4 GDS Helpsheet

World Leaders in Computer Controlled Testing Systems for Geotechnical Engineers and Geologists

Hardware

STD & ADV Controller

Beeping, Error Conditions, and System Setup

1. Error Conditions

The GDS digital controller protects itself from being driven outside its operating limits. It does this by overriding the existing operation and "backing off" from the limit. When it is doing this the controller will "beep" i.e. make an audible signal to attract your attention.

2. Volume Limit

Mechanically, the GDS digital controller comprises a piston moving in a cylinder. The piston is actuated by a screw turned in a captive ballnut by a stepping motor and gearbox. The piston displaces and pressurises deaired water.

The length of the cylinder and the stroke of the piston is finite. The piston sweeps the volumetric capacity of the cylinder as it moves from one end to the other. So that the piston will not hit either end of the cylinder, the moving motor/gearbox assembly attached to the end of the screw carries a small magnet. The position of this magnet (and hence position of the piston) is detected by sensors beneath the top plate of the controller.

When one of the sensors detects the presence of the magnet the controller sounds the beeper and reverses the sense of rotation of the motor. For example, imagine the stroke of the piston is such that the piston is approaching the end of the cylinder near the pressure outlet (i.e. minimum stroke). At this time, the motor and gearbox assembly is close to the pressure cylinder and the protective bellows over the screw is "telescoped" down and compressed to a short length. Here, the controller will detect a forward volume limit and reverse the motor to cause it to back-off.

Once the motor has reversed sufficiently for the magnetic field of the magnet to no longer affect the forward limit detector, the original function (e.g. seek to a target pressure or volume) is restored and the motor will drive forward again. This sequence of events will repeat themselves until some action is taken or until the cause of the condition is removed or goes away.

For the similar case of maximum stroke, the motor and gearbox assembly will be remote from the pressure cylinder and close to the control panel and with the bellows now extended rather than compressed. Here the limit condition will cause the motor to drive the piston back down the cylinder towards the pressure outlet.

3. Pressure Limit

The internal programming of the controller recognises maximum and minimum pressure limits. For example, the maximum pressure limit of a "2000 kPa" range controller is actually 2047 kPa, an apparently strange number which is digitally convenient. The minimum pressure limit of such a controller is -40 kPa in order to avoid cavitation (the vapour pressure of water at normal room temperature and pressure is about -100 kPa).

If a minimum pressure limit is detected the controller causes the motor to drive to correct the condition by increasing pressure by driving the piston towards the pressure outlet. If a maximum pressure limit is detected the piston is driven away from the pressure outlet in order to reduce pressure to below the set maximum whereupon the original function will take over again.

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4. Causes of Limit Conditions

In GDS systems these limit conditions arise mainly as the result of incorrect setting up of the controllers themselves or of the test cell or of the initial test conditions.

5. Setting Up the Controllers

It is essential at the beginning of every test to set the stroke of the piston of each controller so that volume limits will not be exceeded during the test. For example, in the GDS triaxial testing system, it is important to understand that volume changes into the lower chamber and cell are equal and opposite. Accordingly, when setting up a compression test involving large displacements it is a good idea to set the lower chamber and cell pressure controllers to their maximum and minimum strokes, respectively. This can be done by dipping the nylon pressure outlet tube below the surface of a container of deaerated water and setting the function FILL on the lower chamber controller while setting the function EMPTY on the cell controller. For a large displacement extension test the set up is vice versa.

6. Setting Up the Triaxial Cell

The GDS hydraulic triaxial cell comprises two chambers. The upper chamber or "cell" is where the test specimen is set up. The lower chamber is where the axial force is generated. The two chambers are separated by an actuating piston sealed by matched Bellofram Rolling Diaphragms (BRDs) into the chambers at each end. The piston is guided axially by a linear motion bearing and is housed in a turret joining the two chambers. The two chambers are thus a coupled system and the volume changes in one are very nearly the volume changes in the other.

The stroke of the piston is finite and limited by end stops. Imagine a deformation controlled compression test where the piston hits the upper end stop. The pressure in the lower chamber controller will increase until its pressure limit is reached. The online plot will show a sudden increase in pressure.

This sort of problem can be avoided by setting up the lower chamber and its controller as the coupled system it undoubtedly is. One way of doing this is to drive the piston of the cell until it is very nearly at its upper limit. You can observe this by looking at the position of the cross-arm where it sticks out from the slot in the turret. The cross-arm is attached to the piston. When the cross-arm is at either end of the slot the piston is at the corresponding end stop.

Now disconnect the lower chamber controller and set the controller to its minimum stroke using the function EMPTY. Remake the connection using a syringe to deair the coupling. This is now a closed system and in the normal course of events you need not unmake the connection again.

The advantage of setting up the cell in this way is that the lower chamber controller will hit a volume limit before the cell piston hits the upper end stop.

7. Setting Up the Test Parameters

In GDS systems the input of test parameters are validated to avoid "finger trouble" only i.e. the validation cannot anticipate a particular test set up. For example, a terminal strain condition may be set which causes a lower chamber volume limit because the required volume change into the lower chamber exceeded the volumetric capacity currently set up in the controller. This can be easily avoided with a little care.

Not so easy to avoid, perhaps, is exceeding a lower chamber pressure limit in a stress path test which has defined an axial stress requiring a lower chamber pressure greater than 2000 kPa. The relationships between axial stress, deviator stress and mean stress must be used to check that the implied test parameters of cell and lower chamber pressures do not cause a pressure limit.

GDS system software (from GDSTTS GEN 5.0) is written so that whenever an error condition (i.e. a volume or pressure limit) is detected the current test is shut down and a diagnostic error message is displayed on the computer screen and printed out on the printer. Additionally, GDS system firmware (from VER 3.5) is written so that whenever an error condition is detected and corrected the GDS digital controller will display "LIMIT CORRECTED" and abort the current instruction (eg seek to a target pressure) until it receives a new instruction (eg from the controlling computer).