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Effect of Diagonal Bracing and Shear Wall in Multi Storied Building

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ABSTRACT

It is observed that the structure in high seismic areas may be susceptible to the sever damage. Safety and minimum damage level of a structure could be the prime requirement of tall buildings. To get these requirement the structure should have adequate lateral strength, lateral stiffness, and sufficient ductility. Now a day shear wall and diagonal bracing are most popular system to resist lateral loads due to earthquake, wind etc. Shear wall has high in plane stiffness and strength which can be used to simultaneously resist large horizontal loads and support gravity loads but the diagonal bracing will be the viable solution for enhancing earthquake resistance. In this study R.C.C Building (G+10) is modelled and analyzed in seven parts i) Model without Shear wall and Bracing (Bare frame). ii) Model with Shear wall providing at corner side. iii) Model with Shear wall providing at perimeter side. iv) Model with Shear wall providing at centre side. v) Model with diagonal bracing at corner side. vi) Model with diagonal bracing at perimeter side. vii) Model with diagonal bracing at centre area. The computer aided analysis is done by using E-TAB to find out effective lateral load system during earthquake in high seismic areas.

Key words: *R.C. frame, Lateral displacement, Storey shear, Storey drift, Base shear, etc.*

1. INTRODUCTION

General:- The primary purpose of all kinds of structure systems used in the building type of structures is to transfer gravity loads effectively. The most common loads resulting from the effect of gravity are dead load, live load and snow load, building are also subjected to lateral loads caused by wind, blasting or earthquake. Lateral loads can develop high stresses, produce sway movement or cause vibration. Therefore it is very important for the structure to have sufficient strength against vertical loads together with adequate stiffness to resist lateral forces.

RCC Building with Shear wall:- Shear wall are one of the excellent means of providing earthquake resistance to multi-storeyed reinforced concrete building. These wall generally start at foundation level and are continuous throughout the building height. Shear walls are usually provided along length and width of buildings, shear walls are like vertically oriented wide beams that carry earthquake loads downwards to the Foundation. Properly designed and detailed buildings with shear walls have shown very good performance in past earthquake. Shear walls are constructed to counter the effect of lateral load acting on a structure. In residential construction, shear walls are straight walls that typically form a box which provides all of the lateral support for the building. When the shear walls are designed and constructed properly they will have strength and stiffness to resist the horizontal forces.

Shear wall are usually used in tall building to avoid collapse of buildings. When shear wall are situated in advantageous position in the building , they can form an efficient lateral force resisting

system. The position of shear wall in building to achieve rigidity has been found effective and economical. Shear wall building are a popular choice in many earthquake prone countries, like Chile, New Zealand. Shear wall are easy to construct, because reinforcement detailing of walls is relatively straight-forward and therefore easily implemented at site. Shear walls are efficient both in terms of construction cost and effectiveness in minimizing earthquake damage in structure & non-structural elements.

RCC Building with Steel bracing:- The most effective and practical method of enhancing the seismic resistance is to increase the energy absorption capacity of structures by combining bracing elements in the frame. The braced frame can absorb a greater degree of energy exerted by earthquakes. Bracing members are widely used in steel structures to reduce lateral displacement and dissipate energy during strong ground motions. This concept extended to concrete frames. The various aspects such as size and shape of building, location of shear wall and bracing in building, distribution of mass, distribution of stiffness greatly affect the behaviours of structures. Diagonal bracing is efficient and economical method of resisting horizontal forces in a frame structure because the diagonals work in axial stress and therefore call for minimum member sizes in providing stiffness and strength against horizontal shear.

Bracing system improves the seismic performance of the frame by increasing its lateral stiffness and capacity. To the addition of bracing system load could be transferred out of the frame and into the braces, by passing the weak columns. Diagonal braced frames are efficient structural system for buildings subjected to seismic or wind lateral loading. Therefore, the use of diagonal bracing system for both retrofitting as well as newly constructed RC frame with adequate lateral resistance is attractive. The diagonal braces are usually placed in vertically aligned spans. This system allows obtaining a great increase of stiffness with minimum added weight, and so it is very effective for structure for which the poor lateral stiffness is the main problem. Diagonal bracing is well suited for strengthening operations. The stiffness added by the bracing system is maintained almost up to the peak strength. Stiffness is particularly important at serviceability state, where deformations are limited to prevent damage.

2. MODELLING

For the study, (G+10) storey building, with a 3meters height for each storey regular plan is modelled. The buildings are modelled using software E-TAB. The dead load, live load, lateral loads to be applied on the building are based on the Indian standards. The study is performed for seismic zone III (moderate) as per IS1893:2002 (part I). The building adopted consist of reinforced concrete and brick masonry elements. Seven different models were studied with different position of shear wall and steel bracing in building.

Model I- analyzed for seismic of bare frame.

Model II- analyzed with shear wall on corner side.

Model III- analyzed with shear wall on perimeter side.

Model IV- analyzed with shear wall on centre area.

Model V- analyzed with diagonal bracing on corner side.

Model VI- analyzed with diagonal bracing on perimeter side.

Model VII- analyzed with diagonal bracing on centre area.

To find out effectiveness of diagonal bracing and shear wall by changing different position to RCC building there is need to study the parameter as Lateral displacement, Storey shear, Storey drift, Push over curve for that there is need to do Linear and Nonlinear analysis of structure.

Model Data-

Types of building	Residential Building
No of Stories	G+10
Storey height	3.00 m
Thickness of slab	0.12 m
Thickness of external wall	0.25 m
Thickness of internal wall	0.15 m
External column size	0.35 x 0.6 m
Internal column size	0.4 x 0.4 m
Beam size longitudinal & transverse direction	0.35 x 0.6 m
Grade of concrete & Steel	M20 & Fe415

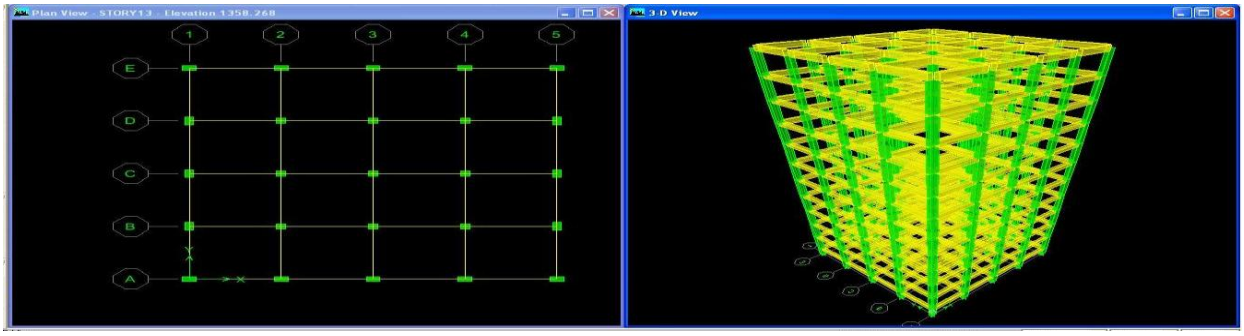


Fig.1. Bare frame model

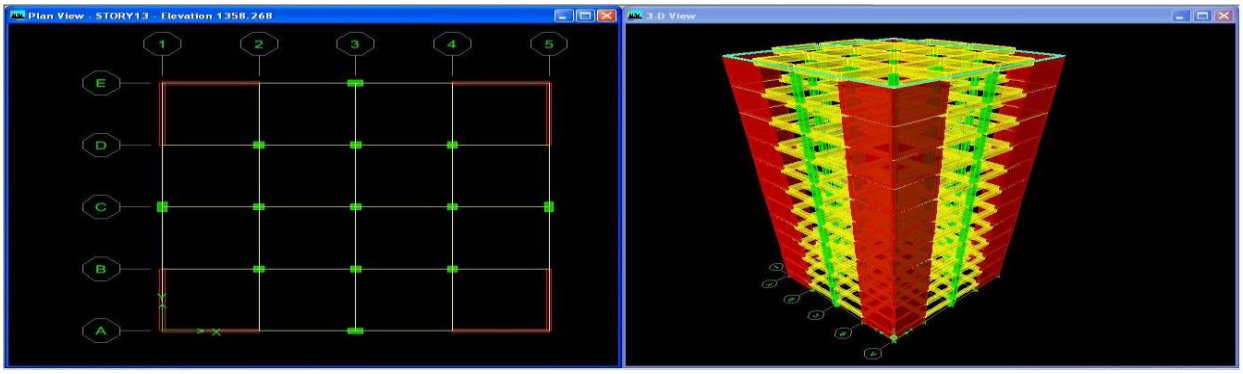


Fig.2. SW Type-I

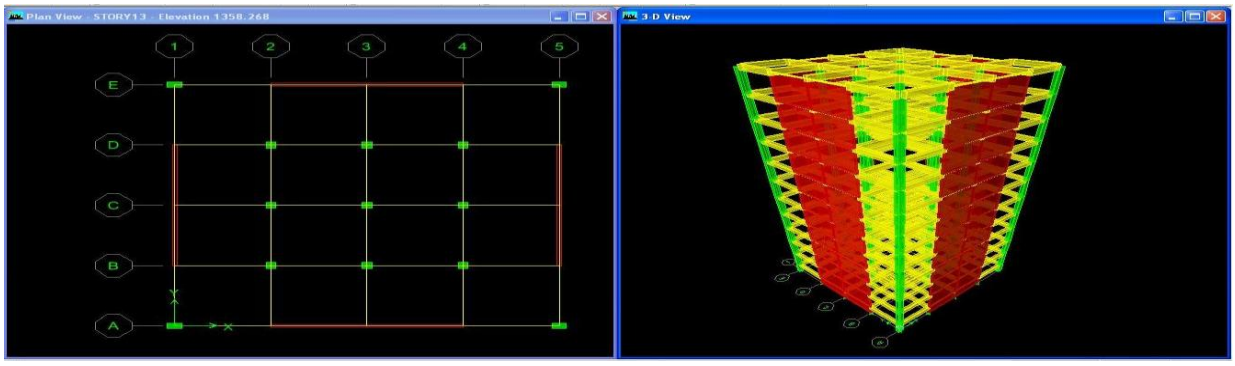


Fig.3. SW Type-II

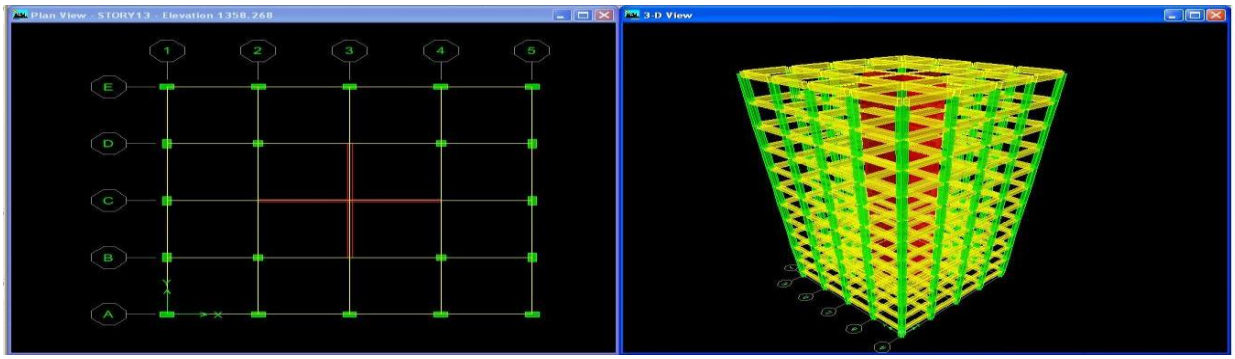


Fig.4. SW Type-III

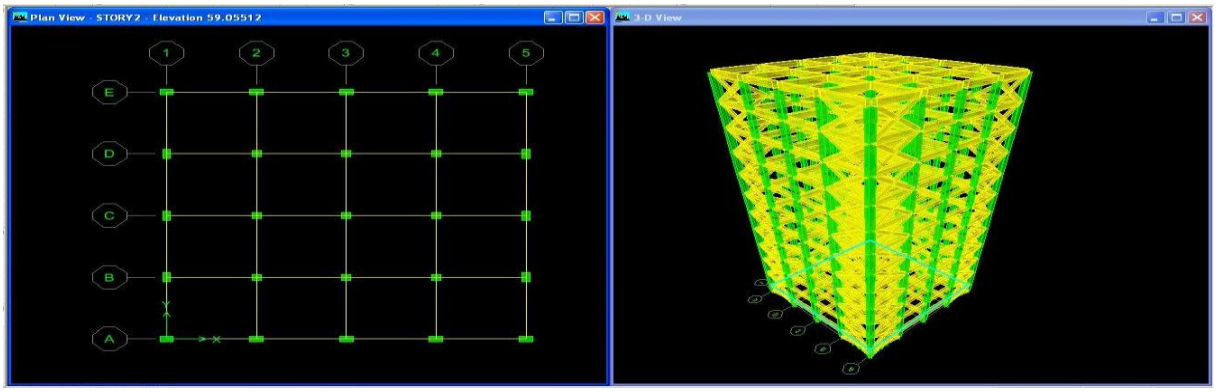


Fig.5. BR Type-I

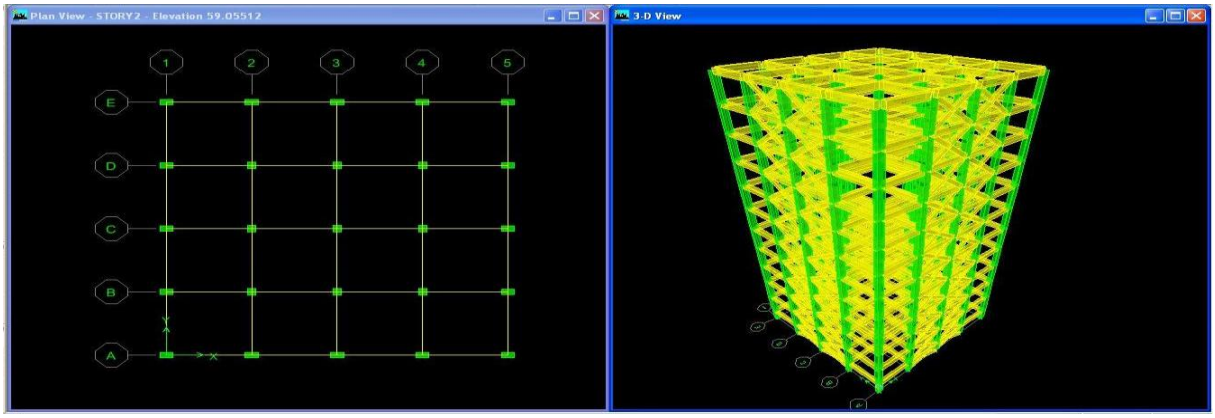


Fig.6. BR Type-II

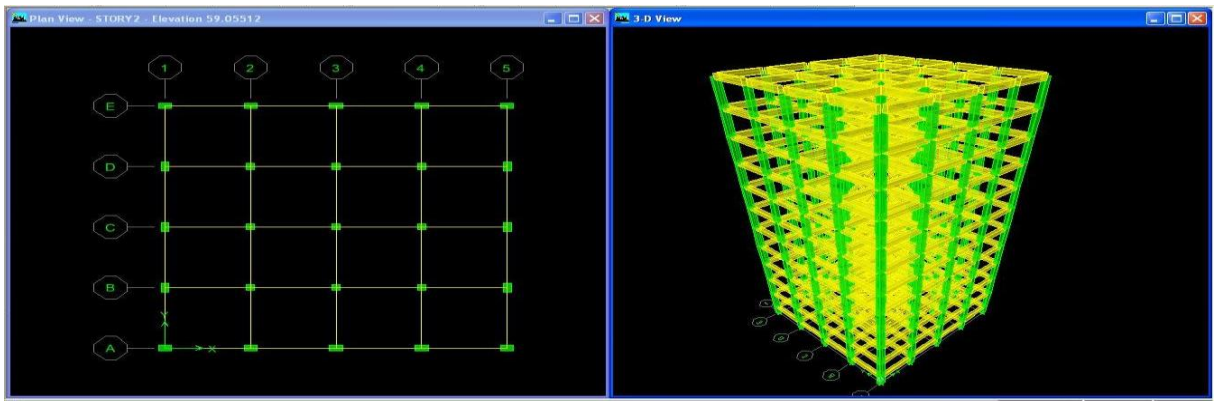
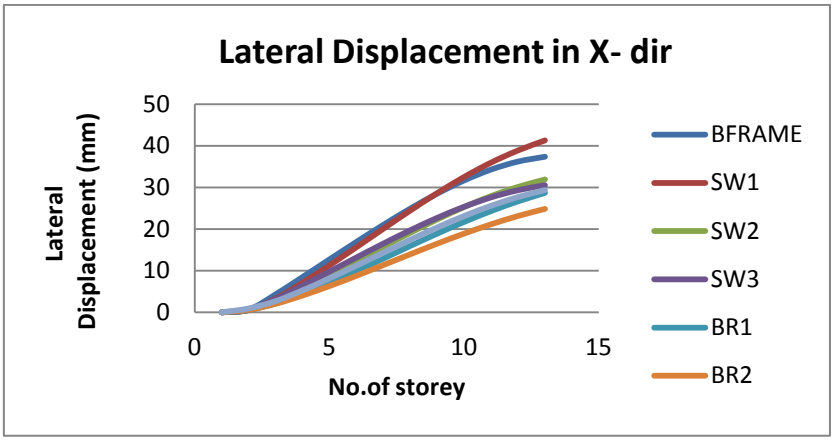


Fig.7. BR Type-III

3. RESULT AND DISCUSSION

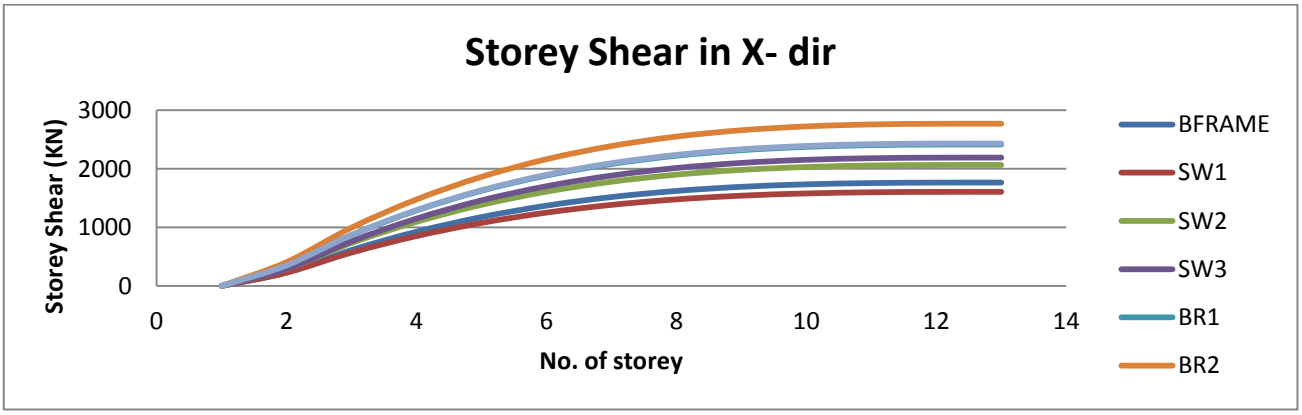
3.1 Linear Analysis:-

3.2 3.1.1. Lateral Displacement



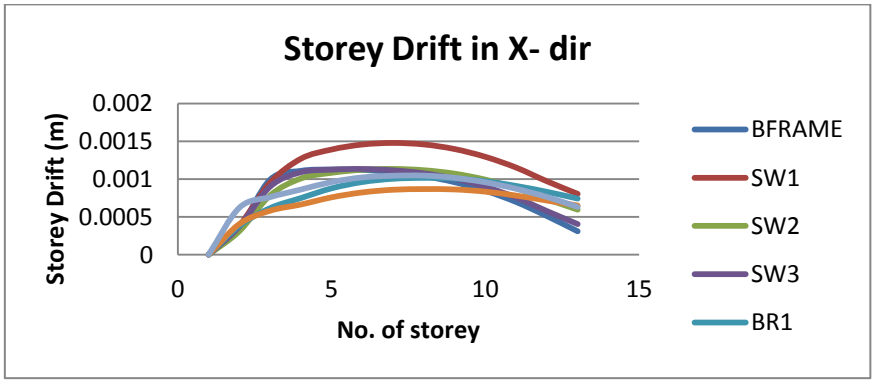
Lateral displacement of bare frame model is controlled by shear wall & steel bracing as lateral load resisting system. The lateral displacement of steel bracing type-II is better than the other model. It reduces 17% displacement as compare with bare frame model.

3.1.2 Storey shear



The storey shear of shear wall and steel bracing is more than the bare frame model. The maximum storey shear of steel bracing 406.23 KN in X and Y direction.

3.1.3 Storey Drift



Shear wall and steel bracing significantly decrease in the storey drift compared with bare frame model which is within limit.

3.2 Nonlinear Analysis:-

Demand Spectrum

It can be observed demand of model with steel bracing intersect the capacity curve that is an elastic response and good security margin.

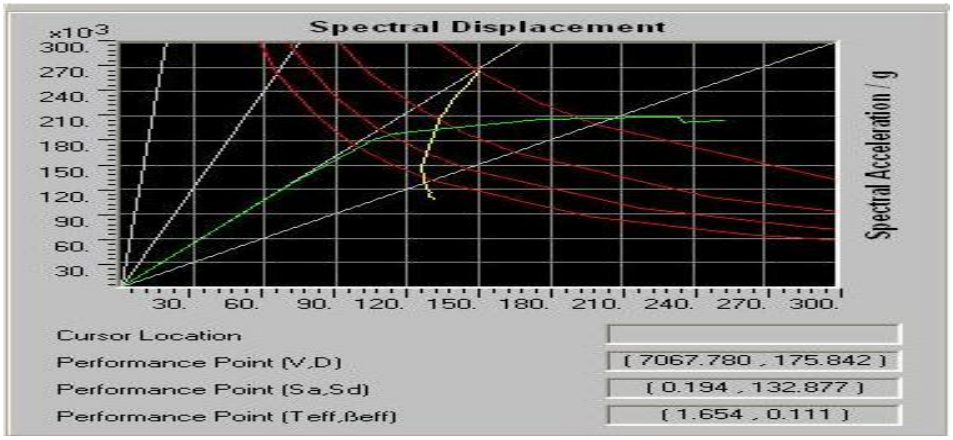


Fig.8. Performance point of Bare frame

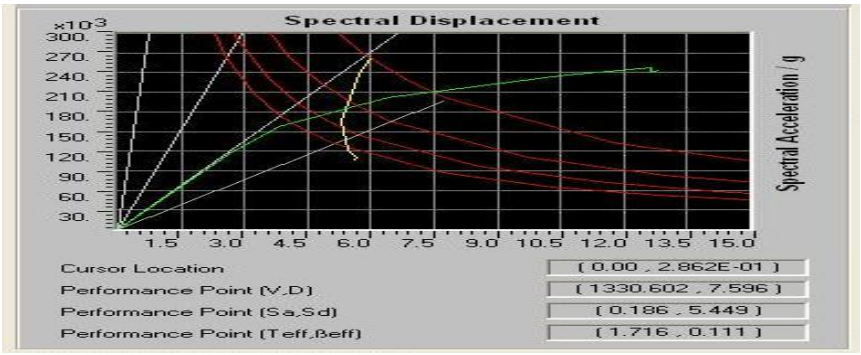


Fig.9. Performance point of SW Type –I

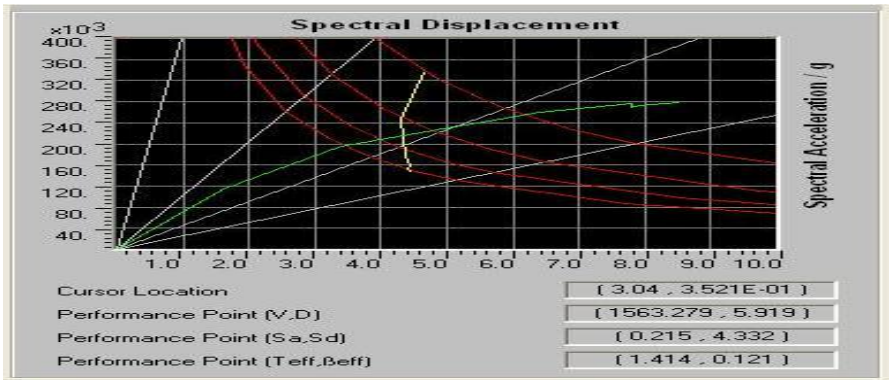


Fig.10. Performance point of SW Type-II

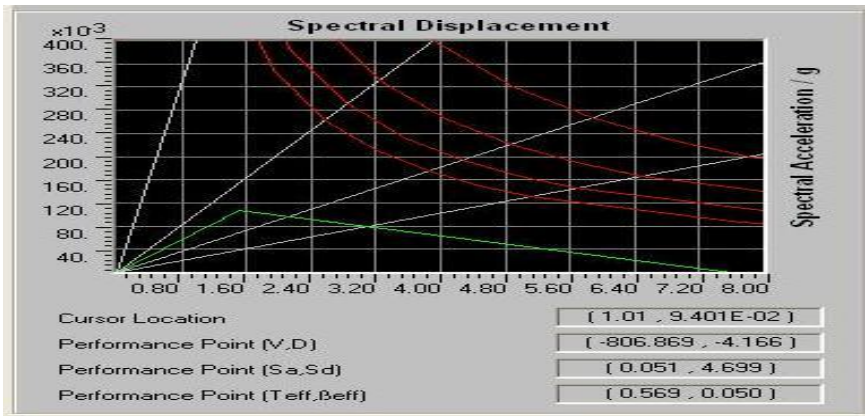


Fig.11. Performance point of SW Type-III

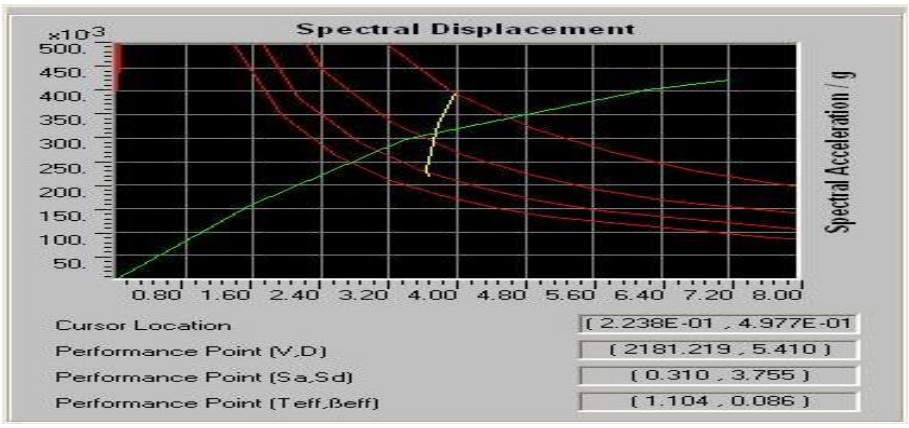


Fig.12. Performance point of BR Type-I

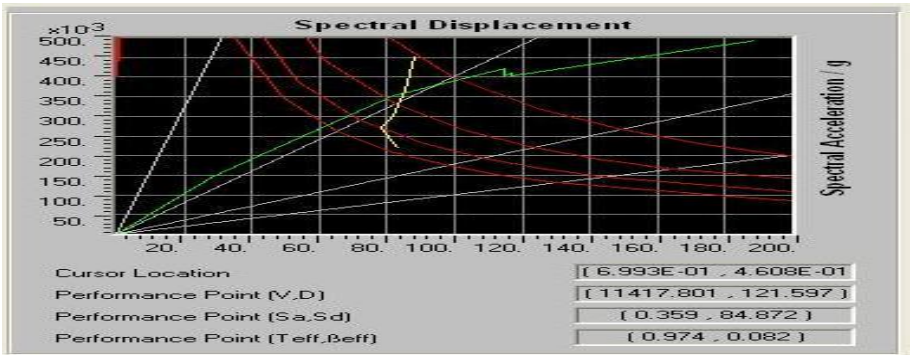


Fig.13. Performance point of BR Type-II

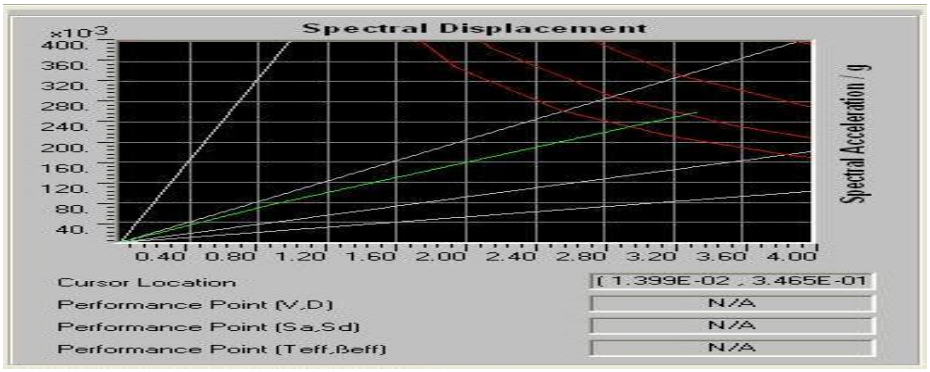


Fig.14. Performance point of BR Type-III

Plastic Hinge Mechanism

Model with diagonal bracing shows better performance. The yielding of model with diagonal bracing occurs at event B-IO and IO-LS and LS-CP the amount of damage in this structure will be limited.

Fig.15. Plastic Hinge Mechanism of Bare frame model

Fig.16. Plastic Hinge Mechanism of SW Type-I

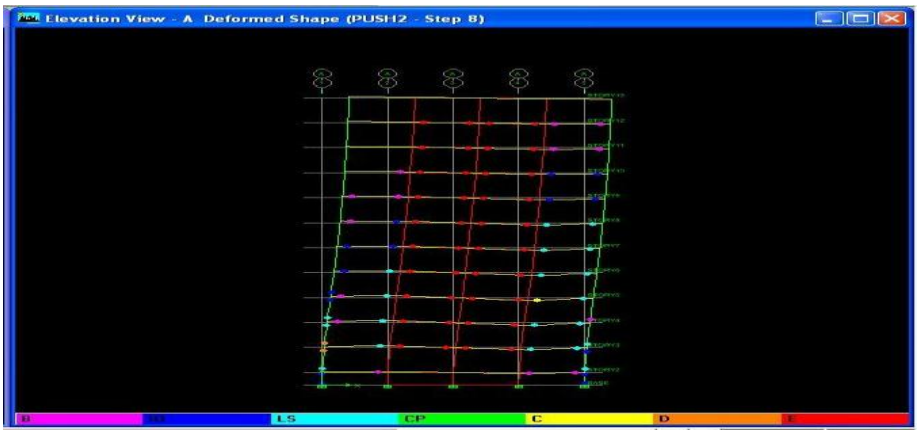


Fig.17 . Plastic Hinge Mechanism of SW Type-II

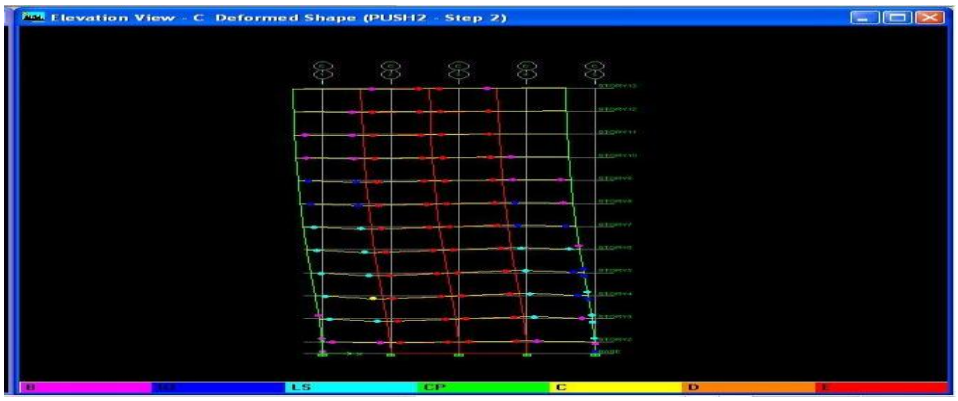


Fig.18 . Plastic Hinge Mechanism of SW Type-III

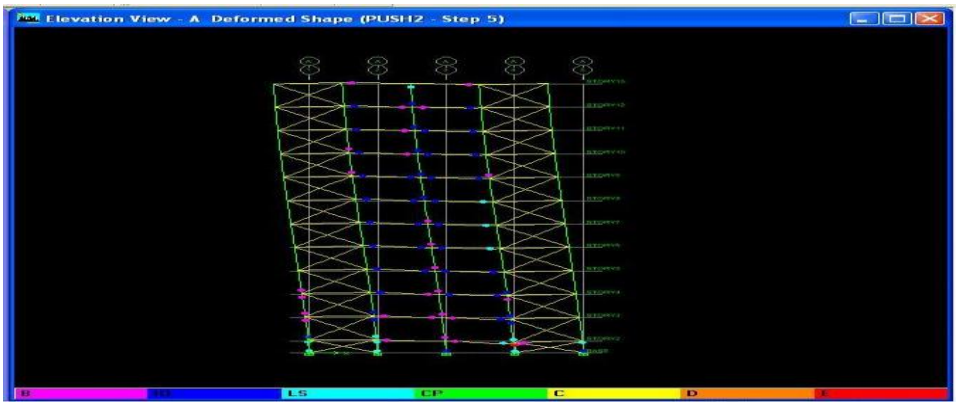


Fig.19. Plastic Hinge Mechanism of BR Type-I

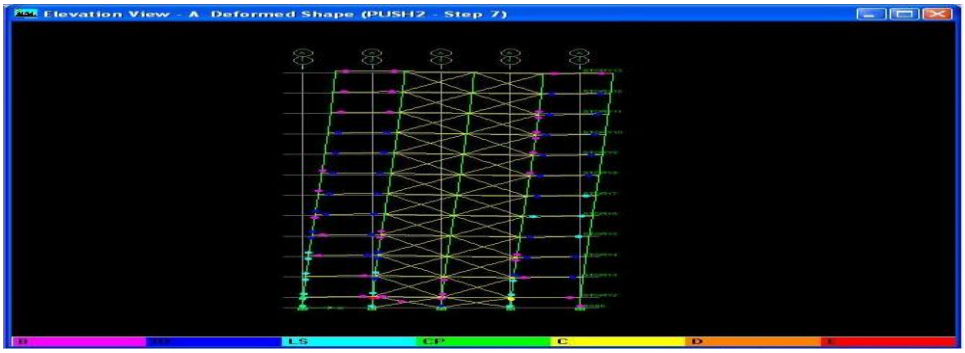


Fig.20. Plastic Hinge Mechanism of BR Type-II

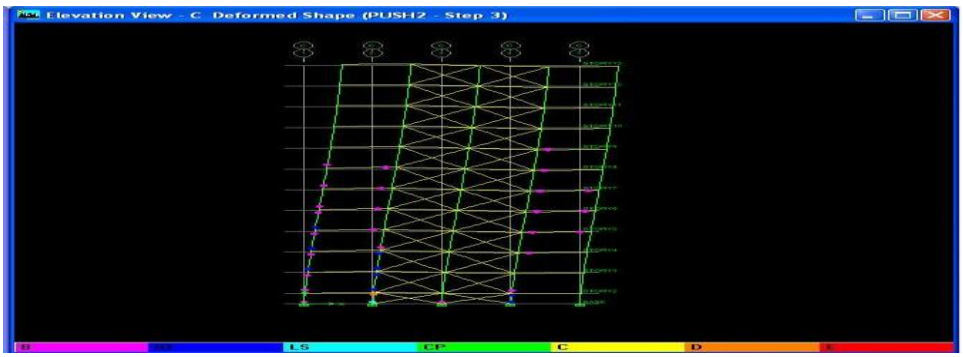


Fig.21. Plastic Hinge Mechanism of BR Type-III

CONCLUSION

1. The technique of using Diagonal bracing is one of the most advantageous concept.Which can be used to strengthen structure.

2.It is observed that model with diagonal bracing type II is more efficient and economical as compare to other model in all parameter.

3. Diagonal bracing increases the level of safety since the demand curve intersect within limit.

4. Providing diagonal bracing at adequate locations substantially reduces the displacement due to earthquake.

5. The bracing in bare frame increases the overall stiffness of the structure. Hence bracing frame is much better than the other.

6. Capacity of diagonal braced structure is more as compare to the shear wall structure.

7. Storey drift shear wall & diagonal brace model is better within the limit.

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