

Response Spectrum Analysis of RC Buildings with and without Rigid Slab Modelling

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Abstract— RC building having reinforced concrete slabs are considered to be rigid in analysis. The consideration of rigid slab helps in simplifying analysis procedure. Such building is termed as shear building as lateral forces due to earthquake is considered in analysis only for column shear. In present study, comparison of results for two such RC buildings with and without rigid slab modeling is performed. The results are for bending moment, lateral displacement and shear forces.

Key words: Earthquake, RC Building, Response Spectrum, Rigid Slab

I. INTRODUCTION

The effect of floor rigidity in steel and reinforced concrete building has been investigated by many researchers.

The paper [1] investigated the analysis result of rigid and flexible floor buildings. In this paper, finite-element technique is employed to investigate the buildings with and while not shear walls.

From variety of response-spectrum analyses, the rigid-floor model was found to be correct enough for normal and nonregular buildings while not shear walls.

However, the distinction between the rigid-floor and flexible-floor analyses may be giant for the buildings with shear walls. Thus, a slip-up formula is generated exploitation the multivariate analysis of the rigid-floor and flexible-floor analyses from 520 rectangular, U-shaped, and formed buildings. exploitation this formula, one will estimate the error of the structural analysis of a building with shear walls once the rigid-floor assumption is employed.

The supposition of in-plane floor unbending nature, ordinarily utilized as a part of the investigation of strengthened concrete multistory structures subjected to sidelong loads, is inspected by diagnostically examining 37 structures [2].

Despite the fact that an unbending floor diaphragm is a decent supposition for seismic examination of most structures, a few building designs may display noteworthy adaptability in floor diaphragm. Be that as it may, the issue of static seismic examination of such structures for torsional building [3].

It is shown in [4] that for long limited structures with indistinguishable edges and indistinguishable dividers, the modes that include in-plane floor distortions are not energized by tremor ground movement. Thus, the floors in such structures can be dealt with as unbending in their own plane [4].

The reference [5] shows the consequences of a logical work tended to comprehend the impacts of in-plane floor adaptability on torsionally lopsided (TU) frameworks subjected to bidirectional firm-soil seismic tremor records. The study utilizes an auxiliary framework.

Building structures are normally composed utilizing the presumption that the floor frameworks serve as

an unbending diaphragm between the vertical components of the horizontal load-opposing framework. Nonetheless, long-floor traverse structures with edge parallel load-opposing frameworks have diaphragms which carry on adaptably. The dynamic conduct of such structures is unlike the conduct expected of normal structures. This distinction can prompt to surprising power and float designs. In the event that constrain levels are adequately under-evaluated, inelastic diaphragm conduct can happen, worsening the impacts of diaphragm adaptability. Such reaction may prompt to a non-pliable diaphragm disappointment or basic insecurity because of high float requests in the gravity framework [6].

The impact of floor adaptability on the seismic reaction of building structures is examined through correlation of the registered seismic reaction for structures with adaptable diaphragms and partner structures with inflexible diaphragms. Contextual investigations of three existing structures with adaptable diaphragms and closely resembling frameworks with inflexible diaphragms are introduced to represent these distinctions. Every building was subjected to the 1989 Loma Prieta Earthquake. The structures were: (1) A two-story firehouse in Gilroy with unreinforced stone work dividers; (2) a two-story timber office working in Palo Alto with grouted and fortified earth unit brick work shear dividers; and (3) an eight-story inn in Oakland with unreinforced mud unit workmanship and strengthened solid shear dividers. The investigative studies demonstrate that, sometimes, diaphragm and shear-divider increasing speeds can increment with the adaptability of the diaphragm. Torsional strengths can lessen significantly as diaphragm adaptability increments. Further, inexact expressions endorsed in current seismic codes can think little of the time of vibration of frameworks with adaptable diaphragm [7].

II. BUILDING MODEL FOR STUDY

For present study, an RC building of regular symmetric plan of total 24.6×15 m is selected. The plan is shown in Fig. 1. Two different models are then modeled - G+3 and G+7 building varying with number of floors. Former is low rise and latter is medium rise building. The elevations of these buildings are shown in Fig. 2 and Fig. 3. These buildings are designed according to IS 456:2000 [8] and are modeled with rigid and flexible slabs in computer Staad.pro.

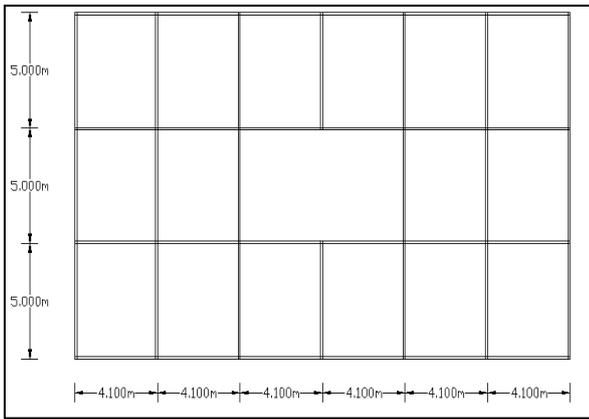


Fig. 1: Plan of building used in this study

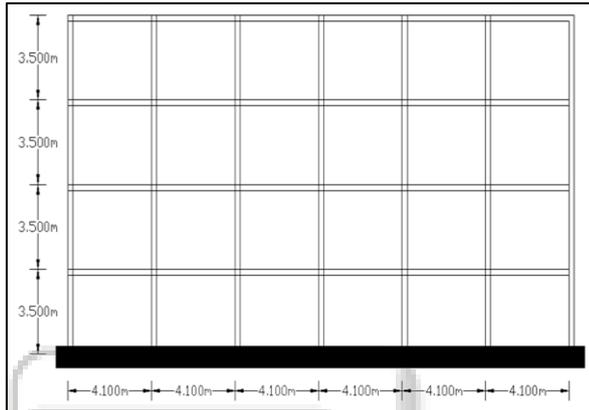


Fig. 2: G+3 storey building elevation model

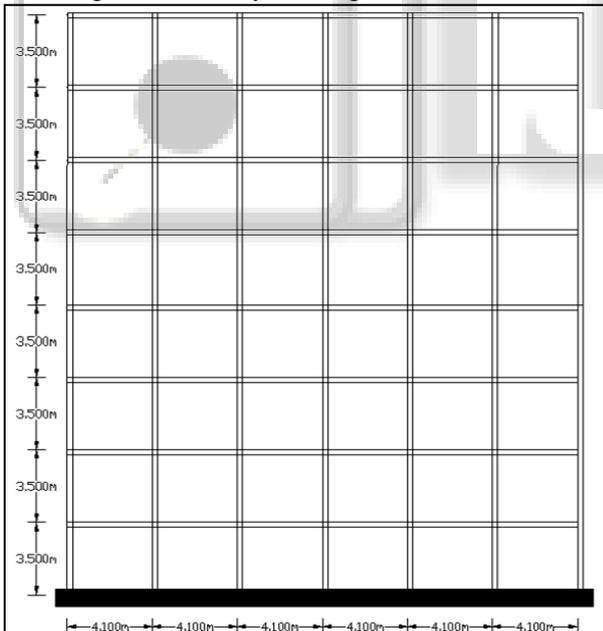


Fig. 3: G+7 storey building elevation model

III. RESPONSE SPECTRUM ANALYSIS

For this study, response spectrum method of seismic analysis is chosen.

The procedure of response spectrum is as per IS 1893:2002 [10]. The response spectrum used for this purpose is shown in Fig. 4. The combination of modal response is done through Complete quadratic combination (CQC).

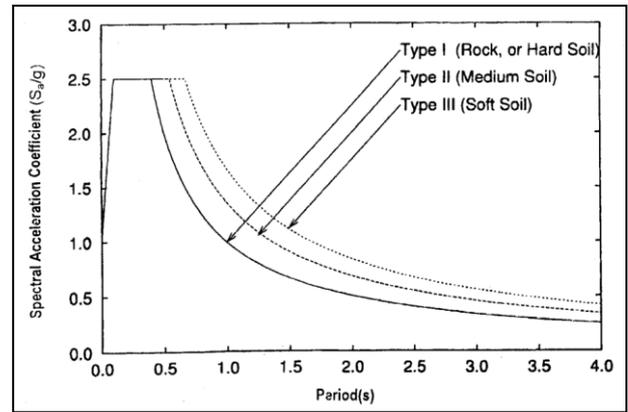


Fig. 4: Response spectrum from IS 1893:2002 [10]

IV. RESULTS AND DISCUSSIONS

After analyzing the building models in Staad.Pro [9], the results obtained are given in this section. The main results of analysis are usually – Bending moments, Lateral displacement and Shear forces, hence, these are shown. The response results are given for each storey and plotted in graphs to obtain comparison.

In here, Rigid and Flexible correspond to building models with rigid floor and flexible floor respectively.

A. Bending Moments

The bending moments for buildings are given here for each storey. These are as follows.

1) G+3 Building

Bending moments for G+3 building is shown in Table 1 and are plotted in Fig. 5. These show reduction in response for flexible floor building.

Storey	Rigid	Flexible
4	274.9318	211.5439
3	151.3828	118.3288
2	128.9591	106.0665
1	84.87753	70.37297

Table 1: Bending moments for G+3 building

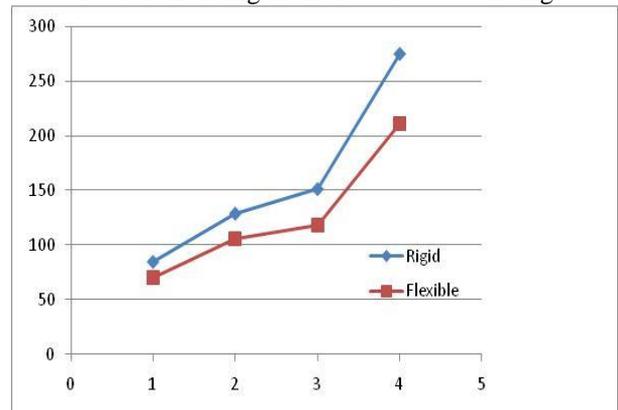


Fig. 5: Plot of bending moment variation for G+3 building

2) G+7 Building

Bending moments for G+7 building is shown in Table 2 and are plotted in Fig. 6. These show reduction in response for flexible floor building but more pronounced than G+3.

Storey	Rigid (kN)	Flexible (kN)
8	473.893	372.6519
7	440.9192	345.7141

6	369.0486	286.376
5	321.6674	250.7249
4	275.3258	220.445
3	198.9474	159.0131
2	138.8746	114.781
1	90.31745	74.23052

Table 2: Bending moment for G+7 building

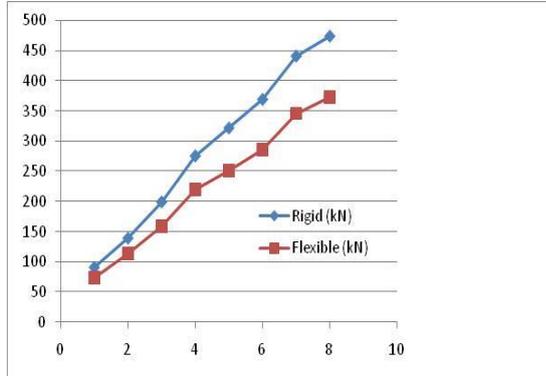


Fig. 6: Plot of bending moment variation for G+7 building

B. Lateral Displacements

The lateral displacements for buildings are given here for each storey. These are as follows.

1) G+3 Building

Lateral displacement for G+3 building is shown in Table 3 and are plotted in Fig. 7. These show reduction in response for flexible floor building.

Storey	Rigid	Flexible
4	199.5103	162.8274
3	102.2946	85.5789
2	77.1385	61.7306
1	64.6714	58.9634

Table 3: Lateral displacement for G+3 building

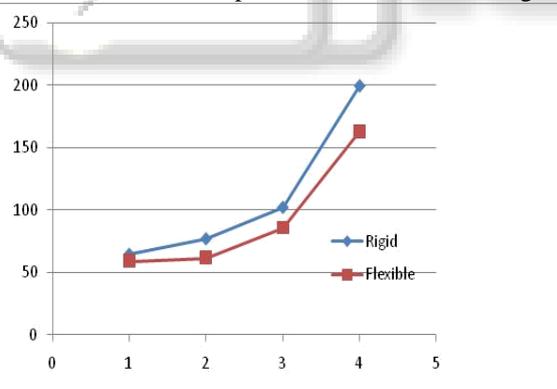


Fig. 7: Plot of lateral displacement variation for G+3 building

2) G+7 Building

Lateral displacement for G+7 building is shown in Table 4 and are plotted in Fig. 8. These show reduction in response for flexible floor building but more pronounced

Storey	Rigid (kN)	Flexible (kN)
8	310.3640	244.6396
7	294.4280	231.0211
6	245.6174	189.7301
5	227.6154	182.2663
4	196.9519	154.0774
3	103.6304	89.4849

2	100.8098	81.2142
1	60.9389	53.3803

Table 4: Lateral displacement for G+7 building

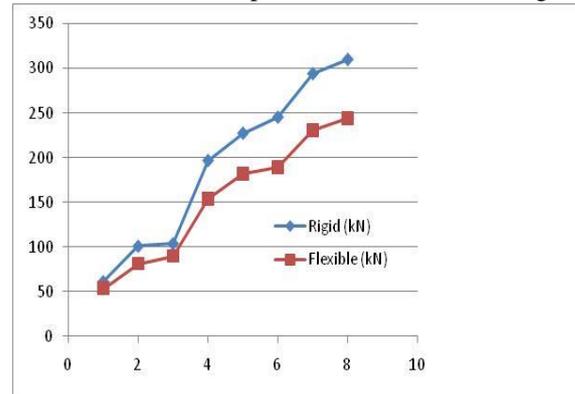


Fig. 8: Plot of lateral displacement variation for G+7 building

C. Shear Forces

The shear forces for buildings are given here for each storey. These are as follows.

1) G+3 Building

Shear forces in columns for G+3 building is shown in Table 5 and are plotted in Fig. 9. These show reduction in response for flexible floor building.

Storey	Rigid	Flexible
4	134.0901	109.4896
3	92.5698	77.8008
2	66.0358	54.9932
1	41.7658	35.5380

Table 5: Shear forces for G+3 building

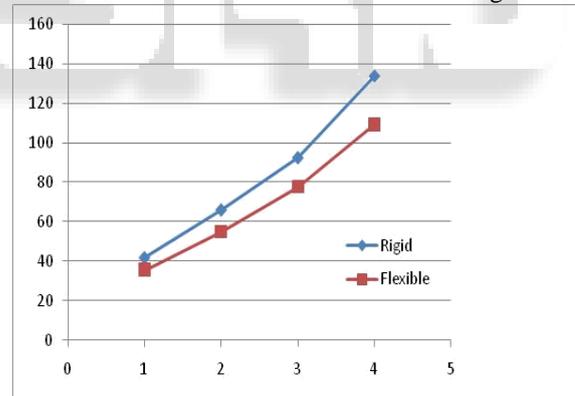


Fig. 9: Plot of shear force variation for G+3 building

2) G+7 Building

Shear forces in columns for G+7 building is shown in Table 6 and are plotted in Fig. 10. These show reduction in response for flexible floor building.

Storey	Rigid (kN)	Flexible (kN)
8	234.5914	183.6559
7	216.1432	175.6711
6	178.1833	138.7802
5	158.0358	127.7530
4	140.2796	117.0933
3	87.9043	68.5477
2	50.7433	45.4305
1	28.7092	27.8970

Table 6: Shear forces for G+7 building

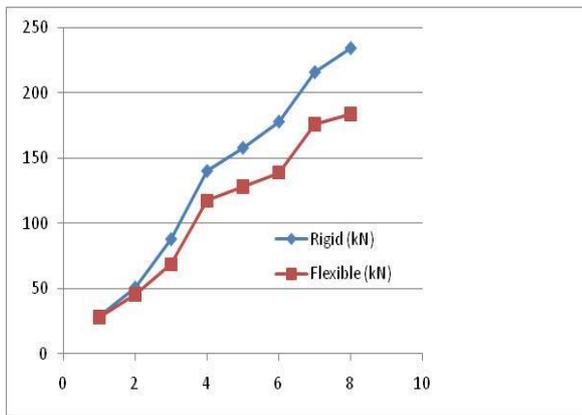


Fig. 10: Plot of shear force variation for G+7 building

V. CONCLUSION

The flexibility or rigidity of slabs affect seismic response of structure. In this study, two different models of RC buildings are modeled with flexible and rigid slab floors. These buildings are analysed for seismic action through response spectrum analysis. The results clearly show that flexibility reduces the response quantities such as bending moment, lateral displacement and shear force.

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