Comparison in Design of Technical Steel Structure by Indian & European Code

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Abstract— Steel is the most popular material used in industrial projects, as steel has advantages which are matched with industrial projects' targets. It is easy to strengthen steel if required without using advanced technology, it is easier and faster to erect as it can be assembled in a short period of time. It is well-matched with the function of the industrial field prospective specifically for oil and gas fields. Various type of steel structure such as Piperack, working platform, skids, equipment supporting structures etc. in industry. Equipment supporting structures is also called as steel technical structure which carry the heavy equipment's load, small and large cylindrical vessels load of the industrial steel plant. Design codes of different countries provide engineers with data and procedure for design of the various structural components. Every country has their own design codes so that steel can be analysis and design by codes manually or by various design softwares. The main aim of the project is to identify critical loads, estimate design actions, select sections and how the economy can be achieved by using two different country codes i.e. Indian code and European code. In this project two different softwares are also used staad.pro and sap2000 for comparison between the results of two codes.

Keywords: Steel technical structure, Staad.Pro, Sap2000, Indian code, European code

I. INTRODUCTION

Steel is a high-performance construction material that combines the strength and stiffness associated with ferrous alloys with the corrosion resistance derived principally from the high chromium content. It is a ductile material which is used in worldwide specially in manufacturing the industrial plant. Now a days steel structure is most commonly used in industrial plant. In this project 12 m length 10 m width and 18.9 m height with projection of 1.2 m cantilever in all the 4 sides is modal and design in staad.pro and sap2000. The analysis and design procedures are carried out by applying various load such as dead load, live load wind load, earthquake load and considering various type of small and large equipment load. Considering the structure is located in Pune city for applying the wind load and seismic load on the structure.

The aim of any design process is the fulfilment of a purpose, and structural steelwork design is on exception. In building design, the purpose is most commonly the provision of space that is protected from the elements. Steelwork is also used to provide internal structure, particularly in industrial situations. The equipment supporting steel structure is design properly with proper design code using certified software so that it can give proper results by applying various types of load i.e. piping loads, equipment loads, wind loads and seismic load and all other loads wherever required.

The aim & objective is to analysis and design the structure to compare the seismic base shear, displacement, reactions & results obtained from two different design codes. Also to obtain sections and weights for cost estimation.

II. MODELING OF TECHNICAL STRUCTURE

The tech structure is modeled as a 3-D space frame in STAAD.Pro and Sap2000. It is modeled in 3 axis of the software i.e. X-Y-Z where Y is vertical and X and Z is horizontal in staad while Z is vertical and X and Y is horizontal in sap2000. All columns, main beams & secondary beams are modeled in software. Structure is 12m long and 10m wide with projections of 1.2 m wide on all sides of the structure at 4 m and 8 m levels. At 12 m level the projection on three sides of the structure is 1.2 m. These serve as working platforms. Structure consists of 4 levels i.e. 4 m - first floor level, 8 m - second floor level, 12 m - third floor level and 18.9 m – fourth level. Fourth level is for supporting monorails. There is a staircase block on the right side of the structure. The staircase block is 2.75 m long and 6 m wide.

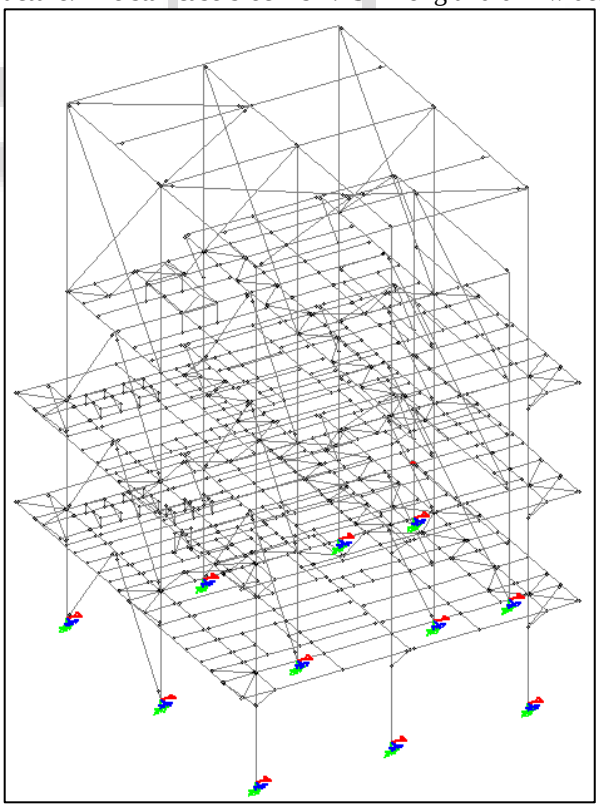

Fig. 1: Steel tech structure modal

The steel columns of the structure are considered as pinned in Z & fixed in X direction in STAAD & pinned in Y & fixed in X direction in Sap2000 at base plate level. Moment allow in only one direction. Sections used in the structure is I section for beams and columns and for vertical and horizontal

plan bracings angle section are used. Indian ISMB sections are used when designing with Indian code. HE & IPE sections are used when designing with European code. The yield strength of steel section is 275000 kN/m2. The ultimate strength of steel is taken as 410000 kN/m2.

The loads are applied on the structure with the help of load cases which are generated by using the commend load case detail in the design software. Various types of load cases are used is the software for analysis and designing the structure are given below: -

LOAD 1	Earthquake Load North-South
LOAD 2	Earthquake Load East -West
LOAD 10	Self-Weight
LOAD 11	Dead Load on floors (DL)
LOAD 12	Live Load on floors (LL)
LOAD 21	Equipment/Piping Empty Load
LOAD 22	Equipment/Piping Operating Load
LOAD 23	Equipment/Piping Hydrotest Load
LOAD 24	Equipment/Piping Friction Load
LOAD 61	Wind Load in + X Direction (WL+X)
LOAD 62	Wind Load in - X Direction (WL- X)
LOAD 63	Wind Load in +Z Direction (WL+Z)
LOAD 64	Wind Load in -Z Direction (WL-Z)

Table 1: Specification of Various Load Cases

Different loads are acting on the structure both in staad.pro and sap2000 in the same manner. The loads are applying in accordance with the codes. There is consideration of loads of heavy and small Equipment loads are applied on the structure at all floor level as a point load on the equipment supporting beams. Heavy and small equipment load such as vertical cylindrical vessels are considered on every floor of the structure. Loads are applied in Empty, Operating and Hydrotest condition. Concentrated point loads are applied on the equipment supporting.

Load Case	Load Applied
Dead Load on floors (DL)	0.5 kN/m2
Live Load on floors (LL)	5 kN/m2
Eq/Piping Empty Load	40% of pipe operating load
Eq/Piping Operating Load	1.5 kN/m^2
Eq/Piping Hydrotest Load	150 % of pipe operating load.
Eq/Piping Friction Load	15 % of pipe operating load

Table 2: Load Application

Wind load on members of structure shall be calculated in accordance with IS 875 (PART-3) & EN 1991.1.4.2005. Considering the structure is located in Pune. Values for wind intensity is calculated. Parameter considered for wind load calculation as per IS 875 (PART 3)

Basic Wind speed (V_b)	39 m/sec
z	10 m (height above ground)
K_1	1.0 (Risk coefficient)
K_2	1.0 for 10 m height
K_3	1.0 (Topography factor)
K_4	1.0 (Cyclonic factor)
Terrain category	II
Wind velocity (Vz)	39 m/sec
Wind intensity (P_d)	0.912 kN/m2

Table 3: Wind Parameters

Earthquake load and Mass calculation: Seismic loads on Buildings are calculated as per IS 1893 part 4 & EN 1998.1.2004. Parameter considered for seismic load calculation as per IS 1893 part 4. Dynamic Response spectra analysis is done and seismic base share is calculated in both the software with Indian and European code for comprising the seismic base share in both the horizontal direction. The application of seismic forces independently only in two orthogonal directions i.e. X and Z direction in staad and X & Y in sap2000. Seismic mass is generated through STAAD & sap2000 by applying loads in their respective load cases.

Seismic zone (Z)	III
Zone factor	0.16 (for zone III)
Importance factor (I)	1.5
Reduction factor (R)	5
Damping ratio	0.02 (for steel structure)
Soil type	2

Table 4: Seismic Parameters

III. Analysis of Seismic Base Shear

The analysis and design of the technical structure is carried out. The seismic base share and displacement values from analysis are recorded in this software. The values of base shear are calculated in kN in both the horizontal direction by two different codes with two different software which are given in chart below: -

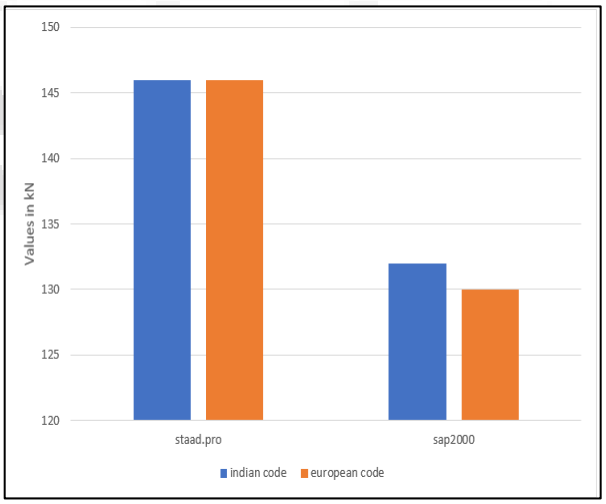

Fig. 2: Base share in horizontal X direction

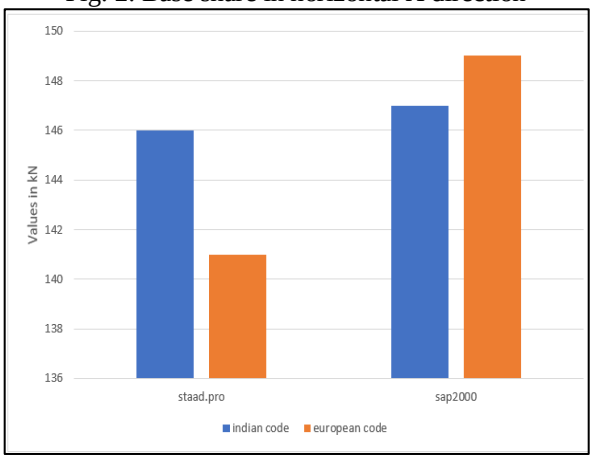

Fig. 3: Base share in horizontal Z direction

IV. ANALYSIS OF DISPLACEMENT

The structural model is analysed for different primary load cases and load combinations as described above. The deflection summary is obtained at the nodes of the beam column junctions from STAAD and sap2000 as tabulated below. The chart shows the values of maximum displacement given below: -

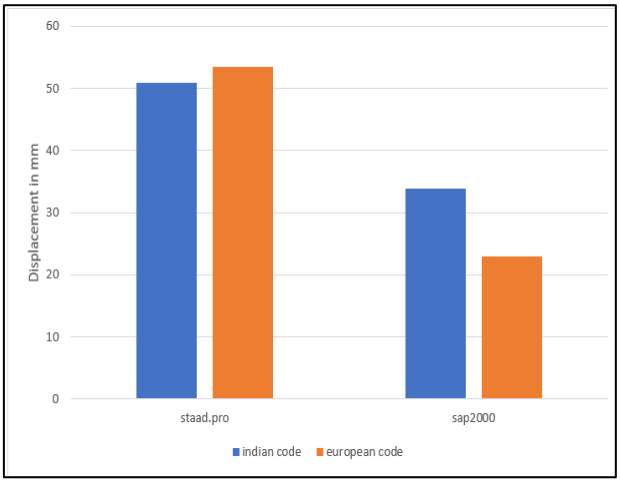

Fig. 4: Displacement in horizontal X direction

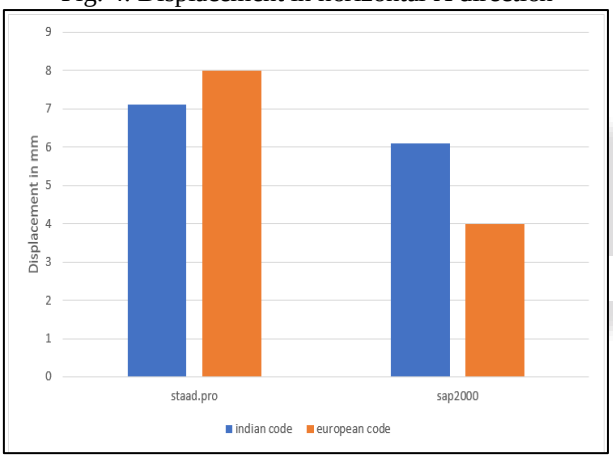

Fig. 5: Displacement in horizontal Z direction

V. MATERIAL TAKEOFF

Weight of the structure by Indian & European code design in staad.pro & sap2000 are shown in graph below: -

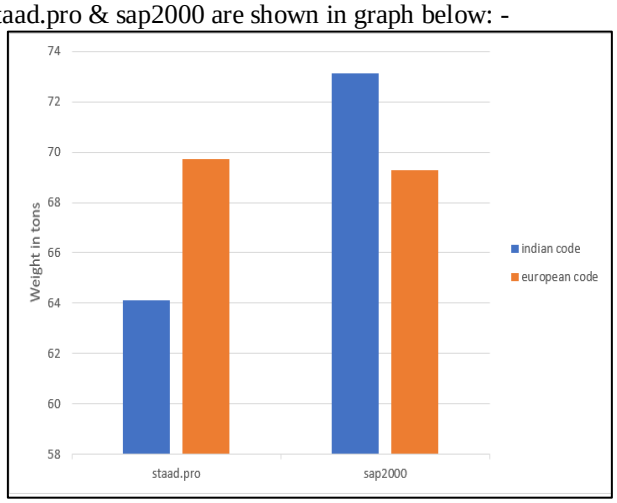

Fig. 6: Weight of structure in staad.pro & sap2000

VI. CONCLUSION

1) It is observed that stress ratios and maximum deflections are less than the permissible limits and hence it is concluded that the technical Structure is structurally safe to withstand the design loads.
2) The base shear values in both the horizontal direction are almost similar in both the software by using Indian and European code.
3) The weight of the structure is also similar by designing with both the codes in both software i.e. Staad.Pro & Sap2000.
4) The results obtained to design technical structure by Indian code & European code are almost similar.
5) The software used for analysis & design of technical structure gives safe & similar results.

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