Break-Away Firewall Connection System

Description and Proof-of-Concept

A Technical Article by

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Executive Summary

One of the main requirements for structural integrity of firewalls under the National Building Code of Canada is that structural components should be connected to firewalls in such a way that a failing structural member may collapse without causing any damage to the firewall. As a result, firefighters would have more time to prevent the spread of fire to adjacent spaces. In some cases, occupants in an adjacent room/structure would be provided with sufficient time to escape before the firewall is compromised and the fire spreads to the adjacent space.

The connection system developed by FERO Corporation consists of a support member and a fusible member and can be used to connect a floor or ceiling structural member to a firewall. The fusible member has a lower melting point than the support member. This break-away connector differs from conventional connectors by the use of a slotted support member that allows for movement and total disengagement of the structural member caused by the melting of a fusible member in the event of a fire.

This article describes the developed break-away firewall connector in detail, including the results of the “proof-of-principle” testing that was performed at FERO Corporation Laboratory. The connector performs similar to a conventional connector under normal service situations (no fire), and effectively allows for disengagement of structural members during fire as required.
**Background**

In residential, commercial and industrial structures, it is desirable to have members that are designed to slow or prevent the spread of fire between adjacent spaces. These members are typically firewalls which are designed and/or treated to resist combustion and prevent rapid heat transfer. Most commonly, firewalls are substantially vertical partitions that define interior spaces such as individual rooms within the same structure, or interior spaces of separate, adjacent structures. Firewalls are required for containing and limiting the effects of fires within buildings, in such a way that allows for better access to the burning sections of a building, allows for sufficient escape time to the occupants, and minimizes the damage caused by fire spreading throughout the building. Firewalls could be loadbearing structural components of the building.

In some multi-level buildings, structural members are supported by at least one firewall. Commonly, horizontal structural components such as floors or ceilings are tied into at least one substantially vertical firewall. In the event that a heat-inducing event occurs within an interior space that is at least partially defined by a firewall, it is desirable for structural members to be releasable from the firewall. If a structural member catches fire, it is beneficial to release the structural member from the firewall to separate the heat source from the firewall. This release can allow the firewall to remain intact for a longer duration. As a result, firefighters would have sufficient time to prevent the spread of fire to adjacent spaces. In some cases, occupants in an adjacent room/structure would be provided with sufficient time to escape before the firewall is compromised and the fire spreads to the adjacent space.

The National Building Code of Canada (NBCC) [1] article 3.1.10.1 specifies that “connections and supports for structural framing members that are connected to or supported on a firewall ... shall be designed so that the failure of the framing systems during a fire will not affect the integrity of the firewall during the fire.” The NBCC Structural Commentary C (Structural Integrity of Firewalls) paragraph 15 suggests a design approach that satisfies the requirements of structural integrity of firewalls under the NBCC by incorporating the use of a weak-link connection of structural components to the firewall in such a way that a failing structural member may collapse without causing any damage to the firewall.
FERO Corporation has developed a firewall connection system that employs this weak-link concept to connect common structural framing elements to firewalls [2]. In the event of a fire, a fusible element in the connection softens and melts, allowing for the displacement and ultimately the disengagement of the connecting element as it fails, which protects the firewall from any increased stresses that may occur as the connected element becomes damaged during the fire. Such a system is desirable for maintaining the integrity of the firewall, allowing for a greater building and occupant safety during fires and a longer time to evacuate.

The use of fusible elements in structural design is not uncommon. Fusible members have been used to allow displacements in structural members to relieve stresses and allow for displacements caused by fires [3, 4]. It was reported that the structure behaves normally until there is a fire, at which point any additional stresses that are developed as a result of the fire may be dissipated by the flexibility created due to the loss of the fusible members.

In timber firewall construction, aluminum clips with a relatively low melting point are commercially available which allow structural members to disengage from a firewall in the event of a fire [5]. Similarly, break away firewall anchors are commercially available for masonry firewalls, using a zinc alloy or a similar material [6]. In all of these connector systems, the connector is designed to melt in its entirety during a fire, causing the collapse of the structural framing element solely due to heat, regardless of whether or not this disengagement is structurally necessary.

This article describes the developed break-away firewall connector in detail, including the results of the “proof-of-principle” tests that were performed at FERO Corporation Laboratory. The break-away connector performs similar to a conventional connector under normal service situations (no fire), and effectively allows for disengagement of structural members during fires as required.
Description of the Break-Away Connector

The connection system developed by FERO Corporation consists of: a) a support member connectable to the firewall for securing a floor or ceiling to the firewall and b) a fusible member having a lower melting point than the support member, and can be used to connect a floor or ceiling structural support to a firewall. This break-away connector differs from conventional structural-to-masonry connectors by the use of a slotted support member that allows for movement or total disengagement of the structural member caused by the melting of a fusible member in the event of a fire. Another advantage of this design is that the support member may provide support for a structural member under normal conditions. Accordingly, the load bearing capacity the break-away connector system is not limited by the load bearing capacity of the fusible member itself.

A schematic of a floor-to-firewall connection using the break-away connector is shown in Figure 1. The structural component of the floor (1) is connected to a masonry firewall by a support member (2) that is bolted to the firewall. The support member contains slots (see Figure 2) which allow for the movement of the connecting bolts (4) when the fusible member (3) is softened or melted during a fire. The movement of the bolts allowed by the slots will relieve lateral stresses caused by the deformation of the framing system in a fire event, and under extreme deformations will allow the framing system to disengage completely.

The fusible member is made of Nylon having a melting point of approximately 260 °C, which is much lower than the support member’s melting point to ensure that the failure mode of the connector as a whole can be anticipated accurately. Nylon, a semi-crystalline plastic, is commonly used in commercial products, and generally has high chemical resistance. Nylon has a heat deflection temperature of 75 °C at 1.82 MPa, and a maximum resistance to continuous heat of 120 °C, allowing for satisfactory connection performance up to the point of fire [7].
Figure 1: Floor-to-Firewall Connection using a Break-away Connector

Figure 2: Support Member Detail
Proof-of-Principal Testing

It is crucial to the integrity of the connection that the fusible member does not fail until it is subjected to fire conditions. In order to validate this requirement, the lateral resistance provided by the break-away connector was tested as shown in Figure 3, where increasing loads were added to test the resistance of the plate to bolts being loaded in shear. The test was continued until a total load of 1,460 pounds (6.5 kN) was applied, at which point there were no signs of movement or failure occurring in the tested connector.

The break-away firewall connector system was also tested in a simulated fire scenario. A transverse load of 110 pounds (0.5 kN) was applied to the OWSJ structural frame while a blowtorch was used to supply heat to the connector as shown in Figure 4.

![Image](image.png)

a) Test Set-up  
b) Detail of Member Connection

**Figure 3: Test of a Fusible Member under Normal Service Conditions**
Several tests of the connectors under extreme heat were performed, with a time to failure ranging between three and four minutes from the onset of the test. The behaviour during one of the tests is shown in Figure 5 where an OWSJ was connected to a firewall using a break-away connector.
Figure 5(a) shows the set-up at the beginning of the test, with a 10 mm fusible member placed at the bottom of the connection assembly. Following the direct application of heat for approximately two minutes, the softening of the fusible member allowed for some displacement in the connection, including noticeable rotation of the structural member as shown in Figure 5(b). Further application of heat resulted in the total failure of the fusible member as shown in Figure 5(c), followed shortly by the disengagement of the structural member from the connection.

Tests were performed using various thicknesses for the fusible member. It was noted that a thickness of 20 mm, double the thickness shown in Figure 5, allowed more room for the structural member to rotate before disengaging, which resulted in a smoother release of the structural member. The time required for failure is not expected to be representative of the time that would be taken in a real fire, as the blowtorch applied a more intense heat than would naturally occur. Instead, the tests act as a “proof-of-principle”, where the fusible material has been shown to melt away given sufficient heat.

At the end of the test, the support member remained attached to the test wall with no visible signs of damage. It is anticipated that during a real fire, the connector would continue to provide sufficient vertical support to any attached structural components. In the event that the fire was strong enough to melt the fusible member of the connector, but the structural component itself was undamaged, it is expected that this connection would only require retrofitting following the fire, unlike several of the other connectors currently available on the market [6]. This provides a significant advantage as disengagement of the structural system will only occur when it is required in order to prevent damage to the firewall, thus minimizing the risk of incidental damage caused by premature disengagement.

The combination of the different types of tests performed on the break-away firewall connector demonstrate that the connector behaves similar to typical connectors under normal conditions by resisting both vertical and horizontal forces, but under fire conditions it releases the structural member from the firewall after sufficient exposure to heat.
Summary and Conclusions

In order for firewalls to perform as effectively as possible, they must restrain the spread of fires while continuing to function as crucial components to the building. Due to these requirements, the National Building Code of Canada (NBCC) specifies that the failure of any structural components connected to a firewall must not damage the firewall itself. FERO Corporation has developed and patented a break-away connector for connecting horizontal structural components, such as joists of floor and roof systems, to firewalls in such a way that meets the requirements of the NBCC. Through the use of a fusible member, the connector allows for displacement and complete disengagement of the structural component from the wall during a fire before any significant damage could happen in the firewall itself.

FERO break-away connection system satisfies the requirements of the National Building Code of Canada to preserve the integrity of a firewall during a fire, while continuing to act as a strong connection and without failing prematurely.

Unlike other break-away connectors currently on the market, this connector uses a simple design that relies on only one part of the connector failing during the fire. This allows for disengagement of the structural component to occur only when required to prevent damage to the firewall, and not earlier. Other systems currently available on the market are made entirely from a fusible material.

The behavior of the break-away firewall connector has been confirmed through testing in both the absence and presence of a fire. The connection demonstrates significant resistance in the absence of fire, allowing it to behave predictably and be used in conventional design. However, in the presence of a fire, the break-away firewall connector will allow for displacement and disengagement of the structural component as desired.

Experimental testing demonstrated that a fusible member with a thickness of 20 mm allowed enough room for the structural member to rotate before disengaging, which resulted in a smoother release of the structural member. The support member remained attached to the test wall with no visible signs of damage. It is anticipated that during a real fire, the connector would continue to provide sufficient vertical support to any attached structural components.
References


Appendix: Break-Away Connection System Details
Firewall Connector Detail
Firewall Connector Detail
Firewall Connector Lateral Support Detail

Connector Size per Design

Scale 3' = 1'

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Firewall Connector Beam Support Detail
Connector Size per Design

Scale 3' = 1'

Detail SiB - 1 - 04

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Firewall Connector Joist Support Detail

Connector Size per Design

Scale 3" = 1'

Detail SIB-1-04