COMPARATIVE STUDY OF RCC FRAMED BUILDING WITH AND WITHOUT EXPANSION JOINT AT DIFFERENT LOCATION

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Abstract: An expansion joint is a gap provided in the structure to allow expansion and contraction of the building due to temperature changes. It absorbs the heat-induced by expansion and contraction of various construction materials. Concrete buildings are subjected to contraction and expansion due to the warming and cooling of our planet through the seasons. Long term effects of such seasonal temperature changes develop stresses and deformation in the building. Concrete creep and shrinkage increase the cracks widths and stresses. For elimination of this expansion joints are provided. A five storied building of length 50 m is analyzed and designed by using STAAD PRO. And compare results by using building with expansion joint and building without expansion joint. This study focuses on the behavior of RCC framed long building in the presence of expansion joint under seismic and temperature loading.

Keywords: **Seismic Analysis, Expansion joints, Thermal stresses, Concrete Creep, Staad Pro.**

I. INTRODUCTION

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. According to IS 456:2000, the buildings exceeding 45m length are subjected to thermal stresses. The structures would crack under the stress of thermal expansion and contraction if expansion joints were not built into the structures. An expansion joint is a gap in the building structure provided by an architect or engineer to allow for the movement of the building due to temperature changes. Expansion joints are necessary in a structure as they counter the adverse effects a structure experiences during its lifespan due to temperature variations. This project presents behavior of RCC framed building of larger length with different location of expansion joints. This work includes the analysis of structure with and without expansion joints. The objective of this study is to analyses the model with and without expansion joints, and with different location of expansion joints in building and compare the results of structure to find out which structure is more suitable for construction.

II. OBJECTIVE

The objectives of present study can be shortening as follows:

To study the effect of temperature load & earthquake load on the structure.

- To study the effect of earthquake load on the structure as per Indian standard code.
- To study the effect of temperature load on the structure as per Indian standard code.
- To study the variation in bending moment, storey displacement due to application of temperature load & earthquake loads.
- To compare the STADD PRO results of building with and without expansion joint.
- Comparative study of the RCC buildings with and without expansion joints of length longer than 45 meters using STADD PRO software.
- To study the variation in reinforcement of RCC building with & without expansion joint. And determine economical structure.

III.METHODOLOGY

In this present study, five storey building at Thane is considered with larger span and analyzed with and without expansion joints subjected to temperature and seismic loading.

Three different cases are considered for comparison:
Case 1: Comparison of results of model without expansion joint and model with expansion joint in x direction of buildings.
Case 2: Comparison of results of model without expansion joint and model with expansion joint in z direction of building.
Case 3: Comparison of results of model without expansion joint and model with expansion joint in corner of buildings.

- Using Equivalent Static Analysis, the building is analyzed.
- Analysis is performed and the results were tabulated and compared to check the effectiveness of the structure with and without expansion joint.

IV. MODELLING

Two structures are modelled for longer span, loadings are done according to Indian Standard code. Static analysis was performed for the structure. Modeling is done using staad pro software. The following building models are considered for analysis:

Sr. No.	Property	Value
1.	Concrete	M25
2.	Steel	Fe500
3.	Live load	2.0 kN/m^2 For allrooms 3.0 kN/m^2 For passages
	sunk load	5.7 kN/m^2 4.0 kN/m^2
4.	Floor finish	1.0 kN/m^2
5.	Zone	Ⅲ
6.	Importance factor (I)	1
7.	Type of soil	Medium

TABLE 1: Materials and Loading Details of the BuildingModels

Model A – building without any expansion joint

Model B – building with expansion joint along X-direction of structure.

Model C – building with expansion joint along Z-direction of structure.

Model D – building with expansion joint along corners of structure.

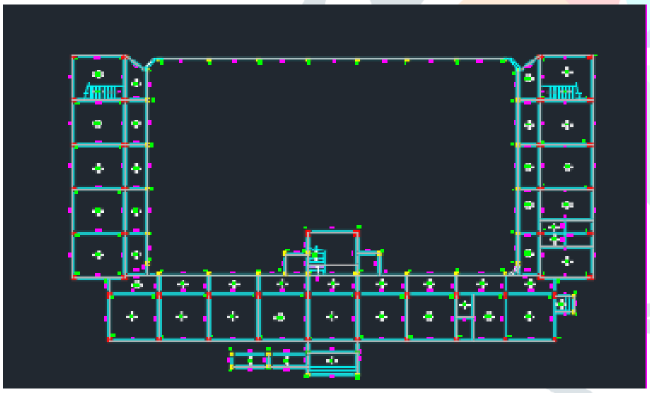

Figure 1: AutoCAD plan of structure is considered single without any expansion joint.

The structure is located in zone Ⅲ and the loadings are done accordingly as per IS 1893 (Part 1) Criteria for earthquake resistant design of structures.

The temperature variation is taken as $31°C$ which is the difference of the maximum (44 ° C) and minimum (13°C) temperature as per the environmental data services of the city.

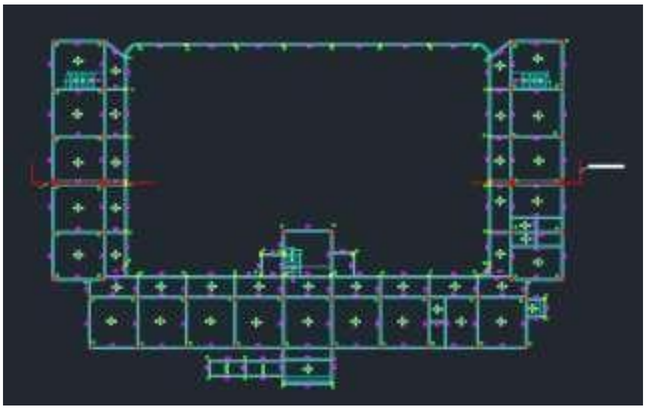

Figure 2: AutoCAD plan of Structure is considered with expansion joint.

Sr. No.	Variables	Dimensions
1.	Plan dimension	50mX 47m
2.	Number of Stories	5
3.	Floor height	3.6m for ground floor 3.15m for upper floors
4.	Building Location	Thane
5.	Wall	230 mm thick
6.	Size ofinner Columns	230x230 mm upto plinth level, 300x300 mm inner columns
7.	Size of outer Columns	300x400 mm, 300x500 mm, 300x600 mm for outer columns
8.	Size of plinth Beams	230x300 mm, 230x400 mm for plinth level,
9.	Size of middle floor Beams	230x450 mm, 230x500 mm for middle floor
10.	Size of upper floor Beams	230x600mm, 230x700mm for upper floors
11.	Depth of slab	125,150mm thick slab

TABLE 2: Preliminary Data Consider for the Analysis.

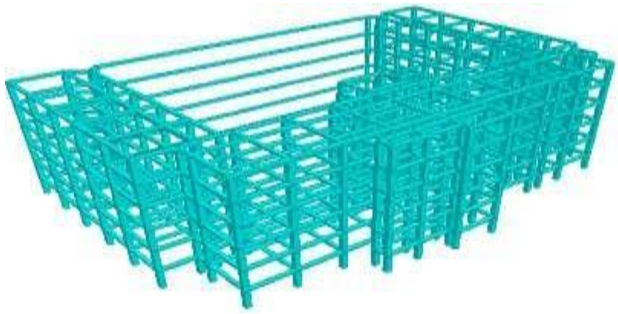

Figure 3: Stadd Pro plan of Without Expansion Joint

V. RESULTS AND DISCUSSIONS

A. Comparison of Maximum Bending Moment in Middle Beams of Bottom Slab

The middle beams of bottom slab were divided into four groups as shown in Figure 4, namely, Beam 1 consisting of beams with moment values ranging from 10-40 kNm, Beam 2 consisting of beams with moment values ranging from 40-60kNm, Beam 3 consisting of beams with moment values ranging from 60-80 kNm and Beam 4 consisting of beams with moment values ranging from 80-100 kNm.

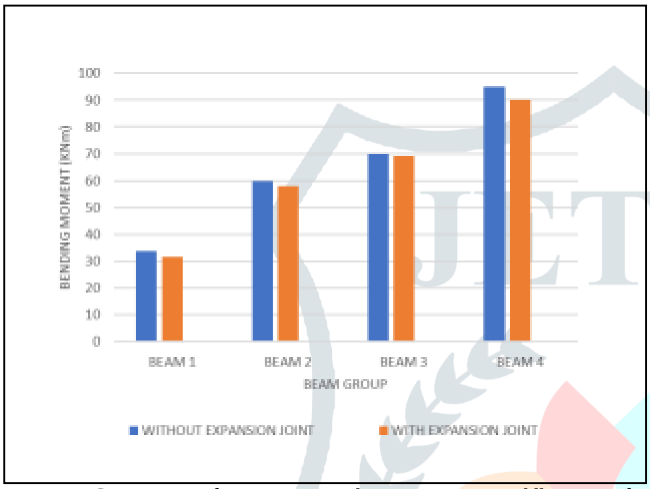

Figure 4: Comparison of Maximum Bending Moment in Middle Beam of bottom slab

B. Comparison of Maximum Bending Moment in Corner Beams of Bottom Slab

The corner beams of bottom slab were divided into four groups as shown in Figure 5, namely, Beam 1 consisting of beams with moment values ranging from 10-40 kNm, Beam 2 consisting of beams with moment values ranging from 40-60kNm, Beam 3 consisting of beams with moment values ranging from 60-80 kNm and Beam 4 consisting of beams with moment values ranging from 80-100 kNm.

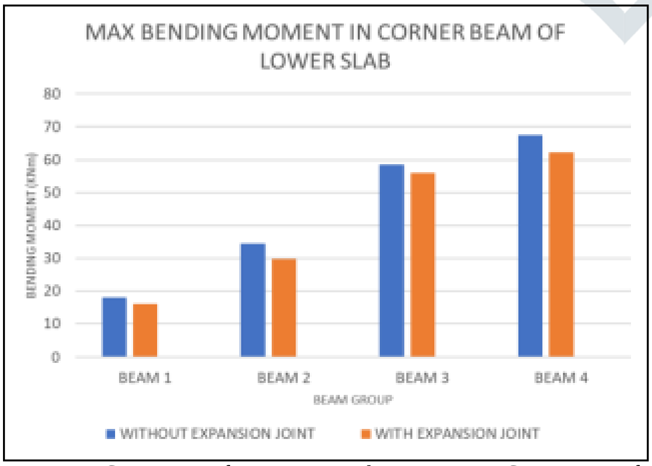

Figure 5: Comparison of Maximum Bending Moment in Corner Beam of Lower Slab

From the Figure 5, it can be seen that the maximum bending moments in the corner beams is reduced by 5 - 15% of its value and the reduction in middle beams are almost similar to corner beams when an expansion joint is introduced in the structure.

C. Comparison of Maximum Bending Moment in Middle beams of upper slab

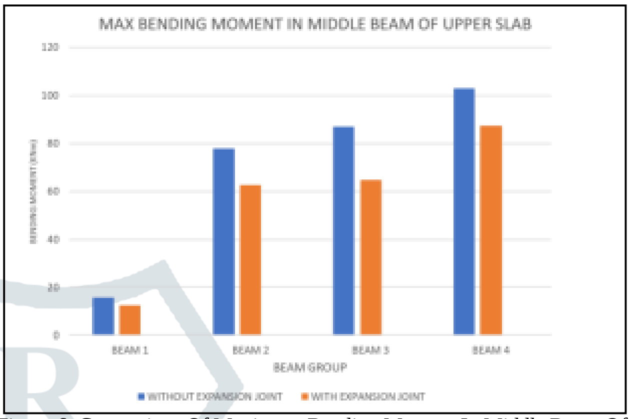

Figure 6: Comparison Of Maximum Bending Moment In Middle Beam Of Upper Slab

The middle beams of upper slab were divided into four groups as shown in Figure 6, namely, Beam 1 consisting of beams with moment values ranging from 10-40 kNm, Beam 2 consisting of beams with moment values ranging from 40-60kNm, Beam 3 consisting of beams with moment values ranging from 60-80 kNm and Beam 4 consisting of beams with moment values ranging from 80-100 kNm.

D. Comparison of Maximum Bending Moment in Corner Beam of Upper Slab

The corner beams of upper slab were divided into four groups as shown in Figure 7, namely, Beam 1 consisting of beams with moment values ranging from 10-40 kNm, Beam 2 consisting of beams with moment values ranging from 40-60kNm, Beam 3 consisting of beams with moment values ranging from 60-80 kNm and Beam 4 consisting of beams with moment values ranging from 80-100 kNm.

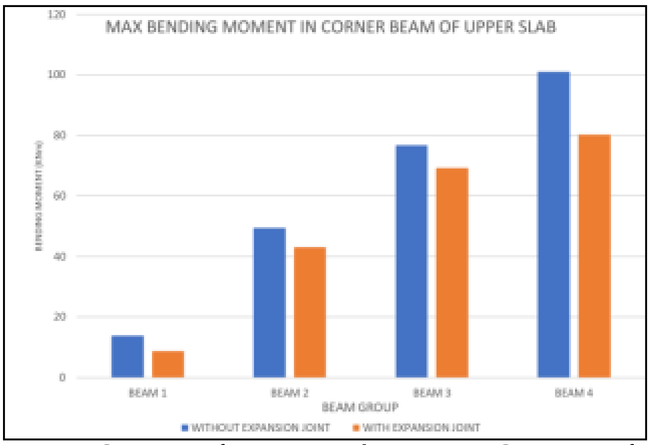

Figure 7: Comparison of Maximum Bending Moment in Corner Beam of UpperSlab

From the Figure 7 it can be seen that the maximum bending moments in the corner beams are reduced by 20%-30% of its value and the reduction in middle beams are seems to be in the range of 15%-25%, when an expansion joint is introduced in the structure.

E. Column Moment

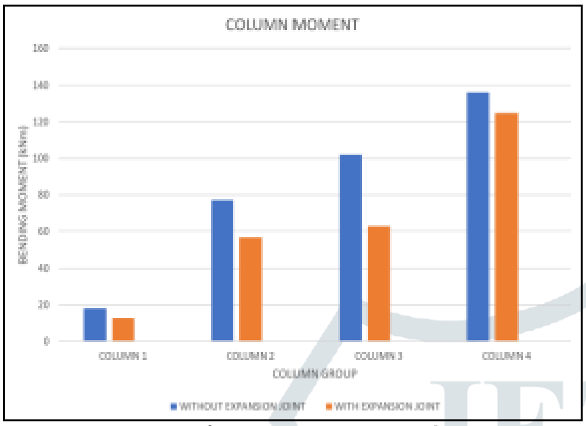

Figure 8: Comparison Of Maximum Moment In Column

For column moment comparison, columns are divided into four groups as shown in Figure 8, namely, Column 1 consisting of columns with moment values ranging from 10-40 kNm, Column 2 consisting of columns with moment values ranging from 40-80kNm, Column 3 consisting of columns with moment values ranging from 80-120 kNm and Column 4 consisting of columns with moment values ranging from 120-160 kNm.

Figure 8 shows that the values of column moments are reduced by 25% for columns near to expansion joint.

F. Steel Consumption

For Steel consumption comparison, columns are divided into four groups as shown in Figure 9, namely, Column 1 consisting of columns with moment values ranging from 350-650mm², Column 2 consisting of columns with moment values ranging from 1250-1550mm², Column 3 consisting of columns with moment values ranging from 1550-1850 mm² and Column 4 consisting of columns with moment values ranging from 1850-2150 mm².

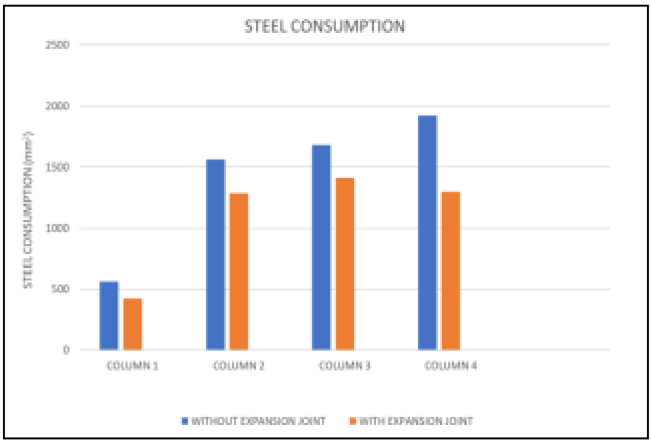

Figure 9: Comparison of Steel Consumption in Column

From Figure 9, it can be found that values of the steel consumption are almost similar for columns away from expansion joints. And columns near expansion shows considerable reduction. Hence, for these columns the reduction in steel consumption is in the range of 20% - 30%.

G. Average Displacement

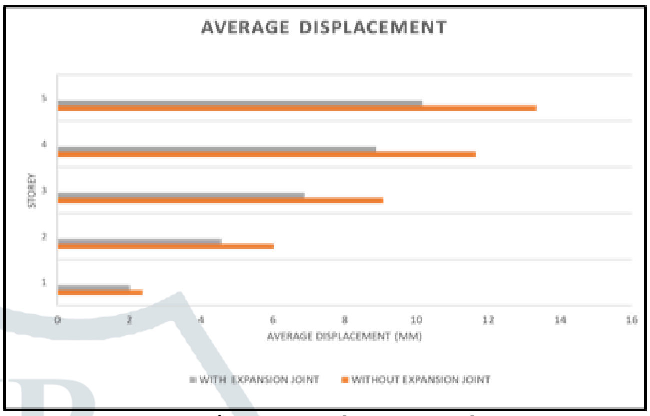

Figure 10: Comparison of Average Displacement in Column

The displacement of one level with respect to the base of the structure is called average displacement of structure. It can be observed that the values of, average displacement is reduced by 20% by introduction of expansion joint in the structure.

VI. Conclusions

Result shows that building without expansion joint gives more stresses & moments than building with expansion joint. In presence gives reduction in steel consumption values are considerably reduced in presence of expansion joint & leads to economic structure. Based on results it concludes that provision of expansion joint is beneficial for structural stability & economical point of view.

VII. Scope For Future Work

Further research can be carried out to study multi-storeyed R.C.C structures by placing expansion joints at different locations. A comparative study can be done to study the response of the structure under different seismic zones and different soil conditions. Effect of temperature variation in RCC structure can also be considered. Temperature effect on steel structure can be studied.

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