ABSTRACT

Over the past three to four decades, mechanically stabilized earth (MSE) walls have gained preference over other wall types due to the several advantages that they offer, such as ease of construction, flexibility to accommodate large differential settlements, architectural versatility, and low cost per unit area of wall face. Because of these advantages, several departments of transportation in the United States have adopted MSE walls to serve as abutments for highway and railway bridges. While the response of conventional MSE walls has been studied both experimentally and numerically, comparatively less work has been done to investigate the behavior of MSE walls used as abutments for bridge support. This dissertation presents a case study of the performance of a pile-supported, MSE bridge abutment in Whitestown, Indiana, during construction and while in service. A zone near the middle of the east MSE abutment wall was instrumented with earth pressure cells, strain gauges, inclinometers, and crackmeters to investigate the transfer of dead and live loads from the bridge to the foundation elements (pile cap and piles), and to assess the performance of the MSE abutment wall under these loading conditions. The data was collected continuously, both during and after construction, using multiplexers and dataloggers powered by solar panels. The values of key parameters used in MSE wall design were determined from the instrumentation results and compared with those obtained using design methods available in the literature. In addition, the measured dead loads carried by the instrumented piles were compared with the estimated dead loads used in the design of the MSE abutment. After the bridge was constructed, a live load test was performed by parking twelve triaxle trucks at different locations along the approach to the instrumented MSE abutment as well as on the bridge deck near the abutment. Finally, a series of three-dimensional finite element analyses of MSE walls and pile-supported MSE abutments were performed using a two-surface-plasticity constitutive sand model. The lateral stresses on the back of the wall facing and the reinforcement tensile loads obtained from the FE analyses were found to be in good agreement with those measured at the end of construction of the Whitestown MSE abutment. The results obtained from the FE analyses highlight the influence of wall height, backfill soil type, and pile offset on the magnitude and distribution of the lateral stresses on the back of the wall facing and the maximum tensile loads in the reinforcements.