Analytical Study of Structure Subjected to Thermal Changes

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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 both healthy/original/undamaged and damaged 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.

INTRODUCTION:

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.

LITERATURE REVIEW:

Material degradation at elevated temperature and restraint stiffness are the different variables on any steel structure when a fire load is applied. Also minimal structural damage on fire techniques limited casualties with particular high rise structures and also to select suitable fire resisting measures are understood in the paper. Computational structural models including the loads will be analysed with the help of advanced structural software. Beam components of the critical section are optimised and processed to thermal analysis. Structural response of a simple steel structure building is studied by using different scenarios to understand the responses of structural element, different fire loads on different structures resulting in fire load study and also differential behaviour of a steel structure for multiple fire load are at every different load is focused in this paper. Effect of temperature on mode shape and modal frequency of a steel structure using ANSYS is performed. In this paper when an elevated steel structure fails under a fire load in a real building this scenario is considered and paid attention on studying the behaviour of a structure. [2.1]

The structural behaviour of a steel structure when exposed to fire. At high temperatures on any metal will have variable effects, one among them is expansion. When different temperature is applied on steel, it tends to expand if this effect continues then the performance of these steel structures are affected. Computational structural models including the earthquake loads will be analysed with the help of advanced structural software. Beam components of the critical section are optimised and processed to thermal analysis. In general effects of rising of temperature in the fire hour induce an expansion in beam components. Reduction in stiffness and strength is the result when a structure is exposed to high temperature, which affects the steel structure, analyses

beam strength and its characteristics when exposed to fire load. Also, different fire conditions are studied with different steel beams. [2.2]

Material degradation at elevated temperature and restraint stiffness are the different variables on any steel structure when a fire load is applied. Also, minimal structural damage on fire techniques limited casualties with particular high-rise structures and also to select suitable fire resisting measures are understood in the above paper. Computational structural models including the loads will be analysed with the help of advanced structural software. Beam components of the critical section are optimised and processed to thermal analysis. In general effects of rising of temperature in the fire hour induce an expansion in beam components. If such expansion is restrained, stress is induced this will affect performance of any structure. Structural response of a simple steel structure building is studied by using different scenarios to understand the responses of structural element, different fire loads on different structures resulting in fire load study and also differential behaviour of a steel structure for multiple fire load are at every different load. [2.3]

This research is a detailed study of plane frame of steel and its behaviour especially when exposed to fire. This research also shows the effect of steel in elevated temperature and with different coating materials. The overall behaviour of steel structure studying various parameters with elevated temperature is studied using ANSYS software. Computational structural models including the loads will be analysed with the help of advanced structural software. Beam components of the critical section are optimised and processed to thermal analysis is focused on stress and strain relationship effects on a fire performance steel frame exposed to uniformly increasing temperature when the material i.e., steel is protected and also unprotected with concrete using Finite Element Method. an overview of a steel material when exposed to fire and also differentiates the performance of steel based on protection of the material. [2.4]

This particular paper defines when a thermal load is applied on a point load on structural carbon steel modal and structural analyses are observed. Deflection and stress of a cantilever element and element with both end fixed are calculated theoretically. A different cross-sectional member with same cross-sectional area on stress and deflection are studied and observed. The variation in temperature results in expansion of material. If such expansion is restrained, stress is induced this will affect performance of any structure. Computational structural models including the loads will be analysed with the help of advanced structural software. Beam components of the critical section are optimised and processed to thermal analysis. In general effects of rising of temperature in the fire hour induce an expansion in beam components. ANSYS is used to carry out Finite element analysis and this result is compared with practical experiments. Effect of temperature on mode shape and modal frequency of a steel structure using ANSYS is performed in the above paper. Characteristics of a steel structure are studied under thermal load. [2.5]

The architectural flexibility of steel structure dominates over other conventional structures, but fire and its associative load are one of the major accidental loads, which could be fatal in steel structures. Load bearing capacity of steel structural components drastically reduces in the fire condition. Performance of steel structural components under accidental fire loads is investigated. Constraints in the experimental investigation lead to the analytical investigation by the method of finite elements. ISO 834 is adopted as standard fire curves for modelling up-to temperature of 6800 C. Computational structural models including the earthquake loads will be analysed with the help of advanced structural software. Beam components of the critical section are optimised and processed to thermal analysis. In general effects of rising of temperature in the fire hour induce an expansion in beam components. If the expansion is restrained, stress induces over the region of restraining, resulting in the change or rise in deformation. In this attempt, the study of behaviour on non-coated and protective coated steel beam structures under direct thermal loading with relation with the total deformation and stress- strain are investigated with help of FEM based software. [2.6]

An overview on travelling fire and a traditional design fires in a multi storey steel frame in any large open plan compartments travelling temperature is considered and observed. A design tool named TFM (Travelling Fires Methodology) is developed and is used for design. A model of steel frame according to ASCE 7-02 is made in finite element program LS-DYNA, i.e., 2-D 10 storeys, 5 bay steel frames. Computational structural models including the loads will be analysed with the help of advanced structural software. Different fire exposures are observed which includes Eurocode parametric curves, travelling fires, ISO-834 standard fire and constant compartment temperature curve from SFPE standard. Different floors are applied with different fire at different intervals to experience the response of steel structure which resulted in 80 different cases. When 2–38% of smallest travelling fire is applied, irregular oscillations are observed, which are regularly not observed in any of the uniform fire. [2.7]

The behaviour of non-linear temperature distributed across a section of steel structure. Increase in temperature result in additive internal forces due to restrained conditions. This compares the study of temperature in two different areas, one with non-protected steel hollow cross section of different size and other with protected steel hollow cross section. When fire load is applied from three sides, a Finite Element Analysis of steel structure is calculated also comparison of simplified calculations according to valid standard and numerical simulations are calculated. Computational structural models including the earthquake loads will be analysed with the help of advanced structural software. Comparison of result obtained when fire testing results in VSB Technical University of Ostrava is compared with numerical thermal analysis. An overview on a steel hollow section when exposed to fire thermal transient analysis is also analysed when thermal load is applied. [2.8]

This study demonstrated the progressive collapse behaviour of a steel frame building using ETABS software. In order to improve the progressive collapse resistance of structures in buildings and reduce the DCR values there are two possible options. One

option is to use larger steel cross sections and the other option is to use more bracing. these two suggestions may lead to higher steel weight and may also cause more deformation after the columns affected by fire load. this paper shows that intermediate column was 27.8 % and 16.36% more critical when compared to re-entrant column and corner column respectively. Since DCR value of each element are within the limit 2 as per GSA guidelines, the building was safe against progressive collapse due to fire load. [2.9]

Higher the intensity of thermal load applied, higher is the rate of heat transfer along the beam length. The duration of thermal load on the surface is directly proportional to the rate of heat transfer along the length of beam. Therefore, longer the duration more is the heat transferred. Displacement and Stress intensity in a cantilever beam is higher for thermal load applied for a longer duration than for thermal load for shorter duration. Displacement and Stress intensity is also higher for high intensity thermal load than lesser thermal load. [2.10]

CONCLUSION

From the literature studies, it shows the behaviour of fire at different temperature and at different conditions. Considering fire at different conditions such as conventional fire and travelling fire it is observed that fire at each condition behaved in various ways. Considering the same fire at different temperature applied on a steel structure the behaviour of different steel element is observed. Not just considering solid beam, hollow steel beam is also studied. Every different elements of steel has different characteristics when fire is applied on it from the above studies it practically proved every different element of steel will behave identically unique for different temperature and different conditions.

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