* 1. General Information
     1. Design Code : IS 456 2000
     2. Unit System : N, mm
  2. Material
     1. : 25.00MPa
     2. : 415MPa
     3. : 415MPa
  3. Section
     1. Section Size : 500 x 500mm
     2. : 3.500m
     3. : 3.500m
     4. : 1.000
     5. : 1.000
     6. Splicing Limit : 50%
     7. Frame Type : Braced Frame
* 
  1. Forces
     1. : 100.00kN
     2. : 100.00kN·m
     3. : 300kN·m
     4. : 100.00kN
     5. : 200kN
     6. : 10.000kN
     7. : 20.00kN
  2. Rebar
     1. Main Bar
        + Layer-1 : 8-3-#18 (62.23mm, 20,645mm²)
        + Layer-2 : -
        + Layer-3 : -
        + Layer-4 : -
        + 20,645mm²
     2. Hoop Bar
        + End : #3@150
        + Middle : #3@300
     3. Tie Bar
        + Apply Tie Bar to Shear Check : Yes
        + Tie Bar :
  3. Option
     1. Special provisions for seismic design is applied.

IS 13920 2016

* 1. Check Slenderness Ratio

Calculate slenderness ratio **[IS 456 25.1.2]**

L/b <= 60 → O.K

* + - * 23.33 > 12 → Slender
      * 23.33 > 12 → Slender
  1. Additional Moments and Reduction Factor

Calculation of Reduction Factor **[IS 456 39.7.1.1]**

* + 1. Calculate Additional moment (Direction X) **[IS 456 39.7]**
       - 5.208333 kN·m
    2. Calculate Additional moment (Direction Y) **[IS 456 39.7]**
       - 5.208333 kN·m
  1. Check Minimum Moment
     1. Calculate minimum eccentricity **[IS 456 24.4]**
        + 30.00mm

= 30 mm

* + - * 30.00mm

= 30 mm

* + 1. Calculate minimum moment
       - 3.000kN·m
       - 3.000kN·m
  1. Check Design Moment
     1. Calculate design moment
        + 100kN·m
        + 301kN·m
        + 317kN·m
  2. Check Design Parameter
     1. Calculate rebar ratio
        + 250,000mm² 20,645mm²
        + 0.008 0.0600
        + 0.0526
     2. Calculate eccentricity
        + 3,007mm
        + 1,002mm
        + 3,170mm
        + Rotation angle of neutral axis = 68.21°
     3. Calculate concentric axial load capacity
        + 14,588kN
        + 11,671kN
        + -9,910kN
  3. Check Moment Capacity ( Balanced axis )
     1. Calculate capacity of compression stress block

290mm

* + - * 106,287mm²
      * 136mm 39.18mm
      * 2,168kN
      * 84.95kN·m
      * 295kN·m
    1. Calculate capacity of rebar

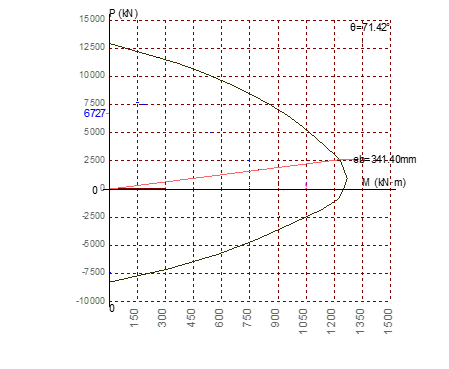
|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **i** | **(mm)** |  | **(MPa)** | **(mm²)** | **(kN)** | **(mm)** | **(kN)** | **(mm)** | **(kN)** |
| 1 | 569 | -0.002000 | -400 | 2,581 | -1,032 | -188 | 194 | -188 | 194 |
| 2 | 499 | -0.001388 | -278 | 2,581 | -716 | 0.000 | 0.000 | -188 | 134 |
| 3 | 430 | -0.000775 | -155 | 2,581 | -400 | 188 | -75.11 | -188 | 75.11 |
| 4 | 255 | 0.000757 | 151 | 2,581 | 391 | 188 | 73.37 | 0.000 | 0.000 |
| 5 | 80.88 | 0.002289 | 400 | 2,581 | 1,032 | 188 | 194 | 188 | 194 |
| 6 | 151 | 0.001677 | 335 | 2,581 | 865 | 0.000 | 0.000 | 188 | 162 |
| 7 | 220 | 0.001064 | 213 | 2,581 | 549 | -188 | -103 | 188 | 103 |
| 8 | 395 | -0.000468 | -93.57 | 2,581 | -241 | -188 | 45.34 | 0.000 | 0.000 |

* + - * 448kN
      * 328kN·m
      * 863kN·m
    1. Calculate nominal capacity for neutral axis
       - 2,616kN
       - 413kN·m
       - 1,158kN·m
       - 1,229kN·m
  1. Check Moment Capacity ( Neutral axis )
     1. Calculate capacity of compression stress block
        + 283mm
        + 79,509mm²
        + 160mm 52.37mm
        + 1,622kN
        + 84.95kN·m
        + 260kN·m
     2. Calculate capacity of rebar

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **i** | **(mm)** |  | **(MPa)** | **(mm²)** | **(kN)** | **(mm)** | **(kN)** | **(mm)** | **(kN)** |
| 1 | 569 | -0.003034 | -400 | 2,581 | -1,032 | -188 | 194 | -188 | 194 |
| 2 | 499 | -0.002295 | -400 | 2,581 | -1,032 | 0.000 | 0.000 | -188 | 194 |
| 3 | 430 | -0.001556 | -311 | 2,581 | -803 | 188 | -151 | -188 | 151 |
| 4 | 255 | 0.000293 | 58.65 | 2,581 | 151 | 188 | 28.42 | 0.000 | 0.000 |
| 5 | 80.88 | 0.002142 | 400 | 2,581 | 1,032 | 188 | 194 | 188 | 194 |
| 6 | 151 | 0.001403 | 281 | 2,581 | 724 | 0.000 | 0.000 | 188 | 136 |
| 7 | 220 | 0.000664 | 133 | 2,581 | 343 | -188 | -64.34 | 188 | 64.34 |
| 8 | 395 | -0.001185 | -237 | 2,581 | -612 | -188 | 115 | 0.000 | 0.000 |

* + - * -1,229kN
      * 316kN·m
      * 933kN·m
    1. Calculate nominal capacity for neutral axis
       - 393kN
       - 401kN·m
       - 1,192kN·m
       - 1,258kN·m
    2. Calculate axial load and moment capacities
       - 290kN
       - 295kN·m
       - 878kN·m
       - 926kN·m

→ O.K **[IS 456 39.6]**

* 
  1. Calculate Shear Force by Special Provisions for Seismic Design (Direction Y).
     1. Calculate bending strength for design shear force.
        + 1,590kN·m
        + 1,590kN·m
        + 1,590kN·m
        + 1,590kN·m
     2. Calculate design shear force by special provision for seismic design **[ IS\_13920\_2016 7.5 ]**
        + 944kN
        + 944kN
        + 944kN
  2. Calculate Shear Force by Special Provisions for Seismic Design (Direction X).
     1. Calculate bending strength for design shear force.
        + 1,652kN·m
        + 1,652kN·m
        + 1,652kN·m
        + 1,652kN·m
     2. Calculate design shear force by special provision for seismic design **[ IS\_13920\_2016 7.5 ]** 
        + 909kN
        + 909kN
        + 909kN
  3. Check Shear Capacity
     1. Calculate maximum space **[IS 13920 7.4.2, IS 456 26.5.1.5]**

* + 1. Calculate shear strength (Direction X)

s = 0.00100mm <

Detla = 1 + 3 Pu / Ag fck **[IS 456 40.2.2]**

Tc = Tc x Delta

* + - * **[IS 456 2000 40.4 c, T table 19]**
      * 186kN **[IS 456 2000 40.4 c]**
      * 324kN

2.808 → N.G

* + 1. Calculate shear strength (Direction Y)

s = 0.00100mm <

Detla = 1 + 3 Pu / Ag fck **[IS 456 40.2.2]**

Tc = Tc x Delta

* + - * 138kN **[IS 456 2000 40.4 c, T table 19]**
      * 186kN **[IS 456 2000 40.4 c]**
      * 324kN

2.915 → N.G

* 1. Check Dimension by Special Provision for Seismic Design
     1. Calculate section dimension limit
        + mm **[IS 13920 2016 7.1.1]**
     2. Calculate section dimension ratio
        + **[IS 13920 2016 7.1.2]**
  2. Check Rebar Limit by Special Provision for Seismic Design
     1. Calculate amount of transverse rebar (Direction X) **[IS 13920 8.1.3]**
     2. Calculate amount of transverse rebar (Direction Y) **[IS 13920 8.1.3]**
  3. Check Crack Width
     1. Calculating for considering flexural member **[IS 456 43.2]**
        + pu  <= 0.2 fck  Ac 002 → Considered as flexural member
     2. Criteria for Crack width **[Annex F]**
        + Exposer Condition : Moderate 0.2 mm
        + em = = 0.00216

wcr = = 0.009

* + 1. check crack width limits

crack width wcr = 0.009 ( 0.009 < 0.002 → O.K )