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Behavior Study of RCC Building In Different Seismic Zone With Bracing System Using STAAD.PRO

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Abstract - *The structure is analyzed as an RC structure in general. Using several types of RCC bracing systems (X type) and bracing system arrangement, an RCC high rise building of G + 11 storeys is braced to increase seismic resistance. to construct a structure with sufficient lateral resistance that is seismically safe. To withstand the lateral stress, a bracing system is inserted in between the column members. Bracing systems are inexpensive, simple to install, and take up less room. Using Staad Pro software, the structure is examined for seismic zones II and V both with and without various bracing systems. The results are compared to the bare frame.*

The application of the load condition follows IS 1893:2016. The bracing system increases the structure's capacity for displacement. It is determined what percentage of the storey displacement was reduced. It is discovered that the X style of concrete bracing considerably lowers the maximum storey drift of the frames and increases structural rigidity. The bracing system increases the structure's displacement capacity in addition to its stiffness and strength.

Key Words: Seismic Zone, Cement, Aggregate, Recycle

1. INTRODUCTION

In recent years, seismic design for tall structures has become more and more important. Seismic design becomes more rigorous as the number of stories increases. Traditional methods, based on the fundamental mode of the structure and the distribution of earthquake forces as static forces at various stories, may be sufficient for structures of small height subjected to low-intensity earthquakes.

House construction is now an important part of the country's socioeconomic progress. Engineers and architects undertake the design work, planning and layout, and other aspects of the projects ona daily basis in order to create houses affordably, rapidly, and in accordance with community requirements. Draughtsman are in charge of completing building drawings under the supervision of engineers and architects. The draughtsman must understand his profession and be able to followthe engineer's instructions in order to make the appropriate drawings of the building, site plans, and layout plans, among other things. The amount of bays and storeys make up a building frame. A sophisticated statically intermediate structure is a multi-story, multi-paneled frame. A design fora R.C.C building with a G+11 storey frame is being considered.

2. LITERATURE REVIEW

V. Abhinav, STAAD Pro software was used to analyze [1] an 11-story RCC structure that was strengthened using shear walls. The primary goal was to locate shear walls. The current investigation found that, in seismic zone V, shear walls around the perimeter of the structure are significantly more effective than other models.

P. Soni [2] I've used STAAD Pro software to analyze a multi-story structure with varying shear wall heights and placements. For the purpose of the comparison analysis, the three construction models—G+10, G+20, and G=26—were taken into account. It has been determined that the optimal shear wall is located in the center.

M. S. Azad [3] ETABS 9.7 software was used to study an RCC high-rise structure with shear walls and a bracing system. Six models have been created for comparison analysis, one for each site of the shear wall. The results showed that the model with the shear wall in the middle was the safest of all.

T. Kirtan [4] Using ETABs V.13, a comparative study on a 30-story RCC frame with shear walls and a Hexagrid system was conducted. For the frame analysis, the base shear and displacement were used as criteria. In comparison to RCC frames with shear walls and Hexagrid systems, the current study found that in the case of RCC frames, base shear is least and storey displacement is largest.

John, R., and Partani, P. [5] examined a zone III seismically loaded RCC framed structure strengthened by crescent bracing in the ground floor soft story. There was a recorded decrease in storey displacements of 12 to 14 percent. Additionally, storey drift was cut by 20%.

P. P. Chandurkar [6] investigated the impact of a multi-story building's shear wall placement. Using ETABS v9.5.0, he examined four distinct models for seismic zones II, III, IV, and V. It has been noted that shear walls, when positioned at the corner of a high-rise building, are both cost-effective and efficient.

Prashar Kartik [7] This research uses ETAB software to assess a structure for seismic zone V utilizing various bracing systems and compare it to the bare frame. The application of the load condition follows IS 1893:2002.

The bracing system increases the structure's capacity for displacement. Stiffness, strength, and energy dissipation are provided by the bracing system in tall reinforced concrete (RC) buildings to withstand lateral loads. This research focuses on the various bracing systems (diagonal, V, inverted, and k types) and how they are arranged. to construct a structure with sufficient lateral resistance that is seismically safe [8-10].

To withstand the lateral stress, a bracing system is constructed between column members. Bracing systems are inexpensive, simple to install, and take up less room. An efficient and successful method of resisting lateral loads is the steel bracing system. An efficient method for lateral load resistance in reinforced concrete structures is the steel braced RC frame. Different types of bracing systems decrease the structure's displacement and storey drift. The X-bracing system is the most efficient bracing configuration for boosting the lateral load capacity of a structure. Bracing systems lessen the column's shear force and bending moment [11-15].

This manuscript is primarily software-based, and it is critical to understand the specifics of these software

3.0. PROBLEM STATEMENT AND METHODOLGY

List of software's used

1. Staad Pro (V8i ss6)
2. Staad Foundation Advanced.
3. Staad RCDC.
4. AutoCAD.

3.1. Methodology

The central objective of this study is to conduct a comprehensive analysis of a structure's earthquake resistance capabilities. Specifically, the paper aims to evaluate the seismic resistance of a structure and make a comparative assessment between structures featuring conventional bracing systems and those incorporating flanged concrete columns. In the context of tall or high-rise buildings, the prevalent approach to earthquake resistance is the integration of bracing systems. It's important to note that various analysis and design software tools are available for the comprehensive examination and design of earthquake-resistant structures. In this paper, the chosen structure for analysis is a residential building, specifically a hotel or apartment-style structure.

Table 1. Problem Statement for The Project Models

Sr. No.	Description of structure	Values
1	Grade of concrete	M30
2	Grade of steel	Fe500
3	Number of bays in X direction and its width	6 bays of 4 m each
4	Number of bays in Z direction and its width	5 bays of 3 m each
5	Story height	3 m each
6	Number of storey (Excluding the plinth and substructure and including the Ground floor)	12
7	Depth of foundation from ground level	2.5 m
8	Plinth height	600 mm
9	Column size	230 mm x 600 mm
10	Beam size	230 mm x 450 mm
11	Thickness of Slab	150 mm
12	Density of concrete	25 kN/m^3
13	Live load on roof	1.5 kN/m^2
14	Live load on floors	3 kN/m^2
15	Floor finish	1 kN/m^2
16	Brick wall on peripheral beams	230 mm
17	Brick wall on internal beams	115 mm
18	Density of brick wall	20 kN/m^3
19	Internal Plaster	12mm
20	Bracing size	230mm x 300
21	Density of Plaster	18 kN/m^3

The following seismic analysis values are presumptive for the current investigation. Based on the reference steps provided in IS 1893-2016, 13920-1993, and IS 456:2000, the values are assumed. According to IS 1893 - 2016 Table 2, zone II and V are assigned for moderate seismic intensity in the current investigation.

Table 2. Seismic Parameters

1	Zone factor for zone II & V	0.1 & 0.36 (As per code)
2	Importance factor	1 (As per code)
3	Special Reinforced Concrete Moment resisting Frame	
4	SMRF is a moment resisting frame detailed to provide ductile behavior and comply with the requirements of 13920-1993	
5	Response reduction factor	5 (As per code)
6	Type of soil	Medium(Type II)
8	Damping percent	5 % (0.05)
9	Thickness of bracing wall	230 mm

3.2. Structural Modelling

In this study, we have undertaken a comprehensive investigation involving a comparative analysis of different bracing systems in both seismic zone II and seismic zone V, in conjunction with a conventional non-braced structure, under the influence of both seismic and gravity loading conditions. The primary focus has been on understanding the behavior and principles of bracing systems. To facilitate this analysis, various structural models have been meticulously developed using the STAAD-PRO software. The models encompass both bracing systems and the conventional non-braced structure, and their characteristics and configurations are expounded upon in this section.

Furthermore, this section delves into a detailed exploration of the various loading specifications, including their combinations, to which both braced and non-braced structures are subjected. The specific methods and design criteria employed for the analysis of the bracing system are also presented.

The overarching objective of this study is achieved by adhering to the following methodological framework:

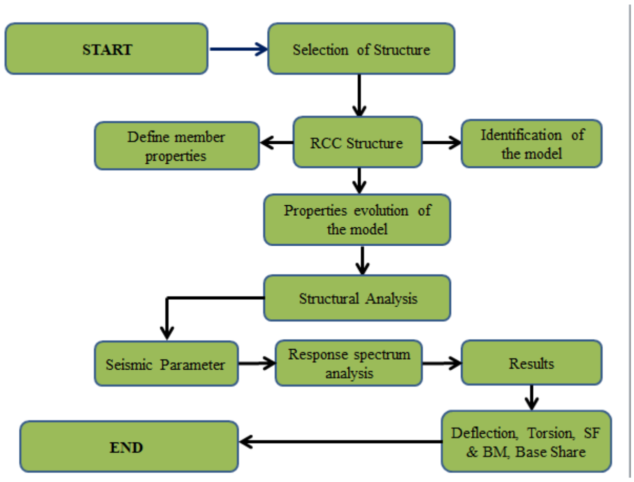

Figure 1. structural modeling

3.3. PLAN

A Model of G + 11 storey is developed, analysis and design using Staad-Pro software.Building Plan Size is 20m X 36m The building is situated in bhuj Gujrat in Zone V.

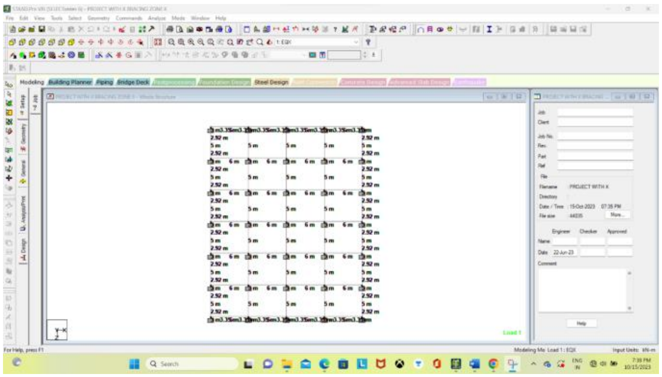

Figure 2. Plane of structure

3.4. Supports

The base supports of the structure are assigned as fixed with and without bracing system high 26m

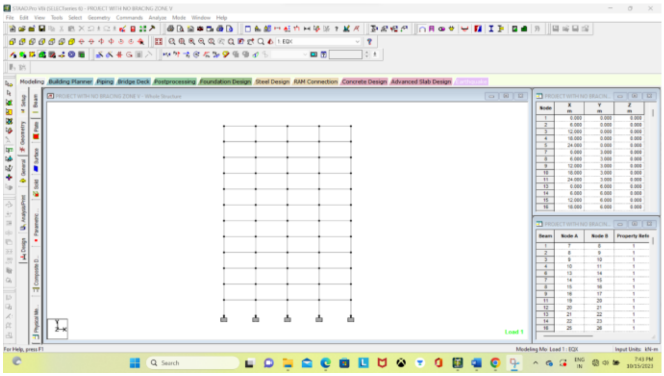

Figure 3. side view of without bracing system

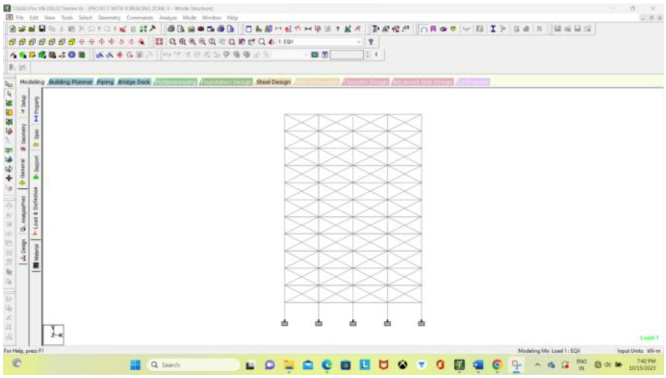

Figure 4. side view of with bracing system

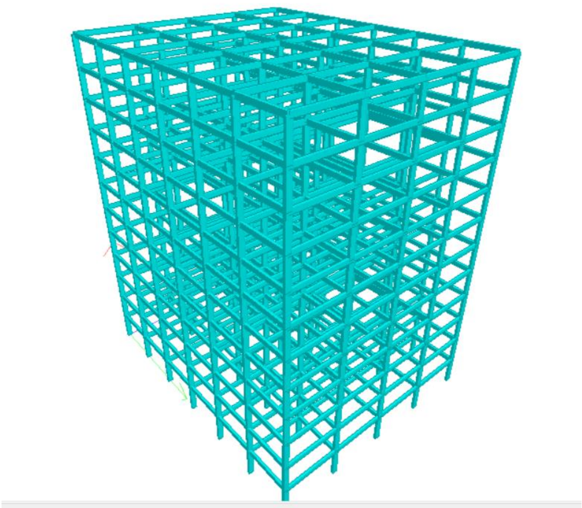

Figure 5. Models (M1) generated in STAAD Pro V8i for the Problem Statement zone II without bracing

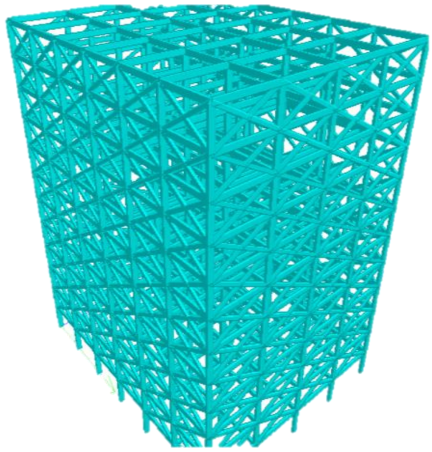

Figure 6. Models (M2) generated in STAAD Pro V8i for the Problem Statement zone II with bracing

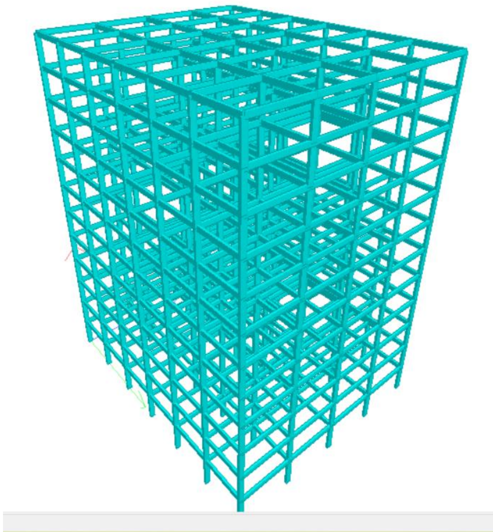

Figure 7. Models (M3) generated in STAAD Pro V8i for the Problem Statement zone V without bracing

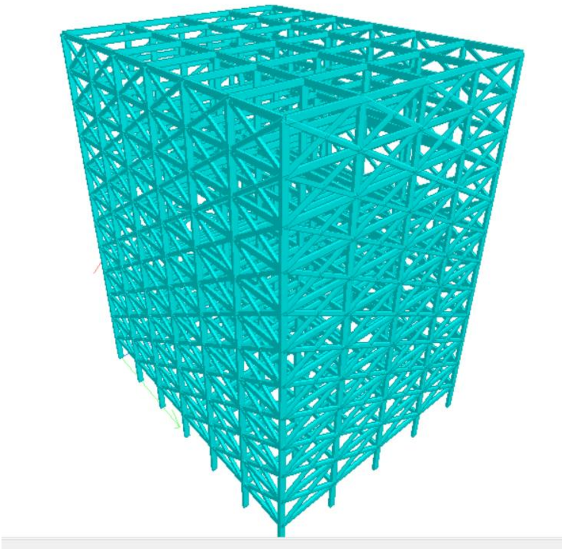

Figure 8. Models (M4) generated in STAAD Pro V8i for the Problem Statement zone V with bracing

4.Result and Discussion

In the context of this study, the equivalent static method or seismic coefficient method was employed to calculate the design lateral forces acting along the stories in both the X and Z directions of a 12-storey reinforced concrete building, chosen for its asymmetrical nature, located in seismic zones II and V, with the structural analysis and design conducted using STAAD Pro V8i software, the outcomes of which were subsequently examined and discussed. The structural configurations for all the models under consideration were previously detailed in the preceding chapter, and each of the two seismic zones was represented by five distinct models, with Model I representing a multistoried building without bracing, Model II featuring X bracing, Model III serving as another example without bracing, and Model IV incorporating X bracing, with each model being subjected to a comprehensive analysis and design process conforming to the pertinent Indian Standard codes, namely IS 1893, IS 13920, IS 875, and IS 456: 2000.

Table 3. Maximum Nodal Displacements

Sr. No.	Height Of Building	Bracing Patterns	Max Displacement MM (zone no II)	Max Displacement MM (zone no V)
1	G + 11	Without Bracing	48.79	84.92
2	G + 11	X Bracing	16.17	21.47

Table 4. Maximum base Shear Force

Sr. No.	Height Of Building	Bracing Patterns	Max Base Shear KN (zone no II)	Max Base Shear KN (zone no V)
1	G + 11	Without Bracing	41.51	71.62
2	G + 11	X Bracing	43.83	73.47

Table 5. Maximum Base Moment

Height Of Building	Bracing Patterns	Max Base Moment KN-M (zone no II)	Max Base Moment KN-M (zone no V)
G + 11	Without Bracing	81.44	121.89
G + 11	X Bracing	91.74	129.75

5.CONCLUSIONS

In the current study, ten distinct models were meticulously designed and thoroughly analyzed utilizing the advanced civil engineering structural software STAAD PRO, wherein the first two models, denoted as M1 and M2, were situated in seismic zone II, with and without X bracing respectively, and similarly, another pair of models, M3 and M4, were located in seismic zone V, with and without X bracing, all possessing identical plan aspect ratios and slenderness ratios while maintaining uniform dimensions for structural components like columns, beams, slabs, and foundations across all models. The findings presented in the preceding chapters led to several noteworthy conclusions: firstly, it was observed that higher seismic zones corresponded to increased nodal displacement, with seismic zone V exhibiting a displacement of 48.79 mm, notably higher than the 84.92 mm displacement observed in seismic zone II; secondly, the implementation of a bracing system was found to significantly diminish lateral displacement, demonstrating an impressive reduction of up to 75% when compared to the displacement observed in bare frame structures; thirdly, among the various bracing types studied, X type bracing emerged as the most effective in minimizing displacement, suggesting its superior capability in resisting deformation and enhancing the overall stiffness of buildings compared to other forms of bracing; and fourthly, the introduction of bracing in building frames led to an increase in base shear, indicating a heightened stiffness in the structure, thereby highlighting the efficacy of bracing systems in enhancing the structural stability of buildings.

5.1. **Future Scope**

1. Analysis of Tall Buildings: STAAD Pro is a powerful tool for accurately analyzing tall and complex structures. It provides the precision required for such intricate designs.
2. Limiting Self-Load: It's important to limit the structure's self-load, and one way to achieve this is by using lightweight, environmentally friendly materials such as ACC Block. This choice reduces the overall load on the structure.
3. High-Grade Concrete and Compaction: Utilizing high-grade concrete is essential for achieving structural strength. Proper compaction techniques, such as using Self-Compacting Concrete, are vital to prevent defects like Honeycomb and blowholes, ensuring the integrity of the structure.
4. Shear Walls in Multistory Buildings: Incorporating shear walls in multistory buildings significantly reduces displacement and stress levels. This reduction allows for the strategic placement of shear walls, leading to reduced column sizes and blockages. Consequently, buildings with shear walls are more cost-effective to construct compared to those without.
5. Importance of STAAD Pro in Technical Problem Solving: STAAD Pro plays a crucial role in examining technical and scientific problems in structural engineering. Its importance is increasing, indicating a shift towards software-based solutions for complex engineering challenges.
6. Advocacy for Software Usage: Encouraging the widespread use of advanced engineering software like STAAD Pro is essential. Transitioning from manual methods to software-based solutions not only ensures accuracy but also enhances efficiency and cost-effectiveness in civil engineering projects.

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