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Two Dimensional Numerical Analysis for the Seismic Response of the Geosynthetic-Reinforced Soil Integral Abutments

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Abstract : The joints between simply supported bridge decks and abutments need to be regularly repaired, which would greatly increase the cost during the service life of the bridge. Simply supported girder bridges suffered the most severe damage during earthquakes. Another type of bridge, the integral bridge, of which the superstructure and abutment are rigidly connected, was also used in some European countries. Because no bearings or joints exit in the integral bridge, this type of bridge could significantly reduce maintenance requirements and costs. However, conventional integral bridge usually result in high earth pressure on the abutment and surface settlement in the backfill. To solve these problems, a new type of integral bridge, geosynthetic-reinforced soil (GRS) integral bridge, was come up in recent years. This newly invented bridge has not been used in engineering practices. There was a lack of research on the seismic behavior of the conventional and new type of integral abutments. In addition, no common design code could be found for the calculation of seismic pressure of soil behind the abutment. This paper developed a dynamic constitutive model, which can consider the soil behaviors under cyclic loading. Numerical analyses of the seismic response of a full height integral bridge and GRS integral bridge were carried out using the two-dimensional numerical code, FLAC. A parametric study was also performed to investigate the soil-structure interaction. The results are presented below. The seismic responses of GRS integral bridge together with conventional simply supported bridge, GRS conventional bridge and conventional integral bridge were investigated. The results show that the GRS integral bridge holds the highest seismic stability, followed by conventional integral bridge, GRS simply supported bridge and conventional simply supported bridge. Compared with the integral bridge with 1 m thick abutments, the GRS integral bridge with 0.4 m thick abutments is subjected to a smaller bending moment, and the natural frequency and horizontal displacement remains almost the same. Geosynthetic-reinforcement will be more effective when the abutment becomes thinner or the abutment is higher.

Keywords : geosynthetic-reinforced soil integral bridge, nonlinear hysteretic model, numerical analysis, seismic response
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