Comparative Study on Effect of Temperature Load on RC Structures

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Abstract - *The main aim of this paper is to study the effect of temperature load on RC structures. Concrete is that the wide used construction material due to its economy it makes the foremost appropriate material for construction. According to IS 456:2000, the buildings exceptional 45m length are subjected to thermal stresses. However, considering temperature load together with the gravity load is being neglected. Concrete Structure are subjected, besides live and dead loads, to seasonal and daily temperature changes and consequently temperature loads as a results of their interaction with the surrounding environment and because of their exposure to solar radiation. Such temperature loadings consequently cause thermal stresses in most structural components. These thermal stresses are often comparable or even exceed in magnitude the stresses induced by the live and dead loading in case of low thermal insulation and can cause severe damages if not thought of throughout the planning part. Thermal load is outlined because the hot temperature that causes the impact on any structure, like outside air temperature, radiation, underground temperature, indoor air temperature and thus the warmth supply instrumentality within the building or material storage tanks with variation in temperature.*

The aim of this study is to prove that the analysis of RC structure and its results of various parameter like story displacement, shear force and bending moment which is analyzed by using different software's which is able to gives the results, comparing the various software results and it gives better results.

***Key Words*: Temperature load, story displacement, shear force, bending moment.**

1.INTRODUCTION

Thermal load is defined as the extreme temperature that causes the effect on any structure, like outdoor air temperature, radiation, underground temperature, indoor air temperature and therefore the heat source equipment inside the building or material storage tanks with variation in temperature. The change of the temperature within the structural and non-structural member causes thermal stress and is defined as the effect of thermal load. Sustainability of structures could be a main concern within the housing industry. Construction of building takes over a substantial period of your time. Structural elements also are installed at different temperature. This natural process may cause stress and displacement within the structure. natural process is that the influencing factor for expansion and contraction for the structural members. extreme temperature causes loss of strength and stiffness which weaken the structure. Response of member to combined thermal and mechanical loading for various styles of restrains is studied which is useful in understanding the behavior of mechanical structure. Concrete Structure are subjected to live and dead loads, to seasonal and daily temperature changes and consequently temperature loads as a results of their interaction with the encompassing environment and because of their exposure to radiation. Such temperature loadings consequently result in thermal stresses in most structural elements. These thermal stresses may be comparable or maybe exceed in magnitude the stresses induced by the live and dead loading in case of low thermal insulation and will result in severe damages if not considered during the planning phase. All concrete elements and structures are subject to volume change in varying degrees, dependent upon the makeup, configuration, and environment of the concrete. Uniform volume change won't produce cracking if the element or structure is comparatively liberal to change volume altogether directions. Concrete contraction or expansion is the algebraic sum of these volume changes. In reinforced concrete elements, the primary concern is with these volume changes resulting from thermal and moisture changes. Other volume changes are alkali-aggregate expansion, autogenous shrinkage, and changes due to expansive cement. Autogenous shrinkage is the volume change due to the chemical process that occurs during hydration.

2. LITERATURE REVIEW

A literature review is a scholarly paper, which consists of the current knowledge together with major findings, as well as theoretical and methodological contributions to particular topic. Literature reviews are secondary sources, do not report new or original experimental work.

2.1 JYOTHI MAKATE, et, al. (2019) [1]

"Effect of thermal load on conventional slab and flat slab"

This study carried out Two storey RCC structure with longer span was considered and three models were generated in ETABS that is Model A (Building without Temperature Loading), Model B (Building with minimum Temperature Loading), Model C (Building with most Temperature Loading). Equivalent static analysis used to be done along with the temperature loading. Analysis used to be carried out to compare more than a few parameters such as storey drift, storey shear, storey displacement, storey stiffness. The outcomes tabulated are compared to test the impact of varying temperature Load.

2.2 K. VAISHNAVI, et, al. (2018) [2]

"Effect of Varying Temperature Load on RCC Structure by Seismic Analysis"

This study carried out Two storey RCC structure with longer span was considered and three models were generated in ETABS that is Model A (Building besides Temperature Loading), Model B (Building with minimum Temperature Loading), Model C (Building with maximum Temperature Loading). Equivalent static analysis was executed alongside with the temperature loading. Analysis was performed to examine a number parameter such as storey drift, storey shear, storey displacement, storey stiffness. The results tabulated are in contrast to test the impact of varying temperature Load.

2.3 POOJA M, et, al. (2017) [3]

"Investigation of flat slab structures with and without expansion joints for thermal stresses"

The study carried out This study mainly deals with design and analysis of structures of length 80m, 138m and 180m with and without expansion joints by using ETABS. During the analysis in ETABS the load of 1.2(D. L+L.L) is applied for buildings with expansion joint and 1.2(D. L+L.L+T. L) is applied for structures without expansion joint. Changes in stress at different levels, torsion on the peripheral beam and overall increase in steel quantity on the structure after imparting temperature loads at some point of the design of a structure.

2.4 G. SUCHITRA, et, al. (2017) [4]

"study of structural behaviour of framed C, T, L, Rectangular structures with and without considering temperature stresses and expansion joints"

In this paper considered 4 different types of RC framed buildings (C, T, L and Rectangular) in each case compared the lateral displacement and quantity of steel by considering with and except expansion joints by using computer software STAAD Pro. G+4 of Four different types of RC framed structures (C, T, L and Rectangular) are analysed with varying temperature of 20°C,30°C,40°C. The lateral displacements and quantity of steel for Regular and Irregular R.C framed structures with and without expansion joints were investigated using the linear static analysis.

2.5 FARIA ASEEM, et, al. (2017) [5]

"Analysis and Comparison of R.C.C Conventional Slab& Flat Slab Under Seismic &Temperature Load."

This study carried out behaviour of R.C.C flat slab and conventional slab is evaluated by nonlinear time history analyses with different temperature loading with the help of SAP 2000 v18 software. The essential parameters evaluated in this study are lateral displacement, inter story drift, axial force, and bending moment. A complete of 12 models with three different structural systems i.e., conventional slab system, flat slab system without drops and flat slab system with drops are considered. For every structural system 150mm and 200mm thickness of the slab is taken, so it has six simple models. For each basic model G+4, G+8 stories are considered. The temperature loading is being considered due to frequent occurrences of fire accidents and also due to the need for knowledge in people about fireplace hazards. Fire will not only cause casualties but also effect the structure predominantly leading to its destruction. From effects it can be concluded that conventional slab of 150 mm thickness is more effective for G+4 & G+8. For normal and high temperature 150mm thickness is good for G+4, G+8.

2.6 ESSAM H. et, al. (2015) [6]

"Analysis of RC Flat slab system for thermal loads"

This study carried out behaviour of R.C.C flat slab and conventional slab is evaluated by nonlinear time This study carried out reinforced concrete flat slab system of lengths much greater than the codes limits, if temperature affect is disregarded, as studied under dead and live loads, and thermal loads in order to examine the effect of temperature variation. The structures are modelled by using accounting for material non linearity, especially cracking. Different temperature gradients, uniform and nonlinear, are considered. The finite element is employed for conducting the analysis by using the finite element code ABAQUS, where different features of material non linearity's are considered. The obtained results for the study cases reveal that material modelling of reinforced concrete flat slab systems performs a major role in how these structures react to temperature variation. Cracking contributes to the release of significant portion of temperature restraint and in some cases this restrain is almost eliminated. The response of the system significantly deviates based on the temperature profile and presence of gravity loads.

2.7 ESSAM H. et, al. (2015) [7]

"Thermal analysis of reinforced concrete beams and frames"

This paper carried out the behaviour of reinforced concrete beams and frames is studied under thermal loads, with the presence of dead and live loads, in order to examine the impact of temperature variation. The beams and frames are modelled by accounting for material nonlinearity, particularly cracking. Different temperature gradients, uniform, linear and nonlinear, are considered. The finite thing technique is employed for conducting the analysis utilizing the computer code ABAQUS. The obtained results of the studied cases reveal that material modelling of reinforced concrete beams and frames plays a major role in how these structures react to temperature variation. Cracking contributes to the launch of significant portion of temperature restrain and in some cases this restrain is almost eliminated. The response of beams and frames deviates significantly based on the temperature gradient, linear or nonlinear; hence, the nonlinear temperature gradient which is the realistic profile is important to implement in the analysis.

3. RESULT AND DISCUSSION

3.1 "Effect of thermal load on conventional slab and flat slab"

from this study results were found that displacement is more in flat slab than RCC Conventional slab of without temperature.

in case of RCC Conventional Slab Displacement and bending moment is a smaller amount.

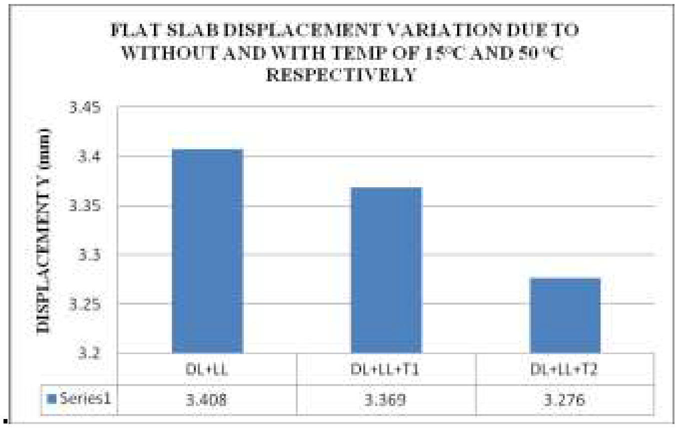

Fig-1 Flat slab displacement variation

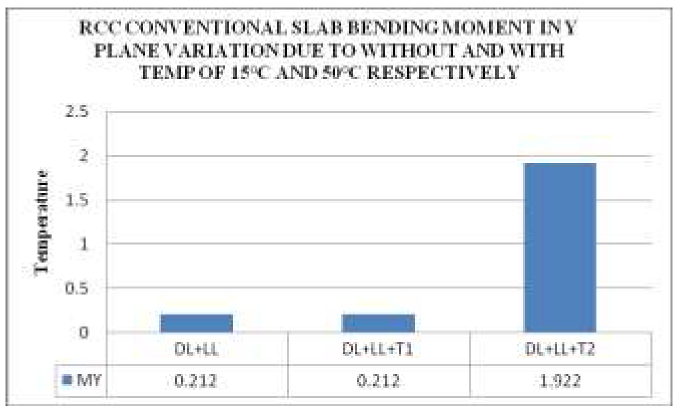

Fig-2 RCC conventional slab bending moment

3.2 Effect of Varying Temperature Load on RCC Structure by Seismic Analysis

In this study, results were analysed from Fig-3 the story drift is maximum for Model A when compared to Model B and Model C.

From Fig-4 Story drift is maximum for Model C - 725KN when compared to Model A – 417KN and Model B – 588KN in Y-Direction.

Due to the ground motion in X-direction from Fig -5, it is

observed that Model A has maximum storey displacement of 9 mm and for Model B and Model C it is 6 mm and 5mm respectively. In Y-direction.

Fig 6, has witnessed that Model A has storey stiffness of

212268 KN-m whereas for Model B and Model C it is 536731 KN-m and 773491 KN-m respectively in X-Direction.

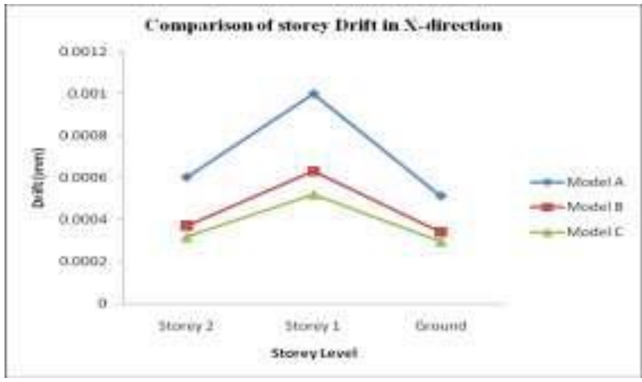

Fig-3 story drift (model A)

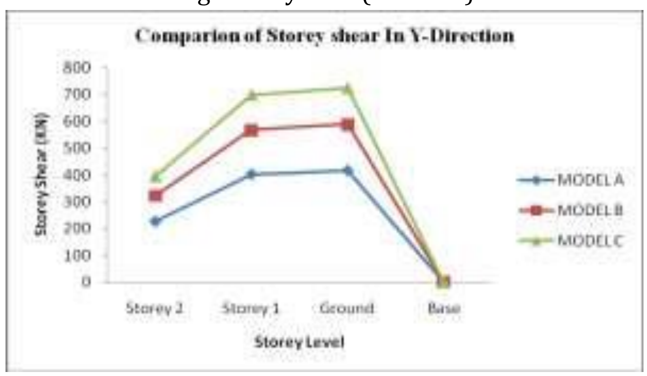

Fig-4 story shear (model C)

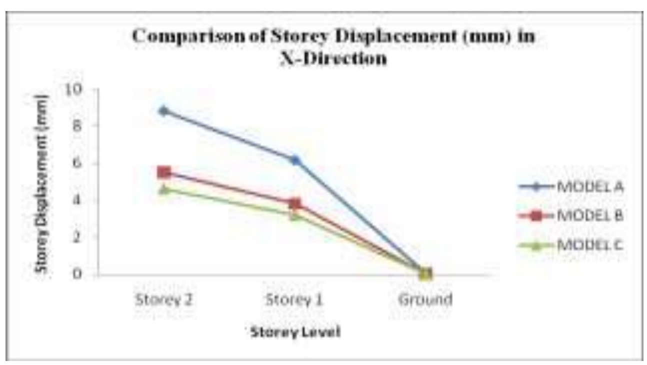

Fig-5 story displacement (model A)

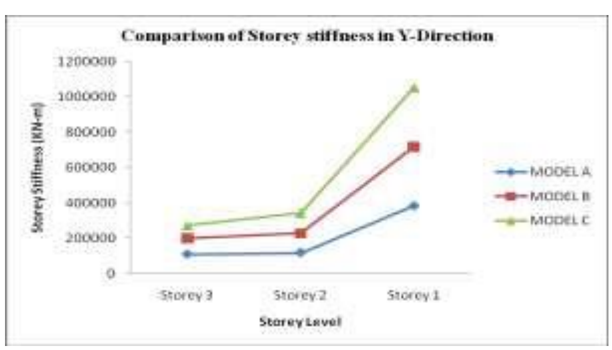

Fig-6 story stiffness (Model C)

3.3 Investigation of flat slab structures with and without expansion joints for thermal stresses

The displacement difference is about 1.1 mm, 3.1mm, and 6.4mm length for 90 m, 138 m slab 180 m slab length respectively. It was observed when displacement is increased as the length of slab increases. Displacement is comparatively more in Y direction than X direction.

This Graph showing the maximum displacement for 138m slab length without expansion joint.

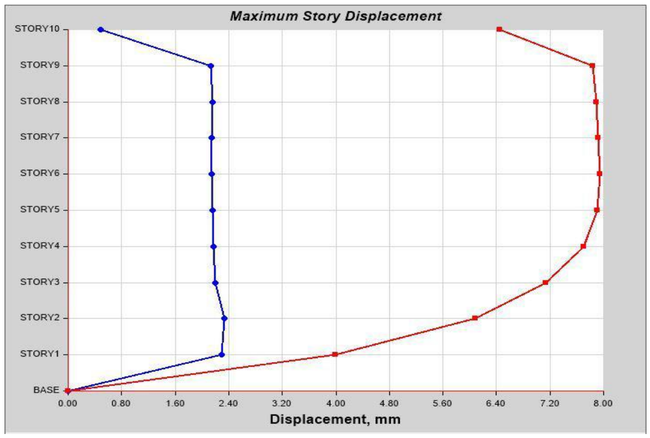

Fig-7 displacement for 138mm slab length

3.4 Study of structural behaviour of framed C, T, L, Rectangular structures with and without considering temperature stresses and expansion joints

In this study the results are observed that there was an increase in lateral displacement of 13.75 % for frames with Expansion joint when compared to structure without expansion joint subjected to temperature stress of 40 degrees.

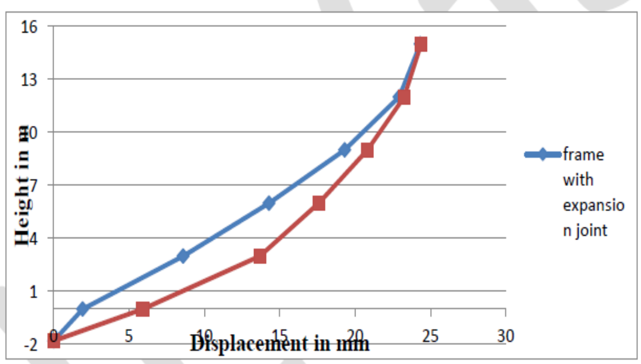

Fig-8 displacement for frame with expansion joint

It was observed that there is increase of lateral displacement of 58.21 % for frames with Expansion joint when compared to structure without expansion joint subjected to temperature stress of 40 degrees.

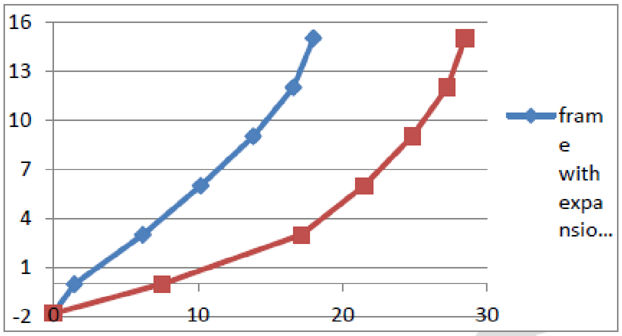

Fig-9 displacement for frame with expansion joint

3.5 Analysis and Comparison of R.C.C Conventional Slab& Flat Slab Under Seismic &Temperature Load

In this paper the results are observed that the displacement is more compared to normal temperature to higher temperature of 150mm thickness slab and displacement is less compared to normal temperature to higher temperature of 200mm thickness of conventional slab to flat slab.

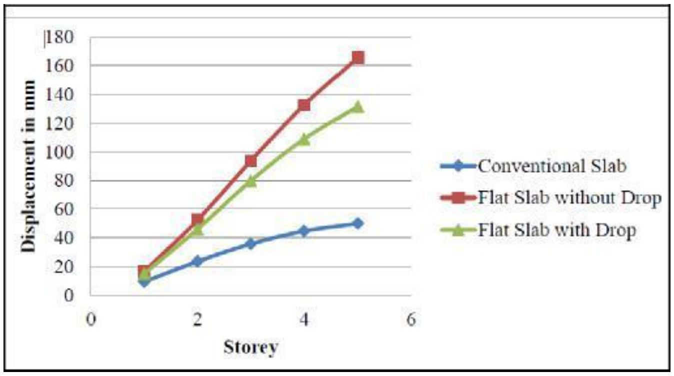

Fig-10 Displacement of 150mm thickness slab

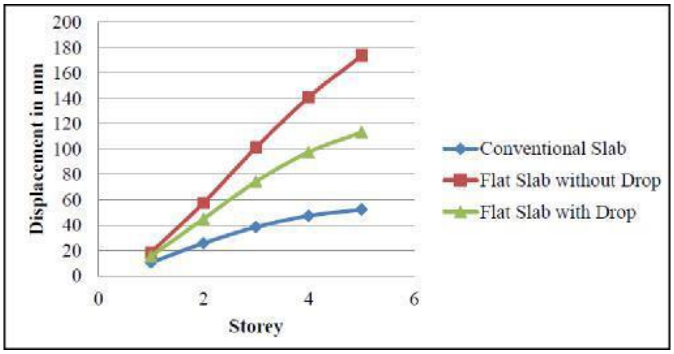

Fig-11 displacement 200mm thickness slab

4. CONCLUSIONS

1. About 5.10% of displacement is more in flat slab than RCC Conventional slab of without temperature Displacement and bending moment is a smaller amount in case of RCC Conventional slab presence of beam in conventional slab which has more stiffness compares to flat slab and conventional slab also has higher load carrying capacity and in conventional RCC slab as temperature load increases bending moment in beam in addition as in-plane bending moment value increases.
2. From the above research paper, it's observed that storey drift is maximum in Model A for both the direction, Storey shear was found to be more in Model C, Storey displacement is maximum for Model A, Story Stiffness was maximum in Model C.
3. From the above results it can be concluded that considering the temperature loads during design of flat slab structures the supply of expansion joints can be eliminated. Flat slab structures without expansion joints beyond 138 m length will be adopted for construction its marginal non variation within the steel quantity and stresses.
4. For "L" type G+4 storey building, it absolutely was observed, in comparison to frame with expansion joint to frame without expansion joints, there was a decrease in percentage of lateral displacements of 17.18 and 4.865 at a temperature stresses of 200c and 300c and there was a rise in percentage of lateral displacement of 7.45 at a temperature stresses of 400c respectively. For "Rectangular" type building it absolutely was observed, compared to frame with and without expansion joint subjected to temperature stresses there was a decrease in percentage of steel of 0.9, 0.49 and 0.98 respectively.
5. From the above study of the paper it may be concluded that 150mm of conventional slab to flat slab, displacement is more compared to normal temperature to higher temperature and 200mm of conventional slab to flat slab, displacement is a smaller amount compared to normal temperature to higher temperature.
6. within the analysis for thermal loads, it's recommended to hold out such analysis within the presence of working gravity loads which cause tension stresses in concrete and cracks and hence the effect of temperature is reduced as compared with the case of uncracked concrete sections.
7. The response of beams or frames deviates significantly supported the gradient, linear or nonlinear.
   Hence, the nonlinear gradient which is that the realistic profile is very important to implement within the analysis

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