INTERNATIONAL STANDARD 3051

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Gypsum plasters — Determination of mechanical properties

Plâtres — Détermination des caractéristiques mécaniques

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FOREWORD

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO Member Bodies). The work of developing International Standards is carried out through ISO Technical Committees. Every Member Body interested in a subject for which a Technical Committee has been set up has the right to be represented on that Committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work.

Draft International Standards adopted by the Technical Committees are circulated to the Member Bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 3051 was drawn up by Technical Committee ISO/TC 152, *Gypsum, gypsum plasters and gypsum products,* and circulated to the Member Bodies in March 1973.

It has been approved by the Member Bodies of the following countries :

Austria	Mexico	Spain
Bulgaria	Netherlands	Sweden
France	Poland	Thailand
Germany	Portugal	Turkey
Iran	Romania	United Kingdom
Ireland	South Africa, Rep. of	U.S.S.R.

The Member Bodies of the following countries expressed disapproval of the document on technical grounds :

Australia
Czechoslovakia
Italy
New Zealand

Printed in Switzerland

Gypsum plasters — Determination of mechanical properties

1 SCOPE AND FIELD OF APPLICATION

This International Standard specifies methods for determining certain mechanical properties[1] of gypsum plasters (hereinafter referred to as "plasters"), namely :

- flexural strength;
- compressive strength;
- hardness.

The tests specified are limited to gypsum plasters requiring for their use only the addition of water.[2]

2 REFERENCES

ISO 3048, *Gypsum plasters — General test conditions.*

ISO 3050, *Gypsum plasters — Determination of physical properties of pure paste.*

3 MOULDS AND TEST PIECES

3.1 Mould

The mould shall have three compartments allowing the simultaneous production of three prismatic test bars 40 mm × 40 mm × 160 mm. The mould shown in figure 1 is given by way of example.

The mould shall be made of a material complying with 3.1.4 or 3.2.4 of ISO 3048, and shall be constructed to resist deformation. It shall be demountable, rigid and leakproof. It shall be provided with a base to which it is clamped.

The internal dimensions of each compartment shall be as follows[3] :

- length : 160 ± 0,4 mm;
- width : 40 ± 0,1 mm;
- height : 40 ± 0,1 mm.

The sides shall have a thickness of at least 10 mm. The two opposite internal faces of 40 mm × 160 mm shall be plane to within 0,02 mm. The angle which they make with the base of the mould shall be 90 ± 0,5°.

Moulds shall be replaced if width or height becomes more than 40,2 mm.

Instruments used to clean the moulds shall be less hard than the metal of the moulds.

3.2 Preparation of test pieces

Oil the interior of the moulds lightly and make their joints leakproof to avoid any loss of water.

Use a mixing vessel in accordance with 3.1.4 or 3.2.4 of ISO 3048 for gauging the plaster.

In a single gauging, prepare the mass of plaster m necessary to fill one mould of three test bars. The volume of paste necessary, taking losses into account, is 950 ml. Using the water/plaster ratio W/P determined using one of the methods specified in ISO 3050 or fixed arbitrarily, the mass of plaster m required may be calculated from the formula :

$$m = \frac{950}{0{,}4 + (W/P)}$$

The mass of water necessary for the gauging is $m \times (W/P)$.

Pour this quantity of water into a container complying with 3.1.4 or 3.2.4 of ISO 3048. Allow to stand for 1 min, then mix the batch by 30 circular movements of the spatula within 30 s. Then give three circular movements with the spatula each minute in order to keep the plaster in suspension; continue until the paste starts to thicken and forms a cone on the surface of the mix when allowed to fall slowly from the spoon.

The gauging method may be varied according to the consistence chosen. This method and the method of determination of the consistence shall be noted in the test report.

1) This International Standard is not exhaustive. The determination of other mechanical properties not covered by this International Standard may be the subject of separate International Standards.

2) The test methods for the determination of the mechanical properties of gypsum plasters mixed with an aggregate will be studied later.

3) The use of moulds 100 mm × 25 mm × 25 mm is allowed even though the dimensions 160 mm × 40 mm × 40 mm are preferable.

Pour the paste into the moulds whilst stirring slowly. In order to eliminate air bubbles, lift the front side of the mould five times for about 10 mm and let it fall.

When the initial set is recognized from the overflowing plaster, strike off with the aid of a knife. Do not polish the surface. After the final set, mark the prisms on this surface and demould them.

3.3 Storage of test pieces

Test pieces which are to be tested mechanically 2 h after the start of setting are to be stored in the laboratory atmosphere.

Test pieces to be tested for strength after other periods of hydration are to be stored immediately after being demoulded, and throughout those periods, in an enclosed area where there is a uniform relative humidity of the air of 90 ± 5 %. The duration of this storage is fixed for each type of plaster.[1)]

After storing, the test pieces which are to be used for the measurement of damp strengths are to be immediately subjected to strength tests. Those which are to be used to measure dry strengths are to be dried in an oven at 40 ± 4 °C to constant mass, then quickly subjected to the mechanical tests.

3.4 Number of test pieces

For each period of storage, a minimum of three test pieces prepared in different gaugings shall be reserved for the flexural test.

Three half-bars of different gaugings resulting from the flexural test shall be used for the compressive test. Three other half-bars shall be used for the determination of hardness.

4 DETERMINATION OF FLEXURAL STRENGTH

4.1 Apparatus

4.1.1 Bending device, having two supporting rollers with a diameter of 10 mm, at 100 ± 1 mm centres, and a loading roller also with a diameter 10 mm (see figure 2).

The three vertical planes through the axes of the three rollers shall be parallel and shall remain so during the test. One of the supporting rollers and the loading roller shall tilt slightly about their centres in a vertical plane to allow a uniform distribution of the load on the width of the prismatic test piece without torsional stress.[2)]

4.1.2 Testing machine in which the bending device is mounted, capable of measuring small loads with a precision of 1 % in the top four-fifths of the measuring scale.

4.2 Procedure

Carry out three determinations.

Increase the load P progressively so that failure occurs 20 to 40 s after the start of loading.

Ensure that the edges of the test pieces are strictly perpendicular to the rollers and that the upper roller is truly equidistant from the lower rollers.

Note the maximum load supported by the test piece.

4.3 Expression of results

The modulus of rupture R_f, in newtons per square millimetre, is given by the following formula :

$$R_f = \frac{6\,M}{b^3} = 0{,}023\,4\,P$$

where

M is the bending moment, in newton millimetres;

b is the length, in millimetres, of the edge of the square section of the test piece;

P is the breaking load, in newtons.

Indicate in the test report the value of P and R_f obtained for each of the three test pieces. Report the age of the test pieces and the conditions of drying.

If the three results obtained for R_f do not vary by more than 15 % from their mean, report this mean expressed to ± 0,05 N/mm^2 or to ± 2 %, taking the expression giving the larger tolerance, as the value of the modulus of rupture.

If one result differs by more than 15 % from the mean, this result shall not be taken into account for the calculation of the mean.

If more than one result differs by more than 15 % from the mean, repeat the test on three new test pieces.

5 DETERMINATION OF COMPRESSIVE STRENGTH

5.1 Apparatus

5.1.1 Compression apparatus, consisting of two metal plates, of thickness at least 10 mm, width 40 ± 0,1 mm and length greater than 40 mm, with a flatness tolerance equal to 0,01 mm.

1) In the relevant International Standards or national standards or, in the absence of such documents, by agreement between the interested parties.

2) The bending device for the flexural strength test specified in this International Standard is for 40 mm × 40 mm × 160 mm moulds. The use of 25 mm × 25 mm × 100 mm moulds entails modifications to this device and to the expression of the test results.

These plates are made from hardened steel. During the test they are guided without friction so that they have the same horizontal projection. One of them may be tilted slightly to allow perfect contact with the test piece.

5.1.2 Testing machine, which by its method of construction and sensitivity of control allows the tests to be carried out with as small a scatter as possible.

Its precision shall be ± 1,5 % for the lowest loads used in all tests. The upper platen shall have a width at least equal to the width of the test pieces and not more than 100 mm.

5.2 Procedure

Place the compression apparatus and the test piece between the platens of the machine in such a manner :

— that the test piece is compressed between the faces which were at the sides during moulding, over a section of 40 mm × 40 mm;

— that the axis of rotation of the upper platen passes through the centre of the surfaces which are compressed.

Increase the load at a rate such that failure is produced between 20 and 40 s after the start of loading.

5.3 Expression of results

The value of the compressive failing load R_c, in newtons per square millimetre, is given by the following formula :

$$R_c = \frac{P}{1\,600}$$

where P is the load, in newtons, which produced failure of the test piece.

Indicate in the test report the values of R_c obtained.

If the three results obtained for R_c do not differ by more than 15 % from their mean, report that mean to ± 0,05 N/mm² or to ± 2 % from that mean, as the value of compressive failing load.

If one result differs more than 15 % from the mean, this result shall not be retained for the calculation of the mean.

If more than one result differs more than 15 % from the mean, repeat the test on three new test pieces.

6 DETERMINATION OF HARDNESS

6.1 Principle

Measurement of the depth of the impression produced by a ball under a fixed load on a test piece of set and dried plaster.

6.2 Apparatus

6.2.1 Device which allows a hardened steel ball of 10 mm diameter to be applied to a fixed point on the surface of the test piece and a fixed load to be applied to the ball perpendicularly to the surface of the test piece.

6.2.2 Comparator, integral with the ball carrier, which can be used to measure the depth of the impression.

6.3 Procedure

Carry out the determination on the two longitudinal faces of the moulding (i.e. the lateral faces in contact with the mould) on each of three half-prisms resulting from the flexural test.

Apply the ball at right angles to the face being tested, in the plane passing through the lateral axis, and at three points, the distance between them being the quarter of the length. However, the extreme points shall be situated at least 20 mm from the ends.

Apply a load of 10 N, then in 2 s increase the load to 200 N. Maintain it for 15 s; 15 s after removing the load, measure the depth of the impression.

6.4 Expression of results

The hardness H, in newtons per square millimetre, is given by the following formula :

$$H = \frac{F}{\pi D t} = \frac{20 \times 1\,000}{\pi \times 1 \times t} = \frac{6\,370}{t}$$

where

F is the load, in newtons;

D is the diameter of the ball, in millimetres;

t is the mean depth, in micrometres, of the impressions.

Record in the test report, in groups of three, corresponding to each face tested, the 18 depths measured.

Calculate the arithmetic mean t and indicate the number of results between $t - 10$ % and $t + 10$ %.

Exclude values for impressions showing obvious pores.

7 TEST REPORT

The test report shall include the following particulars :

a) the reference of the method used;

b) the results and the method of expression used;

c) any unusual features noted during the determination;

d) any operation not included in this International Standard, or regarded as optional.

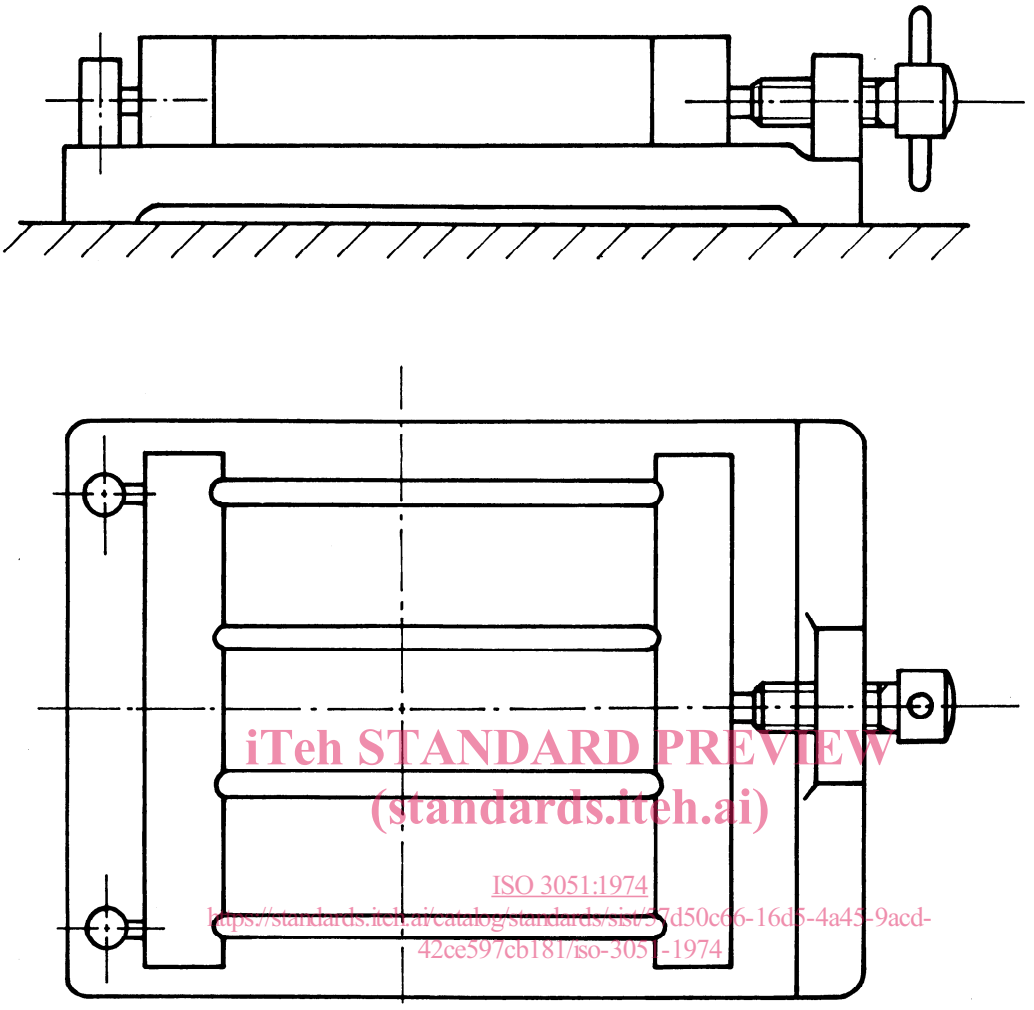

FIGURE 1 — **Mould for forming test pieces 160 mm × 40 mm × 40 mm**

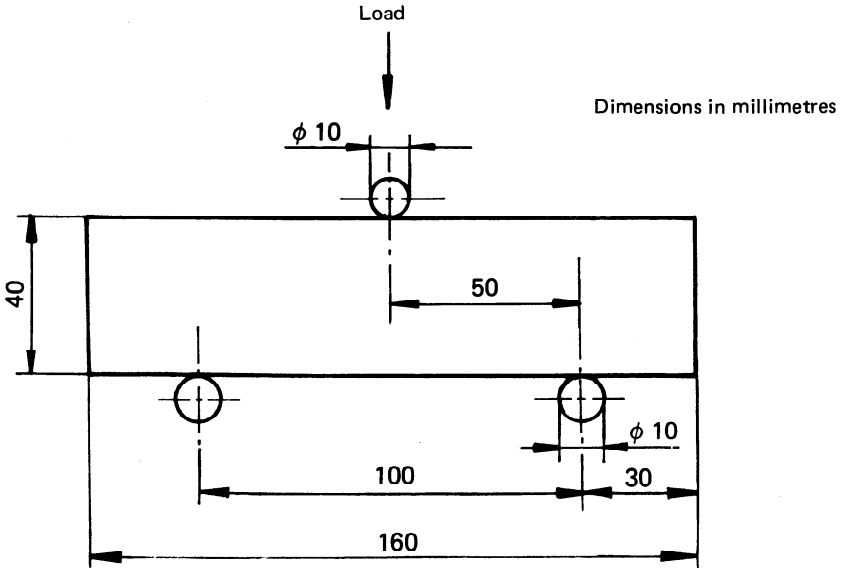

FIGURE 2 — **Flexural strength test**