iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 8 Issue: IV Month of publication: April 2020

DOI:

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue IV Apr 2020- Available at www.ijraset.com

Behaviour of RCC Frame Building with and without Expansion Joint

Snehal S. Patil[1], P. K. Hinge[2]
[1, 2]Department of Civil Engineering, Yeshwantrao Chavan College of Engineering Nagpur, India

Abstract:** 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. As per IS 456:2000 the buildings exceeding 45m length are subjected to thermal stresses. 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. This study focuses on the behaviour of RCC framed long building in the presence of expansion joint under seismic and temperature loading. A four storied building of length 50 m is analysed and designed by using STAAD PRO. And compare results by using building with expansion joint and building without expansion joint.

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

I. INTRODUCTION

Concrete is not only subjected to gravity and imposed loads, but it also subjected to seasonal and daily temperature change. These loads cause thermal stresses in the structural members. As per IS 456:2000, the buildings exceeding 45m length are subjected to thermal stresses. Expansion joints are provided in a structure as they counter the adverse effects on structure due to temperature changes. An expansion joint is well-defined as a mid-structure separation designed to relieve stress on a building which are experienced during the life span of the structure. An expansion joint is opening or a gap in the building structure provided throughout the height of structure to allow movement of the building due to temperature changes. The temperature is different for all regions according to seasonal conditions. The maximum and minimum temperature in the locality where the structure is designed is considered in the analysis of the structure. In the present study a building with & without expansion joint is considered, analysed and designed for seismic conditions & temperature.

II. OBJECTIVE

The objectives of present study are as follows:

A. To study the effect of temperature load & earthquake load on the structure.
B. To study the variation in bending moment, storey displacement due to application of temperature load & earthquake loads.
C. Comparative study of the RCC buildings with and without expansion joints of length longer than 45 meters using staad pro software.
D. To study the variation in reinforcement of RCC building with & with expansion joint.
E. To determine economical structure.

III. METHODOLOGY

In this present study, four storey building at Yavatmal is considered with larger span and analysed with and without expansion joints subjected to temperature and seismic loading.
Two different cases are considered for comparison:

1) *Case 1:* structure is considered single without any expansion joint.
2) *Case 2:* structure is divided by introducing expansion joint along width of structure.
a) Two separate models are generated using staad pro software.
b) The building is analysed using equivalent static method.
c) Analysis is performed and the results were tabulated and compared to check the effectiveness of the structure with and without expansion joint.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue IV Apr 2020- Available at www.ijraset.com

IV. MODELLING

Two structures are modelled for longer span, loadings are done according to Indian Standard code. Static analysis was performed for the structure. Modelling is carried out by using staad pro software.

The following building models are considered for analysis:

Model A – building without any expansion joint

Model B – building with expansion joint along width of structure.

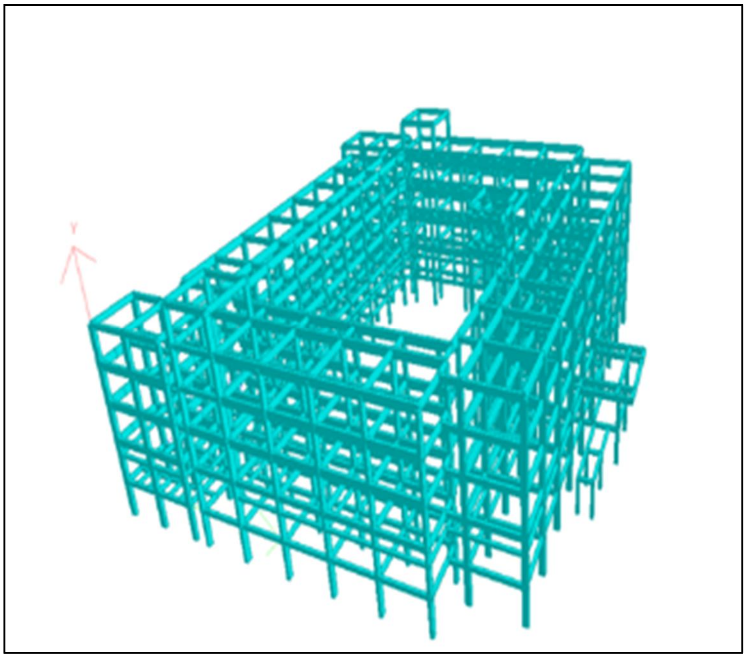


Figure 1: Three-Dimensional view of Model A.

The structure is located in zone II 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. The three-dimensional view of Model A is shown in Figure 1. The dimensions and other detailed information of the models are given in Tables 1 and 2.

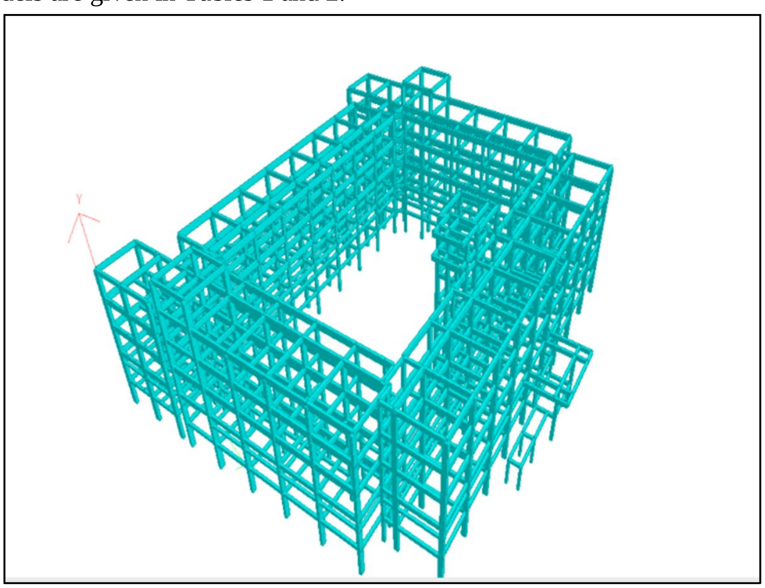


Figure 2: Three-Dimensional view of Model B.

TABLE I

Sr. No.	Property	Value
1.	concrete	M20
2.	steel	Fe500
3.	Live load	2.0 kN/m^2 for all rooms 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	II
6.	Importance factor (I)	1
7.	Type of soil	Medium

Materials and Loading Details of the Building Models

TABLE II. Preliminary Data Considered for the Analysis

Sr. No.	Variables	Dimensions
1.	Plan dimension	50mX 47m
2.	Number of Stories	4
3.	Floor height	3.6m for ground floor 3.15m for upper floors
4.	Building Location	Yavatmal
5.	Wall	230 mm thick
6.	Size of inner Columns	230x230mm up to plinth level, 300x300mm inner columns,
7.	Size of outer Columns	300x400mm,300x500mm,300x600mm for outer columns
8.	Size of plinth Beams	230x300mm,230x400mm for plinth level,
9.	Size of middle floor Beams	230x450mm,230x500mm for middle floor
10.	Size of upper floor Beams	230x600mm, 230x700mm for upper floors
11.	Depth of slab	125,150mm thick slab

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 3, 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.

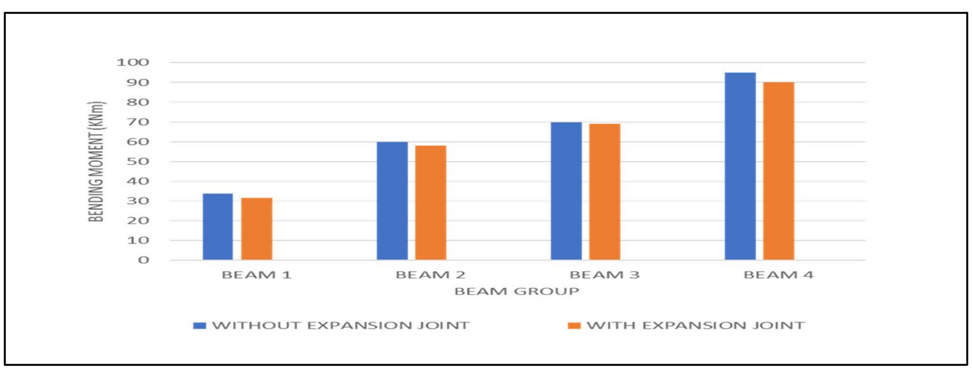


Figure 3: Comparison of Maximum Bending Moment in Middle Beam of bottom slab

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 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.

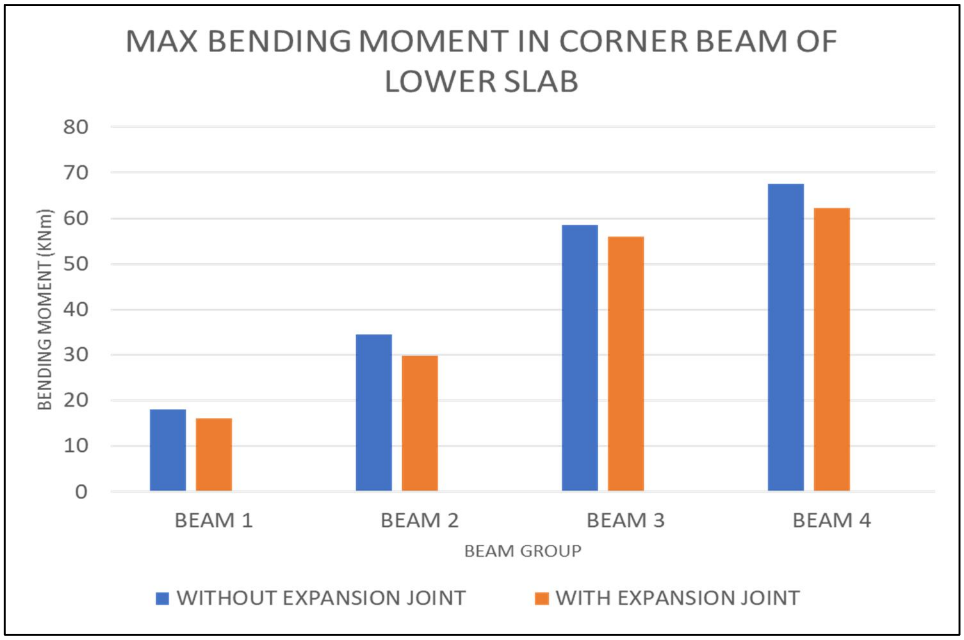


Figure 4: Comparison of Maximum Bending Moment in Corner Beam of Bottom Slab

From the Figures 3 and 4, it can be seen that the maximum bending moments in the corner beams of bottom slab 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

The middle beams of upper 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.

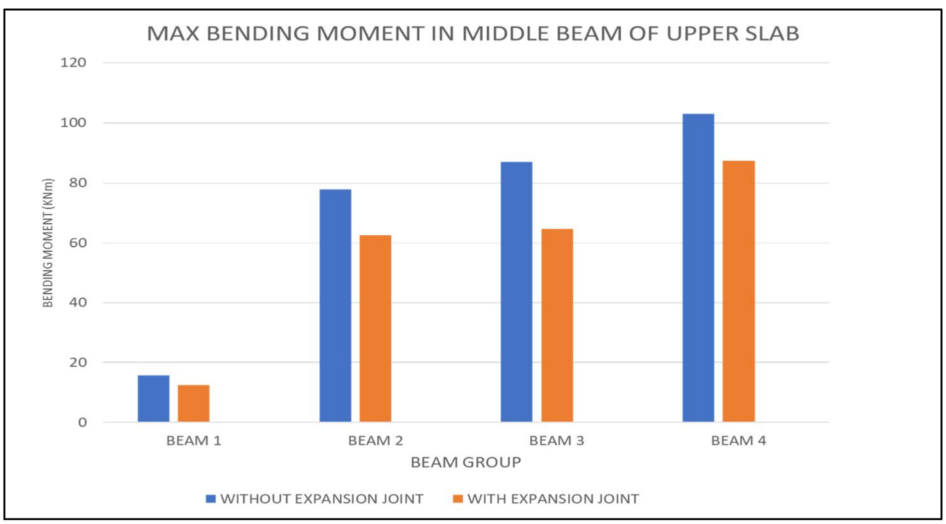


Figure 5: Comparison of Maximum Bending Moment In Middle Beam Of Upper Slab

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue IV Apr 2020- Available at www.ijraset.com

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

The corner 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.

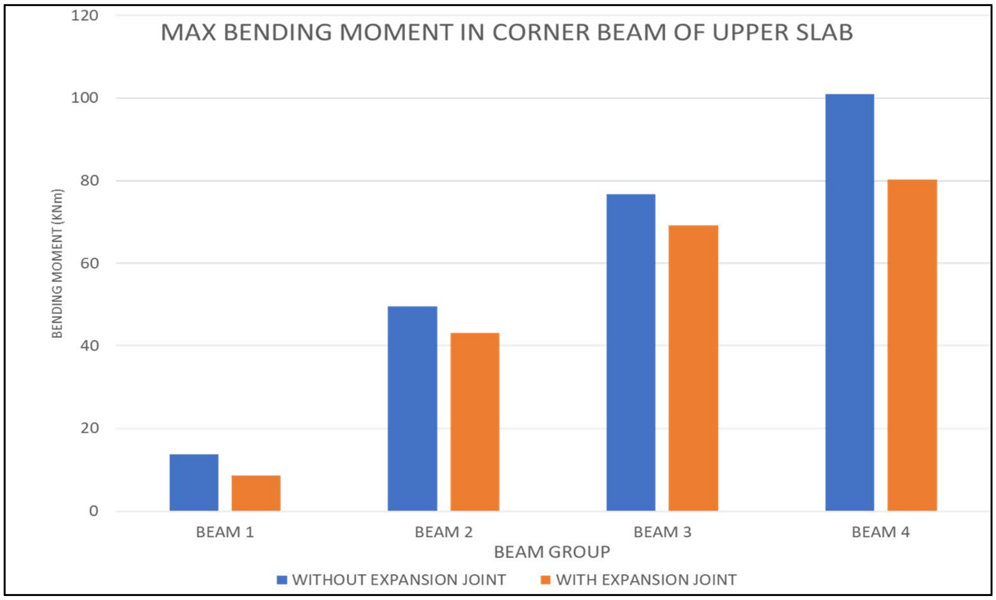


Figure 6: Comparison of Maximum Bending Moment in Corner Beam of Upper Slab

From the Figures 5 and 6 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

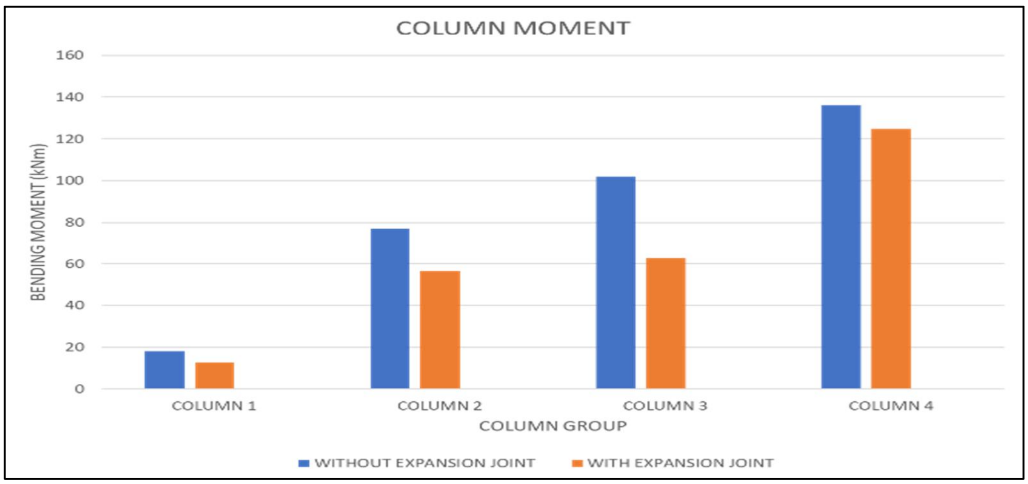


Figure 7: Comparison Of Maximum Moment In Column

For column moment comparison, columns are divided into four groups as shown in Figure 7, 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 7 shows that, the values of column moments are reduced by 25% for columns near to expansion joint.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue IV Apr 2020- Available at www.ijraset.com

F. Steel Consumption

For Steel consumption comparison, columns are divided into four groups as shown in Figure 8, namely, Column 1 consisting of columns with moment values ranging from 350-650mm^2, Column 2 consisting of columns with moment values ranging from 1250-1550 mm^2, Column 3 consisting of columns with moment values ranging from 1550-1850 mm^2 and Column 4 consisting of columns with moment values ranging from 1850-2150 mm^2.

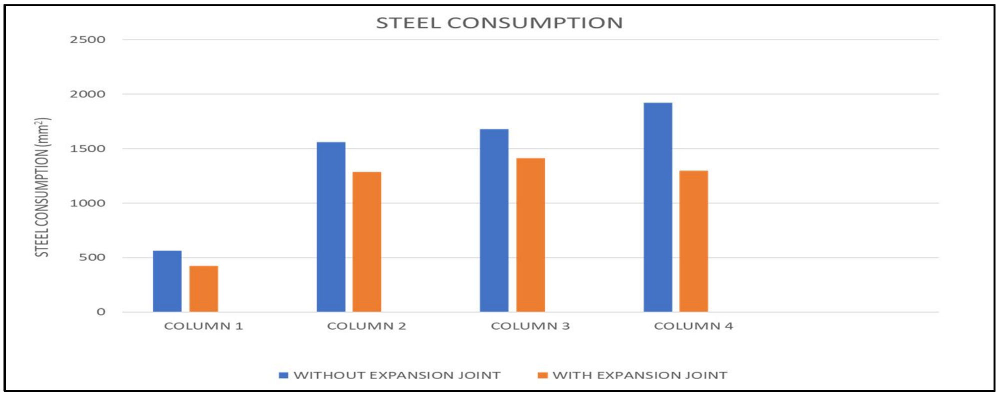


Figure 8: Comparison of Steel Consumption in Column

From Figure 8, 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

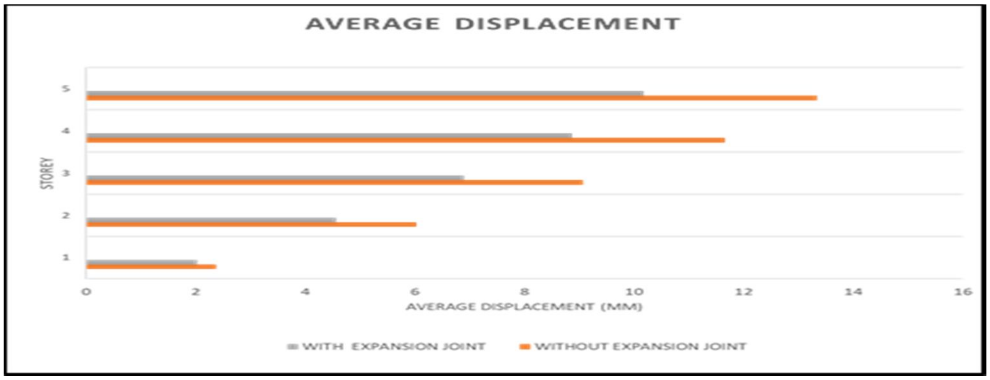


Figure 9: Comparison of Average Displacement in Column

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 are reduced by 20% by introduction of expansion joint in the structure.

VI. CONCLUSIONS

A. From the results it is observed that reduction in bending moment of bottom slab of structure is 5-15%. And reduction in upper slab is 20-30% in corner beams and 15-25% in middle beams.

B. For Steel consumption and column moments the reduction is more near expansion joint. Column moment is reduced by 25% and steel consumption is reduced by 20 -30 %.

C. The average displacement values are reduced by 20 % with expansion joint.

D. From above results it is observed that building without expansion joint gives more stresses & moments than building with expansion joint.

E. Steel consumption values are considerably reduced in presence of expansion joint & leads to economic structure.

F. Based on results it concludes that provision of expansion joint is advantageous 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 also be studied.

REFERENCES

[1] Junaid Aziz , M. A. Azeem, “Comparative Study of a R.C.C Structure for the Elimination of Expansion Joint Subjected to Temperature Stresses”, Journal of Engineering Research and Application ISSN : 2248-9622, Vol. 8, Issue 8 (Part -I) Aug 2018, pp 73-81.

[2] K.Vaishnavi1, B S Suresh Chandra, “Effect of Varying Temperature Load on RCC Structure by Seismic Analysis”, International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056 Volume: 05 Issue: 08 | Aug 2018 p-ISSN: 2395-0072.

[3] Farhana M. Saiyed , Ashish H. Makwana, Jayeshkumar Pitroda, Chetna M. Vyas, “Expansion Joint Treatment: Material &Techniques”, Conference on: “Trends and Challenges of Civil Engineering in Today’s Transforming World”

[4] Pooja M & Dr. Karthiyaini S, “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, April 2017, pp. 1287–1295, Article ID: IJCIET_08_04_145.

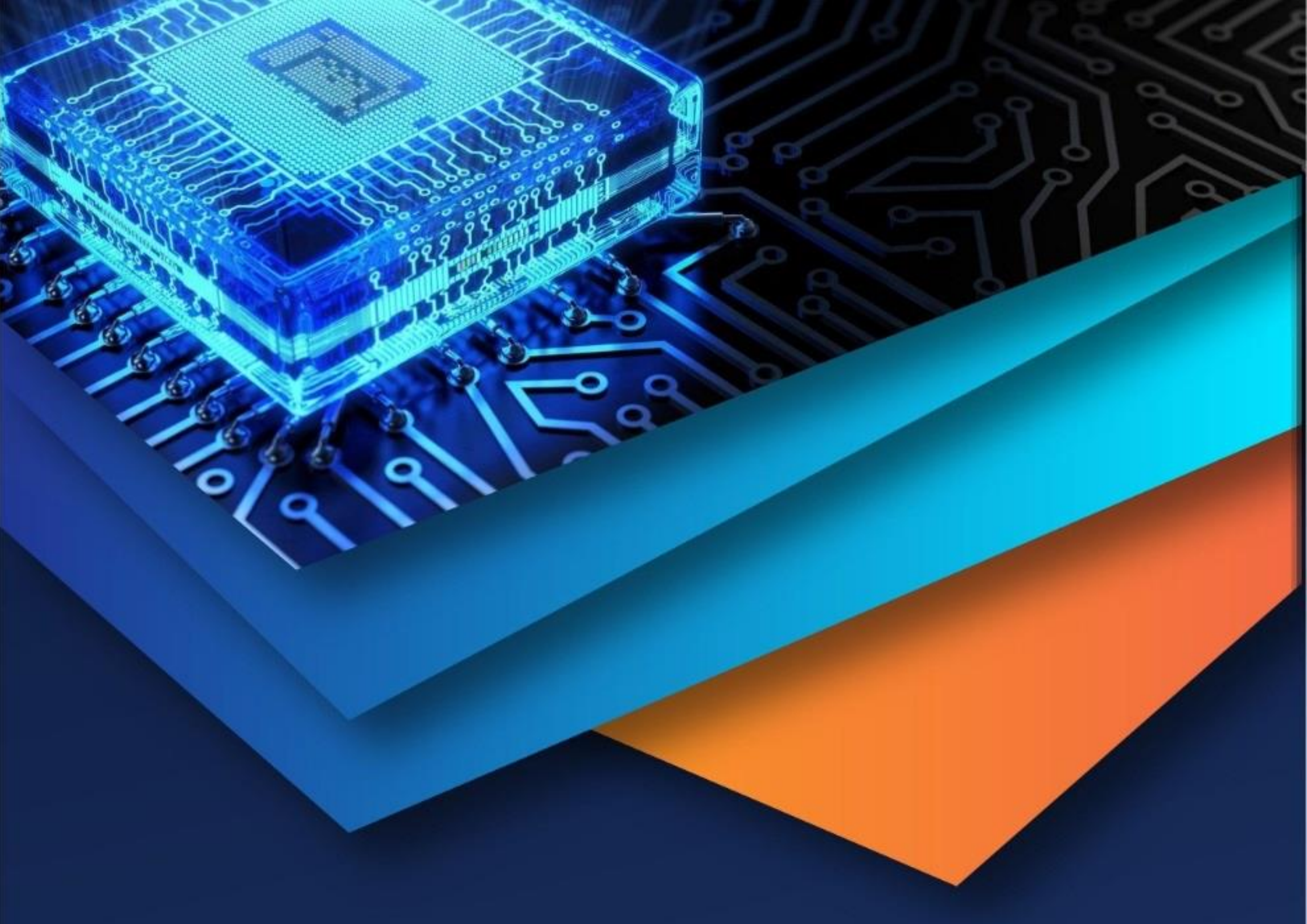
[5] B. Dinesh Kumar& K. Vidhya, “Numerical Study On Seismic And Temperature Effects In A RCC Building” ,International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181 IJERTV3IS051055 Vol. 3 Issue 5, May – 2014.

[6] By Ikhlass Sydnaoui, Roslli Bin Noor Mohamed, Mariyana Aida Binti Ab.Kadir, “The Effects Of Seasonal Thermal Loads At Expansion Joints Locations In Arabic Area Buildings”, International Journal of Innovative Technology and Exploring Engineering (IJITEE) ISSN: 2278-3075, Volume-8, Issue-11S2, September 2019

[7] IS: 1893-2002 (Part 1), Criteria for Earthquake Resistant Design of Structures, Part 1 –General Provisions and Buildings (Bureau of Indian Standards, New Delhi, 2002).

[8] IS: 456-2000, Plain and Reinforced Concrete-code of practice (Fourth Revision) (Bureau of Indian Standards, New Delhi, 2000).

[9] Mohammad Iqbal, “Design Of Expansion Joints In Parking Structures”,July 2012 issue of the PTI Journal © 2012, Post-Tensioning Institute.



10.22214/IJRASET

INDEX COPERNICUS 45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

TOGETHER WE REACH THE GOAL

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY