DD CEN/TS 15406:2010

BSI Standards Publication

Solid recovered fuels — Determination of bridging properties of bulk material

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National foreword

This Draft for Development is the UK implementation of CEN/TS 15406:2010. It supersedes DD CEN/TS 15406:2006 which is withdrawn.

This publication is not to be regarded as a British Standard.

It is being issued in the Draft for Development series of publications and is of a provisional nature. It should be applied on this provisional basis, so that information and experience of its practical application can be obtained.

Comments arising from the use of this Draft for Development are requested so that UK experience can be reported to the international organization responsible for its conversion to an international standard. A review of this publication will be initiated not later than 3 years after its publication by the international organization so that a decision can be taken on its status. Notification of the start of the review period will be made in an announcement in the appropriate issue of *Update Standards.*

According to the replies received by the end of the review period, the responsible BSI Committee will decide whether to support the conversion into an international Standard, to extend the life of the Technical Specification or to withdraw it. Comments should be sent to the Secretary of the responsible BSI Technical Committee at British Standards House, 389 Chiswick High Road, London W4 4AL.

The UK participation in its preparation was entrusted to Technical Committee PTI/17, Solid biofuels.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

ISBN 978 0 580 69902 3

ICS 75.160.10

Compliance with a British Standard cannot confer immunity from legal obligations.

This Draft for Development was published under the authority of the Standards Policy and Strategy Committee on 31 October 2010.

Amendments issued since publication

Date	Text affected

TECHNICAL SPECIFICATION

SPÉCIFICATION TECHNIQUE

TECHNISCHE SPEZIFIKATION

CEN/TS 15406

September 2010

ICS 75.160.10

Supersedes CEN/TS 15406:2006

English Version

Solid recovered fuels - Determination of bridging properties of bulk material

Combustibles solides de récupération - Méthode de détermination des propriétés de formation de voûte dans les matériaux en vrac

Feste Sekundärbrennstoffe - Bestimmung der Neigung zur Brückenbildung von Schüttgut

This Technical Specification (CEN/TS) was approved by CEN on 12 June 2010 for provisional application.

The period of validity of this CEN/TS is limited initially to three years. After two years the members of CEN will be requested to submit their comments, particularly on the question whether the CEN/TS can be converted into a European Standard.

CEN members are required to announce the existence of this CEN/TS in the same way as for an EN and to make the CEN/TS available promptly at national level in an appropriate form. It is permissible to keep conflicting national standards in force (in parallel to the CEN/TS) until the final decision about the possible conversion of the CEN/TS into an EN is reached.

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Ref. No. CEN/TS 15406:2010: E

Contents

Foreword

This document (CEN/TS 15406:2010) has been prepared by Technical Committee CEN/TC 343 “Solid recovered fuels”, the secretariat of which is held by SFS.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes CEN/TS 15406:2006.

CEN/TS 15406:2006 is not be converted into a European Standard as the test method specified in this document was not validated (see [1], [2]).

This document differs from CEN/TS 15406:2006 mainly as follows:

a) Figures 1 and 2 replaced by new examples of figures for a bridging apparatus;

b) dimensions of the shear tester changed;

c) automatic equipment allowed;

d) repeatability limit specified;

e) whole document editorially revised.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to announce this Technical Specification: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

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Introduction

This Technical Specification describes the determination of bridging properties of solid recovered fuels (SRF), which is conveyable in a continuous material flow. Bridging or arching is a complex parameter describing the situation when particles form a stable bridge over an opening that can be several times the length of the single particles. Bridging is dependent on several influencing factors, e.g. the conveying or transport system, particle size and shape, moisture content, bulk density, bed depth.

The behaviour of SRF in bins, hoppers, feeders, and other handling equipment depends on bridging properties [3]. Knowing these properties, already in phase of product development, is essential for avoiding flow problems.

Bridging properties are also important for quality control. By checking the relative bridging properties of a given bulk solid before it is placed into a system, unsatisfactory batches can be rejected or recycled, thereby preventing costly handling problems downstream.

Bridging is not an absolute value and therefore there is a need for standardising the conditions for the determination of bridging tendency in order to gain comparative measuring results.

Bridging of solid recovered fuels is subject to variation due to several impacts such as filling layer, particle shape, and storage time in silos. Measured bridging values can therefore deviate from real conditions in silos and conveyer systems.

1 Scope

This Technical Specification specifies a method for the determination of bridging properties of solid recovered fuels using standard measuring equipment. The method is applicable to all solid recovered fuels with maximum dimensions of the particle of 100 mm.

2 Normative references

The following referenced documents are indispensable for the application of this Technical Specification. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

prEN 15357:2008, *Solid recovered fuels — Terminology, definitions and descriptions*

prEN 15442, *Solid recovered fuels — Methods for sampling*

prEN 15443, *Solid recovered fuels — Methods for the preparation of the laboratory sample*

CEN/TS 15414-1, *Solid recovered fuels — Determination of moisture content using the oven dry method — Part 1: Determination of total moisture by a reference method*

CEN/TS 15414-2, *Solid recovered fuels — Determination of moisture content using the oven dry method — Part 2: Determination of total moisture by a simplified method*

CEN/TS 15415, *Solid recovered fuels — Determination of particle size and particle size distribution by screen method*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in prEN 15357:2008 apply.

4 Determination of bridging properties for non-coalescing materials

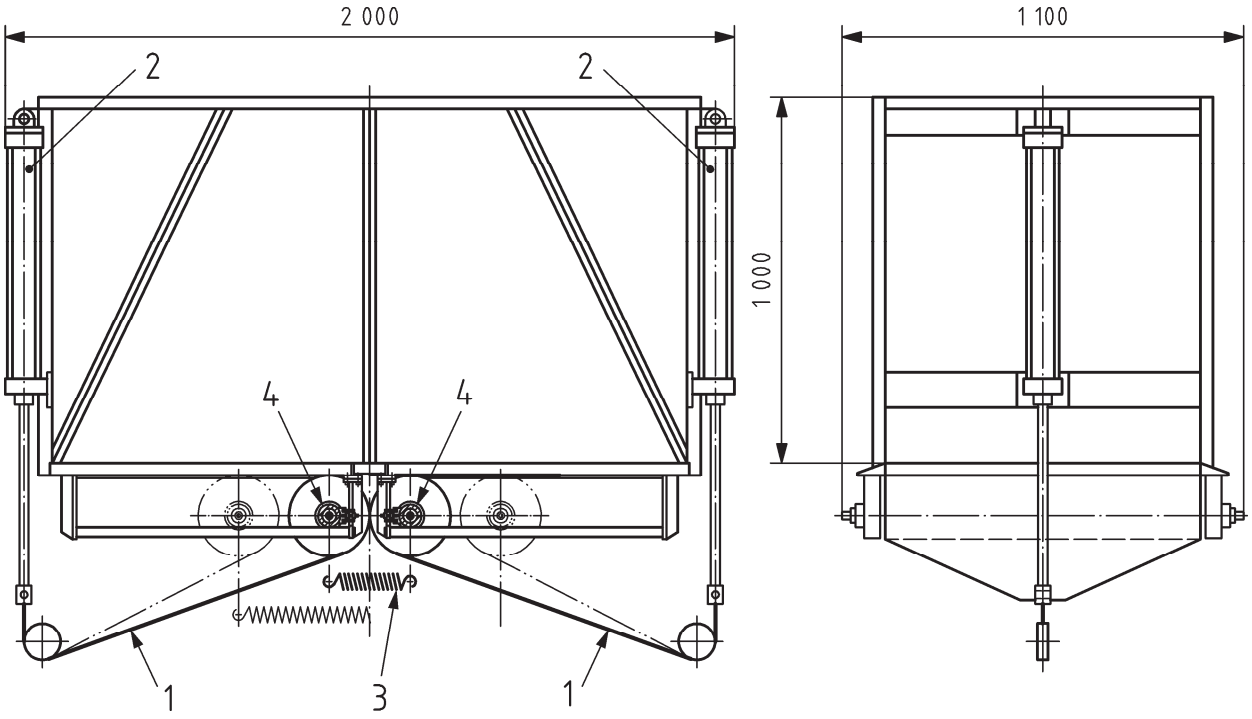
4.1 Principle

A sample is subjected to bridging by placing it over an expandable slot opening in an equipment of standardised dimensions. By increasing the slot opening, the building of a bridge is facilitated which ultimately will collapse; the size of the slot opening at this time represents the bridging value of the fuel tested.

4.2 Apparatus

4.2.1 Bridging apparatus, consisting of a container with an effective area of $[(1{,}1 \pm 0{,}01) \times (2 \pm 0{,}01)]$ m^2 and a minimum height of $(0{,}75 \pm 0{,}01)$ m, the sides of the container manufactured of oriented strand board (OSB) plates. (See Figure 1 and Figure 2.)

Dimensions in millimetres



a) Front view **b) Side view**

Key

1 rubber mat
2 piston
3 spring
4 steel coil

Figure 1 — Example for an assembling of a bridging apparatus in front and side view

The bottom of the container shall be made of two solid rubber mats with the following dimensions:

— width: (1,1 ± 0,01) m

— minimum length: 2,2 m

— thickness: (0,01 ± 0,001) m

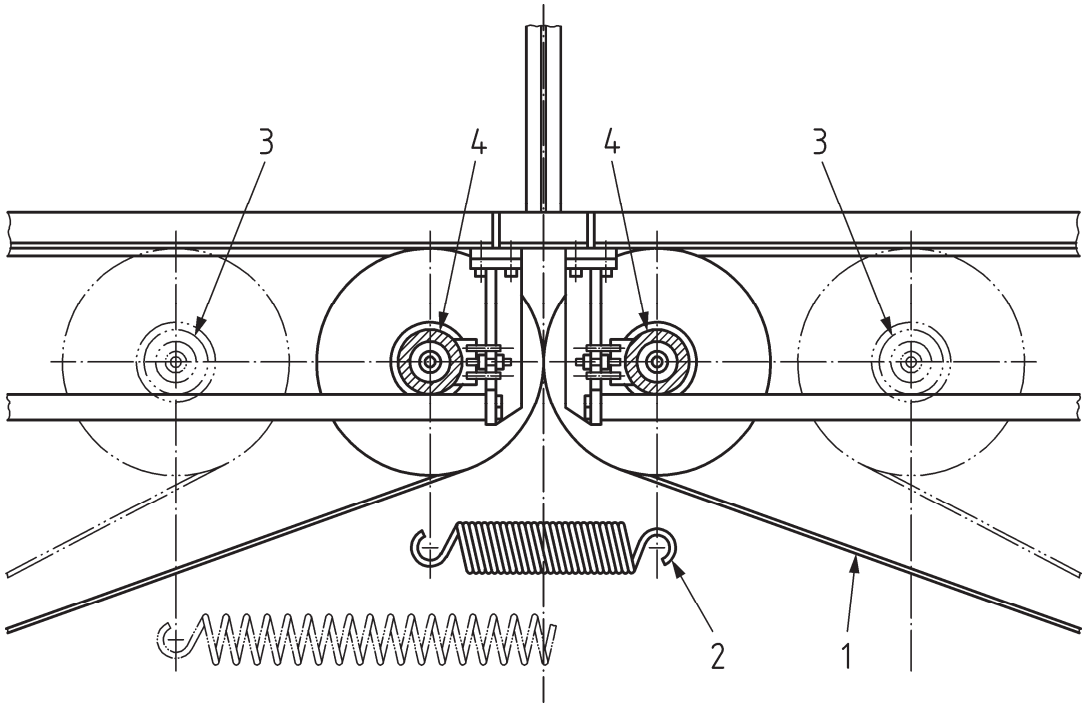
One end of each rubber mat (see positions 1 in Figure 1) shall be fixed to the lower edge of the end plate of the container. The opposite ends shall be fixed to the pneumatic pistons (see positions 2 in Figure 1), after turning around the steel coils (see positions 4 in Figure 1) situated below the bottom of the container. The steel coils shall have external diameters of (0,32 ± 0,001) m. The centre of the coils shall be placed at a distance of (0,43 ± 0,05) m below the horizontal plane of the container underside.

The coils are rolled in the direction of the side surfaces of the container by the movement of the pistons, forming a slot opening in the bottom of the container from the middle outward. When the force of the pistons is released, a spring (see position 3 in Figure 1) causes the two steel coils to return in the initial position, closing the slot opening.

This arrangement allows a constant opening movement minimizing the friction with the particles of the material.

To facilitate the handling, the container may be equipped with wheeled legs.

Figure 2 shows a section of Figure 1 to demonstrate the operation principle of the bridging apparatus more detailed.



Key

1 rubber mat
2 spring
3 steel coil in initial position
4 steel coil in opening phase

Figure 2 — Operation principle of the bridging apparatus

Figures 3 to 5 give pictorial representations of a bridging apparatus.

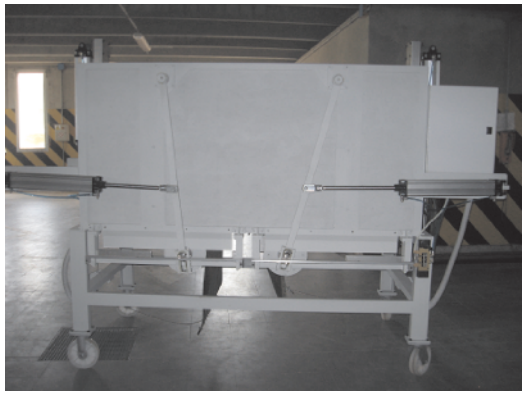


Figure 3 — Pictorial presentation of the front of a bridging apparatus

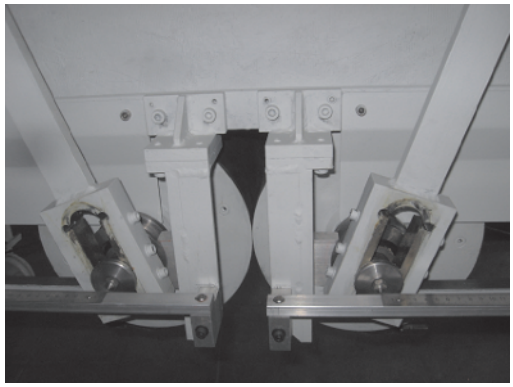


Figure 4 — Pictorial presentation of the operation principle of a bridging apparatus

Figure 5 — Pictorial presentation of the side of a bridging apparatus

4.2.2 Metric steel rule with a scale gradation of 1 mm, for measuring the distance between the coils after the bridge is collapsed.

4.2.3 Shovel, to homogenise the sample.

4.3 Sampling and sample preparation

The sample shall be taken and prepared in accordance with prEN 15442 and prEN 15443. The minimum volume of the test portion shall be 1,1 m^3 loose volume.

The particle size distribution of the material on a separate sub-sample shall be determined following the procedures given in prEN 15443 and CEN/TS 15415. The particle size shall be reported together with the result of the bridging test.

The moisture content of the material on a separate sub-sample shall be determined following the procedures given in prEN 15443 and CEN/TS 15414-1 or CEN/TS 15414-2. The moisture content shall be reported together with the result of the bridging test and at least the minimum sample size in accordance with prEN 15442.

4.4 Procedure

Place the bridging apparatus (4.2.1) horizontally on a clean, solid concrete floor.

A distance shall exist between the floor and to the underside of the apparatus to allow a free fall of the sample material.

The container of the bridging apparatus (4.2.1) shall be dry and empty. Load the sample into this container of the bridging apparatus (4.2.1). Level out the upper surface of the sample so that a layer of 0,5 m thickness is evenly spread in the container.

The loading of the container with the sample may be performed, for example, using a wheel loader.

Roll the rubber mats slowly by activating the pneumatic piston devices, thus generating a slot opening under the sample. As soon as the bridge collapses, stop the opening process and measure the shortest distance between the surface of the coils with the metric steel rule (4.2.2) to the nearest 1 mm.

After the measurement is fully performed, open the bottom of the sample container by reactivating the piston devices and allow the container so to be completely cleared. Unify all the sample and repeat the test after rehomogenisation. The test shall be repeated ten times.

NOTE The test should be performed preferably at the site of SRF production or use since the test portion shall have a minimum volume of 1,1 m^3 (see 4.3).

4.5 Calculation

Calculate the relative bridging property as the arithmetic mean of the ten repetitions.

5 Determination of bridging properties for coalescing materials

5.1 Principle

For coalescing materials, the minimum shear that causes the collapse of a consolidated sample is assumed as an index of bridging properties [4].

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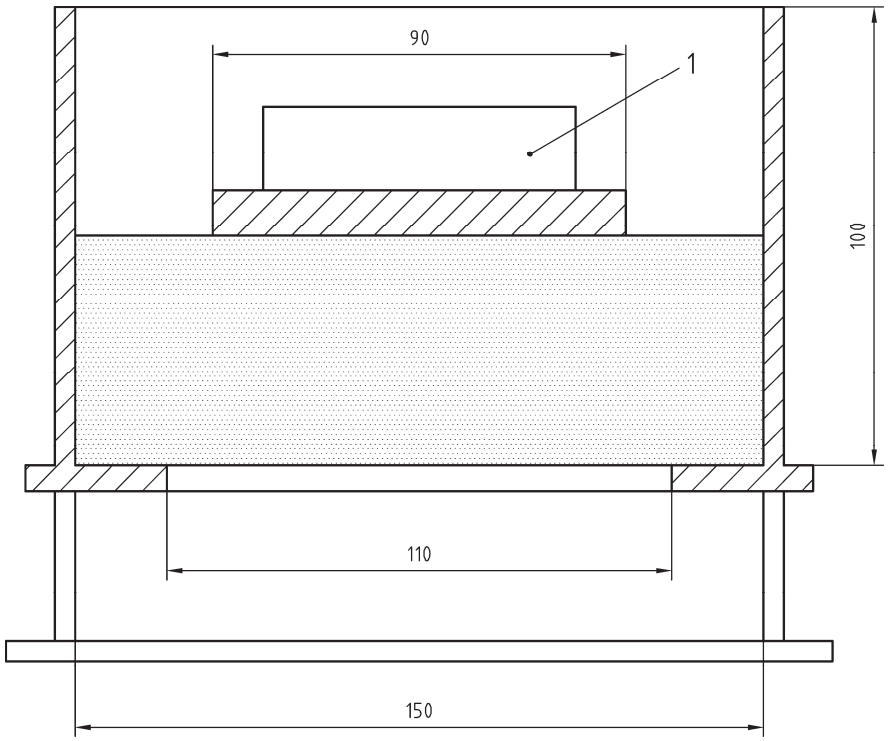
5.2 Apparatus

5.2.1 **Shear tester**, mainly consisting of a test chamber and a cover plate (see Figure 6).

Dimensions in millimetres



Key

1 force gauge

Figure 6 — Schematic diagram of the shear tester (5.2.1) (longitudinal section)

The chamber shall have a circular section. The inside dimensions of this cylinder shall be (150 ± 5) mm width and (100 ± 10) mm high. The bottom of the cylinder shall have a circular hole with a dimension of (110 ± 0,5) mm. The test sample shall be covered by a planar plate with a size of (90 ± 0,5) mm; the plate shall be exactly positioned at the centre line of the test chamber. The plate shall be connected with a force gauge.

Both the test chamber and cover plate shall be made of polished stainless steel.

5.2.2 **Shovel**, to homogenise the sample.

5.3 Sampling and sample preparation

The sample shall be taken and prepared in accordance with prEN 15442 and prEN 15443. If necessary, the sample shall be divided in mass in accordance with prEN 15442. The size of the sample shall be about 1 kg.

The sample material shall have the same temperature as the air of the laboratory where the tests are conducted.

The samples shall be tested at the moisture content as received.

5.4 Procedure

Prepare the consolidated sample in the test chamber of the shear tester (5.2.1) by plugging the bottom with a planar disk. Weigh the sample and introduce it in the chamber such that it is uniformly distributed along the section. Put a planar cover over the sample and apply a moderate pressure, e.g. 5 000 Pa, for consolidation.

Register the height of the consolidated sample.

After removing the disk from the bottom hole, replace the cover plate with the planar disk and increase progressively the force exerted on the disk.

When the rupture of the sample occurs, register the failure load and weigh and report the extruded material.

An automatic equipment may be used if the method is validated by parallel measurements. This automatic equipment shall fulfil all the requirements given in this document regarding sample size, heating procedure, atmosphere, temperatures and weighing accuracy. Deviations from these specifications shall be reported and justified.

5.5 Calculation

Calculate the shear strength, σ, expressed as Newton per square meter, by dividing the failure load by the peripheral area of the extruded plug by Equation (1):

$$\sigma = \frac{W}{\pi \times D \times h} \tag{1}$$

where

W is the failure load, in Newton;

D is the diameter of the bottom circular hole, in meter;

h is the height of the extruded plug, in meter.

Calculate the mean value of the shear strength from five individual determinations.

6 Precision

6.1 General

For definition of precision terms, see ISO 5725-1 and for determination of repeatability and reproducibility data, see ISO 5725-5.

6.2 Repeatability limit

The results of duplicate determinations, carried out in the same laboratory by the same operator with the same apparatus within a short interval of time on the same analysis sample, shall not differ by more than 15 %.

6.3 Reproducibility limit

The means of the results of duplicate determinations carried out in different laboratories, on representative portions taken from the same sample at the last stage of sample preparation, should not differ by more than 25 %.

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7 Test report

The test report shall include at least the following information:

a) name of the testing laboratory;

b) date of the test;

c) identification of the sample tested;

d) reference to this Technical Specification, i.e. CEN/TS 15406;

e) test results including moisture content and particle size;

f) any deviation from this Technical Specification;

g) any unusual features observed during the determination which may have affected the test result and details of any operations not included in this Technical Specification or regarded as optional.

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