Shear Modulus And Damping Variation During Consolidation of Clay

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The present Abstract investigates the variation of shear modulus and Damping ratio of Kaolinite clay during primary consolidation. A Hardin Oscillator was used with a modified resonant column testing device. Initial test results are presented for both normally and over consolidated stages. The results indicate a unique trend in the variation of shear modulus depending on normally or over consolidated state. The results show promise for future research.

The purpose of this research is to use the resonant column testing device to evaluate the nature of variation of shear modulus of a kaolinite clay with void ratio as the sample is being consolidated isotropicly. This data of the shear modulus vs. void ratio will help with understanding the stress state of a sample during consolidation.

Soil Tested:

The soil used for this investigation was kaolinite clay. Using slurry consolidation techniques, kaolinite specimens were obtained under k_o conditions at σ_v' = 207 kPa. At the end of initial slurry consolidation, the specimen had the characteristics found in table 1. The kaolinite specimen was then assembled into the Resonant-column device. After assembly the specimen was flushed with CO_2, followed by deaired water. Flushing the sample in this manner enables the sample to be fully saturated.

Apparatus:

The resonant-column testing apparatus used can be seen in fig. 1. The kaolinite specimen is placed on a fixed bottom platen. The top and active platen is placed on top of the specimen. The specimen is surrounded by a latex membrane and sealed to the top and bottom platens using o-rings. A confining cell is placed around the specimen.

Average Diameter	7.14 cm
Average Height	20.30 cm
Mass	1423 g
Volume	812.91 cc
Density	1.75 g/cc
Void Ratio	1.02
Saturation	100%

Table 1: Specimen Characteristics

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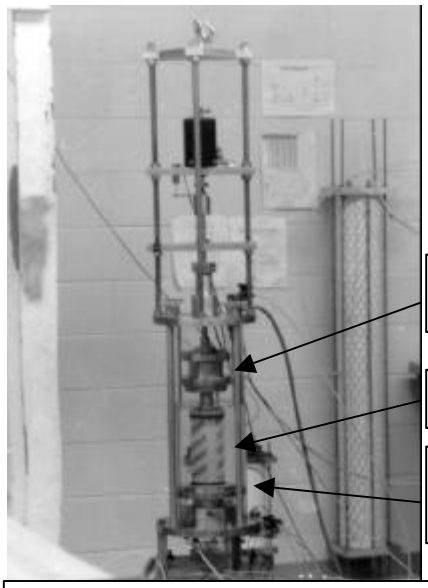

Fig. 1: Resonant Column Testing System

Testing Procedures:

The kaolinte sample was isotropicly consolidated with effective pressures at 276 kPa and 483 kPa. The sample was then unloaded at effective confining pressures of 241 kPa, 121 kPa, and 60 kPa. At each effective stress the specimen was allowed to completely consolidate or dilate before additional pressure was applied or removed.

In order to monitor the void ratio, measurements during each load increment were taken of the change in volume using a burette and the change in sample height using a LVDT. Output voltage and resonant frequency were also collected during the test using an input voltage of 0.05 rms.

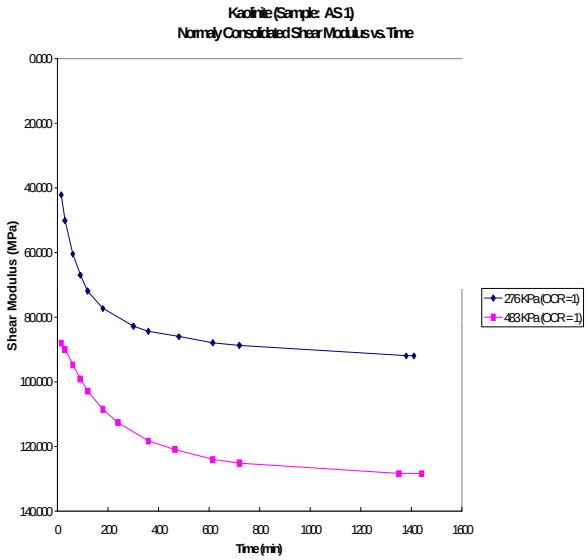

Fig. 2: Normaly Consolidated Shear Modulus vs time

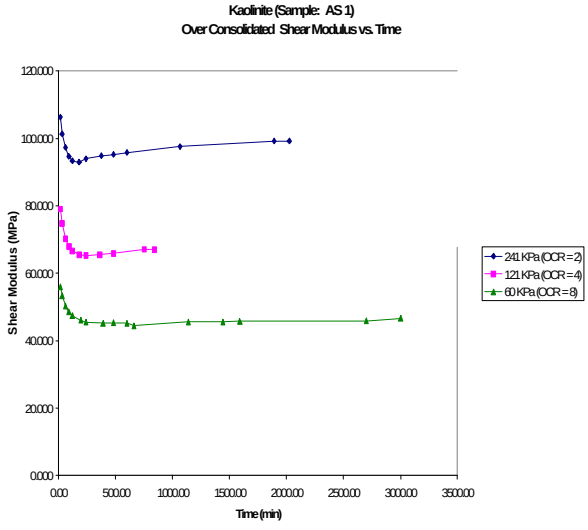

Fig. 3: Over consolidated Shear Modulus vs. Time

Normally Consolidated Test Results:

During normally consolidated stage the void ratio decreases as the shear modulus increases. This can be seen in Fig. 2 for two isotropic pressures.

The first increase was from 207 kPa to 276 kPa. This increase causes the void ratio to decrease form 1.02 to 0.85. During this same time the shear modulus increased from 42.1 MPa to 91.92 MPa. The second isotropic pressure increase was from 276 kPa to 483 kPa. The void ratio decreased from 0.85 to 0.77 and the shear modulus increased from 88.01 MPa to 128.4 MPa during the consolidation.

During normal consolidation the trend is for the shear modulus to increase while the void ratio decreases. This trend shows that the stiffness of the clay increases during consolidation.

Over Consolidated Test Results:

Taking data during the over consolidated stage gives us results that are opposite of the normally consolidated test. As the void ratio increased with time the shear modulus decreased rapidly and then slowly increased. The shear modulus vs. void ratio trend can be seen in fig. 3. The three isotropic pressures during the over consolidated stage and the corresponding over consolidation ratio were 241 kPa (OCR = 2), 121 kPa (OCR = 4), and 60 (OCR = 8). Using these intervals the void ratio and shear modulus trends were found.

Shear Modulus vs. Time:

As the kaolinite clay sample is isotropicly consolidated a trend called the stress increment develops. It is the relationship between the void ratio and shear modulus. By taking data while the sample was consolidating or dilating the variation of void ratio vs. shear modulus was created Fig. 4.

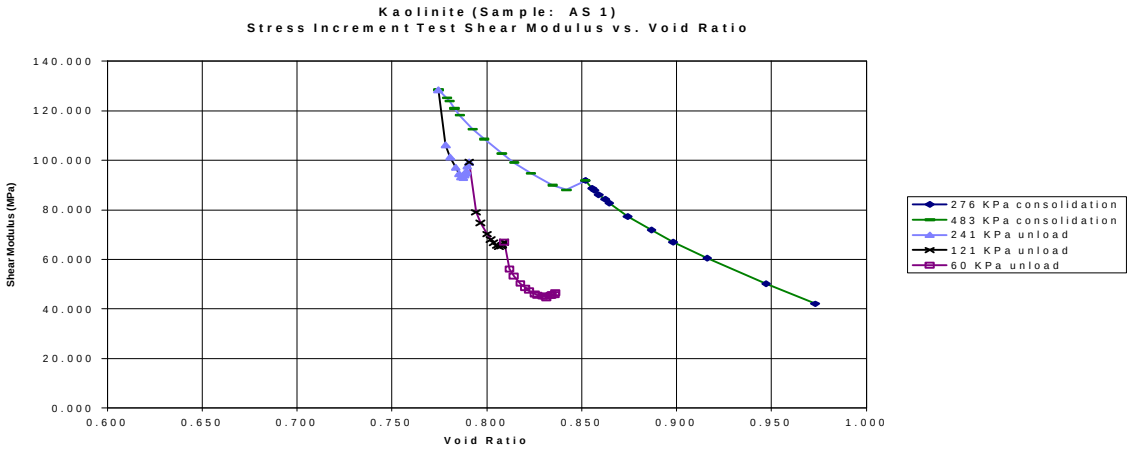

Fig. 4: Stress Increment Test

Conclusion:

In conclusion, this research using the resonant column testing device shows the nature of variation of shear modulus of a kaolinite clay with void ratio as the sample is being consolidated isotropicly. This data of the shear modulus vs. void ratio will help with understanding the stress state of a sample during consolidation.