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ANALYSIS AND DESIGN OF STEEL WAREHOUSE

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ABSTRACT:

Steel warehouse design has become increasingly recognized as a highly economical and efficient method in the realm of steel construction, particularly for low-rise and single-storey facilities. Owing to the high strength-to-weight ratio of steel compared to reinforced concrete structures, steel warehouses are widely adopted in industrial applications, allowing for larger spans and unobstructed interior spaces. This design approach focuses on optimizing structural components to achieve both structural efficiency and economic viability. When compared to conventional steel buildings (CSBs), steel warehouse systems offer several advantages, including cost-effective fabrication and faster construction timelines. In this study, the design process and load assessments for a steel warehouse are carried out in accordance with IS 875 and IS 800 standards, with additional reference to AISC-2011 and MBMA-96 guidelines, using STAAD.Pro V8i software. A hybrid design methodology is utilized to determine the most economical structural sections, drawing from established research and previous studies.

Keyword: Pre Engineered Building, AISC-2011, MBMA-96, IS 875, IS 800:2008, STAAD pro v8i

I. INTRODUCTION

The growing demand for fast, cost-effective, and durable storage solutions has led to a significant rise in the use of steel warehouse structures. These buildings offer numerous advantages such as high structural strength, reduced construction time, and long spans with minimal internal supports, making them ideal for industrial and commercial applications. Steel warehouses are designed to optimize material usage and structural performance while ensuring compliance with modern design standards and safety codes. With the aid of advanced design tools like STAAD.Pro and adherence to relevant codes such as IS 875, IS 800, AISC-2011, and MBMA-96, steel warehouse design has evolved into a highly efficient and reliable construction method. This study focuses on the structural analysis and design of a steel warehouse using a combination of design standards to achieve an economical and structurally sound solution.

II EXPERIMENTAL INVESTIGATION

A. Structure Configuration

In this study, a three-dimensional single-storey industrial building with symmetry in the X and Y directions and a rectangular shape (80m X 25m) is investigated (Table 2: Structure configuration). In the pre-engineered frame model, a steel frame with a tapered "I" section is utilized. A steel rod is used for bracing (X-type) in the models. The structure is supported by fixed support and all joints are absolutely stiff. IS: 875-1987 (Parts I, II), IS: 875-2015, IS: 800-2007 are used for load calculation.

Table 1: Structure Configuration

Location	Jagdalpur
Length	80 m
Width	25 m
Eave height	9 m
Seismic zone	Zone II
Wind speed	39 m/s
Wind terrain category	2
Wind class	C
Lifespan	50 years
Slope of roof	1 in10
Soiltype	Medium
Bay space	8 m c\c
Support condition	fixed
Importance factor	1

Response Reduction Factor	5

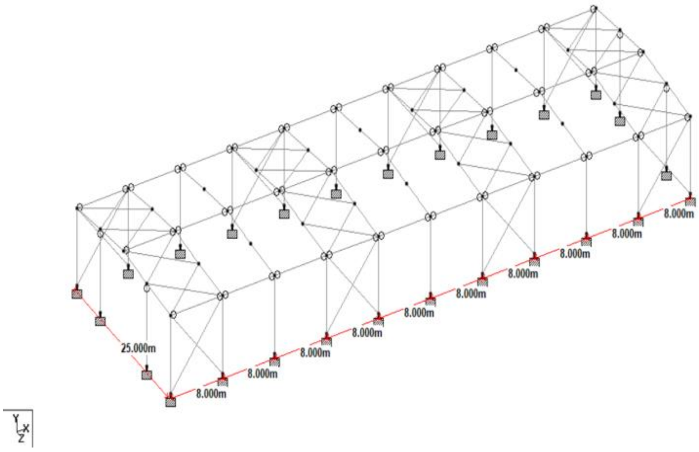

Fig.1 CSB Frame Model 3D View

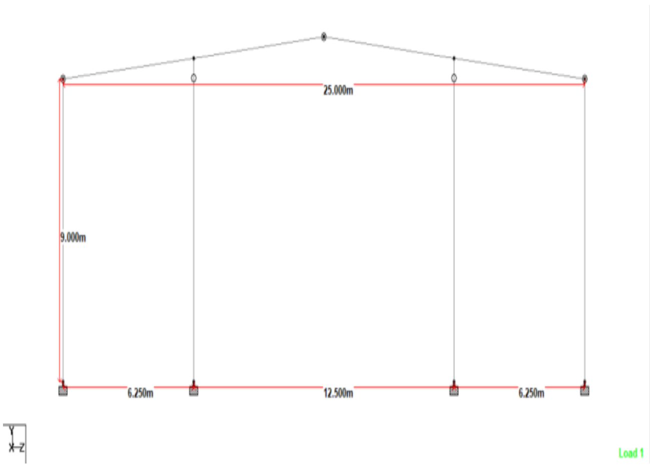

Fig.2 CSB Frame Front View

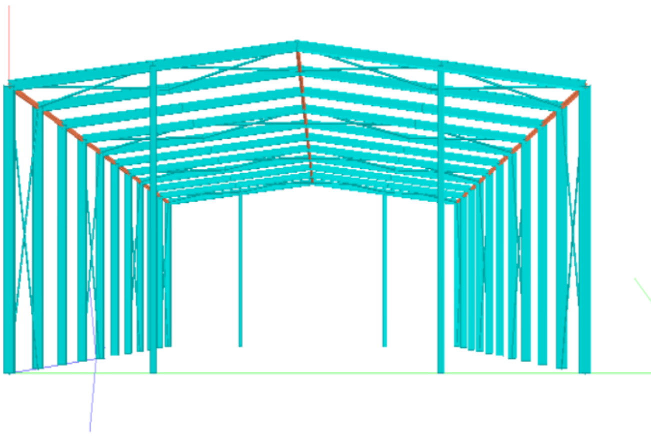

Fig.3 CSB Frame Render image

Fig.4 CSB Frame component

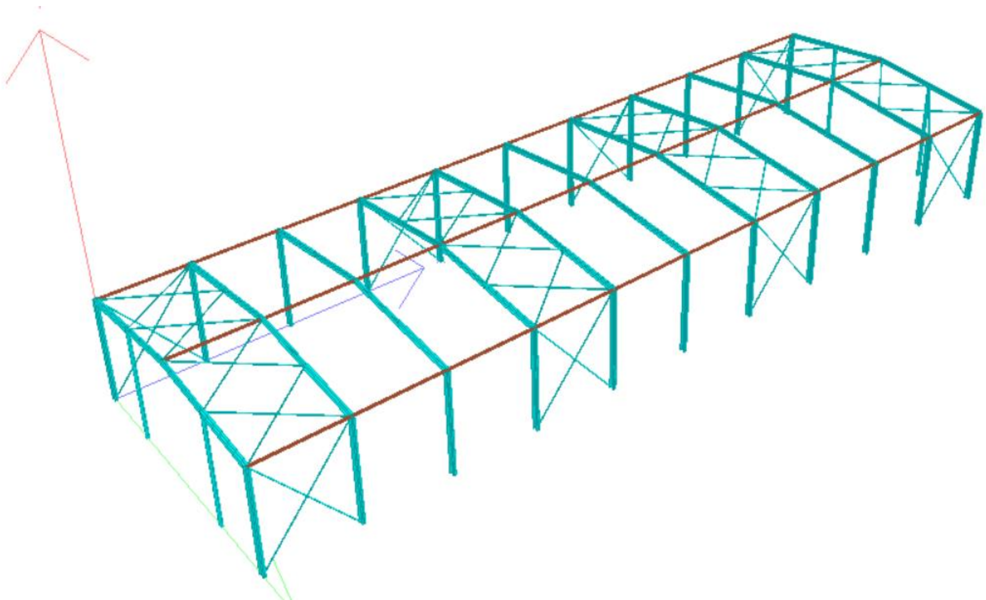

Fig.4 CSB Frame component

B. Dead Load Calculation

Sheet (Galvanized iron sheet) as per IS 875 (part 1)-1987 page 10 [13].
Thickness= 0.63 m
Sheet wt. = 0.054 KN/m²
Purlin wt. = 0.08 KN/m²
Fixtures like (sag rod, bracing etc) wt. = 0.043 KN/m²
Total Dead Load = 0.054+ 0.084+0.04 = 0.181 KN/m²
Dead load for 8 m bay = 0.181 x 8 =1.448 KN/m
For end frame = 1.448/2 = 0.724 KN/m

C. Live Load Calculation

As per IS 875 (part 2)-1987 page -14 [14]
For slope roof with slope up to 10° (including) and access not provided = 0.75KN/m²
Slope <10° no extra calculations is required
Line Load for 8m bay space = 0.75 x 8 = 6KN/m
For end frame = 6/2 =3KN/m.

D. Wind Load Calculation

As per IS 875 (part 3)-2015 [15]

K_d for triangular, square, and rectangular

K_d= 0.9
K_a value depend upon tributary area
K_a= 0.837
K_c depend upon pressure and suction of roof
K_c =0.9
V_b, Basic wind speed (for Jagdalpur)
V_b= 39 m/s
K_1, Risk coefficient
For design life 50 year
K_1=1
K_2, Terrain, height factor
Here terrain category=2
For height= 9 m
K_2=1
K_3, Topography K_3 factor
Here slope is less than 3°
K_3=1
K_4 Cyclonic factor
(As jagdalpur is located > 60 km from east coast) Therefore, for industrial building with no cyclonic factor
K_4=1
V_z , Design wind speed at height Z
$V_z = V_b \times K_1 \times K_2 \times K_3 \times K_4$
V_z = 39 m/s
P_Z ,Wind pressure at height Z
P_z =0.913 KN/m²
P_d ,Designed wind pressure
$P_d = K_d \times K_a \times K_c$
P_d = 0.64 KN/m²
"The value of P_d, however shall not be taken as less
than 0.70 P_z" [5].
$F = (C_{pe} - C_{pi})\, A\, P_d$
where
C_{pe} = external pressure coefficient,
C_{pi} = internal pressure coefficient,
A = surface area of structural element or
cladding unit, and
P_d = design wind pressure [15].

For both pressure and suction, external and internal wind factors are determined for all surfaces. Because the opening in the building is smaller than 5%, the internal coefficients are +0.2 and -0.2, respectively[15].

E. Load Combination

Here the load combination is taken as per IS 800:2007 and not as per AISC because as location of the project the loading conditions depends and load combination by IS 800:2007 gives higher value which contribute towards safety of structure. As per AISC-2011, there is no need for different load combinations for strength and deflection[15].
DL+LL
DL+WL
DL+0.8LL+0.8WL
1.5(DL+LL)
1.5(DL+WL)
(0.9DL+1.5WL)
1.2(DL+LL) +0.6WL
1.2(DL+LL+WL)
DL denotes Dead Load, LL denotes Live Load and WL denotes Wind Loads.

IV RESULT AND DISCUSSION

In this case, the output of the process—pictures—is an attempt to depict the outcomes of the STAAD Pro v8i program.

A. Utilization ratio check

In the construction business, Steel offer quicker, more effective construction with optimal steel utilisation, utilising Indian load calculations.

B. Reaction at supports and Bending Moment about Z due to DL

Support reaction of single frame generated due to applied load and load combinations are represented below in pictorial form.

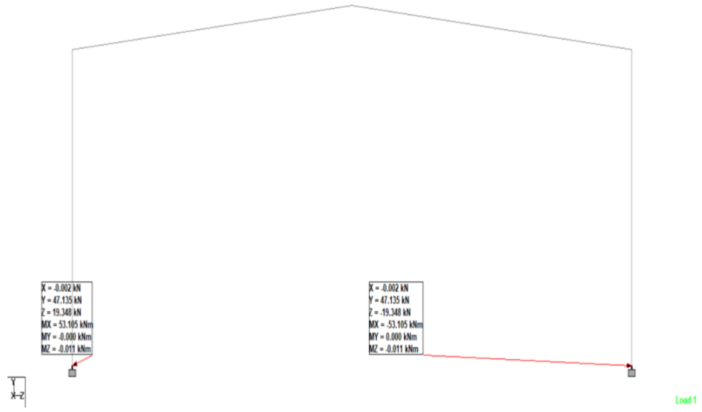

Fig.6 Support Reactions

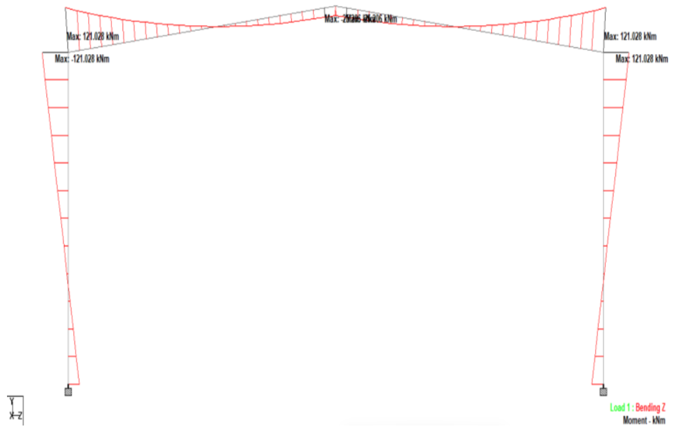

Fig.7 Bending Moment about Z axis due to DL

C. Shear about Y axis

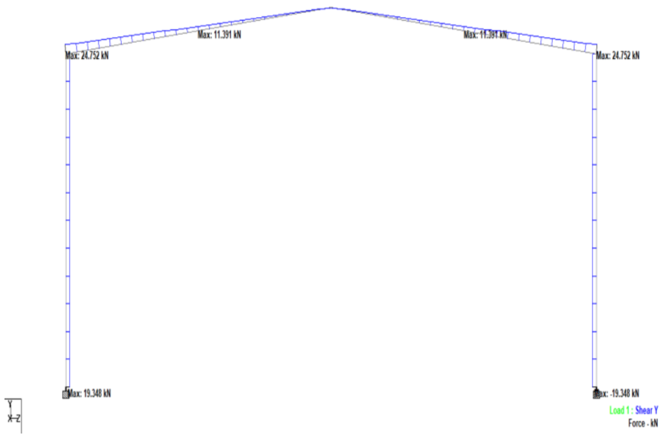

Fig.8 Shear about Y axis

D. Deflections

Deflection Limit

S.No	Description	Vertical	Horizontal
1	Main frame	L/180	H/60
2	Wind column		H/120
3	Mezzanine Beam	L/240	L/325
4	Purlin	L/180	L/180
5	Girt	L/120	L/180
6	Minimum Thickness	4 1.6	

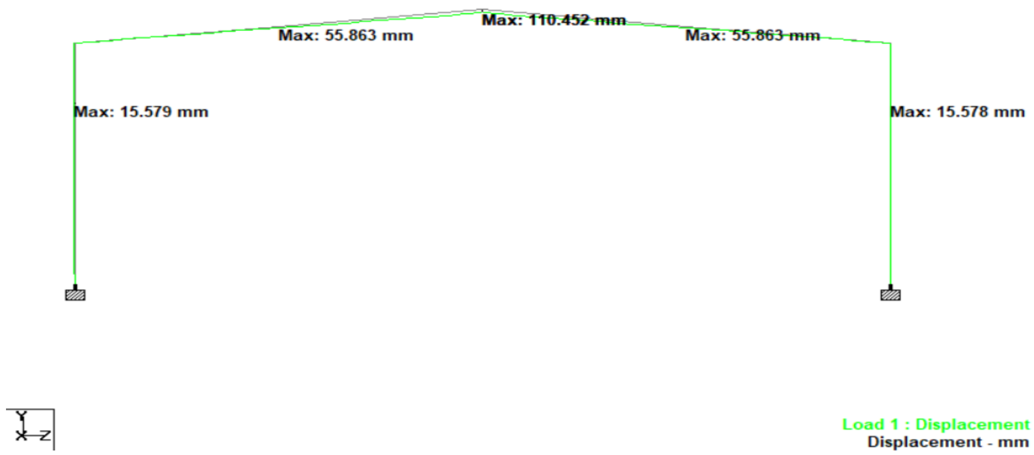

Fig.9 Displacement under LL&DL

E. Steel Take off

Steel take off is the quantity of steel to be used for the designed construction project. It generally provide the detail of the material to be consumed in the project. These features of STAAD pro enable us to estimate the quantity of material as per code standard [5].

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STEEL TAKE-OFF
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   PROFILE                  LENGTH(METE)       WEIGHT(KN   )

Tapered    MembNo:       1        198.00           150.582
Tapered    MembNo:       3        138.19           104.031
Tapered    MembNo:       5        138.19            89.169
Tapered    MembNo:      64         38.50            19.520
D   ISMC125                       240.00            61.210
ST  RD55                          518.14            94.732
                                             ----------------
                                   TOTAL =          519.243


************ END OF DATA FROM INTERNAL STORAGE ************
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Fig.10 Steel take off

V. CONCLUSION

- In this type of design is adopted where IS 875:1987 part 1,part 2 ,875:2015 part 3 and IS 800:2007 is used for load calculation and load combination
- The amount of Steel take off = 519.243 KN

VI. REFERENCES

[1] M. Meena and M. Kammalakannan, "Comparative Study of Seismic Analysis and Design of Pre-Engineering Building with Conventional Industrial Building on different bay spacing," 2017, doi: 10.15680/IJIRSET.2017.0605200.

[2] D. K. Chhajed and S. B. Mulay, "Design and Analysis of Pre Engineered Steel Building with Indian Standard Code and International Code," *International Research Journal of Engineering and Technology*, 2020, [Online]. Available: www.irjet.net

[3] M. J. Gilbile and S. S. Mane, "A Review on Comparative Study on the Structural Analysis and Design of Pre-Engineered Building [PEB] with Conventional Steel Building [CSB]." [Online]. Available: www.ijert.org

[4] S. v Bhagatkar, F. I. Shaikh, B. P. Gupta, D. Kharta, and B. E. Student, "A Study On Pre-Engineered Building-A Construction Technique," 2015. [Online]. Available: www.ijera.com

[5] R. Verma* and Dr. R. Singh, "Advantages of Pre-Engineered Building over Conventional Building," *International Journal of Innovative Technology and Exploring Engineering*, vol. 9, no. 3, pp. 2564–2568, Jan. 2020, doi: 10.35940/ijitee.C8954.019320.

[6] "STUDY OF PRE-ENGINEERED BUILDING CONCEPT."

[7] N. K. Dewani and S. Bhadke, "'STUDY OF PRE-ENGINEERED BUILDING,'" *International Research Journal of Engineering and Technology*, [Online]. Available: www.irjet.net

[8] Prithuvi sai, Moturu ravi, Laishram chandramani singh,"an analytical study on pre engineered building by using STAAD Pro", *Journal of Emerging Technologies and Innovative Research (JETIR),Volume 7, Issue 5,ISSN-2349-5162.*

[9] P. Kumar Ramancharla, "Comparison of Design Procedures for Pre Engineering Buildings (PEB): A Case Study," 2014. [Online]. Available: www.psec.in

[10] M. Darshana and P. Zoad, "Evaluation Of Pre-Engineering Structure Design By IS-800 As Against Pre-Engineering Structure Design By AISC," *International Journal of Engineering Research & Technology (IJERT)*, vol. 1, 2012, [Online]. Available: www.ijert.org

[11] A. Rajendra Thorat and S. K. Patil, "A STUDY OF PERFORMANCE OF PRE-ENGINEERED BUILDING OF AN INDUSTRIAL WAREHOUSE FOR DYNAMIC LOAD," *International Research Journal of Engineering and Technology*, 2017, [Online]. Available: www.irjet.net

[12] "IS 800-2007 General Construction in steel - code of practice," in *Indian Standard*, 2007.

[13] "IS 875 (Part 1)-1987 Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures (Dead Load)," 1987.

[14] "IS 875 (Part 2)-1987 Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures (Imposed Load)," 1987.

[15] "IS 875 (Part 3)-2015 code of Practice for Design Loads (Other than Earthquake) for Buildings And Structures (Wind Load)," 2015.