Effect of Varying Temperature Load on RCC Structure by Seismic Analysis

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Abstract - *Concrete is the widely used construction material because of its economy it makes the most suitable material for construction. According to IS 456:2000, the buildings exceeding 45m length are subjected to thermal stresses. However, considering temperature load along with gravity load is being neglected. Besides gravity and imposed loads, concrete are subjected to seasonal and daily temperature change, as a result of the structure being exposed to solar radiation, the temperature load has to be considered. These loads lead to thermal stresses in the structural members. In this analytical study, 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.*

***Key Words*: Thermal stress, Daily temperature, Concrete, Analysis, Storey displacement, Storey shear.**

1. INTRODUCTION

The most widely used construction material is concrete, because of its economy it makes the most suitable material for construction. Structures like factories, ware-houses, public halls, etc. have longer may be subjected to expansion for various reasons. According to IS 456:2000, the buildings exceeding 45m length are subjected to thermal stresses. However, considering temperature load along with gravity load is being neglected. Construction of building takes over a considerable period of time. Structural elements are also installed at different temperature. This Temperature change may cause stress and displacement within the structure. Temperature change is the influencing factor for expansion and contraction for the structural members. However, the change will not be the same for all the members. It can be defined as a high temperature that causes the effects on structures, like solar radiation, outdoor air temperature, indoor air temperature, underground temperature and any heat from the equipment inside the structure with variation in temperature. These loads will produce stresses in concrete structures with same degree of magnitude as dead loads and live loads.

1.1 OBJECTIVES

The main aim of this analytical study is,

- To study the effect of temperature load on the structure.
- Comparative study of the RCC buildings without temperature loading and buildings with varying temperature loading.
- To study the variation in storey drift, storey displacement, storey shear, storey stiffness, due to application of varying temperature load.

1.2 METHODOLOGY

For this present analytical study the following methodologies are followed,

- An example of Two-storey building with larger span was analyzed for three different cases:
1. Considering the structure without temperature loading.
2. Considering the structure with minimum temperature loading.
3. Considering the structure with maximum temperature loading.
- Three separate models were generated using etabs software.
- Using Equivalent Static Analysis, the buildings were analyzed.
- Analysis was performed and the results were tabulated and compared to check the effectiveness of the Thermal Load applied.

2. MODELLING

Three buildings were modeled for longer span,loadings were done according to Indian Standard code. Static analysis was performed for the structure. Modeling was done using etabs software. The first part involves summary and brief description.

The following building models are considered for analysis:

1. Model A – building without temperature loading.
2. Model B – building with minimum temperature loading.
3. Model C – building with maximum temperature loading.

The buildings are been located in Tarapur, Maharastra. Ordinary moment resisting frame (OMRF) under Zone – III. The brick wall thicknesses are 230 mm for 115mm for partition walls.

Table -1: Description of Models

Parameters	MODEL A	MODEL B	MODEL C
Dimensions(m)	54.5*21	54.5*21	54.5*21
Beam size (mm)	PB(300* 500) FB(230*500) RB(230*400)	PB(300*500) FB(230*500) FB2(230*600) RB(230*400)	PB(300*500) FB(230*500) FB2(230*600) FB3(230*700) RB(230*500)
Column size (mm)	250*500	350*500	450*600
Slab thickness (mm)	150	150	150
Concrete (N/mm²)	M_{30}	M_{30}	M_{30}
Steel (N/mm²)	Fe 500	Fe 500	Fe 500
Live load (KN/m²)	4	4	4
Floor finish (KN/m²)	1.5	1.5	1.5
Zone	III	III	III
Importance factor (I)	1.5	1.5	1.5
Reduction factor (R)	5	5	5
Type of soil	II	II	II
Type of analysis	Equivalent static analysis		

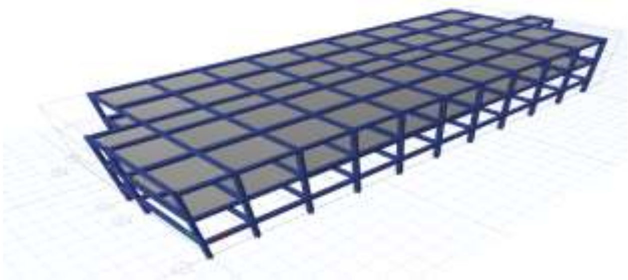

Fig-1: 3D view of Models

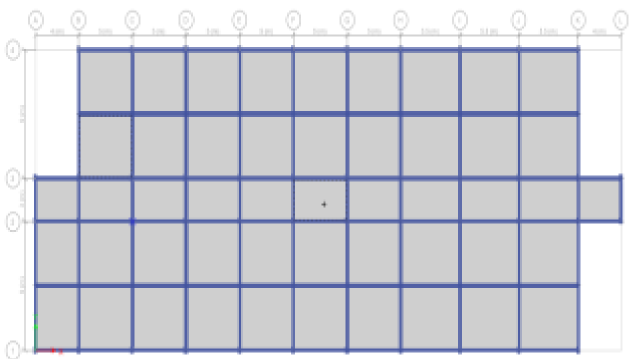

Fig- 2: plan view of Models

2.1 TEMPERATURE LOADING

Temperature loading was applied along with seismic loading, and the data considered is summarized in the table,

Table-2: Temperature Loading for models

MODELS	ROOF SLAB	SOUTH SIDE
MODEL B	41°C	35°C
MODEL C	52.3°C	42.6°C

3. RESULTS AND DISCUSSIONS

Three models were generated using commercial ETABS software. Equivalent static analyses for these buildings were carried out to evaluate seismic behavior of the building. Results obtained from static analysis are given in this section.

Earthquake parameters that is considered for the analysis is shown in the Table 3.

Table-3: Earthquake parameters

Models	EARTHQUAKE PARAMETERS					
	ZONE	ZONE FACTOR (Z)	IMPORTANCE FACTOR (I)	RESPONSE REDUCTION FACTOR (R)	TIME PERIOD USED (sec)	
					X-DIR	Y-DIR
Model A	III	0.16	1	5	1.3	0.9
Model B	III	0.16	1	5	0.8	0.7
Model C	III	0.16	1	5	0.7	0.6

Table-4: Base shear in X and Y direction

Description	Base shear (KN)	
	X-Direction	Y-Direction
Model A	314	417
Model B	523	588
Model C	650	751

➢ Parameters compared for three models are:

1. Storey Drift
2. Storey Shear
3. Storey Displacement
4. Storey Stiffness

- Storey Drift

Table-5: Storey Drift in X-Direction

Storey's	Model A	Model B	Model C
2	6E-4	4E-4	3E-4
1	1E-3	7E-4	6E-4
Ground	5E-4	4E-4	3E-4

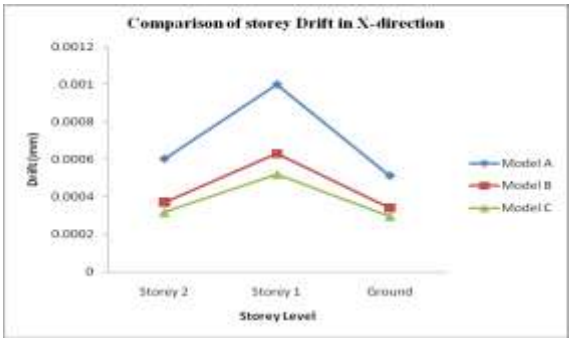

Fig-3: Comparison of Storey Drift in X-Direction

Table-6: Storey Drift in Y-Direction

Storey's	Model A	Model B	Model C
Storey 2	6E-4	5E-4	4E-4
Storey 1	9E-4	7E-4	6E-4
Ground	5E-4	4E-4	3E-4

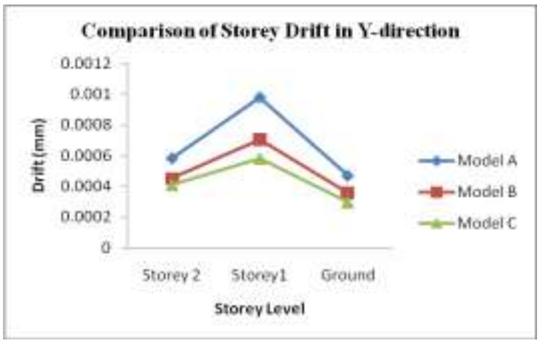

Fig-4: Comparison of Storey Drift in Y-Direction

For the storey drift in X-direction from Fig 3. Model A has storey drift of 1E-3 mm .Model B and Model C has storey drift of 7E-4 mm and 6E-4 mm respectively. In Y-direction, Fig 4, shows MODEL A has storey drift of 9E-4 mm, where as in Model B and Model C it is 7E-4 mm and 6E-4 mm respectively. Storey drift is maximum for Model A, when compared to Model B and Model C.

- Storey Shear

Table-7: Storey shear in X-Direction

Storey's	MODEL A	MODEL B	MODEL C
Storey 2	171	287	355
Storey 1	287	505	627
Ground	355	523	650
Base	0	0	0

Fig-5: Comparison of Storey Shear in X-Direction

Table-8: Storey Shear in Y-Direction

Storey's	MODEL A	MODEL B	MODEL C
Storey 2	227	322	396
Storey 1	403	567	699
Ground	417	588	725
Base	0	0	0

Fig-6: Comparison of Storey Shear in Y-Direction

Fig 5, shows Storey shear in X-direction, Model A has 355 KN,for Model B and Model C it is 523 KN and 650 KN respectively. Fig 6,shows Storey shear in Y-direction, Model A has 417 KN, Model B and Model C storey shear is 588 KN and 725 KN respectively. It is observed that Model C has maximum storey shear compared to Model B and Model A.

- Storey Displacement

Table-9: Storey Displacement in X-Direction

Storey's	MODEL A	MODEL B	MODEL C
Storey 2	9	6	5
Storey 1	6	4	3
ground	0	0	0

Fig-7: Comparison of Storey Shear in Y-Direction

Table-10: Storey Displacement in Y-Direction

Storey's	MODEL A	MODEL B	MODEL C
Storey 2	8	6	5
Storey 1	6	4	3
Ground	0	0	0

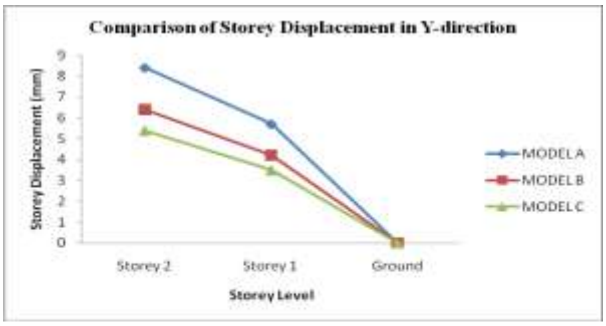

Fig-8: Comparison of Storey Displacement in Y-Direction

Due to the ground motion in X-direction from Fig 7, 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 5 mm respectively. In Y-direction, Fig 8, shows that Model A has displacement of 8 mm, Model B and Model has displacement of 6 mm and 5 mm respectively.It is seen that Model A has maximum displacement when compared to Model B and Model C.

Storey stiffness

Table-11: Storey Stiffness in X-Direction

Storey's	MODEL A	MODEL B	MODEL C
Storey 2	64398	172929	255257
Storey 1	66611	181729	275509
Ground	212268	536731	773491

Fig-9: Comparison of Storey Displacement in X-Direction

Table-12: Storey Stiffness in Y-Direction

Storey's	MODEL A	MODEL B	MODEL C
Storey 2	109826	200069	271797
Storey 1	118205	228354	340921
Ground	384257	718155	1051099

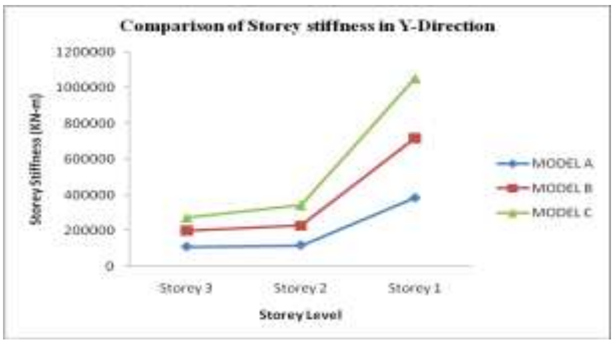

Fig-10: Comparison of Storey Displacement in Y-Direction

Fig 9, has witnessed that Model A has storey stiffness of 212268 KN-m where as for Model B and Model C it is 536731 KN-m and 773491 KN-m respectively in X-Direction. In Y-direction Fig 10, shows that Model A has storey stiffness of 384257 KN-m , Model B and Model C has storey stiffness of 718155 KN-m and 1051099 KN-m respectively. Hence ,Model C has higher stiffness compared to Model A and Model B.

4. CONCLUSIONS

Analysis was carried out for G+1 building, for three different models. Based on storey drift, storey shear, storey displacement, storey stiffness results obtained from equivalent static analysis the following conclusions are drawn.

- Etabs is effective software that can be used for temperature loading analysis.
- It is observed that storey drift is maximum in Model A for both the direction, Model B is 43% lesser than that of Model A, Model C is reduced to 17% compared to Model B, Model C is reduced about 67% compared to Model A in X-direction, where as in Y-direction, Model B is 29% lesser than that of Model A, Model C is 17% lesser than that of Model B, Model C is 50% lesser than Model A.
- Storey shear was found to be more in Model C, storey shear in Model B is increased about 66% compared to Model A, Model C is increased about 24% compared to Model B, Model C is increased about 93% compared to Model A in X direction, in Y-direction storey shear is increased about 41% in Model B compared to Model A, where as in Model C it is increased about 23% compared to Model B. Model C is increased about 74% compared to Model A.
- Storey displacement is maximum for Model A, storey displacement is reduced about 50% for Model B when compared to Model A, for Model C it is reduced about 20% compared to Model B, for Model C it is reduced about 80% compared to Model A in X-direction, storey displacement in Y-direction is reduced about 33% for Model B compared to Model A, Model C it is reduced about 20% when compared to Model B, for Model C it is reduced about 60% compared to Model A.
- Story Stiffness was maximum in Model C, for Model B storey stiffness is increased about 47 % compared to Model A, Model C is increased about 44% compared to Model B, Model C is increased about 64% in X-direction, storey stiffness in Y-direction is increased about 87% for Model B compared to Model A, Model C is increased about 46% compared to Model B, Model C is increased about 73% compared to Model A.

SCOPE FOR FUTURE WORK

- Analysis of high rise RCC building with higher temperature exposure can be done.
- Temperature effect on steel structure can be studied.
- Comparison of structure with and without expansion joint

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