

Principles and methodology

Dilatometer tests are in-situ load tests carried out following certain standards (XP P94-443-1, without creep, and XP P94-443-2, with creep) by expansion of a cylindrical cavity.

Strains are applied on the walls of the cylinder, which is in contact with the ground. The goal is to obtain a stress-deformation relationship characteristic of the surrounding environment.

The probe has a soft membrane, which is expanded by compressed gas (nitrogen). Maximal pressure the probe can withstand is 18 MPa. The pressure sensor is located in the body of the probe, so as to avoid pressure linked to a potential water column inside the borehole and uncertainties linked to the pressure system.

Three deformation sensors are located below the membrane, at 120° from one another, according to three different diameters, which allows for the characterisation of the ground anisotropy. The effective stroke of the sensors is of 20 mm.

A dilatometer test is composed of several load-unload cycles, at increasing pressures. For each pressure, deformations are noted down every minute or continuously recorded, and pressure is maintained until stabilisation of the deformations or for 3 minutes.

The first phase of the procedure consist in reaching the laminating pressure. The latter will be reached by increasing the pressure gradually (0.05 MPa stages), in order to determine the laminating pressure and the cladding diameter. If that diameter is equal to the probe diameter plus 8 mm, the test can be cancelled for technical reasons (sheath bursting, displacement superior to the probe limits).

Pressure is increased gradually for each cycle until maximal pressure in reached. Maximal pressures increase from one cycle to the next. Unloading phases are also done gradually. They remain always superior to the laminating pressure for the probe not to disunite from the ground and, thus, retain contact areas.

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Results are presented in a hysteresis loops format, from which we can calculate the following modules. All the modules correspond to the formula below:

$$\mathbf{E} = (1 + \mathbf{v}) * \mathbf{D} * \delta \mathbf{P} / \delta \mathbf{d}$$

With:

E : Modulus of elesticity in MPa

v: Poisson's ratio (arbitrarily set at 0.25, unless additional data is provided)

D : cladding diameter in mm

 δP : variation of pressure in Mpa

 δd : variation of diameter deformation in mm for δP

- modulus of elactic deformation (Er on the illustration) : calculated between the unload of the cycle n and the load of the cycle n+1 with a δP equal to P75% (75% of the maximal pressure of the cycle n) minus

P25% (25% of the maximal pressure of the cycle n)

- modulus of global deformability (E on the illustration) : calculated between maximal pressures of cycles n and n+1.



Results curve for dilatometer testing

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DILATOMETER TESTS FACT SHEET

Limitations of the method: Tests can be cancelled or disrupted in the following cases :

- too big cladding diameter (superior to probe diameter plus 8 mm)
- fractures where the test is to be done
- non-homogeneous ground on a distance equal to the length of the probe sleeve
- important ground deformation putting sensors at the limit of the effective stroke

These different cases can cause a premature wear of the sleeve or even its bursting. That is why it is advised to test the feasibility of the method and position the probe depending on the drillings.

The probe is placed and taken out of the borehole with a drill string. Therefore, a drilling machine and a special team are required throughout the testing period.

Procedure for testing without creep

The probe used has a diameter of 95 mm for drillings of 101 mm diameters. Tests can be done up to 90 m depth maximum, provided it is possible to position the equipment at the foot of the borehole. The probe is joined to the drill string by a connector Craelieus, size 50 or 60.

Location of test points is defined by agreement with the client in light of the drillings and logs. Each test consists of 3 cycles. Here is how they unfold:

- 10 load levels and 5 unload levels
- Maximal pressure of the different cycles: 5, 10 and 15 MPa (adaptable depending on the site response).

Results are provided in the form of tables summing up the moduli of elastic deformation and of global deformability.

It is the client's responsibility to provide INNOGEO with a drilling machine to place and remove the probe from boreholes. Drilling machine and its team of operators are required to stay on-site and remain available throughout the testing period.



Warning

Tests can only be carried out in homogeneous and non-fractured areas chosen in agreement with the client after assessment of core samplings and logs.

The length of the testing area has to be of at least 2 m.

Tests will not be done is fractures or heterogeneous areas.

Tests will not be carried out for boreholes of more than 103 mm in diameter.

Unless INNEGEO is proven liable, the client is responsible for damage caused on the probe inside the borehole. They agree to provide equipment needed for its extraction (drilling machine and its team) up until its retrieval, and to assure responsibility for repayment or repair of the probe in the event of loss or damage.

Lead time

Under normal conditions, two tests can be done each day. This rate can be decreased (one a day) or increased (3 a day) depending on the actual conditions.

Delays caused either by the change of probe sleeve after bursting or by entrapment, extraction or repair of the probe will not be attributed to INNOGEO. They will also delay result delivery. Delays caused by probe or measuring station failure, or by any type unforeseeable event or case of force majeure outside of INNOGEO's control, will not be attributed to the company either.