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Paper, board and corrugated fibreboard — Description and calibration of compression-testing equipment

Papier, carton et carton ondulé — Description et étalonnage du matériel pour essai de compression

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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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Foreword

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The committee responsible for this document is ISO/TC 6, *Paper, board and pulps*, Subcommittee SC 2, *Test methods and quality specifications for paper and board*.

This second edition cancels and replaces the first edition (ISO 13820:1996), of which it constitutes a minor revision with the following changes:

— 4.1.2 has been updated;

— 5.1 has been updated.

Introduction

This International Standard describes the types of testing equipment available for carrying out compression tests on paper, board, and corrugated fibreboard. It describes two distinct types of instrument. The preferred instrument type, known as the fixed-platen compression tester, develops compressive forces at a constant rate of strain. The other, known as the beam-deflection compression tester, develops compressive forces between one platen driven at constant speed and another platen resting on a deformable beam. With this type neither rate of stress nor rate of strain is constant. The two instrument types give similar but not necessarily the same test results when used for compression tests; literature shows that the beam deflection machine produces results higher than those of the fixed-platen machine.[1][2][3] The extent of the difference depends on the test being conducted and on the characteristics, particularly the elastic characteristics, of the material being tested.

The fixed-platen tester is preferred because of its better reliability, its ability to test over the range of test levels likely to be found, and because the characteristics of existing instruments have been well defined and universally accepted. The beam-deflection tester has been inadequately defined in past International Standards for compression tests; among existing instruments there have been different loading rates, different beam stiffnesses, and therefore different rates of strain. Furthermore, in some countries, the stiffness of beams commonly available is such that no one beam is appropriate for all the test levels likely to be found, so that it has been common practice to use two beams of different stiffnesses interchangeably to cover the full range of loads.

It is expected that the beam-deflection-type tester might be less commonly used in the future, and it can be withdrawn from this International Standard at a future revision.

The testing equipment referred to in this International Standard is used for tests described in ISO 3035[1], ISO 3037[2], ISO 7263[3], and ISO 12192[4].

Paper, board and corrugated fibreboard — Description and calibration of compression-testing equipment

1 Scope

This International Standard specifies the essential characteristics and the principles of calibration of compression testing equipment used in the testing of paper, board, and corrugated fibreboard.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 187, *Paper, board and pulps — Standard atmosphere for conditioning and testing and procedure for monitoring the atmosphere and conditioning of samples*

3 Principle

The compression testing machine is calibrated against reference masses or other traceable standards.

4 Apparatus

4.1 Fixed-platen compression testing machine, operating on the constant rate of deformation (strain) principle and incorporating the following features.

4.1.1 An upper and a lower platen, each large enough to completely accommodate the test piece and sufficiently rigid to resist significant deformation by the compressive forces.

The platens shall be mounted so as to have not more than 0,05 mm relative movement in the horizontal plane and their surfaces shall be parallel to each other, within 0,05 mm per 100 mm of platen surface. The surface of the platens shall be flat to the extent that the lowest and highest points are within 0,05 mm of the average surface.

Some tests require the surface finish of the platen to be such as to prevent slippage of the test piece during the test. Emery cloth, grade 00 or its equivalent (type 240 in Europe, crocus cloth in Canada), secured to the surface of the platens with contact adhesive or with low-compressibility double-sided pressure-sensitive tape (see NOTE), or matte finish of the platen surfaces, or any equivalent means, can be used to achieve this, provided the requirements for parallelism are met.

The emery cloth shall be replaced as soon as any damage is observed. On no account should a knife or other sharp instrument be used to remove the emery cloth or other material adhering to the platens.

NOTE While compliance with ISO 7263 permits emery cloth to be used on the platen surfaces, other test methods do not. With ISO 3037, it is safer to avoid the use of emery cloth. However, it is common practice to use the same tester for tests which do and do not require emery cloth. The possibility of erroneous test results is sufficiently low to allow the use of emery cloth in all ISO test methods in which the use of this compression testing machine is now required, provided that a grade not coarser than 00 is used.

4.1.2 Means of moving one platen towards the other at a constant, controlled speed.

Different speeds are standard in different parts of the world, the most typical being (12,5 ± 0,25) mm/min and (10,0 ± 0,25) mm/min. As test values can be impacted by the strain rate of the applied load, it should not be assumed that operating at these two different speeds will produce the same results.[8][9][10][11][12][13] The speed used shall be within ±0,25 mm/min of the nominal speed which shall be reported with the test values.

4.1.3 Means of measuring peak force to the nearest 1 N or 1 %, whichever is greater, applied to an object placed between the platens.

NOTE Pen recorders might give low results because inertia in the pen movement can prevent detection of the peak force. This fault will not be evident during static calibration.

4.2 Beam-deflection compression testing machine, incorporating the following features.

4.2.1 Beam that deflects (1,00 ± 0,01) mm for 175 N, 300 N, or 350 N of applied load.

4.2.2 An upper and a lower platen, each large enough to completely accommodate the test piece and sufficiently rigid to resist significant deformation by the compressive forces.

One platen rests on the beam and the other is movable. The platens shall be mounted to have not more than 0,05 mm relative movement in the horizontal plane and their surfaces shall be flat and parallel to each other to within 0,05 mm per 100 mm of platen surface. The surfaces of the platens are flat if the lowest and highest points are within 0,05 mm of the average surface.

Some tests require the surface finish of the platens to be such as to prevent slippage of the test piece during the test. Emery cloth, grade 00 or its equivalent (type 240 in Europe, crocus cloth in Canada), secured to the surface of the platens with contact adhesive or with low-compressibility double-sided pressure sensitive tape (see NOTE in 4.1.1), or matte finish of the platen surfaces or any equivalent means, may be used to achieve this, provided the requirements for parallelism are met.

The emery cloth shall be replaced as soon as any damage is observed. On no account should a knife or other sharp instrument be used to remove emery cloth or other material adhering to the platens.

4.2.3 Means of driving the movable platen at a fixed uniform speed to exert a force on an object between the platens.

The speed of platen movement shall be such that when the platens are in contact, the force between them increases at the rate of (110 ± 10) N/s.

NOTE In some countries, a loading rate of (67 ± 23) N/s is used, but loading rates this low are undesirable because there is evidence that loading rates need to be 100 N/s or higher to produce test results similar to those produced by a fixed-platen tester. Any deviation from the specified loading rate shall be reported in the calibration report.

4.2.4 Means of measuring the peak applied load.

See NOTES in 4.1.3 and 4.2.3. The load measurement system can be either of the following:

a) a 0 mm to 10 mm dial gauge or other means of measuring the deflection of the beam to the nearest 0,01 mm or 1 %, whichever is greater; the reading provided can be the direct linear displacement of the beam, in millimetres, or can include a system whereby the reading is converted to force unit;

b) a load cell or other means of measuring the force applied to the test piece to the nearest 1 N or 1 %, whichever is greater. The load cell shall be located in such a position as to detect the peak force applied to the test piece.

With this type of measuring device, the deflection characteristics of the beam are less critical but it is necessary that they be sufficiently close to one of the requirements of 4.2.1 to ensure that the loading rate with the platens in direct contact and with a test piece in contact with the platens is the same as with the dial gauge measurement system operating at the chosen loading rate.

NOTE Dial gauges are fitted with a hairspring to take up play between the pointer pinion and the driving cog. Conventionally this is fitted so that it acts in a clockwise direction. When a lazy hand is fitted to the dial gauge, the hairspring has to be inverted so that it acts in an anticlockwise direction.

5 Verification and calibration

Before calibration and checking, condition the tester for a minimum of 4 h in the standard atmosphere specified in ISO 187.

5.1 Fixed-platen compression testing machine

Check that the platen surfaces conform to the requirements of 4.1.1. Check the condition of any emery cloth facings and renew if necessary.

Check that in operation, one platen approaches the other at a constant, controlled speed which is within ±0,25 mm/min of the nominal speed. The nominal speed used shall be reported with the test values.

Check that the load reading is zero when the platens are not in contact.

Calibrate the machine by placing weights of known mass on the lower platen or by operating the instrument with a precalibrated load cell or a precalibrated proving ring between the platens. The weights, load cell, or proving ring shall have been calibrated to an accuracy of at least 0,1 %.

Carry out the calibration at a minimum of five approximately evenly spaced points covering the working range of the instrument. Immediately before calibration, load and unload the tester to its maximum capacity three times. Calibrate at progressively higher test levels, allowing at least 30 s between each measurement, and repeat three times. The average calibration at each point must be known to within 1 N or 1 %, whichever is greater, with all peripheral equipment (such as computers and printers) operating as they would be while testing is being carried out.

5.2 Beam-deflection compression testing machine

Annex A gives maintenance requirements.

5.2.1 Beam-deflection measurement system

5.2.1.1 Check that the platen surfaces conform to the requirements of 4.2.2. Check the condition of emery cloth facings and renew if necessary.

Check that in operation when the platens are in contact, the force between them increases at rate of (110 ± 10) N/s.

Check that the load or deflection reading is zero when the platens are not in contact.

The instrument shall be calibrated by weights of known mass, a precalibrated load cell or a precalibrated proving ring. The weights, load cell or proving ring shall have been calibrated to an accuracy of at least 0,1 %.

Immediately before calibration, load and unload the tester to its maximum capacity three times.

5.2.1.2 When using weights, zero the dial gauge or digital readout and place the weights directly on the lower platen, or use a suitable bridge that has a known mass, with a maximum error of 0,1 %.

When using a load cell or proving ring, place the load cell or proving ring centrally between the platens and zero the dial gauge or digital readout. Apply a load by lowering the top platen onto the load cell or proving ring.

Apply each increment of load and note the reading of the dial gauge lazy hand or the digital readout. If the instrument gives a deflection reading in millimetres, convert the load to millimetres of deflection on the basis of the known stiffness characteristics of the beam (see 4.2.1). This shall agree with the actual deflection to within 0,01 mm or 1 %, whichever is greater. If the instrument automatically converts the deflection to force units, the first reading shall agree with the true load to within 3 N or 1 %, whichever is greater.

When the instrument is to be used over its whole range, repeat this procedure under conditions of increasing load at a minimum of 10 approximately evenly spaced points corresponding to each 10 % of the range. When only a limited part of the range is to be used, a smaller number of approximately evenly spaced calibration points may be selected, provided they cover the working range to be used. Repeat the calibration at the same point under conditions of decreasing load. If a dial gauge fitted with a lazy hand is used to indicate beam deflection, the lazy hand should be left at the high reading and readings taken from the pointer during this stage of the calibration. Both sets of readings (increasing and decreasing) should agree with each other to within 0,01 mm or 1 %, whichever is greater, for deflection measuring devices, or to within 3 N or 1 %, whichever is greater, for devices which automatically convert the deflection reading to force units. If the agreement is not within these tolerances, check dial gauges for excessive friction in the dial gauge or lazy hand mechanism, or the displacement transducer for friction or sticking.

From the beginning of 5.2.1.2, repeat the selected calibration procedure three times.

If the dial gauge or digital readout gives a low reading, the fulcrums are too close together; if high, the fulcrums are too far apart. Correct by adjusting the fulcrum distance by means of the adjusting screws. Turn each screw through the same distance so that the platens remain equidistant from each fulcrum. After adjustment, check the zero of the indicator and repeat the verification. This adjustment shall be made only when there is no load on the beam.

5.2.2 Load cell measurement system

The load cell shall be verified by weights of known mass with a maximum error of 0,1 %, a precalibrated load cell, or a precalibrated proving ring.

If the load cell is verified *in situ*, it shall be verified with all peripheral equipment (such as computers and printers) operating as they would be when testing is being carried out. Immediately before calibration, load and unload the tester to its maximum capacity three times.

The load cell shall be checked at a minimum of five approximately evenly spaced points covering the working range, under conditions of increasing load using the procedure described in 5.1. The readings shall indicate the true load, within 1 N or 1 %, whichever is greater, at each point.

6 Calibration report

The calibration report shall include the following information:

a) a reference to this International Standard, i.e. ISO 13820:2014;

b) date and place of calibration;

c) conditioning atmosphere used;

d) type of compression testing machine, i.e. fixed-platen or beam-deflection;

e) for the fixed-platen type of compression testing machine, the test speed at which one platen approaches the other (5.1);

f) the mean of, and maximum deviation of, the instrument readings for each point calibrated;

g) any deviation from the specified procedure, or any other information which would help in interpretation of the results.

Annex A
(normative)

Maintenance of beam-deflection compression testing machines

Inspect the machine regularly for cleanliness and for faults such as wear, misalignment, loose parts, and damage. Clean the machine and rectify any faults found.

Check that the lower-platen locating pins do not bind in their holes. If the clearance of the pins in the holes is sufficient, a nonlinear calibration will result. This might not occur until a substantial load is applied, and can go undetected if the instrument is not calibrated over its full working range.

Check pulley belts for wear; check pulleys for misalignment.

Check that motor vibration is not excessive. It shall be reduced by realigning the shaft and/or by using antivibration mountings.

Check that the beam deflects (1,0 ± 0,01) mm for 175 N, 300 N, or 350 N of applied load (see 4.2.1).

Check that the beam does not contact any part of the compression tester, other than the knife edges and the spring-loaded retaining pins.

Check that the beam is straight. Replace if necessary. Check that the fulcrums are equidistant from the centre of the beam, and that the dial gauge or transducer (force or displacement) is midway between the fulcrums and is in the middle of the width of the beam.

Check that the spring-loaded pins that hold down the beam are located directly above the knife edges. It might be necessary to slot the frame to allow these pins to be repositioned.

If desired, microswitches may be installed to restrict the travel of the movable platen and the deflection of the beam.

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