Analysis of Steel Frames using Direct Analysis Method by using Staad Pro Software

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Abstract: This paper provides a detailed investigation of steel frame structures through the application of the Direct Analysis Method (DAM), using STAAD Pro software. DAM has become a favoured approach in modern structural engineering due to its ability to incorporate factors such as geometric imperfections, member flexibility, and second-order effects directly into the analysis—elements that are often neglected in traditional methods. In this study, DAM is employed to simulate and evaluate how steel frames respond under various standard loads including dead, live, and lateral forces. The research aims to determine internal forces, stresses, and deflections within the frame, while also assessing the structure's overall stability and safety. The findings highlight the potential of DAM to enhance accuracy and efficiency in steel design practices.

Keywords: **Direct Analysis Method, Staad Pro Software, Steel frames, Structural Analysis.**

INTRODUCTION

The analysis and design of steel frame structures are essential in today's structural engineering, especially for applications involving high-rise buildings, industrial facilities, and bridges. In the past, engineers often relied on simplified analytical approaches that assumed idealized conditions—frequently ignoring real-world influences such as P-Delta effects, non-linear material properties, and secondary structural behaviour's.

The Direct Analysis Method (DAM) offers a more reliable and refined alternative by integrating these complex factors directly within the design process. This method enables structural engineers to produce more accurate and trustworthy results.

STAAD Pro, a well-established software platform for structural design and analysis, is instrumental in applying DAM effectively. With its strong computational tools, STAAD Pro allows for the detailed simulation of steel structures under realistic conditions. The software not only accelerates the analysis process but also ensures alignment with current design standards.

This paper reviews how the Direct Analysis Method is applied in steel frame modelling using STAAD Pro. It highlights the historical development of this approach, explores the software's advanced features, and discusses its benefits, limitations, and advancements based on case studies and recent literature. The aim is to offer valuable insight into the effectiveness of combining DAM with STAAD Pro for structural design purposes.

Components of steel building:

- Primary Members:
  - Columns
  - Beams
  - Rafters
  - Bracing
  - Steel plates etc..,
- Secondary Members:
  - Purlins/Girts
  - Flange Braces
  - Sag Angles
  - Channels etc..,
- Sheeting Items:
  - Panels
  - Trims
  - Flashings
  - Straps etc..,

Building specifications:

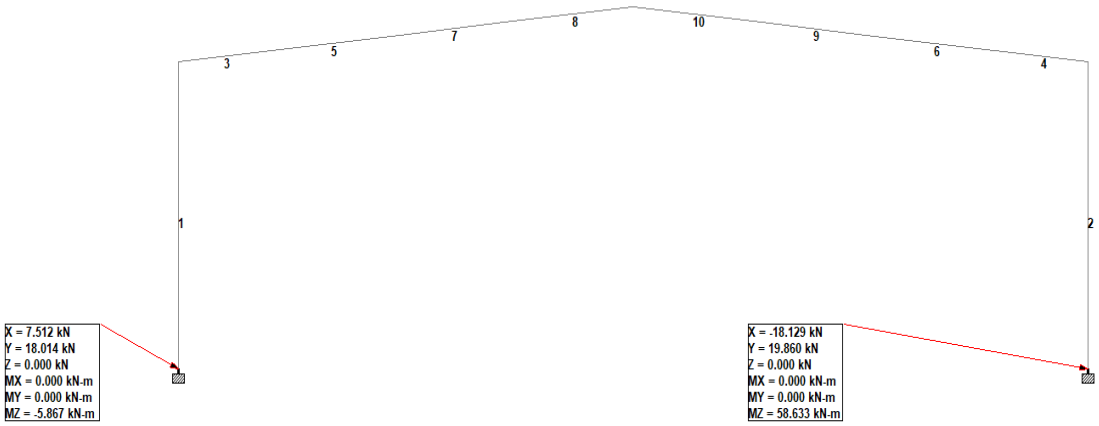
- It is a Rigid Frame Building.
- Length of the Building = 40m.
- Width of the Building = 22.5m.
- Clear Height of the Building = 6m.

Loading Conditions:

- Dead Load = 0.12 kn/m^2
- Live Load = 0.75 kn/m^2
- Wind Load = As per IS875 part-III 2015

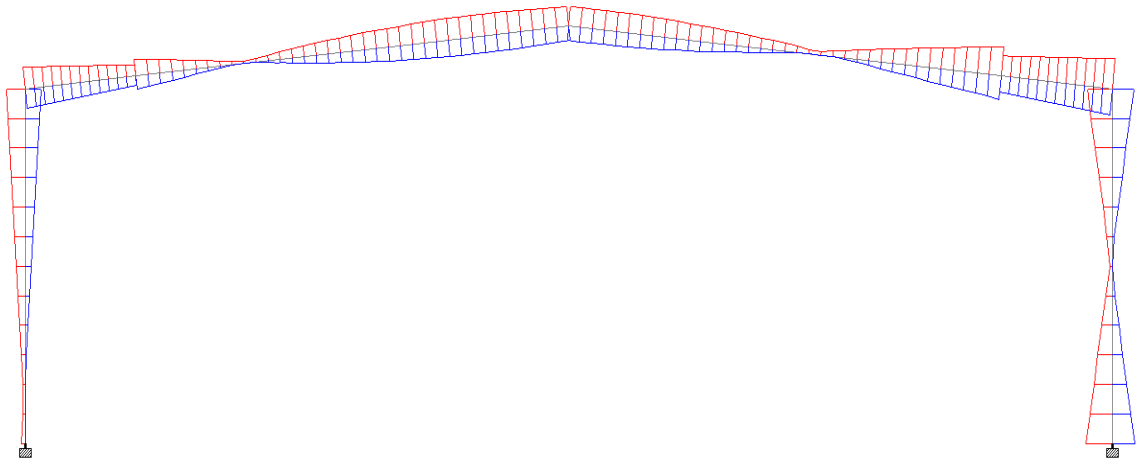
Support Reactions:

Fixed support is considered.



Beam Stress Diagram:

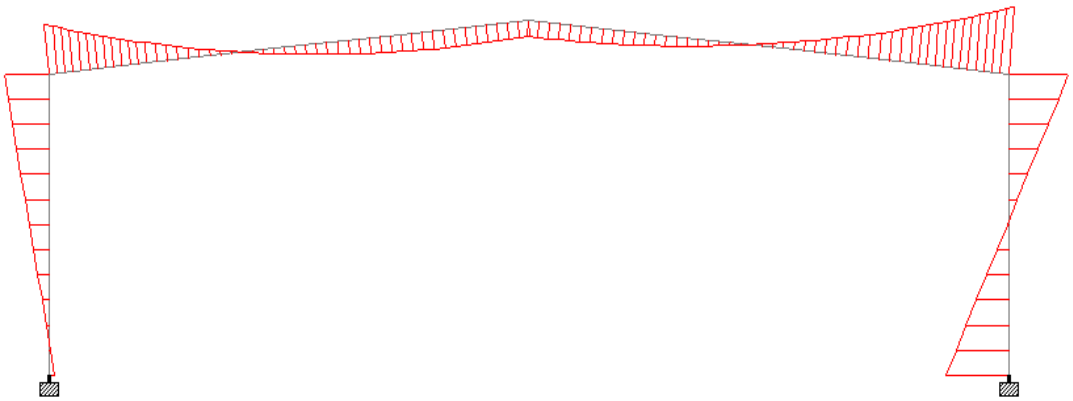
When an external force is induced on a beam, Stress is developed in the beam. This stress is called Beam Stress or Bending Stress. The amount of this stress developed in the beam when the above mentioned loads are induced are shown in the below snapshot.



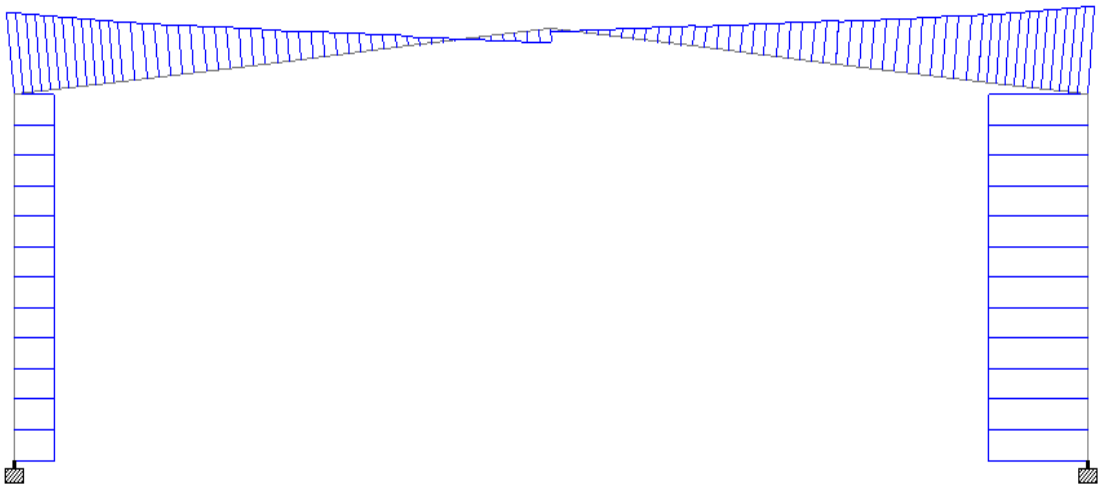
Bending Moment Diagram:

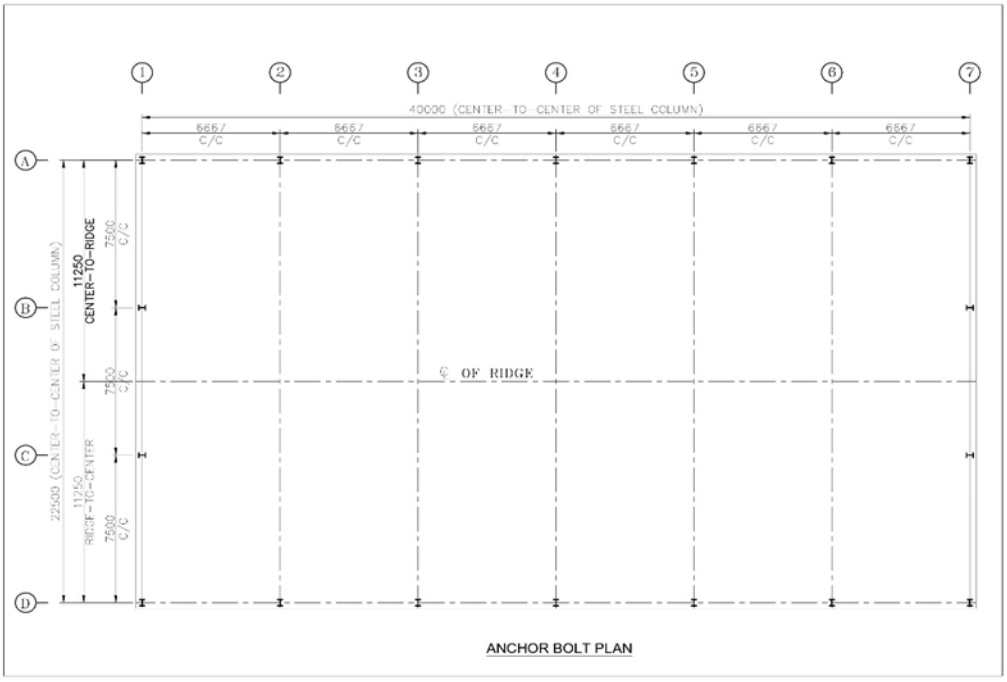
The internal resistance or moment caused by external force acting on the member is called Bending Moment. The graphical representation of Bending Moment along the length of the member is called Bending Moment Diagram.

Shear Force Diagram



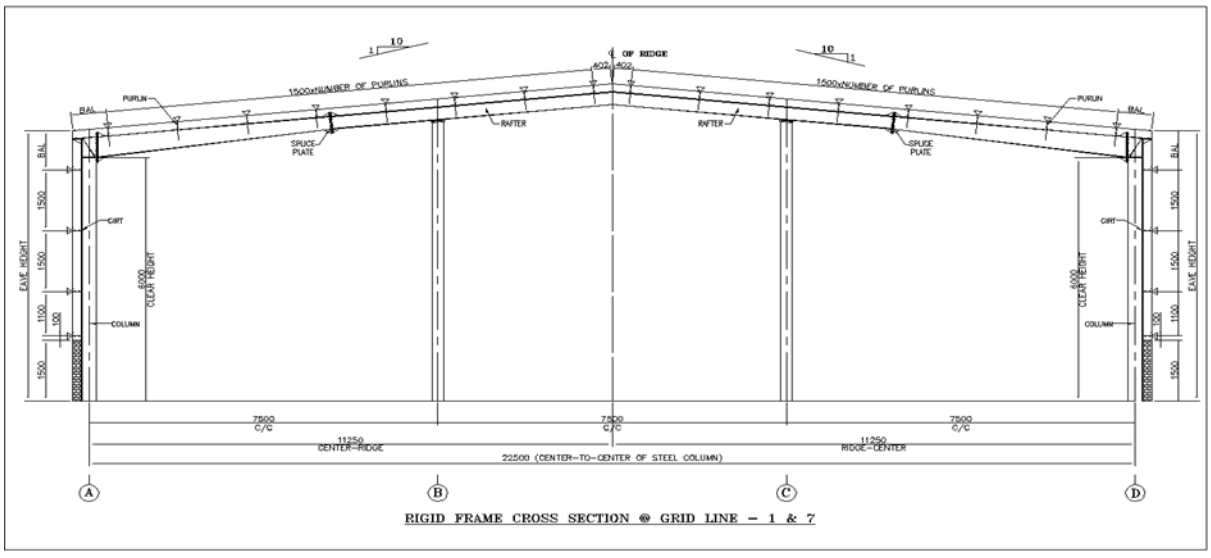
The force which acts parallel to the surface of the member causing the member to deform is called Shear Force. The magnitude of shear force plotted along the length gives Shear Force Diagram.



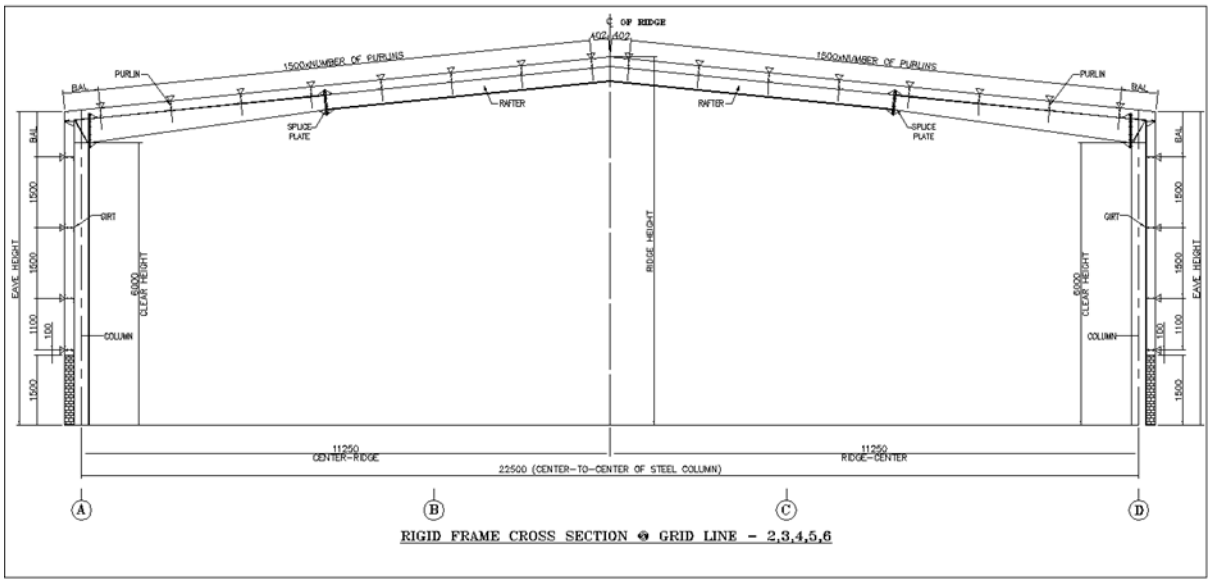


ANCHOR BOLT PLAN

This image shows that proper alignment and accurate placement of structural elements during construction. The anchor bolt plan is a critical component of structural steel detailing. It specifies the exact location of anchor bolts which are used to secure steel columns to the concrete foundation.



RIGID FRAME CROSS SECTION @ GRID LINE – 1 & 7



RIGID FRAME CROSS SECTION @ GRID LINE – 2,3,4,5,6

The following sections are illustrate the structural framing for a steel building, specifically the rigid frame cross sections along designated grid lines. These frames represent the primary load bearing structure of the building, designs to support roof loads, wind loads and other lateral forces.

CONCLUSION

The use of STAAD Pro software significantly simplifies the process of designing optimized structural systems when compared to conventional manual methods, which are often time-consuming. Optimization through software reduces the structural dead load, leading to a more economical foundation design. The integration of the Direct Analysis Method with powerful tools like STAAD Pro marks an important shift in the design and evaluation of steel frames. DAM provides a more realistic approach by accounting for material nonlinearity and second-order behavior, unlike traditional simplified methods. While the software may pose a learning challenge initially, its advantages in terms of safety and accuracy make it a valuable asset. As engineering demands increase, especially in large-scale or high-rise construction, methods like DAM are expected to play a critical role in future design standards.

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