Analysis and Design of a Steel Foot Over-bridge with Tubular Sections using STADD.Pro

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Abstract
This paper deals with the Analysis and Design of Steel Foot over pedestrian bridge with Tubular sections using STADD.Pro V8i Software. In India, steel truss foot over bridges is the most cost-effective and widely used kind of foot over bridges. A foot over bridge is becoming very popular in urban India as it helps to cross the road for pedestrians without worrying about high-speed traffic as well as it is very safe option without interrupting vehicles. So, we are going to design and optimize the section sizes of a foot over bridge with tubular hollow sections under the Tata Structura Section database provided in STADD.Pro V8i.

Keywords: Foot Over-bridge, Tubular Sections, STADD.Pro V8i

1. Introduction

Foot Over Bridge

A foot over bridge (FOB) is a pedestrian bridge or walkway constructed over a road, railway line, or any other obstacle to allow pedestrians to safely cross from one side to the other. FOBs are commonly used in urban areas, especially near busy intersections or areas with high pedestrian traffic. The primary purpose of a foot over bridge is to ensure the safety and convenience of pedestrians by providing them with a designated and elevated path separate from vehicular traffic. FOBs typically have staircases or ramps at both ends to allow easy access for pedestrians. Foot over bridges can be found in various locations such as near train stations, bus terminals, schools, markets, and other public places. They are especially important in areas where pedestrians need to cross busy roads or railways frequently.

Lattice Steel Truss

A lattice steel truss is a structural framework made up of interconnected steel members arranged in a triangular pattern. This truss design provides strength, stability, and rigidity while minimizing the amount of material used, making it an efficient and cost-effective structural solution. Lattice steel trusses are commonly used in various construction applications, including bridges, roofs, towers, and other large-span structures.

2. literature Review

(A) Gousemiya Saudagar, Mubeen Shaikh, Royston Lobo, Saba Shaikh, Reetika Sharan, Reshma Shaikh, "Design of Railway Foot Over Bridge (Shelu)" (2019) – In this paper they have designed a steel truss foot over bridge with an I-section of Web-(650 × 6) mm and Flange-(450 × 30) mm of 250 M_{pa} Yield stress using Ansys Software.

(B) Limje Mayur, Solanki Dharmendra, Patel Darshan, Patel Neel, Patel Hiren, Chauhan Dixit "Appraisal and Design of Foot Over Bridge" (2019) – They have designed a foot bridge for span of 171 m with an I-section (ISMB500) and Angle section of (ISA 150 × 150 × 12) of 250 M_{pa} Yield stress using STADD.Pro Software.

(C) S. Rajesh "Design of a Steel Foot Over Bridge in A Railway Station" (2017) – He has designed a steel foot over bridge for a railway station for 28 m span angle section (ISA 150 × 150 × 12) of 250 M_{pa} Yield stress using STADD.Pro Software.

(D) Naveen Ram Kumar R., Navneet Harshit, Aparna S. Bhaskar, "Pedestrian Steel Truss Over Bridge Analysis and Design at Saharsa Railway Station, Bihar" (2021) - In this paper they have designed a steel truss foot over bridge for 86 m span with an I-section (ISMB 200) and Angle section (ISA 75 × 75 × 8) of 250 M_{pa} Yield stress using STADD.Pro Software.

(E) Akhil Sharma, Ashwani Kumar, Sunil Sharma, Arun Singh Chib, Rakesh Abrol, "Analysis and Design of Foot Bridge Connecting (2nd Floors) of Block A and Block B of MIET, Jammu" (2020) - They have designed a foot bridge for span of 30 m with an I-section (ISMB200), (ISLB125) and Angle section of (ISA 90 × 90 × 10) of 250 M_{pa} Yield stress using STADD.Pro Software.

3. Methodology

(A) Literature collections
(B) Specifications and loadings of foot bridge under (IRC:6-2000)
(C) Material Properties under (Tata Structura steel hollow section brochure IS:4923 and IS:1161)
(D) Design of steel foot over bridge in STADD.Pro
(E) Assigning Assumed Material properties for the foot over bridge
(F) Assigning of Loadings
(G) Estimation of Steel utilized
(H) Results and Conclusions

4. Specifications and Loadings of Foot Over Bridge

Carriageway Width	2 m + 5 m + 2 m + 7.5 m + 2.5 m + 7.5 m + 1.5 m + 4 m + 2 m = 34 m (as per IRC)
Format	Staircase landing (SL) + Shoulder + Kerb + 2 (Lane) + Median + 2 (Lane) + Kerb + Shoulder + (SL)
Width of Gangway	3 m
Clear Height	6.5 m
Staircase Width	2 m
Thickness of Deck Slab	60 mm (RCC)
Thickness of Staircase Slab	50 mm (RCC)
Live Load	4.5 kN/m^2 (as per IRC:6-2000, Clause 209.4)
Dead Load	25 × 0.06 m = 1.5 kN/m^2

Floor Finish	0.35 kN/m^2

5. Material Properties

- **Steel**

The hot rolled structural steel utilized in this design has imported from Tata Structura (Steel Hollow Sections) brochure conforming to IS:4923 and IS:1161.

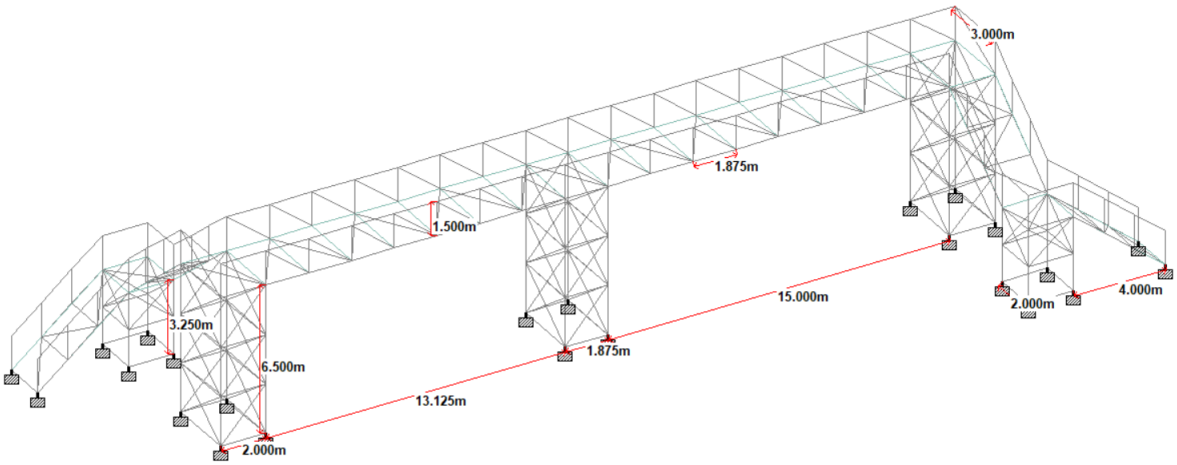
Steel Yield Stress: 310 M_{pa}
Steel Ultimate Stress: 450 M_{pa}

Section Type	Grade	Mechanical Properties			
		YST	UTS	% of Elongation	
		MPa	MPa	< 25.4 mm	> 25.4 mm
RHS/SHS IS : 4923	YST 210	210	330	12	20
	YST 240	240	410	10	15
	YST 310	**310**	**450**	**8**	**10**
CHS IS : 1161	YST 210	210	330	12	20
	YST 240	240	410	12	17
	YST 310	**310**	**450**	**12**	**14**

- **Concrete**

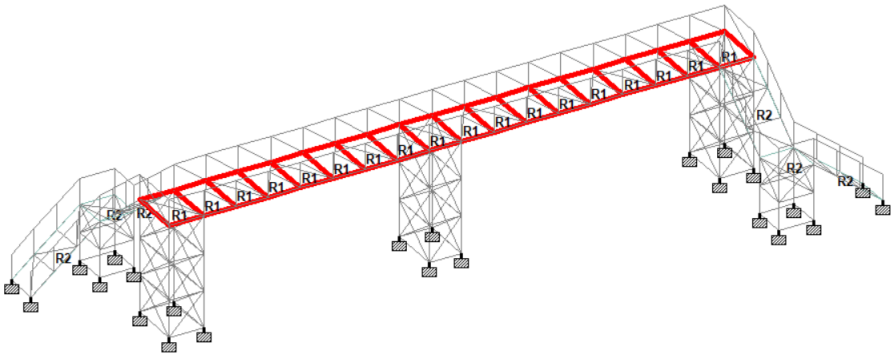
Grade M_{20}
F_{ck}: 20 N/mm^2

6. Design of Steel Foot Over Bridge in STADD.Pro

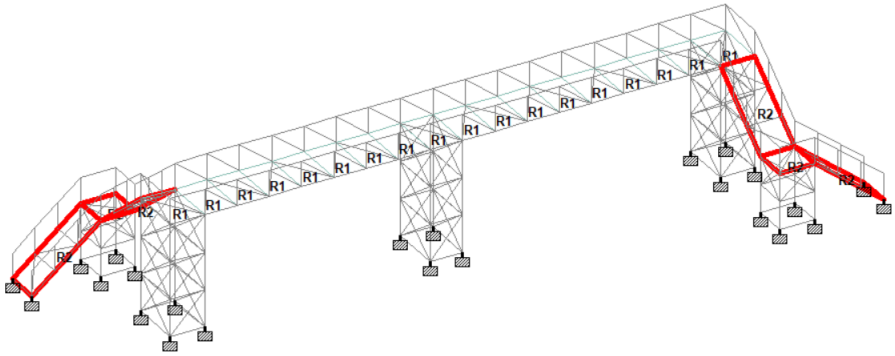


7. Assigning Assumed Material Properties for Foot Over Bridge

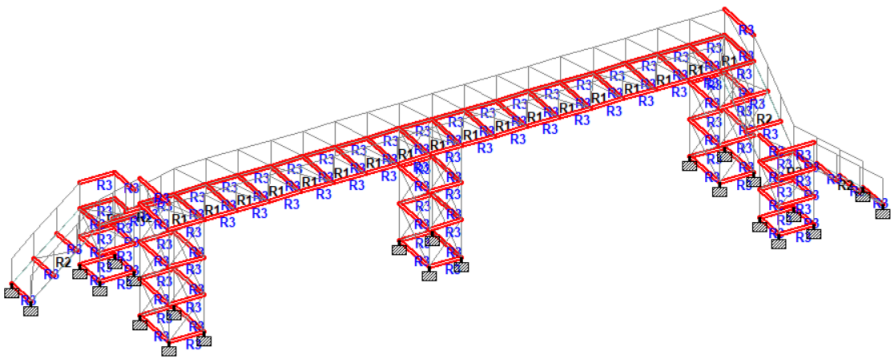
RCC Deck Slab of Thickness 600 mm



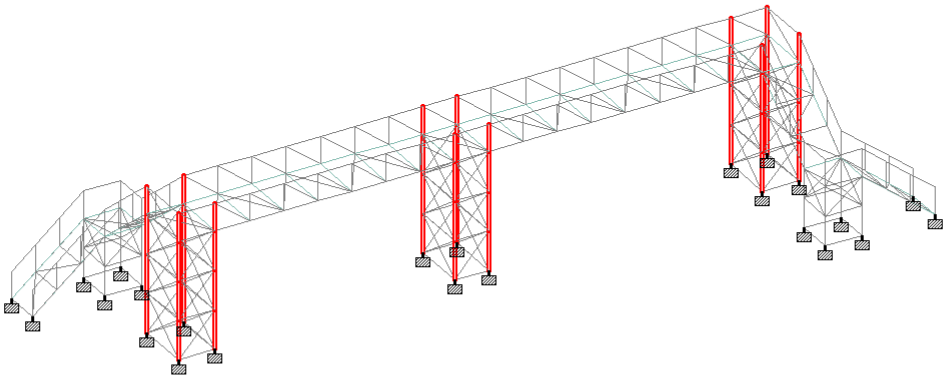
RCC Staircase Slab of Thickness 500 mm



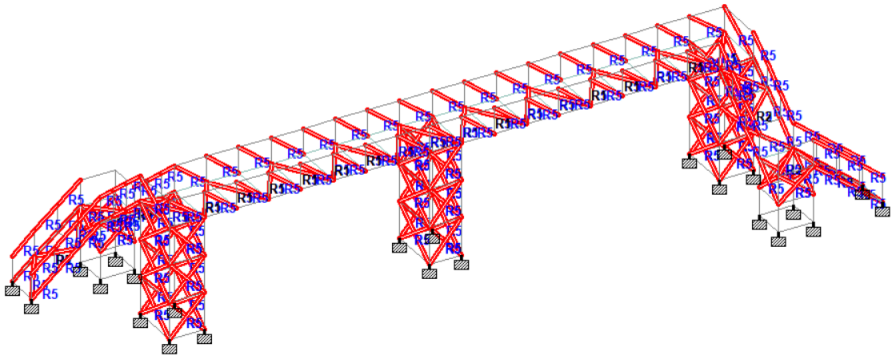
Rectangular Tube Section for Bottom Chord and Other Horizontal Trusses
RHS (96 × 48 × 3.2) mm



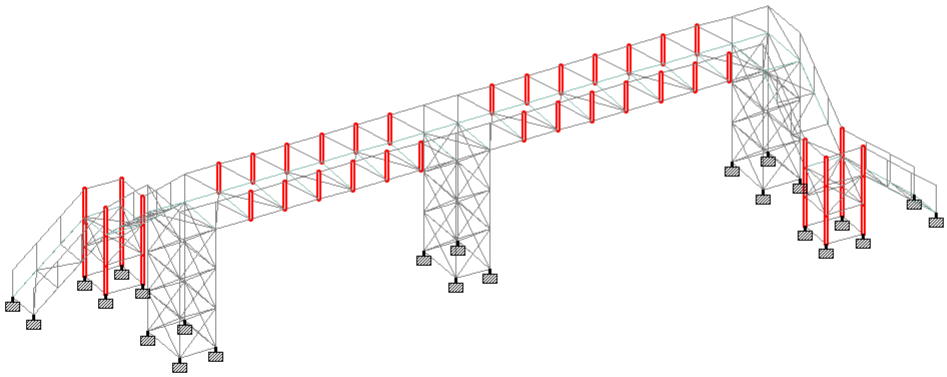
Circular Tube Section for Main Column
CHS (76.1 × 4.5) mm



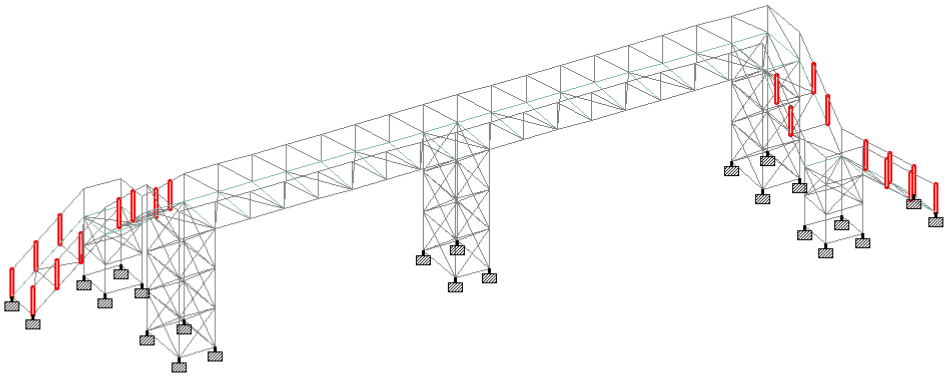
Square Tube Section for Inclined and Cross Bracings
SHS (72 × 72 × 4.0) mm



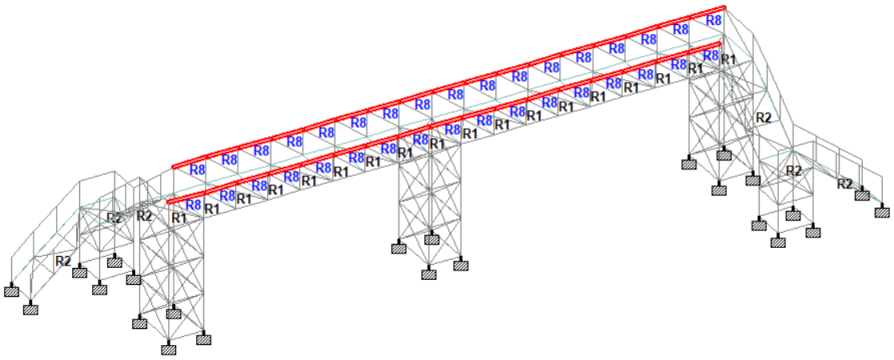
Circular Tube Section for Staircase Column and Deck Slab Vertical Post
CHS (60.3 × 3.6) mm



Circular Tube Section for Staircase Slab Vertical Post
CHS (26.9 × 2.3) mm

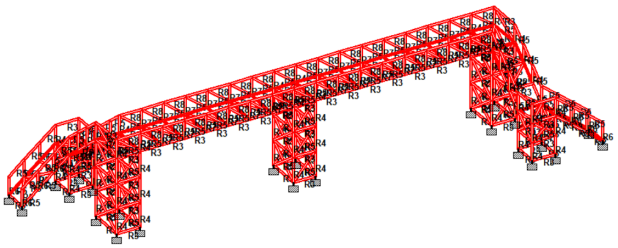


Rectangular Tube Section for Top Chord
RHS (122 × 61 × 3.6) mm

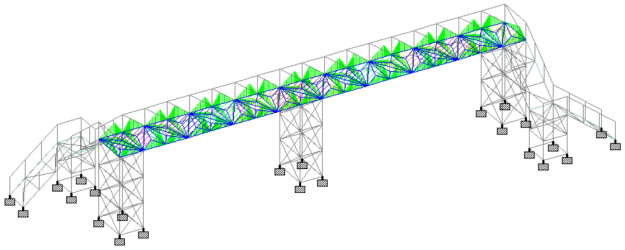


8. Assigning of Loadings

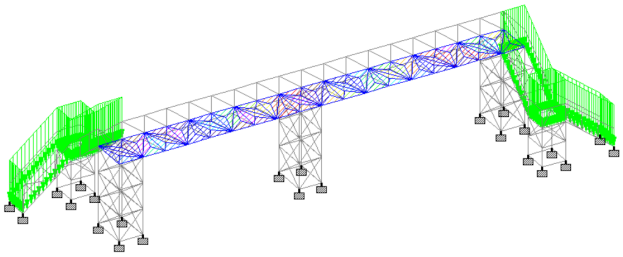
Case 1: Self-weight of the Structure (Dead Load)



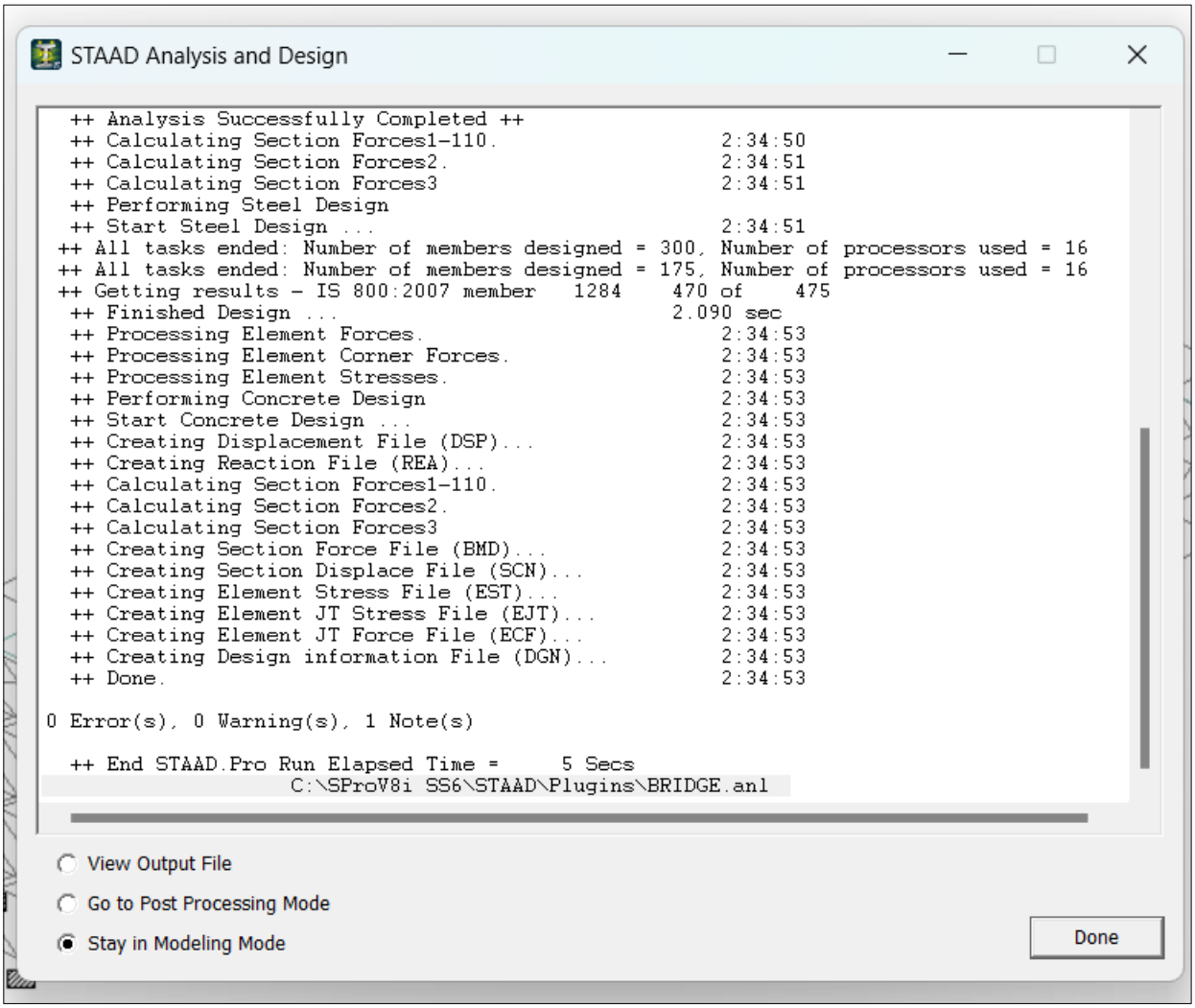
Case 2: 4.85 kN/M^2 of Live Load and Floor Finish Acting on Deck Slab



Case 3: 4.85 kN/M^2 of Live Load and Floor Finish Acting on Staircase Slab

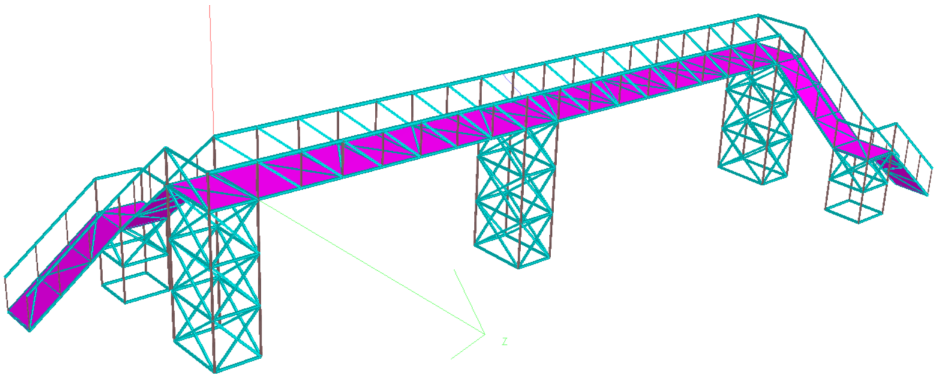


Results



All assigned structural steel sections are under Tata Structura section database in STADD.Pro and analysed with zero error and warnings and also checked for zero failed members in given load conditions. IS456 code was used for define concrete slab. IS800-2007 was used for define steel sections.

3D View of Structure from STADD.Pro



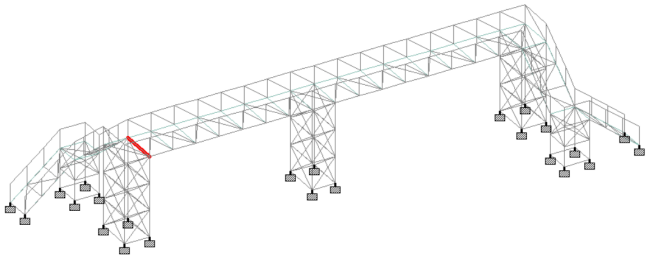
9. Estimation of Steel Utilized for Foot Over Bridge

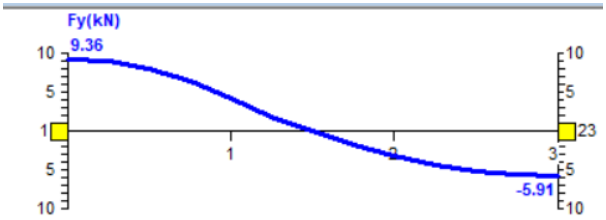
PROFILE		LENGTH (METE)	WEIGHT (KN)
ST	76.1X4.5CHS	96.00	7.463
ST	96X48X3.2RHS	296.25	19.435
ST	72X72X4.0SHS	551.72	44.375
ST	122X61X3.6RHS	64.00	6.057
ST	60.3X3.6CHS	77.00	3.792
ST	26.9X2.3CHS	30.00	0.410
		TOTAL =	81.532

81.532 kN = 8313.950 Kg
Current Market Price of 1 Kg Steel = Rs. 98/-
Price of 8313.950 Kg Cold Form Steel = Rs. 8,14,767.1/-
Wastage Factor 15% = 0.15 × 8,14,767.1 = Rs. 1,22,215.065/-
Total Budget for Steel = Rs. 12,22,150.65/-

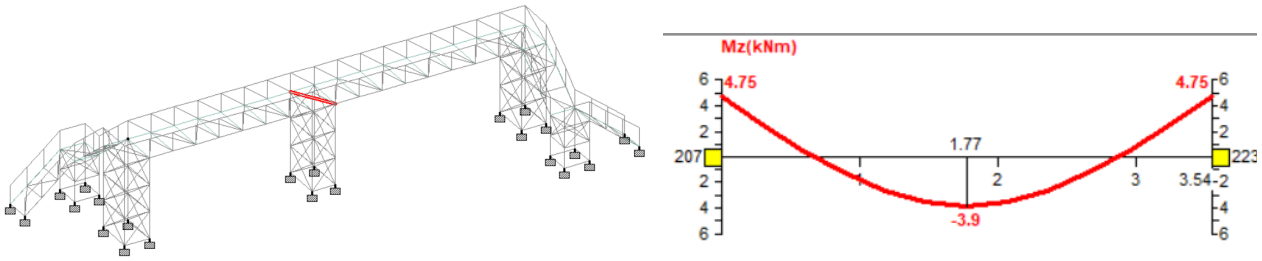
10. Results

Maximum Shear Force Member

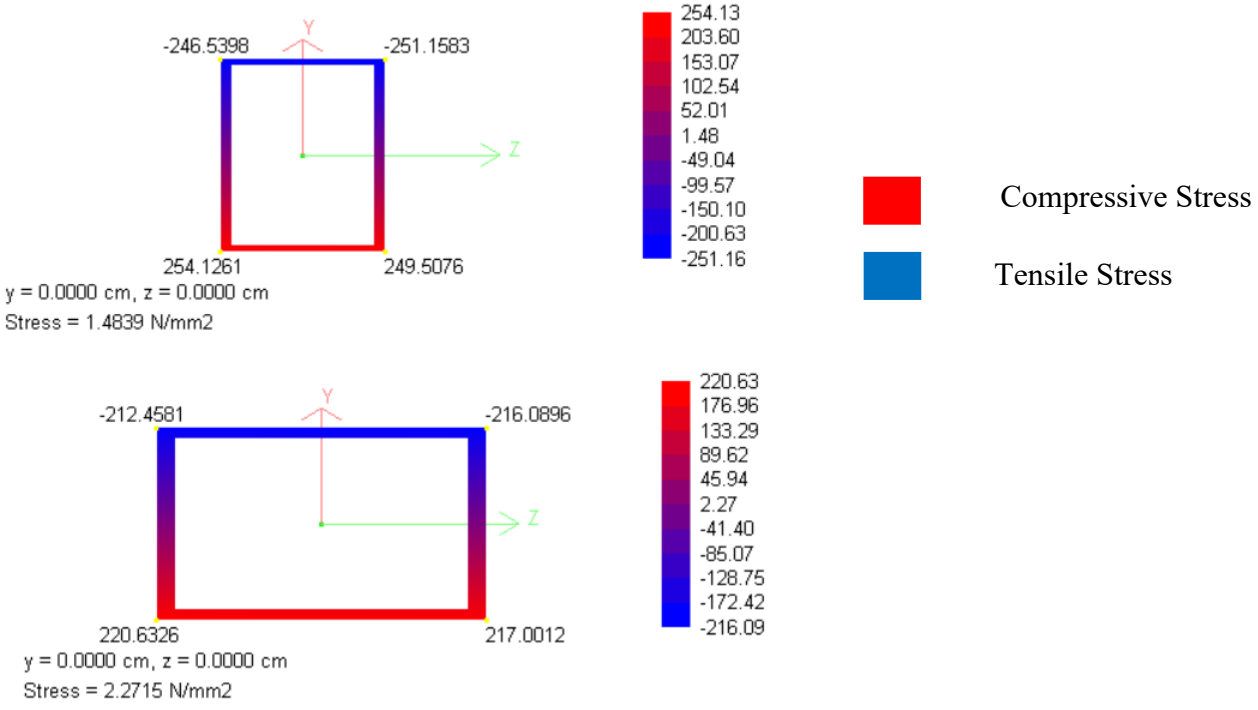




Maximum Bending Moment Member



Maximum Compressive and Tensile Stress due to Load Case 4



11. Conclusion

Thus, the designed foot over bridge with assigned specifications, loadings and material properties has been analysed and optimized to get a positive result of passed structure in STADD.Pro V8i software. The structure has been designed for maximum safety and economically viable. The obtained maximum shear force, bending moment and stress values are mentioned in results. And estimation for the utilized steel for our structure has detailed for all section steels with weight.

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