

# Methods of test for mortar for masonry —

## Part 12: Determination of adhesive strength of hardened rendering and plastering mortars on substrates

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ICS 91.080.30; 91.100.10

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The UK participation in its preparation was entrusted by Technical Committee B/519, Masonry and associated tests, to Subcommittee B/519/2, Mortar, which has the responsibility to:

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- present to the responsible European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

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Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 10, an inside back cover and a back cover.

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Détermination de l'adhérence des mortiers d'enduit durcis  
appliqués sur supports

Prüfverfahren für Mörtel für Mauerwerk - Teil 12: Bestimmung  
der Haftfestigkeit von erhärteten Putzmörteln

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Contents	Page
Foreword .....	3
1 Scope .....	4
2 Normative references.....	4
3 Principle.....	4
4 Symbols .....	4
5 Apparatus.....	5
6 Sampling and sample preparation.....	6
7 Preparation and storage of test specimens .....	7
8 Procedure.....	8
9 Expression of results.....	9
10 Test report.....	10

## Foreword

This European Standard has been prepared by Technical Committee CEN/TC 125, Masonry, the Secretariat of which is held by BSI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by August 2000, and conflicting national standards shall be withdrawn at the latest by December 2001.

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## 1 Scope

This European Standard specifies a method for the determination of the adhesive strength between rendering and plastering mortars and a substrate.

## 2 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.

- |              |  |
|--------------|--|
| prEN 772-11  | Methods of test for masonry units - Part 11: Determination of water absorption of clay, aggregate concrete, autoclaved aerated concrete, manufactured stone and natural stone masonry units due to capillary action. |
| prEN 998-1   | Specification for mortar for masonry - Part 1: Rendering and plastering mortar with inorganic binding agents.  |
| prEN 998-2   | Specification for mortar for masonry - Part 2: Masonry mortar.   |
| EN 1015-2    | Methods of test for mortar for masonry - Part 2: Bulk sampling of mortars and preparation of test mortars.   |
| EN 1015-3    | Methods of test for mortars for masonry - Part 3: Determination of consistence of fresh mortar (by flow table).  |
| prEN 1015-11 | Methods of test for mortars for masonry - Part 11: Determination of flexural and compressive strength of hardened mortar.  |

## 3 Principle

The adhesive strength is determined as the maximum tensile stress applied by a direct load perpendicular to the surface of the rendering or plastering mortar on a substrate. The tensile load is applied by means of a defined pull-head plate glued to the test area of the mortar surface. The adhesive strength obtained is the quotient between the failure load and the test area.

## 4 Symbols

- |       |   |
|-------|---|
| $f_u$ | is the adhesive strength, (N/mm <sup>2</sup> );               |
| $F_u$ | is the failure load, (N);                                     |
| $A$   | is the test area of cylindrical specimen, (mm <sup>2</sup> ). |

## 5 Apparatus

**5.1 Truncated conical rings**, (see Figure 1) made of stainless steel or brass, with internal diameter of  $50 \text{ mm} \pm 0,1 \text{ mm}$  and  $25 \text{ mm} \pm 0,5 \text{ mm}$  in height. The minimum thickness of the mould wall shall be  $5,0 \text{ mm}$  at the top. The external diameter at the base shall be  $51 \text{ mm} \pm 0,1 \text{ mm}$ .

**5.2 Circular pull-head plates**, made of stainless steel, with diameter of  $50 \text{ mm} \pm 0,1 \text{ mm}$  and minimum thickness  $10 \text{ mm}$ , and with central fitting for connection to the direct pull tensile force apparatus.

Dimensions in millimetres

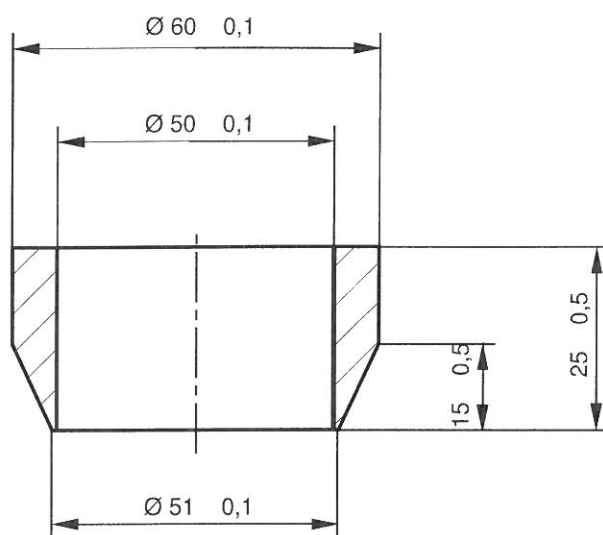


Figure 1 - Sharp-edged, truncated conical ring

**5.3 Adhesive**, based on resin, e.g. epoxy resin or methylmethacrylate resin.

**5.4 Core drilling machine**, with core drill of nominally  $50 \text{ mm}$  internal diameter, suitable to cut core samples from hardened mortars and substrates.

**5.5 Testing machine**, for direct pull tensile force test and with suitable capacity and sensitivity for the test as specified in clause 8. It shall be capable of applying the load to the pull-head plate through a suitable fitting that excludes any bending forces. The machine shall comply with the requirements in Table 1.

**5.6 Storage chamber**, capable of maintaining a temperature of  $20 \text{ }^{\circ}\text{C} \pm 2 \text{ }^{\circ}\text{C}$  and at a relative humidity of  $65 \% \pm 5 \%$ .

**Table 1 - Requirements for testing machine**

Maximum permissible repeatability of forces as percentage of nominal force	Maximum permissible mean error of forces as percentage of nominal force	Maximum permissible error of zero force as percentage of maximum force of range
%	%	%
2,0	±2,0	±0,4

## **6 Sampling and sample preparation**

### **6.1 General**

The fresh mortar for this test shall have a minimum volume of 1,5 l or at least 1,5 times the quantity needed to perform the test, whichever is the greater, and shall either be obtained by reduction of the bulk test sample (see EN 1015-2) using a sample divider or by quartering or by preparation from water and the other constituents in the laboratory. Two test samples shall be prepared.

### **6.2 Laboratory prepared mortars**

The length of mixing period shall be measured from the moment all the constituents are introduced into the mixer.

The mortar shall be brought to a defined flow value as specified in EN 1015-2 determined in accordance with EN 1015-3 and reported. The test procedure shall not start until at least 10 min after completion of mixing and shall be concluded within the specified workable life of the mortar (preferably within 30 min after completion of mixing), unless otherwise instructed by the manufacturer.

### **6.3 Mortars, other than laboratory prepared mortars**

Ready to use mortars (factory-made wet mortars which are retarded), and pre-batched air-lime/sand wet mortars when not gauged with hydraulic binders, shall be used for specimen preparation within their specified workable life.

Before testing, the batch shall be gently stirred by hand using a trowel or palette knife for 5 to 10 seconds to counteract any false setting, etc., but without any additional mixing of the batch.

The flow value of the mortar in the bulk test sample shall determined in accordance with EN 1015-3 and reported.



## 7 Preparation and storage of test specimens

### 7.1 Substrate

For rendering or plastering systems manufactured for a specific background, i.e. clay or calcium silicate masonry units, concrete masonry units, panels or cast in-situ concrete, etc., these materials, in an air-dried condition, should be used as test substrates. The water absorption due to capillary action of the units used in the substrate shall be recorded, if known, or tested in accordance with prEN 772-11 where appropriate.

Where no specific background is prescribed rectangular concrete panels shall be used as substrate, with dimensions not less than 550 mm × 150 mm and 50 mm in thickness. The concrete shall be mixed with a water/cement ratio of 0,55 and using normal graded aggregates with maximum particle size of one third of the concrete panel thickness. The upper surface of the moulded substrate shall be levelled and wood-floated to achieve a suitable surface. Within a period of 6 h to 24 h lightly brush the surface.

The concrete panels shall have an age of not less than 28 d when applying the plastering or rendering system, the panels being cured under standardized conditions as described in prEN 1015-11.

Note: Concrete panels as a substrate will normally give conservative adhesive strength values.

### 7.2 Application

The fresh mortar mix shall be applied to the prescribed substrate according to the manufacturer's recommendations and the intended use. The substrate shall be kept vertical during application. Unless otherwise specified the total thickness of the mortar layer shall be 10 mm ± 1 mm.

### 7.3 Test areas

#### 7.3.1 General

Circular test areas of approximately 50 mm in diameter shall be cut through the mortar layer, either in the fresh mortar according to 7.3.2 or in the hardened mortar according to 7.3.3. The diameter of the circular test area shall be recorded for each specimen. Five test specimens shall be provided.

#### 7.3.2 Fresh mortar

After application and the initial setting of the mortar layer, the truncated conical rings (5.1), cleaned and lubricated with a thin layer of mineral oil, shall be pressed with their sharp edge, slightly rotating, through the fresh mortar layer until full contact with the substrate is reached. The minimum distance between the rings and the free edges of the rendered substrate, and the free distance between the individual rings shall be 50 mm.

The rings shall be carefully removed, still slightly rotating, when the substrate is reached. If it is obvious that the adhesion of any of the cut specimens is disturbed during this preparation, another test specimen shall be cut. The specimen shall then be stored as given in 7.4.

### 7.3.3 Hardened mortars

After curing of the rendering or plastering mortar, test specimens shall be cut using a core drilling machine (5.4). The core shall be cut to a depth of approximately 2 mm into the substrate. Damaged specimens shall be rejected.

### 7.4 Storage and curing conditions

When the mortar is sufficiently hard, the rendered specimens shall be enclosed within a sealed, air-tight polyethylene bag and at a temperature of  $20\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$  for 7 d. The specimens shall subsequently be removed and stored in air (5.6) at a constant temperature of  $20\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$  and at a relative humidity of  $65\% \pm 5\%$  for a further 21 d.

## 8 Procedure

Glue the pull-heads with the adhesive centrally on the test areas, preventing any excess adhesive from bridging the cut around the test areas.

Test the specimens at an age of 28 d immediately after being removed from the storing atmosphere.

Using the testing machine (5.5), apply the tensile load perpendicular to the test area through the pull-head plates (5.2). Apply the load without shock and at a uniform rate. Use a rate such that the stress increases within the range of  $0,003\text{ N}/(\text{mm}^2\cdot\text{s})$  to  $0,100\text{ N}/(\text{mm}^2\cdot\text{s})$  according to the expected adhesive strength and so that failure occurs between 20 s and 60 s (see Table 2). Record the failure load. Reject any test where the mode of failure is fracture at the adhesive layer between the pull-head plate and the mortar.

Table 2 - Loading rate

Expected adhesive strength ( $\text{N}/\text{mm}^2$ )	Loading rate ( $\text{N}/\text{mm}^2\cdot\text{s}$ )
< 0,2	0,003 to 0,010
0,2 to < 0,5	0,011 to 0,025
0,5 to 1,0	0,026 to 0,050
> 1,0	0,050 to 0,100

## 9 Expression of results

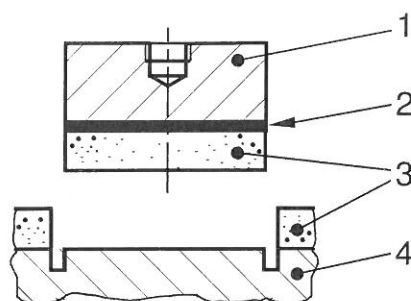
### 9.1 Adhesive strength

Calculate the individual adhesive strengths from the following formula to the nearest 0,05 N/mm<sup>2</sup>.

$$f_u = \frac{F_u}{A}$$

Calculate the adhesive strength as the mean value from the individual values of the 5 specimens to the nearest 0,1 N/mm<sup>2</sup>.

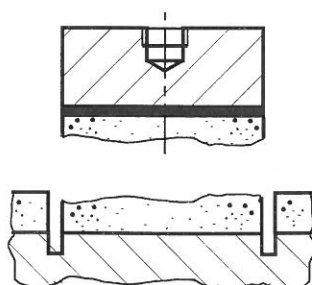
Possible fracture patterns leading to valid results are given in Figures 2 to 4 inclusive. Where fracture patterns occur as shown in Figures 3 and 4, i.e. where there is no failure at the mortar/substrate interface, results shall be considered as lower bound values. These values shall be valid for calculation of the mean value of adhesive strength.



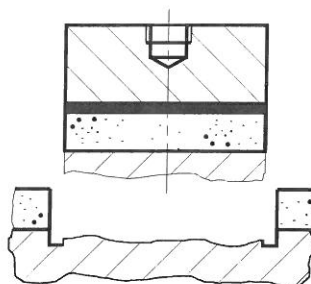
#### Key

- 1 Pull-head plate
- 2 Adhesive layer
- 3 Mortar
- 4 Substrate

**Figure 2 - Fracture pattern a - Adhesion fracture - Fracture at the interface between mortar and substrate. Test value equals the adhesive strength**



**Figure 3 - Fracture pattern b - Cohesion fracture - Fracture in the mortar itself. The adhesive strength is greater than the test value**



**Figure 4 - Fracture pattern c - Cohesion fracture - Fracture in the substrate material. The adhesive strength is greater than the test value**

## 10 Test report

The test report shall provide the following information:

- a) the number, title and date of issue of this European Standard;
- b) the place, date and time of taking the bulk test sample;
- c) the method used for taking the bulk test sample (if known) and the name of the organization that took it;
- d) the type, origin and designation of the mortar by reference to the relevant part of prEN 998;
- e) preparation method;
- f) the type and description of the substrate including the coefficient of water absorption due to capillary action of masonry units (where relevant) comprising the substrate;
- g) any specialized treatment of the substrate in accordance with the manufacturer's instructions;
- h) the date and time of testing;
- i) flow value of test mortar determined in accordance with EN 1015-3;
- j) details of test specimens including number, dimensions, etc., if appropriate;
- k) individual values of adhesive strength rounded to the nearest  $0,05 \text{ N/mm}^2$  and the mean value rounded to the nearest  $0,1 \text{ N/mm}^2$  and description of mode of failure by reference to Figures 2 to 4 inclusive;
- l) remarks, if any.



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