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Utilization of Reinforced Concrete Flexural (Shear) Walls in Multistorey Buildings with Effect of Lateral Loads under Flat Terrain

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Abstract

This research paper presents the relation between base shear and base moment, minimum thickness of shear wall to avoid buckling of shear walls, considered with dimensions classified as class A, class B, class C as per IS : 875 : 1987 (Part 3). Both lateral loads, seismic and wind loads are considered for calculation of minimum thickness of shear wall, base shear and base moment. Seismic zones II, III, IV, V are considered as per IS : 1893 : 2002 and wind loads of 33m/s, 39m/s, 44m/s, 47m/s, 50m/s, 55m/s are considered as per IS : 875 : 1987 (Part 3). The results showed that the minimum thickness of reinforced concrete shear wall as with wind loads and seismic loads. Regression chart equations are also shown for base shear and base moment.

Keywords: Shear walls, lateral forces, wind loads, seismic loads, buckling, and base moment, and base shear, wind region, wind terrain.

Introduction

Shear walls are vertical elements which are used for resisting lateral forces, (seismic and wind forces), shear walls are so designed that they will have the strength and stiffness to resist lateral forces. Shear walls are most efficient to help in withstanding of structure. Lateral loads caused due to wind and seismic forces act normal to the width i.e, thickness of the wall. Shear walls resists maximum amount of lateral shear caused in buildings through flexural deformation only but not through shear deformation.

Research Work Considerations

Wind loads as per IS: 875: 1987 (Part 3) are considered in this research paper. Wind speed varies with time and depends upon several factors such as density of observations in the terrain size of gust, return period and probable life of structure. In India the basic wind speed varies in 33m/s, 39m/s, 44m/s, 47m/s, 50m/s, 55m/s. wind load causes dynamic action for structures whose fundamental frequency of vibrations will be less than 1Hz. During strong winds the acceleration of top floors of a multistoried buildings /structures may increase, wind speed is in general influenced by local topography.

Shear walls deforms essentially in bending mode, shear walls are rarely significant, only very low shear walls with H/S ratio <1 fails in shear, shear walls behaves mostly like slender cantilever and are designed to resist the combined effect of axial, bending about its strong axis and also shear force. American code ASCE 7 allows the use of shear wall up to a height of 45m of buildings /structures. However shear walls are in use up to 70m in height of buildings also unless or otherwise flexural walls in any plane do not resist more than 35% of the seismic forces which includes torsional effects.

The structures are classified into three classes with consideration to dimensions of buildings as per IS: 875: 1987 (Part 3). Class A structures are that their components such as cladding, glazing, roofing etc having maximum dimension less than 20m. Class B structures are such structures with maximum dimensions between 20m and 50m. Class C structures are structures having maximum dimensions greater than 50m.

Software Information

RESIST is software developed by NPEEE (National Program on Earthquake Engineering Education) which was distributed by NICEE (National Information Center of

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Earthquake Engineering). The software was supplied to our college (R.V.R & J.C College of Engineering) under NPEEE an initiative of the ministry of human resource development, Govt of India. RESIST is developed for research and education purpose only.

Design Information

Dimensions and loads:
No of storey: G + 2, G +4, G + 6.

Class A building:
Length in X-direction: 20meters.
Length in Y-direction: 20meters.
Class B building:
Length in X-direction: 40meters.
Length in Y-direction: 40meters.
Class C building:
Length in X-direction: 60meters.
Length in Y-direction: 60meters
Storey height: 3.5meters.
Roof height: 1.5meters.
Floor weight: Heavy (assuming 150mm slab with 50mm mortar and 25mm floor surfacing) dead load:6.5KPa.
Seismic data input: All the considered buildings are analyzed for all the seismic zones specified as per IS: 1893 (part I): 2002 are shown in table 1:

Zone	Intensity	Zone value
II	Low	0.10
III	Moderate	0.16
IV	Severe	0.24
V	Very severe	0.36

*Importance factor considered is 1.0 used for all the buildings as per IS: 1893 (part I): 2002.

Soil type: All the buildings considered are analyzed for medium type soils as per IS: 1893 (part I): 2002.

Wind and Terrain Information

Wind region: 1.
Basic wind speed: 33m/s.
Wind region: 2.
Basic wind speed: 39m/s.
Wind region: 3.
Basic wind speed: 44m/s.
Wind region: 4.
Basic wind speed: 47m/s.
Wind region: 5.
Basic wind speed: 50m/s.

Wind region: 6.
Basic wind speed: 55m/s.
Terrain category: Built up towns considered as per IS : 825.
Site shape: Flat.

Shear wall details:
Wall thickness: 250mm (Kept constant through out this work).
No of walls: 2 walls in X-direction and 2 walls in Y-direction.
Interior walls: medium (all walls are with brick)
Exterior walls: Heavy (assumes 25% glazing and 75% 230mm plastered brick).
Roof weight: Heavy (assumes a 200mm deep hollow core reinforced concrete. slab plus topping and light weight screed to allow for drainage 4.8Kpa.).
Type of wall: Reinforced concrete shear wall.

Load combinations: Wind loads: 1.2G & 1.0Qu & 1.5Wu
Earthquake loads: 1.5G & 1.5Eu.

Results and Conclusions

Result analysis is done in terms of percentages in RESIST software i.e. if the result is <=100% then ok, if >100% condition is failure. Base shear to Base moment graphs are shown and there is a linear increase in base shear and base moment all through out the classes A, B, C structures. Fig 1, 2, 3,4,5,6,7,8,9 shows the variation of base shear and base moment compared to zone values on x axis.

In all the classes of structures the base moment varied in power equation pattern and for base shear the graphs varied linearly. With increase in area the stability of building increased and minimum thickness to prevent buckling of shear wall also decreased as the stability increased. The minimum thickness required for prevention of buckling of shear walls are shown in table 2:

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Table 2: Minimum thickness required for prevention of buckling of shear wall:

Zone / Wind regions (1, 2, 3, 4, 5, 6)	Class of building	Minimum thickness of shear wall (mm)
II	Class A	204
II	Class B	193
II	Class C	177
III	Class A	204
III	Class B	181
III	Class C	175
IV	Class A	204
IV	Class B	176
IV	Class C	175
V	Class A	187
V	Class B	175
V	Class C	175

Regression equations for the graphs mentioned above for base shear and base moment are as follows:

For Fig 1: Base shear vs Base moment for Class A Two storey building:
Base shear: y = 5094x - 167
Base moment: y = 34911x - 1081

For Fig 2: Base shear vs Base moment for Class B Two storey building:
Base shear: y = 5094x - 167
Base moment: y = 34911x - 1081

For Fig 3: Base shear vs Base moment for Class C Two storey building:
Base shear: y = 3829.2e0.4306x
Base moment: y = 34911x - 1081

For Fig 4: Base shear vs Base moment for Class A Four storey building:
Base shear: y = 9388.5x - 647.5
Base moment: y = 80765e0.4367x

For Fig 5: Base shear vs Base moment for Class B Four storey building:
Base shear: y = 9388.5x - 647.5
Base moment: y = 115397x0.9249

For Fig 6: Base shear vs Base moment for Class C Four storey building:
Base shear: y = 9388.5x - 647.5
Base moment: y = 115397x0.9249

For Fig 7: Base shear vs Base moment for Class A Four storey building:
Base shear: y = 1762.5x - 111.5
Base moment: y = 31516x0.9221

For Fig 8: Base shear vs Base moment for Class B Four storey building:
Base shear: y = 6437.4x - 677.5
Base moment: y = 110244x0.938

For Fig 9: Base shear vs Base moment for Class C Four storey building:
Base shear: y = 13998x - 1479.5
Base moment: y = 238503x0.9391

Graphs: Graphs are generated with comparison to base shear and base moment for all the seismic zones of India and also for all the wind speeds.

Fig 1: Base shear vs Base moment for Class A Two storey building:

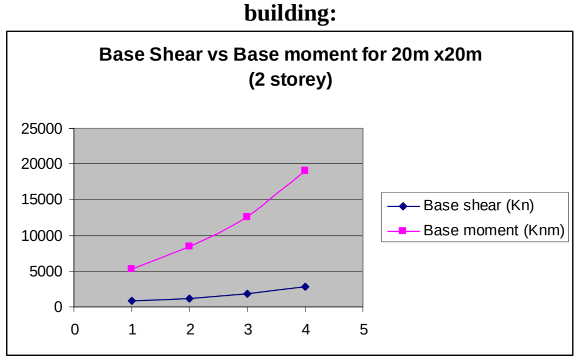

Fig 2: Base shear vs Base moment for Class B Two storey building:

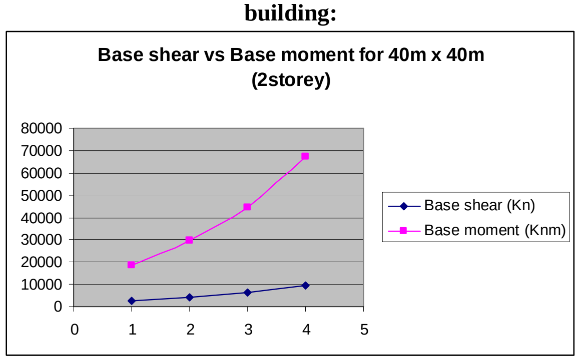

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Fig 3: Base shear vs Base moment for Class C Two storey building:

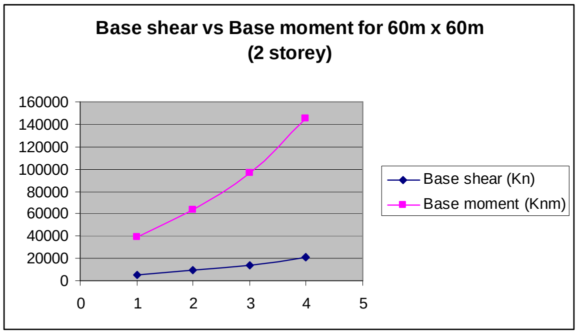


Fig 4: Base shear vs Base moment for Class A Four storey building:

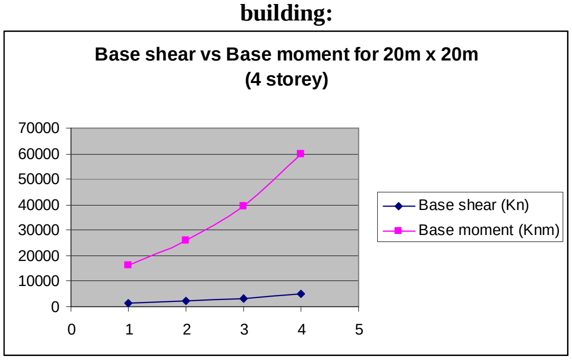


Fig 5: Base shear vs Base moment for Class B Four storey building:

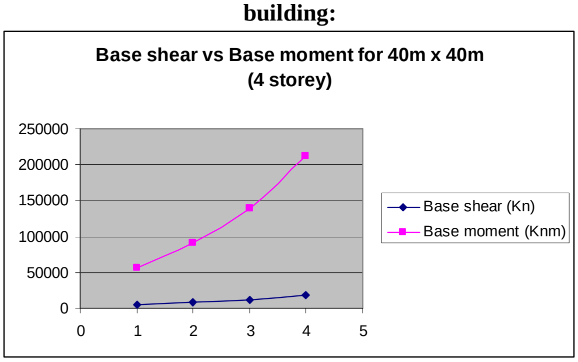


Fig 6: Base shear vs Base moment for Class C Four storey building:

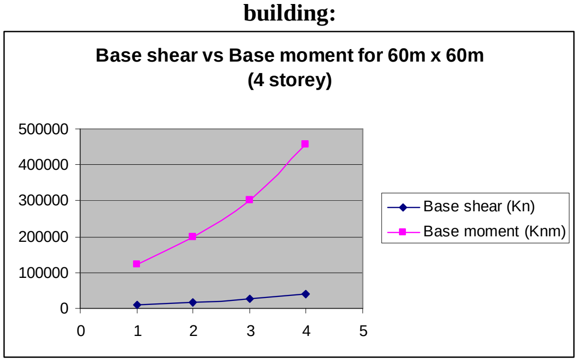


Fig 7: Base shear vs Base moment for Class A Four storey building:

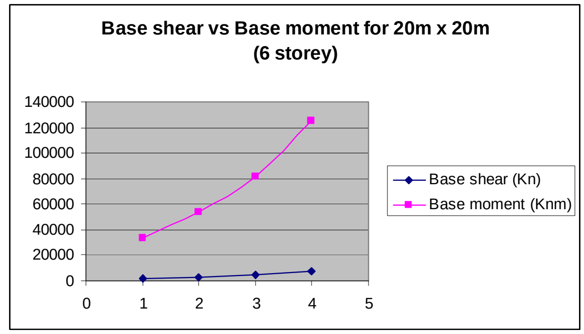


Fig 8: Base shear vs Base moment for Class B Four storey building:

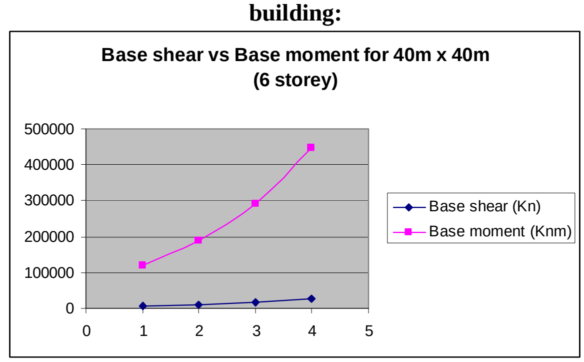
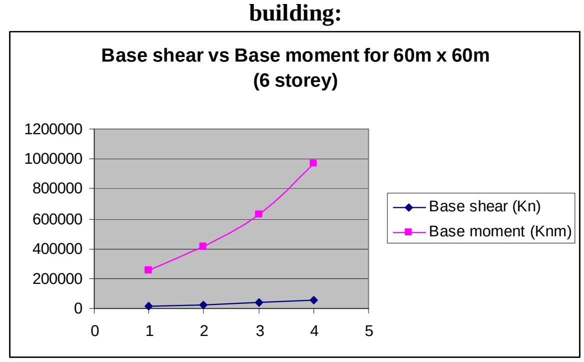


Fig 9: Base shear vs Base moment for Class C Four storey building:



Acknowledgement

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