Fire Separations & Fire-resistance Ratings

FACT SHEET
FIRE

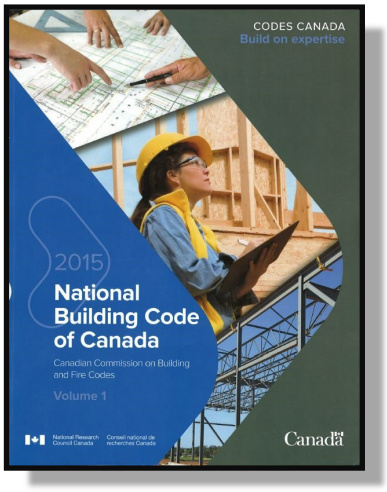
Background

Fire separations and fire-resistance ratings are often required together but they are not interchangeable terms, nor are they necessarily mutually inclusive.

The National Building Code of Canada (NBC)[1] provides the following definitions:

> A fire separation is defined as "*a construction assembly that acts as a barrier against the spread of fire.*"
>
> A fire-resistance rating is defined as "*the time in minutes or hours that a material or assembly of materials will withstand the passage of flame and the transmission of heat when exposed to fire under specified conditions of test and performance criteria, or as determined by extension or interpretation of information derived therefrom as prescribed in [the NBC].*"

In many buildings, the structural members such as beams and columns, and structural or non-structural assemblies such as walls and floors, are required to exhibit some degree of resistance to fire in order to prevent the spread of fire and smoke, and/or to minimize the risk of collapse of the building in the event of a fire. However, fire separations are assemblies that may or may not be required to have a specific fire-resistance rating, while structural members such as beams and columns that require a fire-resistance rating to maintain the structural stability of a building in the event of a fire are not fire separations because they do not "act as a barrier against the spread of fire."



Requirements for fire separations and fire-resistance ratings are just one aspect of the fire-safe design approach used by the Code to reduce risk to building occupants of injury, as well as to reduce risk of property loss. Together, they are key elements to the strategy of controlling fire spread called "compartmentation."

A fire compartment can be compared to a box designed to contain a fire for a limited time within a building. The following definition is provided in the NBC:

> A fire compartment is defined as "*an enclosed space in a building that is separated from all other parts of the building by enclosing construction providing a fire separation having a required fire-resistance rating.*"

Fire separations such as floor assemblies and interior wall assemblies that have a required fire-resistance rating are therefore basic elements of fire compartmentation. Fire separations that are expected to provide compartmentation must be designed to resist the effects of fire for a given time based on the expected fire severity in a compartment. It is this that determines whether a fire separation requires a fire-resistance rating and if so, what level of fire-resistance rating. What this also means is that, by definition in the NBC, a fire compartment is not formed if one or more of the fire separations that form the boundaries of a space are not required to have a fire-resistance rating — for example, when a building is permitted to have unrated floor assemblies between storeys, there are no storey-to-storey fire compartments.

In the early stages of a fire, fire separations and fire-resistance ratings have little impact, but they become increasingly important as the fire grows and approaches full-room involvement (i.e., flashover). With respect to life safety, the combined effect of fire separations and fire-resistance ratings is essential in large or tall buildings where a fire could grow large before all occupants are able to escape in the event that a fire is not controlled by a fire suppression system. They are also important to provide time to emergency personnel to perform their duties, such as search and rescue or fire suppression activities. They also can be important for property protection, particularly when the fire is not controlled by a fire suppression system.

Objectives and Functional Statements Related to Fire Separations and Fire-resistance Ratings in the NBC

The NBC is an objective-based code, meaning that the objectives of the code are fully defined. The objectives describe, in very broad terms, the overall goals that the NBC's requirements are intended to achieve.

A designer now has the option to follow the acceptable solution provided in Division B of the NBC or they may instead propose an alternative solution. The alternative solution must achieve at least the minimum level of performance provided by the acceptable solution in Division B in the areas defined by the applicable objectives and functional statements.

The functional statements provide more detail than the objectives and describe conditions in the building that help satisfy the objectives.

Each requirement under the prescriptive solutions provided in Division B has been assigned one or more objectives and functional statements. This allows the designer or regulatory official to identify what the objective of the requirement is, which then opens the door for alternative solutions to meet the specific objective.

With respect to fire-resistance ratings, the NBC has identified four sub-objectives that the acceptable solutions are intended to achieve.

OS1: An objective of the NBC is to limit the probability that, as a result of the design or construction of the building, a person in or adjacent to the building will be exposed to an unacceptable risk of injury due to fire.

- **OS1.2:** The risks of injury due to fire related to fire-resistance ratings are those caused by fire or explosion impacting areas beyond its point of origin.
- **OS1.3:** The risks of injury due to fire related to fire-resistance ratings are those caused by collapse of physical elements due to a fire or explosion.

OP1: An objective of the NBC is to limit the probability that, as a result of its design or construction, the building will be exposed to an unacceptable risk of damage due to fire.

- **OP1.2:** The risks of damage due to fire related to fire-resistance ratings are those caused by fire or explosion impacting areas beyond its point of origin.
- **OP1.3:** The risks of damage due to fire related to fire-resistance ratings are those caused by collapse of physical elements due to a fire or explosion.

For each sub-objective, there are two functional statements applied:

- **F03:** One applied functional statement, intended to provide additional guidance to the designer, states "retard the effects of fire on areas beyond its point of origin".
- **F04:** Another applied functional statement, intended to provide additional guidance to the designer, states "retard failure or collapse due to the effects of fire".

With respect to fire separations, the NBC has identified two sub-objectives that the acceptable solutions regarding fire separations are intended to achieve. The sub-objectives are the same as those specified for fire resistance that deal with retarding the effects from fire impacting areas beyond its point of origin (F03) with respect to both risk of injury (OS1.2) and risk of damage to the building (OP1.2).

More information on the objectives and functional statements in the NBC can be found in the CWC Fire Fact Sheet entitled "Fire Safety and Canadian Building Codes – General Information."

Fire Separations

As discussed above, to achieve its purpose of containing the fire by construction, there are instances where an assembly may need to be built as a fire separation to restrict the passage of smoke and fire but may not require a fire-resistance rating. In such cases, the fire separation need only remain in place long enough to ensure that occupants can leave the area, or until a sprinkler system is activated that will control and likely suppress the fire.

For the strategy of compartmentation to be successful, it is necessary to maintain the continuity of fire separations. For this reason, the NBC requires that all fire separations be constructed as continuous elements. However, floors and interior walls of a building need to incorporate openings to allow for the passage of people and building services. It is important that these openings be protected so that the fire separation and the desired compartmentation or the protection against fire spread are maintained. It is essential that openings such as doorways and duct openings, be protected with closures: e.g., doors, shutters, fire dampers, and wired glass or glass blocks. Such devices or assemblies must be rated for fire exposure in accordance with specific test standards depending on the type of closure. The following fire test standards are used to rate closures:

- CAN/ULC-S104, "Fire Tests of Door Assemblies"[2]
- CAN/ULC-S106, "Fire Tests of Window and Glass Block Assemblies"[3]
- CAN/ULC-S112, "Fire Test of Fire-Damper Assemblies"[4]

Some devices or assemblies also must be rated for smoke leakage. The following standards are used to evaluate leakage rates:

- CAN/ULC-S112.1, "Standard for Leakage Rated Dampers for Use in Smoke Control Systems"[5]
- ANSI/UL 1784, "Standard for Air Leakage Tests of Door Assemblies and Other Opening Protectives"[6]

Penetrations of assemblies for the passage of building services, such as piping and wiring, also need protection, using firestop systems. More information on firestop systems can be found in the CWC Fire Fact Sheet entitled "Fire Stops and Fire Blocks."

Fire-Resistance Ratings

For an assembly or a structural member that is required to have a fire-resistance rating, Subsection 3.1.7. of the NBC specifies that the fire-resistance rating shall be determined according to the standard fire test method CAN/ULC-S101, "Fire Endurance Tests of Building Construction and Materials."[7] The standard test provides a relative measure of an assembly or structural member's fire resistance under the specific fire exposure conditions of the test. While the results of the test are reported as a fire-resistance rating in units of minutes or hours, this rating does not suggest the structural member or assembly will last that same amount of time in a real fire event. In a real fire event, the time to failure of the assembly or structural member may be greater than or less than that determined in the standard test because the fire exposure will undoubtedly be different. The fire-resistance test is designed to compare one design of structural member or assembly to another structural member or assembly. It is also designed to evaluate an assembly as a complete system, as opposed to evaluating individual components.

Testing criteria for acceptance (also referred to as pass/fail criteria) in this test method differ according to assembly type and/or structural member type.

The assigned fire-resistance rating for an assembly or structural member is the length of time it can withstand the standard fire exposure, which is defined by a temperature-versus-time relationship, while still satisfying the following criteria.

The first criterion applies to all floor and roof assemblies, loadbearing wall assemblies, beams and columns tested. It states:

- The assembly or structural member shall sustain the applied load for the duration of the test.

The second and third criteria are intended to prevent fire spread from the compartment of fire origin to an adjacent compartment and are applied to wall and floor assemblies. They state:

- The assembly shall prevent the passage of flame or gases hot enough to ignite cotton pads.
- The assembly shall prevent the average temperature measured on the unexposed surface of the wall or floor assembly to exceed

140°C above its initial temperature and prevent the temperature rise on the unexposed surface at any individual point greater than 180°C.

The fourth criterion is only used for walls that must have a fire-resistance rating of one hour or more.

- The assembly shall prevent the passage of a hose stream through the assembly.

This fourth criterion is intended to ensure a minimum resistance to the cooling and erosion effects of a hose stream that might be directed at the wall during firefighting. An assembly is first tested to determine its fire-resistance rating; a duplicate assembly is then tested for half the desired fire-resistance rating time to a maximum of one hour and then subjected to a hose stream.

Horizontal assemblies such as floors, ceilings and roofs are tested for fire-resistance from the underside only. This is because a fire in the compartment below presents the most severe threat to horizontal assemblies. Horizontal assemblies, when tested, are subjected to a superimposed load. The test standard requires that the size of the test floor or roof assembly must be at least 16.8 m^2 (180 ft^2) with neither the length nor the width less than 3.66 m (12 ft).

Firewalls and interior vertical fire separations such as interior wall assemblies are tested on each side unless they are symmetric, in which case they only need to be tested from one side. Exterior walls only need to be tested from the inside. The test wall assembly is subjected to a superimposed load if the assembly design is intended to be used structurally. The test standard requires that the size of the test wall assembly must be at least 9.3 m^2 (100 ft^2) with neither the width nor height less than 2.75 m (9 ft).

Superimposed Loads During Testing

If the member or assembly design is to be loadbearing, such as a floor assembly, a load equal to the full specified load (ie., the specified gravity loat that produces a factored load effect as close as practicable to the factored resistance of the test specimen) determined by the applicable design standard is typically applied. If conducted under a reduced load (i.e., a restricted load use condition), the test report must include the load applied, which may influence whether a test result is accepted by a regulator for a particular situation. (See also the CWC Fire Fact Sheet entitled “Fire Resistance Ratings of Light-weight Wood-frame Assemblies and Loading in Canada.”)

Standard Fire Exposure

In the standard fire-resistance test, the fire exposure is controlled by following a prescribed temperature profile inside the furnace as a function of time. The fire temperatures are typically produced inside the furnace using premixed burners that mix propane or natural gas with air. The fuel mixture burns inside the furnace and the amount of fuel is controlled so that the temperature inside the furnace follows the time/temperature relationship shown in Figure 1 as closely as possible.

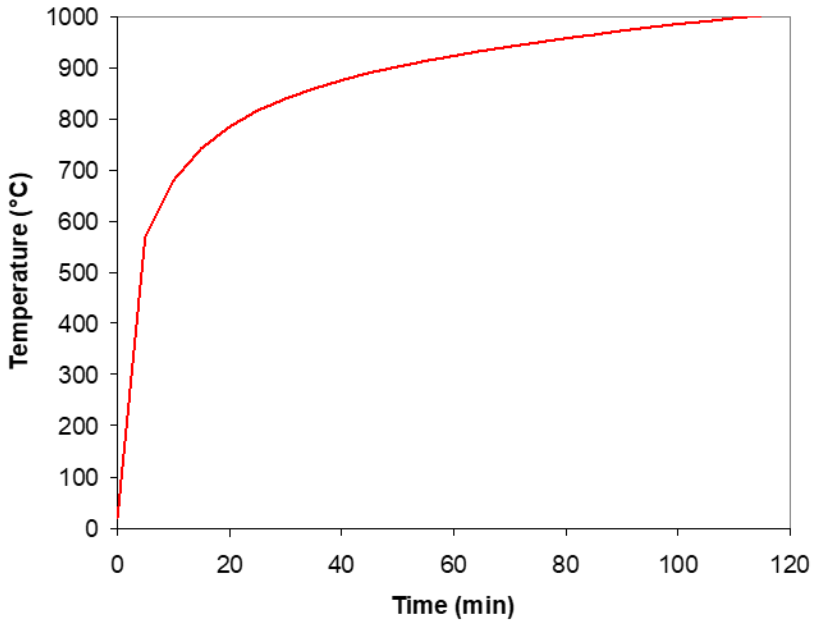


Figure 1. Standard fire resistance test furnace temperature as a function of time.[5]

Fire Separation and Fire-resistance Rating Requirements in the NBC

The application of specific fire separation and fire-resistance rating requirements in the NBC depend on many factors, including the following:

- building area;
- building height;
- general occupancy type, as well as specific use of a compartment/space;
- whether sprinklers are to be installed;
- number of streets the building faces, when the building is not sprinklered; and,
- whether the construction type to be used is permitted to be combustible or required to be noncombustible construction.

The main requirements for fire-resistance ratings are found in Subsection 3.2.2. of the NBC, which provides detailed requirements for the height and area of buildings that are acceptable solutions in Division B. As an example, the following are some generalizations to provide some insight into required fire-resistance ratings for buildings containing only Group C residential occupancies:

- For combustible construction up to three storeys, a 45-minute or one-hour fire-resistance rating may be required for the floor assemblies that are fire separations depending on the size of the building.
- For larger buildings of combustible or noncombustible construction built to six storeys, a one-hour fire-resistance rating is required for floor assemblies that are fire separations.
- For noncombustible construction over six storeys, a two-hour fire-resistance rating is required for floor assemblies that are fire separations.
- Roof assemblies may or may not need a fire-resistance rating not less than that of the floor assemblies.
- In each case, the loadbearing walls, columns or arches that support floor and roof assemblies that are required to have a fire-resistance rating must have a fire-resistance rating not less than that required for the supported assembly. Therefore, if a floor assembly requires a one-hour fire-resistance rating, the loadbearing walls or columns that support the floor assembly must also have a one-hour fire-resistance rating.

Standard fire resistance test of an exterior lightweight wood-frame wall assembly.

In addition to the prescribed fire-resistance ratings required for floor and roof assemblies and for the structure supporting floors and roofs in 3.2.2., other fire separations with fire-resistance ratings may be required within a building or floor area. For example, a fire separation with a one-hour fire-resistance rating is required between suites of residential occupancy (Article 3.3.1.1., Division B, NBC); there are also various minimum fire-resistance rating levels required for fire separations between major occupancies, such as a one-hour fire-resistance-rated fire separation between Group C and Group D major occupancies (Article 3.1.3.1., Division B, NBC).

Methods for Determining Fire-resistance Ratings

Since full-scale fire-resistance tests are very expensive, they are not typically an option available to designers. Therefore, designers must have access to information that allows them to design fire-resistance-rated structural members and assemblies. In addition to individual test reports provided by manufacturers of products, this information can be found in the NBC, in design listings published by listing/certification organizations such as Underwriters Laboratories of Canada (ULC) and Intertek, in publications by manufacturers or industry associations, and through structural design standards used in Canada and other countries. Below are the most commonly used sources for designing fire-resistance-rated assemblies and structural members for wood construction.

Test Reports

Over the last 25 years, a number of large research projects[7,9,10,11] focused on fire resistance and sound transmission have been conducted at the National Research Council of Canada (NRC) for lightweight wood-frame wall and floor assemblies. As well, some mass timber fire-resistance

testing has been completed by the wood industry, particularly on wall and floor assemblies of cross-laminated timber.[12,13,14,15,16]

The NRC research reports and commercial test reports provide test results that can be of use to designers.

Generic Fire and Sound Resistance Tables in NBC

The information generated by the NRC research into the fire resistance of lightweight wood-frame assemblies has been used to provide major additions to the Fire and Sound Resistance of Walls and the Fire and Sound Resistance of Floors, Ceilings and Roofs Tables in the NBC (Tables 9.10.3.1.-A and -B, respectively). These tables are intended to provide designers of buildings that fall within Part 9 of Division B of the NBC with many options to meet the fire-resistance rating and sound transmission class requirements using generic materials. An example of the tables is provided in Figure 2.

While Part 3 of Division B of the NBC does not directly reference Tables 9.10.3.1.-A and -B, the fire-resistance ratings listed were determined on the basis of the tests conducted by NRC in conformance with the NBC-referenced fire test standard, CAN/ULC-S101, and that, therefore, are applicable to all building sizes.

Component Additive Method in the NBC

The Component Additive Method was developed in the early 1960s based on the analysis of fire-test data for light-frame wall, floor and roof assemblies. The estimated fire-resistance ratings tend to be conservative since the assigned ratings must apply to all systems and products covered by the material standard description, as well as all the combinations of elements permitted by the methodology. The assemblies must conform to all requirements in the NBC Appendix D-2.3. for the rating developed using the method to be valid. The Component Additive Method can be used to assign a fire-resistance rating of up to 90 minutes.

The method received a significant revision and update in the 2015 edition of the NBC, using the NRC research data into lightweight wood-frame assemblies. The method now can be used for wood-frame walls (loadbearing and non-loadbearing); wood-frame floor assemblies with wood joists, wood I-joists and three

For more information on the component additive method in Appendix D-2.3. of the NBC, the method for glulam beams and columns in Appendix D-2.11. of the NBC, and the mass timber methodology in Annex B of CSA O86, including examples of the calculations and beam, column and CLT panel (floor, roof and wall) selection tables for fire resistance, see Chapter 10 of the CWC *Wood Design Manual*.

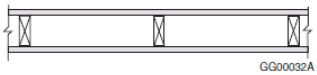
Type of Wall	Wall Number	Description	Fire-Resistance Rating(2)(3)		Typical Sound Transmission Class(2)(4)(5)
			Loadbearing	Non-Loadbearing	
• Wood Studs • Single Row • *Loadbearing* or Non-*Loadbearing*	**W1**	• 38 mm x 89 mm studs spaced 400 mm or 600 mm o.c. • with or without absorptive material • 1 layer of gypsum board on each side	 GG00032A		
	W1a	W1 with • 89 mm thick absorptive material(6) • 15.9 mm Type X gypsum board(7)	1 h	1 h	36
	W1b	W1 with • 89 mm thick absorptive material(6) • 12.7 mm Type X gypsum board(7)	45 min [1 h(6)]	45 min [1 h(8)]	34
	W1c	W1 with • 89 mm thick absorptive material(6) • 12.7 mm regular gypsum board(7)(9)	30 min	30 min [45 min(8)]	32
	W1d	W1 with • no absorptive material • 15.9 mm Type X gypsum board(7)	1 h	1 h	32
	W1e	W1 with • no absorptive material • 12.7 mm Type X gypsum board(7)	45 min	45 min	32

Figure 2. Extract of generic tables in NBC taken from Table A-9.10.3.1.-A.

types of wood trusses, including metal-plate-connected wood trusses; and, wood-framed roof assemblies of wood joists and metal-plate-connected wood trusses (both pitched and parallel chord design). There are minimum size requirements for the wood framing members (Appendix D-2.3.6.).

In general, when applying the CAM, the fire-resistance rating of an assembly is calculated by adding:

- the time assigned to the protective membranes (typically, gypsum board) on the fire side;
- the time assigned to the structural framing members;
- the time allowed for any additional protective measures, such as the inclusion of insulation or reinforcement for a membrane, if applicable; and,
- the time reduction required in some instances, such as when resilient metal channels are installed with a single layer of gypsum board in a loadbearing wall assembly.

It is important to understand that the CAM has been calibrated based on test data and that the times assigned to individual components cannot be used to predict the fire-resistance rating of an assembly that is not explicitly included in the method as published in the NBC.

Proprietary Listings

A multitude of fire-resistance tests have been conducted over the last 80 years by North American Laboratories. In some cases, results are available through design listing services provided by certification organizations, such as:

- Intertek
- PFS
- TECO
- Underwriters Laboratories of Canada / Underwriters Laboratories

In addition, manufacturers of construction products publish results of fire-resistance tests on assemblies incorporating their proprietary products, such as the Gypsum Association's *Fire Resistance Design Manual*.[17]

Heavy Timber Construction

Heavy timber construction is a type of mass timber construction that is specifically recognized in the NBC. A degree of fire safety is attained by placing limitations on the minimum sizes of wood structural members and on the thickness and composition of wood floors and roofs and by the avoidance of concealed spaces under floors and roofs. Heavy timber construction, including various types of connections, following the requirements in Articles 3.1.4.6 and 3.1.4.7 of the NBC are allowed to be used when combustible construction is permitted and is not required to have a fire-resistance rating more than 45 minutes. The heavy timber construction type only permits the use of solid-sawn wood and glued-laminated timber (glulam) members. Minimum sizes for heavy timber floor and roof assemblies and the other type of structural elements are described in Article 3.1.4.7. The minimum dimension requirements of heavy timber beams, columns, and other similar structural elements are summarized in Table 1. The different types of heavy timber connections are described in Article 3.1.4.7 and are not otherwise required to have a fire-resistance rating and therefore need not be protected. Several of these connections are shown in Figure 3. In many cases described within the heights and areas Articles of Subsection 3.2.2 of the NBC, mixed construction is permitted where exposed noncombustible supports (e.g. beams and columns) without a fire-resistance rating can be used to support heavy timber assemblies.

Table 1. Minimum dimensions for wood members to be considered heavy timber construction.

Supported Assembly	Structural Element	Solid Sawn (width x depth), mm x mm	Glued-laminated (width x depth), mm x mm	Round (diam), mm
Roofs only	Columns	140 x 191	130 x 190	180
	Arches supported on the tops of walls or abutments	89 x 140	80 x 152	-
	Beams, girders and trusses	89 x 140	80 x 152	-
	Arches supported at or near the floor line	140 x 140	130 x 152	-
Floors, floors plus roofs	Columns	191 x 191	175 x 190	200
	Beams, girders, trusses and arches	140 x 241 or 191 x 191	130 x 228 or 175 x 190	-

Source: *2015 National Building Code of Canada, Division B, Table 3.1.4.7.*

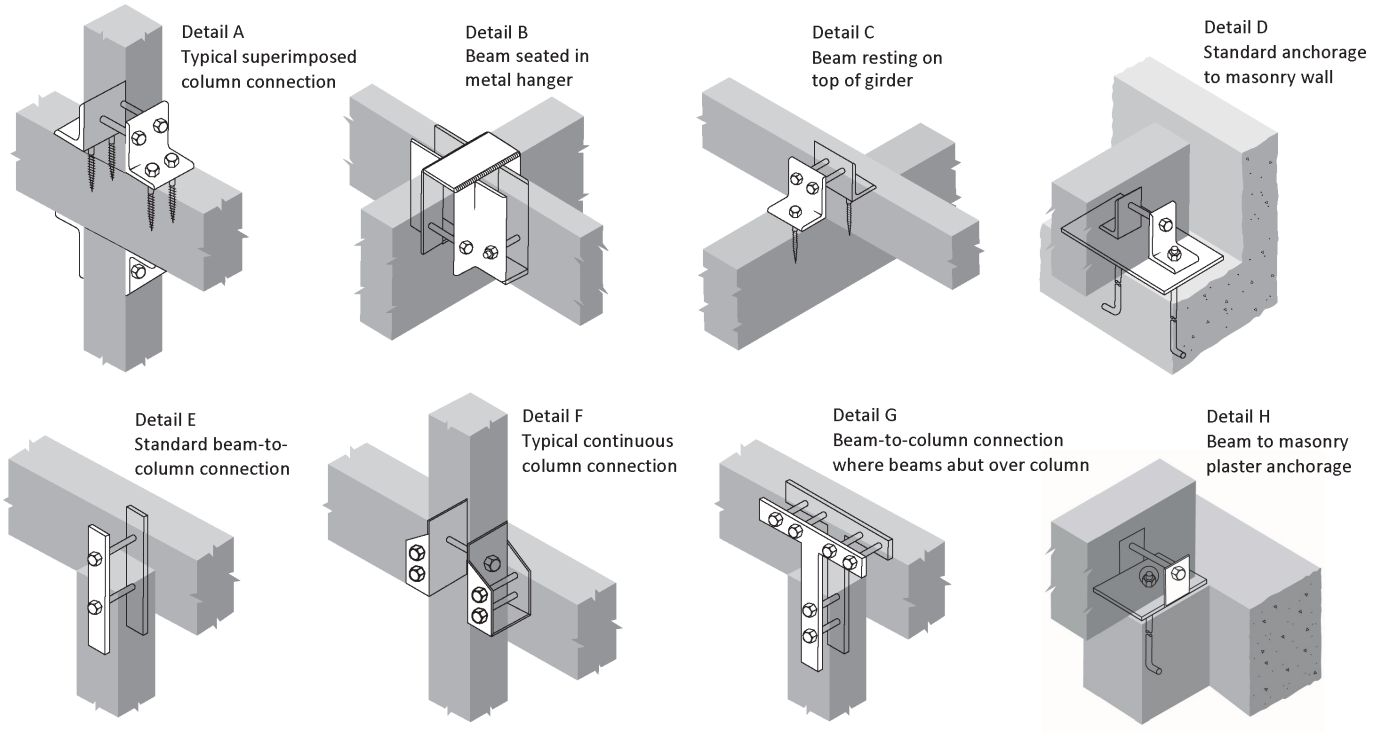


Figure 3. Examples different types of heavy timber connections

Calculation of Glulam Fire-resistance Ratings in Appendix D of the NBC

A calculation procedure to calculate the fire-resistance rating of glulam beams and columns can be found in Appendix D under Section D-2.11., Division B of the NBC. The empirical equations are based on the reduced properties method and validated by fire-resistance tests. The reduced properties method is based on the fact that large wood members (exposed to the 'standard fire exposure' - see above) burn slowly at a rate of approximately 0.6 mm per minute and the insulating effects of the char layer protects the unburned portion of the wood from significant temperature rise. The equations provide provisions for calculating the fire-resistance rating of glulam beams and columns exposed to fire from three or four sides. The methodology takes into account the size of the glulam member, the ratio of the factored load to the factored resistance and the slenderness of the beam or column.

Calculation of Fire-resistance Ratings for Mass Timber Elements in CSA O86

In the 2014 edition of the Canadian Wood Design standard CSA O86,[18] a revised calculation procedure for determining the fire-resistance rating of large timber members was added as Annex B. The procedure is applicable to solid-sawn timbers, glulam, structural composite lumber (SCL) members, and cross-laminated timber (CLT) wall and floor assemblies. The method can also be applied to any structural members as opposed to being restricted to those subjected to simply-supported beams in bending or columns in simple axial compression. For instance, the CSA O86 method can be applied to members in tension, axial members with eccentricity or lateral loads, and continuous beams extending over multiple supports. However, while the NBC Appendix D-2.11. method is considered an acceptable solution for calculating fire resistance, the CSA O86 Annex B method is considered an alternative solution, since it is not directly referenced at this time in the NBC for determining the fire resistance of wood members.

Engineering Judgment

In some cases, the alternative methods described to determine fire-resistance rating of an assembly or structural member are not sufficient. An engineer may decide to propose an alternative solution to meet the fire-resistance requirements using another approach such as engineering judgment. In this case, it is up to the regulatory authority whether they will accept the technical justification used to support the alternative solution.

The standard test method to determine fire-resistance used in the United States is ASTM E 119, "Fire Tests of Building Construction and Materials",[19] which is very similar to CAN/ULC-S101. The two test methods provide the same fire exposure and in many cases produce the same results. Given the close similarity in test standards, the guide ASTM E 2032, "Extension of Data from Fire Resistance Tests Conducted in Accordance with ASTM E 119",[20] is a valuable source of information when extrapolating test results to assemblies that have not been tested but are close to an assembly that has been tested. The guide is in part based on Dr. Tibor Harmathy's The Ten Rules of Fire Endurance, which provides guidance on the impact made on the fire-resistance rating of materials and assemblies when the original product or assembly is altered in some way.

Sometimes it is necessary to determine the fire resistance of an assembly when exposed to a non-standard fire exposure such as in performance-based design. In these cases, a designer may use a computer heat transfer model using the design fire to determine the exposure. This will allow the designer to predict a charring rate in the wood and thereby predict the remaining capacity of the structural member as a function of time.

Firewalls

A firewall is a very special type of fire separation with a fire-resistance rating. It performs the function of separating adjoining buildings sharing a common lot line or separating a single building into two or more separate buildings on the same property. The firewall is used to protect the adjoining building for as long as it takes a fire to burn itself out. Depending on the occupancy it separates, a firewall may require a fire-resistance rating of two or four hours.

The following definition is provided by the NBC:

> A firewall is defined as "*a type of fire separation of noncombustible construction that subdivides a building or separates adjoining buildings to resist the spread of fire and that has a fire-resistance rating as prescribed in the NBC and has structural stability to remain intact under fire conditions for the required fire-rated time*."

A summary of the general requirements for firewalls in the NBC under Subsection 3.1.10. and Article 4.1.5.17. are as follows:

- a firewall must be constructed as a fire separation of noncombustible construction;
- a firewall required to have a fire-resistance rating of two hours need only be constructed using noncombustible construction, while a firewall required to have a fire-resistance rating greater than two hours must be of masonry or concrete construction;
- when a firewall is required to have a fire-resistance rating of two hours and is constructed of noncombustible materials other than masonry or concrete, the assembly providing the fire-resistance rating needs to be protected against damage that would compromise the integrity of the assembly;
- adjoining construction that is supported by the firewall and has a fire-resistance rating less than the firewall must be designed so that the failure of the adjoining construction does not affect the integrity of the firewall;
- under fire conditions, where the fire-resistance rating of the structure is less than that of the firewall, lateral support shall be provided by the structure on one side only, or another structural support system capable of resisting the loads imposed by a fire on either side of the firewall needs to be provided; and,
- in most instances, a firewall must extend through all storeys from the basement slab up through the roof of the building.

Firewalls can be used to divide the building area of building that is too large to meet the maximum building area requirements in Section 3.2.2. of the NBC to be permitted to be of wood construction into two or more smaller building areas where wood construction is permitted to be used.

Additional Reading

1. *Fire Safety Design in Buildings*, Canadian Wood Council (1996).
2. *Structural Design for Fire Safety*, A. Buchanan (2017).
3. *Wood Design Manual*, Canadian Wood Council (2018).

FOR MORE INFORMATION

[1] *National Building Code of Canada*, 2015 Edition, Codes Canada, National Research Council of Canada (2015).
[2] CAN/ULC-S104, "Fire Tests of Door Assemblies", ULC Standards (2015).
[3] CAN/ULC-S106, "Fire Tests of Window and Glass Block Assemblies", ULC Standards (2015).
[4] CAN/ULC-S112, "Fire Test of Fire-Damper Assemblies", ULC Standards (2010).
[5] CAN/ULC-S112.1, "Standard for Leakage Rated Dampers for Use in Smoke Control Systems", ULC Standards (2010).
[6] ANSI/UL 1784, "Standard for Air Leakage Tests of Door Assemblies and Other Opening Protectives", UL (2004).
[7] CAN/ULC-S101, "Fire Endurance Tests of Building Construction and Materials", ULC Standards (2014).
[8] IRC-IR-764: Results of Fire Resistance Tests on Full-Scale Floor Assemblies, by the National Research Council (1998).
[9] IR-833: Results of Fire Resistance Tests on Full-Scale Gypsum Board Wall Assemblies, by the National Research Council (August 2002).
[10] RR No. 184: Results of Fire Resistance Tests On Full-Scale Floor Assemblies – Phase II, by the National Research Council (March 2005).
[11] Research for Wood and Wood-Hybrid Mid-Rise Buildings Project, National Research Council Canada (2011-2015):
- Full-scale standard fire resistance tests of wall assemblies for use in lower storeys of mid-rise buildings, A1-100035-01.8.
- Full-Scale Standard Fire Resistance Test of a Wall Assembly for Use in Lower Storeys of Mid-Rise Buildings, A1-004691.1.

[12] Full Scale Exterior Wall Test on Nordic CLT System, by the National Research Council (January 2015).
[13] Client Report A1-005991.1 – Fire Endurance of Cross-Laminated Timber Floor and Wall Assemblies for Tall Wood Buildings, by the National Research Council (December 2014).
[14] Report No. 101700231SAT-003_Rev.1 – Report of Testing Cross-Laminated Timber Panels for Compliance with CAN/ULC-S101 Standard Methods of Fire Endurance Tests of Building Construction and Materials: Loadbearing 3-ply CLT Wall with 1 Layer of 5/8" Type X Gypsum Board – 1 hr FRR, by Intertek for CWC (November 2014).
[15] Report No. 100585447SAT-002B – Report of Testing Cross-Laminated Timber Panels for Compliance with CAN/ULC-S101 Standard Methods of Fire Endurance Tests of Building Construction and Materials: Loadbearing 3-ply CLT Wall with 1 Layer of 5/8" Fire-rated Gypsum Board (60% load) – 1 hr FRR, by Intertek for CWC (December 2013).
[16] Report No. 100585447SAT-002A_Rev.1 – Report of Testing Cross-Laminated Timber Panels for Compliance with CAN/ULC-S101 Standard Methods of Fire Endurance Tests of Building Construction and Materials: Loadbearing 3-ply CLT Wall with Attached Wood-frame Partition – 1 hr FRR, by Intertek for CWC (January 2012).
[17] Gypsum Association's *Fire Resistance Design Manual* (GA-600-09) can be purchased online at www.gypsum.org.
[18] CSA O86-14, "Engineering Design in Wood", Canadian Standards Association (2014).
[19] ASTM E 119-18ce1, "Fire Tests of Building Construction and Materials", ASTM International (2018).
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