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SEISMIC STABILITY OF LANDFILLS AND DISTRESS ON THE GEOSYNTHETIC BARRIER

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ABSTRACT

In modern waste landfills design, geosynthetic liners are constructed to successfully isolate waste material from the environment and therefore a potential failure is directly related to leakage of leachate to the environment. Thus, seismic design of landfills should consider not only the seismic stability assessment of the waste mass, but also the evaluation of the distress of the composite base liner system. Nevertheless, the dynamic distress of the geosynthetics of a composite base liner has not been fully resolved yet, since most studies focus on the dynamic response and stability of waste mass.

This study aims to highlight the contributing role of the base liner on the seismic behaviour of landfills. For this purpose, two-dimensional dynamic finite-element analyses of an above-ground landfill are performed. The numerical modelling of the geostructure includes the geosynthetic base liner and the interface along which slip displacements may potentially develop. The trapezoid shape of the examined geostructure results to antisymmetric variation of the static shear stress. It is shown that this characteristic is affecting the dynamic behaviour of the landfill, mainly by producing non-uniform permanent displacements along the interface even when a sinusoidal pulse is applied.

Furthermore, as the dynamic response of landfills is strongly dependent on many parameters, related mainly to waste material characterization and excitation characteristics, the current study investigates the impact of these important issues. The tension of the geosynthetics resulting from the seismic loading is estimated numerically along with the potentially induced seismic slip displacements taking place on the interfaces. More specifically, the evaluated slip displacements, shown in Figure 1, are proven to be strongly dependent on the tuning ratio (β), i.e. the ratio of geostructure's eigenperiod to the period of excitation. The results presented refer to the same sinusoidal pulse in both amplitude and period. It is evident that for tuning ratios lower than unit, slip displacements increase as the tuning ratio increases and the displacement distribution is less uniform. On the other hand, when the tuning ratio receives values higher than unit the slip displacements exhibit a strongly non-uniform distribution, resulting even to opposite slip displacements on the two edges of the landfill. Regarding the tension on the geosynthetics, it is noticeable that the highest values of tension

correspond to the higher values of tuning ratio. Moreover, the excitation's period is affecting considerably the displacements and the tension developed on the geosynthetics, as longer periods are related to higher displacements and to higher axial stresses when referring to the same tuning ratio.

Further results indicate that the dynamic behaviour of a geosynthetic lined above-ground landfill is a complex problem. Seismic strains of considerable magnitude may develop on the geosynthetics, along with significant relative displacements. Conclusively, seismic design of landfills should take into account these phenomena and ensure the integrity of the lining systems and the stability of the waste impoundment as well.

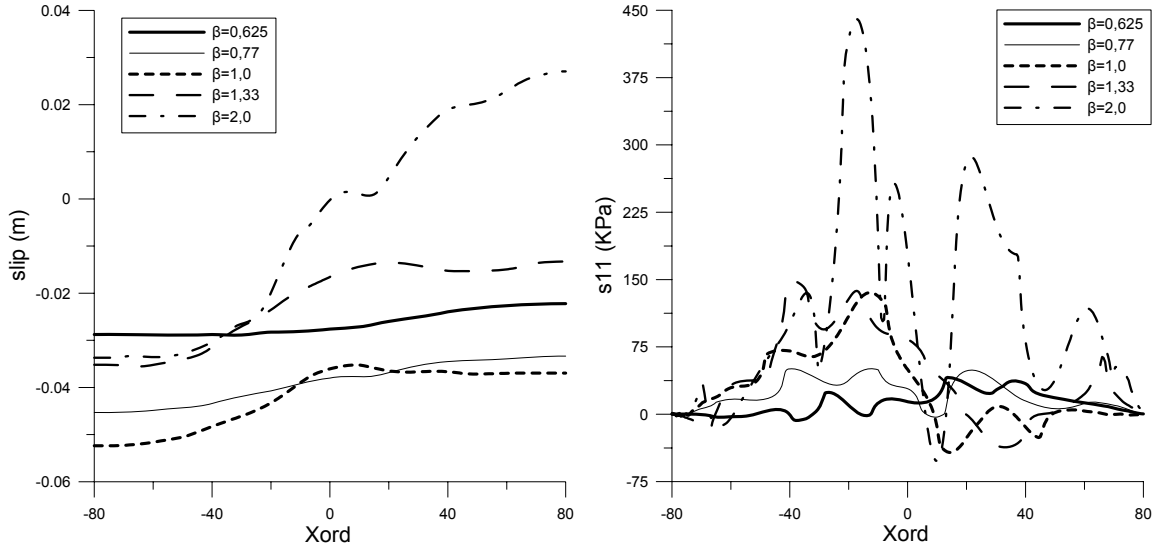

Figure 1. The variation of permanent seismic displacement and axial stress along the geosynthetic layer for different values of tuning ratio (β).

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