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Analysis of a High-Rise Building Considering Hybrid Shear Wall Under Seismic Load

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ABSTRACT

Shear walls are structural elements that protect structures from lateral loads such as wind and earthquakes. When the external walls of a building are insufficiently strong and stiff, shear walls are added to the interior to provide greater strength and stiffness. When the permissible span width ratio for the floor or roof diaphragm is exceeded, these shear walls are required. Shear walls are flexural members that are commonly used in high- and low-rise buildings to prevent total collapse due to seismic stresses.

Here hybrid shear wall means a combination of shear wall and X bracing. This research is focused towards presenting the behavior of structure considering three different cases namely, structure with X bracing at corner, structure with shear wall at corner and structure with hybrid shear wall at corner.

The structure was modelled and analyzed using analytical application ETABS v 2016. The parameters of comparison were Storey displacement, storey shear. Storey drift, storey stiffness and base shear.

Keywords: Hybrid Shear Wall, Response Spectrum Analysis, Shear wall, Seismic Forces.

I. INTRODUCTION

To securely carry gravity and lateral loads, tall building design entails a conceptual design, approximation analysis, preliminary design, and optimization. The basic goal of all structural systems employed in the construction of structures is to effectively transfer gravitational loads. Dead load, active load, and snow load are the three most frequent loads caused by gravity. Buildings are also vulnerable to lateral loads induced by wind and seismic forces, in addition to these vertical loads. High stresses, sway movement, and vibration can all be caused by lateral loads.

The structural design of high-rise buildings incorporates wind and earthquake dynamic calculations. Computer performance has improved dramatically in recent years, and practically all structural designers now utilise computer software for high-rise building structural design. In high-rise buildings susceptible to lateral wind and seismic stresses, shear walls are extremely critical.

II. Literature Survey

In this study we are preparing review of literatures, journals related to advancesin construction industry mainly in concrete technology. Following research has been reviewd as follows:

Alshawabkeh Shorouq and Wu Li (2019) A "hybrid" concrete shear wall system was investigated in this study, which included mild steel reinforcement as well as posttensioned steel for flexural strength and inelastic energy dissipation. In order to examine the expected seismic behaviour of the concrete wall subjected to seismic loading in a series of prototype or model hybrid walls of post tensioned steel in precast concrete shear walls and cast-in-place concrete shear walls, a logical parametric study was conducted.
The use of mild steel in addition to post-tensioned steel in reinforcing the concrete shear wall improved the characteristics of the concrete shear wall in terms of resisting seismic forces, particularly in terms of reducing lateral displacement (i.e., dislocation) caused by an earthquake loading, according to the findings.
Satya Narayan Reddy et al (2019) In this study, a residential building (modeled as conventional Frame, Shear wall and hybrid structure) is evaluated for its Dynamic performance under different seismic zones using ETABS (2016). The load considerations and Design conform to IS 1893: 2016 PART I. The Storey Stiffness, Storey shear, Maximum Storey Drift and Maximum Story Displacement of the three different models under different seismic zones was compared. The analysis incorporates the response spectrum method conforming to IS 1893-2016 part 1 and the load considerations conforming to IS 456 and ductile designing incorporated as per IS 13920-2016.
Conclusion stated that the shear wall structure performs effectively at severe seismic zone. The conventional RC frames are prone to high storey drifts and displacement at higher seismic zones. The Storey drift and the Storey displacements were well within the limits as per the IS codes. Storey drift and Storey displacements was only 25% and 40% respectively in the shear wall structure when compared to the Conventional RC frame structure. The variation of the stiffness was the lowest in the Shear wall structure and the highest in the conventional RC structures. But stiffness variation is slightly varying in case of shear wall structure due to a high percentage of openings in stilt and parking floor.The stiffness variation in the conventional frame structure was found most. Storey shear in shear wall structure is 40 % lesser compared to conventional and 25% in hybrid structure.

III.OBJECTIVES OF THE STUDY

- Behaviour study of 10 storey high rise RCC structure with X bracing, shear walls and hybrid shear wall for seismic & wind loads.
- The variation of storey drifts of the models to be investigated.
- The variation of displacement has to be investigated considering response spectrum analysis.
- It is necessary to perform both similar static analysis and response spectrum analysis.
- The response of three structural system are to be investigated.

IV. METHODS AND MATERIAL

Steps of Modelling

Step 1 Reviewing research papers published by different authors in order to identify the scope of the research.

Step 2 Defining grid system data for x and y coordinates. In ETABS, X coordinates are defined on grid ID as A, B, C etc and Y coordinates as 1, 2, 3 etc. The Z direction defined the storey height.

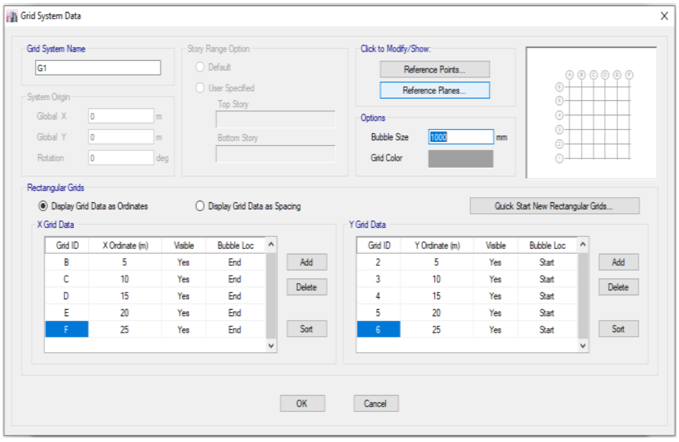


Fig 1 Grid System Data

Step 3 Defining structure object and applying simple storey data, here number of storey is G+10 with typical storey and bottom height is 3.2 m.

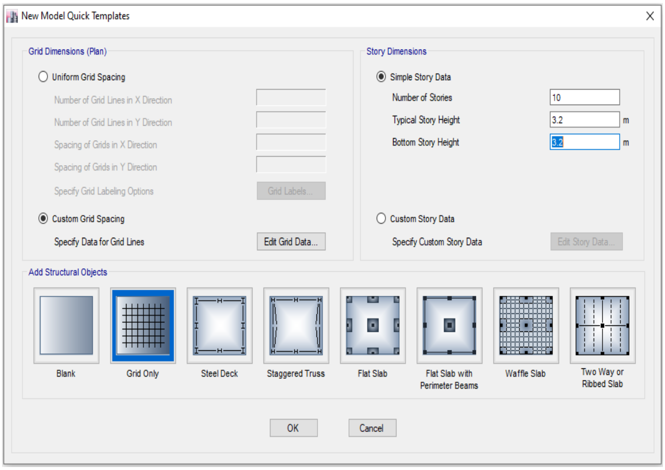


Fig 2 Model Template

Step 3 This step defines the properties of material as here RCC structure is considered with X bracing, shear wall and hybrid shear wall.

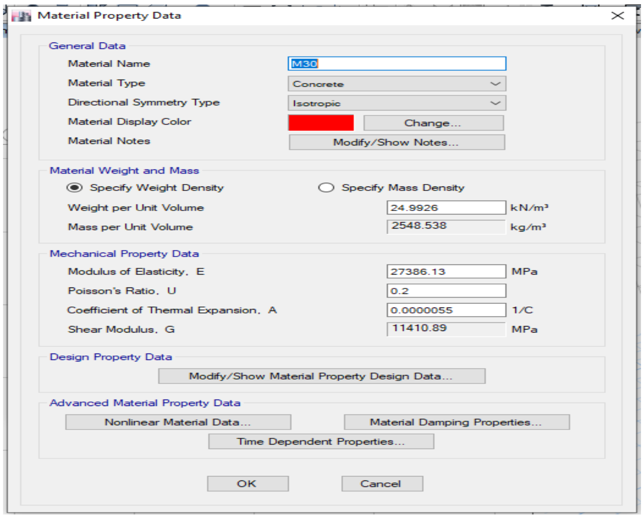


Fig 3.Defining property of concrete (M30)

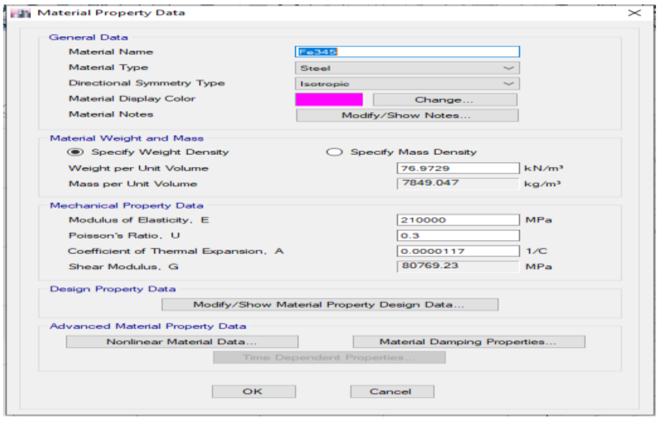


Fig 3 Defining properties of steel

Step 4 Defining section data for beam, column, slab, X bracing system and shear wall

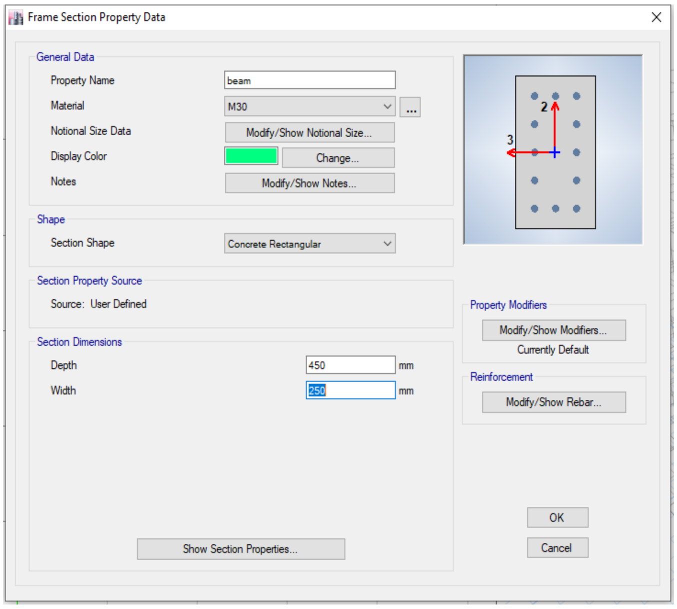


Fig 3 Defining section properties for beam

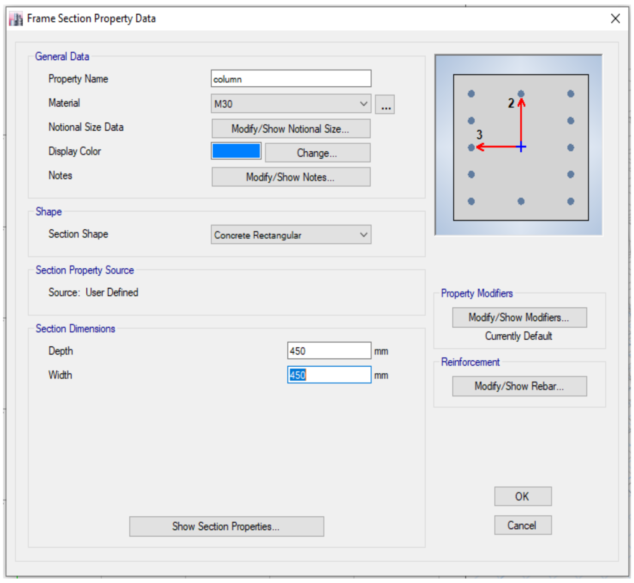


Fig 3 Defining properties of column

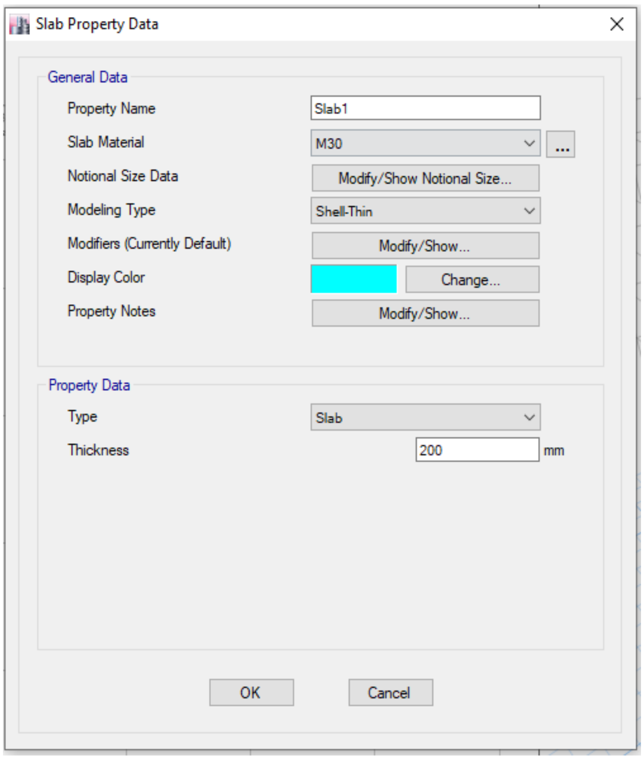


Fig 7 Defining properties of slab

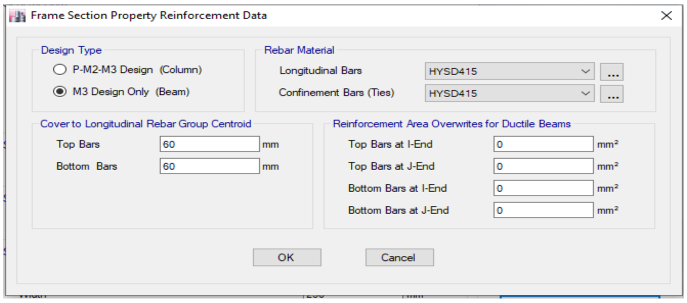


Fig 8 Defining section properties of reinforcement data

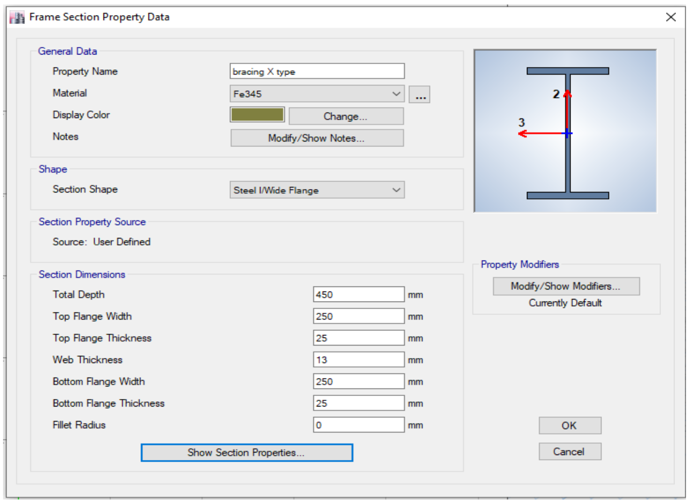


Fig 9 Defining section properties for X bracing system

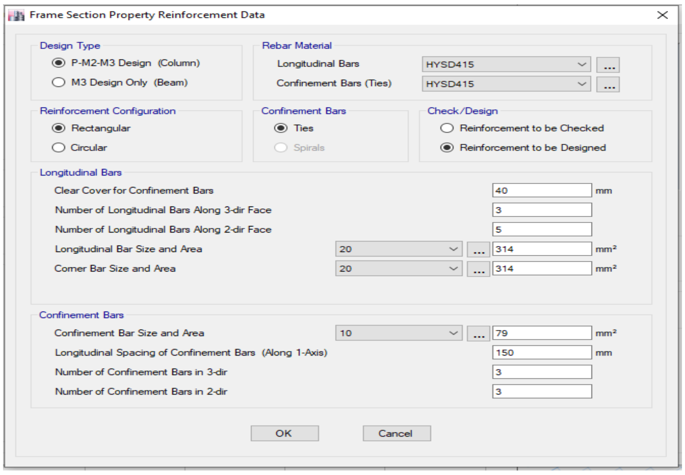


Fig 10 Frame section property reinforcement data fro design type and rebar material

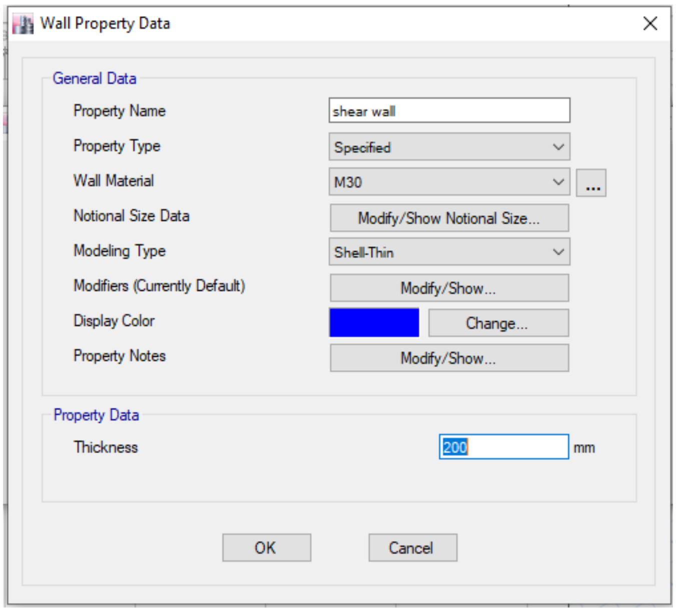


Fig 11 Defining properties of shear wall

Step 5 Defining load pattern for dead, live and seismic

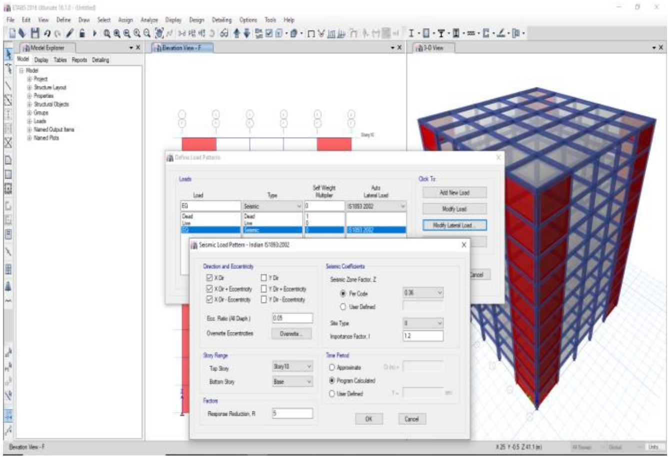


Fig 12 Defining seismic load pattern as per IS 1893 part I 2016

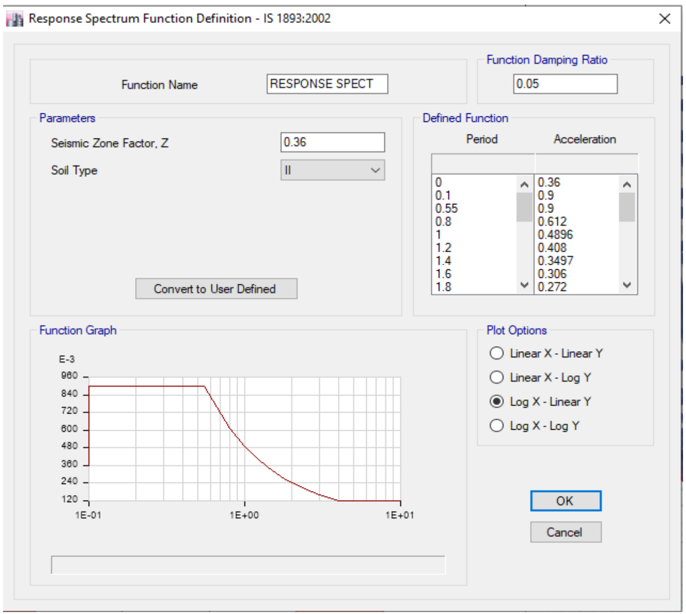


Fig 13 Defining response spectrum function

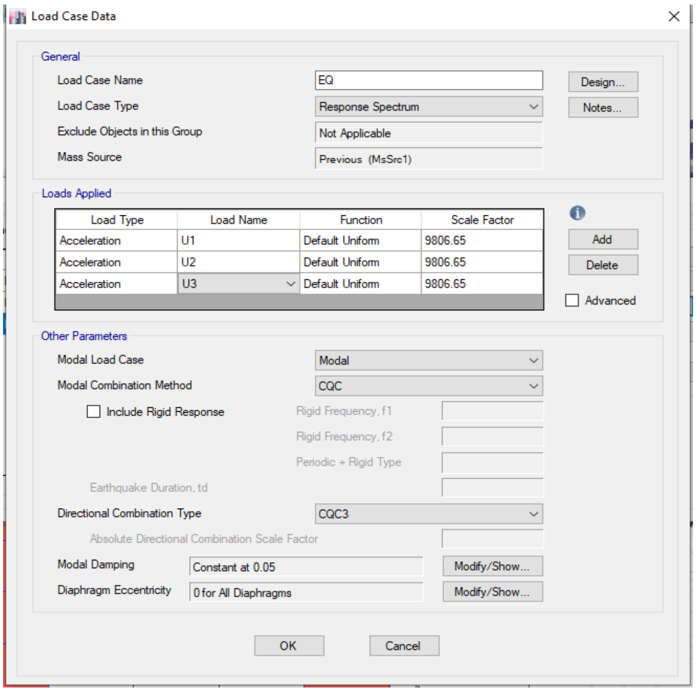


Fig 14 Defining Load case data for Response Spectrum

Step 6 analyzing the structure for displacement, drift and shear force

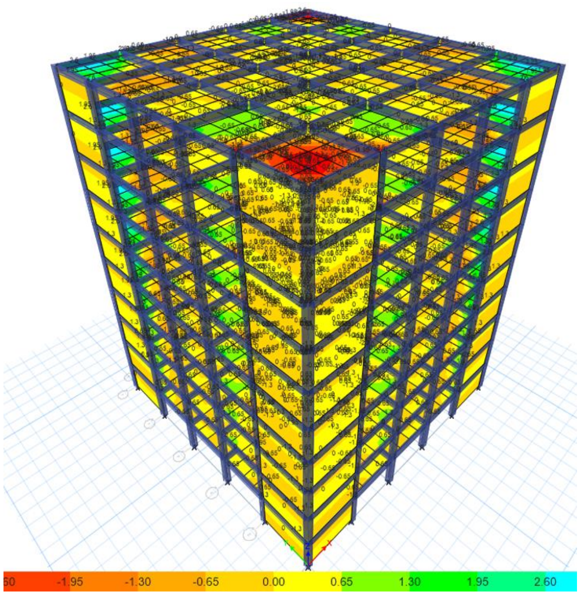


Fig 15 Analyzing stress

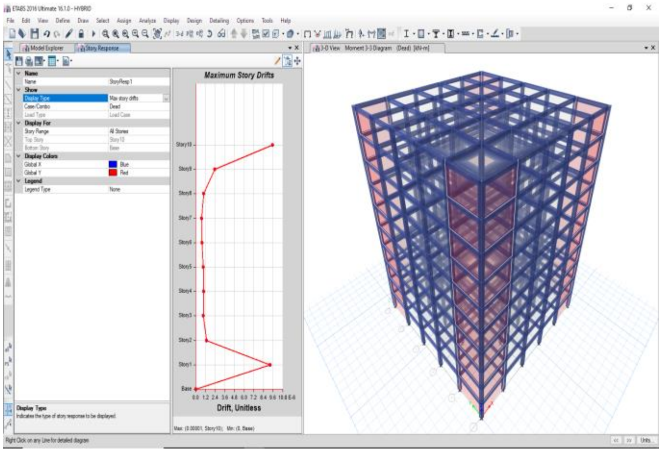


Fig 16 Storey Drift

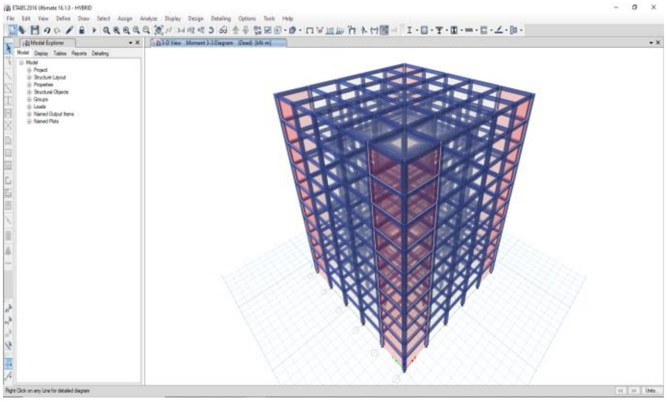


Fig 17 Stress on Shear Wall

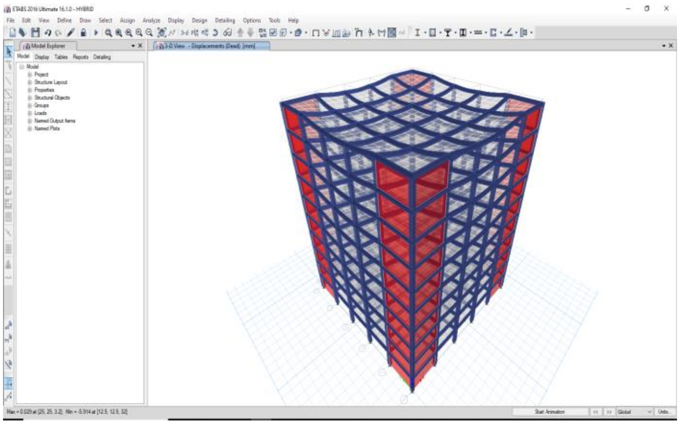


Fig 18 Analysis of Displacement

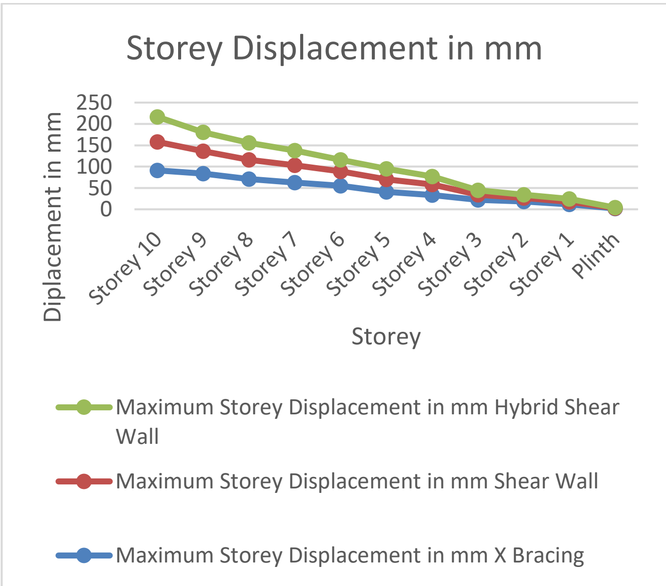
Table 1 Geometrical Description of Symmetrical Building

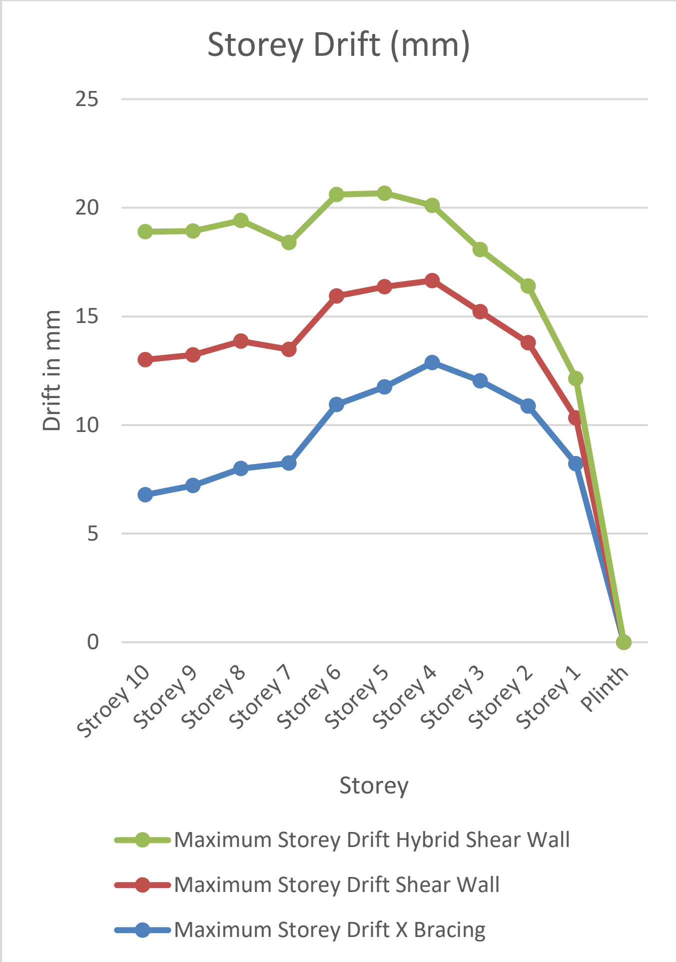
Geometrical Description of Symmetrical Building	
Length in X-direction	25m
Length in Y-direction	25m
Floor to Floor Height	3m
Total Height of Building	30m
Slab Thickness	200mm
Wall Thickness	230mm
Shear wall Thickness	200mm
Column Size	450X450mm
Beam Size	450X250mm

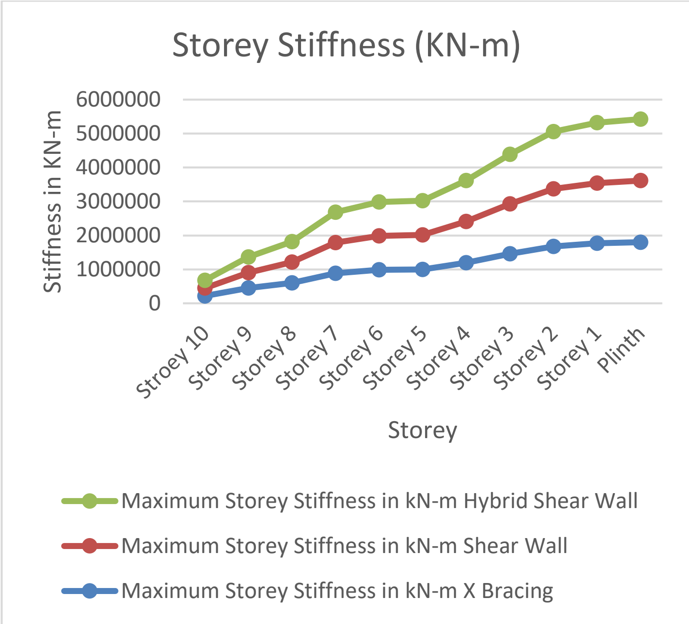
Table 2 Geometrical Description of Bracing System

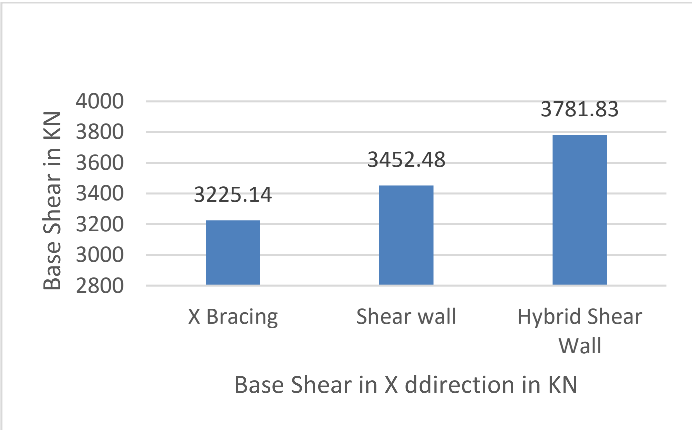
Geometrical Description of X Bracing System	
Total Depth	450 mm
Total Flange Width	250 mm
Total Fhange Thickness	25 mm
Web Thickness	13 mm
Bottom Flange Width	250 mm
Bottom Flange Thickness	25 mm
Fillet Radium	0
Section Shape	Steel I/ Wide Flange

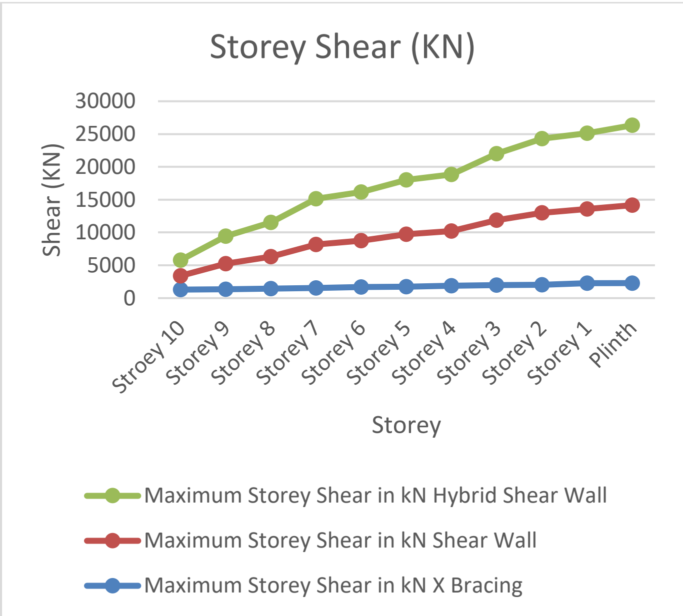
V. ANALYSIS RESULT

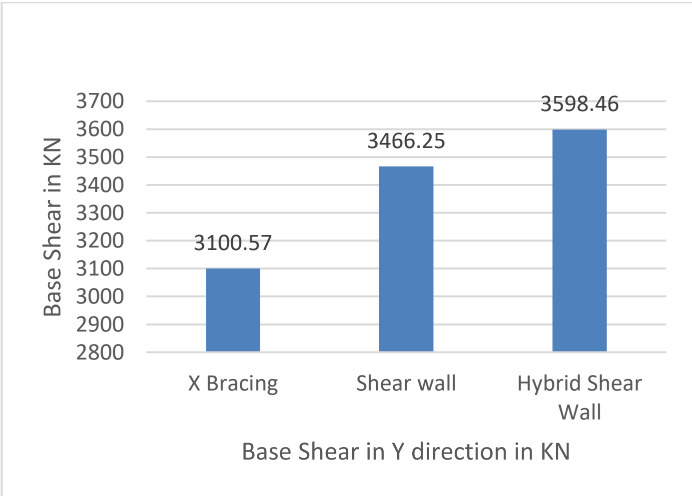



Storey Drift (mm)
Drift in mm
25
20
15
10
5
0
Stroey 10
Storey 9
Storey 8
Storey 7
Storey 6
Storey 5
Storey 4
Storey 3
Storey 2
Storey 1
Plinth
Storey
Maximum Storey Drift Hybrid Shear Wall
Maximum Storey Drift Shear Wall
Maximum Storey Drift X Bracing


Storey Stiffness (KN-m)
Stiffness in KN-m
6000000
5000000
4000000
3000000
2000000
1000000
0
Stroey 10
Storey 9
Storey 8
Storey 7
Storey 6
Storey 5
Storey 4
Storey 3
Storey 2
Storey 1
Plinth
Storey
Maximum Storey Stiffness in kN-m Hybrid Shear Wall
Maximum Storey Stiffness in kN-m Shear Wall
Maximum Storey Stiffness in kN-m X Bracing


Base Shear in KN
4000
3800
3600
3400
3200
3000
2800
3225.14
3452.48
3781.83
X Bracing
Shear wall
Hybrid Shear Wall
Base Shear in X ddirection in KN


Storey Shear (KN)
Shear (KN)
30000
25000
20000
15000
10000
5000
0
Stroey 10
Storey 9
Storey 8
Storey 7
Storey 6
Storey 5
Storey 4
Storey 3
Storey 2
Storey 1
Plinth
Storey
Maximum Storey Shear in kN Hybrid Shear Wall
Maximum Storey Shear in kN Shear Wall
Maximum Storey Shear in kN X Bracing


Base Shear in KN
3700
3600
3500
3400
3300
3200
3100
3000
2900
2800
3100.57
3466.25
3598.46
X Bracing
Shear wall
Hybrid Shear Wall
Base Shear in Y direction in KN

VI.CONCLUSION

This research is focused towards presenting the behaviour of structure considering three different cases namely, structure with X bracing at corner, structure with shear wall at corner and structure with hybrid shear wall at corner. The structure was modelled and analyzed using analytical application ETABS v 2016. The parameters of comparison were Storey displacement, storey shear, storey drift, storey stiffness and base shear.

- ✓ Storey displacement is the lateral displacement of the storey relative to the base. It is the total displacement of the 10th storey with respect to the ground. Compared to X bracing and shear wall, the hybrid shear wall structure has lower displacement values.
- ✓ Storey Drift is defined as the ratio of displacement of two consecutive floor to height of that floor. Compared to X bracing and shear structure, the hybrid Shear wall structure has lower Drift ratios. Storey drift of building is within the limit as clause no 7.11.1 of IS-1893 (Part-1):2002.
- ✓ Storey shear factor is the ratio of the story shear force when story collapse occurs to the story shear force when total collapse occurs. Here the storey shear was minimum for structure with X bracing in comparison to other two cases.
- ✓ Storey stiffness is estimated as the lateral force producing unit translational lateral deformation in that storey, with the bottom of the storey restrained from moving laterally, i.e., only translational motion of the bottom of the storey is restrained while it is free to rotate. Maximum storey stiffness was analyzed in structure with shear wall as compared to structure with x bracing and structure with hybrid shear wall.
- ✓ Base shear is an estimate of the maximum expected lateral force on the base of the structure due to seismic activity. It is calculated using the seismic zone, soil material, and building code lateral force equations. Here the base shear was found maximum in structure with hybrid shear wall at corner in comparison to structure with shear wall and structure with x bracing.

VII. Future Scope

1. Parameters of material consumption in terms of weight of steel, volume of concrete, time of construction and cost should be evaluated to outline and compare the economic efficiency of the structures.
2. In this study hybrid shear wall is considered as a combination of X bracing and shear wall , whereas hybrid shear wall may be prepared using different materials such as using polymers for future study.
3. This research is limited to seismic analysis and in future wind load can be further considered.

VIII. REFERENCES

[1]. Saleem malik yarnal, sagar s allagi, prashant m topalakatti and arif ahmed mulla, [non-linear analysis of asymmetric shear wall with openings], international journal of engineering research & technology (ijert) issn: 2278-0181, vol. 4 issue 08, august-2015.

[2]. Thavera wihardja and iswandi imran, [seismic behavior of hybrid coupled wall system], regional conference in civil engineering (rcce), the third international conference on civil engineering research (iccer), august 1st-2nd 2017.

[3]. Zhangfeng zhu and zhengxing guo, [experiments on hybrid precast concrete shear walls emulating monolithic construction with different amounts of posttensioned strands and

different debond lengths of grouted reinforcements], hindawi publishing corporation advances in materials science and engineering volume 2016, article id 6802503, 13 pages.

[4]. Sooria raj, [feasibility study on the structural behaviour of hybrid wood steel structures using finite element analysis], international journal of scientific & engineering research, volume 7, issue 5, may-2016, issn 2229-5518.

[5]. Abhishek sharma & prince sharma, [seismic performance evaluation of hybrid coupled shear walls in high rise buildings], international journal of innovative technology and exploring engineering (ijitee) issn: 2278-3075, volume-8 issue-8 june, 2019.

[6]. Alshawabkeh shorouq and wu li, [hybrid post-tensioned concrete shear walls behavior under seismic loads], international journal of scientific and research publications, volume 9, issue 5, may 2019, issn 2250-3153.

[7]. Satya narayana reddy y, v mahesh and senthil kumar, [comparative study on conventional, shear wall and hybrid structures indifferent seismic zones], international journal of advances in mechanical and civil engineering, issn: 2394-2827, volume-6, issue-3, may-2019.

[8]. Xu, l., shen, x. And shen, j., [seismic study of hybrid shear wall], tenth u.s. national conference on earthquake engineering frontiers of earthquake engineering july 21-25, 2014.

[9]. Shuzhen chen and m. Poongodi, [an exhaustive research and analysis on seismic performance of prefabricated concrete shear wall structure], issn print 1392-8716, issn online 2538-8460, kaunas, lithuania, 2020.

[10]. Nursiah chairunnisa, iman satyarno, muslikh and akhmad aminullah, [analysis and design of shear wall coupling beam using hybrid steel truss encased in reinforced mortar], procedia engineering 171 (2017) 940 – 947.

[11]. Chong-fang sun, shu-ting liang, xiao-jun zhu, hu li, jian-min guo, gang li, ya-min song and dong-yue wu, [experimental study and numerical simulation of precast shear wall with rabbet-unbonded horizontal connection], international journal of concrete structures and materials, 2020.

[12]. Nima usefi, hamid ronagh, and masoud mohammadi, [finite element analysis of hybrid cold formed steel shear wall panels], streamlining information transfer between construction and structural engineering, 2018.

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