GHL CONSULTANTS LTD
Building Codes & Fire Science

700 W. PENDER STREET, SUITE 800
VANCOUVER, BC V6C 1G8 CANADA

P 604 689 4449
F 604 689 4419
www.ghl.ca
Holder of AIBC Certificate of Practice

CURTAIN WALL FIRESTOP REVIEW OF CODE REQUIREMENT AND DESIGN ISSUES

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by K. M. Gary Chen, MASc, P Eng and Frankie Victor, PL Eng, BCQ

Glazed exterior wall assemblies, commonly called curtain walls, have become a dominant feature in modern architecture. The exterior walls are generally assembled by securing individual glass panels to an arrangement of aluminum vertical and horizontal mullions, which are then suspended from the building's structure. The transparent exterior skin allows the contents of the building to be revealed, creating a sense of modernism, and a shift from the traditional where blocks and bricks have commonly been used. The harmonious display of glass technology and architecture at work, however, has led to a number of fire safety concerns being raised by authorities having jurisdiction in Canada, specifically related to firestops at the junction between floors and the curtain wall system. Over the past several years, GHL has done extensive review and provided expert opinion on this topic. This article provides a review of the Canadian Building Code requirements, curtain wall firestop issues and our approach to design for Building Code compliance.

BUILDING CODE REQUIREMENT

The Building Code requires in Division B, Sentence 3.1.8.3.(4) that continuity of fire separations between storeys be maintained where floors abut an exterior wall assembly. The intent is to maintain the integrity of the fire separation at floors as each storey constitutes an individual fire compartment. This compartmentalization is critical to the broader fire safety strategy employed by the Building Code. In buildings where curtain wall systems are utilized, this has generally been achieved by using a firestop system to close the gap between the edge of the floor and the exterior wall assembly, as illustrated in Figure 1.

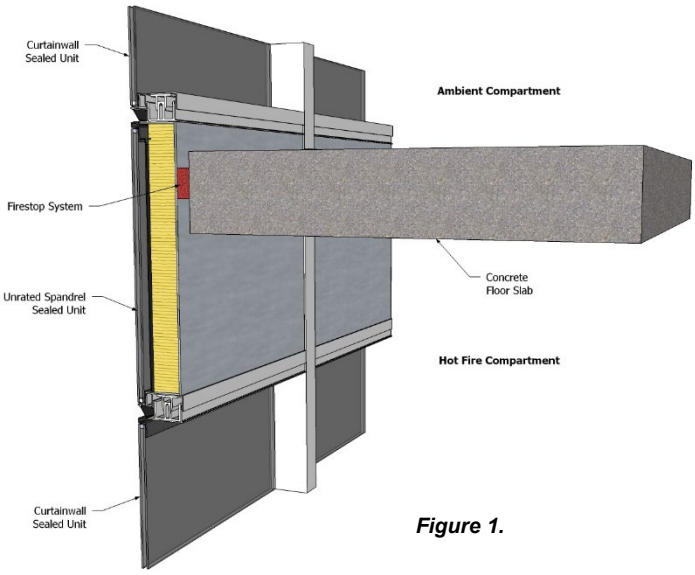

Figure 1.

The curtain wall firestop system generally consists of mineral wool and a firestop sealant where the first is the principal fire-resistive material and the second is the smoke seal. While this practice has been generally regarded as acceptable, review of the *Best Practice Guide on Fire Stops and Fire Blocks* (the NRC guide) published by the National Research Council of Canada (NRC) and the curtain wall firestop standard in the USA indicates that further protection may greatly enhance the design, particularly in high and large buildings where 2h fire resistance ratings are required between storeys.

The current firestop practice has been accepted by designers based on tested firestop systems for joints

between floors and interior walls where both the floor and the wall have a fire resistance rating. This differs from the curtain wall configuration where the exterior wall assembly has no fire resistance rating. Without substantial endurance in fire, the curtain wall could fail or suffer significant deformation after prolonged exposure to heat, leading to failure of the firestop system and a breach in the fire separation between storeys.

CURTAIN WALL PERFORMANCE IN FIRE

Building fires follow a set of physics known as compartment fire dynamics. Due to the retention of heat within fire compartments bounded by walls and floors, compartments can reach temperatures exceeding 1000C. Because the curtain wall is supported by aluminum mullions having a melting point temperature of approximately 650C, the mullions could suffer significant localized deformation or failure, allowing the firestop system to dislodge prior to the intended fire endurance period of the fire separation.

Curtain walls do not have a fire resistance rating and are typically installed where no fire resistance rating is required at the building face. The question is not whether the curtain wall has a fire resistance rating, but whether the integrity of the fire separation at floors is maintained where it abuts the exterior wall and whether this can be achieved using currently available tested firestop systems designed for use with wall assemblies having fire resistance ratings.

It could be argued that where the curtain wall itself fails, the small gap between the wall and the floor edge is irrelevant; however, this is not always the case. In buildings where the exterior wall is constructed of full height windows that bear on the floors, failure of windows will not immediately lead to the spread of fire to the floor level above as the windows at levels above are not directly exposed and the floor fire separation remains intact as shown in Figure 2; in this case fire spread between storeys is at the exterior of the building. The subsequent impingement of the fire plume on the windows above could cause these windows to fail over time. This failure, however, is not associated with the integrity of the floor fire separation. Given the substantial heat loss due to convection and radiation effects (the fire venting to the outdoors), the failure time of windows on the storey above is potentially long after the windows on the storey where fire originates have failed.

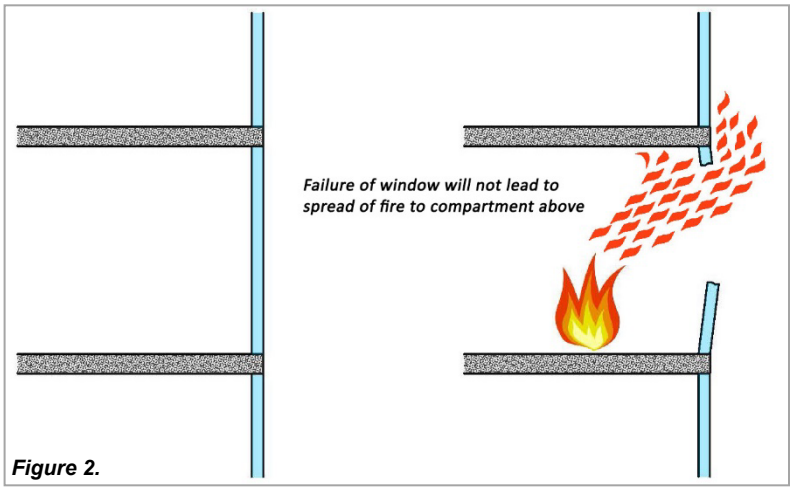

Figure 2.

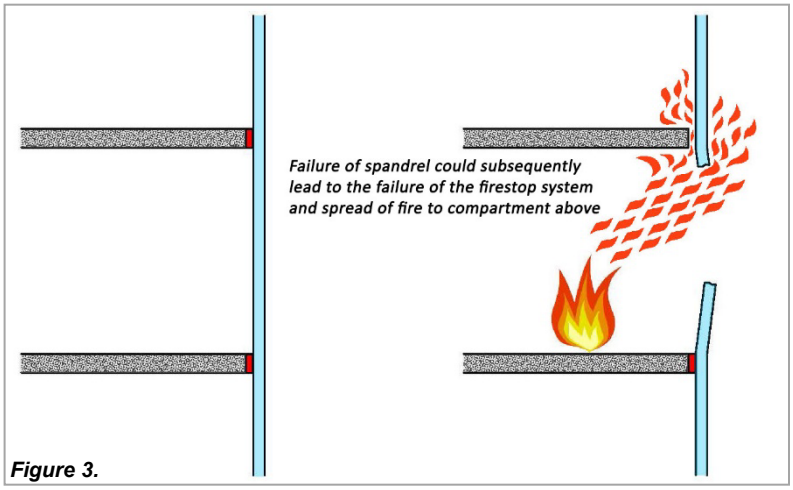

Figure 3.

In contrast, in curtain wall systems, deformation of aluminum mullions or failure of the curtain wall could potentially lead to the failure of the firestop system and allow fire spread between storeys at the interior of the building as shown in Figure 3.

BEST PRACTICE GUIDE ON FIRE STOPS AND FIRE BLOCKS

The NRC Guide acknowledges that curtain wall firestopping is a unique condition that is not currently addressed in the National Building Code. The guide recommends designers to consider the practice in the US, where curtain wall firestop is based on ASTM E2307 "*Standard Test Method for Determining Fire Resistance of Perimeter Fire Barrier Systems Using Intermediate-Scale, Multi-Story Test Apparatus*".

A review of a number of wall firestop designs based on the ASTM E2307 standard reveals that the details generally include additional reinforcement and thermal protection at the joint between floors and curtain walls such as stiffener tees, weld pins or fire-resistive insulation. These features effectively provide an increased level of fire endurance at the mullions such that the curtain wall will be less susceptible to failure and the firestop system more likely to remain in place.

WHAT IS APPROPRIATE PRACTICE IN CANADA?

The NRC Guide states, "Canadian designs for curtain walls may be different from those tested [to ASTM E2307]" and Canadian Building Codes do not currently reference the ASTM E2307 standard. In the absence of regulation, professional engineers have a responsibility to provide prudent design that meets the standard of care expected by the public. In our opinion, any firestop system proposed for use with curtain wall systems should be reviewed by a qualified professional engineer with expertise in compartment fire dynamics and behaviour of curtain wall construction in fires. The engineer should review the floor-to-curtain wall joint detail and possibly make adjustments to the design to reduce the risk of premature curtain wall failure. While such proposed designs may not be 'equivalent' to an ASTM E2307 compliant design, the engineer's review and any subsequent adjustments would be a significant improvement over the minimum requirement of the Building Code.

ABOUT THE AUTHORS

Frankie Victor (PL Eng, BCQ) is a Building Technologist with 11 years' experience as a Building Official with the City of Nanaimo and 10 years of Building Code consulting experience with GHL. Frankie is registered with Engineers and Geoscientists BC as a Professional Licensee Engineering with the title PL Eng, She Served 14 years as a member of the Executive Committee of the Building Officials Association of BC (BOABC) and holds the title BCQ (Building Code Qualified), and sits as vice chair of the BC Building Code Appeal Board.

K. M. Gary Chen (MASc, P Eng) is a professional engineer registered in British Columbia, Alberta, Manitoba, and Ontario with specialized expertise in fire science, thermal fluid mechanics and structural design for fire. As a PhD candidate, he has completed a Master's Degree in Mechanical Engineering from University of Waterloo, specializing in fire engineering, and a Bachelor's Degree in Chemical Engineering from UBC.

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