

SECTION

7

DESIGNING WITH HEIGHT AND AREA LIMITATIONS



1 HEIGHT AND AREA LIMITATIONS

This chapter will help you determine which Construction Types are legally permitted for a building of a given height and area under the model building codes.

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HEIGHT AND AREA LIMITATIONS

The model codes place limitations on building heights and areas in relation to the type of construction employed and the uses to which the building will be put. This is done in order to ensure a minimum standard of fire safety for the occupants of the building as well as for surrounding buildings. Height and area limitations, because they dictate the types of construction from which the designer may choose, have the largest impact on building design of any building code provisions. It is not uncommon during early design stages for consideration of these limits to lead to significant changes in building program requirements or massing simply to enable the use of the most economical construction systems possible.

Though similar in their approaches to limiting building height and area, the model codes differ in detail. To the maximum extent possible, these differences have been minimized in the following height and area tables by pre-

sending the data from the codes in a consistent format, so that the designer may work as readily with one code as with the other. The authors have adopted the names "3-Hour," "2-Hour," and so on, for the Construction Types. These names are based on the required fire resistance ratings of the structural loadbearing frame in each Type and are used to overcome inconsistencies in nomenclature between the codes. In addition, the adjustments permitted in each code for allowable area and height due to the number of stories, use of

sprinklers, and other particulars have been precalculated for instant reference.

One difference between the codes that was not possible to resolve relates to the determination of allowable area. For the International Building Code, the tabulated values are for the *total area for all floors of the building combined*. For the National Building Code of Canada, the tabulated values are for the *area of any single floor*. When working with these tables, be sure to apply the indicated values appropriately.

INTERNATIONAL BUILDING CODE

Occupancy Group	Page
A-1: Assembly, Theaters	372-373
A-2: Assembly, Food and Drink Establishments	374-375
A-3: Assembly, Miscellaneous	376-377
A-4: Assembly, Indoor Arenas	378-379
A-5: Assembly, Outdoor Arenas	380-381
B: Business	382-383
E: Educational	384-385
F-1: Factory, Moderate Hazard	386-387
F-2: Factory, Low Hazard	388-389
H-1: High-Hazard, Detonation Hazard	390-391
H-2: High-Hazard, Accelerated Burning Hazard	392-393
H-3: High-Hazard, Combustibles	394-395
H-4: High-Hazard, Corrosives and Toxics	396-397
H-5: High-Hazard, Hazardous Production Materials	398-399
I-1: Institutional, Residential Care	400-401
I-2: Institutional, Medical and Custodial Care	402-403
I-3: Institutional, Detention and Security	404-405
I-4: Institutional, Day Care	406-407
M: Mercantile	408-409
R-1: Residential, Hotels and Motels	410-411
R-2: Residential, Multifamily	412-413
R-3: Residential, One- and Two-Family	414-415
R-4: Residential, Assisted Living	416-417
S-1: Storage, Moderate Hazard	418-419
S-2: Storage, Low Hazard	420-421
S-2: Open Parking Garages	422-423
U: Utility and Miscellaneous	424-425

Use these indexes to find the height and area limitations table for the building code and use group you are working with.

HEIGHT AND AREA LIMITATIONS

Each code has seemingly endless exceptions to its own basic height and area limitations. The most important exceptions deal with height and area increases permitted in exchange for approved automatic sprinkler systems and excess street frontage. The increases for sprinklered buildings have been incorporated fully into the tables, while the frontage increases are tabulated prominently in the accompanying notes. Other important exceptions have been noted in the text accompanying each table. A few exceptions are so complex that they could not reasonably be

digested into these pages; for these you are directed to the code itself by notes accompanying the appropriate tables. Some exceptions were deemed by the authors to be so minor as not to warrant their inclusion here. For this reason, you must carry out a thorough investigation of the building code itself as a building design progresses to its developmental stage.

The following pages provide information on a number of topics closely related to determining the height and area of a building. Pages 352–355 explain how the model codes address a building

with more than one type of occupancy. Pages 356–357 discusses guidelines for the incorporation of mezzanines and floor openings or atriums into the height and area calculations of a building. Pages 358–359 discuss the construction and fire-resistance requirements of fire walls, exterior walls, and a concept unique to the International Building Code, fire areas. Descriptions of the requirements for Construction Types for both model codes, and listings of typical construction systems that meet these requirements, are presented on pages 360–368.

NATIONAL BUILDING CODE OF CANADA

Occupancy Group	Page
A-1: Assembly, Theaters	428-429
A-2: Assembly, Miscellaneous	430-431
A-3: Assembly, Arenas	432-433
A-4: Assembly, Open-Air	434-435
B-1: Care or Detention, Restrained	436-437
B-2: Care or Detention, Unrestrained	438-439
C: Residential	440-441
D: Business and Personal Services	442-443
E: Mercantile	444-445
F-1: Industrial, High-Hazard	446-447
F-2: Industrial, Medium-Hazard	448-449
F-3: Industrial, Low-Hazard	450-451
F-3: Open-Air Garages	452-453

See pages 13-15 for more information about Occupancy Groups in the National Building Code of Canada.

Single buildings often accommodate more than one type of occupancy, for example retail space on the ground floor of an office building, restaurants, bars, and meeting rooms in a hotel, or parking garages beneath commercial or residential occupancies. Use the following guidelines for preliminary design of such mixed-use structures.

INTERNATIONAL BUILDING CODE

When two or more Occupancy Groups are combined in one building, the International Building Code allows these mixed uses to be treated as either *Nonseparated* or *Separated Occupancies*.

Nonseparated Occupancies

When occupancies are Nonseparated, there are no requirements for fire separation between them, and the allowable building height and area are determined for the whole structure by applying the requirements of the most restrictive occupancy throughout. Within each occupancy area, occupant load calculations, egress configuration, and other such requirements are applied according to the code restrictions for that particular occupancy.

Separated Occupancies

Separated Occupancies are segregated from one another by fire separations, which may consist of fire-resistant walls, fire doors and other rated openings, and fire-resistant floor/ceiling assemblies. The degree of fire resistance required for such separations may vary from 1 to 4 hours, depending on the occupancies involved and whether the building is sprinklered. For preliminary purposes, a 2-hour

rated separation for nonsprinklered buildings and a 1-hour separation for sprinklered buildings may be assumed. Some High-Hazard occupancies may not be mixed with other occupancies under any circumstances. In general, building code requirements for Separated Occupancy buildings result in higher construction costs and greater restriction on space planning in comparison to Nonseparated Buildings. However, under most circumstances, Separated Occupancy Buildings may be built to a larger area and greater height as well.

In a Separated Occupancy building, each occupancy area is required to conform to its own height limitations, both in number of stories and in feet (or meters) above grade. For example, in a four-story Separated Occupancy building, where one of the occupancy's height limitations restricts it to no more than two stories, that occupancy may only be located on the first or second floor of the building. Some other occupancy, with height limits permitting four stories, may be located on any floor.

Considering building area limits, where an entire building floor contains only one type of occupancy, the area of that floor is limited by the restrictions for that particular occupancy. Where a floor shares two or more separated occupancies, the allowable area determination for that floor is based on a proportional calculation as follows:

1. For each occupancy, divide its proposed area on the floor by the maximum area permitted by the code to get a decimal fraction.
2. Add the fractional results for each occupancy on the floor.
3. The sum total must not exceed 1.

For example, consider a four-story university building, sprin-

klered, of Type II-A construction. The proposed footprint of the building is 85,000 sq ft. On the first floor are three 5000-sq-ft auditoriums classified as Group A-3 Assembly and 70,000 sq ft of classroom space classified as Group B Business. In the height and area limit tables on pages 376 and 382, the allowable single floor areas in multifloor buildings for these two Occupancy Groups are 46,500 sq ft for the Assembly Occupancy and 112,500 sq ft for the Business Occupancy (these figures are read from the bottom row of the height and area limit tables). To check the floor area, first divide the proposed area by the allowable area for each occupancy:

Group A-3, area on floor 1:

$$\frac{3 \times 5000 \text{ sq ft proposed}}{46,500 \text{ sq ft allowed}} = 0.32$$

Group B, area on floor 1:

$$\frac{70,000 \text{ sq ft proposed}}{112,500 \text{ sq ft allowed}} = 0.62$$

Then sum the fractions and compare to 1:

$$0.32 + 0.62 = 0.94 < 1 \text{ OK}$$

In this case, the sum of the fractions is less than 1, and this combination of occupancies is within allowable area limits. In a building with more than one floor, this check must be performed for each floor. (These additional checks are omitted in this example.)

For Separated Occupancy buildings over three stories in height, an additional check must be made to verify area limits for the building as a whole. In this case, a similar proportional calculation is performed, but comparing the proposed area on all floors to the allowable area on all floors. Continuing with the example above, assume that the second through fourth floors of the build-

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ing each contain 85,000 sq ft of classroom and office space all classified as Group B Business. Consulting again the height and area limit tables on pages 376 and 382, the total allowable area on all floors for these two occupancy groups are 139,500 sq ft for the Assembly Occupancy and 337,500 sq ft for the Business Occupancy (these figures are read from the row corresponding to the proposed story height of the building). First, for each occupancy, divide the proposed area on all floors by its allowable area on all floors:

$$\begin{array}{l} \text{Group A-3, area on all floors:} \\ \frac{3 \times 5000 \text{ sq ft proposed}}{139,500 \text{ sq ft allowed}} = 0.11 \end{array}$$

$$\begin{array}{l} \text{Group B, area on all floors:} \\ \frac{70,000 \text{ sq ft} + 3 \times 85,000 \text{ sq ft proposed}}{337,500 \text{ sq ft allowed}} = 0.96 \end{array}$$

Then sum the fractions and compare to 1:

$$0.11 + 0.96 = 1.07 > 1 \text{ NOT OK}$$

In this case, considering the area on all floors of the building, the sum of the fractions exceeds 1 and the proposed building is not within the code's area limits for the proposed mix of occupancies. To correct this problem, the building must be reduced in size, the mix of occupancies must be adjusted, or a Construction Type with greater allowable area must be selected.

Accessory and Incidental Uses

Some combinations of uses need not fully meet requirements for mixed-use occupancies. For example, certain specific use combinations are not required to be recognized as mixed use at all and may be treated as single occupancies:

■ Assembly areas less than 750 sq ft (70 m²) in area or with an occupant load of less than 50 may be considered part of any other occupancy within which they occur (for example, meeting rooms in a Business occupancy).

■ Assembly areas not exceeding 10% of the floor area of a Group E Educational Occupancy are considered part of the Educational Occupancy (for example auditoriums, lunch rooms, gymnasiums, etc. in K-12 school buildings).

■ In places of worship buildings, classrooms and auditorium spaces less than 100 sq ft (9 m²) in area, that might otherwise be classified as Group E Educational, may be considered part of the main occupancy, usually Group A-3 Assembly.

Other uses may, at the designer's option, be treated as *Accessory* or *Incidental* to the major occupancy within which they occur, rather than according to the Separated or Nonseparated Occupancy provisions discussed above. One or more uses may be considered Accessory when, in total, they occupy no more than 10% of the area of the floor on which they are located. In such cases, no separation is required between uses, and building height, area, and sprinkler requirements are governed by the major occupancy. Occupant load and egress requirements for each occupancy are still applied individually to each area, and accessory areas themselves may not exceed the unsprinklered height and area limits for their particular occupancy type. Certain occupancies, such as High-Hazard, may not be treated as Accessory to another, regardless of size.

Incidental Uses areas consist of a specific list of uses which may be treated in a manner similar to Accessory spaces. However, because of their higher degree of

hazard, additional protection is required in the form of fire-extinguishing systems, fire sprinklers, and/or rated fire separations between the Incidental Use and the major occupancy within which it is located. Except for these protections, all other requirements, such as height and area requirements, are governed by the major occupancy. Examples of Incidental Uses and their protection requirements include the following:

■ Furnace and boiler rooms with equipment over certain size limits, with either a 1-hour rated separation or an automatic fire-extinguishing system and construction capable or resisting the passage of smoke

■ Paint shops in other than Group F Factory Occupancies, with either a 2-hour separation or a 1-hour separation and an automatic fire-extinguishing system

■ Parking garages, with either a 2-hour separation, or a 1-hour separation and an automatic fire-extinguishing system

■ Laboratories or vocational shops within Group E Educational or I-2 Institutional Occupancies, with either a 1-hour rated separation or an automatic fire-extinguishing system and construction capable or resisting the passage of smoke

■ Laundry, storage, waste collection, and linen collection rooms greater than 100 sq ft (9 m²) in area, with either a 1-hour rated separation or an automatic fire-extinguishing system and construction capable or resisting the passage of smoke

■ Incinerator rooms with a 2-hour rated separation and an automatic sprinkler system

For a complete list of Incidental Uses and their requirements, consult the code.

Parking Garages and Mixed-Use Occupancies

The International Building Code recognizes unique circumstances where parking of one Construction Type is located above or beneath other occupancies of other Construction Types, as summarized below. See the code for details.

Open or Enclosed Parking Below Group A, B, M, R, or S Occupancies:

In this configuration, the upper and lower portions of the structure may be treated as separate buildings for the purpose of determining each portion's limitations in area, number of stories, height (measured in feet or meters), continuity of fire walls, and type of construction for each. The following requirements must also be met:

- The parking garage is located in a basement and/or not more than in the first story above grade.
- The garage is used solely for the storage of private motor vehicles, except for entry lobbies, equipments rooms, and other spaces incidental to its operation.
- The garage is constructed of Type IA construction only.
- There is a 3-hour rated horizontal assembly between the parking and the occupancy above.
- No single Group A assembly space may have an occupant load in excess of 300.

In addition to motor vehicle parking in the lower portion of the structure, Group B and M occupancies and Group A Occupancies with rooms with an occupant load not exceeding 300 are also permitted, provided that the upper structure is fully sprinklered throughout.

Open Parking Below Group A, I, B, M, or R Occupancies: In this configuration, the height, number

of floors, and area of the garage may comply with the requirements of the table on pages 422-423, based on the Construction Type of that part of the structure. The height and area requirements of the upper portion of the structure may be based on its own occupancy and Construction Type requirements. However, both height (in feet or meters) and number of stories above grade for the upper-occupancy portion of the structure must be taken from grade, including the lower (parking) portions of the structure. The following requirements must also be met:

- There is a horizontal separation between the garage and the occupancy above, with a fire-resistance rating of not less than that required by the code for the separated occupancies (typically 2 hours).
- If the Construction Type requirements of the upper portion of the structure exceed those for the parking below, the structural members of the lower portion have fire protection meeting the requirements of the upper portion.

Open Parking with Group B or M Occupancies Below:

In this configuration, the height and area of the upper portion of the structure may comply with the requirements of the table on pages 420-421, with the building height and number of stories measured from grade (including the occupancies below). The height and area of the lower portion of the structure must comply with the requirements for the occupancies in that portion of the structure. The following requirements must also be met:

- There is a horizontal separation between the garage and the occupancy below, with a fire-resistance rating of not less than that required by the code for the separated occupancies (typically 2 hours).

■ The lower portion of the structure is constructed of Type I or Type II construction, but not less than that required for the open parking above.

■ Exits from the parking must discharge directly to public ways and must be separated by 2-hour rated enclosures from the lower occupancies.

Single-Story Enclosed or Open Parking Below Group R Occupancy:

In this configuration, the height and area of the upper portion of the structure may be determined based on the Group R Occupancy and its Construction Type requirements, with the number of stories measured from the first floor above the parking structure. Building height (in feet or meters) must be measured from grade. The following requirements must also be met:

- The garage is single-story, located on grade.
- The garage is of Type I or Type IV (open garage only) construction.
- There is a horizontal separation between the garage and the occupancy above with a fire-resistance rating of not less than that required for floors in the lower garage and not less than that required by the code for separation of the two occupancies (typically 2 hours).

Enclosed Parking Below Open Parking:

In this configuration, the Construction Type, height, and number of floors of the upper, open garage may comply with the requirements of the table on pages 420-421. The total area of both structures combined is limited as explained previously in this section for Separated, mixed-occupancy buildings—that is, the ratio of the total floor area of the lower garage divided by its maximum permitted

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area plus the ratio of the total floor area of the upper garage divided by its maximum permitted area may not exceed 1. The following requirements must also be met:

- The lower garage is located in a basement and/or first story above grade.
- The lower garage is of Type I or Type II construction or, if the garage above is of Type I construction, then the lower garage is of Type I construction only.
- There is a horizontal separation between the garages, with a fire-resistance rating of not less than that required for a floor assembly in the lower garage.
- The lower garage is used solely for the storage of private motor vehicles, except for equipment rooms incidental to the operation of the garage, and up to 1000 sq ft (93 m²) of office, waiting room, and toilet room areas.

NATIONAL BUILDING CODE OF CANADA

The National Building Code of Canada treats mixed occupancies as separated uses. They must be segregated from one another by fire separations including fire-

resistant walls, fire doors and other rated openings, and fire-resistant floor/ceiling assemblies. The degree of fire resistance required varies from 1 to 3 hours, with 1 to 2 hours required for the most common occupancy types. Some High-Hazard Industrial occupancies may not be mixed with other occupancies at all.

In most mixed-use buildings, height and area requirements of the most restrictive occupancy type are applied to the whole building. In cases where one occupancy type occurs fully above or below another, the code provides an alternative treatment in which each portion of the structure may meet the Construction Type requirements for that portion's particular occupancy, while the more restrictive height and area requirements of either occupancy are applied to the building as a whole. This option allows the possibility of a single building of multiple Construction Types, for example, combustible residential units above a noncombustible commercial first story. Accessory uses are also recognized, in which the area of one or more occupancies does not exceed 10% of the total area on a floor. Accessory uses are not required to be separated from the

major occupancy and are not considered in the determination of height and area limits for the building. High- and Medium-Hazard Industrial occupancies may not be treated as accessory to other occupancies. As a related consideration, whenever mixed occupancies or other varied requirements result in a condition where only part of a structure is required to be sprinklered, all portions of a building beneath the portion required to be sprinklered must be sprinklered as well.

Parking Garages and Mixed-Use Occupancies

When a basement is used primarily as a parking garage, exclusive of servicing or fueling of vehicles, it may be considered as a separate building, provided that the separation between the garage and the occupancies above, as well as the portions of the garage walls above grade, are constructed of masonry or concrete with a 2-hour fire-resistance rating. In this case, the structure above the garage is subject to its own Construction Type, height, and area requirements. In some cases, the garage may also require sprinklers. See the code for details.

MEZZANINES

A mezzanine is an intermediate platform located between the floor and ceiling of a room. Under both model building codes, a mezzanine is not counted toward the number of floors or area limits of a building. However, the area of the mezzanine is considered when calculating occupant loads and egress requirements.

International Building Code

In the International Building Code, the area of a mezzanine usually may not exceed one-third of the open area of the room in which it is located (enclosed portions of the room are not included in this calculation). The mezzanine itself is also required to remain open. However, portions of a mezzanine with an occupant load of 10 or less or that do not exceed 10% of the mezzanine area may be enclosed, and mezzanines with two means of egress, at least one of which leads directly to an exit, may be fully enclosed. A mezzanine has the same Construction Type requirements as the floor on which it is located. The number of means of egress required is determined as for any other room or space within a building, considering, for example, the number of occupants, occupancy type, common path of travel requirements, travel distance, and so on; see the Exit Access, beginning on page 254, for more information. Mezzanines in buildings of Noncombustible Construction may be up to one-half of the open area of the room in which they are located when the building is protected throughout with sprinklers and an emergency alarm and communication system. Mezzanines of increased area are also permitted in noncombustible buildings housing certain large-scale industrial occupancies; see the code for details.

National Building Code of Canada

In the National Building Code of Canada, the area of a mezzanine usually may not exceed 40% of the open area of the room in which it is located (enclosed portions of the room are not included in this calculation). A mezzanine is required to remain open to the room, except that portions of the mezzanine not exceeding 10% of the open area of the room below may be enclosed. In some cases, a mezzanine may be constructed to a lesser fire-resistance than the floor on which it is located; see pages 362–363 for more information. The number of means of egress from a mezzanine is generally determined as for any other floor area, except that depending on occupancy type, some mezzanines of limited area and travel distance to an exit may have lesser requirements; see the code for details. In some cases, mezzanines must also meet the requirements for *interconnected floor spaces*; see the following section, Floor Openings, for more information.

FLOOR OPENINGS

In both model codes, openings that create atmospheric connections between floors within a building, other than enclosed vertical structures for exit stairways, elevator hoistways, shafts, and other such elements, are subject to special restrictions intended to protect occupants against the rapid spread of smoke or fire between floors in the event of a building fire.

International Building Code

In the International Building Code, openings between floors are termed *atriums* and must comply with the following:

- Activities on the floor level of the atrium itself are restricted to those with a low fire hazard, unless that area is protected by sprinklers.

- Buildings containing atriums must be sprinklered throughout, except that areas adjacent to or above the atrium need not be sprinklered when separated from the atrium by 2-hour rated assemblies. Additionally, ceilings of atriums more than 55 ft (17 m) above the atrium floor need not be sprinklered.

- Atriums connecting more than two floors must be provided with a mechanical smoke control system designed to protect occupants from smoke and toxic gasses during a fire emergency.

- An atrium must be separated from adjacent spaces by 1-hour rated walls, except that up to three floors may be open to the atrium as long as the smoke control system design accounts for the volume of such connected areas. Additionally, walls separating the atrium from adjacent spaces may include glass when the glass areas are protected with a specially designed sprinkler system that will completely wet the glass surface when activated, or they may be constructed of glass block with not less than a 1-hour fire-resistance rating.

- Except at its lowest level, portions of exit access travel within the atrium space may not exceed 200 ft (61 m).

Floor openings meeting the following requirements are not subject to atrium requirements:

- Openings between a floor and its mezzanine spaces

- Openings within individual dwelling units not more than four stories in height

- In fully sprinklered buildings, openings of limited area for escalators or stairs not part of the means of egress

MEZZANINES AND FLOOR OPENINGS

- In other than Group I-2 or I-3 Occupancies, openings connecting not more than two floors

- Openings connecting not more than two floors as permitted for unenclosed exit stairs (see page 260 for more information)

- In mall buildings, openings not more than three stories in height

- Automobile ramps in parking garages and open exit stairways in open garages

National Building Code of Canada

In the National Building Code of Canada, openings between floors are referred to as *interconnected floor spaces*. Floor openings treated as interconnected floor spaces must conform to the following requirements:

- Buildings with interconnected floor spaces must be sprinklered throughout and must be of either Noncombustible or Heavy Timber Construction.

- Exit access ways must be separated from interconnected floor spaces by fire separations with a

fire-resistance rating not less than the required rating for floor assemblies.

- Exits opening into interconnected floor spaces must be protected by vestibules. Elevator shafts that open into interconnected floor spaces as well as spaces on higher floors must be protected by vestibules either on all interconnected floor space floors or all floors above.

- A mechanical smoke exhaust system serving the interconnected floor spaces is required.

- The quantity of combustible contents located in interconnected floor spaces is limited.

- Sleeping rooms in Group B-2 Care or Detention Occupancies may not be located within interconnected floor spaces.

All openings between floors, including openings for mezzanines, are subject to the requirements for interconnected floor spaces, except as follows:

- Openings for mezzanines within Group A-1 Occupancies, Group A-3 Occupancies in buildings not more

than two stories in height, or for mezzanines not more than 500 m² (5380 sq ft) in area in Group A, C, D, E, or F Occupancies

- Openings connecting only first floors of a building and one floor above or below, used for stairways, escalators, or moving walks, in Group A-1, A-2, A-3, D, E, F-2, and F-3 Occupancies, in buildings not exceeding one-half of their permitted area according to the height and area tables beginning on page 372

- Openings connecting only two floors in Group B-1 Occupancy buildings

- Floor openings of limited area for escalators in sprinklered buildings of Group A-1, A-2, A-3, D, and E Occupancies

- Floor openings for vehicular ramps in parking garages

- Openings in special industrial buildings necessary for the flow of materials for the manufacturing processes taking place within the building

FIREWALLS, EXTERIOR WALLS, AND FIRE AREAS

FIRE WALLS

Fire walls are used to divide structures into two or more parts such that each distinct part may then be considered a separate building for the purposes of determining its allowable height and area. In this way, a building of virtually any horizontal extent can be built, so long as it is subdivided by fire walls into self-contained parts that individually comply with code height and area limitations, and Construction Type requirements, for the types of occupancies involved.

Fire walls require a fire-resistance rating of 2 to 4 hours, depending on the occupancies being separated. They must be constructed either as two separate walls, each independently supported by structure on opposite sides, or as one wall that can remain standing in the event of a structural collapse on either side. They must extend continuously from one exterior wall of the structure to another and from the building foundation to the roof. The International Building Code requires fire walls to be of Non-combustible Construction, unless separating solely Type V Wood Light Frame structures on both sides. The National Building Code of Canada in some cases restricts fire walls to concrete and masonry construction. Depending on the fire resistance of the building exterior construction, fire walls may be required to project beyond exterior walls and/or roofs a distance ranging from 6 to 36 in. (150 to 900 mm) to limit the chance for fire to jump from one side of the wall to the other. Where exterior walls and roofs have sufficient fire resistance themselves, fire walls may be permitted to terminate at these boundaries without projecting beyond. For the same reason, openings in

exterior walls or roofs within certain distances of the fire wall may be restricted as well. Within the fire walls themselves, openings, most commonly for doors, must be fire rated. Each opening must meet specified size limits, and the area of all openings taken together must not exceed 25% of the wall's total area. Where fire walls coincide with property lines (also known as *party walls*), the International Building Code does not permit openings of any type. Fire walls may be vertical structures only. That is, horizontal floor/ceiling assemblies may not be part of fire wall structures.

FIRE-RESISTANCE REQUIREMENTS FOR EXTERIOR WALLS

Exterior walls must be constructed to resist fires originating from within the building itself as well as from nearby structures. In cases where buildings are particularly close to property lines or other structures, the risk of exposure to fire from adjacent buildings may create a more stringent requirement for the fire resistance of the exterior walls of a building than would otherwise be required for its Construction Type. Specific requirements vary with the type of construction, the occupancies within the building, and the distance between buildings. In the International Building Code, excluding High-Hazard Occupancy groups, fire-resistance rating requirements for exterior walls of buildings less than 60 ft (18 m) apart range from 0 to 1 hour, and for buildings separated by less than 20 ft (6 m) from 1 to 2 hours. Exterior wall fire-resistance rating requirements in the National Building Code of Canada range from 45 minutes to 2 hours at dis-

tances ranging from 10 m to as much as 140 m (33 to 460 ft) between buildings, and may also include additional restrictions on the combustibility of the wall construction and its exterior cladding. Similarly, as the distance between buildings decreases, the extent of windows, doors, and other unprotected openings permitted in opposing exterior walls also declines. Consult the code for details.

FIRE AREAS

In the International Building Code, fire-rated walls and floor/ceiling assemblies may be used to subdivide portions of a building into so-called *fire areas*, most frequently as a means of avoiding sprinkler requirements. In its simplest form, a fire area is the total area for any single occupancy classification within a building, including the area on all floors and mezzanines allocated to that occupancy type, where these areas are not separated by fire-resistance rated assemblies. For example, where a 1000-sq-ft meeting room classified as Group A-3 Assembly occurs on a building floor that otherwise contains Group B occupancy space, the Assembly fire area is 1000-sq-ft. If there are three such rooms on the floor, without fire-rated separations between them, the Assembly fire area becomes 3000 sq ft ($3 \times 1000 \text{ sq ft} = 3000 \text{ sq ft}$). If an additional three such rooms are located on an adjacent floor and the floor/ceiling construction between the floors is not a fire-rated separation, the Assembly fire area then becomes 6000 sq ft. If, on the other hand, the floor/ceiling construction does meet requirements for a fire-rated separation, this last example would

FIREWALLS, EXTERIOR WALLS, AND FIRE AREAS

instead be treated as two separate 3000-sq-ft fire areas.

To give an example of how fire area is applied in relation to sprinkler requirements, consider a one-story building classified as a Group F-1 Factory Occupancy, with a total area of 20,000 sq ft. According to the sprinkler requirements listed at the top of page 386, such a building, having a fire area exceeding 12,000 sq ft, must be sprinklered throughout. Therefore, if the factory floor remains entirely open, the building must be sprinklered.

However, if the floor is divided in half by a fire-rated wall into two separate fire areas each 10,000 sq ft in area, this sprinkler requirement is avoided.

Fire-resistance rating requirements for separations between fire areas range from 1 to 4 hours, depending on the type of occupancy involved. For preliminary purposes, a 2-hour rating may be assumed for occupancies other than High-Hazard, and Moderate Hazard Storage or Factory.

CONSTRUCTION TYPES

INTERNATIONAL BUILDING CODE

This section summarizes the fire-resistance rating and construction requirements for Construction Types in the International Building Code. Once you have determined an appropriate Construction Type for a project, based on the height and area tables on pages 372–425, use this section to relate this information to systems of construction. The table on these two facing pages consolidates and simplifies fire-resistance requirements for each Construction Type. The pages following this chart define each Construction Type in terms of specific structural systems, materials, and minimum thicknesses of components necessary to meet the

required minimum fire-resistance rating. The values in the table below may be modified as follows:

■ **Reduction in 1-Hour Rated Construction:** Where building height and area are read from the Unsprinklered column of the Height and Area tables in this book, and a sprinkler system is not otherwise a code requirement, the use of sprinklers may be applied toward a reduction in the protection requirements for buildings of any 1-Hour Construction Type. In such a case, height and area requirements for the building are determined by reading from the Height and Area tables for either Type II-A, III-A, or V-A construction (unsprinklered), but the fire-resistance requirements for the building

structure are based on the unprotected versions of these Construction Types, either Type II-B, III-B, or V-B, respectively. Exterior bearing wall fire-resistance requirements are not reduced.

■ **Exterior Bearing Walls:** In addition to the requirements indicated in the table on these two facing pages, see also Fire-Resistance Requirements for Exterior Walls, page 358, for information regarding protection of exterior walls when in close proximity to other buildings.

■ **Structure Supporting Roofs Only:** Interior bearing walls, columns, girders, trusses, and other members of the structural frame supporting roofs only may be 1-hour rated maximum for any

INTERNATIONAL BUILDING CODE

CONSTRUCTION TYPE
INTERNATIONAL BUILDING
CODE NOMENCLATURE
STRUCTURAL FRAME INCLUDING
COLUMNS, GIRDERS, TRUSSES
EXTERIOR BEARING WALLS
INTERIOR BEARING WALLS
FLOOR CONSTRUCTION
ROOF CONSTRUCTION
PARTY WALLS AND FIRE WALLS

ENCLOSURES OF EXITS, EXIT
HALLWAYS, EXIT STAIRWAYS,
SHAFTS
EXIT ACCESS CORRIDORS
TENANT SPACE SEPARATIONS
DWELLING UNIT AND GUEST
ROOM SEPARATIONS

OTHER NONBEARING
PARTITIONS

Noncombustible				
3-Hour (page 364) Type I-A	2-Hour (page 364) Type I-B	1-Hour (page 365) Type II-A	Unprotected (page 366) Type II-B	
3	2	1	0	
3	2	1	0	
3	2	1	0	
2	2	1	0	
1½	1	1	0	
2–4	2–4	2–4	2–4	
2	2	2 hours connecting 4 stories or more, 1 hour connecting fewer than 4 stories		
0–1	0–1	0–1	0–1	
1	1	1	1	
1	1	1	1	
Noncombustible				

CONSTRUCTION TYPES

Construction Type. Exterior bearing wall fire-resistance requirements are not reduced.

■ **Roof Construction:** Roof structures 20 ft (6 m) or more above the floor below may be unprotected in all occupancies except F-1, H, M, and S-1. Type IV-HT Heavy Timber Construction is permitted wherever a Noncombustible or Combustible roof structure with a fire-resistance rating of 1 hour or less is permitted.

■ **Enclosures for Corridors and Exits:** For more information on corridor enclosure requirements, see page 257, and for exit enclosures, page 260.

■ **Dwelling Unit Separations:** Dwelling unit and guest room sep-

arations may be reduced to ½-hour rated in any Unprotected Construction Type, provided that the building is sprinklered.

■ **Tall Buildings:** Most buildings with occupied floors more than 75 ft (23 m) above grade must be fully sprinklered. For such buildings with a roof height not exceeding 420 ft (128 m), Construction Type and rated assembly requirements may be adjusted as follows:

Buildings of Type I-B construction may be built to the height and area limits of Type I-A construction, except that columns supporting floors must be built to the requirements of Type I-A construction. In other than Group F-1, M, and S-1 Occupancies, buildings of Type II-

A construction may be built to the height and area limits of Type I-B construction. Shafts for other than exits and elevators may be enclosed with 1-hour fire-resistance rated assemblies when the interiors of the shafts themselves are protected with an automatic sprinkler system.

These provisions do not apply to open parking garages, airport traffic control towers, outdoor sports arenas, and some unusually tall Low- and Medium-hazard industrial buildings. For special egress system and smoke control requirements in tall buildings, see High-rise and Underground Buildings, page 277.

Combustible				
Ordinary		Mill (page 366) Type IV-HT	Wood Light Frame	
1-Hour (page 368) Type III-A	Unprotected (page 368) Type III-B		1-Hour (page 368) Type V-A	Unprotected (page 368) Type V-B
1	0	Heavy Timber	1	0
2 Noncombustible	2 Noncombustible	2 Noncombustible	1	0
1	0	1 or Heavy Timber	1	0
1	0	Heavy Timber	1	0
1	0	Heavy Timber	1	0
2-4	2-4	2-4	2-4	2-4
2 hours connecting 4 stories or more, 1 hour connecting fewer than 4 stories				
0-1	0-1	0-1	0-1	0-1
1	1	1	1	1
1	1	1	1	1
0	0	0	0	0

CONSTRUCTION TYPE
INTERNATIONAL BUILDING
CODE NOMENCLATURE
STRUCTURAL FRAME INCLUDING
COLUMNS, GIRDERS, TRUSSES
EXTERIOR BEARING WALLS
INTERIOR BEARING WALLS
FLOOR CONSTRUCTION
ROOF CONSTRUCTION
PARTY WALLS AND FIRE WALLS

ENCLOSURES OF EXITS, EXIT
HALLWAYS, EXIT STAIRWAYS,
SHAFTS
EXIT ACCESS CORRIDORS
TENANT SPACE SEPARATIONS
DWELLING UNIT AND GUEST
ROOM SEPARATIONS

OTHER NONBEARING
PARTITIONS

CONSTRUCTION TYPES

NATIONAL BUILDING CODE OF CANADA

This section summarizes the fire-resistance rating and construction requirements for Construction Types in the National Building Code of Canada. Once you have determined an appropriate Construction Type for a project, based on the Height and Area Tables on pages 428–453, use this section to relate this information to systems of construction. The table on these

two facing pages consolidates and simplifies fire-resistance requirements for each Construction Type. The pages following this chart define each Construction Type in terms of specific structural systems, materials, and minimum thicknesses of components necessary to meet the required minimum fire-resistance rating. The values in the table below may be modified as follows:

■ **Exterior Bearing Walls:** In addition to the requirements indi-

cated in the table on these two facing pages, see also Fire-Resistance Requirements for Exterior Walls, page 358, for information regarding protection of exterior walls when in close proximity to other buildings.

■ **Heavy Timber Construction:** Heavy Timber construction is an acceptable substitute for any building where ¾-Hour or Unprotected Noncombustible Construction is permitted.

NATIONAL BUILDING CODE OF CANADA

CONSTRUCTION TYPE

- LOADBEARING COLUMNS, WALLS AND ARCHES
- FLOOR CONSTRUCTION
- MEZZANINES
- ROOF CONSTRUCTION
- PARTY WALLS AND FIRE WALLS
- ENCLOSURES OF EXITS, EXIT HALLWAYS, EXIT STAIRWAYS
- EXIT ACCESS CORRIDORS
- SUITE SEPARATIONS
- DWELLING UNIT AND GUEST ROOM SEPARATIONS
- OTHER NONBEARING PARTITIONS

Noncombustible			
2-Hour (page 364)	1-Hour (page 365)	¾-Hour (page 365)	Unprotected (page 366)
2	1	¾	0
2	1	¾	0
1	1	0	0
0–1	0–1	0–¾	0
2–4	2–4	2–4	2–4
2	1	¾	¾
1¾	1¾	¾	¾
1	1	¾	¾
1	1	¾	¾
Noncombustible			

CONSTRUCTION TYPES

■ Structure Supporting Roofs

Only: Walls, columns, girders, trusses, and other members of the structural frame supporting roofs only may be constructed to the fire-resistance rating as required for the roof itself.

■ **Roof Construction:** Where roofs support any occupancy, they must be constructed to the fire-resistance rating requirements for a floor assembly. Long-span roofs over arenas, swimming pools, gymnasiums, and other similar types of

space may be of Unprotected Construction when supporting roof loads only and not less than 6 m (20 ft) above the floor. Roofs for fully sprinklered one- and two-story buildings of any occupancy and any construction type may be of Heavy Timber Construction.

■ **Corridor Enclosures:** For more information on corridor enclosure requirements, see page 257.

	Combustible			
	1-Hour (page 368)	Heavy Timber (page 366)	3/4-Hour (page 368)	Unprotected (page 368)
1		Heavy Timber	$\frac{3}{4}$	0
1		Heavy Timber	$\frac{3}{4}$	0
1		Heavy Timber	0- $\frac{3}{4}$	0
0-1		Heavy Timber	0- $\frac{3}{4}$	0
2-4		2-4	2-4	2-4
1		$\frac{3}{4}$	$\frac{3}{4}$	$\frac{3}{4}$
1		$\frac{3}{4}$	$\frac{3}{4}$	$\frac{3}{4}$
1		$\frac{3}{4}$	$\frac{3}{4}$	$\frac{3}{4}$
1		$\frac{3}{4}$	$\frac{3}{4}$	$\frac{3}{4}$
0		0	0	0

CONSTRUCTION TYPE

**LOADBEARING COLUMNS,
WALLS AND ARCHES**

FLOOR CONSTRUCTION

MEZZANINES

ROOF CONSTRUCTION

PARTY WALLS AND FIRE WALLS

**ENCLOSURES OF EXITS,
EXIT HALLWAYS, EXIT STAIRWAYS**

EXIT ACCESS CORRIDORS

SUITE SEPARATIONS

**DWELLING UNIT AND
GUEST ROOM SEPARATIONS**

OTHER NONBEARING PARTITIONS

3-HOUR NONCOMBUSTIBLE CONSTRUCTION

3-Hour Noncombustible Construction requires a fire-resistance rating of 3 hours for columns and bearing walls and 2 hours for floor construction.

■ **Structural Steel** columns, beams, joists, and decking must be protected to these values with applied fireproofing materials or an appropriately fire-resistive ceiling of plaster, gypsum board, or fibrous panels (see pages 98–111).

■ **Reinforced Concrete** columns must be at least 12 in. (300 mm) in dimension, and loadbearing walls must be at least 6 in. (150 mm) thick. Floor slabs must be at least 5 in. (125 mm) thick. Concrete one-way and two-way joist systems (ribbed slabs and waffle slabs) with slabs thinner than 5 in. (125 mm) between joists require protection with applied fireproofing materials or an appropriately fire-resistive ceiling of plaster, gypsum board, or fibrous panels (see pages 113–129).

■ **Posttensioned Concrete** floor slabs must be at least 5 in. (125 mm) thick (see pages 120–129).

■ **Precast Concrete** columns must be at least 12 in. (300 mm) in dimension, and beams at least 7 in. (175 mm) wide. Loadbearing wall panels must be at least 6 (150 mm) thick. Solid slabs may not be less than 5 in. (125 mm) thick. Hollow core slabs must be at least 8 in. (200 mm) deep and may be used without a topping. Double and single tees require applied fireproofing materials or an appropriately fire-resistive ceiling of plaster, gypsum

board, or fibrous panels, unless a concrete topping 3.25 in. (85 mm) is poured (see pages 131–141).

■ **Brick Masonry** loadbearing walls must be at least 6 in. (150 mm) thick. Vaults and domes must be at least 8 in. (200 mm) deep with a rise not less than one-twelfth the span (see pages 80–81).

■ **Concrete Masonry** Columns must be at least 12 in. (300 mm) in dimension, and loadbearing walls must be at least 8 in. (200 mm) thick. Depending on the composition and design of the masonry unit, applied plaster or stucco facings may also be required (see pages 86–89).

Fire-resistive requirements for non-loadbearing walls and partitions are summarized on pages 360–363.

2-HOUR NONCOMBUSTIBLE CONSTRUCTION

2-Hour Noncombustible Construction requires a fire-resistance rating of 2 hours for floor construction, columns, and bearing walls.

■ **Structural Steel** columns, beams, joists, and decking must be protected to these values with applied fireproofing materials or an appropriately fire-resistive ceiling of plaster, gypsum board, or fibrous panels (see pages 98–111).

■ **Reinforced Concrete** columns must be at least 10 in. (250 mm) in dimension, and loadbearing walls must be at least 5 in. (125 mm) thick. Floor slabs must be at least 5 in. (125 mm) thick. Concrete one-way and two-way joist systems (ribbed slabs and waffle slabs) with slabs thinner than 5 in. (125

mm) between joists require protection with applied fireproofing materials or an appropriately fire-resistive ceiling of plaster, gypsum board, or fibrous panels (see pages 113–129).

■ **Posttensioned Concrete** floor slabs must be at least 5 in. (125 mm) thick (see pages 120–129).

■ **Precast Concrete** columns must be at least 10 in. (250 mm) in dimension, and beams at least 7 in. (175 mm) wide. Loadbearing wall panels must be at least 5 in. (120 mm) thick. Solid slabs may not be less than 5 in. (120 mm) thick. Hollow core slabs must be at least 8 in. (200 mm) deep and may be used without a topping. Double and single tees require applied fireproofing materials or an appropriately fire-resistive ceiling of plaster, gypsum board, or fibrous panels, unless a concrete topping 3.25 in. (85 mm) thick is poured (see pages 131–141).

■ **Brick Masonry** loadbearing columns must be at least 12 in. (300 mm) in dimension, and walls must be at least 6 in. (150 mm) thick. Vaults and domes must be at least 8 in. (200 mm) deep with a rise not less than one-twelfth the span (see pages 78–81).

■ **Concrete Masonry** columns must be at least 10 in. (250 mm) in dimension, and loadbearing walls must be at least 8 in. (200 mm) thick. Depending on the composition and design of the masonry unit, applied plaster or stucco facings may also be required (see pages 86–89).

Fire-resistive requirements for non-loadbearing walls and partitions are summarized on pages 360–363.

CONSTRUCTION TYPES

1-HOUR NONCOMBUSTIBLE CONSTRUCTION

1-Hour Noncombustible Construction requires a fire-resistance rating of 1 hour for floor construction, columns, and bearing walls.

■ **Structural Steel** columns, beams, joists, and decking must be protected to these values with applied fireproofing materials or an appropriately fire-resistive ceiling of plaster, gypsum board, or acoustical panels (see pages 98–111).

■ **Light Gauge Steel** framing fire protection requirements vary with factors such as size and weight of the steel framing and the presence of other materials, such as acoustical insulation or resilient attachment channels, within the assembly. For preliminary design purposes, you may assume that a 1-hour fire-resistance rating can be achieved for both floor and wall framing with two layers of ½-in. (13-mm) Type X gypsum wallboard or other equivalent material applied to the fire-exposed sides of the framing (see pages 94–97).

■ **Reinforced Concrete** columns must be at least 8 in. (200 mm) in dimension, and loadbearing walls must be at least 4 in. (100 mm) thick. Floor slabs must be at least

3.5 in. (90 mm) thick. Concrete one-way and two-way joist systems (ribbed slabs, skip-joist slabs, and waffle slabs) require protection with applied fireproofing materials or an appropriately fire-resistive ceiling of plaster, gypsum board, or acoustical panels unless the slab thickness is at least 3.5 in. (90 mm) between joists (see pages 113–129).

■ **Posttensioned Concrete** floor slabs must be at least 3.5 in. (90 mm) thick (see pages 120–129).

■ **Precast Concrete** columns must be at least 10 in. (250 mm) in dimension, and beams at least 4 in. (100 mm) wide. Loadbearing wall panels must be at least 3.5 (90 mm) thick. Solid slabs may not be less than 3.5 in. (90 mm) thick. Hollow core slabs must be at least 8 in. (200 mm) deep and may be used without a topping. Double and single tees require applied fireproofing materials or an appropriately fire-resistive ceiling of plaster, gypsum board, or acoustical panels unless a concrete topping 1.75 in. (45 mm) thick is poured (see pages 131–141).

■ **Brick Masonry** columns must be at least 8 in. (200 mm) in dimension, and loadbearing walls must be at least 6 in. (150 mm) thick. Vaults and domes must be at least 4 in. (100 mm) deep with a rise not

less than one-twelfth the span (see pages 78–81).

■ **Concrete Masonry** columns must be at least 8 in. (200 mm) in dimension, and loadbearing walls must be at least 8 in. (200 mm) thick. Depending on the composition and design of the masonry unit, applied plaster or stucco facings may also be required (see pages 86–89).

Fire-resistive requirements for non-loadbearing walls and partitions are summarized on pages 360–363.

¾-HOUR NONCOMBUSTIBLE CONSTRUCTION

¾-Hour Noncombustible Construction requires a fire-resistance rating of 45 minutes for floors, columns, and bearing walls. This Construction Type, unique to the National Building Code of Canada, may include any noncombustible construction materials meeting the requirements listed on pages 362–363. In practice, it is most commonly applied to light gauge steel framing systems. For preliminary purposes, the information provided on this page for 1-Hour Noncombustible Construction may be used to achieve this system's required levels of fire resistance.

UNPROTECTED NONCOMBUSTIBLE CONSTRUCTION

Unprotected Noncombustible Construction has no fire-resistive requirements for floor construction, columns, or bearing walls, except that they must be constructed of noncombustible materials.

■ **Structural Steel** columns, beams, joists, and decking may be used without applied fireproofing materials or fire-resistive ceilings (see pages 98–111).

■ **Light Gauge Steel Framing** may be used with minimum facings of gypsum board or its equivalent to brace the studs and joists against buckling (see pages 94–97).

■ **Reinforced Concrete** structures of all types may be designed to the minimum dimensions dictated by structural considerations, without need for applied fireproofing materials (see pages 114–129).

■ **Posttensioned Concrete** structures of all types may be designed to the minimum dimensions dictated by structural considerations, without need for applied fireproofing materials (see pages 120–129).

■ **Precast Concrete** structures of all types may be designed to the minimum dimensions dictated by structural considerations, without need for applied fireproofing materials (see pages 132–141).

■ **Masonry** structures of all types may be designed to the minimum dimensions dictated by structural considerations, without need for applied fireproofing materials (see pages 78–91).

366 Fire-resistive requirements for nonloadbearing walls and partitions are summarized on pages 360–363.

HEAVY TIMBER CONSTRUCTION AND MILL CONSTRUCTION

Heavy Timber and Mill Construction depend for their fire-resistant properties on wood framing members and decking of sufficient thickness such that they are slow to catch fire and burn. Either solid wood or glue laminated members may be used.

International Building Code

In the International Building Code, where Heavy Timber Construction is permitted, exterior walls must be of not less than 2-hour fire-resistance rated Noncombustible Construction. In this text, this combination of heavy timber interior structure and rated noncombustible exterior walls is referred to as *Mill Construction*, a name reflecting its origins in early industrial era fire-resistant brick masonry and heavy timber building systems. In this model code, Heavy Timber Construction is also an acceptable substitute for roof structures and their supporting members where any 1-Hour or less, Combustible or Noncombustible Construction system is permitted.

National Building Code of Canada

In the National Building Code of Canada, buildings of Heavy Timber Construction must meet the minimum size requirements for wood members, but there are no special combustibility limitations on the exterior walls of such buildings. In this model code, Heavy Timber Construction is also an acceptable substitute for any building where 1-Hour Combustible Construction is permitted.

Minimum Dimensions for Wood Members

Use the following minimum dimensions for wood members for the preliminary design of both Heavy Timber Construction and Mill Construction buildings in either code:

■ **Solid Wood Columns:** In both model codes, solid wood columns supporting floor loads must be at least 8×8 nominal dimensions ($7\frac{1}{2} \times 7\frac{1}{2}$ in. or 191×191 mm actual size). Columns supporting roof loads only must be not less than nominal 6×8 ($5\frac{1}{2} \times 7\frac{1}{2}$ in. or 140×191 mm).

■ **Glue Laminated Wood Columns:** In the International Building Code, glue laminated wood columns supporting floor loads must be at least $6\frac{3}{4} \times 8\frac{1}{4}$ in. (171×210 mm) actual size, and supporting roof loads only, at least $5 \times 8\frac{1}{4}$ in. (127×210 mm). In the National Building Code of Canada, such columns supporting floors and roofs must be at least 175×190 mm ($6\frac{7}{8} \times 7\frac{1}{2}$ in.) actual size, and supporting roofs only, at least 130×190 mm ($5\frac{1}{8} \times 7\frac{1}{2}$ in.).

■ **Solid Wood Beams and Girders:** In both model codes, solid wood beams and girders supporting floor loads must be at least 6×10 nominal dimensions ($5\frac{1}{2} \times 9\frac{1}{2}$ in. or 140×241 mm actual size), and supporting roof loads only, at least nominal 4×6 ($3\frac{1}{2} \times 5\frac{1}{2}$ in. or 89×140 mm). The National Building Code of Canada also permits solid wood beams and girders supporting floors and roofs to have a minimum actual size of 191×191 mm ($7\frac{1}{2} \times 7\frac{1}{2}$ in.). In some circumstances, the International Building Code permits solid wood members supporting roof loads only to be as small as nominal 3 in. ($2\frac{1}{2}$ in. or 64 mm actual size) wide; see the code for details.

CONSTRUCTION TYPES

■ **Glue Laminated Wood Beams and Girders:** In the International Building Code, glue laminated wood beams and girders supporting floor loads must be at least $5 \times 10\frac{1}{2}$ in. (127×267 mm) actual size, and supporting roof loads only, at least $3 \times 6\frac{3}{8}$ in. (76×175 mm). In the National Building Code of Canada, such beams and girders supporting floors and roofs must be not less than 130×228 mm ($5\frac{1}{8} \times 9$ in.) or 175×190 mm ($6\frac{7}{8} \times 7\frac{1}{2}$ in.) actual size, and supporting roofs only, at least 80×152 mm ($3\frac{1}{8} \times 6$ in.).

■ **Trusses Made of Solid Wood Members:** In the International Building Code, trusses supporting floor loads must be made of solid wood members no smaller than 8×8 nominal dimensions ($7\frac{1}{2} \times 7\frac{1}{2}$ in. or 191×191 mm actual size). Roof trusses must be made of members no smaller than nominal 4×6 ($3\frac{1}{2} \times 5\frac{1}{2}$ in. or 89×140 mm). When trusses are composed of paired solid wood members and the space between members is blocked or covered, individual members may be as little as nominal 3 in. ($2\frac{1}{2}$ in. or 64 mm actual size) wide. In the National Building Code of Canada, minimum sizes for truss members made of solid wood are the same as required in that code for solid wood beams and girders.

■ **Trusses Made of Glue Laminated Wood Members:** In the International Building Code, trusses supporting floor loads must be made of glue laminated wood members no smaller than $6\frac{3}{4} \times 8\frac{3}{4}$ in. (171×210 mm) actual size. Roof trusses must be made of glue laminated wood members no smaller than $3 \times 6\frac{7}{8}$ in. (76×175 mm). In the National Building Code of Canada, minimum sizes for truss members made of glue laminated wood are the same as required in that code for glue laminated wood beams and girders.

■ **Glue Laminated Wood Arches:** In the International Building Code, glue laminated wood arches supporting floor loads must be no smaller than $6\frac{3}{4} \times 8\frac{3}{4}$ in. (171×210 mm) actual size. Arches supporting roof loads only and springing from the floor level must be no smaller than $5 \times 8\frac{3}{4}$ in. (127×210 mm) for the lower half and no smaller than 5×6 in. (127×152 mm) for the upper half. Arches supporting roof loads only and springing from the tops of walls must be not less than $3 \times 6\frac{3}{8}$ in. (76×175 mm). In the National Building Code of Canada, minimum sizes for glue laminated arches supporting floor loads are the same as required in that code for glue laminated wood beams and girders. Arches supporting roof loads only

and springing from the floor level must be no smaller than 130×152 mm ($5\frac{1}{8} \times 6$ in.) actual size, and when springing from the tops of walls, no smaller than 80×152 mm ($3\frac{1}{8} \times 6$ in.).

■ **Floors and Roof Decks:** In both model codes, wood floors must consist of not less than 3 in. nominal dimension ($2\frac{1}{2}$ in. or 64 mm actual size) solid or glue laminated wood structural decking. The decking must also be overlaid with either finish wood flooring not less than nominal 1-in. ($\frac{1}{2}$ in. or 64 mm) thick or wood panels (plywood or other) not less than $\frac{1}{2}$ in. (12.5 mm) thick. Wood roofs must consist of solid or glue laminated wood structural decking not less than nominal 2 in. ($1\frac{1}{2}$ in. or 38 mm actual size), or of $1\frac{1}{8}$ -in. (28 mm) plywood structural panels.

See pages 64–75 for structural information on the wood members in Heavy Timber and Mill Construction. Information on Noncombustible wall systems for Mill Construction may be found on the following pages: 80–81 for brick masonry, 88–89 for concrete masonry, 94–95 for steel lightweight studs, 98–101 for structural steel columns, 114–117 for sitecast concrete, and 132–135 for precast concrete.

ORDINARY CONSTRUCTION

Ordinary Construction, like Mill Construction, is a system with historical roots in early industrial era fire-resistant buildings. It consists of noncombustible exterior walls and interior structure that is usually wood light framing but may also be of concrete or steel.

■ **Exterior Walls** must be noncombustible, with a fire-resistance rating of not less than 2 hours.

■ **Interior Framing** members of wood must meet the requirements listed on this page for Wood Light Frame Construction. For 1-Hour Ordinary Construction, use the requirements for 1-Hour Wood Light Frame; for Unprotected Ordinary Construction, use the requirements for Unprotected Wood Light Frame.

Information on noncombustible wall systems for Ordinary Construction may be found on the following pages: 80–81 for brick masonry, 88–89 for concrete masonry, 94–95 for steel lightweight studs, 98–101 for structural steel columns, 114–117 for sitecast concrete, and 132–135 for precast concrete.

$\frac{3}{4}$ -HOUR COMBUSTIBLE CONSTRUCTION

$\frac{3}{4}$ -Hour Combustible Construction requires a fire-resistance rating of 45 minutes for floors, columns, and bearing walls. This construction classification, unique to the National Building Code of Canada, permits both combustible and noncombustible materials. In practice, it is most commonly applied to Light Wood Frame systems. For preliminary purposes, the information provided on this page for 1-Hour Wood Light Frame Construction may be used to achieve this system's required levels of fire resistance. In this model code, Heavy Timber Construction (page 366) is also permitted as a substitute wherever $\frac{3}{4}$ -Hour Combustible Construction is permitted.

WOOD LIGHT FRAME/ COMBUSTIBLE CONSTRUCTION

Floors, walls, and roofs of Wood Light Frame/Combustible Construction are framed with wood members not less than 2 in. in nominal thickness (actually 1.5 in., or 38 mm). These members are usually spaced at center-to-center dis-

tances of either 16 or 24 in. (400 or 600 mm) and covered with any of a very wide range of sheathing and finish materials.

■ **Unprotected Wood Light Frame/Combustible Construction** allows the structure of the building to remain exposed or to be finished with materials that do not have a sufficient fire-resistance rating to satisfy a higher classification of construction, such as wood paneling or thin gypsum board.

■ **1-Hour Wood Light Frame/Combustible Construction** requires that loadbearing walls and floors have 1-hour fire-resistance ratings. A 1-hour wall may be constructed of wood studs by applying $\frac{5}{8}$ -in. (16-mm) Type X gypsum board or its equivalent to each face of the studs. A floor with 1-in. nominal subflooring and finish flooring (actual dimensions $\frac{3}{4}$ in., or 19 mm) has a 1-hour fire-resistance rating if it is finished below with a ceiling of $\frac{5}{8}$ -in. (16-mm) Type X gypsum board or its equivalent.

For structural information on Wood Light Frame/Combustible Construction, see pages 56–63. Fire-resistive requirements for non-loadbearing walls and partitions are summarized on pages 360–363.