
# Free-of-Obstruction Requirements

## For Buildings Located in Coastal High Hazard Areas in Accordance with the National Flood Insurance Program

*NFIP Technical Bulletin 5 / March 2020*

FEMA

Comments on the Technical Bulletins should be directed to:

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NFIP Technical Bulletin 5 (2020) replaces NFIP Technical Bulletin 5 (2008), *Free-of-Obstruction Requirements.*

Cover photograph: Area beneath an elevated building that is free of obstruction.



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## Revision History

April 2020 Added 44 CFR citation for swimming pools and spas topic in Table 1 (page 8)

April 2020 Corrected caption for Figure 1 (page 16)

# Acronyms

| | |
|---|---|
| ASCE | American Society of Civil Engineers |
| BFE | base flood elevation |
| CFR | Code of Federal Regulations |
| DFE | design flood elevation |
| DHS | Department of Homeland Security |
| FEMA | Federal Emergency Management Agency |
| FIRM | Flood Insurance Rate Map |
| IBC | International Building Code® |
| ICC | International Code Council® |
| I-Codes | International Codes® |
| IRC | International Residential Code® |
| ISPSC | International Swimming Pool and Spa Code® |
| NFIP | National Flood Insurance Program |
| PFD | primary frontal dune |
| SEI | Structural Engineering Institute |
| SFHA | Special Flood Hazard Area |

# 1 Introduction

This Technical Bulletin provides guidance on the National Flood Insurance Program (NFIP) free-of-obstruction requirements in Coastal High Hazard Areas, which are designated as Zone V (V, VE, V1-30, and/or VO) on a community's Flood Insurance Rate Map (FIRM), as well as the NFIP requirements for construction in Zone V to minimize flood damage potential that is applicable to construction in Zone V. The free-of-obstruction requirements were instituted to minimize the transfer of flood forces to an elevated building's foundation and also to minimize the diversion or deflection of floodwater or waves that could damage the elevated building or neighboring buildings.

This Technical Bulletin also discusses how the presence or absence of obstructions can affect NFIP flood insurance premiums.

Coastal waves and flooding can exert strong hydrodynamic forces on building elements in their path. Therefore, the NFIP requires that all new and Substantially Improved structures in Coastal High Hazard Areas (Zone V) be elevated on pilings or columns with the bottom of the lowest horizontal structural members of the lowest floor elevated to or above the base flood elevation (BFE). These open foundations allow floodwater and waves to pass beneath the elevated structure.

**NFIP TECHNICAL BULLETIN 0**

NFIP Technical Bulletin 0, *User's Guide to Technical Bulletins*, should be used as a reference in conjunction with this Technical Bulletin. Technical Bulletin 0 describes the purpose and use of the Technical Bulletins, includes common concepts and terms, lists useful resources, and includes a crosswalk of the sections of the NFIP regulations identifying the Technical Bulletin that addresses each section of the regulations and a subject index.

Readers are cautioned that the definitions of some of the terms that are used in the Technical Bulletins are not the same when used by the NFIP for the purpose of rating flood insurance policies.

**EFFECTS OF OBSTRUCTIONS**

The NFIP requires the area beneath elevated structures in Zone V to remain *free of any obstructions that would prevent the free flow of coastal floodwater and waves* during a base flood event. An area beneath a structure elevated on an open foundation is considered to be free of obstructions if flood flow and waves can pass through the area without significant ***flow diversion, wave reflection, or wave runup***.

- **Flow diversion.** Change in the course of flood flow when it encounters an object or structure. Diversion can be accompanied by an increase in the local flood level and/or flood velocity when the blockage is large relative to the area through which the flow would otherwise pass.
- **Wave reflection.** Return or redirection of a wave striking an object.
- **Wave runup.** Rush of water up a slope or structure following wave breaking.

Some flow diversion, wave reflection, and wave runup can occur even with open foundations, but if the guidance in this Technical Bulletin is followed, the effects should be minimized during flood conditions up to the base flood event.

Any element constructed below the BFE that is attached to a building in Zone V is considered part of the building and must meet the free-of-obstruction requirements.

Standard solid foundation walls, such as masonry, concrete, and wood-frame walls, are not permitted in Zone V because they would obstruct flow and be at risk of damage from high-velocity flood forces. In addition, solid foundations and other obstructions could cause wave runup or reflection or divert floodwater into the elevated portion of the building or nearby buildings.

The NFIP interprets the free-of-obstruction requirements to apply to certain site development practices that prevent the free flow of coastal floodwater and waves under or around buildings or increase flood loads on nearby buildings. Construction elements outside the perimeter (footprint) of and not attached to a coastal building (e.g., bulkheads, retaining walls, decks, swimming pools, accessory structures) and site development practices (e.g., addition of fill) may alter the physical characteristics of flooding or significantly increase wave or flood forces affecting nearby buildings. As part of the design certification process for a building in Zone V, the registered design professional must consider the effects these elements and practices will have on the building and on nearby buildings.

The NFIP requires buildings to be constructed using methods and materials that minimize the potential for flood damage. Therefore, any construction element placed on a building site in Zone V (see Sections 6 and 7) has the potential to affect the building and nearby buildings, which must be taken into account. In addition to potential wave and floodwater diversion effects, obstructions can break free and become floodborne debris that may strike and damage other buildings.

The building elements and site development issues in regard to obstruction that are discussed in this Technical Bulletin include:

**Building elements below the BFE**

- Access stairs and ramps
- Decks, porches, and patios
- Elevators
- Enclosed areas
  - Below elevated structures
  - Above-grade (elevated)
  - Two levels
- Equipment and tanks
- Foundation bracing
- Grade beams
- Shear walls
- Slabs

**Site development: Practices and issues**

- Accessory storage structures
- Detached garages
- Erosion control structures
- Fences and privacy walls
- Fill
- Ground elevations at or above the BFE
- On-site septic systems
- Restroom buildings and comfort stations
- Swimming pools and spas

Building elements and site development practices that are not specifically prohibited by the NFIP may be used as long as they will not adversely affect other structures. However, some building elements and site development practices may increase flood-related loading on the building where those practices are proposed. In such cases, the building must be designed to withstand the additional flood-related loading and the registered design professional must provide the required Zone V certification for the building.

Questions about free-of-obstruction requirements should be directed to the appropriate local official, NFIP State Coordinating Office, or Federal Emergency Management Agency (FEMA) Regional Office.

**NFIP TERMS USED IN THIS TECHNICAL BULLETIN**

- **Special Flood Hazard Area (SFHA):** Area subject to flooding by the base flood (1-percent-annual-chance flood) and shown on FIRMs as Zone A or Zone V.
- **Zone A:** Flood zones shown on FIRMs as Zone A, AE, A1-30, AH, AO, A99, and AR.
- **Zone V:** Flood zones shown on FIRMs as Zone V, VE, V1-30, and VO.
- **Coastal High Hazard Area:** Area shown on FIRMs and other flood hazard maps as Zone V, VO, VE, or V1-30.

# 2 National Flood Insurance Program Regulations

An important NFIP objective is protecting buildings constructed in Special Flood Hazard Areas (SFHAs) from damage caused by flooding. The SFHA is the land area subject to flooding by the base flood. SFHAs are shown on Flood Insurance Rate Maps (FIRMs) prepared by FEMA as Zones A and V. The base flood is the flood that has a 1 percent chance of being equaled or exceeded in any given year (commonly called the “100-year” flood).

The NFIP floodplain management regulations include minimum building design criteria that apply to:

- New construction
- Work determined to be Substantial Improvements such as improvements, alterations, and additions
- Repair of buildings determined to have incurred Substantial Damage

A defining characteristic of the NFIP regulations applicable in Zone V is the requirement for the lowest horizontal structural member of the lowest floor to be elevated to or above the BFE. This requirement applies to both residential and non-residential buildings. Furthermore, the area beneath elevated structures must be free of obstructions that would prevent the free flow of coastal floodwater and waves during a base flood event.

**ZONE V CERTIFICATION OF STRUCTURAL DESIGN AND METHODS OF CONSTRUCTION**

The NFIP regulations require communities to ensure that construction meets Zone V requirements, including the free-of-obstruction requirement. Registered professional engineers or architects must develop or review structural designs, specifications, and plans for new construction and Substantial Improvements and certify that designs and methods of construction are in accordance with the accepted standards of practice. Building engineers and architects should consult with communities on their certification requirements before starting design, and communities must obtain and retain the certifications.

Satisfying the NFIP free-of-obstruction requirement is part of the certification. Local officials should determine that construction and/or site plans show all proposed site improvement elements described in this Technical Bulletin. The NFIP requires Zone V certification prior to construction. The community must ensure that what is constructed is compliant; some jurisdictions may require post-construction certification by the registered design professional.

See Technical Fact Sheet 1.5 in the *Home Builder's Guide to Coastal Construction* (FEMA P-499) (2010a) for a discussion of Zone V certification requirements.

The NFIP regulations for Zone V construction are codified in Title 44 Code of Federal Regulations (44 CFR) Part 60 Criteria for Land Management and Use. Specific to this Technical Bulletin, Section 60.3(a)(3) of the NFIP regulations states:

> If a proposed building site is in a flood-prone area, all new construction and substantial improvements shall … (iii) be constructed by methods and practices that minimize flood damages …

Section 60.3(e)(4) states that a community shall require (emphasis added):

> … that **all new construction and substantial improvements** in Zones V1 V30, VE, and also Zone V if base flood elevation data is available, on the community's **FIRM, are elevated on pilings and columns so that (i) the bottom of the lowest horizontal structural member of the lowest floor (excluding the pilings or columns) is elevated to or above the base flood level; and (ii) the pile or column foundation and structure attached thereto is anchored to resist flotation, collapse, and lateral movement due to the effects of wind and water loads acting simultaneously on all building components.** Water loading values used shall be those associated with the base flood. Wind loading values used shall be those required by applicable State or local building standards. A registered professional engineer or architect shall develop or review the structural design, specifications and plans for the construction, and shall certify that the design and methods of construction to be used are in accordance with accepted standards of practice for meeting the provisions of paragraphs (e)(4)(i) and (ii) of this section.

Section 60.3(e)(5) further states that a community shall require (emphasis added):

> **… that all new construction and substantial improvements within Zones V1-V30, VE, and V on the community's FIRM have the space below the lowest floor either free of obstruction or constructed with non-supporting breakaway walls, open wood lattice-work, or insect screening intended to collapse under wind and water loads without causing collapse,**

**displacement, or other structural damage to the elevated portion of the building or supporting foundation system.** For the purpose of this section, a breakaway wall shall have a design safe loading resistance of not less than 10 and no more than 20 pounds per square foot. Use of breakaway walls which exceed a design safe loading resistance of 20 pounds per square foot (either by design or when so required by local or State codes) may be permitted only if a registered professional engineer or architect certifies that the designs proposed meet the following conditions: (i) Breakaway wall collapse shall result from a water load less than that which would occur during the base flood; and (ii) The elevated portion of the building and supporting foundation system shall not be subject to collapse, displacement, or other structural damage due to the effects of wind and water loads acting simultaneously on all building components (structural and non-structural). Water loading values used shall be those associated with the base flood. Wind loading values used shall be those required by applicable State or local building standards. Such enclosed space shall be useable solely for parking of vehicles, building access, or storage.

Section 60.3(e)(6) states that a community shall "prohibit the use of fill for structural support of buildings within Zones V1-30, VE, and V on the community's FIRM."

Section 60.3(e)(7) states that a community shall "prohibit man-made alteration of sand dunes and mangrove stands within Zones V1–30, VE, and V on the community's FIRM which would increase potential flood damage."

For more information on NFIP regulations, refer to the following for:

- Guidance on coastal construction in the *Coastal Construction Manual* (FEMA P-55) (2011) and in the *Home Builder's Guide to Coastal Construction* (FEMA P-499) (2010a)
- Guidance on design considerations, buildings codes and regulations, and best practices for coastal communities in *Local Officials Guide for Coastal Construction* (FEMA P-762) (2009)
- Guidance on the breakaway wall requirements of Section 60.3(e)(5) of the NFIP regulations in NFIP Technical Bulletin 9, *Design and Construction Guidance for Breakaway Walls Below Elevated Buildings Located in Coastal High Hazard Areas*
- Guidance on the requirement that building materials used below the BFE must meet the flood damage-resistant materials requirement of Section 60.3(a)(3) of the NFIP regulations in NFIP Technical Bulletin 2, *Flood Damage-Resistant Materials Requirements for Buildings Located in Special Flood Hazard Areas*

**NFIP REQUIREMENTS AND HIGHER REGULATORY STANDARDS**

**State and Local Requirements.** State or local requirements that are more restrictive or stringent than the minimum requirements of the NFIP take precedence. The Technical Bulletins and other FEMA publications provide guidance on the minimum requirements of the NFIP and describe best practices. Design professionals, builders, and property owners should contact local officials to determine whether more restrictive provisions apply to buildings or sites in question. All other applicable requirements of the state or local building codes must also be met for buildings in flood hazard areas.

**Substantial Improvement and Substantial Damage**. As part of issuing permits, local officials must review not only proposals for new construction but also for work on existing buildings to determine whether the work constitutes Substantial Improvement or repair of Substantial Damage. If the work is determined to constitute Substantial Improvement or repair of Substantial Damage, the buildings must be brought into compliance with NFIP requirements for new construction. Some communities modify the definitions of Substantial Improvements and/or Substantial Damage to be more restrictive than the NFIP minimum requirements. For more information on Substantial Improvement and Substantial Damage, see FEMA P-758, *Substantial Improvement/Substantial Damage Desk Reference* (2010b), and FEMA 213, *Answers to Questions About Substantially Damaged/Substantially Damaged Buildings* (2018a).

**Higher Building Elevation Requirements.** Some communities require that buildings be elevated above the NFIP minimum requirements. The additional elevation is called freeboard. Design professionals, builders, and property owners should check with local officials to determine whether a community has freeboard requirements. References to building elevations in this Technical Bulletin should be construed as references to the community's elevation requirement in areas where freeboard is required.

# 3 Building Codes and Standards

In addition to complying with the NFIP requirements, all new construction, Substantial Improvements, and repair of Substantial Damage must comply with applicable building codes and standards that have been adopted by states and communities.

The International Codes® (I-Codes®), published by the International Code Council® (ICC®), are a family of codes that includes the International Residential Code® (IRC®), International Building Code® (IBC®), International Existing Building Code® (IEBC®), and codes that govern the installation of mechanical, plumbing, fuel gas service, and other aspects of building construction. FEMA has deemed that the latest published editions of the I-Codes meet or exceed NFIP requirements for buildings and structures in flood hazard areas. Excerpts of the flood

**I-CODES AND COASTAL A ZONES**

The 2018 International Codes (I-Codes) treat Coastal A Zones like Zone V if a Limit of Moderate Wave Action (LiMWA) is delineated on FIRMs. If a community designates an area as a Coastal A Zone through its building code or floodplain management regulations, buildings in that area are required to comply with the Zone V requirements for foundations, including the free-of-obstruction requirement, with an exception that permits filled stem wall foundations.

Note: Per the I-Codes and ASCE 24-14, breakaway walls in the Coastal A Zone and Zone V must have flood openings.

provisions of the I-Codes are available on FEMA's Building Code Resource webpage (https://www.fema.gov/building-code-resources).

## 3.1 International Residential Code

The IRC applies to one- and two-family dwellings and townhomes not more than three stories above grade plane. The IRC's free-of-obstruction requirements are summarized in Table 1 and compared to NFIP requirements.

Table 1 refers to selected requirements of the 2018 IRC and notes changes from the 2015 and 2012 editions.

**IRC COMMENTARY**

ICC publishes companion commentary for the IRC. Although not regulatory, the commentary provides guidance that is useful in complying with, interpreting, and enforcing the requirements of the code.

**Table 1: Comparison of Selected 2018 IRC Requirements and NFIP Requirements**

| Topic | Summary of Selected 2018 IRC Requirements and Changes from 2015 and 2012 Editions | Comparison with NFIP Requirements |
|---|---|---|
| Free of obstruction | **Section R322.3.3 Foundations.**<br>Requires in Coastal High Hazard Areas (Zone V) and Coastal A Zones that areas below elevated buildings be either free of obstructions or constructed of breakaway walls. In Coastal A Zones, filled stem wall foundations must be designed to resist flood loads, erosion, and scour.<br><u>Change from 2015 to 2018 IRC:</u> Changes to subsection numbering due to insertion of new subsections expanding requirements for 322.3.4, Concrete slabs; R322.3.7, Stairways and ramps; and R322.3.8, Decks and porches.<br><u>Change from 2012 to 2015 IRC:</u> Applies Zone V requirements in Coastal A Zone, if delineated, with an exception that permits stem wall foundations. | Equivalent to NFIP 44 CFR §§ 60.3(e)(4) and (5), except that 2018 IRC applies in both Zone V and Coastal A Zones, with an exception that permits stem wall foundations in Coastal A Zones. |
| Use of fill | **Section R322.3.2 Elevation requirements [excerpt].**<br>Prohibits the use of fill for structural support in Coastal High Hazard Areas (Zone V) and Coastal A Zones, while allowing minor quantities of nonstructural fill to be used for drainage and landscaping purposes under and around buildings and for support of parking slabs, pool decks, patios, and walkways.<br><u>Change from 2015 to 2018 IRC:</u> No change.<br><u>Change from 2012 to 2015 IRC:</u> No change. | Equivalent to NFIP 44 CFR § 60.3(e)(6), with more specificity for use of fill for specific, nonstructural purposes. |
| Enclosed areas | **Section R322.3.5 Walls below design flood elevation.**<br>In Coastal High Hazard Areas (Zone V) and Coastal A Zones, (1) requires that enclosures below elevated buildings be designed to break away under certain wind and flood loads without damaging the elevated building or the building foundation and (2) prohibits mounting of electrical, mechanical, and plumbing system components on breakaway walls or penetration of the breakaway walls.<br><u>Change from 2015 to 2018 IRC:</u> No change.<br><u>Change from 2012 to 2015 IRC:</u> Clarifies that attachment or penetration by electrical, mechanical or plumbing systems to breakaway walls is not permitted. | Exceeds NFIP 44 CFR § 60.3(e)(5) by specifying components that are not to be mounted on or penetrate through breakaway walls and by requiring flood openings in breakaway walls. |

Table 1: Comparison of Selected 2018 IRC Requirements and NFIP Requirements (continued)

| Topic | Summary of Selected 2018 IRC Requirements and Changes from 2015 and 2012 Editions | Comparison with NFIP Requirements |
|---|---|---|
| Equipment and tanks | **Section R322.1.6 Protection of mechanical, plumbing, and electrical systems.**<br>Requires that new electrical, plumbing, and mechanical system elements, along with replacements due to Substantial Improvements, be elevated to the design flood elevation (DFE) or if below the DFE, to be designed and installed to prevent water from entering or accumulating within the element and be able to withstand certain loads and stresses.<br>Change from 2015 to 2018 IRC: No change.<br>Change from 2012 to 2015 IRC: No change.<br>**Section R322.3.7 Tanks.**<br>Requires tanks to either be located underground or elevated to the DFE. When located underground, tanks must be anchored to resist flotation, collapse, and lateral movement during the base flood. If elevated, tanks must be on platforms that are cantilevered or knee-braced against the building or on a platform with a foundation that resists certain wind and flood loads.<br>Change from 2015 to 2018 IRC: No change.<br>Change from 2012 to 2015 IRC: Added requirements for tanks. | Equivalent to NFIP 44 CFR § 60.3(a)(3)(iv) but with more specificity: components are not to be mounted on or penetrate through breakaway walls and there are explicit requirements for tanks. |
| Concrete slabs | **Section R322.3.4 Concrete slabs.**<br>Requires that slabs used for parking, floors of enclosures, landings, decks, walkways, patios, and similar uses that are beneath buildings or located such that they could be undermined or displaced and could cause damage be either (1) structurally independent of foundations and no more than 4 inches thick, have no turn-downed edges, have no reinforcing, and have isolation joints at pilings and columns and control or construction joints in both directions no more than 4 feet apart or (2) self-supporting and will remain intact under base flood conditions, taking into account scour and erosion, and have building foundations capable of resisting any added loads due to the presence of the slabs.<br>Change from 2015 to 2018 IRC: Moved specifications for slabs from R322.3.3. to separate subsection.<br>Change from 2012 to 2015 IRC: No change. | Exceeds NFIP 44 CFR § 60.3(e)(5) by specifying requirements for concrete slabs. |
| Swimming pools and spas | **Section R326.1 [Swimming Pools, Spas and Hot Tubs] General.**<br>Requires pools and spas to comply with the *International Swimming Pool and Spa Code®* (ISPSC), which requires compliance with American Society of Civil Engineers (ASCE) 24.<br>Change from 2015 to 2018 IRC: No change.<br>Change from 2012 to 2015 IRC: Added requirement to comply with the ISPSC. | Exceeds NFIP 44 CFR § 60.3(e)(5) by specifying requirements for pools and spas. |
| Building envelope | **Section R322.3.6.1 Protection of building envelope.**<br>Requires an exterior door at the top of stairs that provides access to the building.<br>Change from 2015 to 2018 IRC: No change.<br>Change from 2012 to 2015 IRC: Added requirement for door. | Exceeds NFIP 44 CFR § 60.3(e)(5) by specifying requirements for door at top of stairway. |

Table 1: Comparison of Selected 2018 IRC Requirements and NFIP Requirements (continued)

| Topic | Summary of Selected 2018 IRC Requirements and Changes from 2015 and 2012 Editions | Comparison with NFIP Requirements |
|---|---|---|
| Stairways and ramps | **Section R322.3.7 Stairways and ramps.**<br>Provides four options for stairs and ramps located below the lowest floor elevation: (1) open or partially open risers and guards, (2) breakaway, (3) retractable, or (4) designed to resist flood loads. In all cases, the area below stairs and ramps must not be enclosed with walls unless the walls are designed to break away.<br>Change from 2015 to 2018 IRC: New section for stairways and ramps incorporating language from R322.3.3. | Exceeds NFIP 44 CFR § 60.3(e)(5) by specifying requirements for stairways and ramps. |
| Decks and porches | **Section R322.3.8 Decks and porches.**<br>Requires attached decks and porches to meet lowest floor elevation requirement and either have compliant foundations or be cantilevered from or knee-braced to the building. Self-supporting decks and porches must be designed to remain in place or break away and may be below the BFE if not enclosed by solid walls (including breakaway walls).<br>Change from 2015 to 2018 IRC: New section for decks and porches incorporating language from R322.3.3. | Exceeds NFIP 44 CFR § 60.3(e)(5) by specifying requirements for decks and porches. |
| Elevators and foundation bracing | No explicit provisions; see free-of-obstruction requirement in the first row of this table (Table 1). | Meets NFIP 44 CFR § 60.3(e)(5), which has no specific requirements. |

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## 3.2 International Building Code and ASCE 24

The flood provisions of the International Building Code® (IBC®) meet or exceed the NFIP requirements for buildings largely through reference to the ASCE 24, *Flood Resistant Design and Construction*. The IBC applies to all applicable buildings and structures. While primarily used for buildings and structures other than dwellings within the scope of the IRC, the IBC may be used to design dwellings. ASCE 24 applies to structures subject to building code requirements. The ASCE 24 requirements, summarized in Table 2, are more specific than the NFIP free-of-obstruction requirements.

**IBC AND ASCE COMMENTARIES**

ICC publishes companion commentary for the IBC, and ASCE publishes companion commentary for ASCE 24. Although not regulatory, the commentaries provide information and guidance that are useful in complying with, interpreting, and enforcing requirements.

Table 2: Comparison of Selected 2018 IBC and ASCE 24-14 Requirements with NFIP Requirements

| Topic | Summary of Selected 2018 IBC / ASCE 24-14 Requirements and Changes from 2015 and 2012 IBC / ASCE 24-05 | Comparison with NFIP Requirements |
|---|---|---|
| General design requirement | **2018 IBC Section 1612.2 Design and construction.**<br>Requires design and construction of buildings and structures located in Coastal High Hazard Areas (Zone V) and Coastal A Zones to comply with Chapter 5 of ASCE 7 and ASCE 24.<br><u>Change from 2015 to 2018 IBC:</u> No change except renumbering of section.<br><u>Change from 2012 to 2015 IBC:</u> Applies Coastal High Hazard Area requirements in Coastal A Zones if delineated. | Exceeds NFIP 44 CFR § 60.3(e) by referring to ASCE 24, which has more specificity for some foundation elements and higher minimum building elevations, and which requires meeting Zone V design and construction standards in Coastal A Zones (which are not defined in the NFIP). |
| Obstruction | **ASCE 24-14 Section 1.2 Definitions.**<br>"Obstruction – Any object or structural component attached to a structure below the DFE that can cause an increase in flood elevation, deflect floodwaters, or transfer flood loads to any structure." The DFE in the definition of obstruction is the Design Flood Elevation, which will be equal to or higher than the BFE.<br><u>Change from ASCE 24-05:</u> No change. | The NFIP does not define "obstruction." |
| Free of obstruction | **ASCE 24-14 Section 4.5.1 Foundation Requirements, General.**<br>• Applies to foundation systems in Coastal High Hazard Areas (Zone V) and Coastal A Zones.<br>• Requires foundations to be designed to minimize forces acting on foundations, to minimize damage to the foundations and the elevated structures, and to adequately transfer all loads imposed on the foundations and elevated structures to the supporting soils.<br>With the exception of certain bracing and shear walls, requires foundation system to be free of obstructions that will restrict or eliminate free passage of high-velocity flood waters and waves during design flood conditions.<br><u>Change from ASCE 24-05:</u> No change. | Equivalent to NFIP 44 CFR § 60.3(e)(5). |

Table 2: Comparison of Selected 2018 IBC and ASCE 24-14 Requirements with NFIP Requirements (continued)

| Topic | Summary of Selected 2018 IBC / ASCE 24-14 Requirements and Changes from 2015 and 2012 IBC / ASCE 24-05 | Comparison with NFIP Requirements |
|---|---|---|
| Use of fill | **2018 IBC Section 1804.5 Grading and fill in flood hazard areas.**<br>Specifies that fill is only allowed where constructed and placed to avoid diversion of water and waves toward any building or structure. Where allowed, fill is required to be stable under conditions of flooding, including rapid rise and drawdown and wave action.<br>Change from 2015 to 2018 IBC: Clarifies that fill where allowed must be stable under conditions of flooding.<br>Change from 2012 to 2015 IBC: No change.<br>**ASCE 24-14 Section 4.5.4 Use of Fill.**<br>• Specifies that placement of nonstructural fill for minimal site grading and landscaping and to meet local drainage requirements is permitted.<br>• Specifies that placement of nonstructural fill under and around a structure for dune construction or reconstruction is permitted if an engineering report documents that the fill will not result in wave runup, ramping, or deflection of floodwaters that can cause damage to structures.<br>Change from ASCE 24-05: Clarifies that an engineering report is necessary to document the effect of fill, and the commentary clarifies that the intent is to allow minor amounts of nonstructural fill for specific purposes. | Equivalent to NFIP 44 CFR § 60.3(e)(6), with more specificity for use of fill for specific, nonstructural purposes. |
| Enclosed areas | **ASCE 24-14 Section 4.6 Enclosed Areas Below Design Flood Elevation.**<br>Requires enclosed areas below DFE to be designed and constructed with breakaway walls, with flood openings in those walls, and requires stairways within the enclosed area to have an exterior door at the top of the stairs.<br>Change from ASCE 24-05: Modified to refer to subsections for requirements and adds the requirement for an exterior door at the top of the stairs.<br>**ASCE 24-14 Section 4.6.1 Breakaway Walls.**<br>Change from ASCE 24-05: No change.<br>**ASCE 24-14 Section 4.6.2 Openings in Breakaway Walls.**<br>Change from ASCE 24-05: Modified to require flood openings in breakaway walls forming an enclosure. | Exceeds NFIP 44 CFR § 60.3(e)(5) by requiring flood openings in breakaway walls and a door at the top of stairways within enclosures. |
| Utilities and equipment | **ASCE 24-14 Section 7.1 General.**<br>Requires attendant utilities and equipment to be at or above specified elevations or be specifically designed, constructed, and installed to prevent floodwaters from entering or accumulating within components.<br>Change from ASCE 24-05: No change | Exceeds NFIP 44 CFR § 60.3(a)(3)(iv) with freeboard requirements for utility system platforms and equipment for most buildings. |
| Tanks | **ASCE 24-14 Section 9.7 Tanks.**<br>Requires tanks in Coastal High Hazard Areas (Zone V) and Coastal A Zones to be (1) elevated on platforms meeting certain requirements or (2) installed and anchored below the eroded ground surface.<br>Change from ASCE 24-05: Consolidated requirements for tanks in Section 9.7. | Exceeds NFIP 44 CFR § 60.3(a)(3)(iv) with specificity for platforms and requirements for tanks. |

Table 2: Comparison of Selected 2018 IBC and ASCE 24-14 Requirements with NFIP Requirements (continued)

| Topic | Summary of Selected 2018 IBC / ASCE 24-14 Requirements and Changes from 2015 and 2012 IBC / ASCE 24-05 | Comparison with NFIP Requirements |
|---|---|---|
| Slabs | **ASCE 24-14 Section 9.3 Concrete Slabs.**<br>Requires in Coastal High Hazard Areas (Zone V) and Coastal A Zones that concrete slabs be either (1) designed as frangible, not structurally connected to structure, and not capable of creating debris that would cause significant damage to other structures or (2) be self-supporting and remain in place and functional after the design flood.<br>Change from ASCE 24-05: Slabs were moved from Section 4.8 to Section 9.3. New text permits (non-building-foundation) self-supporting structural slabs for parking/enclosure/deck/patio in Zone V and Coastal A Zone. | Exceeds NFIP 44 CFR § 60.3(e)(5) with requirements for concrete slabs. |
| Swimming pools and spas | **2018 IBC Section 3109.1 General.**<br>Requires, within Coastal High Hazard Areas (Zone V) and Coastal A Zones, that the design and construction of swimming pools, spas, and hot tubs comply with the ISPSC, which requires pools to be designed in accordance with ASCE 24.<br>Change from 2015 to 2018 IBC: No change<br>Change from 2012 to 2015 IBC: Replaces specific requirements with reference to the ISPSC.<br>**ASCE 24-14 Section 9.6.2 Pools in Coastal High Hazard Areas, Coastal A Zones and Other Flood Hazard Areas.**<br>Requires pools to be (1) elevated, (2) designed to break away without producing damaging debris, or (3) designed to remain in the ground without obstructing flow that could cause damage. Pools must be structurally independent of buildings and structures unless located in or on elevated floors or roofs that are above the DFE.<br>Change from ASCE 24-05: Clarifies pool requirements for pools within Coastal High Hazard Areas, Coastal A Zones, and other flood hazard zones. | Exceeds NFIP 44 CFR § 60.3(e)(5) with requirements for swimming pools and spas. |
| Elevators | **2018 IBC Section 3001.3 Referenced standards.**<br>Requires the design, construction, installation, alteration, repair, and maintenance of elevators and conveying systems and their components to comply with the standard specified in 2018 IBC Section 3001.3, Table 3001.3, and ASCE 24 unless the code states otherwise.<br>Change from 2015 to 2018 IBC: Standards moved to Table 3001.3.<br>Change from 2012 to 2015 IBC: No change. | Exceeds NFIP 44 CFR § 60.3(e)(5) with requirements for elevators. |
| Access stairs and ramps | **ASCE 24-14 Section 8.1 General.**<br>In Coastal High Hazard Areas (Zone V) and Coastal A Zones provides four options for the design and construction of stairways and ramps below the required elevation.<br>Change from ASCE 24-05: Adds option for retractable stairways and ramps. | Exceeds NFIP 44 CFR § 60.3(e)(5) with requirements and alternatives for stairways and ramps. |

Table 2: Comparison of Selected 2018 IBC and ASCE 24-14 Requirements with NFIP Requirements (continued)

| Topic | Summary of Selected 2018 IBC / ASCE 24-14 Requirements and Changes from 2015 and 2012 IBC / ASCE 24-05 | Comparison with NFIP Requirements |
|---|---|---|
| Decks and porches | **ASCE 24-14 Section 9.2 Decks and Porches**<br>**9.2.1 Attached Decks and Porches.**<br>In coastal high hazard areas (Zone V) and Coastal A Zones, specifies that attached decks and porches be elevated on certain foundations or cantilevered from the main structure.<br>**ASCE 24-14 Section 9.2.2 Detached Decks and Porches.**<br>In Coastal High Hazard Areas (Zone V) and Coastal A Zones, specifies that detached decks and porches be (1) designed and constructed to remain intact and in place during the base flood or (2) be designed to be frangible, minimizing debris capable of causing significant damage to any structure.<br><u>Change from ASCE 24-05:</u> Clarifications with no new requirements or limitations. | Exceeds NFIP<br>44 CFR § 60.3(e)(5) with requirements for decks and porches. |
| Foundation bracing | **ASCE 24-14 Section 4.5.11 Bracing.**<br><u>Change from ASCE 24-05:</u> No change. | Exceeds NFIP<br>44 CFR § 60.3(e)(5) with requirements for bracing. |

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# 4 NFIP Flood Insurance Implications

> **EFFECT OF CONSTRUCTION BELOW THE BFE**
>
> Any construction or site development practice below the BFE (even piles and columns permitted by the NFIP) will cause a localized disruption of flow and waves during the base flood. The question is whether the localized disruption will be great enough to harm the elevated building or surrounding buildings.

**Meeting the minimum NFIP floodplain management requirements does not necessarily result in the lowest NFIP flood insurance premium.** NFIP flood insurance premiums depend on the presence, location, construction, size, age, and use of enclosures and other building components and equipment. Floodplain management regulations allow enclosures greater than 300 square feet, but structures with these enclosures have higher NFIP flood insurance premiums. Designers should consult a qualified insurance agent and review FEMA's *NFIP Flood Insurance Manual* to determine insurance implications of design and construction decisions.

NFIP floodplain management regulations allow certain construction elements below the BFE that may or may not break away during the base flood (e.g., stairwells, elevator shafts, shear walls). These elements may or may not be considered obstructions for NFIP flood insurance rating purposes. For example:

- The NFIP floodplain management regulations in 44 CFR § 60.3(e) allow open wood lattice, insect screening, and solid, non-load-bearing, breakaway walls below elevated buildings in Coastal High Hazard Areas. Even though floodplain management regulations permit solid breakaway walls, garage doors, and slats or lattice (with less than 40 percent of the area open), building designers and owners should be aware that these elements can result in higher NFIP flood insurance premiums. See the text box "NFIP Flood Insurance Free-of-Obstruction Rate" below for details.

- The NFIP floodplain management regulations in 44 CFR § 60.3(e) restrict uses of space below the BFE to parking of vehicles, building access, and storage. Stairs, ramps, and elevators are permitted. However, depending on how stairs, ramps, and elevators are constructed, they may be considered obstructions for NFIP flood insurance rating purposes and could result in higher premiums.

**DETERMINING FLOOD INSURANCE IMPLICATIONS BEFORE THE DESIGN**

Design professionals and property owners may wish to contact a qualified insurance agent or the NFIP regarding the flood insurance rating and premium implications of obstructions before a building is designed.

**NFIP FLOOD INSURANCE FREE-OF-OBSTRUCTION RATE**

In order for a structure to qualify for the NFIP flood insurance free-of-obstruction rate, the space below the lowest elevated floor must be free of obstructions with the following exceptions:

- Insect screening provided that no additional supports are required for the screening
- Wooden or plastic lattice with at least 40 percent of its area open and constructed of material no thicker than ½ inch
- Wooden or plastic slats or shutters with at least 40 percent of their area open and constructed of material no thicker than 1 inch
- One solid breakaway wall or garage door with the remaining sides of the enclosure constructed of the above-mentioned insect screening, wooden or plastic lattice, slats, or shutters

# 5 Free-of-Obstruction Requirement Considerations

Some NFIP flood-resistant design and construction requirements, including free-of-obstruction requirements, are performance related and are not prescriptive. In other words, the expected building performance is stated, but how to achieve the performance is not specified. It is up to the design professional to create a design that complies with the free-of-obstruction performance requirements and up to the local official to determine whether the design satisfies the community's requirements.

It is not always clear whether a particular building element or a site development practice would create a significant obstruction that would prevent the free passage of floodwater and waves. "Significant" is used because *any* construction element or site development practice below the flood level would cause a localized disruption of flow and waves during the base flood. Determining whether the disruption would be significant is not always easy because in most cases, there are no analytical or readily usable numerical tools to answer the question with certainty. Local experience, results of post-disaster assessments, and application of coastal processes and building science principles must be relied on to reach a conclusion.

Some local floodplain management regulations require potential obstructions below or near a building to be evaluated to determine their effects on flow and waves. Fluid mechanics and coastal engineering references, such as the U.S. Army Corps of Engineers *Coastal Engineering Manual* (2002), provide some guidance, but the methods in these references are not generally capable of evaluating the potential effects of small building elements or small amounts of fill on flooding and waves during a base flood. Numerical coastal storm surge and wave models used in Flood Insurance Studies do not have sufficiently detailed resolution to discern building-sized disruptions to flow and wave fields.

Currently, developing models with fine enough resolution is technically challenging, time consuming, and cost prohibitive. And although recently developed, sophisticated numerical models show some promise in analyzing flow around buildings, their use is not economically feasible for most communities, owners, or designers interested in examining the potential obstructions discussed in this Technical Bulletin.

# 6 Building Elements Below the Base Flood Elevation

This section discusses common building elements under elevated buildings that can impede the free passage of flood flow and waves. Following the guidance in this section will minimize potential obstructive effects and satisfy the NFIP free-of-obstruction requirement.

## 6.1 Access Stairs and Ramps

Access stairs and ramps that are attached to or beneath an elevated building may be enclosed with breakaway walls or unenclosed. However, like foundation bracing (see Section 6.8), stairs and ramps can impede breakaway walls from breaking away cleanly as intended. To minimize this possibility, unenclosed stairs and ramps are preferred, but if enclosures are used, the design should be such that the stairs and

**ENTRY DOOR AT TOP OF ACCESS STAIRS**

Access stairs to elevated buildings are often constructed inside a breakaway enclosure with an entry door at the bottom of the enclosure but no entry door into the building at the top of the stairs. The lack of an entry door at the top results in a large opening in the building envelope when enclosures break away. Numerous post-disaster damage assessments have shown that loss of breakaway enclosures exposes building interiors to higher internal wind pressures and wind-driven rain. Loss of breakaway enclosures can also provide an easy path for floodwater to enter buildings, resulting in damage that can be avoided when doors are provided at the top of the access stairs.

Beginning with the 2015 IRC and ASCE 24-14, solid entry doors capable of resisting all design loads are required to be installed at the top of access stairs inside breakaway enclosures.

ramps do not interfere with breakaway wall performance. Enclosing stairways also affects NFIP flood insurance rates.

Stairs and ramps are not required to break away, but it is a design option. Stairs and ramps must be designed and constructed to either:

- Resist flood loads and remain in place during floods up to and including the base flood. If this option is selected, the elevated building and its foundation must be designed to resist any flood loads that are transferred from the stairs or ramp to the building, or
- Break away during base flood conditions without causing damage to the building or its foundation.

Figure 1 shows an example of an elevated building that was damaged as a result of stairs that did not break away cleanly; the stairway pulled out the exterior wall of the elevated building as the stairway failed.

**Figure 1:**
**Damage to an elevated building as a result of stairs that did not break away cleanly**

Constructing access stairs with open sides (open guards and railings) and risers, to the extent allowed by building codes, minimizes the potential for flood loads acting on the stairs, thereby minimizing flood damage and also minimizing transfer of flood loads to the elevated building. Open stairs should be considered whenever possible (see Figure 2). Note that building codes may have maximum opening size limits on stair risers and railings, necessitating a longer run. Check with the local jurisdiction for requirements.

Ramps must be designed and constructed to minimize the obstruction of floodwater and waves and configured so that floodwater and waves cannot flow directly up the ramp toward the elevated building. This means that ramps should be positioned to avoid a straight alignment from the elevated building to the likely direction of wave and surge approach.

**Figure 2:**
**Open stairs, which minimize transfer of flood and wave forces**

Massive exterior stairs are not permitted because they are inconsistent with the free-of-obstruction requirement and because other types of stairs can provide access. Figure 3 shows massive stairs that are attached to an elevated coastal home. These massive stairs will act as an obstruction and increase the likelihood of trapping or reflecting waves and flood flow beneath the elevated building.

In some cases, life-safety code requirements dictate that stairs and stairwells in structures of certain occupancy categories be constructed to be fire resistant and structurally stable even if portions of the adjacent structure fail. Stairs and stairwells that meet these requirements are usually constructed of some combination of steel, reinforced masonry, and reinforced concrete and will not break away under

**Figure 3:**
**Massive stairs attached to an elevated coastal home, which act as an obstruction**

expected base flood loads and conditions. These stairs and stairwells, typically found in mid- and high-rise buildings, must be designed to withstand all base flood loads, including flow, waves, and floodborne debris impacts.

## 6.2 Decks, Porches, and Patios

Decks, porches, and patios are typically outside the footprint of elevated residential and commercial buildings and may be constructed at grade, above grade but below the BFE, at the BFE, or above the BFE.

In Coastal High Hazard Areas, decks and porches outside the building footprint must meet one of the following conditions:

- If structurally attached to a structure, the bottom of the lowest horizontal structural member of the deck or porch must be at or above the BFE. Deck and porch supports that extend below the BFE (e.g., pilings, bracing) must comply with Zone V design and construction requirements, and the structure must be designed to accommodate any increased loads resulting from the attached deck or porch.
- If an attached deck or porch is located above the BFE but relies on support elements (posts, columns, braces) that extend below the BFE, the supports must comply with Zone V design and construction requirements.
- If a deck, porch, or patio (not counting its supports) lies in whole or in part below the BFE, it must be structurally independent from the structure and its foundation system.

Decks that are constructed within the building footprint between the ground and the elevated building are sometimes referred to as mezzanine decks. In Coastal High Hazard Areas, mezzanine decks should be treated similar to the floors of above-grade (elevated) enclosures (see Section 6.5). If directly below the footprint, a mezzanine deck that is structurally attached to the host building is treated as the lowest floor elevation for NFIP flood insurance rating purposes.

From a floodplain management perspective, mezzanine decks must meet building code requirements for dead, live, and other applicable loads and must be designed to either:

1) Break apart into small pieces without causing collapse, displacement, or other structural damage to the elevated building or the supporting foundation under flood loads less than those that occur during the base flood or
2) Along with the building foundation, accommodate flood loads transferred from the mezzanine deck to the building foundation during flooding up to and including base flood conditions.

Mezzanine decks may be independently supported on an open foundation and must be designed to either withstand flooding up to and including the base flood or break apart into small pieces under base flood or lesser conditions. Structurally independent decks below the BFE and below a structure's footprint are not considered the lowest floor for NFIP flood insurance purposes.

Decks, porches, and patios must not adversely affect the structure with which they are associated, or nearby structures, by diverting floodwater and waves during flood conditions up to and including the base flood. Some decks and patios, such as low-profile decks and patios constructed at natural grade or on minor quantities of fill necessary to level the site (see the textbox in Section 7.5), are deemed to comply by minimizing harmful diversion of floodwater or wave runup and reflection. A low-profile deck or patio, as used here, has a floor system depth of 12 inches or less, some of which may be below the adjacent finished grade. The depth does not include railings, which should be open to allow water to flow through. Attaching seats, benches, tables, planters, or similar features will cause a deck or patio to lose its deemed-to-comply low-profile classification. These features may or may not be obstructions (depending on size, number, and configuration) and should be evaluated for potential effects on flow and waves.

Decks, porches, and patios must be designed and constructed so that when subject to flooding up to and including base flood conditions, they do not create debris capable of causing significant damage to nearby structures. This means that decks, porches, and patios must remain intact and in place during base flood conditions or break apart into small pieces so the resulting debris does not lead to structural damage to nearby structures.

Decks and porches that are structurally attached to structures in Zone V must be supported to resist the simultaneous action of design wind loads and base flood loads. Most attached decks and porches are supported on piles or columns embedded in the ground and are capable of surviving anticipated erosion and scour. Post-storm assessments frequently identify decks and porches that were elevated on posts whose diameters were too small or on structural elements without sufficient embedment into the ground. The result of inadequate support is loss of decks and porches and sometimes damage to elevated structures. Unless the building code or local community prescribes otherwise, the foundation for an elevated deck or porch attached to a structure in Zone V should be similar to the structure's foundation. Attached decks and porches may be cantilevered from main structures instead of supported on piles or columns.

## 6.3 Elevators

Elevators attached to or beneath elevated structures in Zone V must comply with building, fire, electrical, and mechanical code requirements. Elevators and elevator shafts are not required to break away but must meet flood damage-resistant material and equipment requirements.

Flood loads acting on elevator components, any non-breakaway shaft walls, and potential wave runup and reflection effects must be accounted for in the design of the elevated structure and its foundation system. Therefore, it is advantageous to minimize the size of elevators, especially residential elevators in one- and two-family structures. Elevators should be designed and installed to satisfy the requirements of ASCE 24, which FEMA has determined meets or exceeds the minimum NFIP requirements. Additional guidance can be found in NFIP Technical Bulletin 4, *Elevator Installation for Buildings Located in Special Flood Hazard Areas.*

**NFIP FLOOD INSURANCE AND ELEVATOR SHAFTS AND ELEVATOR EQUIPMENT**

Elevator shafts and elevator equipment below the BFE will result in higher NFIP flood insurance premiums. The presence of elevators always increases the premium, regardless of how the shafts are constructed.

## 6.4 Enclosed Areas

The types of enclosed areas that are discussed in this section are:

- Enclosed areas below elevated structures
- Above grade (elevated) enclosures
- Two-level enclosures

### 6.4.1 Enclosed Areas Below Elevated Structures

The use of enclosed areas below elevated structures is restricted to parking of vehicles, building access, and storage. Enclosed areas must not be used for habitable purposes. Enclosed areas, including foyers, must be constructed of flood damage-resistant materials and not be finished. All enclosed areas below elevated buildings will be considered when the NFIP flood insurance premium is determined.

**PRIVACY SCREENING**

Privacy screening around outdoor shower areas is permitted if the sides are open at top and bottom and the screening will break away under base flood or lesser conditions. If a space under the building footprint is enclosed with privacy screening, there will be an NFIP flood insurance premium increase.

The NFIP regulations in 44 CFR § 60.3(e)(5) state that the area beneath the elevated portion of a structure in Zone V may be enclosed only with open lattice, insect screening, or non-supporting breakaway walls (see NFIP Technical Bulletin 9, *Design and Construction Guidance for Breakaway Walls Below Elevated Buildings in Coastal High Hazard Areas*). However, while NFIP regulations permit all enclosure walls to be solid breakaway walls, construction of such will lead to a With-Obstruction rating by the NFIP.

**SIZE OF ENCLOSURES AND NFIP FLOOD INSURANCE**

The NFIP does not limit the size of enclosures under elevated structures. However, higher NFIP flood insurance premiums will generally be assessed for structures in Zone V with enclosed areas of any size (including stairwells and elevator enclosures), even if enclosed by breakaway walls. Annual NFIP premiums can be even higher when buildings have enclosures that are 300 square feet or larger. Some communities have adopted restrictions or prohibitions on enclosures. Designers, contractors, and owners should check local requirements prior to construction.

The NFIP does not require flood openings in the walls of enclosures in Zone V. However, beginning with ASCE 24-14 and the 2015 IRC and IBC, enclosures in Zone V require flood openings.

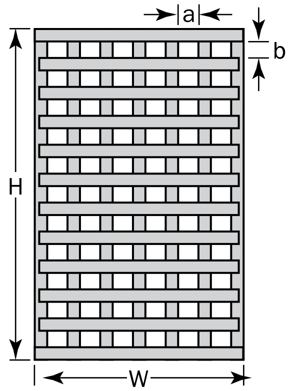
FEMA guidance states that the following lattice and slats are acceptable:

- Wood or plastic lattice no thicker than ½ inch with at least 40 percent of its area open
- Wood or plastic slats or fixed louvers no thicker than 1 inch that, when installed, have at least 40 percent of their area open

Figure 4 and Figure 5 show examples of compliant slats, which are typically installed flat against foundation pilings (see Figure 4) or angled like louvers between the pilings (see Figure 5). Percent open area of a lattice or louver wall should be calculated based on the area through which water can flow through lattice or louvers, divided by the total area of the enclosure wall (see Figure 6).

Figure 4:
Compliant wood slats installed flat against foundation pilings

Figure 5:
Compliant, fixed, wood louvers installed between pilings

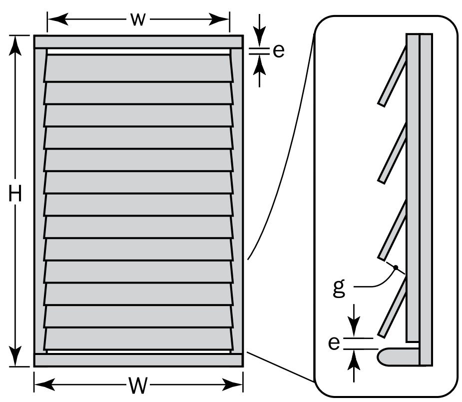



**Lattice wall**

Percent open area is the sum of all individual open areas, divided by the overall panel area, times 100.

Measure the height and width of the opening, multiply by the total number of openings, and divide by the total panel area (height times width). To get a percentage, multiply the result by 100.

$$\% \text{ open area} = \frac{\Sigma\,(ab) \times 100}{HW}$$




**Louver wall**

Percent open area is the sum of all individual open areas in gaps between louvers, plus top and bottom edge opening areas, divided by the overall panel area, times 100.

The individual open areas are calculated as the distance between louvers multiplied by the panel width. Multiply that area by the total number of gaps, add the edge opening areas, and divide by the total panel area (height times width). To get a percentage, multiply the result by 100.

$$\% \text{ open area} = \frac{(\Sigma\,(gw) + (2ew)) \times 100}{HW}$$

Figure 6: Determination of the percentage of open area for a lattice or louver wall

Figure 7 shows an elevated building in which a portion of a solid breakaway wall enclosure did not break away. Waves were not able to pass beneath the elevated structure, and wave runup against the enclosure wall likely caused damage above the elevated floor.

Figure 7:
Breakaway wall that did not break away, which led to wave runup and contributed to flood damage on the side of the elevated building

### 6.4.2 Above-Grade Enclosed Areas (Elevated)

Another enclosure option is to construct enclosures with floor systems that are elevated above grade and are not in contact with the ground (see Figure 8). Placing the enclosure floor above grade minimizes the potential for damage to the enclosure and contents during frequent, low-level flood events.

**Figure 8: Above-grade enclosure**

An above-grade enclosed area (sometimes referred to as a hanging enclosure) is any enclosure with its floor system above grade. The enclosure may be supported by a foundation beneath the enclosure or by the elevated building and/or building foundation. A hanging floor is the lowest floor elevation for NFIP flood insurance rating purposes.

Above-grade enclosures may be used only for storage and building access and must meet all other requirements applicable to enclosures, including the use of breakaway walls and flood damage-resistant materials below the BFE. Additionally, mechanical and electrical systems in the enclosure must be elevated to or above the BFE. A floor grate should be installed in the enclosure floor, and flood openings should be installed in breakaway enclosure walls. The grate will reduce vertical uplift (buoyancy) loads on the enclosure floor before water flows through the openings in the enclosure walls and allow the elevated enclosure to drain fully, reducing the downward load caused by water that would otherwise be trapped above the enclosure floor.

**ABOVE-GRADE ENCLOSURES AND NFIP FLOOD INSURANCE**

NFIP flood insurance policies for elevated buildings with above-grade enclosures are rated assuming the floor of the above-grade enclosure is the lowest floor (or based on the elevation of the lowest horizontal structural member of the enclosure instead of the lowest horizontal structural member of the lowest floor of the elevated building). Owners should ask their insurance companies to submit requests to the NFIP for a special rating for buildings with above-grade enclosures.

The design of the foundation and enclosure floor system for above-grade enclosures that are in Zone V must meet one of the following conditions:

- The floor system is designed to break away under flood loads less than those that occur during the base flood without causing collapse, displacement, or other structural damage to the elevated building or the supporting foundation (see Figure 9), or
- The floor system is designed to remain in place and intact, and the building foundation is designed to accommodate flood loads transferred from the enclosure floor system to the foundation during flood conditions up to and including the base flood (see Figure 9), or
- The enclosure floor system is independently supported on an open foundation (see Figure 10).

Flood openings in above-grade enclosure walls are required by the building code but do not reduce NFIP flood insurance premiums for the enclosure.

### 6.4.3 Two-Level Enclosed Areas

In flood hazard areas where the BFE is very high above the ground or where owners elect to elevate buildings very high, some owners opt to build two-level enclosures (see Figure 11 and Figure 12). Two-level enclosures are permitted but not recommended due to their more complicated construction and increased potential for

**TWO-LEVEL ENCLOSURES**

Two-level enclosures are also known as two-story enclosures, double enclosures, and stacked enclosures.

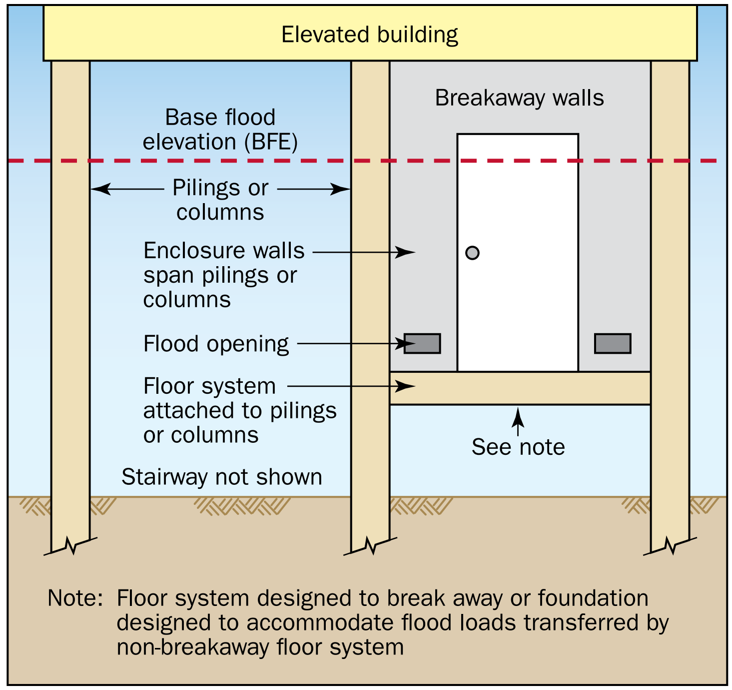



**Figure 9: Above-grade enclosure floor system attached to building foundation**

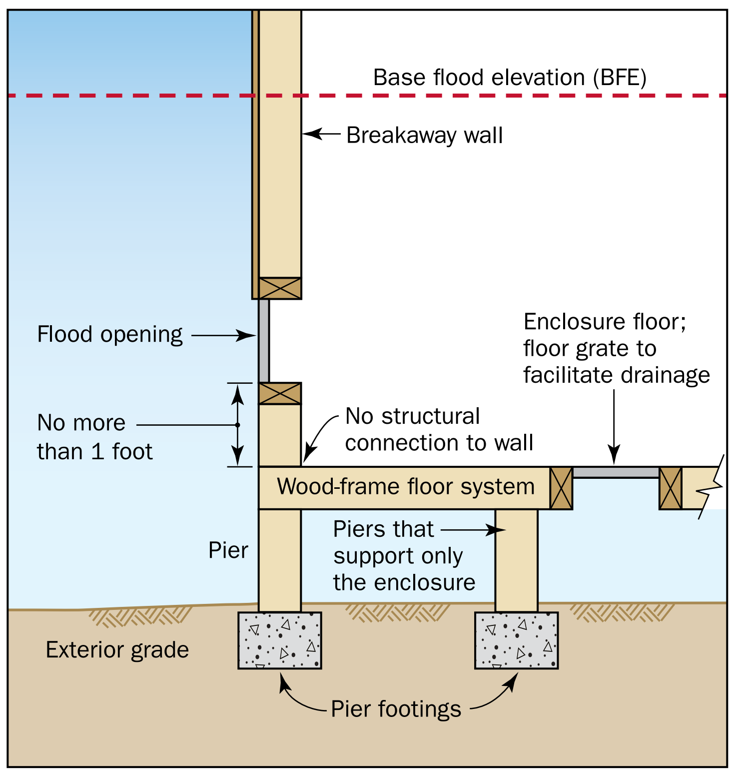



**Figure 10: Above-grade enclosure supported by independent foundation**

**Figure 11:**
**Two-level enclosure**

floodborne debris. Two-level enclosures could also result in the floor of the upper level being considered the lowest floor for NFIP flood insurance rating purposes.

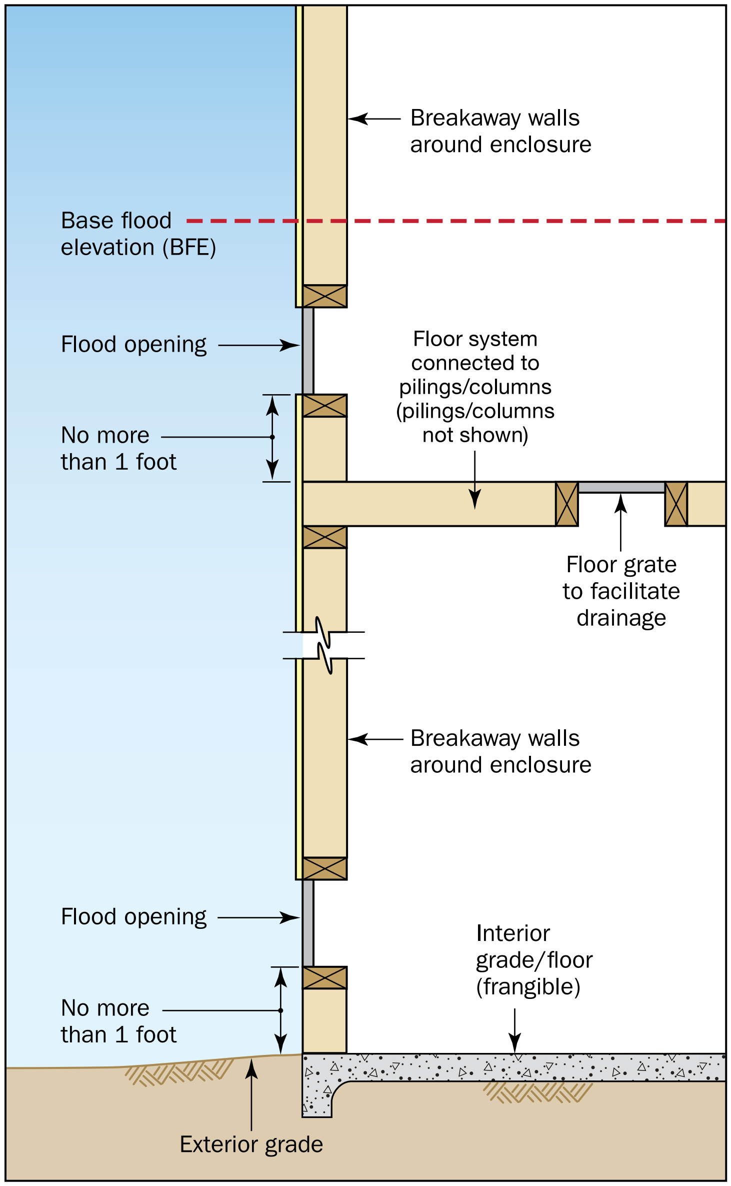
Both levels of the enclosure must meet all of the floodplain management and building code requirements for enclosed areas, including breakaway walls, elevated utilities, flood damage-resistant materials, and limitations on use (parking of vehicles, building access, and storage). The floor system of the upper enclosure level must be designed to meet one of the options for above-grade (elevated) enclosed areas (see Section 6.4.2).

Openings with grates should be installed in the floor to facilitate drainage from the upper level enclosure. In the event that floodwater enters the upper level but does not cause failure of the breakaway walls, the floor grates will allow trapped water to drain to the lower level and not overload the upper level floor system.

### TWO-LEVEL ENCLOSURES AND NFIP FLOOD INSURANCE

Designers and owners should be aware that a building with a two-level enclosure, even if allowed by permit, could result in higher NFIP flood insurance premiums than if the building has a one-level enclosure. Even if a two-level enclosure complies with building code and floodplain management requirements for enclosures, the upper floor of the two-level enclosure could be deemed the lowest floor for NFIP flood insurance rating purposes (the lowest floor elevation for flood insurance purposes is the first floor elevated above ground). Owners should ask their insurance companies to submit requests to the NFIP for a special rating for buildings with two-level enclosures.

Figure 12:
Two-level enclosure schematic




## 6.5 Mechanical, Electrical, and Plumbing Equipment, Ducts, Tanks, and Fixtures

Mechanical, electrical, and plumbing equipment, ducts, tanks, and fixtures serving elevated buildings are required to be elevated to or above the BFE or protected from water entry during the base flood.

There are exceptions for elevator equipment that cannot be elevated (see NFIP Technical Bulletin 4, *Elevator Installation for Buildings Located in Special Flood Hazard Areas*, and ASCE 24).

**EQUIPMENT BELOW AN ELEVATED BUILDING AND NFIP FLOOD INSURANCE**

Designers and owners should be aware that elevator equipment and other equipment below an elevated building will result in higher NFIP flood insurance premiums, even if the equipment is allowed by permit.

Utility lines, pipes, risers, and chases may need to extend below the BFE but should be installed to minimize potential damage from flooding (some utility companies place meters below the BFE so they can be easily accessed). The following help minimize potential damage:

- Utility lines, pipes, risers, and chases are not allowed to be attached to or penetrate through breakaway walls (see Figure 13).
- Utility lines, pipes, risers, and chases should be located on the sides of piles and columns that are opposite the anticipated direction of flood flow and wave approach, where possible.

Fuel tanks and other tanks serving elevated buildings and located under or adjacent to the buildings must be in-ground or elevated above the BFE. In both cases, tanks should be anchored to prevent flotation or lateral movement during base flood conditions. Platforms supporting elevated tanks should resist flooding up to and including base flood conditions.

To satisfy free-of-obstruction requirements, above-ground tanks must not be located beneath elevated buildings or attached to elevated buildings below the BFE. This requirement also applies to permanently

### UTILITY CHASES

For floodplain management and NFIP flood insurance purposes, utility chases designed to protect utility lines from freezing are not considered enclosures. Utility chases must be small and not allow access for a person to enter the space (access panels for servicing the lines are appropriate).

Because a utility chase is not considered an enclosure, it does not have to meet the requirement of breakaway walls, louvers, or open latticework; however, the chase may be breakaway under flood conditions.

The utility chase must be constructed of flood damage-resistant materials below the BFE, and the enclosed utility lines must meet the requirement to be watertight and capable of withstanding flood loads (hydrostatic, hydrodynamic, wave). Additionally, the portions of the utility system located below the BFE and the utility chase should not be attached to, mounted on, pass through, or be located along breakaway walls.

**Figure 13:**
**Utilities mounted on wall, which prevented the wall from breaking away cleanly**

installed fuel tanks for outdoor kitchens. Portable gas grills and associated propane fuel tanks and similar devices for which building permits are not required are not subject to these requirements. However, communities may have other fire and life-safety requirements that must be met. In addition, when flooding is anticipated, owners should move portable grills and propane fuel tanks to a safe location where they will not pose a hazard or become floodborne debris.

Additional guidance can be found in FEMA P-348, *Protecting Building Utilities from Flood Damage* (2017), and FEMA P-259, *Engineering Principles and Practices for Retrofitting Flood-Prone Residential Structures* (2012).

## 6.6 Foundation Bracing

Foundation bracing is often used to stiffen pile foundations and/or improve comfort and reduce sway in elevated buildings. However, foundation designs without bracing are preferred in coastal areas because they minimize obstructions to flow and waves.

Free-of-obstruction considerations call for using only the minimum amount of foundation bracing necessary to achieve a stable design, and such bracing should be designed to withstand flood conditions up to and including the base flood. Additional bracing may be used to improve the comfort of building occupants (i.e., reduce building sway under non-flood conditions), but the additional bracing should not be as strong as that required for structural stability and should not be relied on to yield a stable design, as it may be lost during a flood.

Many coastal construction experts and design references advise relying on shore-perpendicular bracing and minimizing the use of shore-parallel bracing. However, because wind and seismic loads can act in any direction, this alternative may not always provide the structural stability that is required in some locations. Increasing the number of piles (by decreasing horizontal spacing), detailing moment connections at the tops of the piles (in the case of concrete piles and beams), and using grade beams are accepted ways of eliminating or reducing the need for foundation bracing. Designers may determine other ways to minimize the amount and type of bracing.

Diagonal timber cross-bracing is the most common type of bracing used on foundations under coastal homes. Unfortunately, timber braces frequently fail during severe flood events as a result of wave or debris impacts. If they survive, they can interfere with breakaway wall failure, trap debris, and transfer lateral flood loads to the foundation. Metal rod braces, while less susceptible to failure, can also trap floating debris (see Figure 14). Knee braces at the tops of pilings are sometimes preferred (Figure 15) because their position higher up on the pilings will present less obstruction to flow and waves.

When foundation bracing below the BFE is used, it must be placed so as not to interfere with the intended failure of breakaway wall panels (see Figure 16). Avoiding interference may require eliminating breakaway walls, shifting the location of breakaway walls, or redesigning the foundation so the need for certain braces is eliminated. Breakaway walls and foundation bracing should not be placed close to each other if either could adversely affect the intended performance of the other.

Figure 14:
Floating debris trapped by metal rod cross bracing

Figure 15: Knee bracing

Figure 16: Cross bracing that interfered with the failure of a breakaway wall

## 6.7 Grade Beams

Grade beams are horizontal elements at or below the ground surface that tie the foundation piles or columns together and provide additional lateral support. They are typically reinforced concrete or wood.

Grade beams that are placed with their upper surfaces flush with or below the natural grade (the grade before the site is altered by fill or grading, if any) are not considered obstructions and are allowed by NFIP. However, storm erosion and local scour can expose and undermine grade beams, sometimes leaving them suspended above the post-storm ground profile. Designers must anticipate this circumstance and design grade beams to resist flood, wave, and debris loads and to remain in place and functional when undermined by scour and erosion (see Figure 17). Grade beams must also be designed and constructed so the vertical thickness is minimized, thereby reducing the lateral flood, wave, and debris loads acting on the beam and minimizing the transfer of these loads to the foundation.

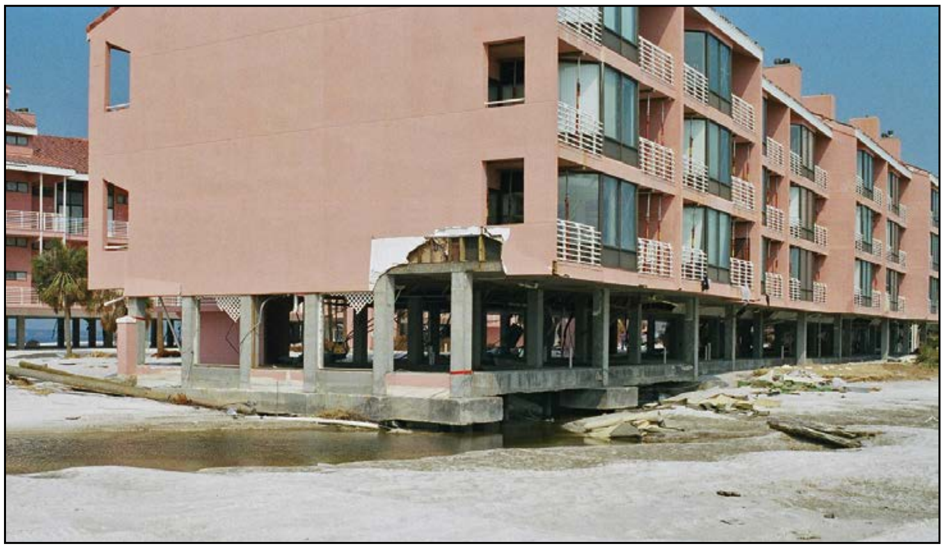


**Figure 17:**
**Grade beams that were exposed to flood forces during hurricane-induced scour; grade beams must resist flood, wave, and debris loads when undermined**

## 6.8 Shear Walls

The NFIP regulations in 44 CFR § 60.3(e) state that only pile and column foundations are permitted in Zone V. In practice, this requirement has been relaxed by the NFIP and building codes for mid- and high-rise structures to allow certain types of solid walls, called shear walls, if detailed engineering calculations demonstrate that such walls are required to transfer lateral loads acting on upper stories to the ground, particularly in extreme-wind zones (see Figure 18). Even in these cases, shear walls should be used only if foundations and buildings are designed to resist all base flood conditions, all other design loads, and all appropriate load combinations.

> **SHEAR WALLS**
>
> ASCE 24 contains flood-related requirements and limitations for shear walls used to support buildings in Zone V. Contact your local building department for rules and building code requirements for shear walls in Zone V.

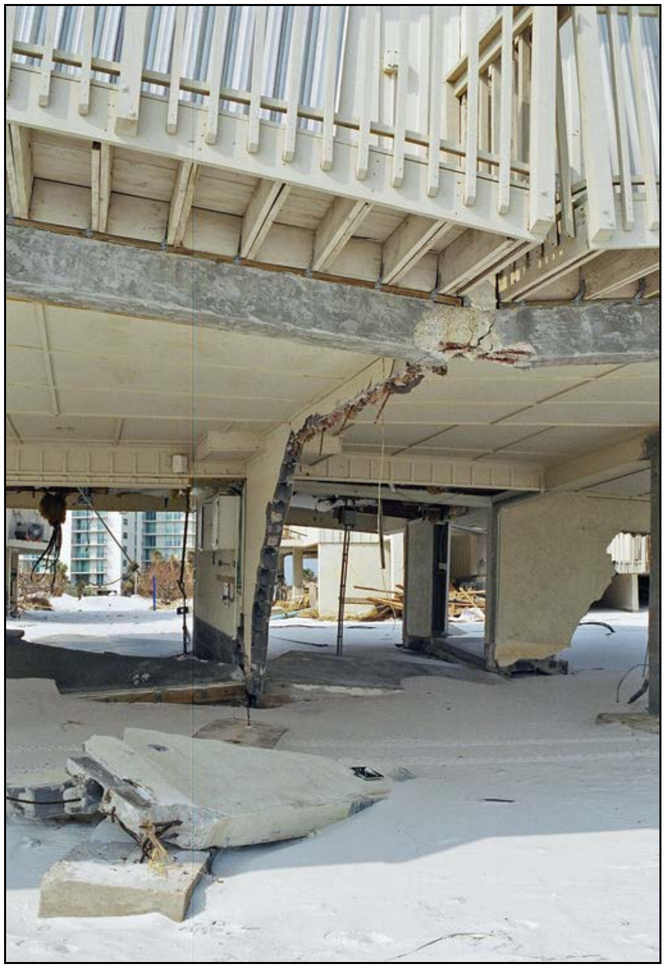
Shear walls should be constructed parallel to the anticipated direction of flood flow and wave attack (typically perpendicular to the shoreline) to allow floodwater and waves to pass freely. In some cases, building designs require both shore-perpendicular and shore-parallel shear walls. Use of shore-parallel shear wall segments should be limited to the minimum length required to transfer upper-story loads to

Figure 18:
High-rise buildings elevated on shore-perpendicular shear walls

the foundation. Shore-parallel shear walls should be designed with openings in the walls or gaps between shear wall segments to minimize trapping of floodwater, waves, and debris and minimize the total flood loads acting on the building. In any case, designs of these walls must be certified by registered design professionals as part of the requirement for certification of foundation designs.

Low-rise buildings in Zone V should be designed with pile or column foundations that are consistent with the NFIP regulations. Post-flood assessments have found that shear walls supporting older low-rise buildings often do not survive severe storm events. See Figure 19, which shows the failure of a wall section of a building supported on columns and shore-perpendicular walls. Wall failure led to failure of the elevated floor beam and floor. In this instance, the building was an older non-conforming building, and the solid walls rested on shallow footings (a means of support not permitted by the NFIP or building codes for buildings in Zone V). The wall failure was likely due to both lateral flood loads and foundation undermining.

Figure 19:
Failure of a shore-perpendicular solid foundation wall that supported a low-rise building, which resulted in failure of the beam and floor system that were supported by the shore-perpendicular wall



## 6.9 Slabs

Concrete slabs are commonly used beneath elevated buildings in Zone V for vehicle parking and as floors of enclosed storage or building access areas. The vertical elements elevating the building should not rest on the slab to avoid an NFIP flood insurance rating of "non-elevated."

**SLABS AND NFIP FLOOD INSURANCE**

There is no difference in NFIP flood insurance premiums between having a frangible slab or a self-supporting structural slab for two otherwise identical elevated buildings.

Post-disaster assessments conducted by FEMA have concluded that unreinforced slabs less than 4 inches thick tend to break up into small pieces without causing adverse effects to elevated buildings (see Figure 20). Reinforced concrete slabs thicker than 4 inches tend not to break up into small pieces, can become dislodged and act as obstructions, and can transfer unanticipated loads to building foundations (see Figure 21).

Figure 20:
Damage to building foundation caused in part by failure of the reinforced slab undermined by erosion

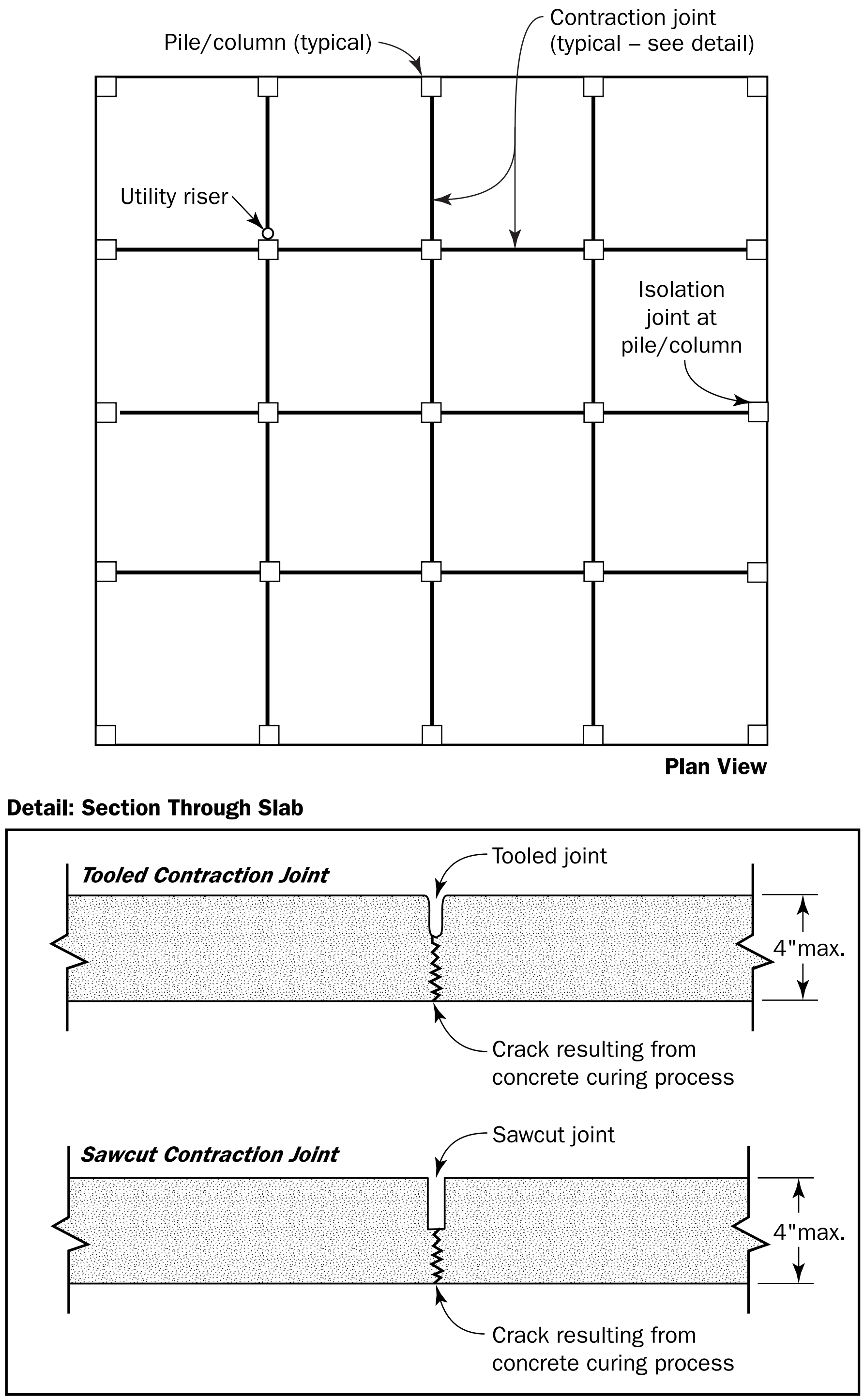
Figure 21:
Unreinforced slab that broke apart without imposing loads on the foundation

Post-disaster assessments have determined that slabs perform well if they meet the requirement in ASCE 24-14, Section 9.3, to either:

- Be frangible (break into small pieces), floating slabs supported by compacted soil, not attached to the building foundation, and designed and constructed with a maximum thickness (traditionally 4 inches), without reinforcement and without turned down edges, or
- Be designed and constructed as self-supporting structural slabs capable of remaining intact and functional during flooding up to and including base flood conditions, including expected erosion.

Building foundations must be capable of resisting any added loads and increase in local scour due to the presence of the slabs.

In most circumstances, and for low-rise buildings in Zone V (including residences), the best alternative is to use frangible slabs. This alternative is also appropriate for other uses of slabs, such as pool decks, sidewalks, and patios. Figure 22 illustrates one possible design for such a slab.




**NOTE:** Install expansion and isolation joints as appropriate in accordance with standard practice or as required by state and local codes.

Figure 22: Example of frangible slab design

Reinforced, self-supporting structural slabs below the BFE may be appropriate for large mid- and high-rise structures that are supported on deep piles because these structures are typically much heavier and less prone to damage from flood loads. If a frangible parking slab is constructed beneath such a structure, reoccupation of an otherwise intact and usable structure after a severe coastal storm event may be delayed due to loss of parking. A self-supporting structural slab could be considered in such situations.

Reinforced, self-supporting structural slabs and grade beams beneath large buildings should be designed to be only as thick as necessary to support vehicle loads and other design loads. The slabs and beams should be connected and integral to the foundations, and all below-BFE components should be designed to act together to resist flood loads and other design loads. Obstructive effects will be minimized as long as the slab systems remain intact and horizontal so floodwater and waves pass above and below the slabs.

# 7 Site Development: Practices and Issues

This section discusses common site development practices and issues that may significantly affect the free passage of flood flow and waves under or around elevated buildings. When these practices are undertaken in accordance with the guidance in this section, they will be deemed to satisfy the NFIP free-of-obstruction requirement, and the potential obstructive effects will be minimized.

## 7.1 Accessory Storage Structures

In Zone V, certain small accessories structures (as defined in a community's floodplain management ordinance, which has been approved by FEMA) may be permitted below the BFE. Small accessory structures include small storage structures such as metal, plastic, or wood sheds that are disposable. FEMA considers "small" to mean less than or equal to 100 square feet.

If accessory storage structures below the BFE do not meet the size considerations mentioned above, or if the structures are of significant size and made of material that is likely to create either damaging debris or flow and wave-diversion problems, communities could consider granting variances in accordance with their floodplain management ordinances and 44 CFR § 60.6. Alternatively, a best practice is to have accessory storage structures constructed and elevated in compliance with NFIP requirements.

**ADDITIONAL ACCESSORY STRUCTURE CONSIDERATIONS**

Some communities have FEMA-approved regulations that specify limitations on the size of accessory structures that are allowed in SFHAs without having to comply with elevation requirements. Other considerations for accessory structures are set forth in FEMA policies and guidance.

Local officials should consult NFIP State Coordinators or FEMA Regional Offices for additional guidance and for appropriate size limits and language to include in local regulations.

Small accessory storage structures that are not elevated must be anchored to resist wind loads (see Figure 23) and designed to resist flotation that may occur even under relatively shallow flood depths. However, because small accessory storage structures are unlikely to withstand wave loads, their loss should be anticipated during the base flood, and the effects that resultant debris may have on nearby structures must be considered.

**Figure 23:**
**Small accessory structure that was moved by flood and wind forces**

In addition, small accessory storage structures must be unfinished on the interior, constructed of flood damage-resistant materials, and used only for storage; moreover, if a structure is provided with electricity, the service must be above the BFE with all branch circuits descending below the BFE fed from ground-fault circuit interrupter breakers. Accessory storage structures must not be used for any habitable or other prohibited purpose.

Separate accessory storage structures must not be located directly under elevated buildings. An alternative is to create storage space below the elevated structure by enclosing an area with breakaway walls.

## 7.2 Detached Garages

Detached garages, such as those typically built for single-family homes or multi-family structures, are too large to qualify as accessory structures that are allowed below the BFE (see Section 7.1). Therefore, detached garages must be elevated on piles or columns and comply with other requirements for structures in Zone V.

Large, fully engineered, free-standing parking garages that satisfy Zone V design and construction requirements are permitted, even if portions lie below the BFE (e.g., vehicle ramps, stairwells, elevator shafts, parking spaces). These structures are not walled and roofed in the traditional sense and can be designed to allow the free passage of floodwater and waves.

**ALTERNATIVE TO DETACHED GARAGES**

Garages may be constructed under elevated buildings and enclosed with breakaway walls (see Technical Bulletin 9, *Design and Construction Guidance for Breakaway Walls*).

## 7.3 Erosion Control Structures

Erosion control structures, such as bulkheads, seawalls, retaining walls, and revetments, are obstructions when installed beneath elevated coastal buildings and are not permitted even if not attached to the building foundations. Erosion control structures can transfer damaging flood loads to building foundations and greatly increase the potential for redirecting flood flow and waves onto the elevated portions of coastal buildings). Figure 24 shows an example of waves running up and overtopping an erosion control structure. Figure 25 shows an example of timbers attached to a pile foundation (constituting a bulkhead), which is not permitted.

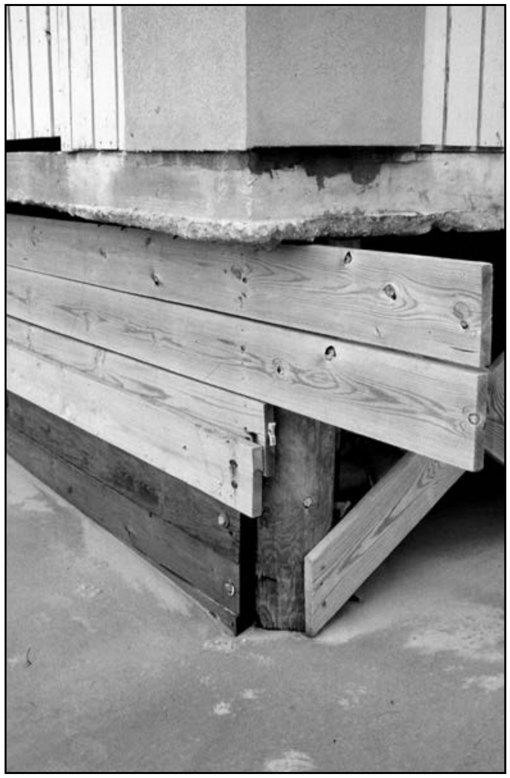
**EFFECT OF EROSION CONTROL STRUCTURES ON WAVES**

Guidance for evaluating potential effects of erosion control structures on waves is contained in the U.S. Army Corps of Engineers *Coastal Engineering Manual* (2002 and updates). Generally, erosion control structures with a steep face (1:2 [vertical to horizontal] or steeper) result in the greatest wave runup.

**Figure 24: Wave runup and overtopping at an erosion control structure**

Although the NFIP does not prohibit bulkheads, seawalls, retaining walls, or revetments outside a building's footprint, communities and design professionals must carefully consider the potentially significant effects of these structures. A general rule of thumb is the greater the horizontal distance between an erosion control structure and a building, the less likely that wave runup and overtopping will adversely affect the building. Although local or state regulations may prohibit the construction of erosion control structures until erosion is within a few feet of a building foundation (to maximize the recreational beach area seaward of the structure), the proximity of erosion control structures to buildings may contribute to wave runup and wave reflection damage.

Figure 25:
Shore-parallel timbers attached to a pile foundation that were intended to act as a bulkhead but constituted an obstruction and are not permitted



FEMA's coastal mapping guidance suggests that a 30-foot-wide "VE overtopping splash zone" (the area where waves breaking on or running up the seaward face of an erosion control structure land or splash down) be mapped landward of erosion control structures, but the guidance also contains site-specific calculations that can lead to a narrower splash zone. For floodplain management purposes, a 30-foot minimum splash zone width is desirable for new construction landward of existing erosion control structures, but this width may not be feasible for existing buildings situated close to erosion control structures. There is no established minimum distance between a building and an erosion control structure, but a reasonable minimum width is 10 to 15 feet. States and communities should take local conditions and observed building damage into account when establishing minimum distances.

## 7.4 Fences and Privacy Walls

Fences and privacy walls, including walls separating one property from another, may obstruct or divert flood flow and waves toward buildings. Their potential effects on buildings, including debris generation, should be evaluated. Open fences (e.g., wood, plastic, open masonry units, metal slat fencing with generous openings) are presumed to not cause harmful diversion of floodwater or wave runup and reflection. Fences with small openings and solid fences and walls may divert flow and waves and can trap debris.

Solid fences, privacy walls, and fences prone to trapping debris must be designed and constructed to fail under base flood conditions without causing harm to nearby buildings. Where building or fire codes require ground-level walls for tenant fire separation, designers should strive to satisfy code requirements while minimizing potential adverse effects from flood diversion.

Siting of new buildings near fences and privacy walls should be reviewed carefully given the impact that these structures could have on a building if they fail during a flood event. Figure 26 shows an example of a shore-perpendicular solid privacy wall that failed during a coastal flood event and damaged the pile foundation of an adjacent elevated building.

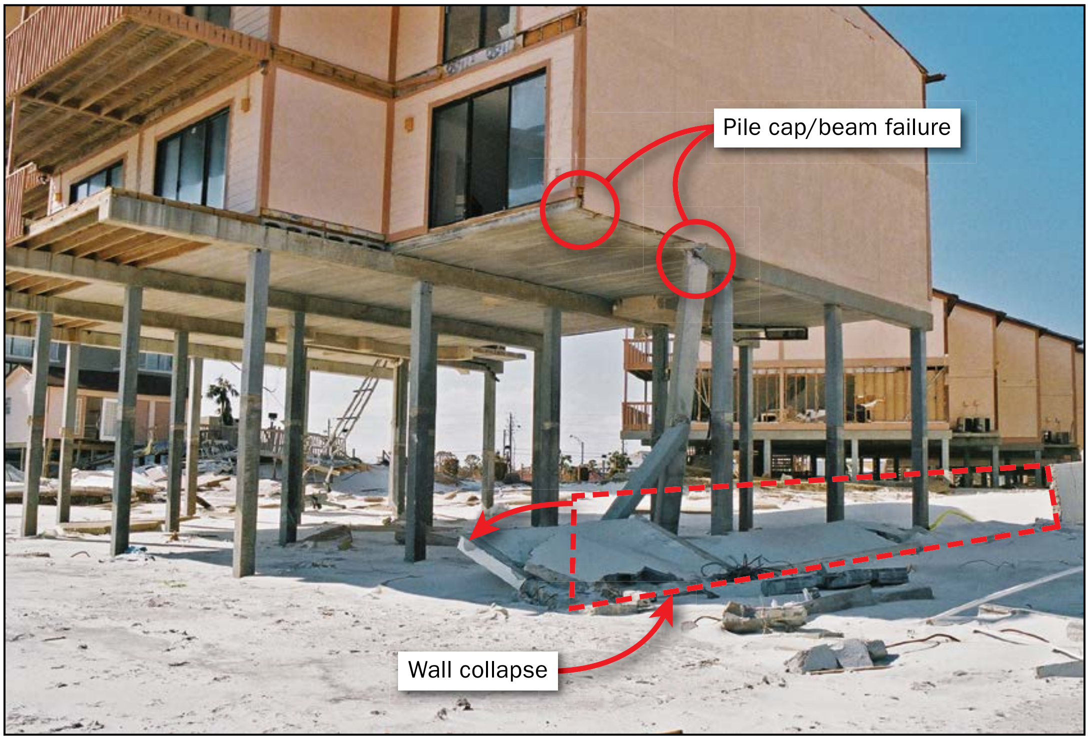



**Figure 26: Shore-perpendicular reinforced masonry privacy wall that collapsed into the foundation of an adjacent building and contributed to failure of the corner foundation piling and pile cap/beam**

## 7.5 Fill

NFIP regulations prohibit the use of fill for structural support of buildings in Zone V. Minor grading and the placement of minor quantities of nonstructural fill are allowed in Zone V but only for landscaping, drainage under and around buildings, and support of parking slabs, pool decks, patios, walkways, and similar site elements. Nonstructural fill should not prevent the free passage of floodwater and waves beneath elevated buildings, divert floodwater or waves such that building damage is exacerbated, or lead to damaging flood and wave conditions on a site or adjacent sites. Nonstructural fill should be assumed to wash away and should not be used in foundation design calculations.

> **MINOR GRADING AND MINOR QUANTITIES OF NONSTRUCTURAL FILL**
>
> **Minor grading:** Minimum grading necessary to provide for landscaping and drainage purposes required or allowed by community regulations, subject to the limitations described in this Technical Bulletin.
>
> **Minor quantity of fill:** Minimum quantity necessary to provide for adequate drainage of areas below and around elevated buildings; support of parking slabs, in-ground pool decks, decks, patios, walkways, and similar site elements; and for site landscaping, subject to the limitations described in this Technical Bulletin.

Determining whether the placement and shaping of nonstructural fill will be detrimental is complicated. Therefore, some state and local regulations essentially prohibit placement of any nonstructural fill in Zone V. However, such limits on nonstructural fill can also lead to problems such as ponding of rainfall around or under buildings. Other states and communities accept some (unspecified) amount of nonstructural fill provided an engineering analysis is performed and an engineer certifies that the fill will not lead to damaging flow diversion or wave runup and reflection. However, credible and defensible analyses are difficult to perform using current engineering methods and models for the small quantities of fill typically used on individual lots.

The placement of nonstructural fill in Zone V for landscaping, drainage, and slab support may be acceptable under certain circumstances using the evaluation criteria described below. Unless in conflict with state or local limitations, local officials are expected to apply these criteria using discretion to achieve the desired performance while giving deference to the general intent of the following criteria as described in the paragraphs that follow. Several criteria are listed, and they may not all agree, depending on specific circumstances.

### 7.5.1 Type of Fill

Fill placed on Zone V sites should be similar to natural soils in the area. In many coastal areas, natural soils are clean sand or sandy soils free of large quantities of clay, silt, and organic material. Nonstructural fill should not contain large rocks and debris. If the fill is similar to and compatible with natural soils, there is no need to require designers to investigate or certify whether the fill has a tendency for excessive natural compaction; an investigation or certification is a common requirement in many floodplain regulations. If the fill material is similar to natural soils, its behavior under flood conditions will be similar to the behavior of natural soils.

### 7.5.2 Fill Thickness

The addition of small thicknesses of site-compatible, nonstructural fill in Zone V is not likely to lead to adverse effects on buildings. There are no established rules as to what constitutes an acceptable fill thickness, so it must be addressed on a case-by-case basis and in some cases may require an engineering analysis of flow and wave effects of the fill. Designers should check with the community about fill thickness thresholds triggering engineering analyses.

Placement of up to 2 feet of fill under or around an elevated building can generally be assumed to comply with free-of-obstruction requirements and be acceptable without engineering analysis or certification, provided basic site drainage principles are not violated (see Section 7.5.4) and provided there are no other site-specific conditions or characteristics that would render the placement of the fill damaging to nearby buildings (e.g., if local officials have observed that the placement of similar quantities of fill has led to building damage during coastal storm events).

If fill is proposed for a site, the proposed final grade should be compared to local topography. If the proposed final fill configuration is below the threshold established by the community and the fill configuration is similar to grades and slopes in the immediate vicinity, a detailed analysis of the effects on flood flow and waves may not be needed. However, if the proposed fill configuration exceeds the community's configuration deemed to comply fill thickness threshold or the proposed fill configuration exceeds local grade heights and variations, an engineering analysis may be required by the community.

In cases where site development involves removing a layer of soil and fill is added to the site later, the fill thickness should be evaluated relative to the pre-removal soil elevation, not the removed soil elevation.

### 7.5.3 Prevention of Ponding

Most communities establish minimum floor elevations to ensure that water does not collect at or under buildings. Floor elevation requirements are frequently tied to nearby road elevations, and the quantity of fill required to raise building footprint areas typically falls within the fill height allowance mentioned in Section 7.5.2. There is no compelling reason to restrict the placement of site-compatible, nonstructural fill beneath buildings in Zone V if the fill will prevent ponding and saturated soil conditions, as long as other drainage requirements for grades and slopes can be satisfied.

### 7.5.4 Site Drainage Requirements

Most communities establish minimum slopes for building sites to facilitate drainage away from buildings (typically 1 unit vertical to 20 units horizontal [5 percent]). Slopes of 1 unit vertical to 3 units horizontal (or steeper) can produce appreciable wave runup. Conversely, slopes shallower than 1 unit vertical to 5 units horizontal (regardless of fill height) will probably not cause or worsen wave runup or wave reflection capable of damaging adjacent buildings. Figure 27 shows an example of fill placement that is considered acceptable because the fill depth is modest and the side slopes are gentle. FEMA's Hurricane Ivan Mitigation Assessment Team concluded that the presence and configuration of the fill did not cause additional flood or wave damage to either the elevated building or the nearby older non-elevated building (FEMA, 2005). The adjacent older, non-elevated building in Figure 27 would likely sustain structural damage during a coastal flood, even if the fill were not present. Swales and conventional site drainage practices should be used to mitigate potential effects of runoff from filled areas.

**Figure 27: Post-hurricane photo showing an elevated building surrounded by gently sloping fill and an adjacent, damaged, older, non-elevated building**

### 7.5.5 Vertical Clearance between Top of Fill and Bottom of Lowest Horizontal Structural Member of Lowest Floor

There are no established rules as to what constitutes acceptable vertical clearance, so it must be addressed on a case-by-case basis. Designers should check with the jurisdiction about minimum vertical clearance requirements.

When the BFE is above the existing ground, placement of nonstructural fill between the ground and the lowest horizontal structural member of the lowest floor may be permitted, but it is advisable to maintain some vertical clearance between the bottom of the lowest horizontal structural member and the top of the fill. Vertical clearance should be established to ensure that base flood flow and waves will pass beneath the elevated building and the fill will not contribute to wave runup and flood damage to the elevated building.

When the BFE is below the existing ground elevation (see Section 7.6), vertical clearance between the ground (including any nonstructural fill) and the lowest horizontal structural member of the lowest floor may not be needed as long as adequate site drainage is provided.

### 7.5.6 Fill Compaction

The NFIP regulations are explicit in that fill must not be used for structural support of buildings in Zone V. However, compaction of fill below and around elevated buildings used to support parking slabs, in-ground pool decks, patios, sidewalks, and similar site amenities is consistent with the intent of the regulations.

### 7.5.7 Dune Construction, Repair, and Reconstruction

Dunes are natural features in many coastal areas, and they can erode during storms and recover naturally over time. The natural recovery process can be accelerated by replacing the eroded dune with compatible sand, planting dune grasses, and installing sand fences (see Chapter 5 of *The Dune Book* [Rogers and Nash, 2003]). In general, these activities should not be considered detrimental even if part of the dune lies under a building's footprint. The addition of sand to restore a site to its pre-storm grades and stabilization with dune vegetation will likely do more good than harm in terms of flood damage reduction.

> **DUNE EXCAVATION MAY INCREASE POTENTIAL FLOOD DAMAGE**
>
> Communities must prohibit manmade alteration of sand dunes in Zone V if such alteration would increase potential flood damage (per 44 CFR § 60.3(e)(7)). Where the ground (dune) elevation is at or above the BFE, excavation to place the bottom of the lowest horizontal structural member of lowest floor at the BFE is not recommended and may in fact violate the limitation on alterations that increase potential flood damage.

Concerns about placement of nonstructural, clean sand under and around beachfront buildings should not be the basis for prohibiting dune maintenance and construction, beach nourishment, or similar activities. Dune construction, repair, and reconstruction under or around elevated buildings may be assumed to be acceptable as long as the scale and location of the dune work is consistent with local beach-dune morphology and reasonable vertical clearance is maintained between the top of the dune and the elevated building's floor system. ASCE 24-14 permits dune construction and reconstruction under and around elevated buildings but requires an engineering report documenting that the fill placement will not cause building damage by wave runup or reflection or deflection of floodwater.

### 7.5.8 Timing of Fill Placement

Sometimes fill is placed on a site months or years before building construction begins. This can be problematic unless the community tracks site improvements and fill placement. If the original natural grade elevation is unknown, borings or other site investigations may be required to determine the depth of fill and ensure adequate foundation depth.

## 7.6 Ground Elevations At or Above the Base Flood Elevation

In some Zone V areas, ground elevations are at or above the BFE, particularly along shorelines with well-developed dune fields. Mapped Zone V areas with ground above the BFE seem counterintuitive, but they are possible because of two Zone V mapping considerations:

- **Dune erosion.** Dunes can erode during the base flood (or lesser floods), resulting in a substantial lowering of the pre-storm grade to a level below the BFE. The BFE is mapped based on surge and waves passing over the eroded and inundated ground surface.
- **Presence of a primary frontal dune (PFD).** Zone V is mapped at a minimum to the inland extent (heel) of the PFD, even where the dune elevation is higher than the BFE (FEMA, 2014).

A ground elevation at or above the BFE may complicate the need to comply with Zone V design and construction requirements but does not eliminate it. It does raise the question of how the free-of-obstruction requirement applies in this situation: Because the soil at the site may erode during a coastal flood event, the area under the building will be exposed, and the exposed area must be free of obstructions.

The same free-of-obstruction considerations that apply to buildings elevated above grade apply to buildings where the BFE is below grade. Buildings must still be designed and constructed on pile or column foundations that are embedded deep into the ground, and the bottoms of the lowest horizontal structural members supporting the lowest floor must still be at or above the BFE. Vertical clearance between the bottom of the lowest horizontal structural member and the ground (see Section 7.5.5) is not required by the NFIP where ground elevations are at or above the BFE; however, communities should be contacted because they may have vertical clearance requirements. Any lowest horizontal structural members that come in contact with the fill must be composed of materials that can resist ground contact moisture levels. Minor site grading to drain water away from the foundation will also be necessary.

## 7.7 On-Site Septic Systems

On-site buried septic systems and mounded septic systems in Zone V are frequently exposed and/or displaced. In addition to compromising their subsequent use, damage can cause release of contents. Septic systems are often destroyed if they are near a shoreline. Therefore, septic systems should be located outside areas subject to erosion during the base flood or, if placed in an area subject to erosion, installed below the depth of expected erosion. The latter stipulation may conflict with septic system groundwater considerations, in which case an on-site septic system is not appropriate for the area, and alternate designs may be necessary.

On-site septic system tanks serving elevated buildings must not be structurally attached to building foundations. Plumbing and piping connections are required, and these items are allowed in Zone V. However, plumbing and piping components must not be attached to or pass through breakaway wall panels.

If mounded septic systems are used, they can require significant volumes of fill, which, if placed under or immediately adjacent to buildings, may constitute obstructions that divert flood flow and waves. An analysis of flow and wave effects should be undertaken. Mounded septic systems may be allowed in Zone V if they will not worsen flood and wave conditions for the buildings they serve or nearby buildings (see Section 7.5.2 for guidance on evaluating mounded systems near elevated buildings).

An additional consideration for on-site septic systems in Zone V is stated in 44 CFR § 60.3(a)(6)(ii) of the NFIP regulations, which requires "on-site waste disposal systems to be located to avoid impairment to them or contamination from them during flooding." FEMA P-348 provides additional guidance.

## 7.8 Restroom Buildings and Comfort Stations

Restroom buildings and comfort stations must be treated the same as other types of structures in Zone V and must meet the same elevation and design requirements as other buildings, even when the facilities are situated in public parks or recreation areas.

## 7.9 Swimming Pools and Spas

Three primary considerations relate to the placement of swimming pools and spas under or adjacent to buildings in Zone V:

- Whether the pool or spa will cause increased flood loads on buildings or exacerbate scour and erosion near buildings.
- Whether the pool or spa configuration is subject to NFIP use limitations for enclosed areas under elevated buildings.
- Whether a removable enclosure is placed around a pool or spa (usually in the winter) that will cause increased flood loads on buildings or exacerbate scour and erosion near buildings. NFIP flood insurance treats these enclosures as permanent enclosures even if they are only used seasonally or for short periods of time.

**SWIMMING POOLS AND SPAS**

Pools and spas adjacent to coastal buildings are allowed only if they will not act as obstructions that could lead to damage to nearby buildings. This effectively means that most pools and spas must be installed in-ground (either frangible or immovable) or completely elevated above the BFE. Swimming pools, spas, and related equipment are not covered by NFIP flood insurance.

Pools, pool decks, and walkways that are placed under or adjacent to coastal buildings must be structurally independent of the buildings and their foundations and must not contribute to building or foundation damage during the base flood. Three options, also recognized by ASCE 24-14, Section 9.6.2, satisfy this requirement:

- The pool can be elevated so the bottom of the lowest horizontal structural member supporting the pool (and the pool itself) is at or above the required flood elevation, or

- The pool can be designed and constructed to break away without producing debris capable of damaging nearby buildings, or
- The pool can be designed and constructed to remain in the ground and not divert flow or waves that can damage nearby buildings.

Registered design professionals must certify that pools or spas beneath or near buildings in Zone V will not be subject to flotation or displacement that will damage building foundations during a base flood or lesser event. In cases where pools are empty part of the year, flotation calculations should assume that pools are empty. Figure 28 shows a spa that was displaced and likely caused the failure of two piles that supported an elevated deck.

**Figure 28:**
**Failure of two piles supporting an elevated deck that was likely caused by movement of a spa**

The NFIP permits swimming pools and spas beneath elevated building only if the top of the pool or spa and accompanying deck or walkway are flush with the existing grade and the area around the pool or spa remains unenclosed. However, some states and communities may prohibit or restrict unenclosed pools and spas beneath elevated buildings. Designers should check with the local jurisdiction for any additional requirements.

The NFIP limits the use of enclosures under elevated buildings to parking of vehicles, building access, and storage. Because pools and spas do not satisfy these limitations, they are not allowed to be enclosed, even if enclosed by glass or breakaway walls. Use of lattice and insect screening is permitted around pools and spas below elevated buildings.

# 8 References

This section lists the references cited in this Technical Bulletin. Additional resources related to NFIP requirements are provided in Technical Bulletin 0.

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