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DESIGN AND ANALYSIS OF EARTHQUAKE BUILDING C+G+7 USING STAAD.PRO

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ABSTRACT: The main steps of any building construction and planning is drafting, analyzing and designing the building. In the present days of improving science and technology, analyzing and designing of a building has been made easy by using STAAD.PRO software. STAAD.PRO software helps civil engineers to make their work easy and decreases time necessary for planning. The project going to be done is design of a multistory building which is going to be used as a residential. The building plan has been drafted using the AutoCAD software by the requirement and available area. The super structure i.e. the building frame has been analyzed and designed using the STAAD.PRO software. In the present project G+5 building consider to analysis and design for both gravity and lateral (wind and earth quake) loads as per Indian standards. By using the software building can be analyzed and we can check for any failures in the analysis and redesign them, so that we can prevent failures after construction. By using the output building can be constructed according to the design.

Keywords: Building, Wind and Earth quake, STAAD.PRO.

INTRODUCTION

General

A building is a man-made structure with a roof and walls standing more or less permanently in one place. Buildings come in a variety of shapes, sizes and functions, and have been adapted throughout history for a wide number of factors, from building materials available, to weather conditions, to land prices, ground conditions, specific uses and aesthetic reasons. To better understand the term building compares the list of structures. Buildings serve several needs of society – primarily as shelter from weather, security, living space, privacy, to store belongings, and to comfortably live and work. A building as a shelter represents a physical division of the human habitat (a place of comfort and safety) and the outside (a place that at times may be harsh and harmful). Ever since the first cave paintings, buildings have also become objects or canvases of artistic expression. In recent years, interest in sustainable planning and building practices has also become an intentional part of the design process of many new buildings. A slab is a flat two-dimensional planar structural element having thickness small compared to its other two dimensions. It provides a working flat surface or a covering shelter in buildings. It primarily transfers the load by bending in one or two directions. Reinforced concrete slabs are used in floors, roofs and walls of buildings and as the decks of bridges. The floor system of a structure can takes many forms such as in situ solid slab, ribbed slab or pre-cast units. Slabs may be supported on monolithic concrete beam, steel beams, walls or directly over the columns. Concrete slab behaves primarily as flexural members and the design is similar to that of beams.

LATERAL LOAD RESISTING UNITS

In general, a shear wall building, and for that matter any other structure, is designed to satisfy in basic structural and functioning requirements. The structural requirements are:

1. Strength
2. Stiffness
3. Stability

STAAD.PRO

STAAD or (STAAD.Pro) is a structural analysis and design computer program originally developed by Research Engineers International in Yorba Linda, CA. In late 2005, Research Engineer International was bought by Bentley Systems. It can make use of various forms of analysis from the traditional 1st order static analysis, 2nd order p-delta analysis, geometric nonlinear analysis or buckling analysis. It can also make use of various forms of dynamic analysis from modal extraction to time history and response spectrum analysis.

OBJECTIVE

The main objective of this study is to identify various parameters that affected the frame DESIGN AND ANALYSIS OF EARTHQUAKE BUILDING C+G+7 USING STAAD.PRO. This is based on the stiffness matrix and finite element-based software. The analysis and design are done to satisfy all the checks as per Indian standards. Finally, data base is prepared for various structural responses.

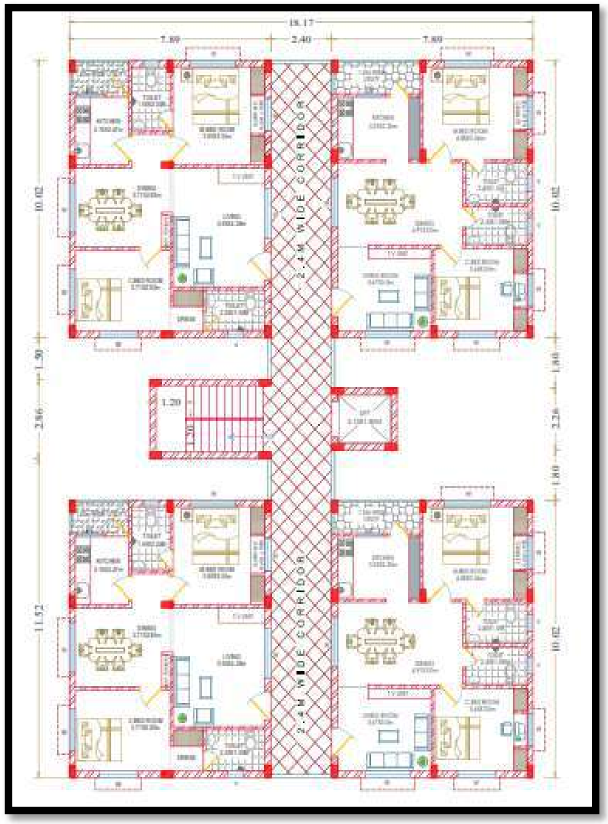
SCOPE OF WORK

The analysis is implemented for DESIGN AND ANALYSIS OF EARTHQUAKE BUILDING C+G+7 USING STAAD.PRO. The structure is analyzed for both gravity and lateral loads (seismic). The individual structural elements are designed for worst load combinations.

MODELING OF THE STRUCTURE

General

The C+G+7 building structure is analysed for garvity and latral load (wind loads & Seismic load). The effect of axial force, out of plane moments, lateral loads, shear force, storey drift, storey shear and tensile force are observed. The analysis is carried out using STAAD.PRO.



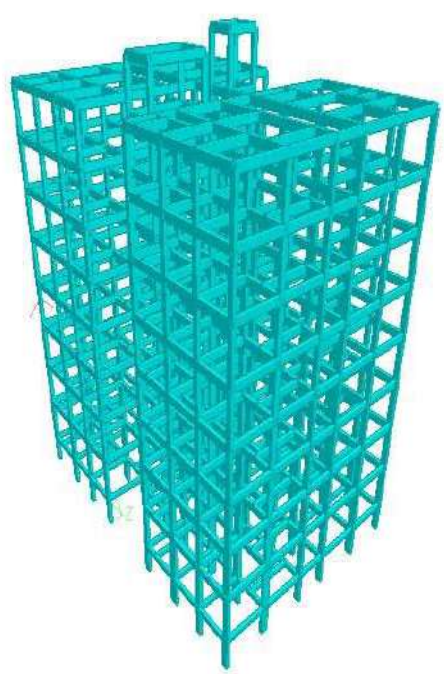


Fig: 3D view of the structure

ANALYSIS AND RESULT

General

Structure having C+G+7 storey is analysed for garvity and latral load (sesimic and wind load). The effect of axial force, out of plane moments, lateral loads, shear force, storey drift, storey shear and tensile force are observed for different stories. The analysis is carried out using Staad.pro and data base is prepared for different story levels as follows.

LOAD CALCULATIONS

GRAVITY LOADS

- Dead load
- Live load

Dead load

- Slab load (125 mm thick)
- Wall load
  - External wall load (230 mm thick)
  - Internal wall load (115 mm thick)
  - Parapet load (230 mm thick)

Live load

The live load of the structure is taken for typical floors is 2kN/m^2 (as per IS: 875 part-2), for terrors 1.5 2kN/m^2

LATERAL LOADS

- Seismic load
- Wind load

SEISMIC LOAD CALCULATIONS

- **Design spectrum calculations**

The design horizontal seismic coefficient Ah for a structure shall be determined by the following expression:

$$A_h = \frac{ZIS_a}{2Rg}$$

Zone Factor (Z)

Importance factor (I)

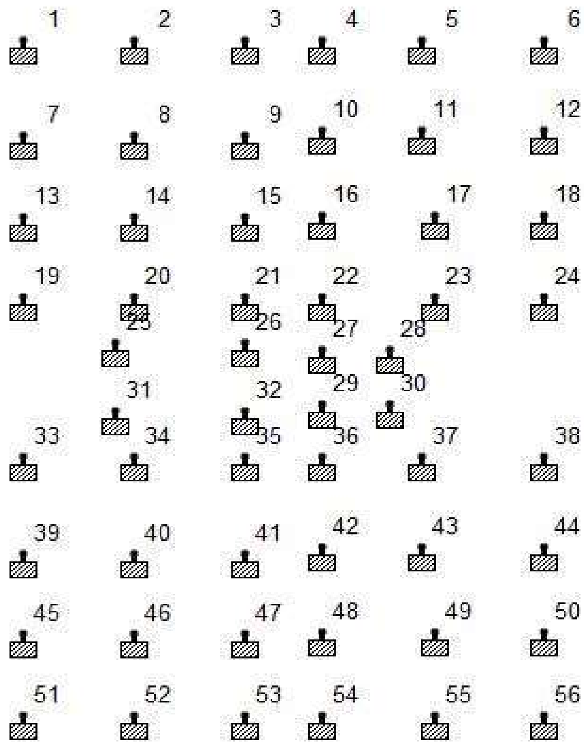
Response Reduction Factor (R)

Structural response factor (Sa /g)

LOAD CASES AND LOAD COMBINATIONS

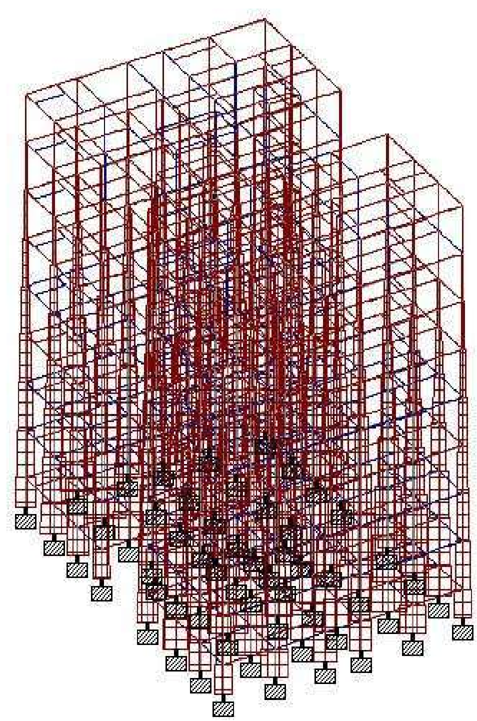
Type	L/C	Name
Primary	1	EQ+X
Primary	2	EQ-X
Primary	3	EQ+Z

Primary	4	EQ-Z
Primary	5	DEAD LOAD
Primary	6	LIVE LOAD
Primary	7	WL+X
Primary	8	WL-X
Primary	9	WL+Z
Primary	10	WL-Z
Combination	11	1.0(D. L+L.L)
Combination	12	1.0(D. L+L.L+EQ+X)
Combination	13	1.0(D. L+L.L+EQ-X)
Combination	14	1.0(D. L+L.L+EQ+Z)
Combination	15	1.0(D. L+L.L+EQ-Z)
Combination	16	1.0(D. L+L.L+WL+X)
Combination	17	1.0(D. L+L.L+WL-X)
Combination	18	1.0(D. L+L.L+WL+Z)
Combination	19	1.0(D. L+L.L+WL-Z)
Combination	20	1.5(D. L+L.L)
Combination	21	1.2(D. L+L.L+EQ+X)
Combination	22	1.2(D. L+L.L+EQ-X)
Combination	23	1.2(D. L+L.L+EQ+Z)
Combination	24	1.2(D. L+L.L+EQ-Z)
Combination	25	1.2(D. L+L.L+WL+X)
Combination	26	1.2(D. L+L.L+WL-X)
Combination	27	1.2(D. L+L.L+WL+Z)
Combination	28	1.2(D. L+L.L+WL-Z)
Combination	29	1.5(D. L+EQ+X)
Combination	30	1.5(D. L+EQ-X)
Combination	31	1.5(D. L+EQ+Z)
Combination	32	1.5(D. L+EQ-Z)
Combination	33	1.5(D. L+WL+X)
Combination	34	1.5(D. L+WL-X)
Combination	35	1.5(D. L+WL+Z)
Combination	36	1.5(D. L+WL-Z)
Combination	37	1.0(D. L+EQ+X)
Combination	38	1.0(D. L+EQ-X)
Combination	39	1.0(D. L+EQ+Z)
Combination	40	1.0(D. L+EQ-Z)
Combination	41	1.0(D. L+WL+X)
Combination	42	1.0(D. L+WL-X)
Combination	43	1.0(D. L+WL+Z)
Combination	44	1.0(D. L+WL-Z)

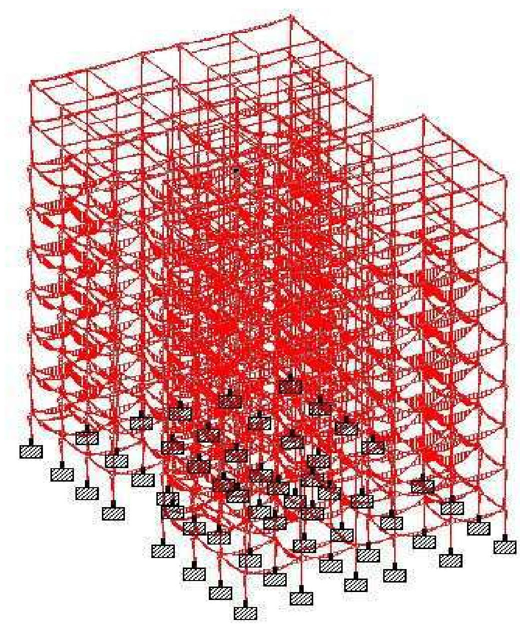


REACTIONS OF THE STRUCTURE

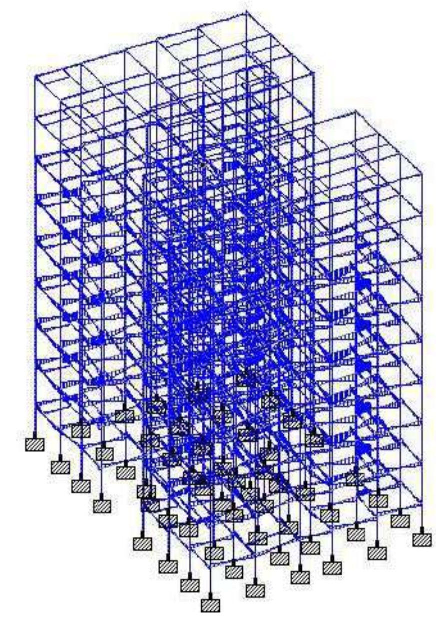
			Horizontal	Vertical	Horizontal	Moment		
	Node	L/C	Fx kN	Fy kN	Fz kN	Mx kNm	My kNm	Mz kNm
Max Fx	8	30 1.5(D. L+EQ-X)	56.204	1952.9	-3.347	-2.427	-0.311	-138.928
Min Fx	8	33 1.5(D. L+WL+X)	-81.663	1966.858	-2.212	-0.854	-0.844	165.887
Max Fy	8	20 1.5(D. L+L.L)	-4.844	2188.831	-2.274	-1.09	-0.023	1.729
Min Fy	30	2 EQ-X	13.24	-167.137	-0.036	-0.032	0.002	-20.483
Max Fz	35	32 1.5(D. L+EQ-Z)	-2.495	1231.883	38.446	63.347	-0.104	1.347
Min Fz	21	31 1.5(D. L+EQ+Z)	-3.302	1221.625	-39.742	-65.147	0.066	1.841
Max Mx	46	32 1.5(D. L+EQ-Z)	-8.267	1571.561	37.377	74.408	0.024	5.134
Min Mx	39	31 1.5(D. L+EQ+Z)	9.726	1245.763	-37.26	-67.331	-0.124	-6.228
Max My	46	33 1.5(D. L+WL+X)	-38.323	1651.392	7.498	9.546	1.379	55.363
Min My	43	28 1.2(D. L+L.L+WL-Z)	4.898	1559.041	11.225	38.295	-1.048	-2.969
Max Mz	8	33 1.5(D. L+WL+X)	-81.663	1966.858	-2.212	-0.854	-0.844	165.887
Min Mz	8	30 1.5(D. L+EQ-X)	56.204	1952.9	-3.347	-2.427	-0.311	-138.928



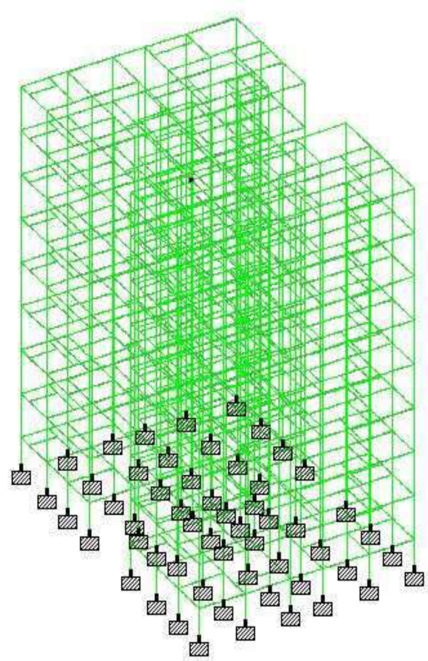
Whole Structure of Axial Force



Whole Structure of Bending Moment



Whole Structure of Shear Force Moment



Whole Structure of Deflection

Node displacement

			Horizontal	Vertical	Horizontal	Resultant
	Node	L/C	X mm	Y mm	Z mm	mm
Max X	1815	33 1.5(D. L+WL+X)	42.235	-4.522	1.184	42.492
Min X	1806	30 1.5(D. L+EQ-X)	-46.101	-2.853	0.071	46.189
Max Y	1318	2 EQ-X	-23.086	0.833	-0.013	23.101
Min Y	1156	20 1.5(D. L+L.L)	-1.324	-9.901	-0.23	9.992
Max Z	1815	31 1.5(D. L+EQ+Z)	-0.117	-5.907	24.81	25.503
Min Z	1813	32 1.5(D. L+EQ-Z)	0.145	-5.926	-25.16	25.849
Max rX	1350	31 1.5(D. L+EQ+Z)	-0.603	-4.275	12.786	13.495
Min rX	1288	32 1.5(D. L+EQ-Z)	-0.481	-4.287	-12.821	13.528
Max rY	1817	33 1.5(D. L+WL+X)	37.465	-6.501	-0.077	38.025
Min rY	1818	33 1.5(D. L+WL+X)	39.185	-6.541	-0.085	39.728
Max rZ	1352	30 1.5(D. L+EQ-X)	-24.242	-5.066	-0.088	24.765
Min rZ	1352	29 1.5(D. L+EQ+X)	22.453	-3.606	0.021	22.74
Max Rst	1805	30 1.5(D. L+EQ-X)	-46.099	-5.612	-0.205	46.44

CONCLUSION

- The G+7 residential building has been analyzed and deigned using STADD. Pro.
- Seismic forces have been considered and the structure is designed as an earthquake resistant structure.
- To conclude, STADD. Pro is versatile software having the ability to determine the reinforcement required for any concrete section on based on its loading and determine the nodal deflections against lateral forces.
- It experiences static as well as dynamic analysis of the structure and gives accurate results which are required. The following point have been obtained at the end of the design.
- The values of bending moment and shear force for every individual member have been studied.
- The short-term deflection for all horizontal members is within safe limits.
- The final output for beams and columns has been generated and reinforcement details have been studied.

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