BEHAVIOUR OF BUILDING BY CHANGING POSITION OF SHEARWALL

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ABSTRACT

In recent decades, shear walls structures are the most appropriate structural forms, which have caused the height of concrete buildings to be soared. So, recent RC tall buildings would have more complicated structural behavior than before. Therefore, studying the structural systems and associated behavior of these types of structures would be very interesting. Shear wall system with irregular openings are utilized under both lateral and gravity loads, and may result some especial issues in the behavior of structural elements such as shear walls, coupling beams and etc. In many respects concrete is an ideal building material, combining economy, versatility of form and function, and noteworthy resistance to fire and the ravages of time. In this project the analysis of G+20 reinforced concrete frame building with and without shear wall has been done. The analysis is done using designing software ETab Different models with different condition of shear wall has been considered for analysis and study the effects of displacements in different direction, behavior of different story , structural stability and flexibility , economy etc. has been observed , same shown with the help of comparison with different models.

1. INTRODUCTION

1.1 Motivation

Besides, food and clothing, shelter is a basic human need. India has been successful in meeting the food and clothing requirements of its vast population; however the problem of providing shelter of all is defying solutions. "While there has been an impressive growth in the total housing stock from 65 million in 1947 to 187.05 million in 2001, a large gap still exists between the demand and supply of housing units. The Working Group on Housing for the 9th five-year plan estimated the housing shortage in 2001 at 19.4 million units- 12.76 million in rural area and 6.64 million in urban area. The shortage of housing is acutely felt in urban areas more so in the 35 Indian cities, which according to the 2001 census have a population of more than a million". In earthquake prone areas due to earth vibrations buildings are collapsed and it leads to death of many people.Hence in order to overcome this problem construction process should be quick, tall, safe and effective to accommodate huge population in a given area. So we have chosen this topic of "Efficiency of RC Shear Wall at DifferentLocation of Multi-Storey Building". This type of shear wall construction helps to build tall structure of about 20 floors within no time. Hence the construction process will become much quicker and efficient.

Constructions made of shear walls are high in strength, they majorly resist the seismic force, wind forces and even can be built on soils of weak bases by adopting various ground improvement techniques. Not only the quickness in construction process but the strength parameters and effectiveness to bare horizontal loads is very high. Shear walls generally used in high earth quake prone areas, as they are highly efficient in taking the loads. Not only the earth quake loads but also winds loads which are quite high in some zones can be taken by these shear walls efficiently and effectively.

1.2 Definition of shear wall

In modern high rise buildings shear wall are commonly used as a vertical structural element for resisting the lateral loads that may be induced by the effect of wind and earthquake which cause the failure of structure. So it is necessary to analyse the structure with provision of shear wall. The current work is focused on the comparative study of building without shear wall, building with shear wall and building without shear wall having different percentage of opening.The use of shear wall structure has gained popularity in high rise building structure, especially in the construction of service apartment or office/commercial tower. It has been proven that this system provides efficient structural system for multi storey building in the range of 20-35 storey's . In the past 30 years of the record service history of tall building containing shear wall element, none has collapsed during strong winds and earthquakes .

Generally shear wall can be defined as structural vertical member that is able to resist combination of shear, moment and axial load induced by lateral load and gravity load transfer to the wall from other structural member. When walls are situated in advantageous positions in a building, they can be very efficient in restating lateral loads originating from wind or earthquakes .Reinforced concrete shear walls are usually provided in tall buildings to avoid collapse of buildings under seismic forces. Shear wall buildings are usually regular in plan and elevation. Shear walls are usually provided between columns, stairwells, lift wells, toilets, and utility shafts. The high rise building is mostly considered as the one which requires mechanical transportation for use. High rise building is the one which has a height of 35 metres or more than that. As the height of building increases, the loads coming on the building also increase, which may affect the stability of building. Our project hence focuses on the use of these additional structural elements discussed above in a G+20 floor building. The structural elements used are Shear Wall. A comparative analysis of shear wall with respect to the stability of the structure has been carried out using software.

1.3 INFORMATION ON SOFTWARE

Software to be used for Analysis of Shear Wall are:-
3.1) E-TABS
3.2) STAAD PRO
3.3) SAP2000

1.3.1 E-TABS

ETABS provides an unequalled suite of tools for structural engineers designing buildings, whether they are working on one-story industrial structures or the tallest commercial high-rises. Immensely capable, yet easy-to-use, has been the hallmark of ETABS since its introduction decades ago, and this latest release continues that tradition by providing engineers with the technologically-advanced, yet intuitive, software they require to be their most productive.

1.3.2 STAAD PRO

STAAD PRO is a structural analysis and design software based on the finite element method. It is capable of analyzing and designing civil engineering structures such as buildings, bridges and plane and space trusses. It can generate loads (wind and earthquake) as per building codes of selected countries. It can carry out design of steel and reinforced concrete buildings as per codes of selected countries.It can carry out linear elastic (static and dynamic) and nonlinear dynamic analysis (although I am not sure how good the nonlinear analysis algorithms are, not having used those features).

1.3.4 Advantages of ETABS

1. It is easy to operate
2. It is research oriented software.
3. It uses same user interface.
4. Used for both concrete and steel sections.
5. All types of structures can be analysed. i.e. buildings, bridges, dome shaped structures, etc.
6. Analysis can be done in less time.
7. This software provide base to other software's like ETABS.

1.4 Scope of the work

The aim of shear wall is to investigate the different ways in which the tall structures can be stabilized against the effect of strong horizontal wind loading and seismic loading some other reasons why we use shear wall are tall structures can be can be constructed which reduces area used and we can accommodate a large population in that particular area other objectives is to construct a cost effective in less period of time. This study helps in the investigations of strength and ductility of walls. The scope is to analyse the constructed shear wall that is to be constructed.Firstly the model is implemented into known computer software and then it is analysed based on the investigation of strength and ductility. The strength of shear walls tested are compared with the calculated strengths based on design codes.

Fig 1.4 Sample tall building

1.5 Objectives

Shear walls are not only designed to resist gravity / vertical loads (due to its self-weight and other living / moving loads), but they are also designed for lateral loads of earthquakes / wind. The walls are structurally integrated with roofs / floors (diaphragms) and other lateral walls running across at right angles, thereby giving the three dimensional stability for the building structures. Shear wall structural systems are more stable. Because, their supporting area (total cross-sectional area of all shear walls) with reference to total plans area of building, is comparatively more, unlike in the case of RCC framed structures. Walls have to resist the uplift forces caused by the pull of the wind. Walls have to resist the shear forces that try to push the walls over. Walls have to resist the lateral force of the wind that tries to push the walls in and pull them away from the building. Shear walls are quick in construction, and in a country like India where shelter is very important in a short lapse of time shear walls can be built very quickly. The precision to which they are built is also very high compared to normally built brick structures. Hence the key objective of shear wall is to build a safe, tall, aesthetic building.

- To Analyse the high rise structure with shear wall on ETAB software.
- To Analyse the high rise structure by changing the position of shear wall on ETAB software.
- To study the behaviour of high rise structure with application of lateral forces.

2. PROBLEM STATEMENT AND METHODOLOGY

3.1 Problem Statement

Table . 3.2.1: Problem statement

Number of storey	21
Seismic zone	V
Type of soil	Medium
Size of beam	230 x 350 mm
Size of column	500 x 500 mm
Floor to floor height	3 m
Depth of shear wall	150 mm
Live load on floor	2 KN/m^2
Floor finishing	1.5 KN/m^2
Size of frame	20 x 20
Spacing between frames	4m
Grade of concrete	M30
Grade of steel	FE500
Structure type	OMRF

2.2 Main methodology

1. G+20 residential building is considered in Zone V.
2. Shear wall are modelled using ETABS software
3. Comparison of bare frame system with shear wall frame interaction system and finding the effectiveness of shear wall in seismic performance.
4. Model 1: Model 1 is bare frame model.

5. Model 2: Model 2 is of dual type structural system (Shear wall and frame interaction system) with shear wall will located at periphery of the building. The thickness of shear wall will be considered as 150mm.
6. Model 3: Model 3 is also dual type structural system (Shear wall and frame interaction system) in which shear wall will be located at central core that is lift. Equivalent Static analysis Equivalent static analysis will be carried out on the above three models. Earthquake forces will be calculated for each of the model according to IS 1893:2002 (part I) and will be distributed along the height of the building.
7. Both Static and dynamic analysis will be done.
8. Results will be presented in terms of shear force, Bending moment, storey stiffness, deflections, torsion.

2.3 LOAD COMBINATIONS

Load combination used as per IS1893 (Part 1):2002 clause6.3.1.2, the following load cases have to be consider for analysis

a) 1.5 (DL + IL)

b) 1.2 (DL ± IL ± EL)

c) 1.5 (DL ± EL)

d)0.9 DL ± 1.5 EL

3.RESULTS AND DISCUSSION

3.1 DISPLACEMENT RESULTS

Bare framed model

STOREY	DISPLACEMENT(in mm)
21	225.418
20	222.130
19	217.732
18	212.011
17	204.955
16	196.638
15	187.173
14	176.653
13	165.299
12	153.139
11	140.320
10	126.952

9	113.136
8	98.971
7	84.553
6	69.987
5	55.405
4	41.007
3	27.145
2	14.504
1	4.483

STOREY	DISPLACEMENT(in mm)
21	141.766
20	144.152
19	126.267
18	118.281
17	210.157
16	101.903
15	93.540
14	85.103
13	76.637
12	68.196
11	59.846
10	51.658
9	43.714
8	36.100
7	28.911

6	22.250
5	16.224
4	10.952
3	6.557
2	3.173
1	0.926

3.3 STOREY DRIFT
Bare framed model

STOREY FRAME	STOREY DRIFT(in mm)
21	1.64
20	2.2
19	2.861
18	2.528
17	4.158
16	4.733
15	5.244
14	5.693
13	6.08
12	6.049
11	6.68
10	6.90
09	7.08
08	7.20
07	7.28
06	7.29
05	7.19

04	7.6.93
03	6.32
02	5.01
01	2.243
00	00

Shear wall located at central core

STOREY	MAX SOREY DRIFT(in mm)
20	3.943
19	3.993
18	4.06
17	4.12
16	4.18
15	4.21
14	4.23
13	4.22
12	4.17
11	4.09
10	3.97
09	3.80
08	3.59
07	3.33
06	3.01
05	2.63
04	2.19
03	1.69
02	1.12
01	0.47
00	00

FRAMED

IS1893 2002 Auto Seismic Load Calculation

This calculation presents the automatically generated lateral seismic loads for load pattern EY according to IS1893 2002, as calculated by ETABS.

Direction and Eccentricity

Direction = Y + Eccentricity X

Eccentricity Ratio = 5% for all diaphragms

Structural Period

Period Calculation Method = Program Calculated

Factors and Coefficients

Seismic Zone Factor, Z [IS Table 2] $Z = 0.36$

Response Reduction Factor, R [IS Table 7] $R = 3$

Importance Factor, I [IS Table 6] $I = 1$

Site Type [IS Table 1] = II

Seismic Response

Spectral Acceleration Coefficient, S_a /g [IS 6.4.5] $\frac{S_a}{g} = 0.34$ $\frac{S_a}{g} = 0.34$

Equivalent Lateral Forces

Seismic Coefficient, A_h [IS 6.4.2] $A_h = \frac{ZI\frac{S_a}{g}}{2R}$

Calculated Base Shear

Direction	Period Used (sec)	W (kN)	V_b (kN)
Y + Ecc. X	4.827	54196.6165	1105.611

PERIPHERY

IS1893 2002 Auto Seismic Load Calculation

This calculation presents the automatically generated lateral seismic loads for load pattern EX according to IS1893 2002, as calculated by ETABS.

Direction and Eccentricity

Direction = X + Eccentricity Y

Eccentricity Ratio = 5% for all diaphragms

Structural Period

Period Calculation Method = Program Calculated

Factors and Coefficients

Seismic Zone Factor, Z [IS Table 2] $Z = 0.36$
Response Reduction Factor, R [IS Table 7] $R = 3$
Importance Factor, I [IS Table 6] $I = 1$
Site Type [IS Table 1] = II

Seismic Response

Spectral Acceleration Coefficient, S_a /g [IS 6.4.5] $\frac{S_a}{g} = \frac{1.36}{T}$ $\frac{S_a}{g} = 0.354751$

Equivalent Lateral Forces

Seismic Coefficient, A_h [IS 6.4.2] $A_h = \frac{ZI\frac{S_a}{g}}{2R}$

Calculated Base Shear

Direction	Period Used (sec)	W (kN)	V_b (kN)
X + Ecc. Y	3.834	55618.5715	1183.8432

<u>DUCT</u>

IS1893 2002 Auto Seismic Load Calculation

This calculation presents the automatically generated lateral seismic loads for load pattern EX according to IS1893 2002, as calculated by ETABS.

Direction and Eccentricity

Direction = X + Eccentricity Y

Eccentricity Ratio = 5% for all diaphragms

Structural Period

Period Calculation Method = Program Calculated

Factors and Coefficients

Seismic Zone Factor, Z [IS Table 2] $Z = 0.36$
Response Reduction Factor, R [IS Table 7] $R = 3$
Importance Factor, I [IS Table 6] $I = 1$
Site Type [IS Table 1] = II

Seismic Response

Spectral Acceleration Coefficient, S_a /g [IS 6.4.5] $\frac{S_a}{g} = \frac{1.36}{T}$ $\frac{S_a}{g} = 0.466667$

Equivalent Lateral Forces

Seismic Coefficient, A_h [IS 6.4.2] $A_h = \frac{ZI\frac{S_a}{g}}{2R}$

Calculated Base Shear

Direction	Period Used (sec)	W (kN)	V_b (kN)
X + Ecc. Y	2.914	55811.4895	1562.7214

ACKNOWLEDGEMENT

The Authors would like to thanks Project Guide Prof. S.c Kali & Staff of Civil Engineering Department of Matoshri College Of Engineeering & Research Centre,Nashik

REFERENCES

1. TarunShrivastava, Prof.AnubhavRai, Prof.Yogesh Kumar Bajpai. Effectiveness of shear wall-frame structure subjected to wind loading in multi-storey building.ISSN 2250 – 3005 Vol, 05 Issue 02 February 2015.
2. Suresh Kumar Nagar, AltafAlam. Analysis of RC building with placement and opening in shear wall against earthquake loads. ISSN 2394 – 3386 Volume 4, Issue 3 March 2017.
3. Ashish S. Agrawal, S. D. Charkha.Effect of change in shear wall location on storey drift of multi-storey building subjected to lateral loads. International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622 Vol. 2, Issue 3, May-Jun 2012, pp.1786-1793.
4. N. JitendraBabu, K.V.G.D Balaji& S.S.S.V Gopalaraju (2012). Pushover Analysis of Unsymmetrical Framed Structures on Sloping Ground. International Journal of Civil, Structural, Environmental and Infrastructure Engineering Research and Development (IJCSEIERD) ISSN 2249-6866 Vol. 2 Issue 4 Dec - 2012 45-54.
5. AnujChandiwala December 2012. Earthquake Analysis of Building Configuration with Different Position of Shear Wall. ISSN 2250-2459, Certified Journal, Volume 2, Issue 12, December 2012.
6. Syed Ehtesham Ali, MohdMinhaj Uddin Aquil. Study of Strength of RC Shear Wall at Different Location on Multi-Storied Residential Building. Int. Journal of Engineering Research and Applications. ISSN: 2248-9622, Vol. 4, Issue 9(Version 5), September 2014, pp.134-141.