Time History Analysis of RCC Shear Wall using SeismoStruct

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Abstract

This study presents a time history analysis of prototype reinforced concrete (RCC) shear walls using the SeismoStruct software. The research focuses on the application of SeismoStruct, a widely used software package for nonlinear dynamic analysis of structures, to assess the behavior of RCC shear walls under seismic loading. The study begins with the development of a three-dimensional finite element model of the shear wall system, considering the material properties, geometry, and reinforcement details. The analysis investigates the influence of various parameters on the behavior of RCC shear walls, including wall aspect ratio, reinforcement detailing, and boundary conditions. The study aims to provide insights into the seismic performance of RCC shear walls and identify structural displacements over the time-accelerations values.

Keywords: Shear Wall, RCC, SeismoStruct

Introduction

Reinforced Concrete (RCC) shear walls are vital structural components widely used in buildings to resist lateral forces such as wind and seismic loads. These walls are constructed using a combination of high-strength concrete and steel reinforcement to provide excellent stiffness and strength. They are designed to bear both gravity and lateral loads efficiently, ensuring the overall stability and integrity of the structure. The vertical arrangement of RCC shear walls creates a robust system capable of absorbing and redistributing lateral forces, reducing the risk of structural failure during extreme events. The efficiency and effectiveness of RC shear walls make them a fundamental element in modern construction, enhancing the safety and resilience of buildings.

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.

SeismoStruct is a software program designed for the analysis and design of structures subjected to seismic and other dynamic loads. It provides advanced tools for modeling and analyzing various types of structural systems, including reinforced concrete, steel, and composite structures, allowing engineers to assess their response and performance under seismic events accurately. The SeismoStruct software enables the simulation of earthquake-induced motions and evaluates the structural response in terms of displacements.

Behaviour of Shear Wall

Shear Resistance

Shear walls are primarily responsible for resisting shear forces induced by lateral loads. They are designed to have sufficient strength and stiffness to transfer these forces to the foundation and prevent excessive lateral deflection or structural failure.

Flexural Resistance

Shear walls may also undergo flexural behaviour, meaning they experience bending moments due to the combination of shear and axial forces.

Interaction with Building Frame

In multi-story buildings, shear walls interact with the building frame to distribute lateral loads. The combination of shear walls and the building's frame (columns, beams, and slabs) forms a structural system that resists lateral forces collectively.

Stiffness and Deformation

Shear walls contribute to the overall stiffness of a building, reducing its lateral deflections and preventing excessive sway during lateral loading events.

Ductility and Energy Dissipation

Shear walls in seismic design are often required to exhibit ductile behaviour. Ductility refers to the ability of a structure to undergo large deformations without sudden failure. Shear walls designed for seismic loads are expected to dissipate energy through inelastic deformations, allowing them to absorb and redistribute seismic energy during an earthquake.

Literature Review

G.V. Rama Rao (2016) studied on ductility of shear walls. Ductility of shear wall is influenced by several factors like aspect ratio, axial load on shear wall, percentage of vertical reinforcement and percentage reinforcement in boundary element. A parametric study had been carried out on the nonlinear ductile behaviour of shear wall using ABAQUS finite element software. Concrete Damaged Plasticity (CDP) model is used to represent the nonlinearity. The validity of the model is checked with the experimental results. A comprehensive study is made on codal provisions for shear wall and suitable recommendations are made to improve the ductility of shear wall. From the parametric study, it concluded that, to ensure ductile response under strong seismic shaking, the design of shear wall section needs to ensure the axial load to be not more than about 30% of the ultimate axial compression capacity.

N. Gopala Krishnan (2016) studied on Nonlinear Behaviour of Shear Walls of Medium Aspect Ratio under Monotonic and Cyclic Loading. Shear walls are the ideal choice to resist lateral loads in multi storey RC buildings. Nonlinear performance of medium aspect ratio shear wall specimens are studied on three identical shear wall specimens through application of monotonic and cyclic loading. In order to study the effect of axial load on the flexural behaviour and ductility of shear wall, a parametric study is conducted using a layer-based approach, which is used to generate the analytical pushover curve for the shear wall and validated with the experimentally evaluated pushover curve of the tested shear wall. A comparison is made between monotonic and cyclic load behaviour. Stiffness and strength degradation and pinching parameters are evaluated from cyclic tests. Plastic rotation limits and ductility capacities under monotonic and cyclic loading conditions are compared with recommended values.

Time History Analysis

This project attempts to behaviour of shear wall under varying time-dependent loads and determine their performance during strong ground motions. The prototype shear wall, having dimensions of 3 m in height, 1.56 m in width and 0.2 m in thickness is designed for nonlinear time-history analysis. In reinforcement of shear wall 16 mm diameter bars are used at longitudinal vertical reinforcement in two layers with a non-uniform spacing. 3 nos of 16 mm dia bars are kept in each layer of boundary elements with a spacing of 150 mm c/c and remaining bars are spaced at distance of 300 mm c/c. 10 mm diameter bars are placed as transverse reinforcement with spacing of 300 mm c/c at two layers. M30 grade of concrete and HYSD415 rebars are considered for designing of shear wall in SeismoStruct.

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 available in SeismoStruct software itself.

The Time and Acceleration values are taken from The Imperial Valley (USA) earthquake of October 15, 1979. The Frequency range is (0.1-40.0) Hz at the Time range of (0-39.48) Sec. The time and acceleration data were applied on all the shear wall section on the X-axis.

Figure 1: Imperial Valley Time and Acceleration Values

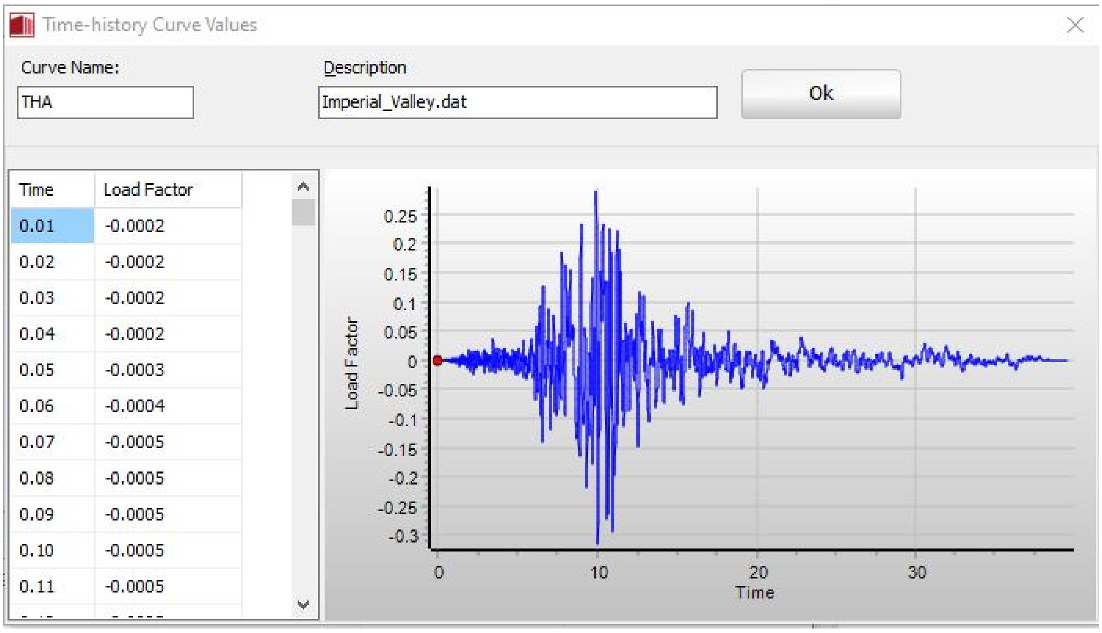
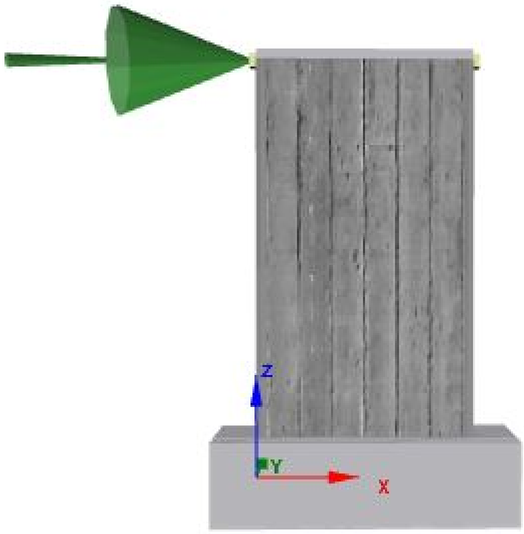


Figure 2: Time and Acceleration Values Applied in Shear Wall



Result

The results obtained from the time history analysis offer valuable information regarding the structural response, such as the distribution of forces, deformation patterns, and structural displacement. Figure 3 showed that the maximum displacement of Prototype RCC shear wall under the time-history function. The shear wall attain maximum displacement of 0.13 m at 9.36 sec. Figure 4 shows the displacement values of shear for every 0.01 sec with respect to time and acceleration force applied on it.

Figure 3: Deformed Shape of Shear Wall

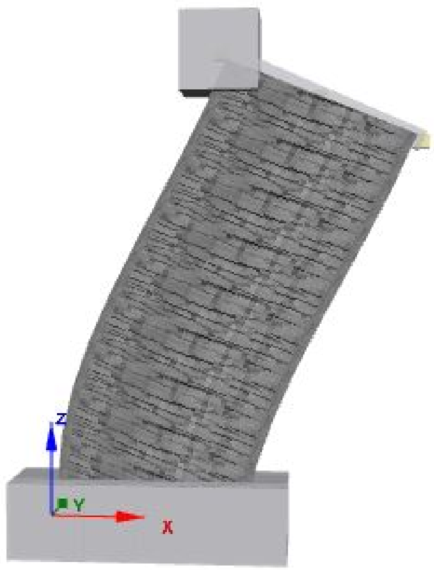
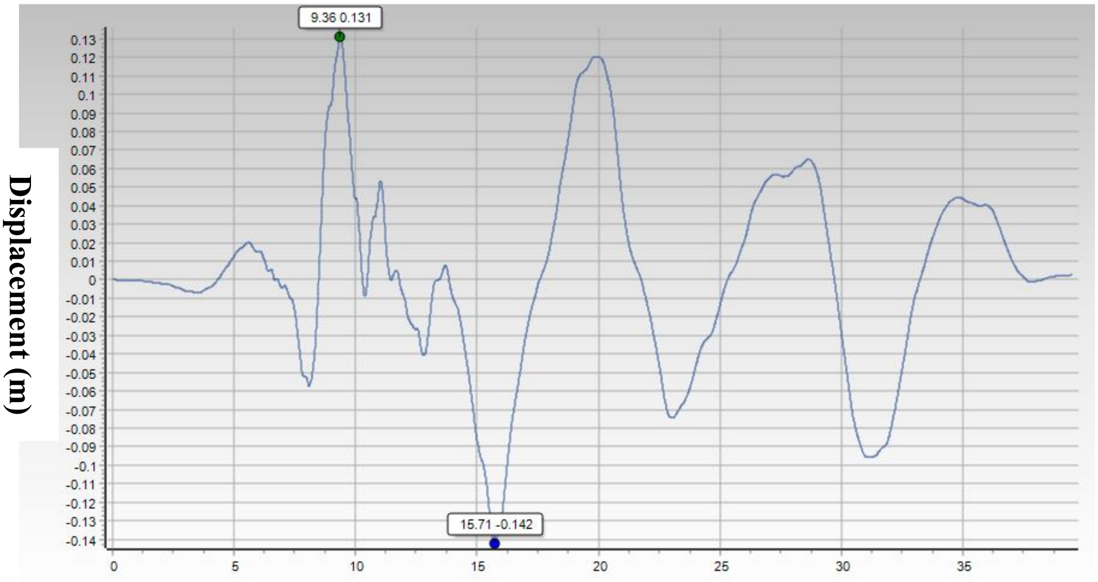


Figure 4: Time and Displacement Values

Displacement (m)



Time (Sec)

Conclusions

In conclusion, the Time history analysis of the RCC shear wall using SeismoStruct software provides valuable insights into the dynamic behavior and seismic response of the structure. The RCC shear wall section demonstrates the ability to effectively resist lateral loads induced by earthquakes. The structural model accurately captures the behavior of the shear wall under time history analysis.

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

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