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ANALYTICAL STUDY OF STRUCTURE SUBJECTED TO THERMAL CHANGES

Shah Fahad Quadri [1], Dr. Neethu Urs[2]

[1]*PG Student Department of Civil Engineering, Dayananda Sagar College of Engineering, Bengaluru, Karnataka.*

[2]*Associate Professor, Department of Civil Engineering, Dayananda Sagar college of Engineering, Bengaluru, Karnataka,*

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Abstract: In any steel structural analysis, the performance of steel structures under increased temperature is very important. The performance is considered on the basis of external environmental conditions like water, fire, air etc. The strength and performance of steel structure depends on many different conditions like material degradation at elevated temperature and restraint stiffness of member. In order to face minimal damage fire resisting studies and implementation is to be performed on the structure for which structural behaviour studies are very important. Since the experimental study on actual steel structure is not always feasible as it requires time, money, space and controlled fire, finite element software like ANSYS is the best alternative. The behaviour of these steel beams are studied under different temperature conditions for steel structures. This study gives an overview of material behaviour and tells us how to design and construct steel structures.

Keywords: *Thermal load, Resistance to fire, Temperature, ANSYS software, Response of steel structure.*

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I INTRODUCTION

Steel structures predominantly show high rate of failure in case of thermal load, which is one of the major concern that over took since last few decades. Reduction in strength and stiffness of member led to an extensive study on steel structure under thermal load. This improvised the behavior and laid the footing to fire protection system. The parameter such as deflection, elongation and sectional form changes drastically when structure subjected to thermal load. Resistance to fire is expressed in terms of hours against fire load. A steel structure behaves identically different at every elevated scenario.

A total of 2,500 citizens in India die per year as a result of fire-building occurrences. Fire causes thousands of deaths and loss of property. The fire incidents across the world have been seen which results in the large amount of damage to reinforced cement concrete framed structures. Building being one of the most important loads bearing member, the whole structure fails due to the failure of the building.

The increased use of cement in building design results in the need to research the behaviour of structures in reinforced concrete. Fire prevention and post fire maintenance should be taken into account in the structure (retrofitting). Many buildings suffer harm that cannot be repaired because of inadequate fire laws.

Fire not just has capacity to harm nature and human life but also is a great source of energy when it is handled effectively. Effective treatment of fire has great advantages for human and his lifestyle. Considering the history of fire and fire accidents it is evident that fire can destroy houses and properties which are human assets also kings and their kingdom from the history have used fire as a weapon against their enemies for centuries. Fire is used as a source of light, in many of the instances such fire source has burnt building structure and lives. Steel has one such major application in construction has it is from discrete part of structural member components. Higher load carrying capacity, reduction in cross section area and ease of erection of building with structural and architectural advantages make it a top priority in the construction field. But Steel Structures have predominantly shown a high rate of failure in the case of thermal load, which is one of the major concerns that overtook since last few decades. Reduction in strength and stiffness of member led to an extensive study on steel structure under thermal load, improvised the behaviour and laid the footing to fire protection system. When several thermal effects are acted on the surface of steel structures will lead to its failure. It is found to be a drastic change in the parameters such as deflection, elongation and sectional form. Mechanical property of a steel structure is important in any steel structure analysis study of mechanical properties at regular temperature is conventionally different from varying elevated temperature a steel structure behaves identically different at every elevated scenario.

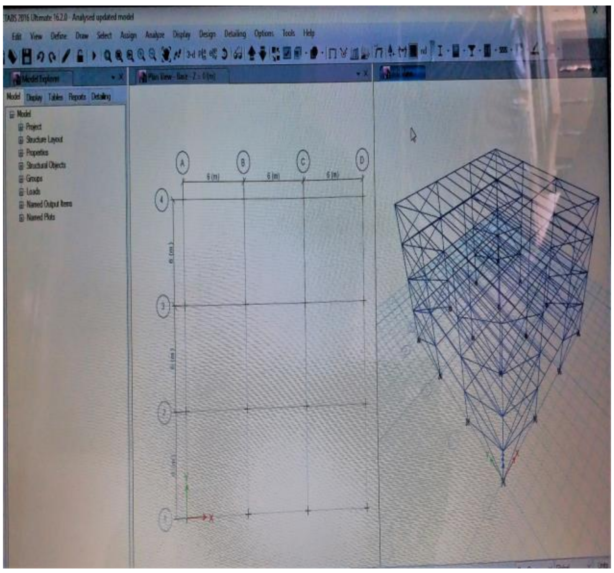
A two-dimensional 10-storey 5-bay steel frame designed according to ASCE 7-02 is modeled in the general finite element program LS-DYNA. Different fire exposures are investigated. They include travelling fires, Eurocode parametric curves, ISO-834 standard fire and the constant compartment temperature curve from the SFPE standard. These fires are applied to different floors, one at a time, to explore the influence on the structural response, resulting in a total of 80 different scenarios. [1]

The development of deflections, axial forces and bending moments is analyzed. Uniform fires are found to result in approx. 15–55 kN (3–13%) higher compressive axial forces in beams compared to small travelling fires. However, the results show irregular oscillations in member utilization levels in the range of 2–38% for the smallest travelling fire sizes, which are not observed for any of the uniform fires. Peak beam mid-span deflections are similar for both travelling fires and uniform fires and depend mainly on the fire duration, but the locations in the frame and times when these peak displacements occur are different. The results indicate that travelling fires and uniform fires trigger substantially different structural responses which may be important in the structural design and selection of the critical members. When 2-38% of smallest travelling fire is applied resulted in irregular oscillations. Which are not regularly observed under uniform fire.[7]

II MODELLING AND ANALYSIS

The structure is first analysed in Etabs software for dead,live and wind loads.Then the structure is modelled in ANSYS for thermal analysis.The steel structure with single bracing,Double bracing and no bracing are analysed and results are compared.The beam column joints are also taken for thermal analysis and results are compared.Then thermal load at diff time intervals and diff temperatures will be analyzed and results will be compared.

A specification for the theoretical simulation study was produced using finite elements in the ANSYS standard code repository. SOLID186 is a solid 3-D 20-node higher order element having a quadratic displacement action. There are 20 nodes in the object, each having three free degrees: x, y, and z node translations. Cognitive function, excessive flexibility, creeping, stress intensification, high deflection, and high strain ability are all supported by this component. It can also model deformations of elastoplastic materials that are nearly incompressible and hyper elastic materials that are almost in compression using hybrid formulations.

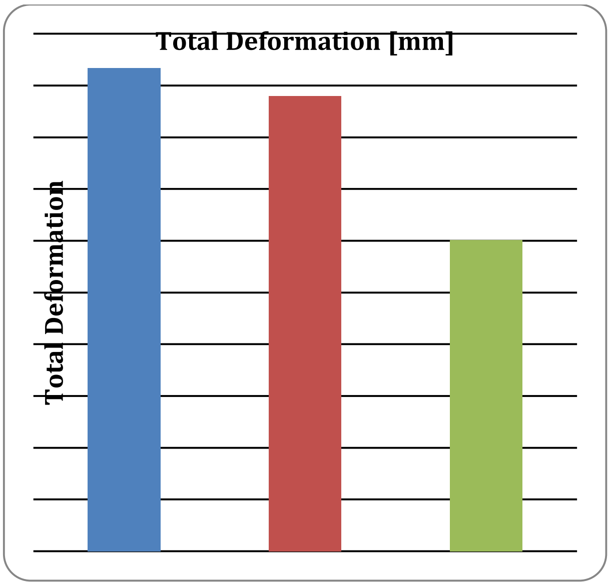


A G+3 steel building modelled in ETABS

Total Deformation (mm)

Total Deformation [mm]		
Without bracing	Single bracing	Double bracing
4.67	4.4	3.01

Results From Total Deformation

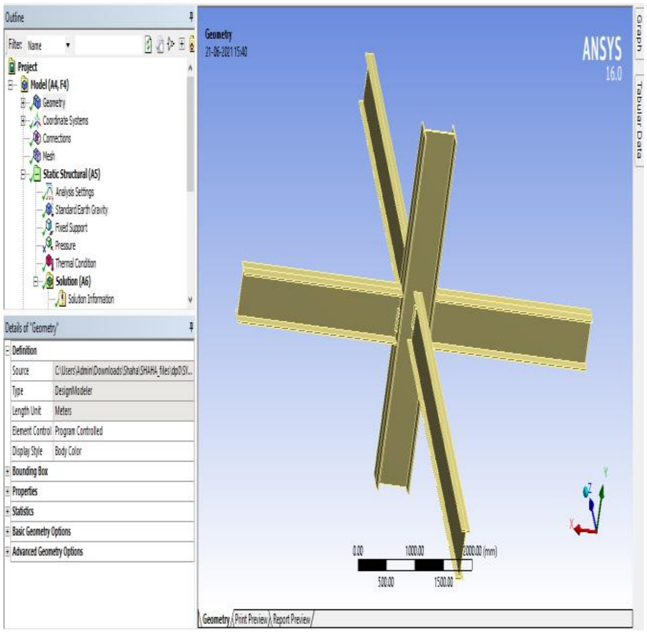


The total deformation of steel structure with NO bracing is 5.7% more as compare to structure with single bracing and 35.5% more as compare to structure with double bracing.

1. **Beam Column Ansys Model**

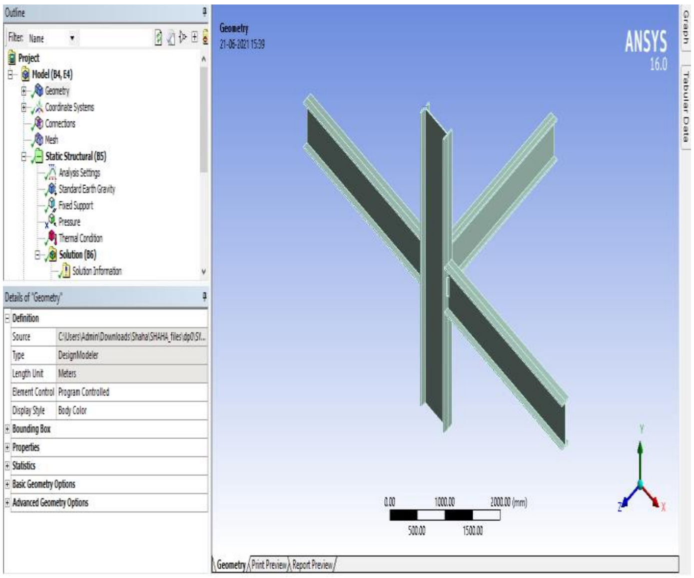
   A) Internal Beam Column

Geometry:



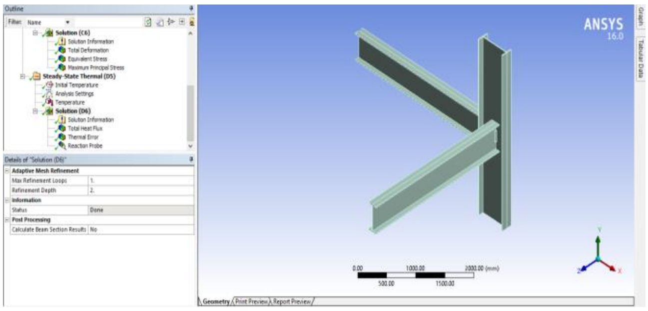
B) Middle Beam Column

Geometry:

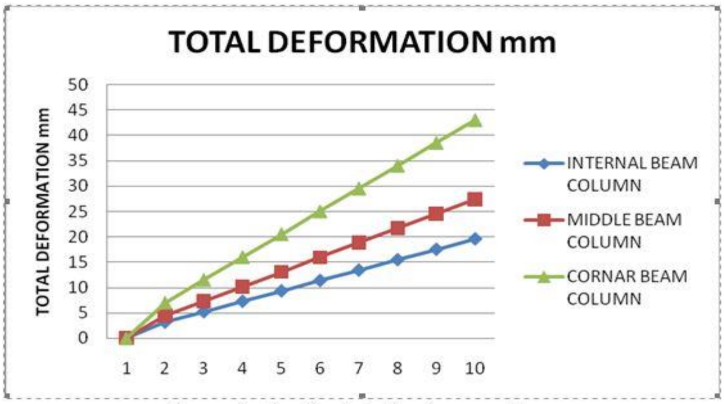


C) Corner Beam Column

Geometry:



Beam Column Results and Graph



Graph.1: Total Deformation

Graph.1: Total Deformation

III CONCLUSION

There are three types of columns, internal beam column, middle beam column and corner beam column subjected to thermal analysis.

TOTAL DEFORMATION mm			
Temperature C	INTERNAL BEAM COLUMN	MIDDLE BEAM COLUMN	CORNAR BEAM COLUMN
50	0	0	0
100	3.19	4.4696	7.0164
150	5.2371	7.3393	11.518
200	7.2843	10.209	16.02
250	9.3314	13.079	20.522
300	11.379	15.949	25.024
350	13.426	18.818	29.526
400	15.473	21.688	34.028
450	17.52	24.558	38.53
500	19.567	27.428	43.032

The results of total deformation, equivalent stress, maximum principal stress and total heat flux for these columns are as follows.

- The total deformation for corner beam column is 54.5% more as compared to internal beam column and 36% more as compared to middle beam column at 500 degree Celsius temperature.
- The equivalent stress for corner beam column is 7.45% more as compared to internal beam column and 15.8% more as compared to middle beam column at 500 degree Celsius temperature.
- The principal stress values for corner beam column is 18.9% more as compared to internal beam column and 27.33% more as compared to middle beam column at 500 degree Celsius temperature.
- The Maximum total heat flux for corner beam column is 8.31% more as compared to internal beam column and 51.7% less as compared to middle beam column at 500 degree Celsius temperature.

REFERENCES

1.Panagiotis,Ann Jeffers, Guillermo rein, et.al. "Structural analysis of steel frames exposed to travelling and traditional design fires" Elsevier (2004)

2.c. crosti, et.al. "Structural analysis of steel structures under fire loading" Acta polytechnicalVol.49 No.1/ (2009)

3.Bramhanand v patil,Prof S Ramgir, et.al. "study of structural steel members under thermal loading"IJSETRISSN:2278-7798VOL 5,ISSUE 8 (2016)

4.Harshad D mahale,Prof S B kandekar, et.al. “Behaviour of steel structure under the effect of fire loading”IJERTISSN:2248VOL 6 (2016)

5.Hemangi k. patade,Dr M A Chakrabarti, et.al. “Thermal stress analysis of beam subjected to fire” IJERTVOL.3 ISSSUE 5 (2016)

6.Mr. Madan M Awatade,Drc.pcpiseProf S S kadam, et.al. “Finite element modelling for effect of fire on steel frame”IJERTISSN:2248VOL6 (2016)

7.Abhishek Bhavna B,N naik, et.al. “Analytical investigation of thermal behavior of steel structure”IJASREe-ISSNVOL 3 (2017)

8.C R chidambara, Jainam shah, et.al. “A study on progressive collapse behavior of steel structure subjected to fire loads” IJSTVOL 9 (2017).