



PARAMETRIC STUDY OF VARIOUS PRE-ENGINEERED BUILDINGS

Joshi Vaibhav Harish¹, Prof. V. B. Patel², Prof. V. A. Arekar³

¹(M.E. Student, Structural Engg. Dept., BVM Engg. College, V.V.Nagar, India.)

²(Asst. Professor, Structural Engg. Dept., BVM Engg. College, V.V.Nagar, India.)

³(Asst. Professor, Structural Engg. Dept., BVM Engg. College, V.V.Nagar, India.)

Abstract - The Pre-Engineered Building is having many advantages over Conventional Steel Building. Many authors have studied about benefits of PEB over CSB but there is lack of study about PEB itself. It is fact that there are variations in use of steel quantity with using different type of PEBs like regular, mono slope and curved frame PEB. For this, the analysis has carried out by taking the optimized section for loads and load combinations calculated by excel sheet, considering DL, LL and WL with the Combination according to IS 800: 2007. The analysis has done through the software ANSYS which is based on FEM. Stresses have found for design load and the stress ratio of the support frame has found with quantity of steel and compared with each other for deriving economic type of PEB. One typical frame has also take for deriving which stress is predominant for failure.

Keywords: PEB, ANSYS, Weight Analysis, Predominant stress, Regular frame, Mono-slope Frame, Curved Frame.

I. PEB

The sections can be varying throughout the length according to the bending moment diagram. This leads to the utilization of non-prismatic rigid frames with slender elements. Tapered I sections made with built-up thin plates are used to achieve this configuration. Standard hot-rolled sections, cold-formed sections, profiled roofing sheets, etc. is also used along with the tapered sections. The use of optimal least section leads to effective saving of steel and reduction of cost.

Design of PEB is Quick and efficient; since PEBs are mainly formed of standard sections and connections, design time is significantly reduced. Basic designs are used over and over. Foundations are Simple in design, easy to construct and light weight. Both costs & time of erection are minimized. The erection process is easy, fast, step by step and with hardly any requirement for equipments. Outstanding architectural design can be achieved at low cost using standard architectural features and interface details. PEBs are designed with future expansion in mind. It is simple, easy and cost effective. One supplier cans co-ordinate changes. It is only that Company's responsibility for design, supply and even erection of PEBs.

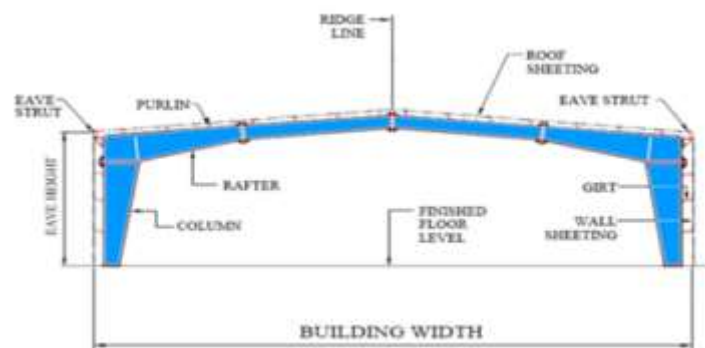


Figure 1 Components of PEB

According to configuration there are two types of PEB:

- i) Clear span PEB
- ii) Multi-span PEB

According to Geometry there are three types of PEB:

- i) Regular frame PEB
- ii) Mono slope Frame PEB
- iii) Curved Frame PEB

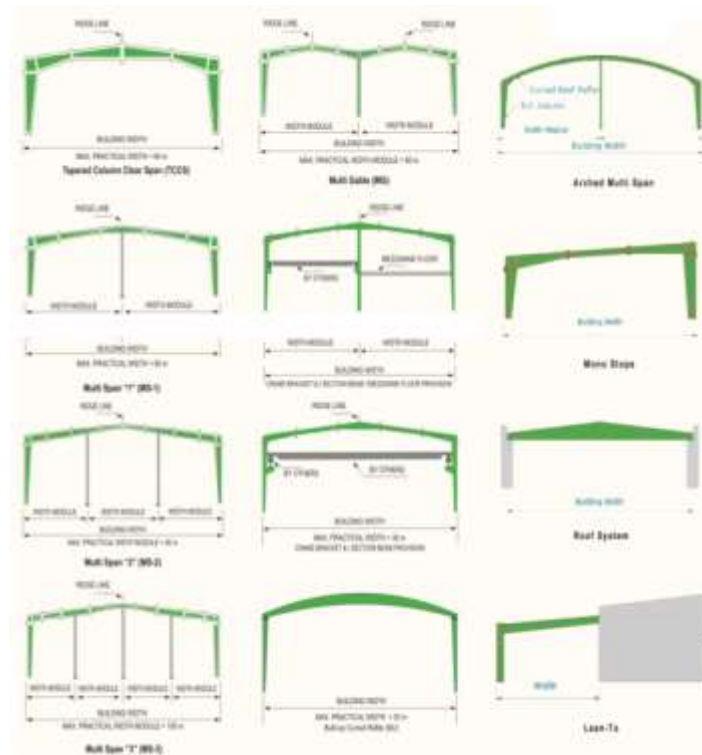


Figure 2 Types of PEB

II. NUMERICAL STUDY

A. TYPICAL REGULAR FRAME ANALYSIS

This typical frame is selected by taking different sections at the frame for checking the strength of section by considering the maximum permissible stress 250MPa and Maximum Shear Stress 125MPa. This study was carried out for finding out the stress causes failure.

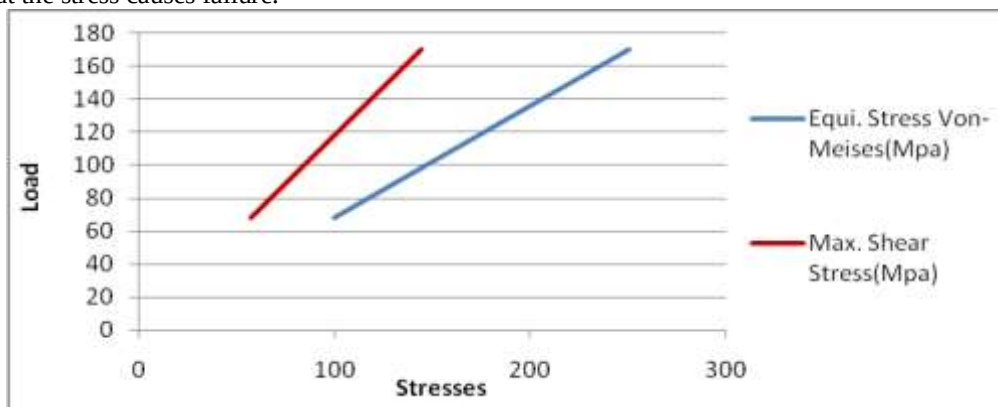


Figure 1 Stresses of typical frame

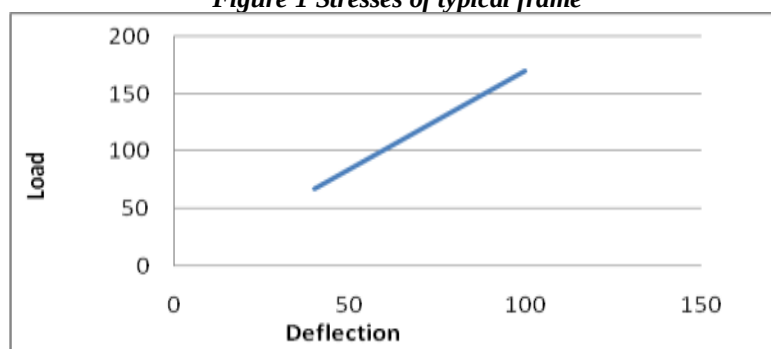


Figure 4 Deflection of typical frame

B. REGULAR FRAME OF 20M SPAN

This regular frame dimensions were taken according to the bending moment diagram. By taking several dimensions, it was found that this section is optimum and also safe for this particular load. The section is given below shown in geometry. Load applied on it for normal condition, is calculated by the excel sheet. The stress values are Evaluate for Design load (downward load-Max. Positive load) which is due to the load combination of $1.2DL+1.2LL-1.2WL$ and value is 115417.96N. Also Evaluated for check load(upward load-Max. Negative load) which is due to the load combination of $1.5DL+1.5WL$ and value is -46552.33 N. Result shows that the maximum shear stress and the equivalent (VON-MISES) stress are at same point which is the centre of web of rafter- column joint.

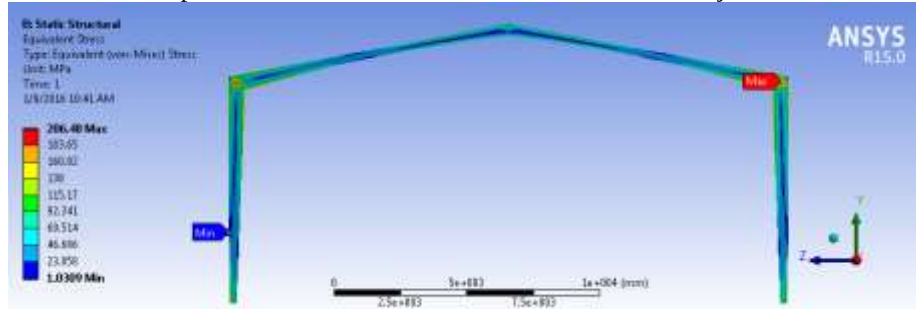


Figure 5 Equivalent (Von-Mises) Stress of 20m regular frame PEB

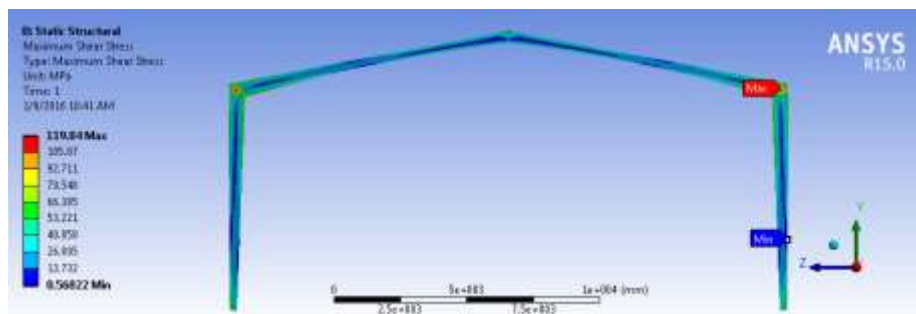


Figure 6 Max. Shear Stress of 20m regular frame PEB

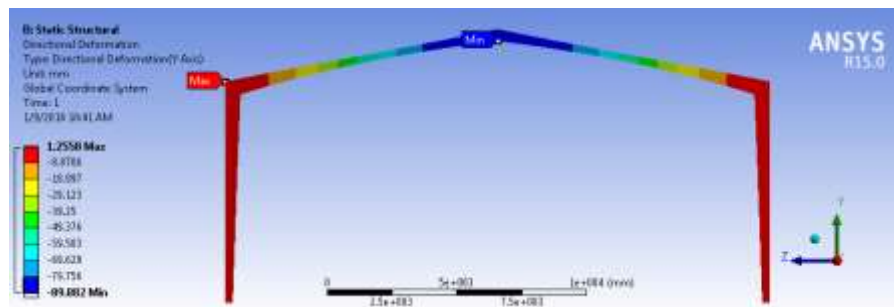


Figure 7 Deflection of 20m regular frame PEB

C. MONO SLOPE FRAME OF 20M SPAN

This Mono Slope frame dimensions were taken according to the bending moment diagram. By taking several dimensions, it was found that this section is optimum and also safe for this particular load. The section is given below shown in geometry. Load applied on it for normal condition, is calculated by the excel sheet. The stress values are Evaluate for Design load (downward load-Max. Positive load) which is due to the load combination of $1.2DL+1.2LL-1.2WL$ and value is 235690.66N. Also Evaluated for check load(upward load-Max. Negative load) which is due to the load combination of $1.5DL+1.5WL$ and value is -91210.07 N. Result shows that the maximum shear stress and the equivalent (VON-MISES) stress are at same point which is the centre of web of rafter- column joint.

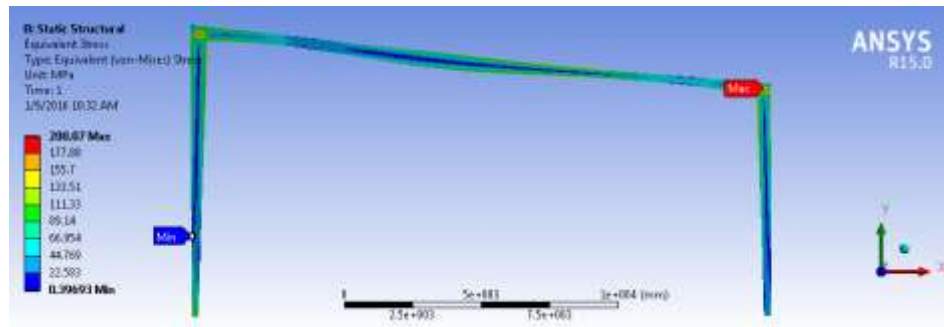


Figure 8 Equivalent (Von-Mises) Stress of 20m mono slope PEB

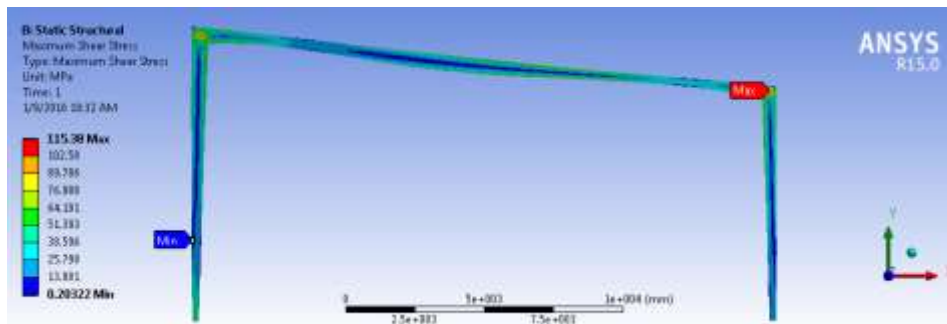


Figure 9 Max. Shear Stress of 20m mono slope PEB

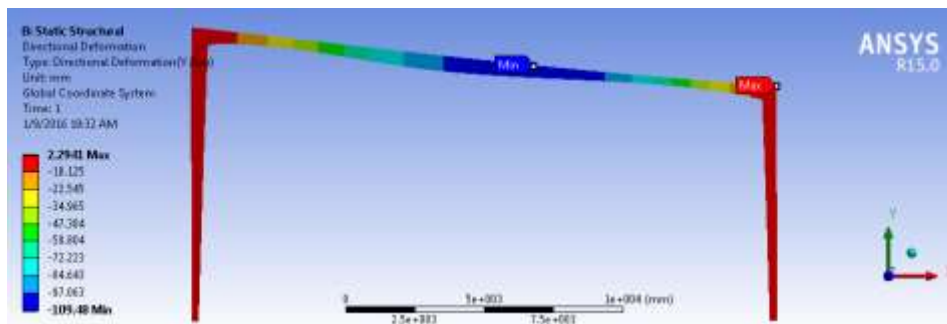


Figure 10 Deflection of 20m mono slope PEB

D. CURVED FRAME OF 20M SPAN

The dimensions of Curved frame were taken according to the bending moment diagram. By taking several dimensions, it was found that this section is optimum and also safe for this particular load. The section is given below shown in geometry. Load applied on it for normal condition, is calculated by the excel sheet. The stress values are Evaluate for Design load (downward load-Max. Positive load) which is due to the load combination of $1.2DL+1.2LL-1.2WL$ and value is 231756.02N. Also Evaluated for check load(upward load-Max. Negative load) which is due to the load combination of $1.5DL+1.5WL$ and value is -93955.40 N. Result shows that the maximum shear stress and the equivalent (VON-MISES) stress are at same point which is the centre of web of rafter- column joint.

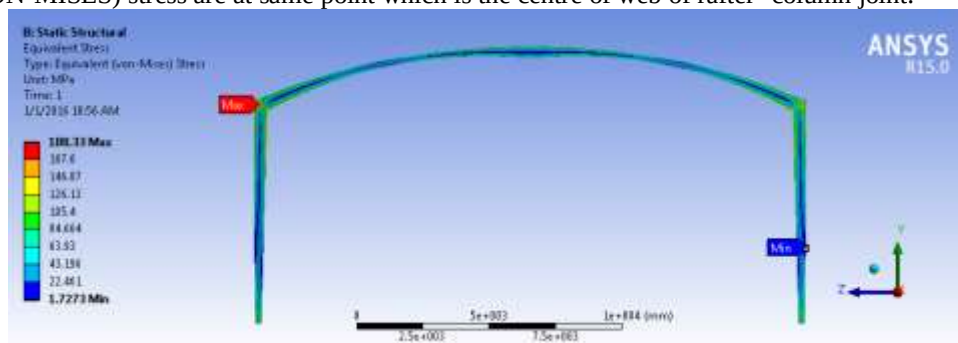


Figure 11 Equivalent (Von-Mises) Stress of 20m curved frame PEB

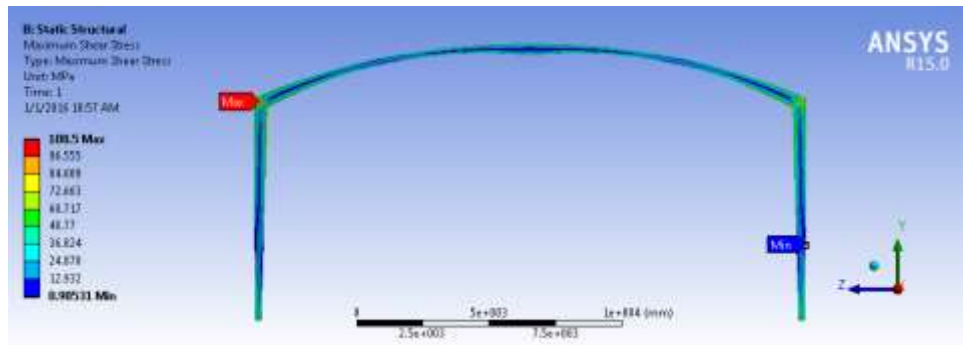


Figure 12 Max. Shear Stress of 20m curved frame PEB

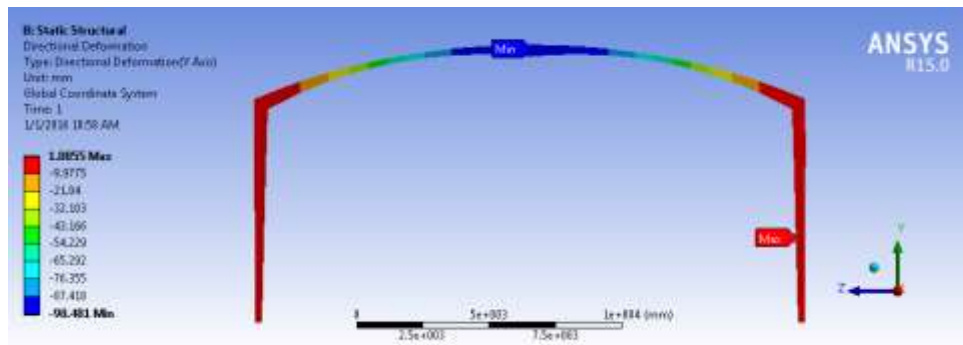


Figure 13 Deflection of 20m curved frame PEB

III. STRESS RATIO FOR DIFFERENT CONDITIONS FOR WEIGHT COMPARISON

This Stress ratio is the minimum value from two values of ratio of the permissible stress to actual stress in principal stress and shear stress. This Stress ratio is considered for safer section provided with the load combination which is taken with partial safety factor according to IS 800: 2007.

Table 1 Selection of safety for PEBs

Type of PEB	Stress ratio	Shear ratio	Min. of Stress ratio and Shear ratio
Regular PEB 20m Positive load	1.163	1.050	1.050
Mono Slope PEB 20m Positive load	1.167	1.085	1.085
Curved Frame PEB 20m Positive load	1.282	1.152	1.152

*Maximum of trio maximum principal stress, minimum principal stress and equivalent (VON-MISES) stress.

The Cost comparison is considered in terms of weight for support frame by deriving the steel quantity in Kg for single frame and multiplied with total frame required for the pre engineered shed of 30m x 20m x 8m with maximum height of 10m.

Table 2 Weight of Frames

	Weight in Kg.	Total Weight in Kg.	% usage
Regular frame PEB	3022.1	21154.7	100 %
Mono Slope PEB	3915.8	27410.6	129.57 %
Curved Frame PEB	2755.1	19285.7	91.16 %

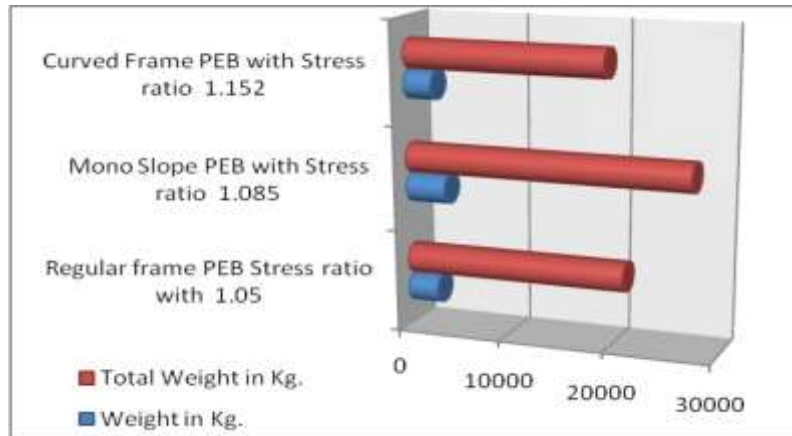


Figure 14 Weight Comparison of Different PEB Frame for Support Frame

IV. CONCLUSION

- For all PEB Equivalent (VON-MISES) stress is predominant stress.
- Among all three typical frames, arched frames are more economical. It saves 8.84% steel compare to regular frame.
- Mono slope frame consumes around 1.3 times more steel then regular frame.

V. REFERENCES

1. SAI KIRAN GONE, RAO KAILASH, RAMANCHARLA PREDEEP KUMAR ^[1] "Comparison of Design Procedures for Pre Engineering Buildings (PEB): A Case Study" International Journal of Civil, Architectural, Structural and Construction Engineering August 2014, Report No: IIIT/TR/2014/-1.
2. CHARKHA S.D. AND SANKLECHA LATESH S. ^[2] "Economizing Steel Building using Pre-engineered Steel Sections", International Journal of Research in Civil Engineering, Architecture & Design Volume 2, Issue 2, April-June, 2014, pp. 01-10.
3. BALAJI A RAJU, PRAVEEN A. ^[3] "INNOVATIVE COLD FORM BASED COMPOSITE SECTION FOR ENHANCING SUSTAINABILITY IN BUILT ENVIRONMENT", International Journal of Innovative Research in Science, Engineering and Technology, Volume 2, Special Issue 1, December 2013.
4. PROF. LANDE P. S., KUCHERIYA VIVEK. V. ^[4] "COMPARATIVE STUDY OF PRE-ENGINEERED BUILDING WITH CONVENTIONAL STEEL BUILDING", International journal of pure and applied research in engineering and technology, 2015; volume 3 (8): 28-39.
5. PRADEEP V, PAPA RAO G ^[5] "Comparative Study of Pre Engineered and Conventional Industrial Building", International Journal of Engineering Trends and Technology (IJETT) – Volume 9 Number 1 - Mar 2014.
6. ZENDE AIJAZ AHMAD, PROF. KULKARNI A. V., HUTAGI ASLAM Comparative Study of Analysis and "Design of Pre-Engineered - Buildings and Conventional Frames", IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) ISSN: 2278-1684 Volume 5, Issue 1 (Jan. - Feb. 2013), PP 32-43.
7. SYED FIROZ, SARATH CHANDRA KUMAR B, S.KANAKAMBARA RAO, "Design concept of pre engineered building", International Journal of Engineering Research and Applications (IJERA) Vol. 2, Issue 2, Mar-Apr 2012, pp.267-272.
8. Mansi B Solanki, Tausif F Kauswala, "Comparative Study of Design of an Industrial Workshop with Pre-Engineering Building", Journal of Advance Engineering and Research Development (IAERD), National Conference on Recent Research in Engineering and Technology (NCRRET -2015).
9. C. M. Meera, "Pre-engineered building design of an industrial Warehouse", International Journal of Engineering Sciences & Emerging Technologies, June 2013. Volume 5, Issue 2, pp: 75-82.
10. Saleem M. Umair, Q. Hisham, and Zahid A. Siddiqi, "Optimum Unbraced Length Ratios of Slender Steel Sections", IACSIT International Journal of Engineering and Technology, Vol. 5, No. 4, August 2013.
11. IS: 800-2007 General Construction in Steel- Code of Practice.
12. IS: 875(all) -1987 Code of Practice for Design Loads (Other than Earthquake) For Buildings and Structures.
13. Profiles R. S. Factory manual for PEB.
14. Metal Building Systems, Design and Specifications By Alexander Newman.
15. <http://www.infinityfab.com>
16. <http://mabanisteel.com.p8.hostingprod.com>
17. <http://www.tridenttruss.com>
18. <https://en.wikipedia.org/>
19. <https://www.google scholar.com/>