International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 11 Issue: 11 | Nov 2024 www.irjet.net p-ISSN: 2395-0072

COMPARATIVE STUDY OF RCC AND STEEL STRUCTURES USING STAAD PRO SOFTWARE

Mrs. Yashaswi H. V [1], Vivek R[2], Shivaprasad B. S[3], Nithin K. N[4], Sachin[5]

[1] Asst Professor, Department of Civil Engineering, Dr. AIT, Bengaluru
[2,3,4,5] UG Students, Department of Civil Engineering, Dr. AIT, Bengaluru

---

Abstract - *This project work focuses on comparison of RCC and Steel structures of (G+2) commercial building using STAAD Pro software. The dead load & live loads are applied for beams, columns, slabs in STAAD Pro. The live load is considered for the commercial building specified in IS 875 part 2. Plan of the project is done in AutoCAD and converted it into nodes in STAAD Pro. The loads are applied on the model and analysis is done. The results obtained are as mentioned, the maximum bending moment and the shear force acting on RCC structure is higher compared to steel structures. The strength of the steel structures is more than RCC structure. Due to lower weight of steel structure the shear force and the bending moment acting on the structure is also less. The maximum axial force acting on RCC structure is higher compared to steel structures. The member size ratio required for steel structures decreases when the span of column is increased when compared to that of RCC structures.*

Key Words: RCC & Steel structure, Auto Cad & STAAD Pro software, Loads, Maximum bending moment, Maximum shear force

1. INTRODUCTION

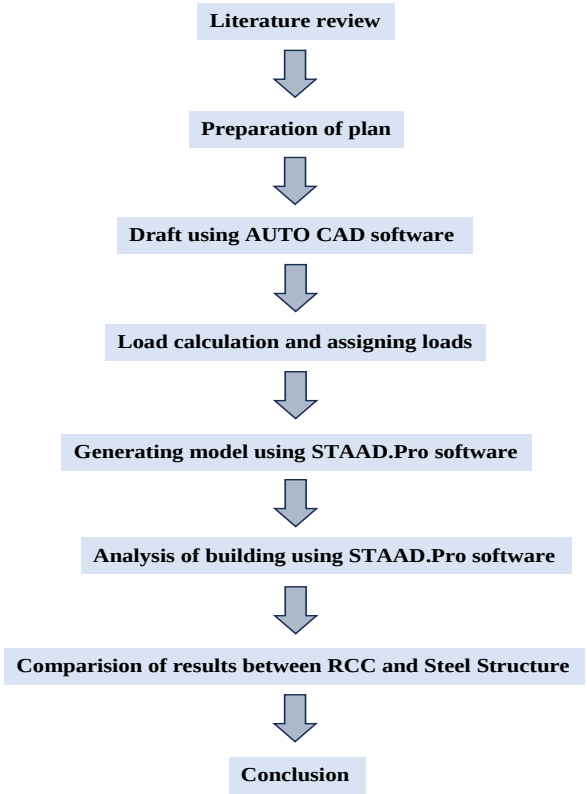
In order to compete in the ever-growing competent market, it is very important for a structural engineer to save time. As a sequel to this, an attempt is made to analyze a multi-storied building using a software package STAAD.Pro. For analyzing a multi storied building one has to consider all the possible loadings and see that the structure is safe against all possible loading conditions. There are several methods for analysis of different frames like Kani's method, cantilever method, portal method, Matrix method and also there are three design philosophies: Working Stress Method (WSM), Ultimate Load Method (ULM), and Limit State Method (LSM) for designing. WSM focuses on keeping materials within their elastic limits, ensuring safety through allowable stress, but it can lead to over-conservative designs. ULM, on the other hand, takes into account the ultimate strength of materials, reducing section sizes but lacking serviceability considerations. LSM offers a balanced approach by considering both safety and serviceability through partial safety factors for steel and concrete.

This project involves analysis of main structural elements - slab, beam, and column—of a G+2 multi-storied building using AutoCAD and STAAD.Pro. AutoCAD is used to draft the plan and modelling is done using STAAD.Pro, which was employed for detailed structural analysis. STAAD.Pro is particularly useful for simulating real-world conditions, ensuring that the design meets international standards, and allowing engineers to perform structural analysis for various loads.

RCC and steel structures are compared in terms of load-carrying capacity. RCC structures offer durability, fire resistance, and good compressive strength, but require skilled labor and continuous checking. Steel structures, known for their high strength-to-weight ratio and elasticity, are quicker to construct but need regular maintenance due to corrosion risks. Ultimately, steel structures are preferred for tall buildings and industrial projects, while RCC remains a reliable option for everyday construction.

2. METHODOLOGY

2.1 FLOW CHART REPRESENTING METHODOLOGY



2.2 BUILDING SPECIFICATIONS

In this work following building details are considered:
No. of stories = 03
Height = 09m, each bay @3m
Site size = 12*20m
Live load = 4 KN/m^2
Location = Bengaluru
Concrete grade M25
Steel grade Fe415
Seismic loads and Wind loads are not considered

2.3 PLAN AND COLUMN LAYOUT

A plan below is considered for the analyses. The plan is drawn in the Auto cad software, and exported to the STAAD.Pro.

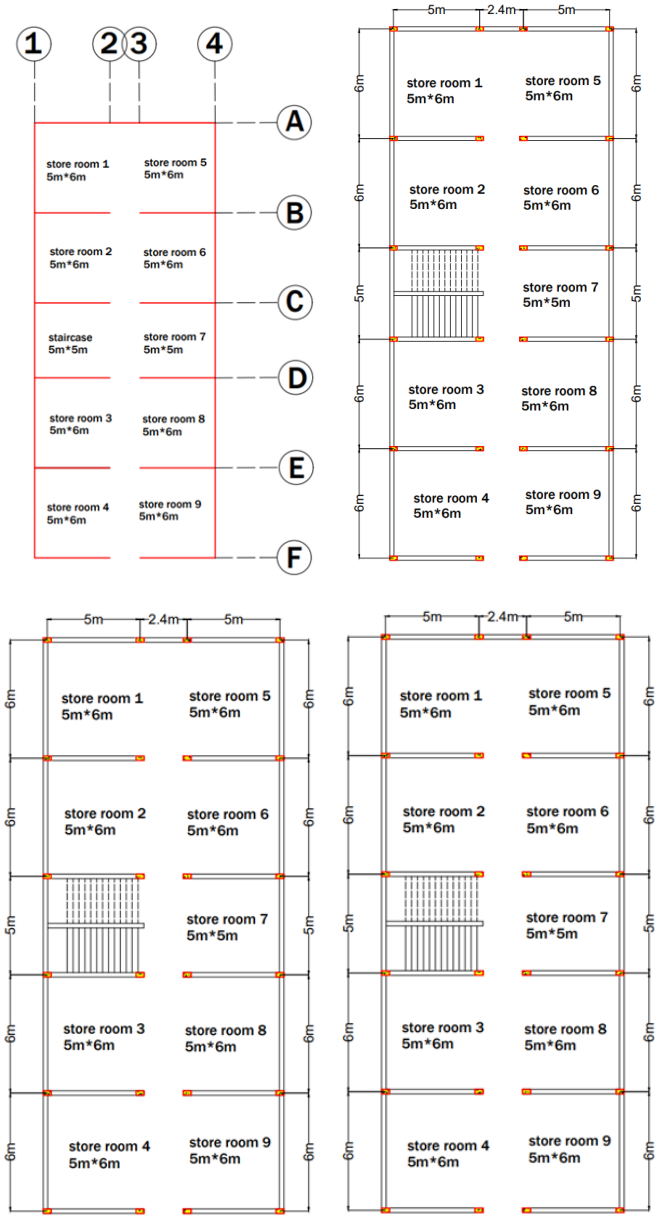


Fig 2.1 Plan and column layout of G + 2 building

2.4 MODELLING AND STRUCTURAL ANALYSIS OF RCC STRUCTURE

Structural analysis, which is an integral part of any engineering project, is the process of predicting the performance of a given structure under a prescribed loading condition. The plan was imported from the AutoCAD and G+2 storey building was generated in Staad.pro analysis was performed, the performance characteristics usually of interest in structural design are:

- Stress
- Deflection
- Support reactions
- Bending moment
- Shear force

2.4.1 Generating Model Geometry

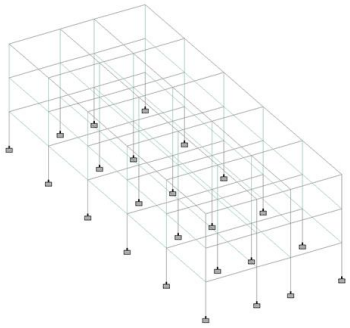
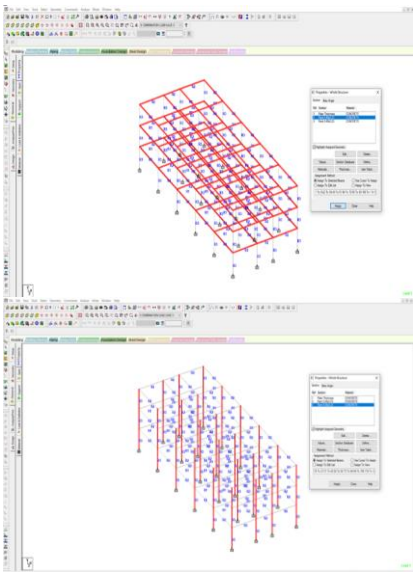


Fig 2.2 Geometric view Of Whole Structure

2.4.2 Specifying Member Property

The member properties are taken as given:
Thickness of slab = 150mm
Beam = 450 X 230 mm
Column = 230 X 450 mm



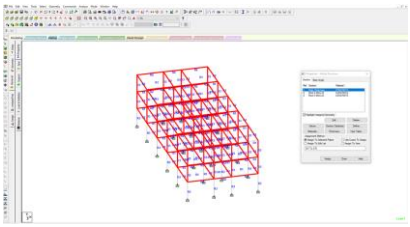


Fig 2.3 Assigned member property

2.4.3 Specifying Supports

The base nodes of all columns are restrained against translation and rotation about all the three global axes. In other words, fixed supports are specified at these nodes.

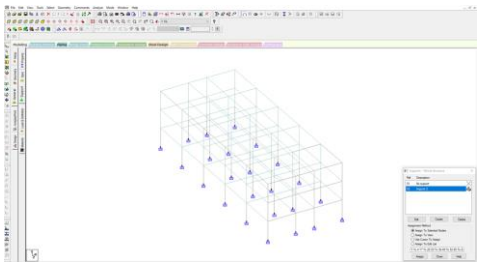


Fig 2.4 Assigned support

2.4.4 Defining and Assigning Loads

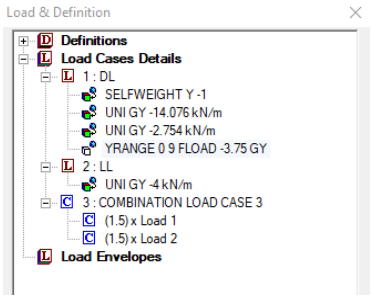


Fig 2.5 Loads

Dead Load
As per IS 875:1987 (Part I)
Self-weight = -1 kN/m^2
Slab load = 0.15*25 = 3.75 kN/ m^2
Wall load
Outer wall = 0.23*3*20.4 = 14.076 kN/ m^2
Parapet wall = 0.15*0.9*20.4 = 2.754 kN/ m^2

Live Load
As per IS 875:1987 (Part II)
For Commercial Buildings
Live load = 4 kN/ m^2

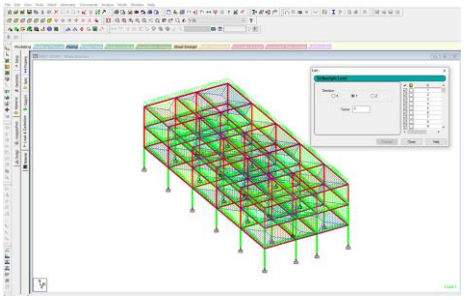


Fig 2.5.1 Self weight

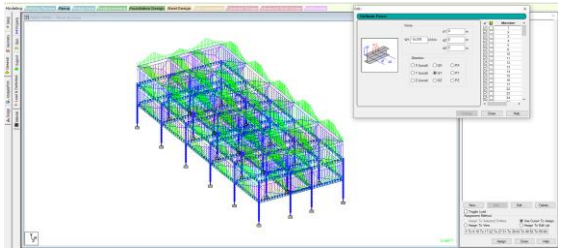


Fig 2.5.2 Outer Wall Load

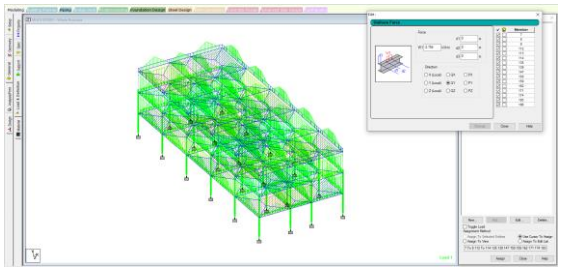


Fig 2.5.3 Parapet Wall Load

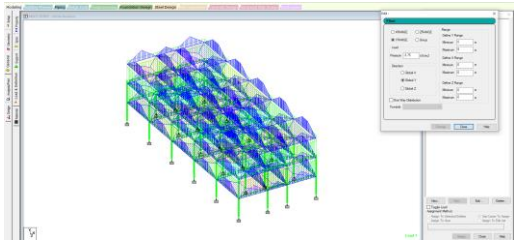


Fig 2.5.4 Slab Load

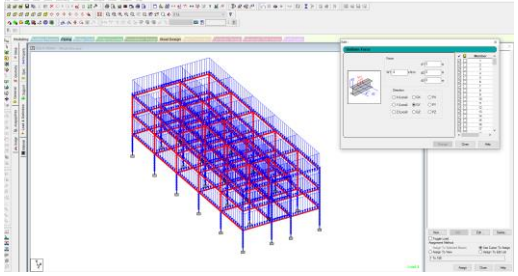


Fig 2.5.5 Live Load

2.4.5 Analysis

The bending moment and the shear force can be studied from the graphs generated by post processing after the analysis in STAAD.Pro. The below figure shows the diagrams for whole structure.

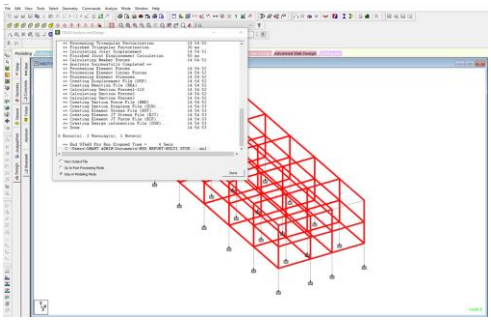


Fig 2.6 STAAD analysis and design

2.5 MODELLING AND STRUCTURAL ANALYSIS OF STEEL STRUCTURE

Structural analysis, which is an integral part of any engineering project, is the process of predicting the performance of a given structure under a prescribed loading condition. The plan was imported from the AutoCAD and G+2 storey building is generated in Staad.pro and analysis was performed, the performance characteristics usually of interest in structural design are:

- Stress
- Deflection
- Support reactions
- Bending moment
- Shear force

2.5.1 Generating Model Geometry

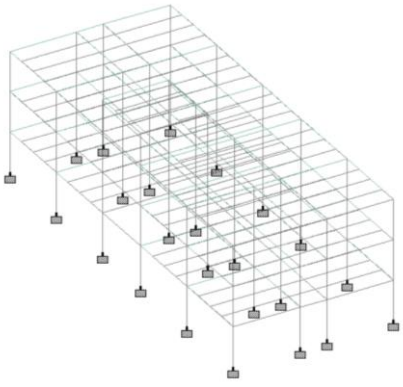


Fig 2.7 Geometric view of Whole Structure

2.5.2 Specifying Member Property

The new task is to assign cross section properties for the beam and columns. The member properties are as given:
Beam - ISMB 125
Sub beam - ISMB 125
Column - ISSC 150

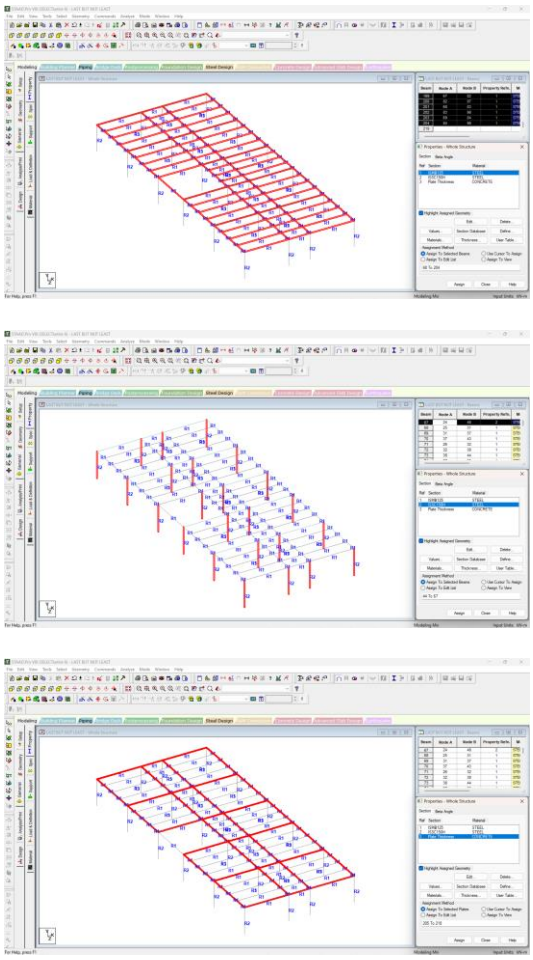


Fig 2.8 Assigned Member Property

2.5.3 Specifying Supports

The base nodes of all columns are restrained against translation and rotation about all the three global axis. In other words, fixed supports are specified at these nodes.

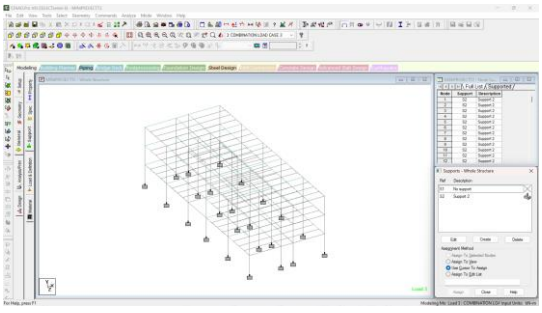


Fig 2.9 Assigned Support

2.5.4 Defining and Assigning Loads

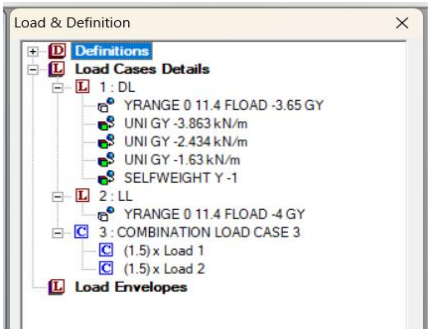


Fig 2.10 Loads

Dead Load
As per IS 875:1987 (Part I)
Self-weight = -1 kN/ m^2
Slab load = 1 x 1 x 0.1 x 24 = 2.4 kN/ m^2

Wall load
Outer wall = 0.23 x 3 x 20.4 = 2.86 kN/ m^2
Inner wall = 0.10 x 3 x 6.374 = 1.912 kN/ m^2
Parapet wall = 1 x 0.1 x 6.374 = 0.63 kN/ m^2

Live Load
As per IS 875:1987 (Part II)
For Commercial Buildings
Live load = 4 kN/ m^2

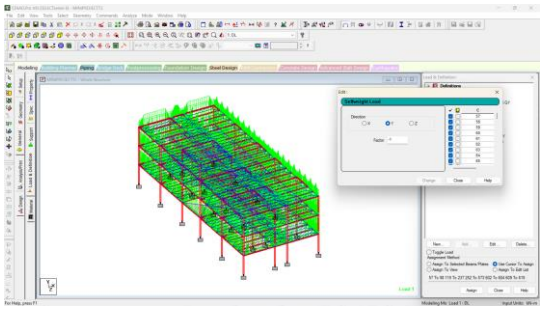


Fig 2.10.1 Self weight

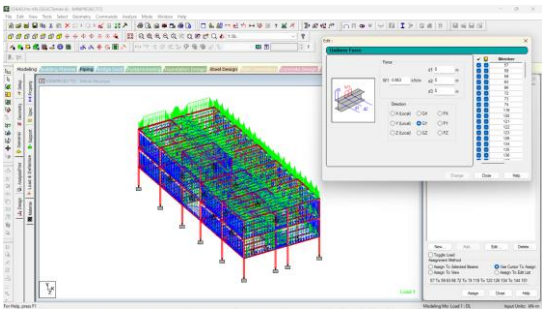


Fig 2.10.2 Outer wall load

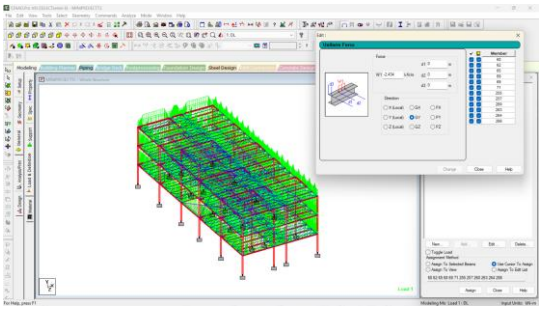


Fig 2.10.3 Inner wall load

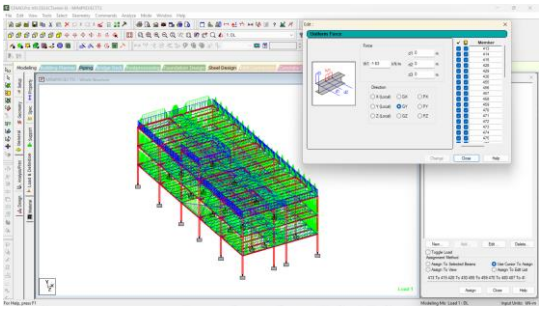


Fig 2.10.4 Parapet wall load

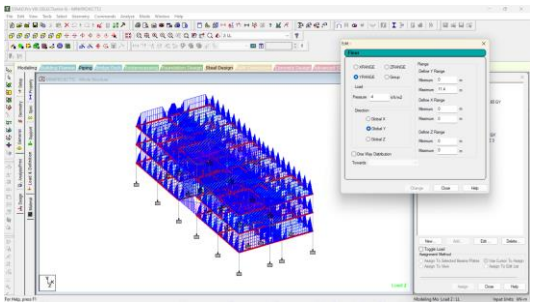


Fig 2.10.5 Live load

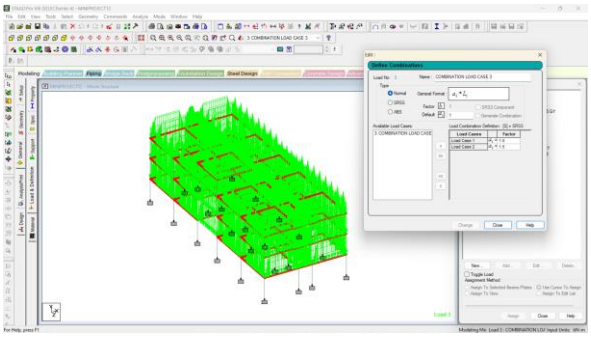


Fig 2.10.6 Combination of loads

2.5.5 Analysis

The bending moment and the shear force can be studied from the graphs generated by post processing after the analysis in STAAD.Pro. The below figure shows the diagrams for whole structure.

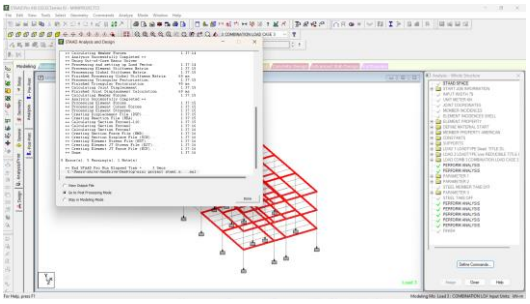


Fig 2.11 STAAD analysis and design

3.1 RESULT OF RCC STRUCTURE

After the analysis the results of critical stresses like Bending moment, Shear force, Axial force and Displacement are obtained in the post processing mode. The results of critical stresses are discussed below.

3.1.1 Bending moment

The reaction induced in a structural element when an external force or moment is applied to the element, causing the element to bend.

The maximum bending moment is observed in the beam 128 with the value of 157.752 kN-m.

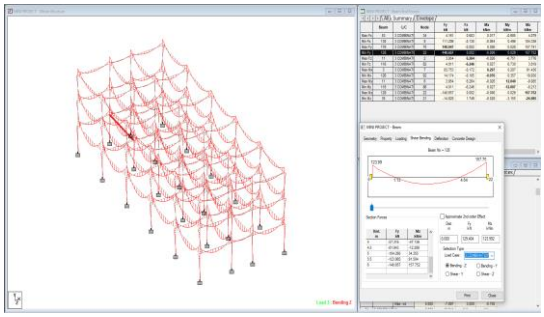
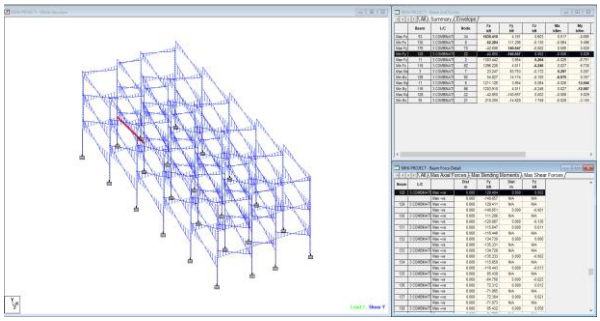


Fig 3.1 Maximum bending moment

3.1.2 Shear Force

Force acting in a direction parallel to a surface or to a planar cross section of a body.

The maximum shear force was observed in the beam 128 with the value of -140.657 kN.



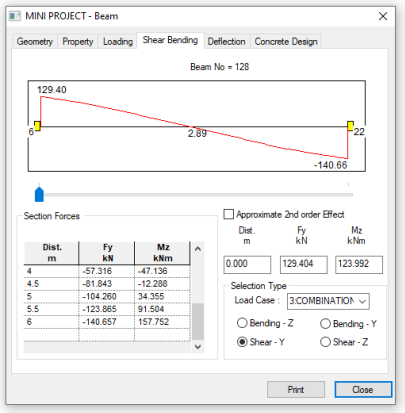


Fig 3.2 Maximum shear force in the structure

3.1.3 Axial Force

Axial force is the force that acts in the direction of the axis of a body. This force may be tensile or compressive.

The maximum axial force was observed in the column 53 and the value is 1839.410 kN.

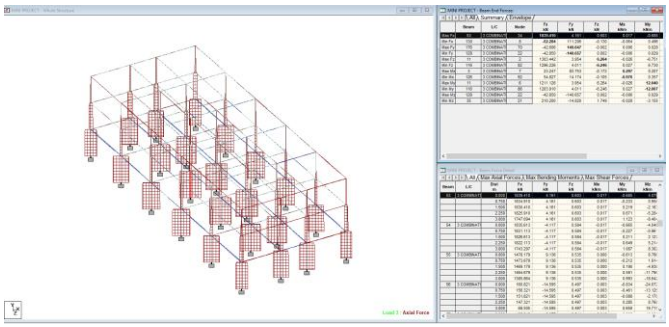


Fig 3.3 Maximum Axial force in the structure

3.2 RESULT OF STEEL STRUCTURE

After the analysis the results of critical stresses like Bending moment, Shear force, Axial force and Displacement are obtained in the post processing mode. The results of critical stresses are discussed below.

3.2.1 Bending moment

The reaction induced in a structural element when an external force or moment is applied to the element, causing the element to bend.

The maximum bending moment is observed in the beam 495 with the value of 127.965 kN-m.

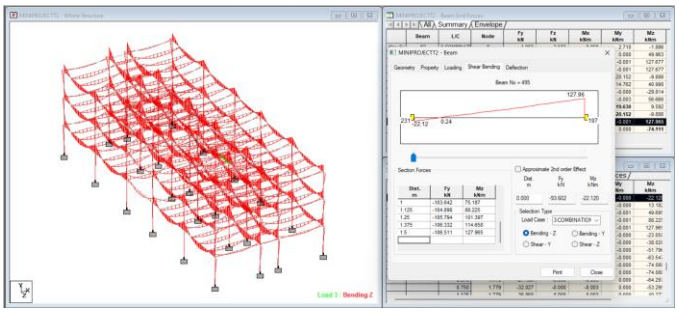


Fig 3.4 Maximum bending moment

3.2.2 Shear Force

Force acting in a direction parallel to a surface or to a planar cross section of a body.

The maximum shear force is observed in the beam 469 with the value of 127.677 kN.

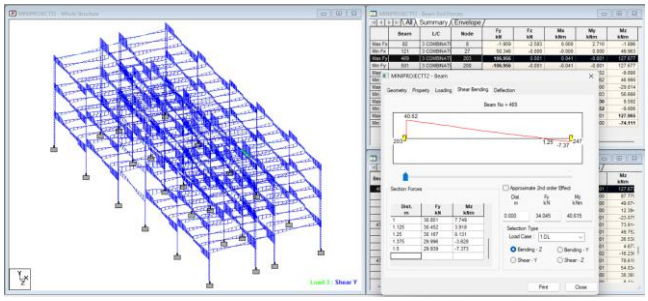


Fig 3.5 Maximum shear force in the structure

3.2.3 Axial Force

Axial force is the force that acts in the direction of the axis of a body. This force may be tensile or compressive.

The maximum axial force is observed in the column 8 and the value is 1100.689 kN.

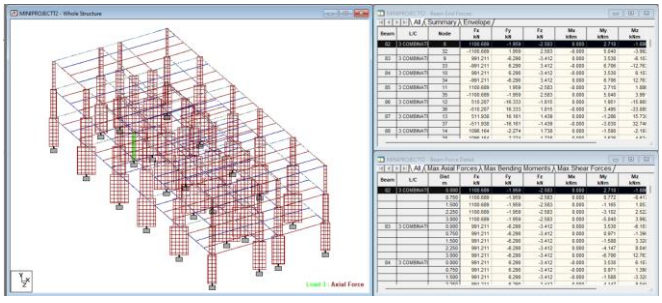


Fig 3.6 Maximum Axial force in the structure

4. CONCLUSIONS

For RCC Structure

1. Maximum bending moment in the beam is 157.752 kN-m.
2. Maximum shear force in beam is -140.657 kN.
3. Maximum axial force is acting on the column is 1839.410 kN.

For Steel Structure

1. Maximum bending moment in the beam is 127.965 kN-m.
2. Maximum shear force in beam is 127.677 kN.
3. Maximum axial force acting on the column is 1100.689 kN.

- The maximum bending moment and the shear force acting on RCC structure is higher compared to steel structures.
- The strength of steel structures are more than RCC structures. Due to lower weight of steel structure the shear force and the bending moment acting on the structure is also less.
- The maximum axial force acting on RCC structure is higher compared to steel structures.
- The member size ratio required for steel structures decreases when the span of column is increased when compared to that of RCC structures.

REFERENCES

[1] IS: 875 (Part 1), for dead loads, Bureau of Indian Standards, New Delhi, India.

[2] IS: 875 (Part 2), for imposed loads, Bureau of Indian Standards, New Delhi, India.

[3] IS: 808: 1989, dimension for steel beam, column sections.

[4] Rachskonda Divya (2021) "Comparative study on design of steel structures and RCC frame structures based on column span", Journals of materials today, volume 46, page no- 8848-8853.

[5] Anurag Saraogi (2018) "A Comparison between RCC and Steel Structure", International Journal of Research in Engineering Science and Management, volume-I, page no-106-108.

[6] Jyothi. D. N (2008) "Comparative analysis of RCC and Steel Structure", International research journal of Engineering and Technology, volume-05, page no-345-347.

[7] Shweta A Wagh, (2014) "Comparative study of RCC and steel concrete composite structures", Journal of Engineering Research and Application, volume 04, pg. no. 369-376.

[8] Johnson R. P., (2004) "Composite Structure of Steel and concrete", Blackwell Scientific publications, Volume 01.

[9] Ankur Tailor, (2016), "Comparative performance evaluation of steel column building and concrete filled tube column building under static and dynamic loading", International symposium of plasticity and impact mechanics, pg. no. 1847-1853.

BIOGRAPHIES

Mrs. Yashaswi H. V

(Asst Professor, Department of Civil Engineering, Dr. AIT, Bengaluru)

Vivek R

(UG Student, Department of Civil Engineering, Dr. AIT, Bengaluru)

Shivaparasd B. S

(UG Student, Department of Civil Engineering, Dr. AIT, Bengaluru)

Nithin K. N

(UG Student, Department of Civil Engineering, Dr. AIT, Bengaluru)

Sachin

(UG Student, Department of Civil Engineering, Dr. AIT, Bengaluru)