An Experimental Study on the Aging of Sands

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ABSTRACT

There are numerous examples in the literature of time-dependent changes in the properties of sands, or aging effects. Most of these aging effects are of increases in the cone penetration resistance. Time-dependent increases in penetration resistance have been measured in hydraulically placed fills and freshly densified deposits, with the largest increases following the use of ground modification techniques such as vibrocompaction, dynamic compaction, and blast densification. It is not known what causes these increases in penetration resistance to occur.

The objective of this research was to gain an understanding of the possible mechanisms responsible for aging effects in sands. Current hypotheses to explain what causes aging effects in sands include increased interlocking of particles, internal stress arching, and precipitation of silica or carbonate minerals at the contacts between grains. To date, no unambiguous evidence has been presented to support these hypotheses. A laboratory testing program was developed to study the influence of different variables on the presence and magnitude of aging effects. Three different sands were tested in rigid wall cells and buckets. Samples were aged under different effective stresses, densities, tempera-

tures, and pore fluids. In every rigid wall cell, three independent measurements were made to monitor property changes during the aging process: small strain shear modulus using bender elements, electrical conductivity, and mini-cone penetration resistance. At the end of each test, detailed mineralogical tests were performed to assess changes in the chemistry of the samples and pore fluids. A total of 22 tests in rigid wall cells were performed with periods of aging ranging from 30 to 118 days. Mini-cone penetration resistances were measured in the buckets before and at various times during the aging process.

Increases in the small strain shear modulus were measured with time. It was found that sand type and pore fluid composition greatly influenced the amount of increase in small strain shear modulus. Density was also found to influence the amount of increase in small strain shear modulus. Temperature was found to have little influence on the increase in small strain shear modulus with time.

Changes in the chemistry of the samples were also measured with time. The dissolution and precipitation of minerals in solution was monitored with electrical conductivity measurements. In most of the tests, there was continual dissolution of minerals with time. Mineralogical studies and conductivity measurements indicated precipitation of carbonates and silica in two of the tests; however, scanning electron micrographs showed no visible evidence of precipitation.

Despite the measured increases in small strain shear modulus and evidence of mineral precipitation, there were no increases in the mini-cone penetration resistance with time. This finding is significant and suggests that small-scale laboratory experiments do not capture the mechanism(s) that are responsible for time-dependent increases in penetration resistance in the field.

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