Study of Temperature Loads on The Behaviour of RCC Structure: A Review

Srikant Aryan[1], Praveen Ghidode[2]
[1]Dept of Civil Engineering
[2]Assistant Professor, Dept of Civil Engineering
[1, 2] Sam Global University, Raisen-464551, Madhya Pradesh, India

Abstract- *With the growth of the population and advancements in construction engineering technologies, high-rise structures are still being constructed. However, cracking poses a threat to the structural integrity and safety of certain high-rise structures, necessitating maintenance and repair. There are a number of reasons why structural elements in high-rise structures might break. The two main factors contributing to high-rise building wall cracking are thermal stress and thermal strain. Therefore, controlling thermal stress and lowering the likelihood of uncoordinated deformation of structural elements are crucial to controlling wall cracking.*

Keywords- Earthquake, Elevated water tank stand, Non-linear Time history analysis, Seismic analysis, Seismic demand, Tekla.

I. INTRODUCTION

Few phenomena may be explained by using basic concepts in order to comprehend the intricate interconnections inside a structure. The behavior of buildings under fire is influenced by both significant deflections under applied loads and strength loss due to thermal deterioration. The fundamental formula that determines how a structure responds to fire is εtotal = εthermal + εmechanical. The true reaction of the structure is determined by the inevitable thermal strain that is caused in a member. The part becomes longer and more curved as a result of the thermal expansion caused by this strain. Weak end translational constraint results from a structure's induced thermal expansion, and stresses cause an effective displacement reaction. However, temperature gradients that cause curvature result in bending action, and member ends are allowed to rotate, which causes deflections.

Thermal Expansion:- It is familiar from basics that materials expand on heating. The expression for thermal expansion is given by,

$$\varepsilon T = \alpha \Delta T$$

Since there are no established stresses for mechanical strain to account for, total strain in a simply supported beam will equal thermal strain due to the lengthening caused by temperature increases.

Thermal Bowing: A temperature differential has a major impact. In comparison to the outer surface, the exposed interior surfaces encounter higher temperatures. As a result of their quick expansion, the inner surfaces flex. Thermal bending is the term for this phenomenon, which is typically observed in masonry and concrete constructions. Deflections: Thermal expansion caused by flames causes a structure's members to swell in length.

The evaluation, restoration, and rehabilitation of fire-damaged structures have gained attention due to the rise in large-scale fires and building fire events. Expertise in several fields, including concrete technology, material science and testing, structural engineering, and repair materials and procedures, is required in this specialist subject. These allied fields are the subject of research and development initiatives. Any building has the potential to experience a fire, yet it cannot be rejected or abandoned as a result. Bringing a structure back to usable condition after fire damage has become a difficult task for the civil engineering sector.

II. LITERATURE REVIEW

Cheng Huang and Juan Chen (2022) he author examined the effects of stack effect on thermal stress and optimized high-rise building structures. First, the stack effect was used to explain the cracking process of structural elements in high-rise buildings, and that effect was taken into consideration while analyzing the thermal stress of these structures. The instantaneous stress field of high-rise buildings was calculated using finite elements, and a thorough analysis of the thermal stress of these structures was conducted. The findings showed that the thermal strain and thermal stress of structural parts initially rise and subsequently decrease with time. With the height of the structure increasing, the thermal stress progressively decreases.

Prajwal Shivaji Berad and Dr.U.R.Kawade (2022) Using the ETABS 2018 software, two methods—the linear static approach and the G+7 moment-resisting steel frame building—were examined for progressive collapse in the study report. Temperatures between 250°C and 750°C were applied to the columns at different levels, with intervals of 250°C. The material characteristics and yield strength were measured in accordance with IS 800-2007. As per IS-875 parts I and II, various load combinations were taken into consideration. In accordance with General Service Administration (GSA) -2016 requirements, the building's chosen columns received an extra fire load at various storeys. The structure was examined, and the DCR values were examined in relation to the GSA's 2016 allowable limitations.

The outcome demonstrated that following the chosen column's failure. Under fire circumstances, the steel structure's gradual collapse varies depending on the loadings. The steel frame will slide horizontally before collapsing when the building is subjected to low stresses; typically, this collapse is limited to the storey above the heated floor. As early as 400°C, the mode for large loadings of progressive collapse, which manifests as a downward collapse of the entire structure, may occur. The structure is safe from progressive collapse due to fire load as, according to GSA 2016 rules, the DCR value of each column in the beginning stage of fire loads is within limit 2.

Seelam Srikanth et.al (2022) The study paper's goal was to assess the decreased beam section's deformations, stresses, and transient temperature deformations at static structural analysis. The steel connection dissipated more energy and made the beam section less ductile than the other connections. An exhaustion response transient temperature investigation was conducted statically and a nonlinear finite element program was employed. The purpose of the investigation was to determine how temperature affected the behavior of material characteristics in the plastic and elastic zones. By reducing the beam flange, four different types of reduced beam sections were modeled using the ANSYS 14.5 program. According to the results, under static structural circumstances, the maximum at-static structural total deformation for all connections is between 29.83mm and 26.238mm. Static structural transient thermal maximum total deformation for all connections is between 97.028mm and 92.66mm.

Suhas Latpate and U. R. Kawade (2022) The study paper's goal was to evaluate how steel structures behave when subjected to unintentional loads that might eventually cause the entire building to collapse.The steel structure's performance was assessed for unexpected column loss using the current guidelines, such as GSA or DOD, for essential column removal. E-Tab (2018) was used to predict the behavior of steel building structures on special moment resting frames (SMRF) under the progressive collapse G+10 structure.

The findings showed that, when compared to increasing the size of the beam and column at crucial locations, the effect of progressive collapse in diagonal braced systems was superior. When a corner column was abruptly removed, the effect of progressive collapse was greater. However, as the number of stories increased, the effect of progressive collapse decreased since there were more members to support the dispersed load. What caused the failure, which might be partial or complete, was an increase in the beam's bending moment brought on by the redistribution of loads on the deleted region location rather than shear force (strong column and weak beam). The removal of a column increases the strain on the columns adjacent, yet on subsequent levels, the same column loses strength.

Anushree G S and B S Suresh Chandra (2021 The goal of the study article was to examine how multi-story frames behaved when subjected to varying pressures and temperatures, with a minimum and maximum of 0°C, 30°C, and 60°C. An analysis of G+5 Story's multi-story frameworks was done. The analytical program ETABS was used for the modeling and analysis. Evaluation criteria used to assess the outcomes were joint reactions, temperature load variations, bending moment, shear force, and story displacement. The results showed that, in comparison to other scenarios, the shear force for the beam model with 60°C was bigger, the bending moment for exposed columns and beams is maximum for column models with 60°C temperature, and the bending moment for beam models with 0°C temperature was greater.

D. S. Thakur and M. Chourasia (2021) A 12-story skyscraper was modeled in ETABS for the study paper. Utilizing direct and non-straight static examination techniques in accordance with the guidelines provided in GSA (2003) and FEMA: 356 rules, which separately consider the arrangements of IS1893:2016 codes to recreate dynamic breakdown issues, software and investigation of a fortified cement encircled structure under basic section evacuation were conveyed. Since the values of PMM are closer to the limiting value, or 2.0, the interior column removal scenario is the most crucial, while the corner column removal case is the least critical. For every beam in flexure, the Demand Capacity ratios (DCR) range from a maximum of 4.5 to a minimum of 3.5, which is nearly double the limitation value of 2.0 specified by the GSA in 2013. Therefore, in the event of a building's gradual collapse, the flexure of the beam is a crucial criterion for the removal of the ground floor column. For every beam in Shear, the Demand Capacity ratios (DCR) are somewhat greater than 2 (but not by more than 2.6). Therefore In the event that a ground floor column needs to be removed during a building's gradual collapse, shear in the beam is not crucial. Since the DCR ratio exceeds the limitation value (2.0) for both shear and flexure, beams up to the top storey in column removal scenarios involving the ground floor would collapse.

Rahul Waibhase and Omkar Gangatire (2021) Using ETABS 2018 software, a study article examined the gradual collapse of a G + 8 moment resistant steel frame structure using two distinct methods: the linear static approach and the non-linear static method. According to IS 800-2007, the model study involved subjecting the columns at different levels to temperature variations between 300°C and 1000°C while maintaining the steel material characteristics and yield strength. According to IS 875 parts I and II, load combinations were taken into account. The General Service Administration (GSA) 2016 rules state that a fire load was added to the chosen columns at various levels. Software was used to analyze the structure, and the DCR values of the columns that were produced were compared to the GSA 2016 permitted limits.

According to the examination of the steel structure, the characteristics that are most impacted are the section properties, load capacity ratio, and fire load. Heavy portions must be included in the design to avoid fire in the section. Before being used, structural members need to have a fireproof coating put to them. It is preferable to use a web stiffener and fire protection to reinforce the column. It is essential to have collapse-resistant structures in case of a fire in order to prevent structural failure. By employing stiffer connections between components and more reinforcement in the deck slab, the failure connection can be avoided.

III. CONCLUSION

The logical research papers were identified and summarized who have primarily focused on temperature loads effects. Implementation of softwares is found beneficial in order to develop a relation between software and practical condition. As temperature is increased, the respective demand capacity ratio values (DCR) of the column also gets increased.

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