# Abstract

Research into tuned mass dampers (TMDs) has mainly been conducted in the form of analytical parametric optimisation studies into TMD performance in attenuating dynamic structural response parameters. In comparison, very little experimental case studies – be it from field recordings or the investigation of experimental models – have been conducted on this subject.

Whereas the effectiveness of TMDs in wind-excited structures has long been established, the use of TMDs in seismically-excited structures has been explored to a far lesser extent. The studies which have looked into the use of TMDs in base-excited applications mostly consider structural fixed-base conditions and adopt many model simplifications. However, as has been illustrated in a series of major recent earthquakes, the foundation soil can play a major role in influencing structural response and could – even in the absence of drastic changes in soil conditions following an earthquake – induce soil-structure system properties which may significantly differ from those of structural fixed-base conditions.

For the purpose of this research a series of geotechnical centrifuge and small-scale shaking table tests were conducted on small-scale model structures founded on dry sand and subjected to a wide range of simulated earthquakes and earthquake records. The effects of dynamic soil-structure interaction (SSI) on the performance of TMDs were investigated. More specifically, the performances of a wide range of single tuned mass damper (STMD) and multiple tuned mass damper (MTMD) configurations were investigated in multiple degrees of freedom (MDOF) structures experiencing dynamic soil-foundation-structure interaction (SFSI) and structure-soil-structure interaction (SSSI).

The outcomes of this research have conveyed the importance of conforming TMDs to soil-structure system properties in the presence of a participating soil foundation. Designing TMDs to structural fixed-base conditions under such conditions was found to reduce the operational effectiveness of TMDs and potentially even lead to system response amplification. The practicality of the use of TMDs in seismically-excited applications has been illustrated, particularly in light of resonance between the natural frequency of the system and the excitation frequency. MTMDs were consistently found to perform better than STMDs deployed in the same

system and with the same overall ratio of mass between the (M)TMD and structure. Given the multiple modes of MDOF structures, it was shown that positioning (M)TMDs on the storey that undergoes the largest deflection in a given eigenmode is consistently associated with improved performance. In addition to reduced peak structural response attenuations, non-optimal positioning in MDOF structures was found to induce susceptibility to external loading, potential amplification of peak system responses and a potential increase in the duration of high-intensity structural response motion. Analytical models capable of predicting the response of a range of soil-structure-TMD systems were developed. Finally, the effects from the installation of a TMD in a structure were found to have the potential of aggravating the response of an adjacent structure under SSSI, implying that careful consideration needs to be given to the use of TMDs in earthquake-prone urbanised areas. Given this finding and the general lack of experimental case studies into SSSI, further studies in this field are highly encouraged.