Design of MSE Walls Welded with Wall Panels

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Abstract

This study delineates the use and application of finite element analysis (FEA) software, namely, ABAQUS, for modeling and designing a mechanically stabilized earth (MSE) wall welded with wired wall panels. A three-dimensional wall panel welded by steel wires is constructed for analysis under service loads with varying parameters and standard properties of steel and concrete. The earth pressure and pullout loads on the anchorage system are calculated to examine the feasibility of using ABAQUS software as an effective tool for simulating the wired wall panels for a MSE wall and hence determine the modes of failure for 3D wall facings.

Keywords: *ABAQUS, FEA, MSE wall, Soil Stabilization, Wall panel.*

I. INTRODUCTION

Mechanically stabilized earth (MSE) walls constructed with wired wall panels are now well-established technologies to achieve the earth retaining function. Their antecedents can be found in the literature to the late 1960s for the case of steel reinforced structures and shortly thereafter for geosynthetic (polymeric) reinforced structures (Richard J Bathrust). Present design standards for the internal stability of reinforced MSE walls have links to familiar geotechnical concepts of active Rankine and Coulomb earth pressure theory. On the other hand, aesthetical viewpoint and availability of materials; economic and environmental considerations; geographic surroundings and performance standards; size, shape and purpose of the adjacent infrastructures; stability concerns; etc. are the core factors that shall be taken into consideration prior to modeling and designing of wall panels for such walls (Berg et al. 2009).

Earlier, it was found that three dimensional wired wall panels tested under lateral loads showed excellent results for both post-cracking strength and ductile behavior (Poluraju and Apparao 2015). These panels are manufactured by expanded polystyrene (EPS) inserted in the middle of two sheets of welded wire mesh. At first, galvanized steel truss wires impale the rigid polystyrene core at different offset angles and are then welded to the sheets of steel welded wire fabric mesh (WWFM) on the outer layers of the panel. Then 3D panels are placed into their intended position where concrete layers and/or steel bars are put into practice. Consequently, this study focuses to develop a satisfactory anchorage system for MSE walls considering erstwhile numeric models.

II. METHODOLOGY

The sophisticated finite element analysis (FEA) software, ABAQUS/Explicit is chosen to analyze the said wall panels considering materials non-linearity. It also gave the explicit integration results to solve the equations for small time increments via different steps. Besides the model can to account for large deformations (Dassault Systemes, 2013). Prior to simulation, ABAQUS/CAE is used to generate a model of the MSE wall welded with wired panels to check the results of the analyses. Here, layers of concrete and steel wires were modeled as 3D solid elements and the welded wire steel mesh and diagonal truss members were considered as beam elements. The two layers of concrete were modeled and designed as 2.5 ft. x 2.5 ft. layers with different spacing between the layers, one layer in each side of the wall. The steel anchors are composed of steel bars and steel plates which were placed inside the concrete layers as 3in. x 3in. square steel plates and have ½ in. thickness. Steel wire meshes were originally considered 18-inch diameter welded wires with a spacing of 2in. x 2in. (Figure 1).

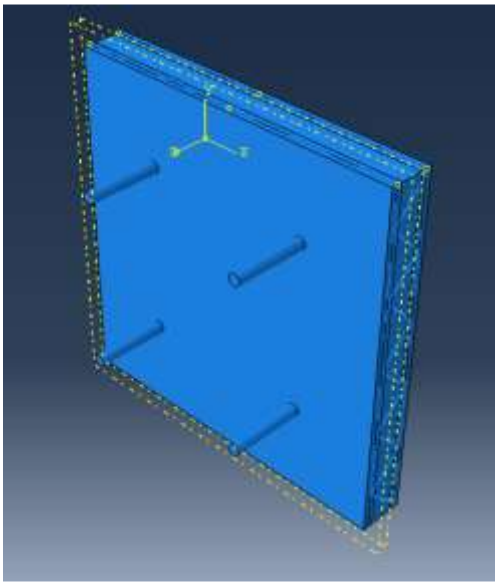

Figure 1: MSE Wall with 3D Welded Wire Panel

Another consideration for the model were the diagonal truss members with 18-inch diameter made of steel wires attached to each mesh in both concrete layers. Boundary conditions for simulating each panel as a part of the wall facing were included in the modeling process. The in plane degrees of freedom (x and y direction) were constrained leaving the z direction perpendicular to the wall and free to move. Note that on the bar portion of each anchor only the z direction restricted. This is done because this face of the concrete would be in direct contact with the soil that the wall would be retaining.

III. RESULTS

The experimental results for MSE walls welded with wired wall panels at different configurations are determined. Both the models illustrated the linear and nonlinear performance of the wall panels. Finite element analyses were conducted retaining the formerly modeled 2.5 ft. x 2.5 ft. panel. In addition to that, a 1.25 ft. x 1.25 ft. panel was also modeled. The soil pressure vs. deformation at the corner of the 3D wall panels with respect to the anchorage point for both the models are drawn. Here, the y-axis displays the soil pressure on the panel (psi) and the x-axis shows the deformation (in) of the corner of the concrete layer with respect to the anchorage point.

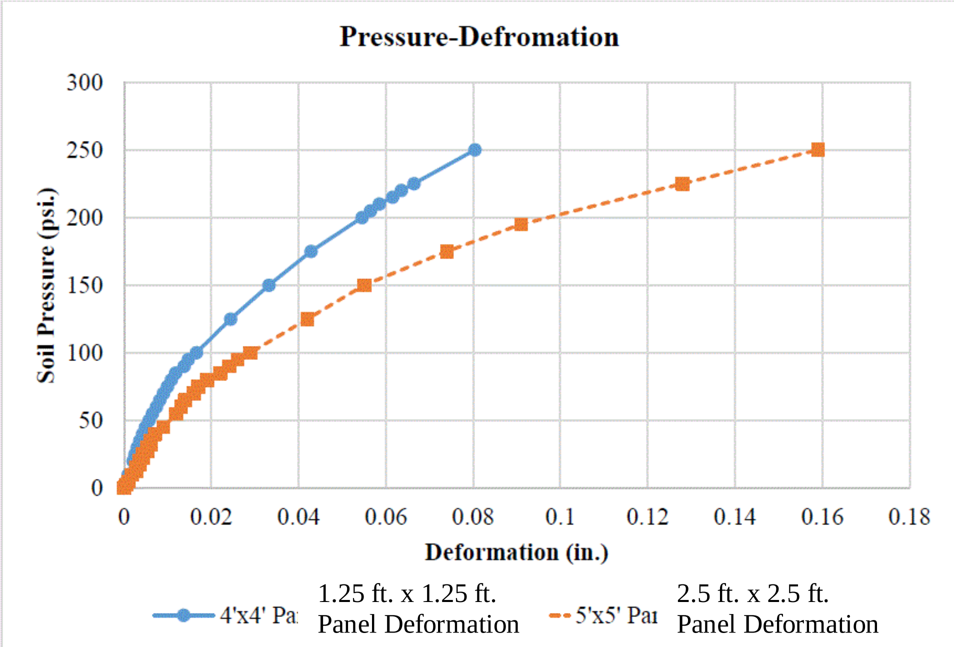

Figure 2: Pressure vs. Corner Deformation of Different Dimensioned Panels

From Figure 2, it can be seen that, after the yield point the deformation increases abruptly with small increase in earth pressure. From the test results, it is evident that, the 1.25 ft. x 1.25 ft. panel shows less deformation for similar soil pressure compared to the 2.5 ft. x 2.5 ft. panel.

IV. CONCLUSIONS AND DISCUSSION

In this paper, the feasibility of using welded wall facings for Mechanically Stabilized Earth (MSE) walls was examined. ABAQUS/CAE has proven to be effective in modeling the MSE walls to conduct a finite element analyses. The anchorage system with varying panel dimension showed good performance in both linear and nonlinear analysis.

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REFERENCES

i. *Berg, R., Christopher, B., and Samtani, N., Design of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes Volume 1, Federal Highway Administration, Woodbury, Minnesota, 2009.*

ii. *Dassault Systemes, Abaqus 6.13 Online Documentation, 2013.*

iii. *Poluraju, P., and Apparao, G., Sandwich 3D Panel System: Construction Practices and Experimental Investigations, The 7th Asia Pacific Young Researchers and Graduates Symposium, Kuala Lumpur, India, 231-240, August 20-21, 2015.*