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Improvement of the unconfined compressive strength of 3D-printed model rock via silica sand functionalization using silane coupling agents

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Abstract

Model rock is being explored for use in geotechnical research due to the ability to customize the design and production of specimens for a variety of testing techniques. However, a current limitation of model rock manufacture is that the mechanical properties are not similar enough to natural rock, such as Berea sandstone. In this study, silane coupling agents (SCAs) were used to functionalize the surface of silica sand to test the feasibility of increasing the unconfined compressive strength (UCS) of model rock fabricated using furfuryl alcohol as a binder. Observations of the wetting angle of furfuryl alcohol on functionalized glass slides and the adhesive strength on steel tensile stubs were used to select possible candidates for UCS sample fabrication. UCS testing of samples fabricated with bare and functionalized silica sand showed that there is a significant improvement of the UCS of model rock when (3-glycidoxypropyl)trimethoxysilane (GPTMS) is used to functionalize the sand prior to fabrication. The following study provides a possible approach to increase the UCS of model rock via SCAs, providing a strength closer to natural rock for geotechnical testing.

Keywords

Surface treatment; contact angles; silanization; silica sand