Seismic Retrofitting of Building with Soft Storey and Floating Column

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Abstract - *Open ground storey along with the floating columns has been a peculiar feature in the latest multi-storey buildings in India. These features are hugely in admissible in the buildings which are built in earthquake prone areas. In this report, after understanding the behavior of buildings in earthquakes, why, when, where and how seismic retrofitting is done, has been studied. In addition, various local and global deficiencies in a building, along with their retrofit strategies, have also been studied. Further, a study is performed on an example building with open ground storey and floating columns to highlight the importance of their presence in the seismic analysis using program in ETABs. The analysis is done with Equivalent Static Analysis and Response Spectrum Analysis, as per IS:1893-2002. Various features of lateral stiffness strengthening system, namely lateral bracings, shear walls, increasing the column size in the soft ground storey and their combinations, and are proposed to reduce the stiffness irregularity and discontinuity in the load path incorporated by the soft ground storey and the floating columns respectively. Also, it is inspected that the shear walls are most impressive when used as one long structural wall instead of two short walls having separated by the interrelated beams, and properly placed at the periphery of the buildings to avoid the torsion. It is also noticed that the Chevron braces are most productive when placed under the floating columns to make the force transfer less horizontal.*

***Key Words*: Open Ground Storey, Floating Column, Shear Walls, Braces.**

1. INTRODUCTION

Casualties caused due to the recent earthquakes have unfolded the vulnerability of the Indian buildings. Most of the engineered constructions, such as multi-storied apartments are lacking the very basic features which are required for the resisting earthquakes. This may be because of the lack of awareness of earth quake resistant design and necessary requirements of the Indian codes. Nowadays, especially after the desolating Nepal earthquake 25 April 2015, there has been a mutual effort throughout India to provide more awareness, especially in practice and education, with respect to earthquake resistant design of structures.

Most of the existing buildings have revealed to deficit observance with the current practice codes, particularly with respect to seismic resistance. This is because of the up-gradation of the seismic code (IS:1893 Part 1-2002). Also the properly designed buildings which were constructed in the past, are lacking the earthquake resistance and the requirements of design codes, such as IS:4326-1993 and IS:13920-1993.The extent of seismic vulnerability can be verified only after a genuine evaluation of the structure is attempted. Depending on this evaluation, retrofitting of the vulnerable buildings can be started. The Seismic retrofitting can be done in different ways and to various extents. The purpose should be to certify that the building takes all the damage, but does not collapse when severe earthquake occurs. Seismic retrofitting of a building usually affects the functionality and use during the evaluation and further strengthening. The procedure of believing the users on the importance and necessity for retrofit is also very difficult. Thus, before a project is begun, the aim and procedure of the retrofitting have to be kept in mind.

II METHODOLOGY

Modeling of frame structure-

Modeling of structure is done in standard software ETAB which is based on finite element method. the space frame of multi-storey building is prepared considering special moment resisting frame. Column base are assigned as fixed support, column and beam are model as line element, slab and shear wall are area section but are assigned as membrane.

Model-1: A multistory frame building is taken into consideration. Building having a RCC members like slab, beams, and columns. Building having soft storey at ground floor, also floating columns at 1st floor level.

Model 2: Building model similar as 1st model with increasing size of column of the soft storey.

Model 3: Building model similar as 1st model with steel bracings (cross bracings) at perimeter of the soft storey.

Model 4: Building model similar as 1st model with rcc shear wall at corners of the soft storey.

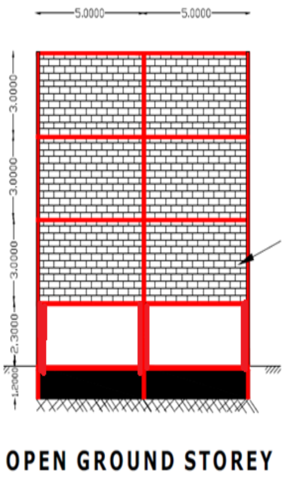

Fig1- model 1

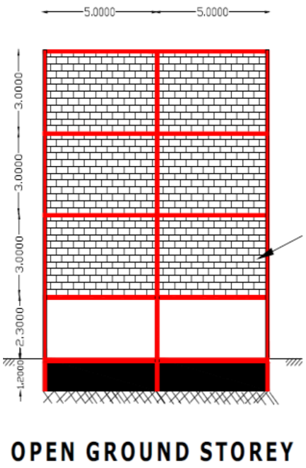

Fig2- model 2

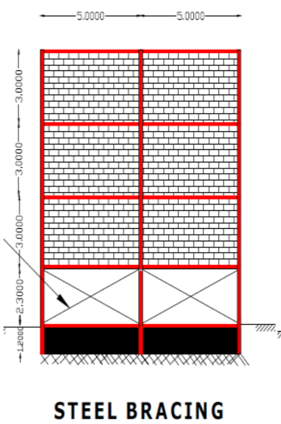

Fig3 – model 3

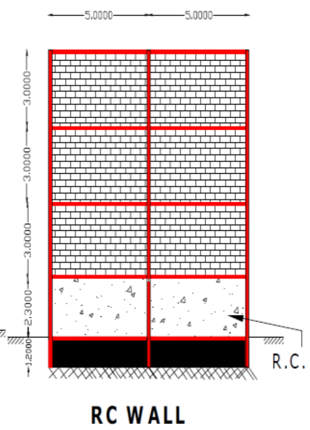

Fig4- model 4

Details of multistory frame building are as follows-

Storey of building: G+ 5 storey

Use of building: commercial

Frame type: Special moment resisting frame structure

Floor to floor height : 3 m

Seismic zone: Zone III

Soil type: Medium soil (Type II)

Shear wall: 230 mm thick

Steel bracings; steel cross bracings (ISMB200).

Basic load cases used for analysis-

Table -1: Load Cases

SR.NO	Load cases	Load
1	Dead load	Gravity
2	Live load	Gravity
3	Super imposed DL	Gravity
4	EQX	IS 1893:2002
5	EQY	IS 1893:2002

Load consideration-

Live load: 3 KN/m^2

Live load on stair: 4 KN/m^2

Super imposed load: 2KN/m^2

Brick wall load (230mm thk.): 13 KN/m

Load combination used as per IS1893 (Part 1):2002 clause6.3.1.2, the following load cases have to be consider for analysis

a) 1.5 (DL + IL)

b) 1.2 (DL ± IL ± EL)

c) 1.5 (DL ± EL)

d) 0.9 DL ± 1.5 EL

Section properties -

Preliminary section properties are taken into consideration while modeling the structure, section properties of beam, column and shear walls are as follows.

Beam in X-direction : 230 x 525 mm

Beam in Y-direction : 230 x 525 mm

Column : 230 x 525 mm

Retrofitted column : 230 x 750 mm

RCC slab : 150 mm thick

RCC shear wall : 230 mm thick

Earthquake zone : III

Size of steel bracing : ISMB200

III SEISMIC ANALYSIS OF BUILDING-

The recent increase in the speed of computers has made it practical to run many time history analyses in a short period of time. In addition, it is now possible to run design checks as a function of time, which produces superior results, since each member is designed by the response spectrum method.

IV RESULTS AND DISSCUSION

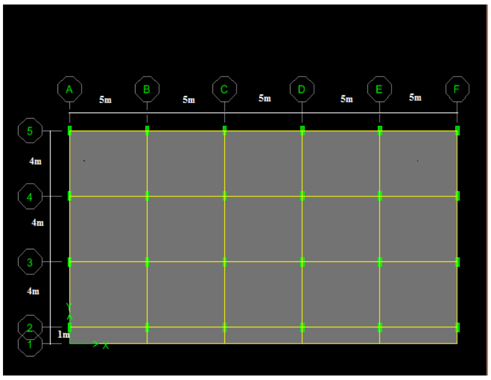

Fig5-model of structure1

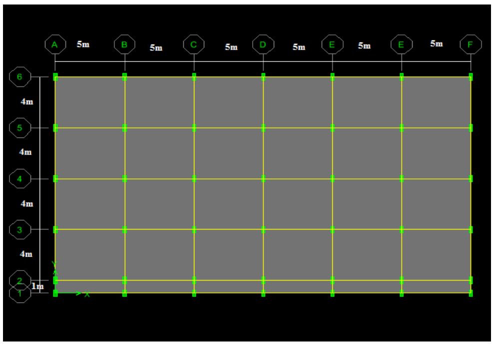

Fig6-model of structure2

1. Story Shear

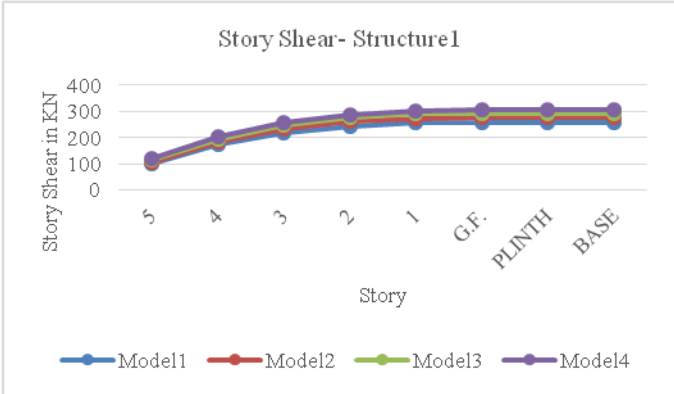

Fig7-Story Shear (KN)

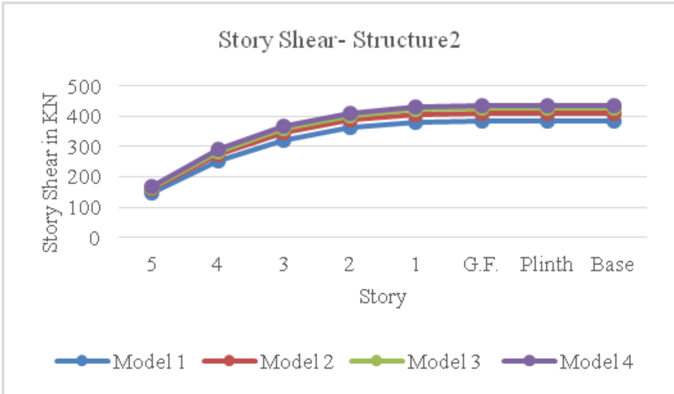

Fig8-Story Shear (KN)

G+5 building without retrofit, base shear obtained from earthquake analysis is less than that obtained from retrofit structures.

2. Story Displacement

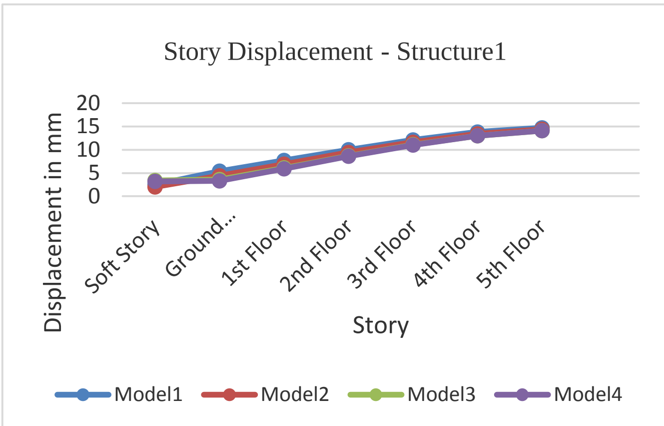

Fig9-story displacement (in mm)

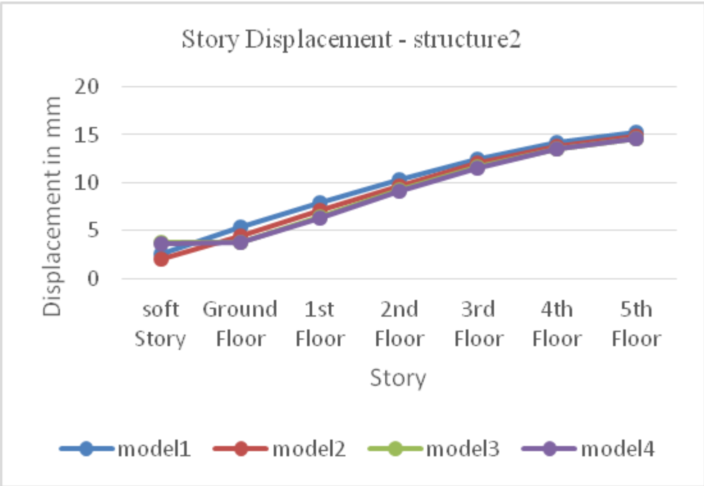

Fig10-Story Displacement (in mm),

The displacement of without shear wall building is more, and it is not feasible for high rise structure. Displacement can be control by using various retrofitting methods.

3. Story Drift

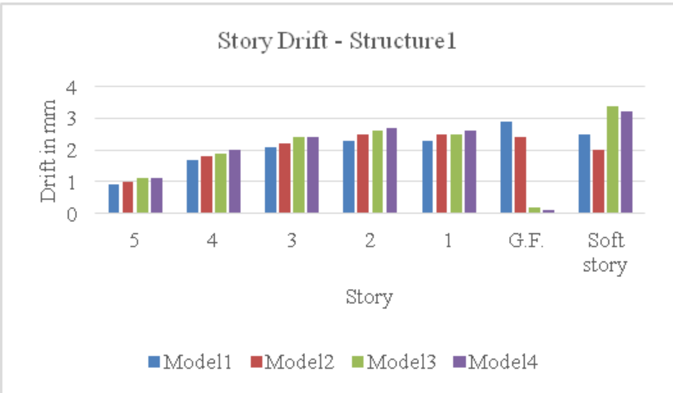

Fig11-Story Drift

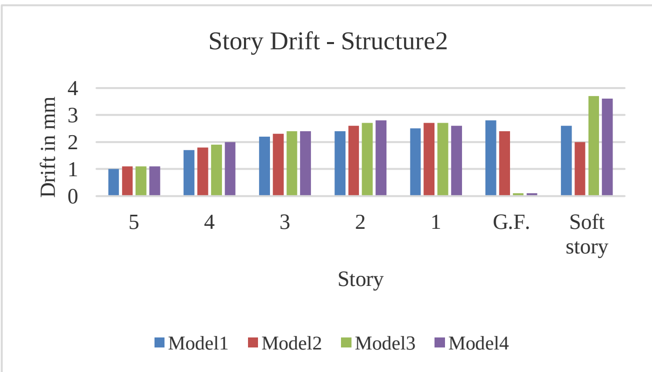

Fig12-Story Drift

As per IS 1893(part1): 2002 (cl 7.11.1) storey shall not exceed 0.004 times of story height. In this study maximum story height is 3m and as per IS recommendation allowable story drift is 7.2mm.

4.Time Period

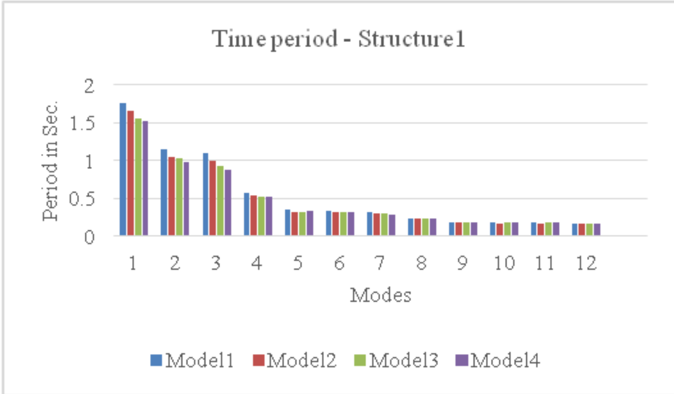

Fig13-Time Period

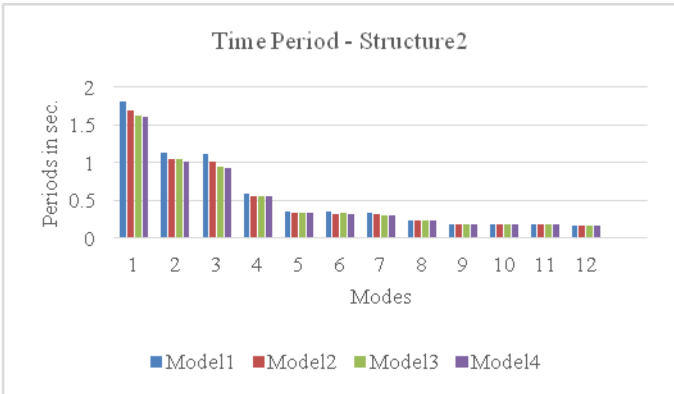

Fig14-Time Period

Time period of building is more it means the structural damage of the building is minimum. But Deflection is more, so we can control by using various position of shear wall in structure.

V. CONCLUSION

Story displacement of 1st structure model 2 is 2 mm at soft story which is lesser than the other models. For same structure the ground floor displacement is less for shear wall retrofit structure which is 3.3mm at top of the retrofit.
Story displacement of the 2nd structure for model 2 is also 2mm at bottom of the soft story and for shear wall retrofit it is 3.7mm at the top of retrofit.
So that shear wall retrofit is the best method of retrofit the soft story which also reduce the displacement of the whole structure.

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