iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 6 **Issue:** II **Month of publication:** February 2018

DOI: http://doi.org/10.22214/ijraset.2018.2110

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:6.887
Volume 6 Issue II, February 2018- Available at www.ijraset.com

Seismic Performance and Lateral Stability of Steel Moment Resisting Building with Vertical Irregular Infill Arrangement

Mr. Salunkhe-Patil. R.S. [1], Mr.Patil.C.S.[2]
[1]P.G. Student, Department of Civil Engineering, Sanjay Ghodawat group of institutes, Atigre, Kolhapur, Maharashtra, India[1]
[2]Assistant Professor, Department of Civil Engineering, Sanjay Ghodawat group of institutes, Atigre, Kolhapur, Maharashtra, India[2]

Abstract: This paper presents a case study of seismic performance comparison of nine-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 and nonlinear time history analysis. The findings of evaluation study showed that the with infill MRF is significantly more efficient than the bare frame MRF.
Keywords: Steel moment resisting frame, Nonlinear infill, Nonlinear static pushover analysis, Nonlinear time history 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 behaviour 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 behaviour 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 building for seismic analysis and effect of these modelling on different selected ground motion data.

III. NONLINEAR MODELLING OF INFILL WALL

It is micro level of modelling in which the nonlinearity is assigning by considering it as elements. In SAP 2000v15 shear wall is modelled 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

A. 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

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:6.887
Volume 6 Issue II, February 2018- Available at www.ijraset.com

displacement versus base shear plot and the approximate one and yield point (yield displacement, Dy; yield base shear, Vby) is obtained for each design.

B. Nonlinear time History Analysis

Non-linear structural analysis is becoming more important in earthquake resistant design, which requires more information about the drifts, displacements and inelastic deformations of a structure than traditional design procedures. In non-linear dynamic analysis, the non-linear properties of the structure are considered as part of a time domain analysis. This approach is the most rigorous, and is required by some building codes for buildings of unusual configuration or of special importance. However, the calculated response can be very sensitive to the characteristics of the individual ground motion used as seismic input; therefore, several analyses are required using different ground motion records. The time history analysis is an actual dynamic analysis that can be done for both linear and nonlinear systems.

V. RESULT AND DISCUSSION

A. Nonlinear 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 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 2. 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.

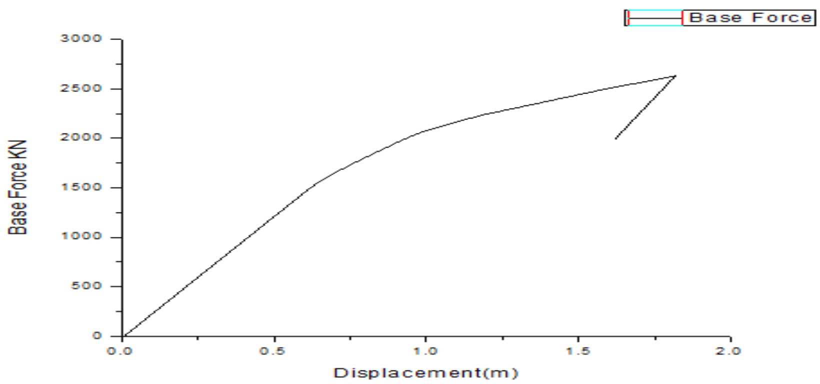


Figure 1: Capacity Curve of Nine Story Steel MRF for bare Frame.

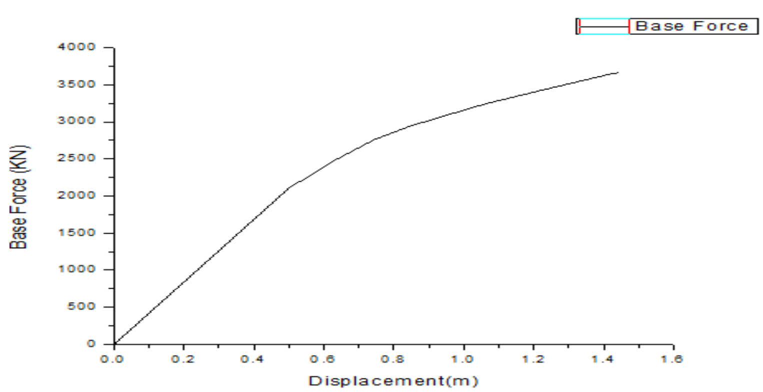
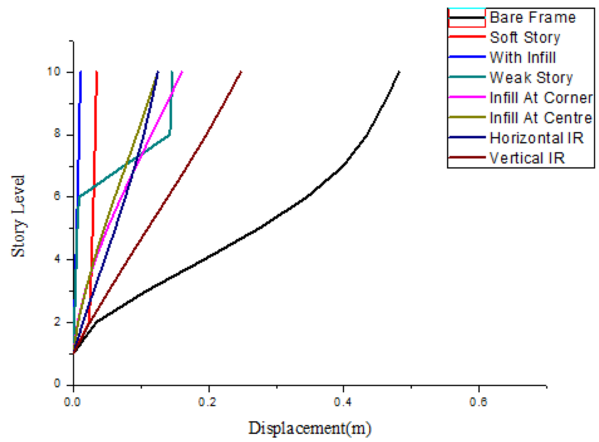


Figure 2: Capacity Curve of Nine Story Steel MRF for with infill frame.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:6.887
Volume 6 Issue II, February 2018- Available at www.ijraset.com

B. Nonlinear Time History Analysis (Ntha)

Results obtained from NLTHA. On the basis of these results, seismic analysis of nine storey steel MRF with and without infill wall is discussed. Dynamic analyses of for 9-story, frames were carried out for selected ground motions. For NLTHA of each design under specific record, the acceleration time history of each earthquake is scaled through scale factor so as to have the same design spectral acceleration at the fundamental period gives calculation of typical scale factor. In order to investigate the performance of MRF in high to medium seismicity, Nonlinear Time History Analysis is performed under the ground motion records of 1979 El Centro, 1984 Northridge, 1987 Superstition hills and 1995 Kobe earthquakes.



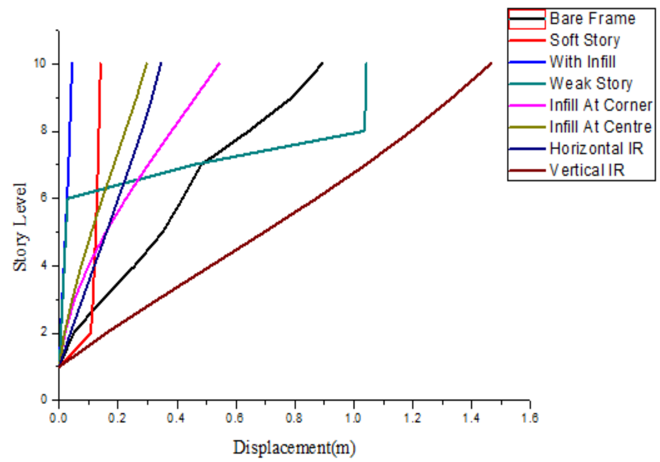
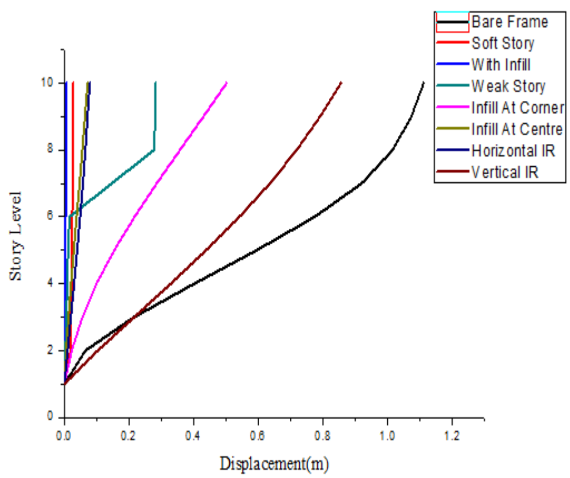


Figure 3: Displacement profiles of 9 Story with Different irregular arrangements for Imperial Valley

Figure 4: Displacement profiles of 9 Story with Different irregular arrangements for Kobe

Ground motion data. Ground motion data.



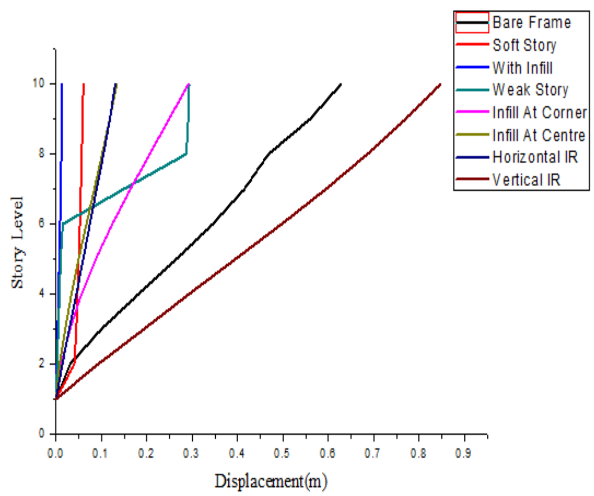


Figure 5: Displacement profiles of 9 Story with Different irregular arrangements for Northridge

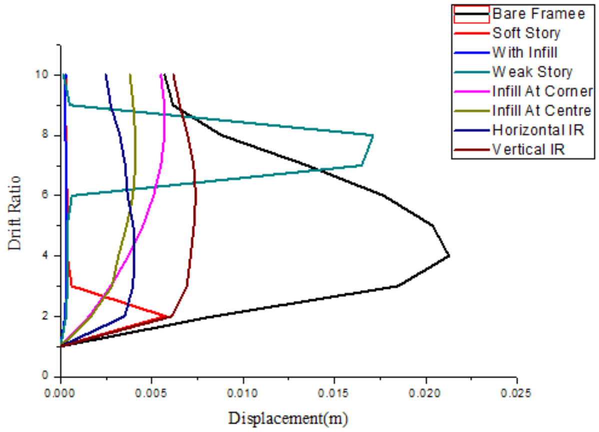
Figure 6: Displacement profiles of 9 Story with Different irregular arrangements for superstition hills

Ground motion data. Ground motion data.

As Imperial Valley ground motion data is applied on different types of infill frames. It is observed that the bare frame has reached max displacement of 0.481 mm and structure with infill wall reached minimum displacement of 0.0105mm then Kobe ground motion data is applied on different types of infill frames. It is observed that the vertical irregular arrangement frame has reached max displacement of 1.46 mm and structure with infill wall reached minimum displacement of 0.0429 mm after that the Northridge ground motion data is applied on different types of infill frames. It is observed that the bare frame has reached max displacement of 1.11 mm and structure with infill wall reached minimum displacement of 0.0061mm and Superstitions Hills ground motion data is

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:6.887
Volume 6 Issue II, February 2018- Available at www.ijraset.com

applied on different types of infill frames. It is observed that the vertical irregular arrangement frame has reached max displacement of 0.847 mm and structure with infill wall reached minimum displacement of 0.013 mm.



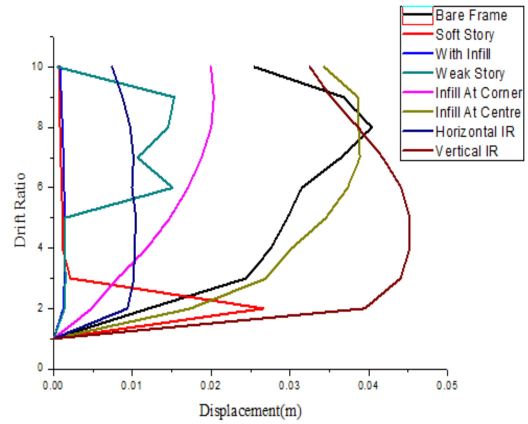
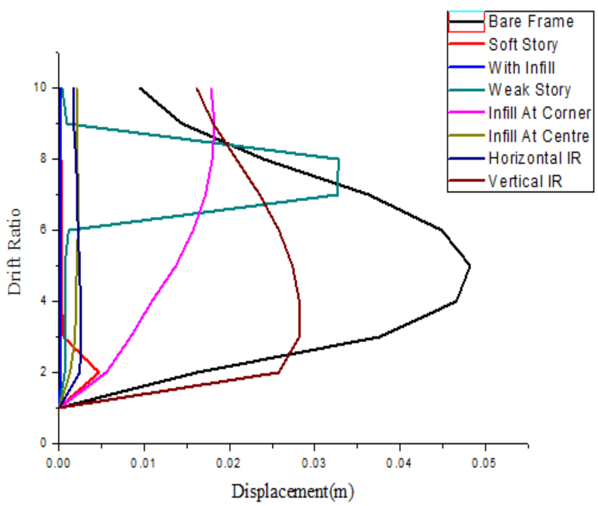


Figure 7: Inter Story drift of 9 Story with Different irregular arrangements for Imperial Valley

Figure 8: Inter Story drift of 9 Story with Different irregular arrangements for Kobe

Ground motion data. Ground motion data.



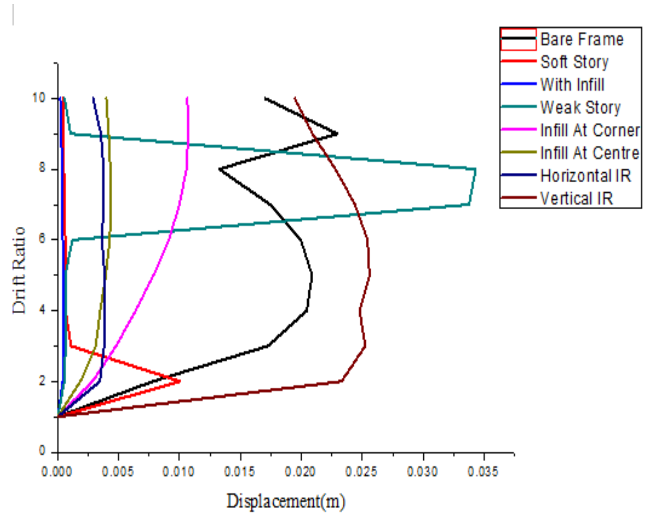


Figure 9: Inter Story drift of 9 Story with Different irregular arrangements for Northridge

Figure 10: Inter Story drift of 9 Story with Different irregular arrangements for superstition hills

Ground motion data. Ground motion data.

As Imperial Valley ground motion data is applied on different types of infill frames. It is observed that the bare frame has reached max inter story drift of 0.021 mm and structure with infill wall reached minimum displacement of 0.0002mm .As Kobe ground motion data is applied on different types of infill frames. It is observed that the vertical irregular arrangement has reached max inter story drift of 0.0425 mm and structure with infill wall reached minimum displacement of 0.0087 mm. As Northridge ground motion data is applied on different types of infill frames. It is observed that the bare frame has reached max inter story drift of 0.048 mm and structure with infill wall reached minimum displacement of 0.0017 mm. As Superstition Hills ground motion data is applied on different types of infill frames. It is observed that the weak story has reached max inter story drift of 0.0343 mm and structure with infill wall reached minimum displacement of 0.0002 mm. In vertical irregular arrangement shows that it is slightly constant i.e. the displacement increases as the story of the building increases up to 0.024mm. For bare frame initial increasing displacement is up 0.021 mm. Horizontal irregular arrangement, soft story and infill at corner shows relatively similar behaviour but less than that of bare frame.

VI. CONCLUSION

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

A. 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.

B. From the different applied ground motion data it is found that greater the opening in the building it causes in reduction of lateral stiffness of the infilled frame as the effect of ground motion is initially absorbed by infill.

C. 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 also, deflection is more at last story because earthquake force acting on it more effectively.

D. In multistory 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 1893-2002 Cl.7.10) to increase strength and stiffness of weak story.

E. 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

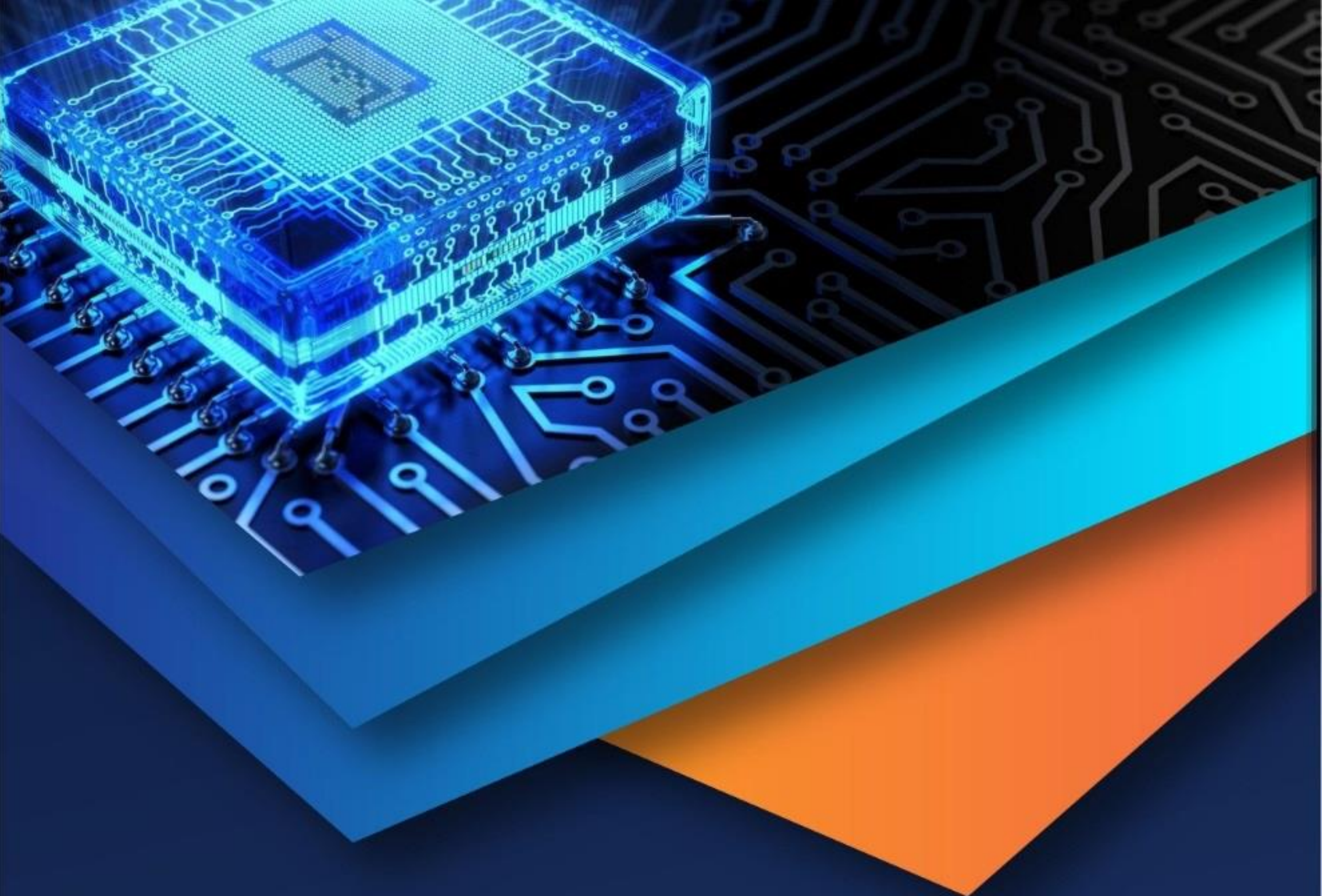
[6] Carter C Smith B. Stafford.(1969), "A method of analysis for infilled frames" ICE publications.

[7] Dalal. S. P., Vasanwala S.A., Desai A.K. (2013), "Comparison of steel moment resisting frame designed by elastic design and performance based plastic design method based on the inelastic response analysis"international journal of civil and structural engineering, Volume 2, No 4, ISSN 0976 – 4399.

[8] Desai Niranjan and McGinley W.M. (2013), "A study of the out-of-plane performance of brick veneer wall systems in medium rise buildings under seismic loads" Engineering Structures. 48 pages 683–694

[9] Das Dipankar ,SinghYogendra. (2006), "Effects of URM Infills on Seismic Performance of R.C. Frame Building." International Conference on Earthquake Engineering, Taipei, Taiwan.

[10] Desai.A.K ,DalalSejal P, Vasanwala.S.A. (2012) "Comparison of steel moment resisting frame designed by elastic design and performance based plastic design method based on the inelastic response Analysis" International journal of civil and structural engineering,Volume 2, No 4, ISSN 0976 – 4399.



10.22214/IJRASET

INDEX COPERNICUS

45.98

IMPACT FACTOR: 7.129

TOGETHER WE REACH THE GOAL

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Call : 08813907089 (24*7 Support on Whatsapp)