Numerical investigation of the interaction of back-to-back MSE walls

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Abstract. The behaviour of back-to-back MSE walls is significantly influenced by the geometry, especially for the horizontal distance (D) between the back of the reinforced soil zone of the two MSE walls or the width-to-height ratio (R_{WH}) of the system. In the Federal Highway Administration (FHWA) design guidelines [1] (Berg et al. 2009), two cases are considered based on the horizontal distance of the two MSE walls. However, no justification is provided for this assumption. Therefore, research is needed to investigate the interaction of back-to-back MSE walls with different horizontal distances. In addition, previous studies generally indicate that ignoring the interaction effect between the back-to-back MSE walls would result in overestimation for the design; however, no quantitative evaluation is provided regarding the interaction of back-to-back MSE walls [2-4]. This paper presents a numerical study of the interaction analysis of the static behaviour of back-to-back MSE walls. A parametric study is conducted to investigate the effect of horizontal distance (width-to-height ratio) on lateral soil thrust and required tensile strength. Results from this investigation provide insights on the interaction of back-to-back MSE walls.

A parametric study is performed to evaluate the effect of horizontal distance (width-to-height ratio R_{WH}) on the static behaviour of back-to-back MSE walls with modular block facing. For all the models, the reinforcement length of $L = 0.7H = 4.2$ m, and vertical spacing of $S_v = 0.6$ m. Only the horizontal distance between the two MSE walls changes, as shown in Table 1, and the corresponding horizontal distance range from -0.5 to 2.6.

Table 1 Geometrical configuration of back-to-back MSE walls for baseline case series

Geometrical Parameter	Values									
R_{WH} [1]	0.9	1.1	1.25	1.4	1.65	1.9	2.2	2.5	3.0	4.0
D (m)	3.0	-1.8	0.9	0	1.5	3.0	4.8	6.6	9.6	15.6
d [2]	-0.5	-0.3	0.15	0	0.25	0.5	0.8	1.1	1.6	2.6

[1] defined as the width of back-to-back MSE walls divided by wall height, W/H
[2] defined as the horizontal distance between MSE walls divided by wall height, D/H

Figure 1(a) shows the lateral soil thrust behind the reinforced soil zone. Lateral soil thrust increases significantly from 49.3 kN/m at d = -0.5 to 89.8 kN/m at d = 0.25. For these cases,

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the overlapping reinforcement layers result in strong interaction effect between the two opposing MSE walls. As longer reinforcement layers could provide more anchorage resistance, which would reduce the lateral soil thrust. With increasing horizontal distance, lateral soil thrust further increases mildly to 99.7 kN/m at $d = 0.5$, and then remains nearly constant at approximately 100 kN/m for larger distances. The failure wedge could be fully developed for $d \geqslant 0.5$, and the full active soil thrust could be mobilized. Therefore, the interaction effect of the two opposing MSE walls on lateral soil thrust could be ignored for these conditions.

The required reinforcement tensile strength T_{req} is the maximum value of each maximum tensile force profile and is plotted versus the width-to-height ratio in Fig.1(b). The required reinforcement strength increases nonlinearly from 11.3 kN/m to 13.9 kN/m when the d increases from -0.5 to 0.25, and then remains nearly constant at approximately 14 kN/m for larger ratios. The critical horizontal distance d for constant required reinforcement strength of the back-to-back MSE walls is approximately 0.25. The calculated required tensile strength using the simplified method is 21.5 kN/m, which is much larger than the simulated maximum values. In addition, the simplified method does not account for the interaction of the back-to-back MSE walls, which would result in even larger overestimation for the cases with smaller width-to-height ratios that involve strong interaction. In general, the simplified method is overconservative for the internal stability design of back-to-back MSE walls.

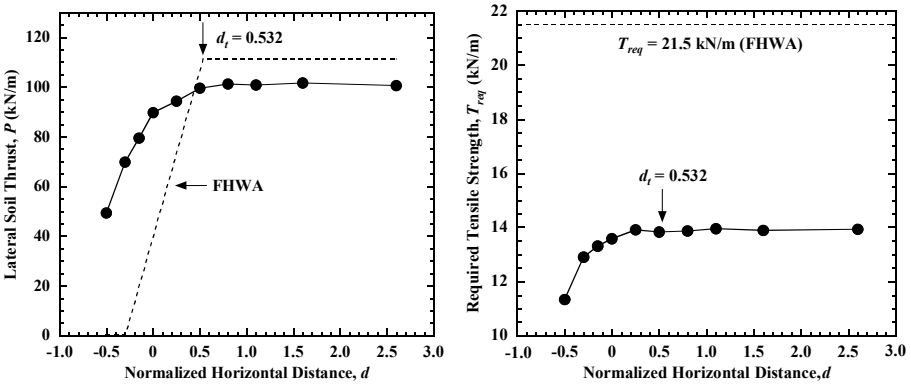

Fig. 1. Effect of horizontal distance on lateral soil thrust and required tensile strength: (a) lateral soil thrust (b) required tensile strength.

References

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