INTERNATIONAL JOURNAL OF SCIENTIFIC & ENGINEERING RESEARCH, VOLUME 9, ISSUE 7, JULY-2018
ISSN 2229-5518

Optimum location of a shear wall in a R.C building

Mr.Madhu sudhan rao.kondapalli

Department of civil engineering, anil neerukonda institute of technology and sciences
Sanghivalasa,visakhapatnam,andhra pradesh,531162,india.
Mail id : madhusudhan.14.civil@anits.edu.in

Abstract: ***Shear walls are commonly used as vertical structural element for resisting the lateral loads that may be induced by the loads due to wind and earthquake. Besides that, they also carry gravity loads. A well designed system of shear wall in building frame improves seismic performance significantly. This study aims at comparing various parameters such as storey drift, storey shear and storey displacement of a building under lateral loads based on strategic positioning of shear walls. Linear static analysis has been adopted in this paper. The software used is E-TABS.***

Keywords: story displacement, storey drift, linear analysis, shear wall, seismic zone.

1. Introduction

Shear wall systems are one of the most commonly used lateral load resisting systems in high rise buildings. An introduction of shear wall represents a structurally efficient solution to stiffen a building, because the main function of a shear wall is to increase the rigidity for lateral load resistance. In modern tall buildings, shear walls are commonly used as a vertical structural element for resisting the lateral loads that may be induced by the effect of wind and earthquakes. Shear wall has high in-plane stiffness and strength which can be used to simultaneously resist large horizontal loads and support gravity loads, which significantly reduce lateral sway of the building and thereby reduce damage to structure. Shear walls in buildings must be symmetrically located in plan to reduce ill-effects and twist in buildings.

Shear walls are like vertically-oriented wide beams which transfer these horizontal forces to the next element in the load path. These other components in the load path may be other shear walls, floors, foundation walls, slabs or footings and finally these walls carry earthquake loads downwards to the foundation. These walls generally start at foundation level and are continuous throughout the building height. It is possible for a Reinforced concrete multi-storey building to resist both the vertical and horizontal load without considering a shear wall, but the problem is beam and column sizes are become quite heavy, steel quantity requirement is also in large amount thus there is lot of congestion takes place at joints and it is difficult to place and vibrate concrete.

When shear walls are situated in advantageous positions in the building, they can form an efficient lateral force resisting system by reducing lateral displacements under earthquake loads. Therefore it is very necessary to determine effective, efficient and ideal location of shear wall.

It may be possible to decide the optimum or ideal location of shear wall in a building by comparing various parameters such as **storey displacement**, **storey (or) base shear**, **storey drift** and reinforcement requirement in columns etc of a building under lateral loads based on strategic positioning of shear wall. In our project some of the above parameters are being calculated by using software E-TABS 9.5.

2. Objectives :

- The main objective is to check and compare the seismic response of multi-storied building for different location of shear wall, so that one can choose the best alternative for construction in earthquake-prone area.
- Different location of shear wall in R.C.Building will be modelled in E-TABS software and the results in terms of storey displacement, storey drift, storey shear is compared.

3. Storey parameters

- **Storey displacement**
  It is the total displacement of the storey with respect to ground.
  Allowable displacement = $\frac{\text{Total Height Of Building}}{500}$.
- **Storey drift**
  Storey drift is the displacement of one level relative to the other level above or below it: As per Clause no. 7.11.1 of IS 1893 (Part 1): 2002, the storey drift in any storey due to specified design lateral force with partial load factor of 1.0, shall not exceed 0.004 times the storey height. In Software value of storey drift is given in ratio.
  Storey drift ratio
  $= \frac{\text{Difference Between Displacement Of Two Storeys}}{\text{Height Of One Storey}}$
- **Base(or)storey shear**
  It is the maximum expected lateral force that will occur due to seismic ground motion at the base of structure.

4. Design Loads (Types of Loads Used)

INTERNATIONAL JOURNAL OF SCIENTIFIC & ENGINEERING RESEARCH, VOLUME 9, ISSUE 7, JULY-2018
ISSN 2229-5518

4.1 Dead Loads (Dl) :
The first vertical load that is considered is dead load. Dead loads are permanent or stationary loads. Which are transferred to structure throughout the life span. Dead load is primarily due to self weight of structural members, permanent partition walls, fixed permanent weight of different materials. The calculation of dead loads of each structure are calculated by the volume of each section and multiplied with the unit weight.
4.2 Imposed Loads Or Live Loads (IL Or LL) :
The second vertical load that is considered in design of a structure is imposed loads or live loads. Live loads are either movable or moving loads without any acceleration or impact. These loads are assumed to be produced by the intended use or occupancy of the building including weights of movable partitions or furniture etc.
Live loads keep on changing from time to time. These loads are to be suitably assumed by the designer. It is one of the major loads in the design. The minimum values of live loads to be assumed are given in IS 875 (part 2)–1987. It depends upon the intended use of the building.
4.3 Wind Loads :
Wind load is primarily horizontal load caused by the movement of air relative to earth. Wind load is required to be considered in structural design especially when the height of the building exceeds two times the dimensions transverse to the exposed wind surface.
4.4 Earthquake Loads (Or) Seismic Loads:
The seismic (or) earth quake loads on the structure during an earthquake result from inertia forces which were created by ground accelerations. The magnitude of these loads is a function of the following factors: mass of the building, the dynamic properties of the building, the intensity, duration, and frequency content of the ground motion, and soil-structure interaction.

5. Seismic Zones of India:

The earthquake zoning map of India divides India into 4 seismic zones (Zone 2, 3, 4 & 5). According to the present zoning map, Zone 5 expects the highest level of seismicity whereas Zone 2 is associated with the lowest level of seismicity.

Table 1 zone factors

Zone no	Factors
5	**0.36**
4	**0.24**
3	**0.16**
2	**0.1**

6. Building details

Table 2 Building Details

S.no	Particulars	Data
1	No. Of storeys	15
2	Plan dimension	20x20 m
3	Storey height	3.0 m
4	Grade of concrete	M25,M30
5	Grade of steel	Fe415
6	Thickness of slab	0.2 m
7	Beam size	0.6x0.6 m
8	Column size	0.6x0.6 m
9	Seismic zone	2
10	Seismic factor	0.1
11	Earthquake load for type2	As per IS 1893:2002
12	Top storey load	1.5 KN/m^2
13	Intermediate storey load	3.0 KN/m^2
14	Floor/cover load	1.0 KN/m^2

7. Material properties:

Strength of concrete
(f_{ck}) = 30 N/mm^2
Yield strength of main reinforcement
(f_y) = 415N/mm^2
Yield strength of shear reinforcement
(f_{ys}) = 415 N/mm^2
Young's modulus of concrete
(E_c) = $3x10^4$ N/mm^2

8. Loading:

Table 3 load cases

Load cases	Type	Details
Dead	Dead load	Use self-weight multiplier
Floor	Live load	Slab: 200mm
Storey	Live load	Slab: 200 mm Beams: 600x600 mm
Earthquake	Seismic load	Is:1893:2002 response reduction factor = 5

INTERNATIONAL JOURNAL OF SCIENTIFIC & ENGINEERING RESEARCH, VOLUME 9, ISSUE 7, JULY-2018
ISSN 2229-5518

9. Model in E-TABS

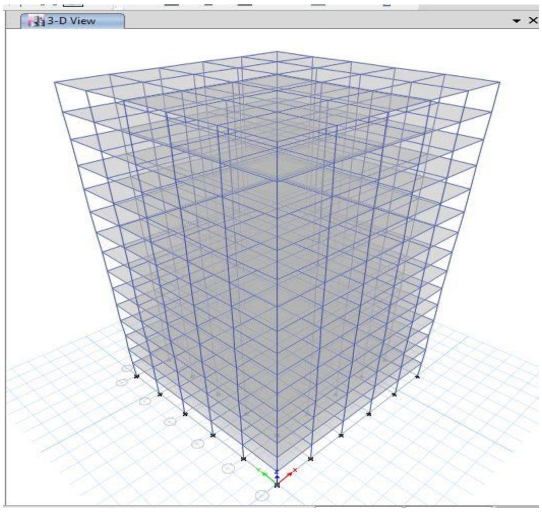


Fig 1 3-D view of model

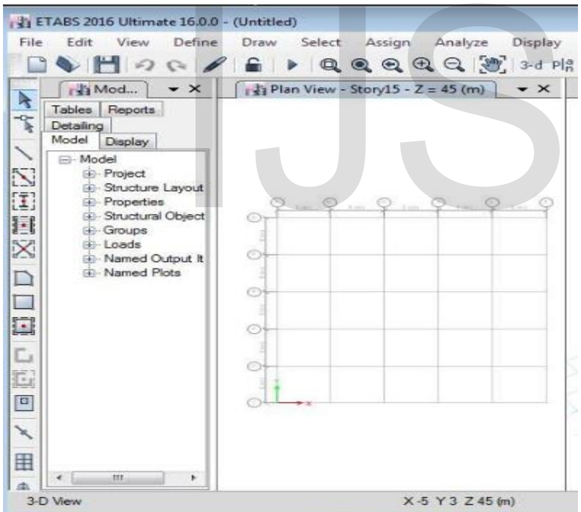


Fig 2 floor plan

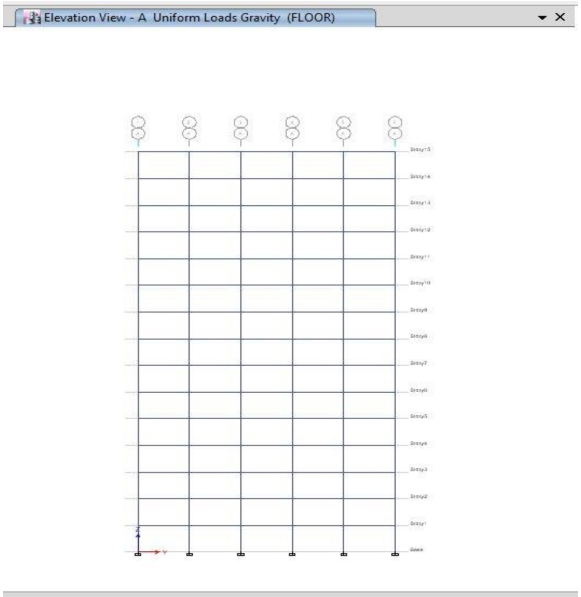


Fig 3 elevation

10. Models:

The following are the models to be considered for analysis of a R.C building with shear walls at various locations.

i.	Bare frame (no shear walls)	M1
ii.	Shear wall at central core	M2
iii.	Shear walls at corners	M3
iv.	Shear walls at edge faces	M4
v.	Shear walls at core + corners	M5
vi.	Shear walls at core + edges	M6

11. Results and discussions

After analysis done for the building without shear walls the various storey parameters are compared with the models having shear walls placing at strategic positions. The following results are evaluated below by comparing the storey parameters.

11.1 Comparison Of A Parameter (Storey Displacement) :

INTERNATIONAL JOURNAL OF SCIENTIFIC & ENGINEERING RESEARCH, VOLUME 9, ISSUE 7, JULY-2018
ISSN 2229-5518

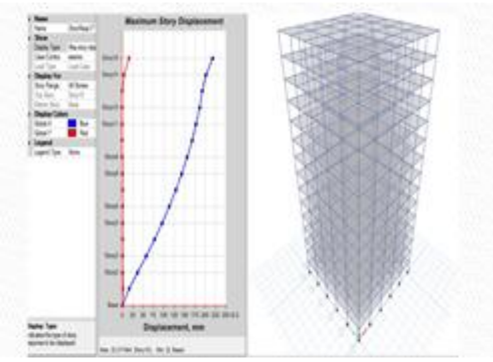


Fig 4 model 1 storey displacement plot

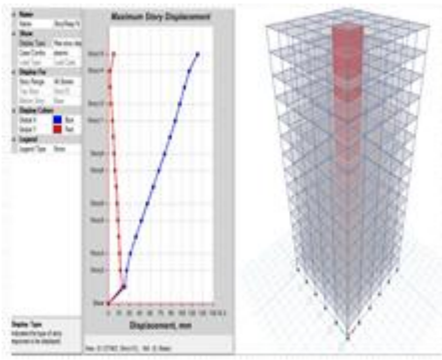


Fig 5 model 2 storey displacement plot

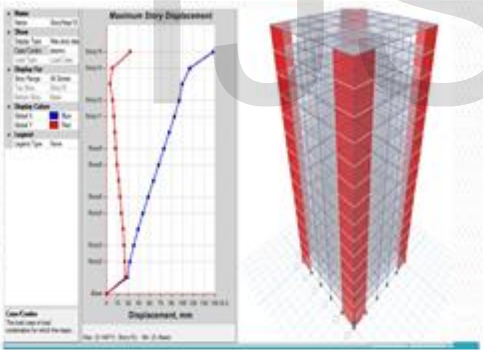


Fig 6 model 3 storey displacement plot

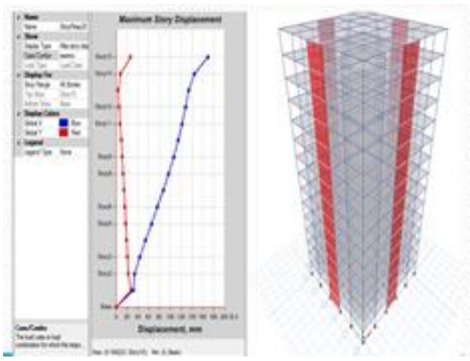


Fig 7 model 4 storey displacement plot

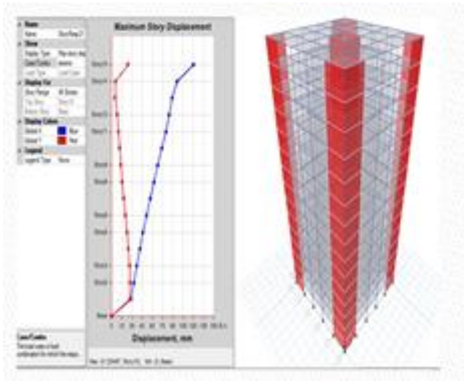


Fig 8 model 5 storey displacement plot

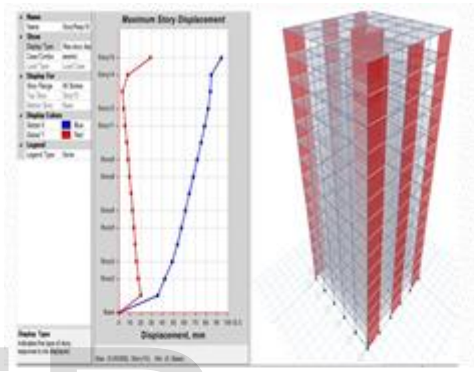
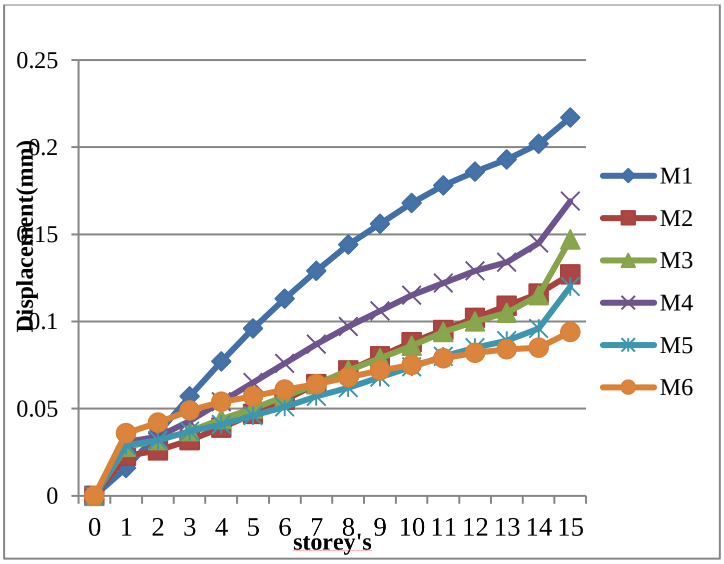
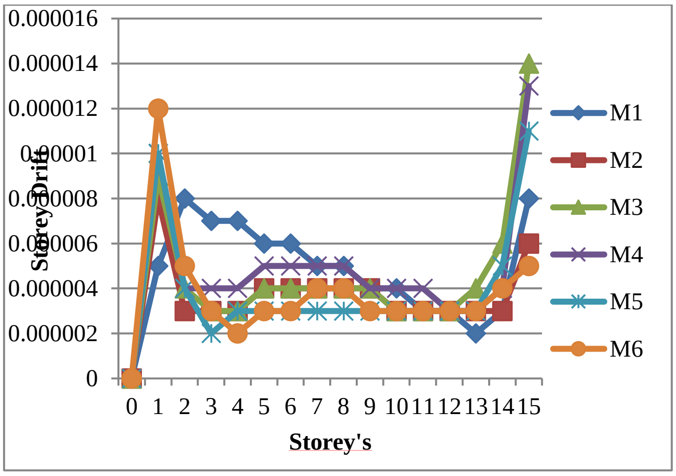


Fig 9 model 6 storey displacement plot

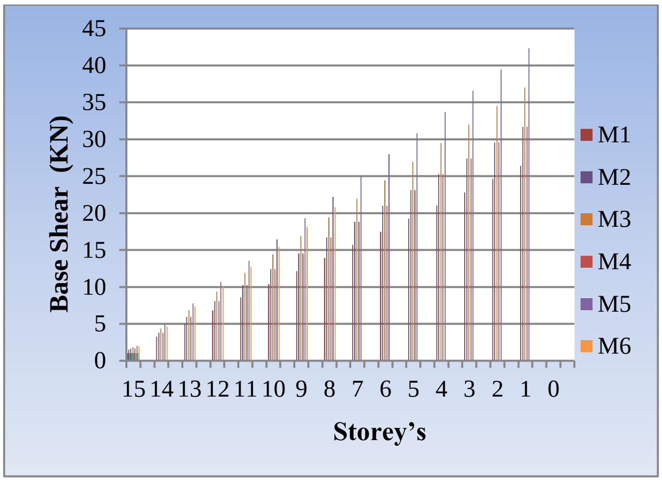


Graph 1 storeys vs storey displacement(mm)

INTERNATIONAL JOURNAL OF SCIENTIFIC & ENGINEERING RESEARCH, VOLUME 9, ISSUE 7, JULY-2018
ISSN 2229-5518



Graph 2 storeys vs storey drift



Bar chart 1 storeys vs base shear (kn)

Table 4 Combination of storey displacement plots of above six models

Storey's no's	M1 displacement(mm)	M2 displacement(mm)	M3 displacement(mm)	M4 displacement(mm)	M5 displacement(mm)	M6 displacement(mm)
15	0.217	0.127	0.147	0.169	0.12	0.094
14	0.202	0.116	0.115	0.145	0.096	0.085
13	0.193	0.109	0.105	0.134	0.089	0.084
12	0.186	0.102	0.1	0.129	0.085	0.082
11	0.178	0.095	0.094	0.122	0.08	0.079
10	0.168	0.088	0.086	0.115	0.074	0.075
9	0.156	0.08	0.079	0.106	0.068	0.072
8	0.144	0.072	0.072	0.097	0.062	0.068
7	0.129	0.064	0.064	0.087	0.057	0.064
6	0.113	0.055	0.057	0.076	0.051	0.061
5	0.096	0.047	0.05	0.065	0.046	0.057
4	0.077	0.039	0.044	0.054	0.041	0.054
3	0.057	0.032	0.037	0.043	0.037	0.049
2	0.036	0.026	0.032	0.034	0.032	0.042
1	0.016	0.023	0.028	0.031	0.029	0.036
0	0	0	0	0	0	0

INTERNATIONAL JOURNAL OF SCIENTIFIC & ENGINEERING RESEARCH, VOLUME 9, ISSUE 7, JULY-2018
ISSN 2229-5518

Table 5 comparison of models to model 1 by % reduction in displacement

Storey's	M2	M3	M4	M5	M6
No's	% reduction in displacement	% reduction in displacement	% reduction in displacement	% reduction in displacement	% reduction in displacement
15	41.47	32.25	22.11	44.7	56.68
14	42.57	43.06	28.21	52.47	57.92
13	43.52	45.59	30.56	53.88	56.47
12	45.161	46.23	30.64	54.30	55.91
11	46.62	47.191	31.46	55.05	55.61
10	47.61	48.80	31.54	55.95	55.35
9	48.71	49.35	32.05	56.41	53.84
8	50	50	32.63	56.94	52.77
7	50.38	50.38	32.55	55.81	50.38
6	51.32	49.55	32.74	54.86	46.01
5	51.041	47.91	32.291	52.083	40.625
4	49.35	42.85	29.87	46.75	29.87
3	43.85	35.08	24.56	35.08	14.03
2	27.77	11.11	5.55	11.11	-16.66
1	-43.75	-75	-93.75	-81.25	-125
0	0	0	0	0	0

INTERNATIONAL JOURNAL OF SCIENTIFIC & ENGINEERING RESEARCH, VOLUME 9, ISSUE 7, JULY-2018
ISSN 2229-5518

Table 6 combination of storey drifts of above six models

STOREYS	M1	M2	M3	M4	M5	M6
15	8.00E-06	6.00E-06	1.40E-05	1.30E-05	1.10E-05	5.00E-06
14	3.00E-06	3.00E-06	6.00E-06	4.00E-06	5.00E-06	4.00E-06
13	2.00E-06	3.00E-06	4.00E-06	3.00E-06	3.00E-06	3.00E-06
12	3.00E-06	3.00E-06	3.00E-06	3.00E-06	3.00E-06	3.00E-06
11	3.00E-06	3.00E-06	3.00E-06	4.00E-06	3.00E-06	3.00E-06
10	4.00E-06	3.00E-06	3.00E-06	4.00E-06	3.00E-06	3.00E-06
9	4.00E-06	4.00E-06	4.00E-06	4.00E-06	3.00E-06	3.00E-06
8	5.00E-06	4.00E-06	4.00E-06	5.00E-06	3.00E-06	4.00E-06
7	5.00E-06	4.00E-06	4.00E-06	5.00E-06	3.00E-06	4.00E-06
6	6.00E-06	4.00E-06	4.00E-06	5.00E-06	3.00E-06	3.00E-06
5	6.00E-06	4.00E-06	4.00E-06	5.00E-06	3.00E-06	3.00E-06
4	7.00E-06	3.00E-06	3.00E-06	4.00E-06	3.00E-06	2.00E-06
3	7.00E-06	3.00E-06	3.00E-06	4.00E-06	2.00E-06	3.00E-06
2	8.00E-06	3.00E-06	4.00E-06	4.00E-06	4.00E-06	5.00E-06
1	5.00E-06	8.00E-06	9.00E-06	1.00E-05	1.00E-05	1.20E-05
0	0	0	0	0	0	0

12. Conclusions:

1. Shear wall placing at adequate locations is more significant in case of base shear and displacement.
2. It is observed that horizontal displacement of a 15 storey building with shear wall at core+edge faces(x-dir) of building is lesser when compared to other models.
3. Larger the width of shear wall , the larger will be the resistances against lateral forces.
4. The graph of displacement reflects that for structure having core shear wall the displacement is least. The maximum structural displacement for 15 storey building is 0.271mm for bare frame structure and least value is 0.127mm for structure with shear wall at core+edge(x-dir) location. The displacement observed is within the limits specified in IS 1893:2002 (Part I).
5. Base shear is inversely proportional to the storey displacement. Hence the model with least storey displacement have the maximum base shear value.it means to resists the maximum lateral force.
6. From the results above it was possible to notify the optimum location of a shear wall by approximate quantitative analysis. since it was model 6 having shear walls at (core+edges). However the edges direction is parallel to the earth quake load applied.

13. Future scope:

1. In this paper i have considered building of 15 storeys only, we can also consider buildings with more number of storeys.
2. I have studied only three major parameters i.e.. storey displacement, storey drift and storey (or) base shear. The volume of work undertaken in this study is limited to comparison of seismic response parameters in a building with different shear wall locations using linear analysis. The study could be extended by including various other parameters such as torsional effects and soft storey effects in a building. Non-linear dynamic analysis may be carried out for further study for better and realistic evaluation of structural response under seismic forces .

3. In this paper I considered the building with regular plan and assumes seismic load be acts in a unidirection.it also to carry out for irregular plan and load acts in a multi directional.

14. References:

[1] **Anshumn. S, Dipendu Bhunia, Bhavin Rmjiyani (2011),** "Solution of shear wall location in Multi-storey building." International Journal of Civil Engineering Vol. 9, No.2Pages 493-506.

[2] **Anuj Chandiwala (2012),** "Earthquake Analysis of Building Configuration with Different Position of Shear Wall", International Journal of Emerging Technology and Advanced Engineering ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 2, Issue 12, December 2012, Adhoc Lecturer in Sarvajanik College of Engineering & Technology, Athvalines, Surat, Gujarat, India.

[3] **A.B. Karnale and Dr.D.N. Shinde (2015)**, "Comparative Seismic Analysis of High Rise and Low Rise RCC Building with Shear Wall", International Journal of Innovative Research in Science, Engineering and Technology, September 2015.

[4] **Chen Qin and Qian Jiaru (2002)**, "Static inelastic analysis of RC shear walls", department of civil engineering, Tsinghua University, Beijing 100084, China.

[5] **IS. 456-2000,** Indian standard Plain and Reinforced Concrete code of practice, Bureau of Indian standards, New Delhi.

[6] **IS 1893 (Part 1): (2002)** Indian Standard Criteria for Earthquake Resistant Design of Structures General Provisions and Buildings.

[7] **Pavan K.E., Naresh A., Nagajyothi M. and Rajasekhar M., (2014), "**Earthquake analysis of multi storied residential building - a case study", Int. Journal of Engineering Research and Applications, Vol. 4 (11), 59-64.

[8] **P. P. Chandurkar and Dr. P. S. Pajgade (2013)**, "Seismic Analysis of RCC Building with and Without Shear Wall", International Journal of Modern Engineering Research (IJMER) www.ijmer.com Vol. 3, Issue. 3, May - June 2013.

[9] **Shah M. D and Patel S. B., (2011),** "Nonlinear static analysis of R.C.C. frames" - Software implementation ETABS 9.7, National Conference on Recent Trends in Engineering & Technology, 1-6.

[10] **Shaik Kamal Mohammed Azam, Vinod Hosur,(2013),** "Seismic Performance Evaluation of Multistoried RC framed buildings with Shearwall", International Journal of Scientific & Engineering Research.

[11] **S.K.Duggal (2007),** "Earthquake resistant design of structures" Oxford university press 2, New Delhi ISBN-13:978-0-19-568817-7.

[12] **S. M. Yarnal, S.S. Allagi, P.M. Topalakatti and A. A. Mulla (2015)**, "Non-Linear Analysis of Asymmetric Shear Wall with Openings", International Journal of Engineering Research & Technology (IJERT) Vol. 4 Issues 08, August-2015.

[13] **Venkata Sairam Kumar.N, Surendra Babu.R, Usha Kranti.J(2014)**,"Shear walls – A review",International Journal of Innovative Research in Science, Engineering and Technology, Feb 2014.