A Study On Bracing Systems On High Rise Steel Structures

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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 G+15 stories steel building models is used with same configuration and different bracing systems such as Single-Diagonal, X bracing, Double X bracing, K bracing, V bracing is used. A commercial software package STAAD.Pro V8i is used for the analysis of steel buildings and different parameters are compared. The property of the section is used as per IS 800:2007 which incorporates Limit State Design philosophy.

Keywords— *Single-Diagonal brace, X brace, Double X brace, K brace, V brace, Storey Drift, Displacement.*

1. Introduction

A steel frame can be strengthened in various types to resist lateral forces. These systems are moment resisting beam-column connections, braced frames with moment-resisting connections, braced frames with pin jointed connections and braced frames with both pin-jointed and moment-resisting connections. In steel buildings the most widely used method of constructing lateral load resisting system is braced frames. Hence, the main concern is to select the appropriate bracing model and to decide the suitable connection type. Bracing systems are used in structures in order to resist lateral forces. Diagonal structural members are inserted into the rectangular areas so that triangulation is formed. These systems help the structure to reduce the bending of columns and beams and the stiffness of the system is increased. There are lots of advantages of the bracing systems so that they are widely used. These are:

1. Braced frames are applicable to all kind of structures like bridges, aircrafts, cranes, buildings and electrical transmission towers.
2. Braced frames are easy to fabricate and construct. No lots of knowledge or skills are needed.
3. If the bolted connections are used, there is no deformation problem at the connections.

2. Details of the Structure

A. Modeling and Analysis

The main objective of the analysis is to study the different types of bracings in building. The analysis is carried out in STAAD Pro V8i software. Results of different types of bracing system for buildings are discussed below. Different types of bracing system for buildings are modeled and analyzed for gravity and wind loads. The comparison is made between the Without Bracing, Single-Diagonal brace, X Bracing, Double X Bracing, K Bracing and V Bracing.

B. Assumptions

The following are the assumptions made:
The plan dimension of the building is 45mX15m and height of storey is 3m. Building is situated in Belgaum and wind speed is 33m/s.

C. Group Properties

Type	: Office Building
Beam	: ISMB 600
Column	: ISMC 400 (F to F)
Bracings	: ISA200*200*12

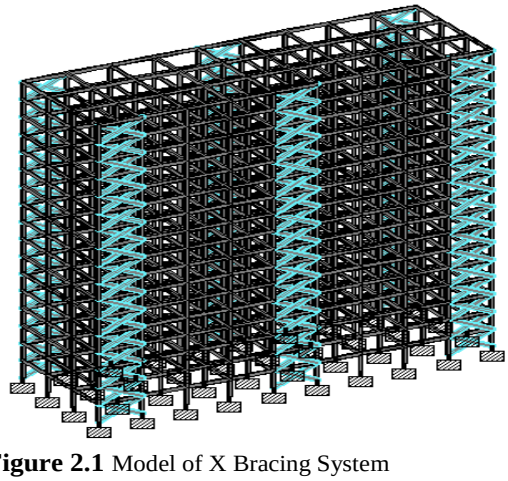

Figure 2.1 Model of X Bracing System

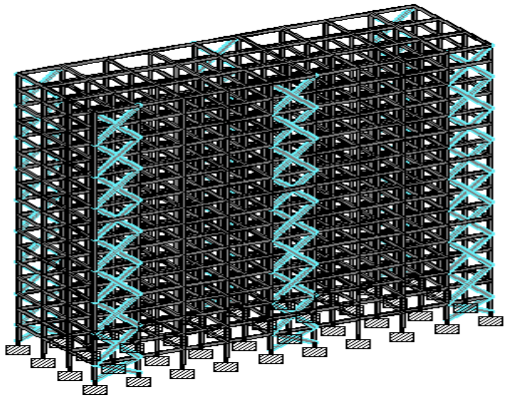

Figure 2.2 Model of Double X Bracing System

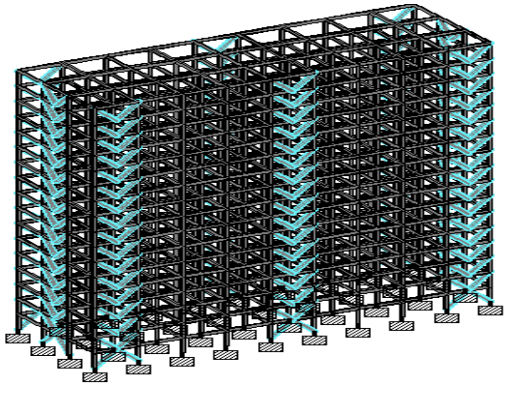

Figure 2.3 Model of V Bracing System

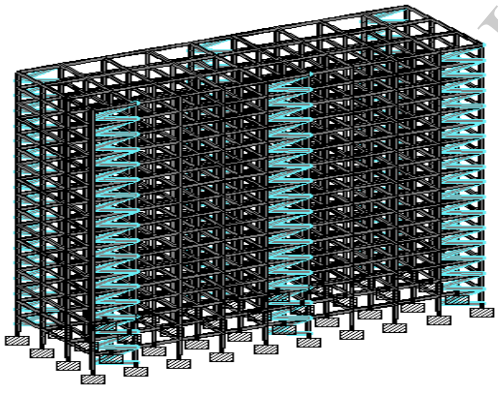

Figure 2.4. Model of K Bracing System

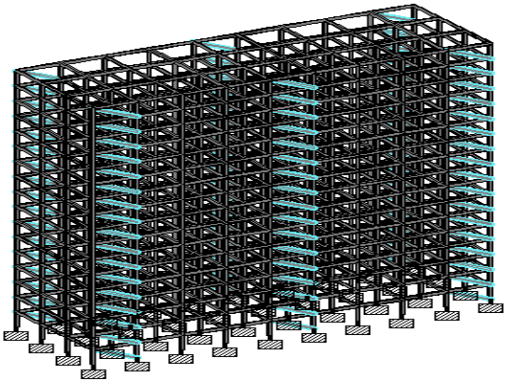

Figure 2.5 Model of Single diagonal Bracing System

3. Description for Loading

3.1. Gravity Loading: - Floor load and member weight are calculated as per general considerations as per IS 875-part1. Live load as per IS 875 part2 taken for office building, Intermediate floors is 2kN/m^2 and roof is 1.5kN/m^2

3.2 Wind Loading: - Static wind load is given as per IS 875-part3. Following assumptions are used for calculations.

Location : Belgaum
Wind speed : 33m/s
Terrain category : 3
Class : C
K1 : 1.05
K2 : Depending upon the variation of height.
K3 : 1.0(flat topography)

4. Results and Discussions

Wind analysis is carried out for different types of bracing system. After the analysis significant change in parameters such as Displacement, base shear, axial force, weight and storey drift of the structure is noticed. Permissible displacement of the displacement is 102 and all the displacements are well within permissible.

Table 4.1 Maximum Displacement (mm) for Different Types of Bracing System

Type of Bracing	Displacement(mm)
Without Bracing	62.007
Single Diagonal	56.284
X Bracing	56.594
Double X Bracing	56.753
K Bracing	57.893
V Bracing	56.884

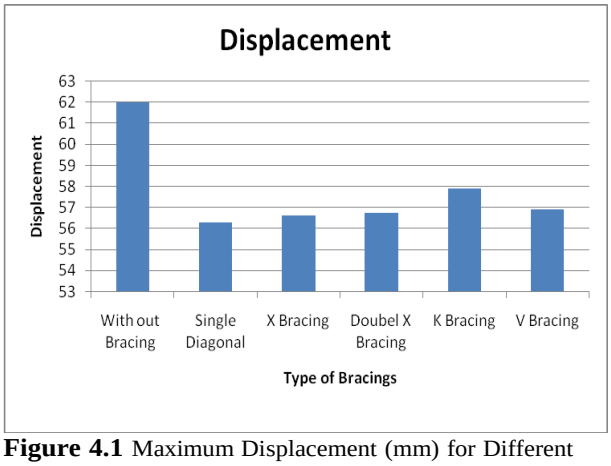

Figure 4.1 Maximum Displacement (mm) for Different Types of Bracing System

Table 4.2 Design Base Shear (kN) for Different Types Of Bracing System

Type of Bracing	Base Shear (kN)
Without Bracing	2935.936
Single Diagonal	3149.557
X Bracing	3133.788
Double X Bracing	3221.473
K Bracing	2978.174
V Bracing	3172.35

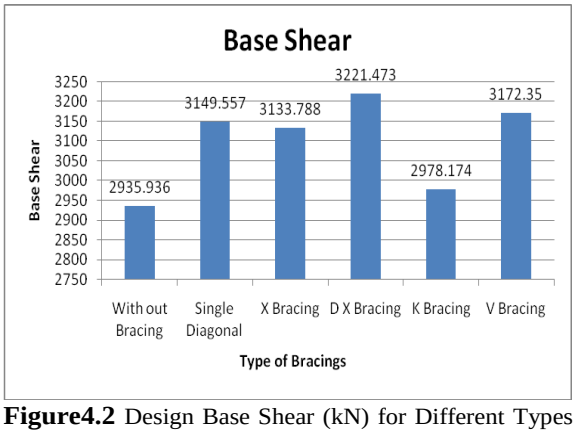

Figure4.2 Design Base Shear (kN) for Different Types of Bracing System

Table 4.3 Maximum Axial Force (kN) for Different Types Of Bracing System

Type of Bracing	Axial Force (kN)
Without Bracing	2935.936
Single Diagonal	3000.582
X Bracing	2965.944
Double X Bracing	3055.797
K Bracing	2978.174
V Bracing	2908.036

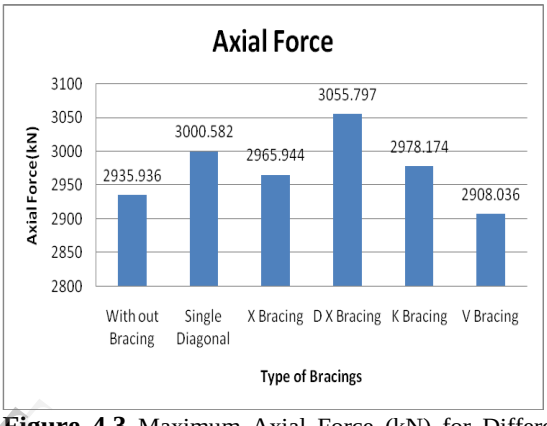

Figure 4.3 Maximum Axial Force (kN) for Different Types of Bracing System

Table 4.4 Maximum Weight (kN) for Different Types of Bracing System

Type of Bracing	WEIGHT(KN)
Without Bracing	8894.336
Single Diagonal	8966.874
X Bracing	9039.413
Double X Bracing	8994.316
K Bracing	9024.216
V Bracing	8991.497

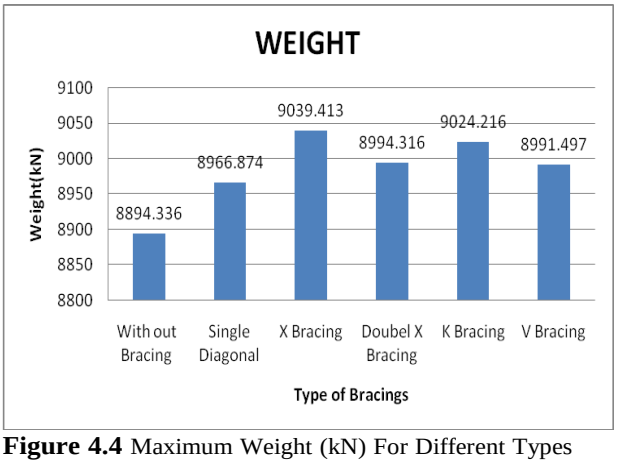

Figure 4.4 Maximum Weight (kN) For Different Types of Bracing System

Table 4.5 Storey Drift for Different Types of Bracing System

	Without Bracing	Single Type	X Type	Double X Type	K Type	V Type
1	0	0	0	0	0	0
2	0.4798	0.3569	0.3646	0.3661	0.3968	0.3532
3	1.0209	0.7643	0.7775	0.7867	0.8425	0.7621
4	1.5426	1.1608	1.1793	1.1882	1.2739	1.1621
5	2.041	1.5429	1.5665	1.582	1.6879	1.5482
6	2.5144	1.9087	1.9372	1.9525	2.0828	1.9183
7	2.9611	2.2565	2.2897	2.3107	2.4571	2.2706
8	3.38	2.5849	2.6225	2.6432	2.8095	2.6036
9	3.7697	2.8928	2.9345	2.9603	3.1389	2.916
10	4.1293	3.1791	3.2245	3.2497	3.4444	3.2067
11	4.4579	3.443	3.4918	3.5215	3.7251	3.4748
12	4.7546	3.6836	3.7355	3.7641	3.9803	3.7196
13	5.0189	3.9005	3.955	3.9877	4.2094	3.9404
14	5.2501	4.093	4.15	4.181	4.4119	4.1367
15	5.448	4.2609	4.3199	4.3546	4.5875	4.3084
16	5.6122	4.4039	4.4646	4.4972	4.7359	4.4551
17	5.7426	4.5219	4.5841	4.6203	4.8571	4.5769
18	5.8403	4.6154	4.679	4.712	4.9517	4.7424

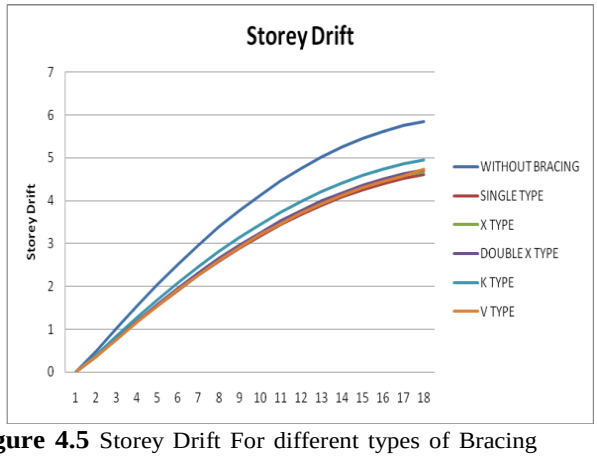

Figure 4.5 Storey Drift For different types of Bracing System

5. Conclusions

On the basis of the present study, following conclusions are made:

1. As per displacement criteria, bracings are good to reduce the displacement and in case of K and V-bracing, the displacement is higher than without bracing because of irregularity in shape of the structure.
2. The reactions and weight of the structure are more in different types of bracing structures when compared to un braced structure with same configuration of the structure.
3. It is also seen that as there are different bracing systems employed the displacement and storey drifts, may increase or decrease for the braced buildings with the same configurations.
4. The braced buildings of the storey drift either increases or decreases, as compared to un braced building with the same configuration for the different bracing system.

6. References

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