SUGGESTED METHOD FOR DETERMINING ROCK MASS DEFORMABILITY USING A HYDRAULIC DRILLHOLE DILATOMETER

Scope

1. (a) This test determines the deformability of a rock mass by subjecting a section of drillhole to hydraulic pressure and measuring the resultant wall displacements.[1] Elastic moduli and deformation moduli are calculated in turn.

(b) The results are employed in design of foundations and underground construction.

(c) The dilatometer is self-contained and tests are relatively inexpensive compared to similar tests at a larger scale.[2] Also, the wall is damaged only minimally by the drilling of the hole and usually remains representative of the undisturbed rock condition. These advantages, however, come at a sacrifice of representation of the effects of joints and fissures which are usually spaced too widely to be fully represented in the loaded volume around the drillhole.

(d) This method reflects practice described in the references at the end.

(e) Another type of dilatometer for drillholes transmits pressure to the rock through mechanical jacks: See RTH-368.

Apparatus

2. Drilling equipment to develop access hole in a given orientation without disturbing the wallrock.[3]

3. A drillhole dilatometer similar to that in Figure 1, which consists of:

(a) stainless steel cylinder

(b) Rubber (neoprene) jacket surrounding the steel cylinder and sealed at both ends to confine pressurized fluid between the jacket and the steel cylinder

(c) Two end plugs containing pipes, electric wires, and relief valves.

(d) Linear differential transformers oriented along different diameters of the drillhole (commonly four at 45-degree sectors). Deflections as large as 5 mm are measured, commonly with accuracy of about 0.001 mm.

4. Hydraulic pump capable of applying the required pressure and of holding this

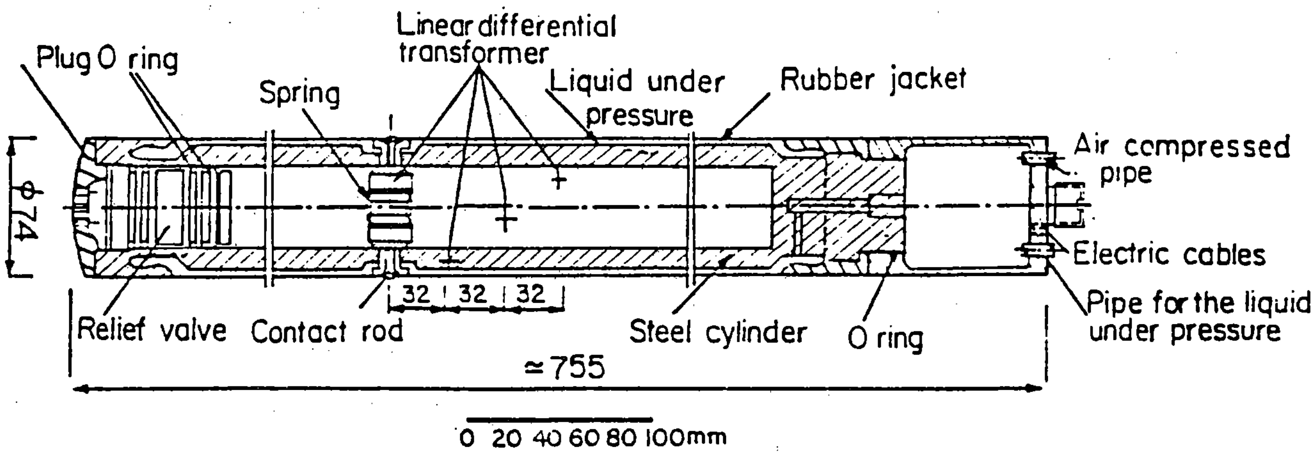

Figure 1. Example hydraulic drillhole dilatometer.

pressure constant within 5% for a period of at least 2 hr. together with all necessary hoses, connectors, and fluid.

5. Hydraulic pressure gages or transducers of suitable range and capable of measuring the applied pressure with accuracy better than 2%.

Procedure

6. Preparation

(a) The positions for testing are planned with due regard to the location of drilling station and the rock conditions to be investigated. The effects of geological structure and fabric are particularly important.

(b) The hole is drilled and logged. The log is studied for possible modifications in positions for testing. Multiple testing positions in one hole should be separated by at least 0.5 m.

(c) The dilatometer is assembled and inserted into the hole, commonly using an attachable pole to position and rotate and taking special care with trailing lines.

(d) The rods of the linear differential transformers are seated against the wall.

7. Testing

(a) The dilatometer is pressurized in increased stages, with pressure released between stages. Typically, the stage pressures are 25, 50, 75, and 100 percent of the planned maximum of the complete test.[4]

(b) Pressure is increased at a rate of 0.5 MPa/min. or less.

(c) On reaching the planned pressure for the stage, the pressure is held constant for at least 1 min. to detect and define nonelastic deformation. Each stage is completed by releasing pressure at a prescribed rate up to 0.5 MPa/min.

(d) The test history is documented with no less than four sets of measurements during pressure increase and two during pressure decrease. Supplementary notes are necessary to describe any complexities not otherwise revealed (such as nonelastic deformation).

(e) The pressure is released and fluid withdrawn. The rods of the linear differential transformers are retracted away from the wall and the dilatometer is removed from the hole.

Calculations

8. For presumed quasi elastic conditions, an elastic modulus is calculated from

$$E = \frac{p\ a}{U_r}(1 + \nu)$$

where

p = fluid pressure

a = hole radius

U_r = change in radius

ν = Poisson's ratio

Where permanent deformation (nonelastic) occurs also, that portion of U_r should be excluded from the equation.

Reporting

9. The report should include for each test or all tests together the following:

(a) Position and orientation of the test, presented numerically, graphically, or both ways.

(b) Logs and other geological descriptions of rock near the test. The structural details are particularly important.

(c) Tabulated test observations together with graphs of displacement versus applied pressure and displacement versus time at constant pressure for each of the displacement measuring devices (e.g. linear differential transformers).

(d) Transverse section of hole showing the displacements resulting from the pressure in all orientations tested. Calculated moduli are indicated also.

Notes

[1]In very deformable rocks, the diametral strain can also be determined indirectly from changes in volume of pressurizing fluid. See RTH-362 for that procedure.

[2]See RTH-361, -366, and -367 for similar test at tunnel scale.

[3]Diamond core drilling is recommended for obtaining the necessary close tolerance when using dilatometer only slightly smaller than the hole and displacement measuring devices with very limited stroke.

[4]Typically, the maximum pressure is about 15 MPa.

References

Lama, R. D., and Vutukuri, V. S., Handbook on Mechanical Properties of Rock, Vol.III, TransTech Publications, 1978, 406 pp.

Stagg, K. G., "In Situ Tests on the Rock Mass," in Rock Mechanics in Engineering Practice, John Wiley & Sons, New York, 1968, pp. 125-156.