WIND LOAD ANALYSIS OF HIGH RISE BUILDING WITH AND WITHOUT SHEAR WALL AND ITS COMPARISON

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ABSTRACT-Indian standard code IS 875(part-3)-1987 gives the specifications for wind load analysis on the different structures. The analysis is based on various steps provided for wind pressure intensity, wind load calculation by wind coefficients. Behavior of building by the wind pressure is dependent on the angle on which the wind is striking the structure.Wind load is dangerous for the high rise building ,hence various techniques are used to reduce its effects. Shear wall is a good option for this, which is effected up to approximate 70 stories. It is expected in this study that a shear walled structure will show the better result and stability against normal building without shear wall.This study compares the performance of buildings with and without shear wall in terms of deflection of at the different stories and various parameters. As a case study, a 40 storey building designed for Gravity loads(dead load +live load) as well as lateral load (wind load) as per IS:875(part-3)-1987 for wind zone IV is considered. This paper also provides other important conclusions on wind load design provisions and shear wall specifications.

Keywords- wind velocity, wind pressure intensity, gravity loads, wind force at diff. Height, etc.

1.INTRODUCTION

The necessity of high rise building in urban areas is to minimize the land requirements. The wind force acts on high rise building structure very high compared to low rise building. Worldwide as it's necessity has increased hence the various code are adopted in different country to analyse and design of high rise structure.
According national building code 2005 of India, the building of height more than 15 m is called high rise building.
Many techniques are used to minimize the wind effect on high rise building like Rigid frames, braced hinge frame, Shear wall /hinged frame, Outrigger Structures.
Shear wall / Rigid frame of the concrete shear wall and concrete frame is effective up to 70 stories. It creates shear wall-frame interaction that resist the lateral load by wind or earthquake.
The main objective of every structural system is to transfer gravity load to the foundation of building. Dead load and live load are the primary load created from the gravity effect. The lateral loads like wind or earthquake also affects the building other than this dead and live load. High stresses are developed due to these lateral loads and also these create sway movement and cause vibration in the structure. Therefore, the building must have sufficient strength and stiffness to encounter the vertical loads and lateral loads respectively.

1.1Goal

Analysis of two 40 stories building with and without shear wall by the STADD-PRO software and their comparison.
There are two 40-stories tall building, and as the policy of construction of building is toward the vertical accommodation, so building would be helpful to approach this goal. The building has two transverse main walls with the angle of 90°.It seems that this kind of architectural configuration is due to aesthetic considerations.

2. LITERATURE REVIEW

The elevator and the introduction of structural steel, towers and skyscrapers have continued to soar skyward, where they are buffeted in the wind's complex environment. Unfortunately, these advances in height are often accompanied by increased flexibility and a lack of sufficient inherent damping, increasing their susceptibility to the actions of wind. While major innovations in structural systems have permitted the increased lateral loads to be efficiently carried, the dynamic nature of wind is still a factor, causing discomfort to building occupants and posing serious serviceability issues. The next generation of tall buildings research has been devoted in part to the mitigation of such wind-induced motions via global design modifications to the structural system.

2.1High Rise Building

Emporis Standards defines a high-rise as "A multi-story structure between 35–100 meters tall, or a building of unknown height from 12–39 floors." According to the building code of Hyderabad, India, a high-rise building is one with four floors or more, or 15 to 18 meters or more in height.
Three Generations of High-Rise Buildings:
Since the first appearance of high-rise buildings, there has been a transformation in their design and construction. This has culminated in glass, steel, and concrete structures in the international and postmodernist styles of architecture prevalent today.

First Generation
The exterior walls of these buildings consisted of stone or brick, although sometimes cast iron was added for decorative purposes. The columns were constructed of cast iron, often unprotected; steel and wrought iron was used for the beams; and the floors were made of wood. "In a fire, the floors tend to collapse, and the iron frame loses strength and implodes. " 38 Elevator shafts were often unenclosed. The only means of escape from a floor was through a single stairway usually protected at each level by a metal-plated wooden door. There were no standards for the protection of steel used in the construction of these high-rises.

Second Generation
The second generation of tall buildings, which includes the Metropolitan Life Building (1909), the Woolworth Building (1913), and the Empire State Building (1931), are frame structures, in which a skeleton of welded- or riveted-steel columns and beams, often encased in concrete, runs through the entire building. This type of construction makes for an extremely strong structure, but not such attractive floor space. The interiors are full of heavy, load-bearing columns and walls.

Third Generation
Buildings constructed from after World War II until today make up the most recent generation of high-rise buildings. Within this generation there are those of steel-framed construction (core construction and tube construction), reinforced concrete construction, and steel-framed reinforced concrete construction.
Techniques to reduce the effects of wind/earthquake load on high rise building:

3. METHODOLOGY

3.1 Aim of the work
Analysis is being done by STAD-PRO by providing adequate material properties and dimension as per the required building standard.
The aim of the project is to briefly know about the shear wall concepts and structural concepts through computer aid STAAD-PRO software and the previous study and theory. Briefly I have gone through following points through out of project work-

- ✓ Understanding of design and detailing concept.

- ✓ Main objective i.e. using STAAD-pro software for the analysis of wind load and shear wall.
- ✓ Learning of analysis and design methodology which can be very useful in the field.
- ✓ Understanding of wind load design concept on the building.
- ✓ Approach for professional practice in the field of structural engineering.

3.2 Methodology Of The Work

The whole analysis is done by the STAAD-PRO.V8i software, in which pressure intensity at different height of the building is predefined for the American code ASCE-07, but not for any other code. This analysis is done on the basis of Indian standard code IS- 875(part-3) for which the intensity values were calculated through the codal provisions.

3.3 Building Details

In this work following building details are to be considered:
No. of stories=40
Length=24m, each bay @4m
Height=120m, each bay @3m
Width=24m, each bay @4m
Live Load; Area load= 2.5Kn/m^2 Location – Delhi
Wind zone –IV
wind speed =47m/s
Wind Load; as per the IS-875(Part-3) Concrete grade M30
Steel grade Fe415
Risk coefficient ,k1=1.07(considered to be an important building with design life = 100 years)
Terrain Coefficient, k2= as per the table-2 [Building is to be considered in terrain type- 3{surrounding structures are the height of between 10m to 25m} and class-B {glazing or roofing type of structural components having its maximum dimension(horizontal or vertical) between 20 to 50m]

- Topography Factor, k3=1.0(upwind slope is assumed to be less than 3o)
- For the given structures ,wind pressure is calculated separately (manually) and these values were added in the analysis by staad-pro by providing 80%exposure to the wind.
- To see the effect of wind , a separate envelope of wind load in +X direction was added in the modeling.
- Concrete design as per the IS-800 ,was added in modeling to perform concrete design.
- A comparative analysis is also done after obtaining all results of both buildings ie; with shear wall and without shear wall.

4. COMPARISONS OF RESULTS AND DISCUSSIONS

4.1 General

It took time to run the analysis as the basic version of the software was used. Results of deflection, shear force, moment of the entire building and individual member were analysed; also the graphical diagrams of deflection, shear force, moment of each member and of whole structure were analysed

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4.2 Shear Wall Effect On Deflection

Storey drift also known as shear wall deflection is limited by two primary causes. The first is for limiting cracks in wall by plaster, gypsum, and paint in serviceability. The second is for limiting the shear wall's maximum inelastic response, which is important in the seismic or wind design of wood buildings.

Furthermore, the relative flexibility and rigidity of shear wall and diaphragms is also calculated by storey drift.

4.3 Deflection result on both analysis

TABLE- 5.1 Deflection Values comparison

storey	w/o shear wall (mm)	with shear wall(mm)	%Reduction
40	141.908	88.621	37.55038476
39	140.297	87.093	37.92240746
38	138.601	85.486	38.32223433
37	136.786	83.855	38.6962116
36	134.85	82.194	39.04783092
35	132.793	80.496	39.38234696
34	130.614	78.752	39.7063102
33	128.314	76.958	40.02369188
32	125.894	75.108	40.34028627
31	123.355	73.199	40.65988407
30	120.7	71.229	40.98674399
29	117.929	69.195	41.32486496
28	115.046	67.095	41.6798498
27	112.052	64.931	42.05279692
26	108.952	62.7	42.45172186
25	105.748	60.405	42.87835231
24	102.442	58.046	43.33769352
23	99.038	55.626	43.83368
22	95.538	53.145	44.37291968
21	91.947	50.608	44.95959629
20	88.267	48.017	45.60028097
19	84.503	45.375	46.30368153
18	80.659	42.689	47.07472198
17	76.739	39.964	47.92217777
16	72.746	37.204	48.85766915
15	66.692	34.418	48.39261081
14	64.575	31.614	51.04297329
13	60.403	28.801	52.31859345
12	56.181	25.981	53.75482814
11	51.916	23.196	55.32013252
10	47.812	20.432	57.26595834
9	43.278	17.715	59.06696243
8	36.921	15.066	59.19395466
7	34.547	12.51	63.7884621
6	30.164	10.073	66.60588781
5	25.781	7.789	69.78782825
4	21.397	5.696	73.37944572
3	16.997	3.835	77.4371948
2	12.483	2.263	81.87134503
1	7.363	1.034	85.95681108

Supports	0	0	0

□□Deflection values in the building with shear wall are significantly less than the building withoutshear wall, at the top of building deflection of thestorey has been reduced upto 37.55% .

□□Moment value for beam and nodes has also been reduced in shear wall building ,that shows its more reliability to the load as compared to without shear wall building.

□□By this analysis and study in the urban areas to reduce the requirement of space for the building, high rise buildings are used; and to prevent danger against wind load on those buildings ,shear wall is a good and easy choice in the construction.

5. FUTURE SCOPE

An experimental study also can be performed on the same structures by Wind Tunnel Experiment and their results can be compared by the experiment and STAAD-PRO analysis.

6. CONCLUSIONS

□ From the above study work, it is observed that in 40 story building, constructing building with shear wall in short span at middle is economical and effective as compared with the building without shear wall. From this it can be concluded that large dimension of shear wall is not effective in less number of stories of any building but it is effective in high number of stories.

• Software does not take direct values from IS-875(3) for the wind load; hence must be improved.

• Software does not support Indian codes like IS-456 for concrete design and IS -13920 for shear wall design, hence must be improved.

• Results are acceptable in both building and very significantly loss (37.55% in top story) in deflection in shear wall building has been shown compared to normal building without shear wall.

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