Visualization of load transmission during pile penetration in granular material by using elastico-mechanoluminescence particle

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ABSTRACT

An elastico-mechanoluminescent (EML) material was used to visualize particle-level contact load distribution through an analog granular material comprising of 1.4 - 1.7 mm diameter glass beads. The EML material was defect-controlled strontium aluminate doped with europium as the luminescent center (SrAl2O4:Eu). The surface of the glass beads was coated with an EML paint produced by mixing the EML material with epoxy resin.

The EML-coated glass particles were placed in a transparent plane strain container and subjected to vertical penetration to visualize the penetration resistance through the granular material. Image analysis was used to identify the chains of load transmission from images captured during testing and the magnitude of internal contact forces was estimated from time-integrated luminescence intensity of the EML material. Fig.1 shows the penetration length - force response in different relative density packed samples. Fig.2 shows that load transmission occurred through chains of particles with orientations that were predominantly in the bottom of closed end pile. The methodology provides the alternative examples for validation of particle method simulation from the view point of force field. Moreover, it holds promise as a tool to better understand the micro-mechanics of granular media.

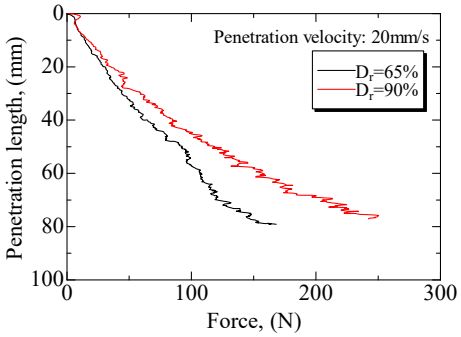

Fig.1 Relationship between force and penetration length

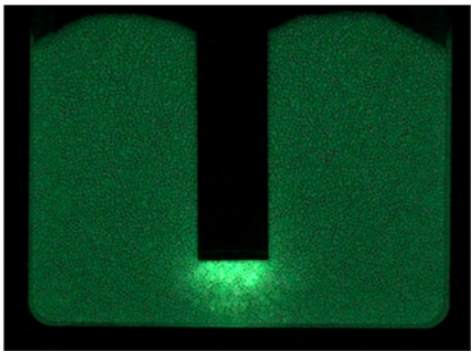

Fig.2 Visualization of penetration resistance below closed end pile after 75 mm of penetration

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