

Methods of testing

Refractory materials —

Part 10: Investment casting shell mould systems —

Section 10.1 Determination of resistance to deformation at elevated temperatures

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Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Refractory Products Standards Policy Committee (RPM/-) to Technical Committee RPM/1, upon which the following bodies were represented:

- British Ceramic Research Ltd.
- British Industrial Ceramic Manufacturers' Association
- British Steel Industry
- Refractories Association of Great Britain
- Refractory Contractors' Association
- Society of Glass Technology

The following bodies were also represented in the drafting of the standard, through subcommittees and panels:

- British Investment Casting Trade Association
- Department of Trade and Industry (National Engineering Laboratory)
- Institute of British Foundrymen

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Foreword

This Section of BS 1902-10 has been prepared under the direction of the Refractory Products Standards Policy Committee. It is one of a series of three covering the testing of investment casting shell mould systems, as follows:

- *Section 10.1: Determination of resistance to deformation at elevated temperatures;*
- *Section 10.2: Determination of permeability and standard air flow capacity at elevated temperatures;*
- *Section 10.3: Determination of thermal profile.*

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 8 and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

1 Scope

This Section of BS 1902-10 describes a method for determining the resistance to deformation under constant loading rate, at elevated temperatures, of investment casting shell mould systems, thus providing a meaningful measurement of shell mould performance during casting operations. The test is applicable to all types of refractory shell moulds used in the investment casting industry.

2 Principle

The test is designed to measure the hot deformation resistance of shell mould systems at relatively low levels of strain and is not therefore a test to failure. The resistance to hot deformation of a shell mould is a measure of its ability to resist shell mould wall movement at low strain levels at high temperature. Consequently two strain values are selected as the criteria for comparison: 0.075 % and 0.25 % strain. The stress levels at these strain values are thus ascertained from the test. This test essentially measures the intrinsic strength of the shell mould and the result is not dependent on the mould thickness, which can vary considerably from operation to operation depending on the application. Thus materials for making shells, including binders, fillers and stuccos, can be readily compared.

However, the test procedure also determines the load-bearing capacity of the shell mould, which does depend on the mould thickness. Again this is determined at two levels of deformation. Two deflection levels are selected at 0.2 mm and 0.5 mm. Thus for the same composition of shell mould, the influence of the number of shell coats, as related to shell thickness, may be discerned in relation to the ability to resist shell mould wall movement.

Test pieces cut from an investment casting shell mould are placed on a test fixture located within a furnace which is already at a designated test temperature. After the test pieces have stabilized at the test temperature, they are loaded at a constant rate until the higher of the two strain values is passed. If the test piece fractures before the upper strain level is reached, then the test stops and the lower strain level is utilized. During the test the load and deflection values are continuously recorded, allowing an accurate characterization of the ability of the shell material to resist deformation under load at high temperature.

3 Apparatus

3.1 Test fixture, having two fixed lower bearing edges to support the test piece (the support bearing edges), and one moveable upper bearing edge for the application of the load (the load application edge). The three bearing edges shall be parallel to each other. The distance between the support bearing edges shall be $76 \text{ mm} \pm 1 \text{ mm}$ (see Figure 1), and the load application edge shall be placed centrally between them with an accuracy of $\pm 2 \text{ mm}$. These distances shall have been measured at room temperature to an accuracy of $\pm 0.5 \text{ mm}$. The bearing edges shall have a radius of curvature of $2.75 \text{ mm} \pm 0.5 \text{ mm}$ and a length no less than 25 mm (see Figure 1). It shall be capable of applying a load (via the load application edge) normal to, and uniformly across, the centre of the test piece and of increasing this load at a constant rate of 5 kg/min.

NOTE The bearing edges should be examined periodically (e.g. yearly) and replaced if they become flattened.

3.2 Load measuring system, capable of measuring the load throughout the test with a minimum accuracy of $\pm 5 \%$, and calibrated over the full range of the system at intervals of 20 % of full scale deflection. The interval of calibration shall not exceed 10 test batches or a period of 3 months, whichever is the shorter (see 4.1).

3.3 Deflection measuring system, capable of measuring the deflection of the test piece under load with a minimum accuracy of $\pm 5 \%$ within the range 0 mm to 5 mm, and calibrated over the full range of the system at intervals of 1 mm. The interval of calibration shall not exceed 10 batches or a period of 3 months, whichever is the shorter (see 4.1).

3.4 Furnace, capable of providing the overall heating of both the test fixture and the test piece, and designed so that during the test no part of the test piece shall fall outside $\pm 10 \text{ K}$ of the test temperature (see Annex A). The atmosphere in the furnace shall normally be air. The use of a different atmosphere shall be stated in the test report.

3.5 Temperature measuring device, consisting of a calibrated thermocouple in the immediate proximity of the midpoint of the tensile face of the test piece (see Annex A).