

FEMA Building Types

Table D-1. NEHRP Building Types

The following 15 common building types are excerpt from FEMA 178.

Building Type 1 - Wood, Light Frame: These buildings are typically single- or multiple- family dwellings of one or more stories. The essential structural character of this type is repetitive framing by wood joists on wood studs. Loads are light and spans are small. These building may have relatively heavy chimneys and may be partially or fully covered with veneer. Most of these buildings are not engineered; however, they usually have the components of a lateral-force-resisting system even though it may be incomplete. Lateral loads are transferred by diaphragms to shear walls. The diaphragms are roof panels and floors. Shear walls are exterior walls sheathed with plank siding, stucco, plywood, gypsum board, or fiberboard. Interior partitions are sheathed with plaster or gypsum board.

Building Type 2 - Wood, Commercial and Industrial: These buildings usually are commercial or industrial buildings with a floor area of 5,000 square feet or more and with few, if any, interior walls. The essential structural character is framing by beams on columns. The beams may be glulam beams, steel beams, or trusses. Lateral forces usually are resisted by wood diaphragms and exterior walls sheathed with plywood, stucco, plaster, or other paneling. The walls may have rod bracing. Large openings for stores and garages often require post-and-beam framing. Lateral force resistance on those lines can be achieved with steel rigid frames or diagonal bracing.

Building Type 3 - Steel Moment Frame: These buildings have a frame of steel columns and beams. In some cases, the beam-column connections have very small moment resisting capacity but, in other cases, some of the beams and columns are fully developed as moment frames to resist lateral forces. Usually the structure is concealed on the outside by exterior walls, which can be of almost any material (curtain walls, brick masonry, or precast concrete panels), and on the inside by ceilings and column furring. Lateral loads are transferred by diaphragms to moment resisting frames. The diaphragms can be of almost any material. The frames develop their stiffness by full or partial moment connections. The frames can be located almost anywhere in the building. Usually the columns have their strong direction oriented so that some columns act primarily in one direction while the others act in the other direction, and the frames consist of lines strong columns, and their intervening beams. Steel moment frame buildings are typically more flexible than shear wall buildings. Their low stiffness can result in large interstory drifts that may lead to extensive nonstructural damage.

Building Type 4 - Steel Braced Frame: These buildings are similar to Type 3 buildings except that the vertical components of the lateral-force resisting system are brace frames rather than moment frames.

Building Type 5 - Steel Light Frame: These buildings are pre-engineered and prefabricated with transverse rigid frames. The roof and walls consist of lightweight panels. The frames are designed for maximum efficiency, often with tapered beam and column sections built up of light plates. The frames are built in segments and assembled in the field with bolted joints. Lateral loads in the transverse direction are resisted by the rigid frames with loads distributed to them by shear elements. Loads in the longitudinal direction are resisted entirely by shear elements. The shear elements can be either the roof and wall sheathing panels, an independent system of tension-only rod bracing, or a combination of panels and bracing.

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Building Type 6 - Steel Frame with Concrete Shear Walls: The shear walls in these buildings are cast-in-place concrete and may be bearing walls. The steel frame is designated for vertical load only. Lateral loads are transferred by diaphragms of almost any material to the shear walls. The steel frame by provide a secondary lateral-force-resisting system depending on the stiffness of the frame and the moment capacity of the beam-column connections. In modern "dual" systems, the steel moment frames are designed to work together with the concrete shear walls in proportion to their relative rigidities. In this case, the walls would be evaluated under this building type and the frames would be evaluated under Type 3, Steel Moment Frames.

Building Type 7 - Steel Frame with Infill Shear Walls: This is one of the older types of building. The infill walls usually are offset from the exterior frame members, wrap around them, and present a smooth masonry exterior with no indication of the frame. Solidly infilled masonry panels act as a diagonal compression strut between the intersections of the moment frame. If the walls do not fully engage the frame members (i.e., lie in the same plane), the diagonal compression struts will not develop. The peak strength of the diagonal strut is determined by the tensile stress capacity of the masonry panel. The post-cracking strength is determined by an analysis of a moment frame that is partially restrained by the cracked infill. The analysis should be based on published research and should treat the system as a composite of a frame and the infill. An analysis that attempts to treat the system as a frame and shear will is not capable of assuring compatibility.

Building Type 8 - Concrete Moment Frame: The buildings are similar to Type 3 buildings except that the frames are of concrete. Some older concrete frames may be proportioned and detailed such that brittle failure can occur. There is a large variety of frame systems. Buildings in zones of low seismicity or older buildings in zones of high seismicity can be frame beams that have broad shallow crosssections or are simply the column strips of flat-slabs. Modern frames in zones of high seismicity are detailed for ductile behavior and the beams and columns have definitely regulated proportions.

Building Type 9 - Concrete Shear Walls: The vertical components of the lateral-force-resisting system in these buildings are concrete shear walls that are usually bearing walls. In older buildings, the walls often are quite extensive and the wall stresses are low but reinforcing is light. When remodeling calls for enlarging the windows, the strength of the modified walls becomes a critical concern. In newer buildings, the shear walls often are limited in extent, thus generating concerns about boundary members and overturning forces.

Building Type 10 - Concrete Frame with Infill Shear Walls: These buildings are similar to Type 7 buildings except that the frame is of reinforced concrete. The analysis of this building is similar to that recommended for Type 7 except that the shear strength of the concrete columns, after cracking of the infill, may limit the semiductile behavior of the system. Research that is specific to confinement of the infill in reinforced concrete frames should be used for the analysis.

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Building Type 11 - Precast/Tilt-Up Concrete Walls with Lightweight Flexible Diaphragm: These buildings have a wood ornamental deck roof diaphragm, which often is very large, that distributes lateral forces to precast concrete shear walls. The walls are thin but relatively heavy while the roofs are relatively light. Older buildings often have inadequate connections for anchorage of the walls to the roof for out-of-plane forces, and the panel connections often are brittle. Tilt-up buildings often have more than one story. Walls can have numerous openings for doors and windows of such size that the wall looks more like a frame than a shear wall.

Building Type 12 - Precast Concrete Frames with Concrete Shear Walls: These buildings contain floor and roof diaphragms typically composed of precast concrete elements with or without cast-in-place concrete topping slabs. The diaphragms are supported by precast concrete girders and columns. The girders often bear on column corbels. Closure strips between precast concrete floor elements and beam-column joints usually are cast-in-place concrete. Welded steel inserts often are used to interconnect precast elements. Lateral loads are resisted by precast or cast-in-place concrete shear walls. Buildings with precast frames and concrete shear walls should perform well if the details used to connect the structural elements have sufficient strength and displacement capacity; however, in some cases, the connection details between the precast elements have negligible ductility.

Building Type 13 - Reinforce masonry Bearing Walls with Wood or Metal Deck Diaphragms: These buildings have perimeter bearing walls of reinforced brick or concrete-block masonry. These walls are the vertical elements in the lateral-force-resisting system. The floors and roofs are framed either with wood joints and beams with plywood or straight or diagonal sheathing or with steel beams with metal deck with or without a concrete fill. Wood floor framing is supported by interior wood posts or steel columns; steel beams are supported by steel columns.

Building Type 14 - Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms: These buildings have bearing walls similar to those of Type 13 buildings, but the roof and floors are composed of precast concrete elements such as planks or tee-beams and the precast roof and floor elements are supported on interior beams and columns or steel or concrete (cast-in-place or precast). The precast horizontal elements often have a cast-in-place topping.

Building Type 15 - Unreinforced Masonry Bearing Wall Buildings: These buildings included structural elements that vary depending on the buildings's age and, to a lesser extent, its geographic location. In buildings built before 1900, the majority of floor and roof construction consists of wood sheathing supported by wood subframing. In large multistory buildings, the floors are cast-in-place concrete supported by the unreinforced masonry walls and/or steel or concrete interior framing. In buildings built after 1950, unreinforced masonry buildings with wood floors usually have plywood rather than board sheathing. In regions of lower seismicity, buildings of his type constructed more recently can include floor and roof framing that consists of metal deck and concrete fill supported by steel framing elements. The perimeter walls, and possible some interior walls, are unreinforced masonry. The walls may or may not anchored to the diaphragms. Ties between the walls and diaphragms are more common for the bearing walls than for walls that are parallel to the floor framing. Roof ties usually are less common and more erratically spaced than those at the floor levels. Interior partitions that interconnect the floors and roof can have the effect of reducing diaphragm displacements.