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Coastal Construction: Pre-Design Considerations

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7 Pre-Design Considerations

This chapter provides an overview of the issues that should be considered before the building is designed.

Coastal development has increased in recent years, and some of the sites that are chosen for development have higher risks of impact from natural hazards than in the past. Examples of sites with higher risks are those that are close to the ocean, on high bluffs that are subject to erosion, and on artificial fill deposits. In addition, many of the residential buildings constructed today are larger and more costly than before, leading to the potential for larger economic losses if disaster strikes. However, studies conducted by the Federal Emergency Management Agency (FEMA) and others after major coastal disasters have consistently shown that coastal residential buildings that are properly sited, designed, and constructed have generally performed well during natural hazard events.

Important decisions need to be made prior to designing the building. The decisions should be based on an understanding of regulatory requirements, the natural hazard and other risks associated with constructing a building on a particular site (see Chapter 4), and the financial implications of the decisions. The financial implications of siting decisions include the cost of hazard insurance, degree of hazard resistance and sustainability in the design, and permits and inspections.



CROSS REFERENCE

For resources that augment the guidance and other information in this Manual, see the Residential Coastal Construction Web site (<http://www.fema.gov/rebuild/mat/fema55.shtm>).

Once a site has been selected, decisions must be made concerning building placement, orientation, and design. These decisions are driven primarily by the following:

- Owner, designer, and builder awareness of natural hazards
- Risk tolerance of the owner
- Aesthetic considerations (e.g., building appearance, proximity to the water, views from within the building, size and number of windows)
- Building use (e.g., full-time residence, part-time residence, rental property)
- Requirements of Federal, State, and local regulations and codes
- Initial and long-term costs

The interrelationships among aesthetics, building use, regulatory and code requirements, and initial cost become apparent during siting and design, and decisions are made according to the individual needs or goals of the property owner, designer, or builder. However, an understanding of the effect of these decisions on long-term and operational costs is often lacking. The consequences of the decisions can range from increased maintenance and utility costs to the ultimate loss of the building. The goal of this Manual is to provide the reader with an understanding of these natural hazards and provide guidance on concepts for designing a more hazard-resistant residential building.

7.1 Design Process

The design process includes a consideration of the types of natural hazards that occur in the area where the building site is located and the design elements that allow a building to effectively withstand the potential damaging effects of the natural hazards (see Figure 7-1). The intent of this Manual is to provide sufficient technical information, including relevant examples, to help the designer effectively design a coastal residential building.

This Manual does not describe all combinations of loads, types of material, building shapes and functions, hazard zones, and elevations applicable to building design in the coastal environment. The designer must apply engineering judgment to a range of problems. In addition, good design by itself is not enough to guarantee a high-quality structure. Although designing building components to withstand site-specific loads is important, a holistic approach that also includes good construction, inspection, and maintenance practices can lead to a more resilient structure.

Before designing a building and to optimize the usefulness of Volume II of this Manual, the designer should obtain the codes and standards, such as ASCE 7 and ASCE 24, that are listed in the reference section of each chapter and other relevant information such as locally adopted building codes and appropriate testing protocols.

Although codes and standards provide minimums, the designer may pursue a higher standard. Many decisions require the designer's judgment, but it is never appropriate to use a value or detail that will result in a building that is not constructed to code.

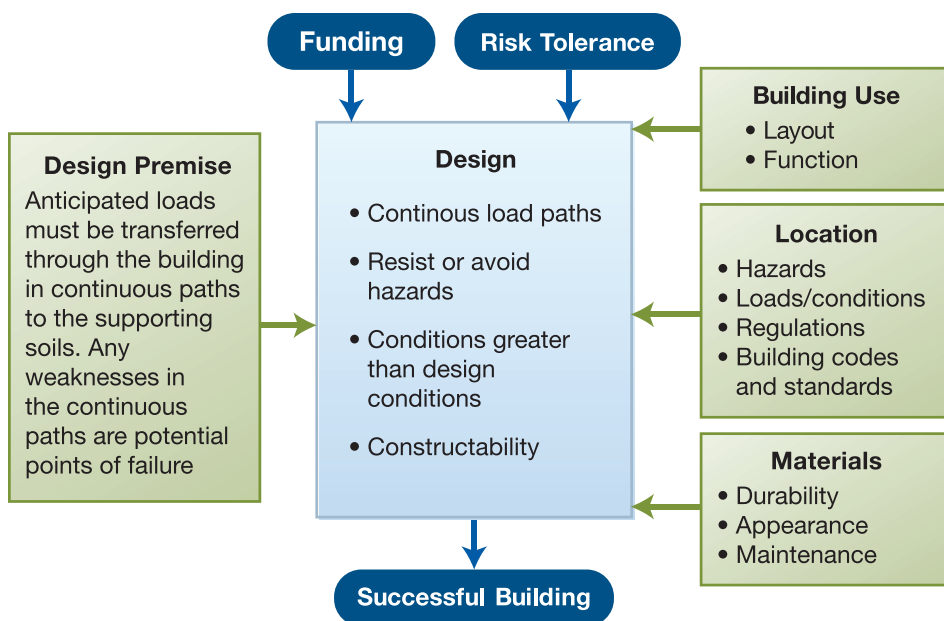


Figure 7-1.
Design framework for a successful building, incorporating cost, risk tolerance, use, location, materials, and hazard resistance

Volume II contains many design equations, but they do not cover all of the design calculations that are necessary and are provided only as examples.

7.2 Design Requirements

The minimum design requirements for loads, materials, and material resistances for a given building design are normally specified in the locally adopted building code. Nothing in this Manual is intended to recommend the use of materials or systems outside the uses permitted in building code requirements. The loads used in this Manual are based on ASCE 7-10, which is the reference load standard in model building codes. Material and material resistance requirements cited in this Manual are based on the minimum requirements of applicable building codes. However, designers are encouraged throughout the Manual to seek out information on loads and materials that exceed the minimum requirements of the building code. Other sources of information for loads and materials are also provided.

7.3 Determining the Natural Hazard Risk

Assessing risk to coastal buildings and building sites requires identifying or delineating hazardous areas and considering the following factors:

- Types of hazards known to affect a region
- Geographic variations in hazard occurrence and severity
- Methods and assumptions underlying existing hazard identification maps or products

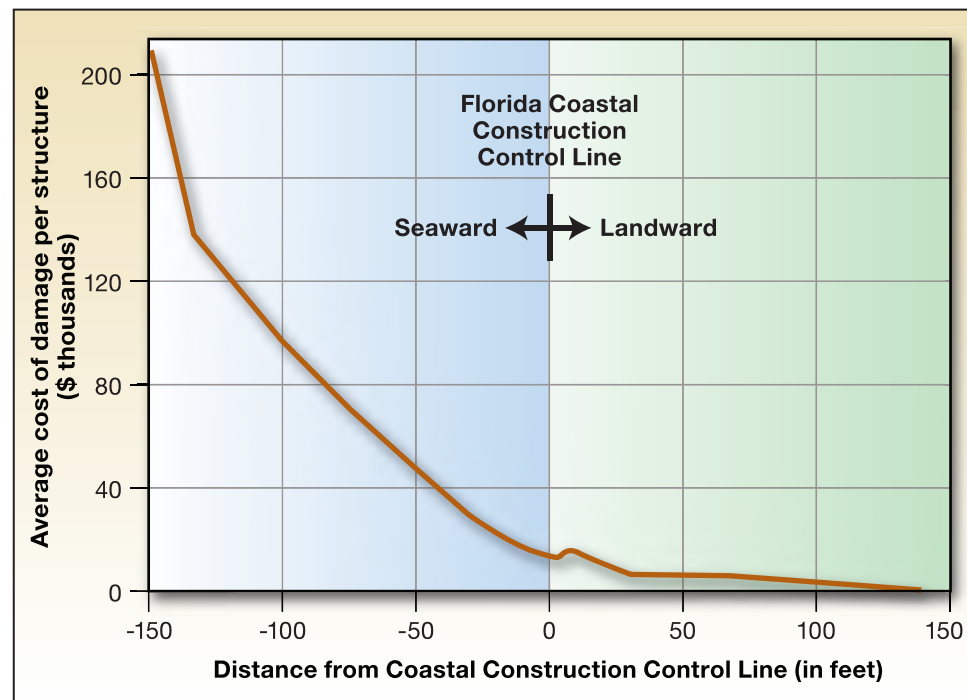
- “Acceptable” level of risk
- Consequences of using (or not using) recommended siting, design, and construction practices

Geographic variations in coastal hazards occur, both along and relative (perpendicular) to the coastline. Hazards affecting one region of the country may not affect another. Hazards such as wave loads, which affect construction close to the shoreline, usually have a lesser or no effect farther inland. For example, Figure 7-2 shows how building damage caused by Hurricane Eloise in 1975 was greatest at the shoreline but diminished rapidly in the inland direction. The figure represents data from only one storm but shows the trend of a typical storm surge event on coastlines (i.e., damage decreases significantly as wave height decreases). The level of damage and distance landward are dictated by the severity of the storm and geographic location.

Through Flood Insurance Studies (FISs) and Flood Insurance Rate Maps (FIRMs), FEMA provides detailed coastal flood hazard information (see Section 3.5). However, these products reflect only flood hazards and do not include a consideration of a number of other hazards that affect coastal areas. Other Federal agencies and some states and communities have completed additional coastal hazard studies and delineations. The Residential Coastal Construction Web site (<http://www.fema.gov/rebuild/mat/fema55.shtm>) provides introductory information concerning more than 25 hazard zone delineations developed by or for individual communities or states (see “Web Sites for Information about Storms, Big Waves, and Water Level”). Some delineations have been incorporated into mandatory siting and/or construction requirements.

When reviewing the hazard maps and delineations that are provided on the Residential Coastal Construction Web site, designers should be aware that coastal hazards are often mapped using different levels of risk or recurrence intervals. Thus, the *consistent* and *acceptable level of risk* (the level of risk judged by the designer to be appropriate for a particular building) should be considered early in the planning and design process (see Chapter 6). The hazard maps and delineations are provided as a historical reference only. The most up-to-date information can be obtained by contacting local officials.

Figure 7-2.
Average damage per structure (in thousands of 1975 dollars) versus distance from the Florida Coastal Construction Control Line for Bay County, FL, Hurricane Eloise (Florida, 1975)
SOURCE: ADAPTED FROM SHOWS 1978



7.4 Losses Due to Natural Hazards in Coastal Areas

It is easy for property owners to become complacent about the potential for a natural disaster to affect their properties. Hurricanes and earthquakes are generally infrequent events. A geographic area may escape a major hazard event for 20 or more years. Or, if an area has recently been affected, residents may believe the chances of a recurrence in the near future are remote. These perceptions are based on inaccurate assumptions and/or a lack of understanding of natural hazards and the risk of damage.

The population and property values along the U.S. coast are both rapidly increasing. Although better warning systems have reduced the number of fatalities and injuries associated with natural disasters, increases in the number and value of structures along the coast have dramatically increased potential property losses.

From 2000 through 2009, there were 13 presidentially declared disasters resulting from hurricanes and tropical systems, each causing more than \$1 billion in losses. Hurricane Katrina in 2005 was the most expensive natural disaster in U.S. history, causing estimated economic losses of more than \$125 billion and insured losses of \$35 billion, surpassing Hurricane Andrew's \$26.5 billion in losses in 1992. Other recent memorable storms are Tropical Storm Allison (2001), Hurricane Rita (2005), Hurricane Wilma (2005), Hurricane Ike (2008), and the 2004 hurricane season in which four storms (Charley, Frances, Ivan, and Jeanne) affected much of the East Coast in both coastal and inland areas.

Following Hurricane Andrew, which ravaged south Florida in 1992, studies were conducted to determine whether the damage suffered was attributable more to the intensity of the storm or to the location and type of development. According to the Insurance Institute for Business and Home Safety (IBHS):

Conservative estimates from claim studies reveal that approximately 25 percent of Andrew-caused insurance losses (about \$4 billion) were attributable to construction that failed to meet the code due to poor enforcement, as well as shoddy workmanship. At the same time, concentrations of population and of property exposed to hurricane winds in southern Florida grew many-fold (IBHS 1999).

After Hurricane Andrew, codes and regulations were enacted that support stronger building practices and wind protection. IBHS conducted a study in 2004 following Hurricane Charley that found:

... homes built after the adoption of these new standards resulted in a decrease in the frequency and severity of damage to various building components. Furthermore, based on the analysis of additional living expense records, it is concluded that the new building code requirements allowed homeowners to return to their home more quickly and likely reduced the disruption of their day to day lives (IBHS 2004, p. 5).



NOTE

According to the Mortgage Bankers Association (2006), from 1985 to 2005, hurricanes and tropical storms accounted for the major share of all catastrophic insurance losses. The percentages of property damage caused by various catastrophic events during this period were:

- 43.7 percent from hurricane/tropical storms
- 23.3 percent from wind/thunderstorms
- 5.1 percent from earthquakes

Approximately 94.4 percent of all catastrophic events occurring during this period were attributed to natural disasters.

The past several decades have not resulted in major losses along the Pacific coast or Great Lakes, but periodic reminders support the need for maintaining a vigilant approach to hazard-resistant design for coastal structures in other parts of the country. In February 2009, the Hawaiian Islands and portions of California were under a tsunami watch. This type of watch occurs periodically in sections of northern California, Oregon, Washington, and Alaska and supports the need to construct buildings on elevated foundations. Although tsunamis on the Pacific coast may be less frequent than coastal hazard events on the Atlantic coast, ignoring the threat can result in devastating losses.

Hazard events on the coastlines of the Great Lakes have resulted in damage to coastal structures and losses that are consistent with nor'easters on the Atlantic coast. Surge levels and high winds can occur every year on the Great Lakes, and it is important for designers to ensure that homeowners and builders understand the nature of storms on the Great Lakes. As in other regions, storm-related losses can result in the need to live in a house during lengthy repairs or be displaced for extended periods while the house is being repaired. The loss of irreplaceable possessions or property not covered by flood or homeowners insurance policies are issues a homeowner should be warned of and are incentives to taking a more hazard-resistant design approach.

Chapters 2 and 3 contain more information about the hazards and risks associated with building in coastal areas.

7.5 Initial, Long-Term, and Operational Costs

Like all buildings, coastal residential buildings have initial, long-term, and operational costs.

- **Initial costs** include property evaluation, acquisition, permitting, design, and construction.
- **Long-term costs** include preventive maintenance and repair and replacement of deteriorated or damaged building components. A hazard-resistant design can result in lower long-term costs by preventing or reducing losses from natural hazard events.
- **Operational costs** include costs associated with the use of the building, such as the cost of utilities and insurance. Optimizing energy efficiency may result in a higher initial cost but save in operational costs.

In general, the decision to build in any area subject to significant natural hazards—especially coastal areas—increases the initial, long-term, and operational costs of building ownership. Initial costs are higher because the natural hazards must be identified, the associated risks assessed, and the building designed and constructed to resist damage from the natural hazard forces. Long-term costs are likely to be higher because a building in a high-risk area usually requires more frequent and more extensive maintenance and repairs than a building sited elsewhere. Operational costs are often higher because of higher insurance costs and, in some instances, higher utility costs. Although these costs may seem higher, benefits such as potential reductions in insurance premiums and reduced repair time following a natural disaster may offset the higher costs.

7.5.1 Cost Implications of Siting Decisions

The cost implications of siting decisions are as follows:

- The closer buildings are sited to the water, the more likely they are to be affected by flooding, wave action, erosion, scour, debris impact, overwash, and corrosion. In addition, wind speeds are typically higher along coastlines, particularly within the first several hundred feet inland. ***Repeated exposure to these hazards, even when buildings are designed to resist their effects, can lead to increased long-term costs for maintenance and damage repair.***
- Erosion—especially long-term erosion—poses a serious threat to buildings near the water and on high bluffs above the floodplain. Wind-induced erosion can lower ground elevations around coastal buildings, exposing Zone V buildings to higher-than-anticipated forces, and exposing Zone A buildings to Zone V flood hazards. ***Maintenance and repair costs are high for buildings in erosion hazard areas, not only because of damage to the building, but also because of the need for remedial measures (e.g., building relocation or erosion protection projects, such as seawalls, revetments, and beach nourishment, where permitted).***
- Sites nearest the water are likely to be in Zone V where building foundations, access stairs, parking slabs, and other components below the building are especially vulnerable to flood, erosion, and scour effects. As a result, ***the potential for repeated damage and repair is greater for Zone V buildings than buildings in other zones, and the buildings have higher flood insurance rates and increased operational costs.*** In addition, although elevating a building can protect the superstructure from flood damage, it may make the entire building more vulnerable to earthquake and wind damage.



COST CONSIDERATION

Designers and homeowners should recognize that erosion control measures can be expensive, both initially and over the lifetime of a building. In some instances, erosion control costs can equal or exceed the cost of the property or building being protected.



CROSS REFERENCE

For information on siting coastal residential buildings, see Chapter 4.

7.5.2 Cost Implications of Design Decisions

The cost implications of design decisions are as follows:

- For aesthetic reasons, the walls of coastal buildings often include a large number of openings for windows and doors, especially in the walls that face the water. ***Designs of this type lead to greater initial costs to strengthen the walls and to protect the windows and doors from wind and wind-borne debris (missiles).*** If adequate protection in the form of shutter systems or impact-resistant glazing is not provided, long-term costs are greater because of (1) the need to repair damage to glazing and secondary damage by the penetration of wind-driven rain and sea spray and/or (2) the need to install retrofit protection devices at a later date.



NOTE

Over the long term, poor siting decisions are rarely overcome by building design.

- As explained in Chapter 5, National Flood Insurance Program (NFIP) regulations allow buildings in Coastal A Zones to be constructed on perimeter wall (e.g., crawlspace) foundations or on earth fill. Open (pile, pier, or column) foundations are required only for Zone V buildings. Although a Coastal A Zone building on a perimeter wall foundation or fill may have a lower initial construction cost than a similar building on an open foundation, it may be subject to damaging waves, velocity flows, and/or erosion and scour over its useful life. As a result, ***the long-term costs for a building on a perimeter wall foundation or fill may actually be higher because of the increased potential for damage.***
- In an effort to reduce initial construction costs, designers may select building materials that require high levels of maintenance. Unfortunately, the initial savings are often offset because (1) coastal buildings, particularly those near bodies of saltwater, are especially prone to the effects of corrosion, and (2) owners of coastal buildings frequently fail to sustain the continuing and time-consuming levels of maintenance required. ***The net effect is often increased building deterioration and sometimes a reduced capacity of structural and non-structural components to resist the effects of future natural hazard events.***

Table 7-1 provides examples of design elements and the cost considerations associated with implementing them. Although these elements may have increased costs when implementing them on a single building, developers may find that incorporating them into speculative houses with large-scale implementation can provide some savings.

Table 7-1. Examples of Flood and Wind Mitigation Measures

Mitigation Measure	Cross References ^(a)	Benefits/Advantages	Costs/Other Considerations
Adding 1 to 2 feet to the required elevation of the lowest floor or lowest horizontal structural member of the building	5.4.2 6.2.1.3	Reduces the potential for the structure to be damaged by waves and/or floodwaters; reduces flood insurance premiums	May conflict with community building height restrictions; may require additional seismic design considerations; longer pilings may cost more
Increasing embedment depth of pile foundations	10.2.3 13.1.2	Adds protection against scour and erosion	Longer pilings may cost more
Improving flashing and weather-stripping around windows and doors	11.4.1.2	Reduces water and wind infiltration into building	Increases the number of important tasks for a contractor to monitor
Installing fewer breakaway walls or more openings in continuous foundation walls than currently noted on the building plans	5.4.2	Decreases potential for damage to understory of structure; reduces amount of debris during storm event	Reduces the ability to use understory structure for storage for open foundations
Elevating a building in a Coastal Zone A on an open foundation or using only breakaway walls for enclosures below the lowest floor	5.4.2 10.3.1	Reduces the potential for the structure to be damaged by waves, erosion, and floodwaters	Breakaway walls still require flood openings in Zone A

Table 7-1. Examples of Flood and Wind Mitigation Measures (concluded)

Mitigation Measure	Cross References ^(a)	Benefits/Advantages	Costs/Other Considerations
Adding shutters for glazing protection	11.3.1.2	Reduces the potential for damage from wind-borne debris impact during a storm event; reduces potential for wind-driven rain water infiltration	Shutters require installation or activation before a storm event
Using asphalt roof shingles with high bond strength	11.5.1	Reduces shingle blowoff during high winds	High bond strength shingles are slightly more expensive
Instead of vinyl siding, installing cladding systems that have passed a test protocol that simulates design-level fluctuating wind pressures (on a realistic installed wall specimen)	11.4.1.1 14.2.2	Tested cladding systems reduce blowoff on walls during high winds	These systems may cost more than other materials and may require additional maintenance
Using metal connectors or fasteners with a thicker galvanized coating or connectors made of stainless steel	14.1.1 14.2.6	Increases useful life of connectors and fasteners	Thicker galvanized or stainless steel coatings are more costly
Installing roof sheathing using a high-wind prescriptive approach for improved fasteners, installing additional underlayments, or improving roof covering details as required	11.5 15.3.1	Reduces wind and water damage to roof covering and interior from a severe event	Minimal increased cost when these tasks are done during a reroofing project

(a) Sections in this Manual

DESIGNING FOR FLOOD LEVELS ABOVE THE BASE FLOOD ELEVATION (BFE)

Designers and owners should consider designing buildings for flood levels above the BFE for the following reasons:

- Floods more severe than the base flood can and do occur, and the consequences of flood levels above the BFE can be devastating.
- Older FIRMs may not reflect current base flood hazards.
- FIRMs do **not** account for the effect of future conditions flood hazards; future flood hazards may exceed present-day flood hazards because of sea level rise, coastal erosion, and other factors.
- Buildings elevated above the BFE will sustain less flood damage and will be damaged less often than buildings constructed at the BFE.
- For a given coastal foundation type, the costs of building higher than the BFE are nominal when compared to reduced future costs to the owner.
- Flood damage increases rapidly with flood elevation above the lowest floor, especially when waves are present. Lateral and vertical wave forces against elevated buildings (“wave slam”) can be large and destructive. Waves as small as 1.5 feet high can destroy many residential walls.
- Elevated buildings whose floor systems and walls are submerged during a flood may enhance foundation scour by constricting flow between the elevated building and the ground.
- Over a 50-year lifetime, the chance of a base flood occurring is about 40 percent. For most coastal areas, the chance of a flood approximately 3 feet higher than the BFE occurring over 50 years will only be about 10 percent. Designing and constructing to an elevation of BFE + 3 feet is not normally difficult.
- Owners whose buildings are elevated above the BFE can save significant amounts of money through reduced flood insurance premiums. Premiums can be reduced by up to 50 to 70 percent, and savings can reach several thousands of dollars per year in Zone V.



7.5.3 Benefits and Cost Implications of Siting, Design, and Construction Decisions

This Manual is designed to help property owners manage some of the risk associated with constructing a residential building in a coastal area. As noted in Chapter 2, studies of the effects of natural disasters on buildings demonstrate that sound siting, design, engineering, construction, and maintenance practices are important factors in the ability of a building to survive a hazard event with little or no damage. This chapter and the remainder of Volume II provide detailed information about how to site, design, construct, and maintain a building to help manage risks.



CROSS REFERENCE

For more information on designing coastal residential buildings, see Chapter 9.

Constructing to a model building code and complying with regulatory siting requirements provides a building with a certain level of protection against damage from natural hazards. However, compliance with minimum code and regulatory requirements does not guarantee that a building is not at risk from a natural hazard. Exceeding code and minimum regulatory requirements provides an added measure of safety but also adds to the cost of construction, which must be weighed against the benefit gained.

The often minimal initial cost of mitigation measures offers long-term benefits that provide a cost savings from damage avoided over the life of the building. Incorporating mitigation measures can reduce a homeowner's insurance premiums and better protect the building, its contents, and occupants during a natural hazard event, thus decreasing potential losses. Similar to cost reductions provided by the U.S. Green Building Council *LEED [Leadership in Energy and Environmental Design]* for Homes Reference Guide (USGBC 2009) and ICC 700-2008, incorporating hazard mitigation measures into a building may pay for themselves over a few years based on insurance premium savings and the improved energy efficiency that some of the techniques provide.

Table 7-1 lists examples of flood and wind mitigation measures that can be taken to help a structure withstand natural hazard events. The need for and benefit of some mitigation measures are difficult to predict. For example, elevating a building above the design flood elevation (DFE) could add to the cost of the building. This additional cost must be weighed against the probability of a flood or storm surge exceeding the DFE. Figure 7-3 illustrates the comparative relationship between damage, project costs, and benefits associated with a hazard mitigation project on a present-value¹ basis over the life of the project.

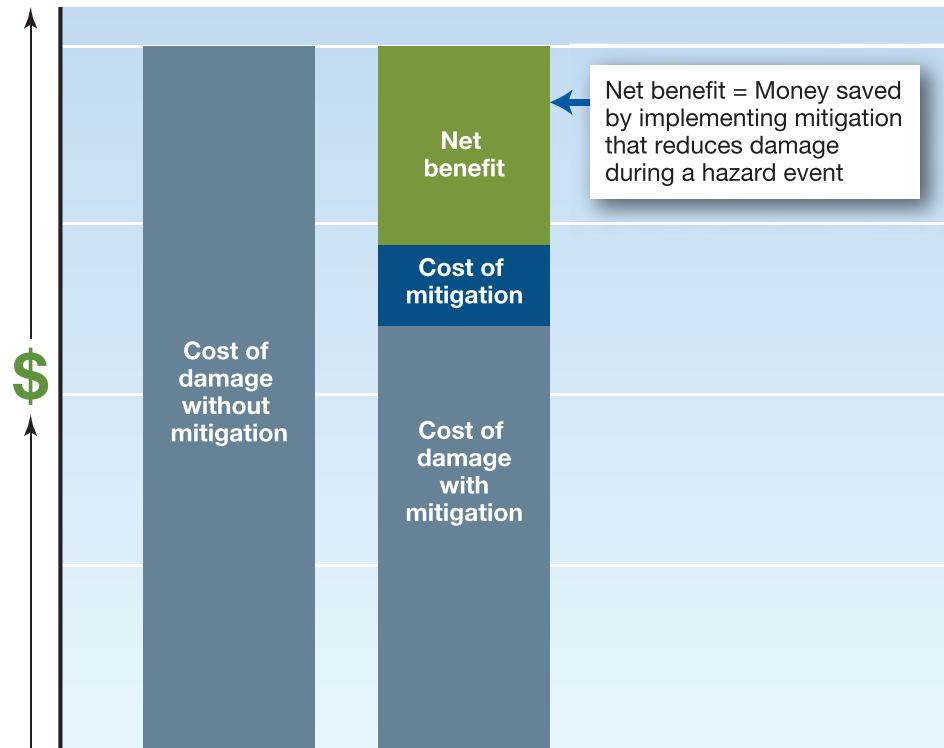


CROSS REFERENCE

Unless both questions presented in Section 4.8 of this Manual (regarding the acceptable level of residual risk at a site) can be answered affirmatively, the property owner should reconsider purchasing the property.

¹ Present value is the current worth of future sums of money. For example, the present value of \$100 to be received 10 years from now is about \$38.55, using a discount rate equal to 10 percent interest compounded annually.

Figure 7-3.
Basic benefit-cost model



7.6 Hazard Insurance

Insurance should never be viewed as an alternative to damage prevention. However, despite best efforts to manage risk, structures in coastal areas are always subject to potential damage during a natural hazard event. Hazard insurance to offset potential financial exposure is an important consideration for homeowners in coastal areas. Insurance companies base hazard insurance rates on the potential for a building to be damaged by various hazards and the predicted ability of the building to withstand the hazards. Hazard insurance rates include the following considerations:

- Type of building
- Area of building footprint
- Type of construction
- Location of building
- Date of construction
- Age of the building



NOTE

A single-family home is covered by homeowners insurance, and a multi-family building is covered by a dwelling policy. A homeowner policy is different from a dwelling policy. A homeowner policy is a multi-peril package policy that automatically includes fire and allied lines, theft, and liability coverage. For a dwelling policy, peril coverages are purchased separately. In addition to Federal and private flood insurance, this chapter focuses on homeowners insurance.

- Existence and effectiveness of a fire department and fire hydrants (or other dependable, year-round sources of water)
- Effectiveness of the building code and local building department at the time of construction

Although designers and builders may not be able to control the rates and availability of insurance, they should understand the implications of siting and construction decisions on insurance costs and should make homeowners aware of the risk and potential expense associated with owning a house in a high-hazard area. Insurance considerations can and do affect the decisions about the placement and height of coastal buildings and the materials used in their construction. Input from an insurance industry representative during the design process, rather than after the completion of the building, can positively influence important decisions in addition to potentially saving homeowners money on insurance premiums.

Standard homeowners insurance policies cover multiple perils, including fire, lightning, hail, explosion, riot, smoke, vandalism, theft, volcanic eruption, falling objects, weight of snow, and freezing. Wind is usually (but not always) covered, and an endorsement can often be added for earthquake coverage. Homeowners insurance also includes liability coverage. A separate policy is normally required for flooding.

7.6.1 Flood Insurance

As described in Chapter 5, flood insurance is offered through the NFIP (see Section 6.2.2.1) in communities that participate in the program (e.g., incorporated cities, towns, villages; unincorporated areas of counties, parishes, and federally recognized Indian tribal governments). This flood insurance is required as a condition of receiving federally backed, regulated, or insured financial assistance for the acquisition of buildings in Special Flood Hazard Areas (SFHAs). This includes almost all mortgages secured by property in an SFHA. NFIP flood insurance is not available in communities that do not participate in the NFIP. Most coastal communities participate in the program because they recognize the risk of flood hazard events and the need for flood insurance.

The following sections summarize how coastal buildings are rated for flood insurance and how premiums are established.

7.6.1.1 Rating Factors

The insurance rate is a factor that is used to determine the amount to be charged for a certain amount of insurance coverage, called the premium. Premiums are discussed in Section 7.6.1.3. The following seven rating factors are used for flood insurance coverage for buildings (not including contents):

- Building occupancy
- Building type
- Flood insurance zone



NOTE

Standard homeowners insurance policies do not normally cover damage from flood or earth movement (e.g., earthquakes, mudslides).



NOTE

NFIP regulations define basement as any area of a building with the floor subgrade (i.e., below ground level) on all sides.

- Date of construction
- Elevation of lowest floor or bottom or the lowest horizontal structural member of the lowest floor
- Enclosures below the lowest floor
- Location of utilities and service equipment



CROSS REFERENCE

For additional information about enclosures, the use of space below elevated buildings, and flood insurance, see Chapter 5.

Building Occupancy

The NFIP bases rates for flood insurance in part on four types of building occupancy:

- Single-family
- Two- to four-family
- Other residential
- Non-residential

Only slight differences exist among the rates for the three types of residential buildings.

Building Type

The NFIP bases rates for flood insurance in part on the following building-type factors:

- Number of floors (one floor or multiple floors)
- Presence of a basement
- First floor elevation (whether the building is elevated and/or whether there is an enclosure below the lowest elevated floor)
- Manufactured home affixed to a permanent foundation

NFIP flood insurance is generally more expensive for buildings with basements and for buildings with enclosures below BFE.

Flood Insurance Zone

The NFIP bases rates for flood insurance in part on flood insurance zones. The zones are grouped as follows for rating purposes:

- **Zone V (V, VE, and V1–V30).** The zone closest to the water, subject to “coastal high hazard flooding” (i.e., flooding with wave heights greater than 3 feet). Flood insurance is most expensive in Zone V because of the severity of the hazard. However, the zone is often not very wide. Zones V1–V30 were used on FIRMs until 1986. FIRMs published since then show Zone VE.

■ **Zone A (A, AE, AR, AO, and A1–A30).**

Coastal flood hazard areas where the wave heights are less than 3 feet. Zones A1–A30 were used on FIRMs until 1986. FIRMs published since then show Zone AE.

- **Zones B, C, and X.** The zones outside the 100-year floodplain or SFHA. Flood insurance is least expensive in these zones and generally not required by mortgage lenders. Zone B and Zone C were used on FIRMs until 1986. FIRMs published since then show Zone X.

FIRMs show areas designated as being in the Coastal Barrier Resource System (CBRS) or “otherwise protected areas.” These areas (known as “CBRA zones”) are identified in the Coastal Barrier Resources Act (CBRA) and amendments. Flood insurance is available for buildings in these zones only if the buildings were walled and roofed before the CBRA designation date shown in the FIRM legend and only if the community participates in the NFIP.



NOTE

Because Zones B, C, and X designate areas outside the SFHA, construction in these zones is not subject to NFIP floodplain regulations. Homeowners in these areas, however, can purchase Preferred Risk Policies of flood insurance. The rates in these areas are significantly lower than those in Zone V and Zone A.



CROSS REFERENCE

For more information about the CBRA and CBRS, see Chapter 5.

Date of Construction

In communities participating in the NFIP, buildings constructed on or before the date of the first FIRM for that community or on or before December 31, 1974, whichever is later, have flood insurance rates that are “grandfathered” or “subsidized.” These buildings are referred to as pre-FIRM. They are charged a flat rate based on building occupancy, building type, and flood insurance zone.

The rates for buildings constructed after the date of the first FIRM (post-FIRM buildings) are based on building occupancy, building type, flood insurance zone, and two additional factors: (1) elevation of the top of the lowest floor (in Zone A) or bottom of the lowest horizontal structural member of the lowest floor (in Zone V), and (2) enclosed areas below the lowest floor in an elevated building.

If a pre-FIRM building is substantially improved (i.e., the value of the improvement exceeds 50 percent of the market value of the building before the improvement was made), it is rated as a post-FIRM building. If a pre-FIRM building is substantially damaged for any reason (i.e., the true cost of repairing the building to its pre-damaged condition exceeds 50 percent of the value of the building before it was damaged), it is also rated as a post-FIRM building regardless of the amount of repairs actually undertaken. The local building



NOTE

Flood insurance is available through the NFIP for the following types of buildings: single-family, 2- to 4-family, other residential, and non-residential buildings. Condominium policies are also available. Designers may wish to consult knowledgeable insurance agents and the *Flood Insurance Manual* (FEMA 2011) for policy details and exclusions that affect building design and use. Additional information is available in FEMA FIA-2, *Answers to Questions about the National Flood Insurance Program* (2004).

official or floodplain administrator, not the insurance agent, determines whether a building is substantially improved or substantially damaged. If a building is determined to be substantially improved or substantially damaged, the entire structure must be brought into compliance with the current FIRM requirements.

An additional insurance rate table is applied to buildings constructed in Zone V on or after October 1, 1981. The table differentiates between buildings with an obstruction below the elevated lowest floor and those without such an obstruction.

Elevation of Lowest Floor or Bottom or Lowest Horizontal Structural Member of the Lowest Floor

In Zone A, the rating for post-FIRM buildings is based on the elevation of the lowest floor in relation to the BFE. In Zone V, the rating for post-FIRM buildings is based on the elevation of the bottom of the lowest floor's lowest horizontal structural member in relation to the BFE. Flood insurance rates are lower for buildings elevated above the BFE. Rates are significantly higher for buildings rated at 1 foot or more below the BFE.

Ductwork or electrical, plumbing, or mechanical components under the lowest floor must either be designed to prevent water infiltration or elevated above the BFE. Additional elevation of the lowest floor may be required.

In Zone A, a building on a crawlspace must have openings in the crawlspace walls that allow for the unimpeded flow of floodwaters more than 1-foot deep. If the crawlspace walls do not have enough properly sized openings, the crawlspace is considered an enclosed floor, and the building may be rated as having its lowest floor at the elevation of the grade inside the crawlspace. Similarly, if furnaces and other equipment serving the building are below the BFE, the insurance agent must submit more information on the structure to the NFIP underwriting department before the policy's premium can be determined.



WARNING

Differences exist between what is permitted under floodplain management regulations and what is covered by NFIP flood insurance. Some building design considerations should be guided by floodplain management requirements and by knowledge of the design's impact on flood insurance policy premiums. Although allowable, some designs that meet NFIP requirements will result in higher premiums.

Enclosures Below the Lowest Floor

In Zone V, buildings built on or after October 31, 1981, are rated in one of three ways:

1. A building is rated as "free of obstruction" if there is no enclosure below the lowest floor other than insect screening or open wood latticework. "Open" means that at least 50 percent of the lattice construction is open.
2. A building is subject to a more expensive "with obstruction" rate if service equipment or utilities are located below the lowest floor or if breakaway walls enclose an area of less than 300 square feet below the lowest floor.
3. If the area below the lowest floor has more than 300 square feet enclosed by breakaway walls, has non-breakaway walls, or is finished, the floor of the enclosed area is the building's lowest floor and



COST CONSIDERATION

Significant financial penalties may be associated with the improper design, construction, conversion, or use of areas below the lowest floor.

the insurance agent must submit more information on the structure to the NFIP before the policy's premium can be determined.

Although the NFIP allows enclosures below the lowest floor, enclosures affect the flood insurance premiums. The addition of a floor system above the ground, but below the lowest floor of the living space, can result in additional impacts to flood insurance premiums.

7.6.1.2 Coverage

The flood insurance that is available under the NFIP is called a Standard Flood Insurance Policy (SFIP). See FEMA F-122, *National Flood Insurance Program Dwelling Form: Standard Flood Insurance Policy* (FEMA 2009a) for more information about NFIP coverage.

To be insurable under the NFIP, a building must be walled and roofed with two or more rigid exterior walls and must be more than 50 percent above grade. Examples of structures that are **not** insurable because they do not meet this definition are gazebos, pavilions, docks, campers, underground storage tanks, swimming pools, fences, retaining walls, seawalls, bulkheads, septic tanks, and tents. Buildings constructed entirely over water or seaward of mean high tide after October 1, 1982, are not eligible for flood insurance coverage. Certain parts of boathouses located partially over water (e.g., ceiling, roof over the area where boats are floated) are not eligible for coverage.

Coverage does not include contents. Contents of insurable walled and roofed buildings can be insured under separate coverage within the same policy. Finishing materials and contents in basements or in enclosures below the lowest elevated floor in post-FIRM buildings are not covered with some exceptions. Certain building components and contents in areas below the elevated floors of elevated buildings are covered. Coverage can even include some items **prohibited** by FEMA/local floodplain management regulations if the NFIP deems the items essential to the habitability of the building. ***Designers and building owners should not confuse insurability with proper design and construction. Moreover, significant financial penalties (e.g., increased flood insurance rates, increased uninsured losses) may result from improper design or use of enclosed areas below the BFE.***

With the above caveats in mind, buildings insured under the NFIP include coverage (up to specified policy limits) for the following items below the BFE:

- Minimum-code-required utility connections, electrical outlets, switches, and circuit breaker boxes
- Footings, foundation, posts, pilings, piers, or other foundation walls and anchorage system(s) as required for the support of the building
- Drywall for walls and ceilings and nonflammable insulation (in basements only)
- Stairways and staircases attached to the building that are not separated from the building by an elevated walkway



NOTE

The amount of building and contents coverage should be based on replacement value, not market value. Replacement value is the actual cost of rebuilding the building or replacing the contents. This may be higher or lower than market value.

- Elevators, dumbwaiters, and relevant equipment, except for such relevant equipment installed below the BFE on or after October 1, 1987
- Building and personal property items—necessary for the habitability of the building—connected to a power source and installed in their functioning location as long as building and personal property coverage has been purchased. Examples of building and personal property items are air conditioners, cisterns, fuel tanks, furnaces, hot water heaters, solar energy equipment, well water tanks and pumps, sump pumps, and clothes washers and dryers.
- Debris removal for debris that is generated during a flood

An SFIP does **not** provide coverage for the following building components and contents in areas below the elevated floors of elevated residential buildings:

- Breakaway walls and enclosures that do not provide support to the building
- Drywall for walls and ceilings
- Non-structural slabs beneath an elevated building
- Walks, decks, driveways, and patios outside the perimeter of the exterior walls of the building
- Underground structures and equipment, including wells, septic tanks, and septic systems
- Equipment, machinery, appliances, and fixtures not deemed necessary for the habitability of the building
- Fences, retaining walls, seawalls, and revetments
- Indoor and outdoor swimming pools
- Structures over water, including piers, docks, and boat houses
- Personal property
- Land and landscaping

7.6.1.3 Premiums

Premiums are based on the seven rating factors discussed in Section 7.6.1.1, plus the following:

- An expense constant
- A Federal policy fee
- The cost of Increased Cost of Compliance coverage
- The amount of deductible the insured chooses

If a community elects to exceed the minimum NFIP requirements, it may apply for a classification under the NFIP Community Rating System (CRS). Based on its floodplain management program, the community

could receive a CRS classification that provides up to a 45 percent premium discount for property owners within the community. At the time of this publication, nearly 1,250 communities were participating in the CRS, representing more than 69 percent of all flood insurance policies. For more information on the CRS, see Section 5.2.4.

Tables 7-2, 7-3, and 7-4 list sample NFIP premiums for a post-FIRM, one-story, single-family residence without a basement located in various flood zones. For buildings in Zone V, premiums are somewhat higher for structures with breakaway obstructions, and premiums are dramatically higher for structures with obstructions (e.g., service equipment, utilities, non-breakaway walls) below the lowest floor.

Reductions in flood insurance premiums can quickly offset the increased costs associated with building above the BFE.

For buildings in Zone A, premiums are higher when proper flood openings are not provided in enclosed areas or when service equipment or utilities are located below the BFE.

Table 7-2. Sample NFIP Flood Insurance Premiums for Buildings in Zone A; \$250,000 Building/\$100,000 Contents Coverage

Floor Elevation above BFE	Reduction in Annual Flood Premium	Annual Premium	Savings
0	0%	\$ 1,622	\$ 0
1 foot	45%	\$ 897	\$ 725
2 feet	61%	\$ 638	\$ 984
3 feet	66%	\$ 548	\$ 1,074
4 feet	67%	\$ 530	\$ 1,092

Rates as of May 2011 per the National Flood Insurance Program Flood Insurance Manual (FEMA 2011) for a Zone V structure free of obstruction. Rates include building (\$250,000), contents (\$100,000), and associated fees, including increased cost of compliance.

Table 7-3. Sample NFIP Flood Insurance Premiums for Buildings in Zone V Free of Obstruction Below the Lowest Floor; \$250,000 Building/\$100,000 Contents Coverage

Floor Elevation above BFE	Reduction in Annual Flood Premium	Annual Premium	Savings
0	0%	\$ 7,821	\$ 0
1 foot	33%	\$ 5,256	\$ 2,565
2 feet	55%	\$ 3,511	\$ 4,310
3 feet	65%	\$ 2,764	\$ 5,057
4 feet	71%	\$ 2,286	\$ 5,535

Rates as of May 2011 per the National Flood Insurance Program Flood Insurance Manual (FEMA 2011) for a Zone V structure free of obstruction. Rates include building (\$250,000), contents (\$100,000), and associated fees, including increased cost of compliance; premium to be determined by NFIP underwriting.

Table 7-4. Sample NFIP Flood Insurance Premiums for Buildings in Zone V with Obstruction Below the Lowest Floor; \$250,000 Building/\$100,000 Contents Coverage

Floor Elevation above BFE	Reduction in Annual Flood Premium	Annual Premium	Savings
0	0%	\$ 10,071	\$ 0
1 foot	22%	\$ 7,901	\$ 2,170
2 feet	40%	\$ 6,056	\$ 4,015
3 feet	50%	\$ 5,076	\$ 4,995
4 feet	54%	\$ 4,591	\$ 5,480

Rates as of May 2011 per the National Flood Insurance Program Flood Insurance Manual (FEMA 2011) for a Zone V structure free of obstruction. Rates include building (\$250,000), contents (\$100,000), and associated fees, including increased cost of compliance; premium to be determined by NFIP underwriting.

7.6.1.4 Designing to Achieve Lower Flood Insurance Premiums

Tables 7-2, 7-3, and 7-4 demonstrate that considerable savings can be achieved on flood insurance premiums by elevating a building above the BFE and by constructing it to be free of obstruction. Other siting, design and construction decisions can also lower premiums. Designers should refer to FEMA's V Zone Risk Factor Rating Form to estimate flood insurance premium discounts and as a planning tool to use with building owners. The form is in Chapter 5 of the Flood Insurance Manual (FEMA 2011), available at <http://www.fema.gov/business/nfip/manual.shtm>. Discount points, which translate into reduced premiums, are awarded for:

- Lowest floor elevation
- Siting and environmental considerations
- Building support systems and design details
- Obstruction-free and enclosure construction considerations

In addition to lowest floor elevation and free-of-obstruction discounts illustrated in Tables 7-2 and 7-3, flood insurance premium discounts also can be obtained for:

- Distance from shoreline to building
- Presence of large dune seaward of the building
- Presence of certified erosion control device or ongoing beach nourishment project
- Foundation design based on eroded grade elevation and local scour
- Foundation design based on this Manual and ASCE 7-10 loads and load combinations
- Minimizing foundation bracing

- Spacing of piles/columns/piers
- Size and depth of piles and pier footings
- Superior connections between piles/columns/piers and girders

Some poor practices reduce discount points. Negative discount points, which result in higher flood insurance premiums, are given for:

- Shallow pile embedment
- Certain methods of pile installation
- Small-diameter piles or columns
- Non-bolted connections between piles/columns/piers and girders
- Over-notching of wood piles
- Small pier footings
- Presence of elevators, equipment, ductwork and obstructions below the BFE
- Presence of solid breakaway walls
- Presence of finished breakaway walls

Table 10 (V Zone Risk Relativities) in the *Flood Insurance Manual* (FEMA 2011) provides an indication of how building discount points translate into flood premium discounts. Designers and owners should review this table and consult with a knowledgeable flood insurance agent regarding the flood insurance premium implications of using or avoiding certain design construction practices

7.6.2 Wind Insurance

Wind insurance coverage is generally part of a homeowners insurance policy. At the time this Manual was published, underwriting associations (or “pools”) provided last resort insurance to homeowners in coastal areas who could not obtain coverage from private companies. The following seven states had beach and windstorm insurance plans at the time this Manual was released: Alabama, Florida, Louisiana, Mississippi, North Carolina, South Carolina, and Texas. Georgia and New York provide this kind of coverage for windstorm and hail in certain coastal communities through other property pools. In addition, New Jersey operates the Windstorm Market Assistance Program (Wind-MAP) to help residents in coastal communities find homeowners insurance on the voluntary market. When Wind-MAP does not identify an insurance carrier for a homeowner, the New Jersey Insurance Underwriting Association, known as the FAIR Plan, may provide a policy for windstorm, hail, fire, and other perils but does not cover liability.

Many insurance companies encourage their policyholders to retrofit their homes to resist wind-related damage, and some companies have established discount programs to reduce premiums, and other types of financial incentives, to reflect the risk reduction for homes that have been properly retrofitted. Some State insurance departments also have put in place insurance discount programs for properly retrofitted homes. The IBHS FORTIFIED *for Existing Homes* Program has been designed with the support of IBHS

member insurance companies, although each individual company makes its own decisions about how it is implemented.

Wind is only one part of the rating system for multi-peril insurance policies such as a homeowners insurance policy. Most companies rely on the Homeowner's Multistate General Rules and State-specific exceptions Manual of the Insurance Services Office (ISO) as the benchmark for developing their own manuals. ISO stresses that the rules in the manual are advisory only and that each company decides what to use and charge. The ISO publishes a homeowner's manual in every state except Hawaii, North Carolina, and Washington (where State-mandated insurance bureaus operate).

The seven basic factors in rating a homeowners insurance policy are:

- Form (determines type of coverage)
- Age of the structure
- Territory
- Fire protection class
- Building code effectiveness
- Construction type
- Protective devices

The last five factors are discussed below. Premiums can also vary because of factors such as amount of coverage and deductible, but these additional factors are not related to building construction. Some companies, however, adjust their higher optional deductible credit according to construction type, giving more credit to more fire-resistant concrete and masonry buildings.

7.6.2.1 Territory

Wind coverage credit varies by territory. An entire state may be one territory, but some states, such as Florida, are divided into county and sub-county territories. In Florida, the Intracoastal Waterway is often used as the boundary line.

7.6.2.2 Fire Protection Class

ISO publishes a public protection classification for each municipality or fire district based on an analysis of the local fire department, water system, and fire alarm system. This classification does not affect wind coverage but is an important part of the rate.

7.6.2.3 Building Code Effectiveness Grading Schedule

The adoption and enforcement of building codes by local jurisdictions are routinely assessed through the Building Code Effectiveness Grading Schedule (BCEGS) program, developed by the ISO. Participation in BCEGS is voluntary and may be declined by local governments if they do not wish to have their local

building codes evaluated. The results of BCEGS assessments are routinely provided to ISO's member private insurance companies, which in turn may offer rating credits for new buildings constructed in communities with strong BCEGS classifications. Conceptually, communities with well-enforced, up-to-date codes should experience fewer disaster-related losses and as a result, should have lower insurance rates.

In conducting the assessment, ISO collects information related to personnel qualification and continuing education, as well as number of inspections performed per day. This type of information combined with local building codes is used to determine a grade for the jurisdiction. The grades range from 1 to 10, with a BCEGS grade of 1 representing exemplary commitment to building code enforcement, and a grade of 10 indicating less than minimum recognized protection. Most participating communities fall in the 3 to 5 grade range.

7.6.2.4 Construction Type

To simplify insurance underwriting procedures, buildings are identified as being in only one of four categories:

- **Frame:** exterior walls of wood or other combustible construction, including stucco and aluminum siding
- **Masonry veneer:** exterior walls of combustible material, veneered with brick or stone
- **Masonry:** exterior walls of masonry materials; floor and roof of combustible materials
- **Superior:** non-combustible, masonry non-combustible, or fire resistive

Masonry veneer and masonry are often difficult to differentiate and are therefore often given the same rating.

Not many single-family homes qualify for the superior category, which results in a 15 percent credit off rates for the masonry categories. A home in the superior category may also qualify for a wind credit because some insurers believe that buildings with walls, floors, and roofs made of concrete products offer good resistance to windstorms and Category 1 hurricanes. Therefore, a fire-resistive home may get a wind-resistive credit.

ISO's dwelling insurance program allows companies to collect data from the owner, the local building department, or their own inspectors to determine whether a house can be classified as wind-resistive or semi-wind-resistive for premium credit purposes.

7.6.2.5 Protective Devices

Protective devices are not considered basic factors but items that may deserve some credits. This approach is more common for fire and theft coverage than for wind. Fire and theft coverage credits sprinklers and fire and/or burglar alarms tied to the local fire or police stations. ISO's rules do not address wind-protective devices except in Florida. In Florida, a premium credit is given if exterior walls and roof openings (not including roof ridge and soffit vents) are fully protected with storm shutters of any style and material that are designed and properly installed to meet the latest ASCE 7-10 engineering standard. This standard has been adopted by Dade County. Shutters must be able to withstand impact from wind-borne debris in accordance

with the standards set by the municipality, or if there are no local standards, by Dade County. The rules also provide specifications for alternatives to storm shutters, such as windstorm protective glazing material.

7.6.3 Earthquake Insurance

Earthquake insurance is an addition to a regular homeowners insurance policy. Earthquake insurance carries a very high deductible—usually 10 or 15 percent of the value of the house. In most states, ISO has developed advisory earthquake loss costs based on a seismic model used to estimate potential damage to individual properties in the event of an earthquake. The model is based on seismic data, soil types, damage information from previous earthquakes, and structural analysis of various types of buildings. Based on this model, postal Zip codes have been assigned to rating bands and loss costs developed for each band. The number of bands varies within each state and, at times, within a county.

In California, the California Earthquake Authority (CEA), a State-chartered insurance company, writes most earthquake policies for homeowners. These policies cover the dwelling and its contents and are subject to a 15-percent deductible. CEA rates are also based on a seismic model used to estimate potential damage to individual properties in the event of an earthquake.

7.7 Sustainable Design Considerations

Sustainability concepts are increasingly being incorporated into residential building design and construction. The voluntary green building rating systems of the past decade are being replaced with adoption by local and State jurisdictions of mandatory minimum levels of compliance with rating systems such as the U.S. Green Building Council *LEED for Homes Reference Guide* (USGBC 2009) or consensus-based standards such as ICC 700-2008. These programs and standards use a system in which credits are accumulated as points assigned to favorable green building attributes pertaining to lot design, resource efficiency, energy efficiency, water efficiency, and indoor environmental quality.

Although green building programs are implemented as above-minimum building code practices, many aspects of green construction and its impact on structural performance and durability are not readily apparent upon initial consideration. Green building programs such as National Association of Home Builders (NAHB) Green, EarthAdvantage, and other State and local programs may incorporate LEED for Homes, ICC 700-2008, EnergyStar and other rating systems or product certifications as part of their offerings. For example, a homeowner may decide to add a rooftop solar panel system after the home is built. Depending on its configuration, this system could act as a “sail” in high winds, adding significant uplift loads to the roof and possibly triggering localized structural failure. To maintain expected structural performance in a high-wind event, these additional loads not only must be accommodated by the roof framing, but the complete load path for these additional loads must be traced and connections or framing enhanced as needed.

Examples of other green attributes that may require additional design consideration for resistance to natural hazards are large roof overhangs for shading (due to the potential for increased wind loads), vegetative green roofs (due to the presence of added weight and moisture to sustain the roof), and optimized or advanced framing systems that reduce overall material usage and construction waste (due to larger spacing between framing members and smaller header and framing member sizes).

It is important to verify that the design wind speed for an area is not in excess of the recommended maximum wind speeds for these systems. Building for resilience should not work against other green practices by unreasonably increasing the material resources needed to construct the building. However, buildings constructed to survive natural hazards reduce the need to be rebuilt and thus provide a more sustainable design approach.

When new green building attributes introduce new technology or new building materials into the building design, new interactions may affect the building's structural integrity and durability. Examples of interactions between green building attributes and resistance to natural hazards (e.g., resilience of the building) are described in FEMA P-798, *Natural Hazard Sustainability of Residential Construction* (FEMA 2010c). When implementing green attributes into a design, the designer should consider that building for resilience is possibly the most important green building practice. A green building fails to provide benefits associated with green building practices if it is more susceptible to heavy damage from natural hazard events that result in lost building function and increased cost of repair.

7.8 Inspection Considerations

After the completion of building permits and construction plans, good inspection and enforcement procedures are crucial. For coastal construction, building inspectors, code officers, designers, and floodplain managers must understand the flood-resistant design and construction requirements for which they need to check. The earlier a deviation is found, the easier it is to take corrective action working with the homeowner and builder.

A plan review and inspection checklist tailored to flood-related requirements should be used. Some of the inspections that can be performed to meet compliance directives with the local community's flood-resistant provisions are listed below. For a community that does not have a DFE, a BFE is applicable.

- Stake-out or site inspection to verify the location of a building; distances from the flood source or body of water can also be checked
- Fill inspection to check compaction and final elevation when fills are allowed in SFHAs
- Footing or foundation inspection to check for flood-opening specifics for closed foundations, lowest floor inspection for slab-on-grade buildings, and embedment depth and pile plumbness for pile-supported structures
- Lowest floor inspection (floodplain inspection) per Section 109.3.3 of 2012 IBC and Section R109.1.3 of 2012 IRC. This is also a good time to verify that the mechanical and electrical utilities are above the BFE or DFE for additional protection.
- Final inspection points for flood-prone buildings can include:
 - Enclosures below elevated buildings for placement of flood vents and construction of breakaway walls, where applicable
 - Use of enclosures for consistency with the use in the permit
 - Placement of exterior fill, where permitted, according to plans and specifications

- Materials below the DFE for flood-resistance; see NFIP Technical Bulletin 2, *Flood Damage-Resistant Materials Requirements* (FEMA 2008)
- Building utilities to determine whether they have been elevated or, when instructions are provided, installed to resist flood damage
- Existence of as-built documentation of elevations
- If a plan review and inspection checklist have been used, verification that have been signed off and placed in the permit file with all other inspection documentation

More information regarding inspections is available in FEMA P-762, *Local Officials Guide for Coastal Construction* (FEMA 2009b).

7.9 References

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