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Analysis of G+14 Structures: Variations in Column Removal and Belt Wall Application Using ETABS

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ABSTRACT

Analyzing G+14 structures involves investigating the effects of different scenarios involving column removal and the application of belt walls using the ETABS software. This analysis aims to comprehend how variations in these factors impact the structural integrity and stability of buildings comprising ground floor plus 14 stories. The study involves simulating and evaluating structural behavior under diverse conditions, primarily focusing on the consequences of column removal at various locations within the building. Additionally, it explores the influence of incorporating belt walls in different configurations to reinforce the structure's lateral stability. Utilizing the ETABS software, a comprehensive structural analysis platform, this research scrutinizes the responses of G+14 structures to these alterations. The simulations encompass the effects of potential localized incidents, such as accidental column removal, and assess how these changes propagate or mitigate structural vulnerabilities and potential collapse scenarios.

Keywords :- Multi Story, High Rise Building, Belt Wall, Progressive Collapse.

I. INTRODUCTION

The Progressive collapse refers to the structural failure of a building or infrastructure due to the sequential spread of localized damage, initiating a chain reaction that leads to partial or total collapse [1]. This phenomenon gained significant attention following pivotal incidents such as the dismantling of the Ronan Point apartment complex in 1968. The term itself emerged as engineers investigated the aftermath of specific events, notably instances where a localized incident triggered a catastrophic series of failures, causing extensive damage and collapse.

This concept highlights the potential vulnerability of structures to propagate failure beyond the initial point of impact, leading to widespread structural instability [4]. The term "progressive collapse" encapsulates the idea that a seemingly minor failure or damage in a particular area can propagate throughout the entire structure, resulting in disproportionate and often catastrophic consequences.

Understanding progressive collapse is crucial in engineering, architecture, and disaster management as it involves analyzing the structural integrity of buildings to mitigate the risk of such catastrophic failures [5]. It necessitates the implementation of designs and safety measures that can prevent or minimize the potential for progressive collapse, ensuring the resilience and safety of buildings and infrastructure under various conditions and stresses [9]. The belt wall serves as a retaining wall and is typically made of reinforced concrete. It consists of a continuous horizontal concrete beam or wall constructed around the perimeter of an excavation site [3]. This wall runs parallel to the excavation's edges and functions by resisting the lateral pressure exerted by the surrounding soil.

The construction process involves excavating the area in stages while simultaneously constructing the belt wall to support the exposed soil. Engineers carefully design and plan the dimensions, depth, and reinforcement of the wall to withstand the lateral forces exerted by the soil, groundwater, and any additional external loads.

Reinforcement techniques, such as the use of steel bars or tiebacks anchored into the soil behind the wall, are often incorporated to enhance the structural integrity of the belt wall. These reinforcements help distribute the lateral pressures and increase the wall's stability, ensuring it can withstand the forces acting upon it during and after excavation.

Moreover, various construction methods, including cast-in-place concrete or prefabricated panels, can be employed to build the belt wall depending on the specific requirements of the project and the soil conditions encountered.

The belt wall plays a crucial role in maintaining safety and structural stability during construction activities, allowing for deeper excavations in urban environments without compromising the integrity of adjacent structures or risking potential soil collapses. Its design and implementation are fundamental in ensuring the success and safety of below-grade construction projects.

II. METHODOLOGY

This section involves the study and outlining the research methodology. The aim is to utilize ETABS software alongside the response spectrum method to carry out modeling work. This chapter constitutes the primary focus of the project, encompassing detailed procedures, plans, and analyses conducted on a specific section of a building. It will include the structural investigation, methodologies used in modeling, and the essential data derived from the analysis.

Table 1: Basic Specification of Model

Data	Value
Grade of steel	Fe375
Grade of concrete	M35
Belt Wall	200mm
No. of stories	G+14
No. of bay along X-direction	5
No. of bay along Y-direction	7
Span along X-direction	5m
Span along Y-direction	5m
Floor height	3m
Column size	500X500,600X600, 400X400mm
Beam size	600X500, 600X400mm
Depth of Slab	150mm
Dead load	---------------
Live load	$2.5kN/m^2$
Software	CSI ETABS with Response Spectrum

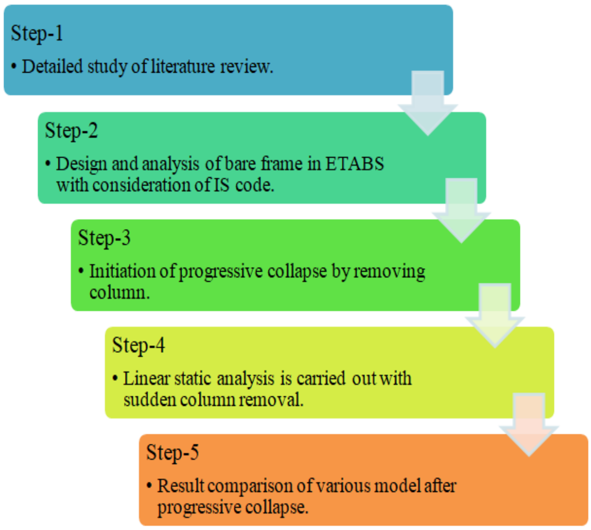

Fig 1: Flow Diagram to proposed Work

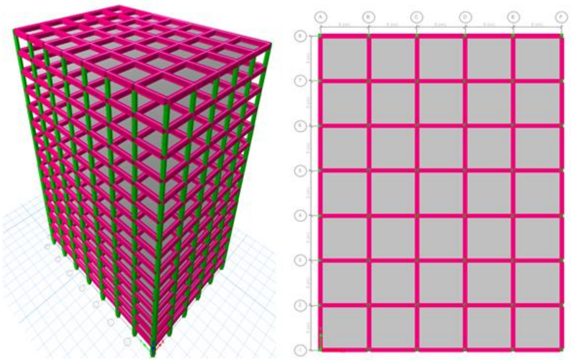

Fig 2: Model of G +14

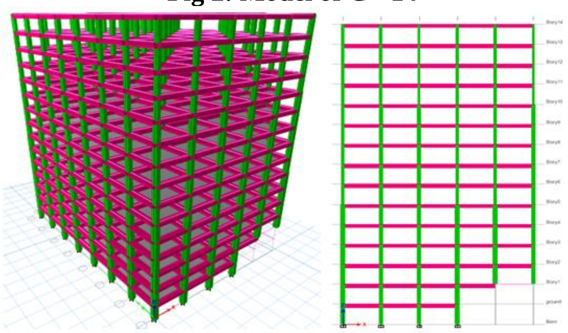

Fig 3: Model with corner column removed from one side

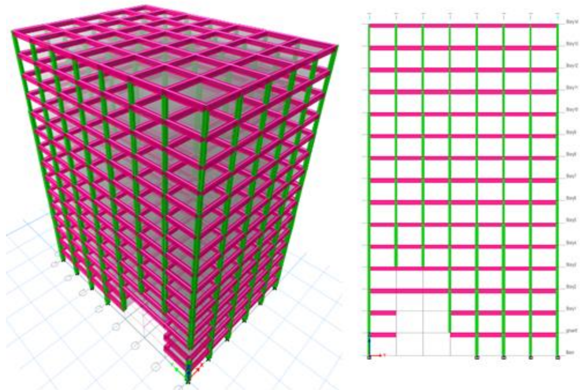

Fig 4: Sudden loss of column from long side edge

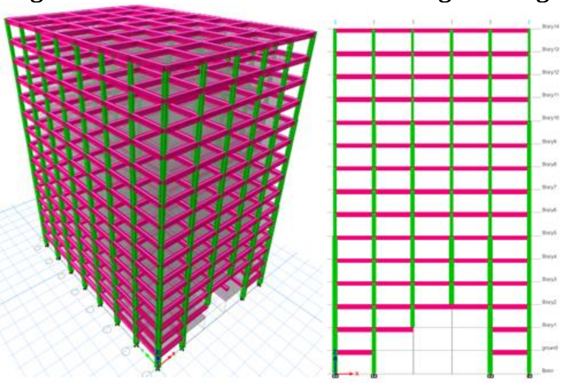

Fig 5: Sudden loss of column from short side edge

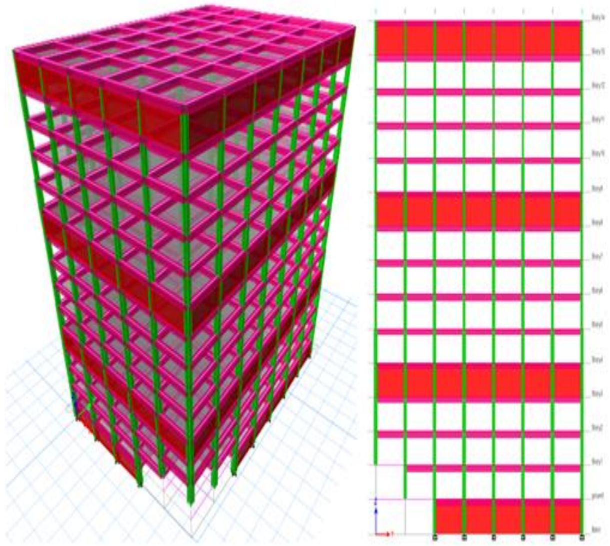

Fig 6: Model with belt wall with critical case of removed column

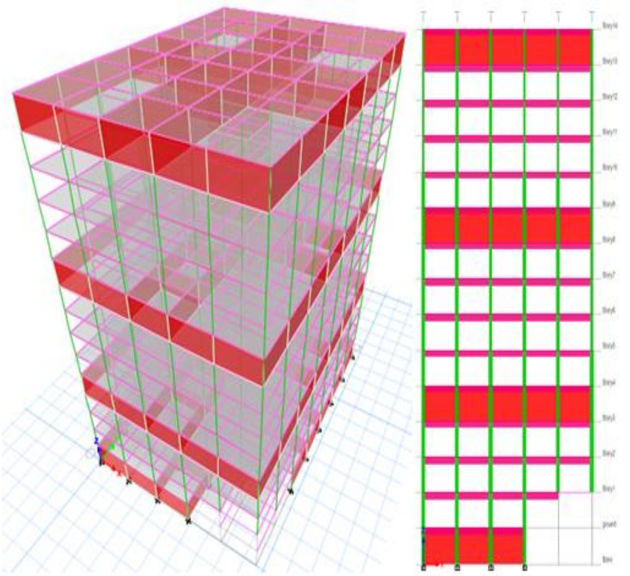

Fig 7: Model with belt wall connected with centre in critical case

III. RESULTS AND DISCUSSION

In this section address specific parameters such as storey displacement, base reaction, bending moment, shear force, and demand capacity ratio. The detailed study will involve gathering data from the analysis conducted using ETABS 2016 and presenting the findings through graphical representations. A comparative analysis will be performed to juxtapose the results obtained from different parameters, leading to conclusive remarks regarding their relationships and implications.

Table 2: Story Displacement Data of All Cases

Storey's	Storey Height (m)	Case-1	Case-2	Case-3	Case-4	Case-5	Case-6
14	45	86.668	121.36	96.071	106.913	77.925	47.062
13	42	84.131	115.498	93.659	103.76	76.864	45.853
12	39	79.793	108.269	89.055	98.376	71.493	42.694
11	36	73.797	99.787	82.43	90.944	63.424	38.696
10	33	66.382	90.231	74.08	81.758	53.91	34.221
9	30	60.31	81.692	67.371	74.228	48.333	30.383
8	27	53.642	72.699	59.94	65.962	47.116	29.178
7	24	46.775	63.547	52.27	57.451	40.556	24.847
6	21	39.859	54.327	44.538	48.88	31.78	19.724
5	18	33.423	44.837	37.336	40.905	23.905	14.874
4	15	27.375	36.273	30.663	33.406	18.774	11.088
3	12	21.21	27.638	23.856	25.767	17.547	10.179
2	9	14.983	18.986	17.03	18.26	12.302	6.755
1	6	8.83	10.536	10.234	11.042	5.312	2.928
ground	3	3.204	3.518	3.841	3.947	0.353	0.185
Base	0	0	0	0	0	0	0

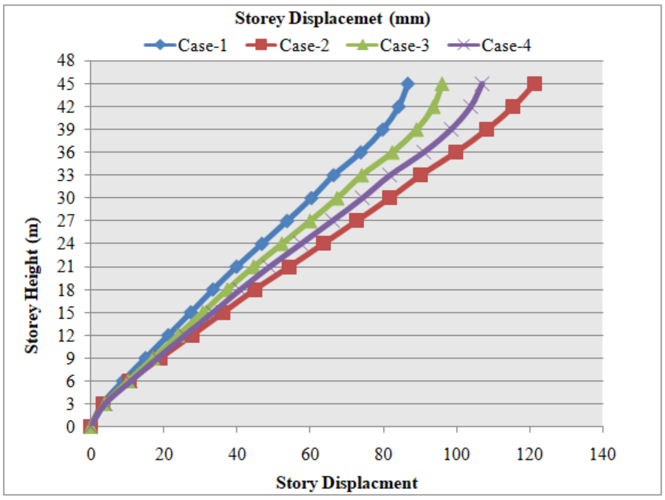

Fig 8: Story Displacement of Bare Frame and Cases from Column Removal at Different Location

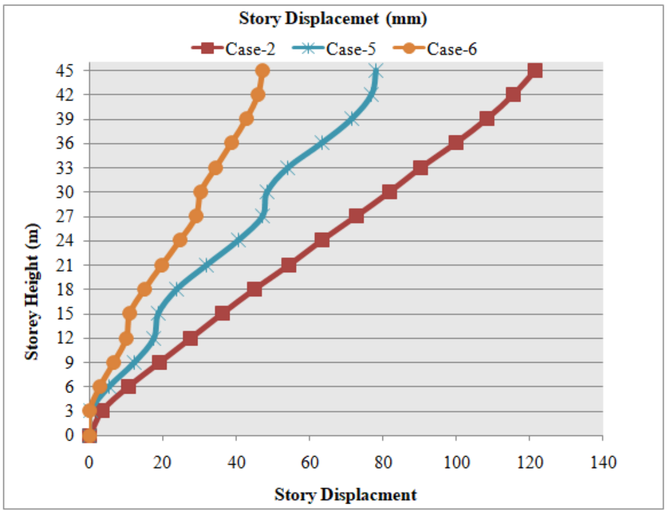

Fig 9: Comparative Story Displacement Controlled by Belt wall at Different Location

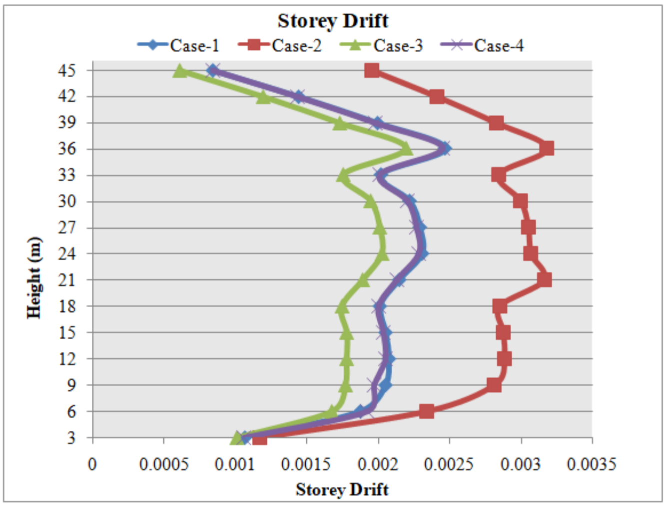

Fig 10: Story Drift of Bare Frame and Cases from Column Removal at Different Location

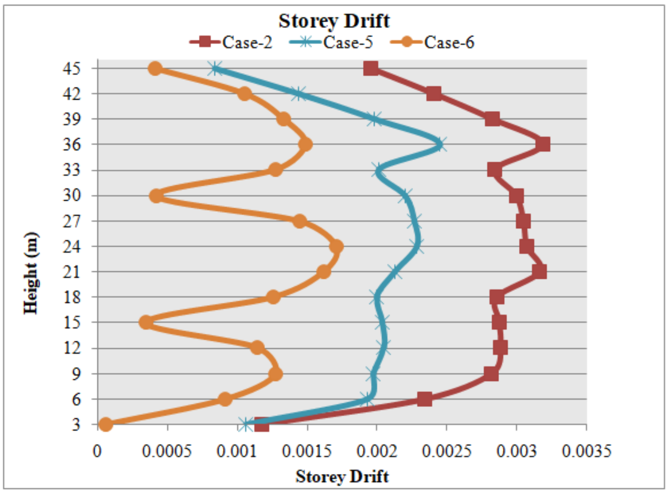

Fig 11: Comparative Story Drift Controlled by Belt wall at Different Location

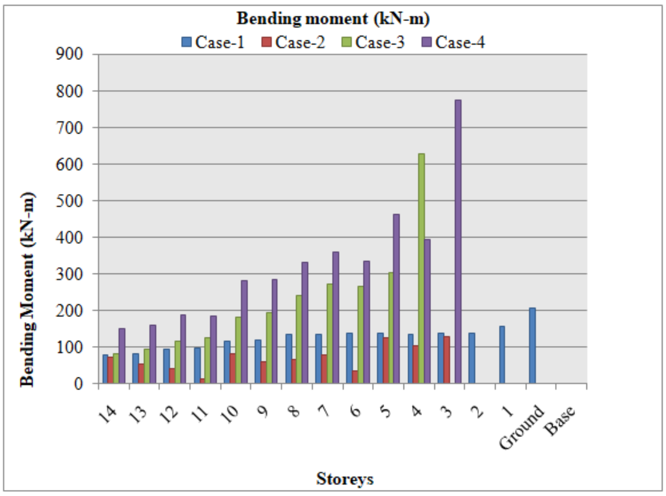

Fig 12: Story Drift of Bare Frame and Cases from Column Removal at Different Location

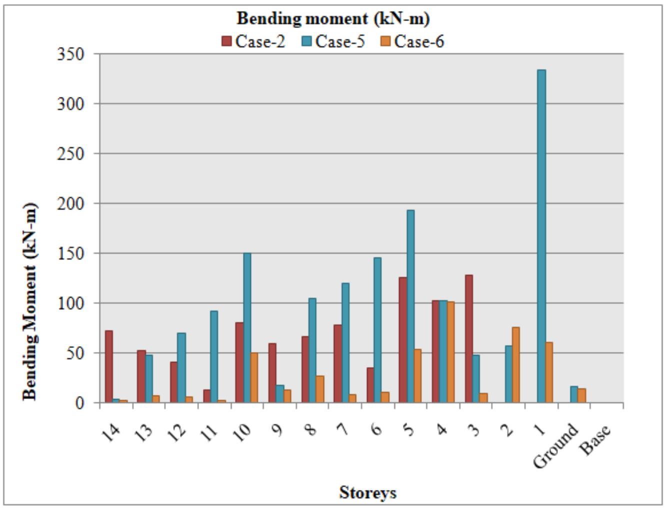

Fig 13: Comparative Story Drift Controlled by Belt wall at Different Location

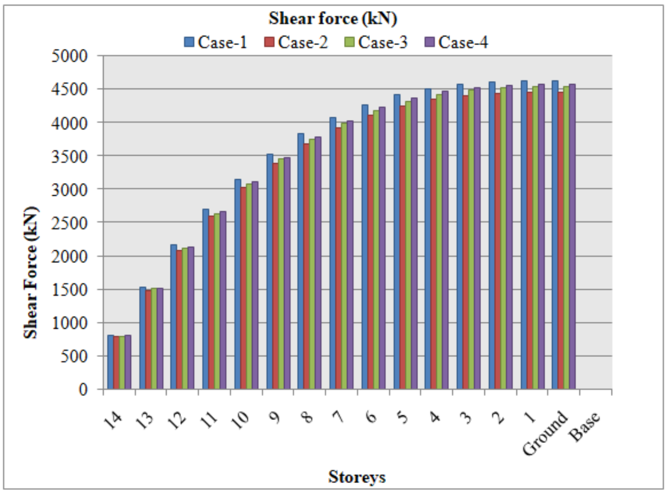

Fig 14: Shear Force of Bare Frame and Cases from Column Removal at Different Location

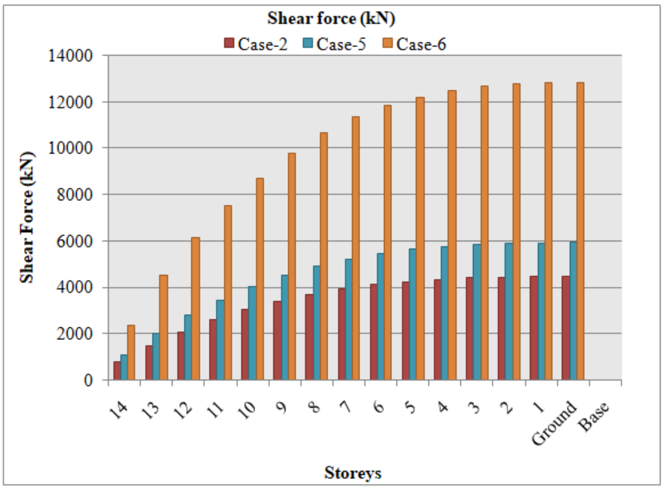

Fig 15: Comparative Story Drift Controlled by Belt wall at Different Location

IV. CONCLUSIONS

The belt wall plays a crucial role in maintaining safety and structural stability during construction activities, allowing for deeper excavations in urban environments without compromising the integrity of adjacent structures or risking potential soil collapses. Its design and implementation are fundamental in ensuring the success and safety of below-grade construction projects. The investigation will provide insights into the structural resilience of G+14 buildings under different stressors, shedding light on the significance of column distribution and the efficacy of belt walls in enhancing the overall stability and safety of such structures. The findings derived from these analyses aim to offer valuable guidance for engineers and stakeholders in devising more robust structural designs and implementing preventive measures to bolster the resilience of similar buildings against unforeseen events.

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