CHAPTER 3

Dead, Live, Rain and Soil Lateral Loads

3.1 Dead Loads

Nominal dead loads, *D*, are determined in accordance with IBC 1606. In general, design dead loads are the actual weights of construction materials and fixed service equipment that are attached to or supported by the building or structure. Various types of such loads are listed in IBC 202 under "Dead Load."

Dead loads are considered to be permanent loads; that is, loads in which variations over time are rare or of small magnitude. Variable loads, such as live loads and wind loads, are not permanent. It is important to know the distinction between permanent and variable loads when applying the provisions for load combinations (see IBC 1605, ASCE/SEI Chapter 2 and Chapter 2 of this publication for information on load combinations).

The weights of materials and service equipment (such as plumbing stacks and risers, HVAC equipment, elevators and elevator machinery, fire protection systems and similar fixed equipment) are not usually known during the design phase. Estimated material and equipment loads are often used in design. Typically, estimated dead loads are assumed to be greater than the actual dead loads so that the design is conservative. While such practice is acceptable when considering load combinations where the effects of gravity loads and lateral loads are additive, it is not acceptable when considering load combinations where gravity loads and lateral loads counteract. For example, it would be unconservative to design for uplift on a structure using a value of dead load that is overestimated.

ASCE/SEI Table C3-1 provides minimum design dead loads for various types of common construction components, including ceilings, roof and wall coverings, floor fill, floors and floor finishes, frame partitions and frame walls. Minimum densities for common construction materials are given in ASCE/SEI Table C3-2.

The weights in ASCE/SEI Tables C3-1 and C3-2 can be used as a guide when estimating dead loads. Actual weights of construction materials and equipment can be greater than tabulated values, so it is always prudent to verify weights with manufacturers or other similar resources prior to design. In cases where information on dead load is unavailable, values of dead loads used in design must be approved by the building official (IBC 1606.2).

3.2 Live Loads

3.2.1 General

Nominal live loads are determined in accordance with IBC 1607. Live loads are those loads produced by the use and occupancy of a building or structure and do not include construction loads, environmental loads (such as wind loads, snow loads, rain loads, earthquake loads and flood loads) or dead loads (see the definition of "Live Load" in IBC 202).

In general, live loads are transient in nature and vary in magnitude over the life of a structure. Studies have shown that building live loads consist of both a sustained portion and a variable

portion. The sustained portion is based on general day-to-day use of the facilities and will generally vary during the life of the structure due to tenant modifications and changes in occupancy, for example. The variable portion of the live load is typically created by events such as remodeling, temporary storage and similar unusual events.

Nominal design values of uniformly distributed and concentrated live loads are given in IBC Table 1607.1 as a function of occupancy or use. The occupancy category listed in the table is not necessarily group specific (occupancy groups are defined in IBC Chapter 3). For example, an office building with a Business Group B classification may also have storage areas that may warrant live loads of 125 psf or 250 psf depending on the type of storage.

The design values in IBC Table 1607.1 are minimum values; actual design loads can be determined to be larger than these loads, but in no case shall the structure be designed for live loads that are less than the tabulated values. For occupancies that are not listed in the table, live loads used in design must be approved by the building official. It is also important to note that the provisions do not require concurrent application of uniform and concentrated loads. Structural members are designed based on the maximum effects due to the application of either a uniform load or a concentrated load, and they need not be designed for the effects of both loads applied at the same time. Unless specified otherwise, concentrated loads are to be applied over an area of 2.5 by 2.5 feet and are to be located so as to produce the maximum load effects in the supporting structural members.

ASCE/SEI Table 4-1 also contains minimum uniform and concentrated live loads, which differ in some cases with the corresponding ones in IBC Table 1607.1. ASCE Tables C4-1 and C4-2 can also be used as a guide in establishing live loads for commonly encountered occupancies.

3.2.2 Partitions

Provisions for partitions are given in IBC 1607.5. Partitions that can be relocated (that is, those types that are not permanently attached to the structure) are considered to be live loads in office and other buildings because they are considered to be variable by nature. A live load equal to at least 15 psf must be included for moveable partitions where the nominal uniform floor load is less than or equal to 80 psf.

The weight of any built-in partitions that cannot be moved is considered a dead load in accordance with IBC 1602.

3.2.3 Helipads

Uniform and concentrated live loads that are to be used in the design of helipads are given in IBC 1607.6 and are summarized in Table 3.1. The concentrated loads that are specified are not required to act concurrently with other uniform or concentrated live loads.

Table 3.1 Summary of Nominal Live Loads for Helipads

Load Type	Minimum Load
Uniform	• 40 psf for a helicopter with a maximum take-off weight of 3,000 pounds • 60 psf for a helicopter with a maximum take-off weight greater than 3,000 pounds
One Single, Concentrated	3,000 pounds applied over an area of 4.5 by 4.5 inches located to produce maximum load effects on the structural elements
Two Single, Concentrated	0.75 times the maximum take-off weight of the helicopter applied over an area of 8 by 8 inches and located 8 feet apart on the landing pad to produce maximum load effects on the structural elements

Landing areas that are designed for a helicopter with a maximum take-off weight of 3,000 pounds must be identified as such by providing a numeral "3" (for 3 kips) that is at least 5 feet in height in the bottom right corner of the landing area.

ASCE/SEI Table 4-1, including footnotes d, e, f and g, contain the same requirements for helipads as those covered in the preceding discussion.

3.2.4 Heavy Vehicle Loads

Live load requirements for heavy vehicle loads (that is, vehicle loads greater than 10,000 pounds) are given in IBC 1607.7. In general, portions of structures where such vehicles can have access must be designed for live loads—including impact and fatigue—determined in accordance with codes and specifications for the design and construction of roadways and bridges (IBC 1607.7.1). The American Association of State Highway and Transportation Officials (AASHTO) design specifications (Reference 3.2) have been adopted by many jurisdictions throughout the United States and contain provisions on how to determine these live loads.

In the case of fire trucks and emergency vehicles, the actual operational loads and the reactions from the vehicle outriggers, where applicable, must also be considered. The supporting structure must be designed for the greater of the operational loads or the loads described in IBC 1607.7.1.

Garages that accommodate vehicle loads exceeding 10,000 pounds must also be designed for the live loads specified in IBC 1607.7.1, except that the design need not include the effects due to impact or fatigue. The exception that is provided to this requirement in IBC 1607.7.3 permits garage floors to be designed for the actual weights of the vehicles that are anticipated to occupy the garage as long as (1) the loads and their placement are based on a rational analysis, (2) the loads are greater than or equal to 50 psf and are not reduced and (3) the loads are approved by the building official.

For forklifts and similar moveable equipment, the supporting structure is to be designed for a minimum live load corresponding to the total vehicle or equipment load and the individual wheel loads. Additionally, impact and fatigue loads must be considered in design. It is permitted to account for these additional loads by increasing the vehicle and wheel loads by 30 percent (IBC 1607.7.4.1).

Similar to heavy live loads for floors, the live load for heavy vehicles must be posted in accordance with IBC 106.1.

ASCE/SEI Table 4-1 makes specific reference to the AASHTO *LRFD Bridge Design Specifications* (Reference 3.2) for the design of garages that can accommodate trucks and buses.

3.2.5 Handrails and Guards

IBC 1607.8.1 requires that handrails and guards for stairs, balconies and similar elements be designed for the live loads specified in ASCE/SEI 4.5.1. In particular, the following live loads are applicable:

1. A single concentrated load of 200 pounds applied in any direction at any point on the handrail or top rail to produce the maximum load effect on the element being considered (load condition 1 in Figure 3.1);

2. A load of 50 pounds per linear foot applied in any direction along the handrail or top rail (load condition 2 in Figure 3.1); and

3. A load of 50 pounds distributed normal to a 12-inch by 12-inch area on intermediate rails (that is, on all elements except the handrail or top rail) located to produce the maximum load effects (see Figure 3.2).

Figure 3.1
Handrail Live Load Conditions

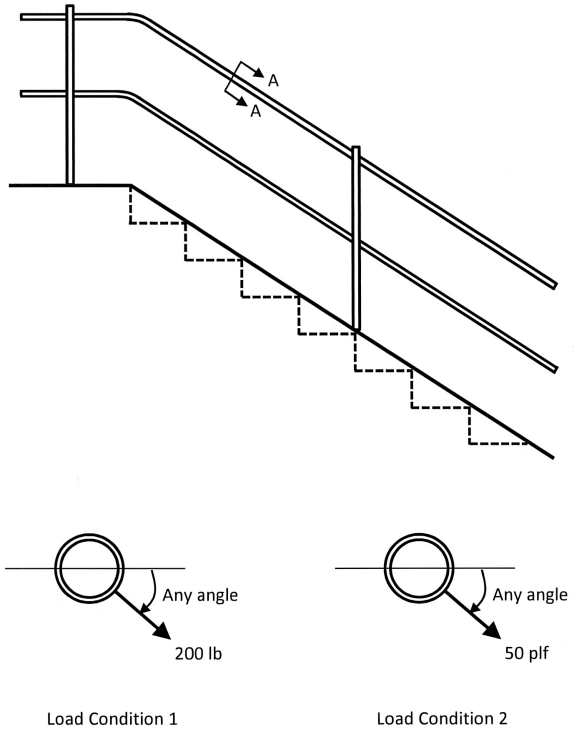
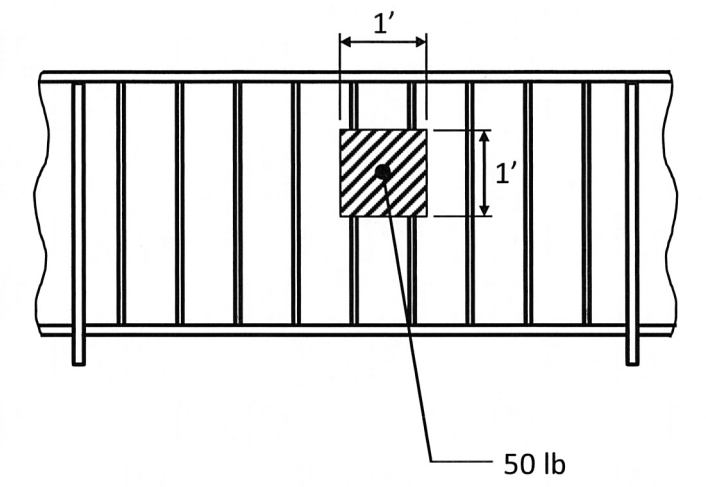


Figure 3.2
Intermediate Rail Load



The concentrated load in load condition 1 is meant to simulate the maximum anticipated load from a person grabbing or falling into the handrail or guard while the line load in load condition 2 is the maximum anticipated load on a handrail or guard from use by a crowd of people on a stairway. These loads can occur in any direction, as shown in Figure 3.1, and need not be applied concurrently.

Exceptions to these requirements recognize the circumstances that are applicable in occupancies where the handrail or guard is inaccessible to the public. In particular, load condition 2 need not be considered in one- and two-family dwellings or in factory, industrial and storage occupancies that are not accessible to the public and that have an occupant load of 50 or less.

The second exception in IBC 1607.8.1 differs from that in ASCE/SEI 4.5.1 in three ways. First, Group I-3 institutional occupancies (correctional centers, jails, prisons and the like) are included in addition to factory, industrial and storage occupancies. Second, this exception is applicable to occupant loads less than 50 instead of 50 or less. Finally, a minimum line load of 20 pounds per linear foot is required in such occupancies instead of the line load not being considered (that is, set equal to zero).

The area load specified in item 3 is a localized load for the guard members; as shown in Figure 3.2, the balusters that would resist this load are those within the one-square-foot area in the plane of the guard. This load need not be superimposed with any other loads.

IBC 1607.8.1 also stipulates that glass handrail assemblies and guards comply with IBC 2407; that section includes minimum requirements related to material properties and support conditions.

3.2.6 Grab Bars, Shower Seats and Dressing Room Bench Seats

Live load requirements for grab bars, shower seats and dressing room bench seats are given in IBC 1607.8.2. Such elements are to be designed for a single concentrated load of 250 pounds applied in any direction and at any point of the grab bar or seat so as to produce the maximum load effects. This load is anticipated to be encountered from the use of such elements.

The same requirement is given in ASCE/SEI 4.5.2 but only for the case of grab bars.

3.2.7 Vehicle Barriers

Vehicle barriers are defined in IBC 202 as a component or a system of components that are positioned at open sides of a parking garage floor or ramp or at building walls that act as restraints for vehicles. In other words, these barriers provide a passive restraint system that is located where vehicles could fall to a lower level.

IBC 1607.8.3 refers to ASCE/SEI 4.5.3, which requires that vehicle barrier systems be designed to resist a single load of 6,000 pounds applied horizontally over an area not to exceed 12 by 12 inches in any direction to the barrier system at heights between 18 and 27 inches above the floor or ramp surface (see Figure 3.3). This load is to be located so as to produce the maximum load effects, and it need not act concurrently with any handrail or guard loading discussed in Section 3.2.5 of this publication.

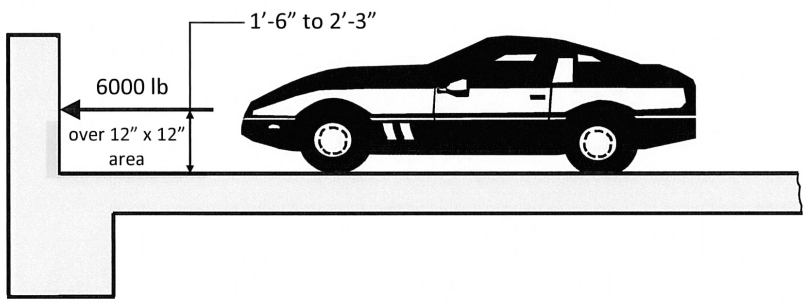


Figure 3.3
Vehicle Barrier Load Requirements