STUDY ON CONCENTRIC STEEL BRACING AT SOFT STOREY DURING EARTHQUAKE

LAKSHMI BALIGA[1], BHAVANI SHANKAR[2]

[1]*M.Tech Student, Department of civil Engineering, Srinivas School of Engineering, Mangaluru*
[2]*Assistant Professor, Department of civil Engineering, Srinivas School of Engineering, Mangaluru*

Abstract – *Earthquake causes a large loss to the building structure, so the important steps to be taken to overcome the damage caused due to earthquake. Seismic analysis performance is carried to know how the structure behaves during earthquake. Nowadays high rise buildings are built keeping open space in the ground floor with the intentions for parking. This open space in the ground floor is termed as soft storey. Bracing is one of the best method to overcome soft storey effect. In the present study infill walls are modeled as equivalent diagonal strut and bracings are provided by considering different steel sections and whole performance is done through Equivalent static analysis method by using Etabs-15 software.*

***Key Words*: soft storey, concentric steel bracing, infill wall, equivalent diagonal strut, Linear static analysis.**

1. INTRODUCTION

Earthquake is generated in the earth's crust. It will be for a short period of a few seconds or a minute. The main loads which we get through gravity effect are Dead load and Live load. Apart from these two types of loads there is a lateral load which is produced by seismic effect and also known as Earthquake load and wind load.

Sometimes Earthquake will cause a large loss to the human beings but sometimes will be a minor attack, inspite of knowing that buildings are destroyed due to seismic effect still the buildings are constructed such that the basements are kept open without any walls or any other strengthening material.

1.1 SOFT STOREY

Soft storeys are the storey where the ground storeys are kept open. These storeys are the weakest storey when compared to the other storey. These ground storeys are meant for parking facility purpose or for shops etc. In soft storey building there are various types of failure. Soft storey at the basement is the main reason for the failure of the building this is also known as soft storey failure.

Usually when the buildings are constructed water tanks are provided above the building. When the earthquake occurs, the water tanks get departed from the structure and this is known as Mass irregularity failure.

Usually apart from regular building we can observe irregular building also there are L-Shaped-Shaped etc types of buildings, torsional effect are formed due to damage, usually we can see that the damage is caused on the outer surface of the wall.so this unsymmetrical building is responsible for such failure. This is known as Plan irregularity failure.

1.2 MASONRY INFILL

Masonry infill walls are the most common way of strengthening the building. Masonry infills are the toughest and stiffness modeling form of structure. Masonry infill is modeled by Equivalent diagonal strut. There are various types of diagonal strut. It can be provided in the form of single diagonal strut or double diagonal strut.

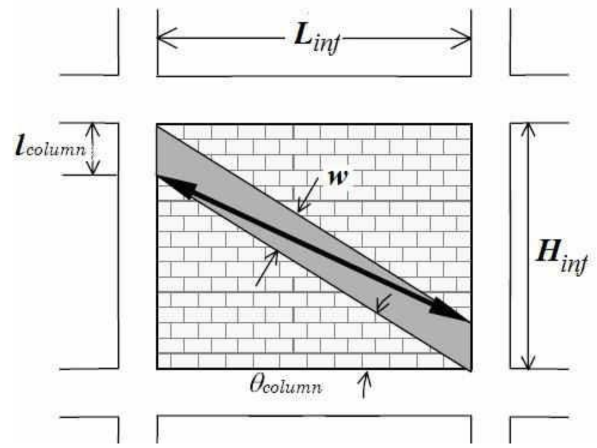
1.3 BRACINGS

One more important procedure which can be provided to strengthen the building is by using bracings. Bracings can be of any type i.e. X-bracing, K-bracing, inverted V-bracing, diagonal bracing, Out of these bracings X-bracing is found to be more frequently used bracings.

2. INFILL WALL MODELLING

The infill wall modeling is done in the form of equivalent diagonal strut method. The self-weight of the infill wall is applied to the beam by uniformly distributed load, this will neglect the stiffness of the wall and this will affect the result of the analysis.

Infill models are classified as micro models and macro models. Micro models are used for the small structures. Macro models are used for large structures. In the present paper the modelling of the infill wall is done by using formula which is proposed by Mainstone in 1974.



The Equivalent strut width 'w' is given by

W= 0.175 $(\lambda H)^{-0.4}$ D where

$\lambda=4\sqrt{}(E_{inf}t\sin2\theta/4E_cI_cH_{inf})$

$\theta=\tan^{-1}(H/L)$.

Where H=Floor to Floor height

D=diagonal length of infill

E_{inf}= Infill wall young'modulus

t= Infill wall thickness

θ=Angle of the strut with horizontal

E_c=Concrete Young's modulus

I_C=Moment of Inertia for column

H_{inf}= infill wall height

L_{inf}= Infill Wall length

W=width of the strut

3. METHODOLOGY

In the present study Equivalent static analysis is performed using Etabs-15 Software. Equivalent static analysis are simple way of defining the method and does not require more effort. The dynamic analysis is not carried out in this process. The calculation is done using the formula in the code book[IS 1893(Part-1) 2002].In the present study eight models are done. The results are compared in the terms of displacements, storey shear, storey drift, bending moment and time period in both X and Y directions.

The models used for analysis are as follows:

Model 1-Bare frame

Model 2-Fully infilled frame except first storey.

Model 3-Infilled frame building having concentric steel ISMB 200 X-bracing in X and Y directions only at soft storey level.

Model 4-Infilled frame building having concentric steel ISMB 200 Inverted V-bracing in X and Y directions only at soft storey level.

Model 5-Infilled frame building having concentric steel ISMC 200 X-bracing in X and Y direction only at the soft storey level.

Model 6-Infilled frame building having concentric steel ISMC 200 inverted V-bracing in X and Y direction only at soft storey level.

Model 7-Infilled frame building having concentric steel ISB 172 X-bracing in X and Y direction only at the soft storey level.

Model 8-Infilled frame building having concentric steel ISB 172 inverted V-bracing in X and Y direction only at soft storey level

3.1 BUILDING CONFIGURATION

A G+7 multi-storied building with X-type, Inverted V-type and steel tube section are provided which are used in analyzing the structure. The structure is designed using IS code 1893-2002 using the Etabs-15 Software.

Table -1: Parameters considered

Frame type	**Special moment resisting**
Number of storey's	G+7
Storey height	3.3m
Depth of foundation	2.5m
Plan dimension	22.5mx12m
Size of columns	600mmx600mm
Size of beams	300mmx450mm
Section property used as bracings	ISMB 200,ISMC 200,ISB 172
Unit weight of RCC	25KN/m^2
Unit weight of masonry	20KN/m^2
Live load intensity on floor	5.0KN/m^2
Live load intensity on roof	2.0KN/m^2
Weight of floor finish	1.875KN/m^2
Water proofing load on roof	2.0KN/m^2
Thickness of wall	230mm
Height of parapet	1.2m
Seismic zone	V
Importance factor(I)	1.5
Response reduction factor(R)	5
Soil type	medium

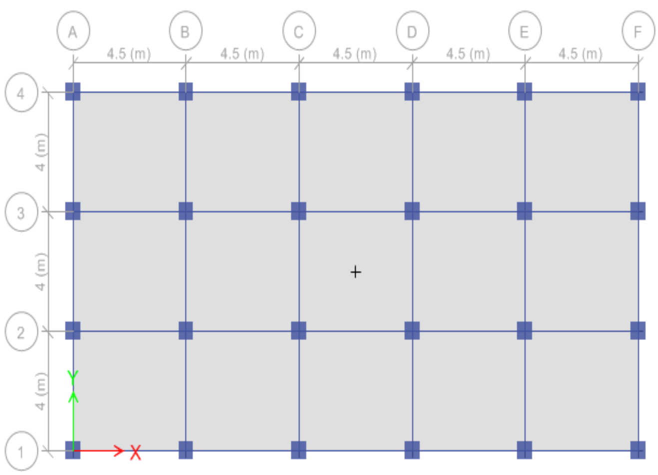


Fig -1: Plan of the building

4. RESULTS AND DISCUSSIONS

4.1 STOREY DISPLACEMENT

Storey displacement of model-1 gives the maximum displacement with 49.5mm in the top storey when compared to the other models. Model 3 and Model 5 gives the lesser lateral roof displacements when compared to the other models provided.

Table -2: Longitudinal Storey displacement

Storey displacement in x-direction								
Storey No	M 1	M 2	M 3	M 4	M 5	M 6	M7	M8
7	49.5	24.2	21.6	21.7	21.6	21.8	21.7	21.9
6	47.1	23.4	20.5	20.7	20.6	20.8	20.6	20.9
5	43.2	22.1	18.8	19	18.8	19.1	18.9	19.2
4	37.8	20.3	16.3	16.6	16.4	16.8	16.5	16.8
3	31.2	18.1	13.4	13.8	13.6	14	13.6	14.1
2	23.9	15.8	10.3	10.7	10.4	10.9	10.5	11
1	16.1	13.3	6.9	7.5	7.1	7.7	7.2	7.8
ground	8.4	10	3.8	4.4	4	4.6	4.1	4.7
plinth	2.1	3	2.1	2.2	2.1	2.2	2.1	2.2
0	0	0	0	0	0	0	0	0

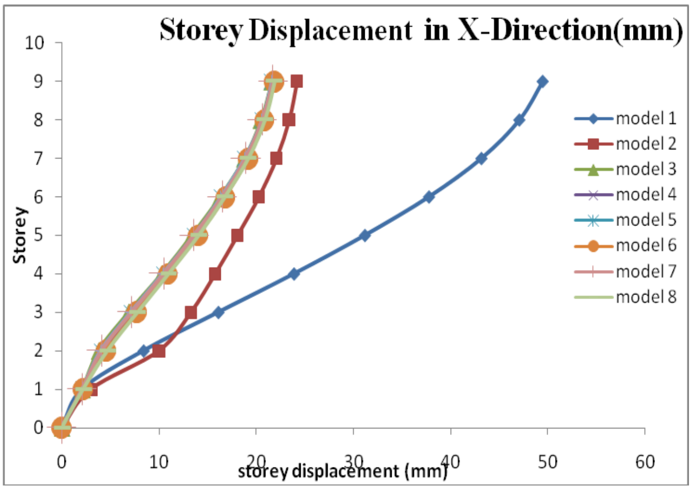


Chart 1: Storey displacement in X-direction

4.2 BENDING MOMENT

M1 is having the highest bending moment of 72.9934 KN-m. M4 has the minimum bending moment of 47.3998 KN-m. This shows that soft storey provided with inverted V-bracing has the capacity for resisting lateral loads.

Table -3: BENDING MOMENT

MODEL NO	BENDING MOMENT(KN-m)
M 1	72.9934
M 2	47.4937
M 3	47.4321
M 4	47.3998
M 5	47.4416
M 6	47.4068
M 7	47.4417
M 8	47.4061

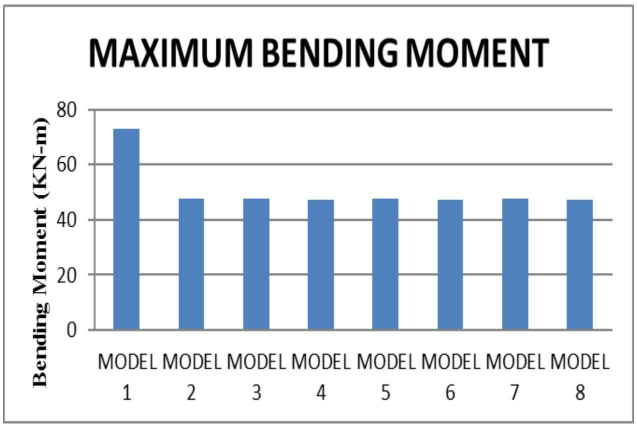


Chart 2: Bending moment

4.3 TIME PERIOD

According to Eigen values 12 modal periods are noted down using Etabs software. The time period for the M1 is maximum when compared to the other models. M1 has no laterally supporting member so the time period increases.

Table -4: TIME PERIOD

Time period in sec								
modes	M1	M2	M3	M4	M5	M6	M7	M8
Mode1	1.54	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Mode2	1.53	0.88	0.70	0.72	0.71	0.73	0.71	0.73
Mode3	1.35	0.81	0.65	0.67	0.66	0.68	0.66	0.68
Mode4	0.47	0.28	0.28	0.28	0.28	0.28	0.28	0.28
Mode5	0.47	0.26	0.22	0.23	0.22	0.23	0.22	0.23
Mode6	0.42	0.24	0.21	0.22	0.21	0.22	0.22	0.22
Mode7	0.25	0.14	0.14	0.14	0.14	0.14	0.14	0.14
Mode8	0.25	0.13	0.12	0.13	0.12	0.13	0.12	0.13
Mode9	0.23	0.13	0.12	0.12	0.12	0.12	0.12	0.12
Mode10	0.16	0.09	0.09	0.09	0.09	0.09	0.09	0.09
Mode11	0.16	0.09	0.09	0.09	0.09	0.09	0.09	0.09
Mode12	0.14	0.08	0.08	0.08	0.08	0.08	0.08	0.08

5. CONCLUSION

1. The displacement for M l 1 is 51.1% more than M2 at the roof level in X-direction. The displacement for the M1 is 46.4% more than the model 2 in the Y-direction in roof level. It is also observed that M3 has the minimum displacement when compared to the other model. It can be concluded from the above observation that X-bracing gives the better results when compared to the Inverted V-bracing

2. From the above data collected it is observed that the storey shear for the M3 is 57.13% more than the M1 at the roof level in X-direction. From this it is concluded that providing bracing in a building increases its storey shear.

3. From the above observation it is shown that the storey drift for M1 is 66.67% more than the M2 at the roof level. It can be concluded that modelling a structure with infill frames gives lesser storey drift compared to the bare frame.

4. It is observed that bending moment is 35.06% more in M1 when compared to M4. Therefore it is concluded that inverted V-bracing given in both directions is an better option for reducing the bending moment.

5. The time period for the M1 is 39.74 % more when compared to other models at the roof level . Finally it is concluded that that provision of infill wall and bracings decreases time period.

6. SCOPE FOR FUTURE WORK

1. Furthur the work can be carried out for hard soil and soft soil.

2. Present work is carried out for Zone -V but in future the work can be carried out for different zones.

3. It can be carried out by using different methods like time history analysis, push over analysis and response spectrum analysis.

4. The work can be carried out by taking different dimensions.

5. The work can be carried out by using other equivalent strut width expressions.

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