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Effect of Backstay in Design of Tall Structure as Per IS 16700:2017

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Abstract: *Seismic analysis of structural systems with floor diaphragms has been a requisite in the recent past. The duty of a structural engineer is to be prudent about the behaviour of every structural system adopted. Amongst the structural systems that areadopted world over, diaphragm with rigid and semi-rigid floor plate are adopted widely in the analysis. This research focuses on the backstay effect i.e. podium structural interaction with the tower area and consideration of retaining wall as increment of lateral stiffness as specified in latest tall building code IS6700:2016 for low and high rise structures. In the current studymodels were prepared with low to high rise storeys with rigid and semi rigid diaphragms considering backstay diaphragm placing tower at centre and corner. The models were subjected to seismic forces; response spectrum along with the combination of thegravity loads. The structural responses like natural periods, base shear, displacement and inter storey drift were also studied.*

Keywords: Podium tower, Backstay effects, rigid andSemi-rigid diaphragm. Seismic Analysis

I. INTRODUCTION

Increase in population, urbanization and requirement of various infrastructure resulted into limited availability of suitable land for development. So, to take leverage as well as to satisfy demand of larger commercial space near to road level and making building compliant to minimum parking space requirements Architects and Developers have come up with unique idea of Podium type Buildings. Traditionally, lateral systems (Shear Walls) have been viewed as simple cantilever beams fixed at the base. While this analogy is reasonable correct for the above-grade structure, but for podium + tower type building a more realistic and justifiable analogy would be cantilever with back span to include the effects of the relatively larger lateral stiffness of podium.

In this analogy, the lateral load resisting system is viewed as a cantilever beam overhanging from one intermediate support, where this intermediate support is provided by the above ground,at-ground and below ground diaphragms and peripheral shear (basement walls) as per structural geometry. Backstay Effect is set of lateral forces developing within a podium structure to equilibrate the lateral forces and moment of a tower extending above the podium structure. The so-called "**Backstay Effect**" can result in very large transfer of forces and may produce a drastic change in the distribution of shear force and overturning moment below the podium-level diaphragm. Back-Stay effect is also called as Shear-Reversal because due to the overturning resistance provided by the podium to the tower, the seismic force resisting elements of the tower observe change in the direction of the Shear force at the podium-tower interface level and below.

II. OBJECTIVE

1).To understand the phenomena of the Backstay effect observed in the tower-podium type structures by considering the provisions given in the Indian standards (IS 16700: 2017).

2). With this parameters different models will be prepared & Compare

1. Tower Only
2. Single tower with Podium
3. Multiple towers with common (Sharing) podium etc.
4. Cut-outs in the diaphragms with podium and tower together.

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II. ANALYSIS

CSI ETABS 2018 software was used for the analysis of the said 20 storey structure. The whole study was performed considering Earthquake load and Gravity Loads. Diaphragm have been modelled as Semi-Rigid because they transfer the loads acting on it (transverse & in plane) through out of plane to study the Backstay Effect these factors are to be considered and understood.

Table 1: Load and Seismic Factor

LOAD AND SEISMIC FACTOR	
Dead Load	1.5 kN/m^2
Live Load	3 kN/m^2
Seismic Zone	III
Zone Factor	0.16
Response reduction factor	5
Importance factor	1.2
Soil condition	Medium

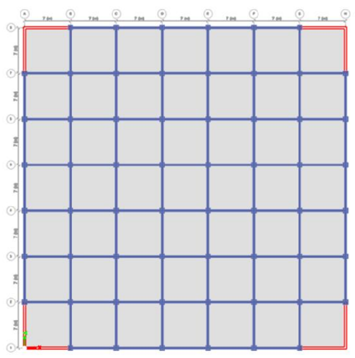
Fig1: Tower Plan

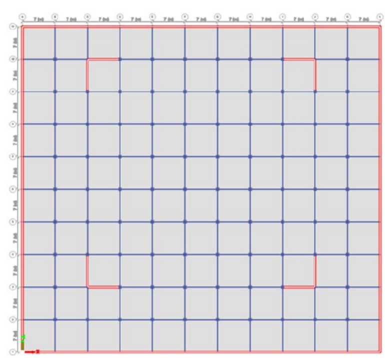
Fig2: Podium Plan

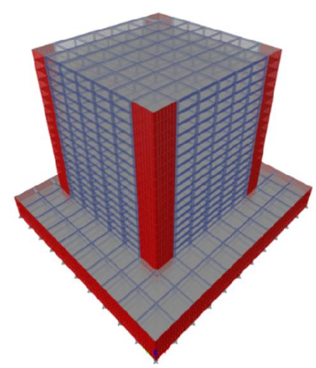
Fig3: 3d view of building

Concrete Grade for slabs is M40 and different sizes of thickness considered are 150 mm, 200 mm. Concrete Grade for Beams is M45 and sections are (300x750) mm. Concrete Grade for Columns is M45 and sections used are (750x750) mm. Concrete Grade for Structural Wall is M35 and sections are 300 mm.

III. RESULT

Following 4 ETABS Models were prepared.

- Model 1: T: Tower only
- Model 2: T+P1: Tower + 1 storey podium
- Model 3: T+P2: Tower + 2 Storey Podium
- Model 4 : T+P3: Tower + 3 Storey Podium

As per tall building code clause 5.4 for lateral drift for factored earth quake load factored combination the drift is limited to h_i / 250.For dynamic analysis displacement for scaled factor of base shear for bare frame h_i/250 theoretical limit was calculated to be 240 mm. It was found that bare frame displacement was found to be within the limits for dynamic analysis. The Top storey displacement for only tower is 198.21 mm and Three Storey podium Displacement is 151 mm. The top storey displacements for rigid decreased about 20 to 25 % when back stay diaphragm effectwas considered. This is because increase in stiffness and massdue to backstay diaphragm.

Inter storey drift = 0.004 x H (Floor height 3000 mm). Storey drift limitation as per IS 1893-2016 clause 7.11.1 shallnot exceed 0.004 times the storey height under the action of design base shear V_b. As per IS 16700- 2017 the storey tall building code the drift is taken as limited as h_i/400. Drift limit0.004 x 3000 = 12.0 mm.

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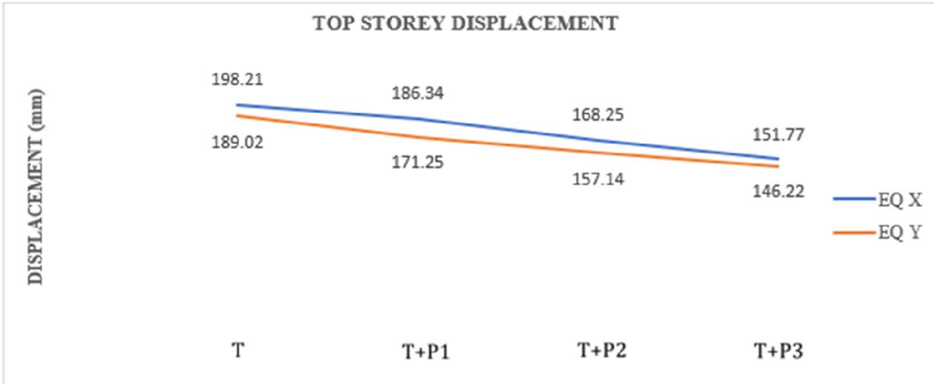

Fig 4: Maximum Displacement

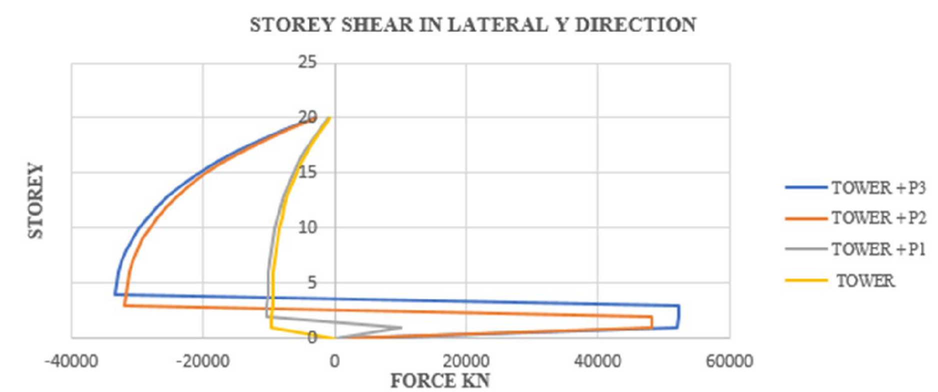

Fig 5: Storey Shear

Fig 5: showed maximum shear reversal. From the results obtained, and Fig6: maximum Bending Moment in case of only Tower was observed at the Base level while considering Backstay (Podium + Tower), maximum Bending Moment was observed at the main Backstay level. Similar Shear Reversals were observed in case of both the Lateral directions.

Shear reversal is critical because shear force changes direction within the podium levels, and same lateral load resisting element helps resist the changing shear force.

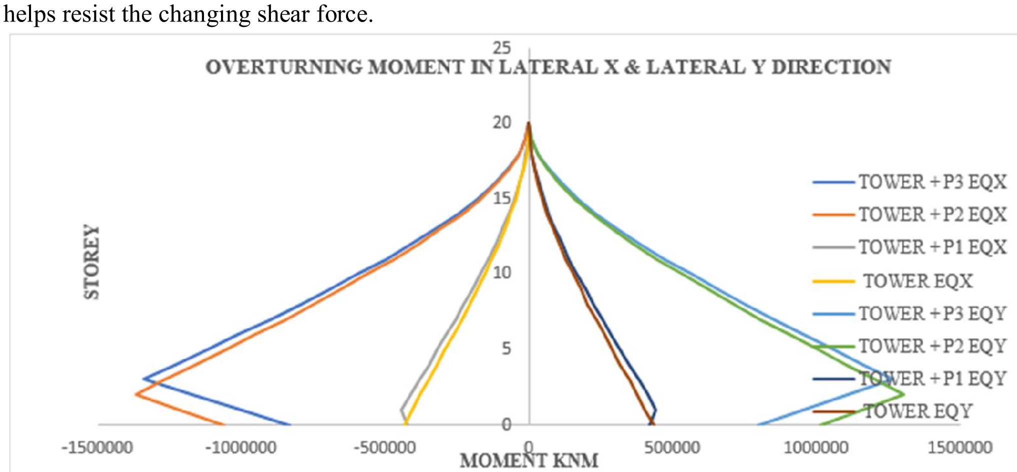

Fig6: Overturning moment

V. CONCLUSION

The effect of backstay diaphragm results in increased mass therefore resulting in proportional increase in base shear. For low rise structure the stiffness of building the benefit of backstay diaphragm were not much when compared to high structure.

There was 20 -25 % of reduction in displacement with consideration of backstay effect with backstay diaphragm effect in Three storey podium when compared to Tower only.

Displacement gradually reduces more with effect of backstay and retaining wall.

The effect of backstay diaphragm had the drift with in permissible limit (0.004 times floor height).

The increase in podium height also lead to a rise in the backstay force at the Tower podium interface level.

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REFERENCES

[1]. Geetha, Kiran Kamath, Seismic performance of a tall multi storey tower connected by a large podium, Volume:8, Issue:2 (IJRTE, 2019)

[2]. Mehair Yacoubian, Nelson Lam, John L. Wilson, Effects of podium interference on shear force distribution in tower walls supporting tall buildings, (Elsevier, 2017)

[3]. Ankan Kumar Nandi, Jairaj C, Back-Stay effect of diaphragm in tall building, Volume:9, Issue:3 (IJITEE, 2020)

[4]. Los Angeles Tall buildings Structural Design Council, an alternative procedure for seismic analysis and design of tall buildings located in the Los Angeles region, a consensus document 2014 edition.

[5]. B.o.I Standards, IS:16700:2017 – Criteria for Structural Safety of Tall Concrete Buildings, India,Bureau of Indian Standards, 2017

[6]. B.o.I Standards, IS:13920:2016 – Ductile Design and Detailing of Reinforced Concrete Structures subjected to Seismic Forces, India, Bureau of Indian Standards, 2016.

[7]. B.o.I Standards, IS: 1893(PART-1):2016 – Criteria for Earthquake Resistant Design of Structures, India, Bureau of Indian Standards, 2016.

[8]. B.o.I Standards, IS: 875(PART-3):2015 – Design Loads (Other than Earthquake) for Buildings and Structures – Code of Practice Part-3 Wind Loads, India, Bureau of Indian Standards, 2015.

[9]. B.o.I Standards, IS: 456:2000 - Plain and Reinforced Concrete, India, Bureau of Indian Standards, 2000.

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BIOGRAPHY

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