Fahad Alshawmar

Title

Evaluation of Compressibility, Anisotropy and At-rest Lateral Earth Pressure in a Sensitive Clay

Abstract

An experimental study is undertaken to evaluate the characteristics and the degree of anisotropy of sensitive Champlain Sea clay that underlies vast areas in Eastern Canada. Undisturbed samples obtained from a site in Ottawa from a range of depths (from ~ 5.82 to 21.55 m) were trimmed along both the vertical and horizontal orientations for consolidation and simple shear tests. The anisotropy in the consolidation characteristics is determined by using an instrumented Oedometer, and the anisotropy in the shear characteristics is determined by using the simple shear apparatus.

The results of the one-dimensional consolidation tests indicate that the vertical orientation has greater preconsolidation pressures than that in the horizontal orientation. The ratio of the horizontal preconsolidation to vertical preconsolidation pressure is varied between 0.71 and 0.95 with average value of 0.83. Tests show that the horizontal orientation leads to higher (1 % to 23 %) compression indices than those in the vertical orientation in general. The ratio of the horizontal to vertical compression index is varied between 1.01 to 1.23 with 1.11 as an average value. The values of the coefficients of consolidation and permeability in the horizontal orientation are found to be larger than those in the vertical orientation (regardless of whether calculated using Casagrande′s method or Taylor′s method). In addition, the ratios of both coefficients of consolidation and permeability in the horizontal orientation to that in the vertical orientation are shown to evolve as the effective vertical stress is increased in the loading stage, with the exception of one data point near the preconsolidation pressure. The average ratio of the horizontal-to-vertical coefficient of consolidation throughout all tests (5.82 m to 21.55 m) ranges from1.49 to 1.72 by Casagrande′s method and from 1.38 to 1.71 by Taylor’s method. The average ratio of the horizontal-to-vertical coefficient of permeability throughout all tests (5.82 m to 21.55 m) ranges from 1.34 to 1.93 by Casagrande′s method and from 1.36 to 1.93 by Taylor’s method. The vertical and horizontal at rest lateral earth pressure coefficients are diminished during the loading and reloading stages, however, increased in the unloading stage. Generally, the at rest lateral earth pressure coefficient in the horizontal orientation was greater than that in the vertical orientation. The average ratio of the at rest lateral earth pressure coefficient throughout all tests (5.82 m to 21.55 m) ranges from 0.90 to 1.82 during the entire stress history. Based on the observation of one-dimensional consolidation tests, it is noted that sensitive Champlain Sea clay shows anisotropic behaviour with respect to the ratio of the horizontal-to-vertical coefficient of consolidation, the ratio of the horizontal-to-vertical coefficient of permeability, and the ratio of at rest lateral earth pressure coefficient. However, the ratio of compression index is subject to very limited anisotropy only.

The undrained monotonic simple shear resistance is somewhat dependent on sample orientation. Test results indicate that samples in the vertical orientation have lower peak and residual shear strengths than those sampled along the horizontal orientation. The horizontal to vertical peak strength ratio varied between 1.05 and 1.42. However, the mobilized friction angle at peak and residual states appears to be not dependent on the loading orientation. Also, the test results show that the peak effective cohesion in the vertical orientation has normally consolidated behaviour, on the other hand, the horizontal orientation has over consolidated behaviour. Based on the observation in the limited number of simple shear tests, it appears that sensitive Champlain Sea clay is subject to anisotropy in terms of the shear strength (peak and residual) and is subject to isotropic behaviour in terms of the effective internal friction angle (peak and residual).

Degree:

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