Analysis of Coupling Beam Embedded with Reinforced Concrete Shear Walls

P. Vishnu Priya, Assistant Professor, Annamacharya Institute of Technology and Sciences Tirupati & India, vishnupriya0026@gmail.com

Nithya S, Assistant Professor, Al Ameen Engineering College Kulappully & India, nithyasivadas2018@gmail.com

Abstract **Most of the tall reinforced concrete structures are subjected to horizontal force due to wind and seismic loads. In order to resist these forces, the efficient method is to provide shear wall. The shear walls which are having openings such as doors, windows, corridors, elevator wells are commonly designed by providing a beam in between them. Such shear walls are called coupled shear walls. These are built in full height of the structural building. Shear wall with coupling beam shows more energy dissipation when compared to others. This paper presents a study on the behavior of coupling beam embedded in shear wall. The study has been carried out using ABAQUS-CAE**

Keywords —conventional shear wall, concrete coupling beam, coupled shear wall, Linear analysis, Finite element method, ABAQUS-CAE

I. Introduction

During the past few years, a number of researches were carried out to developing the solutions to resists the seismic lateral forces. The important thing we need to consider here is the life safety in case of high intensity earthquake and minimum damages to the structure. From the all-possible solutions, the concrete shear wall which controls the horizontal displacements and storey drifts has the good capability to resist these lateral forces.

The high level of detailing and the provision of sufficient anchorage of steel reinforcement in the connected walls are also the problems we have to face when designing a concrete coupled shear walls. To overcome the drawbacks of concrete coupling beam, steel coupling beams can be used and the structure is known as steel coupled shear wall system. In this, the steel coupled shear wall dissipate more energy when compared to the concrete coupled shear wall by yielding.

II. LITERATURE REVIEW

In the experiment conducted by Wan-Shin Park and Hyun-Do Yun [1], the main parameter they considered was the ratio of the coupling beam strength to the connection strength. The result shows that designing a coupling beam as shear yielding member is better because shear critical coupling beam dissipates more energy than flexure critical coupling beam.

Daniel J. Borello and Larry A. Fahnestock [2] carried out an experiment on the steel coupling shear wall with the two test variables degree of coupling and plastic strength. They examined thirty-two coupled shear wall structures with criteria such as difference in degree of coupling, coupled length and height of the structure. They found that analytical and numerical results are similar when they studied those structures under nonlinear static numerical simulations.

F. Morelli, et al [3] analyzed the reinforced concrete coupling beam with two side steel columns. The behavior of the dissipative coupling system was studied. The experiment was carried out on a total of eight specimens, and they all showed a good dissipative capacity without any serious damages to the concrete wall. Also, the test results shows that angle connection influence the overall behavior.

Experiments were conducted by Wan-Shin Park and Hyun-Do Yun [4] to determine the factors which is influencing the bearing strength of the steel coupling beam wall connections. They found that there was a relation between degree of conservatism and the width of the embedded steel coupling beam sections. And also, they notice that the conservatism increase was due to increase in the concrete bearing stress.

J. C. D. Hoender kamp [5] carried out an experiment by taking two parameters, the degree of coupling and the peak shear demand. Analysis of single shear wall and mixed shear wall structures were done to determine the influence of both the walls on the degree of coupling and on the peak shear demand. The result shows that the mixed shear wall structures exhibit more degree of coupling.

Motamarri Sarat Chandra and B. Sowmya [6] conducted studies on shear walls in multistorey structures with varying

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opening size. They found that there is an effect on the depth of the coupling beam for undersized and oversized openings also they concluded that the stress concentration fully depends on the size of the opening.

The project done by R. Yeghnem and et al. [7] mainly relates to the use of bonded composite plates in the field of strengthening RC shear walls, to mitigate the seismic response of high-rise buildings braced by coupled shear wall structures. In this a typical 20-storey RC strengthened coupled shear wall was analyzed. They found that it is possible to improve the structural performance by using appropriate sizes and material of the bonded composite plates. The results of this investigation also shows that significant top deflection reductions can be achieved.

III. OBJECTIVES

- Modelling and analysis of shear wall with reinforced concrete coupling beam
- Modelling and analysis of Conventional shear wall and shear wall with coupling beam
- To study and compare the behaviour of coupling beam with reinforced concrete coupling beam
- Obtaining result from analysis

IV. ANALYSIS

A. Material Properties:

The present paper has two model one is conventional shear wall and other one is shear wall with coupling beam. Both the shear wall has same properties. Characteristic strength of concrete for shear walls is given as 25 N/mm^2. Density of Steel is given as 78.50 kN/m^3.

B. Details of Shear wall:

For Analysing models, the dimension of shear wall is 5200mm x 4000 mm, opening is provided of different sizes model 1 has opening size of 3000 mm x 2000mm and model 2 has opening size of 2000 mm x 1200 mm model 3 size of opening is 1200 mm x 2500 mm last model 4 has size of 2000 mm x 3000 mm with diagonal reinforcement. Model 5 has opening of 1200 mm x 2000 mm with coupling beam above opening. Model 6 has opening of 2000 mm x 3000 mm with diagonal reinforcement. Model 7 shear wall has no opening in the wall. The thickness of the walls provided is 200 mm. Base foundation is same for all models 5800 mm x 600 mm x 500 mm.

C. Details of Shear wall with different sizes and Aspect Ratio:

	Size of Opening (m)	Aspect Ratio
Model 1 & 4	3 x 2	1.5
Model 2 & 5	2 x 1.2	1.67
Model 3 & 6	2.5 x 1.2	2.08

Table1: Shear wall details with Aspect ratio

V. ANALYSIS & RESULTS

A. Figures

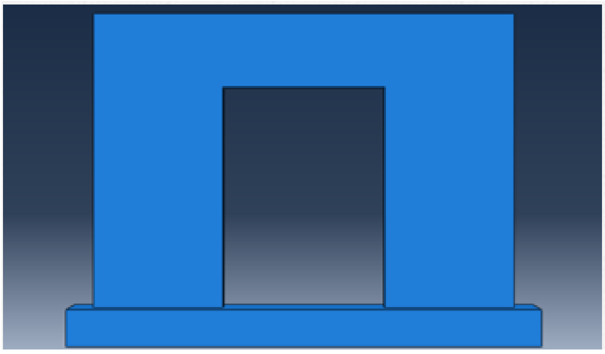

Figure 1: Model 1 Shear wall with size of opening 3 m x 2 m

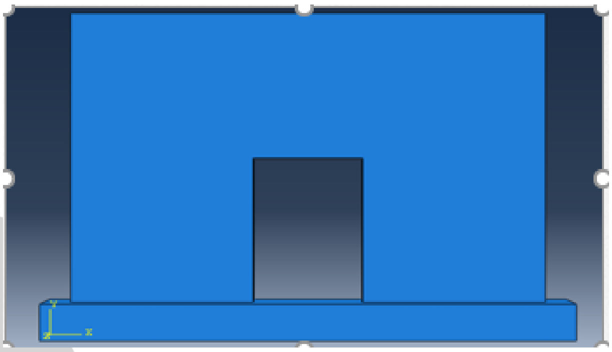

Figure 2: Model 2 Shear wall with size of opening 2 m x 1.2 m

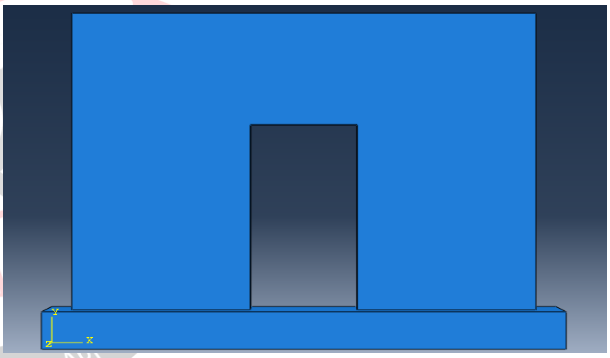

Figure 3: Model 3 Shear wall with size of opening 2.5 m x 1.2 m

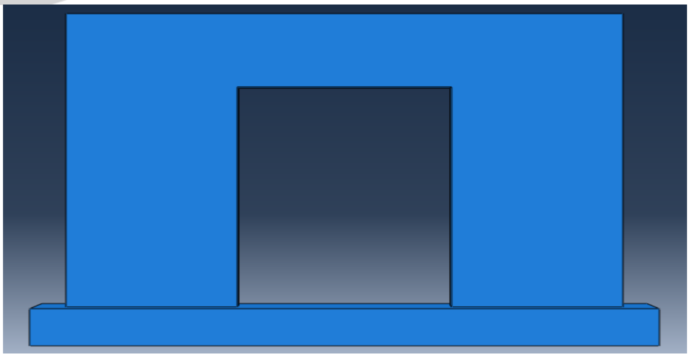

Figure 4: Model 4 Shear wall with size of opening 3 m x 2 m

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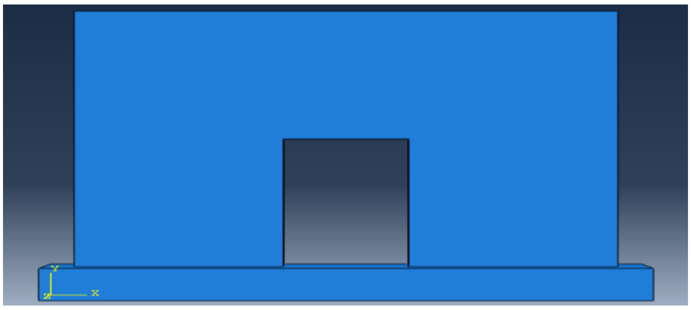

Figure 5: Model 5 Shear wall with size of opening 2 m x 1.2 m

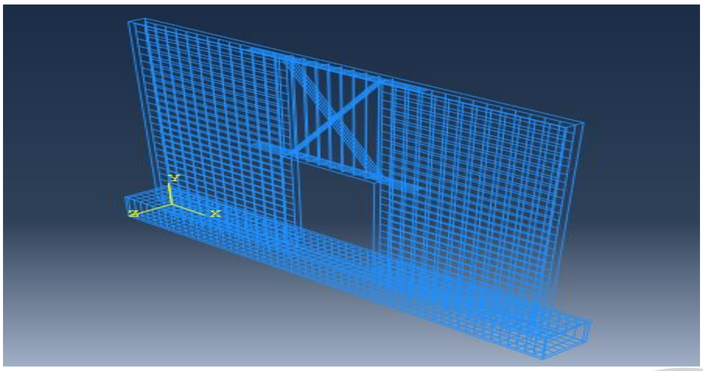

Figure 6: Model 5 Shear wall with reinforcement detailing

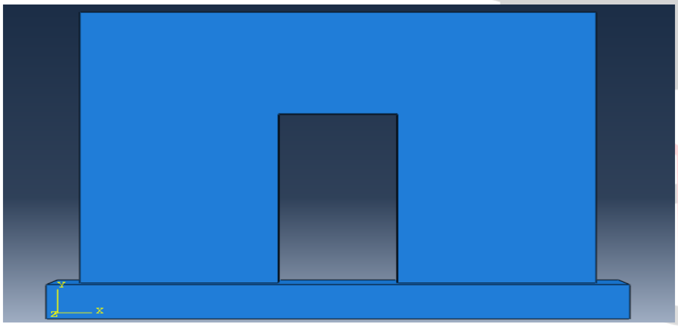

Figure 7: Model 6 Shear wall with size of opening 2.5 m x 1.2 m

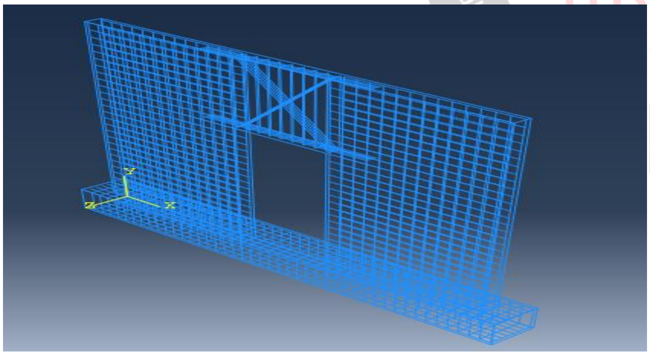

Figure 8: Model 6 Shear wall with reinforcement detailing

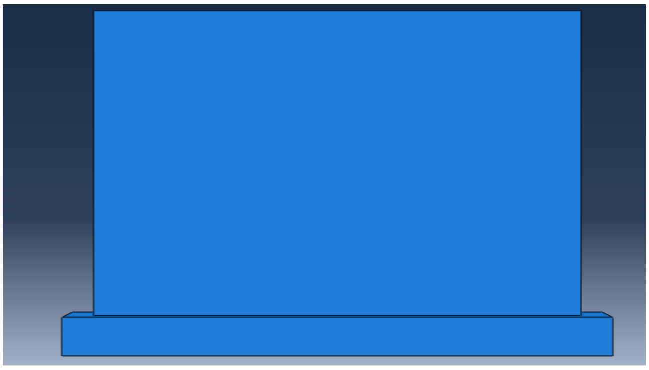

Figure 9: Model 7 Shear wall with no opening

B. Stress Figures

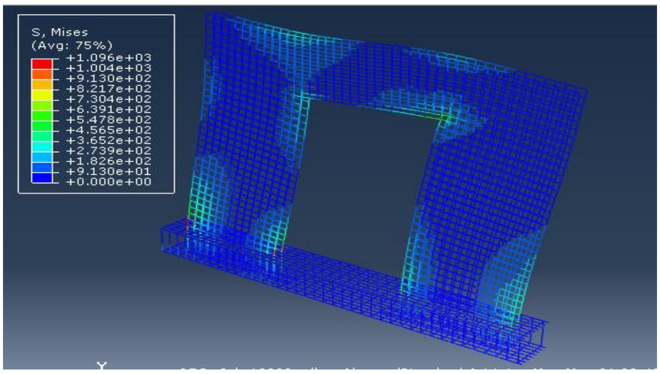

Figure 10: Stress of Model 1

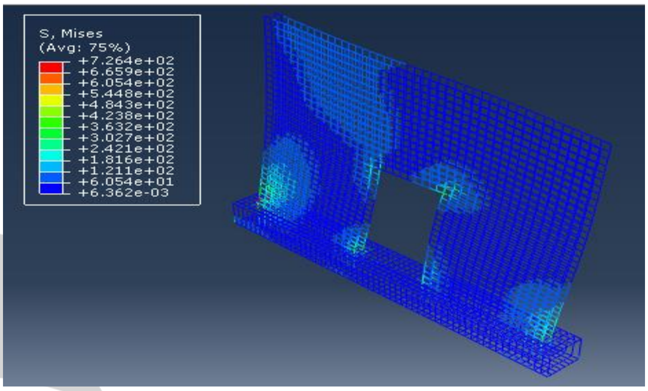

Figure 11: Stress of Model 2

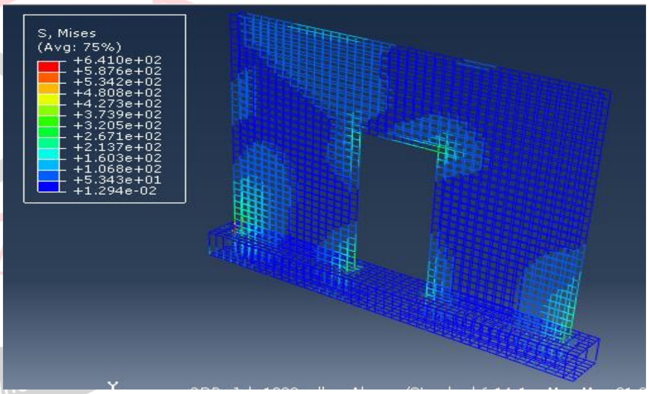

Figure 12: Stress of Model 3

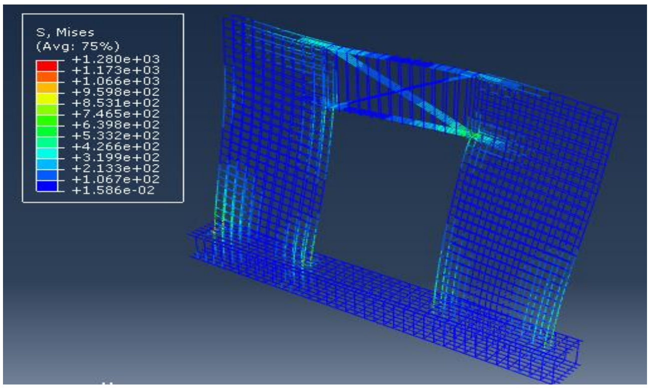

Figure 13: Stress of Model 4

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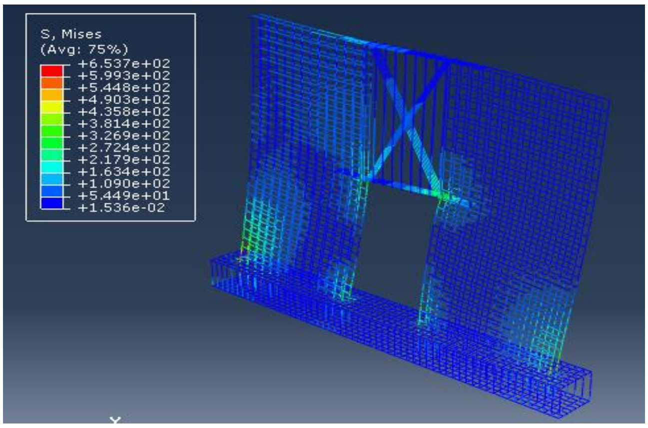

Figure 14: Stress of Model 5

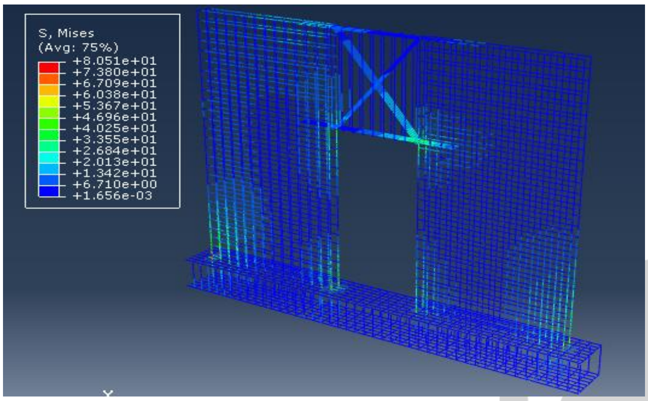

Figure 15: Stress of Model 6

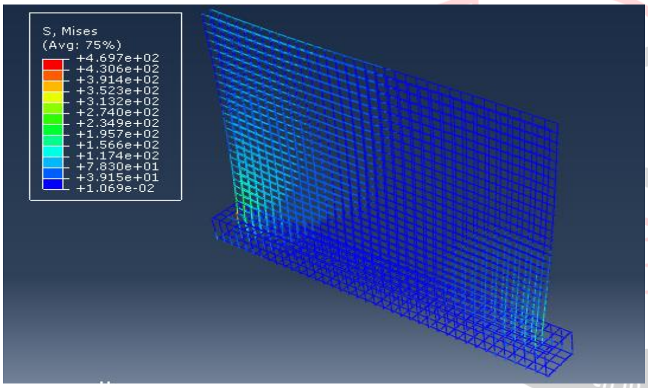

Figure 16: Stress of Model 7

C. *Deformation Figures*

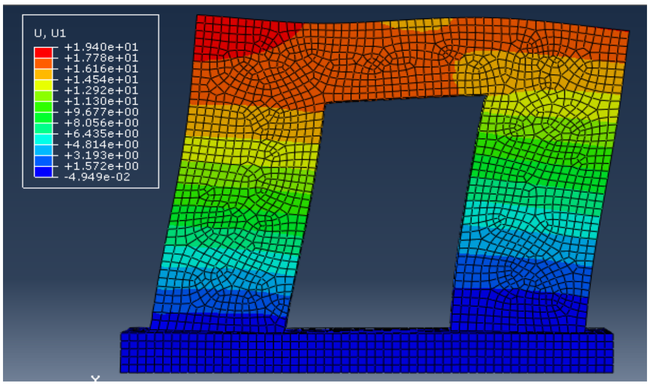

Figure 17: Deformation Shape of Model 1

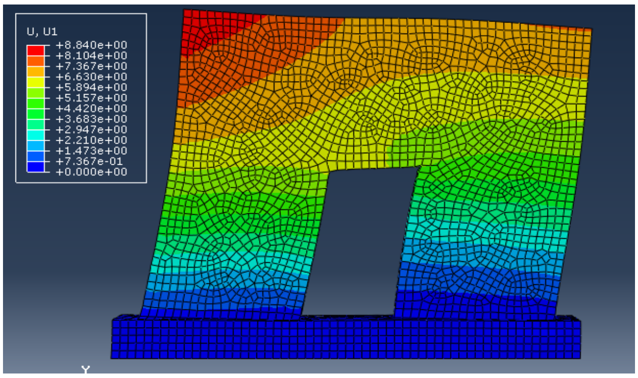

Figure 18: Deformation Shape of Model 2

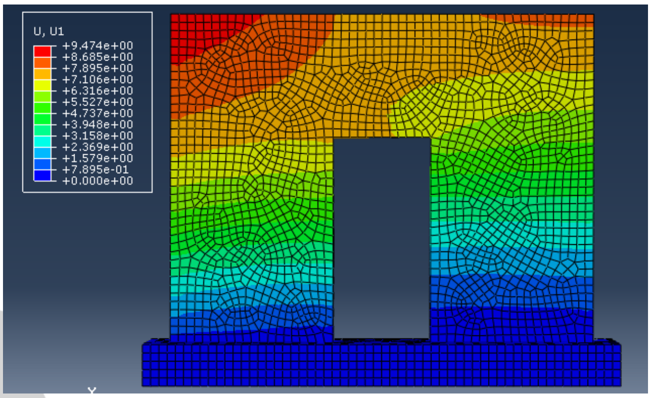

Figure 19: Deformation Shape of Model 3

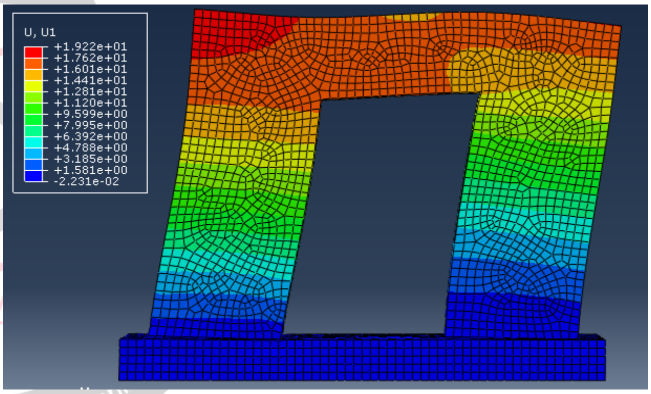

Figure 20: Deformation Shape of Model 4

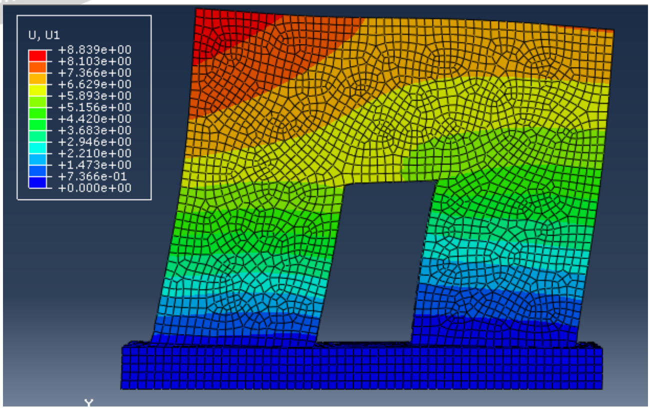

Figure 21: Deformation Shape of Model 5

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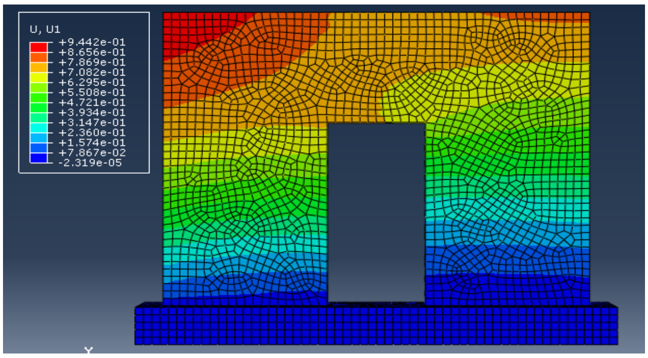

Figure 22: Deformation Shape of Model 6

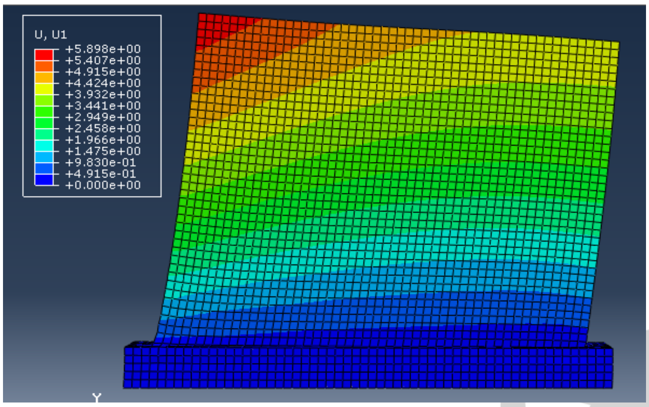

Figure 23: Deformation Shape of Model 7

D. Results:

- Model 4 shows more stress when compared to model 1 that shows it has more ductility property and both the models have almost same deflection.
- Model 2 shows more stress when compared to model 5 that shows it has more ductility property and both the models have almost same deflection
- Model 3 has more stress when compared to model 6 that shows it has more ductility property and both models have same deflection

VI. CONCLUSION

- When comparing these models diagonal reinforced coupling beam shear wall have more ductile property for shear wall having aspect ratio of 1.5.
- For aspect ratio of 1.67 & 2.08 conventional shear wall shows better ductility property and same deflection.
- To increase ductility property for shear wall with diagonal reinforcement having aspect ratio of 1.67 & 2.08 more reinforcement should be provided.

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