ISSN 2395-695X (Print)
ISSN 2395-695X (Online)

International Journal of Advanced Research in Biology Engineering Science and Technology (IJARBEST)
Vol. 2, Issue 4, April 2016

SEISMIC ANALYSIS AND RETROFITTING OF R.C.C STRUCTURE

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ABSTRACT

Seismic Analysis is a part of structural analysis and it deals with the calculation of the response of a building structure to earthquakes. Most losses of lives in the earthquakes in developing countries have occurred due to collapse of buildings. These buildings are mostly non-engineered. However, not designed and constructed to meet the seismic requirements. In many of the collapsed buildings during the past earthquakes, several of them has open ground storey utilized for parking, garage and various utilites. so we have to strengthen or retrofit the ground storey to resist the seismic forces in an effective manner.

This project is aimed to provide a brief presentation about earthquake resistant design and the methodology about seismic evaluation and rehabilitation of existing structures. It also provides certain aspects of computer software modeling against seismic loads and shows the necessity of seismic retrofitting.

INTRODUCTION

Earth quake is a sudden shaking of the ground caused by movement of the tectonic plates relative to each other, both in direction and magnitude. This creates horizontal forces in the structures, which is termed as seismic forces. In order to withstand this, the structure has to be designed also for Seismic loads. But in older buildings, even if constructed in compliance with prevailing standards, may not comply with the stringent specifications of the latest standards of IS 1893(Part 1):2002, IS 4326:1993 and IS 13920: 1993.The existing buildings can become seismically deficient since design codes requirements are constantly upgraded due to advancement in engineering knowledge.Hence the existing structures should be made seismic resistant by incorporating various seismic retrofitting techniques to meet the present safety requirements and codal provisions.

SCOPE

Our project is aimed to understand the action of seismic forces on the structure. And analyzing the effect on structures, necessary and effective retrofitting technique is to be proposed.The increase in seismic resistance of the structure after providing the retrofitting measure is calculated by modeling, analyzing the structure in Staad.pro and results has been obtained

SOFT STOREY

Soft storey is the portion of the structure which has lateral stiffness less than 70 percent of that in the storey above or less than 80 percent of the average lateral stiffness of the storey above. This storey is also known as weak storey in which the storey lateral strength is less than 80 percent of that in the storey above. The lateral strength of soft storey is the total strength of all seismic force resisting elements sharing the storey shear in the considered direction.

STRUCTURAL FEATURES

Open ground storey buildings were poor system of design in which sudden drop in stiffness and strength occurs in the ground storey. For architectural purposes, the Stiff masonry wall are not provided in the current design practice, and only bare frames are considered in the design calculations. Hence, the load path is completely misrepresented and the inverted pendulum effect is not captured in the structural design. It makes the ground storey columns under-designed for the actual earthquake effects likely to occur on the building. Such buildings are more flexible and weak in the ground storey, and perform poorly during earthquake shaking.

RETROFIT

Retrofit is the enhancement of the structural capacities of a building that is found to be deficient or vulnerable. Since it is carried out in enhancing the resistance of a vulnerable building to earthquakes, the term seismic retrofit is used. The retrofit is intended to reduce the effect of a future earthquake in the strucuture.

Seismic retrofit can effectively raise the performance of a building against earthquakes to a desired level, and even to satisfy the requirements of an upgraded seismic design code.

RETROFITTING TECHNIQUES

Structural or Global retrofitting

when the entire structural lateral load resisting system is deemed to be deficient, Structural level retrofitting is applied. Common approaches in this regard are employed to increase stiffness and strength with limited ductility.

Member or local retrofitting

Member or local retrofitting deals with an increase of the components with adequate capacities to satisfy their specific limit states.

GLOBAL	LOCAL
1.Adding shear wall	1.Jacketing of beams
2. Adding infill wall	2.Jacketing of columns
3.Adding bracing	3.Jacketing of beam – column joints
4.Adding wing wall/ buttresses	4.Strengthening individual footings
5.Wall thickening	
6.Mass reduction	
7.Supplemental damping and base isolation	

Table-1- Global and local retrofitting

TECHNIQUES USED TO RESIST EARTHQUAKE

The provision of Infill walls and Bracing without affecting parking and aesthetic appearance can be used to avoid the damages and collapse of building.

LOAD COMBINATIONS

As per IS 1893 (Part 1) : 2002 clause 6.3.1.2, In the limit state design of reinforced and pre-stressed concrete structures, the following load combinations shall be accounted for:

1. 1.5 (DL + LL)
2. 1.2 (DL + LL + EL)
3. 1.2 (DL + LL – EL)
4. 1.5 (DL ± EL)
5. 0.9 DL ±1.5 EL

ANALYSIS

Preliminary Data

Type of Structure =Apartment building

Zone = III

Number of Stories = G+4

Ground Floor Height = 2.95m

1 to 4th floors height = 3.15m

Material Properties	
Grade of concrete	M20
Grade of steel	Fe 415
Density of reinforced concrete	25 kN/m3
Density of brick masonry	20 kN/m3
Member Properties	
Thickness of slab	0.15 m
Beam size	0.23 x 0.4 m
Column size	0.23 x 0.45 m
Thickness of wall	0.23 m
Dead Load Intensities	
Floor finishes	1.0 kN/m2
Live Load Intensities	
Floor	2.0 kN/m2
Roof	1.5 kN/m2
Earthquake LL on slab as per Cl. 7.3.1 and 7.3.2 of IS 1893(part 1)-2002	
Roof	0 kN/m2
Floor	0.25 x 2.0 = 0.5kN/m2

Table-2- Existing building details

STAAD Pro. ANALYSIS

STATIC ANALYSIS

Load combination for 1.5DL + 1.5EL

Storey height in m	Load Combination	Average displacement in mm		Drift value in Mm
		X dir	Z dir	
2.95	1.5DL + 1.5EL	1.28	3.36	1.28
6.10	1.5DL + 1.5EL	3.41	8.01	2.13
9.25	1.5DL + 1.5EL	5.50	12.23	2.09
12.4	1.5DL + 1.5EL	7.25	15.63	1.73
15.55	1.5DL + 1.5EL	8.42	17.56	1.17
19.55	1.5DL + 1.5EL	10.01	17.82	1.62

Table 3- Storey drift for ordinary building frame

Storey height m	Load Combination	Avg displacement mm		Drift Mm
		X dir	Z dir	
2.95	1.5DL + 1.5EL	0.20	0.53	0.2
6.10	1.5DL + 1.5EL	2.1	5.1	1.89
9.25	1.5DL + 1.5EL	4.29	9.7	2.19
12.4	1.5DL + 1.5EL	6.14	13.4	1.84
15.55	1.5DL + 1.5EL	7.38	15.44	1.24
19.55	1.5DL + 1.5EL	9.09	15.86	1.71

Table 4- Storey drift for building frame with brickwall

Storey height m	Load Combination	Avg displacement in mm		Drift mm
		X dir	Z dir	
2.95	1.5DL + 1.5EL	0.45	0.98	0.45
6.10	1.5DL + 1.5EL	2.35	5.36	1.90
9.25	1.5DL + 1.5EL	4.42	9.61	2.07
12.4	1.5DL + 1.5EL	6.16	12.99	1.73
15.55	1.5DL + 1.5EL	7.33	14.92	1.17
19.55	1.5DL + 1.5EL	8.95	15.3	1.62

Table 5 - Storey drift for building frame with bracing

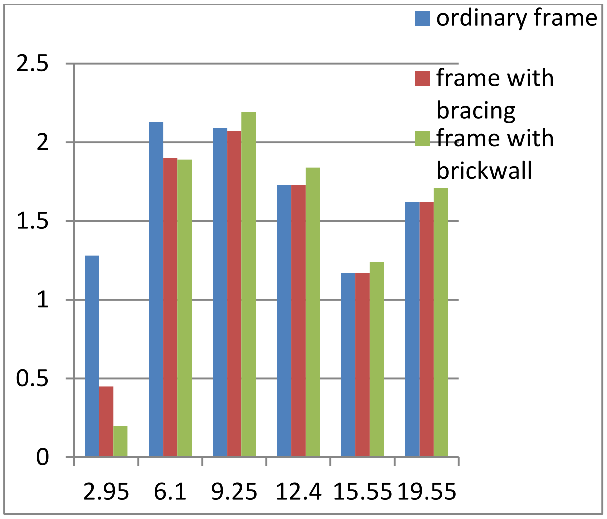

Fig. 1 storey drift value comparison- 1.5DL + 1.5EL

DYNAMIC ANALYSIS (RESPONSE SPECTRUM METHOD)

For combination of loads

Storey height m	Drift value in mm	
	X dir	Z dir
2.95	5.16	0.63
6.10	8.06	0.84
9.25	7.06	0.69
12.4	4.97	0.49
15.55	2.65	0.25
19.55	4.01	1.59

Table -6 Storey drift for ordinary building frame

Table -7 Drift for building with brick wall

Storey height in m	Drift value in mm	
	X direction	Z direction
2.95	1.79	0.20
6.10	7.23	0.74
9.25	7.50	0.93
12.4	5.89	0.7
15.55	3.78	0.45
19.55	3.41	1.91

Storey height in m	Drift value in mm	
	X direction	Z direction
2.95	0.87	0.2
6.10	7.05	0.59
9.25	7.55	0.86
12.4	5.33	0.62
15.55	2.61	0.29
19.55	5.64	1.49

Table 8 drift for building frame with bracing

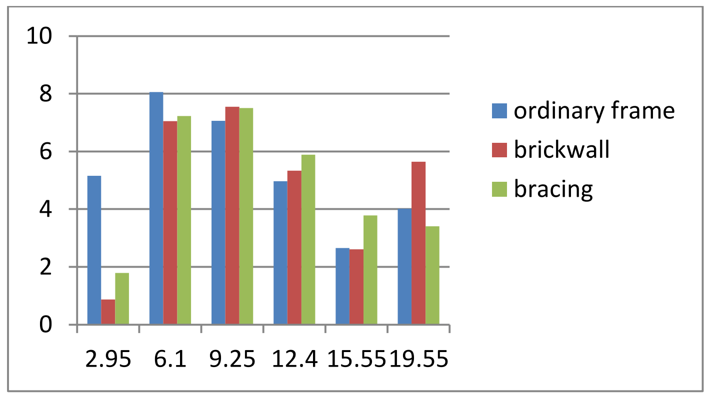

Fig 2 comparison of results

RESULTS AND DISCUSSION

The analysis of G+4 open ground storey reinforced concrete frame building with Bracing and Brick wall model using STAAD Pro for Seismic coefficient method and Manual analysis also done. The Dynamic analysis of the building frame for the load combination is done using response spectrum method in STAAD Pro software. From the analysis, the results of different types of load combinations for the retrofitted frame and ordinary frame models are compared. The comparison of these results shows X bracing system and Brick wall provided frame are effective in terms of storey drift.

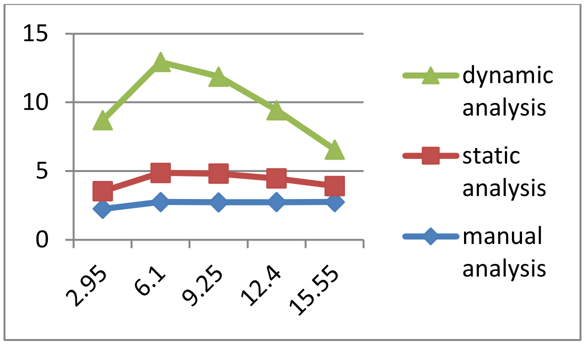

Fig. 3 comparison of results for ordinary frame

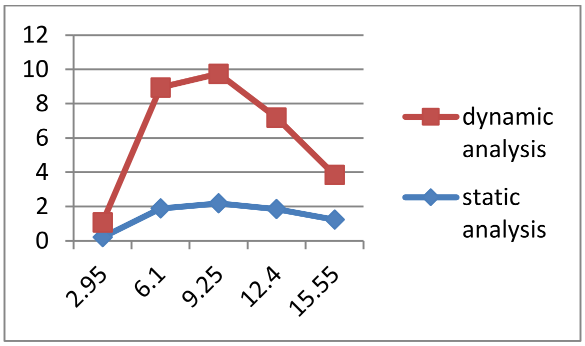

Fig 4 comparison of results for building frame with brick wall

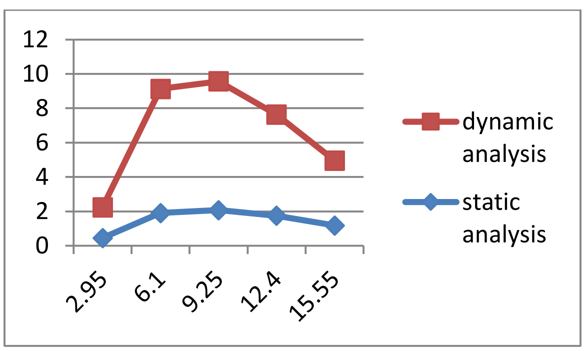

Fig 5 comparison of results for building frame with bracing

CONCLUSION

The analysis of G+ 4 Rcc framed structure with soft storey retrofitted by Bracing and Brick wall is done using STAAD Pro. From the Static analysis, the percentage of reduction in Storey drift for Frame with brick wall is 84% as compared to the ordinary frame.

From the Dynamic analysis, the percentage of reduction in Storey drift for Frame with brick wall is 83% as compared to the ordinary frame.

Hence, For retrofitting the existing building, X bracing and Brick wall techniques are effective to reduce storey drift value.

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