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ISO RECOMMENDATION

R 834

FIRE RESISTANCE TESTS OF STRUCTURES

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BRIEF HISTORY

The ISO Recommendation R 834, *Fire resistance tests of structures,* was drawn up by Technical Committee ISO/TC 92, *Fire tests on building materials and structures,* the Secretariat of which is held by the British Standards Institution (BSI).

Work on this question by the Technical Committee began in 1961 and led, in 1965, to the adoption of a Draft ISO Recommendation.

In December 1966, this Draft ISO Recommendation (No. 1060) was circulated to all the ISO Member Bodies for enquiry. It was approved, subject to a few modifications of an editorial nature, by the following Member Bodies :

Australia	Germany	Romania
Austria	Greece	South Africa, Rep. of
Belgium	Hungary	Spain
Brazil	India	Sweden
Canada	Iran	Switzerland
Chile	Israel	U.A.R.
Czechoslovakia	Japan	United Kingdom
Denmark	Korea, Rep. of	U.S.S.R.
Finland	Netherlands	
France	Poland	

One Member Body opposed the approval of the Draft :

Norway

The Draft ISO Recommendation was then submitted by correspondence to the ISO Council, which decided, in September 1968, to accept it as an ISO RECOMMENDATION.

CONTENTS

ILLUSTRATION

ISO Recommendation R 834 September 1968

FIRE RESISTANCE TESTS OF STRUCTURES

1. SCOPE

This ISO Recommendation specifies standard heating conditions, methods of test and criteria for the determination of the fire resistance of elements of structure of different categories.

The test provides for the determination of fire resistance of elements of structure on the basis of the length of time for which the test specimens, of specified dimensions, satisfy the criteria laid down under the prescribed test conditions.

2. FIELD OF APPLICATION

This test is intended to determine the fire resistance of the following elements of structure :

- loadbearing and non-loadbearing walls, partitions,
- columns,
- beams,
- floors,
- flat roofs (where appropriate).

This list is not exhaustive. Elements which fall into none of these categories may be tested by analogy with a similar element.

Doors, shutters and glazing will be the subject of separate ISO Recommendations.

3. APPARATUS

3.1 Furnace

The furnace should be capable of subjecting a specimen element to the standard heating conditions specified below.

3.2 Standard heating conditions

3.2.1 The temperature within the furnace should be controlled so as to vary with time within the limits specified in clause 3.4 according to the following relationship :

$$T - T_o = 345 \log_{10} (8t + 1)$$

where

t is the time, expressed in minutes;

T is the furnace temperature at time t, expressed in degrees Celsius;

T_o is the initial furnace temperature, expressed in degrees Celsius.

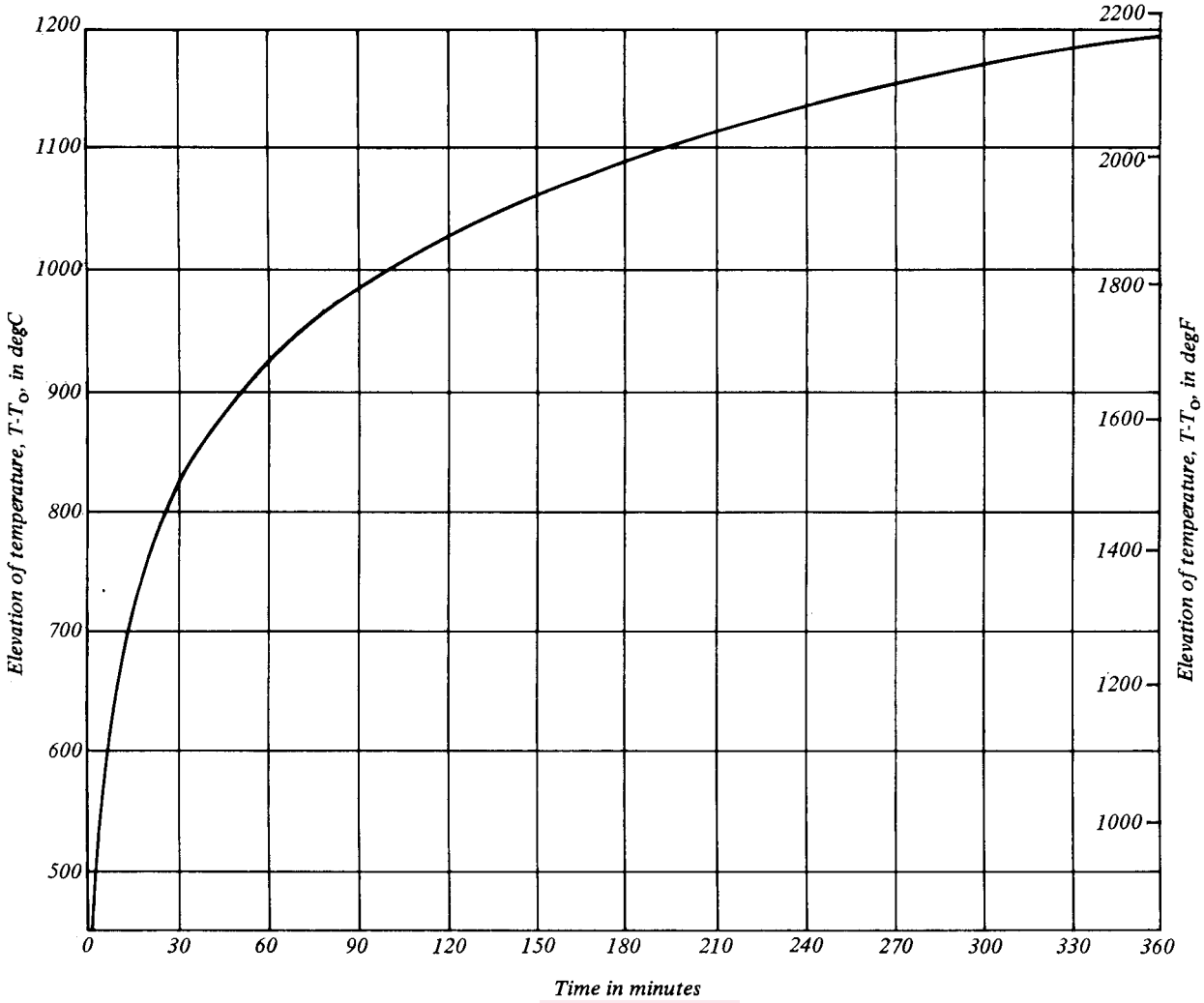

FIGURE – **Standard time-temperature curve**

3.2.2 The curve representing the function described in clause 3.2.1 is named the "standard time-temperature curve" (see Figure above).

The relationship expressed in clause 3.2.1 gives the values shown in the Table below.

TABLE – **Temperature rise as a function of time**

Time *t* in minutes	**Elevation of furnace temperature $T - T_o$**	
	degC	degF
5	556	1033
10	659	1218
15	718	1325
30	821	1510
60	925	1697
90	986	1807
120	1029	1886
180	1090	1994
240	1133	2072
360	1193	2180

3.3 Measurement of furnace temperature

3.3.1 The furnace temperature is deemed to be the average of the temperatures recorded by thermocouples, symmetrically arranged within the furnace to give an approximation of its average temperature.

3.3.2 These thermocouples should not be fewer than

- one to each 1.5 m^2 (16.1 ft^2) of surface for walls and floors;
- one to each 1 m (3 ft 3 $\frac{1}{2}$ in) of length for beams;
- two to each 1 m (3 ft 3 $\frac{1}{2}$ in) of height for columns.

3.3.3 Bare wire thermocouples not less than 0.75 mm (0.03 in) in diameter should be arranged so that the hot junction is 100 mm (4 in) from the nearest point of the test specimen. This distance should be kept as constant as possible during the test.

The wires of the thermocouples should be placed in open tubes of heat-resisting material, for example porcelain, within 25 mm (1 in) of the hot junction.

3.4 Tolerances for furnace temperatures

The accuracy of the temperature control should be such as to satisfy the following two sets of tolerances for furnace temperatures :

3.4.1 *Tolerances for mean deviation.* The mean deviation of the furnace temperature as a percentage is given by the following expression :

$$\left| \frac{A - B}{B} \times 100 \right|$$

where

A is the integral value of the average furnace temperature as a function of time,

B is the integral value of the function specified in clause 3.2.1.

The tolerances on the mean deviations are as follows :

(1) ± 15 % during the first 10 minutes of test;

(2) ± 10 % during the first half-hour of test;

(3) ± 5 % after the first half-hour of test.

3.4.2 *Tolerances for single average values.* At any time after the first 10 minutes of test, the average furnace temperature should not differ from the corresponding temperature of the standard time-temperature curve by more than ± 100 degC (180 degF), even for combustible materials.

4. PREPARATION OF TEST SPECIMENS

4.1 Dimensions of test specimens

4.1.1 The test specimens should be full size wherever possible.

4.1.2 Where this is not possible, the following minimum dimensions of the parts of a test specimen exposed in the furnace are recommended :

–	Walls and partitions :	height	2.5 m (8 ft 2 $\frac{1}{2}$ in)
		width	2 m (6 ft 6 $\frac{3}{4}$ in)
–	Floors :	span	4 m (13 ft 1 $\frac{1}{2}$ in)
		width	2 m (6 ft 6 $\frac{3}{4}$ in)
–	Beams :	span	4 m (13 ft 1 $\frac{1}{2}$ in)
–	Columns :	height	3 m (9 ft 10 in)

4.2 Construction of test specimens

4.2.1 The test should be made on a test specimen representative of a complete element of structure. For example, a partition should include at least one of each representative type of joint (see also clause 5.2.3.1). The methods of fixing and supporting the components and the finishes used should be as in service.

4.2.2 The materials and standard of workmanship of the test specimen should be representative of those applying in good practice, as defined by existing national codes and standards.

4.3 Conditioning of test specimens

The test specimen should be conditioned in such a way that it corresponds as closely as possible, in moisture content and mechanical strength, to the expected state of a similar element in service.

4.3.1 *Moisture content.* The test specimen should not be tested until its moisture content is in equilibrium with an ambient atmosphere approximating to that expected in service. This equilibrium may be checked either on the test specimen itself or on a representative sample.

The drying of the test specimen may be by natural or artificial means, but a temperature should not be reached which could impair the fire-resisting properties of the element. It is recommended that a temperature of 60 °C (140 °F) should not be exceeded.

4.3.2 *Mechanical strength.* For loadbearing elements the constituent materials of the specimen should have attained a mechanical strength close to that expected for a similar element in service.

5. PROCEDURE

5.1 Conditions of test

5.1.1 *Restraint and loading*

5.1.1.1 The role of the element in service should be analysed so that the methods adopted for supporting or restraining the ends or sides of a test specimen during a test are as far as possible similar in nature to those which would be applied to a similar element in service.

5.1.1.2 For floors and beams with uncertain or variable boundary service conditions the test specimen should be simply supported all round the edges or at the ends.

5.1.1.3 Before heating, a loadbearing test specimen should be subjected to a loading which produces stresses of the same magnitude as would be produced normally in the full-size element when subjected to the design load.

5.1.1.4 The loading should be maintained constant during the test period.

5.1.1.5 Test specimens of non-loadbearing elements should not be loaded during test.

5.1.2 *Exposure in furnace*

5.1.2.1 *Free-standing columns* should be tested by applying heat on all sides over their whole height.

5.1.2.2 *Separating elements* represented by test specimens of elements which have the function of separating spaces should be heated over the whole of one face only.

Those which may be required to resist fire in one direction only should be tested in that direction.

Those which may be required to resist fire from either direction should be tested in the direction considered to give the lower resistance by the testing authority.

In cases of doubt, each face should be tested on separate test specimens.

5.2 Observations during test

5.2.1 *Stability*

5.2.1.1 During a test, the deformation of the test specimen should be measured, and note should be made of the moment when collapse takes place.

5.2.1.2 For a loadbearing test specimen the time at which it can no longer support the test load should be noted.

5.2.2 *Integrity*

5.2.2.1 Observations should be made of cracks, holes or other openings through which flames or gases could pass in a test specimen of a separating element.

5.2.2.2 When there is doubt about the ability of flames or hot gases to pass through such openings, a pressure difference should be created so that the furnace pressure exceeds the pressure on the unexposed face by 15 ± 5 N/m^2 (1.5 ± 0.5 mmH_2O or 0.06 ± 0.02 inH_2O) and observations made of the ignition of a pad of cotton wool held 20 to 30 mm (about 1 in) from the opening on the unexposed side, indicating the emission of hot gases.

NOTE. – The pressure differential may also be achieved by lowering the pressure on the unexposed face.

5.2.3 *Insulation*

5.2.3.1 *Average temperature of unexposed face.* In the case of elements with an unheated surface, the temperature of the unexposed face should be measured by means of not less than five thermocouples, one placed approximately at the centre of the face and the others approximately at the centres of the straight lines joining the centre and the corners.

Any points of measurement additional to these five thermocouples should be disposed as uniformly as possible over the unexposed face of the specimen.

In the case of structures comprising composite elements, the arrangement of the test specimen should ensure that the joints do not coincide with the points of measurement specified above.

The average of the temperatures measured at the points specified above, omitting temperatures measured at joints, is deemed to be the temperature of the unexposed face.

5.2.3.2 *Maximum temperature of unexposed face.* In addition, the temperature should be measured at the point that appears to be the hottest at any time during the test.

This temperature should not be used in the calculation of average temperature, but should be taken into account in determining whether the maximum temperature criterion has been complied with.

5.2.3.3 *Temperature measurement.* Surface temperatures are measured by means of thermocouples with a wire diameter of 0.5 mm (0.02 in).

Each thermocouple junction should be attached to the centre of the face of a copper disk 12 mm (0.47 in) in diameter and 0.2 mm (0.008 in) thick, which is secured to the surface of the specimen at the required position.

The disks should be covered with oven-dry square asbestos pads 30 mm × 30 mm (1.2 in × 1.2 in) and 2 mm (0.08 in) thick.

The disk and the pad may be fixed to the surface of the specimen by pins, tape or a suitable adhesive, depending on the nature of the material forming the side of the specimen.

5.2.4 *Additional observations.* Throughout the test, observations should be made of all changes and occurrences which are not criteria of performance but which could create hazards in a building, for example the emission of appreciable volumes of smoke or noxious vapours from the unexposed side of a separating element.

5.3 Duration of test

5.3.1 The test specimen should be heated, in the prescribed manner, normally until failure occurs under any one of the relevant test requirements, namely :

- stability (see clause 6.2.1),
- integrity (see clause 6.2.2),
- insulation (see clause 6.2.3).

5.3.2 In tests other than those on test specimens judged only by the criterion of stability (see clause 6.2.1) the testing may be continued after failure under either of the other two conditions (see clause 6.2.2 or 6.2.3) by prior agreement between the sponsor of the test and the testing authority until failure occurs under the other condition, provided collapse of the specimen has not already occurred.

5.3.3 Alternatively the test may be concluded after a period determined by prior agreement between the sponsor and the testing authority, even if no failure under any of the conditions has occurred at the end of that time.

5.3.4 The length of time from the commencement of heating for which the test specimen complies with the relevant requirement(s) should be expressed in hours and minutes.

6. EXPRESSION OF RESULTS

6.1 Fire resistance

6.1.1 The fire resistance of test specimens is the time, expressed in hours and minutes, from commencement of the test until failure occurs, under the conditions (stability, integrity, insulation) appropriate to the test.

6.1.2 If more than one test specimen of the same element is tested the result which should be taken is that which gives the shortest time of compliance with the test requirements.