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Analysis and Design of Foot-Over Bridge

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ABSTRACT

The main purpose of this assignment is to understanding using of STAAD Pro to evaluate & build a Truss. An efficient structural engineer is essential in today's rapidly developing and more competitive industry. As a follow-up, an effort is made to use the programme STAAD pro to evaluate and build a Truss. Manual load estimates and STAAD Pro analysis complete the design. Using STAAD Pro's load case information, structure were subject to its own weight in addition to dead & live loads and wind pressure. STAAD Pro calculated wind loads at various heights according to requirements of IS 875, taking into account specified wind intensities. By using different sizes and shapes of steel elements we are trying to analyze the steel structure by trial and error method by selecting various sections and analyzing the structure using the Staad Pro software. For buildings to meet their basic structural safety obligations, minimum design loads including dead loads, imposed loads, as well as other exterior loads must be considered. It is intended that structural integrity of structures being planned would be guaranteed by strict adherence to loading requirements. specified in this code.

Keywords: Foot-over bridge, STAAD-PRO, Truss

1. Introduction

In order to connect the two zones of a particular place which are separated by an obstruction a bridge is constructed as a medium of movement and transportation. The obstruction may be a road or railway or any other physical obstruction to avoid it a steel truss bridge is to be designed and analyzed before constructing it. In the last centuries the bridges are designed by manual calculations and then by the advent of powerful and helpful software the designing and analysis of structures are made more easy and accurate and as well as less time consuming. In this project a pedestrian bridge is to be designed by using software known as STAAD Pro. In this the steel truss bridge is loaded with a dead load, live load, pedestrian loads etc.

1.1 Configuration of foot over bridge

Foot over bridge of 20 spans investigated& designed. Formation of bridge follows:

Span of bridge	20m
Height of bridge	8.50m
Width of pedestrian	2m
Spacing between each truss	2m
Type of truss	Pratt Truss

2. Literature Review

1) Shubhank Gupta et.al (2017) provided technical study & designing for a 50-meter-long steel-truss railway bridge. The bridge with equal train applied loads of 32.5 tones was already allocated in several kinds of truss segments to discover the cheapest and most stable section. Design and analysis is conducted utilising tool staad pro for optimising section and select optimal stable portions for comparison. Each truss's structural elements were designed following the guidelines set out by Indian Roads Congress Code & Indian Railway Standard Code.

2) M.C Paliwal & Chandresh Kumar Jha (2017) Using STAAD. Pro V8i software, the authors of this paper offered an analysis of Howe Truss optimization through the Fully Stressed Design (FSD) method (SELECT series4). Each truss in the three span ranges (8 m, 10 m, and 12 m) has been exposed to 24 different load situations by varying the nodal load and position of the applied load, which is always symmetric. The four load configurations of 100 kN, 125 kN, 150 kN, & 175 kN are used. 72 trusses used in this research were designed such that they would produce a stress level of 100 MPa. Maximum deflection and optimum truss mass have been determined for every scenario. For each span, we also computed the deflection per unit of weight & compared results graphically. The study's findings will be useful in developing the truss that can both save money and withstand heavy loads.

3) Pradeep K. Goyal & Ramesh Kumar Dhaka (2017) use of Staad Pro to illustrate the plan for a steel arch bridge in Jaipur. The suggested arch bridge in this research has a 350 -meter span, a width of 13.3 metres, and a mean height of 29.977 metres. Arch bridges are designed by taking into account wind loading, seismic stress, live loading, & dead loading. The structure evaluation & planning software Staad Pro is used in conjunction with Indian standards to complete the design.

4) S. R. Satone & Vipin A. Saluja (2016) The seismic study of the footbridge was conducted for a variety of ground conditions. We use Staad-Response Pro's Spectrum analysis to illustrate the impact of varied soil conditions in earthquake zones.

5) Blanchard J, Davies B L, Smith J W[1], On the basis of preliminary studies of human resistance, this research proposes a limit to the acceptable rising rate of footbridge deck, trembling beneath individual on foot stacking. A formula is found for calculating the maximum vertical acceleration of a footbridge due to the coupled dynamically stack of a moving man. Finally, computational evidence showed that static stacking conditions would reliably ensure how this stacking will be safe. Vibration caused by wind is ignored here.

3. Analysis & Designing

Staad Pro is used for analysis& designing process.

Staad Pro was used to create model of building, & lines connecting nodes represent the distance between them.
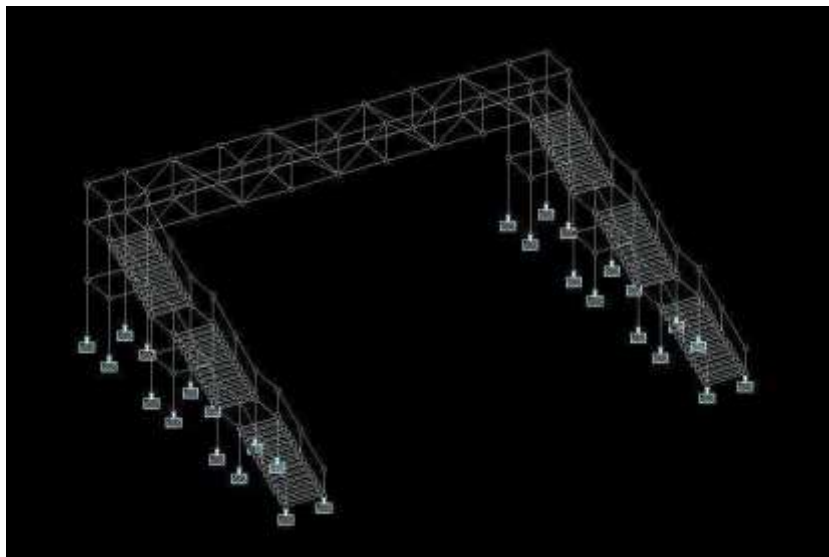

Figure 1: Structural Model

The structure model shown in above figure is drawn by using STAAD Pro software. In this the firstly the nodes are created by using coordinates into 3Di.e. X-Axis, Y-Axis & Z-Axis for proper execution of nodes these coordinates are entered in the software then a node is created, after the coordination of nodes these nodes are then connected by using "Add Beam" option in the tool bar, by selecting this you can join the nodes to form a beam or column element, with this series of nodes and elements this structure has been created.
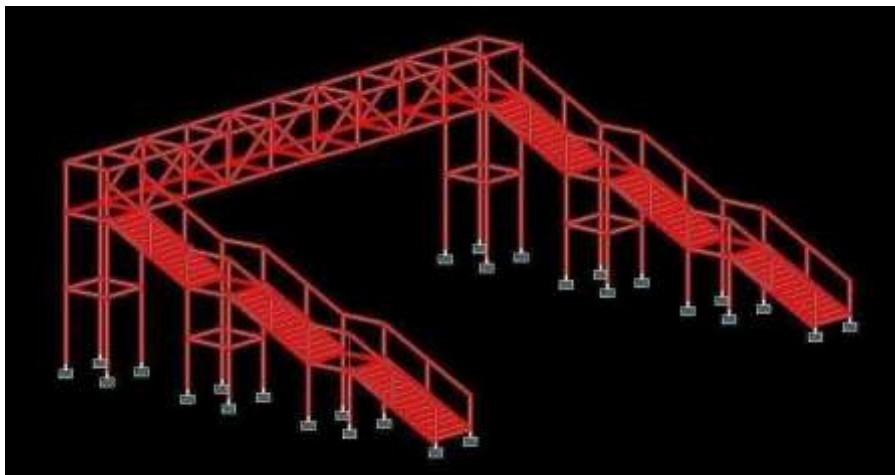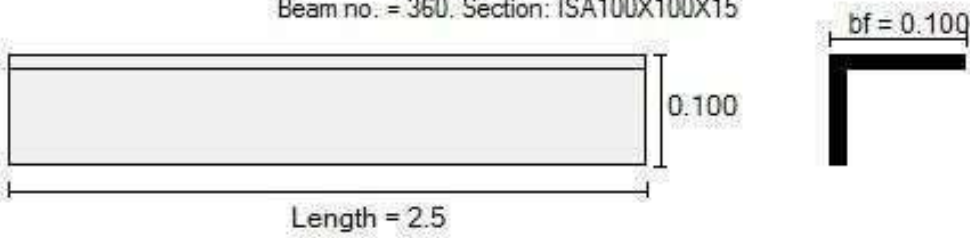

Figure 2: shows the loading of structure

The structure is imposed with dead live & wind loading upon structure and are assigned with material properties of the structure which are consisting of different steel sections according to Indian Standard Codes.

Beam no. = 360. Section: ISA100X100X15

Length = 2.5

bf = 0.100

0.100

Physical Properties (Unit: m)

Ax	0.00279	Ix	2.16562e-00
Ay	0.001	Iy	3.9695e-006
Az	0.001	Iz	1.06816e-00
D	0.1	W	0.1

Assign/Change Property
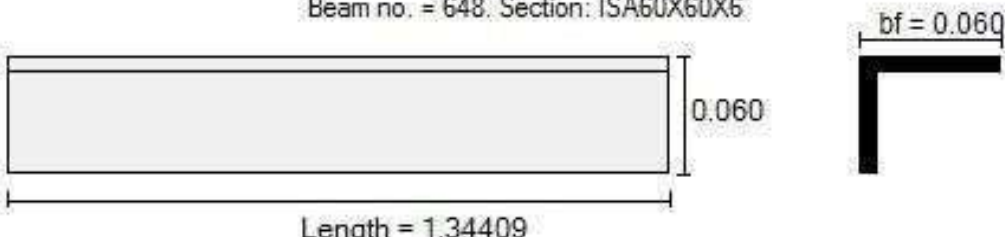
Material Properties

Elasticity(kN/mm2)	205	Density(kg/m3)	7833.41
Poisson	0.3	Alpha	1.2e-005

STEEL

Assign Material

Beam no. = 648. Section: ISA60X60X6

Length = 1.34409

bf = 0.060

0.060

Physical Properties (Unit: m)

Ax	0.000684	Ix	8.424e-009
Ay	0.00024	Iy	3.71412e-00
Az	0.00024	Iz	9.51594e-00
D	0.06	W	0.06

Assign/Change Property

Material Properties

Elasticity(kN/mm2)	205	Density(kg/m3)	7833.41
Poisson	0.3	Alpha	1.2e-005

STEEL

Assign Material

Beam no. = 406. Section: ISMB200

0.200

0.006

Length = 3

bf = 0.100
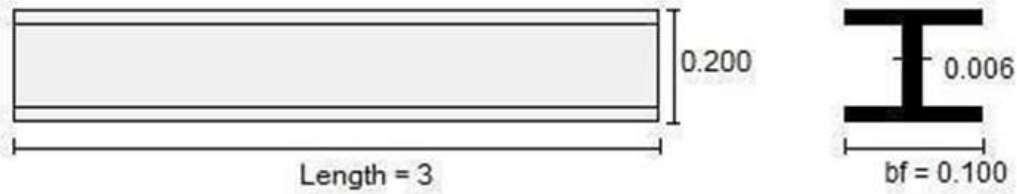
Physical Properties (Unit: m)

Ax	0.00308	Ix	1.06e-007
Ay	0.00114	Iy	1.37e-006
Az	0.00133333	Iz	2.115e-005
D	0.2	W	0.1

Assign/Change Property

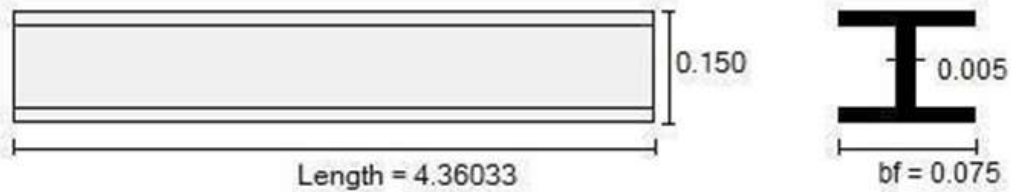**Material Properties**

Elasticity(kN/mm2)	205	Density(kg/m3)	7833.41
Poisson	0.3	Alpha	1.2e-005

STEEL ▼

Assign Material

Beam no. = 654. Section: ISMB150

0.150

0.005

Length = 4.36033

bf = 0.075

Physical Properties (Unit: m)

Ax	0.00191	Ix	4.29e-008
Ay	0.00075	Iy	4.68e-007
Az	0.0008	Iz	7.18e-006
D	0.15	W	0.075

Assign/Change Property

Material Properties
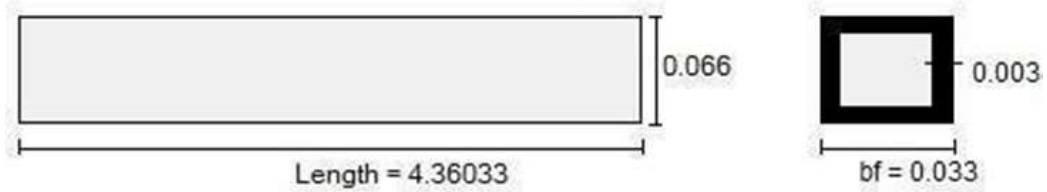
Elasticity(kN/mm2)	205	Density(kg/m3)	7833.41
Poisson	0.3	Alpha	1.2e-005

STEEL ▼

Assign Material

Beam no. = 704. Section: TUB66332.9

0.066

0.003

Length = 4.36033

bf = 0.033

Physical Properties (Unit: m)

Ax	0.000519	Ix	2.24494e-00
Ay	0.0003828	Iy	9.12e-008
Az	0.0001914	Iz	2.73e-007
D	0.066	W	0.033

Assign/Change Property

Material Properties

Elasticity(kN/mm2)	205	Density(kg/m3)	7833.41
Poisson	0.3	Alpha	1.2e-005

STEEL ▼

Assign Material

Beam no. = 139. Section: TUB40402.6

0.040

0.003

Length = 2

bf = 0.040

Physical Properties (Unit: m)

Ax	0.000372	Ix	1.36015e-00
Ay	0.000208	Iy	8.45e-008
Az	0.000208	Iz	8.45e-008
D	0.04	W	0.04

Assign/Change Property

Material Properties

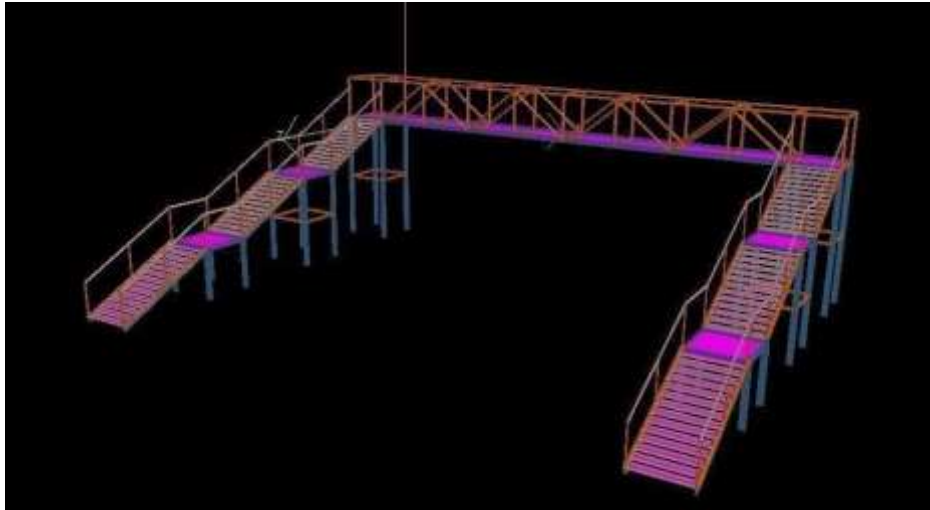| Elasticity(kN/mm2)	205	Density(kg/m3)	7833.41
Poisson	0.3	Alpha	1.2e-005

STEEL ▼

Assign Material

Figure 3: showing the three dimensional view of foot over bridge

As it contains different sections of steel structures and various properties that can be seen in the 3D rendering view in the Staad pro software.

The Model Consists Of Following Elements:

Total Number of Nodes	460
Total Number of Beams	710
Total Number of Plates	94

In this plates are used as a floor to with stand the area loads and moving loads on the bridge which is consist of a 2mm thickness steel plate as per the specification given by the staad pro software and assigned on the structure.
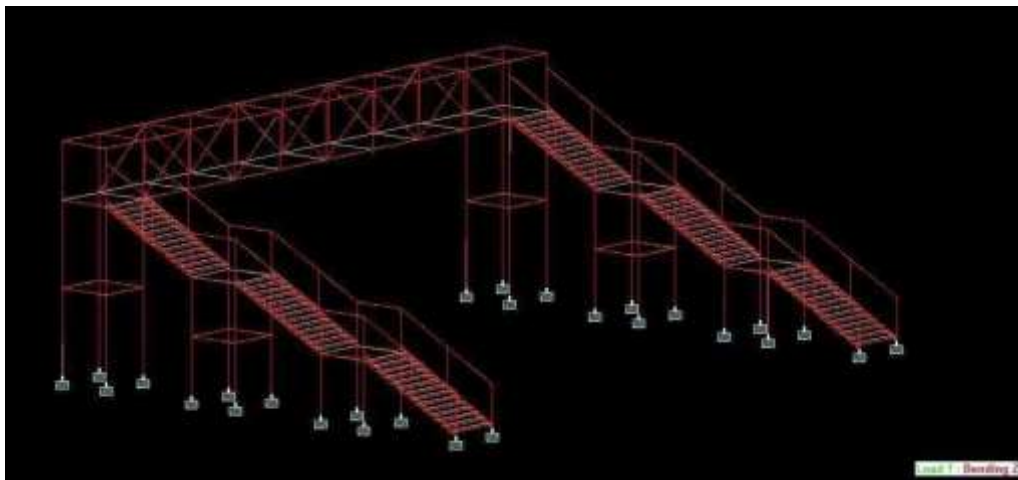

Figure 4 : shows the bending moment of beam elements

In this figure the red lines shows the bending moment of steel elements i.e. the beams and columns which is known after the analysis of structure. The structural model is created then its properties are been assigned then the loading conditions are assigned then the analysis is done and checked for the further process of post processing and designing of the structure.

After the analysis is done output file is given by the software about the analysis showing the results of each and every member regarding stress and strain reactions of that member and if it is safe to carry out further design on that member and hence it move on to next step of analysis.

These deflections of the beam can be easily seen in the figure and as well as in the output report of given bending moment is given in millimeters or else if the member fails then the output of such elements is not seen on the modeling view and the given deflection and bending moments are shown in the output file
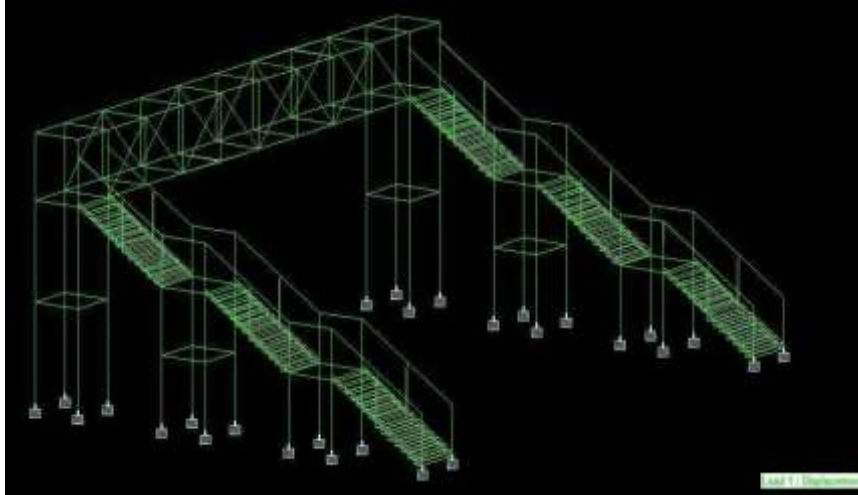
Figure 5: shows the displacement of members

In this above figure displacement of members are been shown when the structure is loaded and analyzed then the results were shown as per the loading on the structure and further displacements are shown on the structure. Particularly each and every member can be checked by selecting the member, its properties and deflection is also known of every element, if there is any failure of member then we can change the member properties of the member and increase the properties from the section database and improve its strength. And hence this result shows the displacement of members and can be rectified by knowing output results.

The software provides the easy access to the given deflections of a model to clearly identify the loadings and its deflections appears when the loading is applied with that we can easily rectify the mistake and necessary corrections are made to avoid the deflection of large volume.
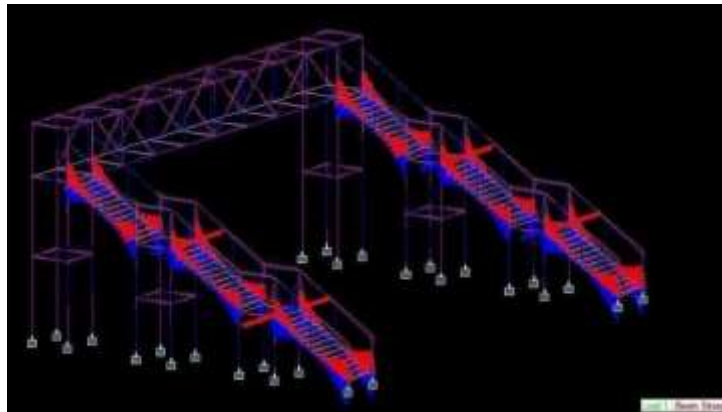

Figure 6: portrays stresses inducing into beam

Figure shows stresses induced in beam when the structure is analyzed, the output results shows the reactions of each and every beam reacting to the loads and can be seen in the figure. In this the red lines shows the negative stress and the blue lines shows the positive bending stress of a beam, the most effected member is the beams of the staircase. The pattern emerged is as per the stresses induced in the member the higher the rise the more will be the stress on that member, and hence by knowing this further process of analyzing and designing is started.

The stresses are clearly seen in the modeling view of every single member with that we came to know the action of load on that particular member then with this we can upgrade or modify the properties of the member and lower the stresses induced on the member or else we can reduce the clear span of the model by the use of staad pro software.

Assumed Data

Bolts diameter	16mm
Gusset plate thickness	8 mm
Property class is	4.6
Steel grade	410

Design Procedure

Nominal diameter of bolts	16mm
Ultimate tensile strength of bolt	400N/mm²
Edge distance (e)	1.7x18=30.6mm
Pitch distance (p)	2.5x16=40mm
Ultimate tensile stress of plate	410N/mm²

Shear capacity of bolt as given by Equation Vdsp = Vnsb/γmb

Where,

Vnsb = Nominal shear capacity of bolts γmb = Partial safety factor 1.25

Nominal shear capacity of bolts is given by Vnsb = <u>fub (nn x Anb)</u>

1.732

4. Foundation Design

Having completed the software-based analysis and design process, the maximal reaction values obtained are referenced from the aforementioned table, & isolated footing is created in accordance with IS code IS:456-2000.

Sl.No	Footing No	Foundation Geometry		
-	-	Length	Breadth	Thickness
1	1	1.200 m	1.200 m	0.305 m
2	2	1.150 m	1.050 m	0.305 m
3	3	1.150 m	1.050 m	0.305 m
4	4	1.150 m	1.050 m	0.305 m
5	5	1.350 m	1.350 m	0.305 m
6	6	1.150 m	1.050 m	0.305 m
7	7	1.100 m	1.100 m	0.305 m
8	106	1.200 m	1.200 m	0.305 m
9	107	1.450 m	1.450 m	0.305 m
10	108	1.150 m	1.050 m	0.305 m
11	109	1.150 m	1.050 m	0.305 m
12	110	1.150 m	1.050 m	0.305 m
13	111	1.150 m	1.050 m	0.305 m
14	112	1.900 m	1.900 m	0.305 m
15	240	1.200 m	1.200 m	0.305 m
16	241	1.450 m	1.450 m	0.305 m
17	242	1.150 m	1.050 m	0.305 m
18	243	1.150 m	1.050 m	0.305 m
19	244	1.150 m	1.050 m	0.305 m
20	245	1.150 m	1.050 m	0.305 m
21	246	1.900 m	1.900 m	0.305 m
22	345	1.250 m	1.250 m	0.305 m
23	346	1.150 m	1.050 m	0.305 m
24	347	1.150 m	1.050 m	0.305 m
25	348	1.150 m	1.050 m	0.305 m
26	349	1.350 m	1.350 m	0.305 m
27	350	1.150 m	1.050 m	0.305 m
28	351	1.100 m	1.100 m	0.305 m
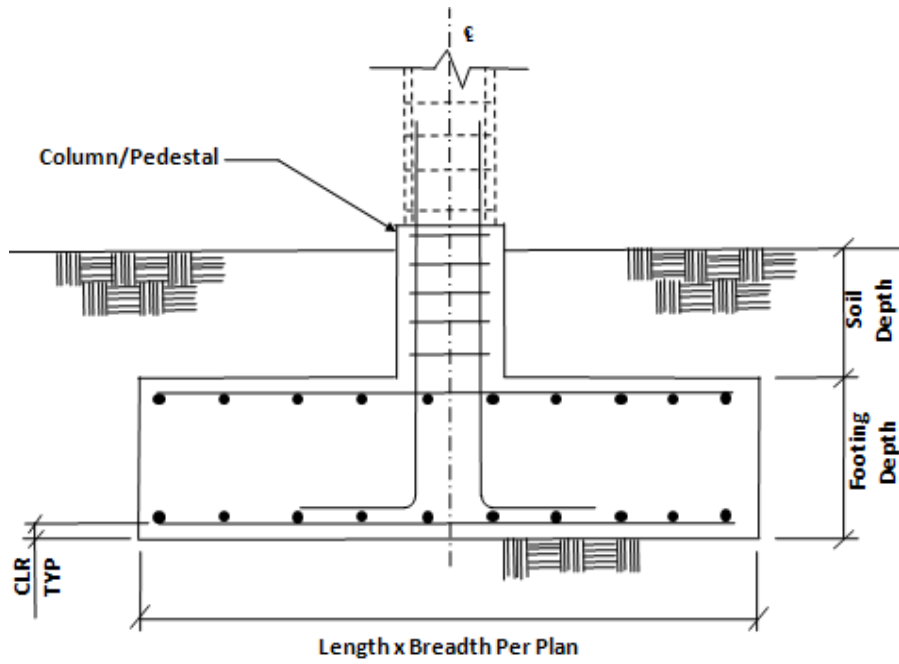
ELEVATION
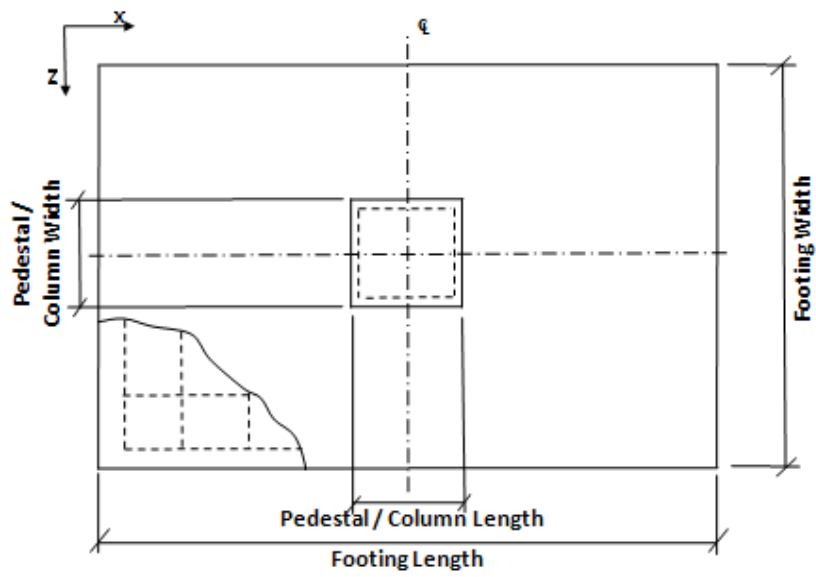
PLAN

Footing No	Footing Reinforcements			
-	Bottom Reinforcements	Bottom Reinforcements	Top Reinforcements	Top Reinforcements
1	#10 @ 215 mm c/c	#10 @ 215 mm c/c	#10 @ 215 mm c/c	#10 @ 215 mm c/c
2	#10 @ 235 mm c/c	#10 @ 205 mm c/c	#10 @ 235 mm c/c	#10 @ 205 mm c/c
3	#10 @ 235 mm c/c	#10 @ 205 mm c/c	#10 @ 235 mm c/c	#10 @ 205 mm c/c
4	#10 @ 235 mm c/c	#10 @ 205 mm c/c	#10 @ 235 mm c/c	#10 @ 205 mm c/c
5	#10 @ 205 mm c/c	#10 @ 205 mm c/c	#10 @ 205 mm c/c	#10 @ 205 mm c/c
6	#10 @ 235 mm c/c	#10 @ 205 mm c/c	#10 @ 235 mm c/c	#10 @ 205 mm c/c
7	#10 @ 195 mm c/c	#10 @ 195 mm c/c	#10 @ 195 mm c/c	#10 @ 195 mm c/c
106	#10 @ 215 mm c/c	#10 @ 215 mm c/c	#10 @ 215 mm c/c	#10 @ 215 mm c/c
107	#10 @ 220 mm c/c	#10 @ 220 mm c/c	#10 @ 220 mm c/c	#10 @ 220 mm c/c
108	#10 @ 235 mm c/c	#10 @ 205 mm c/c	#10 @ 235 mm c/c	#10 @ 205 mm c/c
109	#10 @ 235 mm c/c	#10 @ 205 mm c/c	#10 @ 235 mm c/c	#10 @ 205 mm c/c
110	#10 @ 235 mm c/c	#10 @ 205 mm c/c	#10 @ 235 mm c/c	#10 @ 205 mm c/c
111	#10 @ 235 mm c/c	#10 @ 205 mm c/c	#10 @ 235 mm c/c	#10 @ 205 mm c/c
112	#10 @ 220 mm c/c	#10 @ 220 mm c/c	#10 @ 220 mm c/c	#10 @ 220 mm c/c
240	#10 @ 215 mm c/c	#10 @ 215 mm c/c	#10 @ 215 mm c/c	#10 @ 215 mm c/c
241	#10 @ 220 mm c/c	#10 @ 220 mm c/c	#10 @ 220 mm c/c	#10 @ 220 mm c/c
242	#10 @ 235 mm c/c	#10 @ 205 mm c/c	#10 @ 235 mm c/c	#10 @ 205 mm c/c
243	#10 @ 235 mm c/c	#10 @ 205 mm c/c	#10 @ 235 mm c/c	#10 @ 205 mm c/c
244	#10 @ 235 mm c/c	#10 @ 205 mm c/c	#10 @ 235 mm c/c	#10 @ 205 mm c/c
245	#10 @ 235 mm c/c	#10 @ 205 mm c/c	#10 @ 235 mm c/c	#10 @ 205 mm c/c
246	#10 @ 220 mm c/c	#10 @ 220 mm c/c	#10 @ 220 mm c/c	#10 @ 220 mm c/c
345	#10 @ 225 mm c/c	#10 @ 225 mm c/c	#10 @ 225 mm c/c	#10 @ 225 mm c/c
346	#10 @ 235 mm c/c	#10 @ 205 mm c/c	#10 @ 235 mm c/c	#10 @ 205 mm c/c
347	#10 @ 235 mm c/c	#10 @ 205 mm c/c	#10 @ 235 mm c/c	#10 @ 205 mm c/c
348	#10 @ 235 mm c/c	#10 @ 205 mm c/c	#10 @ 235 mm c/c	#10 @ 205 mm c/c
349	#10 @ 205 mm c/c	#10 @ 205 mm c/c	#10 @ 205 mm c/c	#10 @ 205 mm c/c
350	#10 @ 235 mm c/c	#10 @ 205 mm c/c	#10 @ 235 mm c/c	#10 @ 205 mm c/c
351	#10 @ 195 mm c/c	#10 @ 195 mm c/c	#10 @ 195 mm c/c	#10 @ 195 mm c/c

5. Design Parameters

Concrete & Rebar Properties

Unit Weight of Concrete:	25.000 kN/m3
Strength of Concrete:	25.000 N/mm2
Yield Strength of Steel:	415.000 N/mm2
Minimum Bar Size:	#10
Maximum Bar Size:	#32
Minimum Bar Spacing:	50.000 mm
Maximum Bar Spacing:	500.000 mm
Pedestal Clear Cover (P, CL):	50.000 mm
Footing Clear Cover (F, CL):	50.000 mm

Soil Properties

Soil Type:	Drained
Unit Weight:	22.000 kN/m3
Soil Bearing Capacity:	100.000 kN/m2
Soil Surcharge:	0.000 kN/m2
Depth of Soil above Footing:	0.000 mm
Cohesion:	0.000 kN/m2

6. Design Calculations:

Coefficient of Friction:	0.500
Factor of Safety Against Sliding:	1.500
Factor of Safety Against Overturning:	1.500

Consider Footing 1 Footing Size

Initial length (L_o) = 1.000m Initial width (W_o) = 1.000m

Initial width&lengthArea, $A_o = L_o \times W_o$ = 1.000 m^2

Minimal area needed from bearing pressure, $A_{min} = P / q_{max}$ = 0.096 m^2 Final Footing Size

Length	=	1.200m
Width	=	1.200m
Depth	=	0.305m
Area	=	1.440m^2

Pressure at 4 corners
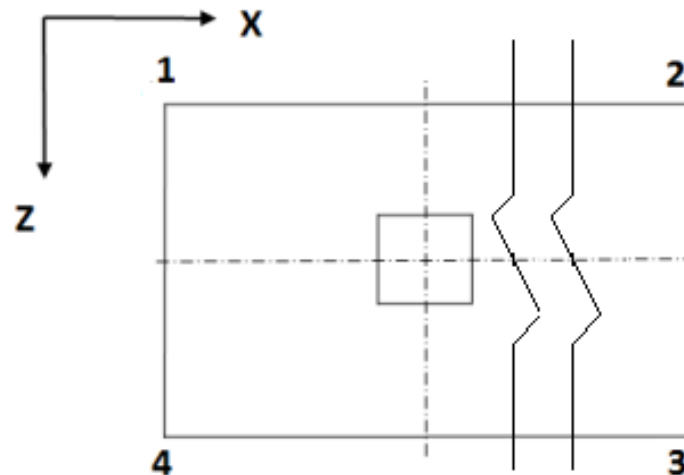
Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)	Area of footing in uplift (A_u) (m²)
3	**26.1517**	7.5629	-10.5748	8.0140	0.242
1	10.9418	**8.4908**	7.0593	9.5104	0.000
1	7.6107	7.6324	**7.6320**	7.6103	0.000
1	10.9418	8.4908	7.0593	**9.5104**	0.000

Assuming A_u0, Nothing has to be lifted, and the air pressure doesn't have to be changed either. If uplift is present, the negative pressure would be reset to 0, & pressure would be reallocated to other corners.

Summary of Adjusted Pressures at 4 corners

Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
3	**31.4102**	5.5713	0.0000	6.1194
1	10.9418	**8.4908**	7.0593	9.5104
1	7.6107	7.6324	**7.6320**	7.6103
1	10.9418	8.4908	7.0593	**9.5104**

Checking for stability against sliding & overturning
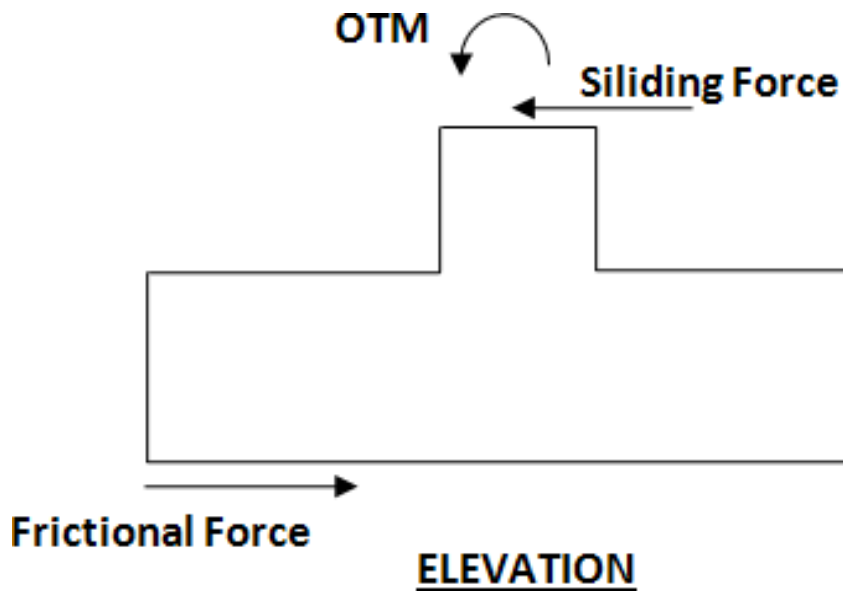
	Factor of safety against sliding		Factor of safety against overturning	
Load Case No.	Along X-Direction	Along Z-Direction	About X-Direction	About Z-Direction
1	39.483	56.277	37.725	22.033
2	14.470	10.025	6.506	7.601
3	7.750	6.518	4.258	4.155

Critical Load Case & Governing Factor Of Safety For Sliding &Overturning - X Direction

Critical Load Case for Sliding along X-Direction:	103
Governing Disturbing Force:	-1.195 kN
Governing Restoring Force:	5.604 kN
Minimum Sliding Ratio for the Critical Load Case:	4.688
Critical Load Case for Overturning about X-Direction:	103
Governing Overturning Moment:	-2.611 kNm
Governing Resisting Moment:	6.724 kNm
Minimum Overturning Ratio for the Critical Load Case:	2.575

Critical Load Case & Governing Factor Of Safety For Sliding & Overturning - Z Direction

Critical Load Case for Sliding along Z-Direction:	103
Governing Disturbing Force:	-1.421 kN
Governing Restoring Force:	5.604 kN
Minimum Sliding Ratio for the Critical Load Case:	3.943
Critical Load Case for Overturning about Z-Direction:	101
Governing Overturning Moment:	2.677 kNm
Governing Resisting Moment:	6.729 kNm
Minimum Overturning Ratio for the Critical Load Case:	2.514

Moment Calculation

Check Trial Depth against moment (w.r.t. X Axis)

$$\text{Critical Load Case} = \#201$$
$$\text{Effective Depth} = D - (cc + 0.5 \times d_b) = 0.250 \text{ m}$$
$$\text{Governing moment } (M_u) = 1.845 \text{ kNm}$$

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 $(K_{umax}) = \dfrac{700}{(1100 + 0.87 \times f_y)}$ = 0.479107

Limiting Factor2 $(R_{umax}) = $ = 3444.291146 kN/m2

$$0.36 \times f_{ck} \times k_{umax} \times (1 - 0.42 \times kumax)$$

Limit Moment Of Resistance $(M_{umax}) = R_{umax} \times B \times d_e$ = 258.317132 kNm

       $M_u <= M_{umax}$ hence, safe

Check Trial Depth against moment (w.r.t. Z Axis)

     Critical Load Case   = #201

     Effective Depth = $D - (cc + 0.5 \times d_b)$ = 0.250 m

     Governing moment (M_u) = 1.597 kNm

     As Per IS 456 2000 ANNEX G G-1.1C

     Limiting Factor1 $(K_{umax}) = \dfrac{700}{(1100 + 0.87 \times f_y)}$ = 0.479107

     Limiting Factor2 $(R_{umax}) = $ = 3444.291146 kN/m2

$$0.36 \times f_{ck} \times k_{umax} \times (1 - 0.42 \times kumax)$$
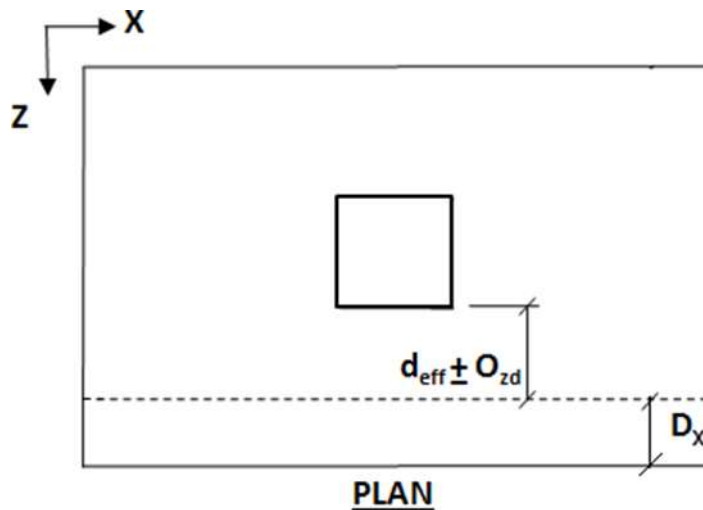
     Limit Moment of Resistance $(M_{umax}) = R_{umax} \times B \times d_e^2$ = 258.317132 kNm

       $M_u <= M_{umax}$ hence, safe

Shear Calculation

     Check Trial Depth for one way shear (Along X Axis)

     (Shear Plane Parallel to X Axis)

PLAN

Critical Load Case = #205

$$D_X = 0.250 \text{ m}$$

Shear Force(S) = 6.309 kN

Shear Stress (T_v) = 21.031049 kN/m2

Percentage Of Steel (P_t) = 0.1464
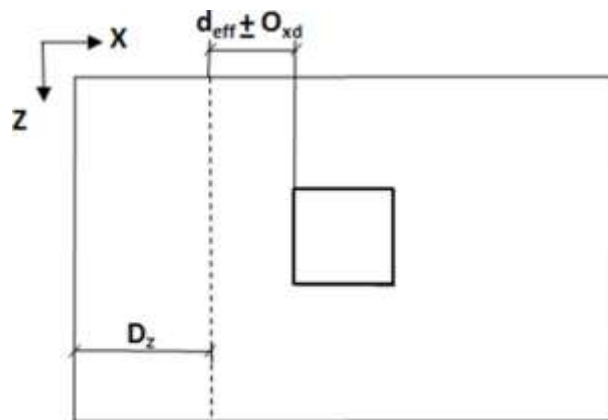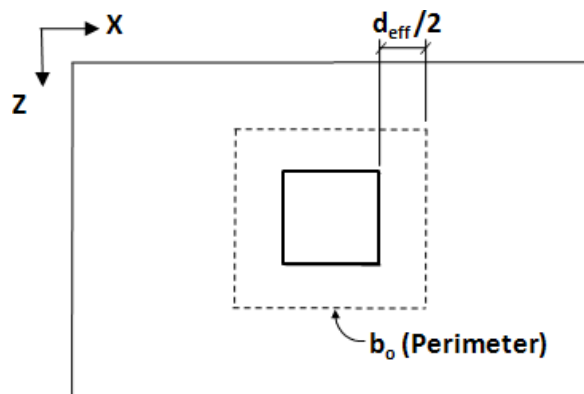
As Per IS 456 2000 Clause 40 Table 19

Shear Strength of Concrete (T_c) = 287.798 kN/m2

$T_v < T_c$ hence, safe

Check Trial Depth for one way shear (Along Z Axis)

(Shear Plane Parallel to Z Axis)

PLAN

Critical Load Case = #205

$$D_Z = 0.250 \text{ m}$$

Shear Force(S) = 6.376 kN

Shear Stress (T_v) = 21.254790 kN/m2

Percentage Of Steel (P_t) = 0.1464

As Per IS 456 2000 Clause 40 Table 19

Shear Strength Of Concrete (T_c) = 287.798 kN/m2

$T_v < T_c$ hence, safe

Check Trial Depth for two way shear

PLAN

Critical Load Case	= #1
Shear Force(S)	= 1.764 kN
Shear Stress(T_v)	= 4.410 kN/m2

As Per IS 456 2000 Clause 31.6.3.1 $\quad\quad min[(0.5 + \beta),1]$

$K_s = \quad\quad = 1.000$

Shear Strength(T_c)= $\quad 0.25 \times \sqrt{f_{ck}}\quad$ = 1250.0000 kN/m2

$\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad K_s \text{ x } T_c \quad\quad$ = 1250.0000 kN/m2

$T_v <= K_s \text{ x } T_c$ hence, safe

Reinforcement Calculation

Calculation of maximum bar size

Along X Axis

Bar diameter corresponding to max bar size (d_b) = 10 mm

As Per IS 456 2000 Clause 26.2.1

Development Length(l_d) = $\dfrac{d_b \times 0.87 \times f_y}{4 \times \Gamma_{bd}}$ = 0.403 m

Allowable Length(l_{db}) = $\left[\dfrac{(B-b)}{2} - cc\right]$ = 0.450 m

$l_{db} >= l_d$ hence, safe

Along Z Axis

Bar diameter corresponding to max bar size(d_b) = 10 mm
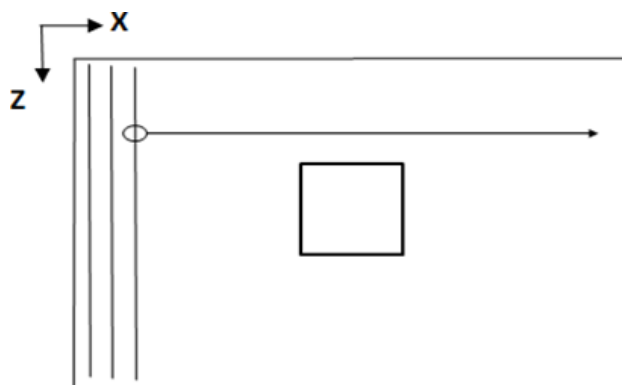
As Per IS 456 2000 Clause 26.2.1

Development Length(l_d) = $\dfrac{d_b \times 0.87 \times f_y}{4 \times \Gamma_{bd}}$ = 0.484 m

Allowable Length(l_{db}) = $\left[\dfrac{(H-h)}{2} - cc\right]$ = 0.500 m

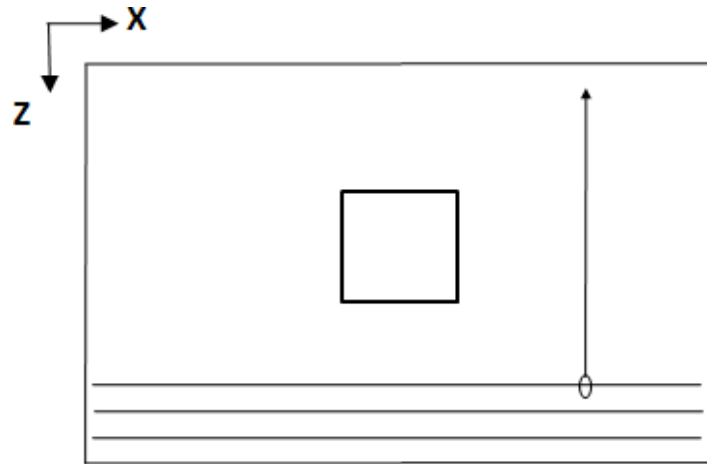$l_{db} >= l_d$ hence, safe

Bottom reinforcement
Design Along Z Axis

PLAN

Along X Axis

PLAN

Based on spacing reinforcement increment; provided reinforcement is

For moment w.r.t. Z Axis (M_z)

As Per IS 456 2000 Clause 26.5.2.1

Critical Load Case $= \#201$

Minimum Area of Steel (A_{stmin}) $= 439.200$ mm2

Calculated Area of Steel (A_{st}) $= 17.709$ mm2

Provided Area of Steel ($A_{st,Provided}$) $= 439.200$ mm2

$A_{stmin} <= A_{st,Provided}$ Steel area is accepted

Selected bar Size (d_b) $= Ø10$

Minimum spacing allowed (S_{min}) $= = 50.000$ mm
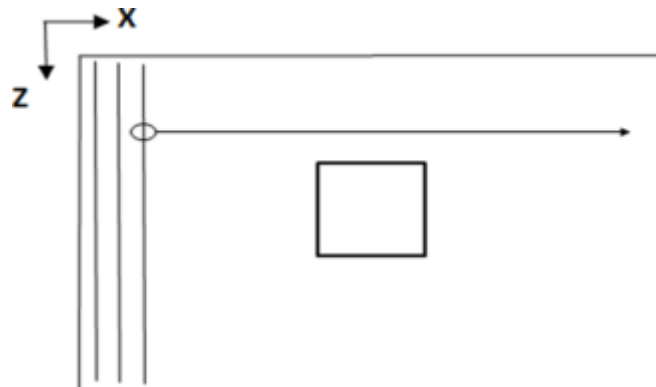
Selected spacing (S) $= 218.000$ mm

$S_{min} <= S <= S_{max}$ and selected bar size < selected maximum bar size...

The reinforcement is accepted.

Ø10 @ 215.000 mm o.c.

Top Reinforcement Design
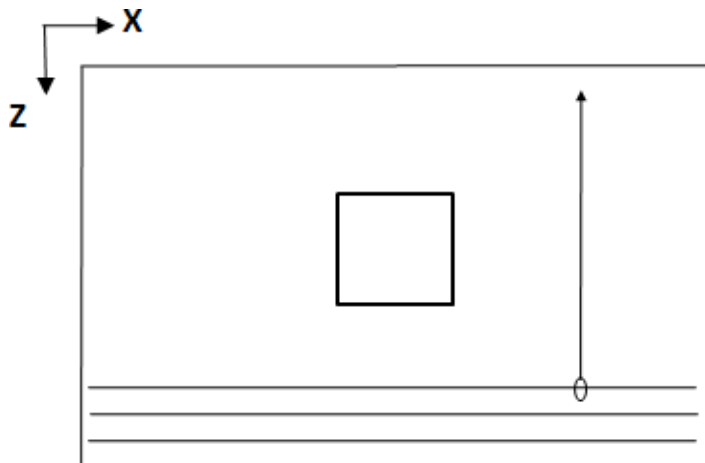
Along Z Axis

PLAN

Minimum Area of Steel (A_{stmin}) = 439.200 mm2

Calculated Area of Steel (A_{st}) = 439.200 mm2

Provided Area of Steel ($A_{st,Provided}$) = 439.200 mm2

$A_{stmin} \leq A_{st,Provided}$ Steel area is accepted

Governing Moment = 1.538 kNm

Selected bar Size (d_b) = Ø10

Minimum spacing allowed (S_{min}) = 50.000 mm

Selected spacing (S) = 218.000 mm

$S_{min} \leq S \leq S_{max}$ and selected bar size < selected maximum bar size...

The reinforcement is accepted.

Based on spacing reinforcement increment; provided reinforcement is

Ø10 @ 215 mm o.c.

Along X Axis

PLAN

Minimum Area of Steel (A_{stmin}) = 439.200 mm2

Calculated Area of Steel (A_{st}) = 439.200 mm2

Provided Area of Steel ($A_{st,Provided}$) = 439.200 mm2

$A_{stmin} \leq A_{st,Provided}$ Steel area is accepted

Governing Moment = 1.271 kNm

Selected bar Size (d_b) = Ø10

Minimum spacing allowed (S_{min}) = = 50.000 mm

Selected spacing (S) = 218.000 mm

$S_{min} \leq S \leq S_{max}$ and selected bar size < selected maximum bar size...

The reinforcement is accepted.

Based on spacing reinforcement increment; provided reinforcement is

Ø10 @ 215 mm o.c.

7. Results

1. The following findings are acquired from an IS: 802 compliant design completed in Staad Pro:

2. The analysis and layout of a footbridge with a 24-meter span. Following is the tower's layout:

3. Staad Pro V8i is used to determine the wind load in accordance with IS: 875(Part 3)1987[3].

4. The steel columns are bolted to a gusset plate that is affixed to the foundation's square footings; the bars are 10mm in diameter and are spaced 215mm apart centre to centre.

5. The overall estimated weight of footbridge's structural components is 150.37 KN.

8. Conclusion

Knowledge of the building and designing of bridge methods like foot over bridge structural components, columns, beams, loadings on foot over bridge, etc. is essential in today's rapidly evolving construction industry. So, accurate guesswork is required throughout the footbridge's design and analysis.

There is a lot of room for cost and resource savings if we can find a way to improve the current inefficient design or uneconomical method of the foot over bridge. While traditionally just angle sections were utilized to make the truss in the footbridge's construction, nowadays so many sections are favored because to their low material and labor costs.

Since the footbridge has more apertures than the towers, the wind load operating on it will be less, but towers fail mostly because of strong winds & earthquakes, hence the towers need a large safety factor.

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