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Seismic Analysis of Post-Tensioned RCC Building Using ETABS

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ABSTRACT:

In RCC, the monetary consumption is extremely high in business and institutional structures as a result of progressively material required in development and subsequently, Post Tensioned building turns out to be increasingly financial and strong. Post- Tensioned building spares amount of steel and concrete when contrasted with RCC and expands clear range in rooms. Through this investigation, the accentuation is to plan a post- tensioned building utilizing ETABS. ETABS represent Extended Three-Dimensional Analysis of building frameworks. The primary motivation behind this product is to structure multistoried working in a precise procedure which will be as per Indian Standard plan codes. In this similar examination we have consider an unsymmetrical arrangement of G+9 floors considering Seismic burden according to I.S.8 I.S.1893-I-2002 and delicate soil. In this investigation relative examination is finished with exposed casing building structure considering same stacking information to decide greatest story relocation, hub powers, shear powers, most extreme bowing, story float, solidness, toppling minute, uprooting in x and z course and cost investigation according to S.O.R.

Keywords: Storey Shear, Bending Moment, Storey Drift, Bare Frame, Post Tensioning Frame

I. INTRODUCTION

Dynamic actions are caused on buildings by both wind and earthquakes. But, design for wind forces and for earthquake effects are distinctly different. The intuitive philosophy of structural design uses force as the basis, which is consistent in wind design, wherein the building is subjected to a pressure on its exposed surface area; this is force-type loading. However, in earthquake design, the building is subjected to random motion of the ground at its base, which induces inertia forces in the building that in turn cause stresses; this is displacement-type loading. Another way of expressing this difference is through the loaddeformation curve of the building – the demand on the building is force (i.e., vertical axis) in force-type loading imposed by wind pressure, and displacement (i.e., horizontal axis) in displacement-type loading imposed by earthquake shaking. Wind force on the building has a non-zero mean component superposed with a relatively small oscillating component. Thus, under wind forces, the building may experience small fluctuations in the stress field, but reversal of stresses occurs only when the direction of wind reverses, which happens only over a large duration of time. On the other hand, the motion of the ground during the earthquake is cyclic about the neutral position of the structure. Thus, the stresses in the building due to seismic actions undergo many complete reversals and that to over the small duration of earthquake.

In this comparative study we have consider a unsymmetrical plan of G+9 floors considering Seismic zones V and soft type soil as per I.S. 1893 part 1 2016. for analyzing and modeling purpose ETABS 17 programming is utilized and study is done on the premise of maximum storey displacement, axial forces, shear forces, maximum bending, storey drift, stiffness, overturning moment, displacement in x and z direction and cost analysis as per S.O.R. (C.P.W.D.)

II. OBJECTIVES

The objectives of the study are as follows:

a) Determination of the effect of External Post Tensioning members on a High rise building

b) Evaluation of cost effectiveness and variation in cost as per S.O.R.

c) Seismic strengthening of the building due to post tensioning members at exterior region.

d) Utilization of Advance analysis tool ETABS'17 for post tensioning method.

e) To prepare a reference study for implementation of post tensioning members in Indian region as per seismic code 1893-part-1:2016

III. PROBLEM STATEMENT

In present work in order to do make Comparative study of seismic (Response spectrum) analysis between bare frame, post tensioning member frame at corners of reinforced concrete structure considering seismic zone-V. It will be modeled and analyzed in ETABS'17 software. Linear dynamic response spectrum analysis will be performed on the structure. In the present work cost analysis is also included to determine the most economical structure.

Table3.1-Geometrical properties

Design data of building	**Dimension**
Plan dimension	12 x15 m
No. of bay in X direction	3 Bay
No. of bay in Y direction	3 Bay
No. of storey	G+9
Typical storey height	3.0 m
Bottom storey height	2.5 m
Column size	450 x450
Beam size	450x300
Thickness of slab	150 mm
Grade of concrete	M-25
Grade of steel	Fe-415
Wall thickness	230mm for external wall
Post tensioning wire	230mm diameter cable

IV. MODELLING APPROACH

4.1 General:

In the present scenario, because of the wide range of plans possible, the accumulated understanding is still limited, thus there is need of an attempt to investigate the behavior of irregular plans in RCC building frame.

Cases selected for comparative study areas follows:

Case-1 Conventional (bare) frame, G+09

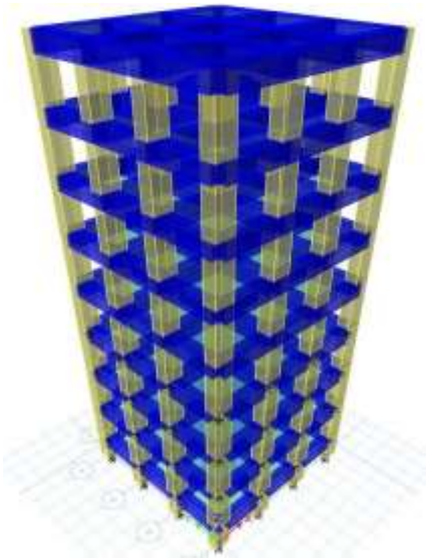


Fig 4.2-Bare Frame Case

Case-2 Frame with Post tensioning members

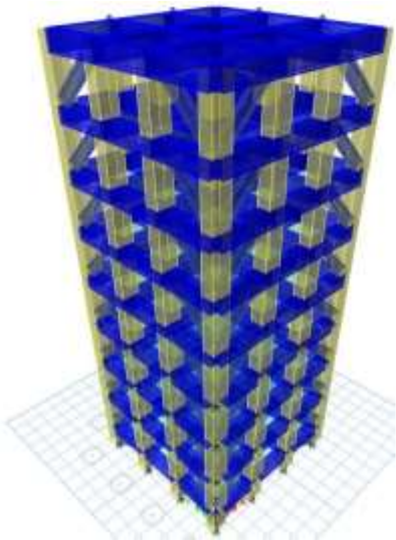


Fig4.3: frame with post tensioning Members

4.2 Load Combination

Table 4.1 Load Combination

Load case no.	**Load cases**
1	D-L
2	L-L
3	EQ_X
4	E.Q._Z
5	1.5(D-L+L-L)

6	1.5(D-L+E.L.+X)
7	1.5(D-L-E.L.+X)
8	1.5(D-L+E.L.+Z)
9	1.5(D.L- E.L.+Z)
10	1.2(D.L+L.L+ E.L.+X)
11	1.2(D.L+L.L- E.L.+X)
12	1.2(D.L+L.L+ E.L.+Z)
13	1.2(D.L+L.L- E.L.+Z)

V. RESULT & DISCUSSION

5.1 Parameters selected for Analysis

This result contains comparative study of G+9 storey RCC building with different model configuration located in earthquake zone V for soft soil condition.RCC building frames are designed for same gravity loading condition and RCC slab is used in all cases. Column, beam and Post tensioning members are of same section and property in each case. ETABS 2017.v17.1software is used to compare the result obtained during the analysis and design of structure.

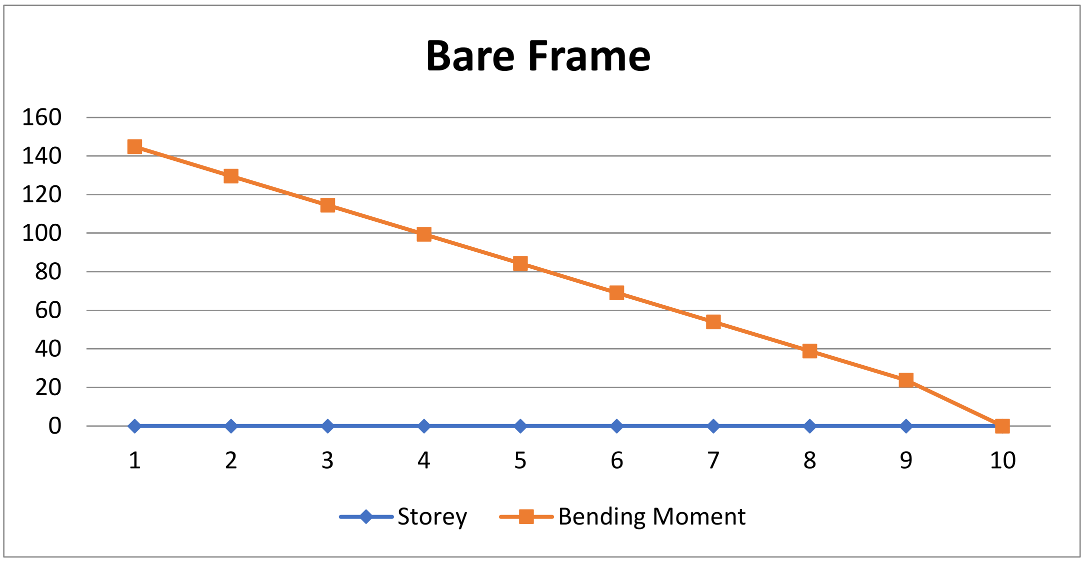
5.2 Comparative Results

Bending Moment kN-m: Bending moment is defined as the reaction which is induced in the element of structure when external force or moment is applied to the element causing the element to bend. Bending moment generate tensile and compressive stresses in structural member which increase proportionally with bending moment.

Table5.1: Bending moment kN-m

Storey	Max. Bending moment kN-m	
	Bare Frame	**Post-tensioning frame**
9th	144.8	69.18
8th	129.67	62.79
7th	114.54	56.4
6th	99.41	50.01
5th	84.28	43.62
4th	69.15	37.23
3rd	54.02	30.84
2nd	38.89	24.45
1st	23.76	18.06

0	0	0



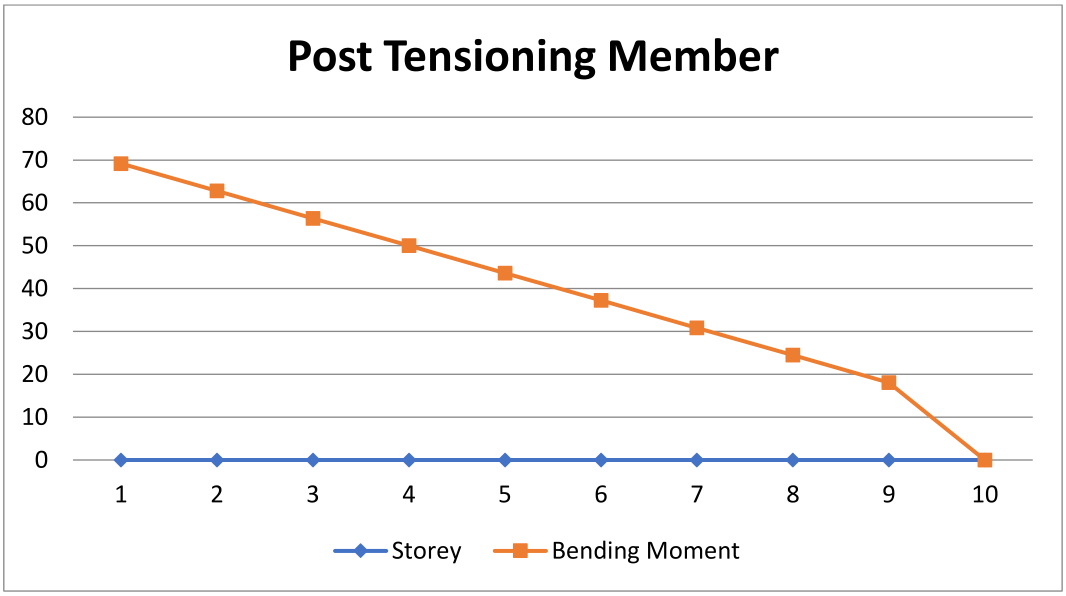


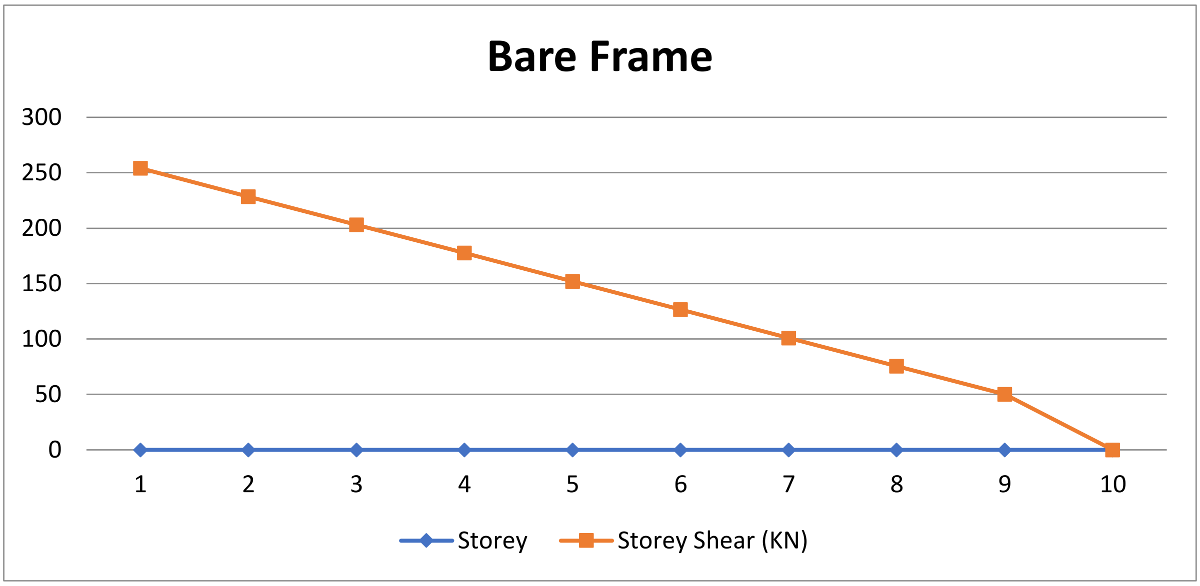
Fig5.1: Max. Bending Moment KN-M

Storey Shear KN: Storey shear is designed to estimate the maximum expected lateral force will occur at the base of each storey of a structure due to Lateral force.

Table5.2: Storey shear KN

Storey	**Max. Shear Force kN**	
	Bare Frame	**Post-tensioning frame**
9th	254.05	197.93
8th	228.55	177.62
7th	203.05	157.31
6th	177.55	137
5th	152.05	116.69

4th	126.55	96.38
3rd	101.05	76.07
2nd	75.55	55.76
1st	50.05	35.45
0	0	0



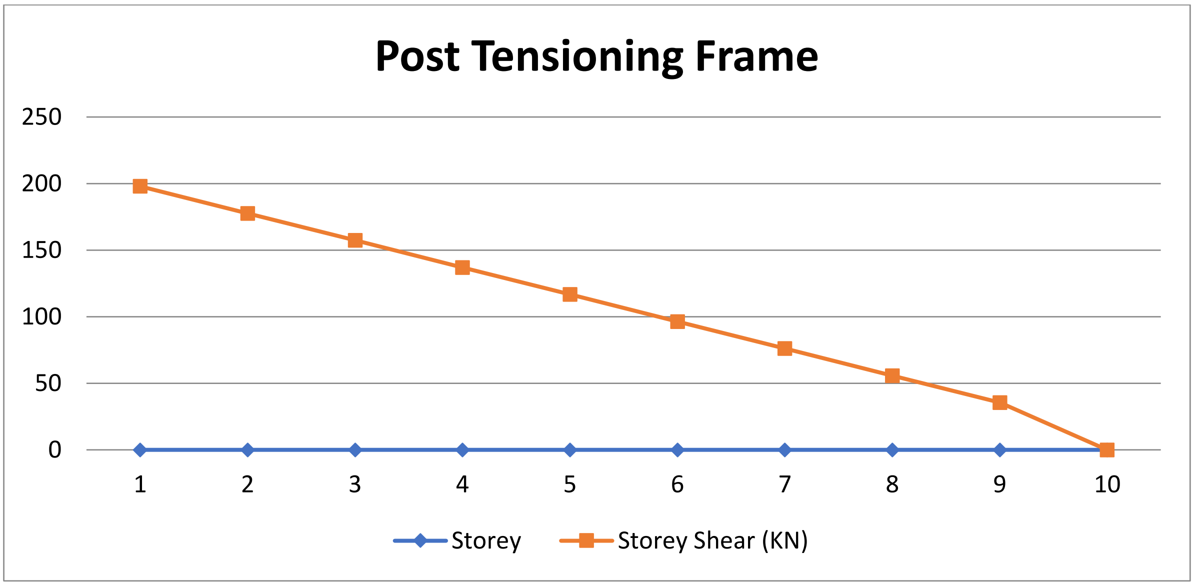
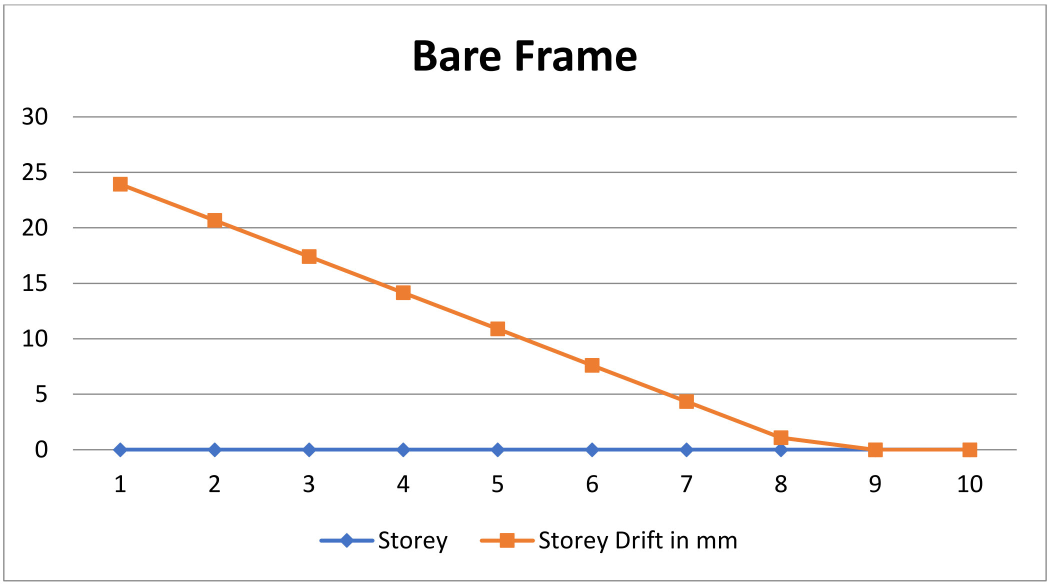


Fig 5.2: Storey Shear in KN

Storey Drift: It is the drift of one level of a multi-storey building relative to the level below. Inter-story drift is the difference between the roof and floor displacements of any given story as the building sways during the earthquake, normalized by the story height.

Table5.3: Storey Drift

Storey	Max. Storey Drift in mm	
	Bare Frame	Post-tensioning frame
9th	23.928	11.7564559
8th	20.6655	10.1533576
7th	17.403	8.5502593
6th	14.1405	6.947161
5th	10.878	5.3440627
4th	7.6155	3.7409644
3rd	4.353	2.1378661
2nd	1.0905	0.5347678
1st	0.001	0.0001339
0	0	0



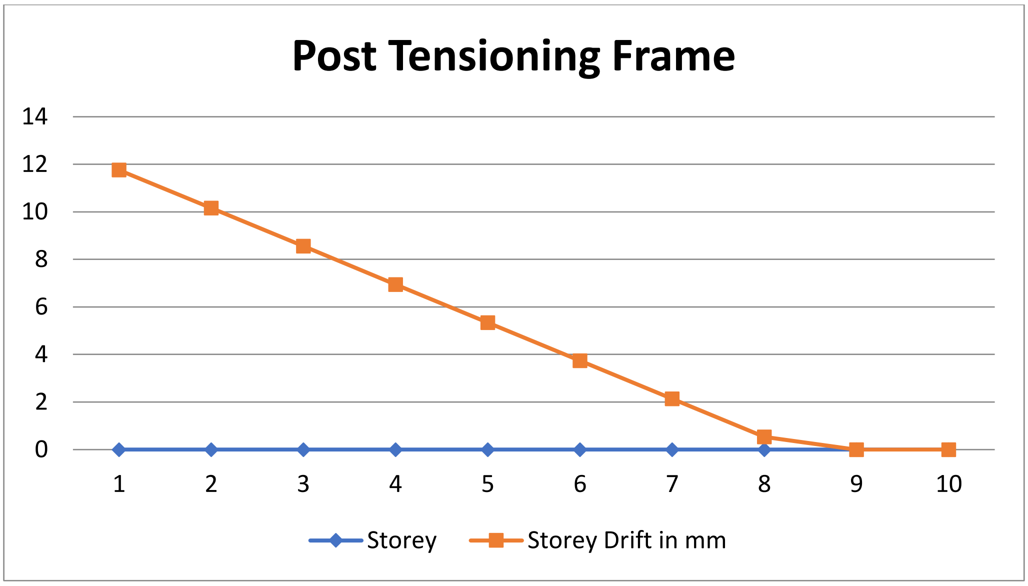


Fig 5.3: Storey Drift in mm

VI. CONCLUSION

The Study presents results of implement post-tensioning method in the building. High-rise structure is modelled and analyzed in this study using ETABS software. Presented project is a first venture of this type in project. Results of measurements of deflection during construction of the building indicate Stability of the structure due to post tensioning members which shows deviations from predicted values. In this study following results are observed as follows:

1. Bending moment in each storey decreased due to introduction of post-tensioning• members, these results in economical sections. In this study it is observed that 47.7% decrement in moment is resulted in Post tensioning frame comparing to bare frame.
2. Storey shear is decreasing causing minimize risk of unbalanced forces in post• tensioning structure. It is observed in above chapter that unbalanced force are observed 13.87% less in post tensioning building frame comparing to bare frame.
3. Storey Drift is the relative displacement of two adjoining stories, In the chapter above• it is observed that post tensioning member results in 49% reduction in relative displacement compared to bare frame structure.

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