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Parametric study of High-rise building models with Plus, L, T ,U shape having different position with belt wall

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ABSTRACT

Engineers conducted an assessment focusing on tensional irregularities, reentrant corners, and plan anomalies, identified as having substantial effects on seismic response. Reentrant corners in L, T, U, C, and plus-shaped buildings, constructed per architectural specifications, experienced considerable damage. To mitigate the repercussions of reentrant corners, these structures underwent segmentation. Particularly in tall, multi-story plus-shaped buildings surpassing code-specified limits, reentrant corners hold critical importance. Seismic-prone areas demand special attention regarding shear walls, and the placement of these walls significantly influences the building's performance under dynamic loads. Adjusting the shear wall positions within a plus-shaped building can yield remarkable improvements without altering the wall specifications. Longer wings and a ten-story plus design elevate the likelihood of structural detachment from corners and induce movement. The positioning of shear walls at the core, flange edges, and reentrant corners was analyzed to determine the most effective configuration. Mitigating the adverse effects of these irregularities involves incorporating shear walls at reentrant corners. This research focused on studying three distinct asymmetrical structures: L, and T. Each unsymmetrical model integrated a belt wall on every fifth floor. The analysis employed M40 grade concrete and Fe550 steel, employing ETABS for modeling and analysis. Selected parameters included bending moment, base reaction, storey drift, joint displacement, and stiffness to prepare comparative graphs and evaluate results.

***Keywords* —** Building, Multi Story, RC Frame, Shear wall, Building Structure, T Shape, L Shape.

I. INTRODUCTION

In burgeoning urban landscapes of emerging countries and megacities, the solution to accommodating growing populations often lies in erecting tall buildings. Beyond their visual appeal, these high-rise structures symbolize progress and modernity. While attention is often drawn to towering superstructures exceeding 30 stories, medium-height high-rises ranging from 8 to 20 stories are prevalent worldwide. Understanding the structural behavior of both categories, especially their response to seismic activity, holds utmost significance. A thorough comprehension of their intricate dynamic properties is imperative before inhabitants can inhabit high-rise settings confidently.

Reinforced concrete (RC) has long been a primary material for constructing skyscrapers. Modern RC construction methods allow for diverse architectural configurations. Within RC buildings, shear walls assume a crucial role in fortifying structures against lateral loads such as seismic forces and gravity loads like wind. Strategic placement of shear walls is essential for optimal sustainability and resilience under varying loading conditions, especially in regions identified as high-seismic zones.

Guided by seismic engineering research from the Bureau of Indian Standards (BIS), the IS 1893 code serves as a benchmark for earthquake-resistant structural design. Evolving through multiple editions from 1962 to 2016, this code initially segmented India into six zones, later simplified to four (II, III, IV, and V).

The 2006 Kutch Earthquake in Gujarat exposed vulnerabilities in construction norms, local regulations, engineering education, and safety protocols. Widespread damage to structures between four and ten stories highlighted the urgency for seismic awareness. The NPEEE initiative aimed at educating on earthquake-resistant building design, emphasizing the impact of soft alluvium deposits and weak ground stories on devastation.

In response to these revelations, the "Ductile design and detailing of reinforced concrete structures subjected to seismic forces" code (IS 13920-1993) was introduced, advocating for RCC walls due to their seismic resilience. These vertical, plate-like RCC walls, varying from 150mm to 400mm thick, significantly contribute to earthquake resistance, drawing upon their successful performance track record.

II. DEFORMED SHAPE OF L MODEL

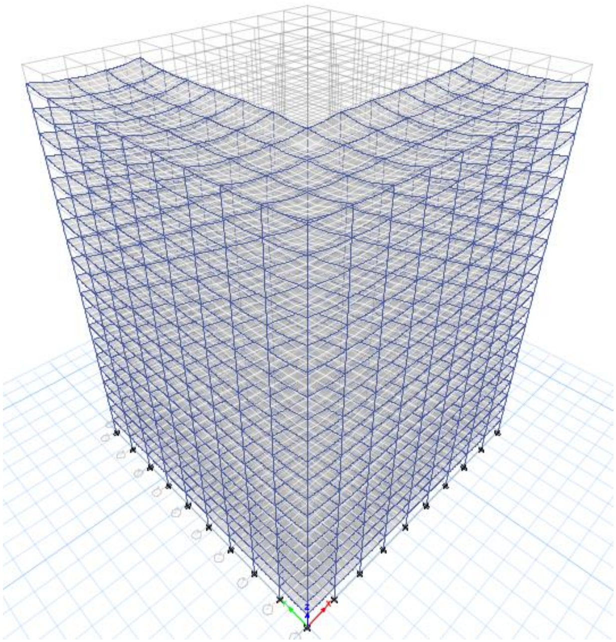

Figure 1: Deformed shape of L - shape model cause from dead load in bare frame

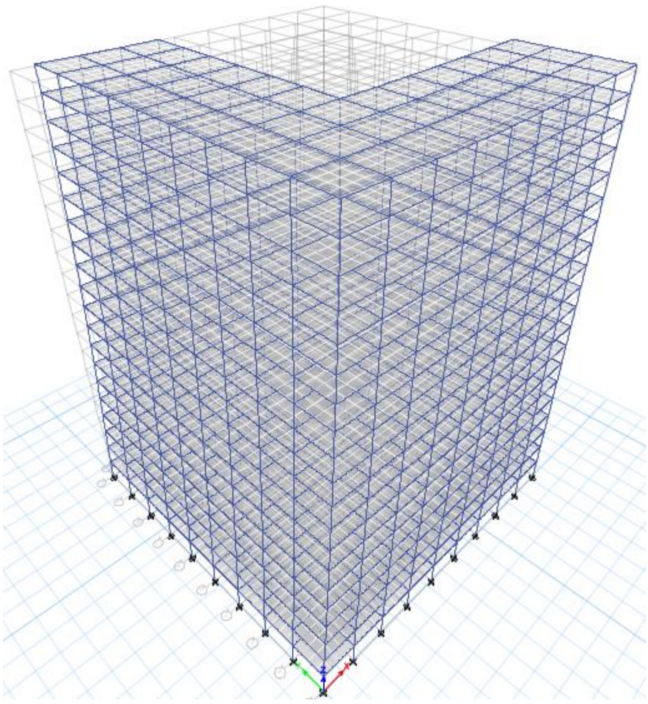

Figure 2: Deformed shape of L - shape model cause from Earthquake (RS-X) load in bare frame

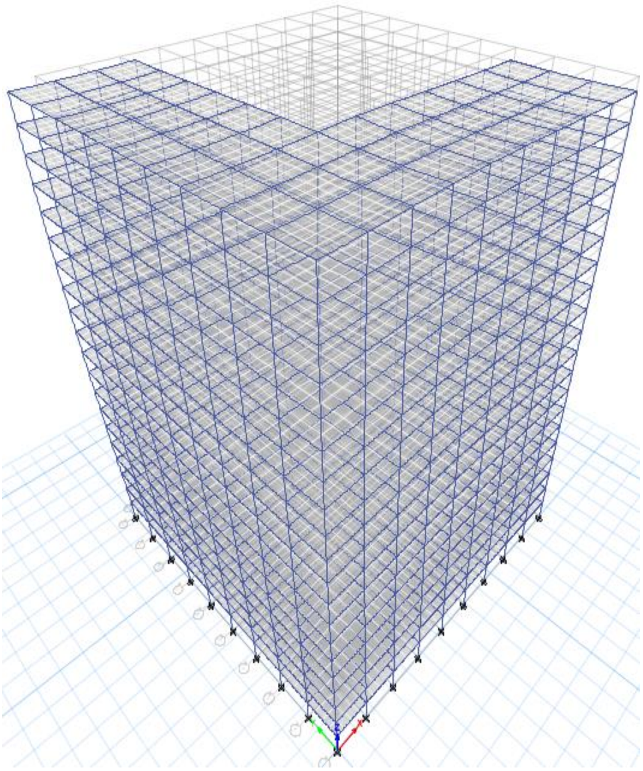

Figure 3: Deformed shape of L - shape model cause from load combination 1.5 (DL+RS-X) in bare frame

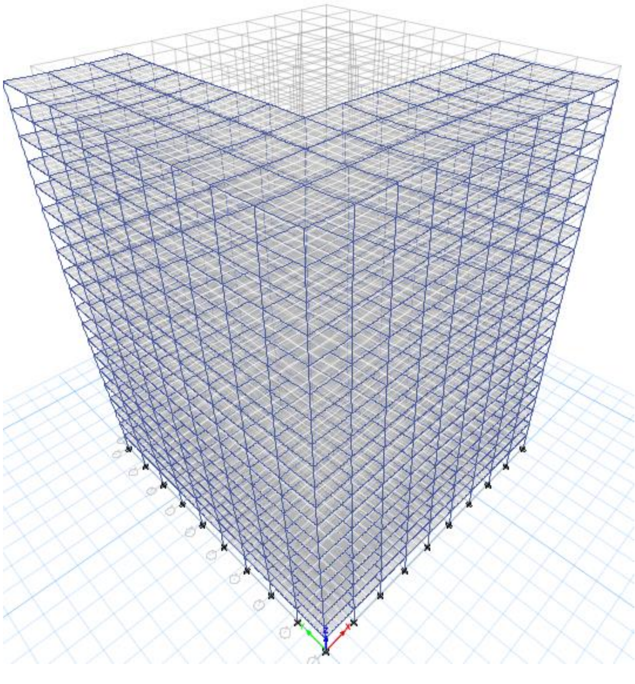

Figure 4: Deformed shape of L - shape model cause from load combination 1.2 (DL+LL+RS-X) in bare frame

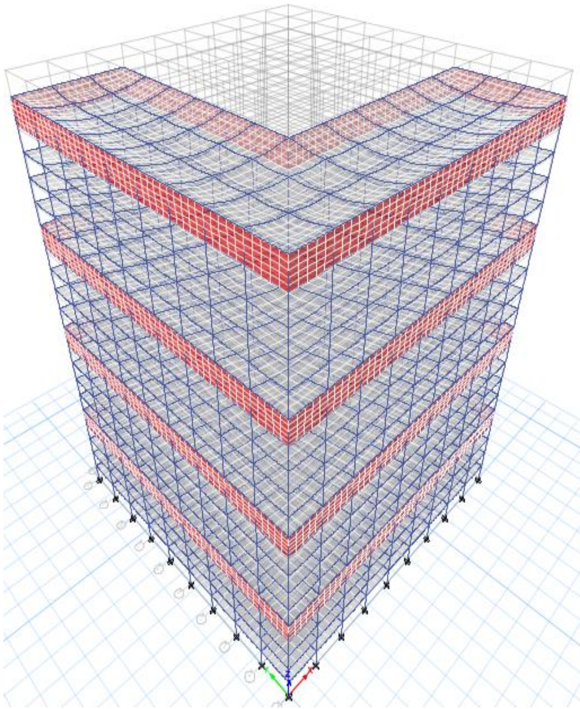

Figure 5: Deformed shape of L - shape model cause from dead load in belt wall

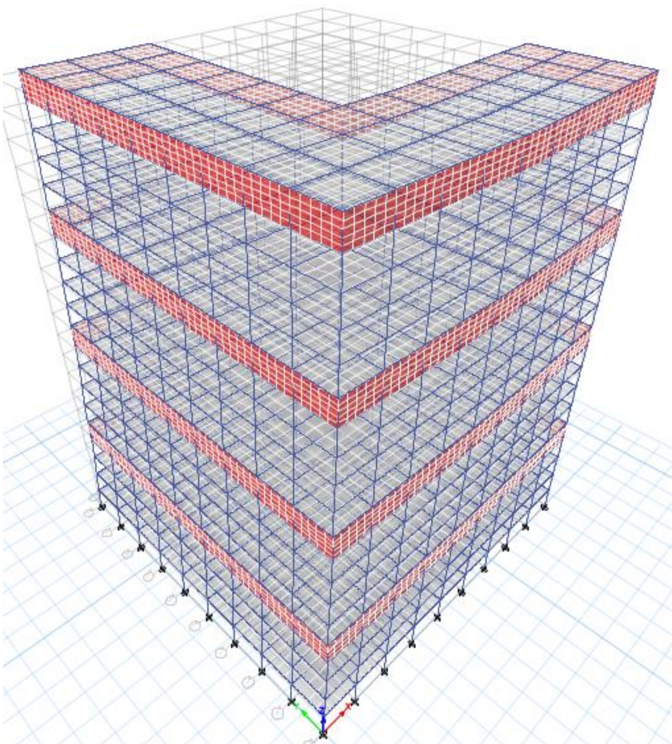

Figure 6: Deformed shape of L - shape model cause from Earthquake load (RS-X)in belt wall

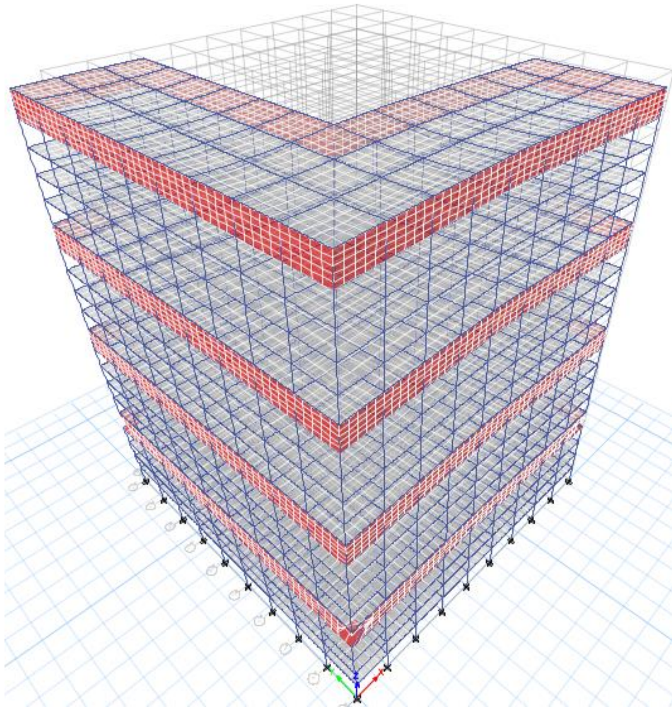

Figure 7: Deformed shape of L - shape model cause from load combination 1.5 (DL+RS-X) in belt wall

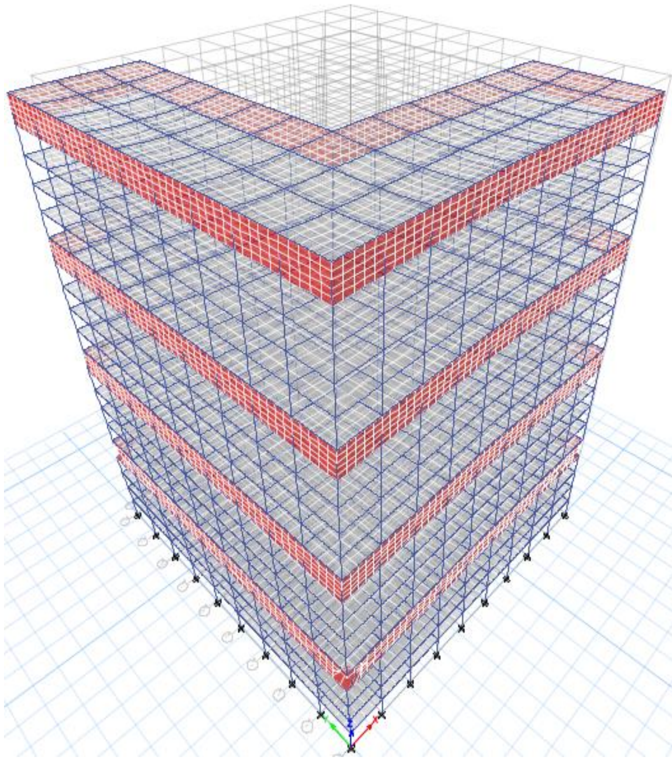

Figure 8: Deformed shape of L - shape model cause from load combination 1.2 (DL+LL+RS-X) in belt wall

III. DEFORMED SHAPE OF T MODEL

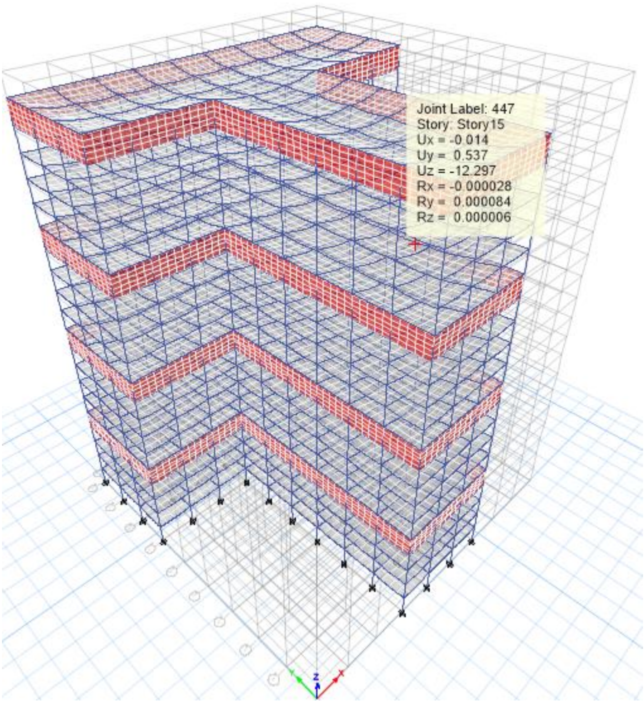

Figure 9: Deformed shape of T - shape model cause from dead load in belt wall

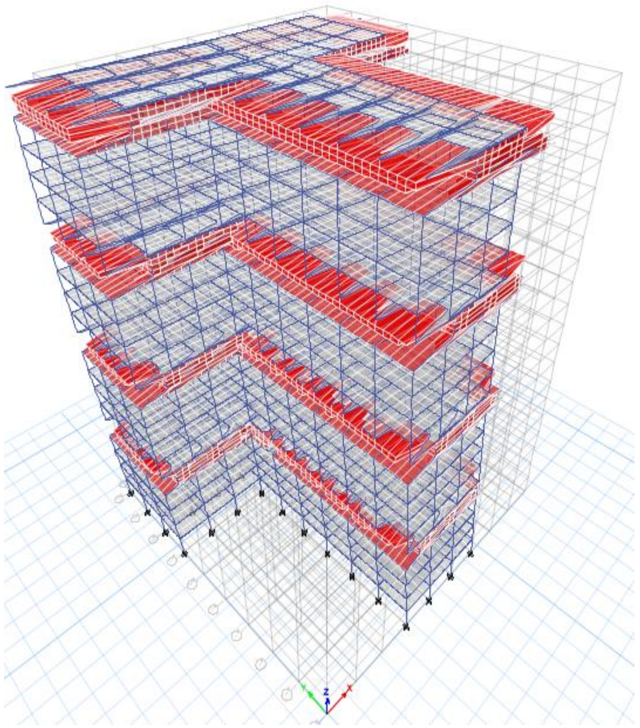

Figure 11: Deformed shape of T - shape model cause from load combination 1.5 (DL+RS-X) in belt wall

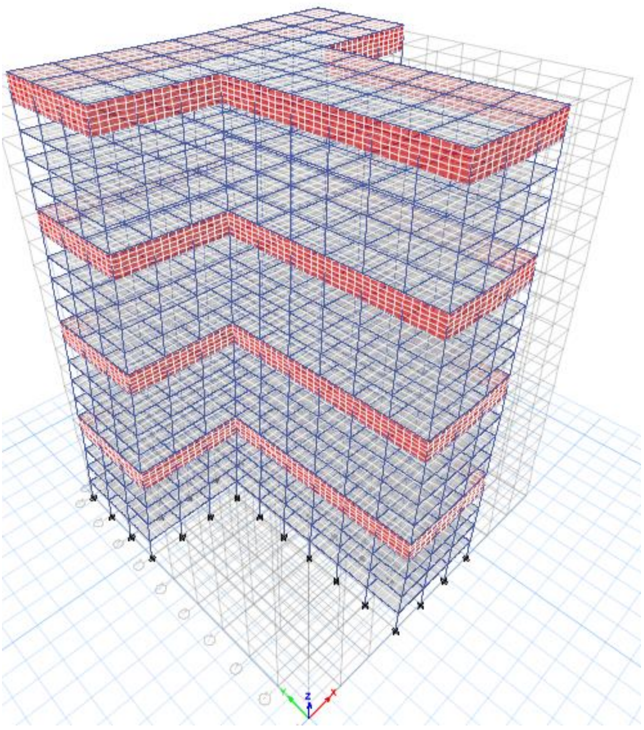

Figure 10: Deformed shape of LT- shape model cause from Earthquake load (RS-X) in belt wall

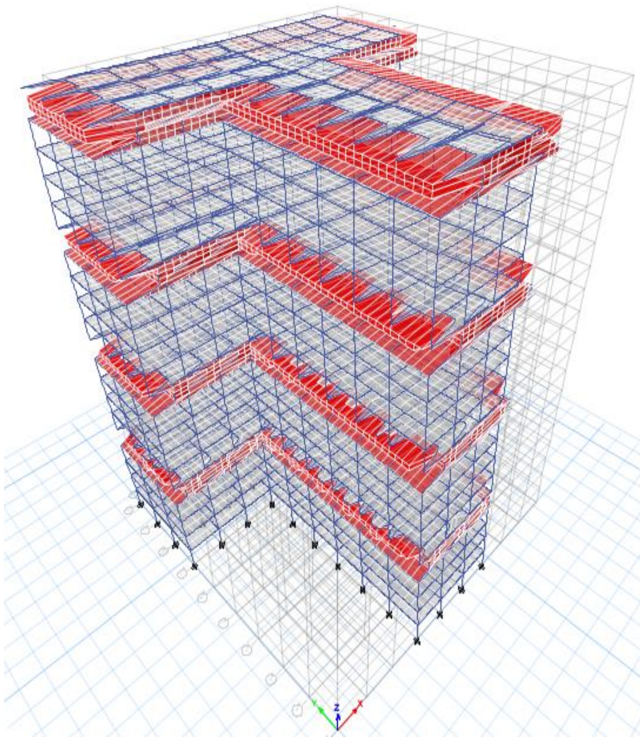

Figure 12: Deformed shape of T - shape model cause from load combination 1.2 (DL+LL+RS-X) in belt wall

IV. CONCLUSIONS

An innovative architectural strategy, known as the distributed ring wall system, has been devised to counter lateral forces in concrete high-rise buildings. Unlike the conventional ring system, this approach involves dispersing ring walls separately along the entire height of the structure, covering the area between column edges.

The distributed belt wall system, functioning akin to detached virtual outriggers from the core wall, proves to effectively reduce lateral drift in high-rise structures, comparable to traditional belt and outrigger configurations. The system's success relies on the arrangement and quantity of belt walls. Considering that belt walls primarily handle pure shear, the applicability of shear strength equations based on flexure-shear cracking might be limited. It's essential to establish shear strengths, integrating both cracking and yield strengths, based on the belt wall panel's response to pure shear. Strengthening belt walls with high-strength restressing strands can help meet increased shear demands. Determining the shear strength at the point of inclined shear cracking, employing compression field theory that focuses on uniform stress and strain fields, aligns closely with outcomes from FE analysis. Enhancing the shear resistance of the PSC belt wall can be achieved by boosting effective prestress and the ratio of PS strand reinforcement.

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