DESIGN OF A STEEL FOOT OVER BRIDGE IN A RAILWAY STATION

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ABSTRACT
Civil engineering deals with the design, construction and maintenance of physical and naturally built environment, including works like bridges, roads, canals, dams and buildings. It is the oldest and broadest engineering profession. All the engineering specialties have been derived from civil engineering. It is divided into various sub disciplines including environmental engineering, geotechnical engineering, structural engineering, transportation engineering, material engineering, surveying and construction engineering. The principles of all the above engineering aspects are applied to the residential, commercial, industrial and public works projects of all sizes and levels of construction.

Keyword: Bridge, Railway Station

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1. OBJECTIVES
1. To analyse and design a Foot Over Bridge at a railway station in a metropolitan city.
2. To design a light weight structure with maximum strength, durability and safety factor.
3. To make use of a simple and effective design methodology and construction. The design procedure and methodology adopted is to be in conformance to the present methodology being used in the industry.
4. To analyze the structure using STAAD. Pro for the various loads acting on the structure.
5. To meet the requirements of the codal provisions given in the codes, being considered and try to adopt economical sections in the structure.
6. To make detailed drawings indicating the sections used for the various components

2. METHODOLOGY
1. Collection of details and information about analysis and design of steel structural elements and current practices in the industry.
2. Review of literature and study of examples for the proposed project.
4. Selection of site and collection of site information from previously completed projects and concerned authorities.
5. Preparation of plan and elevation of the structure using AUTOCAD.
6. Making the models of the various components in STAAD and assigning member and material properties as per the design.
7. Loading the structure elements for Dead Loads, Imposed Loads and Wind Loads as per the Indian Railway Standard – Steel Bridge code.
8. Design of structural components of the foot over bridge for the loading details acquired from STAAD model.
9. Design of the appropriate foundation for the loading details.
10. Preparation of detailed design drawings.

3. LOCATION
The site chosen for the design of Foot Over Bridge is Park Railway Station located in Chennai district, Tamil Nadu. The Foot Over Bridge spans for a total length of 28m over 3 tracks.

4. DESIGN DATA
The various parameters considered in the design of foot over bridge are as follows:

4.1. MINIMUM SPECIFICATIONS
Minimum specifications as per Indian Railways Work Manual are listed below:
- Width of gangway : 2m
- Clearance from centre line of rail : 2.36m
- Height from the rails to the base of gangway : 6.26m

LOADING DATA
- Location : Park Railway Station, Chennai
- Total span : 28 m
- Gangway width : 3 m
- Height from the rails to the base of gangway : 6.26 m
- Live load : 5 KN/ m²

LOADING DETAILS
The loads acting on the structure is distributed to all the structural elements. The live load and dead load acting on the main truss gets distributed from the gangway to the column. This load is then transferred to the footing below.
4.2. MATERIAL PROPERTIES

STEEL
1) Structural steel used in this design confirms to IS 2062 with the following properties:
   - Yield stress : 250 Mpa
   - Ultimate stress : 410 Mpa
2) HYSD reinforcement of grade Fe 415 confirming to IS 1786 is used throughout.

CONCRETE
All components unless specified in design : M20 grade
   - Characteristic compressive strength f_{ck} : 20 N/mm²

4.3. ANALYSIS BY STAAD.PRO - STRUCTURAL SOFTWARE

MAIN TRUSS
The dead loads and the live load were considered for the Main Truss. The loads act on all the panel points equally with the end panels taking up half of the load which acts on the other panel points. The loading diagram is as shown.

![Figure 2 Loading diagram of Main Truss](image)

COLUMN
The loads acting on the structure get distributed through the primary and secondary girders to the column. This load is then distributed to the foundation below. Horizontal and inclined bracings are provided to arrest buckling. The loading diagram is shown below.

![Figure 3 Loading diagram of Column](image)
LOAD CALCULATION

Live load = 500 kg/m² = 5.00 kN/m²  
Weight of RCC slab = 0.15x25 = 3.75 kN/m²  
Total load = 8.75 KN/m² say 10 kN/m²  
Dead load (safety) = 1.5 kN/m²  
Final load = 11.5 kN/m²  
Load on each panel = 11.5x3x1.4/2 = 24 kN  
Load at the end panels = 12 kN  

The forces in the members were calculated using STAAD and the maximum forces in the members were found to be as follows:

- Top chord members = 660.02 kN (compression)
- Bottom chord members = 213.38 kN (tension)
- End diagonals = 272.22 kN (compression)
- Other diagonals = 253.13 kN (tension), = 222.13 kN (compression)
- Vertical members = 22.15 kN (tension)

4.4. DESIGN OF TOP CHORD MEMBER

Design force in the member = 660.02 kN (compression)

Choose a section 2L ISA150x150x12mm,

Properties of the section from steel tables:

- A = 6918 mm²
- Width of the section (b) = 150 mm
- Depth of the section (d) = 150 mm
- Thickness of the section (t) = 12mm
- b/t = 150/12 = 12.5 (<15.7ε)
- d/t = 150/12 = 12.5 (<15.7ε)

Hence the section is semi compact.

- r_xx = 46.1 mm
- Effective length of member, L_eff = 1400 mm
- Slenderness ratio, λ = (L_eff/r) = 1400/46.1 = 30.36

For the slenderness ratio, λ = 30.36, buckling class 'c' of table 9(c) of IS800:2007,

The maximum permissible compressive stress,

- f_cd = 210.53 N/mm²
Load carrying capacity \(= f_{cd} \times A\)
\(= 210.53 \times 6918\)
\(= 1456.4 \text{kN} > 660.02 \text{kN}\)

Load carrying capacity of the member > Design force of the member

Check for deflection

Deflection \(= \frac{P L}{AE}\)
\(= \frac{660.02 \times 10^3 \times 1400}{6918 \times 2 \times 10^5}\)
\(= 0.667 \text{mm} < 5\text{mm}\)

Hence the section 2L ISA150x150x12mm is safe and maybe adopted.

4.5. DESIGN OF BOTTOM CHORD MEMBER

Design force in the member \(= 213.38 \text{kN} \text{ (tension)}\)

Choose a section 2L ISA 150x150x12mm

Properties of the section:

\(A = 6918 \text{mm}^2\)
\(r_{xx} = 46.1 \text{mm}\)

According to Clause 6.2 of IS 800:2007,

Load carrying capacity \(= A_f \frac{f_y}{\gamma_m0}\)
\(= 6918 \times 250/1.1\)
\(= 1572.27 \text{kN} > 213.38 \text{kN}\)

Load carrying capacity of the member > Design force of the member

Check for deflection

Deflection \(= \frac{P L}{AE}\)
\(= \frac{213.38 \times 10^3 \times 1400}{6918 \times 2 \times 10^5}\)
\(= 0.215 \text{mm} < 5\text{mm}\)

Hence the section 2L ISA150x150x12mm is safe and maybe adopted.

4.6. DESIGN OF INCLINED MEMBERS

a) COMPRESSION MEMBER

Design force in the member \(= 222.13 \text{kN} \text{ (compression)}\)

Choose a section 2L100x100x10mm

Properties of the combined section:

\(A = 3806 \text{mm}^2\)
\(r_{xx} = 30.5 \text{mm}\)
Width of the section \(b\) \(= 100 \text{mm}\)
Depth of the section \(d\) \(= 100 \text{mm}\)
Thickness of the section \(t\) \(= 10 \text{mm}\)
\(b/t = 100/10\)
\[ d/t = \frac{100}{10} = 10 \text{ (<9.4ε)} \]

Hence the section is compact.

Effective length of member, \( L_{eff} \) = 3130 mm

Slenderness ratio, \( \lambda \) = \( \frac{L_{eff}}{r} \)
= 3130/30.5
= 102.62

For the slenderness ratio, \( \lambda = 102.62 \), buckling class 'c' of table 9(c) of IS800:2007,

The maximum permissible compressive stress,
\[ f_{cd} = 103.75 \text{ N/mm}^2 \]

Load carrying capacity
= \( f_{cd} \times \text{area} \)
= 103.75 \times 3806
= 394.87 kN > 222.13 kN

Load carrying capacity of the member > Design force of the member
Check for deflection
Deflection
= \( \frac{P L}{AE} \)
= 222.13 \times 10^3 \times 3130
= 3806 \times 2 \times 10^5
= 0.913 \text{mm} < 5 \text{mm}

Hence the section **2L ISA100x100x10mm** is safe and maybe adopted.

**b) TENSION MEMBER**

Design force in the member = 253.13 kN (tension)

Choose a section **2L ISA100x100x10mm**

Properties of the combined section:
\[ A = 3806 \text{ mm}^2 \]
\[ r_{xx} = 30.5 \text{ mm} \]

Effective length of member, \( L_{eff} \) = 3130 mm

According to Clause 6.2 of IS 800:2007,

Load carrying capacity = \( A_x f_y / \gamma_{m0} \)
= 3806 \times 250/ 1.1
= 865 kN > 253.13 kN

Load carrying capacity of the member > Design force of the member
Check for deflection:
Deflection
= \( \frac{P L}{AE} \)
= 253.13 \times 10^3 \times 3130
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\[ = 3806 \times 2 \times 10^5 \]
\[ = 1.04 \text{ mm} < 5\text{mm} \]

Hence the section **2L100x100x10** is safe and maybe adopted.

c) **END DIAGONALS**

Design force in the member \( = 272.22 \text{ kN} \) (compression)

Choose a section **2L ISA150x150x12mm**,

Properties of the section from steel tables:

- Area, \( A \) = 6918 mm\(^2\)
- Width of the section (b) = 150 mm
- Depth of the section (d) = 150 mm
- Thickness of the section (t) = 12 mm

\[ \frac{b}{t} = \frac{150}{12} = 12.5 \text{ (<15.7} \varepsilon) \]
\[ \frac{d}{t} = \frac{150}{12} = 12.5 \text{ (<15.7} \varepsilon) \]

Hence the section is semi compact.

\[ r_{xx} = 46.1 \text{ mm} \]

Effective length of member, \( L_{eff} = 3130 \text{ mm} \)

Slenderness ratio, \( \lambda = \frac{L_{eff}}{r} \)
\[ = \frac{3130}{46.1} = 67.89 \]

For the slenderness ratio, \( \lambda = 67.89 \), buckling class 'c' of Table 9(c) of IS800:2007

The maximum permissible compressive stress, \( f_{cd} = 155.37 \text{ N/mm}^2 \)

Load carrying capacity \( = f_{cd} \times \text{area} \)
\[ = 155.37 \times 6918 = 1074.89 \text{ kN} > 272.22 \text{ kN} \]

Load carrying capacity of the member > Design force of the member

Check for deflection

Deflection \( = \frac{P L}{AE} \)
\[ = \frac{272.22 \times 10^3 \times 3130}{6918 \times 2 \times 10^5} \]
\[ = 0.615 \text{ mm} < 5\text{mm} \]

Hence the section **2L ISA150x150x12mm** is safe and maybe adopted.

4.7. **DESIGN OF VERTICAL MEMBER**

Design force in the member \( = 22.15 \text{ kN} \) (tension)

Choose a section ISA 90x90x8mm

Properties of the section:

\[ A = 1379 \text{ mm}^2 \]
According to Clause 6.2 of IS 800:2007,

Load carrying capacity

\[ \text{Load carrying capacity} = \frac{A_g f_y}{\gamma_{m0}} \]

\[ = \frac{1379 \times 250}{1.1} \]

\[ = 313.40 \text{kN} > 22.15 \text{kN} \]

Load carrying capacity of the member > Design force of the member

Check for deflection

Deflection

\[ = \frac{P L}{AE} \]

\[ = \frac{22.15 \times 10^3 \times 2800}{1379 \times 2 \times 10^5} \]

\[ = 0.224 \text{mm} < 5 \text{mm} \]

Hence the section **ISA 90x90x8mm** is safe and maybe adopted.

### 4.8. DESIGN OF GANGWAY

#### LOAD CALCULATION

Uniformly distributed load  =  24KN/m²

Factored load  =  1.5 x 24

=  36 KN/m²

**CALCULATION OF BENDING MOMENT AND SHEAR FORCE**

Bending moment  =  \( Wl^2/8 \)

\[ = 36 \times 3^2/8 \]

=  40.5 KNm

Shear force  =  \( WL/2 \)

\[ = 36 \times 3/2 \]

=  54 KN

Choosing an initial section (from table 14 of IS800:2007)

\[ \lambda = 100 \]

\[ \frac{h}{t_f} = 25 \]

\[ f_{cr,b} = 291.4 \text{N/mm}^2 \]

As per clause 8.2.2 of IS 800:2007,

\[ \lambda_{LT} = \left( \frac{f_y}{f_{cr,b}} \right)^{1/2} \]

\[ = \left( \frac{250}{291.4} \right)^{1/2} \]

=  0.926

\[ \Phi_{LTb} = 0.5 \left[ 1 + \alpha_{LT} (\lambda_{LT} - 0.2) + \lambda_{LT}^2 \right] \]

\[ = 0.5 \left[ 1 + 0.21(0.926 - 0.2) + 0.926^2 \right] \]

=  1.005

\[ \chi_{LT} = \frac{1}{\Phi_{LT} + \left( \Phi_{LT}^2 - \lambda_{LT}^2 \right)^{0.5}} \]

\[ = \frac{1}{1.005 + \left[ 1.005^2 - 0.926^2 \right]^{0.5}} \]

=  0.716
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\[ f_{bd} = \chi_{LT} f_y/\lambda_{mo} \]
\[ = 0.716 \times 250/1.1 \]
\[ = 162.73 \text{ N/ mm}^2 \]

Therefore section modulus required:
\[ = 40.5 \times 10^6/162.73 \]
\[ = 248.87 \times 10^3 \text{ mm}^3 \]

Try a section of ISMB 200 from steel tables
D = 200 mm
B = 140 mm
t_f = 10.8 mm
t_w = 5.7 mm

Depth of web
\[ = D – 2[t_f + R] \]
\[ = 400 – 2(16+14) \]
\[ = 340 \text{ mm} \]

Moment of inertia \( I_z \) = 20458.4 \times 10^4 \text{ mm}^4
\( I_y \) = 622.1 \times 10^4 \text{ mm}^4
\( I_z \) = 20458.4 \times 10^4 \text{ mm}^4

Section modulus \( z_{ez} \) = 1022.9 \times 10^4 \text{ mm}^4
\( Z_{pz} \) = 1.14 \times 1022.9 \times 10^4 \text{ mm}^4
\[ = 1166.106 \times 10^3 \text{ mm}^3 \]

Minimum radius of gyration = 28.2 mm

SECTION CLASSIFICATION
Compression flange
\[ = 70/16 \]
\[ = 4.375<9.4 \]

Web with NA at mid depth
\[ = 340/8.9 \]
\[ = 38.2<84 \]

Hence the section is plastic
\[ \begin{align*}
G &= E/2[1+0.3] \\
&= 2 \times 10^5/(2 \times 1.3) \\
&= 0.75 \times 10^5 \\
I_t &= b_i t_i^3/3 \\
&= (2 \times 100 \times 10.8^3)/3 + (165 – 2x10.8) \times 5.7^3/3 \\
&= 92.832 \times 10^3 \text{ mm}^3 \\
b_f &= 100 \\
h_f &= D-t_f \\
&= 200 – 10.8 \\
&= 189.2 \text{ mm} \\
I_w &= [1-0.5] \times 0.5 \times 150 \times 10^4 \times 189^2 \\
&= 1.34 \times 10^4 \text{ mm}^4
\end{align*} \]

As per clause 8.2.2.1 of IS 800:2007,
CALCULATION OF SHEAR CAPACITY

\[ V_d = \frac{f_y d w}{\gamma_{mo}} \sqrt{3} \]

\[ = 250 \times 200 \times 5.7/\sqrt{3} \times 1.1 \]

\[ = 149.58 \text{KN} \]

\[ 0.6V_d = 149.58 \text{KN} > 108 \text{KN} \]

CALCULATION OF DEFLECTION

Actual deflection

\[ = \frac{5wl^4}{384EI} \]

\[ = 5 \times 24 \times 3000^4/(384 \times 2 \times 10^5 \times 2235.4 \times 10^4) \]

\[ = 5.66 \text{mm} \]

Allowable deflection

\[ = \frac{L}{300} = \frac{3000}{300} = 10 \text{mm} \]

Hence the section ISMB200 is safe and maybe adopted.

Also provide a channel section ISMB 200 as a cross beam for the placement of the precast concrete planks on the gangway.

4.9. DESIGN OF COLUMN

**DESIGN DATA**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Width of walkway</td>
<td>3m</td>
</tr>
<tr>
<td>Spacing of columns</td>
<td>28m</td>
</tr>
<tr>
<td>Length of the column</td>
<td>6.525m</td>
</tr>
<tr>
<td>No. of horizontal bracings</td>
<td>4</td>
</tr>
<tr>
<td>Design force in the column</td>
<td>275 kN</td>
</tr>
</tbody>
</table>

http://www.iaeme.com/IJCIET/index.asp 1542 editor@iaeme.com
Choose a section of ISMB 500

Properties according to steel tables are:

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area (A)</td>
<td>11074mm²</td>
</tr>
<tr>
<td>Depth of section (h)</td>
<td>500mm</td>
</tr>
<tr>
<td>Width of flange (b)</td>
<td>180mm</td>
</tr>
<tr>
<td>Thickness of flange (t_f)</td>
<td>17.2mm</td>
</tr>
<tr>
<td>Radius of gyration (r_y)</td>
<td>35.2mm</td>
</tr>
<tr>
<td>Thickness of web (t_w)</td>
<td>10.2mm</td>
</tr>
<tr>
<td>Depth of the web (d)</td>
<td>465.6mm</td>
</tr>
<tr>
<td>( b/t_f )</td>
<td>10.5 (&lt; 10.5 \varepsilon)</td>
</tr>
<tr>
<td>( d/t_w )</td>
<td>45.6 (&lt; 84\varepsilon)</td>
</tr>
</tbody>
</table>

Hence the section is compact.

Slenderness ratio (\( \lambda \)) = \( L_{eff}/r \)

- \( L_{eff}/r = 1500/35.2 = 42.61 \)
- \( h/b_f = 500/180 = 2.7 > 1.2 \)
- \( t_f = 17.2 \leq 40 \text{ mm} \)

Buckling is about z-z axis

Referring Table 9(a) of IS 800:2007 for buckling class ‘a’

- Max compressive stress \( f_{cd} \) = 210.8 N/mm²
- Load carrying capacity = \( f_{cd} \times A = 210.8 \times 11074 = 2334 \text{ kN} \) > design force (275 kN)

Buckling about y-y axis

Referring Table 9(b) of IS 800:2007 for buckling class ‘b’

- Max compressive stress \( f_{cd} \) = 203.90 N/mm²
- Load carrying capacity = \( f_{cd} \times \text{area} = 203.90 \times 11074 = 2257.9 \text{ kN} \) > design force (275 kN)

Hence the section ISMB500 is safe and maybe adopted.

### 4.10. DESIGN OF BRACINGS

**HORIZONTAL BRACINGS AND VERTICAL BRACINGS:**

Design force = Maximum compressive force + Self weight

- = 0.68 kN + 5.115 kN
- = 5.795 kN

Choose a section of 2L ISA 75 x 75 x 8 mm

Properties from the steel tables are:

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area (A)</td>
<td>1138mm²</td>
</tr>
<tr>
<td>Width of the section (b)</td>
<td>75mm</td>
</tr>
</tbody>
</table>
Depth of the section (d) = 75mm
Thickness of the section (t) = 8mm
b/t = 75/8
= 9.3 (<9.4ε)
h/t = 75/8
= 9.3 (<9.4ε)

Hence the section is plastic.
For double angle = 2 x 1138
= 2276mm²
Radius of gyration (r_y) = 22.8mm
Effective length (L_{eff}) = 3m
Slenderness ratio (λ) = L_{eff}/r
= 3000/22.8
= 131.57

Referring Table 9(c) of IS 800:2007 for buckling class ‘c’
Max compressive stress f_{cd} = 72.9 N/mm²
Load carrying capacity = f_{cd} x A
= 72.9 x 2276
= 165.9 kN > design force (5.795 kN)

Hence the section **2L ISA 75x75x8mm** is safe and maybe adopted.

### 4.11. DESIGN OF FOOTING

**DESIGN DATA**
Assume square column as pedestal = 900x900mm
Load = 320kN
Safe bearing capacity = 190KN/m²
Depth of foundation = 1.8m

Use M20 grade concrete and Fe415 grade steel

**SIZE OF FOOTING**
P = 320kN
Q_u = 190kN/m²
H = 1.8m
P_u = 320/190
= 1.6845m²
Minimum size of square footing = √1.6845
= 1.29m

Assume a size of **1.4mx1.4m**

**THICKNESS OF FOOTING SLAB BASED ON SHEAR**
Q_U = 320/0.25
= 1.28 N/m²

One way shear,
V_{U1} = 1.28 x 1400 x (250 – D)
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\[ V_{u2} = 1.28 \times (1400^2 - (900+d)^2) \]

Substitute \( d = 200 \text{mm} \)

\[ V_{u2} = 1.28 \times (1400^2 - (900+200)^2) = 960 \text{ kN} \]

Two way shear resistance

\[ V_{c2} = K_c \tau_c \times (4 \times (900+d)d) \]

\[ \tau_c = 0.25 \sqrt{20} = 1.12 \text{MPa} \]

\[ V_{c2} = 1 \times 1.12 \times 4d \times (900+d) = 4032d+4.48d^2 \]

\[ V_{u2} = V_{c2} = 960 \times 10^3 = 4032d+4.8d^2 \]

\[ d = 195.5 \text{mm} \]

Assuming that a clear cover of 75mm and 16mm \( \phi \) bars are used

\[ D = 200 + 75 + 8 = 283 \text{mm} \]

Provision an overall depth of 300mm

For the purpose of flexural reinforcement calculation, an average value of \( d \) is used

\[ d = 300-75-8 = 217 \text{mm} \]

A depth of 220mm is provided

Assuming unit weight of concrete and soil as 24 kN/m\(^2\) and 18 kN/m\(^2\) respectively, actual gross pressure at footing base

\[ q = \frac{320/1.4 \times 1.4 + (24 \times 0.3) + (18 \times 0.3)}{1.4} = 175.86 \text{kN/m}^2 < 190 \text{kN/m}^2 \]

4.12. DESIGN OF FLEXURAL REINFORCEMENT

Factored moment at column face (in either direction)

\[ M_u = 1.28 \times 1400 \times ((1400-900)/2)^2 = 112 \times 10^6 \text{Nmm} \]

\[ R = M_u / b d^2 = 112 \times 10^6 / (1400 \times 220^2) = 1.65 \text{ N/mm}^2 \]
\[
P_t/100 = \frac{f_{ck}(1-\sqrt{1-4.598R/f_{ck}})}{2f_y} = 20/2\times415 \left(1 - \sqrt{1-4.598\times1.65/20}\right) = 0.018
\]

\[
A_{st,\min} = 0.0012bd = 0.0012\times1400\times300 = 504\text{mm}^2
\]

\[
P_t = 100 \times 504/(1400 \times 220) = 0.16 < 0.25 (\text{assumed percentage reinforcement})
\]

From IS 456:2000 tables 19

\[
A_{st,req} = 0.25 \times 1400 \times 220/100 = 770\text{mm}^2
\]

Using 10mm $\phi$ bars, number of bars required is

\[
n = 770/78.53 = 9.8 \approx 10 \text{ Nos (approx)}
\]

To determine the spacing

\[
S_v = 78.53/770 \times 100
\]

\[
= 100\text{mm}
\]

Provide 10# 10mm $\phi$ bars at 100mm c/c spacing in both ways

Check for shear

\[
V_u = 200.96 \times (1000-900) = 20.64 \text{ kN}
\]

\[
100A_{st} = 100 \times 770
\]

\[
B_d = 1000 \times 220
\]

\[
= 0.35
\]

From table 19 IS 456:2000 and from clause 40.2.1.1

\[
K_S\tau_C = 1 \times 0.46 = 0.46 \text{ N/mm}^2
\]

\[
\tau_v = 20.64 \times 10^3/1000 \times 220 = 0.092 \text{ N/mm}^2
\]

\[
\tau_v < K_S\tau_C
\]

Provide footing of size 1.4mX1.4m at a depth of 1.8m below ground level and footing depth of 300mm.

5. RESULTS AND CONCLUSIONS

The various structural elements of the Foot Over Bridge were analyzed using STAAD. Pro for the dead load and live load. The structural steel elements were then designed for the corresponding data using IS 800:2007. The footing was designed according to IS456:2000.
The sections which are designed for use for the various structural elements are specified in the following Table 1 to Table 4. The detailed structural drawings have been presented in Figure.

### Table 1 Sections used for main truss

<table>
<thead>
<tr>
<th>COMPONENT</th>
<th>MEMBER</th>
<th>SECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top chord</td>
<td>Compression</td>
<td>ISA 150x150x12 (double)</td>
</tr>
<tr>
<td>Bottom chord</td>
<td>Tension</td>
<td>ISA 150x150x12 (double)</td>
</tr>
<tr>
<td>Diagonals</td>
<td>Compression</td>
<td>ISA 100x100x10 (double)</td>
</tr>
<tr>
<td></td>
<td>Tension</td>
<td>ISA 100x100x10 (double)</td>
</tr>
<tr>
<td>End diagonals</td>
<td>Compression</td>
<td>ISA 150x150x12 (double)</td>
</tr>
<tr>
<td>Vertical</td>
<td>Tension</td>
<td>ISA 90x90x8 (single)</td>
</tr>
</tbody>
</table>

### Table 2 Sections used for gangway

<table>
<thead>
<tr>
<th>COMPONENT</th>
<th>SECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary girder parallel to gangway</td>
<td>ISMB 200</td>
</tr>
<tr>
<td>Secondary girder perpendicular to gangway</td>
<td>ISMB 200</td>
</tr>
</tbody>
</table>

### Table 3 Sections used for column

<table>
<thead>
<tr>
<th>COMPONENT</th>
<th>SECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main column</td>
<td>ISMB 500</td>
</tr>
<tr>
<td>Horizontal bracing</td>
<td>ISA 75x75x8 (double)</td>
</tr>
<tr>
<td>Inclined bracing</td>
<td>ISA 75x75x8 (double)</td>
</tr>
</tbody>
</table>

### Table 4 Schedule of footings

<table>
<thead>
<tr>
<th>COMPONENT</th>
<th>X(mm)</th>
<th>Y(mm)</th>
<th>D(mm)</th>
<th>REINFORCEMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Footing</td>
<td>1400</td>
<td>1400</td>
<td>300</td>
<td>10mm dia @ 100mm c/c both ways</td>
</tr>
</tbody>
</table>

5. CONCLUSIONS

Thus the various components of the Foot Over Bridge namely Main Truss, Columns along with the Footings have been analyzed using STAAD. Pro software and the most economic and safe sections are arrived through manual design. The use of steel as the construction material has resulted in the overall economy of construction when compared to Reinforced Concrete Structure. The components are designed for the maximum safety and the adaptability of the structure to future changes has also been given due consideration.

REFERENCES