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Performance and Optimization of PT Beam Using Dynamic Load Condition of Larger Span Structure

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ABSTRACT

Many of the complex behaviours of reinforced cement concrete under shear and flexure are yet to be identified to employ this material advantageously and economically. The progress in the understanding and quantitative assessment of the behaviour of member subjected to flexure and shear has been less spectacular. The fundamental nature of shear and diagonal tension strength is not yet clearly understood. So, further basic research should be encountered to determine the mechanism, which results in shear failure of reinforced concrete members. The study presents the study of the behaviour of reinforced concrete deepbeam under seismic (vibration) loading and the effect of shear reinforcement. The influence of variation of web reinforcement spacing (both vertical and horizontal) on the shear strength of deep R.C. beam is investigated. The general trend in crack pattern, the load deflection characteristics and the mode of failure of deep R.C. beam under two-points loading are also investigated. Through the investigation, it is observed that under two-points loading system, diagonal cracks are usually the first cracks to be observed in the clear span of the deep beam. In this study we will compare deep beam with PT beam in G+10 structure using analysis tool ETABS.

Keywords : PT Beam ,Bending moment, Deflection, Shear strength , base shear , story drift

I. INTRODUCTION

In India RCC Structures are commonly used for Residential as well as commercial Buildings. Post-tensioned Pre-stressed beams are rarely used for the same Buildings, or we can say for short Span Buildings. As the floor system plays an important role in the overall cost of a building, a post-tensioned floor system is invented which reduces the time for the construction and finally the cost of the structure. In some countries, including the U.S., Australia, South Africa, Thailand and India, a great number of large buildings have been successfully constructed using post-tensioned floors. The reason for this lies in its decisive technical and economical advantages.Two Decade ago there was a big problem of Skilled Workers for Pre-Stressing work. But now there are so many agencies for execution of the same work. In RCC Beams, depth of beam increases with increase in Span, because of deflection limitation. Depth of beam can be reduced in Pre-stressed section, for longer span pre-stressed beams are cheaper. This work is proceeding because I want to know the percentage cost difference between both techniques with respect to span. Deep beam can be defined as a beam having a ratio of span to depth of about 5 or less, or having a shear span less than about twice the depth and which are loaded at the top or compression face only (ACI-1989).

They are encountered in multi-storey buildings to provide column offsets, in foundation walls, walls of rectangular tanks and bins, floor diaphragms and shear walls. Because of their properties deep beam are likely to have strength controlled by shear.

The study is subjected to evaluation of performance of RCC deep beam and PT beam slab with multistory building system with seismic loading performance using analysis tool ETABS.

Floor slabs under horizontal load, short span beams carrying heavy loads, and transfer girders are examples of deep beams. Deep beam is a beam having large depth/thickness ratio and shear span depth ratio less than 2.5for concentrated load and less than 5.0 for distributed load. Because the geometry of deep beams, their behavior is different with slender beam or intermediate beam.Deep beams play a very significant role in design of mega and as well as small structures. Some times for architectural purposes buildings are designed without using any column for a very large span. In such case if ordinary beams are provided they can cause failure such as flexural failure.To avoid this problem of construction of some very long span halls etc the concept of deep beams is very effective and durable. But there are also some minor problems with the construction of deep beams.

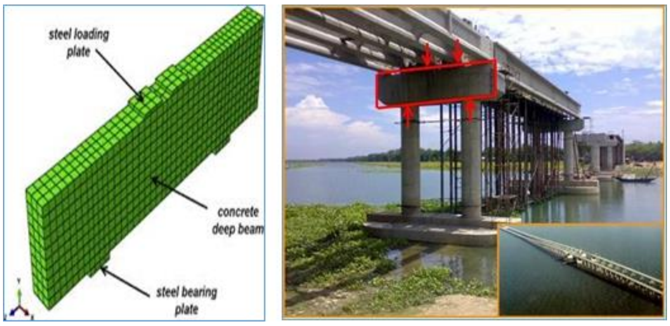


Figure 1 RCC Beam

Objectives of the Study

1. To evaluate performance of PT beam under seismic effect with different profile of tendons.
2. To check performance of RCC deep beam and PT beam slab with multistory building system with seismic loading performance.
3. To compare cost of deep RCC beam with PT beam.
4. To study advantages & disadvantages of Deep & PT BEAM in the form of cost stability & strength

II. LITERATURE REVIEW

Sridhar and Rose (2019)[23] the research paper presented comparison of the flexural behavior of post-tensioned concrete beams with bonded system. Four rectangular post-tensioned beams were tested and analyzed. The beams were tested under single point monotonic loading condition and two point monotonic loading condition. The load-deflection behavior, stress-strain behavior and crack patterns are presented from the test results. Post-tension system effectively controlled deflection and crack due to the presence of tendons in addition to the reinforcing steel. The results stated that the prestressed concrete beam with high PT force (64kN and 42kN) achieved the maximum load when compared to other beam under two point loading and single point-loading condition respectively. There was an increase in load by 11.11% when the PT stress is maintained at

150kg/cm2 compared to 120kg/cm2 under two point loading condition.

Reddy et. al. (2019)[21] the research paper presented comparative analysis of deep beams considering specimen of length 1200 mm X 200 mm X 600 mm, 1100 mm X 200 mm X 600 mm and 1000 mm X 200 mm X 600 mm. The flexural, shear, crack pattern of reinforced concrete deep beams with different l/D ratios. The width of bearing plate, depth, the percentage of tension reinforcement, and the percentage of vertical and horizontal shear reinforcement are constant under three-point loading using loading frame are tested. The experimental results showcased the Load Vs Deflection and crack width of the beam. The results concluded that The Load obtained for the deep beam of length 1000mm is 837kN and was more when compared to other deep beams and the load obtained by the deep beams experimentally was more compared to the load calculated by using code. The deflection obtained for the 1000mm length beams was also satisfactory when compared to other beams. The crack obtained in this deep beam was less when compared to other beam and the width of crack was about 6.78mm and the first crack obtained at 640.3kN load.

Harsha and Raju (2019)[7] the paper presented preliminary support for proposing a new shear strengthening technique during the design of the member. The results concluded that Diagonal Tensile Stresses increases rapidly if proper care was not taken for the stresses criteria while designing the beam. Major Failure was diagonal cracking in Deep Beams, with the increase in span to depth ratio, the inclination of cracks increases. The portions of un-cracked concrete depth resist the shear stress and the transfer of shear at cracked portion was negligible. Concentrating of shear reinforcement within middle region of shear span can improve the ultimate shear strength of deep beam. Shear strength decreases with the increase in the depth of the beam

Methodology:

Step-1 First step is collection of data related to RCC Deep Beams and PT Beams considering to software implementation.

Step-2 Modelling of Structure using ETABS

An RCC Structure is chiefly a get together of Beams, Columns, Slabs, and establishment between associated with one another as a solitary unit. For the most part, the move of a load in these structures is from chunk to bar, from shaft to the segment lastly section to the establishment which thus exchanges the whole load to the soil. In this investigation, we have received three cases by expecting distinctive frameworks for load opposing structure demonstrated utilizing Csi-ETABS'16. The arrangement and 3-D perspective of the unpredictable building are appeared in the figure beneath.

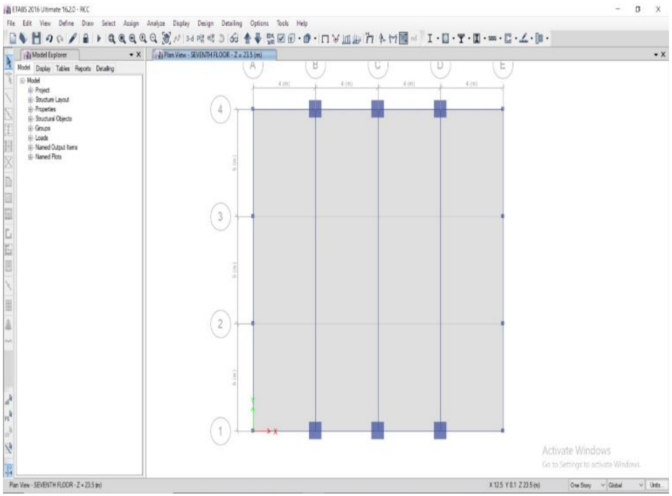


Figure 2 Plan

The dimensions of the structure were designed in all the two cases.

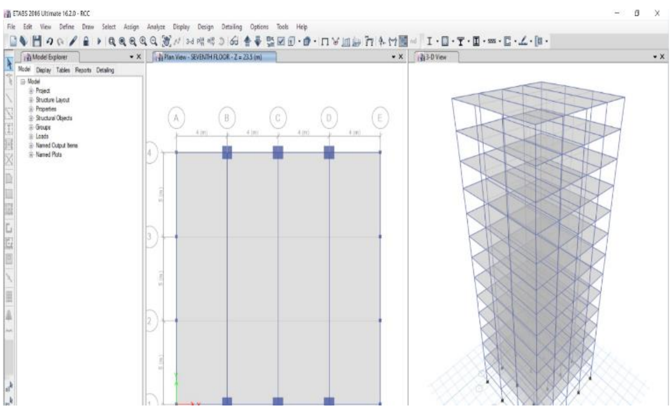


Figure 3 Modelling of Structure with RCC DEEP Beams

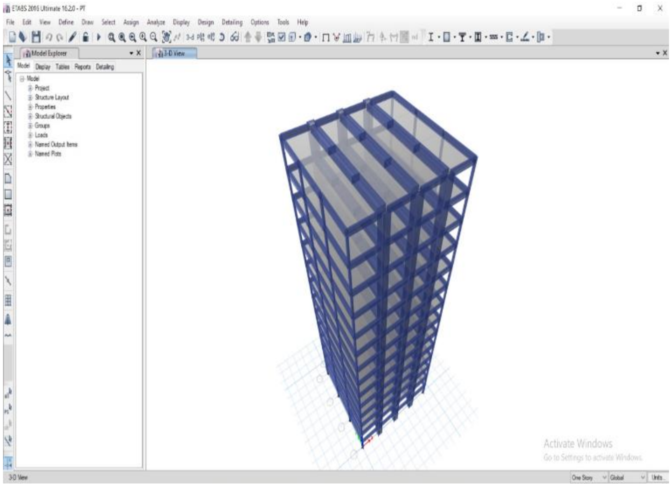


Figure 4 Modelling of structure using Post Tensioned Beams

Step-3 Generating material properties

Etabs give us a development alternative to give material properties in a particular way to dole out in structure. In etabs we are allowed to dole out any sort of material as it gives a practical altering device to make the material.

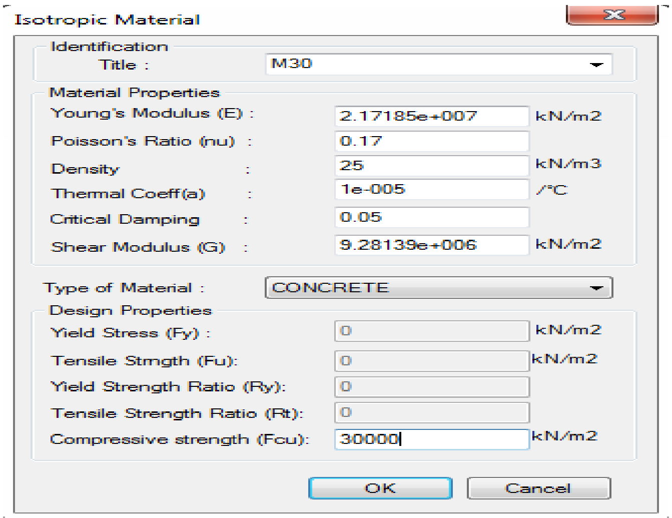


Figure 5 Creating M30 concrete in ETABS.

Materials make up the essential components, which all assembling procedures need to work with. Assembling top-notch items easily require itemized information on complex collaborations among an enormous number of variables including item plan necessities, materials and their properties and assembling forms that convert these materials into required structures. Today there is a wide scope of materials and procedures accessible and the assignment of choosing the most ideal material while limiting the expenses of assembling is a significant test. Meeting such a test requires an intensive comprehension of the attributes of materials and forms and the related assembling innovation.

Step-4 Creating beam and column section of the structure

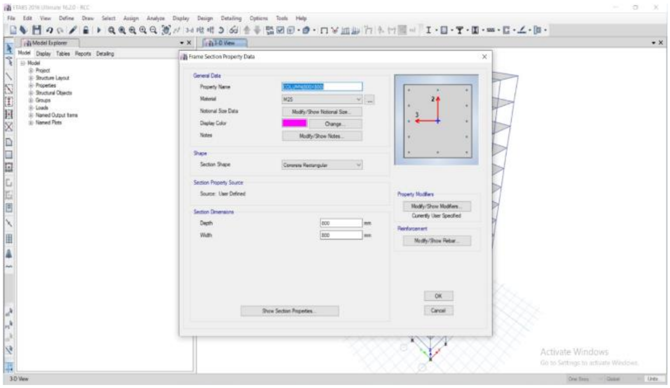


Figure 6 Creating sectional properties

Step-5 Assigning support condition

In ETABS we are allowed to dole out any sort of help either settled, stick or roller for which we have to tap on dole out instrument on the menu bar > then we will choose joint > after that we have select the kind of help we have to dole out.

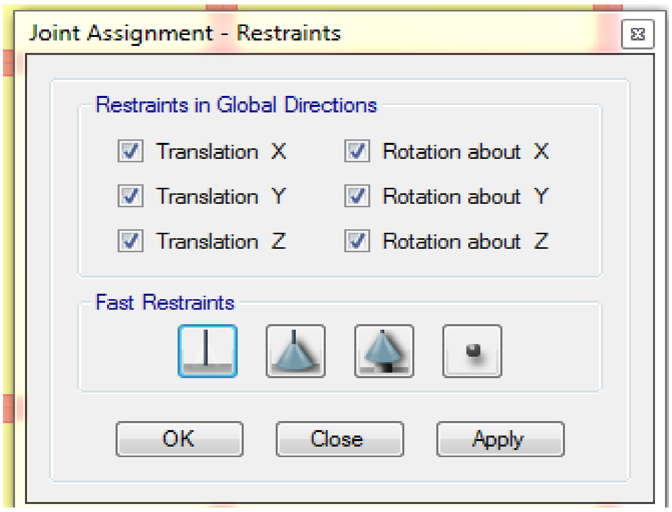


Figure 7 Support Conditions

Step-6 Defining response spectrum as per I.S. 1893:I:2002

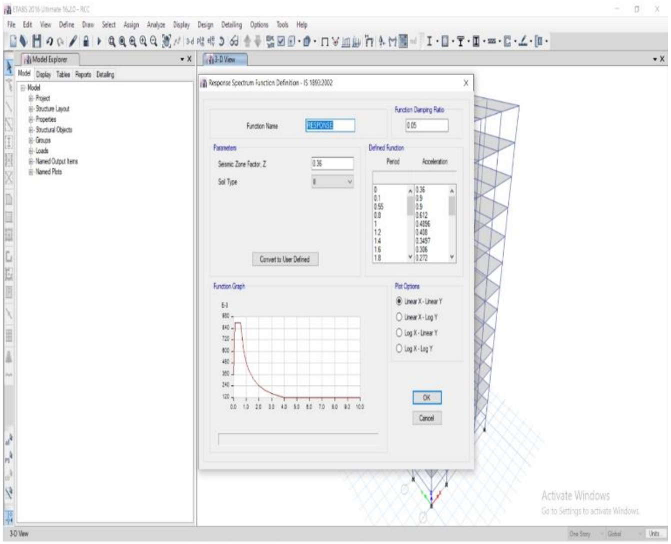


Figure 8 Seismic load

Step-7 Assigning Loading Conditions

For the investigation of the structure, all the Load conditions to the structure are connected. The estimations of configuration loads are computed according to IS 875 Part I and II and IS-1893 section I. Dead loads will be computed based on unit weights of materials given in IS 875 (Part I) which will be set up considering the materials indicated for development. The circulation of the dead load. The forced load is characterized as the heap that is connected to the structure that isn't lasting and can be variable and will be accepted as per IS 87S (Part II). The dispersion of the live load.

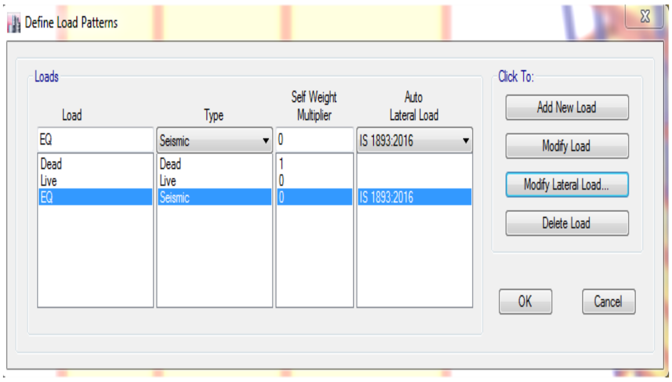
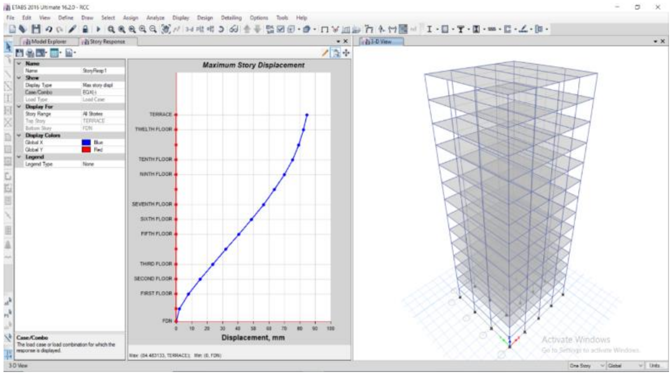


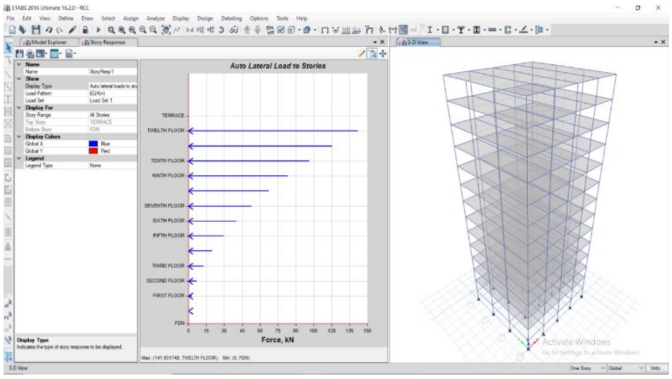
Figure 9 Assigning Load Condition

Step-8 To perform finite element analysis

The Finite Element Analysis (FEA) is the reproduction of some random physical marvel utilizing the numerical procedure called Finite Element Method (FEM). Architects use it to lessen the number of physical models and tries and enhance parts in their structure stage to grow better items, quicker.



a. Displacement in mm



b. Forces in KN

Figure 10 Analysis results

Step-9 Designing of RCC and PT beam.

Plan of RCC structure is done on ETABS programming utilizing IS-456:2000. Amid the plan of RCC framework segments such as Beams, Columns, Slabs different outline parameters are chosen as given underneath:-

Grade of concrete = M-30
Grade of main steel = Fe415
Grade of secondary steel = Fe415
Clear Cover = 40 mm
Max. Size of main reinforcement = 40 mm
Min. Size of main reinforcement = 25 mm
Max. Size of secondary reinforcement = 12 mm
Min. Size of secondary reinforcement = 8 mm

Table 1: Geometrical details

Sr, no,	**Number of Stories**	**Ground + 10 storey**
	Height of stilt floor	3.3 m.
	Height of upper stories	3.3 m.
	Depth of foundation	-1.5 m
	Grade of concrete for	M 30

	RCC structure	
1.	Plan area	16 x 15 m
2.	PT beam	450 x 300 mm
3.	Column	500 x 500 mm
4.	Slab	150 mm
5.	Seismic	Response Spectrum (V)

III. ANALYSIS RESULTS

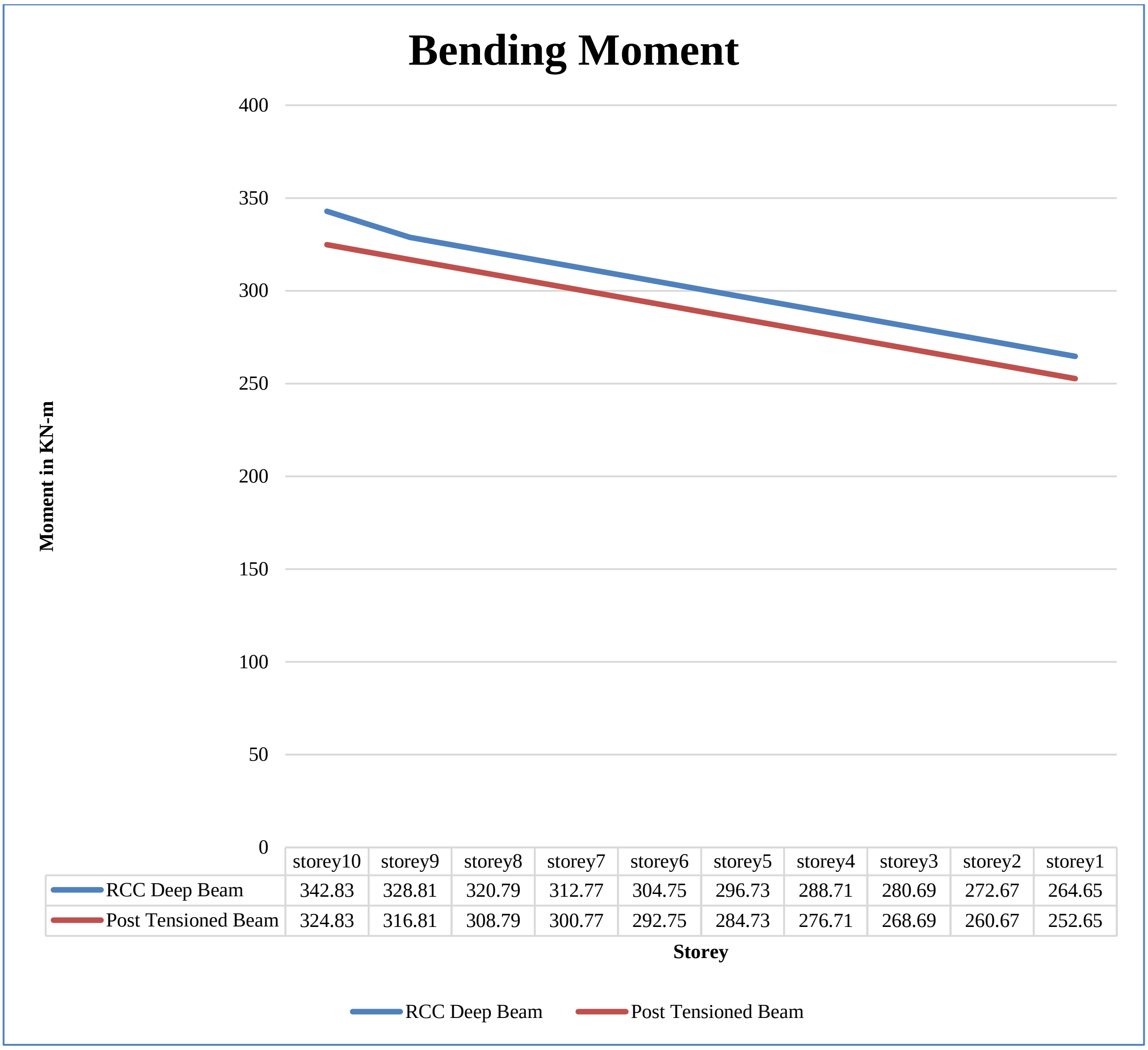


Fig 11: Bending Moment

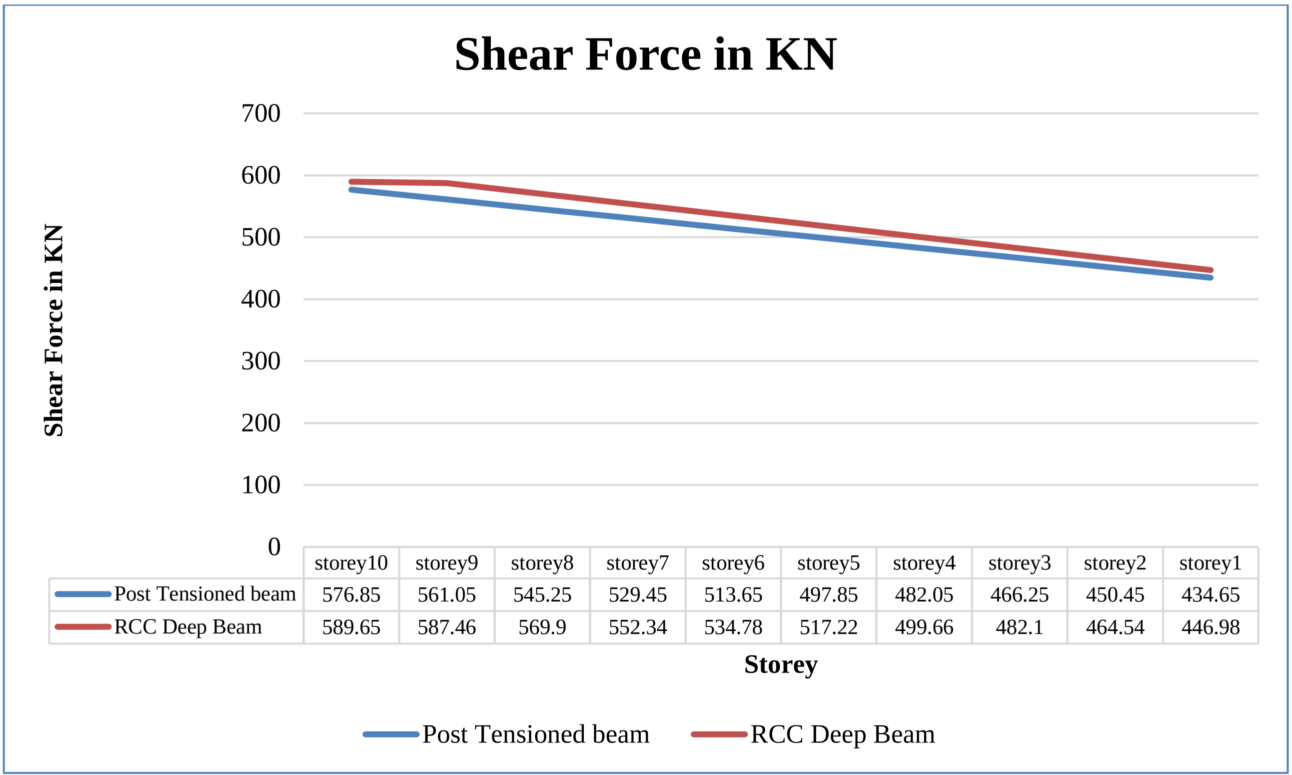


Fig 12: Shear Force

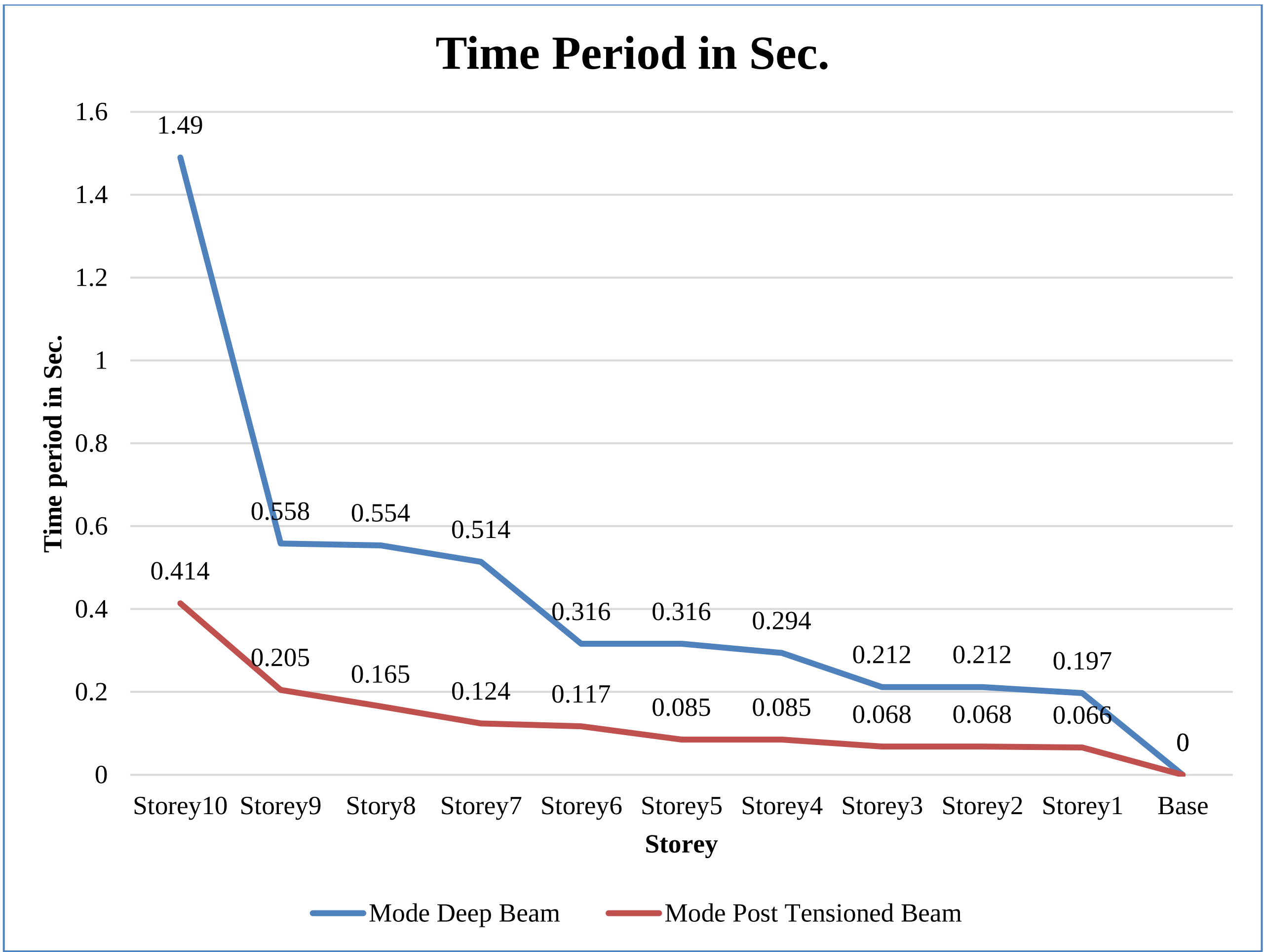


Fig 13: Time period

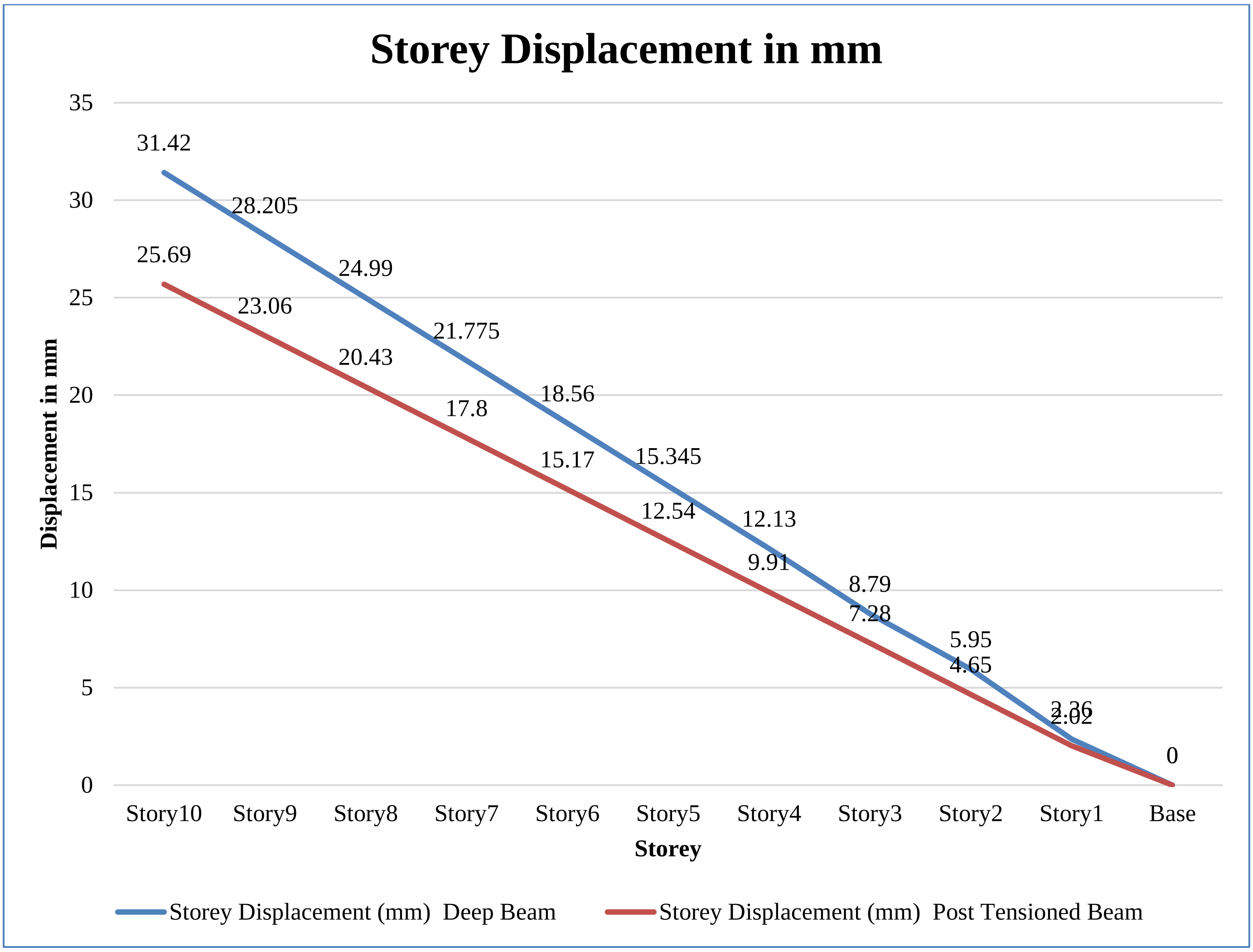


Fig 14: Displacement

IV. CONCLUSIONS

In present study comparative study is done on a G+ 10 storey structure with different beams namely RCC deep beam and Post Tensioned Beam for same loadings which will be stable, good in stiffness, cost effective, economical and easily available.

Shear force: As shear force is generated due to unbalancing at the joints connecting different members, here in above chapter it is observed that structure using Post tensioned beam can minimize the forces unbalancing by approximately 22% thus making structure more stable.

Deflection: The deflection distance of a member under a load is directly related to the slope of the deflected shape of the member under that load, and can be calculated by integrating the function that mathematically describes the slope of the member under that load. In results above it is observed that frame structure using Post tensioned beam is resisting deflection comparing to structure with deep beams

Cost Analysis: As India is a developing nation thus development of new construction with cost effectiveness is important for its proper and budgeted development. Here results shows that using Post tensioned beam structure can minimize the cost by 21.41% of the total cost.

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