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Seismic Analysis & Design of RCC Building

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Abstract-In India RCC structures are most commonly used in the construction area. Therefore, RCC structures are economical and convenient in all over the India. This paper work describes the seismic analysis and design of RCC building subjected to dead load, live load and earthquake load. For paper work the equivalent static analysis is carried out for multi-storey RCC building is done . The seismic analysis & design of multi-storey RCC building is carried out using Software Computer Aided Design i.e., (STAAD PRO 2007) .The main parameters consider for comparing seismic performance of buildings are bending moment ,shear force ,deflection and axial force. The seismic design of building frame presented in this paper is based on IS:1893:2002and IS:456:2000 .The building consists of four (GF+3)storey. The selection of arbitrary sections has been done following a standard procedure.

Keywords-RCC structure, multi-storey, Seismic Forces

1. INTRODUCTION

In India reinforced concrete structures are most commonly used in construction industry. It has always been a human aspiration to create taller and the taller structures. Development of metro cities in India there is increasing demand in high rise building. The reinforced cement concrete moment resisting frames in filled with unreinforced brick masonry walls are very common in India and in other developing countries. Masonry is a very commonly used material in construction all over the world for the reason that includes accessibility, functionality and cost. RCC structures are very strong and carry maximum forces. RCC structures have long life. After the construction there is no need of maintenance for a long period.

2. SCOPE

Over here the study is done for seismic analysis & design of RCC building subjected to seismic load. The analysis is done for stresses, bending moments, deflections and axial forces as per grid formation methodology.

3. DESIGN PHILOSOPHY

Before we proceed with the actual analysis and design of structure following points are considered -

1. The structural system and type
2. The choice of an open or covered structure
3. The selection of the construction material
4. The location, ground conditions i.e., geography of the area
5. The method which is used
6. The design concept
7. IS codes used

   With the use of proper method, IS code and also all analysis and design done by STAAD PRO.

4. EXPERIMENTAL WORK

Problem considerations:

Design is done for a RCC building for the following data:
Overall length of the building = 15 m
Overall width of the building = 30 m
Spacing of the frame members =5 m
Height of column = 5 m
The building is located in residential area, Akola.
Use concrete of grade M_{20}steel of grade Fe_{415}.
DL & LL are on the assumption basis.

STAAD PRO:2007 Details :

Number of Nodes	80	Highest Node	80
Number of Elements	160	Highest Beam	160

Section Properties

Prop	Section	Area (cm^2)	I_{yy} (cm^4)	I_{zz} (cm^4)	J (cm^4)	Material
1	Rect 0.40x0.35	1.4E 3	143E 3	187E	272E	CO
2	Rect 0.45x0.35	1.57E 3	161E 3	266E	338E	CO

Materials

Mat	Name	E (kN/mm^2)	ν	Density (kg/m^3)	α (1/°K)
3	STEEL	205.00	0.300	7.83E	12E -6
4	ALUMINUM	68.948	0.330	2.71E	23E -6
5	CONCRETE	21.718	0.170	2.4E 3	10E -6

Supports

Node	X (kN/mm)
1	Fixed
2	Fixed
3	Fixed
4	Fixed
21	Fixed
22	Fixed
23	Fixed
24	Fixed
41	Fixed
42	Fixed
43	Fixed
44	Fixed
61	Fixed
62	Fixed
63	Fixed
64	Fixed

5. RESULT AND OBSERVATION

Example was taken under consideration with dimensions and material grade as follows –All the values of constant are calculated using IS:1893:2002 and IS:456:2000.

Design is done for a RCC building for the following data:

Overall length of the building = 15 m

Overall width of the building = 30 m

Spacing of the frame members =5 m

Height of column = 5 m

The building is located in residential area, Akola.

Use concrete of grade M_{20}steel of grade Fe_{415}.

Whole design is done in STAAD PRO Software using IS:456:2000

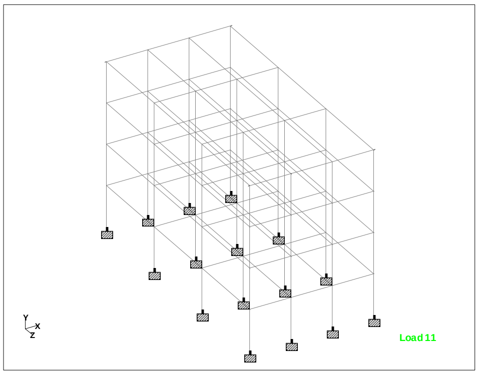
For analysis and design static method is adopted.

In this paper the above example solved and all analysis & design is done.

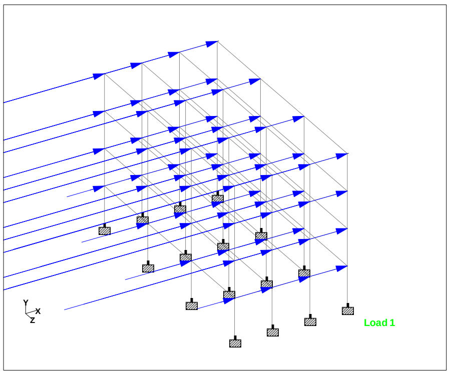
Table shows the results from solving above example.

All the results of analysis and design are obtained using basic load cases and their load combinations with the help of STAAD PRO Software only.

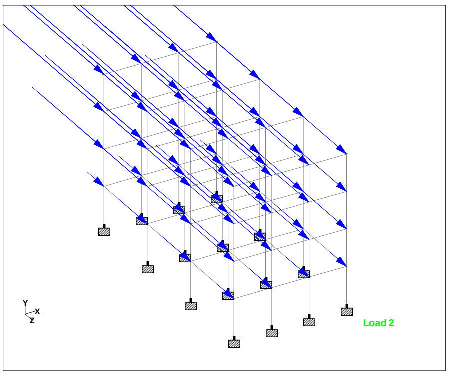
STAAD Model



3D View of RCC Building



EQX



EQZ

Basic Load Cases

Number	Name
1	ELX
2	ELZ
3	DL
4	LL

Combination Load Cases :

Comb.	**Combination L/C Name**	**Primary**	**Primary L/C Name**	**Factor**
5	COMBINATI	3	DL	1.50
		4	LL	1.50
6	COMBINATI	3	DL	1.20
		4	LL	1.20
		1	EQX	1.20
7	COMBINATI	3	DL	1.00
		4	LL	1.00
		1	EQX	-1.20
8	COMBINATI	3	DL	1.20
		4	LL	1.20
		2	EQZ	1.20
9	COMBINATI	3	DL	1.20
		4	LL	1.20
		2	EQZ	-1.20
10	COMBINATI	3	DL	1.50
		1	EQX	1.50
11	COMBINATI	3	DL	1.50
		1	EQX	-1.50
12	COMBINATI	3	DL	1.50
		2	EQZ	1.50
13	COMBINATI	3	DL	1.50
		2	EQZ	-1.50
14	COMBINATI	3	DL	0.90
		1	EQX	1.50
15	COMBINATI	3	DL	0.90
		1	EQX	-1.50
16	COMBINATI	3	DL	0.90
		2	EQZ	1.50
17	COMBINATI	3	DL	0.90
		2	EQZ	-1.50

Beam Displacement Detail Summary

	Beam	**L/C**	**d** (m)	**Resultant** (mm)
Max X	141	10:COMBINATION		43.888
Min X	144	11:COMBINATION		43.889
Max	146	2:EQZ		8.347
Min Y	122	5:COMBINATION		17.835
Max Z	11	12:COMBINATION		54.210
Min Z	95	13:COMBINATION		54.211
Max Rst	126	12:COMBINATION		**55.425**

Beam End Displacement Summary

	Beam	**Node**	**Resultant** (mm)
Max X	38	37	42.668
Min X	40	40	42.669
Max Y	38	37	28.412
Min Y	38	38	3.712
Max Z	10	18	54.111
Min Z	94	78	54.111
Max Rst	10	18	**54.111**

Beam End Force Summary

	Beam	Node	L/C	Axial	Shear		Torsio	Bending	
				Fx (kN)	**Fy** (kN)	**Fz** (kN)	**Mx** (kNm)	**My** (kNm)	**Mz** (kNm)
Max	42	22	5:COM	**1.1E 3**		-	-0.000	2.260	0.359
Min	41	21	1:EQX	-		-	-0.198	0.011	
Max	145	45	5:COM	-			0.000	-	
Min	113	25	5:COM	-	-	-	-0.000	-	
Max	18	6	9:COM				-0.113	-	0.615
Min	102	66	8:COM			-	0.113		0.615
Max	117	9	10:CO	4.182			**0.771**	-	
Min	149	49	10:CO	4.182		-	**-0.771**	4.191	
Max	102	66	8:COM			-	0.113		0.615
Min	18	6	9:COM				-0.113	-	0.615
Max	114	26	8:COM	-	-		0.000	0.166	
Min	43	23	11:CO		-	-	0.150	1.188	-

6. CONCLUSION

In this paper ,for analysis and design purpose the total four frames are considered. Whole analysis and design is done for inner and outer frames. The values of forces are obtained by considering inner & outer frames . For the final results beam end forces i.e., axial forces are taken out. These values of forces are maximum for load combination 1.5(DL+LL) only and for remaining conditions these values are small with including the seismic forces as shown in tables.
Comparative Study of Axial Forces on 1st Outer Frame

BEAM	LOAD COMBINATION		AXIAL FORCE
85	1.5(DL+LL)	Max +ve	N/A
		Max -ve	-3.548
86	1.5(DL+LL)	Max +ve	N/A
		Max -ve	-3.567
87	1.5(DL+LL)	Max +ve	N/A
		Max -ve	-3.548
88	1.5(DL+LL)	Max +ve	0.277
		Max -ve	N/A
89	1.5(DL+LL)	Max +ve	N/A
		Max -ve	-0.063
90	1.5(DL+LL)	Max +ve	0.277
		Max -ve	N/A
91	1.5(DL+LL)	Max +ve	0.242
92	1.5(DL+LL)	Max +ve	0.274
		Max -ve	N/A
93	1.5(DL+LL)	Max +ve	0.242
		Max -ve	N/A
94	1.5(DL+LL)	Max +ve	7.386
		Max -ve	N/A
95	1.5(DL+LL)	Max +ve	7.486
		Max -ve	N/A
96	1.5(DL+LL)	Max +ve	7.386
		Max -ve	N/A

Comparative Study of Axial Forces on Last Outer Frame

BEAM	LOAD COMBINATION		AXIAL FORCE
1	1.5(DL+LL)	Max +ve	N/A
		Max -ve	-3.548
2	1.5(DL+LL)	Max +ve	N/A
		Max -ve	-3.567
3	1.5(DL+LL)	Max +ve	N/A
		Max -ve	-3.548
4	1.5(DL+LL)	Max +ve	0.277
		Max -ve	N/A
5	1.5(DL+LL)	Max +ve	N/A
		Max -ve	-0.063
6	1.5(DL+LL)	Max +ve	0.277
		Max -ve	N/A
7	1.5(DL+LL)	Max +ve	0.242
		Max -ve	N/A
8	1.5(DL+LL)	Max +ve	0.274
		Max -ve	N/A
9	1.5(DL+LL)	Max +ve	0.242
		Max -ve	N/A
10	1.5(DL+LL)	Max +ve	7.386
		Max -ve	N/A
11	1.5(DL+LL)	Max +ve	7.486
		Max -ve	N/A
12	1.5(DL+LL)	Max +ve	7.386

Comparative Study of Axial Forces on 1ST Inner Frame

BEAM	LOAD COMBINATION		AXIAL FORCE
57	1.5(DL+LL)	Max +ve	N/A
		Max -ve	-3.563
58	1.5(DL+LL)	Max +ve	N/A
		Max -ve	-3.582
59	1.5(DL+LL)	Max +ve	N/A
		Max -ve	-3.563
60	1.5(DL+LL)	Max +ve	0.355
		Max -ve	N/A
61	1.5(DL+LL)	Max +ve	0.02
		Max -ve	N/A
62	1.5(DL+LL)	Max +ve	0.355
		Max -ve	N/A
63	1.5(DL+LL)	Max +ve	N/A
		Max -ve	-0.247
64	1.5(DL+LL)	Max +ve	N/A
		Max -ve	-0.341
65	1.5(DL+LL)	Max +ve	N/A
		Max -ve	-0.247
66	1.5(DL+LL)	Max +ve	7.811
		Max -ve	N/A
67	1.5(DL+LL)	Max +ve	8.034
		Max -ve	N/A
68	1.5(DL+LL)	Max +ve	7.811

Comparative Study of Axial Forces on Last Inner Frame

BEAM	LOAD COMBINATION		AXIAL FORCE
29	1.5(DL+LL)	Max +ve	N/A
		Max -ve	-3.563
30	1.5(DL+LL)	Max +ve	N/A
		Max -ve	-3.582
31	1.5(DL+LL)	Max +ve	N/A
		Max -ve	-3.563
32	1.5(DL+LL)	Max +ve	0.355
		Max -ve	N/A
33	1.5(DL+LL)	Max +ve	0.02
		Max -ve	N/A
34	1.5(DL+LL)	Max +ve	0.355
		Max -ve	N/A
35	1.5(DL+LL)	Max +ve	N/A
		Max -ve	-0.247
36	1.5(DL+LL)	Max +ve	N/A
		Max -ve	-0.341
37	1.5(DL+LL)	Max +ve	N/A
		Max -ve	-0.247
38	1.5(DL+LL)	Max +ve	7.811
		Max -ve	N/A

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