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Cyclic Loading Behaviour of RCC Shear Wall Using ABAQUS

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ABSTRACT: This study investigates the response of RCC (Reinforced Concrete) shear wall under cyclic loading using Abaqus software. In Abaqus, the models are subjected to predefined cyclic loading patterns to evaluate their performance under repeated stress cycles. The analysis involves modelling the shear wall with appropriate material properties and reinforcement details. Numerical analysis includes defining material behaviours, such as concrete and steel in RCC, and accurately capturing their nonlinear responses under cyclic loading. Abaqus enables the implementation of constitutive models for concrete and reinforcement, considering factors like strain rate effects and fatigue damage accumulation. The numerical study involves in finding of structural displacement, energy dissipation, joint acceleration and compressive behaviour of RCC shear wall under cyclic loading.

Keywords: Shear wall; ABAQUS; cyclic loading analysis; structural displacement.

INTRODUCTION:

Reinforced Concrete (RCC) shear walls are critical components in buildings, designed to resist lateral forces such as those generated by earthquakes and wind. Evaluating their performance under lateral cyclic loading where forces are applied and reversed repeatedly is essential for ensuring structural safety. This study examines the behaviour of RCC shear walls under lateral cyclic loads using ABAQUS, a leading finite element analysis software. By simulating these complex loading conditions, we aim to assess key factors such as strength degradation, stiffness changes, and potential failure modes. ABAQUS provides advanced capabilities for detailed modeling and accurate representation of shear wall responses, offering valuable insights into their behaviour under dynamic conditions. The results from this analysis will inform better design practices, enhancing the resilience and durability of structures exposed to lateral cyclic forces.

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 RCC shear wall dimension has height 1500mm, width 800mm and thickness of 150mm. The aspect ratio of shear wall is $hw/Lw = 1500/800 = 1.875 < 2$, The aspect ratio of shear is lesser than 2 the shear wall is classified as Intermediate type (as per clause 10.1.4) in IS: 13920 – 2016. Considering M25 grade concrete and HYSD500 rebars as material properties while designing the RCC shear wall.

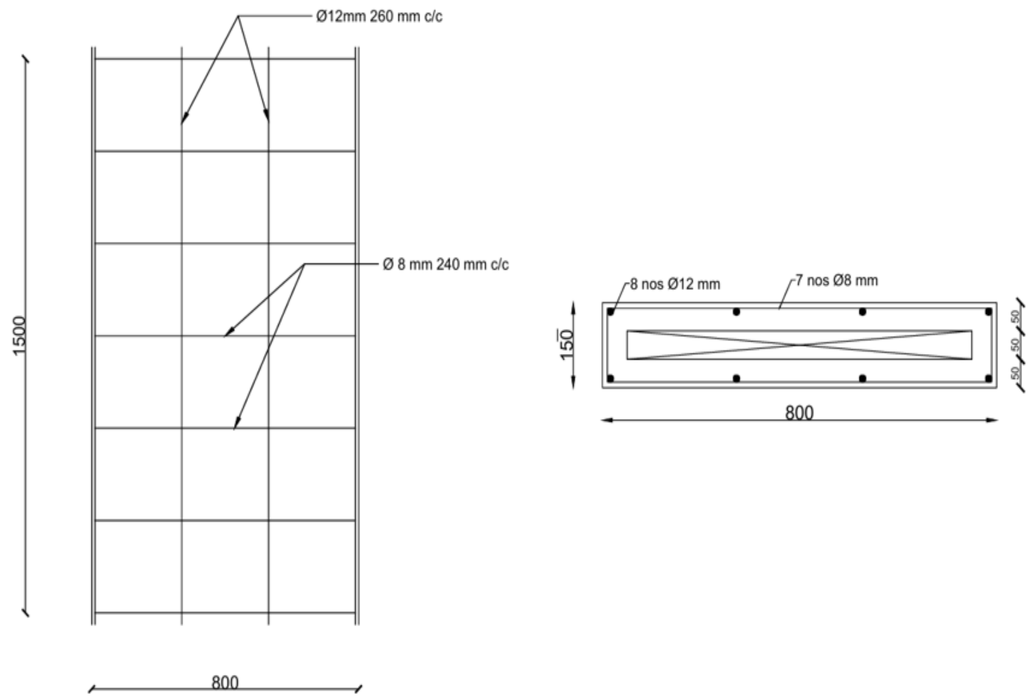

Figure 1: Reinforcement Detail of RCC Shear Wall

CYCLIC LOADING ANALYSIS:

Lateral cyclic loading analysis in ABAQUS is a vital tool for evaluating the performance of Reinforced Concrete (RCC) shear walls under dynamic, repeated lateral forces, such as those experienced during earthquakes. This analysis involves creating detailed 3D models of shear walls, incorporating both concrete and reinforcement with advanced nonlinear material properties. ABAQUS allows for precise simulation of these materials, capturing behaviours such as cracking in concrete and yielding in steel reinforcement.

The process begins with defining the cyclic loading conditions, which typically involve displacement or force-controlled patterns that mimic seismic activity. ABAQUS then performs a series of static or dynamic load steps, analysing the response of the shear wall to these lateral forces. Key outcomes include displacement patterns, strength degradation, and changes in stiffness over the loading cycles. Additionally, the software helps identify critical failure modes and cracking patterns. The process of Time-History analysis in SAP2000 done by finite-element analysis procedure as follows.

Results from the analysis are compared with experimental data to validate the model's accuracy. This comprehensive approach enables engineers to refine designs, ensuring that RCC shear walls can effectively withstand dynamic forces, enhancing the overall safety and resilience of structures.

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Geometry Creation

Material Properties

Reinforcement Modelling

Assembly of Modelling

Interaction

Meshing

Boundary Conditions and Load Application

Simulation and Analysis

CYCLIC LOAD FUNCTION:

- No of cycles : 9
- Time range per cycle : 4 Sec
- Total time range : 0-36 Sec
- Amplitude range : 0-1

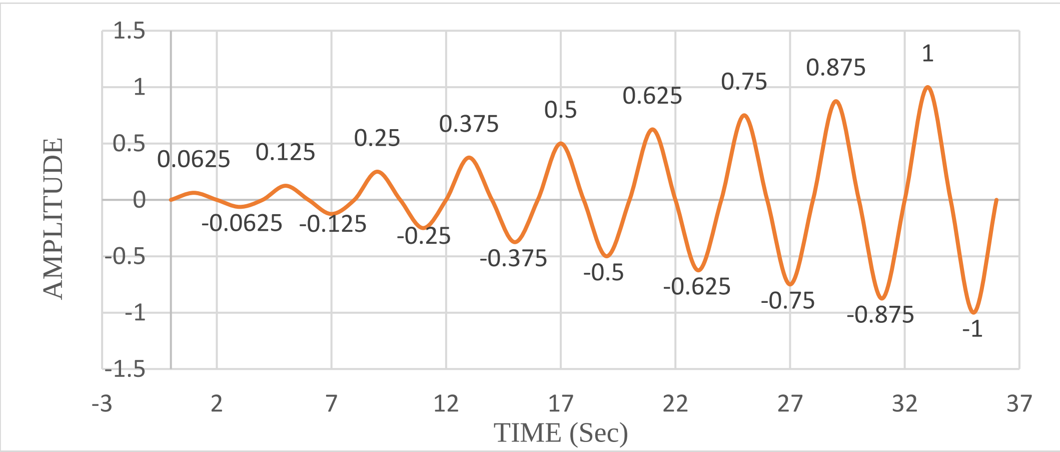

Figure 2: Cyclic Load Graph

LOAD CASES:

The RCC shear wall has fixed support condition in bottom surface and the cyclic load is applied on the top of the shear wall in lateral direction. The cyclic load applied up to the limit of 200kN and vertical load 50kN is applied on the top surface of the shear wall to neglect the cantilever principle. The cyclic load is increased 0.125 times of applied load for every one cyclic.

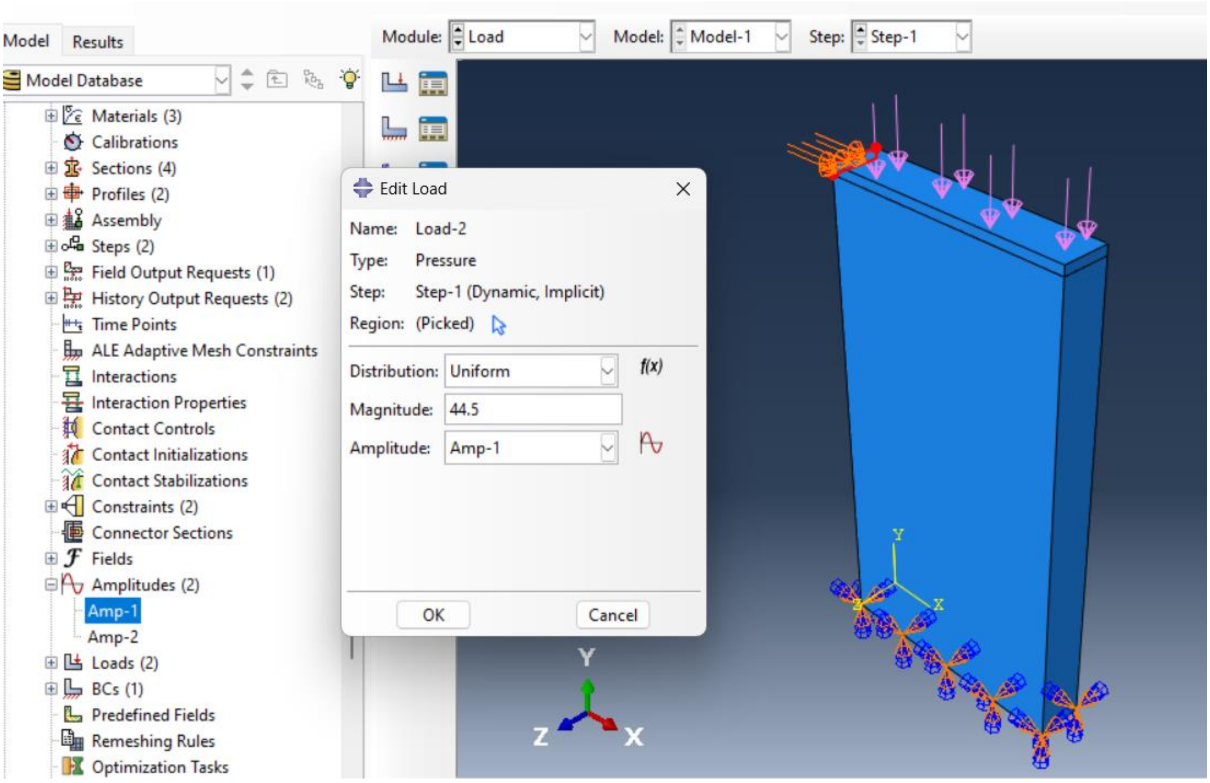

Figure 3: Cyclic Load Conditions in ABAQUS

RESULT:

The result obtained the from the Cyclic load analysis of RCC shear wall based on the aspect ratios offer valuable information regarding the structural response, such as displacement, hysteresis losses and compressive damage of the RCC shear wall relevant to the cyclic load acting on it.

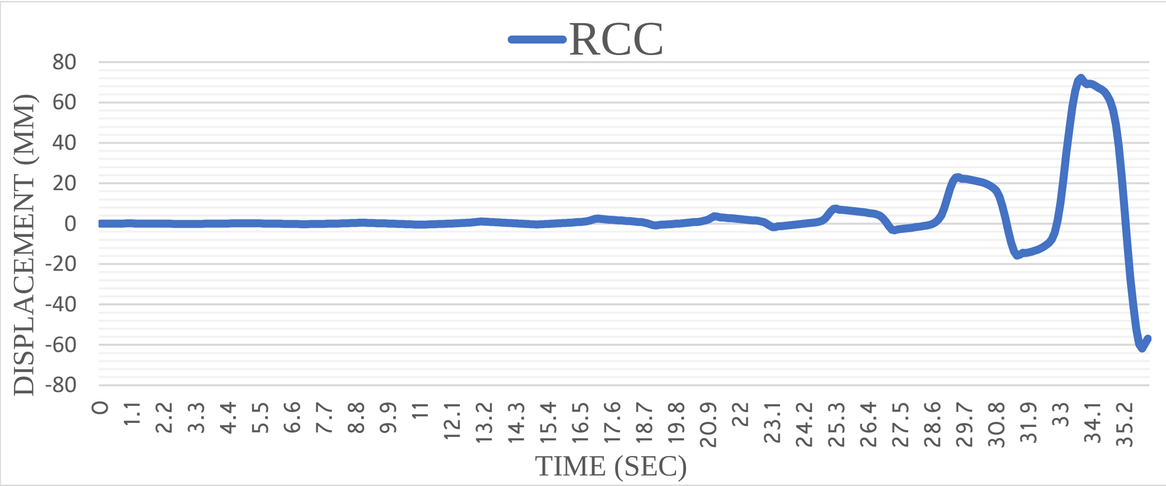

Table 1: Structural Displacement

S.NO	WALL	Initial Displacement(mm)	Cycles Increment	Time (Sec)	Maximum Displacement(mm)
1	RCC	7.539212	7	25.3	72.240

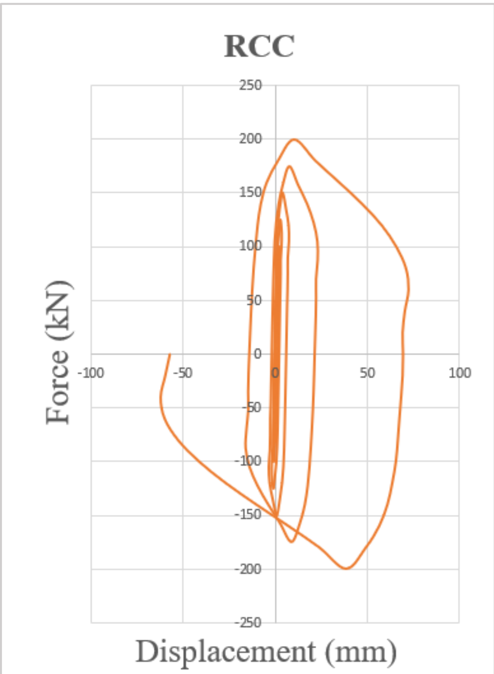

Figure 4: Hysteresis Losses

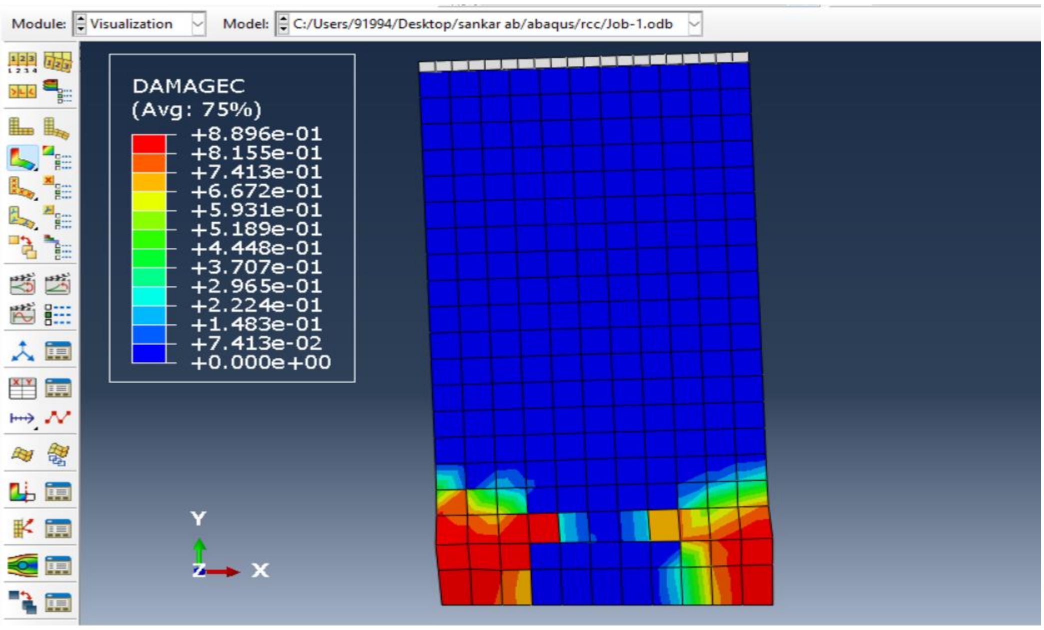

Figure 5: Compressive Damage of the RCC Shear Wall

CONCLUSION:

In conclusion the Cyclic load analysis of the RCC shear wall in lateral direction using ABAQUS software provides valuable insights into the dynamic behaviour and seismic response of the structure. This study contributes to know the dynamic behavior (Structural Displacement, Hysteresis Losses and Compressive Damage) of RCC shear wall.

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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