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Submarine slope stability at the Nankai Trough – dynamic triaxial testing of water-saturated sediment samples

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Submarine mass-movement phenomena are common along the tectonically and seismically active Nankai Trough accretionary prism. Earthquakes as well as other natural dynamic loading mechanisms pose time variant stresses on soils. Most soils show a different response to periodic loading than to static loading – making dynamic loading experiments and the study of the response of continental margins to time variant stresses a fundamental component in offshore natural hazard and risk assessment. Here we present results from dynamic triaxial shearing experiments using the new Marum Dynamic Triaxial Testing Device (DTTD). The experimental strategy is two-fold: (1) End-member tests on different artificial clay-to-quartz ratios were carried out to study the general behavior of different material to dynamic loading. The cohesive end member consists of natural clay (<2μm) containing mainly montmorillonite and illite, while the granular end member is composed of an industrially produced quartz powder (<300μm). Aliquots of each sample were tested under dynamic as well as static conditions. (2) Seven whole round samples from NanTroSEIZE sites C0004C, C0008A and C0008C (IODP Expedition 316) were exposed to dynamic loading in order to study the sediment's strength to resist failure under dynamic loading. The generic end-member tests show typical failure behavior such as liquefaction for granular material as well as cyclic creep for cohesive material. Initial results indicate that under unimodal dynamic loading of the samples, granular end members fail at similar cyclic stress ratios as clayey, intrinsically weak end members. However, if we allow drainage of excess pore pressure between different dynamic loading steps, granular end members show significantly higher shear resistances than cohesive end members. To evaluate the failure potential of the in-situ samples from the Nankai Trough accretionary prism, the standard safety factor method is used. By means of geotechnical investigations on artificial sediments and natural samples from the Nankai Trough, we study the physical and geotechnical properties of sediments to infer failure processes. This study is motivated by the direct social relevance of understanding an earthquake's potential to trigger submarine landslides that have had, and will have, great impact on nearby densely populated coastal areas.

Key words Nankai Trough • Dynamic and cyclic loading • liquefaction • creep in clays • submarine slope stability