SLOVENSKI STANDARD
kSIST FprEN ISO 22477-2:2023

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Geotehnično preiskovanje in preskušanje - Preskušanje geotehničnih konstrukcij - 2. del: Preskušanje pilotov: statični natezni preskus (ISO/FDIS 22477-2:2023)

Geotechnical investigation and testing - Testing of geotechnical structures - Part 2: Testing of piles: static tension load testing (ISO/FDIS 22477-2:2023)

Geotechnische Erkundung und Untersuchung - Prüfung von geotechnischen Bauwerken und Bauwerksteilen - Teil 2: Statisch axiale Pfahlprobelastung auf Zug (ISO/FDIS 22477-2:2023)

Reconnaissance et essais géotechniques - Essais des structures géotechniques - Partie 2: Essai de pieux: essais de chargement statique en traction (ISO/FDIS 22477-2:2023)

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Geotechnical investigation and testing — Testing of geotechnical structures —

Part 2:
Testing of piles: Static tension load testing

Reconnaissance et essais géotechniques — Essais des structures géotechniques —

Partie 2: Essai de pieux: essais de chargement statique en traction

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 182, *Geotechnics*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 341, *Geotechnical Investigation and Testing*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

A list of all parts in the ISO 22477 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Geotechnical investigation and testing — Testing of geotechnical structures —

Part 2:
Testing of piles: Static tension load testing

1 Scope

This document establishes the specifications for the execution of static pile load tests in which a single pile is subjected to an axial static load in tension in order to define its load-displacement behaviour.

This document is applicable to vertical piles as well as raking piles.

All types of piles are covered by this document. The tests considered in this document are limited to maintained load tests. Cyclic load tests are not covered by this document.

NOTE ISO 22477-2 is intended to be used in conjunction with EN 1997-1. Numerical values of partial factors for limit states and of correlation factors to derive characteristic values from static pile load tests to be taken into account in design are provided in EN 1997-1.

This document provides specifications for the execution of static axial pile load tests:

a) checking that a pile behaves as designed,

b) measuring the resistance of a pile.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 7500-1, *Metallic materials — Calibration and verification of static uniaxial testing machines — Part 1: Tension/compression testing machines — Calibration and verification of the force-measuring system*

EN 1990, *Eurocode 0: Basis of structural design*

EN 1997-1, *Eurocode 7: Geotechnical design — Part 1: General rules*

EN 1997-2, *Eurocode 7: Geotechnical design — Part 2: Ground investigation and testing*

3 Terms, definitions and symbols

For the purposes of this document, the terms and definitions given in EN 1990, EN 1997-1, EN 1997-2 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1 Terms, definitions

3.1.1
pile load
F_t
tension load applied to the head of the pile during the test

Note 1 to entry: For tests with embedded jack, the load is applied at another level (see ISO 22477-1).

3.1.2
load increment
ΔF
increment of load added or removed during the test

3.1.3
pile diameter
equivalent pile diameter
D
diameter of the pile

Note 1 to entry: For non-circular pile with cross section A, the equivalent pile diameter equals $\sqrt{\frac{4A}{\pi}}$.

3.1.4
working pile
pile for the foundation of a structure

3.1.5
test pile
pile to which loads are applied to determine the resistance-displacement characteristics of the pile and the surrounding ground

3.1.6
measured tensile resistance
$R_{t,m}$
value of the measured tensile resistance at the ultimate limit state, in one or several pile load tests

Note 1 to entry: The recommended failure criterion may be defined in EN 1997-1 or its national annex.

3.1.7
creep rate
α
ratio of the increase in pile head displacement to the decimal logarithm of time during a specified time interval

3.2 Symbols

A	pile cross section
D	pile diameter/equivalent pile diameter
F_t	load applied to the head of the pile during the test
$F_{t,cr}$	critical creep load in tension
$F'_{t,cr}$	intersection of the linear regression of the first and last part of the alpha versus load curve
$F_{t,k}$	characteristic axial tensile load
F_p	predefined maximum load applied during the test

N axial force

q_s unit shaft friction

$q_{s,m}$ measured value of q_s

$q_{s,mob}$ mobilised shaft friction

R_t tensile resistance of the ground against a pile, at the ultimate limit state

$R_{t,m}$ measured value of R_t in one or several pile load tests

s axial displacement of pile at any depth z

s_h axial displacement of pile head

t time

z depth

α creep rate

4 Equipment

4.1 General

The selection of the equipment shall take into account the aim of the test, the ground conditions and the expected displacement of the pile under the maximum test load.

4.2 Reaction device

The reaction device for pile tested in tension can be:

— shallow foundations;

— compression piles.

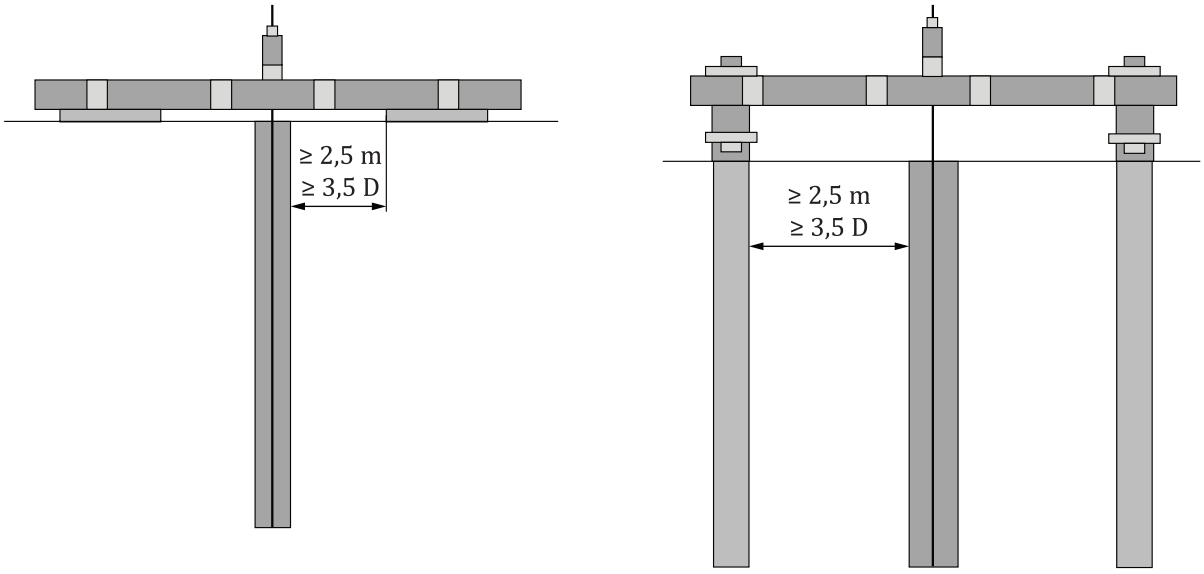
NOTE 1 The reaction device can be the test pile itself where the load is applied at depth by one or more hydraulic jacks which are cast into the pile for bi-directional pile loading (see ISO 22477-1).

The influence of the reaction system on the test pile shall be minimized.

The minimum clear distances between the test pile and the reaction system elements depend on the aim of the test (tensile resistance or stiffness).

For tests aiming at determining tensile resistance (ultimate limit state), minimum required distances are shown in Figure 1 a) and b). The maximum value shall be applied.

NOTE 2 If the minimum clear distance between reaction system and test pile is smaller than 5 D, the tensile resistance can be overestimated. The provided minimum distances limit the overestimation to approximately 5 %.



a) Shallow foundations **b) Compression piles**

Figure 1 — Minimum clear distances between test pile and reaction system

For tests aiming at evaluating the axial displacement for the serviceability limit state design, the influence of reaction system is higher. In this case, a minimum 10 D clear distance should be implemented. This clear distance value may be reduced if a dedicated assessment is performed, taking into account the ground conditions. In any case, the clear distance shall not be lower than the values given in Figure 1 a) and b).

NOTE 3 This assessment can include a modification of the reaction system to reduce its influence on the tested pile. For example, reduction of the skin friction of the reaction piles or the use of embedded jack(s) can be considered.

For static pile load tests on piles with a diameter smaller than 300 mm, these distances may be reduced. However, the minimum clear distance shall be 1,5 m.

The reaction system shall be designed to resist the maximum test load F_p in accordance with the relevant standards. The displacements of the reaction system shall be limited to ensure that the load is applied axially for the duration of the test.

Working piles may be used as reaction piles, provided that their structural resistance is sufficient and there is no detrimental effect on their ability to perform as part of the structure. The displacement of the working piles shall be monitored during the test.

Reaction systems should be arranged symmetrically around the test pile. In cases of non-symmetrical reaction systems, measures shall be taken to avoid detrimental rotation and/or translation of the reaction system.

4.3 Force Input

4.3.1 General

One or more hydraulic jacks should be used to apply the load on the test pile.

If several hydraulic jacks are used to apply the test load, they shall be arranged symmetrically, of the same model and be supplied by a common supply from one hydraulic unit. Each hydraulic jack shall be provided with a shut-off valve and an additional pressure gauge.

If a single jack is used, it shall be arranged centrally in order to ensure the pile is loaded axially.

4.3.2 Specifications of force input

The achievable force of the jack(s) shall exceed F_p. The stroke of the jack(s) shall exceed the expected deformations (pile head displacement and those of the reaction system under load).

It shall be possible to decrease or increase the load smoothly without any shocks or vibrations and to maintain the load at any required value.

To satisfy the required accuracies, an automatic and continuous electric or hydraulic control and regulation of the jack force may be used. Alternatively, a hand pump with accurate measurement of pressure or load and permanent regulation may be considered.

The accuracy of the force regulator shall be better than 0,5 % of F_p or 10 kN, whichever is greater.

4.4 Measurement of pile head displacements

The displacements of the pile head shall be measured either by dial gauges or transducers, supported from reference beams.

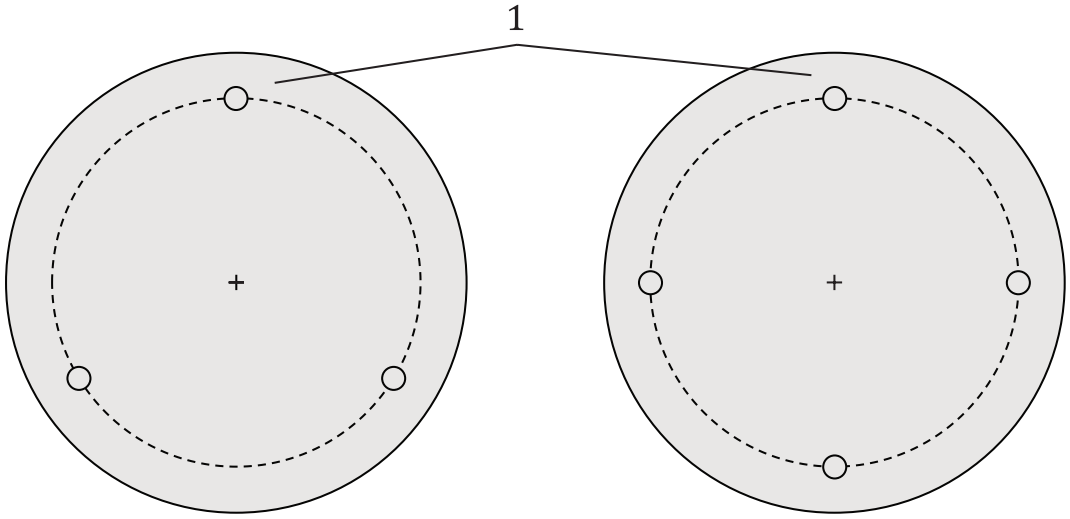
Reference beams shall be supported independently from the test pile.

The clear distance between the supporting ends of the reference beams and the test pile and reaction piles or the nearest edge of the shallow foundations should be at least 2,5 m or 3,5 D, whichever is greater.

One end of each reference beam should be free to slide.

The position of the reference beams shall be checked by a secondary control measuring system, such as levelling methods or other measurement methods. The position of the pile head should be also checked by this secondary control system.

If the load is applied through several jacks or several bars, the axial pile head displacement shall be measured at least with three transducers or gauges. They shall be arranged symmetrically and parallel to the axis of the pile (see Figure 2). The friction between the pile head and the sensors should be minimized by using suitable devices such as glass plates fixed beneath the sensors.



Key

1 displacement transducers or dial gauges

Figure 2 — Location of displacement transducers or dial gauges

If the load is applied through a single jack and a single bar (or tube), the axial pile head displacement may be measured with one displacement transducer or dial gauge.