

# Investigation of Efficient Bracing System As Per IS 800:2007

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*Abstract*— The major concern in the design of multi-storeyed steel building is to have good lateral load resisting system along with gravity load system because it also governs the design. This paper is presented to show the effect of different types of bracing systems in multi storied steel buildings. For this purpose the 20 stories steel buildings models is used with same configuration and different bracings systems such as knee brace, X brace and V brace is used. A commercial package Staad Pro is used for the analysis and design and different parameters are compared. The property of the section is used as per IS 800:2007 which incorporates Limit State Design philosophy.

## I. INTRODUCTION

Bracing is the highly efficient and economical method of resisting horizontal forces in a frame structure. A braced bent consist of the usual columns and girders, whose primary purpose is to support the gravity loading, and diagonal bracing members that are connected so that the total set of members forms vertical cantilever truss to resist the horizontal loading. The braces and girders act as the web members of truss, while the column act as the chords. Bracing is efficient because the diagonals work in axial stress and therefore call for minimum member sizes in providing stiffness and strength against horizontal shear.

## II. CONCENTRIC BRACING

### A. GENERAL

Centrically braced frames are defined as those where the centre lines of all intersecting members meet at a point as shown in Fig.1. This traditional form of bracing is, of course, widely used for all kinds of construction such as towers, bridges, and buildings, creating stiffness with great economy of materials in two dimensional space frames.



Fig.1 Concentric Bracing

### B. BEHAVIOUR

Because lateral loading on a building is reversible, braces will be subjected in turn to both tension and compression, consequently, they are usually designed for the more stringent case of compression. For this reason, bracing systems with shorter braces, for example K bracing, may be preferred to the full diagonal types. As an exception to designing braces for compression, the braces in the double diagonal is designed to carry in tension the full shear in panel.

A significant advantage of the fully triangulated bracing types is that the girders moments and shears are independent of the lateral loading on the structure. Consequently, the floor framing, which in this case, is designed for gravity loading only, can be repetitive throughout the height of the structure with obvious economy in the design and construction.

The role of web members in resisting shear can be demonstrated by following the path of the horizontal shear down the braced bent as shown in Fig.2

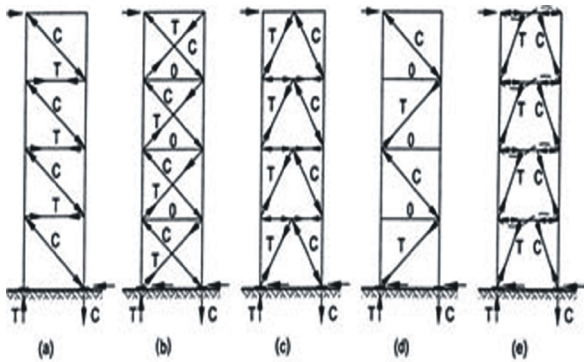


Fig. 2 Load Path For Horizontal Shear

### III. ECCENTRIC BRACING

An eccentric bracing system attempts to combine the strength and stiffness of a braced frame with the inelastic behaviour and energy dissipation characteristics of a moment frame as shown in Fig.2. The system is called eccentric because deliberate eccentricities are inserted between beam-to-column or beam-to-brace connections. The eccentric beam element acts as a fuse by limiting large forces from entering into and causing buckling of braces. The eccentric segment of the beam, called the link, undergoes flexural or shear yielding prior to formation of plastic hinges in other bending members and well before buckling of any compression members. Thus, the system maintains stability even under large inelastic deformations.



Fig.3.Eccentric brace

### IV. ANALYSIS OF BUILDING

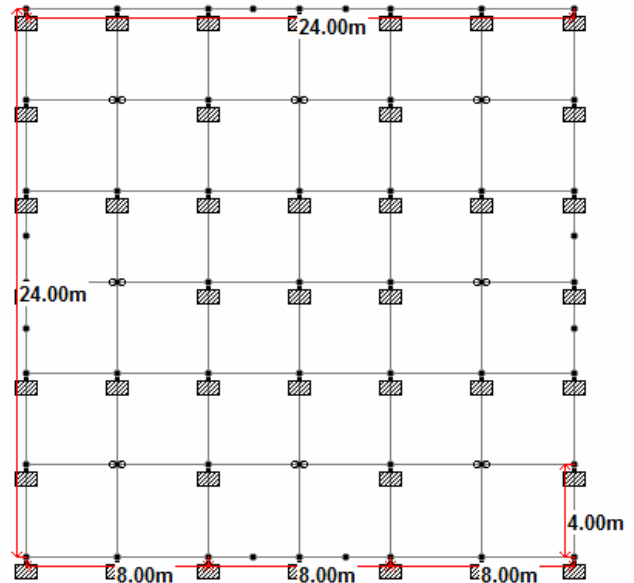


Fig.4.Plan of Building

Staad Pro V8i software is used for analysis and design of members. The seismic and wind loads are applied as per IS1893:2002 and IS875-III.

Following data is used for the analysis and design of building in software.

TABLE I

GENERAL DATA FOR ANALYSIS

Type	Office Building
Plan Dimension	24m X 24m
Height of Storey	3.5m
Earthquake Zone	3
Soil Type	Medium
Location	Ahmedabad
Basic Wind Speed	39m/s

Following models are considered for the analysis and design as per Limit State Design.

1. Without Brace model
2. X brace model
3. V brace model
4. Knee brace model

V. TYPES OF MODELS

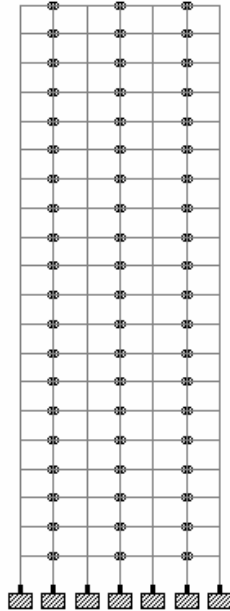


Fig.5. Without brace

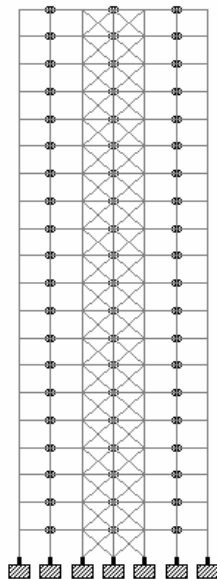


Fig.6. X brace

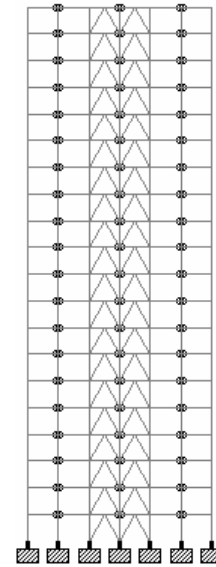


Fig.7. V brace

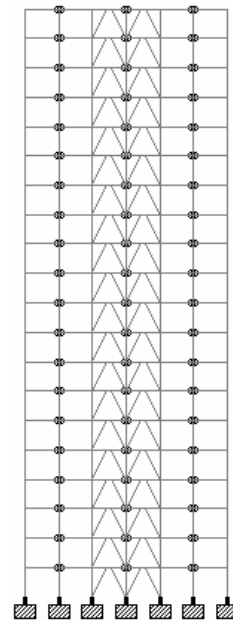


Fig.8. Knee brace

The property for the given models is used as per SP 6 and IS 800:2007. For columns box section 450mm x 450mm with 50 mm thickness in without brace and for X brace and knee brace model 450mm x 450mm with 45 mm thickness and for v brace model 400 x 400mm with 40mm thickness box sections are used Beam section ISWB 600 and ISWB 550 sections are used for all models. The bracing systems are used as per the requirements and they taken as double Channel sections back

to back. For X brace models ISMC 400 D and for V brace and Knee brace models ISMC 300 D sections are used.

*Load calculations*

Loads and Load combinations are given as per Indian standards. (IS 875:1984, IS 1893:2002 and IS 800:2007)

1. Gravity Loading:- Floor load and member weight are calculated as per general considerations as per IS 875 part1. Live load is taken for office building without separate storage as 4kN/m<sup>2</sup> and at top floor live load is taken 1.5kN/m<sup>2</sup> as per IS 875 part 2.

2. Seismic Loading: - Seismic load is given as per IS 1893- 2002. Following assumptions are used for the calculation.

- Zone factor – 0.16
- Soil type – 2 (medium Soil)
- Importance Factor – 1.5
- Damping co-efficient – 2%
- Response reduction – 4 (for concentric brace)  
5 (for eccentric brace)

3. Wind loading: - Static wind load is given as per IS 875-3. Following assumptions are used for calculation.

- Location – Ahmadabad
- Wind speed – 39m/s
- Terrain category – 3
- Class – C
- K1 – 1.06 (life- 100 years)
- K2 – depending upon the variation of height
- K3 – 1.00 (flat topography)

Dynamic wind load also calculated by using gust factor approach.

VI. RESULTS

All loads and load combinations are considered for the comparison but results are presented for maximum load case which is 1.5(DL – EQZ)

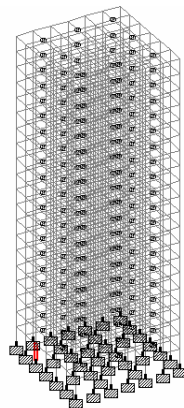
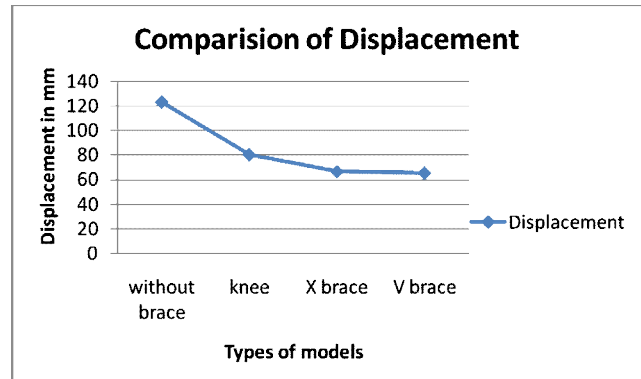


Fig.9. common column for comparison

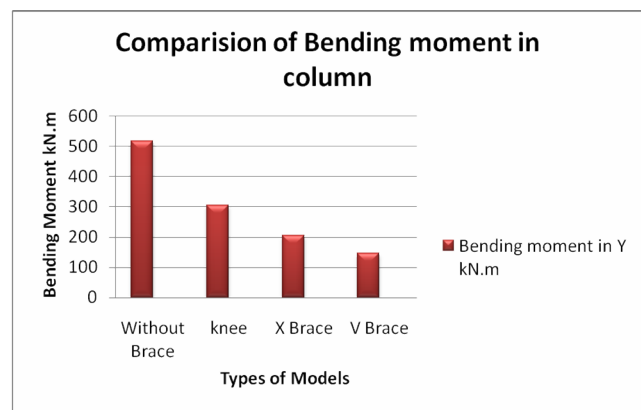
1) LATERAL DISPLACEMENT

Model	Top storey Displacement (mm)	% Decrease compare to without brace
Without brace	123.3	-
Knee brace	80.45	34.58
X brace	66.70	45.90
V brace	65.47	46.90



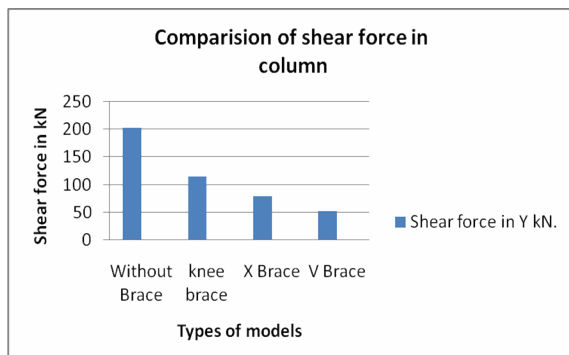
2) BENDING MOMENT IN COLUMN

Model	Bending moment in Y kN.m
Without Brace	518.19
Knee Brace	304.31
X Brace	206.50
V Brace	147.53

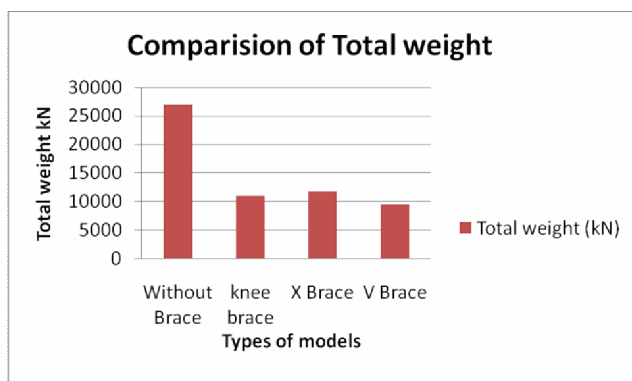


3) *SHEAR FORCE IN COLUMN*

Model	Shear force in Y kN.
Without Brace	203
Knee Brace	115
X Brace	79
V Brace	52

4) *TOTAL WEIGHT OF STRUCTURE*

Model	Total weight (kN)
Without Brace	26979
Z brace	11007
X Brace	11727
V Brace	9631



## VII. CONCLUSION

The different parameters are compared for four models as shown above and it is found that as per displacement criteria bracings are good to reduce the displacement and the max reduction of **46.90%** is observed in V braced model compared to model without brace. The bending moment and shear force in columns are also reduced in braced models from which it can be found that these are less in V brace model compared to other models. Total weight is less in V brace models compared to other models.

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