Guide to BOCA/NBC Requirements for Concrete and Masonry Fire Walls

Introduction

Properly designed and constructed fire walls provide an effective means of stopping or controlling the spread of fire. A generic definition of the term “fire wall” is “a wall of sufficient durability and stability to withstand the effects of the most severe anticipated fire exposure.”¹ In addition, any openings in the wall, if allowed, must be protected.

The BOCA National Building Code (hereafter referred to as BNBC or “the code”) recognizes areas separated by fire walls as being separate buildings. Insurance underwriters also acknowledge this by applying rates individually to each fire area when fire walls used in compartmentation are constructed of concrete or masonry.

Fire walls must meet fire-rating requirements of the code in accordance with ASTM E119 test procedures.² Structural and other requirements of the code must also be considered in fire-wall design, but these are outside the scope of this report. The text that follows will generally focus only on the fire-related provisions of the code applicable to concrete and masonry fire walls, based on the 1987 edition of the BNBC.³

Purpose

The purpose of this report is to provide building officials and the design community with information on the code requirements germane to concrete and masonry fire walls.

The report contains
1. The code’s definition of a fire wall and characteristics common thereto
2. Fire-rating requirements for fire walls and their components (parapets, opening protectives, and so forth)
3. Conceptual drawings of wall-roof connections and restraining conditions necessary for fire walls to meet the code’s stability criterion during a fire

Concrete, clay-brick, and concrete masonry (top, middle, bottom) fire walls provide excellent barriers for containing the spread of fire from one side of the wall to another.
Common Characteristics of Fire Walls

In general, fire walls share the following characteristics:
1. Areas divided by them are considered separate buildings
2. The number needed in a structure is generally governed by height and area restrictions that are based on occupancy and construction type
3. All openings in fire walls must be protected by appropriate fire-rated assemblies

What Is a Fire Wall?

The BNBC defines a fire wall as follows:
Fire wall—a fireresistance-rated wall, having protected openings, which restricts the spread of fire and extends continuously from the foundation to or through the roof.*

Section 908.1 further expands on the definition: [Fire] walls shall have sufficient structural stability under fire conditions to allow collapse of construction on either side without collapse of the wall, and shall be constructed of any approved noncombustible materials providing the required strength and fireresistance rating specified in Table 401 for the type of construction, but not less than the fire grading of the use group specified in Table 902.*

Additional requirements for fire walls are provided in other subsections of Section 908.0 of the code. Applicable subject matter includes cutting of walls, hollow walls, combustible insulation, continuity of walls, and offset fire walls.

Structural strength and stability requirements are found in Articles 11 and 21 but are outside the scope of this report.

Fireresistance Requirements

The required fire-endurance rating of a fire wall is a function of construction type and use group. Ratings based on construction type are indicated in Table 401. Use-group requirements are referenced by this table and specified in Table 902. The more severe of the two requirements dictates the assembly's minimum fire-resistance rating. Requirements from these tables pertaining to fire walls are shown here in Tables 1 and 2. Thicknesses of concrete and masonry wall assemblies corresponding to these ratings can be determined from Fig. 1, Table 3, or Table 4 accordingly.(4)

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Table 1. Fireresistance Ratings of Structure Elements, in Hours*

<table>
<thead>
<tr>
<th>Structure element, note a</th>
<th>Type of construction, Section 401.0</th>
<th>Noncombustible</th>
<th>Noncombustible/Combustible</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Type 1 Section 402.0</td>
<td>Protected</td>
<td>Protected</td>
</tr>
<tr>
<td></td>
<td>Type 2 Section 403.0</td>
<td>Protected</td>
<td>Unprotected</td>
</tr>
<tr>
<td></td>
<td>Type 3 Section 404.0</td>
<td>Protected</td>
<td>Unprotected</td>
</tr>
<tr>
<td></td>
<td>Type 4 Section 405.0</td>
<td>Heavy timber, note b</td>
<td></td>
</tr>
<tr>
<td>1. Fire walls and party walls (Section 906.0)</td>
<td>4</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

Note a. For increased fireresistance-rating requirements in special high-hazard uses involving a higher degree of fire severity and higher concentration of combustible contents, see Section 600.2. For fireresistance-rating requirements for structural membranes and assemblies that support other fireresistance-rated members or assemblies, see Section 912.1.

Note b. For substitution of other structural materials for timber in Type 4 construction, see Section 1702.2.

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When Are Fire Walls Required?

Height and area limitations, based on the occupancy and type of construction, govern the number of fire walls required within a given structure. For new construction, areas and heights of all buildings and structures between exterior walls, or between exterior walls and fire walls, must not exceed the limits specified in Table 501 of the code (not shown here).

The tabular height and area values may be modified by Sections 501, 502, 503, 504, and notes to Table 501.

Mixed Occupancies

Where different use groups occur on either side of a fire wall, the fire-endurance rating of the wall shall be the higher of (1) the value from Table 401 (Table 1 here) based on type of construction or (2) the higher value from Table 902 (Table 2 here) for each individual occupancy.

Fire-Wall Components

In designing fire walls, important aspects to consider are structural stability, fire-resistance rating requirements, and the design and protection of integral wall components. Three of these components—parapets, openings, and penetrations—are discussed below.

Parapets and Wall Continuity

A parapet is that part of any wall entirely above the roof line (see photo, front page). As an extension of a fire wall, its function is to prevent the spread of fire across the roof from one building to another. The code requires that the fire-wall parapet extend 2 ft 8 in. above the roof surface. Where a noncombustible roof is present, the wall is permitted to terminate at the underside of the roof deck provided the roof is properly firestopped at the wall. Other exceptions are indicated in Section 908.5.2 of the code.

Table 2. Fire Grading of Use Groups*

<table>
<thead>
<tr>
<th>Use group</th>
<th>Fire grading in hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-1</td>
<td>Assembly, theaters</td>
</tr>
<tr>
<td>A-2</td>
<td>Assembly, night clubs</td>
</tr>
<tr>
<td>A-3</td>
<td>Assembly, recreation centers, lecture halls, terminals, restaurants</td>
</tr>
<tr>
<td>A-4</td>
<td>Assembly, churches</td>
</tr>
<tr>
<td>B</td>
<td>Business</td>
</tr>
<tr>
<td>E</td>
<td>Educational</td>
</tr>
<tr>
<td>F</td>
<td>Factory and Industrial</td>
</tr>
<tr>
<td>H</td>
<td>High hazard</td>
</tr>
<tr>
<td>I-1</td>
<td>Institutional, residential care</td>
</tr>
<tr>
<td>I-1</td>
<td>Institutional, incapacitated</td>
</tr>
<tr>
<td>I-3</td>
<td>Institutional, restrained</td>
</tr>
<tr>
<td>M</td>
<td>Mercantile</td>
</tr>
<tr>
<td>R-1</td>
<td>Residential, hotels</td>
</tr>
<tr>
<td>R-2</td>
<td>Residential, multifamily dwellings</td>
</tr>
<tr>
<td>R-3</td>
<td>Residential, 1- and 2-family dwellings</td>
</tr>
<tr>
<td>S-1</td>
<td>Storage, moderate hazard</td>
</tr>
<tr>
<td>S-2</td>
<td>Storage, low hazard</td>
</tr>
</tbody>
</table>

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Table 4. Minimum Equivalent Thickness in Inches of Load-Bearing Concrete Masonry Unit Walls for Fire-resistance Ratings

<table>
<thead>
<tr>
<th></th>
<th>4 hour</th>
<th>3 hour</th>
<th>2 hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expanded slag or pumice</td>
<td>4.7</td>
<td>4.0</td>
<td>3.2</td>
</tr>
<tr>
<td>Expanded clay, shale, or slate</td>
<td>5.1</td>
<td>4.4</td>
<td>3.6</td>
</tr>
<tr>
<td>Limestone, cinders, or slag</td>
<td>5.9</td>
<td>5.0</td>
<td>4.0</td>
</tr>
<tr>
<td>Calcareous and siliceous gravel</td>
<td>6.2</td>
<td>5.3</td>
<td>4.2</td>
</tr>
</tbody>
</table>

Reproduced from Table 1405.6.1 of the BOCA Code, 1987.*

Fire ratings for the thicknesses between tabulated values may be obtained by direct interpolation.

BOCA—Walls composed of hollow concrete masonry units having a nominal thickness of 8 in. or greater and having a fire-resistance rating of at least two hours shall be classified as four hours when the hollow spaces are completely filled with insulation, grout, or a dry granular material such as expanded slag, clay, shale, or sand.

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Table 3. Fire-resistance Periods for Load-Bearing Clay and Shale Brick Walls*

<table>
<thead>
<tr>
<th>Nominal</th>
<th>Wall type</th>
<th>Ultimate fire-resistance period in hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>wall</td>
<td></td>
<td></td>
</tr>
<tr>
<td>thickness, in.</td>
<td>Wall type</td>
<td>Noncombustible members framed into wall or no framed-in members</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No plaster</td>
</tr>
<tr>
<td>4</td>
<td>Solid</td>
<td>1½</td>
</tr>
<tr>
<td>8</td>
<td>Solid</td>
<td>5</td>
</tr>
<tr>
<td>12</td>
<td>Solid</td>
<td>10</td>
</tr>
<tr>
<td>12</td>
<td>Solid</td>
<td>12</td>
</tr>
<tr>
<td>9 to 10</td>
<td>Cavity</td>
<td>5</td>
</tr>
</tbody>
</table>

1BOCA references BIA "Building Code Requirements for Engineered Brick Masonry." Table 3 is a reprint from that standard.
2Based on load failure.
3Based on temperature rise (for non-load-bearing walls).
4Based on temperature rise (for non-load-bearing walls).
In a case where two buildings of different heights are separated by a fire wall, the code's criterion for a fire wall applies only to that part of the wall up to the point where the fire wall would normally terminate if both buildings were the height of the lower of the two.

The portion of the wall above the fire-wall termination point must comply with requirements in Tables 401 and 906.2 for exterior walls with zero fire-separation distance. Openings in the portion of the wall above the fire wall and within 15 feet vertically above the lower roof must be protected in accordance with NBC Section 906.5, unless the lower roof has a fireresistance rating of not less than one hour. This case is illustrated in Fig. 2.

Fire walls are required to be made smoke-tight at their junction with exterior walls, and in exterior wall construction where studs are utilized, the fire wall shall extend through the stud space to the exterior sheathing.

Openings

Size Requirements. Provisions regulating openings in fire walls are specified in Section 909 of the code. Fire-wall openings must not exceed 120 ft in area, and cumulatively, their width at any floor level shall not exceed 25% of the length of the fire wall. An exception to the above applies to the first story that complies with Section 909.2.1 of the code.

Protection Requirements. Every opening in a fire wall shall be protected with an approved automatic opening protective assembly complying with NBC Section 916.2 except as provided in Section 814.2.1 for horizontal exit openings.

Associated sections on specific types of opening protectives include

- 909.3.1 Hold-open devices
- 916.0 Fire-door assemblies
- 918.0 Fire dampers
- 919.0 Wired glass

It should be mentioned that wired glass in fire doors in fire walls is prohibited unless the door is used as a horizontal exit. In this case, the glass limitations are specified in Section 919.1.1 of the code.

Penetrations

Where penetrations through fire walls are permitted, approved noncombustible materials must be installed to prevent the passage of flame and products of combustion through spaces in the wall, without decreasing the fireresistance rating or structural integrity of the wall. Firestopping must comply with the provisions specified in NBC Section 921.

Conceptual Design of Fire Walls

In many ways, a fire wall is no different from other walls. It can be used in a nonstructural capacity or as a load-bearing and/or shear wall when designed to the structural provisions of the code. When used as a shear or bearing wall, special attention must be paid to wall-roof connections such that the wall will still be able to meet the collapse criterion in Section 908.1 of the code. Types of connections and restraining conditions necessary to stabilize the fire wall against collapse during a fire are conceptually illustrated in Figs. 3, 4, and 5.
Concrete and Masonry Wall Joints

The rules that govern control-joint selection for interior concrete and masonry walls also apply to concrete and masonry fire walls. Although this discussion is beyond the scope of the report, a number of publications are available on the subject.\(^5,6,7,8\)

Where tilt-up construction is utilized, joints between panels should be protected as shown in Fig. 6.\(^9\) The figure specifies the minimum thickness of ceramic-fiber blanket\(^*\) required between wall panels to provide fire-resistance ratings up to four hours. Ratings are based on joint widths of \(\frac{3}{8}\) in. and 1 in. for a variety of panel thicknesses. Direct interpolation of the curves can be made for joint widths between \(\frac{3}{8}\) in. and 1 in.

Summary

This report explains provisions from the BNBC specifically pertinent to concrete and masonry fire walls. The text may be applicable to fire walls constructed of other materials but should not be assumed as such. In retrospect, the key points regarding concrete and masonry fire walls can be summarized as follows:

\(^*\)Ceramic-fiber blanket— a mineral wool insulation material made of alumina-silica fibers and weighing 4 to 10 lb per cubic foot.
1. The function of a fire wall is to contain effectively the most severe anticipated fire for the duration of the assembly's rating period such that the fire does not spread from one side of the wall to the other.

2. Three characteristics of code-required walls are:
   a. Areas on opposite sides of a fire wall are considered separate buildings
   b. The number of fire walls required in a structure is generally governed by allowable height and area limits, based on occupancy and type of construction
   c. All fire-wall openings must be protected by approved fire-rated assemblies

3. In terms of physical characteristics, the principal differences between fire walls and other wall assemblies lies in their superior fireresistance and ability to withstand the collapse of construction on either side of the wall without collapse of the wall itself.

4. Fire walls may be used structurally when designed in accordance with the appropriate provisions of the code.

References

6. Control of Wall Movement with Concrete Masonry, NCMA-TEK 3, National Concrete Masonry Association, Herndon, Virginia, 1972.

Organizations represented on the Concrete and Masonry Industry Fire Safety Committee

- BIA: Brick Institute of America
- CRSI: Concrete Reinforcing Steel Institute
- ESCSI: Expanded Shale Clay and Slate Institute
- NCMA: National Concrete Masonry Association
- NRMCA: National Ready Mixed Concrete Association
- PCA: Portland Cement Association
- PCI: Prestressed Concrete Institute

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