Structural behaviour of a Multi-Storey Building Constructed by Shear Walls

Gowrishankar B N[1] Nethravathi S M[2] Preetham H P[3] Darshan T G[4] Ravikumar B S[5]
[1,3,4]PG Student [2,5]Assistant Professor
[1,2,3,4,5]Department of Civil Engineering
[1,2,3,4,5]Sahyadri College of Engineering and Management, Karnataka, India

Abstract— Shear walls are structurally efficient solution to stiffen a building structural system because the main function of a shear wall is to increase the rigidity for lateral load resistance. Shear walls in medium and high rise reinforced concrete buildings for the sake of interaction with the lateral forces, used by many of engineers, however past studies on the behavior and situation of shear wall indicated that shear walls has better behavior. The present study was carried out in a 15 story shear wall building, located in seismic zone 2.Two models was considered for the study, first one was the building constructed only by shear wall (Model-M1) and the second one was with RC-Frame structure with shear wall (Model-M2). Response spectrum analysis is conducted and from the response spectrum analysis, the maximum displacement obtained for building with for RC-Frame structure than the building with only shear wall, i.e. storey drift is reduced when shear wall is provided for entire structure. To analyze the wall-frame interaction behavior, lateral forces obtained from the equivalent static analysis were applied on the nodes of exterior faces. The study shows that, as the height of building increases, shear wall absorb more lateral force than the frame.

Key words: Shear Walls, Base Shear, Displacement, Storey Drifts, Response Spectrum Analysis

I. INTRODUCTION

Particularly population is increasing day by day in metropolises, it give rise to demand for tall buildings. As terrestrial offered, for construction is less, this partakes the builders to recourse to perpendicular development of the structures in the form of multi-storeyed buildings. A RC-frame structure may enclose beams, columns, slabs, walls and several storeys. A structure frame is generally exposed to both horizontal and perpendicular loads. The lifeless weight of the beams, columns and slabs are comes under vertical loads and wind and shaking loads are comes under horizontal loads. The basic conduct of structures is firmly influenced by the task of shear walls and the inflexibility of floors and the associations of floors to the walls. Shear walls are ordinarily organized such that, they oppose parallel load on either axis of the building adequately. As the efficiency of the system is artificial by the locality of shear walls. The present study has, therefore been planned on "Structural Performance of multi storeyed building constructed by shear walls", with a goal to identify the most proper shear wall system. To analyse RC framed multi-storeyed buildings with shear walls in some part and providing only shear walls to entire building without beams and sections. Shear walls are the walls which are constructed to diminish lateral displacement of the structure due to earthquake loads as well as wind loads. Shear walls have the quality of providing stiffness to structure to counterattack the parallel forces.

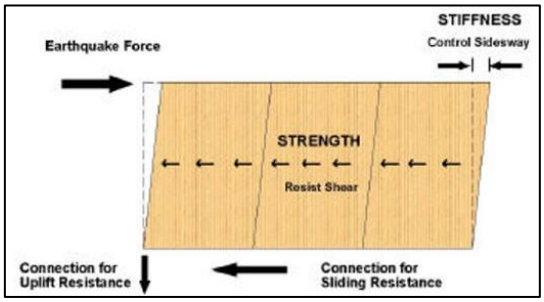

Fig. 1: Function of shear wall.

II. NEED FOR STUDY

The principle goal of giving these walls in structure is to discover the different courses in which the tall structures can be stabilized against the impacts of strong horizontal wind load and quake load. Some different reasons why we utilize shear walls in tall structures to diminish the region utilized and we can oblige an extensive population in that specific territory. Other reason is to build a financially effective structure in less timeframe.

III. OBJECTIVE OF THE STUDY

- Shear walls auxiliary frameworks stay steadier. Since, their supportive part, with location to aggregate arrangements region of structure, is relatively extra, not at all like on account of RCC framed structures.
- Walls need to fight back the horizontal force of the gust that tries to drive the walls in and jerk them far on or after the building.
- Shear walls are brisk in development, and popular in nation similar to India wherever settlement is imperative in a little space of time, shear walls be able to build rapidly. The accuracy to which they are assembled stays additionally great related with regularly constructed brick structures.
- Hence the key autonomous of shear barrier is to construct a sheltered, big, wonderful structure.

IV. LITERATURE REVIEW

Ravikanth Chittiprolu, defined about the "Significance of Shear Wall in High rise Irregular Buildings". The utilization of shear walls in the basic arranging of high rise structures has for quite some time been perceived. At the point as soon as walls are arranged in various places in a building, walls can be exceptionally well-organized in opposing horizontal masses beginning from gust or quakes. A review, on an unpredictable tall structure with shear barrier & without shear barrier was examined to know the horizontal loads, floor drifts, and twisting impacts. After the outcomes, he demonstrates that shear walls are extra impervious to horizontal loads in an asymmetrical structure. Subsequently,

it is reasoned that shear barriers are reward impervious to equivalent loads in a structure. Additionally they are utilized to diminish the impacts of twisting.

Mr.K.LovaRaju agent area of shear walls on execution of structure casing subjected to seismic activity load. In his paper, three sorts of structures by means of G+7 is considered in which one of the case lacking shear wall & two edges with shear wall in different positions. The reaction range investigation is finished utilizing ETABS v9.7.2 programming. The structure is intended for Seismic region 2, 3, 4 and 5. In pushover analysis the sidelong strength increments by increment in ht. of structure. The conduct of building is controlled by containing, extreme load and most extreme avoidance.

V. MODELLING OF THE BUILDING

The entire analysis has done for all the 3D models using ETABS Nonlinear version software. Major two models are done. Types of buildings considered for present study are:

– Shear wall building
– Reinforced Concrete Frame building.

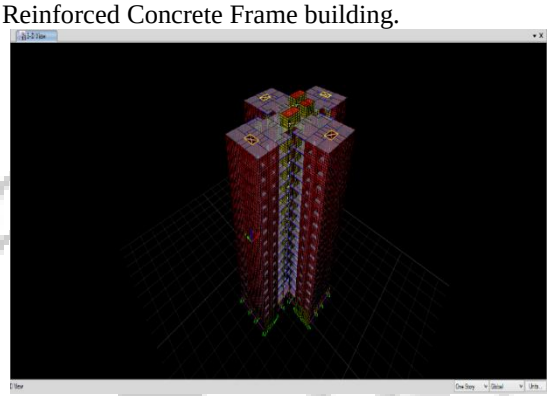

Fig. 2: 3D Model Shear Wall Structure (Model M1)

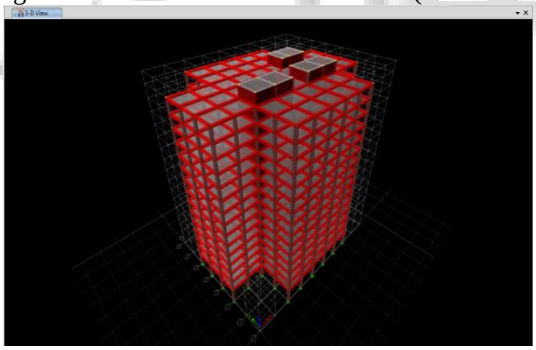

Fig. 3: 3D Model of RC-Frame Structure (Model M2).

VI. METHODOLOGY

The software used for the present study is ETABS 15.2.2. It is product of Computers and Structures, Berkeley, USA. ETABS 15.2.2 is used for analyzing general structures including bridges, stadiums, towers, industrial plants, offshore structures, buildings, dam, silos, etc. It is a fully integrated program that allows model creation, modification, execution of analysis, design optimization, and results review from within a single interface. ETABS 15.2.2 is a standalone finite element based structural program for analysis and design of civil structures. It offers an intuitive, yet powerful user interface with many tools to aid in quick and accurate construction of models, along with sophisticated technique needed to do most complex projects. The analysis is carried out by both linear static and nonlinear static methods in accordance with IS-1893-2002 (part-1), to study the performance levels and performance points of the building. Building data used for modeling all kinds of the buildings are tabulated below:

Parameters	Model M1	Model M2
Seismic Zone	II	II
Seismic Zone Factor	0.1	0.1
Response Reduction Factor	3	3
Height of Building	47.4m	47.4m
Thickness of Shear Wall	160mm	150mm
Thickness of Slab	180mm	180mm
Beam Size	-	300*450mm
Column Size	-	450*450mm
Live Load	2kN/m^2	2kN/m^2
Material Properties	M30, Fe415, Fe500	M30, Fe415, Fe500

Table 1: Building Data Used For Modeling.

VII. RESULTS AND DISCUSSIONS

Maximum storey displacement and Mass participation ratio are considered as parameters for results and discussions. Graphs are plotted from the result obtained from E – TABS 2015. These graphs are merged according to their Zones are related according to the models prepared.

Storey	Model-M1	Model-M2
OHT Bottom	0.269	0.855
TF Slab	0.285	1.009
13 FR	0.262	0.852
12 FR	0.238	0.749
11 FR	0.215	0.654
10FR	0.193	0.563
9 FR	0.171	0.477
8 FR	0.15	0.397
7 FR	0.13	0.324
6 FR	0.112	0.258
5 FR	0.094	0.201
4 FR	0.084	0.18
3 FR	0.082	0.165
2 FR	0.088	0.153
1 ST	0.113	0.142
GFR	0.173	0.139
BFR	0.102	0.135
PLINTH	0.064	0.127
Base	0	0

Table 2: Lateral displacement along X-Direction.

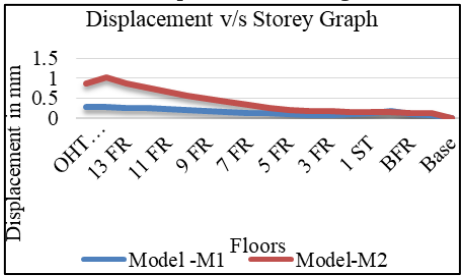

Fig. 4: Comparison of Lateral Displacement of Shear wall and RC-frame with maximum and minimum top storey displacements.

Mode	Model-M1	Model-M2

	Period	UX	Period	UX
1	0.572	0.2613	1.046	0.0033
2	0.457	0.4905	0.845	0.2248
3	0.42	0.0003	0.709	0.4717
4	0.143	0.0357	0.279	0.0071
5	0.128	0.1151	0.243	0.0118
6	0.12	0.0149	0.176	0.1765
7	0.068	0.0027	0.149	0.0058
8	0.063	0.0383	0.119	0.0015
9	0.058	0.0025	0.102	0.0006
10	0.044	0.0003	0.086	0.0538
11	0.042	0.0001	0.08	0.0005
12	0.041	0.0166	0.078	0
Sum	97.83	98.55	Sum	95.77

Table 3: Mass participation ratio of Model 1 and Model 2.

According to IS 1893(part 1)-2002 clause no.7. 8.4.2, the amount of modes to be recycled in the analysis had better be such that the sum of total modal mass consider is at smallest amount 90% of the overall seismic mass in Model-M2 is greater than 92%.and in Model-M1 is greater than 95%. Hence torsional effect nullify in Model-M1 because of providing only Shear walls.

Mode	Model-M1		Model-M2	
	Period	Frequency	Period	Frequency
1	0.572	1.749	1.046	0.956
2	0.457	2.187	0.845	1.184
3	0.42	2.381	0.709	1.41
4	0.143	6.999	0.279	3.579
5	0.128	7.83	0.243	4.114
6	0.12	8.348	0.176	5.685
7	0.068	14.722	0.149	6.727
8	0.063	15.771	0.119	8.412
9	0.058	17.261	0.102	9.774
10	0.044	22.957	0.086	11.623
11	0.042	23.857	0.08	12.528
12	0.041	24.332	0.078	12.86

Table 4. Modal Periods and Frequencies of M1 and M2.

From the above Table 4, it is observed that Natural time period is low in Shear wall structure i.e. Model-M1, where natural time period of Model-M2 i.e. RC Frame structure is high compared to Model-M1.

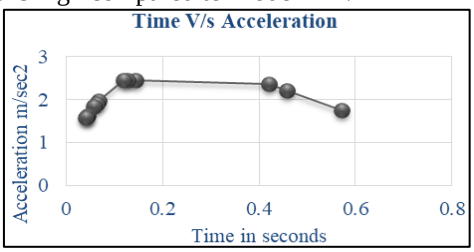

Fig. 5: Time v/s Acceleration graph for Model-M1.

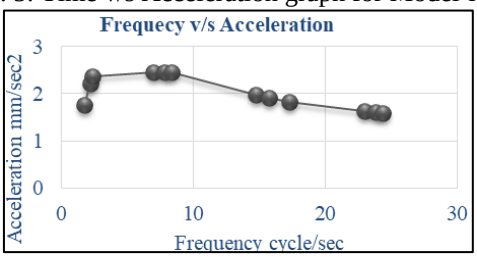

Fig. 6: Frequency v/s Acceleration graph along X-Direction for Model-M1.

VIII. CONCLUSIONS

Shear walls remain the most nominal structural elements in counterattacking lateral/horizontal forces during quake. By means of providing shear barriers in appropriate location, shear walls be able to minimize the effect and harms of the structures due to quake and winds. Stiffness of building increases by adding shear wall, hence reducing the damage to structure.

- As per study, storey drift in Model-M1 is less than Model-M2.
- As per study, Maximum deflection of Model-M1 i.e. Shear wall structure has lesser deflection value compared to RC-Frame structure i.e. Model-M2.
- Modal mass participation ratios for Model M1 and Model M2 are 97.83% and 95.77%, which are above 90% satisfying the clause 7.8.4.2 of IS 1892(Part 1) : 2002.
- Shear wall structure have more base shear than RC-Frame structure ,where structures having more seismic weight will be having high base shear and low natural period.
- Provision of shear walls in high rise buildings usually outcomes in decreasing the displacement of the structure because it growths the stiffness of the structures and withstands lateral forces. The healthier performance is witnessed and displacement is cheap both in X-direction & Y-directions. It displays improved performances w.r.t displacement when study is carried out by linear dynamic analysis.
- It is proved that shears walls which are provided from bottom of structure i.e. from foundation to roof top, are one of the excellent mean for providing earthquake resistance in tall structures. These are little bit expensive but desirable for safe structures.

REFERENCES

[1] RavikanthChittirolu, Ramancharla Pradeep Kumar, "Significance of Shear Wall in High rise Irregular Buildings". International Journal of Education and Applied Research, 2014.

[2] Mr.K.LovaRaju, Dr .Balaji, "Effective location of shear wall on presentation of building frame exposed to earthquake load," International Advanced Research Journal in Science, Engineering and Technology Vol. 2, Issue-1, January 2015,pp 33-36

[3] Shahabodin. Zargarizi. "Comparative investigation on using shear wall and infill to improve seismic performance of existing buildings". The 14th World Conference on Earthquake Engineering, Beijing, China. October 12-17, 2008

[4] Lakshmi K.O, Prof. Jaya Ramanujan,, Mrs. Bindushree, Sunil, Dr. LajuKotllil, Prof. Mercey Joseph Powerth, "Effect of shear wall location in buildings subjected to seismic loads," ISOI Journal of Engineering and Computer science, Volume 1 Issue 1;2014, Page No. 07-17,2014.

[5] S.K. Duggal ,"Earth quake resistant design of structures" Text book, Page no:301 ,8.12 about Shear walls

[6] Marc Gerin, Perry Adebar, "Accounting For Shear In Seismic Analysis Of Concrete Structures" 13th World

Conference On Earthquake Engineering Vancouver, B.C., Canada August 1-6, 2004 Paper No. 1747

[7] Rahul RANA1, Limin JIN2 And Atila ZEKIOGLU3, "Pushover Analysis Of A 19 Story Concrete Shear Wall Building", 13th World Conference on Earthquake Engineering Vancouver, B.C., August 1-6, 2006 Pg no. 133

[8] Romy Mohan and C Prabha, "Dynamic Analysis of RCC Buildings with Shear Wall", IJESE, Volume 04, no 06, July 2011, pg no. 659-662

