Analysis of Various Truss System for Industrial Structure

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Abstract — The goal of the project is to select the most cost-effective truss for use in warehouses, workshops, light and medium engineering industries, and process industries. By doing this, a great deal of time will be saved in setting up an industry, leading to increased production. Indirectly, this would boost the nation's economy as a whole. Since it would largely relieve from the repetitive and routine calculations, this would also aid in the orderly use of structural engineering. Thus, the engineer's time could be better spent considering less expensive and more creative options. Ten pitched roof trusses in all are compared in this work. For a span of 12 m and an interval of 6 m, the analysis and design outcomes of steel roof trusses are presented. Double Howe, Double Fink, Fan, Fink, Pratt, Queen post, Fink-2, Multi panel, Attic, and Piggyback truss configurations are used. The provided roof truss slope of 180 is generally advised as it shouldn't present any fabrication issues. For wind zones I to VI, roof truss analysis is conducted. The relevant Indian standards have been used as the basis for the analysis and design. Trusses make use of box sections. A comparison is made between axial force, shear force, weight, and cost in members. Additionally, these trusses' axial and shear forces are contrasted. The outcome demonstrates that the Pratt truss is more cost-effective than other trusses taken into account. The Fink-2 type truss, on the other hand, is more expensive and heavier than other trusses.

Keywords: Pitched Roof, Different Types of Trusses, Cost Comparison

I. INTRODUCTION

Trusses are employed in a variety of situations where a strong yet lightweight structure is necessary. Bridges, buildings (especially those with roofing and flooring), radio and television towers, and space-based structures all frequently use trusses. Because building roof trusses requires a lot of labour and prefabricated roof trusses save time, materials, and money, many home builders order prefabricated roof trusses from a manufacturer and have them delivered to a construction site.

A. Advantages of Roof Trusses

- Carpenters with less experience can set trusses and thus lower the labour costs.
- Fewer interior load bearing walls are needed due to the trusses' longer free spans.
- Trusses can usually be set in 1 day; meaning that the interior of the home is exposed to the weather for a minimal amount of time.

B. Types of Roof Trusses:

1) Pitched Truss:
The pitched truss has a triangular shape with additional structural members within the triangle and is used primarily in roof construction. Types of pitched roof trusses are further explained briefly.

2) Parallel Chord Truss:
The parallel chord truss consists of two parallel chords that make up the top and bottom of the truss, with diagonal and perpendicular webbing connecting the two parallel chords. The top parallel chord is usually in compression and the bottom parallel chord is usually in tension.

C. Types of Pitched roof trusses

1) Double Howe Truss:
Howe Trusses are meant to span up to 10 m and a Double Howe is rated for as much as 20 m. The longest Howe Truss design is the Triple Howe, and it is designed for spans ranging from 16 m to 25 m in length.

2) Double Fink Truss:
A single Fink Truss can be up to 10 m in size, while a Double Fink Truss can be up to 15 m. It is even possible to create a Triple Fink Truss.

3) Fink Truss:
A Fink truss is one of the most used types of trusses for residential construction. It is a symmetrical truss that has arms which angle upwards from the bottom chord, forming V-shaped webs, which support the interior of the structure. These trusses can cover over 25 m when the web pattern is duplicated. Fink trusses were used frequently in bridges for railroads and are now commonly used as roofing trusses today. This type of roof has under a 35-degree pitch. The Fink truss has been a popular style for many years because it can accommodate many different rooflines and provide the structural support necessary to uphold the roof. In addition, this type of roof truss can extend over a distance while still accommodating the load path that is needed. They can also be stacked together to assist several more styles of roof profiles in building.

4) Modified Queen Post Truss:
A modified Queen Post truss can be used in bay barns or for something that requires an even longer span than what a queen post truss can handle. These trusses have added members that provide compression and tension support over the longer span of the truss.

5) Fan Truss:
The Fan truss resembles a triangle with inverted triangular webs on each side of the apex, both supported by central vertical posts. Fan trusses do not contain a main king post or central post and are available in double and triple fan styles. Double Fan trusses reach a width of up to 10 m and a triple fan may span as much as 25 m of open space.

6) Fink-2 Truss:
A symmetrical truss is formed by three triangles and is commonly used in supporting large, sloping roofs.

7) Pratt Truss:
This truss having both vertical and diagonal members between the upper and lower chords, with the diagonals

sloped towards the centre. Vertical members are in compression and diagonal members (which slant towards the centre) are in tension.

8) Attic Truss:

Attic Truss designs leave open space that may be used for storage or converted to additional living space. Attic roof Trusses are usually designed to give the building a standard 2.5 m tall attic space. The design of the trusses does not change the exterior appearance of the home. The most common type of attic truss design in residential construction is the Double Cantilever style. Unlike standard roof trusses, an attic truss leaves most of the area beneath the roof open and framed; so adding walls and a ceiling at a later time is fairly inexpensive. Although Attic roof Truss designs are more expensive than other types of trusses, they offer savings over stick construction and add value to a house.

9) Piggyback Truss-

Piggyback trusses are used when the height of a required roof truss exceeds the limit; the limit is usually around 3.5 to 4 m.

II. OBJECTIVE OF THE WORK

- To analyze different steel roof trusses i.e., Double Howe, Double Fink, Fink, Queen Post, Fan, Fink-2, Pratt, Multi panel, Atticand Piggyback using STAAD Pro.
- To analyze different types of steel roof trusses of span 12m and spacing of 6m for wind zones I, II, III, IV, V and VI.
- To compare axial forces of typical members, principal rafter, tie member and web members (strut and vertical) in steel roof trusses.
- To compare shear force of typical members, principal rafter, tie member and web members (strut and vertical) in steel roof trusses.
- To compare trusses with reference to weight and cost.

III. METHODOLOGY

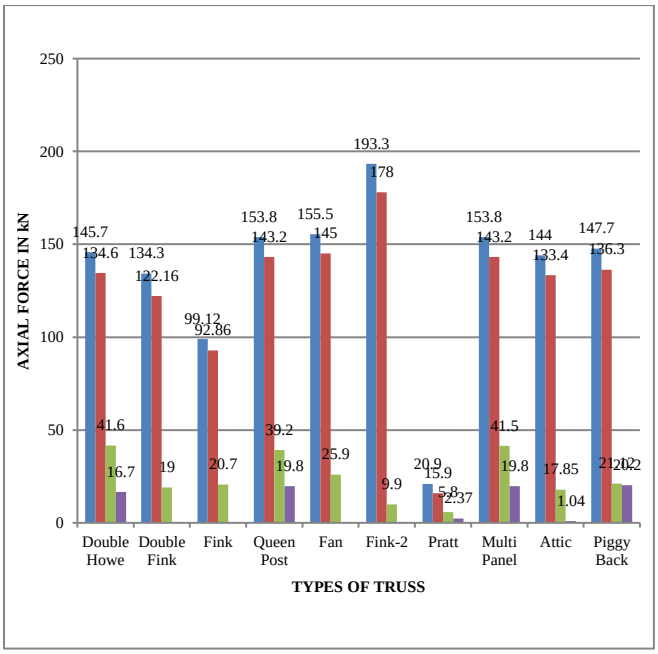
This project involves analysis and design using a popular designing software STAAD Pro. STAAD Pro was chosen because of its following advantages:

- Easy to use interface,
- Conformity with the Indian Standard Codes,
- Versatile nature of solving any type of problem, and
- Accuracy of the solution.

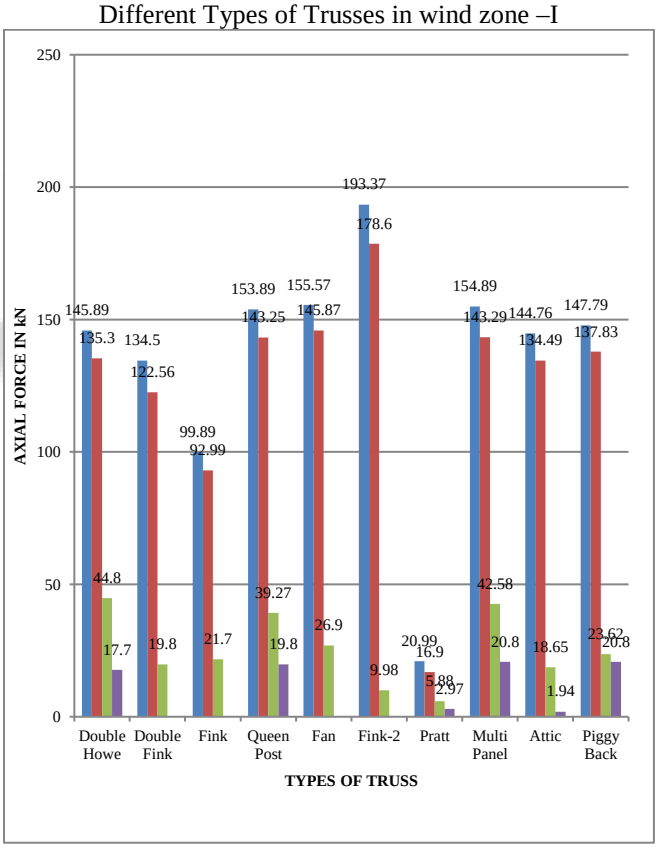
STAAD. Pro features a state-of-the-art user interface, visualization tools, powerful analysis and design engines with advanced finite element and dynamic analysis capabilities. From model generation, analysis and design to visualization and result verification, STAAD. Pro is the professional's choice for steel, concrete, timber, aluminum and cold-formed steel design of low and high-rise buildings, trusses, culverts, petrochemical plants, tunnels, bridges, piles and many more types of structures.

IV. RESULTS

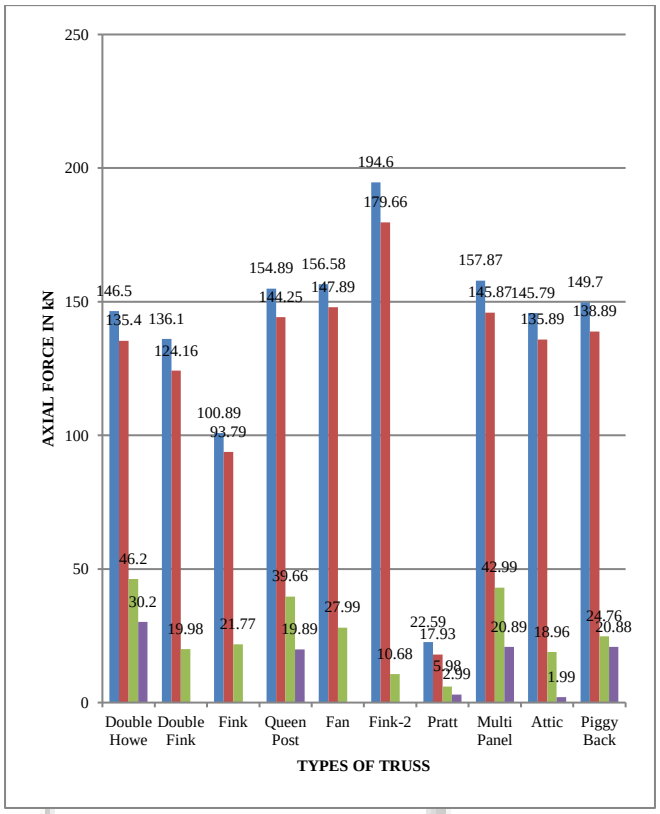
From the analysis of different types of trusses using STAAD Pro., the following results are briefly discussed in this section. The results obtained from the design are also compared in respect of cost and weight.



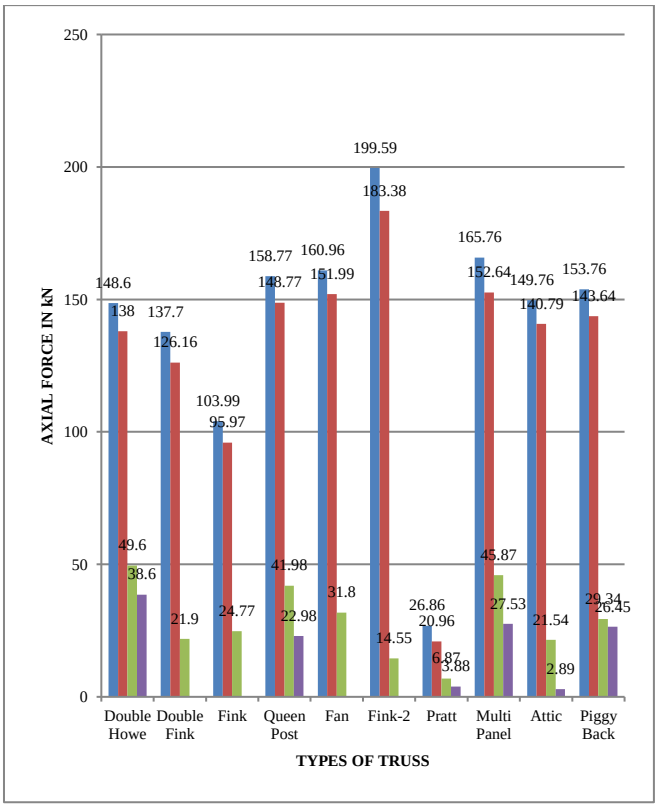
Comparison of Axial Forces for Typical Members in Different Types of Trusses in wind zone –I



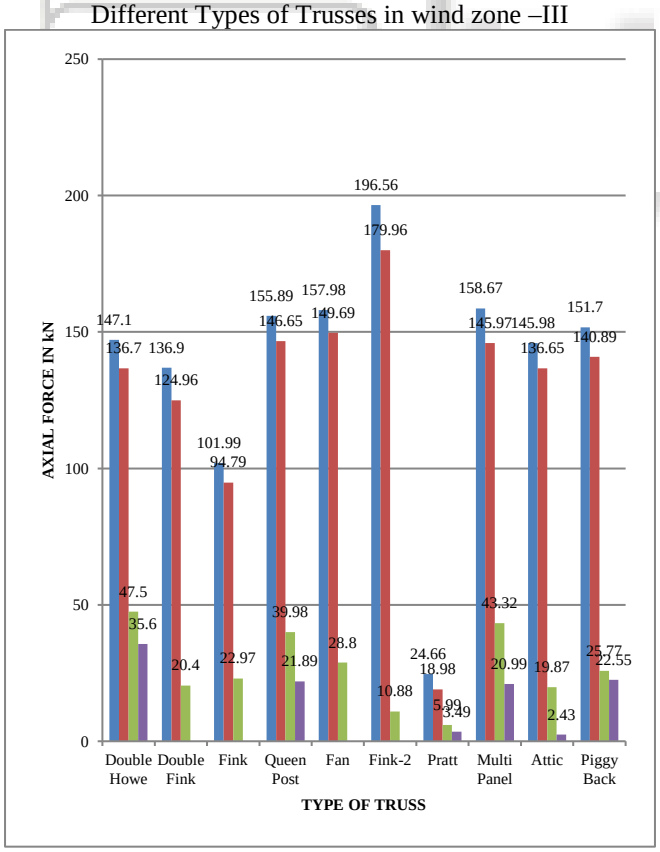
Comparison of Axial Forces for Typical Members in Different Types of Trusses in wind zone –II



Comparison of Axial Forces for Typical Members in Different Types of Trusses in wind zone –III



Comparison of Axial Forces for Typical Members in Different Types of Trusses in wind zone -V



Comparison of Axial Forces for Typical Members in Different Types of Trusses in wind zone –IV

V. CONCLUSIONS

1) Weight of Fink-2 type truss is more than other trusses considered for the same span.
2) Similarly, comparing truss on the basis of cost, Fink type truss is costlier than other trusses.
3) Weight and cost of Pratt truss is found to be less than that of other trusses.
4) Weight of Fink-2 type truss varies from wind zone I to VI. It is about 59.4%, 61.2%, 64.2%, 66.2% and 69% of weight of truss for wind zone VI, respectively.
5) Shows that steel structure is providing least value of drift, but aluminum structure value is relatively same as steel bracing with free end case values. Aluminum bracing with free ends show less displacement in x directional as compared to steel displacement.

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