NONLINEAR PUSHOVER ANALYSIS OF STEEL MOMENT RESISTING BUILDING WITH VERTICAL IRREGULAR INFILL ARRANGEMENT

[1]Abhijit Baliram Kamble, [2]Prof.M.V.Nagendra

Structural Engineering Department, PVPIT Budhgaon.
[1]M.Tech Student
[2]Associate Professor

Abstract: This paper presents a case study of seismic performance comparison of 9,15,21-story steel MRF designed with and without irregular infill arrangement. The seismic performance of MRF is evaluated under a suit of various ground motion representing high to medium seismicity using nonlinear static pushover analysis. The findings of evaluation study showed that the with infill MRF is significantly more efficient than the bare frame MRF.

Index Terms -Steel moment resisting frame, nonlinear infill, nonlinear static pushover analysis

I. INTRODUCTION

Moment resisting steel frames comprise one of the most common forms used in modern building and industrial structures. Their main advantage for seismic resistance is that, they provide very ductile response. However, numerous moment resisting frames suffered beam to column connections and other failures in brittle manner during some recent earthquakes, particularly the 1994 Northridge and 1995 Kobe earthquakes. Although many experimental and analytical studies have been conducted to investigate the seismic behavior of moment resisting frames for several decades, the lessons learned from recent earthquakes indicated that the current earthquake resistant design concept and methods could not prevent the failure of the frames subjected to severe earthquakes. To prevent the failures during severe earthquakes that can occur in the future, the seismic behavior of moment-resisting frames should be investigated in a more rational manner and considering different types of irregular infill arrangements.

II. PROBLEM STATEMENT

Present research involves the study of with and without models of infill in steel moment resisting 9, 15, 21 story building for nonlinear pushover analysis.

III. NONLINEAR MODELING OF INFILL WALL

It is micro level of modeling in which the nonlinearity is assigning by considering it as elements. In SAP 2000v15 shear wall is modeled as single layer shell element in which in plane behavior is kept as nonlinear and out plane behavior is linear The shell element is made up of single layers with uniform thickness and uniform material properties are assigned to single layer. During the finite element calculation, the axial strain and curvature of the layer can be obtained in element. Then according to the assumption that plane remains plane, the strains and the curvatures of the other layers can be calculated. And then the corresponding stress will be calculated through the constitutive relations of the material assigned to the layer. From the above principles, it is seen that the structural performance of the infill wall can be directly connected with the material constitutive law. For performance-based design, the recommendation of ACI 40 and FEMA 356 define the performance criteria for the steel members in terms of plastic rotations. Therefore, for practical engineering, further development of this model is needed.

IV. SEISMIC EVALUATION BY USING SAP2000

4.1 Nonlinear static pushover analysis

Nonlinear static pushover analysis is used to evaluate the expected performance of a structural system by estimating its strength, deformation demands in design earthquakes and failure pattern. This evaluation is based on an assessment of important performance parameters, including global drift and inelastic element deformations. The model of design is subjected to the unidirectional monotonic push till the respective target displacement to induce significant inelastic deformations in the system. This type of curve is closer to an elastic plastic type. The initial slopes of the pushover curves are marginally same. The capacity curve roof displacement versus base shear plot and the approximate one and yield point (yield displacement, Dy; yield base shear, Vby) is obtained for each design.

V. RESULTS AND DISCUSSION

5.1Nonlinear static pushover analysis (NSPA)

The pushover curve shows the graph between base shear and displacement. In the graph, x – axis represents displacement (m) and y – axis represents base shear force (kN). Here pushover curve graph is drawn for two types of frame viz. steel moments resisting bare frame and steel moments resisting frame with infill. The graph is drawn for three steel frame structures i.e. 9, 15, 21 stories. In pushover curve, the base shear increases in the case of frame with infill as compared to bare frame. Simultaneously displacement of frame with infill decreases as compared to bare frame.

The pushover curves of the frames are presented in Figure 1 to 6. The presence of the infill walls substantially increased the strength and stiffness of the frame. The Maximum shear force is reached in relatively small displacements for the infilled frames Compared to the bare frame.

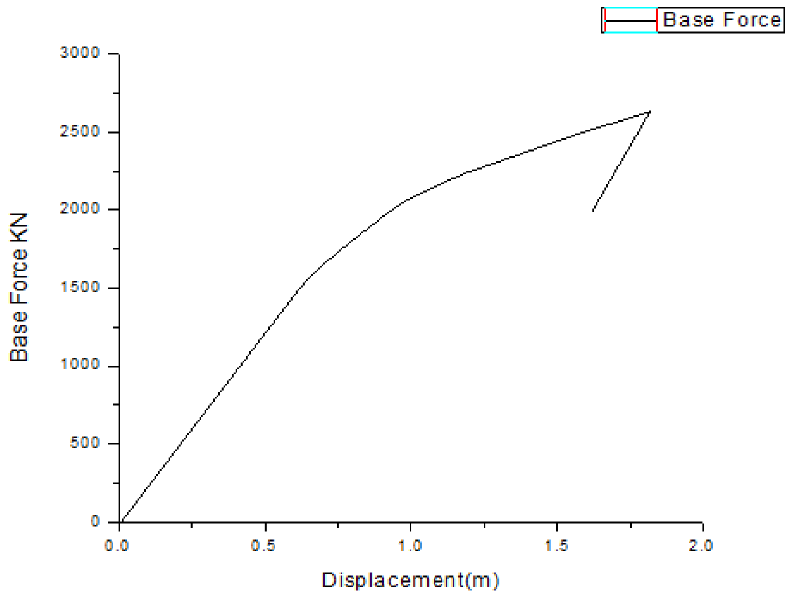

Figure 1: Capacity Curve for 9 Story Steel Moments Resisting Bare Frame.

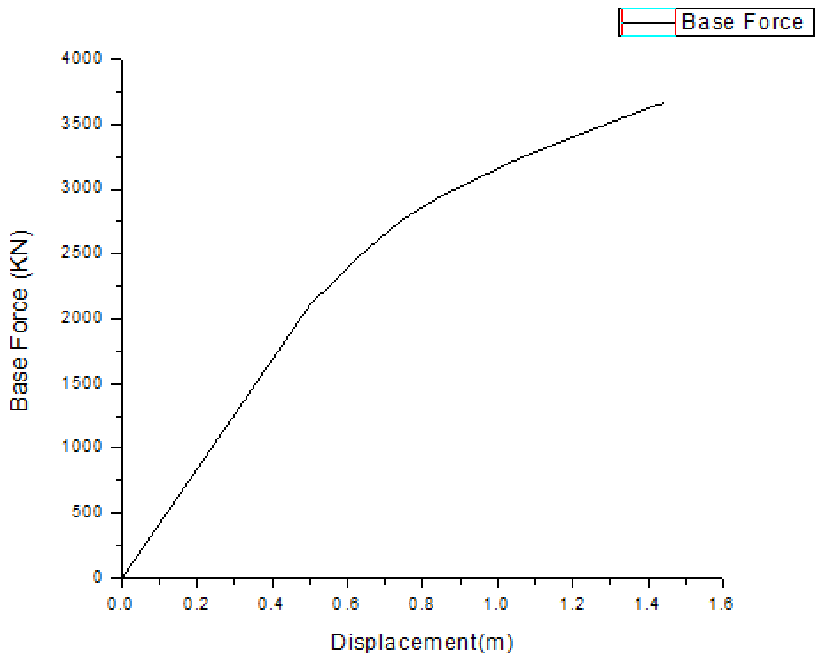

Figure 2: Capacity Curve for 9 Story Steel Moments Resisting Frame with Infill.

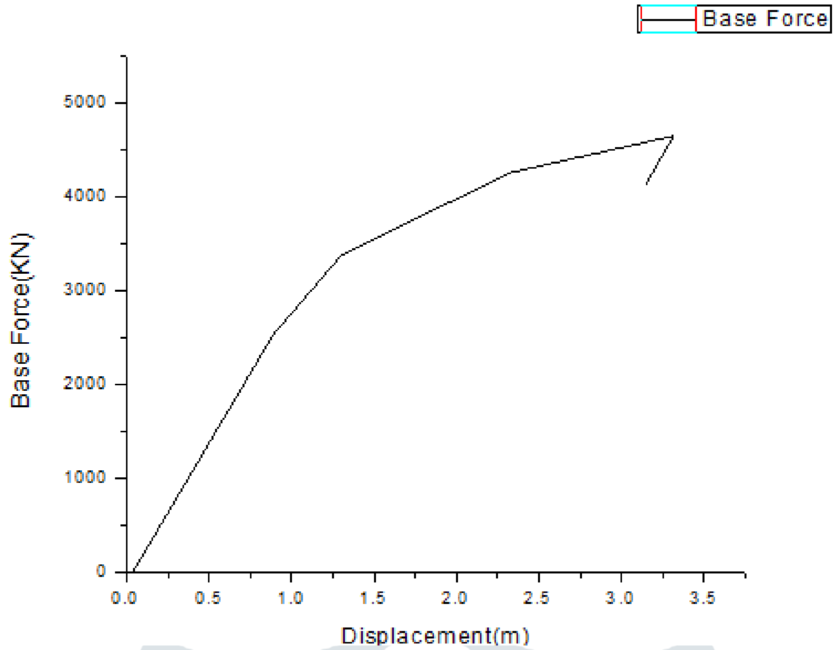

Figure 3: Capacity Curve for 15 Story Steel Moments Resisting Bare Frame.

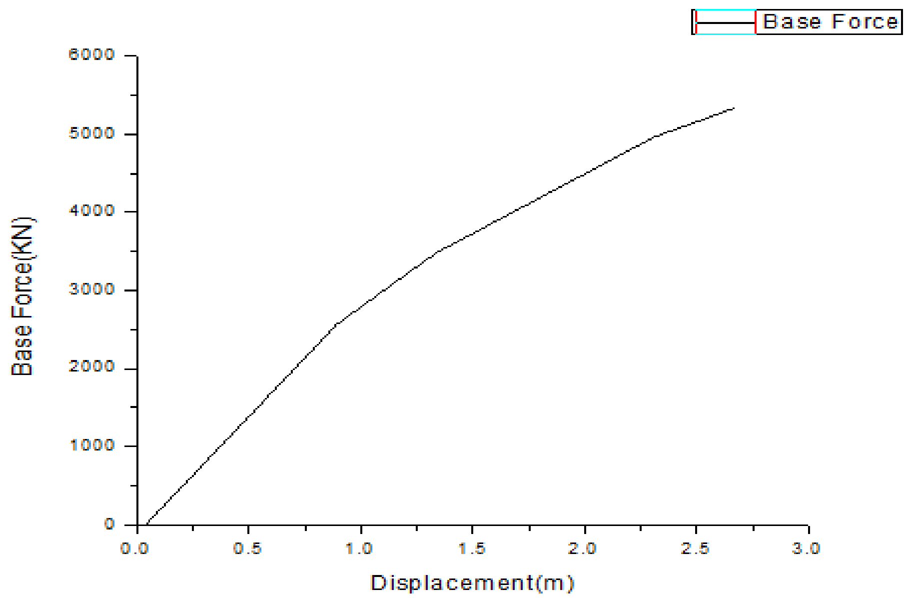

Figure 4: Capacity Curve for 15 Story SteelMoments Resisting Frame with Infill.

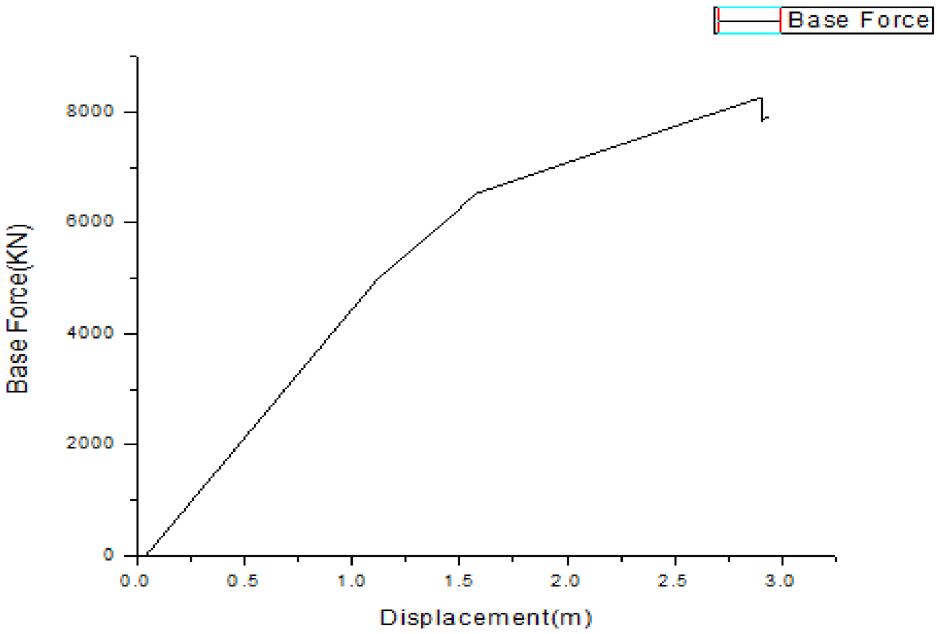

Figure 5: Capacity Curve for 21 Story Steel Moments Resisting Bare Frame.

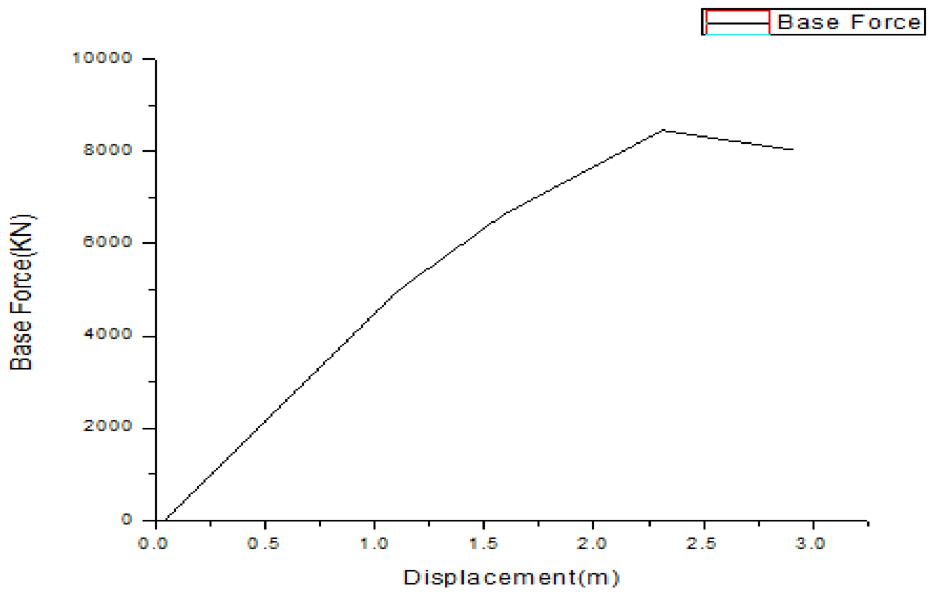

Figure 6: Capacity Curve for 21 Story Steel Moments Resisting Frame with Infill.

The pushover curve shows the graph between base shear and displacement. In the graph, x – axis represents displacement (m) and y – axis represents base shear force (kN). Here pushover curve graph is drawn for two types of frame viz. steel moments resisting bare frame and steel moments resisting frame with infill. The graph is drawn for three steel frame structures i.e. 9, 15, and 21 stories. In pushover curve, the base shear increases in the case of frame with infill as compared to bare frame. Simultaneously displacement of frame with infill decreases as compared bare frame.

The pushover curves of the six frames are presented in Figure 1 to 6. It can be seen that the presence of the infill walls substantially increased the strength and stiffness of the frame. The Maximum shear force is reached in relatively small displacements for the infilled frames compared to the bare frame.

VI. CONCLUSION

The concluding remarks on the seismic performance of these designs are summarized as follows: -

1. The capacity of the frame is increased due to the presence of infill. The stiffness contribution of infill in lower story's is large. Since, the maximum displacement induced by strong ground motions is sensitive to stiffness with decreasing periods, the displacement demand for the infilled frames decreased.
2. From this present result it shows that, deflection is very large in case of bare frame as compare to that of infill frame with opening. If the effect of infill wall is considered, then the deflection has reduced drastically. And, deflection is more at last story because earthquake force acting on it more effectively.
3. In multi-storey structures columns in the soft story and weak story shows large deformations under the lateral forces. Therefore, the soft and weak story columns should be designed as per IS code provisions (IS 1893-2016 Cl.7.10) to increase strength and stiffness of weak story.
4. The results indicate that controlling the stiffness distribution along the height of the buildings by infill walls which have varying stiffness properties may help mitigating drift concentrations in the lower stories and improving the seismic performance. Another implication is that the existence of infill walls changes the behaviour and damage distribution of the structures significantly. Therefore, expected behaviour in structural designs which ignore the infill walls may not be the actual behaviour and unforeseen damages may occur in the buildings. This implication shows the necessity of taking the infill walls into account in the design process.

REFERENCES

[1] Asteris P.G. (2008), "Finite element Micro-Modelling of in filled Frames", *Electronic Journal of Structural Engineering* (8).

[2] Agrawal Nikhil S., Prof. Kulkarni P.B., RautPooja. (2013), "Static analysis of masonry infilled R.C. frame with and without opening including soft story of symmetric building*" IOSR, Journal of Mechanical and Civil Engineering*.

[3] Crowther Adrian, Hurdmanb Gordon, Wilkinson Sean. (2006), "A moment resisting connection for earthquake resistant structures" *Journal of Constructional Steel Research*.62, pages 295–302.

[4]Andrew Chan, John Paulino, MoisesQuirregularoz, and Jose Valdovinos. (2011) "Seismic Evaluation & Design: Special Moment Resisting Frame Structure" *San Francisco State University, Canada College and NASA Sponsored Collaboration*.

[5] Davidson B.J. and Bell D.K. (2001) "Evaluation of Earthquake Risk Buildings with Masonry Infill Panels"*NZSEE Conference*, Paper No.4.02.01. 1-10