DYNAMIC RESPONSE OF BUILDINGS WITH SOFT STOREY

Akhildev K S[1], Bhagyaraj U[1], Jithin Sebastian[1], Kiranji K C [1], Dr. C Prabha[2]

[1]Student, Dept. of Civil Engineering, M. A. College of Engineering, Kothamangalam, Kerala, India
[2] Asst. Professor, Dept. of Civil Engineering, M. A. College of Engineering, Kothamangalam, Kerala, India

---***---

Abstract -.*This paper consists of seismic analysis of a multi-storied building with soft storey using ETABS and comparison of effectiveness of various methods to mitigate soft storey effects. A soft storey is a regular feature of multi storey structures for parking and auditoriums. The behavior of a building during earthquake highly depends on the effects of soft storey due to its inherent vulnerability to seismic forces.*

Key Words: reinforced concrete, seismic effects, soft storey, frame, infill wall

1. INTRODUCTION

Open ground storey for parking is common in multi-storied buildings nowadays. As result, severe vertical irregularities are created in such buildings resulting in their high seismic vulnerability. Thus, the strengthening of soft storey is relevant for such buildings. In this study, the ground storey of proposed building is left open for parking; and the seismic performance of a cultural complex with soft storey is studied using ETABS by Response Spectrum Analysis. This paper evaluates several strengthening schemes such as, infill walls, diagonal bracings and shear walls for improving seismic performance of the building with soft storey.

1.1 Building considered in the study

A six storied RC building (fig.1) was analyzed for most critical load combination using relevant Indian standards, strength and stiffness of infill walls are not considered in the analysis. Columns were assumed to be fixed at base and grades of concrete and steel are M30 and Fe415 respectively. Building is considered to be situated in earthquake zone III and wind speed considered was 39 m/s for wind load. Maximum live load considered on the frame was 5 kN/m². Self-weight and wall load is also considered.
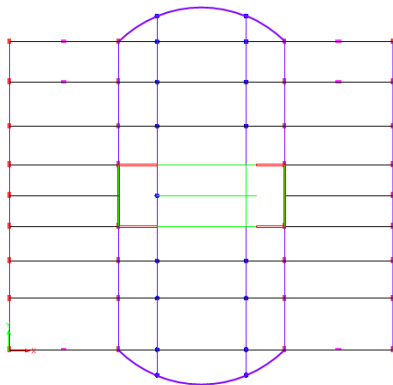

Fig.1. Plan of the building

1.2 Masonry infill wall

As per Indian seismic code IS1893: Part -1(2016), masonry infills can be conveniently modelled as compressive diagonal struts. In the present study, infill walls are modelled as pin jointed diagonal struts.
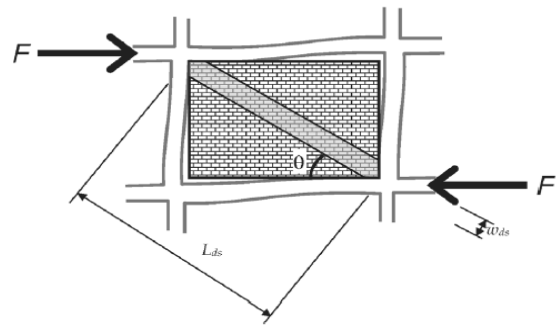

fig.2 Details of diagonal strut model for masonry infill wall

Width of equivalent diagonal strut, $W_{ds}=0.175\alpha_h^{-0.4}L_{ds}$

$$\alpha_h = h\sqrt[4]{\frac{E_m \times t \times \sin 2\theta}{4 E_f \times I_c \times h}}$$

E_m – Modulus Of Elasticity Of Masonry Infill Wall
$E_m = 550f_m$
$f_m = 0.433f_b^{0.64}f_{mo}^{0.64}$
f_b - Compressive Strength of Brick
f_{mo} - Compressive Strength of mortar

2. MODELS CONSIDERED FOR STUDY

Response Spectrum Analysis of the building shown in fig.3 was carried out by considering bare frame; open first storey frame and frame strengthened using several strengthening strategies like fully infilled frame, diagonal bracings in open storey, diagonal bracings in alternate bays, shear walls (fig.4).
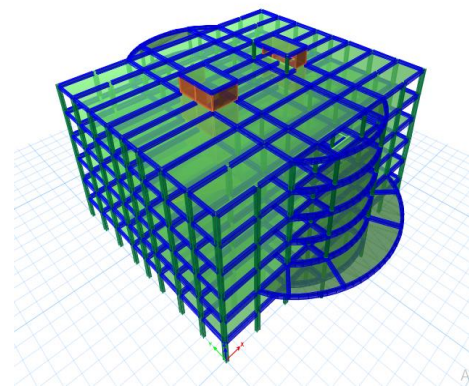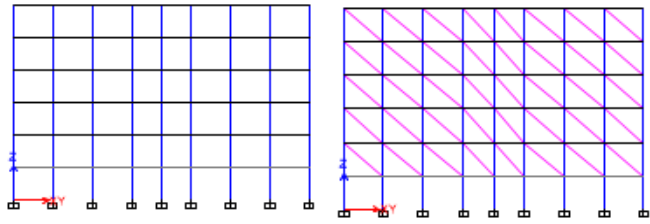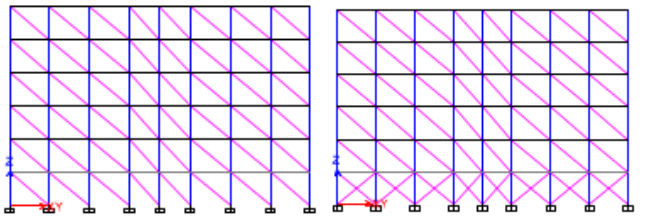

Fig.3. Building considered for the analysis
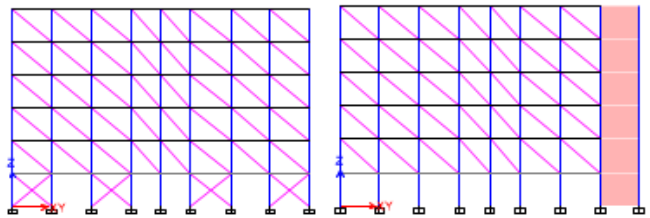
Model 1: Bare Frame   Model 2: Open first storey

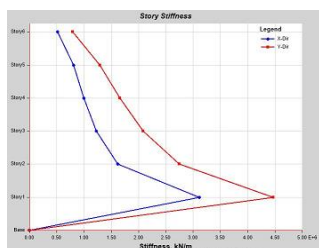Model 3: Fully infilled   Model 4: Diagonal bracing

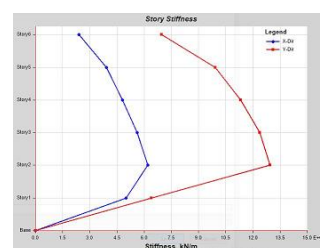Model 5: Alternate bracings   Model 6: Shear wall

Fig.4. Strengthening methods
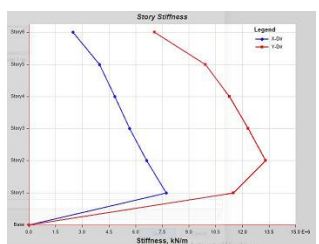
3. RESULTS

Plots showing stiffness of various stories for the different strengthening methods considered for the building are shown in fig.5
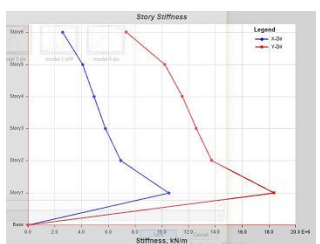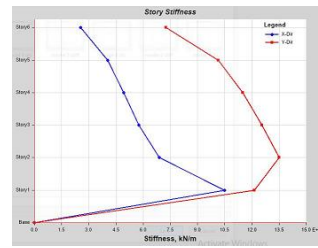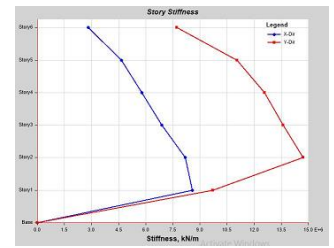

Plot 1 for model 1   Plot 2 for model 2

Plot 3 for model 3   Plot 4 for model 4

Plot 6 for model 5   Plot 6 for model 6

Fig.5. Plots for stiffness

3. CONCLUSION

In the present study, the effectiveness of several strengthening schemes in improving the performance of open first-story RC frames was evaluated using Response Spectrum analyses of typical frames. Various soft storey strengthening strategies like fully infilled frame, diagonal bracings in open storey, diagonal bracings in alternate bays, shear walls were studied. There is a reduction in storey drift by 20% on providing diagonal struts compared to that of bare frame. Strengthening methods done in model 3, 4 and 5 bring down drift to a value 60% less that of bare frame. Stiffness of the building was increased 70% than that of bare frame while a strengthening strategy was adopted. Diagonal bracings give maximum stiffness for the soft storey than other methods. Infill walls and alternate diagonal bracings give satisfactory results and provision of infill walls seems to an economical mitigation method for soft storey effects.

REFERENCES

[1] Hemant B. Kaushik1; Durgesh C. Rai2; and Sudhir K. Jain,(2009) M.ASCE. Effectiveness of Some Strengthening Options for Masonry-Infilled RC Frames with Open First Story.

[2] Bureau of Indian Standards _BIS_. _2016_. "Indian standard criteria for earthquake resistant design of structures. Part 1: General provisions and buildings." IS 1893, Fifth Revision, New Delhi, India.

[3] Das, D., and Murty, C. V. R. (2004). "Brick masonry infills in seismic design of RC framed buildings. Part 2: Behavior." Indian Concr. J.,78/8/, 31–38. R.

[4] Kaushik, H. B., Rai, D. C., and Jain, S. K. ꞏ2006ꞏ. "Code approaches to seismic design of masonry infilled reinforced concrete frames: A state of-the-art review." Earthquake Spectra, 22 4 , 961–983.