SLOVENSKI STANDARD
oSIST prEN ISO 22476-9:2014

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Geotehnično preiskovanje in preskušanje - Preskušanje na terenu - 9. del: Preskus s terensko krilno sondo

Ground investigation and testing - Field testing - Part 9: Field vane test

Geotechnische Erkundung und Untersuchung - Felduntersuchungen - Teil 9: Flügelscherversuch

Reconnaissance et essais géotechniques - Essais en place - Partie 9: Essai au scissomètre de chantier

Ta slovenski standard je istoveten z: prEN ISO 22476-9

ICS:

93.020	Zemeljska dela. Izkopavanja. Gradnja temeljev. Dela pod zemljo	Earthworks. Excavations. Foundation construction. Underground works

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DRAFT INTERNATIONAL STANDARD
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Ground investigation and testing — Field testing —

Part 9: Field vane test

Reconnaissance et essais géotechniques — Essais en place —

Partie 9: Essai au scissomètre de chantier

ICS: 93.020

ISO/CEN PARALLEL PROCESSING

This draft has been developed within the European Committee for Standardization (CEN), and processed under the **CEN lead** mode of collaboration as defined in the Vienna Agreement.

This draft is hereby submitted to the ISO member bodies and to the CEN member bodies for a parallel five month enquiry.

Should this draft be accepted, a final draft, established on the basis of comments received, will be submitted to a parallel two-month approval vote in ISO and formal vote in CEN.

To expedite distribution, this document is circulated as received from the committee secretariat. ISO Central Secretariat work of editing and text composition will be undertaken at publication stage.

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Foreword

This document (FprEN 22476-9) has been prepared by Technical Committee CEN/TC 341 “Geotechnical Investigation and Testing”, the secretariat of which is held by BSI.

This document is currently submitted to the UAP/FV Enquiry.

Introduction

The field vane test is used to determine undrained shear strength of cohesive soils, by pushing a rectangular vane body into cohesive soil and rotating it. During rotation the torque and rotation are measured. This test can measure the peak strength, the residual strength and the remoulded strength .From the measured torque and the dimensions of the vane the undrained shear strength can be derived.

The tests are carried out in boreholes as well as with pushed in types or down hole types. The torque and rotation are normally measured at ground level using extension rods; with downhole types the torque and rotation are measured just above the vane body.

For field vane testing four methods are commonly used, depending on the soil conditions and the required accuracy:

a) Downhole
The vane is inserted to the bottom of the borehole, the measurement takes place just above the vane body.

b) Surface level, with cased extension rods
The vane is inserted to the bottom of the borehole, the measurement takes place at surface level, transfer of torque by cased extension rods.

c) Surface level, with uncased extension rods with slip coupling
The vane is inserted to the bottom of the borehole, the measurement takes place at surface level, transfer of torque by uncased extension rods with slip coupling.

d) Push in type
The vane is pushed in, the measurement takes place at surface level

This international standard is part of the range of international standards EN-ISO 22476 that deal with geotechnical field testing:

— *Part 1: Electrical cone penetration tests*

— *Part 2: Dynamic probing*

— *Part 3: Standard penetration test*

— *Part 4: Menard pressuremeter test*

— *Part 5: Flexible dilatometer test*

— *Part 6: Self-boring pressuremeter test* (under preparation)

— *Part 7: Borehole jack test*

— *Part 8: Full displacement pressuremeter* (under preparation)

— *Part 9: Field vane test* (under preparation)

— *Part 10: Weight sounding test* (TS) [1)]

— *Part 11: Flat dilatometer test* (TS) [1)]

— *Part 12: Mechanical cone penetration test (CPTM)*

— *Part 13: Plate loading test* (under preparation)

1 Scope

This European Standard specifies requirements for investigations of soil by the field vane test within the scope of the geotechnical investigations according to EN 1997-2.

This European Standard covers the field vane test used in cohesive soils for the determination of the undrained peak and remoulded shear strength and the sensitivity of the soil.

2 Normative references

The following referenced documents are indispensable for the application 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.

EN 1997-2:2006, *Eurocode 7: Geotechnical design – Part 2: Ground investigation and testing*

ISO 10012, *Measurment management systems – Requirements for measurement processes and measuring equipment*

3 Terms and definitions

For the purposes of this European Standard, the following terms and definitions apply.

3.1
field vane test
FVT
in situ test carried out with a rectangular vane, consisting of four plates fixed at 90º to each other, pushed into the soil to the desired depth and rotated

3.2
maximum torque
$T_{max,u}$
torque required to obtain failure of undisturbed soil

3.3
maximum torque for remoulded conditions
$T_{max,r}$
torque required to to obtain failure of remoulded soil

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1) TS Technical Specification.

3.4
test depth
depth at mid height of the vane

3.5
waiting time
time between reaching the test depth and first application of the torque to the vane

3.6
time to failure
time between the first application of the torque to the vane until the moment when maximum torque is reached when measuring the undisturbed strength value

3.7
undisturbed shear strength
c_{fv}
undrained shear strength of undisturbed soil, derived from maximum torque

3.8
residual shear strength
$c_{res,fv}$
undrained shear strength after peak shear strength has been exceeded and a constant shear strength value is measured or at a total rotation of 180°

3.9
remoulded shear strength
$c_{rem,fv}$
undrained shear strength after remoulding the soil

3.10
sensitivity according to field vane test
S_{fv}
sensitivity of the soil for disturbance

NOTE Sensitivity according to field vane test is the ratio of the undisturbed shear strength value to the remoulded shear strength value.

3.11
undrained shear strength
definition needed?

4 Equipment

4.1 Vane

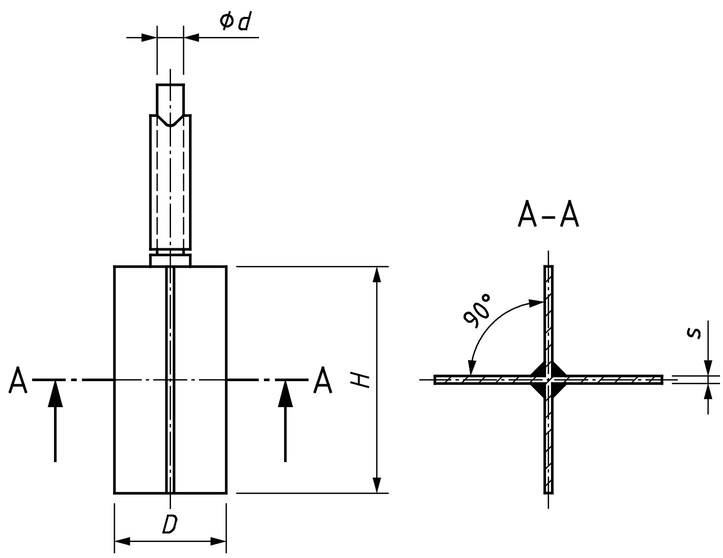
4.1.1 General vane dimensions

The vane shall consist of four rectangular plates fixed at 90º to each other, see Figure 1. The blades shall be parallel with the extension rods and no significant distortion is allowed.

4.1.2 Dimensional limitations to minimise the effect of rod friction

The shape shall still be essentially rectangular with an H/D ratio of 2. Any deviation from the rectangular shape shall be accounted for in the evaluation.

NOTE For practical reasons, uncased vanes often have slightly tapered lower ends of the blades. Some equipment using uncased extension rods and a slip coupling to separate the rod friction from the torque on the vane are designed with slightly tapered blades in order to disengage the slip coupling during the pushing stroke.



Key

H Height of the vane
D Diameter of the vane
s Blade thickness
d Diameter of the rod

Figure 1 — Design of the vane

The relation between the height H and the diameter D of the vane shall be 2,0.

NOTE For standard vanes commonly used dimensions are:

— a maximum vane size $D \times H$ of 100 mm × 200 mm for soils with low to extremely low undrained shear strength according to EN-ISO 14688-2,

— a minimum vane size $D \times H$ of 40 mm × 80 mm for soils with medium to high undrained shear strength according to EN-ISO 14688-2,

— a minimum vane size $D \times H$ of 33 mm x 66 mm for soils with very high to extremely high undrained shear strength according to EN-ISO 14688-2.

The blade thickness s shall not exceed 3,0 mm but shall not be less than 0,8 mm. In clays with S_{fv} > 30 the blade thickness should not exceed 2,0 mm to minimise the disturbance of the soil during pushing the vane into the soil.

The area ratio of the blades R_a should not be less than 12 %.

$$R_a = \frac{8h \cdot (D-d) + \pi \cdot d^2}{\pi \cdot D^2} \times 100\% \quad (1)$$

where:

R_a is the area ratio, in %;

h is the height of the vane, in mm; $h = 2\,D$;

D is the diameter of the vane, in mm;

d is the diameter of the vane shaft, in mm.

The diameter of the vane shaft, as well as possible welding seams in the centre of the vane shall be small enough to avoid disturbing effects to the measured shear strength value.

NOTE In some easily disturbed soils and in organic soils, the actual size of the vane may affect the results.

If the vane is fitted with a protective casing, the length of the protrusion at the test shall be at least 5 times the diameter of the vane.

The diameter of the vane shaft close to the vane should be less than 16 mm in sensitive soils. However, vane shaft shall be of such rigidity that it does not twist significantly under full load conditions. In very stiff clays and clay till, the diameter of the vane shaft above the vane may be 20 mm.

The vane shall be fitted with a device to separate the torque of the vane from any significant friction torque along the extension rods. A casing, slip coupling or downhole torque sensor can be used.

4.2 Extension rods

Extension rods shall be used if the application of torque is at ground surface.

Extension rods shall have a diameter and torsional stiffness large enough to transmit the torque generated during the test to the vane

The rods shall be straight. The eccentricity of the threads at the rod joints shall be less than 0,1 mm. Then maximum permitted bending for rods or for two jointed rods is 2 mm over each 1 m of length, measured as height of arch.

If casing tubes are used friction along the rods shall be minimised. The inner diameter of the tubes should be large enough. For application class 2 the friction along the rods shall be measured at zero load just before starting to rotate the vane.

4.3 Equipment for rotation and recording instrument

The equipment for rotation of the vane shall be designed to rotate at a given and constant rate, or be hand-rotated in application class 4.

The recording instrument shall be designed to obtain the torque with accuracy compatible with the application class in table 1.

Automatic recording is recommended. For interpretation of the test results a graph of the measured torque versus the rotation angle should be made if possible.

The measuring range for the necessary measurements of the angle of rotation should be 360º, with a resolution of 1º.

NOTE In many measuring systems, the registered rotation is the sum of the deformation in the measuring device, (often some kind of spring), the twist in the extension rods and the rotation of the vane. This is sufficient for evaluation of the mode of failure and identification of the maximum torque.

5 Test procedure

5.1 Selection and type of field vane test

The type of field vane test shall be chosen from table 1.

Table 1 — Type of field vane test

Test	Measurement	Torque transfer	Torque and rotation registration
FVT a	Continuous downhole measurement of torque versus rotation	No transfer	Torque – real rotation
FVT b	Continuous uphole measurement of torque versus rotation	Transfer of torque by cased extension rods	Torque – apparent rotation
FVT c	Continuous uphole measurement of torque versus rotation	Transfer of torque by uncased extension rods with slip coupling	Torque – apparent rotation
FVT d	Uphole measurement of maximum torque	Transfer of torque by uncased extension rods without slip coupling	Maximum torque

5.2 Predrilling and pushing down the vane

With dry crust, fill or a stiff layer overlying a softer layer predrilling may be necessary to avoid the stiff soil sticking to the vane or damage to the equipment.

If using an outer system with a casing protecting the vane, the water pressure in the casing system shall be the same as that in the soil at the test level.

The vane shall be pushed straight down, if possible without use of blows or vibration. The pushing rate shall be constant and not exceed 20 mm/s.

In stiff clays, silts and in clay till driving may be needed to get the vane to the desired depth.

The distance between investigation points shall be at least 2,0 m in plan in case of test depths greater than 5 m.

The first test shall normally be conducted at a depth of at least 0,5 m below the ground surface or at a depth of at least 5 times the diameter of a predrilled hole below its base.

The minimum vertical distance for two tests conducted in the same borehole shall be at least 0,5 m.

NOTE In clay till, where the vane often cannot be pushed or driven 0.5 m into the soil without risk of considerable damage, the minimum allowable test depth below the ground surface or base of a hole is. The minimum vertical distance between two tests in the same borehole is then 2 times the vane height or 0.2 m whichever is the largest.

5.3 Vane shear test

In application classes 1 and 2, the time from the moment when the desired test depth has been reached to the beginning of the vane test (waiting time) shall be at least 2 min and no more than 5 min.

The vane shall be loaded by application of torque in such a way that failure of the soil occurs in undrained conditions. The vane shall be rotated at a constant rate.

NOTE The application of torque must not be too fast since the measured maximum torque is also sensitive to the time to failure.

A guiding value for the rotating rate of the vane to fulfil the criteria given above in cohesive soils is that the maximum torque is reached within 2 to 4 minutes. This time relates to the time after application of torque to the vane itself, e.g after any slip coupling has been engaged.

The test shall be run in such a way that any significant skin friction along the rods can be separated.

In application classes 1, 2 and 3 hammering is not allowed.