of Longest Stream | 0.350 | Km |
| D | Height Of farthest point | 210.520 | M |
| E | Height of Point of Interest | 207.700 | M |
| F | Height Diff of 10 & 11 | 2.82 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 207.700 | M |
| I | Observed HFL | 208.450 | M |

**BR NO-117 IR KM 47.581 (Khurja-HafizPur)**

**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 = $[ L^3 / H ]^{0.345}$

= $[ 0.35 \times 0.35 \times 0.35 / 2.82 ]^{0.345}$

= **0.2359 hr.**

= 0.2359 hr. x 60

= **14.1555 Min**

**BR NO-117 IR KM 47.581 (Khurja-HafizPur)**

**Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , C = 0.249(R x F) ^ 0.2**

R = 300.00 mm
F = 0.72
$C = 0.249 \times ( R \times F )^{0.2}$
= **0.8511**

**3 Calculation of Intensity of Rainfall ( I )**

a tc h Ratio = *0.1430* From Fig. 4 of RBF - 16

b 1h Ratio = = 0.34 From Fig. 4 of RBF - 16

c Coefficient K = $\frac{\text{tc h Ratio}}{\text{1h Ratio}}$

= $\frac{0.1430}{0.34}$

= **0.4205**

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 )

= 0.4205 x102.00

= **42.8888 mm**

iv Int. of rainfall (I) = $\frac{\text{R-50 (tc)}}{\text{tc}}$

= $\frac{42.89}{0.2359}$

= **181.7898 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 181.7898 x 0.0366

= **1.5743 cum/sec**

**BR NO-117 IR KM 47.581 (Khurja-HafizPur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.5743 cum/sec

c Avg. Waterway Required = $\frac{Q}{V}$

= $\frac{1.5743}{1.75}$

= **0.8996 Sq.m**

d Proposed Opening = 1 1.2 1.2

e Height of Water = $\frac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\frac{0.8996}{1.2}$

= **0.7500 m**

f Avg. Bed Level = 207.700

h **Min. Formation Required** B.L + Ht of water + free Board

= 207.7000 +0.7500 +0.8510

= 209.3010

k **Formation level adopted** = 209.3010

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-118 IR KM 47.694 (Khurja-HafizPur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0371 | Sq Km |
| C | Length of Longest Stream | 0.400 | Km |
| D | Height Of farthest point | 210.985 | M |
| E | Height of Point of Interest | 207.845 | M |
| F | Height Diff of 10 & 11 | 3.14 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 207.845 | M |
| I | Observed HFL | 208.587 | M |

**BR NO-118 IR KM 47.694 (Khurja-HafizPur)**

**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 = $[ L^3 / H ]^{0.345}$

= $[ 0.4 \times 0.4 \times 0.4 / 3.14 ]^{0.345}$

= **0.2610 hr.**

= 0.2610 hr. x 60

= **15.6618 Min**

**BR NO-118 IR KM 47.694 (Khurja-HafizPur)**

**Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , C = 0.249(R x F) ^ 0.2**

R = 300.00 mm
F = 0.72
$C = 0.249 \times ( R \times F )^{0.2}$
= **0.8511**

**3 Calculation of Intensity of Rainfall ( I )**

a tc h Ratio = *0.1544* From Fig. 4 of RBF - 16

b 1h Ratio = = 0.34 From Fig. 4 of RBF - 16

c Coefficient K = $\frac{\text{tc h Ratio}}{\text{1h Ratio}}$

= $\frac{0.1544}{0.34}$

= **0.4542**

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 )

= 0.4542 x102.00

= **46.3237 mm**

iv Int. of rainfall (I) = $\frac{\text{R-50 (tc)}}{\text{tc}}$

= $\frac{46.32}{0.2610}$

= **177.4647 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 177.4647 x 0.0371

= **1.5578 cum/sec**

**BR NO-118 IR KM 47.694 (Khurja-HafizPur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.5578 cum/sec

c Avg. Waterway Required = $\frac{Q}{V}$

= $\frac{1.5578}{1.75}$

= **0.8902 Sq.m**

d Proposed Opening = 1 1.2 1.2

e Height of Water = $\frac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\frac{0.8902}{1.2}$

= **0.7420 m**

f Avg. Bed Level = 207.845

h **Min. Formation Required** B.L + Ht of water + free Board

= 207.8450 +0.7420 +0.8080

= 209.3950

k **Formation level adopted** = 209.3950

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-119 IR KM 47.914 (Khurja-HafizPur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0363 | Sq Km |
| C | Length of Longest Stream | 0.325 | Km |
| D | Height Of farthest point | 211.309 | M |
| E | Height of Point of Interest | 208.029 | M |
| F | Height Diff of 10 & 11 | 3.28 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 208.029 | M |
| I | Observed HFL | 208.790 | M |

**BR NO-119 IR KM 47.914 (Khurja-HafizPur)**

**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

$tc = [L^3 / H]^{0.345}$

$= [0.325 \times 0.325 \times 0.325 / 3.28]^{0.345}$

= **0.2074 hr.**

= 0.2074 hr. x 60

= **12.4444 Min**

**BR NO-119 IR KM 47.914 (Khurja-HafizPur)**

**Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , C = 0.249(R x F) ^ 0.2**

R = 300.00 mm
F = 0.72
$C = 0.249 \times ( R \times F )^{0.2}$
= **0.8511**

**3 Calculation of Intensity of Rainfall ( I )**

a tc h Ratio = *0.1287* From Fig. 4 of RBF - 16

b 1h Ratio = = 0.34 From Fig. 4 of RBF - 16

c Coefficient K = $\frac{\text{tc h Ratio}}{\text{1h Ratio}}$

= $\frac{0.1287}{0.34}$

= **0.3785**

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 )

= 0.3785 x102.00

= **38.6110 mm**

iv Int. of rainfall (I) = $\frac{\text{R-50 (tc)}}{\text{tc}}$

= $\frac{38.61}{0.2074}$

= **186.1608 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 186.1608 x 0.0363

= **1.5989 cum/sec**

**BR NO-119 IR KM 47.914 (Khurja-HafizPur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.5989 cum/sec

c Avg. Waterway Required = $\frac{Q}{V}$

= $\frac{1.5989}{1.75}$

= **0.9137 Sq.m**

d Proposed Opening = 1 1.2 1.2

e Height of Water = $\frac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\frac{0.9137}{1.2}$

= **0.7610 m**

f Avg. Bed Level = 208.029

h **Min. Formation Required** B.L + Ht of water + free Board

= 208.0290 +0.7610 +0.7890

= 209.5790

k **Formation level adopted** = 209.5790

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-120 IR KM 48.404 (Khurja-HafizPur)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0807 | Sq Km |
| C | Length of Longest Stream | 0.350 | Km |
| D | Height Of farthest point | 209.850 | M |
| E | Height of Point of Interest | 207.100 | M |
| F | Height Diff of 10 & 11 | 2.75 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 207.100 | M |
| I | Observed HFL | 208.750 | M |

**BR NO-120 IR KM 48.404 (Khurja-HafizPur)**

**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 = $[ L^3 / H ]^{0.345}$

= $[ 0.35 \times 0.35 \times 0.35 / 2.75 ]^{0.345}$

= **0.2380 hr.**

= 0.2380 hr. x 60

= **14.2788 Min**

**BR NO-120 IR KM 48.404 (Khurja-HafizPur)**

**Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , C = 0.249(R x F) ^ 0.2**

R = 300.00 mm
F = 0.72
C = 0.249 x ( R x F ) $^{0.2}$
= **0.8511**

**3 Calculation of Intensity of Rainfall ( I )**

a tc h Ratio = *0.1440* From Fig. 4 of RBF - 16

b 1h Ratio = = 0.34 From Fig. 4 of RBF - 16

c Coefficient K = $\frac{\text{tc h Ratio}}{\text{1h Ratio}}$

= $\frac{0.1440}{0.34}$

= **0.4235**

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 )

= 0.4235 x102.00

= **43.1970 mm**

iv Int. of rainfall (I) = $\frac{\text{R-50 (tc)}}{\text{tc}}$

= $\frac{43.20}{0.2380}$

= **181.5152 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 181.5152 x 0.0807

= **3.4659 cum/sec**

**BR NO-120 IR KM 48.404 (Khurja-HafizPur)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 3.4659 cum/sec

c Avg. Waterway Required = $\frac{Q}{V}$

= $\frac{3.4659}{1.75}$

= **1.9805 Sq.m**

d Proposed Opening = 1 1.2 2

e Height of Water = $\frac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\frac{1.9805}{1.2}$

= **1.6500 m**

f Avg. Bed Level = 207.100

h **Min. Formation Required** B.L + Ht of water + free Board

= 207.1000 +1.6500 +1.2370

= 209.9870

k **Formation level adopted** = 209.9870

**Provided formation Level is O.K.**

# MEERUT – SAHARANPUR SECTION

**Dedicated freight corridor Corporation of India.**

**BR NO-134 IR KM 86.926 (MTC-SRE)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0389 | Sq Km |
| C | Length of Longest Stream | 0.415 | Km |
| D | Height Of farthest point | 233.252 | M |
| E | Height of Point of Interest | 230.322 | M |
| F | Height Diff of 10 & 11 | 2.93 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 230.322 | M |
| I | Observed HFL | 231.085 | M |

**BR NO-134 IR KM 86.926 (MTC-SRE)**

**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

$tc = [L^3 / H]^{0.345}$

$= [0.415 \times 0.415 \times 0.415 / 2.93]^{0.345}$

= **0.2777 hr.**

= 0.2777 hr. x 60

= **16.6633 Min**

**BR NO-134 IR KM 86.926 (MTC-SRE)**

**Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , C = 0.249(R x F) ^ 0.2**

R = 300.00 mm

F = 0.72

$C = 0.249 \times ( R \times F )^{0.2}$

= **0.8511**

**3 Calculation of Intensity of Rainfall ( I )**

a tc h Ratio = *0.1611* From Fig. 4 of RBF - 16

b 1h Ratio = = 0.34 From Fig. 4 of RBF - 16

c Coefficient K = $\frac{\text{tc h Ratio}}{\text{1h Ratio}}$

= $\frac{0.1611}{0.34}$

= **0.4738**

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 )

= 0.4738 x102.00

= **48.3267 mm**

iv Int. of rainfall (I) = $\frac{\text{R-50 (tc)}}{\text{tc}}$

= $\frac{48.33}{0.2777}$

= **174.0110 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 174.0110 x 0.0389

= **1.6016 cum/sec**

**BR NO-134 IR KM 86.926 (MTC-SRE)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.6016 cum/sec

c Avg. Waterway Required = $\frac{Q}{V}$

= $\frac{1.6016}{1.75}$

= **0.9152 Sq.m**

d Proposed Opening = 1 1.2 1.2

e Height of Water = $\frac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\frac{0.9152}{1.2}$

= **0.7630 m**

f Avg. Bed Level = 230.322

h **Min. Formation Required** B.L + Ht of water + free Board

= 230.3220 +0.7630 +0.7870

= 231.8720

k **Formation level adopted** = 231.8720

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-135 IR KM 88.604 (MTC-SRE)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0762 | Sq Km |
| C | Length of Longest Stream | 0.350 | Km |
| D | Height Of farthest point | 232.984 | M |
| E | Height of Point of Interest | 229.814 | M |
| F | Height Diff of 10 & 11 | 3.17 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 229.814 | M |
| I | Observed HFL | 230.600 | M |

**BR NO-135 IR KM 88.604 (MTC-SRE)**

**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

$tc = [L^3 / H]^{0.345}$

$= [0.35 \times 0.35 \times 0.35 / 3.17]^{0.345}$

= **0.2266 hr.**

= 0.2266 hr. x 60

= **13.5955 Min**

**BR NO-135 IR KM 88.604 (MTC-SRE)**

**Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , C = 0.249(R x F) ^ 0.2**

R = 300.00 mm
F = 0.72
$C = 0.249 \times ( R \times F )^{0.2}$
= **0.8511**

**3 Calculation of Intensity of Rainfall ( I )**

a tc h Ratio = *0.1383* From Fig. 4 of RBF - 16

b 1h Ratio = = 0.34 From Fig. 4 of RBF - 16

c Coefficient K = $\frac{\text{tc h Ratio}}{\text{1h Ratio}}$

= $\frac{0.1383}{0.34}$

= **0.4068**

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 )

= 0.4068 x102.00

= **41.4888 mm**

iv Int. of rainfall (I) = $\frac{\text{R-50 (tc)}}{\text{tc}}$

= $\frac{41.49}{0.2266}$

= **183.0990 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 183.0990 x 0.0762

= **3.3012 cum/sec**

**BR NO-135 IR KM 88.604 (MTC-SRE)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 3.3012 cum/sec

c Avg. Waterway Required = $\frac{Q}{V}$

= $\frac{3.3012}{1.75}$

= **1.8864 Sq.m**

d Proposed Opening = 2 1.2 1.2

e Height of Water = $\frac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\frac{1.8864}{2.4}$

= **0.7860 m**

f Avg. Bed Level = 229.814

h **Min. Formation Required** B.L + Ht of water + free Board

= 229.8140 +0.7860 +0.7640

= 231.3640

k **Formation level adopted** = 231.3640

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-136 IR KM 89.534 (MTC-SRE)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0424 | Sq Km |
| C | Length of Longest Stream | 0.500 | Km |
| D | Height Of farthest point | 233.471 | M |
| E | Height of Point of Interest | 230.451 | M |
| F | Height Diff of 10 & 11 | 3.02 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 230.451 | M |
| I | Observed HFL | 231.225 | M |

**BR NO-136 IR KM 89.534 (MTC-SRE)**

**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 = $[ L^3 / H ]^{0.345}$

= $[ 0.5 \times 0.5 \times 0.5 / 3.02 ]^{0.345}$

= **0.3333 hr.**

= 0.3333 hr. x 60

= **19.9978 Min**

**BR NO-136 IR KM 89.534 (MTC-SRE)**

**Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , C = 0.249(R x F) ^ 0.2**

R = 300.00 mm
F = 0.72
$C = 0.249 \times ( R \times F )^{0.2}$
= **0.8511**

**3 Calculation of Intensity of Rainfall ( I )**

a tc h Ratio = *0.1800* From Fig. 4 of RBF - 16

b 1h Ratio = = 0.34 From Fig. 4 of RBF - 16

c Coefficient K = $\frac{\text{tc h Ratio}}{\text{1h Ratio}}$

= $\frac{0.1800}{0.34}$

= **0.5294**

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 )

= 0.5294 x102.00

= **53.9967 mm**

iv Int. of rainfall (I) = $\frac{\text{R-50 (tc)}}{\text{tc}}$

= $\frac{54.00}{0.3333}$

= **162.0077 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 162.0077 x 0.0424

= **1.6253 cum/sec**

**BR NO-136 IR KM 89.534 (MTC-SRE)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.6253 cum/sec

c Avg. Waterway Required = $\frac{Q}{V}$

= $\frac{1.6253}{1.75}$

= **0.9287 Sq.m**

d Proposed Opening = 1 1.2 1.2

e Height of Water = $\frac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\frac{0.9287}{1.2}$

= **0.7740 m**

f Avg. Bed Level = 230.451

h **Min. Formation Required** B.L + Ht of water + free Board

= 230.4510 +0.7740 +0.7760

= 232.0010

k **Formation level adopted** = 232.0010

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-137 IR KM 90.429 (MTC-SRE)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0384 | Sq Km |
| C | Length of Longest Stream | 0.425 | Km |
| D | Height Of farthest point | 232.054 | M |
| E | Height of Point of Interest | 229.174 | M |
| F | Height Diff of 10 & 11 | 2.88 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 229.174 | M |
| I | Observed HFL | 229.920 | M |

**BR NO-137 IR KM 90.429 (MTC-SRE)**

**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

$tc = [L^3 / H]^{0.345}$

$= [0.425 \times 0.425 \times 0.425 / 2.88]^{0.345}$

= **0.2863 hr.**

= 0.2863 hr. x 60

= **17.1808 Min**

**BR NO-137 IR KM 90.429 (MTC-SRE)**

**Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , C = 0.249(R x F) ^ 0.2**

R = 300.00 mm

F = 0.72

$C = 0.249 \times ( R \times F )^{0.2}$

= **0.8511**

**3 Calculation of Intensity of Rainfall ( I )**

a tc h Ratio = *0.1645* From Fig. 4 of RBF - 16

b 1h Ratio = = 0.34 From Fig. 4 of RBF - 16

c Coefficient K = $\frac{\text{tc h Ratio}}{\text{1h Ratio}}$

= $\frac{0.1645}{0.34}$

= **0.4839**

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 )

= 0.4839 x102.00

= **49.3616 mm**

iv Int. of rainfall (I) = $\frac{\text{R-50 (tc)}}{\text{tc}}$

= $\frac{49.36}{0.2863}$

= **172.3841 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 172.3841 x 0.0384

= **1.5662 cum/sec**

**BR NO-137 IR KM 90.429 (MTC-SRE)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.5662 cum/sec

c Avg. Waterway Required = $\frac{Q}{V}$

= $\frac{1.5662}{1.75}$

= **0.8950 Sq.m**

d Proposed Opening = 1 1.2 1.2

e Height of Water = $\frac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\frac{0.8950}{1.2}$

= **0.7460 m**

f Avg. Bed Level = 229.174

h **Min. Formation Required** B.L + Ht of water + free Board

= 229.1740 +0.7460 +0.8040

= 230.7240

k **Formation level adopted** = 230.7240

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-140 IR KM 91.848 (MTC-SRE)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0381 | Sq Km |
| C | Length of Longest Stream | 0.375 | Km |
| D | Height Of farthest point | 233.667 | M |
| E | Height of Point of Interest | 231.047 | M |
| F | Height Diff of 10 & 11 | 2.62 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 231.047 | M |
| I | Observed HFL | 231.810 | M |

**BR NO-140 IR KM 91.848 (MTC-SRE)**

**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

$tc = [L^3 / H]^{0.345}$

$= [0.375 \times 0.375 \times 0.375 / 2.62]^{0.345}$

= **0.2599 hr.**

= 0.2599 hr. x 60

= **15.5941 Min**

**BR NO-140 IR KM 91.848 (MTC-SRE)**

**Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , C = 0.249(R x F) ^ 0.2**

R = 300.00 mm

F = 0.72

$C = 0.249 \times ( R \times F )^{0.2}$

= **0.8511**

**3 Calculation of Intensity of Rainfall ( I )**

a tc h Ratio = *0.1540* From Fig. 4 of RBF - 16

b 1h Ratio = = 0.34 From Fig. 4 of RBF - 16

c Coefficient K = $\frac{\text{tc h Ratio}}{\text{1h Ratio}}$

= $\frac{0.1540}{0.34}$

= **0.4528**

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 )

= 0.4528 x102.00

= **46.1882 mm**

iv Int. of rainfall (I) = $\frac{\text{R-50 (tc)}}{\text{tc}}$

= $\frac{46.19}{0.2599}$

= **177.7144 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 177.7144 x 0.0381

= **1.6020 cum/sec**

**BR NO-140 IR KM 91.848 (MTC-SRE)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.6020 cum/sec

c Avg. Waterway Required = $\frac{Q}{V}$

= $\frac{1.6020}{1.75}$

= **0.9154 Sq.m**

d Proposed Opening = 1 1.2 1.2

e Height of Water = $\frac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\frac{0.9154}{1.2}$

= **0.7630 m**

f Avg. Bed Level = 231.047

h **Min. Formation Required** B.L + Ht of water + free Board

= 231.0470 +0.7630 +0.7870

= 232.5970

k **Formation level adopted** = 232.5970

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-141 IR KM 92.241(MTC-SRE)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0369 | Sq Km |
| C | Length of Longest Stream | 0.360 | Km |
| D | Height Of farthest point | 234.237 | M |
| E | Height of Point of Interest | 231.367 | M |
| F | Height Diff of 10 & 11 | 2.87 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 231.367 | M |
| I | Observed HFL | 232.120 | M |

**BR NO-141 IR KM 92.241(MTC-SRE)**

**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

$tc = [L^3 / H]^{0.345}$

$= [0.36 \times 0.36 \times 0.36 / 2.87]^{0.345}$

= **0.2414 hr.**

= 0.2414 hr. x 60

= **14.4862 Min**

**BR NO-141 IR KM 92.241(MTC-SRE)**

**Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , C = 0.249(R x F) ^ 0.2**

R = 300.00 mm

F = 0.72

$C = 0.249 \times ( R \times F )^{0.2}$

= **0.8511**

**3 Calculation of Intensity of Rainfall ( I )**

a tc h Ratio = *0.1457* From Fig. 4 of RBF - 16

b 1h Ratio = = 0.34 From Fig. 4 of RBF - 16

c Coefficient K = $\frac{\text{tc h Ratio}}{\text{1h Ratio}}$

= $\frac{0.1457}{0.34}$

= **0.4286**

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 )

= 0.4286 x102.00

= **43.7156 mm**

iv Int. of rainfall (I) = $\frac{\text{R-50 (tc)}}{\text{tc}}$

= $\frac{43.72}{0.2414}$

= **181.0642 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 181.0642 x 0.0369

= **1.5808 cum/sec**

**BR NO-141 IR KM 92.241(MTC-SRE)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.5808 cum/sec

c Avg. Waterway Required = $\frac{Q}{V}$

= $\frac{1.5808}{1.75}$

= **0.9033 Sq.m**

d Proposed Opening = 1 1.2 1.2

e Height of Water = $\frac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\frac{0.9033}{1.2}$

= **0.7530 m**

f Avg. Bed Level = 231.367

h **Min. Formation Required** B.L + Ht of water + free Board

= 231.3670 +0.7530 +0.7970

= 232.9170

k **Formation level adopted** = 232.9170

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-142 IR KM 92.502 (MTC-SRE)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0421 | Sq Km |
| C | Length of Longest Stream | 0.510 | Km |
| D | Height Of farthest point | 235.448 | M |
| E | Height of Point of Interest | 232.678 | M |
| F | Height Diff of 10 & 11 | 2.77 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 232.678 | M |
| I | Observed HFL | 233.430 | M |

**BR NO-142 IR KM 92.502 (MTC-SRE)**

**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 = $[ L^3 / H ]^{0.345}$

= $[ 0.51 \times 0.51 \times 0.51 / 2.77 ]^{0.345}$

= **0.3505 hr.**

= 0.3505 hr. x 60

= **21.0296 Min**

**BR NO-142 IR KM 92.502 (MTC-SRE)**

**Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , C = 0.249(R x F) ^ 0.2**

R = 300.00 mm
F = 0.72
C = 0.249 x ( R x F ) $^{0.2}$
= **0.8511**

**3 Calculation of Intensity of Rainfall ( I )**

a tc h Ratio = *0.1851* From Fig. 4 of RBF - 16

b 1h Ratio = = 0.34 From Fig. 4 of RBF - 16

c Coefficient K = $\frac{\text{tc h Ratio}}{\text{1h Ratio}}$

= $\frac{0.1851}{0.34}$

= **0.5446**

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 )

= 0.5446 x102.00

= **55.5444 mm**

iv Int. of rainfall (I) = $\frac{\text{R-50 (tc)}}{\text{tc}}$

= $\frac{55.54}{0.3505}$

= **158.4750 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 158.4750 x 0.0421

= **1.5786 cum/sec**

**BR NO-142 IR KM 92.502 (MTC-SRE)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.5786 cum/sec

c Avg. Waterway Required = $\frac{Q}{V}$

= $\frac{1.5786}{1.75}$

= **0.9021 Sq.m**

d Proposed Opening = 1 1.2 1.2

e Height of Water = $\frac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\frac{0.9021}{1.2}$

= **0.7520 m**

f Avg. Bed Level = 232.678

h **Min. Formation Required** B.L + Ht of water + free Board

= 232.6780 +0.7520 +0.7980

= 234.2280

k **Formation level adopted** = 234.2280

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-143 IR KM 92.7 (MTC-SRE)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0377 | Sq Km |
| C | Length of Longest Stream | 0.435 | Km |
| D | Height Of farthest point | 235.580 | M |
| E | Height of Point of Interest | 232.580 | M |
| F | Height Diff of 10 & 11 | 3.00 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 232.580 | M |
| I | Observed HFL | 233.310 | M |

**BR NO-143 IR KM 92.7 (MTC-SRE)**

**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 = $[ L^3 / H ]^{0.345}$

= $[ 0.435 \times 0.435 \times 0.435 / 3.00 ]^{0.345}$

= **0.2892 hr.**

= 0.2892 hr. x 60

= **17.3532 Min**

**BR NO-143 IR KM 92.7 (MTC-SRE)**

**Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , C = 0.249(R x F) ^ 0.2**

R = 300.00 mm
F = 0.72
$C = 0.249 \times ( R \times F )^{0.2}$
= **0.8511**

**3 Calculation of Intensity of Rainfall ( I )**

a tc h Ratio = *0.1657* From Fig. 4 of RBF - 16

b 1h Ratio = = 0.34 From Fig. 4 of RBF - 16

c Coefficient K = $\frac{\text{tc h Ratio}}{\text{1h Ratio}}$

= $\frac{0.1657}{0.34}$

= **0.4873**

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 )

= 0.4873 x102.00

= **49.7065 mm**

iv Int. of rainfall (I) = $\frac{\text{R-50 (tc)}}{\text{tc}}$

= $\frac{49.71}{0.2892}$

= **171.8635 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 171.8635 x 0.0377

= **1.5330 cum/sec**

**BR NO-143 IR KM 92.7 (MTC-SRE)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.5330 cum/sec

c Avg. Waterway Required = $\frac{Q}{V}$

= $\frac{1.5330}{1.75}$

= **0.8760 Sq.m**

d Proposed Opening = 1 1.2 1.2

e Height of Water = $\frac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\frac{0.8760}{1.2}$

= **0.7300 m**

f Avg. Bed Level = 232.580

h **Min. Formation Required** B.L + Ht of water + free Board

= 232.5800 +0.7300 +0.8200

= 234.1300

k **Formation level adopted** = 234.1300

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-144 IR KM 94.585 (MTC-SRE)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.1291 | Sq Km |
| C | Length of Longest Stream | 0.600 | Km |
| D | Height Of farthest point | 236.363 | M |
| E | Height of Point of Interest | 232.913 | M |
| F | Height Diff of 10 & 11 | 3.45 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 232.913 | M |
| I | Observed HFL | 233.800 | M |

**BR NO-144 IR KM 94.585 (MTC-SRE)**

**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 = $[ L^3 / H ]^{0.345}$

= $[ 0.6 \times 0.6 \times 0.6 / 3.45 ]^{0.345}$

= **0.3844 hr.**

= 0.3844 hr. x 60

= **23.0670 Min**

**BR NO-144 IR KM 94.585 (MTC-SRE)**

**Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , C = 0.249(R x F) ^ 0.2**

R = 300.00 mm
F = 0.72
$C = 0.249 \times ( R \times F )^{0.2}$
= **0.8511**

**3 Calculation of Intensity of Rainfall ( I )**

a tc h Ratio = *0.1953* From Fig. 4 of RBF - 16

b 1h Ratio = = 0.34 From Fig. 4 of RBF - 16

c Coefficient K = $\frac{\text{tc h Ratio}}{\text{1h Ratio}}$

= $\frac{0.1953}{0.34}$

= **0.5745**

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 )

= 0.5745 x102.00

= **58.6004 mm**

iv Int. of rainfall (I) = $\frac{\text{R-50 (tc)}}{\text{tc}}$

= $\frac{58.60}{0.3844}$

= **152.4269 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 152.4269 x 0.1291

= **4.6560 cum/sec**

**BR NO-144 IR KM 94.585 (MTC-SRE)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 4.6560 cum/sec

c Avg. Waterway Required = $\frac{Q}{V}$

= $\frac{4.6560}{1.75}$

= **2.6606 Sq.m**

d Proposed Opening = 1 3 1.2

e Height of Water = $\frac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\frac{2.6606}{3}$

= **0.8870 m**

f Avg. Bed Level = 232.913

h **Min. Formation Required** B.L + Ht of water + free Board

= 232.9130 +0.8870 +0.7630

= 234.5630

k **Formation level adopted** = 234.5630

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-145 IR KM 95.153 (MTC-SRE)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.4146 | Sq Km |
| C | Length of Longest Stream | 0.800 | Km |
| D | Height Of farthest point | 235.863 | M |
| E | Height of Point of Interest | 231.683 | M |
| F | Height Diff of 10 & 11 | 4.18 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 231.683 | M |
| I | Observed HFL | 234.250 | M |

**BR NO-145 IR KM 95.153 (MTC-SRE)**

**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 = $[ L^3 / H ]^{0.345}$

= $[ 0.8 \times 0.8 \times 0.8 / 4.18 ]^{0.345}$

= **0.4846 hr.**

= 0.4846 hr. x 60

= **29.0766 Min**

**BR NO-145 IR KM 95.153 (MTC-SRE)**

**Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , C = 0.249(R x F) ^ 0.2**

R = 300.00 mm
F = 0.72
$C = 0.249 \times ( R \times F )^{0.2}$
= **0.8511**

**3 Calculation of Intensity of Rainfall ( I )**

a tc h Ratio = *0.2219* From Fig. 4 of RBF - 16

b 1h Ratio = = 0.34 From Fig. 4 of RBF - 16

c Coefficient K = $\frac{\text{tc h Ratio}}{\text{1h Ratio}}$

= $\frac{0.2219}{0.34}$

= **0.6527**

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 )

= 0.6527 x102.00

= **66.5766 mm**

iv Int. of rainfall (I) = $\frac{\text{R-50 (tc)}}{\text{tc}}$

= $\frac{66.58}{0.4846}$

= **137.3818 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 137.3818 x 0.4146

= **13.4767 cum/sec**

**BR NO-145 IR KM 95.153 (MTC-SRE)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 13.4767 cum/sec

c Avg. Waterway Required = $\frac{Q}{V}$

= $\frac{13.4767}{1.75}$

= **7.7010 Sq.m**

d Proposed Opening = 1 3 3

e Height of Water = $\frac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\frac{7.7010}{3}$

= **2.5670 m**

f Avg. Bed Level = 231.683

h **Min. Formation Required** B.L + Ht of water + free Board

= 231.6830 +2.5670 +0.7830

= 235.0330

k **Formation level adopted** = 235.0330

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-146 IR KM 95.892 (MTC-SRE)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.1179 | Sq Km |
| C | Length of Longest Stream | 0.420 | Km |
| D | Height Of farthest point | 237.596 | M |
| E | Height of Point of Interest | 234.096 | M |
| F | Height Diff of 10 & 11 | 3.50 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 234.096 | M |
| I | Observed HFL | 234.800 | M |

**BR NO-146 IR KM 95.892 (MTC-SRE)**

**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

$tc = [ L^3 / H ]^{0.345}$

$= [ 0.42 \times 0.42 \times 0.42 / 3.50 ]^{0.345}$

= **0.2645 hr.**

= 0.2645 hr. x 60

= **15.8676 Min**

**BR NO-146 IR KM 95.892 (MTC-SRE)**

**Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , C = 0.249(R x F) ^ 0.2**

R = 300.00 mm

F = 0.72

$C = 0.249 \times ( R \times F )^{0.2}$

= **0.8511**

**3 Calculation of Intensity of Rainfall ( I )**

a tc h Ratio = *0.1558* From Fig. 4 of RBF - 16

b 1h Ratio = = 0.34 From Fig. 4 of RBF - 16

c Coefficient K = $\frac{\text{tc h Ratio}}{\text{1h Ratio}}$

= $\frac{0.1558}{0.34}$

= **0.4582**

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 )

= 0.4582 x102.00

= **46.7352 mm**

iv Int. of rainfall (I) = $\frac{\text{R-50 (tc)}}{\text{tc}}$

= $\frac{46.74}{0.2645}$

= **176.7195 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 176.7195 x 0.1179

= **4.9297 cum/sec**

**BR NO-146 IR KM 95.892 (MTC-SRE)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 4.9297 cum/sec

c Avg. Waterway Required = $\frac{Q}{V}$

= $\frac{4.9297}{1.75}$

= **2.8170 Sq.m**

d Proposed Opening = 2 2 1.2

e Height of Water = $\frac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\frac{2.8170}{4}$

= **0.7040 m**

f Avg. Bed Level = 234.096

h **Min. Formation Required** B.L + Ht of water + free Board

= 234.0960 +0.7040 +0.8460

= 235.6460

k **Formation level adopted** = 235.6460

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-148 IR KM 96.946 (MTC-SRE)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0430 | Sq Km |
| C | Length of Longest Stream | 0.515 | Km |
| D | Height Of farthest point | 236.692 | M |
| E | Height of Point of Interest | 233.842 | M |
| F | Height Diff of 10 & 11 | 2.85 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 233.842 | M |
| I | Observed HFL | 234.610 | M |

**BR NO-148 IR KM 96.946 (MTC-SRE)**

**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

$tc = [L^3 / H]^{0.345}$

$= [0.515 \times 0.515 \times 0.515 / 2.85]^{0.345}$

= **0.3506 hr.**

= 0.3506 hr. x 60

= **21.0354 Min**

**BR NO-148 IR KM 96.946 (MTC-SRE)**

**Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , C = 0.249(R x F) ^ 0.2**

R = 300.00 mm

F = 0.72

$C = 0.249 \times ( R \times F )^{0.2}$

= **0.8511**

**3 Calculation of Intensity of Rainfall ( I )**

a tc h Ratio = *0.1852* From Fig. 4 of RBF - 16

b 1h Ratio = = 0.34 From Fig. 4 of RBF - 16

c Coefficient K = $\frac{\text{tc h Ratio}}{\text{1h Ratio}}$

= $\frac{0.1852}{0.34}$

= **0.5446**

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 )

= 0.5446 x102.00

= **55.5531 mm**

iv Int. of rainfall (I) = $\frac{\text{R-50 (tc)}}{\text{tc}}$

= $\frac{55.55}{0.3506}$

= **158.4562 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 158.4562 x 0.0430

= **1.6121 cum/sec**

**BR NO-148 IR KM 96.946 (MTC-SRE)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.6121 cum/sec

c Avg. Waterway Required = $\frac{Q}{V}$

= $\frac{1.6121}{1.75}$

= **0.9212 Sq.m**

d Proposed Opening = 1 1.2 1.2

e Height of Water = $\frac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\frac{0.9212}{1.2}$

= **0.7680 m**

f Avg. Bed Level = 233.842

h **Min. Formation Required** B.L + Ht of water + free Board

= 233.8420 +0.7680 +0.7820

= 235.3920

k **Formation level adopted** = 235.3920

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-149 IR KM (MTC-SRE)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0543 | Sq Km |
| C | Length of Longest Stream | 0.955 | Km |
| D | Height Of farthest point | 236.731 | M |
| E | Height of Point of Interest | 234.031 | M |
| F | Height Diff of 10 & 11 | 2.70 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 234.031 | M |
| I | Observed HFL | 234.800 | M |

**BR NO-149 IR KM (MTC-SRE)**

**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 = $[ L^3 / H ]^{0.345}$

= $[ 0.955 \times 0.955 \times 0.955 / 2.70 ]^{0.345}$

= **0.6768 hr.**

= 0.6768 hr. x 60

= **40.6101 Min**

**BR NO-149 IR KM (MTC-SRE)**

**Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , C = 0.249(R x F) ^ 0.2**

R = 300.00 mm
F = 0.81
C = 0.249 x ( R x F ) $^{0.2}$
= **0.8922**

**3 Calculation of Intensity of Rainfall ( I )**

a tc h Ratio = *0.2704* From Fig. 4 of RBF - 16

b 1h Ratio = = 0.34 From Fig. 4 of RBF - 16

c Coefficient K = $\frac{\text{tc h Ratio}}{\text{1h Ratio}}$

= $\frac{0.2704}{0.34}$

= **0.7952**

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 )

= 0.7952 x102.00

= **81.1101 mm**

iv Int. of rainfall (I) = $\frac{\text{R-50 (tc)}}{\text{tc}}$

= $\frac{81.11}{0.6768}$

= **119.8373 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8922 x 119.8373 x 0.0543

= **1.6139 cum/sec**

**BR NO-149 IR KM (MTC-SRE)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.6139 cum/sec

c Avg. Waterway Required = $\frac{Q}{V}$

= $\frac{1.6139}{1.75}$

= **0.9222 Sq.m**

d Proposed Opening = 1 1.2 1.2

e Height of Water = $\frac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\frac{0.9222}{1.2}$

= **0.7690 m**

f Avg. Bed Level = 234.031

h **Min. Formation Required** B.L + Ht of water + free Board

= 234.0310 +0.7690 +0.7810

= 235.5810

k **Formation level adopted** = 235.5810

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-150 IR KM 98.921 (MTC-SRE)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.5935 | Sq Km |
| C | Length of Longest Stream | 0.750 | Km |
| D | Height Of farthest point | 236.817 | M |
| E | Height of Point of Interest | 233.217 | M |
| F | Height Diff of 10 & 11 | 3.60 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 233.217 | M |
| I | Observed HFL | 235.070 | M |

**BR NO-150 IR KM 98.921 (MTC-SRE)**

**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 = $[ L^3 / H ]^{0.345}$

= $[ 0.75 \times 0.75 \times 0.75 / 3.60 ]^{0.345}$

= **0.4773 hr.**

= 0.4773 hr. x 60

= **28.6362 Min**

**BR NO-150 IR KM 98.921 (MTC-SRE)**

**Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , C = 0.249(R x F) ^ 0.2**

R = 300.00 mm

F = 0.72

$C = 0.249 \times ( R \times F )^{0.2}$

= **0.8511**

**3 Calculation of Intensity of Rainfall ( I )**

a tc h Ratio = *0.2205* From Fig. 4 of RBF - 16

b 1h Ratio = = 0.34 From Fig. 4 of RBF - 16

c Coefficient K = $\frac{\text{tc h Ratio}}{\text{1h Ratio}}$

= $\frac{0.2205}{0.34}$

= **0.6484**

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 )

= 0.6484 x102.00

= **66.1362 mm**

iv Int. of rainfall (I) = $\frac{\text{R-50 (tc)}}{\text{tc}}$

= $\frac{66.14}{0.4773}$

= **138.5719 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 138.5719 x 0.5935

= **19.4590 cum/sec**

**BR NO-150 IR KM 98.921 (MTC-SRE)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 19.4590 cum/sec

c Avg. Waterway Required = $\frac{Q}{V}$

= $\frac{19.4590}{1.75}$

= **11.1194 Sq.m**

d Proposed Opening = 1 6 2

e Height of Water = $\frac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\frac{11.1194}{6}$

= **1.8530 m**

f Avg. Bed Level = 233.217

h **Min. Formation Required** B.L + Ht of water + free Board

= 233.2170 +1.8530 +0.8970

= 235.9670

k **Formation level adopted** = 235.9670

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-151 IR KM 99.442 (MTC-SRE)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0445 | Sq Km |
| C | Length of Longest Stream | 0.550 | Km |
| D | Height Of farthest point | 237.585 | M |
| E | Height of Point of Interest | 234.665 | M |
| F | Height Diff of 10 & 11 | 2.92 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 234.665 | M |
| I | Observed HFL | 235.440 | M |

**BR NO-151 IR KM 99.442 (MTC-SRE)**

**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 = $[ L^3 / H ]^{0.345}$

= $[ 0.55 \times 0.55 \times 0.55 / 2.92 ]^{0.345}$

= **0.3722 hr.**

= 0.3722 hr. x 60

= **22.3290 Min**

**BR NO-151 IR KM 99.442 (MTC-SRE)**

**Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , C = 0.249(R x F) ^ 0.2**

R = 300.00 mm
F = 0.72
$C = 0.249 \times ( R \times F )^{0.2}$
= **0.8511**

**3 Calculation of Intensity of Rainfall ( I )**

a tc h Ratio = *0.1916* From Fig. 4 of RBF - 16

b 1h Ratio = = 0.34 From Fig. 4 of RBF - 16

c Coefficient K = $\frac{\text{tc h Ratio}}{\text{1h Ratio}}$

= $\frac{0.1916}{0.34}$

= **0.5637**

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 )

= 0.5637 x102.00

= **57.4935 mm**

iv Int. of rainfall (I) = $\frac{\text{R-50 (tc)}}{\text{tc}}$

= $\frac{57.49}{0.3722}$

= **154.4900 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 154.4900 x 0.0445

= **1.6266 cum/sec**

**BR NO-151 IR KM 99.442 (MTC-SRE)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.6266 cum/sec

c Avg. Waterway Required = $\frac{Q}{V}$

= $\frac{1.6266}{1.75}$

= **0.9295 Sq.m**

d Proposed Opening = 1 1.2 1.2

e Height of Water = $\frac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\frac{0.9295}{1.2}$

= **0.7750 m**

f Avg. Bed Level = 234.665

h **Min. Formation Required** B.L + Ht of water + free Board

= 234.6650 +0.7750 +0.7750

= 236.2150

k **Formation level adopted** = 236.2150

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-152 IR KM 99.667 (MTC-SRE)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0465 | Sq Km |
| C | Length of Longest Stream | 0.600 | Km |
| D | Height Of farthest point | 237.507 | M |
| E | Height of Point of Interest | 234.777 | M |
| F | Height Diff of 10 & 11 | 2.73 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 234.777 | M |
| I | Observed HFL | 235.550 | M |

**BR NO-152 IR KM 99.667 (MTC-SRE)**

**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 = $[ L^3 / H ]^{0.345}$

= $[ 0.6 \times 0.6 \times 0.6 / 2.73 ]^{0.345}$

= **0.4168 hr.**

= 0.4168 hr. x 60

= **25.0070 Min**

**BR NO-152 IR KM 99.667 (MTC-SRE)**

**Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , C = 0.249(R x F) ^ 0.2**

R = 300.00 mm
F = 0.72
$C = 0.249 \times ( R \times F )^{0.2}$
= **0.8511**

**3 Calculation of Intensity of Rainfall ( I )**

a tc h Ratio = *0.2050* From Fig. 4 of RBF - 16

b 1h Ratio = = 0.34 From Fig. 4 of RBF - 16

c Coefficient K = $\frac{\text{tc h Ratio}}{\text{1h Ratio}}$

= $\frac{0.2050}{0.34}$

= **0.6030**

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 )

= 0.6030 x102.00

= **61.5105 mm**

iv Int. of rainfall (I) = $\frac{\text{R-50 (tc)}}{\text{tc}}$

= $\frac{61.51}{0.4168}$

= **147.5838 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 147.5838 x 0.0465

= **1.6237 cum/sec**

**BR NO-152 IR KM 99.667 (MTC-SRE)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.6237 cum/sec

c Avg. Waterway Required = $\frac{Q}{V}$

= $\frac{1.6237}{1.75}$

= **0.9278 Sq.m**

d Proposed Opening = 1 1.2 1.2

e Height of Water = $\frac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\frac{0.9278}{1.2}$

= **0.7730 m**

f Avg. Bed Level = 234.777

h **Min. Formation Required** B.L + Ht of water + free Board

= 234.7770 +0.7730 +0.7770

= 236.3270

k **Formation level adopted** = 236.3270

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-153 IR KM 99.909 (MTC-SRE)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0430 | Sq Km |
| C | Length of Longest Stream | 0.545 | Km |
| D | Height Of farthest point | 237.838 | M |
| E | Height of Point of Interest | 234.898 | M |
| F | Height Diff of 10 & 11 | 2.94 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 234.898 | M |
| I | Observed HFL | 235.650 | M |

**BR NO-153 IR KM 99.909 (MTC-SRE)**

**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

$tc = [L^3 / H]^{0.345}$

$= [0.545 \times 0.545 \times 0.545 / 2.94]^{0.345}$

= **0.3678 hr.**

= 0.3678 hr. x 60

= **22.0669 Min**

**BR NO-153 IR KM 99.909 (MTC-SRE)**

**Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , C = 0.249(R x F) ^ 0.2**

R = 300.00 mm

F = 0.72

$C = 0.249 \times ( R \times F )^{0.2}$

= **0.8511**

**3 Calculation of Intensity of Rainfall ( I )**

a tc h Ratio = *0.1903* From Fig. 4 of RBF - 16

b 1h Ratio = = 0.34 From Fig. 4 of RBF - 16

c Coefficient K = $\frac{\text{tc h Ratio}}{\text{1h Ratio}}$

= $\frac{0.1903}{0.34}$

= **0.5598**

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 )

= 0.5598 x102.00

= **57.1004 mm**

iv Int. of rainfall (I) = $\frac{\text{R-50 (tc)}}{\text{tc}}$

= $\frac{57.10}{0.3678}$

= **155.2561 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 155.2561 x 0.0430

= **1.5796 cum/sec**

**BR NO-153 IR KM 99.909 (MTC-SRE)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.5796 cum/sec

c Avg. Waterway Required = $\frac{Q}{V}$

= $\frac{1.5796}{1.75}$

= **0.9026 Sq.m**

d Proposed Opening = 1 1.2 1.2

e Height of Water = $\frac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\frac{0.9026}{1.2}$

= **0.7520 m**

f Avg. Bed Level = 234.898

h **Min. Formation Required** B.L + Ht of water + free Board

= 234.8980 +0.7520 +0.7980

= 236.4480

k **Formation level adopted** = 236.4480

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-155 IR KM 103.868 (MTC-SRE)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 1.1246 | Sq Km |
| C | Length of Longest Stream | 0.375 | Km |
| D | Height Of farthest point | 240.424 | M |
| E | Height of Point of Interest | 235.224 | M |
| F | Height Diff of 10 & 11 | 5.20 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 235.224 | M |
| I | Observed HFL | 238.770 | M |

**BR NO-155 IR KM 103.868 (MTC-SRE)**

**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

$tc = [ L^3 / H ]^{0.345}$

$= [ 0.375 \times 0.375 \times 0.375 / 5.20 ]^{0.345}$

= **0.2052 hr.**

= 0.2052 hr. x 60

= **12.3098 Min**

**BR NO-155 IR KM 103.868 (MTC-SRE)**

**Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , C = 0.249(R x F) ^ 0.2**

R = 300.00 mm
F = 0.72
$C = 0.249 \times ( R \times F )^{0.2}$
= **0.8511**

**3 Calculation of Intensity of Rainfall ( I )**

a tc h Ratio = *0.1276* From Fig. 4 of RBF - 16

b 1h Ratio = = 0.34 From Fig. 4 of RBF - 16

c Coefficient K = $\frac{\text{tc h Ratio}}{\text{1h Ratio}}$

= $\frac{0.1276}{0.34}$

= **0.3752**

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 )

= 0.3752 x102.00

= **38.2746 mm**

iv Int. of rainfall (I) = $\frac{\text{R-50 (tc)}}{\text{tc}}$

= $\frac{38.27}{0.2052}$

= **186.5561 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 186.5561 x 1.1246

= **49.6402 cum/sec**

**BR NO-155 IR KM 103.868 (MTC-SRE)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 49.6402 cum/sec

c Avg. Waterway Required = $\frac{Q}{V}$

= $\frac{49.6402}{1.75}$

= **28.3658 Sq.m**

d Proposed Opening = 2 4 4

e Height of Water = $\frac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\frac{28.3658}{8}$

= **3.5460 m**

f Avg. Bed Level = 235.224

h **Min. Formation Required** B.L + Ht of water + free Board

= 235.2240 +3.5460 +1.0040

= 239.7740

k **Formation level adopted** = 239.7740

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-156 IR KM 104.742 (MTC-SRE)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0395 | Sq Km |
| C | Length of Longest Stream | 0.435 | Km |
| D | Height Of farthest point | 240.797 | M |
| E | Height of Point of Interest | 237.277 | M |
| F | Height Diff of 10 & 11 | 3.52 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 237.277 | M |
| I | Observed HFL | 238.055 | M |

**BR NO-156 IR KM 104.742 (MTC-SRE)**

**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

$tc = [L^3 / H]^{0.345}$

$= [0.435 \times 0.435 \times 0.435 / 3.52]^{0.345}$

= **0.2737 hr.**

= 0.2737 hr. x 60

= **16.4222 Min**

**BR NO-156 IR KM 104.742 (MTC-SRE)**

**Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , C = 0.249(R x F) ^ 0.2**

R = 300.00 mm
F = 0.72
$C = 0.249 \times ( R \times F )^{0.2}$
= **0.8511**

**3 Calculation of Intensity of Rainfall ( I )**

a tc h Ratio = *0.1595* From Fig. 4 of RBF - 16

b 1h Ratio = = 0.34 From Fig. 4 of RBF - 16

c Coefficient K = $\frac{\text{tc h Ratio}}{\text{1h Ratio}}$

= $\frac{0.1595}{0.34}$

= **0.4691**

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 )

= 0.4691 x102.00

= **47.8443 mm**

iv Int. of rainfall (I) = $\frac{\text{R-50 (tc)}}{\text{tc}}$

= $\frac{47.84}{0.2737}$

= **174.8039 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 174.8039 x 0.0395

= **1.6337 cum/sec**

**BR NO-156 IR KM 104.742 (MTC-SRE)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.6337 cum/sec

c Avg. Waterway Required = $\frac{Q}{V}$

= $\frac{1.6337}{1.75}$

= **0.9335 Sq.m**

d Proposed Opening = 1 1.2 1.2

e Height of Water = $\frac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\frac{0.9335}{1.2}$

= **0.7780 m**

f Avg. Bed Level = 237.277

h **Min. Formation Required** B.L + Ht of water + free Board

= 237.2770 +0.7780 +0.7720

= 238.8270

k **Formation level adopted** = 238.8270

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-157 IR KM 105.501 (MTC-SRE)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0416 | Sq Km |
| C | Length of Longest Stream | 0.600 | Km |
| D | Height Of farthest point | 240.058 | M |
| E | Height of Point of Interest | 236.698 | M |
| F | Height Diff of 10 & 11 | 3.36 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 236.698 | M |
| I | Observed HFL | 237.410 | M |

**BR NO-157 IR KM 105.501 (MTC-SRE)**

**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 = $[ L^3 / H ]^{0.345}$

= $[ 0.6 \times 0.6 \times 0.6 / 3.36 ]^{0.345}$

= **0.3880 hr.**

= 0.3880 hr. x 60

= **23.2783 Min**

**BR NO-157 IR KM 105.501 (MTC-SRE)**

**Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , C = 0.249(R x F) ^ 0.2**

R = 300.00 mm
F = 0.72
$C = 0.249 \times ( R \times F )^{0.2}$
= **0.8511**

**3 Calculation of Intensity of Rainfall ( I )**

a tc h Ratio = *0.1964* From Fig. 4 of RBF - 16

b 1h Ratio = = 0.34 From Fig. 4 of RBF - 16

c Coefficient K = $\frac{\text{tc h Ratio}}{\text{1h Ratio}}$

= $\frac{0.1964}{0.34}$

= **0.5776**

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 )

= 0.5776 x102.00

= **58.9174 mm**

iv Int. of rainfall (I) = $\frac{\text{R-50 (tc)}}{\text{tc}}$

= $\frac{58.92}{0.3880}$

= **151.8602 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 151.8602 x 0.0416

= **1.4947 cum/sec**

**BR NO-157 IR KM 105.501 (MTC-SRE)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.4947 cum/sec

c Avg. Waterway Required = $\frac{Q}{V}$

= $\frac{1.4947}{1.75}$

= **0.8541 Sq.m**

d Proposed Opening = 1 1.2 1.2

e Height of Water = $\frac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\frac{0.8541}{1.2}$

= **0.7120 m**

f Avg. Bed Level = 236.698

h **Min. Formation Required** B.L + Ht of water + free Board

= 236.6980 +0.7120 +0.8380

= 238.2480

k **Formation level adopted** = 238.2480

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-158 IR KM 106.138 (MTC-SRE)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0381 | Sq Km |
| C | Length of Longest Stream | 0.375 | Km |
| D | Height Of farthest point | 240.622 | M |
| E | Height of Point of Interest | 237.342 | M |
| F | Height Diff of 10 & 11 | 3.28 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 237.342 | M |
| I | Observed HFL | 238.120 | M |

**BR NO-158 IR KM 106.138 (MTC-SRE)**

**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

$tc = [L^3 / H]^{0.345}$

$= [0.375 \times 0.375 \times 0.375 / 3.28]^{0.345}$

= **0.2405 hr.**

= 0.2405 hr. x 60

= **14.4310 Min**

**BR NO-158 IR KM 106.138 (MTC-SRE)**

**Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , C = 0.249(R x F) ^ 0.2**

R = 300.00 mm
F = 0.72
$C = 0.249 \times ( R \times F )^{0.2}$
= **0.8511**

**3 Calculation of Intensity of Rainfall ( I )**

a tc h Ratio = *0.1453* From Fig. 4 of RBF - 16

b 1h Ratio = = 0.34 From Fig. 4 of RBF - 16

c Coefficient K = $\frac{\text{tc h Ratio}}{\text{1h Ratio}}$

= $\frac{0.1453}{0.34}$

= **0.4272**

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 )

= 0.4272 x102.00

= **43.5776 mm**

iv Int. of rainfall (I) = $\frac{\text{R-50 (tc)}}{\text{tc}}$

= $\frac{43.58}{0.2405}$

= **181.1830 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 181.1830 x 0.0381

= **1.6333 cum/sec**

**BR NO-158 IR KM 106.138 (MTC-SRE)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.6333 cum/sec

c Avg. Waterway Required = $\frac{Q}{V}$

= $\frac{1.6333}{1.75}$

= **0.9333 Sq.m**

d Proposed Opening = 1 1.2 1.2

e Height of Water = $\frac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\frac{0.9333}{1.2}$

= **0.7780 m**

f Avg. Bed Level = 237.342

h **Min. Formation Required** B.L + Ht of water + free Board

= 237.3420 +0.7780 +0.7720

= 238.8920

k **Formation level adopted** = 238.8920

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-159 IR KM 106.764 (MTC-SRE)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0567 | Sq Km |
| C | Length of Longest Stream | 1.350 | Km |
| D | Height Of farthest point | 241.491 | M |
| E | Height of Point of Interest | 237.991 | M |
| F | Height Diff of 10 & 11 | 3.50 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 237.991 | M |
| I | Observed HFL | 238.710 | M |

**BR NO-159 IR KM 106.764 (MTC-SRE)**

**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

$tc = [L^3 / H]^{0.345}$

$= [1.35 \times 1.35 \times 1.35 / 3.50]^{0.345}$

= **0.8855 hr.**

= 0.8855 hr. x 60

= **53.1304 Min**

**BR NO-159 IR KM 106.764 (MTC-SRE)**

**Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , C = 0.249(R x F) ^ 0.2**

R = 300.00 mm
F = 0.81
C = 0.249 x ( R x F ) $^{0.2}$
= **0.8922**

**3 Calculation of Intensity of Rainfall ( I )**

a tc h Ratio = *0.3171* From Fig. 4 of RBF - 16

b 1h Ratio = = 0.34 From Fig. 4 of RBF - 16

c Coefficient K = $\frac{\text{tc h Ratio}}{\text{1h Ratio}}$

= $\frac{0.3171}{0.34}$

= **0.9327**

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 )

= 0.9327 x102.00

= **95.1304 mm**

iv Int. of rainfall (I) = $\frac{\text{R-50 (tc)}}{\text{tc}}$

= $\frac{95.13}{0.8855}$

= **107.4304 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8922 x 107.4304 x 0.0567

= **1.5108 cum/sec**

**BR NO-159 IR KM 106.764 (MTC-SRE)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.5108 cum/sec

c Avg. Waterway Required = $\frac{Q}{V}$

= $\frac{1.5108}{1.75}$

= **0.8633 Sq.m**

d Proposed Opening = 1 1.2 1.2

e Height of Water = $\frac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\frac{0.8633}{1.2}$

= **0.7190 m**

f Avg. Bed Level = 237.991

h **Min. Formation Required** B.L + Ht of water + free Board

= 237.9910 +0.7190 +0.8310

= 239.5410

k **Formation level adopted** = 239.5410

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-162 IR KM 108.161 (MTC-SRE)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.1240 | Sq Km |
| C | Length of Longest Stream | 0.360 | Km |
| D | Height Of farthest point | 241.416 | M |
| E | Height of Point of Interest | 238.656 | M |
| F | Height Diff of 10 & 11 | 2.76 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 238.656 | M |
| I | Observed HFL | 240.170 | M |

**BR NO-162 IR KM 108.161 (MTC-SRE)**

**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 = $[ L^3 / H ]^{0.345}$

= $[ 0.36 \times 0.36 \times 0.36 / 2.76 ]^{0.345}$

= **0.2447 hr.**

= 0.2447 hr. x 60

= **14.6829 Min**

**BR NO-162 IR KM 108.161 (MTC-SRE)**

**Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , C = 0.249(R x F) ^ 0.2**

R = 300.00 mm
F = 0.72
$C = 0.249 \times ( R \times F )^{0.2}$
= **0.8511**

**3 Calculation of Intensity of Rainfall ( I )**

a tc h Ratio = *0.1474* From Fig. 4 of RBF - 16

b 1h Ratio = = 0.34 From Fig. 4 of RBF - 16

c Coefficient K = $\frac{\text{tc h Ratio}}{\text{1h Ratio}}$

= $\frac{0.1474}{0.34}$

= **0.4334**

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 )

= 0.4334 x102.00

= **44.2072 mm**

iv Int. of rainfall (I) = $\frac{\text{R-50 (tc)}}{\text{tc}}$

= $\frac{44.21}{0.2447}$

= **180.6482 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 180.6482 x 0.1240

= **5.3001 cum/sec**

**BR NO-162 IR KM 108.161 (MTC-SRE)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 5.3001 cum/sec

c Avg. Waterway Required = $\frac{Q}{V}$

= $\frac{5.3001}{1.75}$

= **3.0286 Sq.m**

d Proposed Opening = 1 2 2

e Height of Water = $\frac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\frac{3.0286}{2}$

= **1.5140 m**

f Avg. Bed Level = 238.656

h **Min. Formation Required** B.L + Ht of water + free Board

= 238.6560 +1.5140 +0.8360

= 241.0060

k **Formation level adopted** = 241.0060

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-163 IR KM 110.82 (MTC-SRE)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.0369 | Sq Km |
| C | Length of Longest Stream | 0.385 | Km |
| D | Height Of farthest point | 241.452 | M |
| E | Height of Point of Interest | 238.472 | M |
| F | Height Diff of 10 & 11 | 2.98 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 238.472 | M |
| I | Observed HFL | 239.215 | M |

**BR NO-163 IR KM 110.82 (MTC-SRE)**

**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

$tc = [L^3 / H]^{0.345}$

$= [0.385 \times 0.385 \times 0.385 / 2.98]^{0.345}$

= **0.2555 hr.**

= 0.2555 hr. x 60

= **15.3285 Min**

**BR NO-163 IR KM 110.82 (MTC-SRE)**

**Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , C = 0.249(R x F) ^ 0.2**

R = 300.00 mm
F = 0.72
$C = 0.249 \times ( R \times F )^{0.2}$
= **0.8511**

**3 Calculation of Intensity of Rainfall ( I )**

a tc h Ratio = *0.1522* From Fig. 4 of RBF - 16

b 1h Ratio = = 0.34 From Fig. 4 of RBF - 16

c Coefficient K = $\frac{\text{tc h Ratio}}{\text{1h Ratio}}$

= $\frac{0.1522}{0.34}$

= **0.4476**

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 )

= 0.4476 x102.00

= **45.6569 mm**

iv Int. of rainfall (I) = $\frac{\text{R-50 (tc)}}{\text{tc}}$

= $\frac{45.66}{0.2555}$

= **178.7142 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 178.7142 x 0.0369

= **1.5603 cum/sec**

**BR NO-163 IR KM 110.82 (MTC-SRE)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 1.5603 cum/sec

c Avg. Waterway Required = $\frac{Q}{V}$

= $\frac{1.5603}{1.75}$

= **0.8916 Sq.m**

d Proposed Opening = 1 1.2 1.2

e Height of Water = $\frac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\frac{0.8916}{1.2}$

= **0.7430 m**

f Avg. Bed Level = 238.472

h **Min. Formation Required** B.L + Ht of water + free Board

= 238.4720 +0.7430 +0.8070

= 240.0220

k **Formation level adopted** = 240.0220

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-164 IR KM 111.112 (MTC-SRE)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.6967 | Sq Km |
| C | Length of Longest Stream | 1.085 | Km |
| D | Height Of farthest point | 240.382 | M |
| E | Height of Point of Interest | 237.272 | M |
| F | Height Diff of 10 & 11 | 3.11 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 237.272 | M |
| I | Observed HFL | 239.165 | M |

**BR NO-164 IR KM 111.112 (MTC-SRE)**

**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

$tc = [L^3 / H]^{0.345}$

$= [1.085 \times 1.085 \times 1.085 / 3.11]^{0.345}$

= **0.7356 hr.**

= 0.7356 hr. x 60

= **44.1386 Min**

**BR NO-164 IR KM 111.112 (MTC-SRE)**

**Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , C = 0.249(R x F) ^ 0.2**

R = 300.00 mm

F = 0.81

$C = 0.249 \times ( R \times F )^{0.2}$

= **0.8922**

**3 Calculation of Intensity of Rainfall ( I )**

a tc h Ratio = *0.2821* From Fig. 4 of RBF - 16

b 1h Ratio = = 0.34 From Fig. 4 of RBF - 16

c Coefficient K = $\frac{\text{tc h Ratio}}{\text{1h Ratio}}$

= $\frac{0.2821}{0.34}$

= **0.8298**

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 )

= 0.8298 x102.00

= **84.6386 mm**

iv Int. of rainfall (I) = $\frac{\text{R-50 (tc)}}{\text{tc}}$

= $\frac{84.64}{0.7356}$

= **115.0538 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8922 x 115.0538 x 0.6967

= **19.8808 cum/sec**

**BR NO-164 IR KM 111.112 (MTC-SRE)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 19.8808 cum/sec

c Avg. Waterway Required = $\frac{Q}{V}$

= $\frac{19.8808}{1.75}$

= **11.3605 Sq.m**

d Proposed Opening = 1 6 2

e Height of Water = $\frac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\frac{11.3605}{6}$

= **1.8930 m**

f Avg. Bed Level = 237.272

h **Min. Formation Required** B.L + Ht of water + free Board

= 237.2720 +1.8930 +0.8570

= 240.0220

k **Formation level adopted** = 240.0220

**Provided formation Level is O.K.**

# TALHERI – PILKHANI SECTION

**Dedicated freight corridor Corporation of India.**

**BR NO-201B IR KM 153.523 (Talheri-Pilkhani)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 1.8919 | Sq Km |
| C | Length of Longest Stream | 1.115 | Km |
| D | Height Of farthest point | 258.901 | M |
| E | Height of Point of Interest | 254.851 | M |
| F | Height Diff of 10 & 11 | 4.05 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 254.851 | M |
| I | Observed HFL | 257.502 | M |

**BR NO-201B IR KM 153.523 (Talheri-Pilkhani)**

**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

| | 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

$tc = [L^3 / H]^{0.345}$

$= [1.115 \times 1.115 \times 1.115 / 4.05]^{0.345}$

= **0.6908 hr.**

= 0.6908 hr. x 60

= **41.4485 Min**

**BR NO-201B IR KM 153.523 (Talheri-Pilkhani)**

**Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , C = 0.249(R x F) ^ 0.2**

R = 300.00 mm

F = 0.81

$C = 0.249 \times ( R \times F )^{0.2}$

= **0.8922**

**3 Calculation of Intensity of Rainfall ( I )**

a tc h Ratio = *0.2732* From Fig. 4 of RBF - 16

b 1h Ratio = = 0.34 From Fig. 4 of RBF - 16

c Coefficient K = $\frac{\text{tc h Ratio}}{\text{1h Ratio}}$

= $\frac{0.2732}{0.34}$

= **0.8034**

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 )

= 0.8034 x102.00

= **81.9485 mm**

iv Int. of rainfall (I) = $\frac{\text{R-50 (tc)}}{\text{tc}}$

= $\frac{81.95}{0.6908}$

= **118.6270 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8922 x 118.6270 x 1.8919

= **55.6632 cum/sec**

**BR NO-201B IR KM 153.523 (Talheri-Pilkhani)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 55.6632 cum/sec

c Avg. Waterway Required = $\frac{Q}{V}$

= $\frac{55.6632}{1.75}$

= **31.8075 Sq.m**

d Proposed Opening = 4 3 3

e Height of Water = $\frac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\frac{31.8075}{12}$

= **2.6510 m**

f Avg. Bed Level = 254.851

h **Min. Formation Required** B.L + Ht of water + free Board

= 254.8510 +2.6510 +0.8530

= 258.3550

k **Formation level adopted** = 258.3550

**Provided formation Level is O.K.**

**Dedicated freight corridor Corporation of India.**

**BR NO-202 IR KM 154.203 (Talheri-Pilkhani)**

Estimation of Design Discharge for Railway Bridge.

| | | | |
|---|---|---|---|
| A | Topography | Plain | |
| B | Catchment Area | 0.4389 | Sq Km |
| C | Length of Longest Stream | 0.340 | Km |
| D | Height Of farthest point | 258.772 | M |
| E | Height of Point of Interest | 255.412 | M |
| F | Height Diff of 10 & 11 | 3.36 | M |
| G | Nature of Soil | | |
| H | Avg. Bed Level | 255.412 | M |
| I | Observed HFL | 257.240 | M |

**BR NO-202 IR KM 154.203 (Talheri-Pilkhani)**

**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

$tc = [ L^3 / H ]^{0.345}$

$= [ 0.34 \times 0.34 \times 0.34 / 3.36 ]^{0.345}$

= **0.2155 hr.**

= 0.2155 hr. x 60

= **12.9314 Min**

**BR NO-202 IR KM 154.203 (Talheri-Pilkhani)**

**Nature of Soil is , Sandy Soil / Sandy Laom/ arid Areas , C = 0.249(R x F) ^ 0.2**

R = 300.00 mm
F = 0.72
$C = 0.249 \times ( R \times F )^{0.2}$
= **0.8511**

**3 Calculation of Intensity of Rainfall ( I )**

a tc h Ratio = *0.1328* From Fig. 4 of RBF - 16

b 1h Ratio = = 0.34 From Fig. 4 of RBF - 16

c Coefficient K = $\frac{\text{tc h Ratio}}{\text{1h Ratio}}$

= $\frac{0.1328}{0.34}$

= **0.3905**

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 )

= 0.3905 x102.00

= **39.8285 mm**

iv Int. of rainfall (I) = $\frac{\text{R-50 (tc)}}{\text{tc}}$

= $\frac{39.83}{0.2155}$

= **184.7993 mm/hr.**

**4 Design Flood Discharge =**

Q-50 = 0.278 x C xI x A

= x 0.278 x 0.8511 x 184.7993 x 0.4389

= **19.1907 cum/sec**

**BR NO-202 IR KM 154.203 (Talheri-Pilkhani)**

**5 Checking for adequacy of Waterway Provided**

a Discharge = 19.1907 cum/sec

c Avg. Waterway Required = $\frac{Q}{V}$

= $\frac{19.1907}{1.75}$

= **10.9661 Sq.m**

d Proposed Opening = 1 6 2

e Height of Water = $\frac{\text{Avg. Waterway}}{\text{Total Width}}$

= $\frac{10.9661}{6}$

= **1.8280 m**

f Avg. Bed Level = 255.412

h **Min. Formation Required** B.L + Ht of water + free Board

= 255.4120 +1.8280 +1.2020

= 258.4420

k **Formation level adopted** = 258.4420

**Provided formation Level is O.K.**