

EFFECTS OF THERMAL LOADS ON RCC CONVENTIONAL SLAB AND FLAT SLAB

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Abstract - Long structures without any expansion joints have become a necessity in view of demanding architecture and present Industrial trend. As per Indian Standard code, IS-456:2000, buildings longer than 45m shall be analyzed for the thermal stresses and appropriate measures shall be taken during fixing the structural system. However, IS codes are silent in terms of process to follow in such kind of designs as well as on load factors to be considered in design combination of temperature load with gravity loads. To worsen the situation, there are no guidelines available with the design engineers to arrive at design temperature value that should be considered in working out thermal stresses. In this comparative study, the temperature behavior of R.C.C flat slab and conventional slab is evaluated by finite element method with different temperature loading with the help of STAAD Prov8 software. The main parameters evaluated in this study are storey displacement and bending moment. The temperature loading is being considered due to frequent occurrences of fire accidents and also due to the need for knowledge in people about fire hazards. Fire will not only cause casualties but also effect the structure predominantly leading to its destruction. From results it can be concluded that conventional slab of 225 mm thickness is more effective for G+4 For normal and high temperature 275mm thickness is good for G+4.

Key Words: Thermal loads, RCC Conventional slab and Flat slab, Storey displacement and Storey bending moment.

1. INTRODUCTION

In today's construction the use of flat slab has become quite common. Flat-slab building structures possess major advantages over traditional slab-beam -column structures because of the free design of space, shorter construction time, architectural-functional and economical aspects. Flat slab construction is a developing technology in India. The conventional slab has more stiffness and higher load carrying capacity. Due to urbanization and aesthetic reasons flat slab have become quite common. Because of the absence of deep beam. Flat-slab structural system is significantly more flexible for lateral loads than traditional RC frame system. The performance of flat slab system under temperature loading is also very poor. It is necessary to analyses Temperature load to see what are the changes that are going to occur for the conventional RC frame building and flat slab building without drops.

1.1 Comparative study of RCC Conventional slab and Flat slab

RCC slab is a structural element of steel reinforced concrete. These slabs are most often used as floorings, ceilings etc. slabs may be supported on two sides only or have beams on all four sides. RC slabs are constructed using formwork, which is commonly made of wooden planks, boards, plastics, and steel. Now a day's prefabricated RC slabs also used. RC slab is known as reinforced concrete slab providing reinforcement for the stability of the structure. Straight bar and alternative cranked bars are used as reinforcement in the RC slabs.

Flat slab is a two reinforced slab that usually does not have beams and girders, and the loads are transferred to the supporting columns.

2. LITERATURE REVIEW

1) The study carried out in journal paper by ,Essam H. EL-Tayeb, Salah E. EL-Metwally, HamedS.Aksar, Ahmed M Yousef entitled "Analysis of RC Flat slab system for thermal loads" International Journal of Engineering and Innovative Technology (IJEIT) Volume 4, Issue 12, July 2015 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 systems are modeled by accounting for material non linearity, particularly cracking. Different temperature gradients, uniform and non linear, are considered. The finite element is employed for conducting the analysis by utilizing 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 modeling of reinforced concrete flat slab systems plays 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) The study carried out in this journal paper by Essam H. EL-Tayeb, Salah E. EL-Metwally, Hamed S. Aksar, Ahmed M Yousef entitled "Thermal analysis of reinforced concrete beams and frames" In this paper, the behavior of reinforced concrete beams and frames is studied under thermal loads, with the presence of dead and live loads, in order to examine the effect of temperature variation. The beams and frames are modeled by accounting for material nonlinearity, particularly cracking. Different temperature gradients, uniform, linear and nonlinear, are considered. The finite element method is employed for conducting the analysis utilizing the computer code ABAQUS. The obtained results of the studied cases reveal that material modeling of reinforced concrete beams and frames plays a major role in how these structures react to temperature variation. Cracking contributes to the release 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) The study carried out in this journal by Pooja M , Dr. Karthiyaini S, Entitled "Investigation of flat slab structures with and without expansion joints for thermal stresses", International Journal of Civil Engineering and Technology (IJCIET) Volume 8, Issue 4 This study mainly deals with design and analysis of structures of length 80m, 138m and 180m with and without expansion joints. Changes in stress at different levels, torsion on the peripheral beam and overall increase in steel quantity on the structure after imparting temperature loads during the design of a structure.

4) The study carried out in this journal by Faria Aseem¹, Waseem Sohail², Abdul Quadir³ Entitled "Analysis and Comparison of R.C.C Conventional Slab & Flat Slab Under Seismic & Temperature Load", International Research Journal of Engineering and Technology (IRJET) Volume: 04 Issue: 10 | Oct -2017 The seismic, behavior 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 main parameters evaluated in this study are lateral displacement, interstory drift, axial force, and bending moment. A total 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 each structural system 150mm

and 200mm thickness of the slab is taken, so it has six basic 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 fire hazards. Fire will not only cause casualties but also effect the structure predominantly leading to its destruction. From results 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.

5) The study carried out in this journal by K.Vaishnavi¹, B S Suresh Chandras² Entitled "Effect of Varying Temperature Load on RCC Structure by Seismic Analysis", Volume: 05 Issue: 08 | Aug 2018 International Research Journal of Engineering and Technology (IRJET) , 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 maximum Temperature Loading). Equivalent static analysis was done along with the temperature loading. Analysis was performed to compare various parameters such as storey drift, storey shear, storey displacement, storey stiffness. The results tabulated are compared to check the effect of varying temperature Load

3. METHODOLOGY

A total of 12 models with two different structural systems i.e., conventional slab system, flat slab system without drops. For each structural system 225mm and 275mm thickness of RCC conventional Slab and RCC Flat slab respectively, so we have six basic models. For each basic model G+4 stories are considered. The performance of flat slab and conventional slab has to be studied when subjected to Temperature loading due to occurrence of varying Temperatures.

3.1 TABLE

DESGIN DISCRIPTION

1	Type of structure	RCC Conventional slab	RCC Flat slab
2	No. of storey	G+3	G+3
3	Storey height	3.2m	3.2m
4	Plan dimension	54mX24m	54mX24m
5	Materials	M30,Fe 500	M30,Fe 500
6	Size of column	450 X450mm	450 X450mm
7	Size of beam	300X450mm	300X450mm
8	Depth of slab	225mm	275mm

9	Density of concrete	25KN/mm ²	25KN/mm ²
10	CO-efficient of thermal expansion Concrete Steel	11 x10 ⁻⁶ /°C 12 x10 ⁻⁶ /°C	

EXPLANATION OF VARIOUS BUILDING MODELS

MODEL 1: CONVENTIONAL SLAB SYSTEM OF 150MM WITHOUT TEMPERATURE LOAD.

MODEL2: FLAT SLAB SYSTEM OF 150MM WITHOUT TEMPERATURE LOAD.

MODEL3: CONVENTIONAL SLAB SYSTEM OF 150MM WITH TEMPERATURE LOAD OF 15°C.

MODEL4: FLAT SLAB SYSTEM OF 150MM WITH TEMPERATURE LOAD OF 15°C.

MODEL5: CONVENTIONAL SLAB SYSTEM OF 150MM WITH TEMPERATURE LOAD OF 50°C

MODEL6: FLAT SLAB SYSTEM OF 150MM WITH TEMPERATURE LOAD OF 50°C

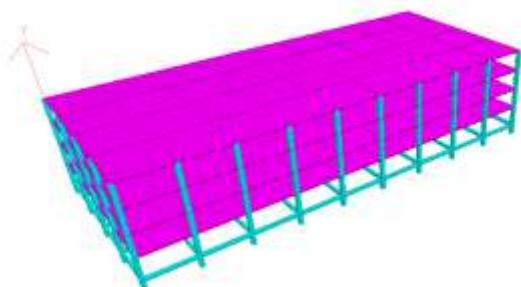


Fig-1:3D View of conventional RCC slab

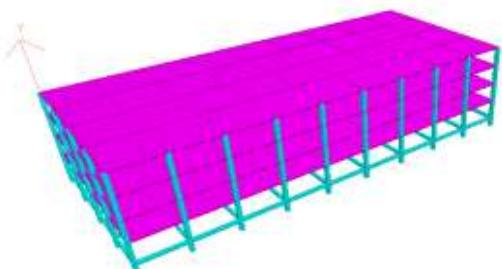


Fig-2: 3D View of RCC Flat slab

RESULTS AND OBSERVATIONS

In the present study, flat and conventional RCC slab building were modeled and subjected to temperature loading varying from 15°C to 50°C. The effects of temperature difference along with dead load and live load on the structural parameters such as bending moment diagram and deflection. The results from analysis are discussed with the help of graph.

DISPLACEMENT GRAPHS:

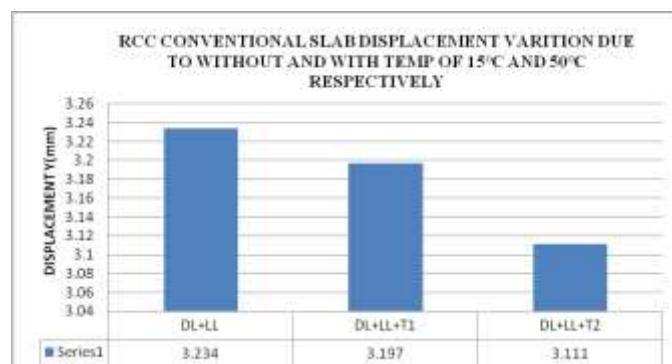


Fig-3: Displacement in RCC Conventional slab due to DL+LL is greater compared to temperature loads

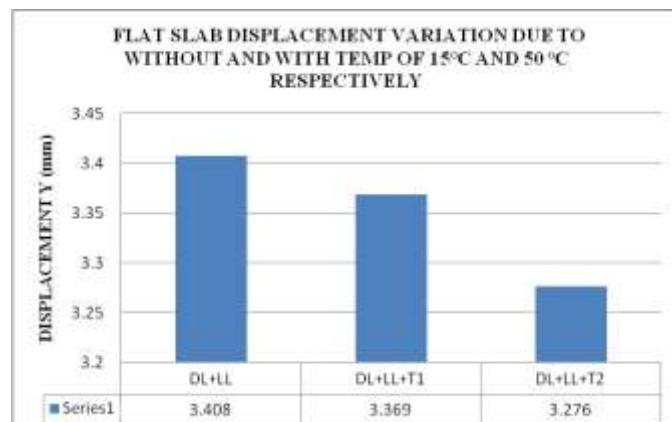


Fig-4: Displacement in Flat slab due to DL+LL is greater compared to temperature loads

- From fig.4 Displacement in flat slab is greater by 5.10% than RCC slab as there are no beams in flat slab to resist the displacement.
- From Fig.5 the nodal displacement decreases with increase in temperature and in conventional slab and as well as in flat slab the variation due to temperature load of 15°C and 50°C with dead load and live load is 1.14% and 3.8% respectively.

BENDING MOMENT GRAPHS

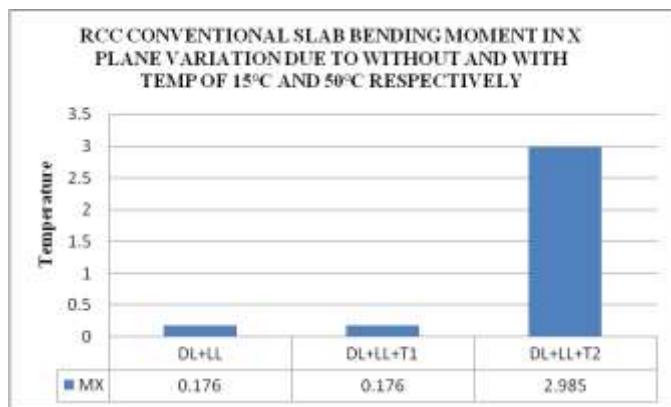


Fig-5: Bending moment in X Plane in RCC Conventional slab due to DL+LL+T2 is greater.

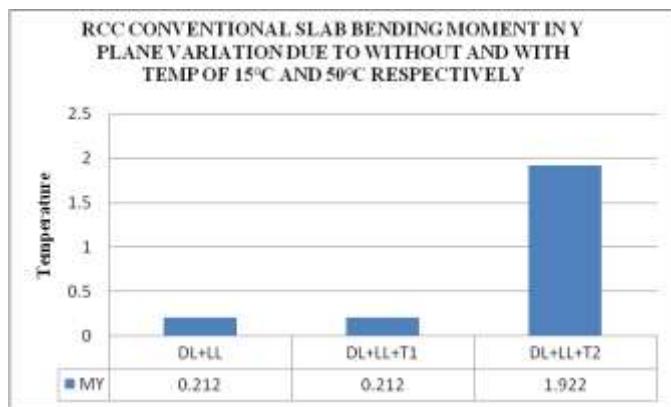


Fig-5: Bending moment in Y Plane in RCC Conventional slab due to DL+LL+T2 is greater.

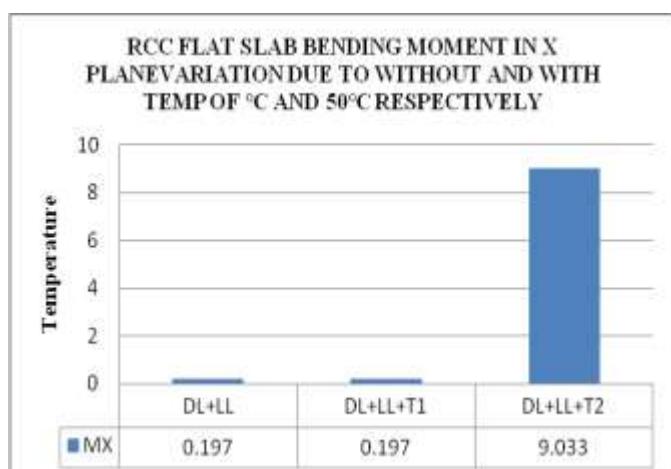


Fig-7: Bending moment in X Plane in RCC Flat slab due to DL+LL+T2 is greater.

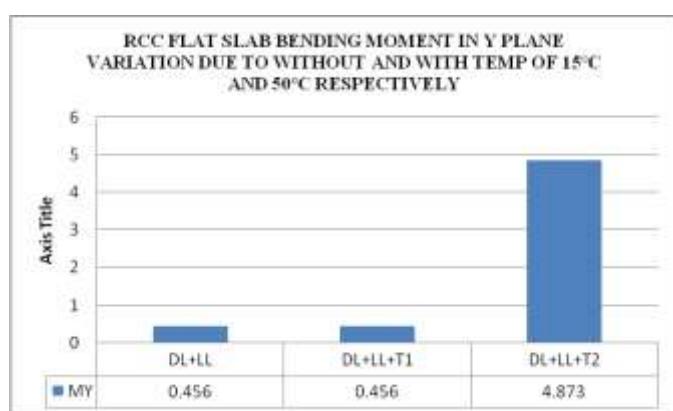


Fig-8: Bending moment in Y Plane in RCC Flat slab due to DL+LL+T2 is greater.

CONCLUSIONS

The objective of the present work is to study the thermal effect in conventional RC slab and flat slab by varying the temperature from 15°C to 50°C. Here the response of structural parameters is studied and compared with normal loading (i.e. dead load and live load). From the results of STAAD and based on the results and observations from previous chapter, the following conclusions are made

- 1) About 5.10% of displacement is more in flat slab than RCC Conventional slab in case of without temperature is observed considering G+4 with thickness of 225mm and 275mm in RCC Conventional and Flat slab respectively.
- 2) Displacement and bending moment is less in case of RCC Conventional slab because of presence of beam in conventional slab which has more stiffness compares to flat slab and conventional slab also has higher load carrying capacity.
- 3) Bending moment in X plane in flat slab is greater by 66.95% than RCC slab. Bending moment in Y plane in flat slab is greater by 60.55% than RCC slab
- 4) In conventional RCC slab as temperature load increases bending moment in beam as well as in-plane bending moment value increases. We can conclude that when there is no expansion joints provided then in conventional slab design, temperature load has to be considered along with dead load and live load.
- 5) Comparing bending moment and deflection values of conventional slab with flat slab it is observed that with increase in temperature load bending moment and deflection values also increases. Hence these values are to be considered in design of conventional and flat slab design.

6) Temperature parameter is less significant as compared to live load but temperature has to be account in the conventional RCC slab and flat slab design along with self weight (dead load) of the structure.

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