The use of closures in fire separations

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SUBJECT THE USE OF CLOSURES IN FIRE SEPARATIONS

The Associate Committee on the National Building Code has, over the years, been concerned with the development of performance requirements in the National Building Code, and with the provision of technical information necessary for the application of these requirements.

The Fire Test Board was established by the Associate Committee on the National Building Code, with responsibility to advise on the contents of Supplement No. 2, Fire Performance Ratings of the National Building Code. The work completed covers fire resistance ratings for walls, floors, columns and beams, and flame spread ratings for surface finishes. It now seems appropriate for the Fire Test Board to consider also the fire performance of the closures that are needed at openings in order to maintain the integrity of fire separations.

This Note has been prepared in order to provide the basic information needed for the consideration of this subject. It appears that many aspects of the study should be considered by the Associate Committee on the National Building Code as well as by the Fire Test Board, as there are a number of situations created by the present provisions of the National Building Code that might be resolved by changes in the Code.

COMPARTMENTS AND CLOSURES

One of the measures that can be incorporated in the initial design of a building to reduce fire hazard is to provide for the subdivision of the building into suitable fire-resistive compartments. Some of these separations are required by the National Building Code, e.g., between floors, around stair wells, and between different occupancies.

If this intended subdivision is to be effective, the separation must be complete: the walls or floors must be without openings through which fire may pass. In practice, however, openings have to be provided in fire separations for access and for ductwork. Any opening in a fire separation must be protected by a closure or by some alternative protection such as a water curtain. The National Building Code of Canada defines a closure as "the complete assembly of a fire door or doors or shutters and equipment including hardware closing devices, frames and anchors".

A closure may be either a door or a damper assembly and may be expected to perform one or more of the following functions.

(1) Limit the transfer of heat and hot gases,

(2) Limit the passage of flame,

(3) Limit the passage of smoke.

Some closures, e.g., those between storage areas, may be intended to limit the spread of fire, and others, such as doors in corridors, may be required to limit the passage of smoke only. It may be assumed that dampers are provided to stop the passage of flames along a duct. It is generally assumed in all cases that combustible materials will not be placed in close proximity to a fire door. The need for compartments and closures is discussed more fully in CBD 33 (1).

THE STANDARD METHODS OF TESTS

The standard fire test for door assemblies recognized in Canada is CSA B54.4, 1963 (2). This fire test is the same in essential features as ASTM E152-58 (3).

The test is made on a complete assembly of door frame and hardware, not on the door alone. The furnace is the same as that used

for a standard wall test and follows the same time-temperature curve. Swinging doors are required to be mounted to open into the furnace chamber with clearances of 3/32 in. at the top and sides and 3/16 in. at the bottom. Sliding doors are mounted on the fire-exposed side of the opening. Immediately following the fire endurance test the assembly is exposed to impact, erosion and cooling effects of a hose stream.

The fire test is regarded as successful if, during the fire endurance test, the door assembly remains in the opening for a period equal to that for which classification is desired, remains there during the hose stream test, and meets the following conditions.

(a) "No openings shall have developed through the assembly. The dislodgement of small portions of glass during the hose stream test shall be disregarded.

(b) Doors mounted on the face of the wall shall not separate from the wall by more than the thickness of the edge of the door at the point of separation.

(c) Doors mounted in guides shall not release from guides and guides shall not loosen from fastenings.

(d) In the case of swinging doors, the edges shall not move from the original position more than the thickness of the door during the first half of the period for which classification is desired, and more than 1 1/2 times the thickness during the whole fire endurance test nor as a result of the hose stream test.

(e) An assembly of a single swinging door shall not exhibit a separation of more than 1/2 in. at the latch location.

(f) An assembly of a pair of swinging doors shall not separate more than 3/4 in. or equal to the throw of the latch bolt at the latch location."

There is provision in the method of test for measuring temperatures on the unexposed surface of the door. This is not used as a criterion for failure. There is no provision limiting the passage of smoke or flames during the test.

UNDERWRITERS' LABORATORIES

Underwriters' Laboratories Inc., Chicago, Ill., conduct fire tests, publish lists and provide labels to identify "fire doors", and "frame and fire door assemblies". The U.L. Test No. C10 (b) (4) is

the same as ASTM E152. Underwriters' Laboratories describe the door assemblies as: 3 hr (A), 1 1/2 hr (B), 1 hr (B), 3/4 hr (C), 1 1/2 hr (D) and 3/4 hr (E). In addition to the time period and the letter indentification, U.L. in some cases further identify door assemblies as "250° F max. at 30 min" and "650° F max. at 30 min".

The installation of these doors to comply with U.L. classification is required to be in accordance with the Standard for the Installation of Fire Doors and Windows of the Canadian Underwriters' Association, CUA 80 (5). This document explains that the letters following the fire resistance rating are intended to define the end use as follows:

(a) "Class A openings are in walls separating buildings or dividing a single building into fire areas. Doors for the protection of these openings have a fire protection rating of 3 hr and except by special permission of the authority having jurisdiction should be installed on each side of the wall.

(b) Class B openings are in enclosures of vertical communication through buildings (stairs, elevators, etc.). Doors for the protection of these openings have a fire protection rating of 1 or 1 1/2 hr.

(c) Class C openings are in corridors and room partitions. Doors for the protection of these openings have a fire protection rating of 3/4 hr."

(d) Classes D, E and F openings are for doors in exterior walls that are subject to fire exposure from outside the building. As the National Building Code makes no provision for such fire exposure, these are not of direct concern to users of the National Building Code.

The CUA Standard No. 80 also describes in some detail a number of frames and certain minimum specifications for the hardware that may be used with the fire doors to provide the described fire resistance. This does not mean, however, that any frame or hardware meeting these specifications is acceptable; a fire test for U.L. inspection is also required. In all cases a labelled fire door must be used in conjunction with a labelled frame and labelled hardware.

Underwriters' Laboratories do not list or label a door frame or assembly having a fire resistance of 20 min.

UNDERWRITERS' LABORATORIES OF CANADA

Underwriters' Laboratories of Canada have at present no facilities for testing doors but do operate a fairly extensive listing and labelling service using the Underwriters' Laboratories in Chicago for tests when these are needed.

U.L. of Canada lists door assemblies using the same letter classification as U.L. Inc. The U.L. of Canada list includes 29 manufacturers of fire doors (27 being Canadian), 13 manufacturers of frames (12 being Canadian) and one each of fire exit hardware and door holders.

NATIONAL BUILDING CODE REQUIRED FIRE RESISTANCE OF CLOSURES

The requirements of the National Building Code (6) for fire resistance of closures is related to that of the separations as follows:

Fire Resistance of Separation, hr	Fire Resistance of Closures, hr
3/4	3/4
1	3/4
1 1/2	1
2	1 1/2
3	2
4	3

The 3/4-hr separation is required in smaller buildings up to 3 or 4 storeys in height. The 1 1/2-hr separation is required only around furnace rooms of 1- and 2-storey buildings. The 3- and 4-hr separations are applied only in the larger and higher buildings of Class F high hazard industrial occupancy. The separations commonly required are, therefore, 3/4 hr, 1 hr and 2 hr and the related closures would be 3/4 hr and 1 1/2 hr.

1 3/4 in. Solid Core Doors

There are two escape clauses, (3.2.2.4(2)) and (3.2.2.4(11)), that permit the use of 1 3/4-in. wood solid-core doors in fire separations of 1 hr or less between a corridor and a room or suite of rooms.

Provisions Covering Dampers

It may be assumed that the requirements for closures described above apply equally to the provision of dampers in ducts that pass through a fire separation. The National Building Code does describe the use of dampers in fire-resistive ceilings. There is no recognized standard test for dampers. It appears, however, that dampers in ducts are covered in the NBC by reference to the NFPA standards for heating installations, NFPA 90A.

Smoke Control Zones

A recent development has been the introduction of provisions for the creation of smoke control zones, which apply at present only to hospital buildings and are intended to assist in the evacuation of the temporarily disabled occupants. The requirements for smoke control doors include the provision of weatherstripping to ensure a smoke-tight seal.

This is a more stringent requirement than that of the standard door test, although it may have been the intention of the NBC that every closure be smoke tight. Clause 3.1.3.7 of the NBC 1965 defines a fire separation and requires "that every opening be protected with closures or other means effectively sealed against the passage of smoke and flame".

RESIDENTIAL STANDARDS

"Residential Standards" (7) is the title of one of the supplements to the National Building Code. As a supplementary document, the Standards describe in more detail, ways in which the NBC requirements can be met. These Standards apply to one- and two-family dwellings and to apartment buildings of any size or height. For buildings over 3 storeys in height above the foundation, the structural requirements of the Code supersede those of the Residential Standards, but this does not extend to fire protection.

Residential Standards provide that doors between suites and a common corridor shall be either 20-min fire doors or 1 3/4-in. solid-core wood doors. On doors to stairs, common lounges, storage rooms, laundries, etc., a 3/4-hr door in a 1-hr separation is required. The doors to furnace rooms are 1 hr or 1 1/2 hr as in the NBC.

CENTRAL MORTGAGE AND HOUSING CORPORATION

CMHC uses Residential Standards as a basis for mortgage approval of residential buildings. In order to assist their inspectors, CMHC also issues a list of acceptable building materials systems and equipment (8).

This includes a number of doors and frames. The doors are all accepted for use in Class A, B, C, D, or E locations, following the U.L. method of classification. The frames, all at present of steel, are accepted for use in openings where 1-hr or 1 1/2-hr fire resistance is specified. There is no reference to hardware on the CMHC list and there is no door or frame listed as being suitable for use in openings where only 20-min fire resistance is required.

FIRE DAMPERS

The National Building Code does not make special provision for dampers, but it is assumed that the general requirement for closures in fire separations will apply. This suggests that a damper should meet the conditions of the standard fire test for door assemblies. Underwriters' Laboratories list a few multiple blade dampers (9). It is understood that the provisions of the standard door test are modified slightly for this purpose, the maximum opening between blades being limited to 3/4 in. during fire exposure and 1 in. during the hose stream test.

The National Building Code makes reference to the standard for the installation of air conditioning and ventilating systems, NFPA 90A of the National Fire Protection Association (10). In this standard, dampers are specified by minimum thickness of metal for certain openings as an alternative to the standard tests (2, 3, 4).

WIRED GLASS

The National Building Code permits limited use of wired glass in openings in 3/4- and 1-hr separations. Underwriters' Laboratories place limits on the use of wire glass depending on the intended use classification and the material of which the door is made.

PUBLISHED TEST INFORMATION

The published test information that is available at present on a fire resistance of door assemblies covers wood panelled and flush doors

in wood or metal frames. The fire resistance of these assemblies varies from 10 min to 1 hr. It is evident that the fire resistance of the assembly depends on the design of the door, the frame, and the hardware.

Door assemblies incorporating a common wood frame may have a fire resistance of 10 to 15 min. Forest Products Laboratories have improved the fire performance of the frame by impregnation with a fire-retardant solution, and the British and French fire testing authorities have obtained good results by increasing the depth of the rebate to 1 in.

The tests on which Underwriters' Laboratories base their listings are not published, although copies of the test reports are made available to the sponsors.

TEST FACILITIES

The only test facilities that are at present available in Canada for testing door assemblies are those of the Fire Section, Division of Building Research. Tests are conducted on complete door assemblies for individual sponsors who will receive a confidential test report. If the sponsor is prepared to disclose an accurate description of the assembly, the Division may publish the test report in the Fire Study series.

SUMMARY AND CONCLUSIONS

1. The standard tests (2, 3, 4) apply to an assembly of door, frame, and hardware; a substitution in any one of these may change the fire resistance significantly. Underwriters' Laboratories have attempted to simplify their problem by specifying the frames and hardware and by listing approved manufacturers of all three.

2. The standard tests do not limit the passage of flames or smoke. The National Building Code has introduced provisions for a smoke stop door that in this respect is more stringent than the standard fire door, although it has no fire resistance as such.

3. The Underwriters' Laboratories letter classification of door openings imposes, in many cases, a higher fire resistance than is called for in the National Building Code. This is evident in the CMHC Approved Materials List, where the alternative to a 1 3/4-in. solid-core wood door may be a Class B or a Class C door having

1 1/2-hr or 3/4-hr fire resistance. The U.L. listing does not go as low as 20-min fire resistance.

4. A 1 3/4-in. solid-core wood door in a standard wood frame may be expected to have a fire resistance of about 15 min.

5. There may be a need to distinguish between closures in fire separations around compartments having a fire load, and closures between corridors and stairs where there is no fire load on either side. If there is an adequate separation between a corridor and rooms containing a fire load there does not seem to be a need for a fire-resisting closure to the stairs. It would, however, be to great advantage if the door between corridor and stairs were a smoke stop door as described in the 1965 National Building Code.

6. There is sufficient published information available on which to base a short list of doors, frames and hardware that may be expected to have 20-min or 3/4-hr fire resistance. The doors might be one of the following:

   (1) solid-core wood,

   (2) hollow core with insulation,

   (3) flush panelled doors with gypsum wallboard or asbestos millboard sandwich filling.

   The frames would be wood with 1 in. rebate, fire-retardant treated wood or steel.

   This list would provide a basis for classifying door assemblies for stairs, suites, etc., and would provide information on the doors that are most commonly required by the NBC, leaving to U.L. of Canada the listing of doors having higher fire resistance. Changes in the NBC and in Residential Standards would become necessary in order to eliminate conflicts and inconsistencies.

REFERENCES

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