ANALYSIS OF KNEE BRACED FRAME WITH DIFFERENT BRACING CONFIGURATIONS

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Abstract *- Steel braced frame is one of the structural systems used to resist earthquake loads in structures. Steel bracing is economical, easy to erect, occupies less space and has flexibility to design for meeting the required strength and stiffness. Bracing can be used as retrofit as well. There are various types of steel bracings are available. In the present study, steel frame with various configurations are analysed by ETABS software. The results of time history analysis were then compared with the results of the pushover analysis. The study also involving the analysis for suggesting the best configurations*

Keywords: *Bracings, knee braced frame, Push over analysis, Time history analysis, Steel brace*

1. INTRODUCTION

Among the different natural hazards, earthquake is one of the most devastating threats which has a severe effect on the safety and welfare of human beings. Building which appear to be strong enough found to be crumbling during strong ground motions. The reasons why the existing structures are under threat are ignorance of building code provisions, wrong construction practices and lack of knowledge of earthquake resistant design. The demolition of existing structures and reconstruction as per the code description is impractical, uneconomical and time consuming so that, the major disasters are avoided. For this, the deficient buildings should be identified first and detailed evaluation is to be carried out to check their strength and performances.

Structures which are subjected to lateral load must have adequate stiffness and strength which helps to controlling the deflection and also prevents any damage which may occur. Braces are used to resist lateral forces in a steel structure while the structures are under seismic excitation. In the case of knee elements, since the damage is concentrated in a secondary member, it can be easily repaired or replaced at minimum cost. So in this study, different knee elements are used in structures and analyzing their resistance against seismic forces. Knee Braced Frames are the frames in which a non buckling diagonal member provides most of the lateral stiffness. The flexural or shear yielding of the knee element provides the ductility under a severe earthquake. In this way, the damage is concentrated in a secondary member, which can be easily repaired or replaced at minimum cost. Moreover large seismic impact can be greatly resisted by encouraging the ordinary braced frames with various bracing configurations.

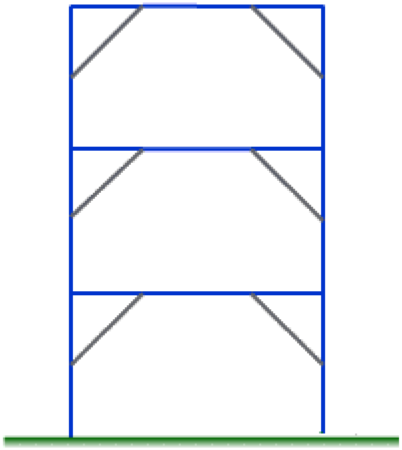

Fig-1: Knee bracing

2. SCOPE

Steel plays an important role in construction industry due to its high strength to weight ratio. A study regarding the seismic response of steel structures is necessary. The present study is intending to perform pushover analysis for different knee braced frames and then to compare their responses with the time history analysis using ETABS. Further, suggesting the best configuration that can be used to resist seismic forces.

3. OBJECTIVES

- To conduct pushover analysis for different knee braced steel frames such as diagonal, chevron, and cross frames.
- To conduct the time history analysis for different knee braced steel frames.
- To compare the responses of pushover analysis with the results of time history analysis
- To suggest the best configuration for seismic resistance which can be adopt in high earthquake areas.

4. METHODOLOGY

- Literature survey
- Frames are modeled with knee element.
- Material properties are assigned.
- Push over analysis is done.
- Time history analysis is done.
- Solution of problem and result interpretation

5. PRESENT STUDY

Here the analytical study has conducted on a 4 storied steel frame. A four storied frame of height 5 m has been selected for this purpose. The beams and columns are I-sections and knee braces of different bracing configurations has considered. Different frame configurations that have been considered for the nonlinear analysis are diagonal, cross and chevron bracings. The material properties and section details given in the ETABS library has used for the purpose of modelling.

<u>Material properties of frame</u>

- Young's modulus of elasticity = 200 Gpa
- Poisson's ratio of steel = 0.3
- Density = 7850 kg/m^3
- Yield stress = 250 Mpa

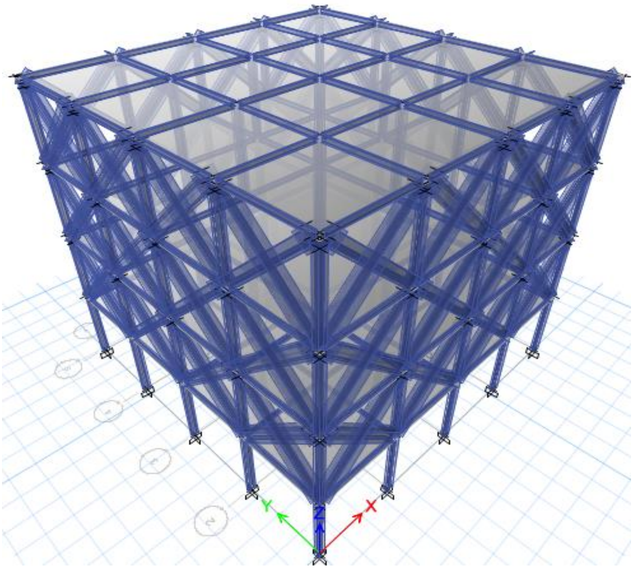

Fig-2: Model of cross braced knee frame

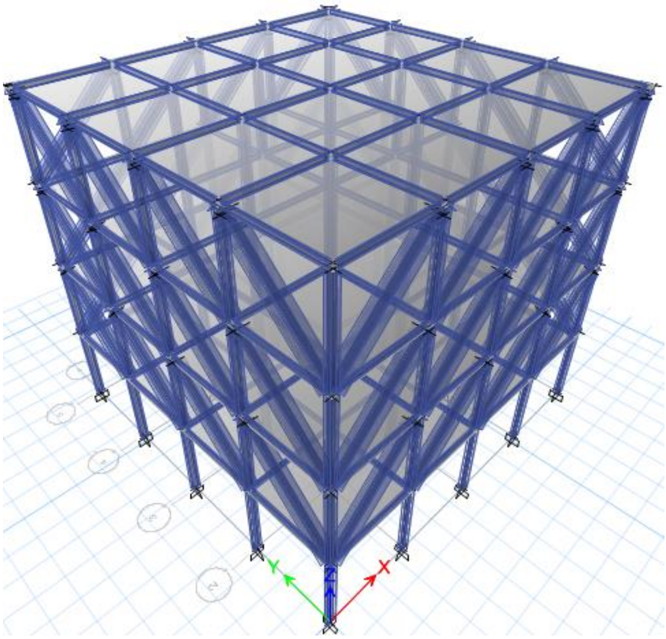

Fig-3: Model of diagonal braced knee frame

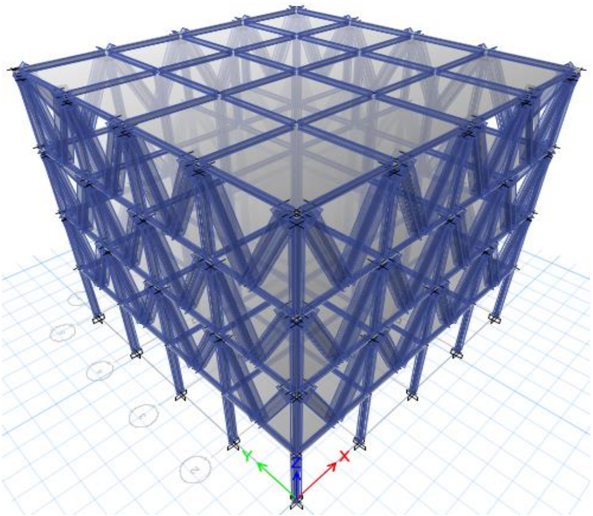

Fig-4: Model of chevron braced knee frame

6.1 Non linear static analysis

It is an analysis to evaluate the seismic performance of new and existing structures. In this dynamic loading is applied to the structure. A non linear relationship is obtained between base shear and displacement. From that the most suitable configuration of knee braced frame can be find out.

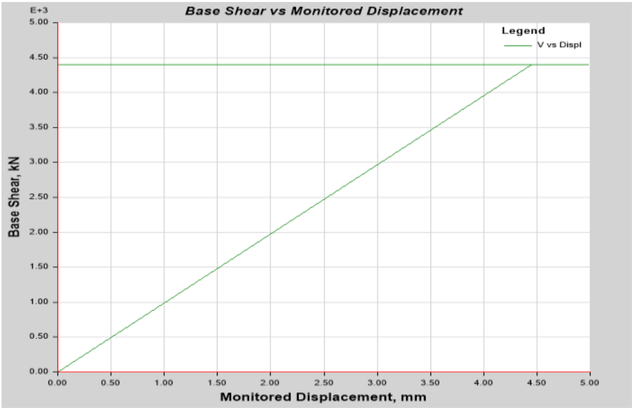

Fig-5: Pushover curve of cross braced frame

Table -2: Base shear Vs Displacement (Cross braced frame)

Monitored displacement (mm)	Base force (k N)
0	0
4.5	4401.479
0.2	4401.479
3.9	4401.479
0.3	4401.479
5	4401.479

Table -3: Base shear Vs Displacement (diagonal braced frame)

Monitored displacement (mm)	Base force (k N)
0	0
4.9	3718.65
0.6	3718.65
4.3	3718.65
0.9	3718.65
5.4	3718.65

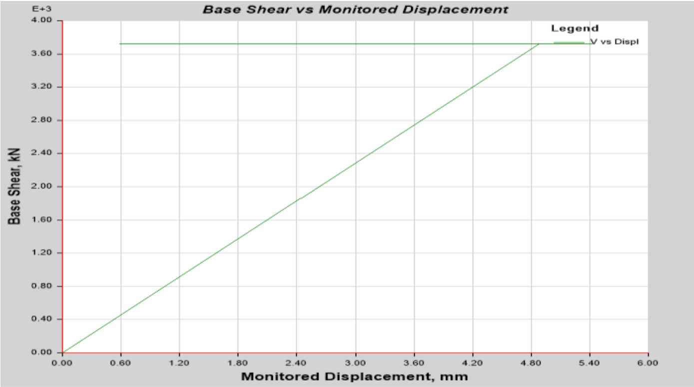

Fig-6 :Pushover curve of diagonal braced frame

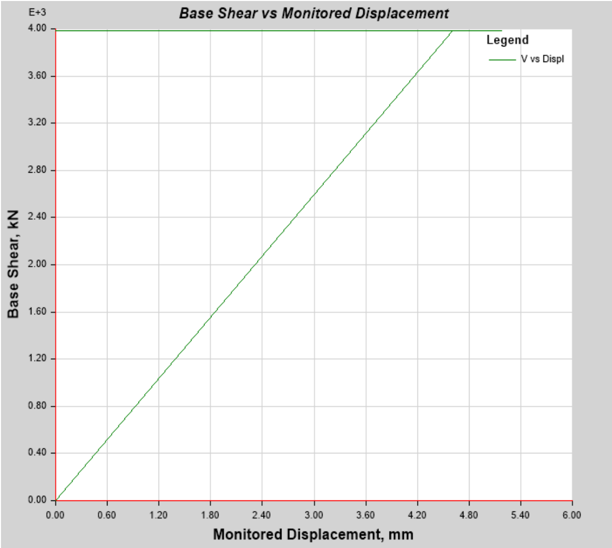

Fig-7 :Pushover curve of chevron braced frame

Table -4: Base shear Vs Displacement (Chevron braced frame)

Monitored displacement (mm)	Base force (kN)
0	0
4.6	3982.5483
3.938E-04	3982.5483
4.1	3982.5483
0.3	3982.5483
5.2	3982.5483

Non linear time history analysis

Non linear static analysis cannot represent seismic phenomena in a high accuracy mode, time history analysis has been performed to get the displacement due to transient loading. Here an earthquake data is used as input loading. El centro earthquake data is used in the present study.

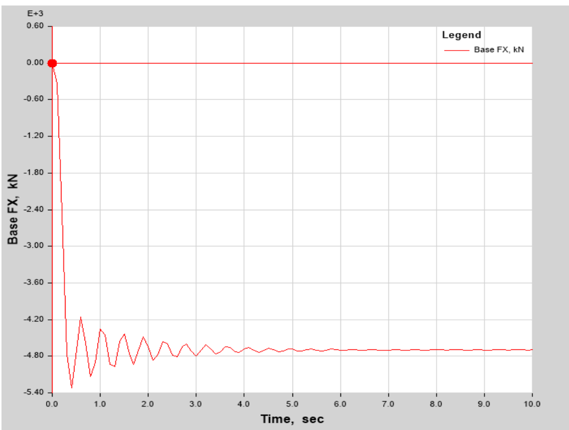

Fig-8 : Time history curve of cross braced frame

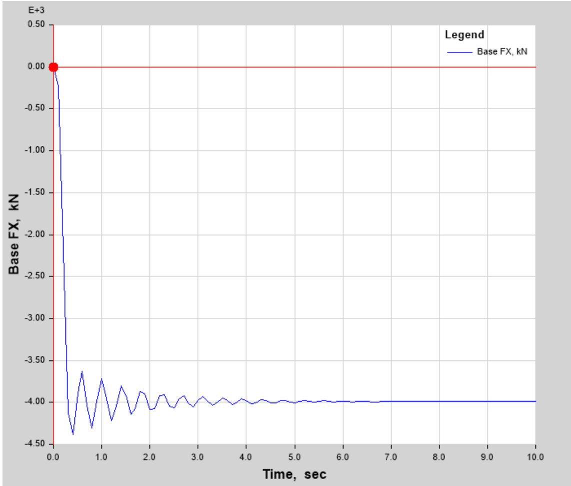

Fig-9 :Time history curve of diagonal braced frame

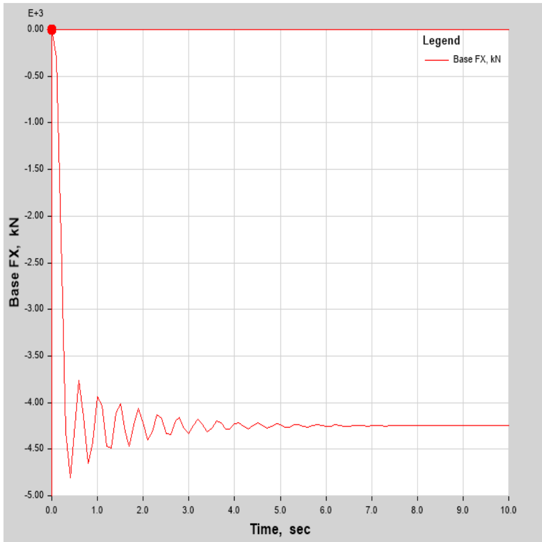

Fig-10 :Time history curve of chevron braced frame

Table -6: Comparison of Time history curves

Knee Braced Frame	Maximum Capacity(k N)
Cross Braced Frame	-5319.7943
Diagonal Braced Frame	-4384.9613
Chevron Braced Frame	-4810.429

6. CONCLUSIONS

From the nonlinear studies that were conducted on different configurations of knee braced frames, the following conclusions can be made;

- The behaviour of building is studied for different parameters like storey shear, storey displacement, etc. by pushover analysis and time history analysis.
- Among the three cases, cross braced configuration was found to be effective under seismic loading. Here, braces are arranged in X shape so that it will contributes structural stiffness and reduces the maximum interstate drift of steel buildings.
- Diagonal braced frame having the least resistance to seismic forces because it having only one diagonal element which reduces the lateral stiffness during earthquake
- So cross braced configuration is most suitable as compared to others that can be adopted for seismic resistance.

REFERENCES

[1].Abou.E.HandGhobaraha.A,"Rehabilitation of a Reinforced Concrete Frame using Eccentric steel bracing",*Engineering Structures*,Vol23(2001),pp.745–755.

[2].Adedeji, A.A,"Comparative Study Of Seismic Analysis For Reinforced Concrete Frame Infill With Masonry and Shape Memory Alloy Wires",*Trends in Applied Sciences Research*,Vol 6,(2011),pp.426-437.

[3].Akbari.R,Maheri.HandMahmoud.R,"Seismic Behaviour Factor,R, for Steel X-braced and knee-braced RC buildings",*EngineeringStructures*,Vol 25,(2003),pp.1505–1513.

[4].Chih.Y.L andThambirajah.B,"Earthquake-Resistant Steel Frames with energy dissipating

knee elements",*EngineeringStructures*,Vol 17(1995),pp.334-343.

[5].Chuang.S.Y, Reginald.D.R, and Roberto.T.L,"Pushover Response of a Braced Frame with Suspended Zipper Struts",*Journal of Structural Engineering*,Vol 134(2008),pp.1619-1626.

[6].IS: 1893-2002 (part-1) "CRITERIA FOR EARTHQUAKE RESISTANT DESIGN OF STRUCTURES"fifth revision, Bureau of Indian Standards, New Delhi.

[7].N.Joseph, Jebin.J, andTinto.G,"Seismic Performance Evaluation of Steel Frames with Knee braces Based on Pushover Analysis",*International journal of advanced engineering sciences and technologies*,Vol 4(2016),pp.242-267.

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