Analyzing RCC Framed Building with Different Bracing System under Seismic Forces and Wind Forces

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Abstract— Lateral stability of building under horizontal loads are the main concern of structure designer while designing any building. Two major types of lateral loads act on building i.e. earthquake load and wind load. Therefore, in present paper, 15 storey RCC framed building was considered when analyzed with earthquake forces and wind forces. Along with lateral forces, different types of bracing system were adopted so that these lateral forces can be resisted well. Comparison between different bracing system along with the earthquake and wind forces was carried out by collecting the results from staad.pro. From the result, it can be concluded that cross bracing and V bracing reduced the maximum displacement of a building by half. And very slight variation was seen in the results of RCC building analyzed with earthquake and wind forces.

Keywords: Dynamic Seismic Analysis, Staad.Pro, Struts, High-Rise Building

I. INTRODUCTION

Structural engineering has existed since humans first started to construct their own house. Structural engineers design, and assess structure to ensure that they are efficient and stable. Structural analysis is a comprehensive determination to assure that the deformations due to load in a structure will be satisfactory and lower than the permissible limits, and failure of a structure will never occur.

There are different types of bracing which can be used in framed structure for resisting lateral loads. Thery are as follows:

- Single diagonal
- Cross Bracing
- K Bracing
- V Bracing
- Zigzag Bracing

II. METHODS

Modeling of various structures was carried out by using designing software i.e. staad.pro. It is a product sold by the company Bentleys and is commonly being used in the design sector all over the world. Following are the models which were modeled for present study:

- Type 1: 15 storey building without Bracing analyzed with Seismic Forces.
- Type 2: 15 storey building with Cross Bracing analyzed with Seismic Forces.
- Type 3: 15 storey building with V Bracing analyzed with Seismic Forces.
- Type 4: 15 storey building without Bracing analyzed with Wind Forces.
- Type 5: 15 storey building with Cross Bracing analyzed with Wind Forces.
- Type 6: 15 storey building with V Bracing analyzed with Wind Forces.

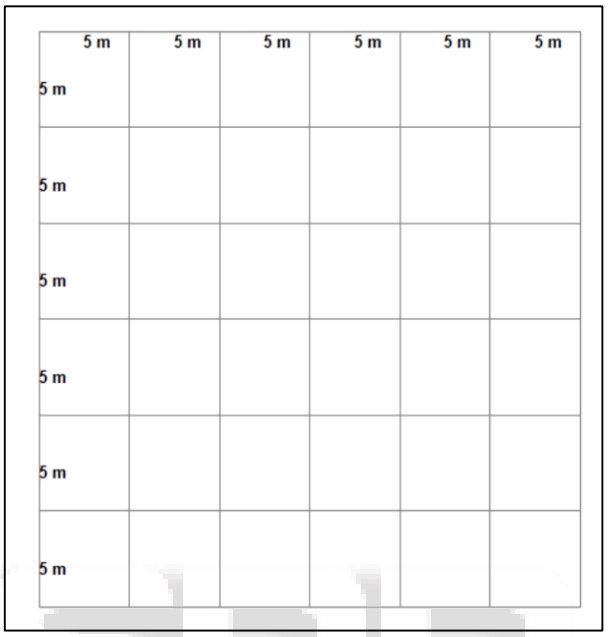

Fig. 1. Plan of the building.

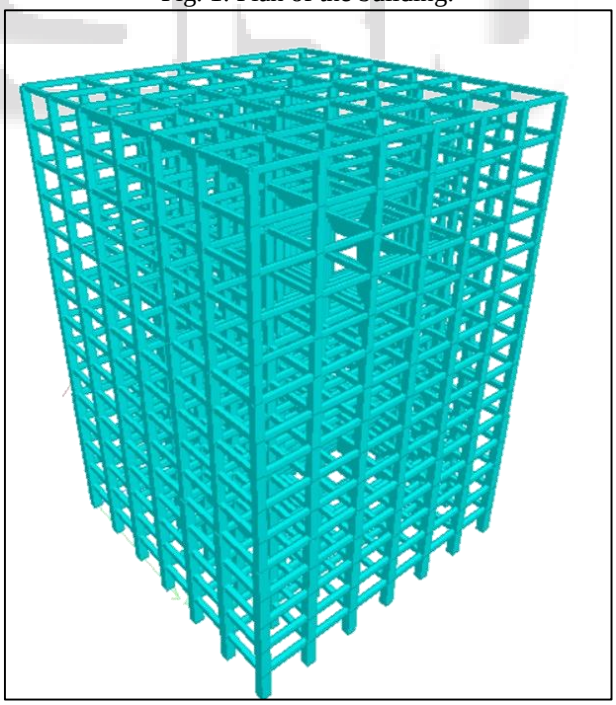

Fig. 2: Rendered View of 15 Storey Building.

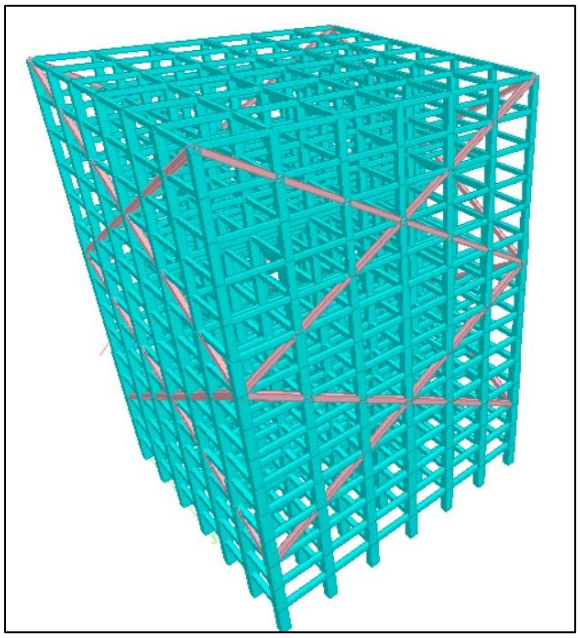

Fig. 3: Rendered view of 15 Storey Building with Cross Bracing.

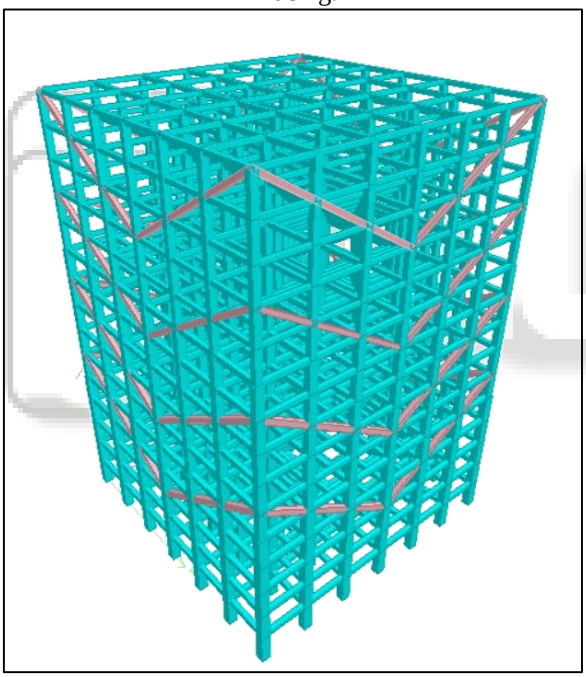

Fig. 4: Rendered view of 15 Storey Building with V Bracing.

Floor	Column size	Beam size	Steel strut size
1st to 5th	900 x 825 mm	675 x 450 mm	550 x 550 x 12
6th to 10th	750 x 600 mm	525 x 380 mm	450 x 450 x 12
11th to 15th	600 x 525 mm	380 x 300 mm	350 x 350 x 12

Table 1: Sectional Properties of 15 storey Building.

A. Seismic Analysis:

As per the new earthquake resistant building code IS: 1893-2016, Dynamic seismic analysis was chosen in seismic zone III for the present study. Following earthquake parameters were chosen for the present study:

- Seismic Zone: III
- Response Reduction Factor: SMRF
- Importance Factor: 1.2
- Type of structure: RCC structure.
- Type of soil: Medium Soil

B. Wind Analysis:

A per the codal provisions of IS: 875 part 3, the wind analysis was carried out on the RCC buildings. Various parameters which were required to perform this analysis was considered such as basic wind speed, terrain of the building, class of building, topography etc. all the codal requirements were met and the building was analyzed in staad pro software.

After taking all the parameters from code, wind pressure was calculated and it comes out to be 1.25 Kn/m2 which was applied on the building from X direction as well as Z Direction.

III. Results and Discussion

Following are the results for 15 storey buildings which were analyzed with earthquake forces in staad.pro.

Floor	Type 1	Type 2	Type 3
1	0.89	0.95	0.92
2	0.86	0.95	0.92
3	0.86	0.95	0.87
4	0.86	0.95	0.85
5	0.86	0.87	0.85
6	1.02	1.12	0.97
7	0.95	0.9	0.97
8	0.95	0.9	0.97
9	0.95	0.82	0.97
10	0.92	0.8	0.95
11	1.15	1.09	1.23
12	0.99	0.92	1.12
13	0.84	0.86	0.8
14	0.8	0.86	0.8
15	0.8	0.86	0.8

Table 2: Percentage of Steel for 15 Storey Building.

Floor	Type 1	Type 2	Type 3
1	1.026	0.559	0.879
2	2.423	1.526	2.012
3	4.212	3.023	3.569
4	6.989	4.895	5.895
5	9.848	6.035	6.862
6	14.623	8.124	9.325
7	17.856	10.213	10.915
8	22.623	11.568	12.325
9	27.256	13.998	14.682
10	31.026	16.032	16.759
11	35.789	18.213	19.356
12	39.848	20.35	21.326
13	43.626	22.013	22.895
14	47.512	24.953	25.625
15	51.959	25.856	26.958

Fig. 3: Displacement (mm) of Columns.

Building Type	Concrete Quantity (Cumec)	Steel R/F Quantity (Kn)	Steel Section Quantity (kN)
Type 1	1474.8	1826.62	-
Type 2	1474.8	1535.72	1007.26
Type 3	1474.8	1586.23	1007.26

Table 4: Total quantities of concrete and steel of 15 storey building.

Following are the results for 15 storey buildings which were analyzed with wind forces in staad.pro.

Floor	Type 4	Type 5	Type 6
1	0.90	0.96	0.89
2	0.89	0.96	0.85
3	0.89	0.96	0.85
4	0.89	0.96	0.85
5	0.82	0.90	0.85
6	0.99	1.06	1.11
7	0.91	0.92	0.97
8	0.91	0.92	0.97
9	0.91	0.92	0.97
10	0.91	0.92	0.90
11	1.06	0.99	1.03
12	0.99	0.92	1.12
13	0.8	0.85	0.82
14	0.8	0.85	0.82
15	0.8	0.85	0.8

Table 5: Percentage of Steel for 15 Storey Building.

Floor	Type 4	Type 5	Type 6
1	1.235	0.625	0.953
2	2.589	1.956	2.123
3	4.851	3.623	4.016
4	7.256	5.213	6.482
5	9.769	6.595	7.213
6	15.652	8.354	9.548
7	18.653	10.951	11.286
8	23.861	12.039	12.869
9	28.651	14.623	15.213
10	32.322	16.513	17.213
11	36.495	18.943	19.586
12	40.623	21.002	21.996
13	43.652	22.483	23.532
14	47.996	25.039	26.092
15	52.32	26.615	27.399

Table 6: Displacement (mm) of Columns.

Building Type	Concrete Quantity (Cumec)	Steel R/F Quantity (Kn)	Steel Section Quantity (kN)
Type 4	1474.8	1886.36	-
Type 5	1474.8	1591.19	1007.26
Type 6	1474.8	1629.64	1007.26

Table 7: Total Quantities of 15 Storey Building.

IV. CONCLUSION

Various design parameters were considered in order to analyze 15 storey buildings in staad.pro with different bracing system under seismic and wind forces. After collecting the results from different sources, following are the conclusions that were drawn from the investigational study:

- There was very slight variation in the percentage of steel of column which ranges from 0.87 to 1.19 when RCC building with earthquake forces was compared with RCC building with wind forces.
- With the introduction of Cross Bracing and V Bracing, maximum displacement was found out to be approximately half the value of maximum displacement of RCC building without bracing system. But there was very little variation in the displacement of RCC building when analyzed with seismic forces and wind forces i.e. ratio of maximum displacement due to earthquake to the maximum displacement due to wind is 0.97.
- With the introduction of braced system in RCC building analyzed with wind and seismic, almost 13% to 16% of steel reinforcement was reduced but the quantity of steel bracing was added.
- Therefore, it was concluded that the braced system (Cross bracing and V bracing) can be effectively used for the RCC building and these bracing system can easily resist earthquake and wind lateral forces.

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