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Physical properties – Determination of solidity – "Vane shear strength": Laboratory reference method by 'Laboratory vane shear apparatus'

Physikalische Eigenschaften – Bestimmung der Festigkeit – "Flügelscherfestigkeit": Laborreferenzmethode mit der 'Laborflügelsonde'

Propriétés […] – Détermination de […] – : […]

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Foreword

This document has been prepared by HORIZONTAL-Committee // CEN /TC /…, " […]".

This document is currently submitted to the HORIZONTAL Enquiry.

Other parts of this European Standard /HORIZONTAL Standards – Physical Properties are:

[…] - Determination of bulk density;

[…] - Determination of dry matter;

[…] - Determination of thixotropic behaviour;

[…] - Determination of piling behaviour;

[…] - Determination of flowability

Introduction

This document is developed in the project 'Horizontal'. It is the result of desk study "Physical properties – Solidity, Thixotropic Behaviour and Piling Behaviour" in the project and aims at a laboratory reference method for determining the solidity of sludge, soil, treated bio-waste and related wastes by means of the laboratory vane shear apparatus. After discussion with all parties concerned in CEN and selection of a number of test methods described in this study will be developed further as an modular horizontal method and validated in the project 'Horizontal'.

Until now test methods determining properties of materials were often prepared in Technical Committees (TC's) working on specific products or specific sectors. In those test methods often steps as sampling, extraction, release or other processing, analyses, etc were included. In this approach it was necessary to develop, edit and validate similar procedural steps over and over again for each other product. Consequently this resulted in a lot of duplicate work. To avoid such duplication of work for parts of a testing procedure often was referred to parts of test methods from other TC's. However following problems are often encountered while using references in this way:

1)The referenced parts are often not edited in a way that they could easily be referred to,
2) the referenced parts are often not validated for the other type of material and
3) the updates of such test standards on products might lead to inadequate references.

In the growing amount of product and sector oriented test methods it was recognised that many steps in test procedures are or could be used in test procedures for many products, materials and sectors. It was supposed that, by careful determination of these steps and selection of specific questions within these steps, elements of the test procedure could be described in a way that they can be used for all materials and products or for all materials and products with certain specifications.

Based on this hypothesis a horizontal modular approach is being investigated and developed in the project 'Horizontal'. 'Horizontal' means that the methods can be used for a wide range of materials and products with certain properties. 'Modular' means that a test standard developed in this approach concerns a specific step in a test procedure and not the whole test procedure.

The texts of the chapters [x,x, and x] are normative; chapter [x, x] are informative chapters; annexes are normative or informative, as stated in the top lines of the annexes.

1 Scope

This Part of this European standard specifies a laboratory reference method for determining the parameter vane shear strength of sludge, soil, treated bio-waste and related wastes by means of the laboratory vane shear apparatus.

This Part of this European Standard is applicable to sludge, soil, treated bio-waste and related wastes from:

— *storm water handling*

— *urban wastewater collecting systems*

— *urban wastewater treatment plants*

— *treating industrial wastewater similar to urban wastewater (as defined in Directive 91/271/EEC)*

— *water supply treatment plants*

— *soil*

— *treated bio-waste (OFMSW, compost, etc. …).*

This method is also applicable to sludge, soil, treated bio-waste and related wastes of other origin.

2 Standards and other normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

ASTM D4648: *Standard Test Method for Laboratory Miniature Vane Shear Test for Saturated Fine-Grained Clayey Soil*

Other Horizontal Standards:

[…], *Sampling (in-situ and during transport) — […]*

[…], *Sample pre-treatment — […]*

[…], *Composition — Inorganic constituents — […]*

[…], *Composition — Organic constituents — […]*

[…], *Hygienic parameters — […]*

[…], *Biological parameters — […]*

[…], *Leaching — […]*

[…], *Vocabulary — […]*

ATV-Arbeitsbericht (1989) [1]

3 Terms and definitions

For the purposes of this Part of this European Standard, the terms and definitions as stated in […], *Vocabulary — […]* and the following terms and definitions apply.

Vane shear strength
special shear strength, which is determined with the aid of laboratory or field vane, whereby the dimensions of the vane and the measured torque have to be declare.

4 Principle

After preparation of the sample the horizontal torque from shearing the sample through the penetrated vane is determined.

The vane apparatus, which is connected with the display over a torque spring, is manually or electrically rotated and the vane cuts a cylindrical shaped sample. The torque is determined by the angle of rotation and the spring constant. The torque is then converted to a shearing strength with the aid of a constant.

5 Equipment

5.1 Laboratory vane shear apparatus

5.1.1 Proctor vessel

5.1.2 Proctor hammer

6 Test sample(s)

For the pre-treatment for measuring the vane shear strength the steps have to be taken as follows:

(1) The material – if needed, dewatered – is reduced to small pieces with particle sizes of about 10 mm

(2) The mould – in this case the small Proctor vessel – has an internal diameter of 100 mm und a height of 120 mm.

(3) The material is filled into the Proctor vessel in three equal portions (each about 100 mm before compaction) and is compressed with ten knocks by the small Proctor hammer (falling weight of 2.5 kg, height of falling 300 mm, diameter of the plunger 50 mm, diameter of compensating plate 99,5 mm, compare *DIN 18127 Proctor test* [2]).

(4) After finishing emplacement and before test performance the density have to determined for a uniform starting position (Proctor density)

7 Working instructions

- Application of a horizontal torque by motorised driven device with a constant shear rate (10°/min).
- The torque is determined by the angle of rotation and the spring constant. When the sample shears, the angle of rotation and thus in that moment applied max. torque is kept by the scale.
- Repetition of the measurement and formation of the average value of three measurements.
- The torque is then converted to shear strength with the aid of a constant.

8 Calculations and expression of results

For the calculation of the vane shear strength τ_v the maximum torque is dividing by a constant:

$$\tau_v = \frac{M}{K}[kN / m^2]$$

where M: max. torque in [kN m],

K: $\frac{\pi}{2} \cdot d^2 \cdot h \cdot (1 + \frac{d}{3h})[m^3]$

where d: diameter of the sheared cylinder = width of the vane,

h: height of the vane.

The shear strength τ_v is equal to the cohesion c_u of the undrained soil by (fast) shearing.

For h = d:

$$\tau_v = \frac{3 \cdot M}{2 \cdot \pi \cdot d^3}$$

9 Test report

The test report shall include the following informations:

a) The standard under consideration and its date of publication (e.g. EN xxxx:2003)

b) Information about the character of the material and the identity of the specific sample(s) to be tested

c) Testing date or period

d) Information on external circumstances

e) All calculation results

f) Identification of the standards used in the total test procedure

g) Optionally: The test results obtained by field test

h) Always finish the report with: ‘Where the test is not carried out in accordance with this standard, reference may only be made to EN xxxx:2003 in the report in case all deviations from the procedures prescribed in this standard are indicated in the report stating the reasons for deviation'.

Annex A
(informative)

Laboratory vane shear apparatus

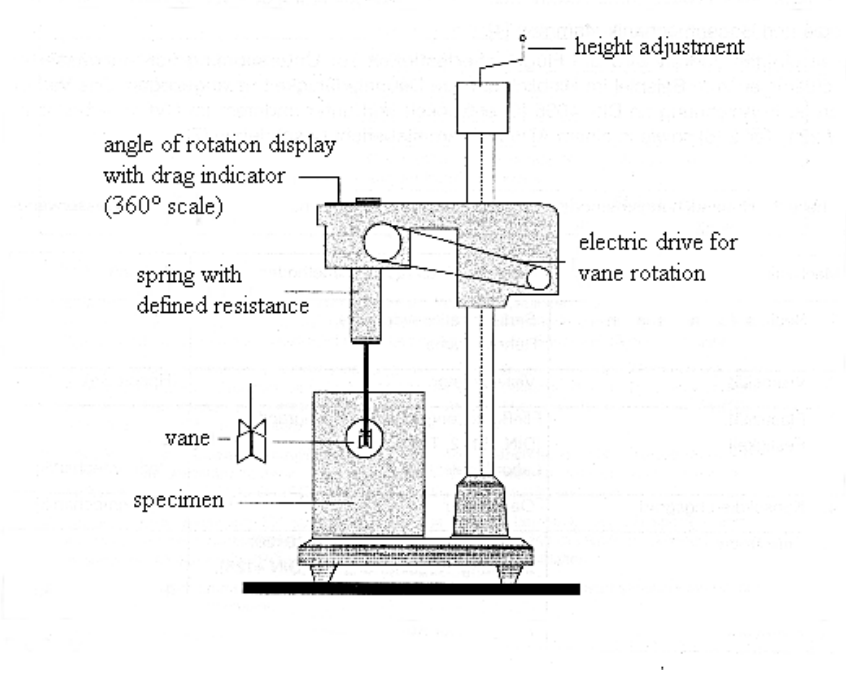

Figure A.1 — Laboratory vane shear apparatus [1]

Bibliography

[1] ATV-Arbeitsbericht: Die Bestimmung der Deponierfähigkeit von Schlämmen mit der Referenzmethode „Laborflügelscherfestigkeit“, ATV-Fachausschuss 3.2 und 3.6, Gesellschaft zur Förderung der Abwassertechnik e.V. (GFA), 53773 Hennef: Korrespondenz Abwasser (1989), 36 (8), S. 903-909

[2] DIN 18127 (1997): Proctorversuch, Beuth-Verlag, Berlin

Date:

Secretariat:

Physical properties – Determination of solidity – "Shear strength": Laboratory reference method by 'Penetrometer'

Physikalische Eigenschaften – Bestimmung der Festigkeit – Scherfestigkeit": Laborreferenzmethode mit dem 'Penetrometer'

Propriétés […] – Détermination de la […] – Partie 1: […]

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The texts of the chapters [x,x, and x] are normative; chapter [x, x] are informative chapters; annexes are normative or informative, as stated in the top lines of the annexes.

(E)

1 Scope

This Part of this European standard specifies a laboratory reference method for determining the parameter shear strength of sludge, soil, treated bio-waste and related wastes by means of the penetrometer.

This Part of this European Standard is applicable to sludge, soil, treated bio-waste and related wastes from:

— *storm water handling*

— *urban wastewater collecting systems*

— *urban wastewater treatment plants*

— *treating industrial wastewater similar to urban wastewater (as defined in Directive 91/271/EEC)*

— *water supply treatment plants*

— *soil*

— *treated bio-waste (OFMSW, compost, etc. …).*

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ISO 2137 — *[…]*

ASTM D217

ASTM D937

BS 2000-49

BS 3712

prEN 13880-2

DIN 51580

DIN EN 1426

ISO/DIS 13765-1

Other Horizontal Standards:

[…], *Sampling (in-situ and during transport) — […]*

[…], *Sample pre-treatment — […]*

[…], *Composition — Inorganic constituents — […]*

[…], *Composition — Organic constituents — […]*

[…], *Hygienic parameters — […]*

[…], *Biological parameters — […]*

[…], *Leaching — […]*

[…], *Vocabulary — […]*

3 Terms and definitions

For the purposes of this Part of this, the terms and definitions as stated in […], *Vocabulary — […]* and the following terms and definitions apply.

4 Principle

For determining the undrained shear strength c_u with the penetrometer the depth - in tenth of a millimetre -, which the needle or cone (in part several cone tips of different sizes) penetrates the sample under specific conditions of weight of the cone and time, is measured.

The undrained shear strength c_u is then calculated by the weight of the cone, the penetration depth and the constant K.

5 Equipment

5.1 Penetrometer

5.1.1 Carrier

5.1.2 Cone tips

6 Test sample(s)

For the pre-treatment for measuring the shear strength the steps have to be taken as follows:

(1) The material – if needed, dewatered – is reduced to small pieces with particle sizes of about 10 mm

(2) The mould – in this case the small Proctor vessel – has an internal diameter of 100 mm und a height of 120 mm.

(3) The material is filled into the Proctor vessel in three equal portions (each about 100 mm before compaction) and is compressed with ten knocks by the small Proctor hammer (falling weight of 2.5 kg, height of falling 300 mm, diameter of the plunger 50 mm, diameter of compensating plate 99,5 mm, compare *DIN 18127 Proctor test* [2]).

(4) After finishing emplacement and before test performance the density have to determined for a uniform starting position (Proctor density)

(E)

7 Working instructions

- Contact the tip of the penetrometer with the surface of the sample (h = 0) and then release the cone or needle.
- After a fixed duration of 5s the depth, which is penetrated by the cone tip or needle, is measured. According to the consistency of the analysed material several cone tips or needles of different sizes and weights (150mg – 150g) have to be used.
- The temperature during the measurements should be 25 C.
- Repetition of the measurement and formation of the average value of three measurements.
- The undrained shear strength c_u is then calculated by the weight of the cone, the penetration depth and the constant K.

8 Calculations and expression of results

The undrained shear strength c_u is calculated by the weight of the cone, the penetration depth and the constant K:

$$c_u = \frac{K \cdot m \cdot g}{i^2} \cdot \left(1 + \frac{h}{i}\right)$$

where m: mass of the cone,

g: acceleration of gravity,

i: depth of penetration (indentation),

h: distance between cone apex and soil surface when the cone is dropped (normally h = 0),

K: function of the apex angle of the cone (Fig. 1).

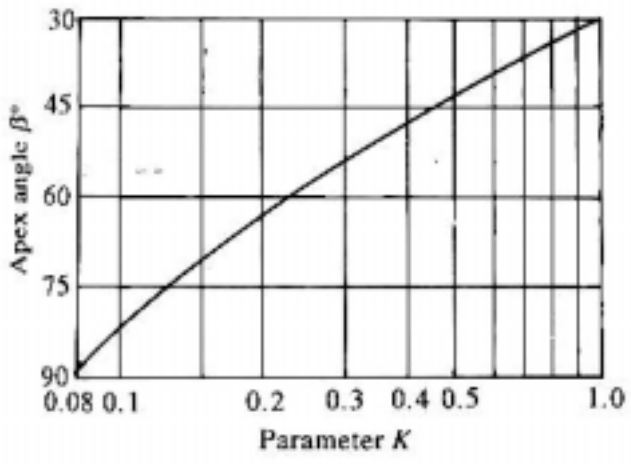

Fig. 1: Relation between the parameter K and the apex angle β of the cone

9 Test report

The test report shall include the following informations:

a) The standard under consideration and its date of publication (e.g. EN xxxx:2003)

b) Information about the character of the material and the identity of the specific sample(s) to be tested

c) Testing date or period

d) Information on external circumstances

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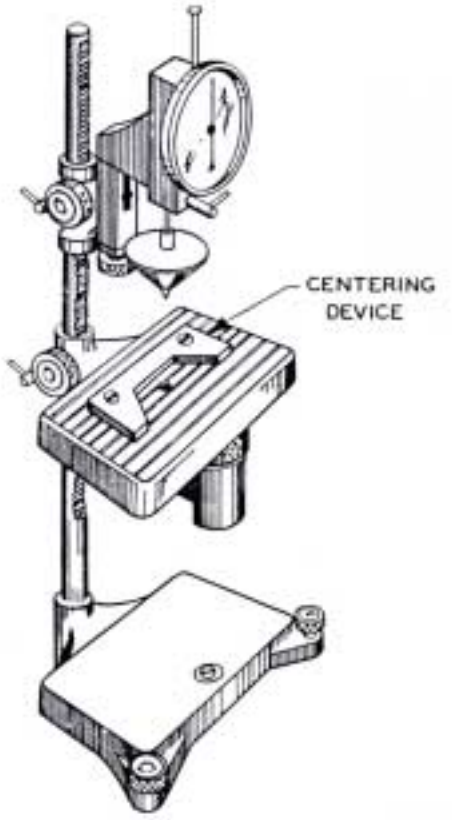
g) Optionally: The test results obtained by field test

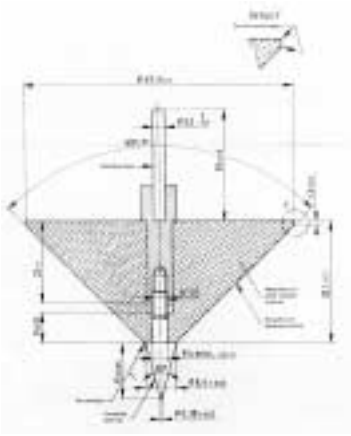
h) Always finish the report with: ‘Where the test is not carried out in accordance with this standard, reference may only be made to EN xxxx:2003 in the report in case all deviations from the procedures prescribed in this standard are indicated in the report stating the reasons for deviation'.

(E)

Annex A
(informative)

Penetrometer





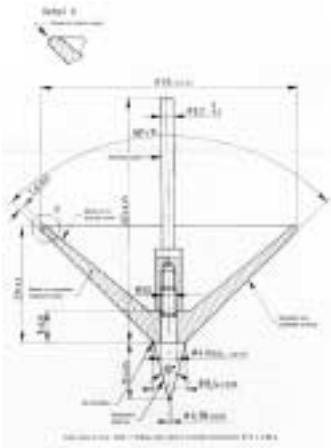


Figure A.1 — Penetrometer

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[1] Hansbo, S. (1994): Foundation Engineering, Developments in Geotechnical Engineering, 75, Elsevier

[2] DIN 18127 (1997): Proctorversuch, Beuth-Verlag, Berlin