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Analysis and Design of Tall Building Subjected to Lateral Loads with and without Shear Wall

G. Naga Lakshmi, Shaik Salma, B. Chinnaiah, S. A. Tejeswari, M. Srinivasa Reddy

Department of Department of Civil Engineering, Chalapathi Institute of Technology, Mothadaka, Guntur, Andhra Pradesh, India.

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KEYWORDS

Sedimentation Tank, Characteristics, STAAD pro, Hydro-static Loads..

ABSTRACT

It is very essential to supply a pure water to the public or to serve it for other purposes. For that we need to treat the water before supplying it. We are focused on to remove suspended solids in given raw water. A study was carried out in a specially designed settling tank to investigate the settling characteristics of raw water for a village of Motadaka (Guntur) with a population of approximately 5000. Analysis and Design of Sedimentation tank was done by using STAADpro V8i software. Here the height and radius of the tank is calculated manually. We have determined the radius of tank is based on the capacity of 250 m3 ie., 5.2 m and height are assumed as 3m. Analysis of tank is done by limit state method, and it is subjected to dead load and hydro-static load due to water. The code books that we have referred to analysis and design of Sedimentation Tank are IS 456-2000, IS 875-2007 part-1 for dead loads part-2 for hydro-static loads. From this we have designed a circular sedimentation tank in STAAD pro.

1. INTRODUCTION

In general, for design of tall buildings both wind as well as earthquake loads need to be considered. Governing criteria for carrying out dynamic analyses for earthquake loads are different from wind loads. According to the provisions of Bureau of Indian Standards for earthquake load, IS 1893(Part 1):2002/2005, height of the structure, seismic zone, vertical and horizontal irregularities, soft and weak storey necessitates dynamic analysis for earthquake load. The contribution of the higher mode effects are included in arriving at the distribution of lateral forces along the height of the building. As per IS 875(Part 3):1987 and ASCE-7-2010, when wind interacts with a building, both positive and negative pressures occur simultaneously, the building must have sufficient strength to resist the applied loads from these pressures to prevent wind induced building failure. Load exerted on the building envelope are transferred to the structural system and they in turn must be transferred through the foundation into the ground, the magnitude of the wind pressure is a function of exposed basic wind speed, topography, building height, internal pressure, and building shape. The main objective of this study is to carry out the analysis of G+16 multi stored residential building against earthquake and wind loads as per Indian standard codes of practice IS 1893(Part 1):2002/2005 and IS 875(Part 3):1987 and ASCE-7-2010. First, the sensitivity of base shear of the building with respect to the location of the building at different wind zones in India is investigated. The wind loads and earthquake loads on the building are calculated assuming the building to be located at Mumbai.

The member forces are calculated with load combinations for Limit State Method given in IS 456: 2000 and the members are designed for the most critical member forces among them. The building is subjected to self-weight, dead load, live load as per IS 875(Part 1, Part 2):1987. Safety of the structure is checked against allowable limits prescribed for base shear, roof displacements, inter-storey drifts and accelerations in codes of practice and other references in literature on effects of earthquake and wind loads on buildings.

Objective

Earthquakes in the last few decades have become a major issue. Vijayawada region are geologically unstable parts of the country and some devastating earthquakes of the world have occurred there. A major part of peninsular India has also been visited by strong earthquakes, but these were relatively few in number and had considerably lesser intensity. It has been a long felt need to rationalize the earthquake resistant design and construction of structures taking into account seismic data from studies of these earthquakes. It is to serve this purpose that we have chosen this topic as our project

2. LITERATURE SURVEY

Borugadda Raju et al., (2015) has been designed and analysed G+30 multi-storey building adopting STAAD.Pro in limit state methodology. STAAD.Pro contains an easy interface that permits the users to produce the mount and the load values and dimensions are inputted. The members are designed with reinforcement details for RCC frames. The analysis is completed for two dimensional frames and then it is done for more multi-storeyed 2-D and 3-D frames under various load combinations.

Sreeshna K.S (2016) this paper deals with structural analysis and design of B+G+4 storied apartment building. The work was completed in three stages. The first stage was three dimensional models and scrutiny of building and the second stage was to design the structural elements and the final was to detail the structural elements. In this project STAAD.Pro software is used for analysing the building. The IS:875 (Part 1) and (Part 2) were referred for dead load and live load. Design of structural elements like beam, column, slab, staircase, shear wall, retaining wall, pile foundation is done according to IS Codes

Nasreen. M. Khan (2016) has mentioned that logical data is incredibly necessary and essential talent required by each and every engineer. The project encompasses a shear wall round the elevator pit. During this project the structure is meant and tested with the help of STAAD.Pro and the scheming was done physically. Layout of beam, column, slab, shear wall, stair case, shear wall, tank and an isolated footing are done. Finally, the detailing was done using AutoCAD

Amar Hugar et al., (2016) has been discussed that the Computer Aided Design of Residential Building involves scrutiny of building using STAAD.Pro and a physical design of the structure. Traditional way of study shows tedious calculations and such tests is a time-consuming task. Analysis is made quickly by using software's. This project completely deals with scrutiny of the building using the software STAAD.Pro. Finally, the results are compared with physical calculations. The elements are created as per IS:456-2000.

Bandipati Anup et al., (2016) this paper deals with evaluate and plan a multi-storeyed building [G + 2 (3-dimensional frame)] adopting STAAD Pro. The technique used in STAAD.Pro is limit state technique. Initially they have created 2-D frames and cross checked with physical calculations. The exact result should be proved. We tested and created a G + 2 storey building [2-D Frame] instantly for all feasible load combinations. The work has been finished with some more multistoried 2-Dimensional and 3- Dimensional frames beneath various load combinations.

Aman et al., (2016) has discussed that the point of the structural engineer is to model a guarded structure. Then the structure is subjected to various types of loading. Mostly the loads put in on the building are considered as static. Finite part analysis that exhibits the result of dynamic load like wind result, earthquake result, etc. The work is conducted using STAAD.Pro software.

3. PROPOSED SYSTEM

AUTO CAD

AutoCAD is a computer-aided drafting (CAD) software application developed by Autodesk that enables drafters, architects, engineers, and other professionals to create two-dimensional (2D) and three-dimensional (3D) models of mesh and solid surfaces. Prior to computer-aided drafting, manual hand drafting tools such as drafting boards and pencils, inking pens, parallel rules, compasses, and triangles only offered a subset of what can now be done with programs such as AutoCAD. Since its original release in 1982, AutoCAD quickly became the most widely used CAD program in the world because of its robust set of automated drafting tools and features. AutoCAD allows you to visually design and explore your conceptual design ideas, modify your designs using 3D free-form design tools, generate intelligent model documentation, transform your designs into 3D renderings, and turn them into cinematic-quality animated presentations. Autodesk has also developed a few other variants of AutoCAD that address discipline-specific needs. These programs include AutoCAD Architecture, Civil 3D, Electrical, Map 3D, Mechanical, Plant 3D, MEP, P&ID, and AutoCAD LT.

BENEFITS OF USING AUTOCAD

Individuals who work in or are currently pursuing careers in the architecture, mechanical or engineering fields will discover many benefits of using AutoCAD. The design aggregation and documentation tools built into AutoCAD not only maximize productivity but also help to streamline your design and documentation workflows, speeding projects from design to completion while automating the tedious drafting tasks that would normally be done by hand. With AutoCAD, surfaces, solids, and offset curves can be dynamically created and manipulated using context-sensitive PressPull operations. 3D models can be imported directly into AutoCAD from a variety of applications, including SolidWorks, CATIA, Pro/ENGINEER, Rhinoceros, and NX products and services allowing you to easily create intelligent 2D views. With Point Cloud tools, scanned objects can be imported with up to 2 billion data points, allowing existing environmental data to be used to help you start your projects. Physical 3D prototypes of your designs can be quickly created using AutoCAD's 3D printing capabilities. With Autodesk Inventor file import support, AutoCAD allows you to import models from Inventor while maintaining a relationship between the AutoCAD and Inventor files. AutoCAD offers many other tools and features that can enhance productivity such as PDF Support, DWG Convert, Materials Library, Social Media Sharing, AutoCAD WS, Autodesk 360 Connectivity, and much more.

STAAD PRO is a structural analysis and design software application originally developed by Research Engineers International in 1997. In late 2005, Research Engineers International was bought by Bentley Systems Additionally, STAAD.Pro is interoperable with applications such as RAM Connection, AutoPIPE, SACS and many more engineering design and analysis applications to further improve collaboration between the different disciplines involved in a project. STAAD can be used for analysis and design of all types of structural projects from plants, buildings, and bridges to towers, tunnels, metro stations, water/wastewater treatment plants and more

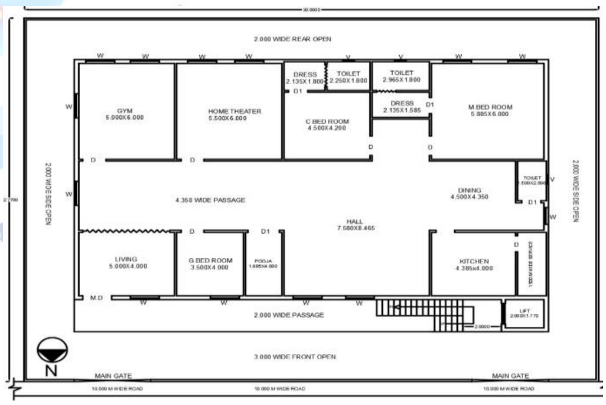

Figure 1: Residential building plan

Structure Details		
No. of Storeys	G+16	
Dimension in X Direction	26	m
Dimension in Z Direction	22	m
Storey Height	3	m
Live Load (Typical)	3	kN/sq.m
Live Load (Terrace)	1.5	kN/sq.m
Floor Finish	1.5	kN/sq.m

I: Importance Factor	1	
Deck thickness	150	mm
Wall Thickness external	230	mm
Wall Thickness internal	115	mm
Concrete Grade	M 25	
Steel Grade	Fe 500	
Wall Load External (2.7 m Height)	12.42	kN/m
Wall Load internal (2.7 m Height)	8. 6.21	k N/m
Parapet Wall (1 m Height)	2.3	kN/m
seismic zone-2 (is-1893-2002)		

4. RESULTS & DISCUSSION

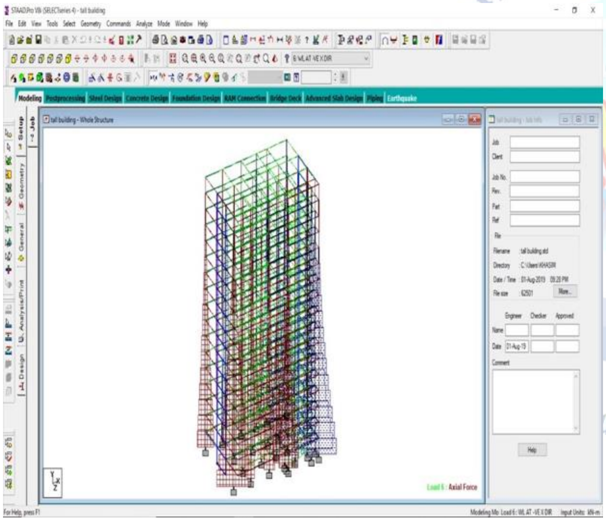

Figure 2: Axial force

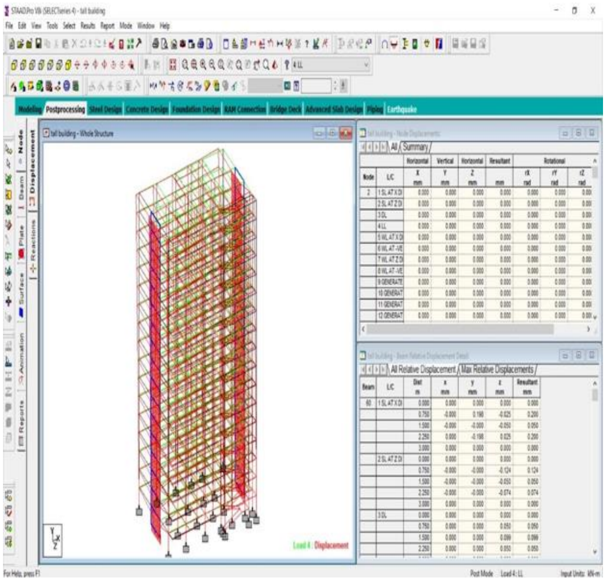

Figure 3: Displacement with shear wall

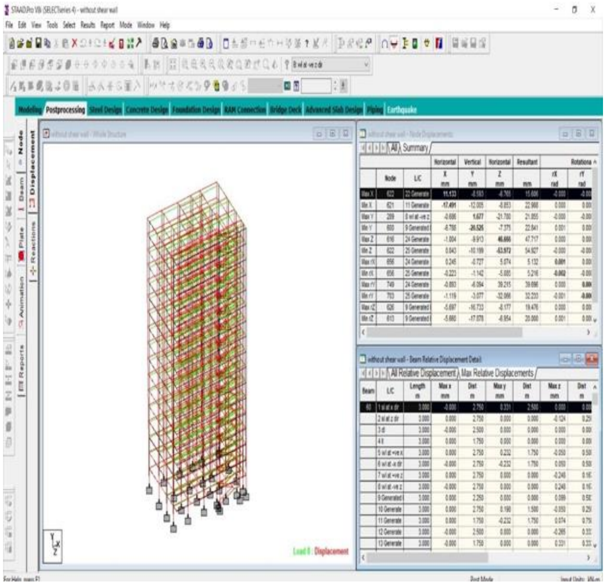

Figure 4: Displacement with-out shear wall

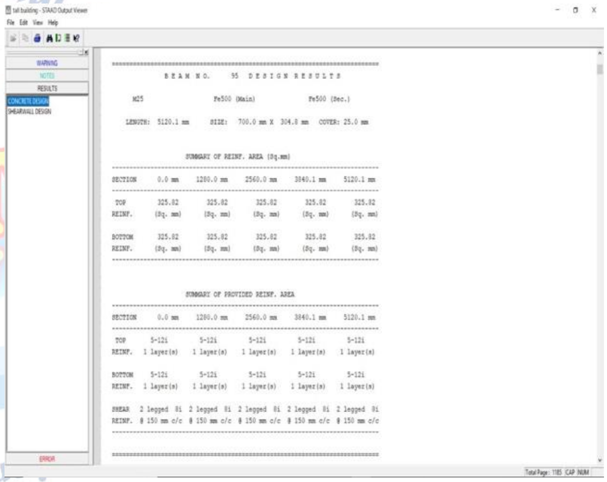

Figure 5: Concrete beam results

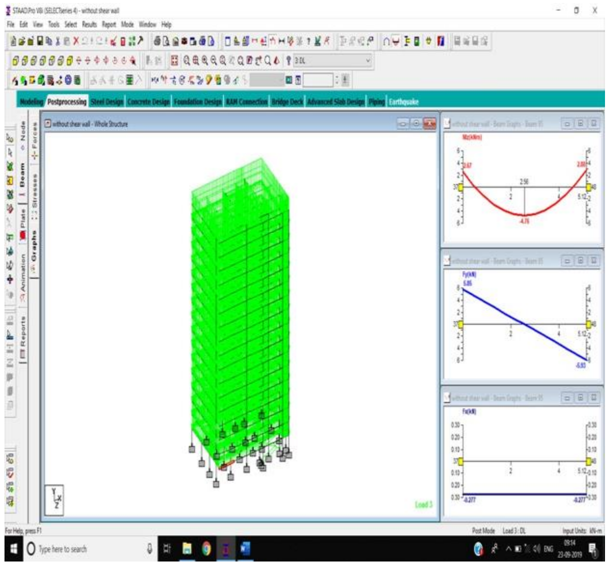

Figure 6: Bending moment, shear force and deflection result

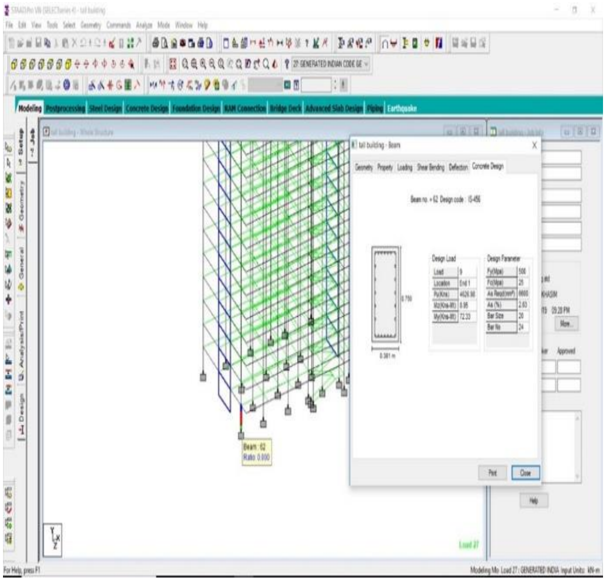

Figure 7: Concrete column results

4.1 Comparative Results with and without Shear Wall

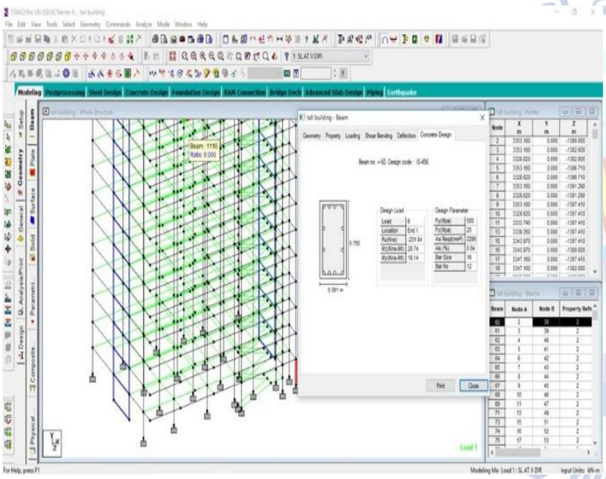

Figure 8: Concrete column results with shear wall

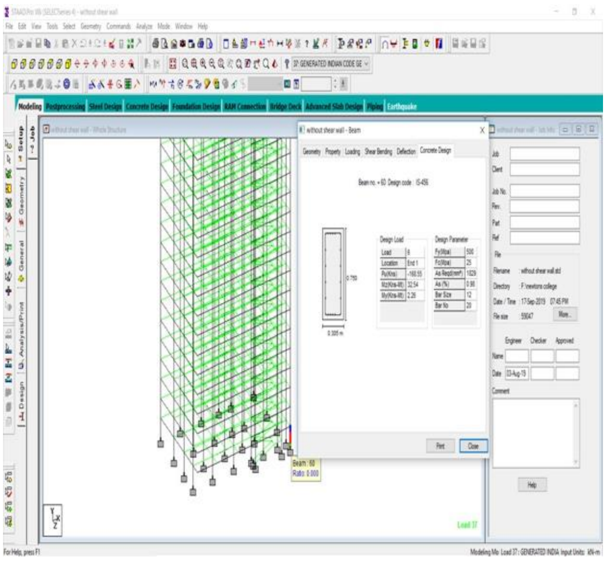

Figure 9: Concrete column results without shear wall

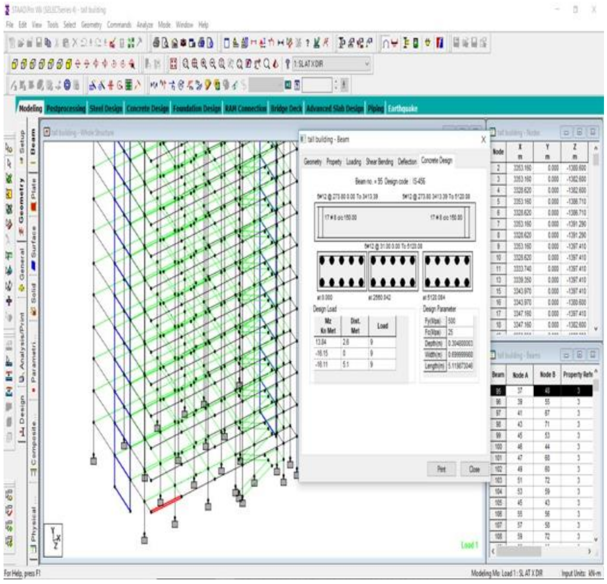

Figure 10: Concrete beam results with shear wall

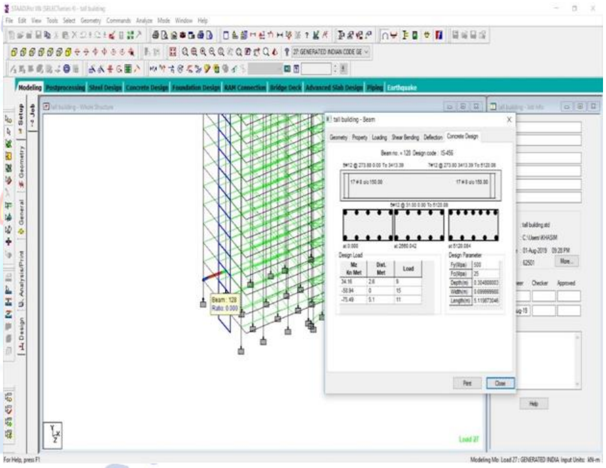

Figure 11: Concrete beam results without shear wall

DISCRIPTION	MANUAL	WITHOUT SHEAR WALL	WITH SHEAR WALL
SHEAR FORCE	5.88	5.85	5.83
BENDING MOMENT	7.53	4.76	3.56
DEFLECTION	1.381	1.075	1.109

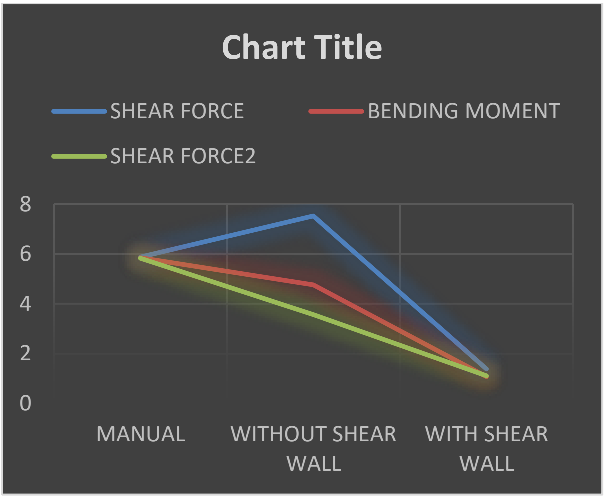

Figure 12: Bending Moment, Shear Force and Deflection Results

5. CONCLUSIONS

STAAD PRO has the capability to calculate the reinforcement needed for any concrete section. The program contains a number of parameters which are designed as per IS: 456(2000). Beams are designed for flexure, shear and torsion.

Design for Flexure:

Maximum sagging (creating tensile stress at the bottom face of the beam) and hogging (creating tensile stress at the top face) moments are calculated for all active load cases at each of the above-mentioned sections. Each of these sections are designed to resist both of these critical sagging and hogging moments. Where ever the rectangular section is inadequate as singly reinforced section, doubly reinforced section is tried.

Design for Shear:

Shear reinforcement is calculated to resist both shear forces and torsional moments. Shear capacity calculation at different sections without the shear reinforcement is based on the actual tensile reinforcement provided by STAAD program. Two-legged stirrups are provided to take care of the balance shear forces acting on these sections.

Beam Design Output:

The default design output of the beam contains flexural and shear reinforcement provided along the length of the beam.

Column Design:

Columns are designed for axial forces and biaxial moments at the ends. All active load cases are tested to calculate reinforcement. The loading which yields maximum reinforcement is called the critical load. Column design is done for square section. Square columns are designed with reinforcement distributed on each side equally for the sections under biaxial moments and with reinforcement distributed equally in two faces for sections under uni-axial moment. All major criteria for selecting longitudinal and transverse reinforcement as stipulated by IS: 456 have been taken care of in the column design of STAAD.

Shear wall:

From the study of literature review it is clear to say that due to the presents of shear walls and their location in the structure place a major role in construction of a building. B. The results obtained from the study shows that shear wall arrangement gives best result towards the building elements like storey displacement, inter-storey drift, base shear, lateral forces compared to bare frames. C. The model with shear wall placed at corners of the building shows less displacements and drifts and thus considered as optimum location. D. In this present paper from the study of literature paper the structure is constructed by shear walls at different locations. It has been observed that the top deflection was reduced and reached within the permissible deflection after providing the shear walls at possible failure positions such as the shorter directions. E. Increasing axial load level decreases R factor. So design base shear will be increased and moment of inertia of the section should be increased. In other hand, the lesser the axial load, the much more cross-sectional area. F. Confinement of concrete in shear walls is a good way to provide more level of ductility and getting more stable behavior. So, the designer would be allowed to bring up the level of axial stresses to have a reasonable design. G. Not only main walls are assumed to carry seismic loads, but also they are going to bear a significant percentage of gravity loads. H. The results for storey displacement, inter-storey drift and base shear are provided in this paper for 15 storey high rise building.**7.0**.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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