Seismic Analysis of Beam-Column Joints for Structure with Conventional & Pre-Tensioning Slab using ANSYS Tool

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Abstract— The behaviour 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 behaviour 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 ANSYS 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 multistorey building #-dimensional frame considering P-delta analysis using ANSYS.

Keywords: P-delta, Non linear analysis, ANSYS, Forces, Moment, Displacement

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 (ANSYS).

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 ANSYS.

A. *Structural Analysis:*

Earthquakes demonstrate vulnerability of various inadequate structures, every time they occur. The lessons taught from the aftermath of earthquakes and the research works being carried out in laboratories give better understanding about the performance of the structure and their components.

Damage in reinforced concrete structures was mainly attributed to the inadequate detailing of reinforcement, lack of transverse steel and confinement of concrete in structural elements.

Typical failures were brittle in nature, demonstrating inadequate capacity to dissipate and absorb inelastic energy. This necessitates a better understanding of the design and detailing of the reinforced concrete structures under various types of loading.

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

Qi Zhang(2004) presented the application of finite element method for the numerical modeling of punching shear failure mode using ANSYS. The author investigated the behavior of slab column connections reinforced with Glass Fiber Reinforced Polymers (GFRPs). SOLID and LINK8 elements represented concrete and reinforcing teelbarsrespectively. Aquarter of the full – size slab column connections, with proper boundary conditions, were used in ANSYS formodeling. The author reported that the general behavior of the finite element models represented by the load deflection plotsat centers how good agreement with the test data. However, the finite element models showed slightly higher stiffness thanthe test data in both the linear and non line arranges.

Antonio F.Barbosaetal (2000) The results of some analyses performed using the reinforced concrete model of the general-purpose finite element code ANSYS are presented and discussed. The differences observed in the response of the same reinforced concrete be am as some variations are made in a material model that is always basically the same are empha sized. The consequences of small changes in modeling are discussed and it is shown that satisfactory results may be obtained from relatively simple and limited models. He took as imply supported reinforced concrete beam subjected to uniformly distributed loading has been analyzed. The internal reinforcements we remodeled using three dimensional spar elements with plasticity, Link8, embedded within the solid mesh. Finite element model so for dearly reinforced concrete beams and post tensioned concrete beams, developed in ANSYS using the concrete element (Solid) have accurately captured the non linear flexural response of these systems up to failure.

Sanjaya Kumar Patroet. al. (2013) Watched that when floor stomachs are taken as firm. M25 audit of cement was used. Significant misshapening was considered for vertical people. Torsional influence was considered by May be 1893:2002. Seismic examination was performed utilizing Response Spectra framework as demonstrated by IS1893:2002. Minute confining customary edge was considered for every single one of these structures in seismic zone III. Also, they viewed bound insidiousness shows up if there should arise an occurrence of Setback building. Departure of best story is most extraordinary for Step back building. On slanting soil Setback-Step back building is favored.

K.N.Mate (2015) Examined the flat slab, flat slab framework is straightforward structure of RCC which give long clear space, a great tallness, basic formwork and no postpone time in development. This examination incorporates finish investigation and outline of level piece according to Indian code of practices IS456:2000. Level piece is more adaptable and temperate as contrast with customary section. This paper directs us how to choose drop, board width, thickness of piece and enumerating of fortification.

A. *Objectives:*

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 ANSYS.
- 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.

III. METHODOLOGY

For this research work following steps should be followed:

1) Step-1 Firstly literature survey should be done to determine the past research and Need of study.
2) Step-2 To Select modelling and Geometry of the work in ANSYS
3) Step-3 To Assign sectional material database in a building frame (G+8) using ANSYS.
4) Step-4 To assign properties and support conditions.
5) Step-5 To Assign lateral force (response spectrum) dynamic analysis as per I.S. 1893-I:2016.
6) Step-6 To analyze the structure.
7) Step-7 To compare the results with different type of slab structure.
8) Step-8 To determine cost analysis as per S.o.R. 2017.

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

A. *Analysis:*

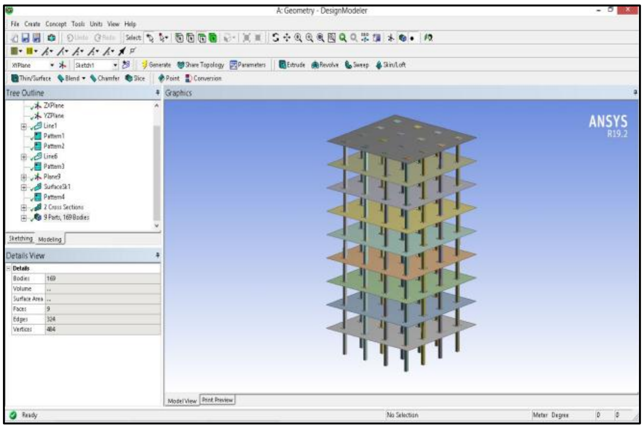

Fig. 1: Pretensioning Slab

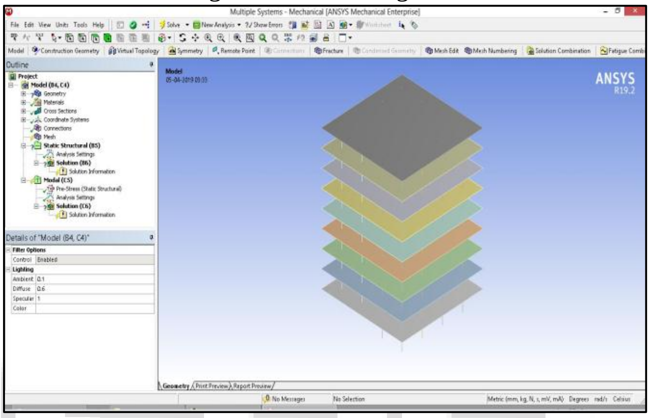

Fig. 2: Conventional slab

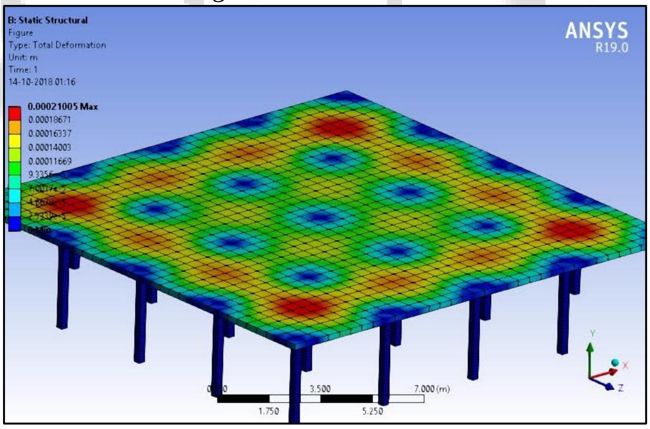

Fig. 3: Joint analysis

Dead Load: I.S.875-I

B. *Self-Load:*

Structure load i.e. beam column and slab.
Wall load: 0.13x2.7x18.5 = -6.49 kN/m
Parapet wall: 0.13x1x18.5 = -2.40 kN/m
Live Load: I.S. 875-II
Residential Building load = -4 kN/m^2

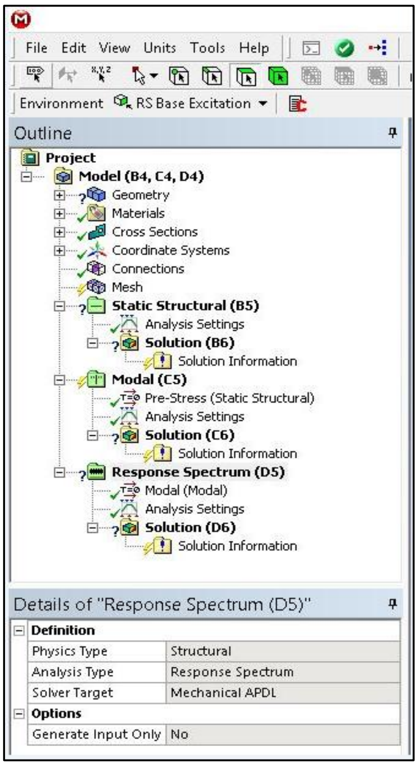

Fig. 4: Non linear analysis

C. *Load Analysis:*

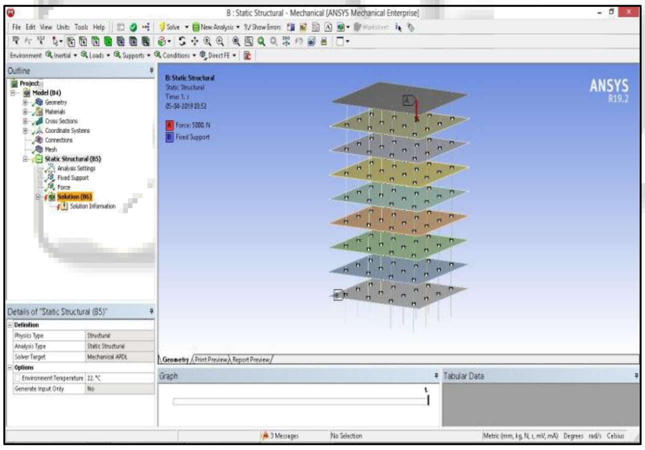

Fig. 5: Analysis

IV. RESULTS

Maximum Moment kN-m		
Storey	Conventional	Pretensioning
8	488.09	350.65
7	464.54	341.67
6	440.99	332.69
5	417.44	323.71
4	393.89	314.73
3	370.34	305.75
2	346.79	296.77
1	323.24	287.79
0	0	0

Shear force kN		
Storey	Conventional	Pretensioning
8	703.67	687.55
7	697.21	671.09
6	690.75	654.63
5	684.29	638.17
4	677.83	621.71
3	671.37	605.25
2	664.91	588.79
1	658.45	572.33
0	0	0

Axial force kN		
Storey	Conventional	Pretensioning
8	3007.45	3008.54
7	3007.3	3008.51
6	3007.15	3008.48
5	3007	3008.45
4	3006.85	3008.42
3	3006.7	3008.39
2	3006.55	3008.36
1	3006.4	3008.33
0	0	0

A. *Plate Stresses:*

Plate	SQX N/mm2	SQY N/mm2	MX kNm/m	MY kNm/m	MXY kNm/m	SX N/mm2	SY N/mm2	SXY N/mm2
227	2.327	-4.484	-3848.967	-1028.684	1754.83	-0.105	-0.855	-0.385
225	2.303	-4.638	-3868.303	-1474.835	1751.619	-0.108	-0.826	-0.385
232	2.508	-5.731	-3994.455	-901.562	1591.724	-0.125	-1.16	-0.355
219	2.378	-6.542	-3890.369	-433.958	1579.506	-0.124	-1.215	-0.349
229	2.403	-6.418	-3833.698	-100.606	1575.054	-0.121	-1.265	-0.354
222	2.564	-5.417	-3856.269	-88.696	1567.214	-0.119	-1.252	-0.362
221	-0.965	0.473	40.078	235.752	17.082	-0.749	-4.404	-0.028
233	0.956	0.292	-76.169	-448.051	17.035	-0.763	-4.49	0
235	0.998	0.191	13.222	77.775	0.155	-0.758	-4.46	0.027

B. *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	-553.475	0.245	553.488	0.164	0	0
160	-3.777	-553.475	-0.245	553.488	-0.164	0	0

140	4.388	-551.997	-0.245	552.015	-0.163	0	0
139	4.388	-551.997	0.245	552.015	0.163	0	0
150	0.307	-550.525	-0.244	550.526	-0.163	0	0
149	0.307	-550.525	0.244	550.526	0.163	0	0
162	-4.672	-346.463	-0.054	346.495	-0.098	-0.002	0.095
161	-4.672	-346.463	0.054	346.495	0.098	0.002	0.095
157	-2.876	-346.293	0.056	346.305	0.097	-0.002	-0.095
158	-2.876	-346.293	-0.056	346.305	-0.097	0.002	-0.095
137	5.276	-345.193	0.054	345.233	0.097	-0.002	-0.095
138	5.276	-345.193	-0.054	345.233	-0.097	0.002	-0.095
141	3.497	-344.718	0.055	344.736	0.097	0.002	0.095
142	3.497	-344.718	-0.055	344.736	-0.097	-0.002	0.095
152	-0.601	-343.931	-0.055	343.931	-0.097	-0.002	0.095
151	-0.601	-343.931	0.055	343.931	0.097	0.002	0.095
147	1.213	-343.615	0.054	343.617	0.097	-0.002	-0.095
148	1.213	-343.615	-0.054	343.617	-0.097	0.002	-0.095

V. Conclusion

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 ansys.

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