Seismic Analysis of High Rise Building G+20 IN Seismic Zone 4 Using Pushover Analysis

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Abstract **- The earthquakes in the Indian subcontinent have led to an increase in the seismic zoning factor over many parts of the country. Furthermore, ductility has become a problem for all buildings that were planned and specified using previous versions of the standards. Building seismic certification has become critical under such conditions. The present study focuses on the seismic performance of high-rise buildings. For this purpose, Tekla Structural Designer, a BIM software, has been used. And to achieve our goals, we perform pushover analysis. POA, or static pushover analysis, is gaining popularity as a simpler computer approach for evaluating the seismic performance of buildings. This technique suggests that the structure's reaction is exclusively governed by the first mode, which remains constant throughout time history.**

Index Terms **- Pushover analysis, Tekla Structural Designer (TSD), High Rise Building, BIM software, Seismic Zone 4.**

I.INTRODUCTION

Seismic design may be simplified into two steps. The first, and typically most essential, is the creation of an effective structural system that requires must be designed with all significant seismic factors in mind Performance goals range from serviceability to life safety and collapse avoidance. The evaluation of uncertainty in the calculated structural response of civil construction is critical for improving safety and optimizing the use of economic resources. Estimating seismic demands at low-performance levels, such as life safety and collapse prevention, necessitates explicit consideration of the structure's inelastic behavior. While the most rigorous approach for calculating seismic demands is non-linear response history analysis (RHA), contemporary civil engineering practice favors the non-linear static procedure (NSP) or pushover analysis in FEMA-273.
Pushover analysis is a static, nonlinear process in which the amplitude of structural loads is steadily raised in accordance with a specified pattern. Static pushover analysis is an attempt by the structural engineering profession to analyze the true strength of the structure, and it promises to be a helpful and practical tool for performance-based design. The ATC-40 and FEMA-273 documents have developed modeling procedures, acceptance criteria and analysis procedures for pushover analysis. These documents define force-deformation criteria for hinges used in pushover analysis. Modeling methodologies, acceptance criteria, and analytical processes for pushover analysis have been defined in the ATC-40 and FEMA-273 papers. The force-deformation criteria for hinges used in pushover analysis are defined in these sources. The values allocated to each of these points differ based on the kind of member and a variety of other characteristics stated in the ATC-40 and FEMA-273 guidelines.
This article presents the steps used in performing a pushover analysis of a High-Rise Building using Tekla structural Designer, which are fully integrated into the program, allow quick and easy implementation of the pushover procedures prescribed in the ATC-40 and FEMA-273 document.

II. EASE OF USE

A. Related Work

(Wang and Ho n.d.)(2007).
In their research, they proposed a method for determining the parameters of plastic hinge properties (PHP) for structures with RC walls in pushover analysis is provided. The nonlinear relationship between lateral shear force and lateral deformation of an RC wall is first estimated using the Response-2000 and Membrane-2000 codes. Where in the pushover study of an RC structure, a dual parameters technique is developed to determine the plastic hinge properties (PHP) of the RC wall. The concordance of the prediction curves with some further test data confirms the usefulness of this basic strategy.

(Golghate, Baradiya, and Sharma n.d.) (2013)
In their study the main purpose the research is to assess the zone -IV reinforced concrete building chosen for non-linear static analysis (Pushover Analysis). The non-linear static analysis provides a better understanding and more accurate seismic performance of buildings that have suffered damage or failure. In the beams and columns, hinges have formed, indicating the three stages of immediate occupancy, life safety, and collapse prevention. The column hinges helped to reduce the damage.
(Wang, Martinez-Vazquez, and Zhao 2020)
In this work they evaluate the structural performance of structures subjected to earthquake and wind combined action the study used a pushover analysis to evaluate the strength capacity of low- and medium-rise concrete structures to their strength as determined by the Chinese seismic design code. The investigation focuses on soil-structure interactions by examining fixed-base e and flexible base conditions of three soil types ranging from thick to soft.

B. Objectives

1 To evaluate the seismic performance of a High-rise building (G+20) in seismic zone 4 for different soil conditions under vertical and earthquake loads.
2 To evaluate the seismic parameters storey displacement, base shear, storey stiffness, Pushover Curve in a (G+20) High-rise building as per Indian standards.
3 To perform non-linear pushover analysis on High-rise building (G+20) for earthquake loads.

C. Methodology

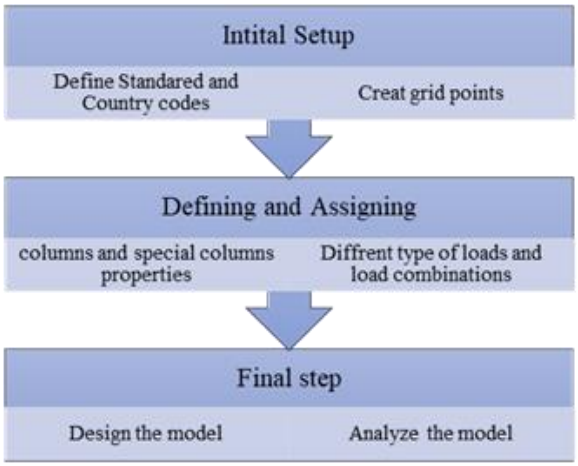


Fig 1. Steps for Modelling

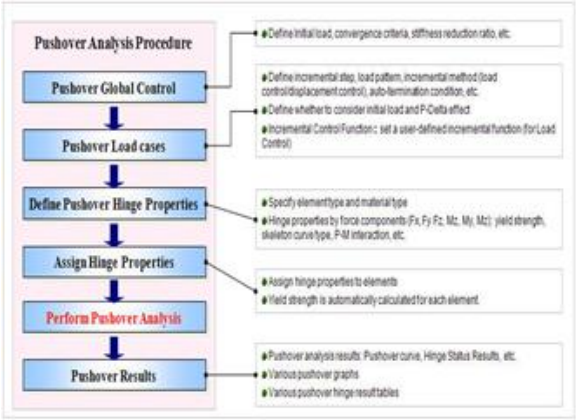


Fig 2. Steps for Pushover Analysis

D. Building Parameters

Area of building	25*20 m^2		
Height of building	63 m		
Shape of building	Rectangular		
Seismic zone	IV		
Zone factor	0.240		
Soil type	I-Hard Soil	II-Medium soil	III-soft soil
Importance Factor, I	1.2		
R, Reduction Factor	5		
IS Codes adopt for research	IS 1893:2016 (part1), IS 456:2000, IS 16700:2017		
Member	Dimensions		Grade
Slab Thickness	150mm		M30
Column	700*750mm^2		M30
	650*700mm^2		
Beam	500*600mm^2		M30
	450*550mm^2		

E. Models

Fig 3 Model of G+20 building

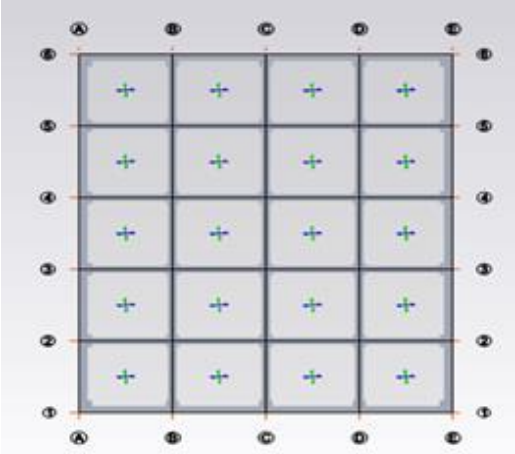
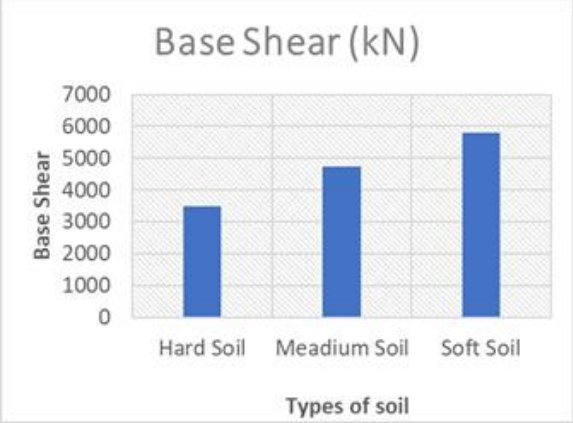


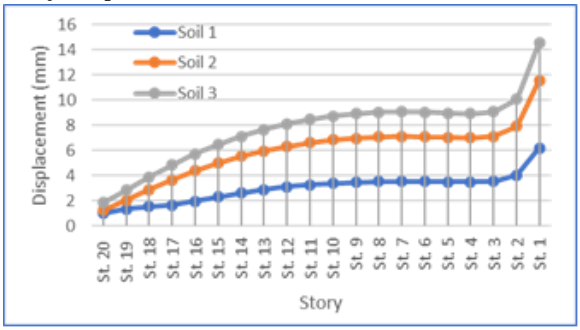
Fig 4 2D plan of building

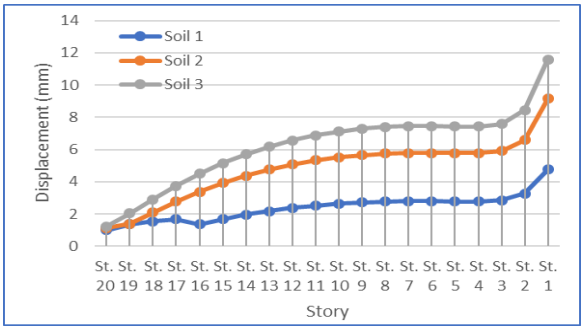
F. Analysis and Results

Base Shear

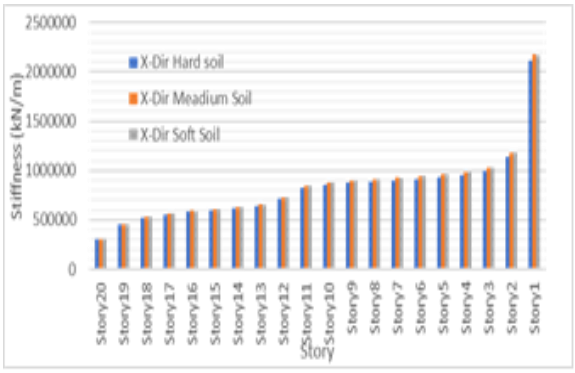


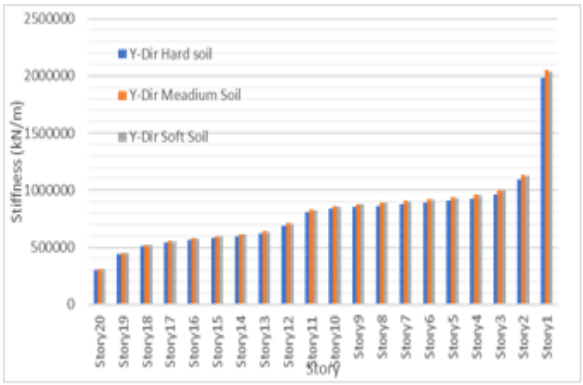
Story Displacement



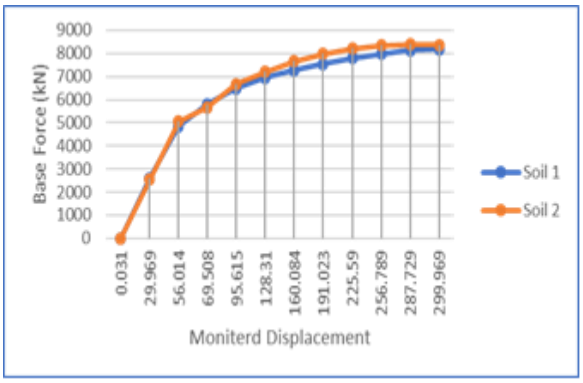


Story Stiffness





Pushover Curve



III.CONCLUSION

The pushover analysis is a simple way to explore the nonlinear behavior of the buildings. The results obtained in terms of pushover demand, capacity spectrum and plastic hinges the real behavior of structures. In a building in seismic zone –IV of different soil condition is designed and constructed using IS-456-2000 and the revised code IS-1893- 2016 provisions

1 As per IS code the storey deflection should less than 12 mm whereas the building in Soil Condition 3 is failed as it shows maximum displacement as compare to other buildings.
2 Stiffness in medium soil building is greater in comparison to other buildings
3 Hinges have developed in the beams and columns showing the three stages immediate occupancy, Life safety, Collapse prevention.
4 The column hinges have limited the damage.

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