e-ISSN: 2455-5703

Optimum Structural Configuration of Multi-Storey Building by Changing Shear Wall Location

[1]Prof. Payal R. Khokhar [2]Prof. Avinash P. Satasiya [3]Prof. Hiten L. Kheni [4]Prof. Karm P. Balar
[1,2,3,4]Assistant Professor
[1,2,3,4]Department of Civil Engineering
[1,2,3,4]SSASIT, Surat, Gujarat, India

Abstract

A shear wall is a structural element used to resist horizontal forces parallel to the plane of the wall. Shear wall has highly in plane stiffness and strength which can be used simultaneously resisted large horizontal loads and support gravity loads. It is very necessary to determine effective, efficient and ideal location of shear wall. Shear wall are specially designed structure walls include in the building to resist horizontal forces that are includes in the plane of the wall due to wind, EQ and other forces. They are mainly a flexural member and usually provided in the high rise building to avoid the total collapse of the high rise building under seismic forces. In this research G+9 storey building is presented with some investigation which is analyzed by changing various location of shear wall for determining the optimum structural configuration of multistory building by changing shear wall location radially by analyzed and designed as a space frame system by computer aided software, subjected to lateral and gravity loading in accordance with IS provisions.
Keyword- Shear walls, Lateral loading, Zero eccentricity, Stresses, Design configuration

I. INTRODUCTION

A vertical plate like RC wall in reinforced concrete building, called SHEAR WALL. Walls of the building are continuous throughout the height and generally start at foundation level. Shear walls acts a vertical oriented wide beams which carry earthquake loads downward to the foundation. Shear walls are provided along both length & width of building. Their thickness can be as minimum as 150mm or as maximum as 400mm in high rise building. Most RC building has columns with shear walls. These columns & shear walls carry lateral loads & gravity load respectively. Shear walls provide high strength & stiffness to building in the direction of their orientation, which significantly reduces damage to structure and its contents and thereby reduces lateral sway of the building.

Shear wall buildings are usually regular in elevation and in plan. Lower floors of some building are being used for commercial use and the buildings are characterized with larger plan dimensions at those floors. There are setbacks at larger floor height. For residential use, shear wall buildings are most commonly used and can have inhabitants ranging from 100 to 500 per building. Shear walls become an important part of mid and high-rise residential building in the last two decades. As a part of an earthquake resistant building design, under the earthquake load the lateral displacement is decreased by placing the walls in building plans and shear wall structure can be obtained.

Both the vertical and horizontal load can be resisted by RC multi-storeyed building. When shear wall is not introduced in such building, the size of beams and columns is larger and difficulty arises at these joint and it causes the concrete to place and vibrate at these places and it causes the larger displacement, and greater forces are introduced in the building member. According to point of view of economy, shear walls are essential. In the horizontal force resisting system, shear walls are the elements of the horizontal force resisting system. The effects of lateral load acting on a structure can be countered by introducing shear walls. Shear walls are straight external walls that typically form a box which provides all of the lateral support for the building in residential construction. When shear walls are constructed and designed properly, and to resist the horizontal forces they will have the strength and stiffness.

A rigid vertical diaphragm capable of transferring lateral forces from roofs, exterior walls, and floors to the ground foundation in a direction parallel to their planes in building construction. Examples are the vertical truss or reinforced-concrete wall. Lateral forces caused by earthquake, wind, and uneven settlement loads, in addition to the weight of structure and occupants; create powerful twisting (torsion) forces. These forces can literally shear a building apart. Reinforcing a frame by placing or attaching a rigid wall inside it maintains the shape of the frame and prevents rotation at the joints.

Shear walls are important part of high-rise and mid residential buildings in the last two decades. These walls are placed to reducing lateral displacement in building plans under earthquake loads as part of an earthquake resistant building design, so shear-wall frame structures are obtained.

II. AIM OF THE STUDY

To locate the shear, wall from the centre of mass of multi-storey building, and the features of shear wall which is constant.

A. Objectives

1) To Study the operation of computer aided software “STRUD.”
2) Validation of “STRUD.” by designing a model building having existing design data.
3) Preparation of problem building drawing from the data.
4) Model generation of problem building in “STRUD.”
5) Comparison of analysis and design data of four different cases having various radial position of shear wall generated in the “STRUD.”

B. Problem Statement

1) General

1) The G+9 storey RC office building is assumed to be located in seismic zone- III on medium soil (as per IS 1893:2002). It is designed as an ordinary moment-resisting frame. Column sections of size 450mm×450mm, beam sections of size 230mm×450mm, 125 mm thick RCC slab on all floors and shear wall having 300 mm thickness are taken for proposed work.
2) In x-direction (the direction in plan) there are 7 bays, each of 4 m width and in y-direction (the direction in plan) there are 5 bays, each of 4 m width.
3) The building will be used for office purpose. So that there are 150 mm thick interior walls and 300 mm exterior walls are considered.
4) For simplicity in analysis, no balconies used in the building.
5) At the ground floor, slabs are not provided and the floor will directly rest on ground.

2) Data of the Example

A typical building (G+9) having three various position of shear wall and one without shear wall having following:

- Data Floor to Floor height = 3000mm
- Height of Plinth = 500mm above ground level.
- Depth of Foundation = 2100mm below ground level.
- External Walls = 300 mm
- Internal Walls = 150 mm
- Column size = 450mm×450mm
- Beam size = 230mm×450mm

3) Imposed Loads

Roof	Roof Finish	=1.0 KN/m^2
	Live Load	=2.0 KN/m^2
Floor	Floor Finish	=1.0 KN/m^2
	Live Load	=2.0 KN/m^2

4) Earthquake Load

- EQ load generation method = Response Spectrum Method
- Seismic Zone = Zone 3
- Soil Type = Medium Soil
- Percentage Damping = 5 %
- Modal Combination method = SRSS

5) Materials

- Concrete = M20
- Steel: Main & Secondary = Fe 415
- Unit Weight of Concrete = 25 KN/m^2
- Unit Weight of Bricks Masonry = 20KN/m^2
- Design Basis =Limit State Method based on IS: 456-2000

III. RESULT

A. For Trial 1

Live Load = 2 KN/m2

Preliminary Beam Size = 230 x 450 mm

TOTAL QUANTITY OF CONCRETE & STEEL (CASE WISE)		
CASE	QUANTITY OF CONCRETE (m^3)	QUANTITY OF STEEL (Kg)
A	427.527	40502.543
B	443.462	43519.958
C	437.365	47777.905
D	436.07	46638.293

Table 1: Total Quantity of Concrete & Steel (Trial 1)

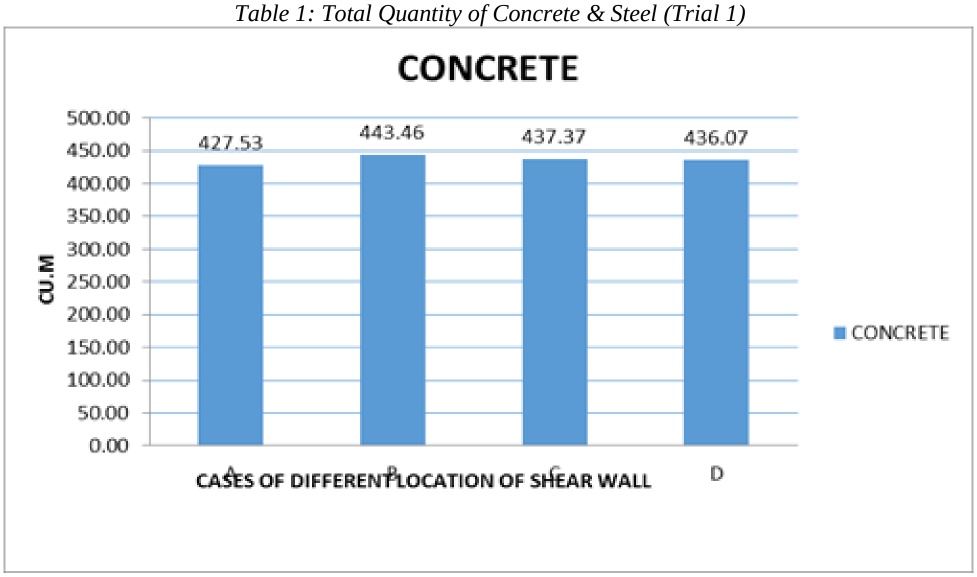

Fig. 1: Comparison of Total Quantity of Concrete Case Wise (Trial 1)

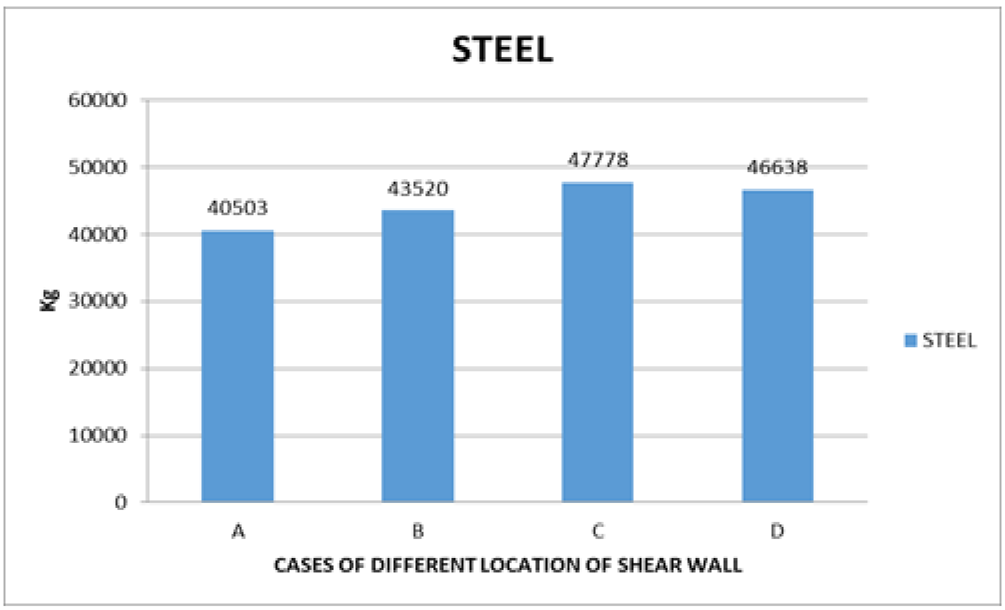

Fig. 2: Comparison of Total Quantity of Steel Case Wise (Trial 1)

B. For Trial 2

Live Load = 2 KN/m^2

Preliminary Beam Size = 230 x 300 mm

TOTAL QUANTITY OF CONCRETE & STEEL (CASE WISE)		
CASE	*QUANTITY OF CONCRETE (m^3)*	*QUANTITY OF STEEL (Kg)*
A	*346.343*	*44417.093*
B	*372.689*	*49253.937*
C	*379.097*	*51502.924*
D	*371.64*	*51442.215*

Table 2: Total Quantity of Concrete & Steel (Trial 2)

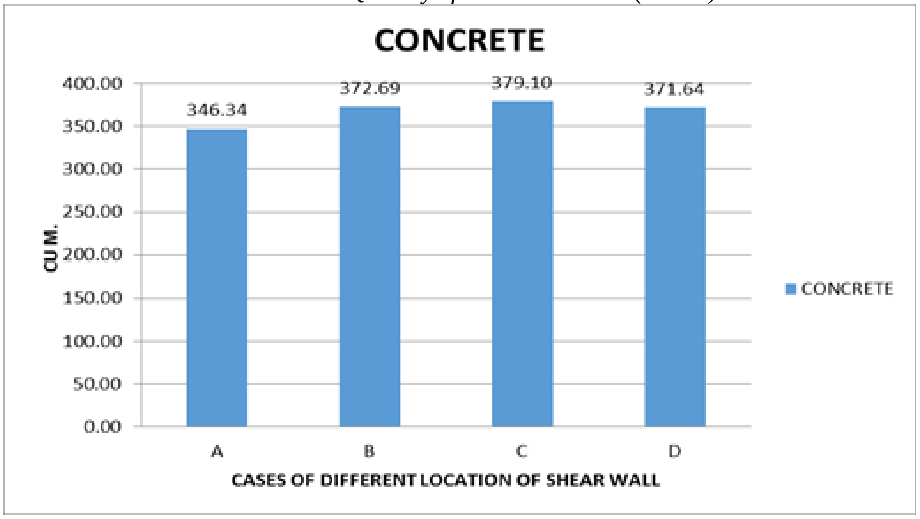

Fig. 3: Comparison of Total Quantity of Concrete Case Wise (Trial 2)

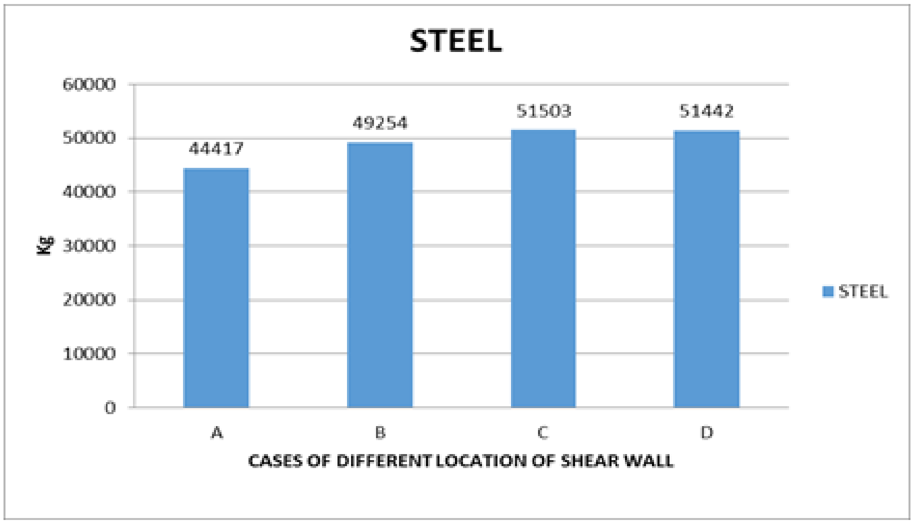

Fig. 4: Comparison of Total Quantity of Steel Case Wise (Trial 2)

C. *For Trial 3:*

Live Load = 3 KN/m^2
Preliminary Beam Size = 230 x 300 mm

TOTAL QUANTITY OF CONCRETE & STEEL (CASE WISE)		
CASE	*QUANTITY OF CONCRETE (m^3)*	*QUANTITY OF STEEL (Kg)*
A	*344.573*	*42026.571*
B	*368.732*	*40526.971*
C	*358.288*	*43556.985*
D	*359.032*	*41639.221*

Table 3: Total Quantity of Concrete & Steel (Trial 3)

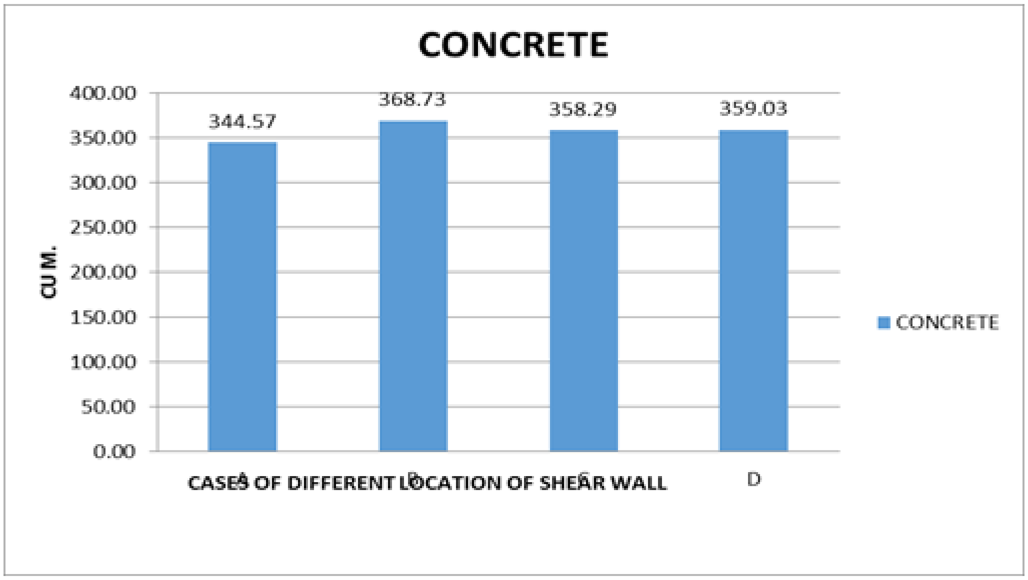

Fig. 5: Comparison of Total Quantity of Concrete Case Wise (Trial 3)

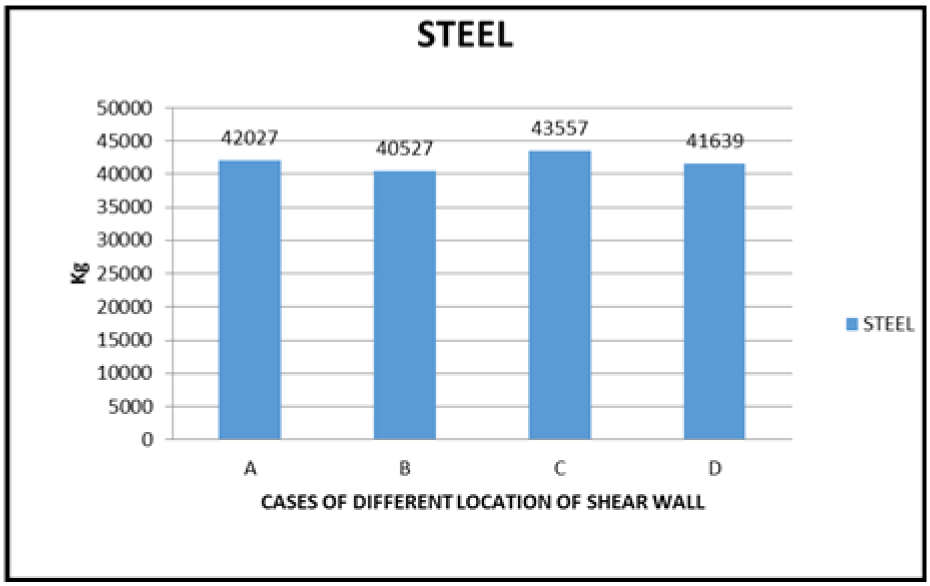

Fig. 6: Comparison of Total Quantity of Steel Case Wise (Trial 3)

IV. CRITICAL REMARKS

When live load 2 KN/m^2 and beam size is 230 x 450mm, quantity of steel is increase (approx 17%) at location of shear wall near to the center of building, compare to shear wall at corner of building.
When the shear wall kept near to the center with live load is 2KN/m^2 and preliminary dimension of beam is 230 x 300mm, quantity of steel in beam increase (approx 15%), while quantity of steel in column is decrease (approx 8.77%) as compare to shear wall at corner of building.
When live load 3 KN/m^2 and beam size is 230X300mm, quantity of steel is increase (approx 13%) at location of shear wall near to the center of building, compare to shear wall at corner of building.
When live load 3 KN/m^2 and beam size is 230 x 300mm, quantity of steel is decrease (approx 22%) at location of shear wall near to the center of building, compare to building without shear wall.
The location of shear wall at corners of building is much effective while increasing live load 3 KN/m^2 with preliminary dimension of beam 230 x 300mm.
The shear wall gives beneficial effect of more clear head way in case of providing it at corners of building or away from the center of building.
Quantity of steel and concrete is less in case of without shear wall so it is said that for G+8 building with 2 KN/m^2 live load and preliminary beam size is 230 x 450 mm or 250 x 300mm, there is no economical beneficial effect of shear wall.

REFERENCES

[1] IS:456-code of practice for plain and reinforced concrete
[2] IS:875(part 1-5)- code of practice for structural safety of building loading standards
[3] IS 1893(Part-1):2002, Criteria for earthquake resistant design of structures.
[4] IS 13920:1993, Ductile detailing of reinforced concrete structure subjected to seismic forces-code of practice.
[5] SP:16-design aids for reinforced concrete
[6] Dr. Memari Ali, (2010), office building G, Eastern United States. Technical report, vol-3.
[7] M.Ashraf, Siddiqi Z.A. & Javed M.A., (2008), Configuration of a multistorey building subjected to lateral forces, vol-9, page no: -525-537.
[8] Kaltakci M.Y., Arslan M.H., Yavuz G., (2010), Effect of internal & external shear wall location on strengthening weak RC frames, vol-17, page no: - 312-323.
[9] Onkar V. Sapate, Dr.A.M.Pande/International journal of Engineering Research and Applications. Vol. 1, Issue 4. pp.1515-1521
[10] Dr. Jain k., Explanatory example on indian seismic code IS 1893 (Part-1).
[11] Dr. Shah H.J. & Dr. Jain Sudhir k., Design example of a six storey building.
[12] Earthquake tips (1 to 24), Learning earthquake design and construction.