Characterization of the Penetration Response of Rotary CPT in Sands and its Engineering Application

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***Abstract*:**

Penetrating into deeper soil and obtaining soil properties using probes with embedded sensors is a vital but challenging requirement for the design and construction of infrastructure systems. Rotary Cone Penetration Testing (RCPT) has been recently shown to build upon the established Cone Penetration Test. Specifically, rotation of the probe enhances the ease of penetration by reducing the soil penetration resistance and providing supplemental torque measurements that provide additional soil information. This study conducts comprehensive RCPT laboratory experiments using a robotic arm on sands of two distinct densities, with controlled variations in probe surface roughness and penetration velocity. The results demonstrate that the penetration force (F_z) and torque (T_z) are governed by the ratio of tangential to vertical velocity, referred to as the speed ratio (*SR),* rather than absolute velocities. Specifically, F_z decreases significantly and T_z increases initially and then reaches a constant value as *SR* is increased. The soil relative density affects the absolute F_z and T_z, yet it has no effect on the rate of F_z reduction with *SR*. Within an *SR* range of 4 to 16, RCPT results provide a reliable estimation of the probe-soil interface friction coefficient (μ'), based on comparison against μ' values measured in laboratory tests. These findings clarify the dominant factors affecting the penetration resistances in RCPT, demonstrate the potential for practical applications of the results, and establish a framework for RCPT data interpretation.

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