Sliding systems under near - fault ground shaking: development and demonstration of inelastic analogues

Numerous earthquakes and subsequent geotechnical failures in the last decade put forward the significance of strong motion phenomena such as “directivity” and “fling”. Moreover, the inelastic behaviour either of the soil or of any geotechnical structure as a whole system, reminds us of the importance of studying non-conventional inelastic systems. The scope of this work is to investigate the seismic response of sliding systems utilising the Newmark analogue not only in its original configuration but including also: (i) different types of frictional behaviour of the yielding interface between the block and its base, (ii) several combinations of triggering motion. Base excitation can be horizontal or simultaneous vertical-and-horizontal in case of a horizontal plane, whereas for an inclined base triggering can be parallel to the plane, horizontal to the plane, or simultaneously horizontal and vertical. In addition, sliding of a rigid body on an inclined base, could occur on top of a single degree of freedom oscillator. In that way the elasticity of the base is embraced too. Several friction models utilised herein: (i) Coulomb’s law of rigid-perfectly-plastic friction with a constant coefficient of friction, μ, (ii) an extended elasto-plastic frictional relationship and (iii) exponentially related friction with sliding velocity. In this way, the sensitivity of sliding response is tested and thorough understanding of the phenomenon is to be achieved. A wide variety of real accelerograms from strong earthquakes are applied as to incorporate near-fault characteristics in our research. Roughly 120 different ground motions are employed. The aim is to end up with empirical expressions to estimate sliding displacement for a minimum of ground motion information. Earthquake records contain information on the seismic intensity and potential destructiveness of ground shaking. Numerous parameters of a ground motion have been proposed over the years to serve as indices of the “damage potential” of a ground motion. They are often called “Damage Potential Indices”. Several Damage Potential Indices are tested herein against the amount of slippage induced by a ground motion. Specifically, the examined indices include: the Arias intensity; the Housner intensity; the RMS acceleration, or velocity, or displacement; the characteristic intensity; the specific energy density; the cumulative absolute velocity; the sustained maximum acceleration and velocity; the acceleration and velocity spectrum intensity; the predominant period; the mean period; the significant duration. In case of sliding systems governed by the Coulomb’s friction law, we introduce the idea of equivalent sliding motions for a given displacement level, and present particular shortcomings of elastic response spectra for such anelastic systems. The concept of equivalent sliding motions is as follows: for a given predetermined level of sliding displacement and yielding acceleration, we obtain the appropriate scaled ground motions that induce this predetermined slippage.