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Static Structural Analysis of Pratt, Flink and Howe Steel Truss using Ansys Software

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Abstract: Development of three-dimensional geometry for roof truss has been analyzed and design. This paper represents the comparison of tubular and steel structure in terms of weight, efficiency and deflection. This analysis and design are performed step-by-step using Ansys software considering Self weight, Live Load. This presents study on behavior and economical of roof truss by using spatial geometry. In this study, the structure that is based on geometry as well as analytical and numerical representation of the relation between form and force. The results are compared and verified proves that tubular structure is economical as compared to steel structure. In this paper analysis of Howe steel truss, flink truss and Pratt truss are carried out and the results of nodal deflections, stresses in elements for all three cases were determined.
Keywords: Pratt Truss, Flink Truss, Howe Truss, Ansys, Deflection.

I. INTRODUCTION

The structural analysis is essential since it identifies the critical parts that need special attention. Furthermore, the analysis helps to understand the design of the structure in more detail. Every part of the structure has a purpose and this should be identified before any adjustments are made. The structure to be analyzed is a warehouse building roof truss structure used to design roof structure. The building experiences a lot of stresses in different parts due to various loading conditions. It is not practical to analyses the building as a whole. For more detailed information, the structure is broken down to different smaller parts for easier examination called Finite Element Analysis. Trusses are triangular frame works in which the members are subjected to essentially axial forces due to externally applied load. They may be plane trusses, wherein the external load and the members lie in the same plane or space trusses, in which members are oriented in three dimensions in space and loads may also act in any direction. Trusses are frequently used to span long lengths in the place of solid web girders and such trusses are also referred to as lattice girders. Steel members subjected to axial forces are generally more efficient than members in flexure since the cross section is nearly uniformly stressed. Trusses, consisting of essentially axially loaded members, thus are very efficient in resisting external loads. They are extensively used, especially to span large gaps. Since truss systems consume relatively less material and more labor to fabricate, compared to other systems, they are particularly suited in the Indian context. A truss is essentially a triangulated system of straight interconnected structural elements. Trusses are widely used in buildings, whereas to support roofs, the floors and internal loading such as services, the main reasons for using trusses are to obtain long span and reduction of self-weight and deflection of the structure. Trusses comprise assemblies of tension and compression elements. Under gravity loads, the top and bottom chords will resist bending and the bracing resists the shear forces. The choice of cross-sectional shape for individual members of trusses is not restricted. Whereas beam members are predominantly I-shaped and L-shaped to accommodate the bending effects. Truss members are generally subject to small direct forces. Consequently angles, tees, or any other standard structural section may be used. For lightly loaded structures the members are usually angles or tees while for more heavily loaded trusses universal beam sections may be more appropriate.

II. ANSYS SOFTWARE

ANSYS is a general-purpose software, used to simulate interactions of all disciplines of physics, structural, vibration, fluid dynamics, heat transfer and electromagnetic for engineers. So ANSYS, which enables to simulate tests or working conditions, enables to test in virtual environment before manufacturing prototypes of products. Furthermore, determining and improving weak points, computing life and foreseeing probable problems are possible by 3D simulations in virtual environment. ANSYS software with its modular structure as seen in the table below gives an opportunity for taking only needed features. ANSYS can work integrated with other used engineering software on desktop by adding CAD and FEA connection modules. ANSYS can import CAD data and also enables to build geometry with its "preprocessing" abilities. Similarly, in the same preprocessor, finite element model (a.k.a. mesh) which is required for computation is generated. After defining loadings and carrying out analyses, results can be viewed as numerical and graphical. ANSYS can carry out advanced engineering analyses quickly, safely and practically by its

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variety of contact algorithms, time-based loading features and nonlinear material models. ANSYS Workbench is a platform which integrates simulation technologies and parametric CAD systems with unique automation and performance. The power of ANSYS Workbench comes from ANSYS solver algorithms with years of experience. Furthermore, the object of ANSYS Workbench is verification and improving of the product in virtual environment. ANSYS Workbench, which is written for high level compatibility with especially PC, is more than an interface and anybody who has an ANSYS license can work with ANSYS Workbench.

III. LOADS ON TRUSSES

1) *Dead Load:* Dead load on the roof trusses in single storey, industrial buildings consists of dead load of claddings and dead load of purlins, self-weight of the trusses in addition to the weight of bracings etc. Further, additional special dead loads such as truss supported hoist dead loads, special ducting and ventilator weight etc. could contribute to roof truss dead loads. As the clear span length (column free span length) increases, the self-weight of the moment resisting gable frame increases drastically. In such cases roof trusses are more economical.
2) *Live Load:* The live load on roof trusses consist of the gravitational load due to erection and servicing as well adjust load etc. and the intensity is taken as per IS:875 Additional special live loads such as snow loads in very cold climates, crane live loads in trusses supporting monorails may have to be considered.
3) *Earthquake Load:* Since earthquake load on a building depends on the mass of the building, earthquake loads usually do not govern the design of light industrial steel buildings. Wind loads usually govern. However, in the case of industrial buildings with a large mass located at the roof, the earthquake load may govern the design. These loads are calculated as per IS: 1893-2002.

IV. MODELING OF ROOF TRUSS STRUCTURE

Three types of Roof Truss structure design here i.e. Howe steel truss, flink truss and Pratt truss with 'L' section used to designed Roof Truss structure. Structural steel used as material for designing of Roof Truss structure. Figures show the geometry of Roof Truss structures.

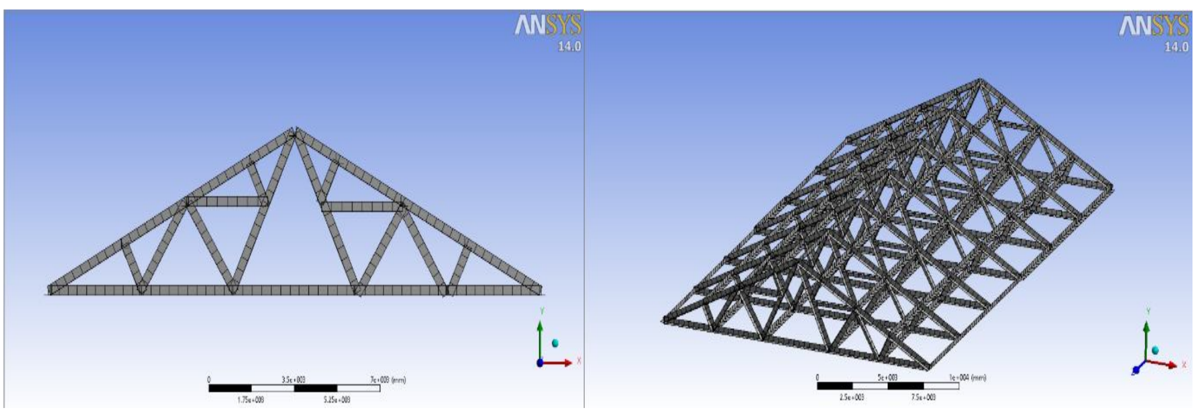

Figure 1: Flink Roof Truss

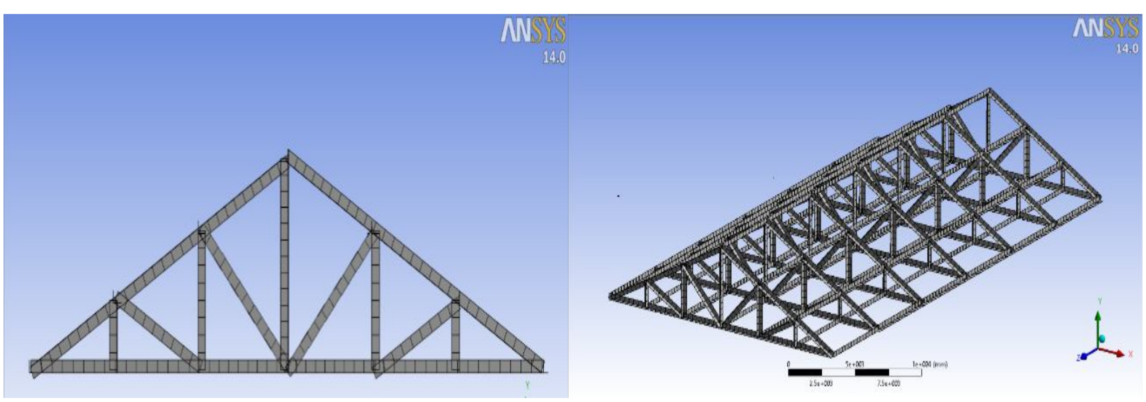

Figure 2: Howe Roof Truss

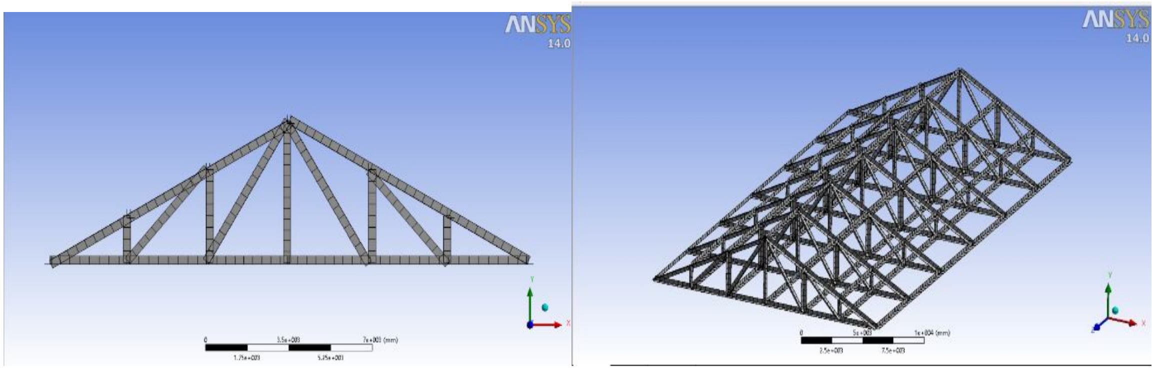

Figure 3: Pratt Roof Truss

V. TEST RESULTS AND DISCUSSION

The deflection and stress occurred in roof truss structure due to self-weight and Live load model is optimized and compared. Loads and supports will be assign and determine the solution of the steel roof truss which are deflection and stress. After that, carry out probabilistic analysis to observe the change of results. Figures Shows the boundary conditions of Roof truss structures.

A. Boundary Conditions of Roof Truss Structures

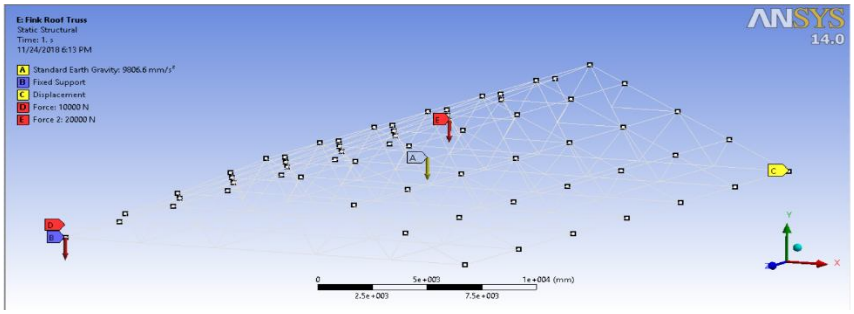

Figure 4: Boundary Conditions of Flink Roof Truss

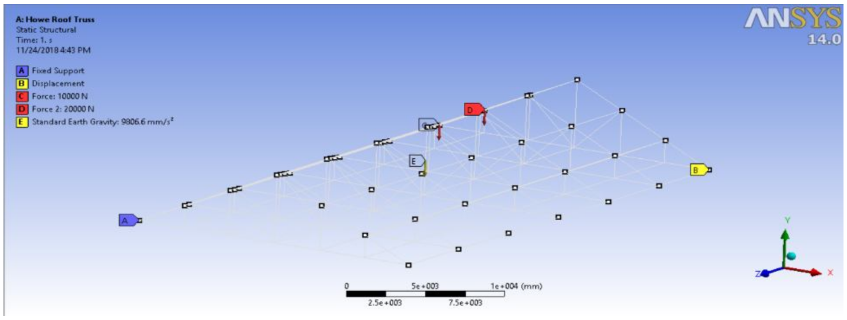

Figure 5: Boundary Conditions of Howe Roof Truss

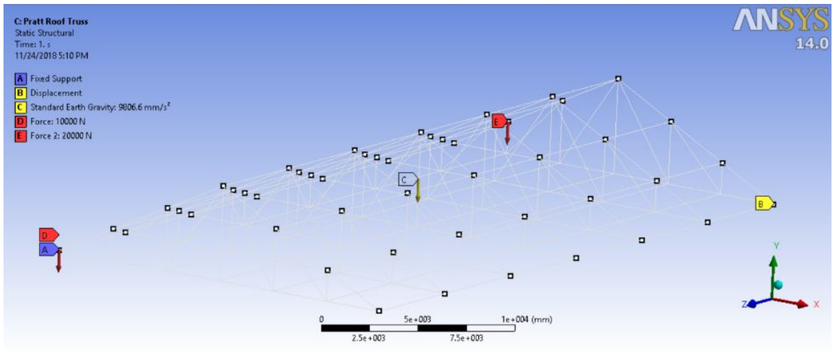

Figure 6: Boundary Conditions of Pratt Roof Truss

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B. Total Deformations in Roof Truss Structures

Figures Shows the total deformations in Howe steel truss, flink truss and Pratt truss structures.

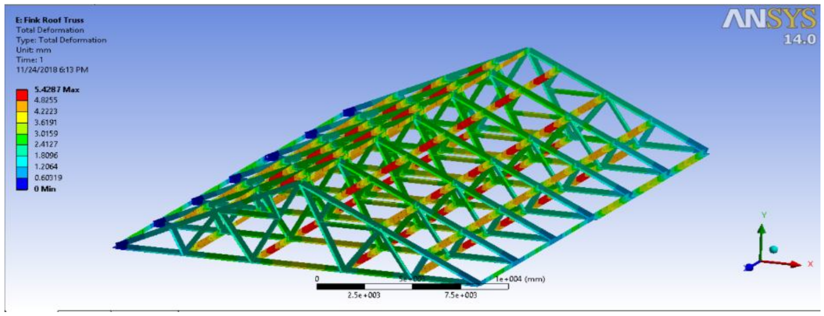

Figure 7: Total Deformations in Flink Roof Truss Structures

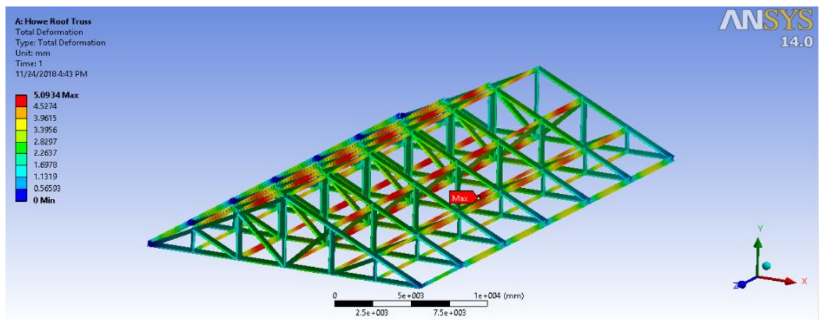

Figure 8: Total Deformations in Howe Roof Truss Structures

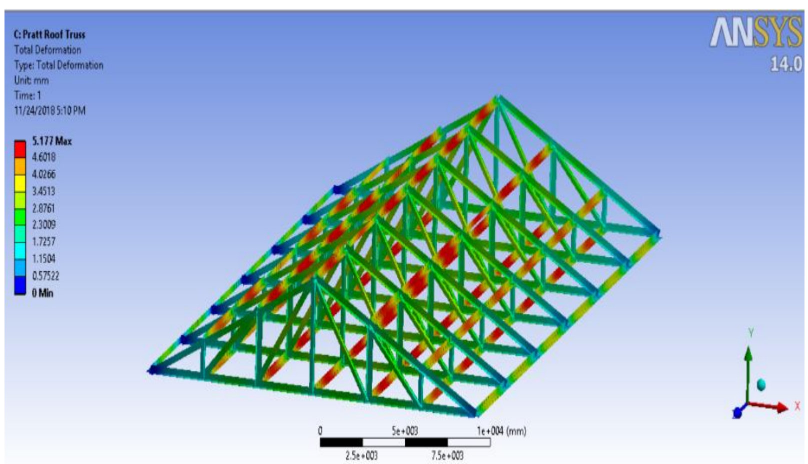

Figure 9: Total Deformations in Pratt Roof Truss Structures

Table 1: Roof Truss Structures Analysis Results Comparison

Roof Truss Types	Total Weight of Truss (Kg)	Total Deformations Due to Self weight	Max Combined Stress Due to Self weight	Total Deformations Due to Live Load + Self weight	Max Combined Stress Due to Live Load + Self weight
Howe Roof Truss	26601	4.93	27.19	5.09	29.32
Pratt Roof truss	27497	5.01	29.24	5.17	31.5
Fink Roof truss	28747	5.25	25.81	5.42	27.63

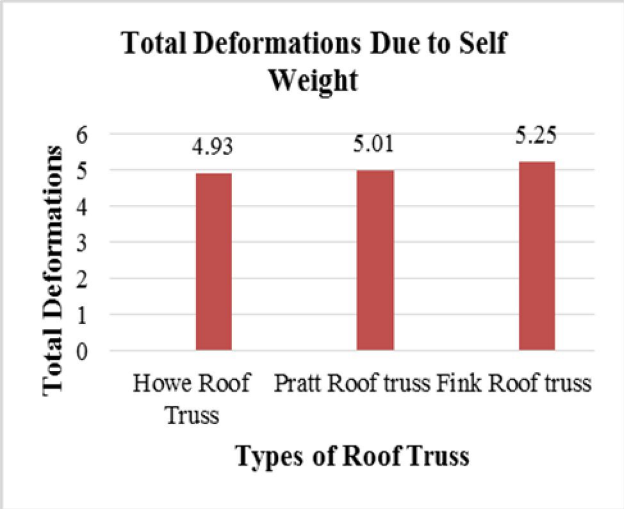

Figure 10: Total Deformations Due to Self Weight

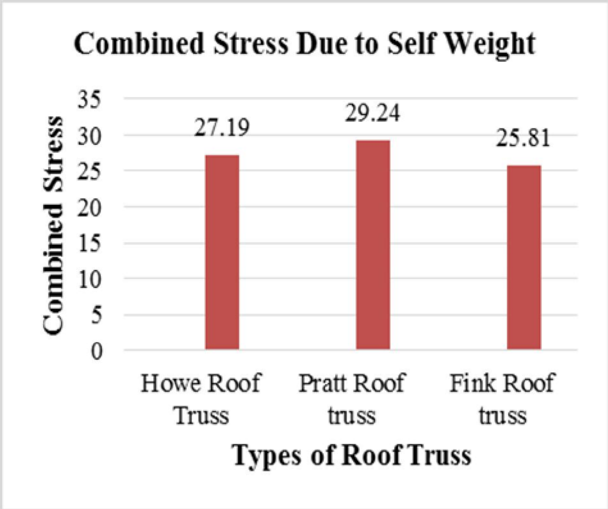

Figure 11: Combined Stress Due to Self Weight

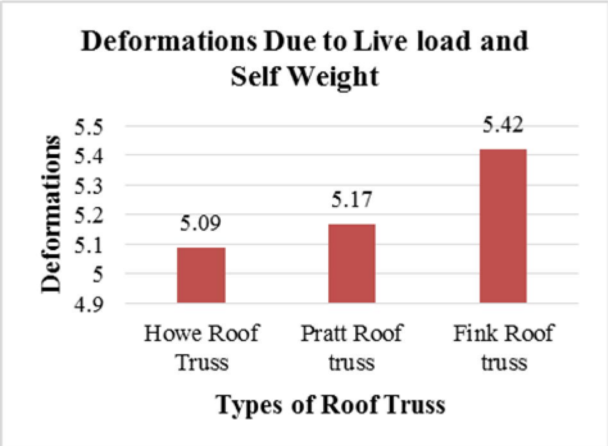

Figure 12: Total Deformations Due to Combined load

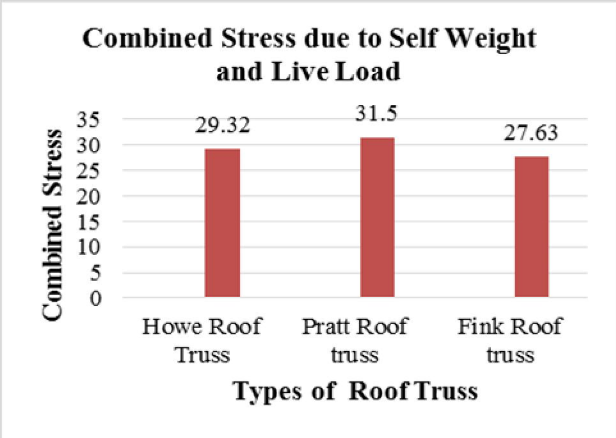

Figure 13: Combined Stress Due to Combined load

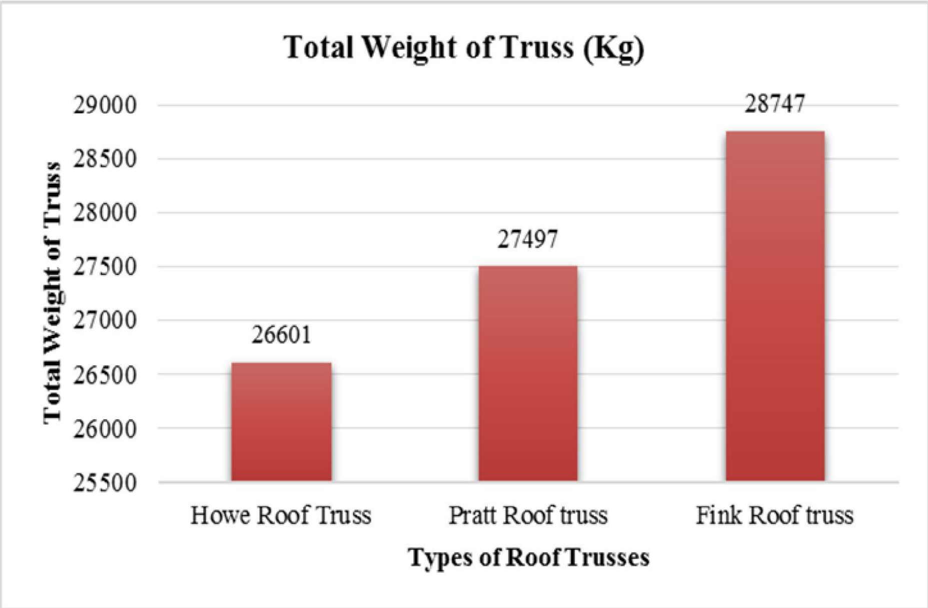

Figure 14: Total Weight of Roof Trusses

VI. CONCLUSIONS

As per Above study it is concluded that the roof truss structure three type designs used in this study and analyzing deflection, stresses and total weight of truss.

By comparing Flink, Howe and Pratt steel truss with each other following conclusions are made.

1) Total deformations due to combined load on roof truss structures shown Maximum deformations in Flink roof truss structure and minimum deformation found in Howe roof truss structure.
2) As per total weight analysis maximum weight found on Flink Roof truss structure and minimum weight found on Howe roof truss structure.
3) Minimum weight of Howe roof truss structure is 26601 Kg and Maximum weight found on Flink roof truss is 28747 Kg.
4) so as per above analysis we can conclude that Howe type roof structure having minimum deflection on minimum weight with respect to other two roof trusses.
5) Howe type roof truss structure has better stability with minimum stresses on loading.

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