2021 Code Conforming Wood Design and the IBC

Introduction

Wood construction offers distinct design options typically not found in a single structural material. It is inexpensive, readily available, easy to work with, strong and adaptable. The economic, environmental and energy efficiency advantages account for more buildings being constructed of wood than any other structural material.

The intent of this book is to summarize the allowable wood use in buildings in accordance with the International Code Council (ICC) 2021 *International Building Code*® (IBC®). Emphasis will be placed on the design flexibility permitted for wood in commercial construction. This publication is not a replacement for the IBC and does not encompass all of the design options in the IBC. The IBC, along with any local amendments, should always be consulted for applicable, specific requirements related to designs and site conditions.

New in the 2021 *Code Conforming Wood Design* (CCWD) *and the IBC* is content specific to the three new Types of Construction that were added to the 2021 IBC. Height and Area tables have been updated for each new Type of Construction. Additionally, new provisions added elsewhere in the code applicable to mass timber construction are identified. ICC and AWC also developed a document titled *Mass Timber Buildings and the IBC*® containing code provisions and extensive commentary. It is available in the ICC Store.

Table of Contents

1. General Information

Use and Occupancy Classification

Building code requirements are dependent on the appropriate classification of the building or structure for its design purpose or current occupancy. Eight occupancy classifications are discussed in this book:

Group A, Assembly
Group B, Business
Group E, Educational

Group F, Factory/Industrial
Group I, Institutional
Group M, Mercantile
Group R, Residential
Group S, Storage

The occupancies are described below, but when a structure is proposed for a purpose that is not specifically listed, it should be classified in the group that the occupancy most nearly resembles in accordance with Section 302.1. The authority having jurisdiction e.g., the building or fire official, has the ultimate responsibility for rendering interpretations of the code, including designation of the occupancy classification.

Group H (Hazardous) and Group U (Utility and Miscellaneous) occupancies also may be of wood construction but are beyond the scope of this book.

Assembly Occupancies

The IBC lists Assembly (Group A) occupancies in Section 303. Group A occupancies are divided into five subcategories. Group A-1 includes fixed seating occupancies for viewing performing arts, television studios with audience seating and motion pictures. Group A-2 includes buildings in which food and drink consumption occurs (e.g., restaurants, banquet halls, casinos, bars and nightclubs); Group A-3 includes places of religious worship, waiting areas in terminals, recreation, amusement and other assembly uses not included in the other groups; Group A-4 includes indoor viewing of sporting events and activities with spectator seating (e.g., arenas, skating rinks, swimming pools and tennis courts); and Group A-5 includes outdoor grandstands, stadiums and amusement park structures.

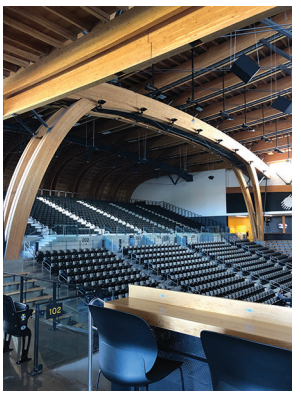

Figure 1—Assembly Occupancy

Business Occupancies

Section 304 describes Business (Group B) occupancies. Group B uses are for office, professional, or service-type transactions, including the storage of records. It is a broad use group that often is chosen when a use does not fit another use group description. Group B can include airport traffic control towers, ambulatory care facilities complying with Section 422, animal hospitals, kennels and pounds, banks, barber and beauty shops, car washes, civic administration, outpatient clinics, dry cleaning and laundry (pick-up and delivery stations and self-service), educational occupancies for students above the 12th grade including higher education laboratories (see Section 428), electronic data processing, testing and research laboratories, food processing establishments not associated with restaurants and dining facilities not more than 2,500 square feet in area, motor vehicle showrooms, post offices, print shops, professional service offices, radio and television stations, telephone exchanges, and training and skill development facilities not located in a school.

Figure 2—Business Occupancy

Educational Occupancies

The IBC lists Educational (Group E) occupancies in Section 305. Group E includes any buildings or portions of a structure used to educate six or more people through the 12th grade. Buildings or portions of a structure used for supervision, personal care or education of more than five children, at least $2^1/_2$ years old, for fewer than 24 hours are also Group E structures.

Figure 3—Educational Occupancy

Factory/Industrial Occupancies

Section 306 defines Factory/Industrial (Group F) occupancies. Group F is subdivided into two occupancy groups: Group F-1 and Group F-2. Group F-1, moderate-hazard factory industrial, includes buildings or portions of buildings used for the manufacturing of materials that cannot be classified as Group F-2, low-hazard industrial. Group F-1 includes the manufacturing of aircraft, appliances, motor vehicles, boats, recreational vehicles, business machines, photo equipment, construction and agricultural machinery, engines, metals, woodworking and millwork, and food processing establishments and commercial kitchens not associated with restaurants and dining facilities and more than 2,500 square feet in area. Group F-1 also includes textile production—canvas, clothing, carpet, hemp, jute and paper—and laundries, printing and publishing, soaps and plastic products, beverages having over 16-percent alcohol content, optical goods, wood working and wood distillation.

Figure 4—Factory/Industrial Occupancy

Group F-2, low-hazard industrial occupancies, are buildings and facilities used for beverage production (up to and including 16-percent alcohol), brick, ceramics, glass, gypsum, ice, metal fabrication and assembly and foundries.

Institutional Occupancies

The IBC lists Institutional (Group I) occupancies in Section 308. Group I includes four subcategories: Group I-1 includes residential and custodial care for more than 16 people receiving care (24-hour care); Group I-2 includes hospitals, foster care facilities (24-hour care), nursing homes and detoxification facilities for more than five people receiving care; Group I-3 includes facilities with five or more people under restraint or security (e.g., jails, detention centers and prisons); and Group I-4 includes day care facilities for more than five adults or children receiving less than 24-hour care.

Figure 5—Institutional Occupancy

Group I-1, I-2 and I-3 occupancies are further broken into conditions based on the occupants' ability to respond to an emergency.

Mercantile Occupancies

Section 309 describes Mercantile (Group M) occupancies. Group M includes department stores, drugstores, greenhouses with display and sale of plants having public access, markets, motor fuel-dispensing facilities, retail or wholesale stores and salesrooms. Essentially any place involving the display and sale of merchandise to the public is classified as a Group M occupancy.

Figure 6—Mercantile Occupancy

Residential Occupancies

The IBC lists Residential (Group R) occupancies in Section 310. Group R contains four subcategories. Group R-1 includes hotels, motels and transient boarding houses with more than 10 occupants; Group R-2 includes apartments, live/work units, timeshare properties and nontransient hotels and motels. R-2 also includes nontransient congregate living facilities with more than 16 occupants such as dormitories and boarding houses. Group R-3 includes single- and two-family dwellings, adult and child day care facilities with less than six occupants receiving care, congregate living facilities—transient (10 or fewer occupants) and nontransient (16 or fewer occupants)—and lodging houses (five or fewer guest rooms and 10 or fewer occupants). Group R-4 includes residential care and assisted living facilities for six to 16 clients who reside on a 24-hour basis. Group R-4 occupancies are further broken into two conditions: Condition 1 where all occupants are capable of responding to an emergency without assistance and Condition 2 where limited assistance may be necessary for any single occupant. This book does not cover requirements for residential occupancies constructed in accordance with the *International Residential Code* (IRC).

Figure 7—Residential Occupancy

Storage Occupancies

Section 311 covers Storage (Group S) occupancies. Group S includes subcategories Group S-1, moderate-hazard storage and Group S-2, low-hazard storage. Group S-1 contains buildings occupied for storage uses that are not classified as Group S-2, including aircraft hangars, beverages over 16-percent alcohol content, clothing, books, paper, lumber, fur, furniture, mattresses, tires, tobacco products, sugar, soap and glue. Group S-1 also includes indoor storage of boats and motor vehicle repair garages that comply with the maximum allowable quantities of hazardous materials.

Figure 8—Storage Occupancy

Group S-2 includes buildings used for storage of noncombustible materials such as beverages up to 16-percent alcohol content, cement, chalk, dry cell batteries, electrical coils and motors, glass, stoves, washers and dryers, metal furniture, metals and food products in noncombustible containers, fresh fruit in nonplastic containers and frozen foods. Open and enclosed public parking garages are also Group S-2 occupancies.

Referenced Code and Standards

The IBC is developed by the International Code Council. Industry and professional standards are referenced in the IBC to clarify specific code requirements. Chapter 35 of the IBC provides a list of the standards referenced, the agency that writes the standard, the identification and title of the standard and its effective date.

Standards represent a consensus on how a material, product or assembly is to be designed, manufactured, tested or installed so it achieves a specified level of performance. Several key standards relating to the design of wood structures are utilized by the IBC. Specifically, the 2021 IBC references four American National Standards which are promulgated by American Wood Council (AWC):

- 2018 *National Design Specification*® (NDS®) *for Wood Construction*
- 2021 *Permanent Wood Foundation* (PWF) *Design Specification*
- 2021 *Special Design Provisions for Wind and Seismic* (SDPWS)
- 2018 *Wood Frame Construction Manual* (WFCM) *for One- and Two-Family Dwellings*

The NDS details structural and fire design methods for the use of lumber, glued-laminated timber, prefabricated wood I-joists, structural composite lumber, wood structural panels and cross-laminated timber. The PWF specification is used for the design of wood foundation systems. The SDPWS addresses materials, design and construction of wood members, fasteners and assemblies used to resist wind and seismic forces. The WFCM includes design and construction provisions for connections, wall systems, floor systems and roof systems. A range of structural elements is also covered, including sawn lumber, structural glued-laminated timber, wood structural sheathing, prefabricated wood I-joists and trusses.

Section 10, Resources, of this book provides information on how to obtain these standards and other related materials.

Figure 9—Referenced standards

2. Types of Construction

Chapter 6 of the IBC defines types of construction, with wood construction typically found in Type V, IV and III. Additionally, the IBC has specific applications that permit the use of wood in construction Types I and II, which are defined as noncombustible. These circumstances are addressed in Sections 5 and 6 of this book.

Type V Construction

Type V construction permits the use of wood or other approved materials for structural elements, including structural frame members, bearing walls, floor and roof construction, as well as nonbearing elements such as exterior walls and interior partitions. Type V construction is further defined as Type VA (all interior and exterior load-bearing walls, floors, roofs and all structural members are designed or protected to provide a minimum 1-hour fire-resistance rating) and Type VB (no fire-resistance rating is required for structural elements based on IBC Table 601).

Figure 10—Type V construction

Type IV Construction

Type IV construction changed significantly in the 2021 IBC, with the addition of three new types of mass timber (MT) construction and the renaming of the historic Type IV to Type IV-HT. The four Type IV construction types are identified as Type IV-A, Type IV-B, Type IV-C and Type IV-HT. Type IV-A, IV-B, and IV-C construction use mass timber building elements and, where required, noncombustible protection to achieve fire-resistance ratings from 1 to 3 hours. Mass timber is defined in Section 202 as structural elements of Type IV construction, primarily wood products that meet minimum cross-section dimensions of Type IV construction (see Section 2304.11). Building elements in Type IV-A construction require protection with noncombustible material for $^{2}/_{3}$ of the required fire-resistance rating. Type IV-B permits some exposed mass timber in the ceiling and walls. When the mass timber is protected, at least $^{2}/_{3}$ of the required fire-resistance rating is required to be of noncombustible protection. When unprotected, the exposed mass timber must be designed for the required fire-resistance rating. In Type IV-C construction, mass timber elements are permitted to be exposed, but must be designed for the required fire-resistance rating (see Figure 12).

Figure 11—Type IV construction