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RCC Structures in Different Seismic Zones II & IV in India Using Staad Pro. and RCDC

Aditya Kumar[1], Dr. Shubha Agrawal[2]
[1]M.Tech Scholar Department of Civil Engineering Lakshmi Narain College of Technology, Bhopal, India.
[2]Professor, Department of Civil Engineering Lakshmi Narain College of Technology, Bhopal, India.

Abstract- The thesis is based on a comparative study of configuration of RC Frame buildings irregular plan. With the increase in demand of high-rise buildings, the concern for safety also increases. High Rise Buildings are against lateral forces like wind load and seismic loads. To ensure safety against these factors, many tools are applied in the structure. In this thesis, we have Analysis and Time History Analysis. Both of these analyses are done under elastic limit, For Response Spectrum Method. Seismic safety of reinforced concrete buildings is a critical concern in regions of high seismic activity, particularly in areas classified under Seismic Zone II & Zone IV, where structures are subjected to severe ground motion and significant lateral forces. The present dissertation focuses on the seismic response analysis of storey reinforced concrete building located in Zone II & Zone IV, with special emphasis on studying the influence of different grades of reinforcing steel on structural behavior under earthquake loading. The primary objective of the study is to assess how variations in steel grade affect key seismic response parameters, including storey displacement, inter-storey drift, base shear, and dynamic characteristics of the building. The research adopts an analytical methodology using dynamic seismic analysis techniques in accordance with the provisions of IS 1893 (Part 1): 2016. A three-dimensional analytical model of the residential storey building is developed using standard structural analysis software.

Keywords: Reinforced Concrete (RC) Frame, Irregular Plan Building, High-Rise Building, Seismic Analysis, Seismic Zone II.

I. INTRODUCTION

In this modern Construction Era, we can see spacious construction activities taking place everywhere, hence there will be a shortage of land space. So construction of tall structures has been triggered up to overcome this problem.

This research is directed to find the cost comparison between conventional structures. And find design and analysis , the quantity and cost variation for conventional for various zones in India. Staad Pro. Connect Edition and RCDC software is used in this present work.

A residential storey building represents a medium-rise structure where seismic effects are significantly pronounced due to cumulative mass, higher mode participation, and increased lateral flexibility. The seismic behavior of such buildings cannot be reliably predicted using simplified static methods alone. Instead, advanced dynamic analysis techniques such as response spectrum analysis and nonlinear time-history analysis are required to capture realistic structural behavior under earthquake loading. Seismic response analysis enables engineers to evaluate critical parameters including lateral displacements, storey drifts, base shear distribution, and demand-capacity ratios across different structural components. The present study focuses on the seismic response analysis of a residential storey reinforced concrete building located in Zone II & Zone IV, with special emphasis on the influence of different grades of reinforcing steel. By systematically evaluating how steel grade affects seismic response characteristics, the study aims to provide meaningful insights that can support safer design decisions and improve code-compliant construction practices in high seismic zones.

Objective of The Present Research

To analyze the bending moment in the region of conventional slab by Staad Pro and RCDC software.
To find maximum deflection in conventional slab by Staad pro software.

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To find story shear due to earthquake along x-axis any z-axis by Staad.

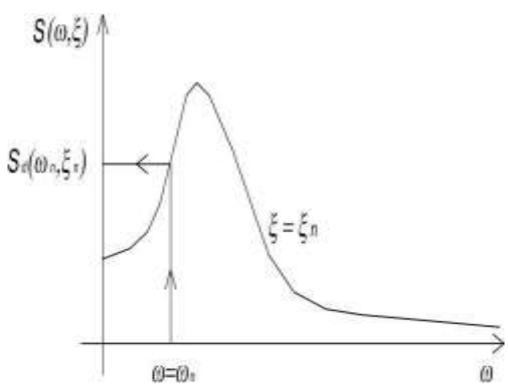
To find overturning moments maximum at base and at top Staad pro software.
To obtain Story stiffness values along X direction and Y direction by Staad Pro. To find Reinforcement provided for conventional Column, beam, slab by Staad Pro and RCDC software.

Comparison of results obtained in terms of Story drift, displacement, base shear in the portion of building with conventional slab and finally verifying the results by the software Staad Pro.

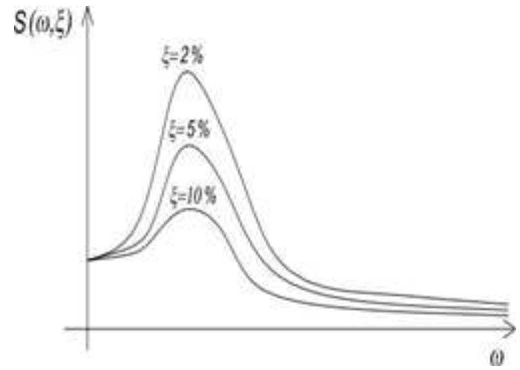
II. LITERATURE REVIEW

Detailed evaluation methods:-
- Equivalent static method
- Response spectrum method

Response Spectrum Method
Response spectrum analysis is a procedure for computing the statistical maximum response of a structure to a base excitation. Each of the vibration modes that are considered may be assumed to respond independently as a single-degree-of-freedom system. Design codes specify response spectra which determine the base acceleration applied to each mode according to its period (the number of seconds required for a cycle of vibration).



Typical representation of response Spectrum



Explaining the response spectrum analysis procedure

"**IS 1893 (Part 1):** 2016 — Criteria for Earthquake Resistant Design of Structures," Bureau of Indian Standards, full text (essential code). [cracindia.in]
Studies on modal properties and higher-mode effects for mid-rise buildings (Applied Sciences, Engineering Structures). Example: Song et al. (2023). [ResearchGate]

Bureau of Indian Standards, IS 1893 (Part 1): 2016 — Criteria for Earthquake Resistant Design of Structures (Part 1: General Provisions and Buildings). [Internet Archive]

Patil et al. (2022): This study focuses on the seismic and wind load analysis of multi-story buildings using STAAD Pro. The research compares the impact of building height on seismic and wind stresses, identifying the height at which wind load becomes predominant over seismic load. The analysis helps in understanding the structural behavior of buildings under these combined forces.

Choubi et al. (2021): This paper compares the structural behavior of three types of steel-only constructions (transmission tower, Howe bridge truss, and Howe roof truss) using two software programs: STAAD Pro. The study shows that both programs provide similar results in terms of shear pressures, bending moments, and base reactions, but ETABS is easier to use and more efficient in terms of identifying stressed members.

Borkar et al. (2021): This study examines the seismic response of unappetizing slab RCC structures in different seismic zones (II to V). The research compares these structures with traditional 2-way slab systems in terms of bending moments, story shear, base shear, and story drift using ETABS software. It aims to provide insights into the seismic resilience of unappetizing slab systems in various seismic conditions.

Borkar et al. (2021): This research also investigates the seismic behavior of different types of slab structures, including flat slabs, conventional slabs, and flat slabs with drops under seismic conditions in various earthquake zones (II-V). The analysis, conducted using ETABS software, focuses on key parameters such as maximum bending moments and overall structural stability.

Kitey et al. (2020): This research analyzes a G+12 multi-story building with flat slabs, column heads, and conventional slabs to study their seismic behavior in different seismic zones (II to V) using ETABS. The study focuses on parameters such as story displacement, drift, shear, base shear, and time period. The objective was to compare how the height of the building affects the seismic performance of these types of structures under seismic forces.

BUILDING ANALYSIS:-

About the building:

Table 1: Building Description:

Building Type	Reinforced Concrete Frame
Usage	Residential
Location	Bhagalpur, Bihar
Year of Construction	2023
Number of Stories	2 Basement + Ground + 5th Floor (8 Stories)
Plan Dimensions	20.0 m X 26.83 m
Building Height	Basement Level to Terrace- 24 m Ground Level to Terrace- 18 m

Table 2: Grade of Materials

Concrete	M 25
Reinforcing Steel	Fe 550

DEFINE LOADING

- Self weight = 1
- Wall Load:-
  250mm Wall = 12 KN/m
  125mm Wall = 6 KN/m
- Floor Finishing Load:-
  Floor Finish = 1 KN/m2
- Sunk Load:-
  Sunk Filling = 2 KN/m2
- Live Load:-

Bedroom, Kitchen, Dining & Drawing Area = 2 KN/m2
Balcony, Stair & Common Area = 3 KN/m2
On Terrace = 2 KN/m2

- Lift Machine Surface Load:-
  Lift Machine Surface = 5 KN/m2
- Water Tank Load:-
  Water Tank = 12 KN/m2

III. METHODOLOGY

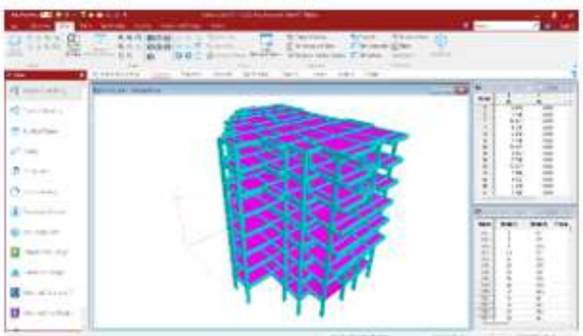
The methodology adopted to perform the seismic evaluation of the building requires an understanding of equivalent lateral force procedure also recognized as equivalent static procedure in literature.

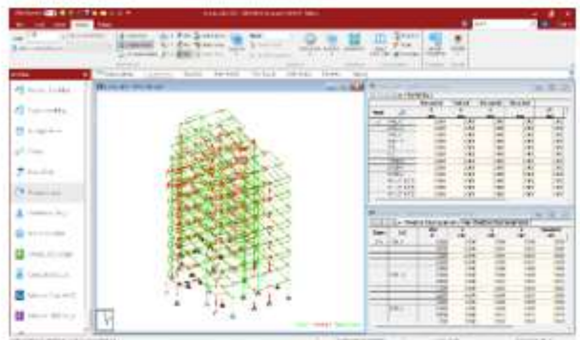
An in depth knowledge of STAAD Pro and RCDC software is required as the building was modeled in STAAD Pro and post analysis data obtained from it was used in the analysis of the structure.

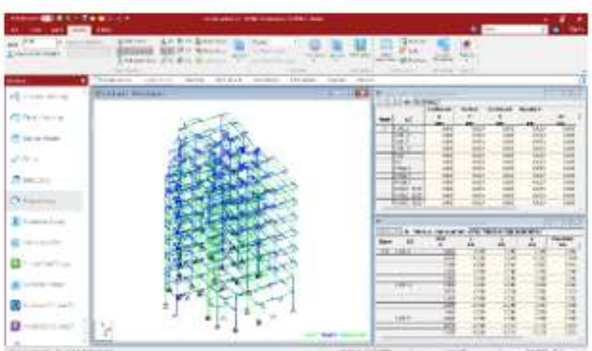
The demand to capacity ratio of members was calculated to analyze the seismic stability of the structure under the various load combinations in accordance with IS 1893-2016 (Part -1).

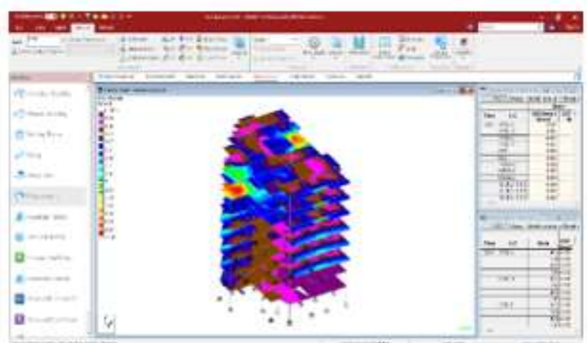
In this dissertation, dynamic analysis methods are adopted to evaluate the seismic response of a residential storey building in Zone II & Zone IV. The selection of analysis methodology ensures accurate representation of seismic demand and enables meaningful comparison between different grades of reinforcing steel.

Figure 1: Seismic analysis methods applied to multi-storey buildings









IV. RESULTS AND DISCUSSION

So it can be concluded from the present study Staad Pro Connect Edition and RCDC software is more preferred option than Staad Pro for for Zone II & IV as in Staad Pro static and dynamic analysis is carried out and value arrived is more closer to the IS-456-2000 codes. The structure is design based on the Staad Pro which is based on limit state of method which provide adequate strength, serviceability, and durability besides economy. The displacement, shear force, bending moment dimensions of beam. Analysis and Design of 2B+G+5 Residential Cum Commercial Building by Using Staad Pro Connect Edition and RCDC.

In Earthquake Zone – II, constructing this structure requires large columns, beams, and foundations, and more reinforcement is needed because the seismic acceleration is 0.24.

Column Sizes For Earthquake Zone – IV	Column Sizes For Earthquake Zone – II
300mm x 900mm	250mm x 500mm
350mm x 800mm	300mm x 600mm
350mm x 900mm	300mm x 700mm
400mm x 900mm	300mm x 900mm

Shear Wall Sizes For Earthquake Zone – IV	Shear Wall Sizes For Earthquake Zone – II	Remark
250mm x 1030mm	250mm x 1030mm	Less Steel Provide in Zone II compare to Zone IV

Beam Sizes For Earthquake Zone – IV	Beam Sizes For Earthquake Zone – II
300mm x 600mm	300mm x 500mm

Slab Thickness For Earthquake Zone – IV	Slab Thickness For Earthquake Zone – II	Remark
125mm	125mm	Less Steel Provide in Zone II compare to Zone IV

Foundation Raft Thickness For Earthquake Zone – IV	Foundation Raft Thickness For Earthquake Zone – II	Remark
600mm	500mm	Less Steel Provide in Zone II compare to Zone IV

However,building the same structure in Earthquake Zone – II requires less material for the columns, beams, and foundations because the seismic acceleration is only 0.1.

The present research establishes a strong analytical foundation and provides meaningful conclusions that can support safer, more informed seismic design practices for residential storey reinforced concrete buildings in high seismic regions, while also identifying clear directions for future advancements in seismic performance assessment.

This Thesis has presented a comprehensive seismic response analysis of a residential storey reinforced concrete building located in Seismic Zone II & Zone IV with particular emphasis on the influence of different grades of reinforcing steel on structural behavior under earthquake loading. The study was motivated by the growing prevalence of medium-rise buildings in high seismic regions and the need to understand how material selection affects seismic performance beyond conventional strength-based design considerations.

By adopting a consistent analytical framework and applying dynamic seismic analysis techniques in accordance with IS 1893-2016 (Part-1) provisions, the research systematically evaluated critical response parameters such as storey displacement, inter-storey drift, base shear, and modal characteristics. The results clearly demonstrate that reinforcing steel grade plays a decisive role in governing the stiffness, deformation capacity, and force demand of the structure. Buildings reinforced with higher-grade steel exhibited reduced lateral displacement and inter-storey drift due to increased stiffness, indicating improved control over deformation and enhanced serviceability performance under design-level earthquakes.

However, this reduction in deformation was accompanied by an increase in base shear demand and internal force concentration, particularly at lower storeys, highlighting the inherent trade-off between stiffness and seismic force demand. Conversely, buildings using relatively lower-grade steel showed greater lateral flexibility and higher displacement demand but demonstrated more favorable energy dissipation characteristics, which are essential for ductile seismic behavior and damage tolerance in high seismic zones.

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