NUMERICAL MODELING OF BURIED PIPELINES SUBJECTED TO SEISMIC SLOPE INSTABILITIES

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Soil slope instability under seismic loading is one of the most challenging problems in geotechnical engineering which in spite of gaining so much attention throughout recent decades, still remains one of the most dangerous earthquake hazards. Besides directly endangering lives and damaging properties in urban areas, this phenomenon can adversely affect infrastructures adjacent to slopes. Of the most important effects, intense deformations of buried pipelines located in soil slopes can be mentioned and the resulting probable failures and improper performance, is considered among the potential secondary seismic hazards. A study is conducted to evaluate the effects of seismic slope instabilities on buried pipelines and how they are affected by topographic effects on earthquake waves near soil slopes. A validated three-dimensional Finite Element (FE) model is used in this study.

The intensity and level of damages induced in pipelines are directly influenced by surface and subsurface deformations and the presence of pipelines, concurrently, affects the level of induced slope permanent displacements. In this paper, by means of numerical models based on physical studies, behaviour of pipelines buried in soil slopes, under seismic loading is investigated. Besides the risks posed by seismically induced slope failures, it has to be considered that these structures are also prone to earthquake vibrations, by the effect of which hydrodynamic pressures are considerably generated, especially in gas pipelines, resulting in additional stresses and strains and probably more severe damages.

It is worth mentioning that in such conditions, gas pipelines are subjected to seismic hazards not only owing to the amplitude of the incoming SV waves, but also to the generated surface Rayleigh waves due to topographic effects. Significance of topographic amplification has been a topic of considerable interest in the recent past due to the apparent relationship between the destructiveness of ground shaking during earthquakes to local site conditions (Assimaki and Gazetas, 2004; Bouckovalas and Papadimitriou, 2005; Uenishi, 2010). As it can be seen in Figure 1, topography aggravation factors $A_h=a_h/a_{h,ff}$ and $A_v=a_v/a_{h,ff}$ varies with distance from the crest x, where a_h and a_v are peak horizontal and vertical accelerations at each point.

Throughout this study, a numerical Finite Element model was calibrated to the results obtained by a physical small-scale shaking table model which can be seen in Figure 2, and then used to peruse the level of strains and deformations induced in buried pipelines (Jafarzadeh *et al.* 2014; Derakhshan Ghazani, 2014). For the verification procedure, maximum horizontal displacements, slope crest settlement and accelerations measured at different parts of the physical and numerical models are compared. Models developed in ABAQUS software are reported and the effect of pipeline position within the soil slope along with the burial depth is investigated.

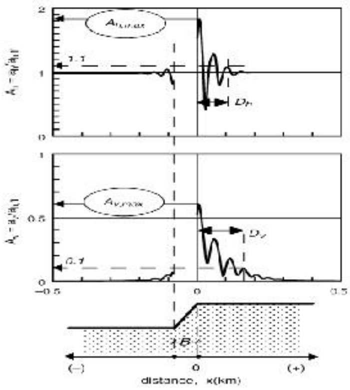

Figure 1. Topographic amplification of peak horizontal A_h and vertical A_v acceleration as a function of horizontal distance x from the crest (Boukovalas and Papadimitriou, 2005)

Figure 2. Physical modelling of buried pipeline response in soil slopes due to seismic loadings (Derakhshan Ghazani, 2014)

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