Comparative Study of a Deep Beam Structure with PT Beam and Supporting Beam Using Analysis Tool

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Abstract — The comparative analysis was followed with numerical values and structure stability where the designing and analysis of the model was done using ETABS programming in the elastic domain and finally with the columns and beams arrangement models. In this study we are considering a G+13 tall building frame with three different condition i.e deep beam, deep beam with secondary beams and post tensioned beams. In this study we are performing dynamic analysis using response spectrum method and I.S 1893-I codal provisions. For analysis and designing we are utilizing Integrated building designing software ETABS.

Keywords: Deep Beam, Deep Beam With Secondary Beam, Post Tensioned Beam, Structural Design, Reinforced Concrete, Strut-And-Tie, Stresses Field

I. INTRODUCTION

Deep beams are primary components stacked as straightforward shafts in which a lot of the load is conveyed to the backings by a pressure power joining the heap and the response. Accordingly, the strain conveyance is at this point not considered straight, and the shear damages become critical when contrasted with unadulterated flexure. The fundamental distinction between a thin bar (a/d>2.5) and a profound pillar is that on account of a slim shaft the shear deformity is insignificant and could be disregarded while it should be considered in the investigation and plan of a profound bar.

This research is focused towards analysis of reinforced deep beam, reinforced deep beam with secondary beam and post tensioned beam. A RCC structure is modelled and analyzed G+13 using the different beams discussed before. Etabs application is used for the modelling and analysis of the structure and results are presented

II. DEEP BEAMS

Floor sections under even burden, limited capacity to focus conveying substantial loads, and move supports are instances of profound bars. A profound pillar is a bar having an enormous profundity/thickness proportion and shear range profundity proportion of under 2.5 for concentrated burden and under 5.0 for the circulated load. In light of the calculation of profound bars, their conduct is distinctive with thin shaft or middle of the road pillar. The Design depends on the ACI Ultimate Strength Design Method and applies to those flexural individuals having an unmistakable range to profundity proportion of under 4.0. The flexural support is planned considering the decreased switch arm because of the non-linearity of the strains' circulation.

Profound shafts assume an extremely critical part in the plan of small and large scale structures. Here and there for structural purposes, structures are planned without utilizing any section for an extremely enormous range. In such case, if conventional pillars are given they can cause disappointment, for example, flexural disappointment. To stay away from this issue of development of some extremely long range lobbies and so forth the idea of profound pillars is exceptionally compelling and tough.

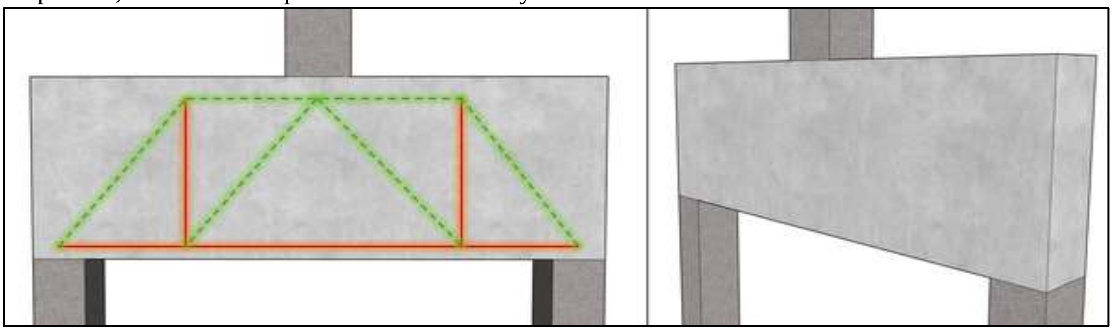

Fig. 1: Deep Beams.

III. OBJECTIVES

To perform a parametric study in order to identify the effect of different parameters on the shear strength of deep beam, deep beam with secondary beam and Post tensioned beams and to compare the accuracy of the available shear equations Comparative analysis of deep beam, deep beam with secondary beam and post tensioned beam on a G+13 symmetrical structure and evaluate their performance under seismic effect.

IV. LITERATURE REVIEW

Khattab Saleem Abdul-Razzaq et.al (2018) the primary point of the examination was to contemplate the impact of compressive strength of cement (f'c) and yield pressure of building up steel (f'y) on the conduct of self-compacted concrete (SCC) profound shafts while supporting their swaggers utilizing the limited component program ANSYS 13 variant. This work presents the aftereffects of the exploratory tests led on nine examples separated into three gatherings. The contrast between the three gatherings was the sort of stacking; 2-concentrated powers for the first gathering, the 1-concentrated power for the second gathering and consistently disseminated load for the third gathering.

The heap is moved from the stacking focuses to the backings by means of the swaggers, which is in pressure. These swaggers make intense points with the ties that produce elastic powers in these ties. In this manner, any adjustment of the compressive strength of concrete or in the elasticity of the primary support prompts a conspicuous impact on a definitive limit. The limited component examination utilized in the exploration had a decent concurrence with the trial brings about terms of burden avoidance conduct Pu and Δu.

Yousif Jabbar Lafta and Kun Ye (2016) The shear strength limit of profound bars is the significant purpose for the development of the utilization of profound bars. By and large, the conditions of code necessities for RC profound shaft capacity are traditionalist. The conduct and extreme shear limit of RC profound bars are affected by a few variables. burden and backing conditions, even and vertical web support, shear length to-profundity proportion, burden and backing bearing plates, conveyance of the support alongside the profundity of the profound shaft's web, pressure support and compressive strength. The most un-impacting boundaries are base cover, side cover, the width of the bar, dissemination of vertical stirrups in the web, and total size; the presence of the openings in the web the shear strength of profound shafts has been changed with various mathematical arrangements.

The conclusion from the outcomes expressed that Deep shafts with high compressive strength show a high shear strength limit. Expanding the Tension Reinforcement sum will build the quantity of breaking just as extreme burden. Then again, diminishing pliability and decreasing diversion. Expanding the upward web Reinforcement sum will build extreme burden limit and controlling the inclining break. Level web support has less impact on extreme limit than vertical support. The presence of even shear support significantly affects the limit of the profound shaft with opening. In the event that the proportion of successful range to profundity expands a definitive shear strength of the profound shaft is diminished for a similar measure of longitudinal steel. Lessening of the general size of high strength substantial profound pillars with a similar proportion brings about a direct decrease in extreme strength. Old style flexible hypothesis of bowing isn't suitable to issues including profound bars. The presence of web openings inside the shear length caused a critical decrease in the shear strength limit of profound bars.

Neeraj Kumar Verma et.al (2020) the objective of the exploration paper was to assess the presentation of PT pillar under seismic impact with various profiles of ligaments, check the exhibition of RCC profound bar and PT shaft section with multi-story building framework with seismic stacking execution and think about the expense of profound RCC bar with PT bar. The demonstrating and examination of the design were finished utilizing the scientific application ETABS. In examination close to assessment was done on a G+ 10 story structure with different bars, specifically, RCC significant column and Post Tensioned Beam for same loadings which will be consistent, satisfactory in solidness, monetarily adroit, traditionalist and viably open.

The results concluded that as shear power is produced due to unbalancing at the joints interfacing various individuals, here in above section it is seen that structure utilizing Post tensioned pillar can limit the powers unbalancing by around 22% consequently making structure more steady. The redirection separation of a part under a heap is legitimately identified with the slant of the diverted state of the part under that heap, and can be determined by incorporating the capacity that numerically portrays the slant of the part under that heap. In results above it is seen that casing structure utilizing Post tensioned bar is opposing diversion contrasting with structure with profound pillars. 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.

Jun-Hong Zhang et.al (2020) the examination planned to research the shear limit execution for eight profound shafts with HTRB600 built up high strength concrete under concentrated burden to empower a superior comprehension of the impacts of the shear length profundity proportion, longitudinal support proportion, vertical stirrup proportion and to further develop plan methodology. The component of eight test examples is 1600 mm x 200 mm x 600 mm. The powerful range to stature proportion l0/h is 2.0, the shear length profundity proportion λ is 0.3, 0.6 and 0.9, separately.

The results stated that the shear span–depth ratio is the most important parameter that controls behavior and shear capacity of high-strength reinforced concrete deep beams. The presence of vertical shear reinforcement can control the crack propagation/opening and improve the ductile behavior of deep beams. But this effect is very limited as further increase in shear reinforcement does not enhance the shear capacity as failure is dominated by crushing of the concrete. The calculation of shear capacity of high-strength reinforced concrete deep beams implemented by EC2 code and CSSA is mostly over-conservative, and the shear equations provided by GB20010-2010 and ACI318-14 can predict results with a reasonable degree of accuracy.

Basawantaraya Gouda et.al (2019) the research paper presented comparative study on design and analysis of high-rise residential building (G+10) using ETABS software. A (G+10) building was analyzed for finding the shear forces, bending moments, deflections & reinforcement details for the structural components of building (such as Beams, columns & slabs) to develop the economic design. Seismic analysis by both Static (Equivalent Lateral) and Dynamic (Response Spectrum Analysis) method for (G+10) residential building using ETABS Software tool.

The Response spectrum analysis produces storey shear in both direction while static analysis only produces in direction of loading and it increases along the depth. As the height of storey increase, the displacement values too gradually increases, top storey has maximum displacement. For R.S analysis storey displacement are 14% less than the corresponding values in Static analysis, leads to Economic design. Storey drift increases with the increase in height of building, maximum at Middle height.

The results concluded that ETABS gives more economical and convenient results than manual design results. And give provision to do comparison of results from linear static analysis and linear dynamic analysis (Response Spectrum Analysis Method Different load combination can be applied easily like seismic load and response spectrum load. The (G+10) Building has analysed & design with reinforcement details. The output of the modelling is economical and safe from manual methods. From the analysis and design of the slabs and beams it was found that the check for deflection and shear was safe. Stiffness of a higher value of a Building is advantageous with respect to Earthquake damage as it can limits the deformation demands on a building but due to Some Soft Storey (~Less Stiff), Static analysis is not enough for high rise buildings & it's necessary to provide dynamic analysis.

Md Shahnewaz et.al (2012) the examination paper intended to research the seismic exhibition of supported substantial profound bars structure. A supported substantial construction with a profound shaft in the primary story was chosen from the writing and was investigated. The limit of the design was determined utilizing non-straight relocation based Pushover Analysis (POA) and the seismic interest was determined for ten unique quake records utilizing non-direct Time.

The outcomes expressed that the sidelong uprooting limit of the design is discovered to be in the protected reach as it doesn't arrive at the quick inhabitance harm level as per FEMA rules. The general factor of wellbeing was determined as 2.1 as far as dislodging limit and 1.1 as far as between story float. The base shear of the design was discovered to be lacking. A little over half of the seismic tremor records showed that the limit of the construction falls beneath the interest. Thusly, a retrofit procedure ought to be carried out at the base segment to build the limit. The shear limit of the slim pillars at the upper story was found palatable. Nonetheless, there was a critical strength deficiency noticed for the shear limit of the profound bar. The shear interest for the profound bar surpassed the limit with respect to twenty percent of the tremor records. It ought to be noticed that the disappointment of the profound pillar will bring about the complete breakdown of the structure. The pivot development in the weakling investigation showed that the principal pivot framed at the profound shaft level in the pillar section joints. Thusly, a retrofitting procedure ought to be applied to fortify the deep beam.

V. PARAMETERS OF MULTI STOREY STRUCTURE

Parameters of Multi Storey Structure	
Type of Building	Multistorey Rigid Plane Frame
Type of Frame	RC Moment Resisting Frame
Zone	V (Response Spectrum)
Types of soil	Soft
Number of stories	G+13
Thickness of Slab	150 mm
Depth of Foundation	1.7 m
Floor to floor height	3.0 m
Materials	M30 and Fe415
Importance factor	1.5
Zone	0.36
Response Reduction Factor	5
Seismic analysis	Dynamic Analysis method considering I.S. 1893-I: 2016 provisions.
Column	500x500mm
Deep Beam	600 x 300mm
Secondary Beam	350x250mm

Table 1: Geometrical Data

VI. METHODOLOGY

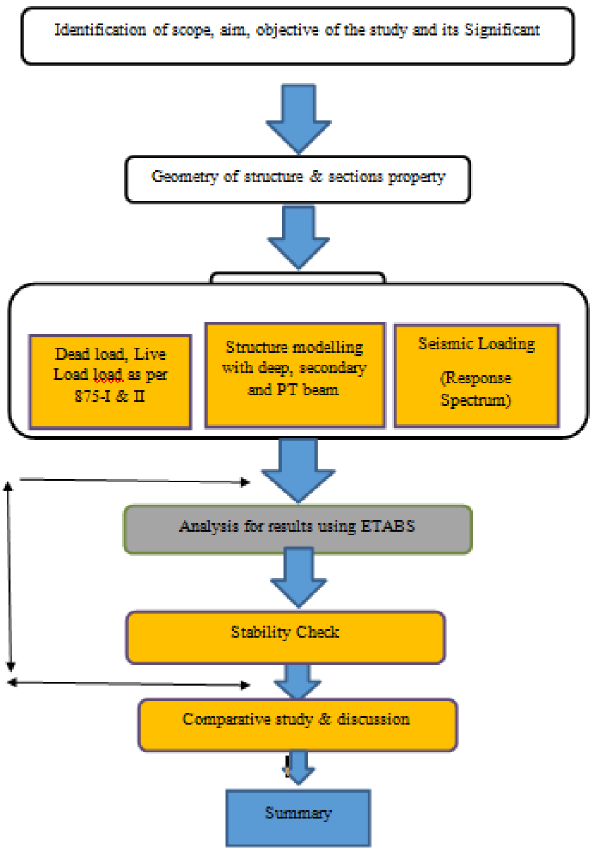

Fig. 2: Flow Chart

VII. ANALYSIS RESULTS

Bending Moment kN-m			
	Deep Beam	Deep Beam with Secondary Beam	PT Beam
Storey 13	384.68	369.68	355.56
storey 12	374.19	352.19	339.9
Storey 11	361.41	339.41	321.98
Storey 10	342.83	324.83	313.75
Storey 9	328.81	316.81	307.42
Storey 8	320.79	308.79	308.79
Storey 7	312.77	300.77	294.81
Storey 6	304.75	292.75	287.93
Storey 5	296.73	284.73	273.87
Storey 4	288.71	276.71	269.43
Storey 3	280.69	268.69	257.21
Storey 2	272.67	260.67	246.91
Storey 1	264.65	252.65	239.22

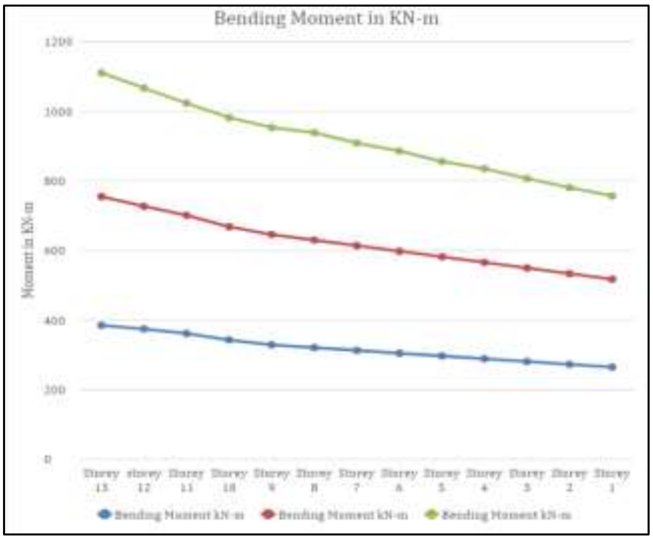

Fig. 3: Bending Moment

Shear Force KN			
Storey	Deep Beam	Deep Beam with Secondary Beam	PT Beam
Storey 13	618.02	606.71	591.72
Storey 12	609.28	594.01	583.1
Storey 11	599.63	587.25	574.66
Storey 10	589.65	576.85	561.32
Storey 9	587.46	561.05	548.49
Storey 8	569.9	545.25	533.71
Storey 7	552.34	529.45	513.99
Storey 6	534.79	513.65	501.1
Storey 5	517.22	497.85	482.52
Storey 4	499.66	482.05	470.25
Storey 3	482.1	466.25	451.34
Storey 2	464.54	450.45	441.87
Storey 1	446.98	434.65	422.32

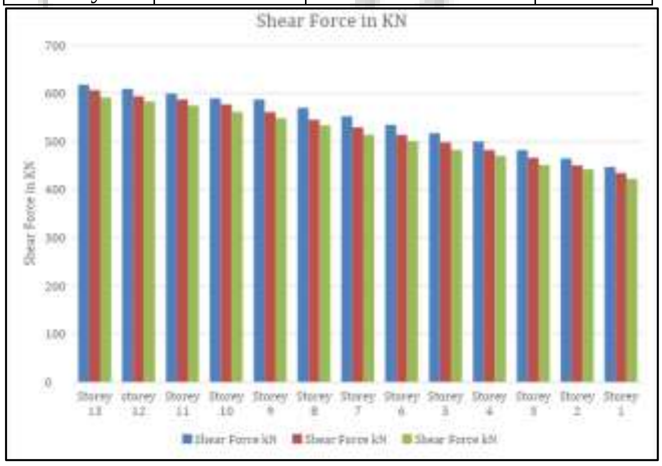

Fig. 4: Shear Force

Storey Displacement in mm			
Storey	Deep Beam	Deep Beam with Secondary Beam	PT Beam
Storey 13	40.98	34.91	32.89
storey 12	37.55	31.5	30.07
Storey 11	34.47	28.41	27.31
Storey 10	31.42	25.69	24.01
Storey 9	28.205	23.06	22.38
Storey 8	24.99	20.43	19.44
Storey 7	21.775	17.8	15.87
Storey 6	18.56	15.17	13.32
Storey 5	15.345	12.54	10.99
Storey 4	12.13	9.91	8.45
Storey 3	8.79	7.28	6.12
Storey 2	5.95	4.65	3.66
Storey 1	2.65	2.52	2.39
Base	0	0	0

Fig. 5: Storey Displacement

Time Period in sec.			
Storey	Deep Beam	Deep Beam with Secondary Beam	PT Beam
Storey 13	2.94	1.99	0.71
storey 12	2.38	1.43	0.599
Storey 11	1.92	0.832	0.599
Storey 10	1.49	0.832	0.414
Storey 9	0.558	0.421	0.205
Storey 8	0.554	0.41	0.165
Storey 7	0.514	0.328	0.124
Storey 6	0.316	0.263	0.117
Storey 5	0.316	0.255	0.085
Storey 4	0.294	0.218	0.085
Storey 3	0.212	0.171	0.068
Storey 2	0.212	0.157	0.068
Storey 1	0.197	0.129	0.066
Base	0	0	0

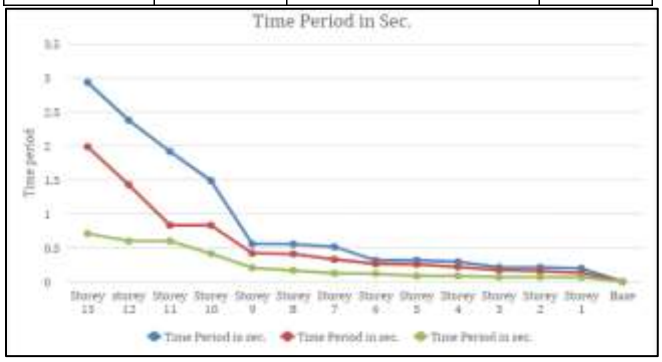

Fig. 6: Time Period

VIII. CONCLUSION

In present study comparative study is done on a G+13 storey structure with different beams namely RCC deep beam, RCC deep beam with secondary beam and Post Tensioned Beam for same loadings which will be stable, good in stiffness, cost effective, economical and easily available.

Bending Moment: it is a measure of the bending effect that can occur when an external force (or moment) is applied to a structural element. The most common structural element that is subject to bending moments is the beam, which may bend when loaded at any point along its length. In this case, the bending moment was found maximum in case of structure with deep beam whereas the results were found more stable in case of structure with post tensioned beam. Maximum bending moment was seen in structure with deep beam as 384.68 kn-m and least was visible in post tensioned beam as 355.56kn -m at storey 13. Bending moment was contained best with post tensioned beam when compared to other two cases.

Shear force: it is a force acting in a direction that's parallel to (over the top of) a surface or cross section of a body, like the pressure of air flow over an airplane wing. The word shear in the term is a reference to the fact that such a force can cut, or shear, through the surface or object under strain. The shear force acting on the three cases stated that most desirable model results were found to be stable in case of deep beam with secondary beam and model with post tensioned beam. 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 the results above it is observed that frame structure using Post tensioned beam is resisting deflection compared to structure with deep beams. Total displacement of any storey with respect to ground and there is maximum permissible limit prescribed in IS codes for buildings. Storey displacement was valued in mm where maximum stability was seen in other two cases namely deep beam with secondary beam and post tensioned beam

REFERENCES:

[1] Khattab Saleem Abdul-Razzaq, Sarah F. Jebur and Abbas H. Mohammed, [Concrete and Steel Strengths Effect on Deep Beams with Reinforced Struts], International Journal of Applied Engineering Research ISSN 0973-4562 Volume 13, Number 1 (2018) pp. 66-73.

[2] Yousif Jabbar Lafta and Kun Ye, [Specification of Deep Beams Affect the Shear Strength Capacity], Civil and Environmental Research, Vol.8, No.2, 2016.

[3] Neeraj Kumar Verma, Deepak Kumar Bandewar, Sachin Jat and Dr, Vikas S. Pagey, [ANALYSIS OF A LONG SPAN STRUCTURE CONSIDERING PRESTRESSED BEAMS USING ETABS], International Journal of Creative Research Thoughts (IJCRT), 2020 IJCRT | Volume 8, Issue 9 September 2020 | ISSN: 2320-2882.

[4] Jun-Hong Zhang, Shu-Shan Li, Wei Xie and Yang-Dong Guo, [Experimental Study on Shear Capacity of High Strength Reinforcement Concrete Deep Beams with Small Shear Span–Depth Ratio], Materials 2020, 13, 1218; doi:10.3390/ma13051218.

[5] Basawantaraya Gouda, Turginev Basumatary, Bijoy Das, Lakshmi. V and Md. Majid Raza, [Seismic Analysis and Design of G+10 RC Residential Building], IJESC, June 2019.

[6] Md Shahnewaz, Ahmad Rteil and M. Shahria Alam, [Seismic Effects on Deep Beams in a Reinforced Concrete Building], 3rd International Structural Specialty Conference June 6-9, 2012.