

A novel experimental study on the effects of soil and faults properties on tunnels induced by normal and reverse faults

ABSTRACT

Due to the world population increasing considerably, there is a need for efficient public transportation, such as the subway. However, it has become a major concern to geotechnical engineers that the development and construction of subways are held underground where faults exist, as it will be a major risk to any structure if the fault is still active. Several seismic events, such as the earthquakes in Taiwan in 1999, China in 2008, and Malaysia (Sabah) in 2015, caused by fault ruptures, signify the importance of this study. In this paper, a physical model of 1000 mm in height, 3000 mm in length, and 1000 mm in width, which is the largest single gravity (1g) model for simulation faults (normal and reverse) ever built, was fabricated to evaluate the influence of various soil properties, various fault angles, and tunnel depths on tunnels affected by normal and reverse faults. The effects of various soil properties, such as water content, particle size, cohesion, and friction angle, had revealed major changes (approximately by 34%, 39%, 64%, and 39%, respectively) in tunnel displacements. Results also showed that increasing of fault angle could increase the tunnel displacement as much as two times. In addition, when a tunnel is located close to the ground surface, 22% less displacement was found to have occurred to the tunnel. With the results obtained from the physical model, simulation had been made using plane strain and axial symmetry (PLAXIS) software. The comparison made between rock and soft soil showed that soft soil imposed two times more displacements than rock, and an existence of foundation in soft soil and rock can decrease the tunnel displacements by 6% and 4%, respectively. This paper asserts that besides the structural design of a tunnel, the geotechnical design also has a major impact on the safety and robustness of the tunnel, in which aspects such as soil properties, tunnel depth, and fault angle have a strong influence on tunnel damages which were not considered in previous research, despite their importance.

Keyword: Soil properties; Fault angles; Tunnel depth; Normal and reverse faults