CONCRETE, HARDENED:
PULLOUT STRENGTH

1. SCOPE AND FIELD OF APPLICATION

This NORDTEST method is intended for the determination of the force needed for pulling out a circular pullout insert that has been cast in the concrete. This force is in this context defined as the pullout force. It is also possible to exert a pull with a certain amount of force without thereby causing a break in the concrete. (See Note 1).

The method may be used for an evaluation of the compressive strength in completed objects with the condition that the values obtained according to the method have been calibrated for concrete with a known compressive strength and of the same composition as the concrete whose compressive strength one intends to evaluate. The relationship between the force and the strength of the concrete may then usually be expressed as a linear function.

The pullout strength may be used to determine whether or not the strength of an object has reached a sufficient level in connection with the following examples and others

Note 1 The method agrees in the main with ISO DP 8046 Concrete (hardened) - Determination of pull out strength.
- prestressed concrete (for pre-tensioned and post-tensioned concrete)
- form stripping
- protection against freezing that may cause damages
- termination of curing.

The method can not be used when the temperature of the concrete is lower than 0 ºC

The number of test specimens and their age are not considered in this method.

2. SAMPLING

Test places for the placing of the pullout inserts (that later on are cast into the concrete) should be selected with reference to the purpose of the investigation. The inserts shall be placed in such a manner that there is an internal distance between them of at least 10 x the diameter and a distance to the edges of the object of at least 4x the diameter. They should also be placed at such a depth from the surface of the concrete that there is no reinforcement nearer the expected test cone after the break, than the size of one rod diameter or the size of the nominal maximum particle size used in the concrete, see Fig. 1.

With regard to the reinforcement in the concrete the test places should be selected so that $d > \phi \text{ and } d > d_{\text{max}}$ where $d_{\text{max}}$ is the max. nominal particle size of the concrete.

The evaluation of the result should be based on not less than six pullout tests.

The thickness of the concrete at the testing place shall be at least 4x the diameter of the pullout insert.
3. METHOD OF TEST

3.1 Principle

The method is based on the principle that a metal pullout insert is cast into the concrete at a certain depth from the surface of the concrete (from the cast surface or a moulded surface). The depth is determined by the length of a shaft that is screwed into the insert, and which has the other end in the concrete surface. The insert is then pulled out at a pre-determined force (up to the ultimate strength if so is desired). The resistance of the bearing ring of the jack against the concrete surface should be larger than the diameter of the steel insert in the concrete.

3.2 Apparatus

Equipment for the pullout test consisting of a metal pullout insert with an attached shaft, see Fig. 1, a loading system (consisting of a jack, a lever and a bearing ring), see Fig. 2 and equipment for the determination of the pullout strength.
Fig. 2. Shaft and bearing ring

The pullout insert and the bearing ring shall have the measures stated in Fig. 1 and 2 if nothing otherwise is stated in the test report.

The loading system shall be such that the insert is pulled centrally and perpendicularly to its own plane.

Measures and design of different types of equipment are related to different systems. The accuracy of the measurements shall lie within ± 2 % of the nominal values.

One should be able to increase the load continuously and at the speed stated in 3.4.

The maximum amount of load shall be determined with an accuracy within ± 2 %. It should be possible to read the ultimate load after a pullout.

3.3 Preparation of Test Samples

The insert with the screwed-in shaft are attached to the form in such a way that the shaft is perpendicular to the surface of the mould and remains so during the filling and compacting of the concrete in the form.
During testing performed in frameform, or similar constructions, the insert with the screwed-in shaft is placed in the concrete after it has been compacted so that the end of the shaft is located in the concrete surface. The concrete around the steel insert is then compacted by means of light tappings on the surface of the concrete so that the insert is completely surrounded by concrete.

3.4 Procedure

The concrete must not be frozen during the testing.

When the concrete shall be tested, all material that has been used to secure the position of the pullout insert during the casting should be removed. Furthermore, all traces of left over material and all traces of any unevenness in the concrete surface that would prevent the pulling to be performed absolutely perpendicularly relative to the insert should be removed.

The bearing ring needed for the jack is placed centrically around the shaft and the jack is then fastened to the shaft. The whole device is so arranged that the jack, the bearing ring and the surface of the concrete are exactly in the positions that they are intended to be in.

If one intends to pull the insert until the ultimate strength is reached, and a rupture occurs in the concrete, it should be loaded continuously until the pullout takes place within 120 ± 30 s. The ultimate force is then recorded.

3.5 Expression of Results

The highest applied force should be stated in kN rounded off to the nearest 0.05 kN, one should also state whether or not a rupture has occurred in the concrete.
3.6 Test Report

If a test report is submitted, it should contain at least the following information:

a) Name and address of the testing laboratory
b) Date and identification symbols of the report
c) Test method (number and title)
d) Any deviation from the test method
e) Name and address of the person or institution who ordered the test
f) Name and address of the person performing the test
g) Name and address of the manufacturer of the concrete
h) The identification symbols of the concrete. If a reference test has been performed, the composition of the concrete and the type and number of the rebound hammer should be noted (for this method only)
i) Date when the test was performed and the age of the concrete, if known
j) Test results
k) Any other information of importance for the evaluation of the test results
l) Evaluation of the test results, if this is required in the request for the test.