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Fire Endurance Tests in the Development of Building Materials and Building Components

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TECHNICAL NOTE

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APPROVED BY NBH

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PREPARED FOR

Inquiry and record purposes

SUBJECT

FIRE ENDURANCE TESTS IN THE DEVELOPMENT OF
BUILDING MATERIALS AND BUILDING COMPONENTS

The trend in building regulations to define materials in terms of performance rather than by specification has resulted in an increased dependence on performance testing. Consequently, anyone concerned with the development or use of modern building materials or components needs to know something of the test methods that are available and something of the performance that may be expected of typical materials when tested.

The Fire Section, Division of Building Research, has been engaged in fire endurance testing of structural elements for some years and has also developed some techniques for measuring the basic properties of building materials when exposed to high temperatures. A number of publications of the Division of Building Research that deal generally with the problems of fire endurance testing and fire performance of building materials are described briefly in this note.

FIRE IN BUILDINGS

The occurrence of fire in buildings can never be completely eliminated. People carry matches, use combustible materials for clothing and furnishings and make widespread use of paper products. It is, therefore, desirable to design buildings that provide safe means of escape, limit the probable size of a fire and maintain structural stability for a reasonable period. Some contribution to each of these objectives is made by the use of construction that has demonstrated ability to endure fire exposure. This subject is covered more fully in reports published by the Division of Building Research (references 1 to 4).

STANDARD TESTS

In order to compare the fire enduring properties of different building elements certain fire tests have been developed and have become recognized as standards. The tests that are generally accepted in this country and are recognized by the National Building Code of Canada are:

- (a) Methods of Fire Tests of Walls, Partitions, Floors, Roofs, Ceilings, Columns, Beams and Girders, CSA B54.3, 1964
- (b) Standard Methods of Fire Test of Building Construction and Materials, ASTM E119-1961, of the American Society for Testing and Materials
- (c) Fire Tests of Building Materials and Structures, BS 476 Part 1, 1953, of the British Standards Institution, London, England.

FACILITIES FOR TESTING

The facilities that are available in Canada for conducting standard fire endurance tests are:

- (1) The wall and floor furnaces of the Fire Section, Division of Building Research
- (2) Two floor furnaces at Underwriters' Laboratories of Canada, Scarborough, Ontario

There is no column or beam furnace in Canada, though beams and steel columns can be tested in floor furnaces by the ASTM alternate methods. The alternate methods of standard fire test permit the specimens to be tested without load. Failure is then dependent on temperature rise in the steel.

The tests are conducted on large specimens; not less than 100 sq ft for walls and not less than 180 sq ft for floors or roofs and are in consequence rather costly. The facilities of the Division of Building Research are described in Fire Study No. 1, (5). Details of the tests, the construction of a test assembly and how to apply for a test at the Division of Building Research are described in Technical Note No. 267 (6).

In order to provide a less expensive means for comparing the fire performance of building assemblies the Fire Section has developed a small furnace. This takes a specimen 2 ft 6 in. by 2 ft 6 in. and can be tipped up or down to simulate either a floor or a wall test. The results obtained by this small furnace have shown reasonably good agreement with

those obtained by the standard furnace. Testing in small scale can be of considerable value when new materials or components are being developed. The furnace is described in Fire Study No. 14 (7).

IDENTIFICATION

In order to make the result of a fire test meaningful, it is essential that the assembly be accurately described and the materials properly identified. The identification is best done by revealing certain basic properties of all materials contained in the specimen to be subjected to a standard fire test. The Fire Section has developed equipment to measure some of the basic material properties such as strength, thermal conductivity, dimensional change, etc., at high temperatures. The information obtained by these basic tests may in time provide a reliable method for predicting the behaviour of materials and components in fire. The need for identification of materials is discussed in Technical Note No. 379 (8).

PROPRIETARY MATERIALS

There are a number of recently developed building materials on the market that are of a proprietary nature. The developers do not, in many cases, wish to have information on the composition or fabrication of their products disclosed; yet publication of the result of a fire test without adequate identification would serve little useful purpose and might on occasion be positively misleading. To some extent this objection can be removed by reporting only the physical properties of such materials and thus establish the nature of the materials without disclosing their composition.

There is, however, another method of publishing test information without disclosing details of manufacture. This is the system operated by Underwriters' Laboratories of Canada, who carry out standard fire tests, list the assemblies, make regular factory inspection of the product and issue labels to indicate that the material is the same as that in the tested assembly.

COMPARISON

The development of a new product may often involve comparison with older products. In addition, some knowledge of the effect of changes in an assembly may be of advantage to the designer. Based on some experimental and theoretical work, the Division of Building Research has prepared a Fire Research Note (9) that may be found useful in assessing probable performance and may enable unrealistic proposals to be rejected without costly testing.

Ratings based on acceptable fire tests are published as Supplement No. 2 (10), (11) of the National Building Code. The test information that was assembled during the preparation of Supplement No. 2 is now being published separately as compilations of the available published test reports.

These are:

1. Fire Endurance of Protected Steel Columns and Beams, Technical Paper No. 194 (12)
2. Fire Endurance of Unit Masonry Walls, Technical Paper No. 207 (13)
3. Fire Endurance of Light Framed and Miscellaneous Assemblies, in preparation
4. Fire Endurance of Concrete Assemblies, in preparation.

FIRE RESISTANCE RATINGS

It is the responsibility of the person authorized to administer a regulation such as a municipal bylaw or provincial statute to establish a fire resistance rating. Information based on tests can serve only as a guide to the responsible authority. The National Building Code of Canada has set out three criteria for establishing a fire resistance rating. These are:

- (1) a report of a standard fire test (see p. 2)
- (2) an entry in Supplement No. 2, Fire Performance Ratings of the National Building Code and
- (3) a listing in the Underwriters' Laboratories of Canada Building Construction List (11).

FIRE TESTING OF A BUILDING ASSEMBLY

If a proposed assembly is not described in Supplement No. 2, is not listed in Underwriters' Laboratories of Canada Building Construction List and is not described in an existing fire test report, it may be necessary for a standard fire test to be conducted.

The Division of Building Research is prepared to conduct a standard fire test for a Canadian sponsor on the basis of an agreed fee. When the test is completed a confidential report is prepared for the sponsor. This cannot be reproduced without the permission of the National Research Council but may be used as evidence that the assembly has the required fire resistance (4). Furthermore, if the sponsor is prepared to disclose sufficient information about his product to ensure that it can be correctly identified and reproduced, the test report may be issued in the Fire Study Series as a publication of the Division of Building Research (4).

If a listing in U. L. of C. 's Building Construction List is desired, this may be obtained by arrangement with Underwriters' Laboratories of Canada (4).

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