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Seismic Control of RCC Frame Using Linear Bracing System

Lomesh P. Chandewar[1], Amey R. Khedikar[2]
[1,2]*Asst. Professor, Civil Engineering Department, Tulsiramji Gaikwad-Patil College of Engg. And Tech., Nagpur, MH.*
lomeshchandewar5@gmail.com
amey.khedikar@gmail.com

Abstract:

This paper presents the seismic behavior of different bracing system in G+9 storey RCC frame with steel bracing. A linear analysis is carried out to on different braced G+9 storey RCC frame to capture the seismic response. In this study Concentric & Eccentric bracing system were used with their different types. The primary goal of this study is to investigate the seismic behavior of different bracing system under seismic load. It is seen that the type of bracing system significantly influence the performance of high rise RCC frame. The seismic performance of G+9 storey RCC frame with steel bracing is measured in terms of displacement, moment. It can be concluded from the study that bracing system increases the stability of structure, moment resisting capacity of the structure. In concentrically braced frame inverted V bracing & in eccentrically braced frame knee X bracing is more suitable than any other bracing system. Eccentrically braced frame reduced more moment than concentrically braced frame.

Keywords

Bracing system, Linear static analysis, Braced frame, Unbraced frame, Seismic behavior.

1. Introduction

Bracing element in structural system plays vital role in structural behavior during earthquake. The pattern of the bracing can extensively modify the global seismic behavior of the framed steel building. For construction of high rise building bracing are constructed for stiffness and lateral load resistance purpose. Steel frame usually refers to a building technique with a "skeleton frame" of vertical steel columns and horizontal I-beams, constructed in a rectangular grid to support the floors, roof and walls of a building which are all attached to the frame. Bracings are strong in compression. Bracing with their surrounding frames has to be considered for increase in lateral load resisting capacity of structure. When bracings are placed in Steel frame it behaves as diagonal compression strut and transmits compression force to another joint. Variations in the column stiffness can influence the mode of failure and lateral stiffness of the bracing.

Seismic Analysis is a subset of structural analysis and is the calculation of the response of a structure to earthquakes. Nowadays High Rise Steel frame building is well establishing in metro cities. Seismic loads are one of the great damaging natural hazards. Seismic waves are formed due to quick transient motion of the ground which results into release of elastic energy in a matter of few seconds. A steel frame with the consideration of wind load produce greater sway value as compared to the steel frame without wind load. The sway prediction by using linear analysis was found to be less compared to the sway prediction from non linear analysis.

2. Example of G+9 RCC Frame

In this study behavior of different bracing system in G+9 storey frame for

seismic load in investigated using Staad Pro. Total 5 different bracing system investigated using linear static analysis. Let us consider a RCC frame is located at zone V, It is 3 bay with following dimensions. Length = 12 m, Width =12 m, Height = 30 m, The dimension of RCC column & Beam are 350 X 600 mm & ISMB 400 is used as a steel bracing system.

3. Calculation of Seismic forces

Frame is located at Zone V,

Design parameters for ZONE V, Zone factor **Z-** 0.36 (Table 2: IS 1893) Importance factor **I-** 1.0 (Table 6:IS 1893) Response reduction factor **R-** 5 (Table7:IS1893 Part1) Seismic weights-**(Referring Clause 7.3.1,Table 8:IS 1893 Part1)** Floor Area= 12*12=144m^2 Total seismic weight on the floor and $W_1=W_2=W_3=144*(3.75+0.50*1.50)=$ 648KN Total seismic weight on the roof floors $W_4=144*3.75=540$KN Total seismic weight on structure **W**=∑W=9*648+1*540=6372KN

Earthquake load in X direction- **T= 0.09h/√d=** 0.09*30/√12= 0.78 The frame is located on type II (Medium soil) Referring fig.2 IS:1893 for T=0.78, S_a/g = 1.8 Referring clause 6.4.2 of IS:1893 (Part 1)

A_h=(ZI/2R)*(S_a/g)=((0.36*1.0)/(2*5))*1.8=0.060 Design base shear- V_b= A_h*W = 0.060*6372 = 383.32KN, In this way seismic forces are calculated on frame which are acted on joint as 1,4,9,16,26,37,51,67,84,87 kN on First to tenth storey respectively.

The following bracing system are used

1) Concentric bracing system
2) Eccentric bracing system

Concentric bracing system types are

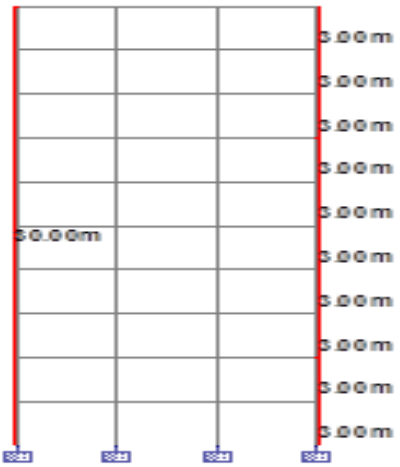
a) X-bracing
b) Inverted V-Bracing
c) V-bracing
d) Forward Diagonal
e) K-Bracing

Eccentric bracing system types are

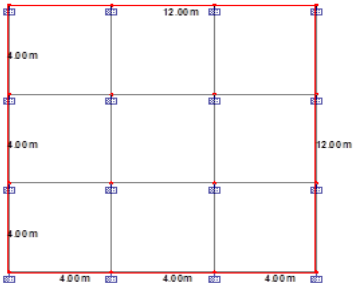
a) K-Bracing
b) Single knee brace with Knee element
c) X-knee bracing,
d) Knee inverted V-bracing.

The above bracings are used at centre bay & outer bay and this structure is analysisd using Staad Pro. & compare for moment and displacement, Based on the Staad Pro. Result the bracing which will give minimum moment & displacement will best bracing systems are identified.

The typical plan and elevation of G+9 RCC frame are as shown below.



Elevation of G+9 RCC Frame

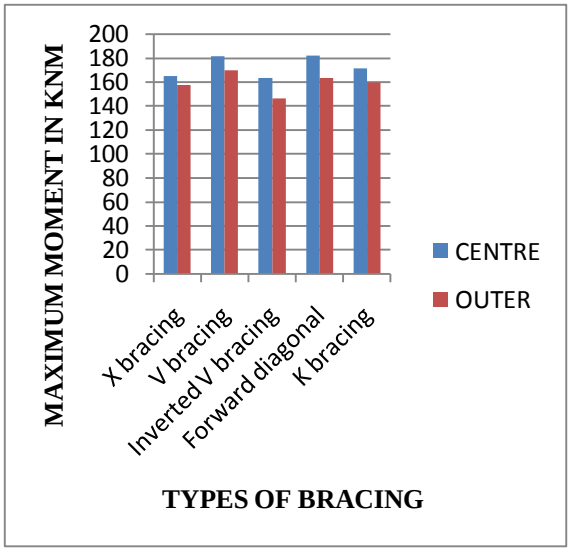


Plan of G+9 RCC Frame

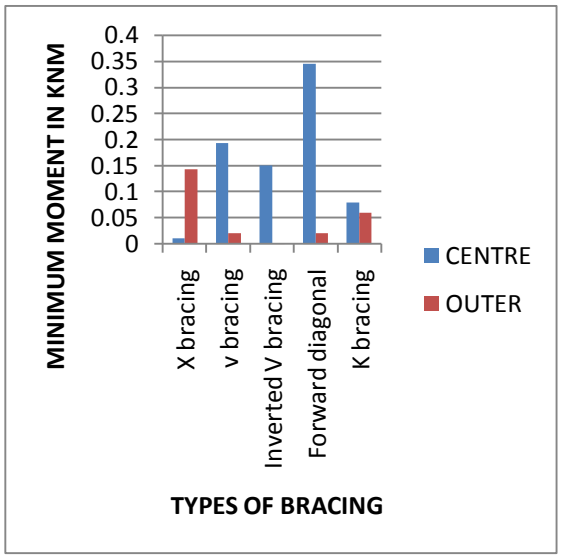
4. Results and Discussion

Linear static analysis is performed using calculated lateral load pattern on example different bracing system in G+9 RCC frame. The responses of different bracing system are studied in terms of the moment and displacement & following graphs are plotted.

4.1 Results of different concentric bracing of G+9 RCC frame.

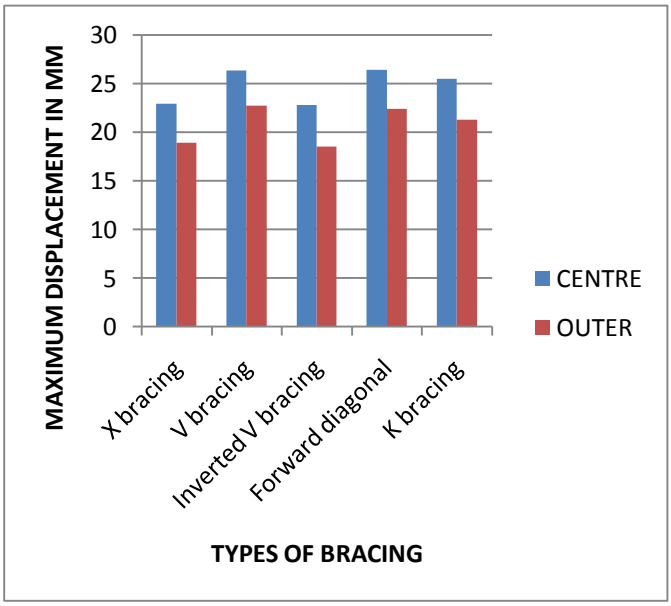


Graph (a)

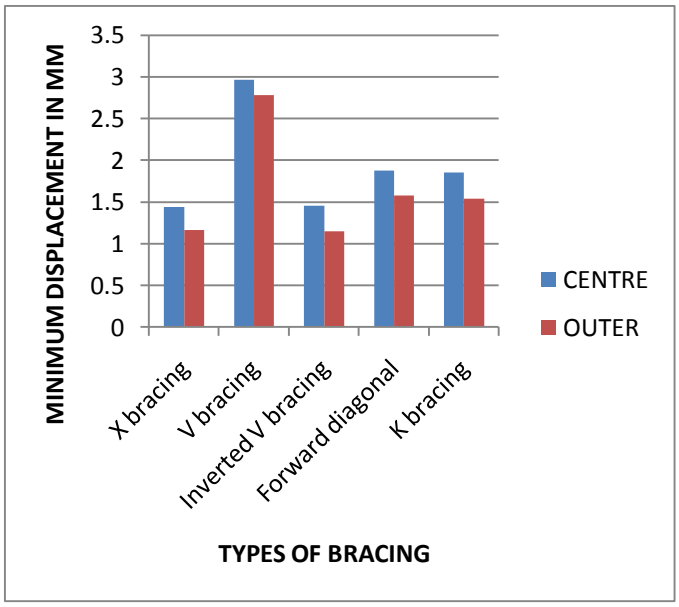


Graph (b)

From graph (a) inverted V bracing shows minimum moment hence it is best bracing among other,& From graph (b) K bracing show minimum moment among other bracing system.

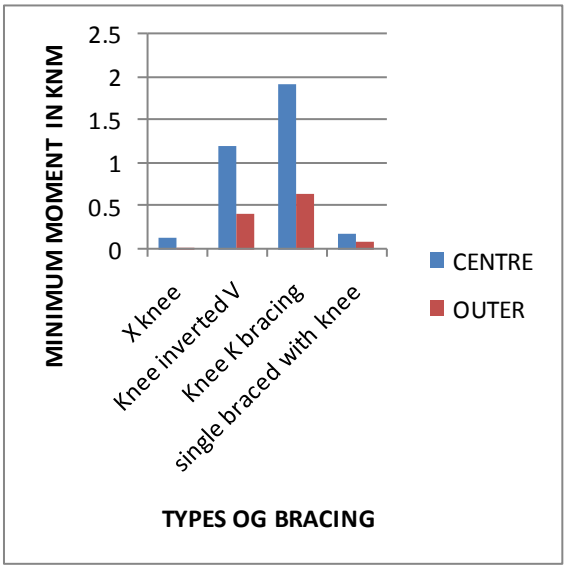


Graph (c)



Graph (d)

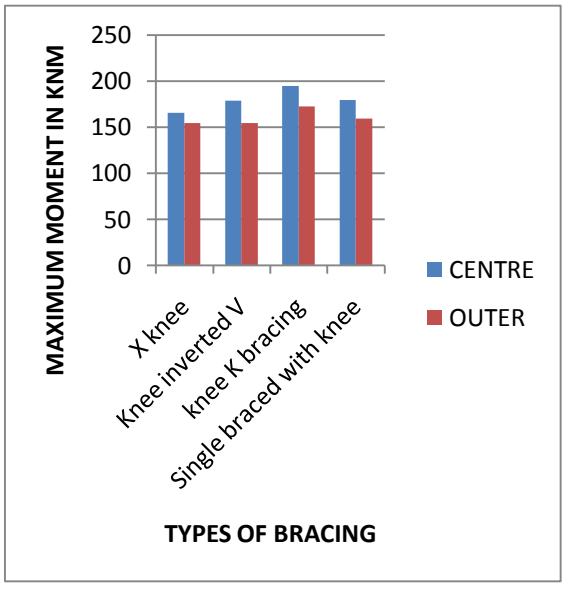
From graph (c) inverted V bracing shows minimum displacement hence it is best bracing among other, & From graph (d) X bracing shows minimum displacement so it is best bracing among other type of bracing.



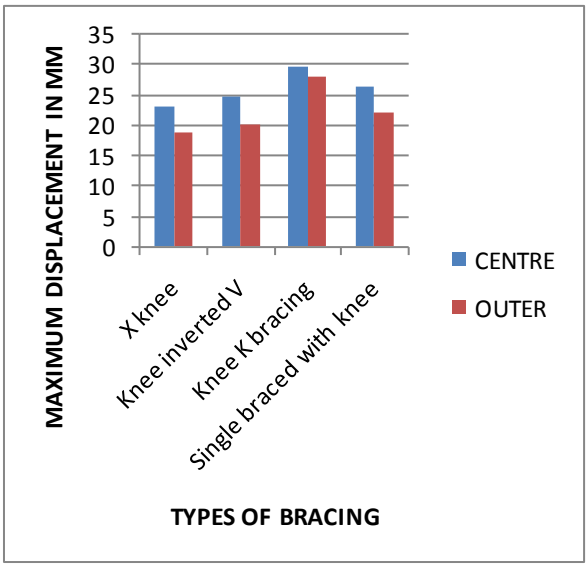
Graph (b)

From graph (a) & (b) X knee bracing shows minimum moment hence it is best bracing among other types of bracing.

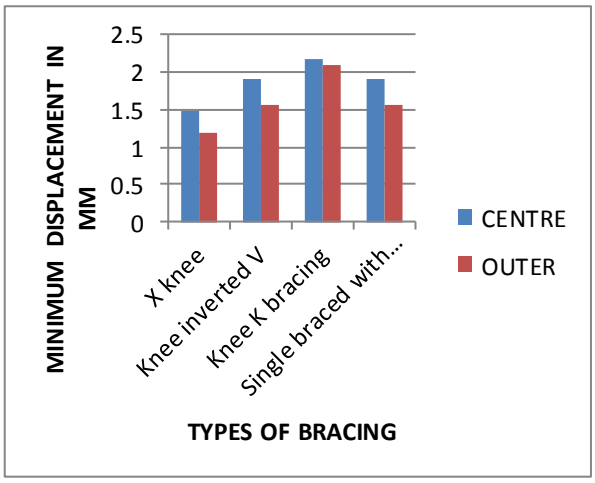
4.2 Results of different Eccentric bracing of G+9 RCC frame.



Graph (a)



Graph (c)



Graph (d)

From graph (a) & (b) X knee bracing shows minimum displacement hence it is best bracing among other types of bracing.

5. Conclusion

In this study an attempt is made to access the seismic response of the G+9 RCC frame of different bracing system. The conclusion of the study can be summarized as follows.

1) Bracing system increases stability of structure.

2) Steel brace increases moment resisting capacity of structures
3) In concentrically braced frame inverted V bracing is more suitable than other bracing.
4) In eccentrically braced frame knee X bracing is more suitable.
5) Eccentric braced frame reduces more moment as compared to concentric braced frame.

6) Bracing at outer bay is better than bracing at center bay.

6. References

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