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Seismic Analysis of a Post Tensioned Slab as Per Indian Design Code Using Etabs

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ABSTRACT

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.

This project deals with comparative analysis on Flat slab and Post tensioned slab considering parameters as storey displacement in X and Y Direction, Bending moment in X and Y Direction and Storey drift. A G+15 storey was considered for the analysis and the modelling and performance of the structure was registered using analytical applications Csi ETABS and SAFE. Seismic analysis was conducted as per defined IS codes. PT slabs provide proper stability and appearance to the structure which is capable of resisting lateral loads with decreasing the dead loads generating due to heavy sections and members.

Keywords : Seismic Analysis, Post Tensioned Slabs, CSI ETABS, SAFE, Storey Displacement, Storey Shear force and bending moment.

I. INTRODUCTION

Reinforced concrete slabs are broadly utilized as a part of the concrete developments. In basic examination, the torsional solidness of slab is disregarded. At the point when this firmness is considered, the correct hypothesis of bending of flexible plates demonstrates that the contorting minute alleviate around 25 percent. The essential capacity of floor and rooftop frameworks is to help gravity stacks for example, sections and dividers.

Besides, they assume a focal part in the circulation of wind and seismic powers to the vertical components of the sidelong load opposing framework. The impact of the slab boards isn't considered in reinforced concrete basic investigation since architects disregard their commitment in parallel load opposition. For the most part, the development completed is reinforced concrete with slabs giving the useable floor territory. As they frame a vast piece of basic framework, in this way creators ought to get advantage from their extensive in plane firmness. So in this investigation the reaction of two basically same structures, with and without thought of solidness of slabs were assessed and looked at based on changed auxiliary parameters. Reinforced concrete slabs are generally utilized as a part of the concrete developments. In auxiliary investigation, the torsional firmness of slab is overlooked in like manner.

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.

In the present study we are comparing a G+15 with terrace RCC conventional slab with PT slab (in flat slab) considering seismic load as per zone V over a hard strata. For analysis Csi SAFE and Csi ETABS softwares are considered. Here we studied the variations in Frame forces, moment, nodal displacements and support reactions also comparing the designing to determine the most effective and economical frame.

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 Failure in India (Assam)

Objectives of the Study

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.

II. Literature Survey

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.

METHODOLOGY:

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

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.

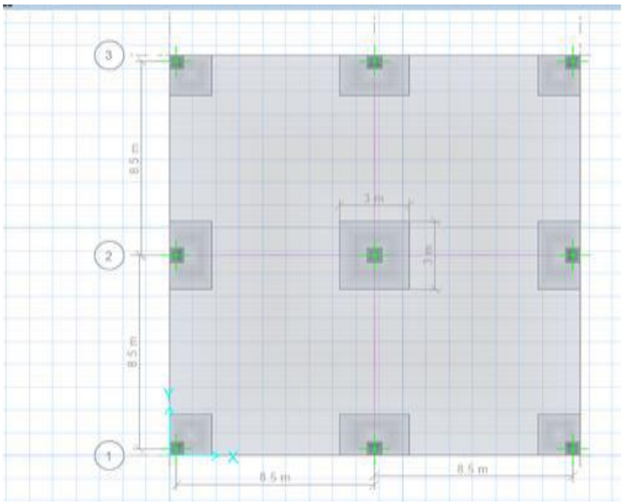


Fig 2 : Plan of the model

Step-3: Assigning PT slab using analysis tool SAFE. SAFE software is utilized for assigning PT technique to the structure.

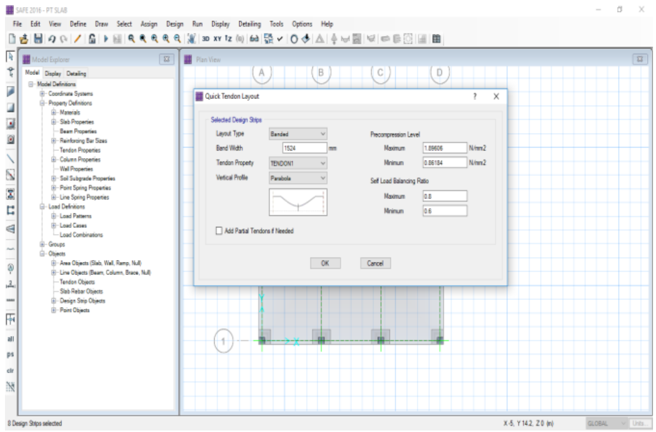


Fig 3: PT technique in slab

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.

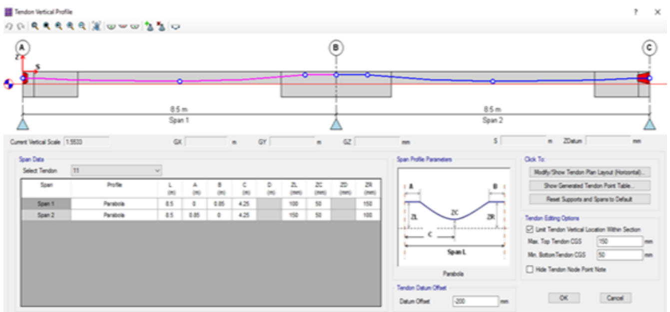


Fig 4 : Assigning Anchors

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.

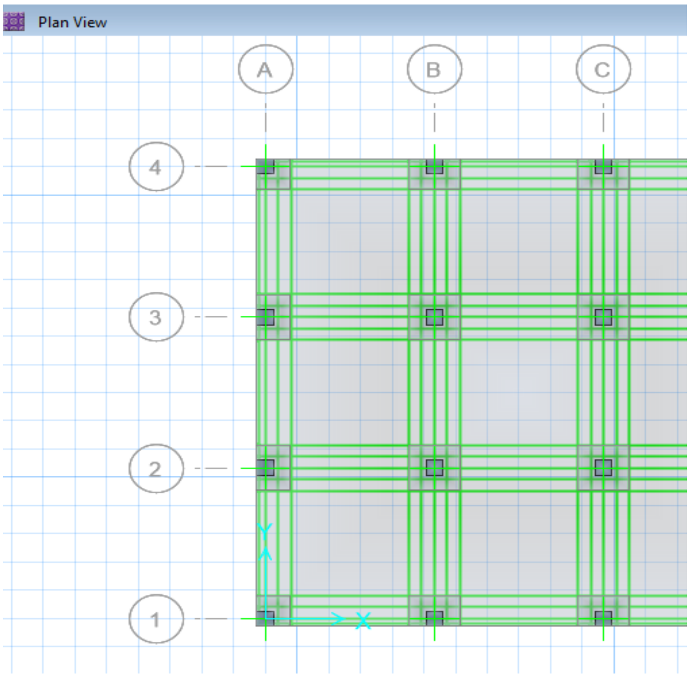


Fig 5: PT technique in Flat slab

Step-6: Assigning Support Conditions:
In this study we are assigning Fixed end condition at the bottom

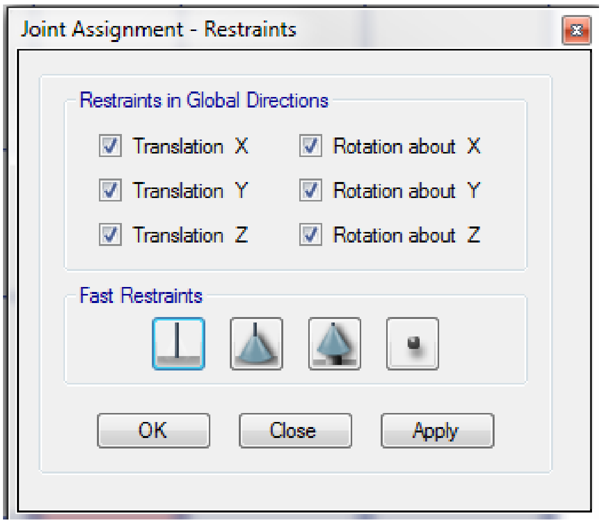


Fig 6: Fixed end condition

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.

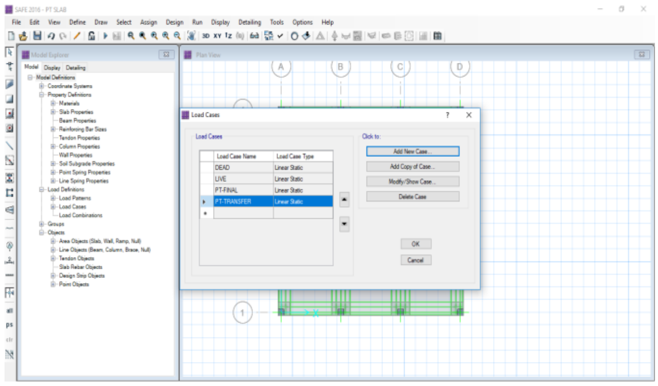


Fig 7 : Load Conditions assigned

Step-8: Performing analysis using analysis tool ETABS:

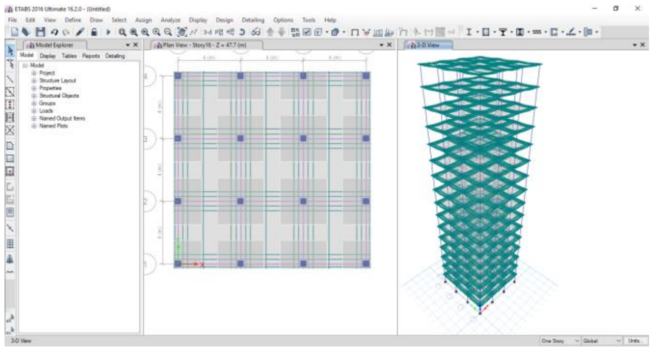
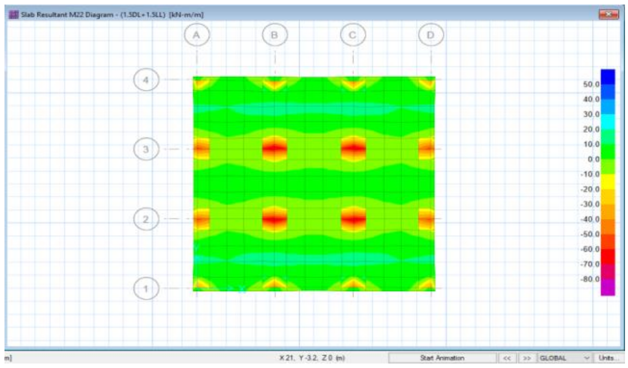
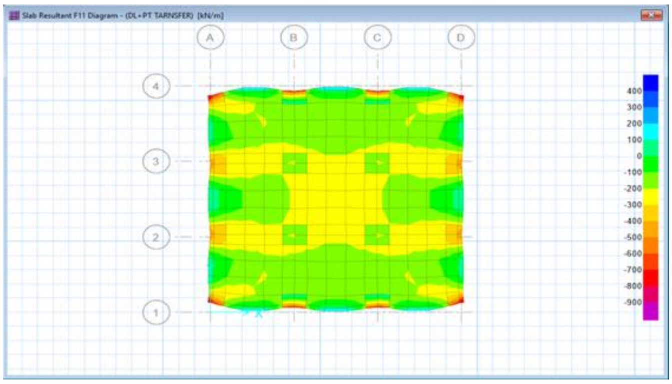


Fig 8: Analysis of the structure

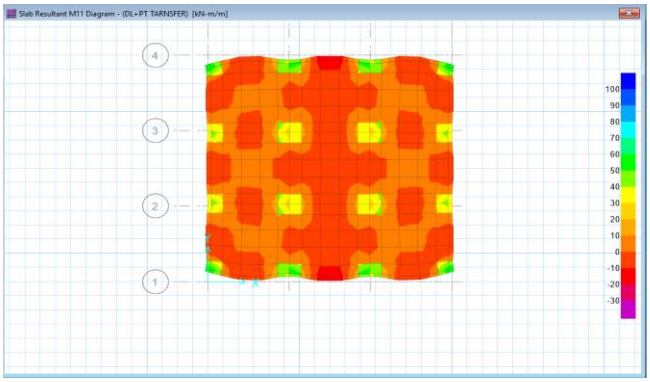
Step-9: Generating Stress diagrams and contours of the loading conditions.



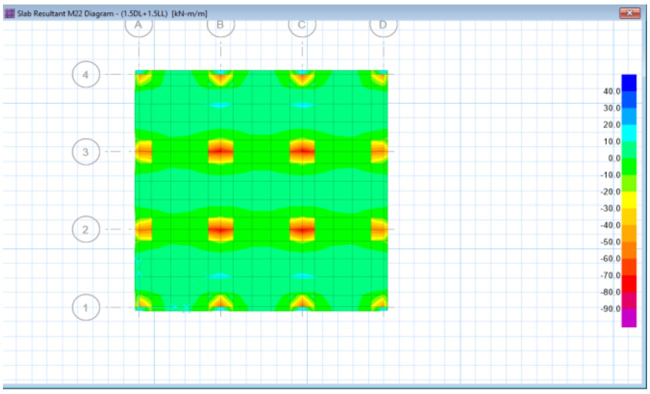
a. Stresses due to dead load over diaphragm



b. Stresses due to Lateral For Moment distribution in slab



c. Moment distribution in slab



d. Moment due to load combinations

Fig 9 : Analysis results

Step-10: Analysis of the structure

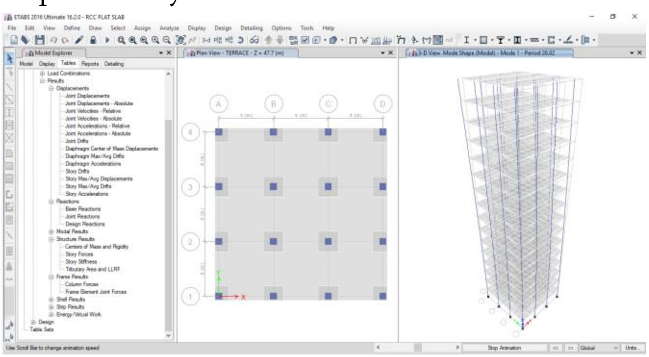


Fig 10 : Seismic effect over the structure

Table no. 1 geometric properties

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

Material properties

Table no 2 material properties

SR.NO.	PARAMETER	DESCRIPTION
1.	CONCRETE	M35
2.	STEEL	FE 500
3.	HT Strand for pre stressing	12.7mm dia,7 ply
4.	Area of strand	98.7 mm2
5.	Design of PT Slab	Bonded system (IS:1343-2012)
6.	Modulus of Elasticity	1.95xE5 MPa
7.	Breaking load	183.7 Kn
8.	Ultimate Tensile	1860 MPa

	Strength	
9.	Wedge draw-in slippage loss	6 mm
10.	Duct wobbles K	0.0016/m

III. ANALYSIS RESULTS

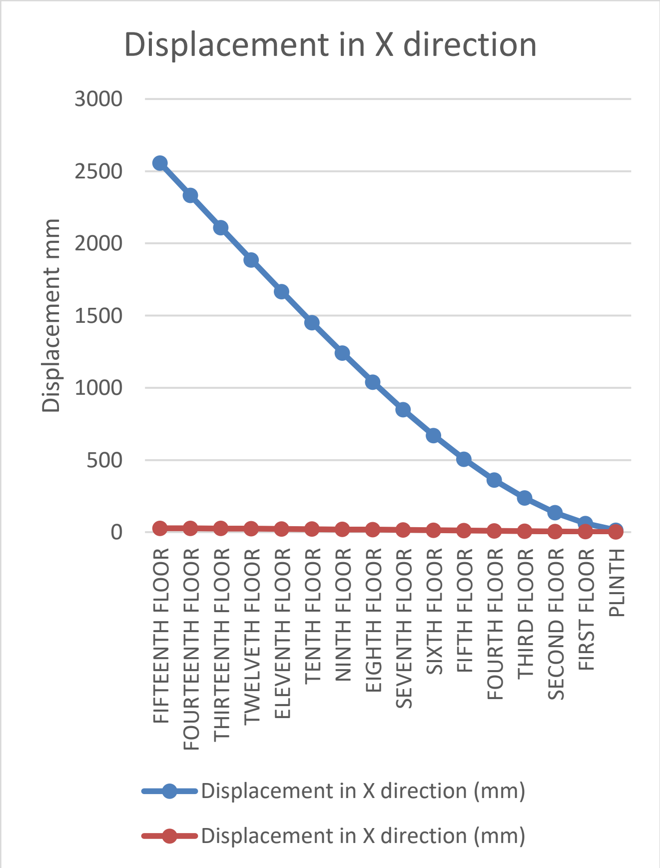


Fig 11 : Displacement in X direction

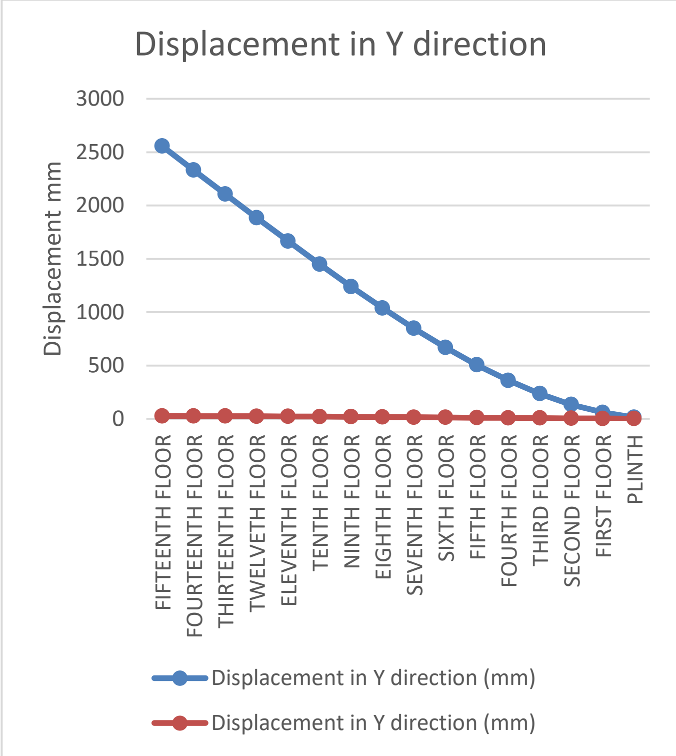


Fig 12 : Displacement in Y direction

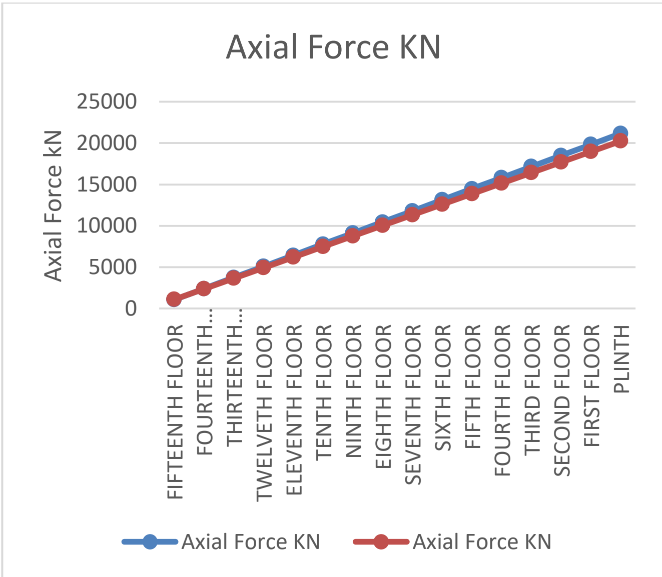


Fig 13 : Axial Force KN

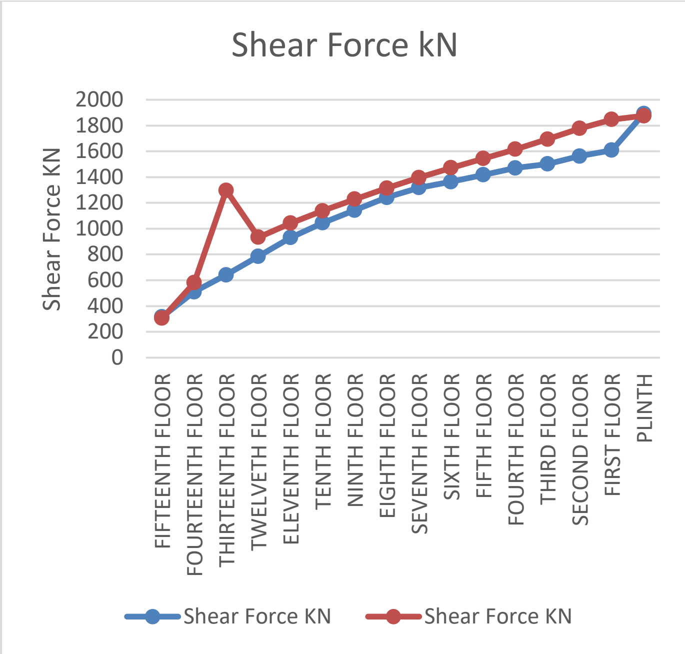


Fig 14 : Shear Force KN

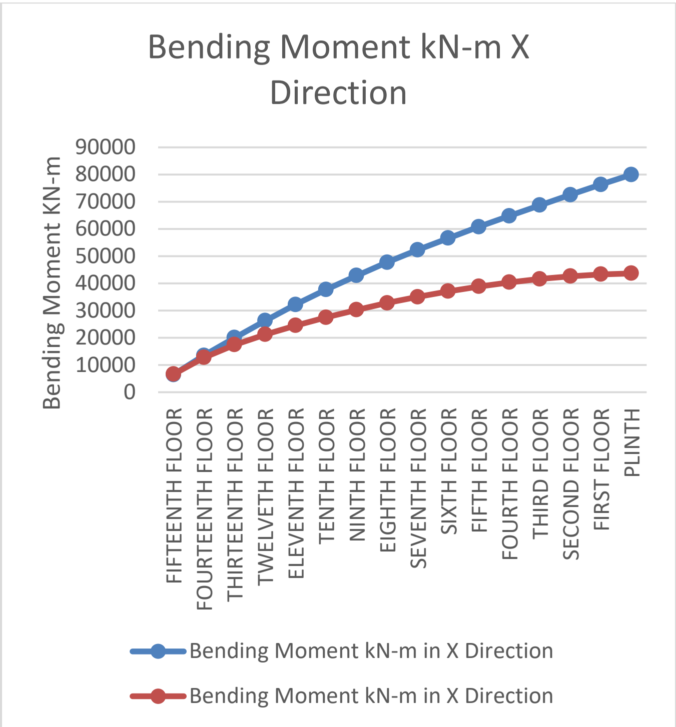


Fig 15 : Bending Moment in X Direction

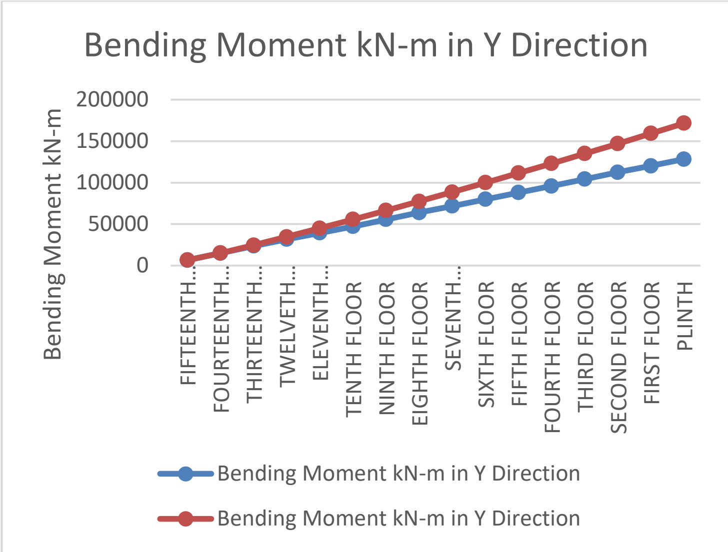


Fig 16 : Bending Moment in Y Direction

IV. CONCLUSION

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.

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%.

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.

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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