# 3D MODELLING OF REINFORCED SOIL WALLS

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**Abstract.** *This report summarizes the scope and conclusions of a 3D numerical modelling analysis of mechanically stabilized earth (MSE) walls constructed with concrete panels and strip reinforcement. These systems pose numerical challenges as a result of the discontinuous reinforcement arrangement which suggest the necessity on the 3D strategies instead of 2D modelling to determine and to fit its actual intrinsic behaviour.*

## 1 INTRODUCTION

This extended abstract summarizes the scope and conclusions of a 3D numerical modelling analysis of mechanically stabilized earth (MSE) walls constructed with concrete panels and strip reinforcement [1]. Numerical 2D models to perform mechanically stabilized earth (MSE) retaining wall full-height structures have been extendedly used and demonstrated that a proper calibration is possible even for non-planar reinforcement cases (i.e., strips, bars, ladders, etc.). The simplification from real 3D to 2D plane strain is possible by the transformation of the structural components width dimensions and the actual amount per width of any discrete component to equivalent 1 m-width component (which derives to an equivalent sheet in case of linear/discontinuous reinforcements). As the main (or weak) stress-strain directions of these kind of structures is well localized due to the slice symmetry assumed along the running direction of the wall, the transformation to a plane-strain continuum-slice is assumed to be, in general, faithfully representative.

However, in cases where linear reinforcement (e.g., strips and ladders) are used, it could be interesting to have a more complete understanding of the system behaviour. Under this scenario, it may be necessary to identify divergences on results which can appear between locations through the less representative plane space direction (i.e., running wall direction). These variations have been already identified many times in the context of the soil-reinforcement pullout tests performance. In those cases, relevant variability is typically obtained on vertical pressures through the width direction of the pullout box (i.e., on the horizontal and opposite to the reinforcement displacement direction) due to the real soil-soil vertical transfer of the shear stresses.

A simplified 3D finite element model with CODE_BRIGHT software program has been developed to analyze a 6 m-high mechanically stabilized earth strip-reinforcement retaining wall structure. The purpose of this model is to be capable to achieve more accurate and faithfully behaviour results beyond the scope of the two-dimensional models. As known, the most relevant behaviour contribution of this type of structures is the soil-structure interfaces definition. After the followed methodology, results achieved, and learnings obtained from soil-facing (precast concrete panels) shear analysis, and soil-reinforcement (steel ladders and polymeric strips) pullout tests, proper interface features could be possible to be implemented in the developed and presented full-scale 3D model.

## 2 NUMERICAL MODEL

Figure 1 presents the mechanical 3D model mesh generated with its geometry, and main components and dimensions.

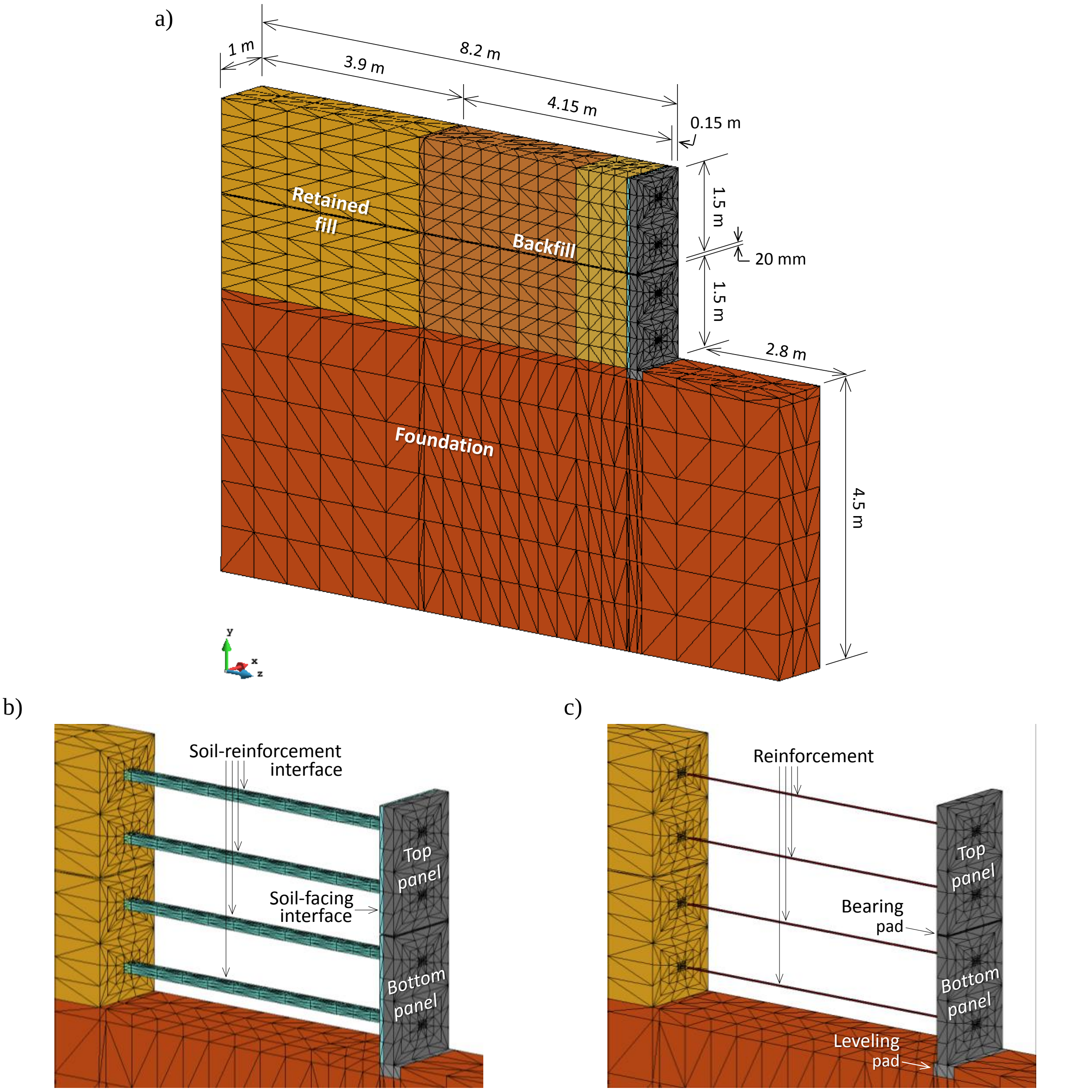


**Figure 1**: 3D model mesh, geometry, components and main dimensions: whole geometry (a), interfaces (b), and structural components detail (c).

## 3 RESULTS

Figure 2 presents general results from vertical and horizontal displacements after wall construction. Figure 3 presents results of the vertical displacements detailed at soil-facing interface rear view. Figure 4 presents the vertical pressures obtained at several locations above and below the reinforcement layers at a cross-section vertical plane 2 meters away from facing.

a) b)

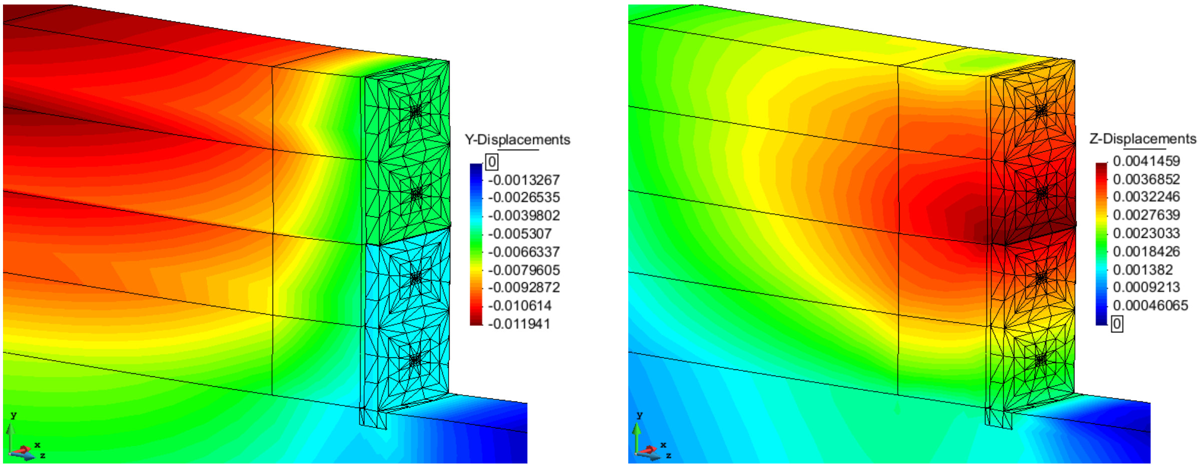


**Figure 2**: Vertical (a) and horizontal (b) displacements (mm) at H = 6 m-equivalent wall height construction..

a) H = 3 m b) H = 6 m-equivalent

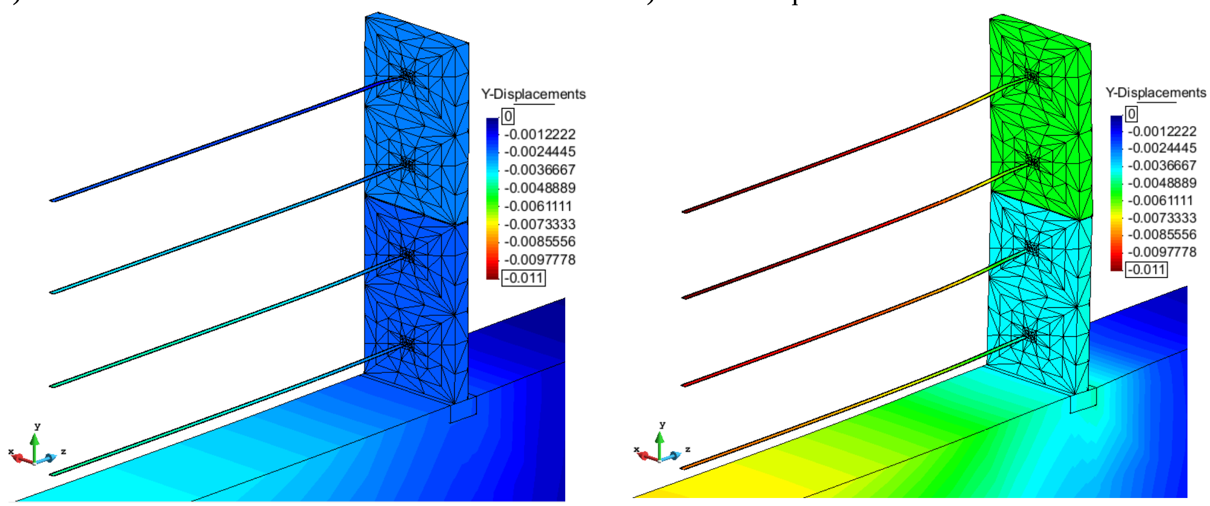


**Figure 3**: Vertical displacements (mm) detailed at soil-facing interface rear view: 3 m (a), and 6 m-equivalent (b) wall height construction. Deformed mesh amplified 20 times.

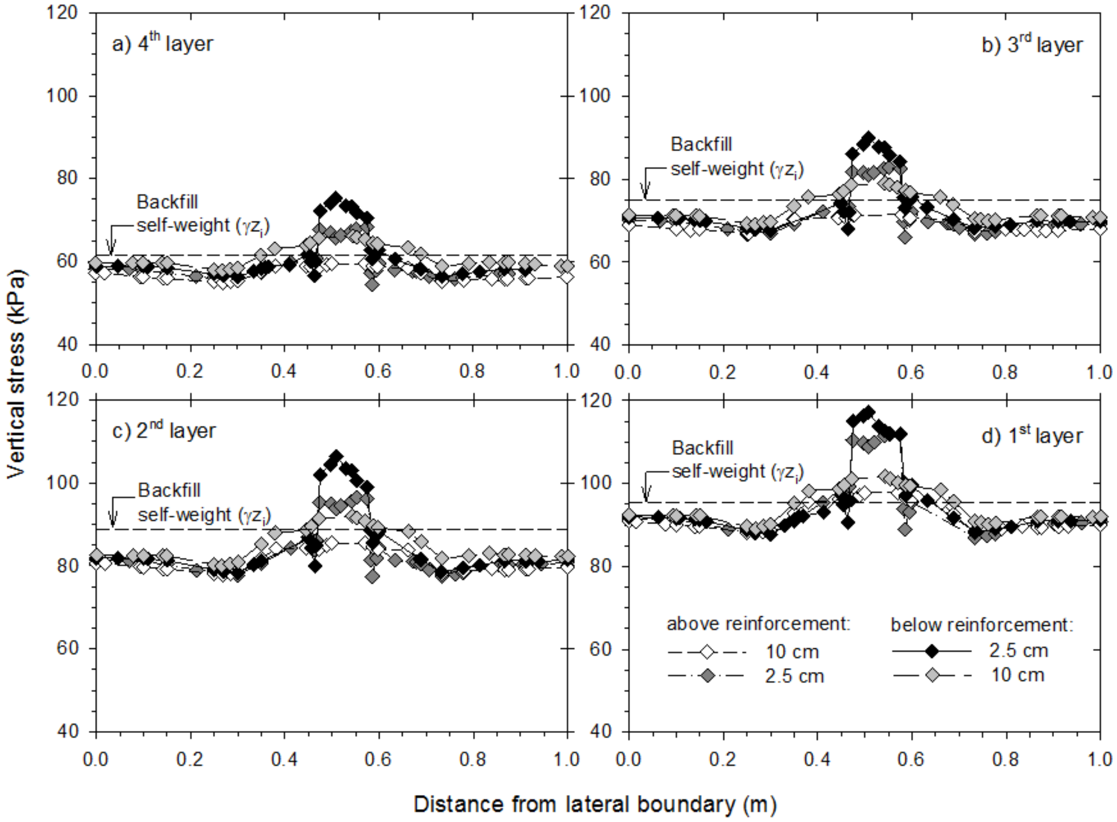


**Figure 4**: Vertical pressure at reinforcement layers location at 2.0 m from facing.

## 4 CONCLUSIONS

- A 3D numerical finite element modelling was generated to analyse a 6 m-high mechanically stabilized earth reinforced soil wall structure.
- The results obtained demonstrated that there is an actual 3D-effect in this kind of structures, not possible to be detected with 2D models analysis.
- Despite in many cases these 3D effects may not be such relevant to justify the use of these complex models (in addition to the related computational issues), the current study showed that this effects could be detected, if required, in particular cases of interest.
- The methodology presented looks promising to achieve further results to other geometries, structural material data, and even under different boundary conditions.

## REFERENCES

[1] Damians, I.P., 2016. Mechanical performance and sustainability assessment of reinforced soil walls (Ph.D. Thesis). https://upcommons.upc.edu/handle/2117/98914/es?range=all.