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Structural Configuration Optimization of a Multistorey Building by Optimum Positioning of Shear Wall

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Abstract

A study has been carried out to determine the optimum Structural configuration of a multistory building by changing the shear wall locations radically. Four different cases of shear wall position for a 10 storey residential building have been analyzed and designed as a space frame system by computer application software, subjected to lateral and gravity loading in accordance with IS provisions.
Keyword- High rise building, lateral loading, Position of shear wall, Seismic response, Shear wall, STRUDS

I. INTRODUCTION

A shear wall is a wall that is designed to resist shear forces and the lateral force that causes the bulk of damage in earthquakes. Reinforced concrete (RC) buildings often have vertical plate-like RC walls called Shear Walls in addition to slabs, beams and columns. These walls generally start at foundation level and are continuous throughout the building height. Their thickness can be as low as 150mm, or as high as 400mm in high rise buildings.

Shear walls in buildings must be symmetrically located in plan to reduce ill-effects of twist in buildings . They could be placed symmetrically along one or both directions in plan. Shear walls are more effective when located along exterior perimeter of the building – such a layout increases resistance of the building to twisting.

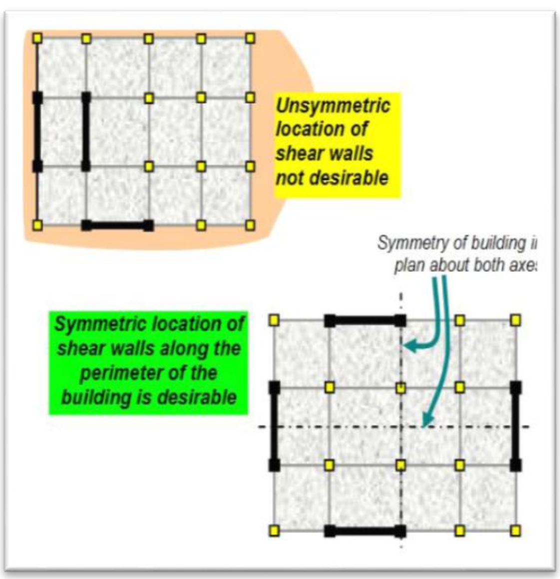

Fig. 1: Architectural Aspects of Shear Walls

II. PROBLEM STATEMENT

A typical building (G+10) having three various position of shear wall and one without shear wall having following data.

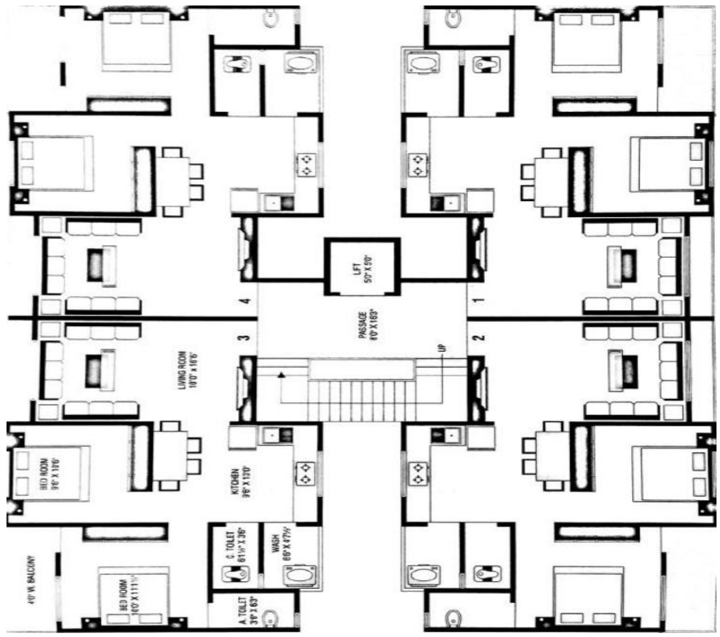

Fig. 2 Layout of Plan

Floor to Floor height = 3000mm
Height of Plinth = 450mm above ground level.
Depth of Foundation = 2100mm below ground level.

A. Imposed Loads

Roof : Roof Finish = 1.5 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

B. Earthquake Load

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

C. Materials

Concrete = M20,
Steel: Main & Secondary = Fe 415
Unit Weight of Concrete = 25 KN/m^2
Unit Weight of Bricks Masonry = 19 KN/m^2
Design Basis: =Limit State Method based on IS: 456-2000

D. Typical Drawing of Each Case

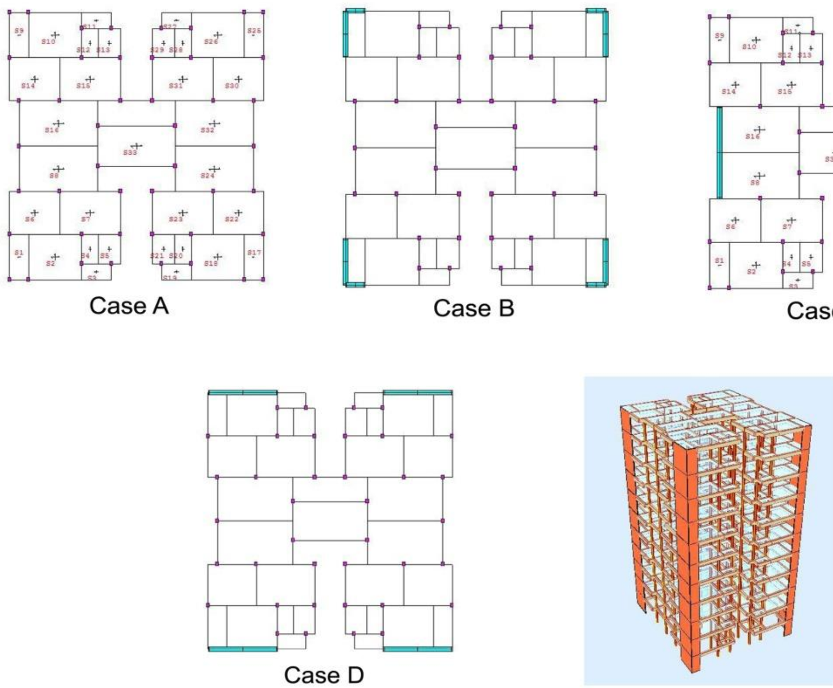

Fig. 1: Case (A) Without Shear wall (B) Shear wall at corner (C) Shear wall in minor axis (D) Shear wall in major axis

III. RESULT AND DISCUSSION

The results for the storey displacement and total weight analysis are based on the loads and their combinations as per IS Code. The results are taken from output file of STRUD Software.

A. Quantity of Concrete & Steel in beam

CASE	*QUANTITY OF CONCRETE (m^3)*	*QUANTITY OF STEEL (Kg)*
A	*414.847*	*36191.45*
B	*685.046*	*28840.01*
C	*395.326*	*40564.25*
D	*384.415*	*31021.90*

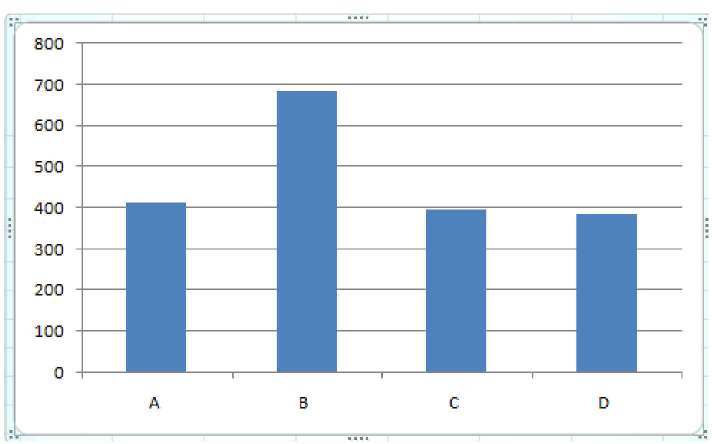

Fig. 4:

From the above results it is clear that the quantity of concrete required is less in the case of structure without shear wall but the required steel is required less in case of the shear wall at the corner of the structure.

B. Quantity of Concrete & Steel in Column

CASE	QUANTITY OF CONCRETE (m^3)	QUANTITY OF STEEL (Kg)
A	197.379	23111.06
B	141.695	16425.42
C	180.862	21376.21
D	155.125	18215.26

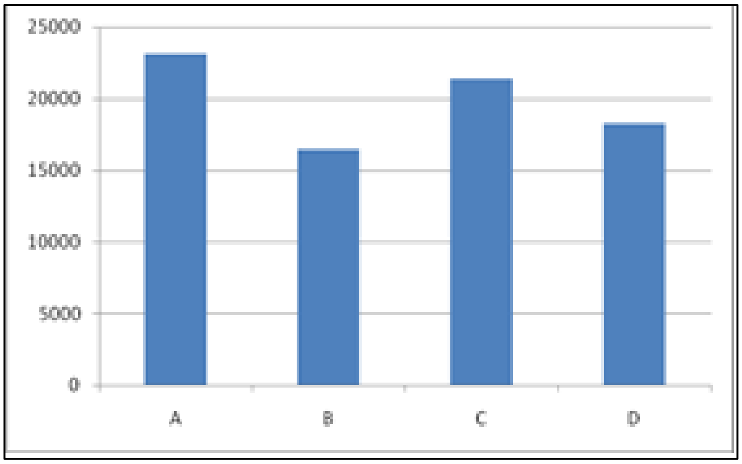

Fig. 5:

From the above results it is clear that the quantity of concrete required is less in the case of shear wall at the corner as well as the required steel is also less in case of the shear wall at the corner of the structure.

C. Quantity of Concrete & Steel in Footing

CASE	QUANTITY OF CONCRETE (m^3)	QUANTITY OF STEEL (Kg)
A	118.757	3261.652
B	85.444	2333.331
C	96.172	2703.860
D	87.821	2413.390

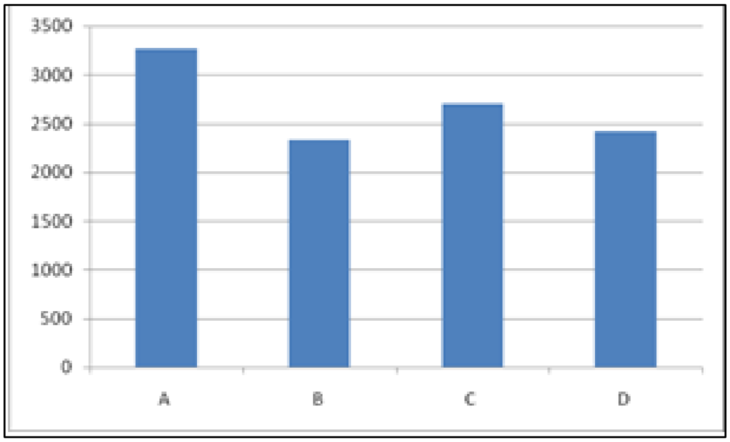

Fig. 6:

From the above results it is clear that the quantity of concrete required is less in the case of shear wall at the corner as well as the required steel is also less in case of the shear wall at the corner of the structure.

D. Quantity of Concrete & Steel in Shear Wall

CASE	QUANTITY OF STEEL (mm3)
A	---
B	153345
C	669538
D	336555

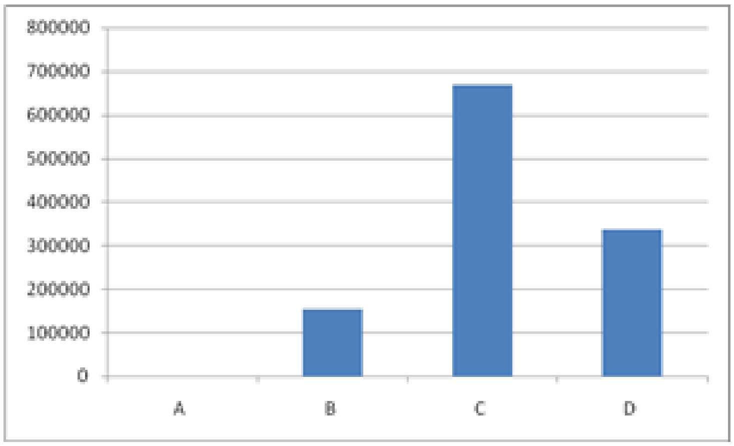

Fig. 7:

From the above results it is clear the minimum required steel is also less in case of the shear wall at the corner of the structure.

IV. CONCLUSION

- The Shear Wall at the corner (CASE B) provides more strength and safety with provision of less steel and concrete as compare to other locations of the Shear Wall.
- The position of shear wall and has significant effect on middle storey of multistoried building.
- Shear walls are more resistant to lateral loads in an irregular multistoried building.
- Shear Wall in at corners (CASE B) are more economical to construction as compared to other location of Shear Wall.

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