Parametric Study on Frequency Analysis of RCC Shear Wall Using SAP2000

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ABSTRACT: This parametric study employs SAP2000 software to conduct a comprehensive frequency analysis on Reinforced Concrete (RCC) shear wall by systematically varying key parameters, such as aspect ratio, by conducting Time-History analysis of RCC shear wall subjected to seismic excitations. The aim of this paper is to study and compare the behaviour RCC shear walls based on aspect ratio by doing Time-History analysis in SAP2000 software, providing detailed response data such as structural displacements, natural frequency and base shear. This parametric study also identifies critical factors impacting the natural frequencies and mode shapes of the shear walls.

Keywords: Shear wall; SAP2000; Aspect ratio; Time history analysis; Frequency.

INTRODUCTION:

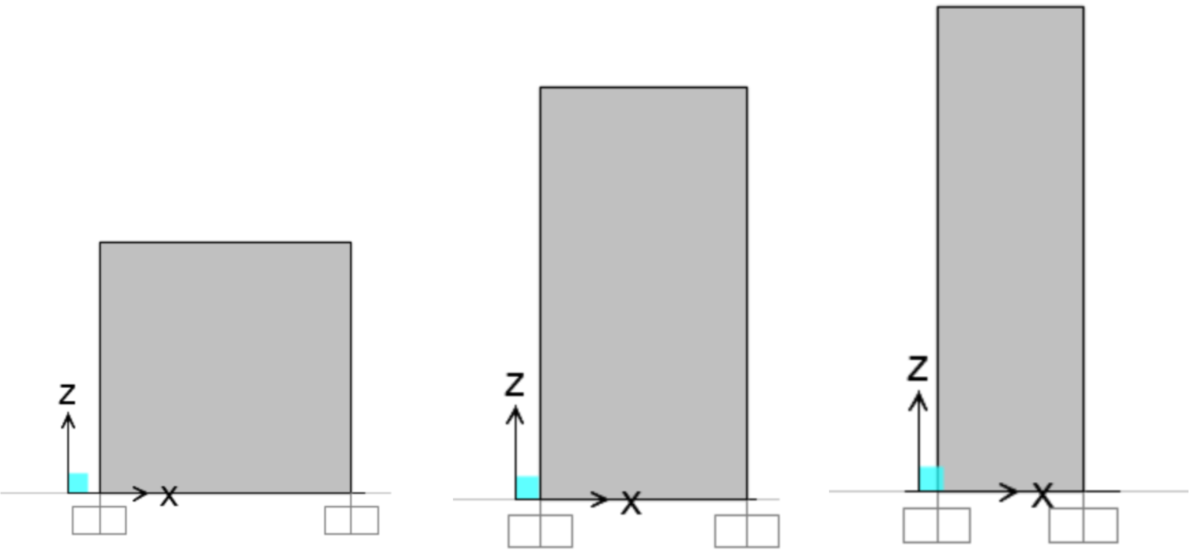
Reinforced Concrete (RCC) shear walls are structural components widely used in high raised buildings to resist lateral forces (wind, earthquake loads) acting on them. The analysis of shear walls based on aspect ratio is a critical aspect of structural engineering, particularly in seismic design. Aspect ratio, defined as the ratio of the height to the width of a shear wall, profoundly influences its behavior and performance under lateral loads. This parameter significantly affects the distribution of forces within the wall and its overall stiffness and strength. Time-History analysis of RCC shear wall based on different aspect ratios influence the distribution of shear forces and moments. The analysis helps to understand the relationship between aspect ratio and structural behavior is essential for designing resilient and efficient structures capable of withstanding seismic events and other dynamic loads.

DESIGN OF RCC SHEAR WALL:

The design of shear wall is based on aspect ratio. The ratio between overall height of the wall to length or width of the wall is defined as aspect ratio of shear wall. The shear wall is classified into three types base on aspect ratio Squat walls (h/w) ≤1, Intermediate walls 1< (h/w) ≤ 2 and slender walls (h/w) > 2 as per IS: 13920 – 2016. Considering M30 grade concrete and HYSD500 rebars as material properties while designing the RCC shear wall.

Table 1: Dimensions of shear wall

WALL SEC.	HEIGHT(h)	WIDTH(w)	THICKNESS(t)
Squat (SQ)	800mm	800mm	100mm
Intermediate (IM)	1600mm	800mm	100mm
Slender (SL)	2640mm	800mm	100mm



Squat Wall **Intermediate Wall** **Slender Wall**

TIME-HISTORY ANALYSIS:

Time-History analysis is an effective method for evaluating the dynamic response and seismic performance of such structures. A comprehensive review of seismic hazard analysis provides the input ground motion records for the time history analysis. The ground motion records, representative of different design earthquake scenarios, are selected to capture a range of seismic intensities and frequencies.

The Time-History analysis of RCC shear wall is done in SAP2000. It is a structural software program developed by Computers and Structures, Inc. The general-purpose of software is ideal for the analysis and design of any type of structural system. Basic and advanced systems, ranging from 2D to 3D, of simple geometry to complex, may be modeled, analysed, designed, and optimized using a practical and intuitive object-based modelling environment that simplifies and streamlines the engineering process. The process of Time-History analysis in SAP2000 done by finite-element analysis procedure as follows.

Grid system data
↓
Material properties
↓
Section properties
↓
Support and Constrains
↓
Time history function
↓
Load cases
↓
Run Analysis

TIME HISTORY FUNCTION:

The time history function is used to define the variation of a load or displacement with respect to time. Time history functions are typically used to simulate dynamic loads or response in structural analysis, where the loads vary over time. In assigning of time history function the time and acceleration is taken from already exist earthquake data.

We have taken the Time and Acceleration values from The Northridge (USA) earthquake of January 17, 1994. Frequency range of (0.12-23.0) Hz between the time range of (0-39.88) Sec. Source from PEER Strong Motion

Database on Recording station (090 CDMG STATION 24278). The time and acceleration data in fig (1) were applied to all shear wall sections in X direction.

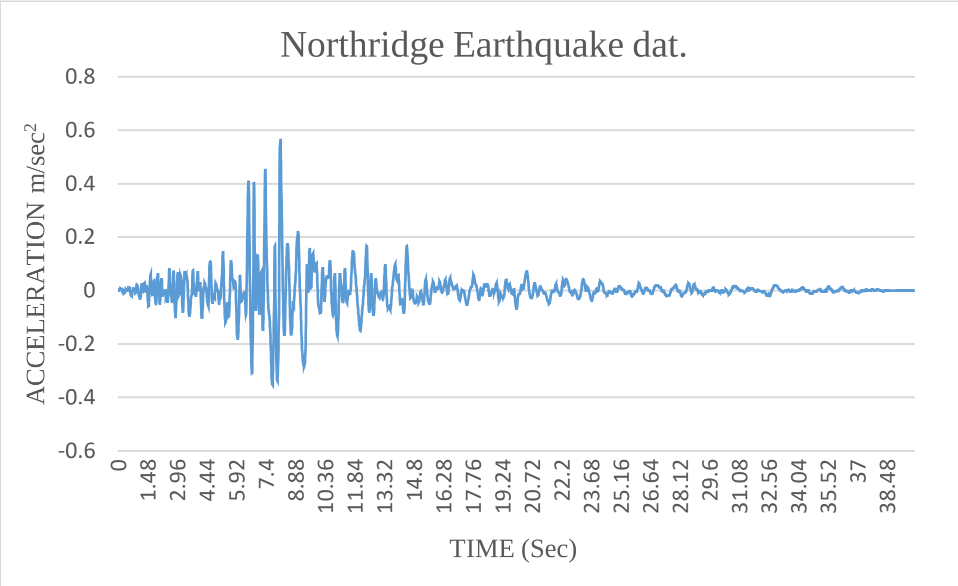


Fig 1: Time and Acceleration values

LOAD CASES:

Dead load (selfweight of the structure), Time history function (time and acceleration values at which direction), Modal load (total loads applied on the structure) are three load cases is to be consider while doing time history analysis of the structure.

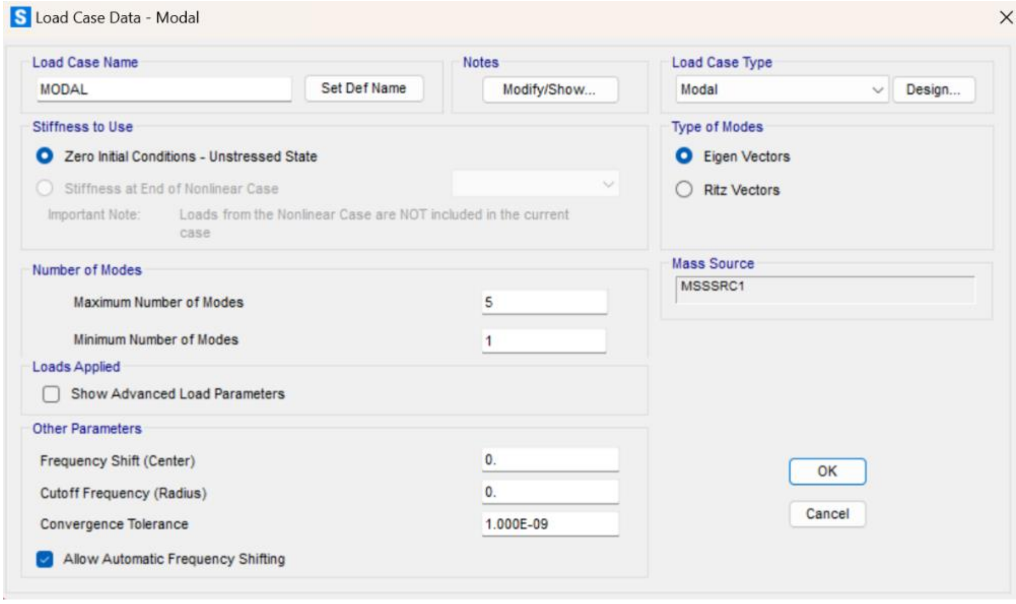


Fig 2: Modal Load Case

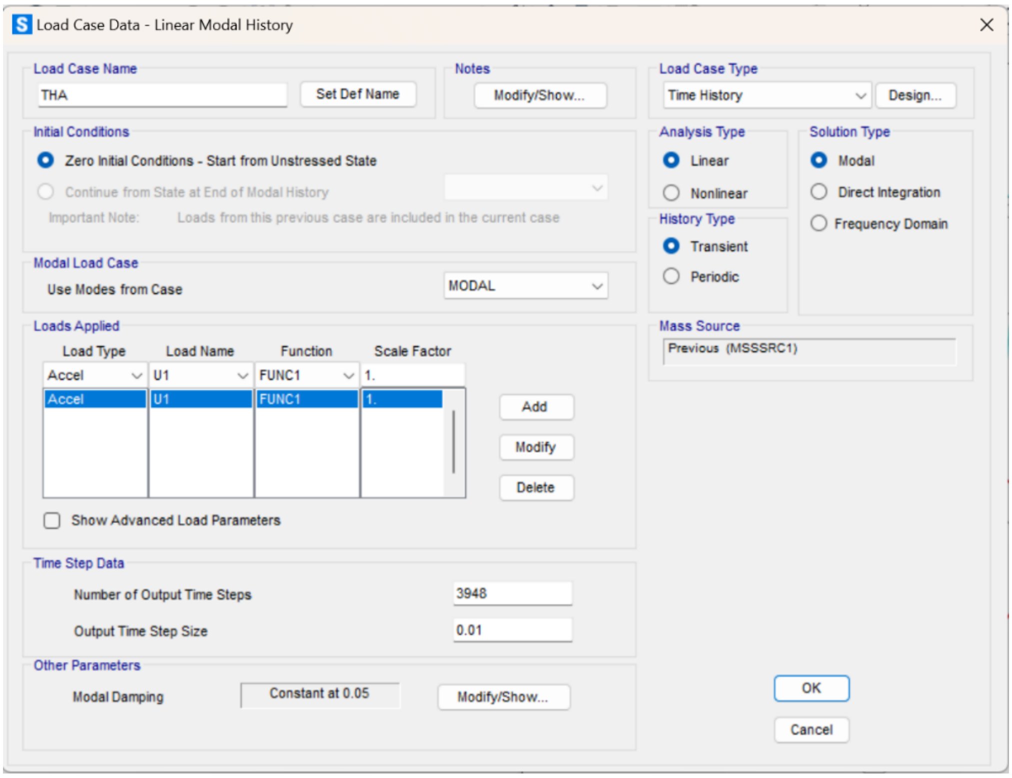


Fig 3: Time-History Load Case

RESULT:

The result obtained the from the Time-History analysis of RCC shear wall based on the aspect ratios offer valuable information regarding the structural response, such as displacement, base shear, joint acceleration, deformation patterns and frequency relevant to the time and acceleration values acting on it.

Table 2: Parameters of RCC shear walls

WALL SEC.	FREQUENCY (Hz)	DISPLACEMENT (mm)		BASE SHEAR (kN)		JOINT ACCELERATION (m/sec^2)	
		Max	**Min**	**Max**	**Min**	**Max**	**Min**
Squat	183.74	4.878	-4.486	1.306	-1.420	0.0308	-0.0315
Intermediate	91.408	5.252	-4.773	1.614	-1.756	0.00659	-0.00773
Slender	46.511	7.837	-7.31	2.126	-2.269	0.07954	-0.06705

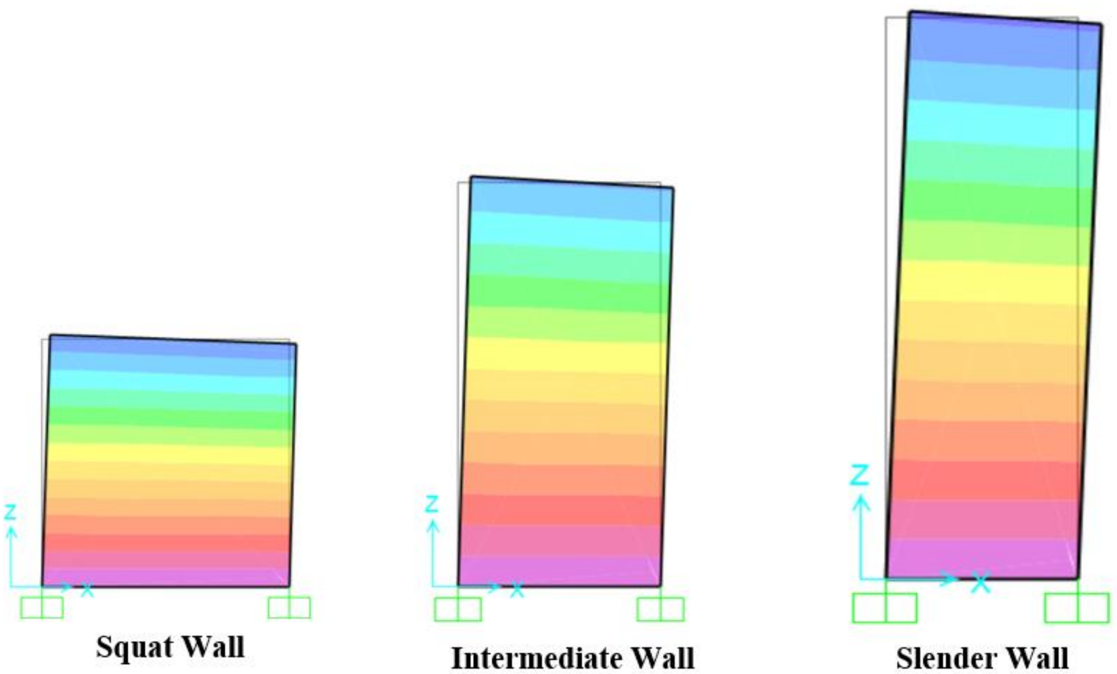


Fig 4: Deformed Shape of Shear walls

CONCLUSION:

In conclusion the Time-History analysis of the RCC shear wall using SAP2000 software provides valuable insights into the dynamic behavior and seismic response of the structure. This study contributes to know the dynamic behavior (Frequency, Base Shear, Joint Acceleration and Structural Displacement) of different types of shear wall based on the aspect ratio.

1. Slender wall has comparatively low frequency range and has maximum structural displacement and base shear.
2. Squat wall has comparatively high frequency range and has minimum structural displacement and base shear.

The study also contributes to enhancing the design based on the aspect ratio and construction practices, ultimately promoting the safety and reliability of RCC shear wall systems in earthquake-prone regions.

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