

157 GDS Helpsheet

Hardware

Triaxial Testing Systems

Low Frequency Liquefaction Studies

1. Cyclic Loading

As part of the test menu, the GDS Triaxial Testing System provides for cyclic loading. This is achieved by cycling axial total stress at a User-defined amplitude and frequency. The wave form may be sinusoidal, triangular or square. The cell pressure remains constant throughout this test so in effect deviator stress is cycled.

2. Low Frequency Operation

Loading frequency depends on wave form, amplitude and test specimen stiffness. Actual realised periods will be longer for complex wave forms (such as sinusoid - incurring longer computer processing time) and high amplitudes and soft materials (requiring greater deformations to achieve set stresses), and shorter for simple wave forms (such as triangular) and low amplitudes and stiff materials.

Generally minimum periods of the order of one to ten minutes may be expected. A minimum period of 100 seconds corresponds to a maximum frequency of 0.01 Hz. Accordingly, the cyclic loading capability of the GDS Triaxial Testing System is a low frequency operation in contrast to, say, resonant column apparatus.

3. Pore Pressure Build-Up Under Cyclic Loading

In the so-called "liquefaction" studies of the build-up of pore water pressure under repeated loading, the worst case for saturated soils is the undrained condition where the change in pore pressure depends on amplitude and number of cycles only and not on frequency.

For example, consider an off-shore platform piled into clay subject to storm wave loading. At the end of a storm, pore pressures have been increased. The worst case is when the next storm arrives before the excess pore pressures have significantly dissipated i.e. the undrained condition.

Accordingly, the GDS low frequency system is used for liquefaction studies.

The apparent disadvantage of a low frequency system is the longer time to accumulate numbers of cycles. The system is fully automated however and runs 24 hours a day, seven days a week. Even for a cycling period of 5 minutes, running the system over a weekend will clock up about 1000 cycles.

In this way, large numbers of cycles can be built up enabling families of curves to be constructed showing the increase in pore pressure (perhaps normalised with respect to the equilibrium value) with number of cycles for varying amplitudes.

4. Advantage of a Low Frequency System

GDS Users carry out liquefaction type testing for various investigations including: track and pavement base subject to vehicle loading; off-shore platforms subject to storm wave loading; seismic instability of undersea slopes.

The GDS low frequency system has been chosen by these GDS Users because it is low frequency. They not only recognise the insensitivity to frequency of the worst (i.e. undrained) case, but also they point out that high frequency testing of small scale test specimens is not only unrepresentative of the soil behaviour in the mass, but also can destroy the test specimen itself before any meaningful measurements can be made.