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Seismic Behaviour of Knee Braced Frame with Different Configuration

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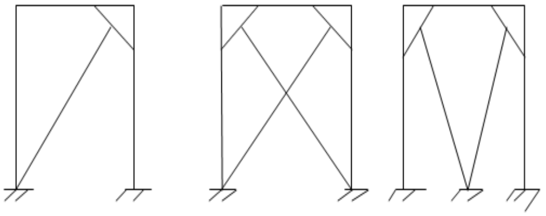
ABSTRACT

In last decades steel structure has played an important role in construction Industry. It is necessary to design a structure to perform well under seismic loads. Steel structures in areas prone to high seismic activity should satisfy two main conditions. It should be stiff enough to control the drift to prevent structural damage, and also must have sufficient ductility to prevent collapse caused by dramatic deformation. Bracing element in structural system plays vital role in structural behavior during earthquake. Steel bracing is an effective and economical solution for resisting lateral forces in a framed structure. Knee braced steel frame is that which has got excellent ductility and lateral stiffness. Since the knee element is properly fused, yielding occurs only to the knee element and no damage to major elements. Compared to other type of bracings it performs better during a seismic activity. Aim of this study is to consider seismic effect of different types of steel knee bracings with different configuration in multistoried frame using ANSYS software. For the analysis five storied frame and ten storied frame were considered. And compared the deformation and base shear values to get the comparatively most effective pattern.
Keywords: ANSYS, Knee Braced Frame, Seismic Effect

I. INTRODUCTION

Bracings are of different types, namely concentric bracings, eccentric bracings and knee bracings. In concentric bracings, inelastic energy dissipation response is generally poor due to the possible buckling of the diagonal elements in compression. In eccentric bracings since it absorbs large seismic force, repair and replacement after a severe earthquake is expensive and time consuming. As a remedy for all these disadvantages, knee braced frame developed. Frames with knee bracings (KBFs) provides an effective bracing solution. It can be obtained by providing a new element called "knee" in between the beam and column along with bracings. These bracings limits interstorey drifts, and knee element absorbs the earthquake energy, by providing cyclic deformations in shear or bending. The main advantage with respect to eccentric braced frames is that damage is concentrated in secondary element and it can easily replaced after destructive earthquakes. The position and stiffness of knee was the most important factor affecting the lateral resisting ability of KBF. The beams and columns got great influence on the lateral behaviour of KBF structure. The knee element will yield first without affecting the other main structural elements.

The knee braced steel frame (KBF) is energy dissipating frame system, which combines excellent ductility and lateral stiffness. The knee element is a fuse-like element that dissipates energy by the formation of plastic flexural hinges at its ends and mid-span when the building is subjected to severe lateral loads. The diagonal brace element, on the other hand, provides the required level of lateral stiffness and remains in the elastic range at all time. In this system, the non buckling diagonal brace provides most of the lateral stiffness. The ductility under a severe earthquake is provided by the flexural yielding of the knee element. In this way, the damage is concentrated in a secondary member which can be easily repaired at minimum cost. Floor distortions are reduced compared to the eccentric braced frame, to a level similar to that of the conventional moment-resisting and concentrically braced frames. Different types of KBF systems are shown in Fig 1. In this study seismic effect of different types of steel knee bracings with different configuration in multi-storied frames using ANSYS software, by time history analysis of 5 storied and 10 storied frames have done.



(a) (b) (c)

(a) K-knee braced frame (b) X-knee braced frame
(c) knee braced frame with single brace and one knee element

Figure 1. Types of knee brace frames

II. METHODS AND MATERIAL

A.Modelling And Analysis

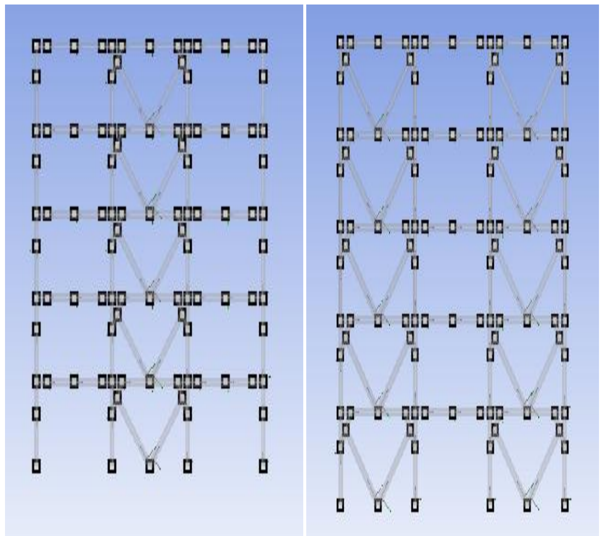
A 5 storeyed and 10 storeyed steel frame with different arrangement patterns of knee bracings has been considered for the current study. The frames considered for the present work is 5 bays in with 3m in Y-direction and 2m in X- direction. 5 storied models considered for design are shown in Fig 2. Four types of models considered for analysis in 5 storied frame. Two type chevron and two type cross knee braced frame. They were categorized as a,b,c &d. In 10 storied frames, four types of chevron knee braced frames and four types cross knee braced frames were considered. They were categorized as Type I, Type II, Type III and Type IV. Sections of columns and beam are explained in Table 1

Table 1 Frame Configuration

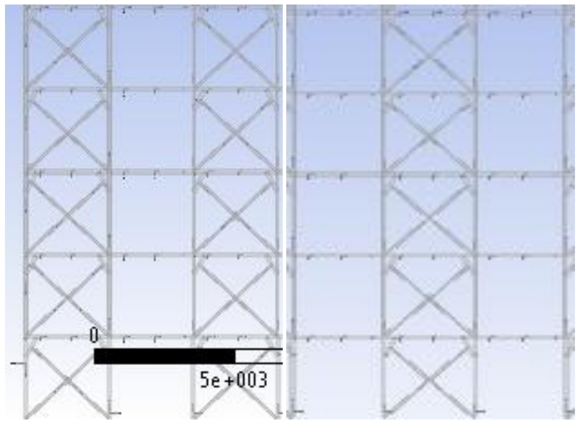
Size of column	BU UC 305*305*240
Size of beam	ISMB 600
Size of knee bracing	ISLB 250

B. Nonlinear time history analysis

Nonlinear 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. Kobe earthquake data is used in the present study.



(a) (b)



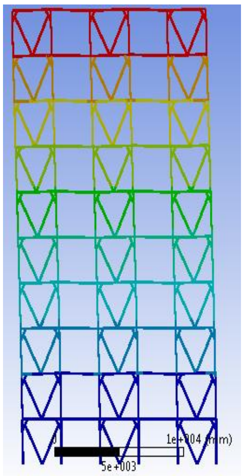
(c) (d)

Fig.2 Models for analysis

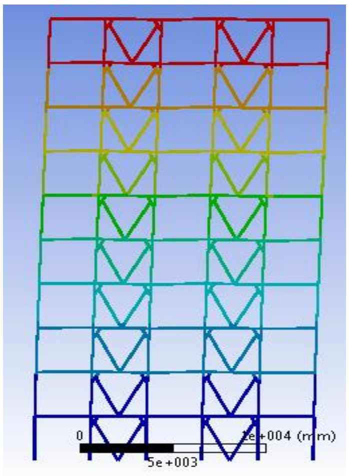
III. RESULTS AND DISCUSSION

A. Total deformation

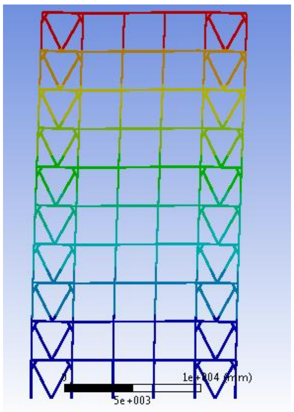
Total deformations of the structures are obtained, in which the maximum total deformation is indicated by red colour and the minimum total deformation by blue colour. The deformation contour varies in between these two which are again indicated by different colours. The frames get deformed laterally when side sway acts under the application of lateral force. The structure gets displaced from its original position towards different directions. The total deformation is the vector sum of the directional deformations. Models after deformation are shown in Fig. 3. Total deformation values are shown in Table2



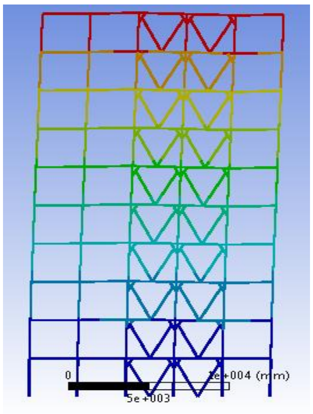
Type I



Type II



Type III



Type IV

Fig.3 Models after deformation for Chevron knee braced frame.

Table 2 Total Deformation

Type of bracings	Number of storeys	Alternate bracings (mm)	Bracings at middle (mm)	% variation (mm)
Chevron	5	59.26	60.789	2.5
Cross knee		116	140	20.68

From the results for five storied frame from Table.1 it is observed that the total deformation value is lesser for Chevron knee braced frames as compared to Cross knee braced frame. And the values are lesser for models having alternate bracings.

Table 3 Total Deformation for 10 storied frame

Type of frame	Chevron knee braced frame (mm)	Cross knee braced frame (mm)
Type I	149.97	148.52
Type II	81.673	104.49
Type III	241.31	277.2
Type IV	146.38	138.2

From Table.3 it is clear that the total deformation value is lesser for Type II in both Chevron knee braced frame and cross knee braced frame.

B. Base Shear

It is an estimate of the maximum expected lateral force that will occur due to seismic ground motion at the base of a structure. Table 4 shows the base shear values of ten storied frame.

Table 4 Base Shear for ten storied frame

Type of frame	Chevron knee (kN)	Cross knee braced frame (kN)	% variation
Type I	3609.1	3323	8.6
Type II	2314	2816.8	21.7
Type III	4229	3638	16.2
Type IV	3073	3563	15.9

Table 5 Base Shear for five storied frame

Type of frame	Chevron knee braced frame (kN)	Cross knee braced frame (kN)
Alternate bracings	952	921
Bracings at middle	1050	1258

Table 4 gives the base shear values for ten storied frame. It is clear from the results that second type of pattern is comparatively better providing less base shear values than other types. By comparing chevron knee braced frame with knee braced frame it is clear from the results that chevron knee braced frames are much better, providing a percentage variation of 21.7% when compared to the cross knee braced frame. By the comparative study it is clear from the results that TypeII chevron knee braced frame having lesser value of chevron knee braced frame. Table 5 gives the Base shear value for five storied frame. By comparing Base shear values in five storied frame from Table 5 it also giving lesser values for Chevron knee braced frame.

IV. CONCLUSION

- Five storey knee braced frame and ten storey five bay knee braced frames were considered for checking the effect of knee bracings in multistoried frames. The bracings patterns considered were chevron knee bracing, cross knee bracings, and arranged in four patterns. Better results obtained for alternate bracing pattern in Five storied frames.
- The results extracted shows that the frame model with type II pattern in chevron knee braced frames experience less base shear values so this bracing configuration can be used to resist seismic forces most efficiently.

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