



## Experimental Studies on Tunnel-soil Interaction in Partially Saturated Ground Subjected to Repeated Shaking Events Using 1-G Shaking Table Experiments

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### Abstract

Underground structures are increasingly used worldwide mainly for transportation and utility services and has become a major component in infrastructure development. Although underground structures are considered safer than above ground structures due to its confinement characteristics, past earthquake events such as Kobe earthquake (1995), Wenchuan earthquake (2008) etc. revealed that tunnels are equally vulnerable under dynamic events. Based on Tohoku, Japan Earthquake (2011), Nepal Earthquake (2015) repeated shaking events (i.e., fore-shocks and aftershock occurrences during earthquake) also contributed equally in inducing failures in infrastructures. In India, major portion of tunnel projects were carried out in Northern parts i.e., Indo-Gangetic plains which contains significant portion of silty sand deposits. In case of dynamic events, the changes in soil saturation in these deposits due to variation in ground water table conditions may results in pore pressure generation and can affect the structural stability of the tunnel system. Considering the above aspects, the present study aims to assess the dynamic behavior of shallow tunnels embedded in partially saturated silty sand bed under repeated shaking events. For this purpose, 1-g shaking table experimental study was conducted on scaled down square tunnel embedded in partially saturated sand bed having 60% relative density with 25% saturation. Incremental repeated shaking events of 0.1g and 0.2g was applied sequentially and tunnel-soil interaction behavior was evaluated in terms of acceleration response, developed pore water pressure, pore water pressure ratio, dynamic earth pressure and displacement of soil respectively. The displacement of tunnel and strain developed during dynamic events, were evaluated using 2-D digital image correlation technique. Based on the obtained test results, the factors influencing the dynamic behavior of tunnels in partially saturated ground under repeated incremental shaking events were evaluated and presented.

**Keywords:** Tunnel soil interaction, Soil saturation, Repeated shaking events, 2- Digital image correlation technique, Liquefaction