COMPARATIVE STUDY OF COLD FORMED SECTION STEEL FOOT OVER BRIDGE UNDER DIFFERENT CONFIGURATION

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Abstract - *This paper deals with the comparative study of Foot over Bridge under different configuration. In this study three types of bridges are considered and from that the best configuration is selected. In this study the bridges are analyzed and designed by using two software's i.e., Tekla structures and Staad-Pro. Results are compared for all and the best suitable foot over bridge is selected under the criteria of light-weight and economical design.*

***Key Words*: Foot over bridge, Steel Truss, Cable-Stayed, Cold Formed Steel, Staad-Pro, Tekla Structures**

1.INTRODUCTION:

A foot over bridge which is also called as pedestrian bridge, pedestrian overpass bridge, or pedestrian overcrossing bridge) is a bridge designed for pedestrians and in some cases cyclists, animal traffic, and horse riders, instead of vehicular traffic.

Foot bridges are used for landscaping and aesthetic purpose which visually links two different areas and for connecting purpose for roads. In many developed countries, footbridges provides both functional and beautiful works of art and sculpture. For rural communities in the developing world, a footbridge may be a community's only access to medical clinics, schools and markets, which would otherwise be unreachable when rivers are too high to cross. Simple suspension bridge designs have been developed to be sustainable and easily constructible in such rural areas using only local materials and labor.

Sometimes the foot bridge which connects two buildings is called as skyway. Bridges which provide for both pedestrians and cyclists are often referred to as green bridges and form an important part of sustainable transport movement towards more sustainable cities. Foot over bridges is often situated to allow pedestrians to cross water or railways in areas where there are no nearby roads to necessitate a road bridge. They are also located across roads for safely pedestrian crossings without disturbance in traffic. The latter is a type of pedestrian separation structure, examples of which. are particularly found near schools, to help prevent children running in front of moving cars. Foot bridge can be built with readily available materials and basic tools.

1.1 Need of Foot-over Bridge

A pedestrian bridge, also called a footbridge, is simply a bridge, can either be above ground or water which is designed for pedestrian traffic. Foot bridges are constructed for pedestrian to cross road from one side to another in a safe way. The pedestrian bridges are also built over railway tracks, rivers, parking lots, canyons and other areas were walking even impossible. Pedestrian bridges are constructed to help pedestrians cross from one side to the other without having to dash across at the risk of being knocked down by speeding vehicles, and also help to ease traffic

1.2 Objectives:

- To Compare the design behaviour for different configuration of members by studying the structural analysis and to provide manual design, software design and comparison between them for economical and weight.
- To design the CFS box section beams and columns using the codal provisions requirements to adopt the economical section.

2. Review of Literature:

They have investigated the performance of cold-formed steel foot over bridge at that city. The main purpose of this paper is to design a bridge which is harmless, more economical and very simple to assemble foot over bridges for walkers. In this paper the analysis of hollow steel box section using STAAD Pro. Software. The thickness of the sheet which is of steel is 2 to 3 mm and yield strength of the steel sheet is 280 $N/mm2$ the cold-formed steel box section of the foot over bridge is constructed because of bending operation simple and low cost. Design of cold-formed steel box-section columns and beams are used EUROCODES EN 1993 and done manually. The authors conclude that the cold-formed box section will reduce the dead weight of the structure and provides high strength and durability

3. Methodology:

The aim of the study is to compare the behavior of the structural members under different configuration for foot over bridges. In this study results will be compared by using two softwares i.e., STAAD-Pro and TEKLA structure for simple steel foot over bridge and cable-stayed foot over bridge and then by using Cold Formed Steel sections as a structural member. Also Studying load behavior patterns, and from all of this the most efficient, applicable, lightweight and economical bridge will be finalized.

3.1 Survey:

- Pedestrian Traffic

The number of persons crossing the road is 2,500 daily. The times that the pedestrian counts were made greatly impacted the outcome. It can be seen the greatest pedestrian flow across the highway occurred between the hours of 7am to 8am, 2pm to 3pm and 5pm to 6pm because most of the students leaved in this time from institute.

- Vehicular traffic-

Due to heavy loaded vehicles travelling continuously on highway, the pedestrians crossing the highway has major risk of accidents

3.2 Location and size of pedestrian bridge:

Fig -1: Location of Foot-Over Bridge

- **Design dimensions**

After conducting the survey in front of road following dimensions were decided with the help of measuring tape.

a. Width of service road=7.2m
b. Width of divider near service road=5m
c. Width of highway=26.72 m
d. Width of divider between two lanes of highway=1 m
e. Width of staircase=3m
f. Height=6.5m above G.L.
g. Total effective span=58m

Following are the design options for considered location:

1. Cold formed section truss foot bridge in Staad-Pro.
2. Cold formed section truss foot bridge in Tekla Str.

3.3 Geometry and Modelling of Foot-over bridge:

With the help of the measurements taken during site survey, the following information is required for the modelling of the basic bridge structural geometry

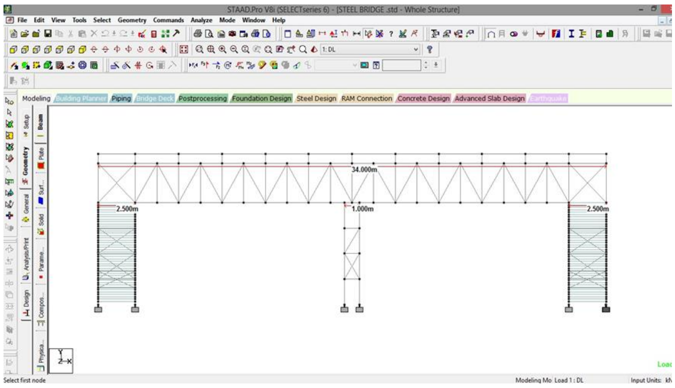

Fig -2: Bridge Plan View

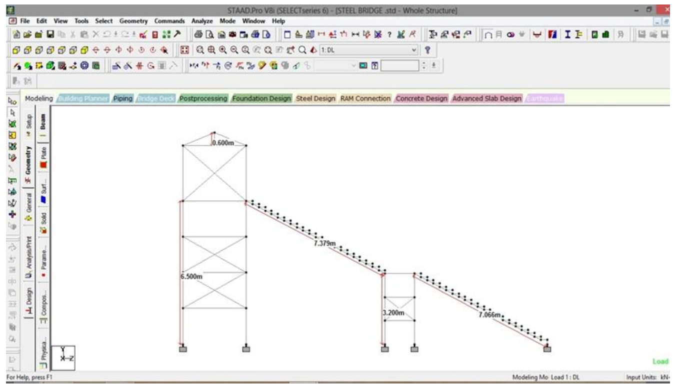

Fig -3: Bridge Elevation View

- **Design Loading:**

The loads were applied to bridge structures in STAAD-PRO and Tekla Structures are

1. 1) Dead load: Dead load means the weight of the material used in the construction of the bridge. Dead load considerations are taken from IS 875 - (Part-1):1987.
Dead load = Self-weight of all members
2. 2)Pedestrian live load: The live load acting on the deck of the bridge. Live load means the weight of the pedestrians walking over the deck. The live load considerations are taken from the provisions with all the considerations from IS 875 – (Part-2):1987.
live load=2KN/m^2
3)Wind load: Since this is an open structure, the wind load is taken into consideration. Wind load is considered according to Indian standards of code IS875(Part-3): 1987.IS code reference clauses and tables.

3.3.1 Modelling of Cold formed section truss foot bridge in Staad Pro.

Firstly, as shown in Fig-4 Modelling of the foot-over bridge is done in Staad-Pro as per dimensions described.
Then section property, loads and load combinations are given to the structure.

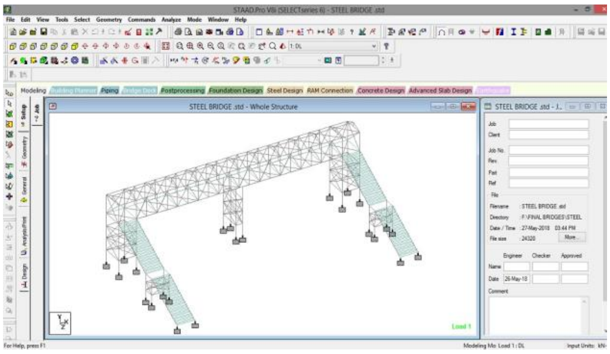

Fig -4: Modeling of Cold Formed Steel Bridge in Staad-Pro

Table -1: Sectional Properties for Bridge in Staad-Pro

SR NO.	MEMBER NAME	SECTION	MATERIAL
1.	Deck Slab	Plate Thickness=8mm	Steel
2.	Staircase Plate	Plate Thickness=5mm	Steel
3.	Main Girder	TUB 132x132x5	Steel
4.	Cross Girder	TUB 113x113x5	Steel
5.	Column Bracing	TUB 113x113x5	Steel
6.	Main Column	TUB 100x100x6	Steel
7.	Mid- Landing Column	TUB 100x100x6	Steel
8.	Members Below Tread	TUB 96x48x5	Steel
9.	Stringer Beam	ISMC200	Steel
10.	Vertical Member of Top Truss	TUB 113x113x5	Steel
11.	All Members of Bottom Truss	TUB 113x113x5	Steel
12.	Cross Member of Bottom Truss	TUB 40x40x3.2	Steel
13.	Incline Member of Bottom Truss	TUB 80x40x5	Steel
14.	Roof Truss	TUB 40x40x3.2	Steel
15.	Riser and Tread	ISMC 100	Steel

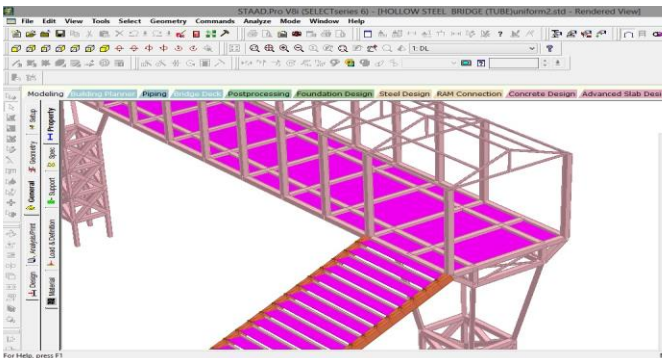

Fig -5: Render View

3.3.1 Modelling of Cold formed section truss foot bridge in Tekla Structures.

Firstly, as shown in Fig-6 Modelling of the foot-over bridge is done in Tekla as per dimensions described.

Then section property, loads and load combinations are given to the structure.

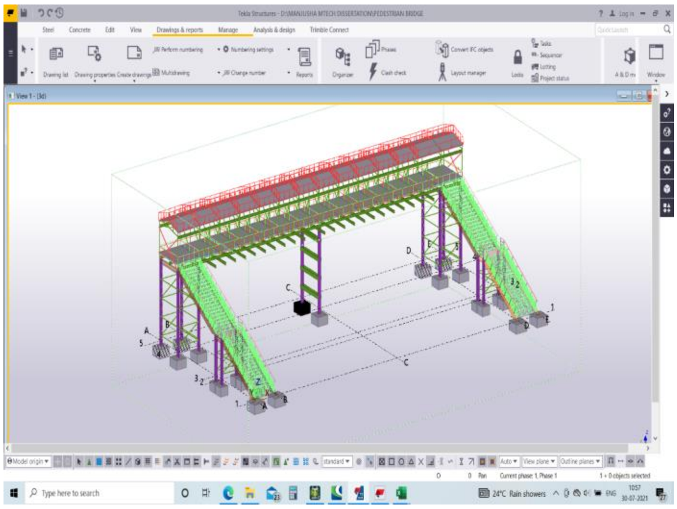

Fig -6: Modeling of Cold Formed Steel Bridge in Tekla Str.

Table -2: Sectional Properties for Bridge in Tekla Struc.

SR NO.	MEMBER NAME	SECTION	MATERIAL
1.	Deck Slab	Plate Thickness=8mm	Steel
2.	Staircase Plate	Plate Thickness=5mm	Steel
3.	Main Girder	TUB 150x150x5	Steel
4.	Cross Girder	TUB 132x132x5	Steel
5.	Column Bracing	TUB 89x89x4.5	Steel
6.	Main Column	ISMB 300	Steel
7.	Mid- Landing Column	TUB 89X89X4.5	Steel
8.	Members Below Tread	TUB 96x48x5	Steel
9.	Stringer Beam	ISMC200	Steel
10.	Vertical Member of Top Truss	TUB 100X50X4.7X7.5	Steel
11.	All Members of Bottom Truss	TUB 132x132x5	Steel
12.	Cross Member of Bottom Truss	TUB 132x132x5	Steel
13.	Incline Member of Bottom Truss	TUB 45X45X4.5	Steel
14.	Roof Truss	TUB 50X50X6	Steel
15.	Riser and Tread	ISMC 100	Steel

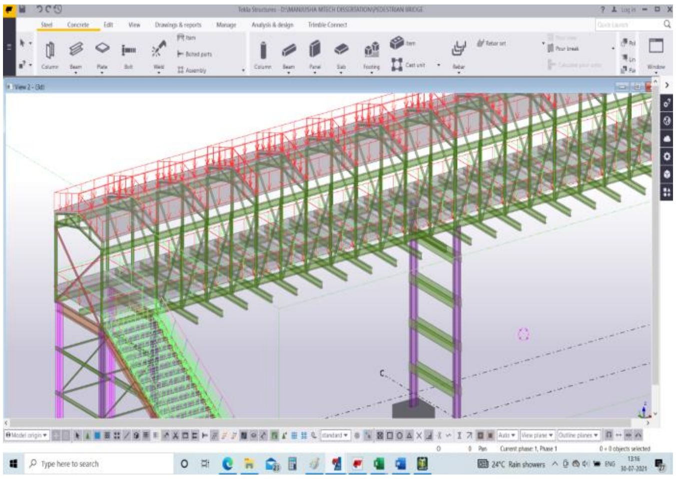

Fig -7: Render View

4. Results and Discussions:

1. The result for Case 1 i.e., Cold formed steel Section Bridge in Staad-Pro is as follows and deflection can be studied for various members in this case under post processing of STAAD Pro. Weight of bridge is 242.191 KN. Following figure shows maximum deflection of a node in truss. Allowable deflection = Span/250 = 136mm whereas resultant deflection is 20.969 mm. Therefore, it is safe.

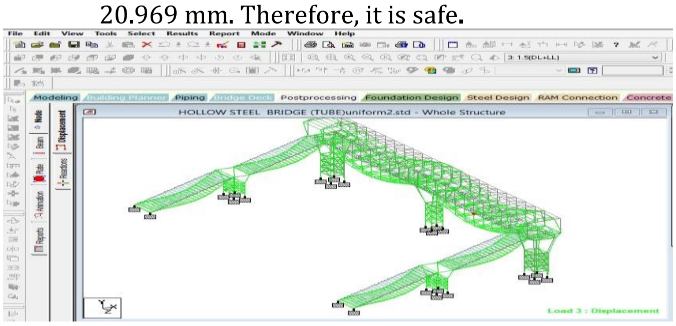

Fig -8: Deflection of Foot-Over Bridge

HOLLOW STEEL BRIDGE (TUBE)uniform2.std - Node Displacements:

	Node	L/C	Horizontal X mm	Vertical Y mm	Horizontal Z mm	Resultant mm	Rotational rX rad	rY rad	rZ rad
Max X	977	12 1.5(DL+W	7.942	-5.778	-0.094	9.822	-0.001	0.000	-0.001
Min X	963	3 1.5(DL+LL)	-5.373	-0.377	-0.352	5.397	-0.000	-0.000	0.001
Max Y	233	10 1.2(DL+LL	0.545	1.418	5.257	5.473	0.001	-0.000	0.001
Min Y	83	3 1.5(DL+LL)	0.460	-20.949	-0.520	20.960	-0.000	-0.000	0.000
Max Z	469	14 1.5(DL+W	-0.504	-2.614	8.830	9.222	-0.000	0.000	0.000
Min Z	309	3 1.5(DL+LL)	0.816	-4.135	-2.061	4.692	0.003	0.000	0.000
Max rX	222	3 1.5(DL+LL)	0.988	-7.726	0.786	7.828	0.004	-0.000	0.000
Min rX	60	3 1.5(DL+LL)	1.016	-7.681	-0.986	7.810	-0.004	0.000	0.000
Max rY	1026	3 1.5(DL+LL)	-1.337	-7.811	-0.114	7.926	0.004	0.001	0.000
Min rY	990	3 1.5(DL+LL)	-1.386	-7.810	-0.283	7.937	-0.004	-0.001	0.000
Max rZ	874	3 1.5(DL+LL)	1.199	-3.718	-0.124	3.909	0.000	-0.000	0.004
Min rZ	906	3 1.5(DL+LL)	2.640	-4.210	-0.250	4.976	-0.000	-0.000	-0.004
Max Rs	80	3 1.5(DL+LL)	0.932	-20.947	-0.217	20.969	-0.000	-0.000	0.000

Fig -9: Summary Sheet (a)

2. The result for Case 2 i.e., Cold formed steel Section Bridge in Tekla software is as follows and deflection can be studied for various members in this case. In case of steel truss foot over bridge which analyzed in Tekla structures, the weight of bridge is 255.71 kN. Allowable deflection = Span/250 = 122mm whereas resultant deflection is 18.269 mm. Therefore, it is safe.

Nos.	Part. Pos	Profile	Quantity	Length / mm	Area / m2	Weight.Net / t	
6	1	ISMB300	6	6,668	43.39	1.708	1.84
95	4	2350*50	95	300	152.47	25.19	26.29
6	6	ISMB300	6	1,300	8.46	0.339	0.359
4	16	ISMB300	4	7,379	32.01	1.262	1.358
2	17	ISMB300	2	3,300	7.16	0.292	0.304
2	19	ISMB300	2	3,300	7.16	0.292	0.304
14	M1	ISMB300	14	6,950	105.52	4.357	4.476
8	M2	ISMB300	8	3,650	31.67	1.308	1.343
8	M3	RHS80*40*4	8	2,492	4.71	0.14	0.14
8	M4	RHS80*40*4	8	2,909	5.49	0.164	0.164
5	M5	SHS150*5	5	34,340	103.04	3.909	3.909
22	M6	SHS132*5.4	22	5,700	66.27	2.692	2.692
1	M7	ISMB200	1	5,700	4.24	0.134	0.138
54	M8	B_BUILT100*50*4.7*7.5	54	2,708	86.03	1.774	1.774
4	M9	SHS45*4.5	4	4,066	2.93	0.093	0.093
46	M10	SHS45*4.5	46	2,962	24.56	0.78	0.78
1	M11	SHS45*4.5	1	3,189	0.57	0.018	0.018
1	M12	SHS45*4.5	1	3,177	0.57	0.018	0.018
30	M13	ISMC100	30	300	3.37	0.083	0.086
30	M14	ISMC75	30	1,677	14.41	0.343	0.359
30	M15	ISMC75	30	1,710	14.7	0.35	0.367
30	M16	ISA50X50X6	30	450	2.63	0.06	0.06

Fig -10: Summary Sheet (b)

15	M17	ISA50X50X6	15	418	1.22	0.028	0.028
15	M18	ISA50X50X6	15	865	2.53	0.057	0.058
15	M19	ISA50X50X6	15	870	2.54	0.058	0.058
16	M20	SHS89*4.5	16	2,492	14.22	0.476	0.476
15	M21	SHS89*4.5	15	2,909	15.56	0.521	0.521
1	M22	ISA50X50X5	1	2,909	0.57	0.011	0.011
14	M23	SHS89*4.5	14	3,300	16.47	0.552	0.552
2	M24	ISMC100	2	3,300	2.47	0.061	0.063
8	M25	SHS89*4.5	8	3,140	8.96	0.3	0.3
1	pl1	150*2495	1	3,300	18.21	9.695	9.695
12	pl2	150*2400	12	3,300	210.6	111.9	111.9
1	pl3	150*3045	1	3,300	22	11.83	11.83
1	pl4	80*1720	1	2,598	9.59	2.794	2.807
11	pl5	80*1732	11	2,420	98.95	28.78	28.97
1	pl6	80*1720	1	2,598	9.58	2.793	2.807
11	pl7	80*1720	11	2,420	98.4	28.62	28.77
1	pl8	80*1720	1	2,594	9.59	2.796	2.802
1	pl9	80*1720	1	2,591	9.59	2.796	2.799
1	pl10	80*1732	1	2,893	10.67	3.119	3.147
1	pl11	80*1720	1	2,882	10.61	3.101	3.114
		Total	550	13,32,983	1,293.67	200	257.6

Fig -11: Summary Sheet (b)continued.

5. CONCLUSIONS:

Coming at solution for problem of pedestrian traffic to cross road without interrupting vehicular traffic and trying various cases of different type of foot over bridges. The components are designed for the maximum safety and the adaptability of the structure to future changes has also been given due consideration. Weight of Cold-formed Steel foot over bridge was low comparatively hence, it is concluded that Cold form Steel section bridge is light-weight and therefore it is economical also.

REFERENCES

1. Arunabha Banerjeea, and Akhilesh Kumar Mauryab (May 2019)," A comparative study of pedestrian movement behaviour over foot over bridges under similar land-use type", Science Direct
2. Mack, G., and Dryver, R., (Nov 1993)," Modal Identification of Cable Stayed Pedestrian Bridge", ASCE Journal Of Structural Engineering Vol. 119, No. 11.
3. Roeder, M., and Karl, E., (2004), "Effect of Live-Load Deflections on Steel Bridge Performance", ASCE Journal of Bridge Engineering Vol. 9, No.3.
4. S. Rajesh Department of Civil Engineering BIHER, Bharath University "Material properties for the foot over bridges"
5. Gousemiya Saudagar, Mubeen Shaikh, Royston Lobo, Saba Shaikh4, Reetika Sharan, Reshma Shaikh "Design of steel foot over bridge at the railway station"
6. V. Chandrikka1, B. Soundarya Lakshmi, M. Praveen Kumar, S. Shanmugave, B. Sivasurya analysis and design of cold-formed steel foot over bridge
7. Narinder Singh Punn and Sonali Agarwal "Crowd Analysis for Congestion Control Early Warning System on Foot Over Bridge"
8. Lee-kuo Lin and Han-wei Huang "A Maintenance Management System of Pedestrian Skybridge".
9. Dhiraj P. Lad and R.D. Patil "Some structural design issues on a timber bridge for pedestrians"
10. Rui Li, Qing-ning Li "General Layout of City Pedestrian Bridge."