Analysis of Behavior of Post Tensioning Slab for Various Framing under the Influence of Lateral Load

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Abstract— Looking at modern trend of construction post tensioning system is used in constructions over pre-stressing systems as post tensioning has less losses compared to prestresssing and also we can give any shape to tendons in post tensioning. Hence Post Tensioned (PT) tendons are added in flat slab as post tensioning gives superior performance because the PT flat floor systems provide improved crack and deflection control, and allow relatively large span to thickness ratios of the order of 35 to 45 which is less in case of RC up to 30. It also reduces floor to floor height, get lighter structures. Post tensioning also gives construction efficiency, sustainability and durability. But understanding and analysis of flat floor system behavior subjected to lateral forces and/or displacements in areas prone to earthquake, i.e. high seismic zone regions, is matter of concern. It becomes a subject of interest to find the seismic force resisting capacity of such buildings in the presence or absence of Lateral Force Resisting System. For that nonlinear static analysis is used as it is partial and relatively simple intermediate solution to complex problem of predicting force and deformation demands imposed on a structure and its elements due to ground motion. This analysis is an attempt to evaluate the real strength of structure and it is a useful and effective tool for performance based design.

Keywords: Nonlinear static analysis, PT slab, prestressed concrete, base shear, punching shear, deflection

I. INTRODUCTION

Prestressed concrete is fundamentally concrete in which interior stresses of an appropriate greatness and circulation are presented with the goal that the anxieties coming about because of outer burdens are checked to an ideal degree. Prestressing of concrete is characterized in a few different ways. The most significant order is pre tensioning and post tensioning which depends on the grouping of throwing concrete and applying strain to tendons. The procedure of tensioning done in the wake of throwing of concrete is known as Post-tensioning. Post-tensioning aides in beating the trouble of fixing required profile of tendons in pre-tensioning.

In building construction, post tensioning permits bigger clear ranges, more slender slabs, less bars and increasingly slim components. Post tensioning is the arrangement of decision for stopping structures since it permits a high level of adaptability in the segment format, range lengths and incline design. More slender slab implies less concrete is required. As the floor framework assumes a significant job in the general expense of a building, a post-tensioned floor framework is created which lessens the ideal opportunity for the construction and by and large cost.

Post tensioning in this way permit a huge decrease in building weight versus a conventional concrete building with same no of floors. This lessens the foundation load and can be a significant bit of leeway in seismic region.

II. SEISMIC FORCE

It has been seen in past seismic tremors that the structures on seismic regions serve more overlay. Shivers make substantial damage to structures, for case, loss of people in the building and if the intensity of tremor is high it prompts breakdown of the structure. In past years people has been produced irrefutably and as a result of which urban zones and towns started spreading out. In light of this reason distinctive structures are being inalienable inclining zones. India has a wide shoreline forefront which is anchored with mountains and plateau. The structures in these zones are made on inclining grounds. A tremendous piece of the unforgiving ranges in India go under the seismic zone II, III and IV zones in such case working in context of slanting grounds are exceedingly slight against seismic tremor. This is a possible result of the way that the bits in the ground floor differentiate in their statures as showed up by the tendency of the ground. Segments toward one side are short and on flip side are long, by righteousness of which they are exceedingly delicate. Seismic forces acts more separate in inclining zones due to the assistant inconsistency. Moreover it has been examined that the seismic tremor exercises are slanted in inclining ranges. In India, for example, the north-east states. The deficiency of plain ground in inclining ranges powers advancement development on inclining ground realizing diverse imperative structures, for instance, reinforced concrete encompassed specialist's offices, colleges, motels and work environments laying on uneven inclinations. The lead of structures in the midst of tremor depends on the dispersal of mass and immovability in both even and vertical planes of the structures. In slanting district both these properties varies with irregularity and asymmetry. Such improvements in seismically slanted regions make them exhibited to more unmistakable shears and torsion.

Fig. 1: Seismic Failures in India

A. Post tension slab:

Is a combination of conventional slab reinforcement and additional distending high-strength steel tendons, which are thus exposed to tension after the concrete has set? This Hybridisation accomplishes the arrangement of an a lot more slender slab with a more drawn out range without any segment free spaces. Post-tensioning outcomes in more slender concrete slabs making the important investment funds in floor to floor tallness accessible as additional floors. This can give extra rentable space inside a similar by and large building stature.

The fundamental component of a post-tensioning framework is known as a ligament. A post-tensioning ligament is comprised of at least one bits of pre-stressing steel, covered with a defensive covering, and housed inside a conduit or sheathing.

Post-Tensioned Slab has a bit of leeway over others as it makes an exceptionally effective base for floor plan with slender slabs and column less spaces in bigger ranges.

Fig. 2: Post Tensioning Slab

III. LITERATURE REVIEW

Sridhar and Rose (2019) [20] author accentuated on structuring a post-tensioned structure utilizing ETABS and SAFE. ETABS represents Extended Three-Dimensional Analysis of structure frameworks. The fundamental reason for this product is to plan the multi-storeyed structure in a precise procedure which will pursue Indian Standard structure codes.

The author venture managed the arrangement of tremor and wind opposition structure where the Minimum sizes of segment and bar gave were C500*500 and B300*500 and later Seismic investigation was finished by utilizing ETABS programming where whole individuals were passed in the plan. As the structure was posted tensioned one, it demonstrated to be efficient.

Srilaxmi et. al. (2018) [22] the author channelized the present days the pre-tensioning and post-tensioning frameworks are prevalently utilized in the significant developments of a structure. The Pre-tensioning and Post-tensioning the two strategies are utilized under the pre-focusing on the procedure. In which has few edges over the standard non-focused on structures like more noteworthy range to profundity proportion, higher minute and shear limit. These techniques were commonly received taking shape of PSC braces, sleepers, Bridges, Slabs in structures, Concrete Pile, Repair and Rehabilitation, Nuclear Forces Plant and so forth

Prakash et. al. (2017) [21] the author expressed that Post-tensioned story areas are seen as the most monetarily fruitful improvement for strip shopping centres, office structures, and stopping where ranges outperform 7.5 meters. The favoured post-tensioning structure used is the all-around illustrated 'reinforced' ligament utilizing from 3 to 5 individual pre-stressing strands housed in oval ducting and secured in a level fan-shaped safe grapple castings.

Nethravathi et. al. (2017) [9] authors research paper included outcomes on an investigation of the unbonded post-tensioned cast set up stopping floor exposed to different game plans of ligament design dependent on FEM examination. Displaying and investigation of the post-tensioned level plate were finished by utilizing SAFE programming. Proportional loads dependent on link profiles were connected to the level plate as indicated by the ligament format. Structure minutes, administration minutes, hyper-static minutes, transient avoidance, long haul redirection, and punching shear was thought about for the different ligament designs at administration and extreme point of confinement state.

Dobariya et. al. (2017) [10] the author investigated a long-range T-shaft with 10-20m range pillar examination in the fortified and unbonded bar with greatest strain zone link profile. The hypothetical outcomes depended on IS 1343-1980 and ACI-318 base considering the development cost of both the frameworks. The correlation depended on the parameters specifically focuses on avoidance, twisting minute and sheer forces.

The outcomes expressed that the prestressed solid pillar with high PT forces (64kN and 42kN) accomplished the most extreme load when contrasted with different shafts under two-point stacking and single point-stacking condition individually. The splits began to show up precisely under the stacking focuses, which unmistakably demonstrated that the bars bombed under flexure.

IV. OBJECTIVES

The main aim of this study are as follows:

1) To evaluate conventional RCC v/s PT system under the various framing system for seismic loadings.
2) To design multi storied commercial building considering flat slab with drop panel system for gravity loadings & seismic loading combinations.
3) To compare the behavior of RCC and PT system under lateral load and review the performance.
4) To study advantages/disadvantages of post tensioned slab as replacement to flat slab and RCC slab at local and global level.
5) To evaluate which type of cables stretching give better results in PT slab under the performance of lateral loading condition.

V. METHODOLOGY

This study is attempted in following steps:

1) Step-1: To prepare a literature survey of past researches related to PT technique, structural analysis and effect of diaphragm over a structure.

2) Step-2: To prepare modelling of the selected geometry

For modelling of the structure we are considering a plan area of 300 m^2 with symmetrical frame. ETABS is utilized in modelling of the structure whereas for modelling of PT slab SAFE software is utilized.

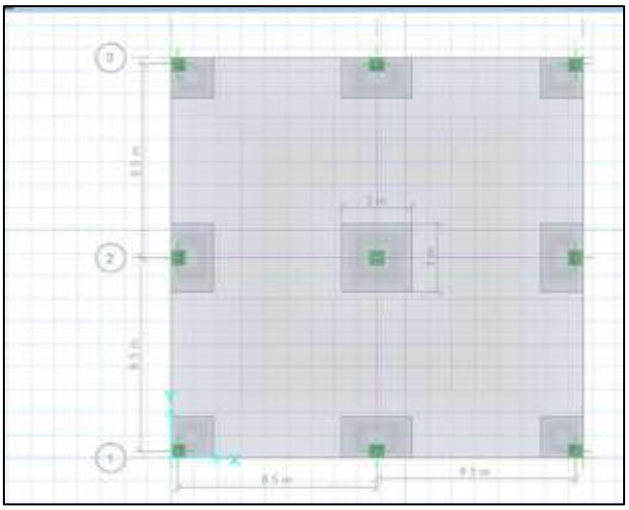

Fig. 3: Plan of the model

3) Step-3: Assigning PT slab using analysis tool SAFE.

SAFE software is utilized for assigning PT technique to the structure.

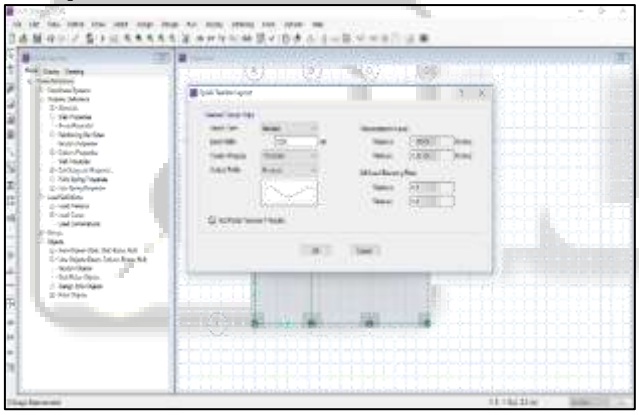

Fig. 4: PT technique in slab

4) Step-4: Assigning anchors to fix the Post tensioning tendons. Tendons are need to be fixed using anchors to assign tension as per requirement, this tension can be generated by stretching tendon wires using anchors.
5) Step-5: Generating PT slab with tendons in flat slab:
In this study we are considering PT technique in flat slab as it is considered as the most suitable type of slab for Post tensioning technique.
6) Step-6: Assigning Support Conditions:
In this study we are assigning Fixed end condition at the bottom
7) Step-7: Assigning Load conditions:
In this study we are assigning dead load, live load and seismic load zone V with hard strata condition as per I.S. 1893-I:2016 provision.
8) Step-8: Performing analysis using analysis tool ETABS:
9) Step-9: Generating Stress diagrams and contours of the loading conditions.
10) Step-10: Analysis of the structure

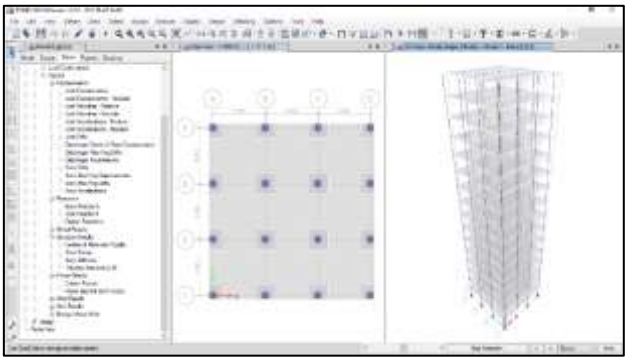

Fig. 5: Seismic effect over the structure

SR NO.	PARAMETER	SIZES
1.	AREA	300 m^2
2.	FLOOR HEIGHT	3 m
3.	LIVE LOAD	3 Kn / m^2
4.	FLOOR FINISH	2 Kn / m^2
5.	SIZE OF COLUMN	500x500 mm
6.	SIZE OF BEAM	300x500 mm
7.	DEAPTH OF SLAB	200 mm
8.	DROP THICKNESS	400 mm
10.	ZONE	v
11.	IMPORTANCE FACTOR	1.2
12.	SOIL PROPERTY	HARD SOIL

Table 1: Geometric Properties

VI. ANALYSIS RESULT

A. *Displacement*

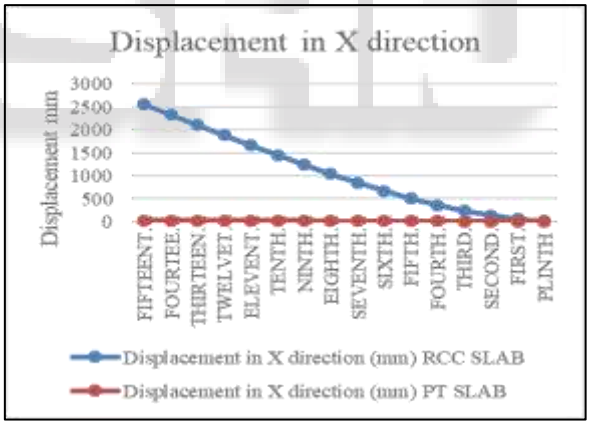

Fig. 6: Displacement

B. *Axial Force kN*

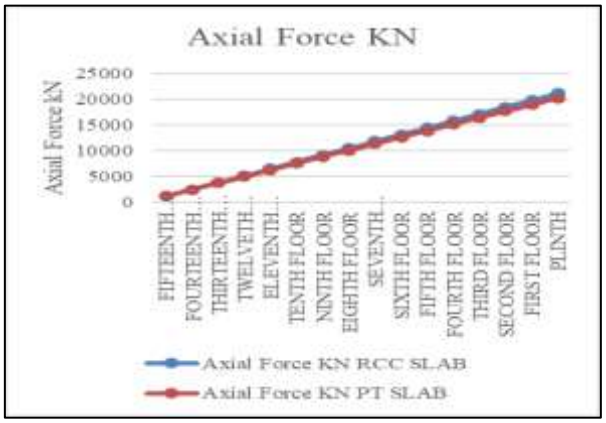

Fig. 7: Axial Force

C. Shear Force:

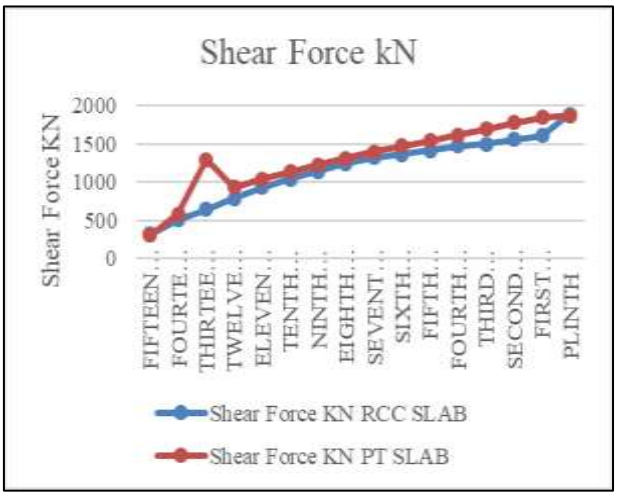

Fig. 8: Shear Force

D. Bending Moment kN-m

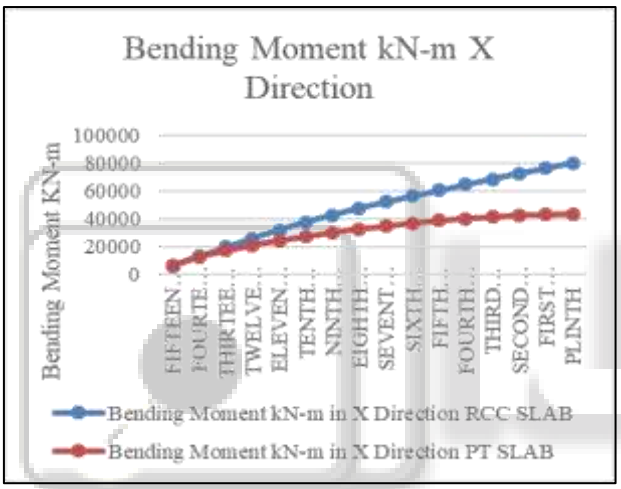

Fig 9: Bending Moment

VII. CONCLUSION

1) From the present study it was examined that PT slab stiffness is much efficient in comparison to simple RCC slab frame system in reducing moment, storey displacement, peak displacement and forces.
2) Following conclusions are observed in chapter 5 are as follows:
3) Axial Force: As results observed in above chapter it can be said that vertical distribution is generally same in both the cases. Variation of 8% is observed in PT slab as it is more resisting and distributing.
4) Shear Force: In terms of unbalance forces it can be said that unbalance forces are linear in both the cases, and values on PT slab case is on the higher end with approximate variation of 5%.
5) Displacement: In terms of displacement it can be concluded that PT slab structure is comparatively more stable 25% less displacement as compared to RCC slab structure.
6) Bending Moment: In terms of bending moment it is observed that Pt slab structure is comparatively more economical and stable structure since ending moment observed is less by 15%.

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