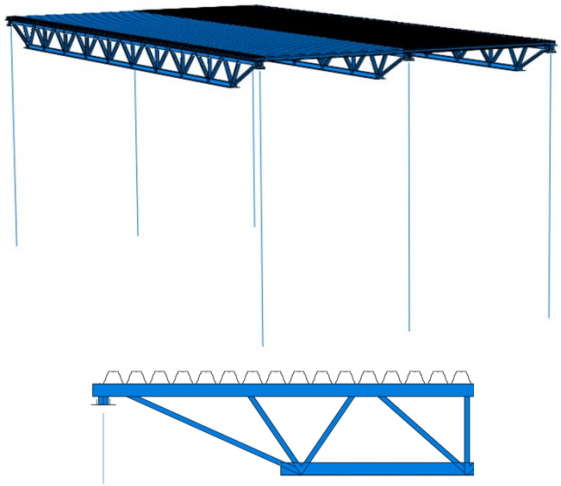
Steel Trusses in Industrial Buildings - Load Bearing Capacity and Lateral Buckling Resistance

Examensarbetare: Hanna Gardshol och Adam El-Sherif

Steel trusses, which are commonly used in industrial buildings, are known for their strength and ability to span large distances. Despite their advantages, there have been collapses in buildings using trusses, especially in regions with heavy snowfall. This study concludes that the trusses deform by rotating sideways, known as torsional buckling, when exposed to heavy loads which heavily influences their utilisation possibilities.

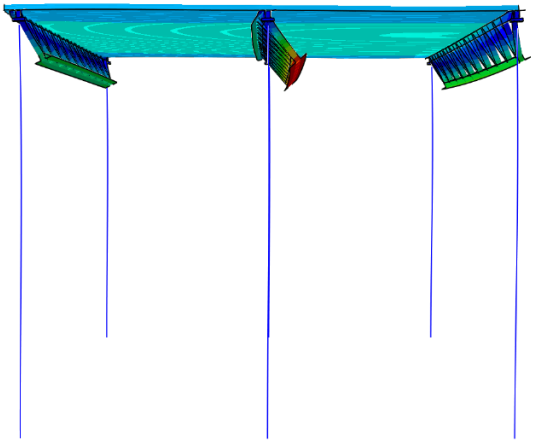
To understand the structural failure of these buildings, we analysed a common Nordic design, as seen in the figure below, in collaboration with AFRY by using the advanced finite element analysis software Abaqus. Previous research investigating the building had shown the trusses to be the weakest component, although our findings surprisingly contradicted that conclusion.



The building and components analysed in the investigation.

Two major tasks were carried out through the research: comparison of modelling approaches and evaluation of the trusses capacity. A total of four methods were used to evaluate the capacity. Initially, we examined a standalone truss to understand the behaviour of the truss itself. It gave insight into the structure's slenderness, as it was prone to torsional buckling under low-loading conditions.

However, when the truss was modelled with a roof, stability improved drastically. Different modelling techniques were used to model the influence of the roof. The studies gave mixed results, one given in the following figure, proving the influence of modelling when simulation structural behaviour. It could be concluded that the bolts attaching the roof to the truss limited movement, increasing the truss utilisation by around sixfold compared to the standalone structure, showing how much the roof impacts the stabilisation of the structure. A parametric study revealed that the axial stiffness of the roof has the most significant impact on overall stability. While rotational stiffness along the truss also contributes, its effect is less crucial.



Result using one of the three methods, where a model consisting of three trusses and the roof was made.

Our study presents several key insights for improving the stability of steel trusses in industrial buildings:

- **Roof Impact and Sensitivity**: Attaching a roof significantly stabilises the slender truss, increasing its load-bearing capacity. Properly designed roofs are crucial for preventing structural failures, more so since the component seem to fail first.

- **Axial vs. Rotational Stiffness**: Enhancing the axial stiffness of the roof is more effective than increasing rotational stiffness in preventing buckling.

- **Modelling approach**: The modelling techniques significantly affected the results of the analyses where different approaches to the roof-truss interaction gave contrasting outcomes.

Our research provides insight into structural failure possibly causing the weakness of the industrial buildings. More so, it proves the importance of modelling approaches and sensitivity analyses when performing simulations. Through continued research, further optimisations could be made on the truss design, and conclusions on the effects of certain modelling choices be drawn.

Examensarbete avslutat 2024: ***Steel Trusses in Industrial Buildings - Load Bearing Capacity and Lateral Buckling Resistance*** *- Report TVSM-5274.*
Handledare Erik Serrano. I samarbete med AFRY genom handledare Arash Roohbakhsh.