Seismic Analysis Of Soft Storey Frame High Rise Building Using Shear Wall With Coupling Beams

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Abstract - When it comes to mitigating the effects of an earthquake, shear walls are among the most useful tools. However, the seismic response of a structure may be affected by the presence of doors, windows, and other gaps in the shear wall. In order to better understand behaviour of shear walls with Coupling beams when subjected to seismic stresses, this study provides a summary of the use of finite element analysis. Using the Pushover analysis approach, the finite element program ETABS is used to analyze the structural integrity of a 15-story frame-shear wall building at the G+ level. The findings of the comparison revealed that arrangement system affects time period, displacement, tale drift, and base shear around the various models.

Key words- Shear Wall, Coupling beams, Seismic Loads, Pushover analysis Method, ETABS.

I. INTRODUCTION

1.1 Shear Wall

Shear walls have been used for building framing for a very long time. An effective lateral-force-resisting system may be created by strategically placed walls in a structure while also serving other functional purposes. If a stable& equivalent portion of floor areas in all levels is mandatory, as in case of hotels or apartment complexes, several shear walls may be employed not only to resist sideways forces but also to transfer gravity loads. Repeated floor-by-floor arrangement in this case allows for walls to be vertically nonstop, which mightattend as exceptional acoustic & fire insulation amongunits. Shear walls might be planar, however to improved match design & increase their flexural stiffness they often have an L, T, I, or U shape. Typically, the placements of shear walls inside a structure are determined by practical needs. These could or might not be suitable for structural planning. Wall configurations that may often be used for lateral force resistance may be necessary depending on the use of a building and the resultant distribution of floor space. The positioning of walls may be negatively impacted from a structural aspect by building sites, design concerns, or client preferences. The best locations for shear walls may frequently be suggested by structural designers in order to improve earthquake protection. Main structural concerns for any particular shear wall are regularity in stiffness, torsional stability, & the existing overturning capability of foundations.

The height of a structure is relative, and neither its height nor the number of storeys can be used to characterize it in absolute terms. However, from the perspective of a structural engineer, a high rise building is one that, owing to its height, is significantly impacted by lateral pressures from wind, earthquake, or both, so that they have a significant impact on structural design. Shear walls are a kind of structural system which offers the building or structure lateral resistance. They are the horizontal force resisting system of the structure's vertical components. They are designed to offset the effects of lateral masses that are applied to the structure. Shear walls, which are exterior straight walls used in residential construction, often provide all of the building's sidesustenance. Indian Code's design methodology IS 1893(Part I): 2002 goal of the "Conditions for Earthquake Resistant Design of Structures" is to have structures which can resist major earthquakes without collapsing at least a minimum strength to withstand major earthquakes without collapsing, resist moderate earthquakes without significant structural damage, resist minor earthquakes without important structural damage. RC constructions frequently include vertical plate-like RC walls, sometimes referred to as shear walls, in addition to slabs, beams, columns. These walls often start at the ground level &continue upward. They may range in thickness from 150mm to 400mm in high-rise structures. Shear walls are often present along a building's length & breadth. Shear walls act as large, vertical beams whichtransmission earthquake loads to foundation. Special detailing is necessary for shear walls in seismically active areas. Shear wall structures are a common option in many earthquake-prone nations, including Chile, New Zealand, the United States. Because wall reinforcing detailing is often simple and simple to execute on site, shear walls are simple to build. Shear walls are useful in reducing earthquake damage to structural and nonstructural components while also being affordable to build.

1.2 RC Shear Wall:
The slabs and the walls are both constructed of reinforced concrete. Provisional on number of stories, the period of the building, and the demand for thermal insulation, wall thickness might vary from 140 mm to 500 mm. A few of these walls are split up at street level or basement level to provide place for parking or commercial places, despite fact that the majority of these walls remain continuous the whole height of the structure. Commonly, wall configuration is symmetrical with regard to at least one axis of symmetry in design.

Fig-1: Shear wall building

Building codes in each nation's distinct regions serve as the basis for reinforcement needs. Two layers of scattered reinforcement that span the length of the wall are commonly used as the wall's reinforcement (horizontal and vertical). Additionally, vertical reinforcing bars are offered at the wall end zones, next to the door and window openings.

1.3 Scope of the work
The shear wall's objective is to investigate the different methods for seismic loading and strong horizontal wind loading mitigation for tall structures. We can build higher buildings, which uses less space and allows us to house a huge population in that area, which is another reason why we employ shear walls. The construction of a cost-effective building in a shorter amount of time is another goal. This research aids in the examination of the ductility and strength of shear wall.

The objective is to evaluate the created shear wall that will be built. The model is first incorporated into well-known computer software, after which it is examined in terms of strength & ductility. Tested shear wall strength is associated to estimated shear wall strength based on design codes.

II. LITERATURE REVIEW

2.1 General

Literature review of related topics of this research has been conducted and presented in this chapter. The research articles are referred from reputed journals and text books. The data collection, research methodology and analysis useful for the present work are derived from these references.

2.1.1.Farjana Khanam, Anik Das AndSharmin Reza Chowdhury "THE IMPACT OF SHEAR WALL LOCATION ON LATERAL LOADING PERFORMANCE OF BUILDING FRAMES"

Shear wall system is widely used in tall buildings as a means of resisting lateral loads. Determining the most effective, efficient, and optimum position for the shear wall is crucial. This essay examines the impact of shear wall placement in multi-story buildings. A residential structure with a base plan size of 49.25 feet by 49.25 feet and an average floor height of 10 feet is taken into consideration. In this study, three alternative models with varied shear wall locations in building frames were examined for crucial characteristics including displacement and base shear under lateral stress. The structures evaluated were 8, 10, 12, 14, and 16 stories tall. Same static method was employed in this study, which was conducted in ETABS 9.6.0. Models without a shear wall, with a shear wall centred on each of four perimeter sides, and with a shear wall positioned at each of four L-shaped corners have all been studied. The results of this research demonstrate that Model 2 (the one with the shear wall positioned in the center of the four peripheral sides) exhibits the greatest performance in terms of top displacement & base shear.

This study's conclusion is that reinforced concrete frame buildings without shear walls will perform poorly in terms of lateral load resistance. Shear walls are shown to be beneficial in strengthening the overall seismic capability of medium high rise structures (i.e. higher than 10 stories). Model 1 (Building without Shear Wall) has the most top displacement among the three models.
Model2 (a building having shear wall positioned in center of four perimeter sides) has the least top displacement value. Compared to model 2, model 3 (a building with a shear wall located at each L-shaped corner's fourth corner) has a greater shear force at ground level. So it can be claimed that shear walls put in the center of the four perimeters of a structure (Model 2) are more effective than those installed in other locations. More buildings with various shear wall placements need to be analyzed in order to offer thorough remarks.

2.1.2. Krishna G S And Chaithra S “Different Opening Configurations in a Frame Shear Wall: A Nonlinear Study”
One of the best solutions to earthquakes is shear walls. However, the placement of architectural apertures in structures, such as doors, windows, and so on, may affect how seismically resistant they are. This work gives an introduction to finite element analysis as applied to study of response of shear walls with openings to seismic stresses. In this investigation, Response Spectrum method and finite element programme ETABS are used to analyse structural integrity of a 10-story frame-shear wall structure. When the data were compared, it became clear that the way the apertures were set up had an impact on the time period, top displacement, base shears, tale drift, stress distributions around openings.
These three domains account for the majority of current nonlinear analysis applications: For parametric investigations, a virtual laboratory Existing structures that need examination, repair, and rehabilitation, and buildings with complex or strict safety requirements (e.g., dams, nuclear plants and bridges).
identifying seismic retrofit alternatives, assessing the performance of structures with shear walls, contrasting different shear wall opening arrangements, and contrasting different opening sizes.

This research looked at how shear walls performed with various opening configurations. Story displacement, stress distribution story shear, story drift, and other construction factors are compared and researched. Lastly, subsequent judgments are made

- The existence of an opening reduces stiffness & strength.
- The top displacement produced by the staggered aperture is quite similar to that produced in shear walls without openings.
- Base shear for staggered setups is considerable.
- The increasing tension in staggered openings
- When compared to the vertical arrangement of apertures, the layout is tiny.
- Staggered opening is preferable than vertical opening from an economic standpoint.

2.1.3. Kollipara V G Manikanta Sreeram, R.P Singh And Sripathi Siva Bhanu Sai Kumar “SHEAR WALLS AND BRACINGS IN AN EFFECTIVE PLACE FOR A MULTI-STORIED BUILDING”
Earthquake is a natural disaster that causes violent earth vibrations that have an impact on buildings. Small or feeble vibrations that humans can or cannot feel. Shear walls and bracings are placed in order to increase the structure's lateral stiffness, ductility, minimal lateral displacements, and safety. When designing structures for earthquakes, storey drift and lateral displacements are crucial considerations. Time history analysis using STAAD-Pro is used to construct and assess two different kinds of frame models.
In the current study, a shear wall and a braced frame are used to assess a G+9 multi-storey building. The findings of Storey drifts, the highest bending moment, the highest sea force, and deflections are investigated, assessed, contrasted.

Finding location of the shear wall and bracing for building that is being exposed to pseudostatic (seismic) stresses is the major goal of this article. STAAD-PRO V8i analyses the structure using a TIME HISTORY analysis. The storeys', maximum shear force, storey drift and maximum bending moment are compared.
A structural system called a dual system resists lateral loads and gravity loads. Frames and shear walls work together to provide a dual system of resistance to lateral forces. A collection of columns & beams that are rigidly joined together.

From the result observed,

- It has been discovered that a structure with dual systems (a shear wall and bracing combination) at the corner would provide less lateral displacement at the top 4.84mm than a typical building.
- It is discovered that the dual system construction at the corner, which combines a shear wall and bracings, will provide less lateral displacement at the top 4.84mm than a typical building.
- In the z-direction, lateral deflection in the dual system is 89% lower than in a typical structure.

2.1.4. Nitin Choudhary And Prof. M. Wadia "Analyzing Collapse Propensity of a R.C. Frame Structure Using a Shear Wall"

Based on an accurate calculation of the right reaction parameter, a performance-based design aims to limit structural damage. Seismic analysis that is performance-based assesses how well a structure is expected to function. Selecting a performance goal is the first step of an iterative process that also involves developing a preliminary design and determining if design fulfillsperformance objective; In current research, pushover analysis was performed on a two-story R.C. frame structure. One building's layout was assumed to be symmetrical and consisted of two bays measuring 4 meters in y direction and 5 meters in x direction, while second building had an unsymmetrical L-shaped plan. Observing lateral pressures that are trying to push against them is made easier by shear wall. This research highlights effect of shear walls on RC frame structures when they are given on both long and short sides of the building. Building displacement and foundation shear will reduce. Base shear, narrative spectral acceleration, drift, spectral displacement, and story displacement have all been the subject of a comparative research.

Two organizations, FEMA and ATC, in respective seismic restoration programs & standards, developed and first recommended the non-linear static pushover process.

1) Both symmetrical and asymmetrical buildings' base shear and roof displacement significantly diminish when shear walls are included.

2) In an L-shaped building, adding a shear wall on larger side of structure reduces base shear by 4.3% and roof displacement by 58.15%; doing so on the smaller side reduces base shear by 7.97% and roof displacement by 55.43%. Therefore, a shear wall has to be installed on the smaller side of an asymmetrical structure.

3) Performance-based seismic design created by the aforementioned method contents specifications for the life safety limit states and immediate occupancy for a variety of earthquake intensities.

4) Seismic design using STAAD, which is based on a code, is contrasted to a manual approach (IS 1893:2002).Steel reinforcement is somewhat reduced as a consequence of performance-based seismic design.

2.1.5. Saleem Malik Yarnal, Sagar S Allagi, Prashant M TopalakattiandArif Ahmed Mulla. "Apparent Openings in an Asymmetric Shear Wall: A Non-Linear Analysis"

Shear walls are one of the best ways to provide high reinforced (RC) structures lateral load resistance. Because shear walls play a large part in lateral load resisting system, they significantly contribute to raising stiffness of the structure, particularly in non-linear analyses. The shear walls of building structures may be examined using a variety of analysis techniques. The structural analysis includes lateral loads that are distributed uniformly as well as lateral loads that are distributed triangularly with a greatest value at the top.

This research examines shear walls with different opening percentages and conducts a seismic analysis of buildings with shear walls in zone III. such as mode form, drift, shear force, stiffness, and fundamental frequency base shear. Different percentages of apertures in the shear wall area are used to compare performance of shear wall. ETABS 2013 is the program utilized in this study to analyze the structure.

The purpose of this research is to compare the results utilizing the E-TABS 2013 software and examine the effect nonlinear static behavior of asymmetric shear walls. Particular focus is placed on:

A. How an asymmetric design behaves in a shear wall system.
B. Effects of shear wall apertures by 40%, 30%, 20%, and 10% openings compared to those without openings. The structure is situated in India's zone III in North Karnataka.

i. The research demonstrates that base shear for shear walls without opening is lower than base shear for shear walls at 40%, 30%, 20%, and 10%.
ii. Shear wall without opening frequency is less than 40%, 30%, 20%, and 10%.With an increase in openness, frequency declines.
iii. Shear walls with apertures have durations that are longer than those with 10%, 20%, 30%, and 40% openings. With an increase in openness, the time period lengthens.
iv. When comparing a building's storey drift with and without shear wall openings of 10%, 20%, 30%, and 40%, we find that the storey drift with openings is larger.

III.OUTCOME OF THE STUDY

- This research comes to the conclusion that buildings made of reinforced concrete without shear walls would perform poorly in terms of lateral load resistance.
- Shear walls are shown to be useful in boosting building's overall seismic resistance.
- Building without a shear wall has the highest possible top displacement value.
- The building's shear wall, which is positioned in the center of its four outer edges, has the smallest top displacement value.
- The shear force at ground level is greater than the shear force at the four corners of an L-shaped structure with shear walls installed.
- Strength and stiffness are reduced by the presence of an aperture.
- The top displacement is caused by the staggered aperture, which matches the displacement caused in shear walls without holes rather well.
- For staggered setups, base shear is considerable.
- When compared to holes that are arranged vertically, the increase in tensions caused by staggered openings is quite minimal.
- From a financial standpoint, staggered opening is preferable than vertical opening.
- The aforesaid technique yielded a performance-based seismic design that complies with the requirements for instantaneous occupancy& life safety limit states for earthquakes of different strengths.
- When compared to the IS 1893:2002 code-based seismic design (as generated by STAAD.PRO), performance-based seismic design results in a little reduction in steel reinforcement.
- According to research, base shear for shear walls without openings is lower for shear walls with bases shears of 10%, 20%, 30%, and 40%.
- Less often than a shear wall without an aperture are frequencies of 10%, 20%, 30%, and 40%. As the opening increases, frequency drops.
- In comparison to a solid shear wall, lifespan of one having an aperture of 10%, 20%, 30%, or 40% is far longer. Time span lengthens when opening widens.
- Comparing storey drift of a building having shear wall apertures of 10%, 20%, 30%, and 40% against that of a building with no shear wall openings yields following results, storey drift of the openings is larger than the non-opening.
- When replacing diagonally reinforced concrete connection beams in coupled shear walls, this type is the most safe and effective option, even if it might yet be improved. This approach achieves this utilizing connection beams made of steel and encased mortar.
- Only bracing and mortar bracing can replace a typical reinforced concrete connecting beam.
- A hybrid steel truss coated in reinforced masonry may have a smaller profile steel dimension if enclosed mortar is used.

IV.OBJECTIVES

1. Modelling and seismic analysis of soft storey building with shear wall and shear wall with coupling beams.
2. Study effects of soft storey at 6^{th} and 8^{th}storey with shear wall and shear wall with coupling beams.
3. Comparing seismic response of soft storey model building with in terms of Base shear, Time period, Story drift and Story displacement.

V. METHODOLOGY

This project aims to investigate the seismic effect on 16 storied framed model. The models of G+15 building are created in ETABS programming software. Height of each floor is kept as 3m. IS 1893 - 2002 {Part I} code is used for seismic analysis. Seismic zone IV is considered and soil type is medium.
Dead load is applied as per norms of IS 875 – Part I.

Live load is applied as per norms of IS 875 – Part II.

Earthquake load is applied as per norms of IS 1893 – 2002.

Pushover analysis method is used to carry out seismic analysis.

Results likestorey displacement, time period, Storey drift and base shear are determined and results are plotted to compare the conclusions.

1. This project aims to investigate the seismic effect on 16 storied framed model.
2. Lateral load analysis will be carried out for the various models of the structure.
3.When seismic analysis of all the models considered is carried out thoroughly, Various factors like storey drift, Storey displacement, base shear, time period are studied in detail.

VI. DESCRIPTION OF THE MODEL

6.1 Geometry Of The Models

- The considered structures are G+15 storey frame structures.
- The story height is 3 m.
- Soft storey height 4.5M (6^{th} and 8^{th})
- The height of the structure is 46.5m.
- Size of the building is 28mx20m.
- Bay number in X-direction is 8 and Y-direction is 6.
- Spacing between the column in both X direction& Y direction is 4M.
- Grade of concrete M35 & M40.
- Grade of steel HYSD HYSD550.
- Dimension of Column 750mmX750mm.
- Dimension of Beam 300mmX500mm.
- Thickness of slab 200mm.
- Thickness of shear wall 200mm.

Soil type-Type II (Medium soil)
Importance factor = 1
Response reduction factor = 5
Zone factor = 0.24 (ZONE IV)

6.2 Models Considered In The Study
5 models are considering for the analysis.
Model 1. 6^{th} Storey As Soft Storey Bare Frame Building.
Model 2. 8^{th} Storey As Soft Storey Bare Frame Building.
Model 3. 6^{th} Storey As Soft Storey With Shear Wall.
Model 4. 8^{th} Storey As Soft Storey With Shear Wall.
Model 5. 6^{th} Storey As Soft Storey With Shear Wall And Coupling Beams.
Model 6. 8^{th} Storey As Soft Storey With Shear Wall And Coupling Beams.

VII. RESULTSAND DISCUSSION

7.1 GENERAL
For the examination of each of structure models pushover analysis strategies are applied. The examination of the all the distinctive structure models is finished by utilizing ETABS programming. The investigation results, for example, story displacements and story drifts of all structure models are introduced and looked at.

7.1.1 DISPLACEMENT

The presentation of the models under the use of seismic burdens is concentrated to comprehend its impact. The displacements for each models which are probably going to happen because of different lateral loads are gotten and tabulated.

According to the Indian guidelines the most extreme permissible displacement in any multi- story building is hs/500,

Where hs- height of building.
For the models utilized in the examination the most extreme permissible displacement =46.5/500=0.093m = 93mm

7.1.2 Storey drifts

According to IS 1893-2016 the greatest permissible drift for any structure is =0.004H H-height of one story
For our models greatest permissible drift = 0.004*3=0.012m = 12mm
For soft storey =0.004*4.5=0.018m=18mm

Parameters studied for all models in Zone IV

7.2 TIME PERIOD

TABLE 1 Maximum time period comparison of all models due to seismic loads in Zone IV.

MODELS	EQX (SEC)
Model 1 bare frame 6^{th}	**1.565**
Model 2 bare frame 8^{th}	**1.489**
Model 3 SW at 6^{th}	**0.858**
Model 4 SW at 8^{th}	**0.853**
Model 5 SW CB at 6^{th}	**0.585**
Model 6 SW CB at 8^{th}	**0.585**

1. Time period is from BARE FRAME 6^{TH}i.e. 1.565 Sec model among all the all models in zone IV.
2. Time period is from shear wall at 6^{th} and 8^{th}storey model i.e. 0.858 Sec.
3. Time period is from shear wall with coupling beams at 6^{th} and 8^{th}storey model i.e. 0.585 Sec.
4. Model 1 and model 2 exhibited a higher value of time period when compared with other models.

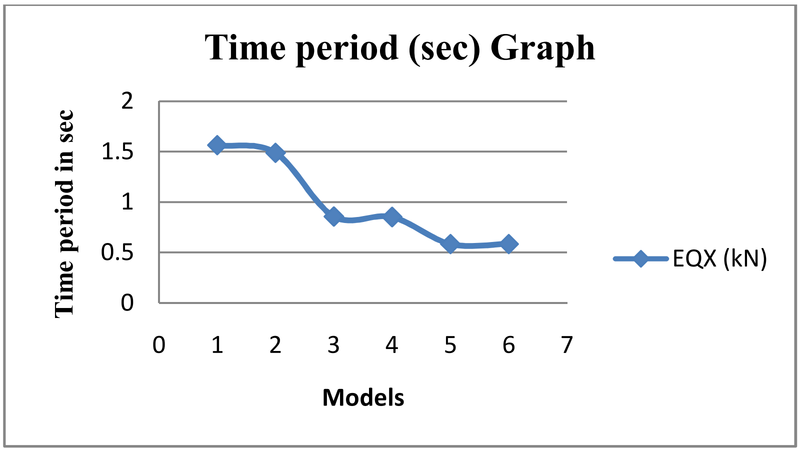

Fig 2 Maximum time period comparison of all models due to seismic loads in Zone IV.

7.3 BASE SHEAR

TABLE 2 Maximum base shear comparison of all models due to seismic loads in Zone IV.

MODELS	EQX (KN)
Model 1	5988.9173

Model 2	6091.7977
Model 3	15421.2421
Model 4	18467.3818
Model 5	38592.4766
Model 6	38188.8690

1. Base shear of model 5 and model 6 (shear wall with coupling beams soft storey as 6th and 8th) is monitored as showing maximum base shear value 38592.47 KN and 38188.86 KN respectively among all models in zone IV.
2. The minimum base shear is obtained from the model 1 and model 2 (bare frame soft storey models) i.e. 5988.91 KN and 6091.79 KN.
3. Shear wall building perfume better than bare frame models with base shear values as 15421.24 SEC and 18467.38 KN.

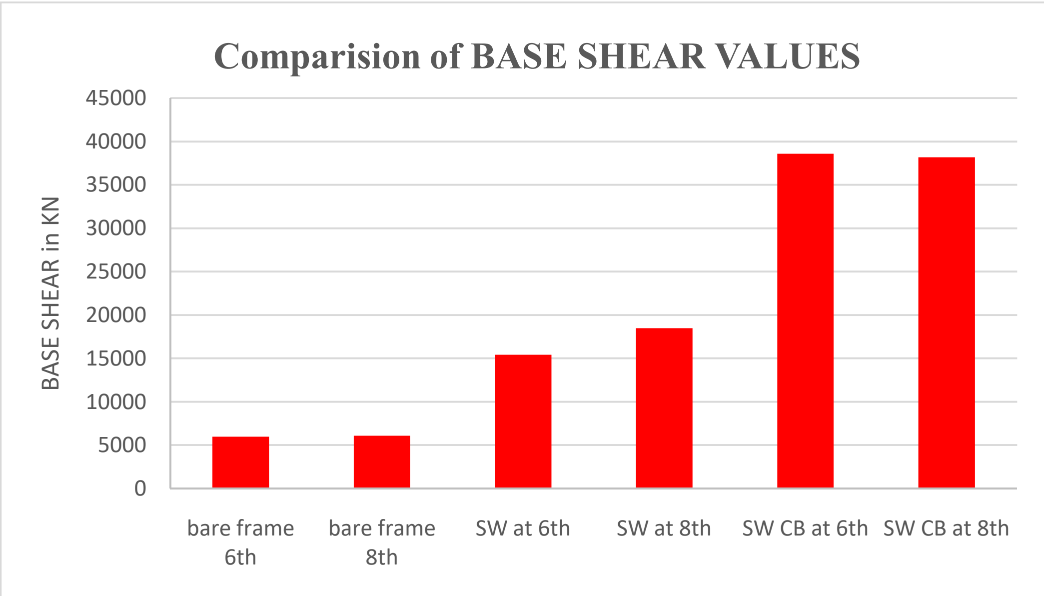

Fig 3 maximum base shear comparison of all models due to seismic loads in zone IV.

7.4 Storey displacements

7.1.3 Storey displacements in X direction for all model in Zone IV

TABLE 3 Storey displacements among model 1, model 3 and model 5along X-direction in mm.(PUSHOVER ANALYSIS method)

STOREY	BARE FRAME 6th	SW at 6TH	SW CB at 6TH
Base	**0**	**0**	**0**
Story1	**1.407**	**0.734**	**1.563**
Story2	**4.064**	**1.792**	**3.544**
Story3	**7.024**	**3.133**	**5.721**
Story4	**9.99**	**4.645**	**8.008**
Story5	**12.953**	**6.276**	**10.266**
Story6	**17.659**	**9.031**	**14.252**
Story7	**20.149**	**10.814**	**16.439**

Story8	**22.259**	**12.626**	**18.617**
Story9	**24.084**	**14.427**	**20.679**
Story10	**25.655**	**16.192**	**22.604**
Story11	**26.982**	**17.908**	**24.389**
Story12	**28.07**	**19.566**	**26.033**
Story13	**28.924**	**21.164**	**27.541**
Story14	**29.555**	**22.692**	**28.9**
Story15	**30**	**24.197**	**30**

1. Storey displacement for shear wall isprovided for all the floors. From model 3 (shear wall soft storey as 6thstorey) shows a displacement of 24.19 mm as compared with rest of models.
2. Model 1 (bare frame soft storey as 6th) shows the 30 mm and model 5 (shear wall with coupling beams 6th as soft storey)
3. Shear wall model 3 (shear wall soft storey as 6thstorey) is 24% less than the model1(bare frame soft storey as 6th). For model 5 (shear wall with coupling beams 6th as soft storey) is slightly similar to model 1.
4. Model 3 shows the minimum displacement among all the 3models considered in above table.
5. According to is 1893:2002 (part 1) in zone iv, all values of storey displacement are determined to be below maximum allowable value of hs/500 times to storey height.

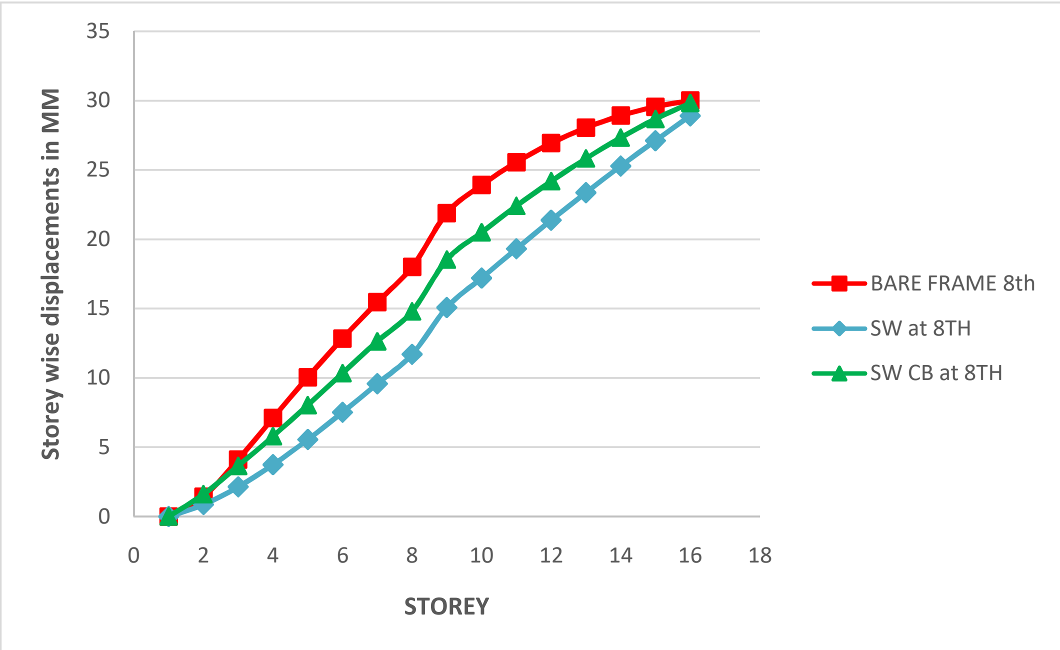

Fig 4Storey wise displacement for model 1,3 and 5

TABLE 4 Storey displacements among model 2 model 4 and model 6 along X-direction in mm. (PUSHOVER ANALYSIS method)

STOREY	**BARE FRAME 8th**	**SW at 8th**	**SW CB at 8th**
Base	**0**	**0**	**0**
Story1	**1.421**	**0.863**	**1.609**
Story2	**4.116**	**2.137**	**3.656**
Story3	**7.104**	**3.736**	**5.785**
Story4	**10.047**	**5.546**	**8.038**

Story5	**12.837**	**7.511**	**10.338**
Story6	**15.461**	**9.574**	**12.632**
Story7	**17.992**	**11.689**	**14.803**
Story8	**21.884**	**15.073**	**18.526**
Story9	**23.898**	**17.196**	**20.488**
Story10	**25.551**	**19.303**	**22.401**
Story11	**26.92**	**21.361**	**24.18**
Story12	**28.034**	**23.35**	**25.817**
Story13	**28.905**	**25.267**	**27.319**
Story14	**29.548**	**27.099**	**28.671**
Story15	**30**	**28.887**	**29.817**

1. Storey displacement for shear wall is provided for all the floors. From model 4 (shear wall soft storey as 8thstorey) shows a displacement of 28.887 mm as compared with rest of models.
2. Model 2 (bare frame soft storey as 8th) shows the 30 mm and model 6 (shear wall with coupling beams 8th as soft storey) is 29.817 mm displaced.
3. Shear wall model 4 (shear wall soft storey as 8thstorey) is 10% less than the model 2 (bare frame soft storey as 8th). For model 6 (shear wall with coupling beams 6th as soft storey) is slightly less to model 2.
4. Model 4 shows the minimum displacement among all the 3 models considered in above table.

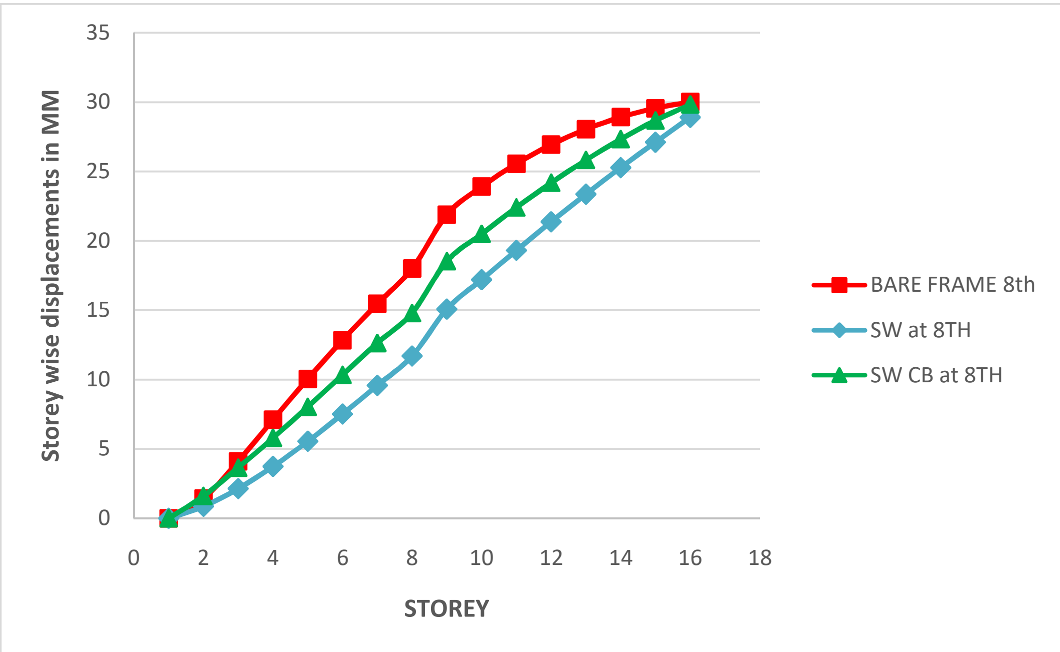

Fig 5Storey wise displacement for model 2,4 and 6

7.5 Storey drift

7.1.4Storey wise storey drift ratio variation in X direction for all models in Zone IV

TABLE 5Storey wise storey drift ratio among model 1 model 3 and model 5 along X-direction in mm. (PUSHOVER ANALYSIS method)

STOREY	BARE FRAME 6^{th}	SW at 6^{th}	SW CB at 6th
Base	0	0	0
Story1	0.002966	0.000283	0.000602
Story2	0.005375	0.000444	0.000863
Story3	0.005898	0.000526	0.000918
Story4	0.005864	0.000595	0.000972
Story5	0.005842	0.00065	0.001018
Story6	0.006178	0.000718	0.001142
Story7	0.004902	0.000716	0.001
Story8	0.004154	0.000716	0.000943
Story9	0.003592	0.000708	0.000884
Story10	0.003092	0.000693	0.000826
Story11	0.002613	0.000674	0.000765
Story12	0.002142	0.000652	0.000705
Story13	0.001681	0.000628	0.000646
Story14	0.001243	0.000608	0.0006
Story15	0.000876	0.000601	0.000587

1. Storey wise drift results in both model 3(shear wall soft storey as 6^{th}) and model 5 (shear wall with coupling beams 6^{th} as soft storey) are slightly similar whencompared with each other. Minimum storey wise drift is observed as compared with model 1(bare frame soft storey as 8^{th}).
2. Minimum displacement is observed in model 3 (shear wall soft storey as 6^{th}).
3. Storey wise drift ratio are decreasing after at 6^{th}storey all models because the storey is assigned as soft storey.

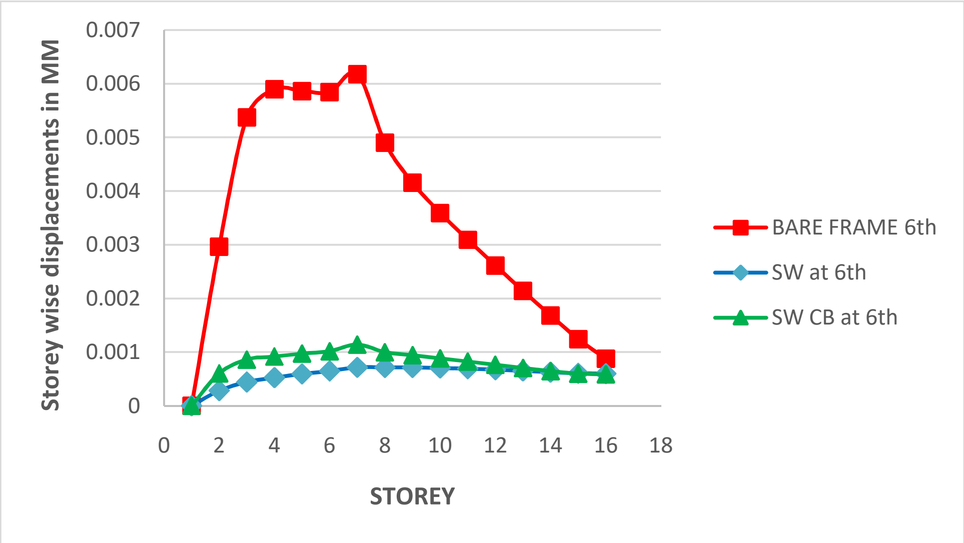

Fig 6Storey wise drift for model 1,3 and 5

TABLE 6Storey wise storeydrift ratio among model 2 model 4 and model 6 along X-direction in mm. (PUSHOVER ANALYSIS method)

STOREY	BARE FRAME 8th	SS at 8^{th}	SW CB at 8^{th}
Base	0	0	0
Story1	0.004746	0.000544	0.000766
Story2	0.009013	0.000879	0.001046

Story3	0.009984	0.001041	0.001085
Story4	0.009829	0.001176	0.001142
Story5	0.00931	0.00128	0.001172
Story6	0.008749	0.001351	0.00118
Story7	0.008427	0.001397	0.001178
Story8	0.008635	0.001468	0.001267
Story9	0.006701	0.001414	0.001074
Story10	0.005501	0.001383	0.00099
Story11	0.004557	0.001343	0.00091
Story12	0.003703	0.001299	0.000836
Story13	0.002894	0.001251	0.000766
Story14	0.002135	0.001207	0.00071
Story15	0.001501	0.001186	0.000694

1. Storey wise drift results in model 2(bare frame soft storey as 8th) shows the max values and model 4 (shear wall 8th as soft storey) are less when compared with model 2.
2. Minimum displacement is observed in model 6(shear wall with coupling beams 8th as soft storey).
3. Storey wise drift ratio are decreasing after at 8thstorey all models because the storey is assigned as soft storey.

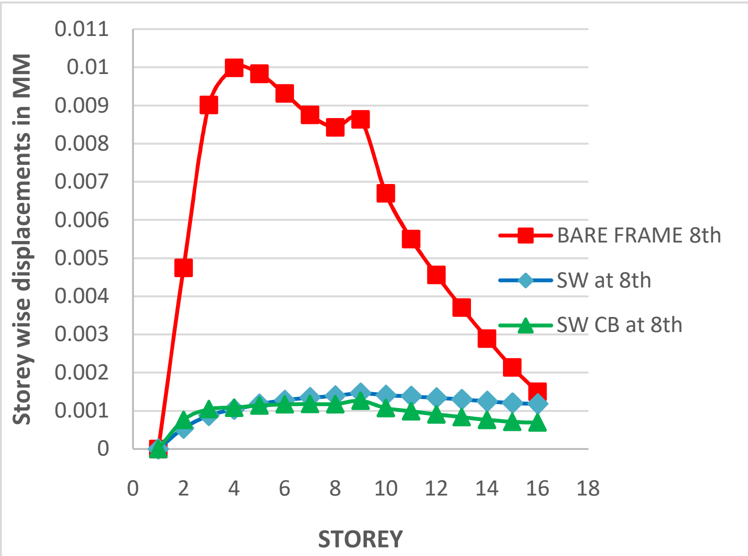

Fig 7Storey wise drift for model 2,4 and 6

7.6 MAXIMUM DISPLACEMENTS COMPARISON OF ALL MODELS DUE TO SEISMIC LOADS IN ZONE IV

TABLE 7 Maximum displacements comparison of all models due to seismic loads in Zone IV.

MODEL	MAX DISPLACEMENT in MM
Bare frame 6th	30
Bare frame 8th	30
SW at 6th	24.197
SW at 8th	28.887
SW CB at 6th	30
SW CB at 8th	29.817

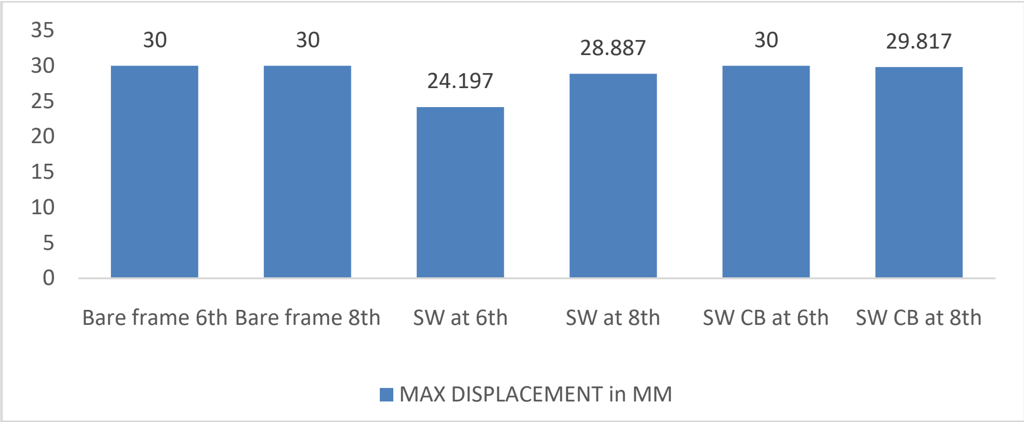

Fig 8 Maximum displacements of all models

Maximum displacements of all models because of seismic burdens in zone-IV (NSP) are recorded in the above table. From the outcomes it tends to be seen that along X-direction,

In comparison of model 1, model 3 and model 5 The maximum displacement for bare frame i.e. 30 mm and model 5 (shear wall with coupling beams as 6^{th})i.e. 30mm. model 3 (Shear wall SS as 6^{th}) is minimum i.e24.197mm.

In comparison of model 2,model 4 model 6. The maximum displacement for model 2 (bare frame 8^{th} soft storey) 30 mm and for model 6 (Shear wall with coupling beams SS as 6^{th}) is i.e. 29.817mm. minimum displacement is from model 4 28.887 mm.

7.7PERFORMANCE POINT

Performance point of building models are shown in the output reports files from the ETABS software that were generated after the NSP analysis, as seen in the file below. The performance point characteristics for structural acceleration (Sa), structural displacement (Sd), base shear (V), roof displacement (D) are displayed in Table 7.7.

MODEL 1. 6^{TH} STOREY AS SOFT STOREY BARE FRAME BUILDING.

Pushover Curve - Equivalent Linearization of the FEMA 440

Summary Description

These are the data for a pushover linearization study using the FEMA 440 equivalent.
General Input Data

Name	Pushover1		
Load Case	PA-X	Plot Type	FEMA 440 EL

Demand Spectrum-Input Data

Source	General ASCE 7-10	Ss	0.31
Site-Class	D	S1	0.460
		Tl	08 sec

Effective Damping and Effective Period Parameters

Inherent Damping	0.05		
Damping Params	Default-Value	Period Parameters	Default-Value
A	4.2	G	0.11

B	-0.830	H	-0.018
C	10	I	0.09
D	1.60	J	0.14
E	22	K	0.77
F	0.4	L	0.05

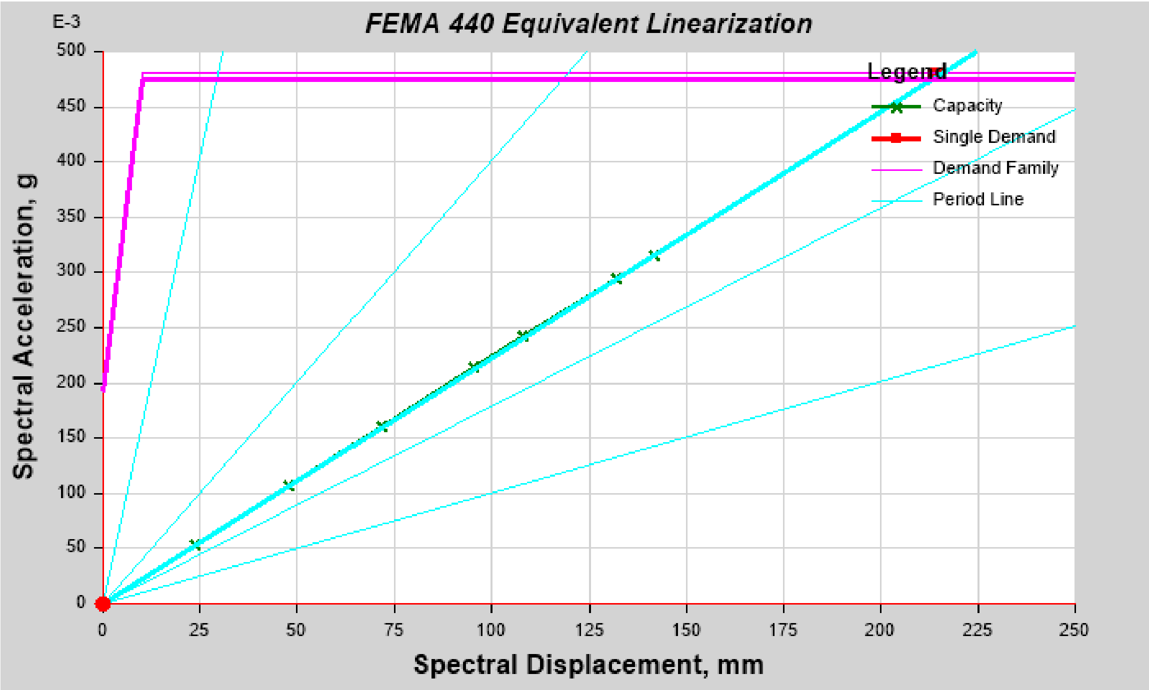

Fig 9 pushover plot of model 1 FEMA 440

Plot Items

Demand Spectra Ductility Ratios	1; 1.5; 2; 2.5
Constant Period Lines	0.5; 1; 1.5; 2

Tabulated Plot-Coordinates
Capacity Curve Coordinates

Sd	Sa	Period
Mm	**g**	**Sec**
0	0	1.338
23.822	0.053562	1.338
47.644	0.107125	1.338
71.466	0.160687	1.338
95.288	0.214249	1.338
107.697	0.242151	1.338
131.894	0.295008	1.342
141.785	0.315205	1.346

Pushover Curve - Displacement Modification as per ASCE 41-13

Summary Description
Information for an ASCE 41-13 displacement modification pushover analysis is provided here.

General Input Data

Name	**Pushover 01**		
Load Case	PA-X	Plot Type	ASCE 41-13 NSP

Demand Spectrum-Input Data

Damping Ratio	0.05	Source	General ASCE 7-10
Include SSI	No	Accel-Ss	0.31
C2 Type	Default-Value	Accel-S1	0.46
Cm Type	Default-Value	Site-Class	D
		Tl	8 sec

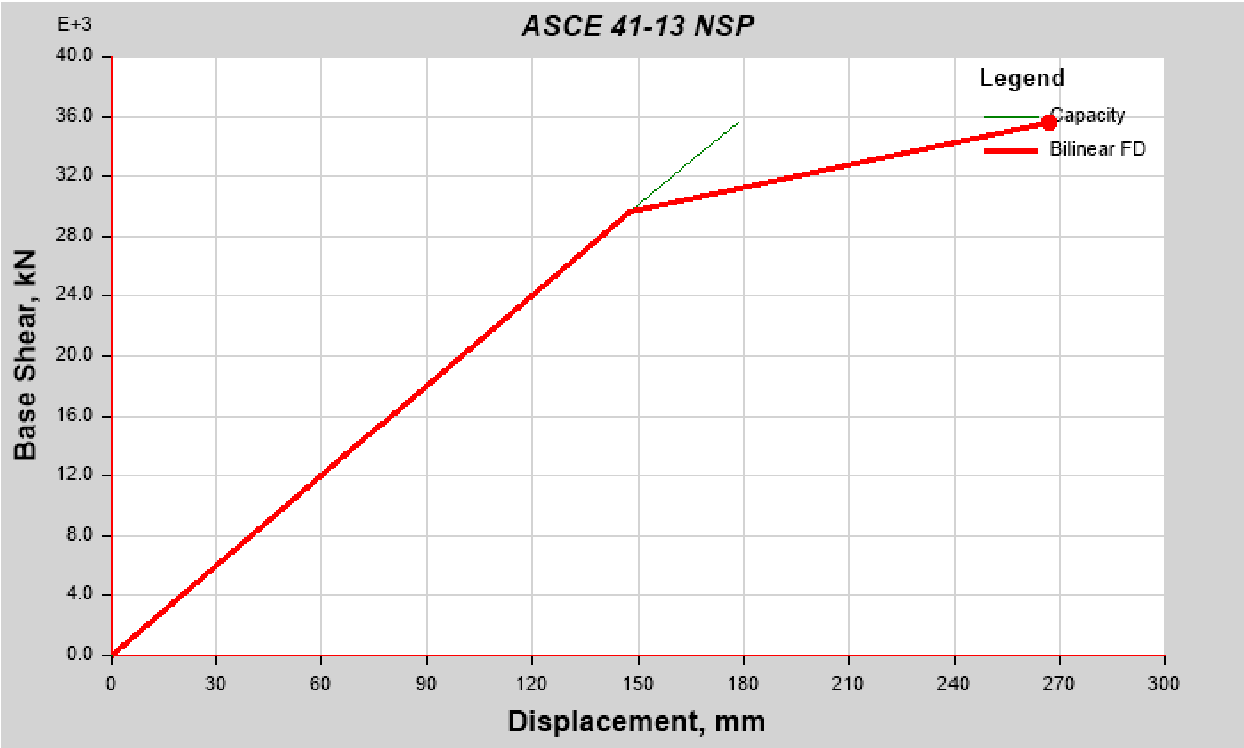

Fig 10 pushover plot of model 1 ASCE 41-13

Results target Displacement

Displacement	267.084 mm	Shear	35617.4106 kN

Parameters Calculated

C0	1.2584	Sa	0.479985 g
C1	1	Alpha	0.247787
C2	1	uStrength	2.284329
Ti	1.338 sec	Dy	147.508 mm
Te	1.338 sec	Vy	29659.7392 kN
Ki	201072.429 kN/m	Weight	141155.6961 kN
Ke	201072.429 kN/m	Cm	1

Tabulated Plot-Coordinates
Capacity Curve Coordinates

Monitored Displ	Base Force
mm	kN
1.145E-11	0
-30	6032.1729
-60	12064.3457
-90	18096.5186
-120	24128.6915
-135.627	27270.9334
-166.079	33273.4949
-178.521	35617.4106

MODEL 2. 8^{TH} STOREY AS SOFT STOREY BARE FRAME BUILDING.

Pushover Curve - Equivalent Linearization of the FEMA 440

Summary Description
These are the data for a pushover linearization study using the FEMA 440 equivalent.

General Input Data

Name	Pushover2		
Load Case	PA-X	Plot Type	FEMA 440 EL

Demand Spectrum-Input Data

Source	General ASCE 7-10	Ss	0.31
Site-Class	D	S1	0.46
		Tl	8 sec

Effective Damping and Effective Period Parameters

Inherent Damping	0.05		
Damping Params	Default-Value	Period Parameters	Default-Value
A	4.2	G	0.11
B	-0.83	H	-0.018
C	10	I	0.09
D	1.6	J	0.14
E	22	K	0.77
F	0.4	L	0.05

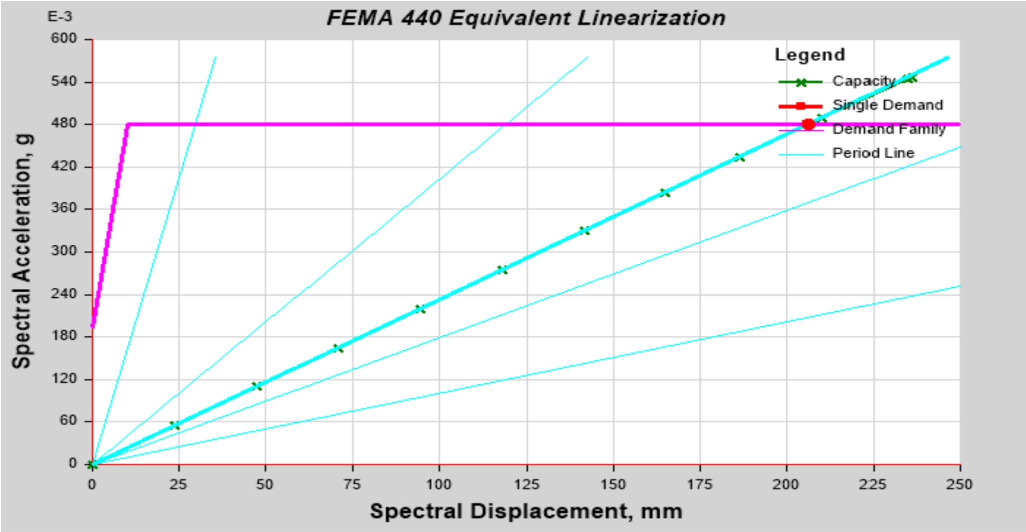

Fig 11 pushover plot of model 2 FEMA 440

Plot Items

Demand Spectra Ductility Ratios 1; 1.5; 2; 2.5

Constant Period Lines 0.5; 1; 1.5; 2

Tabulated Plot-Coordinates
Capacity Curve Coordinates

Sd	Sa	Period
Mm	g	sec
0	0	1.315
23.586	0.054925	1.315
47.171	0.10985	1.315
70.757	0.164774	1.315
94.343	0.219699	1.315
117.929	0.274624	1.315
141.514	0.329549	1.315
165.1	0.384474	1.315
186.61	0.434564	1.315
210.206	0.4893	1.315
234.751	0.544296	1.318
235.925	0.546865	1.318

Pushover Curve - Displacement Modification as per ASCE 41-13

Summary Description
Information for an ASCE 41-13 displacement modification pushover analysis is provided here.

General Input Data

Name	Pushover2		
Load Case	PA-X	Plot Type	ASCE 41-13 NSP

Demand Spectrum-Input Data

Damping Ratio	0.05	Source	General ASCE 7-10

Include SSI	No	Accel-Ss	0.31
C2 Type	Default-Value	Accel-S1	0.46
Cm Type	Default-Value	Site-Class	D
		Tl	8 sec

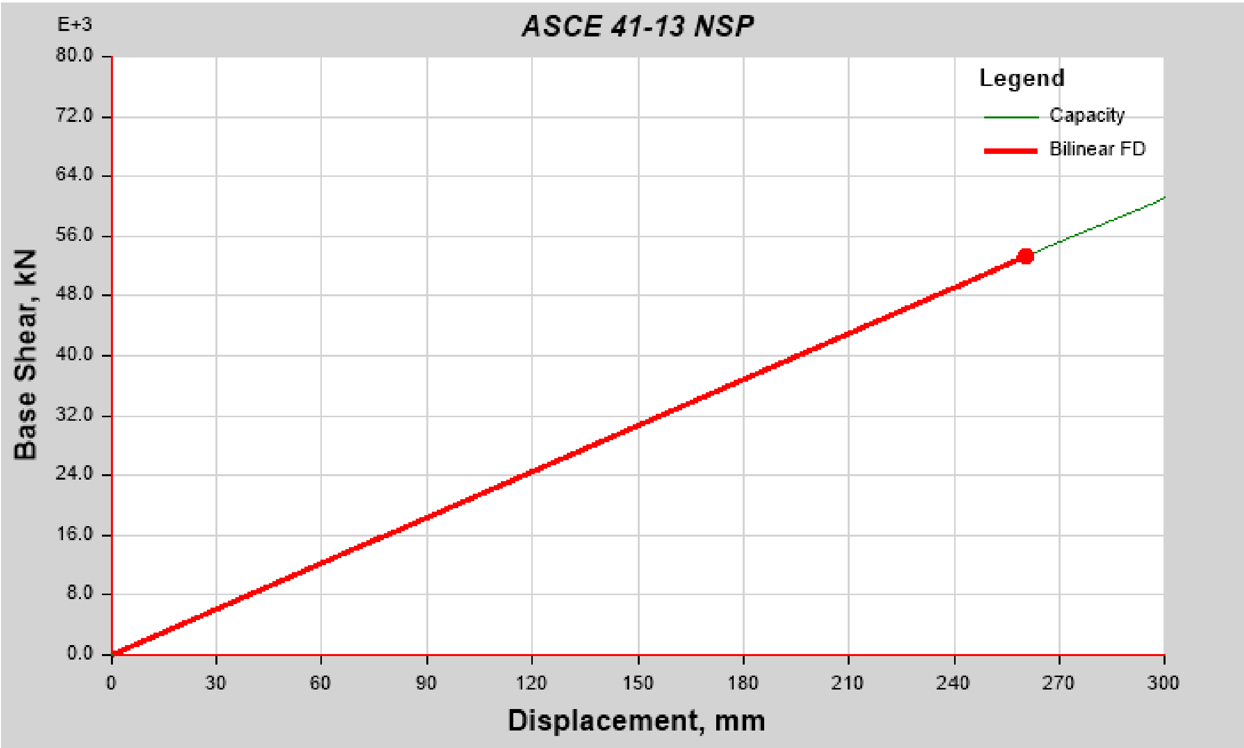

Fig 12 pushover plot of model 2 ASCE 41-13

Results target Displacement

Displacement	260.311 mm	Shear	33227.6401 kN

Parameters Calculated

C0	1.271933	Sa	0.479985 g
C1	1	Alpha	0.99708
C2	1	uStrength	1.392604
Ti	1.315 sec	Dy	237.359 mm
Te	1.315 sec	Vy	48547.0619 kN
Ki	204529.731 kN/m	Weight	140852.0358 kN
Ke	204529.731 kN/m	Cm	1

Tabulated Plot-Coordinates
Capacity Curve Coordinates

Monitored Displ	Base Force
mm	Kn
-2.179E-12	0
-30	6135.8919
-60	12271.7838
-90	18407.6758
-120	24543.5677
-150	30679.4596
-180	36815.3515
-210	42951.2434
-237.359	48547.0619
-267.366	54666.4604
-298.512	60832.7143
-300	61120.7422

MODEL 3. 6^{TH} STOREY AS SOFT STOREY WITH SHEAR WALL.

Pushover Curve - Equivalent Linearization of the FEMA 440

Summary Description
These are the data for a pushover linearization study using the FEMA 440 equivalent.

General Input Data

Name	Pushover3		
Load Case	PA-X	Plot Type	FEMA 440 EL

Demand Spectrum-Input Data

Source	General ASCE 7-10	Ss	0.31
Site-Class	D	S1	0.46
		Tl	8 sec

Effective Damping and Effective Period Parameters

Inherent Damping	0.05		
Damping Params	Default-Value	Period Parameters	Default-Value
A	4.2	G	0.11
B	-0.83	H	-0.018
C	10	I	0.09
D	1.6	J	0.14
E	22	K	0.77
F	0.4	L	0.05

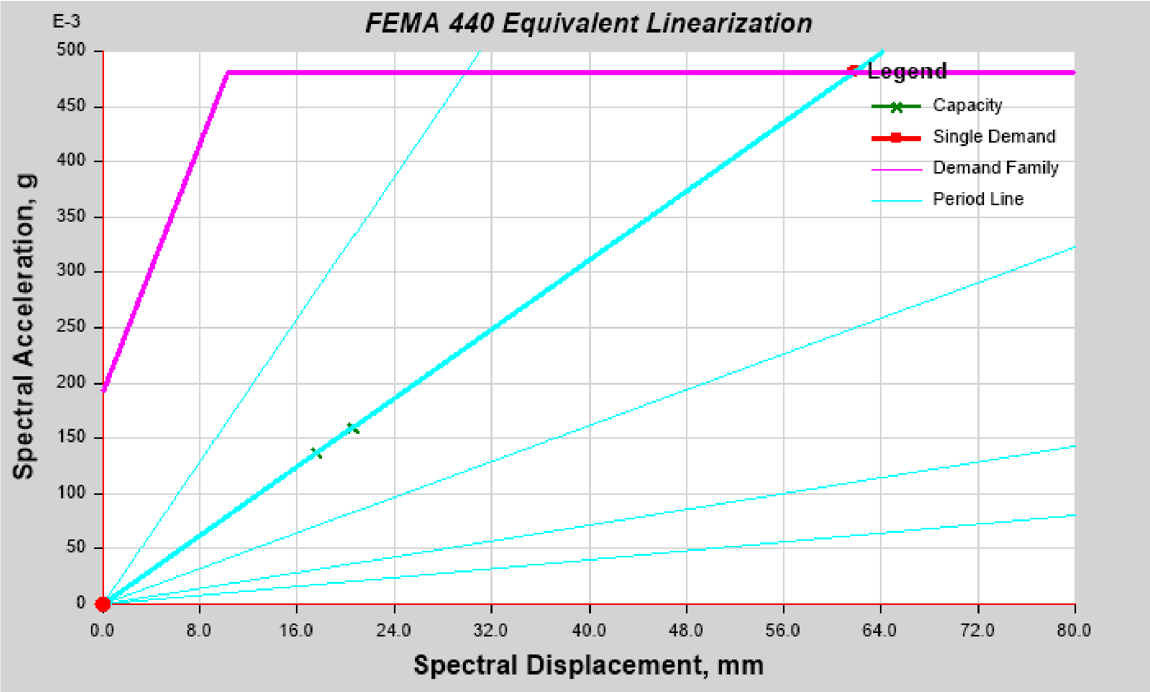

Fig 13 pushover plot of model 3 FEMA 440

Plot Items

Demand Spectra Ductility Ratios 1; 1.5; 2; 2.5

Constant Period Lines 0.5; 1; 1.5; 2

Tabulated Plot-Coordinates

Capacity Curve Coordinates

Sd	Sa	Period
Mm	**g**	**sec**
0	0	0.72
17.655	0.137148	0.72
20.567	0.159627	0.72

Pushover Curve - Displacement Modification as per ASCE 41-13

Summary Description

Information for an ASCE 41-13 displacement modification pushover analysis is provided here.

General Input Data

Name	Pushover3		
Load Case	PA-X	Plot Type	ASCE 41-13 NSP

Demand Spectrum-Input Data

Damping Ratio	0.05	Source	General ASCE 7-10
Include SSI	No	Accel-Ss	0.31
C2 Type	Default-Value	Accel-S1	0.46
Cm Type	Default-Value	Site-Class	D
		Tl	8 sec

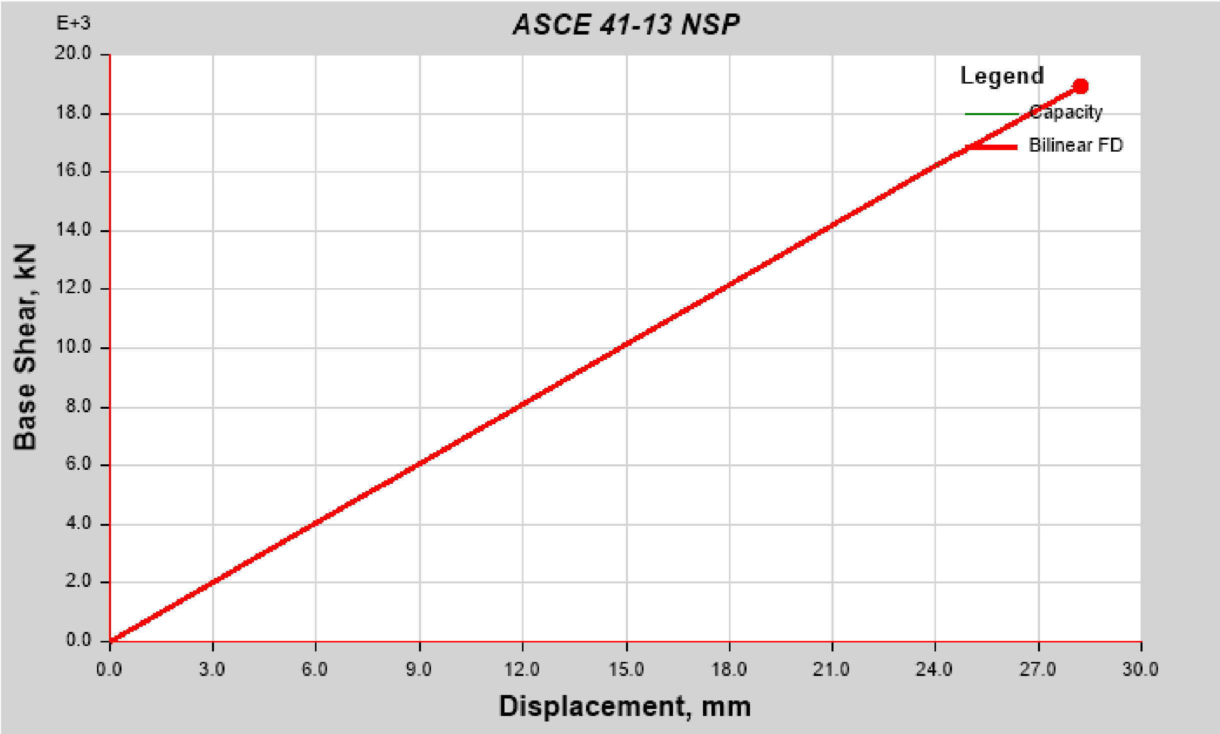

Fig 14 pushover plot of model 3 ASCE 41-13

Results target Displacement

Displacement	88.21 mm	Shear	38930.6492 kN

Parameters Calculated

C0	1.432614	Sa	0.479985 g
C1	1.124989	Alpha	0.938317
C2	1	uStrength	4.886351
Ti	0.72 sec	Dy	24.036 mm
Te	0.72 sec	Vy	16278.1261 kN
Ki	677238.367 kN/m	Weight	165714.8935 kN
Ke	677238.367 kN/m	Cm	1

Tabulated Plot-Coordinates
Capacity Curve Coordinates

Monitored Displ	**Base Force**
mm	**kN**
1.278	0
-24.036	16278.1261
-28.21	18930.6492

MODEL 4. 8TH STOREY AS SOFT STOREY WITH SHEAR WALL.

Pushover Curve - Equivalent Linearization of the FEMA 440

Summary Description
These are the data for a pushover linearization study using the FEMA 440 equivalent.

General Input Data

Name	Pushover4		
Load Case	PA-X	Plot Type	FEMA 440 EL

Demand Spectrum-Input Data

Source	General ASCE 7-10	Ss	0.31
Site-Class	D	S1	0.46
		Tl	8 sec

Effective Damping and Effective Period Parameters

Inherent Damping	0.05

Damping Params	Default-Value	Period Parameters	Default-Value
A	4.2	G	0.11
B	-0.83	H	-0.018
C	10	I	0.09
D	1.6	J	0.14
E	22	K	0.77
F	0.4	L	0.05

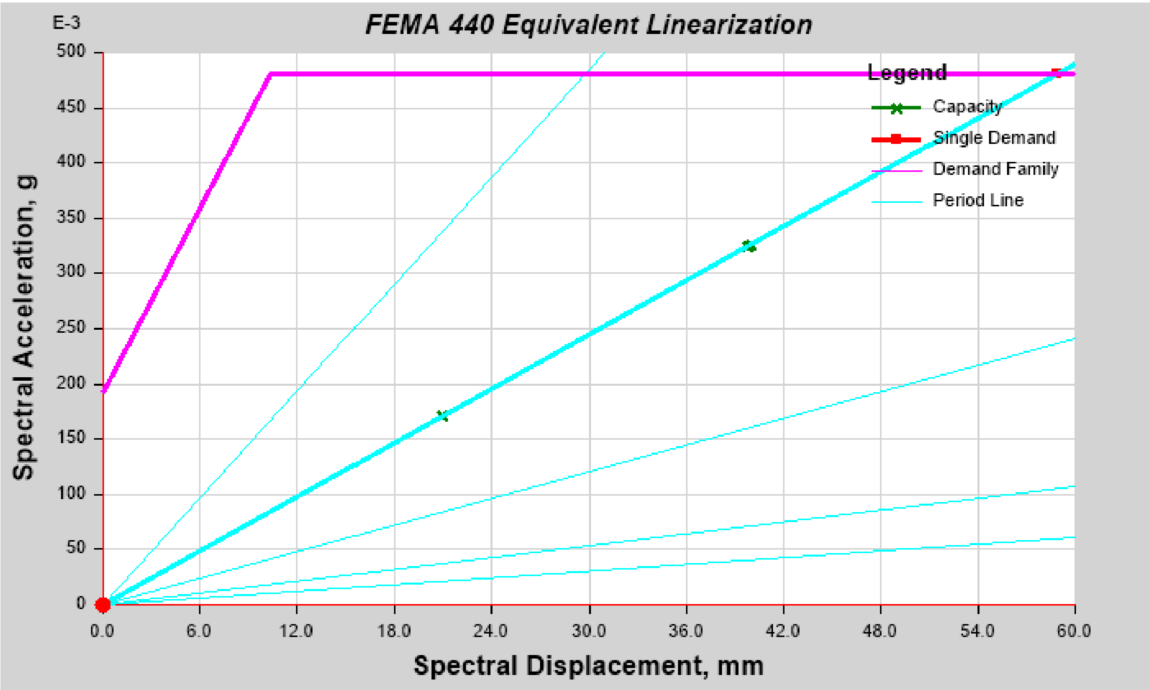

Fig 15 pushover plot of model 4 FEMA 440

Plot Items

Demand Spectra Ductility Ratios	1; 1.5; 2; 2.5
Constant Period Lines	0.5; 1; 1.5; 2

Tabulated Plot-Coordinates
Capacity Curve Coordinates

Sd	Sa	Period
Mm	g	Sec
0	0	0.703
20.91	0.170425	0.703
39.806	0.324437	0.703
39.981	0.325865	0.703

Pushover Curve - Displacement Modification as per ASCE 41-13

Summary Description
Information for an ASCE 41-13 displacement modification pushover analysis is provided here.

General Input Data

Name	Pushover4		
Load Case	PA-X	Plot Type	ASCE 41-13 NSP

Demand Spectrum-Input Data

Damping Ratio	0.05	Source	General ASCE 7-10
Include SSI	No	Accel-Ss	0.31
C2 Type	Default-Value	Accel-S1	0.46
Cm Type	Default-Value	Site-Class	D
		Tl	8 sec

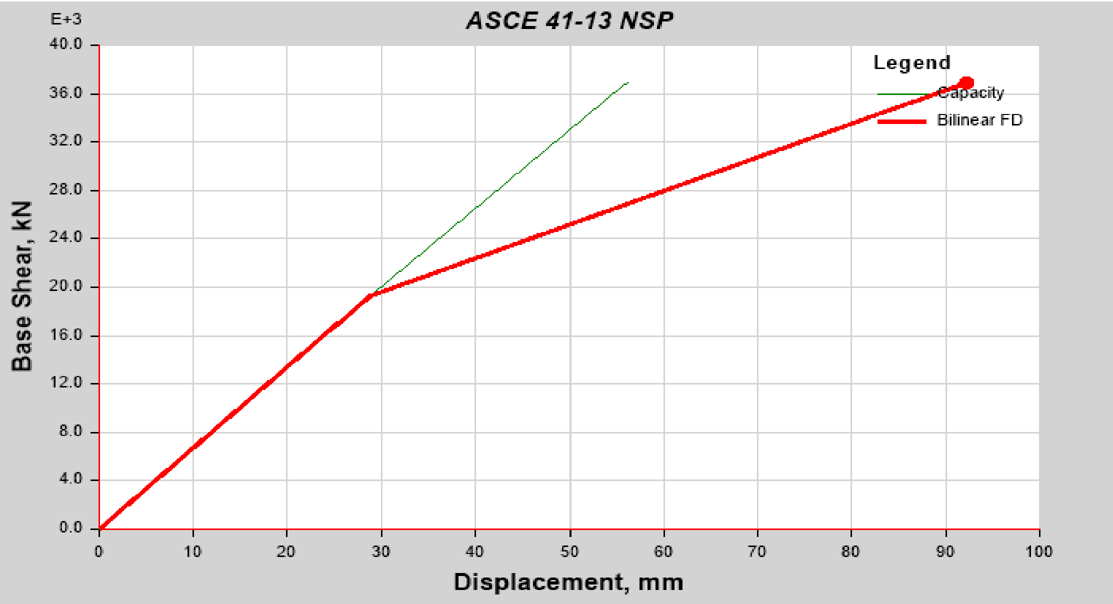

Fig 16 pushover plot of model 4 ASCE 41-13

Results target Displacement

Displacement	92.229 mm	Shear	36963.9057 kN

Parameters Calculated

C0	1.434753	Sa	0.479985 g
C1	1.099793	Alpha	0.412668
C2	1	uStrength	3.95737
Ti	0.703 sec	Dy	28.743 mm
Te	0.703 sec	Vy	19337.9755 kN
Ki	672784.036 kN/m	Weight	159437.3935 kN
Ke	672784.036 kN/m	Cm	1

Tabulated Plot-Coordinates
Capacity Curve Coordinates

Monitored Displ	**Base Force**
Mm	**kN**
1.266	0
-28.734	19331.7917
-55.845	36801.7012
-56.097	36963.9057

MODEL 5. 6TH STOREY AS SOFT STOREY WITH SHEAR WALL AND COUPLING BEAMS.

Pushover Curve - Equivalent Linearization of the FEMA 440

Summary Description
These are the data for a pushover linearization study using the FEMA 440 equivalent.

General Input Data

Name	Pushover5		
Load Case	PA-X	Plot Type	FEMA 440 EL

Demand Spectrum-Input Data

Source	General ASCE 7-10	Ss	0.31
Site-Class	D	S1	0.46
		Tl	8 sec

Effective Damping and Effective Period Parameters

Inherent Damping	0.05		
Damping Params	Default-Value	Period Parameters	Default-Value
A	4.2	G	0.11
B	-0.83	H	-0.018
C	10	I	0.09
D	1.6	J	0.14
E	22	K	0.77

F	0.4	L	0.05

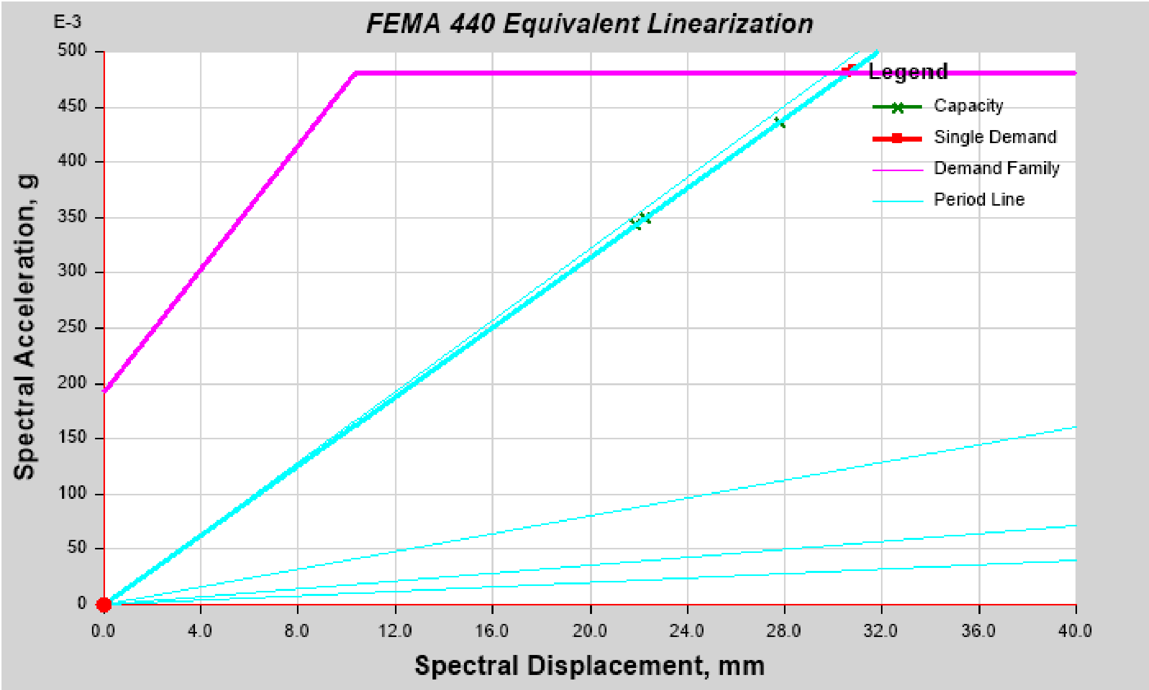

Fig 17 pushover plot of model 5 FEMA 440

Plot Items

Demand Spectra Ductility Ratios	1; 1.5; 2; 2.5
Constant Period Lines	0.5; 1; 1.5; 2

Tabulated Plot-Coordinates
Capacity Curve Coordinates

Sd	Sa	Period
mm	G	Sec
0	0	0.507
21.886	0.343283	0.507
22.262	0.34918	0.507
27.848	0.435934	0.507

Pushover Curve - Displacement Modification as per ASCE 41-13

Summary Description
Information for an ASCE 41-13 displacement modification pushover analysis is provided here.

General Input Data

Name	Pushover5		
Load Case	PA-X	Plot Type	ASCE 41-13 NSP

Demand Spectrum-Input Data

Damping Ratio	0.05	Source	General ASCE 7-10
Include SSI	No	Accel-Ss	0.31

C2 Type	Default-Value	Accel-S1	0.46
Cm Type	Default-Value	Site-Class	D
		Tl	8 sec

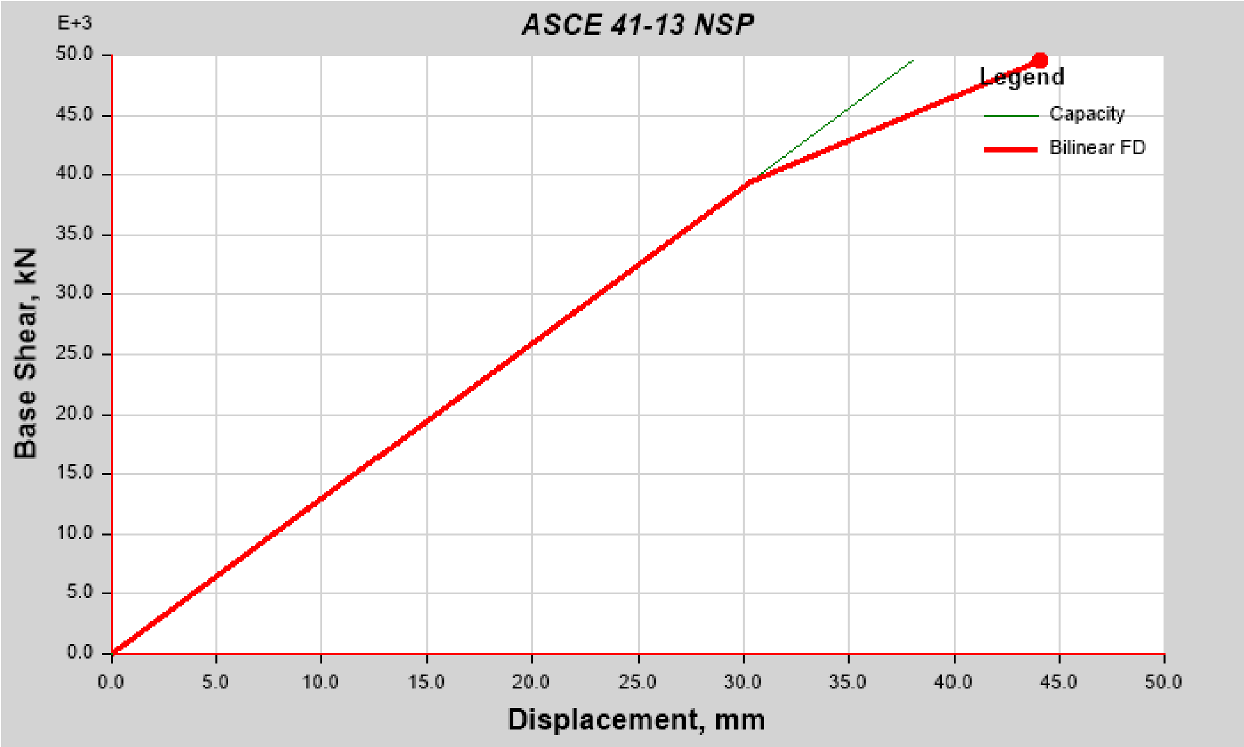

Fig 18 pushover plot of model 5 ASCE 41-13

Results target Displacement

Displacement	44.049 mm	Shear	49480.4293 Kn

Parameters Calculated

C0	1.370353	Sa	0.479985 g
C1	1.052667	Alpha	0.561654
C2	1.003204	uStrength	1.811031
Ti	0.507 sec	Dy	30.347 mm
Te	0.507 sec	Vy	39471.1992 kN
Ki	1300657.085 kN/m	Weight	148928.7727 kN
Ke	1300657.085 kN/m	Cm	1

Tabulated Plot-Coordinates
Capacity Curve Coordinates

Monitored Displ	Base Force
Mm	kN
0.055	0
-29.945	38947.8757
-30.46	39616.9153
-38.111	49480.4293

MODEL 6. 8TH STOREY AS SOFT STOREY WITH SHEAR WALL AND COUPLING BEAMS.

Pushover Curve - Equivalent Linearization of the FEMA 440

Summary Description
These are the data for a pushover linearization study using the FEMA 440 equivalent.

General Input Data

Name	Pushover6		
Load Case	PA-X	Plot Type	FEMA 440 EL

Demand Spectrum-Input Data

Source	General ASCE 7-10	Ss	0.31
Site-Class	D	S1	0.46
		Tl	8 sec

Effective Damping and Effective Period Parameters

Inherent Damping	0.05		
Damping Params	Default-Value	Period Parameters	Default-Value
A	4.2	G	0.11
B	-0.83	H	-0.018
C	10	I	0.09
D	1.6	J	0.14
E	22	K	0.77
F	0.4	L	0.05

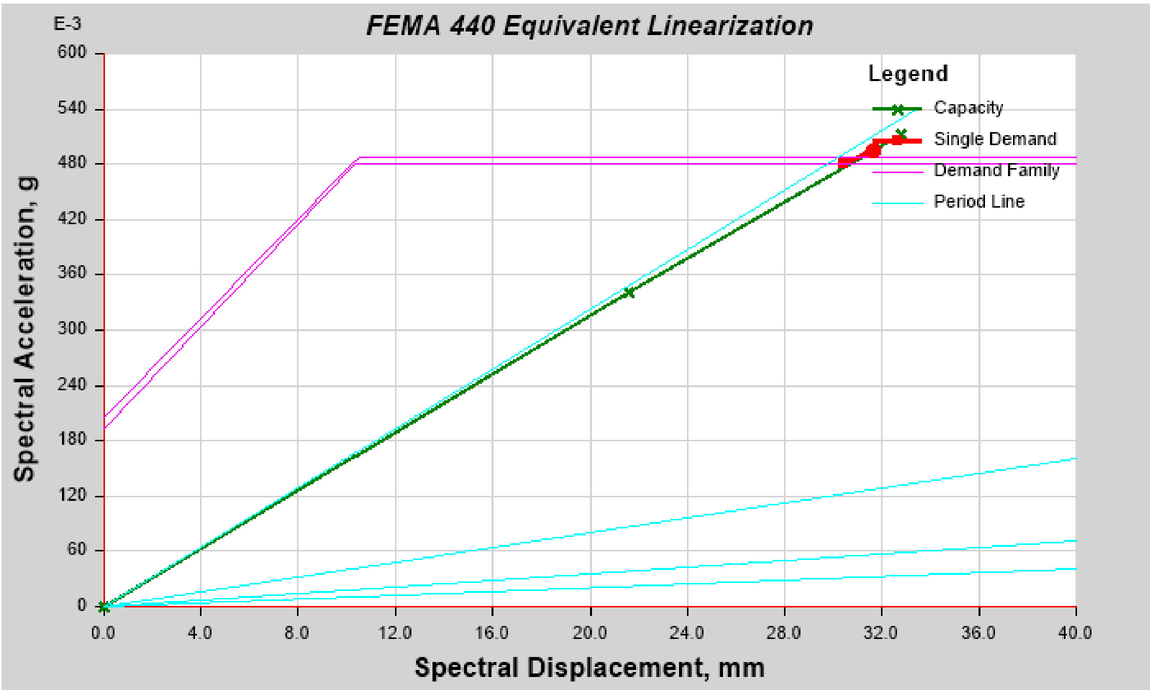

Fig 19 pushover plot of model 6 FEMA 440

Plot Items

Demand Spectra Ductility Ratios 1; 1.5; 2; 2.5

Constant Period Lines 0.5; 1; 1.5; 2

Tabulated Plot-Coordinates
Capacity Curve Coordinates

Sd	Sa	Period
mm	G	sec
0	0	0.505
21.615	0.340531	0.505
32.855	0.513054	0.508

Pushover Curve - Displacement Modification as per ASCE 41-13

Summary Description
Information for an ASCE 41-13 displacement modification pushover analysis is provided here.

General Input Data

Name	Pushover6		
Load Case	PA-X	Plot Type	ASCE 41-13 NSP

Demand Spectrum-Input Data

Damping Ratio	0.05	Source	General ASCE 7-10
Include SSI	No	Accel-Ss	0.31
C2 Type	Default-Value	Accel-S1	0.46
Cm Type	Default-Value	Site-Class	D
		Tl	8 sec

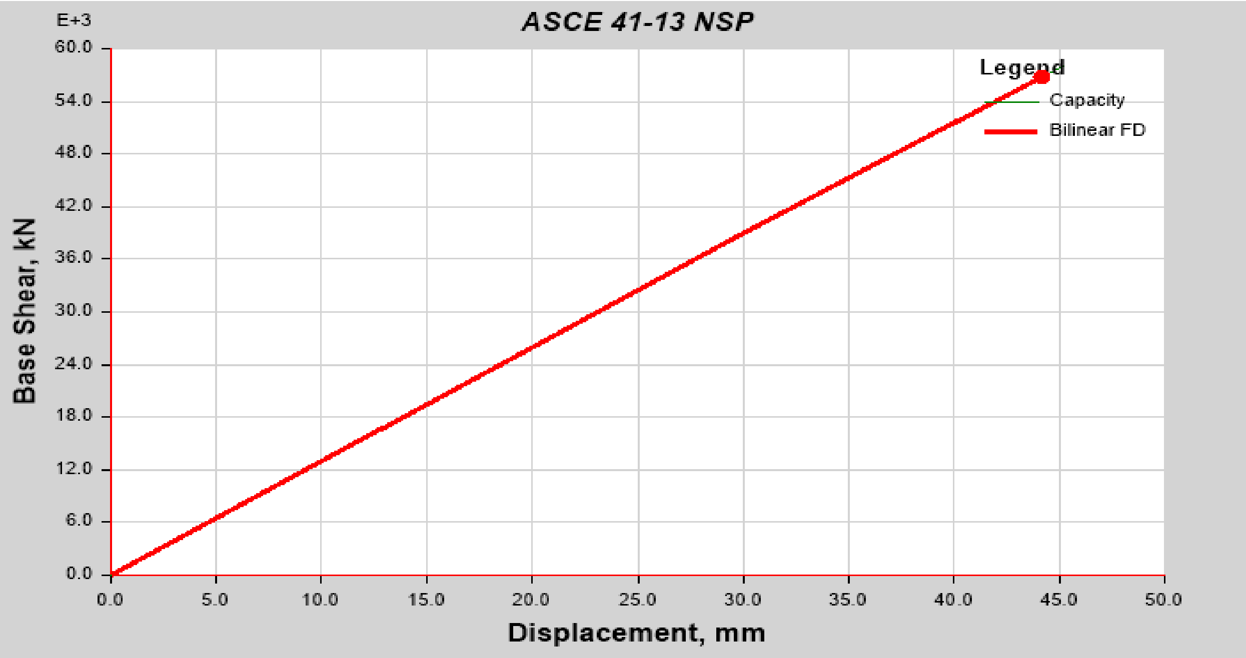

Fig 20 pushover plot of model 6 ASCE 41-13

Results target Displacement

Displacement	44.174 mm	Shear	56827.8408 kN

Parameters Calculated

C0	1.376185	Sa	0.479985 g
C1	1.055656	Alpha	0.976694
C2	1.003562	uStrength	1.853275
Ti	0.505 sec	Dy	29.706 mm
Te	0.505 sec	Vy	38509.7633 kN
Ki	1296348.668 kN/m	Weight	148690.5305 kN
Ke	1296348.668 kN/m	Cm	1

Tabulated Plot-Coordinates
Capacity Curve Coordinates

Monitored Displ	Base Force
Mm	**kN**
0.055	0
-29.706	38509.7633
-45.157	58072.5397

Table8- Performance point parameters for different building models

Models	Structural Acceleration S_a (g)	Roof Displacement D (mm)	Structural Displacement S_d (mm)	Base shear V (KN)
Model 1	0.053	267.08	23.822	35617.41
Model 2	0.053	260.31	23.586	33227.64
Model 3	0.137	88.21	17.655	38930.64
Model 4	0.170	92.29	20.910	36963.90
Model 5	0.343	44.049	21.886	49480.42
Model 6	0.340	44.171	21.615	56827.84

VIII. CONCLUSIONS

1. Maximum time period is from bare frame among all the all models in zone IV.
2. Bare frame increases with level of soft storey increases, respectively compared with base shear to structure having soft storey at 6^{th} and 8^{th} storey
3. Provision of shear wall with coupling beams consequences in huge decreases in displacement & drift and increases in base shear.
4. Storey displacement for shear wall model shows the minimum displacement among all the models

5. Storey drift is monitored to be least in shear wall with coupling beams model as compared with rest of the structure models.

IX. FUTURE WORK OF SCOPE

- Building studies may be carried out at various sites and with thicker shear walls.
- The structure may be examined in various soil types and seismic zones.
- Study the effects of soft storey at various levels in structures with irregular plans.

REFERENCES

1. Farjana Khanam, Anik Das AndSharmin Reza Chowdhury "EFFECTIVE LOCATION OF SHEAR WALL ON PERFORMANCE OF BUILDING FRAME SUBJECTED TO LATERAL LOADING" IJAMC, ISSN: 2394-2827 Volume-4, Issue-6,
2. Krishna G S And Chaithra S "NONLINEAR ANALYSIS OF FRAME SHEAR WALL BUILDING WITH DIFFERENT OPENING CONFIGURATIONS" (IJERT) ISSN: 2278-0181 Vol. 6 Issue 05,
3.Kollipara V G Manikanta Sreeram, Rajendra Prasad Singh And Sripathi Siva Bhanu Sai Kumar "EFFECTIVE LOCATION OF SHEAR WALLS AND BRACINGS FOR MULTISTORIED BUILDING" (IRJET) E-issn: 2395 -0056 Volume: 04 Issue: 01
4. Nitin Choudhary And Prof. Mahendra Wadia "Pushover Analysis Of R.C. Frame Building With Shear Wall" (IJMCE) E-issn: 2278-1684, Volume 11, Issue 2
5. Saleem Malik Yarnal, Sagar S Allagi, Prashant M Topalakatti andArif Ahmed Mulla. "Non-Linear Analysis of Asymmetric Shear Wall with Openings" (IJERT) ISSN: 2278-0181 Vol. 4 Issue 08,
6. Sanjay G and Dr. B Shivakumara swamy "Analysis of Soft Storey Effect At Different Levels In A Framed Structure With And Without Shear Wall For Different Seismic Zone" (IRJET) e-ISSN: 2395-0056 Volume: 05 Issue: 08
7. Ejaz Ahmad Bhat and Mr. Faiyaz Azam "Effect Of Shear Wall Area On Seismic Behaviour Of Multistoried Building With Soft Storey At Ground Floor" (IJERT) ISSN: 2278-0181 Vol. 9 Issue 07,
8. Prof. Patil S.S and Sagare S.D "Dynamic Analysis Of Soft Story-high Rise Building With Shear Wall" (IJLTEMAS) ISSN 2278-2540 Volume VII, Issue IX
9. Prof. Rahul T. Pardeshi, Prof. Pratiksha M. Bhadange, Somesh V."Analysis of Irregular High-rise Building Using Shear Walls At Different Locations"
10. Mahdi Hosseini1, Prof. N.V.RamanaRao "Seismic Analysis of Multi-Storey Building Structure with Shear Walls at the Center Core and Center of Each Side of the External Perimeter
11. Shahzeb Khan, Vishal Yadav, Sandeep Singla "Earthquake Resisting Techniques on A G+10 Storey Building with the Help of Shear Walls & Bracings, using Software
12. S. NATARAJAN1 , S. VEERARAGAVAN (2016) "A Review on Analysis and Design of Shear Walls in High Rise Irregular Building