Comparative Study of Steel Structure using different types of Bracing

SUJITH S K (Asst proff Dept of Civil Engineering NCET)
YOGESH K (Chartered Engineer from Institute of Engineers in India
Nirmala B N (student at NCET)

Abstract –
Now a days, bracings are most popular system. It is the best method for lateral load resisting systems and it will be the viable solution for enhancing earthquake resistance. It is provides for minimizing the lateral deflection of buildings. In the present study G+15 storeys is analyzed for Z-II by considering soil type II. The analysis carried out to assess the structural performance under earthquake ground motions. In this study there are different types of bracing i.e. X bracing, V bracing, K bracing and Diagonal forward bracing and without bracing by using same plan in both X & Z Directions. Results are obtained by considering Storey Displacement, Base Shear, Time period for equivalent static analysis and response spectrum analysis. A braced frame is designed primarily to resist wind and earthquake forces in and a structural system. Bracings are provided to increase stiffness and stability of the structure under lateral loading and also to reduce lateral displacement significantly.

Key Words: Storey displacement, base shear, time period, STADD PRO.

1. INTRODUCTION

Bracing is a structural member which can resist lateral loading. It is made up of Steel and RCC material which enables to resist lateral load. Bracing frames are classified in to X bracing, V bracing, Inverted V bracing, Diagonal forward bracing, Diagonal backward bracing. Bracings help to minimize the beam and column dimension. It also reduces the cost. The provision of bracings enhances stiffness and strength. Bracing which decreases the damage to the structure by decreasing the sway in lateral. Bracing which shows the good performance, if it is properly detailed and designed. Bracing which carries forces due to earthquake, overturning effect. In tall buildings there will be a chances of decrease in the displacement and collapsible chances due to more number of stories. Bracing are effective in minimizing the forces of earthquake and wind. A braced frame is designed primarily to resist wind and earthquake forces in and a structural system. Bracings are provided to increase stiffness and stability of the structure under lateral loading and also to reduce lateral displacement significantly.

SCOPE OF STUDY

Buildings with same types of the zonal condition and for the same category can be adopted. Without bracing and with bracing i.e. X bracing, V bracing, bracing and Diagonal forward bracing can be adopted. It shows the behaviour of the different bracings when it is placed at the alternative layer locations. Analysis of response such as storey displacement, Base shear, and time period is carried out using the STADD PRO software.

Aim and Scope of the Study
• Modelling of the structure using STADD PRO V8 software
• The major goal of this thesis is to look into the impact of bracing systems on steel structure design. The outcomes of different structures with different bracing systems are evaluated.

1. NARRATIVE OF MODEL

The present work involves analysis of without bracing and with bracing i.e. X bracing, V bracing, K bracing and Diagonal forward bracing of same plan. In this project, modeling and analysis are carried for G+15 stories modeling and analysis is done using STADD PRO software. There are five models. Model 1 consist a without bracing, model 2 consists an X bracing, Model 3 consists a V bracing, model 4 consists a Diagonal forward bracing and model 5 consists a K bracing. The dimension of all models is of bay length 6m x 8m. Each model is done by STADD PRO.
Model Description

A rectangular building considered for analysis is symmetric in plan and elevation. The plan dimensions of the building to be modelled are 42m × 24m.

<table>
<thead>
<tr>
<th>Title</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>PlantSize</td>
<td>42m ×24m</td>
</tr>
<tr>
<td>Floorheight</td>
<td>3.35 m</td>
</tr>
<tr>
<td>Beam sizes</td>
<td>ISMB600</td>
</tr>
<tr>
<td>Column sizes</td>
<td>ISMB600</td>
</tr>
<tr>
<td>Slab thickness</td>
<td>150 mm</td>
</tr>
<tr>
<td>Live load</td>
<td>4 kN/m²</td>
</tr>
<tr>
<td>Floor finish</td>
<td>1.5 kN/m²</td>
</tr>
</tbody>
</table>

1. Dead load as per IS:875t(PartI)-1987
   i) Self weight of slab (150 mm thick) – 3.125 kN/m²
   ii) Loading due to floor finishes – 1.50 kN/m²

2. From masonry walls – 8.1 kN/m³.

3. Live load as per: 875t (Part-II)-1987
   i) Live load on floor – 4.00 kN/m²
   ii) Live load on roof – 1.50 kN/m²

4. Earthquake load IS: 1893-2016
   i) Zone factor - 0.16
   ii) Soil type - II
   iii) Importance factor - 1
Elevation View of K, V, diagonal and X type of bracing.

II. Results

Figure - Graph of displacement variation
Comparative Study of Steel Structure using different types of Bracing

**Figure - Graph of displacement variation**

![Graph of displacement variation](image1)

**Figure - Graph of displacement variation**

![Graph of displacement variation](image2)

**Figure - Graph of displacement variation**

![Graph of displacement variation](image3)
Comparative Study of Steel Structure using different types of Bracing

Figure - Graph of variation in time period.

Figure - Graph of base shear variation
Comparative Study of Steel Structure using different types of Bracing

Figure - Graph of base shear variation

Figure - Graph of base shear variation
Comparative Study of Steel Structure using different types of Bracing

III. Result and Discussion

A. Displacement
1. Along X and Z direction
   - Maximum displacement in X type bracing, TV type bracing, tK type bracing, and Diagonal type of bracing, moment resisting frame decreased along X direction by 4.38%, 7.12%, 3.22%, compared to Z direction, for static analysis.
   - Maximum displacement in Diagonal type of bracing, moment resisting frame increased along X direction by 3.99%, 14.33%, compared to Z direction, for static analysis.
   - Maximum displacement in X type bracing, Non regular type bracing, K type bracing, and Diagonal type of bracing, moment resisting frame decreased along X direction by 32.37%, 39.41%, 38.79%, 39.49%, compared to Z direction, for response spectrum analysis.
   - For statics analysis along x direction maximum displacement for in X type bracing, V bracing, K type bracing, decreased along X direction by 4.38%, 7.12%, 3.22%, and
   - Diagonal type of bracing, moment resisting frame is increased by 3.99%, 14.33% compared to Z direction for response spectrum analysis.
   - For statics analysis along Z direction maximum displacement for in X type bracing, V type bracing, K type bracing, Diagonal type of bracing, moment resisting frame decreased along Z direction by 32.37%, 39.41%, 38.73%, 43.76% compared to Z direction for response spectrum analysis.

B. Time period
The Model with V type of bracing has lowered the maximum amount of time period, as shown in the graphs and tables of time period in the results section. It is noted that time period of Model with V type of bracing reduced by about 9.03%, 13.74%, 13.13%, 36.90% compared to X type bracing, K type bracing, Diagonal type bracing and moment resisting frame.

C. Base shear
2. Along X and Z direction
   - Maximum base shear in X type bracing, TV type bracing, K type bracing, and Diagonal type of bracing and moment resisting frame increased along X direction by 24.49%, 57.44%, 24.48%, 24.48%, compared to Z direction, for static analysis.
   - Maximum base shear in X type bracing, Non regular type bracing, K type bracing, and Diagonal type of bracing and moment resisting frame increased along X direction by 14.45%, 27.28%, 24.73%, 22.92%, 25.73% compared to Z direction, for response spectrum analysis.
   - For statics analysis along X direction maximum base shear for in X type bracing, V type bracing, and moment resisting frame increased along X direction by 13.55%, 42.52%, 23.07%, and K type bracing and diagonal type of bracing is decreased along X direction by 2.34%, 0.71% compared to Z direction for response spectrum analysis.
   - For statics analysis along Z direction maximum base shear for in X type bracing, V type bracing, and moment resisting frame increased along X direction by 2.06%, 1.79%, 24.34%, and K type bracing and diagonal type of bracing is decreased along Z direction by 2.02%, 2.72% compared to Z direction for response spectrum analysis.

   - For statics analysis along Z direction maximum base shear for in X type bracing, V type bracing, and moment resisting frame increased along X direction by 2.06%, 1.79%, 24.34%, and K type bracing and diagonal type of bracing is decreased along Z direction by 2.02%, 2.72% compared to Z direction for response spectrum analysis.

IV. Conclusions
By considering the all models with different types of bracings and their behaviour in dynamic earthquake loading. Its concluded that with V type of bracing gives the most suitable results.

The results of this study show that adding braced frame to steel moment frames building is important to reduce displacement when compared to other types of bracing.

In comparison to the others, V type and cross bracing offer the strongest resistance to lateral drift; nevertheless, cross bracing is more expensive due to the additional joints. Furthermore, V-bracing has been shown to be more adaptable to apertures and service channels. As a result, the chevron form is the best sort of bracing. Braced steel frames experience more base shear compared to unbraced frames. This is as result of the increased seismic weight of the structure contributed by the bracing members. Base shear increases in the order: Cross, diagonal, unbraced to V frames.

V type of bracing is preferable as it tends to reduce the time period, reduce the lateral displacement in both X and Z direction by a good margin.
References

[3]. IS 800:2007 “Code of Practice for General Construction in steel”.
and without bracing” 15WCEE LISBOA 2012
[5]. K. Sangle, K.M. Bajoria and V. Mhalunkar “Seismic analysis of high rise steel frame building with
[7]. Multistoried Building with Different Types and Arrangements of Bracing Systems”, International
[8]. Journal of Science Technology & Engineering, ISSN: 2349-784X, Volume 2, Issue 2, August 2015,
[9]. pp 135-149.
[10]. Muhammad UmairSaleem and Hisham Jahangir Qureshi, “Design Solutions for Sustainable Construction of Pre Engineered Steel
Sections for High Rise Structures”.
Structures”.

www.ijres.org 74 | Page