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Comparative Analysis of a Multistoried Residential Building with and Without Shear Wall using STADD Pro.

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Abstract— **Shear wall systems are one of the most commonly used lateral load resisting system in high rise buildings, Shear wall has very high in plane stiffness and strength which could be used to simultaneously resist large horizontal loads and support vertical or gravity loads making them quite advantageous in many structural engineering applications. In multistory building to resist lateral forces incorporation of Shear walls has become inevitable. It is very necessary to determine effective, efficient and ideal location of shear wall. In this paper study of G+4 Storey building in Zone IV is presented with some preliminary investigation which is analyzed by changing various position of shear wall with different shapes for determine parameter like axial load and moments. This analysis is done by using Software package STADD-pro. The buildings are modeled with floor area of 216 sqm (18m x12m) with 6 bays along 18 m span each 3 m. and 4 bays along the 12 m span each 3 m. The design is carried out using STAAD.PRO software. The main aim of the present work is therefore to make a comparative study of structural system and orientation with the shear walls and without shear wall. There are lots of literatures available on design and analysis of the shear wall system. However, the decision about the location of shear wall in multi-storey building is not much discussed in any literatures.A study on a residential building with shear wall and without shear wall was studied to understand the effect of lateral loads.**

Keywords— **Shear wall, Staad Pro, Lateral forces, Stiffness.**

I. Introduction

Shear walls are a type of structural system that provides lateral resistance to the building or structure. Shear walls are vertical elements of the structure i.e the horizontal force resisting system. Shear walls are constructed to counteract the effect of lateral loads acting on the structure. In residential construction, shear walls are straight external walls that typically form a box which provides all of the lateral support for the building. To perform accurate analysis a structural engineer must determine some information such as structural loads, geometry of the structure, support conditions, and materials properties. The results of such an analysis typically include support reactions, stresses and displacements. This information is then compared with the criteria that indicate the conditions of failure. Advanced structural analysis may examine dynamic response, stability and non-linear behaviour. The aim of design is the achievement of an acceptable probability that structures that are being designed will perform satisfactorily during their design life. With an appropriate degree of safety, they should be able to sustain all the loads and deformations of normal construction and use and have enough durability and adequate resistance to the effect of seismic loads and wind loads. Account should be taken of accepted theories, experiments and experience and the need to design for durability. The realization of design objectives requires compliance with clearly defined standards for materials, production, workmanship and also maintenance and use of structure in service. The design of the building is dependent upon the minimum requirements as prescribed in the Indian Standard Codes. The minimum requirements pertaining to the structural safety of buildings are being covered by way of laying down minimum design loads which have to be assumed for dead loads, live loads, and other external forces, the structure would be required to withstand. Acurate conformity to loading standards recommended in this code, it is hoped, will not only ensure the structural safety of the buildings which are being designed.

II. PROBLEM DEFINATION

The principle objective of this paper is to analyse and design a multi-storeyed building [G + 4(3 dimensional frame)] using STAAD Pro. The design involves load calculations manually and analyzing the whole structure by STAAD Pro. STAAD.Pro features a user friendly interface, visualization tools, powerful analysis and design engines with advanced finite element and dynamic analysis capabilities. Complicated and tall structures need very time taking and tiersome calculations using conventional manual methods. STAAD.Pro provides us a fast, efficient, easy to use and accurate platform for analysing and designing structures.Various Loads such as Dead load, Live load, Floor load, Earthquake loads and their suitable combinations have been taken from their respective Indian standard codes. Such as Dead loads has been taken as per IS 875- I, Live load as per IS 875 part-II and sesmic loadings as per IS 1893-I (1984)

Given below is the design data that has been taken from IS Codes for doing the analysis.

Design data:-

Type of Building - Residential
Live load - 3KN/m^2
Earthquake load - IS :1893 (part 1) 1984
Storey height - 3m
Floors - G.F. + 4
Zone - IV
Concrete grade - M30
Steel reinforcement - Fe 415
Size of Column - 300x300mm
Size of Beams - 400x300mm.

III. DETAILS OF MODELS

The four different models have been selected for analysis as shown below:-

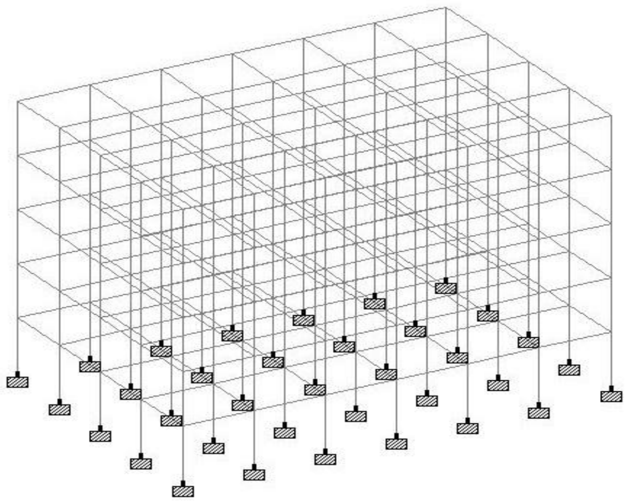

Fig 3.1:CASE –I Without shear wall

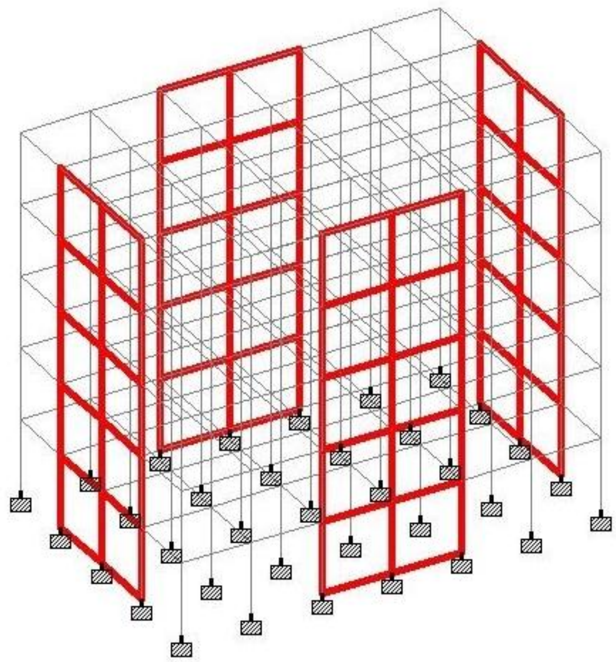

Fig 3.2: CASE-II Shear walls at sides

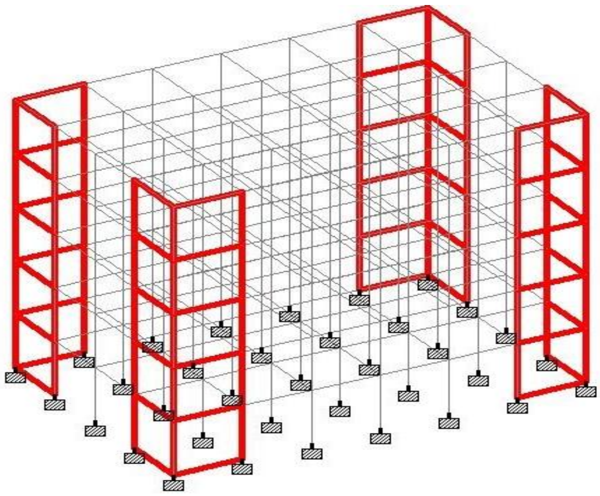

Fig 3.3:CASE-III Shear walls at corners.

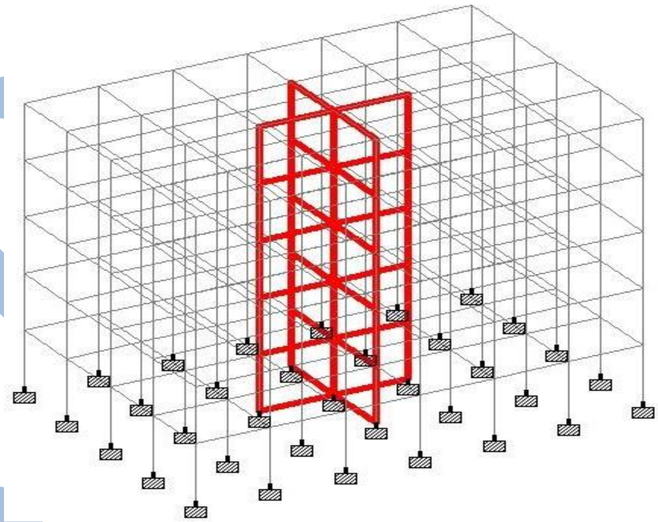

Fig 3.4:CASE-IV Shear walls at center

IV. DISCUSSION AND RESULTS

As already discussed four different models have been analysed and compared for different location of shear wall.
The four different cases selected for analysis are given below:-

- CASE –I Building without shear wall.
- CASE-II Building with Shear walls at sides.
- CASE-III Building with shear walls at corners.
- CASE-IV Building with shear walls at center.

Reults have been obtained using STAAD Pro. Version 2005 and are being discussed below.
Comparison has been made from the given resuls and best suited model has been selected.
Following Tabels contains Results of Max Shear Forces in (KN), Max Moment in (KNM) and Max Local Displacement in (M) of various members of the selected structure for all four cases.
The members have been selected from bottom and top storey and from each corner of the structure for all four cases.Members selected are both horizontal and verticle i.e results compared below are for both beams and columns of different stories.

➢ **Max Shear Force in members:**

Table4.1:Max Shear force in Beams(KN)

Member No	Case I	Case II	Case III	Case IV
99	131.81	51.86	21.94	64.45
100	140.43	74.42	21.95	85.45
145	131.81	59.95	21.95	80.21
146	140.39	54.81	21.94	64.64
471	32.17	58.04	32.56	21.08
472	28.02	52.87	29.46	20.06
517	32.55	50.54	29.47	23.40
518	26.11	57.38	30.87	18.10

Table4.2:Max Shear force in Columns(KN)

Member No	Case I	Case II	Case III	Case IV
59	48.72	4.47	3.26	28.38
65	54.95	7.14	3.89	28.38
87	54.44	7.68	3.55	31.95
93	54.95	7.14	3.89	28.38
431	12.32	17.93	4.18	14.93
437	27.78	26.15	9.15	23.01
459	12.32	17.28	7.72	20.58
465	23.49	17.28	5.72	20.58

- **Max Moments in members:**

Table4.3:Max Moments in Beams(KNM)

Member No	Case I	Case II	Case III	Case IV
99	147	33.12	16.07	62.77
100	132.06	67.60	15.25	79.88
145	147.42	38.23	15.25	89.54
146	132.04	28.58	15.22	59.15
471	38.82	89.76	59.67	28.99
472	20.11	88.27	54.20	23.47
517	38.75	87.95	53.07	33.42
518	22.80	89.24	58.38	21.03

Table4.4:Max Moments in Columns(KNM)

Member No	Case I	Case II	Case III	Case IV
59	86.41	7.67	7.66	50.74
65	91.87	12.09	7.70	54.28
87	92.82	12.09	8.70	54.28
93	85.73	10.88	8.44	50.74
431	23.03	29.45	6.35	25.73
437	43.74	40.72	15.07	35.89
459	38.48	27.23	9.63	33.02
465	38.48	27.23	8.78	33.02

- **Max Deflection in members:**

Table4.5:Deflection in Beams(M)

Member No	Case I	Case II	Case III	Case IV
99	0.0456	0.0397	0.0084	0.0283
100	0.0455	0.0331	0.0084	0.0283
145	0.0455	0.0331	0.0084	0.0283
146	0.0456	0.0397	0.0084	0.0283
471	0.0206	0.0363	0.0087	0.0111
472	0.0206	0.0139	0.0088	0.0109
517	0.0206	0.0139	0.0088	0.0109
518	0.0206	0.0363	0.0087	0.0111

Table4.6:Deflection in Columns(M)

Member No	Case I	Case II	Case III	Case IV
59	0.0284	0.0194	0.0024	0.0178
65	0.0284	0.0194	0.0024	0.0178
87	0.0284	0.0194	0.0024	0.0178
93	0.0284	0.0194	0.0024	0.0178
431	0.0229	0.0142	0.0038	0.0149
437	0.0229	0.0142	0.0038	0.0149
459	0.0229	0.0142	0.0038	0.0149
465	0.0229	0.0142	0.0038	0.0149

V. CONCLUSION

It is quite evident from the results shown above that without the use of shear wall it is nearly impossible to resist lateral loads applied on a structure.It is also very clear from the analysis that shear force gets cosiderably reduced by the use of shear wall.Not only shear force on the members but Max Moment and Displacements also gets reduced.The members near to the shear walls show very little or negligible displacement or moments and structure as a whole becomes more stable and safe against the lateral forces though the self weight of the structure increases.From the above four cases discussed it is quite clear from the results that CASE-III i.e Shear walls at corners show minimum displacement and moments hence from the above all cases this case can be considered most efficient and safe.Max shear force and Moments is also least for the Case-III.Hence Case-III i.e shear wall at corner is most suitable and safe among the various models studied and analysed.

Some of the important points can be summarized as below:-

- Among all the load combination, the load combination of 1.5DL+1.5DL is found to be more critical combination for all the models.
- The least Max displacement for columns from all the cases is for the Case-III which is 2.48mm for the bottom storey and that for top storey is 3.83mm.
- The lateral deflection of column for building with shear wall at corner is reducedas compared to all models.
- The shear force is maximum at the ground level for Case-III as compared to model II and IV.
- The bending moment is maximum at all levels for Case-I among all themodels.

Hence, it can be said that building with shear wall at corner is more efficient than allother types of shear wall

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