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Seismic Analysis of a Structural Frame Considering Joint Analysis of Beam – Column with Conventional and Pre –Tensioning Slab Using Analysis Tool STAAD.PRO

Rahul Singh Parihar, Mayank Gupta
Department of Civil Engineering, Sagar Institute of Research and Technology - Excellence, Bhopal, Madhya Pradesh, India

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ABSTRACT

The behavior of reinforced concrete moment resisting frame structures in recent earthquakes all over the world has highlighted the consequences of poor performance of beam column joints. Large amount of research carried out to understand the complex mechanisms and safe behavior of beam column joints has gone into code recommendations. This Study presents critical review of recommendations of well established codes regarding design and detailing aspects of beam column joints considering rigid diaphragm. In this study conventional slab and Pre-tensioning slab is considered and effect on beam column joint is studied using Staad software considering lateral force (P-delta) and Non-linear analysis. The main motive of our study is to determine the non linear analysis and its effect on joints of a G+8 High rise multistory building 3dimensional frame considering P-delta analysis using Staad.

Keywords : Staad.Pro, Seismic Analysis, P-Delta, Joints, Deflection.

I. INTRODUCTION

The design of reinforced concrete structures solely depends on various parameters like bending moment; shear force and stress induced in a particular member of a structure. Variation in the magnitude of these parameters may alter the entire design of a particular element. Hence the analysis of a member quantifying above parameters is very important. Since the distribution of load from beam to column is most prominent in structural designing thus in this research work analysis of end and intermediate beam-column joint is carried out using finite element method using analysis tool (Staad).

The frequent occurrence of the earthquakes in the world and construction of tall buildings, especially over the last few decades demands for the construction of earthquake resistant buildings. Many of the tall buildings had collapsed in recent earthquakes and the reasons attributed were poor design and construction practices. The objective of this work is to discuss the possibilities of modeling reinforcement detailing of reinforced concrete models in practical use considering flat slab. To carry out the analytical investigations, the structure is modeled in a Finite Element software STAAD.Pro.

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When earthquakes occur, a buildings undergoes dynamic motion. This is because the building is subjected to inertia forces that act in opposite direction to the acceleration of earthquake excitations. These inertia forces, called seismic loads, are usually dealt with by assuming forces external to the building. In past years individuals has been created evidently and because of which urban zones and towns began spreading out. In light of this reason unmistakable structures are being basic slanting zones. India has a wide shoreline front line which is secured with mountains and inclinations.

II. Literature Review

Vishal Gupta et.al (2018) the research paper introduced economical comparison between different type of slab and different type of construction technique and the analysis and design verified all Indian stranded codal provision in manual calculations as well as an efficient computer software SAP2000.

Conclusion derived from the research stated that as per the economical aspect among conventional and post tensioning floor system the post-tensioned flat slab is the most economical. And the Conventional two-way slab with reinforced concrete beam is most uneconomical span. Comparison between the both conventional slab i.e. conventional two-way slab and conventional flat slab, thickness is same but some where the reinforcement in flat slab is more than the conventional two slab but in the same time reinforcement and concrete in supporting beam is saved. So it is clearly shows that flat slab is more economical as compare to two-way slab. From each post-tensioned slab in building frame system the post-tensioned flat slab is economical than the post-tensioned slab because of providing additional supporting concrete beams at all around. Quantity of reinforcement in case of flat slab either it is conventional or post tensioning is greater than two-way slab because beam itself take a greater part of load and transfer to the support.

Vishal D. Dhore and Dr. S.H.Mahure (2019) the research paper presented Comparative Study of R.C.C. and Prestressed Concrete One Way Continuous Slab, which included the design and estimates of R.C.C. and Pre-stressed concrete Slab of various spans. The aim of this work was to design large span R.C.C. one way continuous slab as well as prestressed concrete one way continuous slab variety and then compare the results. The idea was to reach a superior conclusion regarding the superiority of the two techniques over one another. A couple of cases were comprehensively analyses by ETABS 2015 software and designed manually of both the R.C.C. and Prestressed concrete one way continuous slab. Based on the manual design procedure, a computer program in MS EXCEL was developed for designing both R.C.C. and prestressed concrete one way continuous slab. A separate program was developed for estimating. A number of cases were analyzed from 10m, 12m, 15m and 18m span. In India R.C.C structures are commonly used for residential as well as commercial buildings or we can say for short span buildings. In R.C.C. slab depth of slab increases with increase with span because of deflection limitation.

The conclusion derived from the research stated that the prestressed concrete slab gives lesser dead weight as compare to RCC one way continuous slab. RCC slab is economical for span 10 m to 12 m but beyond that the prestressed concrete one way slab is suitable because it gives lesser depth as compare to the RCC slab and achieves economy. As the span is increasing the cost percentage also goes on increasing with reduction in beam and slab section. In prestressed concrete frame structure the beam section is reduced and it will give more headroom and results in lesser deflection as compared to R.C.C. frame structure.

S. Y. Laseima et. al (2020) the research paper examined seismic behavior of full-scale exterior reinforced concrete (RC) beam-column joints retrofitted with externally bonded Carbon Fiber Polymers (CFRP). Casting and testing of two similar reinforced concrete beam column connections in the absence of transverse reinforcement at the joints took place under opposing cyclic loading with regulated displacement so as to examine their fundamental seismic performance. The first joint was examined as the control specimen and the other specimen was then retrofitted with CFRP sheets, with rounded border of the column and beam at and close to the joint region to change them from square to squircle segments.

It was demonstrated in the experimental findings that the retrofitted beam column joint shows significantly greater strength, energy dissipation and ductility in comparison to the control specimen. There was a shift in the failure from the joint region to the beam ends in the retrofitted specimens, which would help in preventing the structure from disintegrating progressively. Because of the change in the beam and column from square to squircle segments, the debonding potential of the CFRP decreased and the restrictive impact of the CFRP increased. As a result, the experimental findings were verified using a 3D nonlinear finite element (FE) model. When the finite element and experimental findings are compared, it is determined that the suggested model is quite accurate. There was a significant improvement in the strength, energy dissipation and ductility capacity by 61.7%, 208.9% and 61.8% respectively due to retrofitting of beam-column joints using CFRP stating suitability of using CFRP for retrofitting.

III. Objectives of the Study

The main aim of this study are as follows:

- Analysis of beam column joint of a high rise 3-dimensional structure considering rigid diaphragm.
- To perform non linear analysis of a high rise frame using Staad.
- To Determine the effect on column-beam joint due to type of slab i.e. conventional slab and Pre tensioning slab.
- To analyse a structure considering P-delta seismic analysis.

Parameters Considered:

Table 1. Geometrical Sections

Description	**Value**
HEIGHT OF BUILDING	27 m (G+8)
Length	18 m
Width	20 m
Column	0.45 x 0.3 m
Beam size (main)	0.4 x 0.3 m
Beam size (distributive)	0.3 x 0.2 m
Slab	0.15 m
Support type	Fixed support

Loading Conditions

Following loading is adopted for analysis: -

a). **Dead Loads**: as per IS: 875 (part-1)-1987.

Table 2 - Details of Dead Load

Brick Masonry Wall Load				
Loading type	Calculation	Load	Unit	Remarks
For floor height 3m	0.23m x (3.2-0.5)m x 18 kN/m^2	10.35	kN/m^2	As per wall height
Parapet wall	0.23m x (1.0)m x 18 kN/m^2	4.6	kN/m^2	Assume parapet wall height 1 m
Floor Load				
Slab load	0.15m x 25kN/m^2	3.75	kN/m^2	Adopting Slab Thickness 150 mm
Floor Finishing	(16 x 16) = 256m^2	0.9	kN/m^2	Assume
Total Floor Load		**4.65 kN/m^2**		

b). **Live Loads**: as per IS: 875 (part-2) 1987. Live Load on each floor = 3.00KN/m^2

Live Load considered for seismic calculation as per I.S. code 1893-part-1 = 0.75 KN/m^2

c). **Earth Quake Loads**: All frames are analyzed for (II) and (V) earthquake zone. The seismic load calculation is as per IS: 1893(part-1)-2016.

Table 3 - Seismic force parameters for proposed issue

S.No.	Parameter	Value	Remarks
1	Zone Intensity	0.10	Table 2 (1893-part-1 2002)
2	Damping ratio	0.5	Table-3 (1893-part-1 2002)
3	Importance factor	1.5	School building Table 6 (1893-part-1 2002)
4	Response Reduction Factor	5	Ductile detailing (S.M.R.F.) Table-7 1893-part-1 2002
5	Soil site factor	Soft	Adopt

IV. METHODOLOGY

For this research work following steps should be followed:

Step-1 Firstly literature survey should be done to determine the past research and need of study.

Step-2 To Select modelling and Geometry of the work in Staad.Pro.

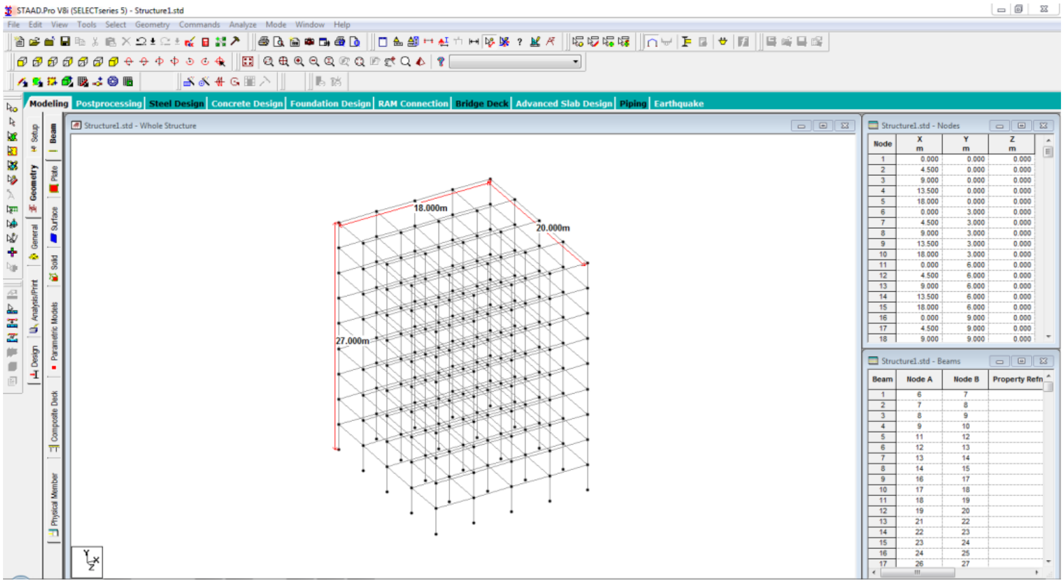

Fig 1. Modelling of Frame

Step-3 To Assign sectional material database in a building frame (G+8) using Staad.

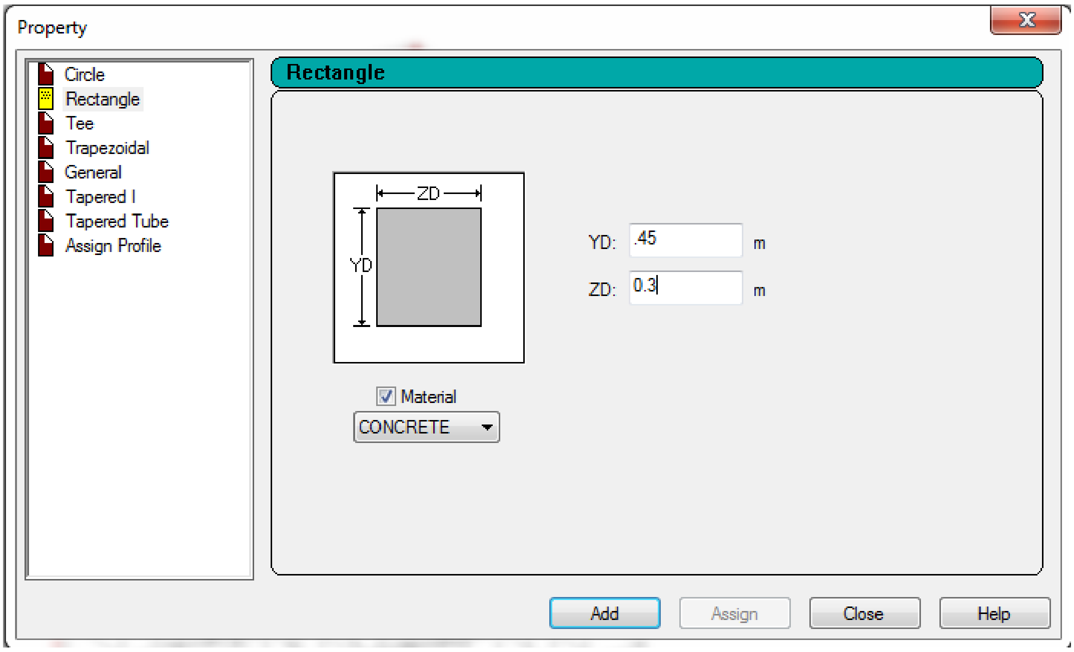

Fig 2. Assigning Sections Material

Step-4 To assign properties and support conditions.

Step-5 To Assign lateral force (response spectrum) dynamic analysis as per I.S. 1893-I:2016.

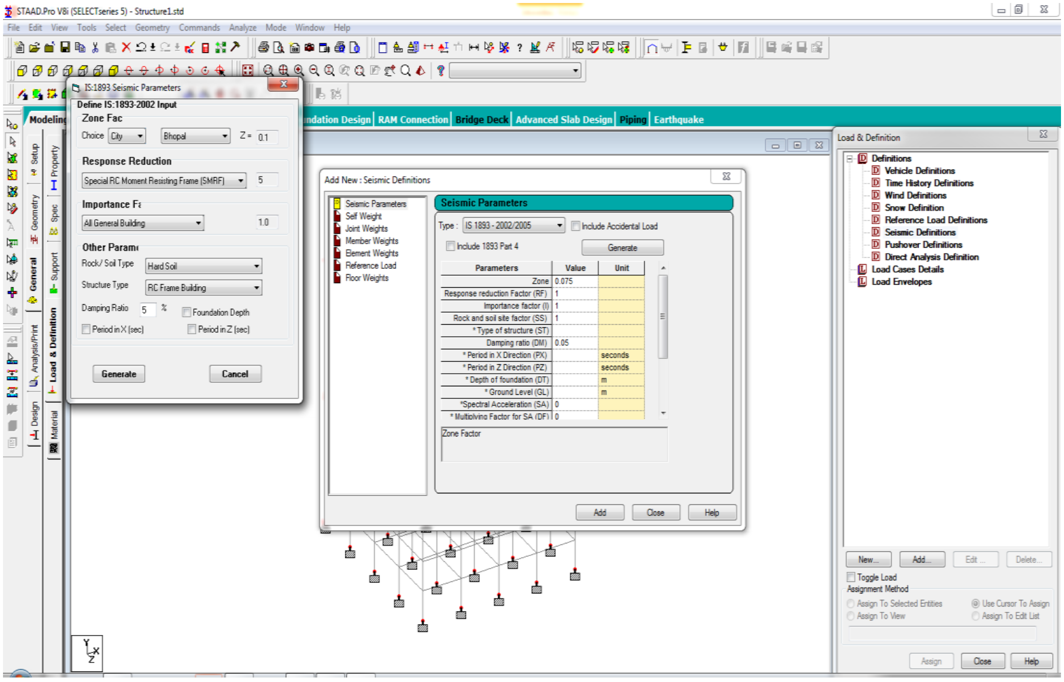

Fig 3. Assigning Seismic load as per IS 1893-2002-2005.

Step-6 Analyzing the structure

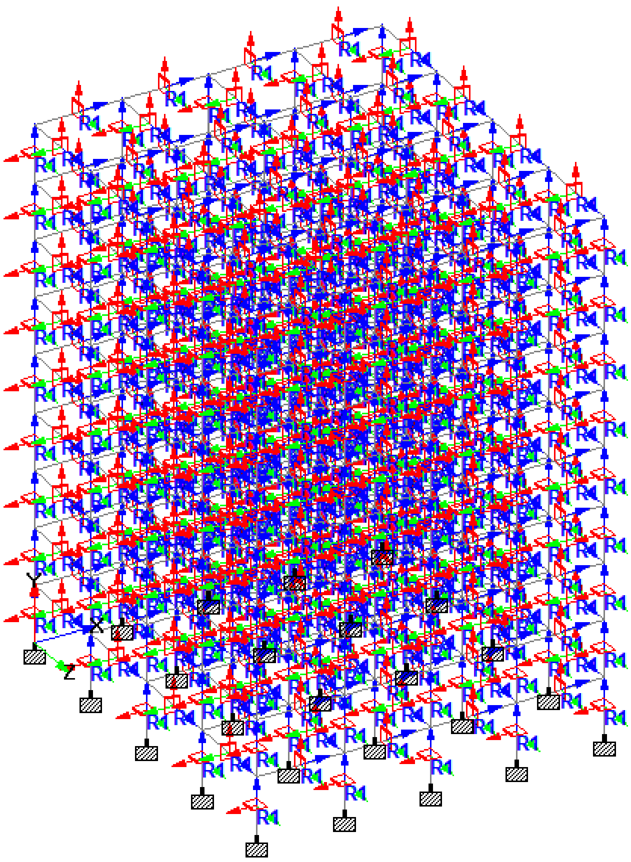

Fig 4. Structure Analysis

Step-7 To compare the results with different type of slab structure.
Step-8 To determine cost analysis as per S.O.R. 2017.

Flow Chart

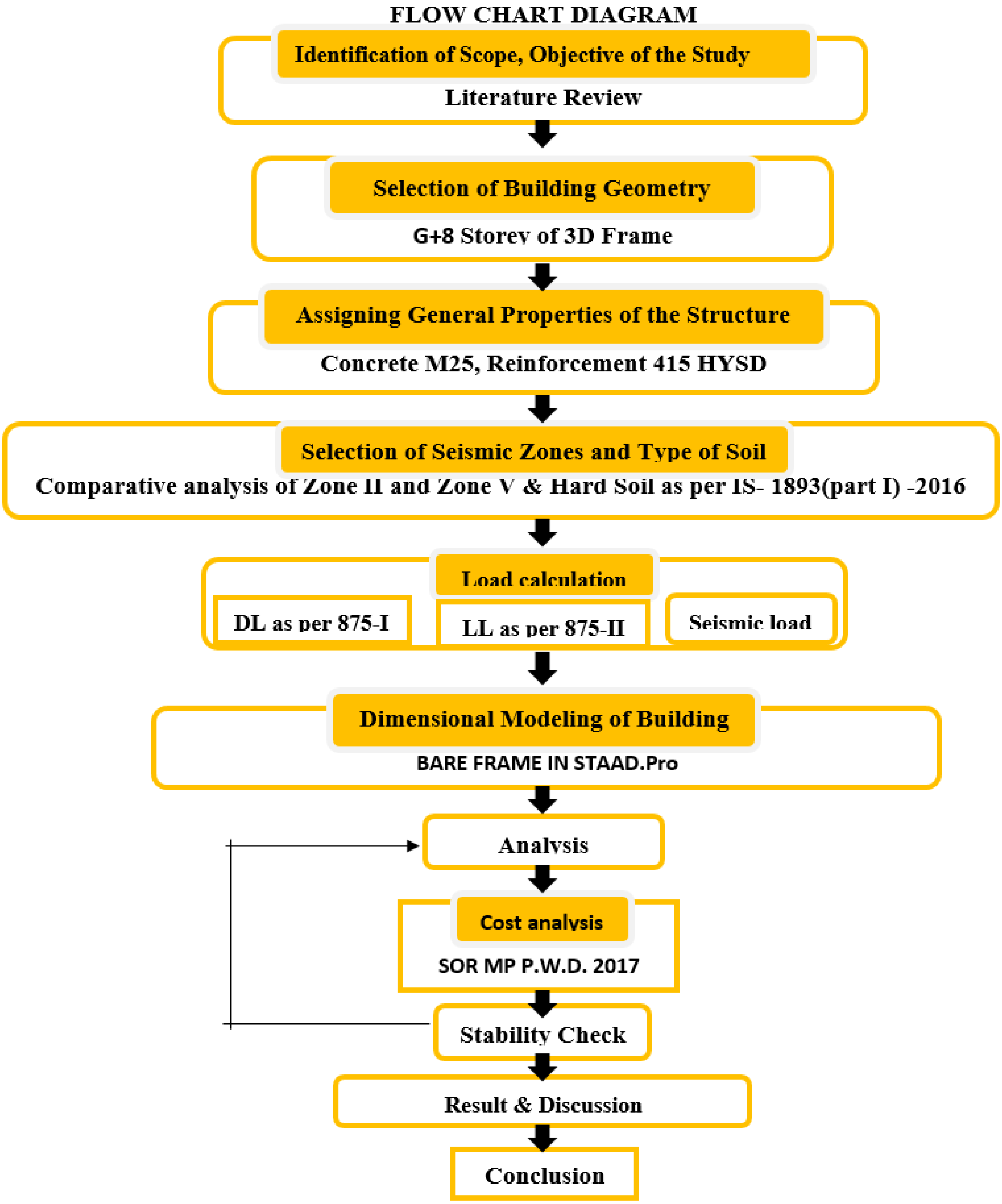

Fig 5. Flow Chart Diagram

Analysis Results:

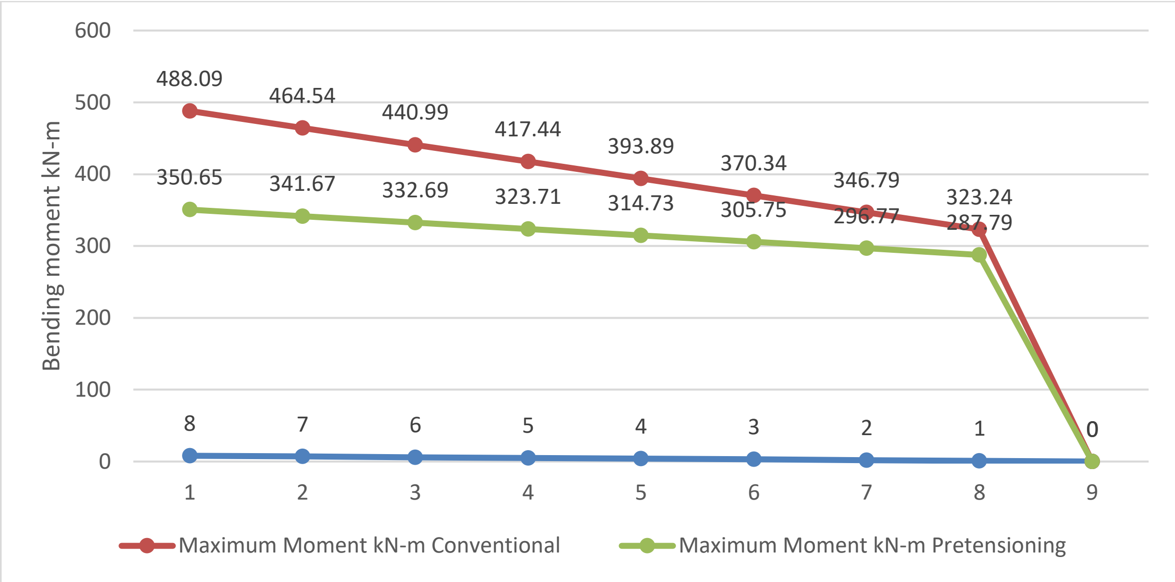

Fig 6 : Bending Moment

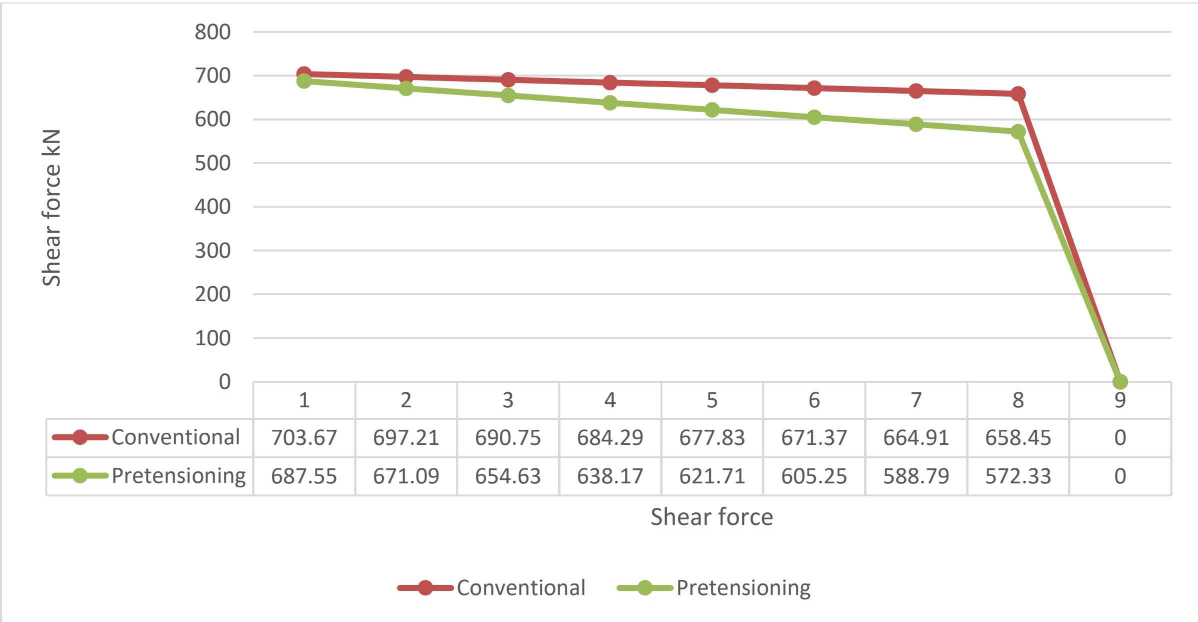

Fig 7 : Shear Force

Table 4: Joint Analysis

Node	X-Trans mm	Y-Trans mm	Z-Trans mm	Absolute mm	X-Rotan rad	Y-Rotan rad	Z-Rotan rad
159	-3.777	-553.48	0.245	553.488	0.164	0	0
160	-3.777	-553.48	-0.245	553.488	-0.164	0	0
140	4.388	-552	-0.245	552.015	-0.163	0	0

139	4.388	-552	0.245	552.015	0.163	0	0
150	0.307	-550.53	-0.244	550.526	-0.163	0	0
149	0.307	-550.53	0.244	550.526	0.163	0	0
162	-4.672	-346.46	-0.054	346.495	-0.098	-0.002	0.095
161	-4.672	-346.46	0.054	346.495	0.098	0.002	0.095
157	-2.876	-346.29	0.056	346.305	0.097	-0.002	-0.095
158	-2.876	-346.29	-0.056	346.305	-0.097	0.002	-0.095
137	5.276	-345.19	0.054	345.233	0.097	-0.002	-0.095
138	5.276	-345.19	-0.054	345.233	-0.097	0.002	-0.095
141	3.497	-344.72	0.055	344.736	0.097	0.002	0.095
142	3.497	-344.72	-0.055	344.736	-0.097	-0.002	0.095
152	-0.601	-343.93	-0.055	343.931	-0.097	-0.002	0.095
151	-0.601	-343.93	0.055	343.931	0.097	0.002	0.095
147	1.213	-343.62	0.054	343.617	0.097	-0.002	-0.095
148	1.213	-343.62	-0.054	343.617	-0.097	0.002	-0.095

V. CONCLUSION

Joint Analysis:
As observed in chapter above, in comparative analysis it is determined that slab stiffness resist force and provide a linear distribution of resultant forces through joints. In our study it is observed that unbalance force in joints are minimized in pre-tensioning slab case by approx. 6.80%.

Bending Moment:
Bending moment in members of a structure determine its reinforcement requirement. In our study it is observed that value of bending moment decreases with pre-tensioning slab stiffness comparing to conventional slab.

Shear force:
Shear force are the unbalance forces act near the joint of beam and column, in this study our motive was to justify the decreament of unbalance forces at the joint which we observed in the process of analysis thus we can state that rigid diaphragm is effective in resisting unbalance forces.

Support Reactions:
Support reactions are the reaction which is transmitting building load to the soil or strata beneath. This determine the amount load to be distributed to the soil.

As observed in above chapter Frame with consideration of pre-tensioning slab stiffness provides a variation of 0.98 to 1.02 times in vertical support reactions as compared to frame with conventional slab stiffness however Effect of slab stiffness on vertical support reactions is found to be insignificant Change in torsional moment and bending moment at support due to introduction of pre-tensioning slab is found to be insignificant for given load case.

Plate stresses:
The application of external forces to a body produces an internal state of stress. Stress is measured in units of force per unit area, and can be thought of as the intensity of the internal forces acting at a particular point in the body. Here in this study it is observed that stresses induced in both cases are generally same as loading provided is same.

The conclusions which are made from the present investigation for the Joint Analysis having rigid diaphragm From the present investigation it has been observed that the natural frequencies of vibration of a structure with rigid diaphragm. It has been observed that the changes in the forces due to the presence of rigid diaphragm is effective. It can be concluded that due to introduction of pretensioning slab, structure become more stable and stiffer in comparison. It can be said that P-delta analysis results in observing overturning moment and rotational forces using analysis tool Staad.pro.

In this study it can be said as per above results that pretensioning structure is comparatively more economical and have balanced design for safety.

VI. REFERENCES

[1]. Ankit Purohit and Lovish Pamecha, [Seismic Analysis of G+12 Multistory Building Varying Zone and Soil Type], SSRG International Journal of Civil Engineering (SSRG – IJCE) – Volume 4 Issue 6 – June 2017.

[2]. Arvindreddy and R.J.Fernandes, [Seismic analysis of RC regular and irregular frame structures], International Research Journal of Engineering and Technology (IRJET), Volume: 02 Issue: 05 | Aug-2015.

[3]. Boskey Bahoria, R. S. Deotale and Dr D K Parbat, [Comparative Design of RCC & Posttensioned flat slabs], INTERNATIONAL CONFERENCE ON CURRENT TRENDS IN TECHNOLOGY, „NUiCONE – 2010‟.

[4]. Boskey Vishal Bahoria and Dhananjay K. Parbat, [Analysis and Design of RCC and Post-tensioned Flat Slabs Considering Seismic Effect], IACSIT International Journal of Engineering and Technology, Vol. 5, No. 1, February 2013.

[5]. Jnanesh Reddy R K and Pradeep A R, [Comparative Study of Post Tensioned and RCC Flat Slab in Multi-Storey Commercial Building], International Research Journal of Engineering and Technology (IRJET), Volume: 04 Issue: 06 | June -2017.

[6]. Rajat Srivastava and Sitesh Kumar Singh, [Seismic Analysis and Design of G+9 RCC Residential Building in STAAD.PRO for Zone II Region], International Journal of Innovative Research in Science, Engineering and Technology, Vol. 7, Issue 5, May 2018.

[7]. Vishal Gupta, Rohit Sahu and Dr. Pankaj Singh, [Comparative Analysis of Conventional Slab, Flat Slab and Post-Tensioning Slab], International Journal for Scientific Research & Development| Vol. 6, Issue 03, 2018.

[8]. Vishal D. Dhore and Dr. S.H.Mahure, [COMPARATIVE STUDY OF RCC AND PRESTRESSED CONCRETE ONE WAY CONTINUOUS SLAB FOR VARIOUS SPANS], INTERNATIONAL JOURNAL FOR ENGINEERING APPLICATIONS AND TECHNOLOGY, Issue 9 vol 3 ISSN: 2321-8134, 2019.

[9]. Akanshu SHARMA, R. ELIGEHAUSEN and J. HOFMANN, [INFLUENCE OF JOINT MODELING ON SEISMIC EVALUATION OF NON-SEISMICALLY DESIGNED RC FRAME STRUCTURES], Second European Conference of Earthquake Engineering and Seismology, Istanbul Aug. 25-29, 2014.

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