



6 Fundamentals of Risk Analysis and Risk Reduction

A successful building design incorporates elements of risk assessment, risk reduction, and risk management. Building success as defined in Chapter 1 can be met through various methods, but they all have one thing in common: careful consideration of natural hazards and use of siting, design, construction, and maintenance practices to reduce damage to the building. Designing in areas subject to coastal hazards requires an increased standard of care. Designers must also be knowledgeable about loading requirements in coastal hazard areas and appropriate ways to handle those loads. Failure to address even one of these concerns can lead to building damage, destruction, or loss of use. Designers should remember that the lack of building damage during a high-probability (low-intensity) wind, flood, or other event cannot be construed as a building success—success can only be measured against a design event or a series of lesser events with the cumulative effect of a design event.

A critical component of successful building construction in coastal environments is accurately assessing the *risk* from natural hazards and then reducing that risk as much as possible. Accurate risk assessment and risk reduction are directly tied to correctly identifying natural hazards relevant to the building site. Before beginning the design process, it is important to understand and identify the natural hazard risks associated with a particular site, determine the desired level of protection from those hazards, and determine how best to manage *residual risk*. Design professionals must communicate these concepts to building owners so



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>).

they can determine if the level of residual risk is acceptable or whether it would be cost-beneficial to further increase the hazard resistance of the building, and thereby reduce the residual risk. Once the desired level of protection and the residual risk have been evaluated by the designer and the owner, the information in Volume II can be used to incorporate appropriate forces and loads into a successful hazard-resistant design.



TERMINOLOGY

RISK:

Potential losses associated with a hazard, defined in terms of expected probability and frequency, exposure, and consequences.

RESIDUAL RISK:

The level of risk that is not offset by hazard-resistant design or insurance, and that must be accepted by the property owner.

6.1 Assessing Risk

A hazard-resistant building design begins with a proper risk assessment. Building success can only be achieved by successfully identifying and managing natural hazard risks. Designing a successful building requires an understanding of the magnitude of the hazards and how frequently the building may be subjected to these hazards. This information is used to assess the potential exposure of the building to these hazards, i.e., the risk to the building. For the purposes of this Manual, *risk assessment* is the process of quantifying the total risk to a coastal building from all significant natural hazards that may impact the building.

Designers should be well informed with current hazard and risk information and understand how risk affects their design decisions and the requirements of the client. Designers should:

- Obtain the most up-to-date published hazard data to assess the vulnerability of a site, following the steps outlined in Section 4.3.
- Conduct or update a detailed risk assessment if there is reason to believe that physical site conditions have changed significantly since the hazard data were published or published hazard data is not representative of a site.
- Review or revise an existing risk assessment if there is reason to believe that physical site conditions will change significantly over the expected life of a structure or development of the site (see Section 3.7).
- After a risk assessment is completed, the designer should review siting and design options that will mitigate the effects of the identified hazards. The building owner may not find the amount of damage or loss of function acceptable, and the designer should work with the building owner to mitigate the risk to an acceptable level.

6.1.1 Identifying Hazards for Design Criteria

Coastal areas are subject to many hazards, including distinct events such as hurricanes, coastal storms, earthquakes, and earthquake-induced landslides and tsunamis. Coastal hazards also include continuous, less obvious coastal phenomena, such as long-term erosion, shoreline migration, and the corrosion and decay of building materials. The effects of hazards associated with distinct events are often immediate, severe,



CROSS REFERENCE

Chapter 7 presents an introduction to Volume II and a summary of the insurance and financial implications of design decisions.

and easily visible, while those associated with slow-onset, long-term processes are more likely to become apparent only over time. Manmade structures such as bulkheads, dams, dikes, groins, jetties, levees, and seawalls may also be present in coastal areas and the effects of these structures on nearby buildings must be considered.

The designer must determine which specific hazards will affect a particular site and the vulnerability of the site to the identified natural hazards. Not all sites have the same hurricane exposure, erosion exposure, or seismic risk. The exposure of the building to these natural hazards should be evaluated and incorporated into the design criteria. The designer must first focus on code compliance. By following code provisions and NFIP regulations for flood, wind, and seismic design, the immediately understood and quantified hazards are mitigated to a certain degree. To fully understand the risk at a particular site, the designer should then study the risk associated with an above-design-level event. Finally, the designer should consider mitigation solutions to long-term issues such as erosion, subsidence, and sea level rise.

The designer should also address the possibility of unlikely events such as a levee failure (when appropriate). While such events may seem very unlikely or improbable to the owner, it is important that designers review flood maps, flood studies, and historical events to understand the risks to the building and how to best manage them.

Additionally, cumulative effects of multiple hazards should be considered. For example, hurricane-induced wind and flooding impacts may be exacerbated by sea level rise or subsidence. Designing buildings to resist these forces may present numerous challenges and therefore, these issues should be carefully evaluated.

6.1.2 Probability of Hazard Occurrence and Potential Consequences

Understanding the probabilities and the consequences of building damage or failure will help designers determine the level of natural hazard resistance they seek in the building design and better quantify the risk. Flood, wind, and seismic events have been studied and modeled with varying degrees of accuracy for centuries. Careful study of each of these hazards has resulted in a notable historical record of both the frequency and intensity of those events. The historic frequency of events with different intensities allows mathematical analysis of the events and the development of probabilities of future events. The probability of future events occurring can be used to predict the potential consequences of building design choices.

For instance, understanding the probability that a site will experience a specific wind speed allows a designer to carefully design the building for that wind speed and understand the wind risk to that building. The designer can also consult with the owner on the level of wind protection incorporated into the building design and help them determine how to manage the residual risk. Residual risk will be present because storm events that result in greater-than-design wind speeds can occur. Based on the owner's level of acceptance to risk, the owner may then decide to seek a higher level of building performance or purchase insurance to reduce the residual risk.

Designers must determine the probability of occurrence of each type of hazard event over the life of the structure and evaluate how often it might occur. The frequency of the occurrence of a natural hazard is



CROSS REFERENCE

For information on identifying coastal hazards, refer to Chapter 3.

For siting considerations, refer to Chapter 4.

For discussion of codes and standards, refer to Chapter 5.

referred to in most design codes and standards as the *recurrence interval*. The probability of the occurrence of severe events should be evaluated over the life of the structure, and the consequences of their occurrence should be addressed in the design. While more frequent and less severe events may not have the same drastic consequences as less frequent but more severe events, they should still be identified and assessed in the risk assessment. In contrast, some events may be so severe and infrequent that it is likely not cost-effective to design the building to withstand them.

In most coastal areas of the United States, buildings must meet minimum regulatory and code requirements intended to provide protection from natural hazard events of specified magnitudes. These events are usually identified according to their recurrence intervals. For instance, the base flood used by the NFIP is associated with a recurrence interval of 100 years, the basic wind speed for Risk Category II structures in ASCE 7-10 is associated with a recurrence interval of 700 years, and the return interval for earthquake design is 2,500 years.

After identifying the recurrence interval of a natural hazard event or design event (through codes, standards, or other design criteria) the designer can determine the probability of one or more occurrences of that event or a larger event during a specified period, such as the expected lifespan of the building.

Table 6-1 illustrates the probability of occurrence for natural hazard events with recurrence intervals of 10, 25, 50, 100, 500, and 700 years. Of particular interest in this example is the event with a 100-year recurrence interval because it serves as the basis for the floodplain management and insurance requirements of the NFIP regulations, and floodplain regulations enforced by local governments. The event with a 100-year recurrence interval has a 1 percent probability of being equaled or exceeded over the course of 1 year (referred to as the 1-percent-annual-chance flood event). As the period increases, so does the probability that an event of this magnitude or greater will occur. For example, if a house is built to the 1-percent-annual-chance flood level (often referred to as the 100-year flood level), the house has a 26 percent chance of being flooded during a 30-year period, equivalent to the length of a standard mortgage (refer to the bolded cells in Table 6-1). Over a 70-year period, which may be assumed to be the useful life of many buildings, the home has a 51 percent chance of being flooded (refer to the bolded cells in Table 6-1). The same principle applies to other natural hazard events with other recurrence intervals.



WARNING

Designers of structures along Great Lakes shorelines, if they are using Table 6-1 to evaluate flood probabilities, should be aware that the table may underestimate actual probabilities during periods of high lake levels. For example, Potter (1992) calculated that during rising lake levels in 1985, Lake Erie had a 10 percent probability of experiencing a 100-year flood event in the next 12 months (versus 1 percent as shown in Table 6-1).

Table 6-1. Probability of Natural Hazard Event Occurrence for Various Periods of Time

Length of Period (Years)	Frequency – Recurrence Interval					
	10-Year	25-Year	50-Year	100-Year	500-Year	700-Year
1	10%	4%	2%	1%	0.2%	0.1%
10	65%	34%	18%	10%	2%	1%
20	88%	56%	33%	18%	4%	3%
25	93%	64%	40%	22%	5%	4%
30	96%	71%	45%	26%	6%	4%
50	99+%	87%	64%	39%	10%	7%
70	99.94+%	94%	76%	51%	13%	10%
100	99.99+%	98%	87%	63%	18%	13%

The percentages shown represent the probabilities of one or more occurrences of an event of a given magnitude or larger within the specified period. The formula for determining these probabilities is $P_n = 1 - (1 - P_a)^n$, where P_a = the annual probability and n = the length of the period.

The bold blue text in the table reflects the numbers used in the example in this section.

6.2 Reducing Risk

Once the risk has been assessed, the next step is to decide how to best mitigate the identified hazards. The probability of a hazard event occurrence is used to evaluate risk reduction strategies and determine the level of performance to incorporate into the design. The chance of severe flooding, high-wind events, or a severe earthquake can dramatically affect the design methodology, placement of the building on the site, and materials selected. Additionally, the risk assessment and risk reduction strategy must account for the short- and long-term effects of each hazard, including the potential for cumulative effects and the combination of effects from different hazards. Overlooking a hazard or underestimating its long-term effects can have disastrous consequences for the building and its owner.



WARNING

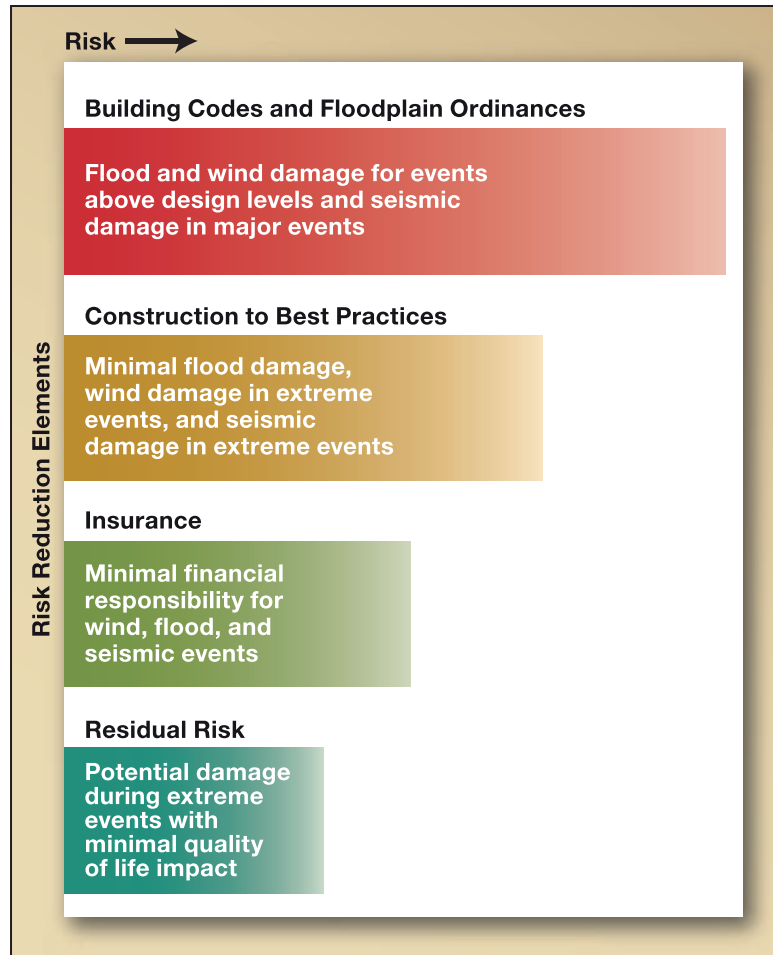
Meeting minimum regulatory and code requirements for the siting, design, and construction of a building does not guarantee that the building will be safe from all hazard effects. Risk to the building still exists. It is up to the designer and building owner to determine the amount of acceptable risk to the building.

Although designers have no control over the hazard forces, the siting, design, construction, and maintenance of the building are largely within the control of the designer and owner. The consequences of inadequately addressing these design items are the impetus behind the development of this Manual. **Risk reduction** is comprised of two aspects: *physical risk reduction* and *risk management through insurance*.

Eliminating all risk is impossible. Risk reduction, therefore, also includes determining the **acceptable level of residual risk**. Managing risk, including identifying acceptable levels of residual risk, underlies the entire coastal construction process. The initial, unmitigated risk is reduced through a combination

of floodplain ordinances, building codes, best practices construction, and insurance. Each risk reduction element decreases the residual risk; the more elements that are applied, the smaller the remaining residual risk. Figure 6-1 shows the general level of risk reduction after each risk reduction element is applied.

Figure 6-1. Initial risk is reduced to residual risk through physical and financial risk reduction elements



6.2.1 Reducing Risk through Design and Construction

Building codes and Federal, State, and local regulations establish minimum requirements for siting, design, and construction. Among these are requirements that buildings be constructed to withstand the effects of natural hazards with specified recurrence intervals (e.g., 100-year for flood, 700-year for wind, 2,500-year for earthquake). Therefore, when building codes and regulatory requirements are met, they can help reduce the vulnerability of a building to natural hazards and, in a sense, provide a baseline level of risk reduction. However, *meeting minimum regulatory and code requirements leaves a certain level of residual risk* that can and should be reduced through design and construction of the best practices described in this Manual.



CROSS REFERENCE

Chapter 5 presents information on building codes and standards for coastal construction.

Design decisions including elevation, placement and orientation of the building on the site, size and shape of the building, and the materials and methods used in its construction all affect a building's vulnerability to natural hazard events. However, these decisions can also affect initial and long-term costs (see Section 7.5), aesthetic qualities (e.g., the appearance of the finished building, views from within), and convenience for the homeowner (e.g., accessibility). The tradeoffs among these factors involve objective and subjective considerations that are often difficult to quantify and likely to be assessed differently by developers, builders, homeowners, and community officials. The cost of siting and design decisions must be balanced with the amount of protection from natural hazards provided.

6.2.1.1 Factors of Safety and Designing for Events that Exceed Design Minimums

Codes and standards require minimum levels of protection from natural hazards, including a minimum factor of safety. Factors of safety are designed to account for unknowns in the prediction of natural hazards and variability in the construction process and construction materials. Since the designer may have limited control over these factors it is important that they not only embrace the minimum factors of safety, but determine whether a *higher factor of safety* should be incorporated into the design to improve the hazard resistance of buildings. Such decisions can often result in other benefits besides increased risk reduction such as potential reduced insurance premiums and improved energy efficiency (see Chapter 7). The designer should also evaluate what the consequences would be to the building if the minimum design conditions were exceeded by a natural hazard event.

When beginning the design process, it is important to determine the building's *risk category* as defined in ASCE 7-10 and the 2012 IBC. A building's risk category is based on the risk to human life, health, and welfare associated with potential damage or failure of the building. The factors of safety incorporated into the design criteria increase as the risk category increases. These risk categories dictate which design event is used when calculating performance expectations of the building, specifically the loads the building is expected to resist. The risk categories from ASCE 7-10 are summarized as:

- **Category I.** Buildings and structures that are normally unoccupied, such as barns and storage sheds, and would likely result in minimal risk to the public in the event of failure.
- **Category II.** All buildings and structures that are not classified by the other categories. This includes a majority of residential, commercial, and industrial buildings.
- **Category III.** Buildings and structures that house a large number of people in one place, and buildings with occupants having limited ability to escape in the event of failure. Such buildings include theaters, elementary schools, and prisons. This category also includes structures associated with utilities and storage of hazardous materials.
- **Category IV.** Buildings and structures designated as essential facilities, such as hospitals and fire stations. This category also includes structures associated with storage of hazardous materials considered



NOTE

ASCE 7-10 and the 2012 IBC introduced the term *risk categories*. Risk categories are called "occupancy categories" in previous editions. The broad categories in ASCE 7-10 are intended to represent the specific listings in the 2012 IBC. The descriptions provided in this Manual are broad, and both ASCE 7-10 and the 2012 IBC should be consulted to determine risk category.

a danger to the public and buildings associated with utilities required to maintain the use of other buildings in this category.

Performance expectations for buildings vary widely depending on the type of hazard being resisted. Selection of the design event in the I-Codes is determined by the hazard type, the risk category of building, and the type of building damage expected. Selecting a higher risk category for most residential buildings should result in a higher final design wind pressure for design and should improve building performance in high-wind events. It can also result in additional freeboard in Zone V and Coastal A Zone if using ASCE 24 in flood design.

For **flood hazard design**, the building is divided into two distinct parts: the foundation and the main structure. For the foundation, standard methods of design target an essentially elastic response of the foundation for the design event such that little or no structural damage is expected. The main structure is designed to be constructed above the DFE to eliminate the need for designing it to resist flood loads. If flooding occurs at an elevation higher than the DFE, flood loads can be significant where flood waters impact solid walls (as opposed to open foundation elements). Additionally, a water level only a few inches above the minimum floor elevation can result in damage to walls and floors, and the loss of floor insulation, wiring, and ductwork. The IRC incorporates freeboard for houses in Zone V and Coastal A Zone, and the IBC incorporates freeboard for buildings by virtue of using ASCE 24. Including freeboard in the building design provides a safety factor against damage to the main structure and its contents caused by flood elevations in excess of the design flood. While **codes and standards set minimum freeboard requirements**, a risk assessment may indicate the merits of incorporating additional freeboard above the minimum requirements (see Sections 6.2.1.3 and 6.3).



NOTE

Designing to only minimum code and regulatory requirements may result in designs based on different levels of risk for different hazards. The importance of each hazard level addressed by such requirements, and whether an acceptable level of residual risk remains, should therefore be carefully considered during the design process.

For **wind hazard design**, standard methods of design also target an essentially elastic response of the building structure for the design event (i.e., 700-year wind speed, 3-second gust per ASCE 7-10) such that little or no structural damage is expected. For wind speeds in excess of the design event, wind pressures increase predictably with wind velocity, and factors of safety associated with material resistances provide a margin against structural failure.

For **seismic hazard design**, life safety of the occupants is the primary focus rather than preventing any damage to the building. All portions of the building should be designed to resist the earthquake loads. Buildings are designed using the Maximum Considered Earthquake (i.e., 1 percent in 50 years) and include factors such as ground motion and peak ground acceleration. Adjustment factors are applied to design criteria based on the risk category for the building.

For **erosion hazard design** for bluff-top buildings, the ratio of soil strength to soil stresses is commonly used as the safety factor by geotechnical engineers when determining the risk of



NOTE

In the past, little thought was given to mitigation. Homeowners relied on insurance for replacement costs when a natural hazard event occurred, without regard to the inconvenience and disruption of their daily lives. Taking a mitigation approach can reduce these disruptions and inconveniences.

slope failures. The choice of a safety factor depends on the type and importance of bluff-top development, the bluff height, the nature of the potential bluff failure (e.g., deep rotational failure versus translational failure), and the acceptable level of risk associated with a bluff failure. Studies in the Great Lakes provide guidance for the selection of appropriate geotechnical safety factors (Valejo and Edil 1979, Chapman et al. 1996, and Terraprobe 1994).

6.2.1.2 Designing above Minimum Requirements and Preparing for Events That Exceed Design Events

In addition to incorporating factors of safety into design, homeowners, developers, and builders can make siting and design decisions that further manage risks by increasing the level of hazard resistance for the building. For example, hazard resistance can be improved by the following measures:

- A building can be sited further landward than the minimum distance specified by State or local setback requirements
- A building can be elevated above the level required by NFIP, State, and local requirements (refer to Section 6.2.1.3 for example)
- Supporting piles can be embedded deeper than required by State or local regulations
- Structural members and connections that exceed code requirements for gravity, uplift, and/or lateral forces can be used
- Improved roofing systems that provide greater resistance to wind than that required by code can be used
- Roof shapes (e.g., hip roofs) that reduce wind loads can be selected
- Openings (e.g., windows, doors) can be protected with permanent or temporary shutters or covers, whether or not such protection is required by code
- Enclosures below an elevated building can be eliminated or minimized



NOTE

While some coastal construction techniques have the combined effect of improving hazard resistance and energy efficiency, some design decisions make these considerations incompatible (see FEMA P-798, *Natural Hazards and Sustainability for Residential Buildings* [FEMA 2010]). Designers should discuss the implications and overall financial impacts of design decisions with homeowners so they can make an informed decision. The combination of insurance, maintenance, energy costs, and flood and wind resistance requires careful consideration and an understanding of the tradeoffs.

Incorporating above-code design can result in many benefits, such as reduced insurance premiums, reduced building maintenance, and potentially improved energy efficiency. These design decisions can sometimes offset the increased cost of constructing above the code minimums.

6.2.1.3 Role of Freeboard in Coastal Construction

The IRC and IBC (through ASCE 24) incorporate a minimum amount of freeboard. Including freeboard beyond that required by the NFIP and the building code should be seriously considered when designing for a homeowner with flooding risks. As of 2009, the IRC requires 1 foot of freeboard in Zone V and Coastal A

Zone. In most locations, designing for at least the freeboard requirements in ASCE 24, which requires more freeboard than the IRC in many cases, may establish the level of care expected of a design professional. Freeboard that exceeds the minimum NFIP requirements can be a valuable tool in maintaining NFIP compliance and lessening potential flood damage.

Some benefits of incorporating freeboard are:

- Allows lower flood insurance premiums
- Provides additional protection for floods exceeding the BFE
- Provides some contingency if future updates to FIRMs raise the BFE
- Helps account for changes within the SFHA that are not represented in the current FIRM or FIS
- Provides some contingency for surveying benchmarks that may have moved
- Provides some contingency for errors in the lowest floor elevation during construction without compromising the elevation above the BFE
- Provides some contingency for changes in water levels due to sea level change or subsidence



CROSS REFERENCE

Section 7.5.2 includes a discussion of freeboard, BFE, and DFE.

Even if a freeboard policy is not in force by the State or local jurisdiction, constructing a building to an elevation greater than the BFE reduces the homeowner's flood insurance premium. A FEMA report titled *Evaluation of the National Flood Insurance Program's Building Standards* (American Institutes for Research 2006) evaluates the benefits of freeboard. The report finds that freeboard is a cost-effective method for reducing risk in many instances and provides some guidance on the comparison of the percent increase in cost of construction with the reduced risk of flooding. Additionally, it evaluates the cost of construction for implementing freeboard and compares it to the flood insurance premium savings. A reevaluation of this study in December of 2009 validated that freeboard is still a cost-effective option in many coastal areas.

6.2.2 Managing Residual Risk through Insurance

Once all of the regulatory and physical risk reduction methods are incorporated into a building design, there will still be a level of residual risk to the building that must be assumed by homeowners. One way to minimize the financial exposure to the residual risk is through insurance. Insurance can be divided into a number of categories based on the type of hazard, and whether the insurance is private or purchased through a pool of other policy holders on a State or Federal level. While it is not the role of the designer to discuss insurance policies with an owner, it is important to understand the types of insurance available to an owner and the effect of building design decisions on various insurance programs. The following sections summarize of the types of hazard insurance and discuss how some design decisions can affect insurance premiums.

6.2.2.1 Types of Hazard Insurance

For houses in coastal areas, residual risks associated with flooding, high winds, and in some areas, earthquakes, are of particular concern. The financial risks can be mitigated through a variety of insurance mechanisms, including the NFIP, homeowners wind or earthquake insurance, insurance pools, and self-insurance plans.

National Flood Insurance Program

Federally backed flood insurance is available for both existing and new construction in communities that participate in the NFIP. To be insurable under the NFIP, a building must have a roof, have at least two walls, and be at least 50 percent above grade. Like homeowners insurance, flood insurance is obtained from private insurance companies. Flood insurance, because it is federally backed, is available for buildings in all coastal areas of participating communities, regardless of how high the flood hazard is. The following exceptions apply:

- Buildings constructed after October 1, 1982, that are entirely over water or seaward of mean high tide
- New construction, substantially improved, or substantially damaged buildings constructed after October 1, 1983, that are located on designated undeveloped coastal barriers included in the CBRS (see Section 5.1.1 of this Manual)
- Portions of boat houses located partially over water (e.g., the ceiling and roof over the area where boats are moored)

The flood insurance rates for buildings in NFIP-participating communities vary according to the physical characteristics of the buildings, the date the buildings were constructed, and the magnitude of the flood hazard at the site of the buildings. The flood insurance premium for a building is based on the rate, standard per-policy fees, the amount of the deductible, applicable NFIP surcharges and discounts, and the amount of coverage obtained.

Wind Insurance

Homeowners insurance policies normally include coverage for wind. However, insurance companies that issue homeowner policies occasionally deny wind coverage to buildings in areas where the risks from these hazards are high, especially in coastal areas subject to a significant hurricane or typhoon risk. At the time of publication of this Manual, underwriting associations,



WARNING

Purchasing insurance is not a substitute for a properly designed and constructed building. Insurance is a way of reducing financial exposure to residual risk.



CROSS REFERENCE

For more information on hazard insurance, see Section 7.6.



COST CONSIDERATION

The NFIP places a cap on the amount of coverage for the building and its contents, which may not cover the entire cost of high value properties. Additional flood insurance will be required to insure losses above this limit.



NOTE

The Florida Division of Emergency Management has an online insurance savings calculator that estimates wind insurance savings for wind mitigation design in new construction and retrofits. The calculator is available at <http://floridadisaster.org/mitdb>.

or “pools,” are a last resort for homeowners who need wind coverage but cannot obtain it from private companies. Seven States have beach and wind insurance plans: Alabama, Florida, Louisiana, Mississippi, North Carolina, South Carolina, and Texas. Georgia and New York provide this kind of coverage for windstorms and hail in certain coastal communities through other property pools. In addition, New Jersey operates the Windstorm Market Assistance Program (Wind-MAP; <http://www.njiua.org>) to help residents in coastal communities find homeowners insurance in the voluntary market. When Wind-MAP does not identify an insurance carrier for a homeowner, the homeowner may apply to the New Jersey Insurance Underwriting Association, known as the FAIR Plan, for a perils-only policy.



WARNING

Hurricanes cause damage through wind and flooding; however, flood insurance policies only cover flood damage, and wind insurance policies only cover damage from wind and wind-driven rain. For more comprehensive insurance protection, property owners should invest in both flood and wind insurance.

Earthquake Insurance

A standard homeowners insurance policy can often be modified through an endorsement to include earthquake coverage. However, like wind coverage, earthquake coverage may not be available in areas where the earthquake risk is high. Moreover, deductibles and rates for earthquake coverage (of typical coastal residential buildings) are usually much higher than those for flood, wind, and other hazard insurance.

Self-Insurance

Where wind and earthquake insurance coverage is not available from private companies or insurance pools—or where homeowners choose to forego available insurance—owners with sufficient financial reserves may be able to assume complete financial responsibility for the risks not offset through siting, design, construction, and maintenance (i.e., self-insure). Homeowners who contemplate self-insurance must understand the true level of risk they are assuming.

6.2.2.2 Savings, Premium, and Penalties

Design and siting decisions can often have a dramatic effect on both flood and wind insurance premiums. The primary benefit of the guidance in this Manual is the reduction of damage, disruption, and risk to the client. However, the reduction of insurance costs is a secondary benefit. Siting a building farther from the coastline could result in moving a building from Zone V into Zone A, thereby reducing premiums. Additionally, the height of the structure can affect flood insurance premiums. Raising the first floor elevation above the BFE (adding freeboard) reduces premiums in all flood zones.

Some design decisions increase, rather than decrease, insurance premiums. For instance, while the NFIP allows for enclosures below the lowest floor, their presence may increase flood insurance premiums. Breakaway walls and floor systems



COST CONSIDERATION

Constructing enclosures can have significant cost implications. This Manual recommends the use of insect screening or open wood lattice instead of solid enclosures beneath elevated residential buildings. See also Section 2.3.5 of this Manual.

elevated off the ground can raise premiums. Although these are allowed by the program, these types of design elements should be considered carefully and discussed with homeowners in light of their overall long-term cost implications.

In some States, building a house stronger than required by code results in reduced wind insurance premiums. For example, Florida requires insurance companies to offer discounts or credits for design and construction techniques that reduce damage and loss in windstorms. Stronger roofs and wall systems and improved connections may reduce premiums. Conversely, the addition of large overhangs and other building elements that increase the building's wind exposure can increase premiums. Building a structure stronger than the minimum code can have the dual benefit of reducing insurance premiums and decreasing damage during a flood or wind event.



WARNING

Improper construction of enclosures below elevated residential buildings in Zone V and post-construction conversion of enclosed space to habitable use (in Zone A and Zone V) are common compliance violations of the NFIP. For more guidance on enclosures, see Section 2.3.5 of this Manual.

6.3 Communicating Risk to Clients

Many homeowners may not be aware of the hazards that could affect their property and may not understand the risk they assume through their design decisions. Communicating risk to homeowners in a variety of ways, both technical and non-technical, is important so they understand the benefits and drawbacks of decisions they make. Designers should communicate how design decisions and material selections (as discussed in Volume II) can reduce risk, and the mitigation of residual risk through insurance.

It is important for homeowners to understand how the choices they make in designing their home could potentially reduce its risk of being damaged or destroyed by natural hazards. Designers need to be familiar with the potential risks for the property and be prepared to suggest design measures that not only meet the needs and tastes of homeowners, but that also provide protection from hazard impacts. In addition, design choices that have implications for building performance during a hazard event and on insurance premiums should be discussed clearly with the homeowner.

Although the effects of natural hazards can be reduced through thoughtful design and construction, ***homeowners should understand that there will always be residual risk*** from coastal hazards as long as they choose to build in a coastal environment. Proper design elements can mitigate some of those risks, but there is no way to completely eliminate residual risk in coastal areas. As described in this chapter, mitigating natural hazard risk in a coastal environment entails implementing a series of risk reduction methods, such as physical risk reduction and risk management through insurance. While some level of residual risk will remain, owners can use these tools to protect themselves and their investments.

Homeowners often misunderstand their risk; therefore, risk communication is critical to help them understand the risk that they assume. Designers are often tasked with explaining complicated risk concepts to homeowners. The discussion of risk with a homeowner can be difficult. It is important to find methods to convey the natural hazard risks for a site and how those risks may be addressed in the design process. The following discussion and examples are provided for designers to use with their clients. These examples use comparisons to other hazards, graphics, and monetary comparisons to provide alternatives to annual probabilities and recurrence intervals.

6.3.1 Misconceptions about the 100-Year Flood Event

Homeowners commonly misunderstand the *1-percent-annual-chance flood, often called the 100-year flood*. There is a 1 percent chance each year of the occurrence of a flood that equals or exceeds the BFE. By contrast, the chance of burglary in 2005 was only 0.6 percent nationwide, but homeowners are concerned enough by this threat that they use security systems and buy homeowners insurance to cover their belongings. Many homeowners believe that being in the 1-percent-annual-chance floodplain means that there is only a 1 percent chance of ever being flooded, which they deem a very small risk. Another misconception is that the “100-year” flood only happens once every 100 years. Unfortunately, these misconceptions result in a gross underestimation of their flood risk. In reality, a residential building within the SFHA has a 26 percent chance of being damaged by a flood over the course of a 30-year mortgage, compared to a 10 percent chance of fire or 17 percent chance of burglary.

6.3.2 Misconceptions about Levee Protection

Another common misconception involves levee protection. *Many homeowners behind a levee believe that the levee will protect their property from flood so they believe they are not at risk*. Since each levee is constructed to provide protection against a specific flood frequency, the level of protection must be identified before the risk can be identified. Owners and designers must understand that because levees are only designed to withstand certain storm event recurrence intervals, they may fail when a greater-than-design event occurs. Additional risk factors include the age of the levee and whether the level of protection provided by it may have changed over time. Designers must also understand that levees may have been designed for a specific level of protection, but if flood data changes over time due to an improved understanding of flood modeling, the current level of protection may be less than the designed level of protection. If a levee should fail or is overtopped, the properties behind the levee will be damaged by flooding, which could be as damaging as if there were no levee there at all. Therefore, even in levee-protected areas, homeowners need to be aware of the risk and should consider elevation and other mitigation techniques to minimize their flood risk.



CROSS REFERENCE

Section 2.3.2 discusses building behind a levee.

EXAMPLE: ELEVATING ABOVE THE MINIMUM CONSTRUCTION ELEVATION

Consider the following example of how just one decision made by the designer, builder, or homeowner can affect risk. Local floodplain management requirements consistent with NFIP regulations require that any building constructed in Zone V be elevated so that the bottom of the lowest horizontal structural member is at or above the BFE (1-percent-annual-chance flood elevation, including wave effects). Meeting this requirement should protect the elevated portion of the building from the 1-percent-annual-chance and lesser floods. However, the elevated part of the building is still vulnerable to floods of greater magnitude. As shown in Table 6-1, the probability that the building will be subjected to a flood greater than the 1-percent-annual-chance flood during a period of 30 years is 26 percent. But during the same 30-year period, the probability of a 0.2-percent-annual-chance (“500-year”) or greater flood is only 7 percent. Therefore, raising the lowest horizontal structural member to the elevation of the 0.2-percent-annual-chance flood would significantly reduce the building’s vulnerability to flooding and reduce insurance premiums. If elevating to the level of the 0.2-percent-annual-chance flood is not possible because of cost or other considerations, elevating by some lesser amount above the BFE will still reduce the risk.



CROSS REFERENCE

Sections 6.2.1.3 and 6.2.2 provide some discussion on how raising the lowest horizontal structural member to the elevation of the 0.2-percent-annual-chance flood instead of the BFE would provide benefits by reducing both the physical risk to the structure and the insurance premiums.

Illustration A on the next page shows the percent chance over a 30-year period of houses being flooded. The left side of the illustration reflects houses constructed to the BFE, while the right side reflects houses constructed to an elevation above the BFE, the 0.2-percent-annual-chance (“500-year”) flood elevation. Explain to the homeowner that the number of flooded houses shown is the percent of houses that would be potentially flooded over the next 30 years in each condition. Constructing to the 0.2-percent-annual-chance flood elevation reduces both physical risk and insurance cost. Illustration B shows the potential cost savings over a 30-year period for a house constructed to the BFE and a house constructed to the 0.2-percent-annual-chance flood elevation. For the purposes of calculating costs, the difference in elevation between BFE and the 0.2-percent-annual-chance flood in this example is 3 feet. The difference in elevation between the BFE and the 0.2-percent-annual-chance flood actually varies by location.

After a quick overview of the illustrations, most homeowners will understand how elevating the building higher than the BFE can result in significantly lower chances of the house experiencing flooding over the next 30 years. Once they understand the advantages of elevating a house higher than the minimum, they can be shown that while constructing the house higher will result in increased construction costs, it will also result in reduced flood insurance premiums. The designer can further explain that these reduced flood insurance premiums will quickly offset the increased construction costs. In this example, spending an additional \$12,000 in construction costs to build the house 3 feet above the BFE will save the homeowner \$151,710 in premiums over a 30-year mortgage period (for a total savings of \$139,710). Designers can use illustrations such as these or other such comparisons to explain exposure to natural hazards, risk, and reasons for making design decisions.

EXAMPLE: ELEVATING ABOVE THE MINIMUM CONSTRUCTION ELEVATION
(concluded)

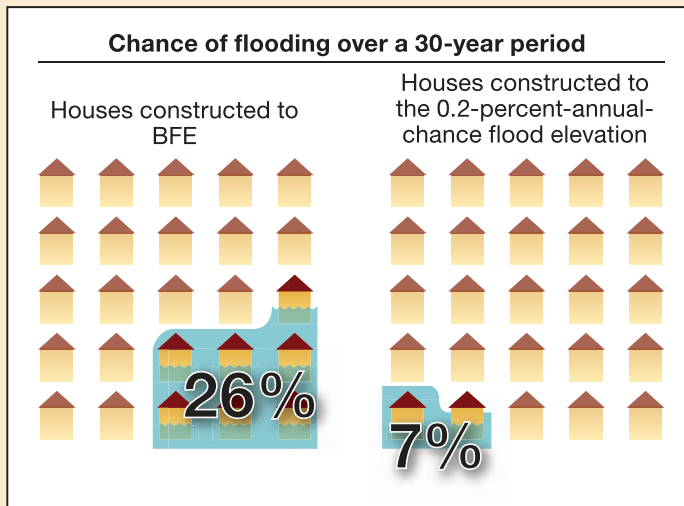


Illustration A:
Comparison of the percent chance of houses being flooded over a 30-year period after being elevated to the BFE (left) and the 0.2-percent-annual-chance flood elevation (right)

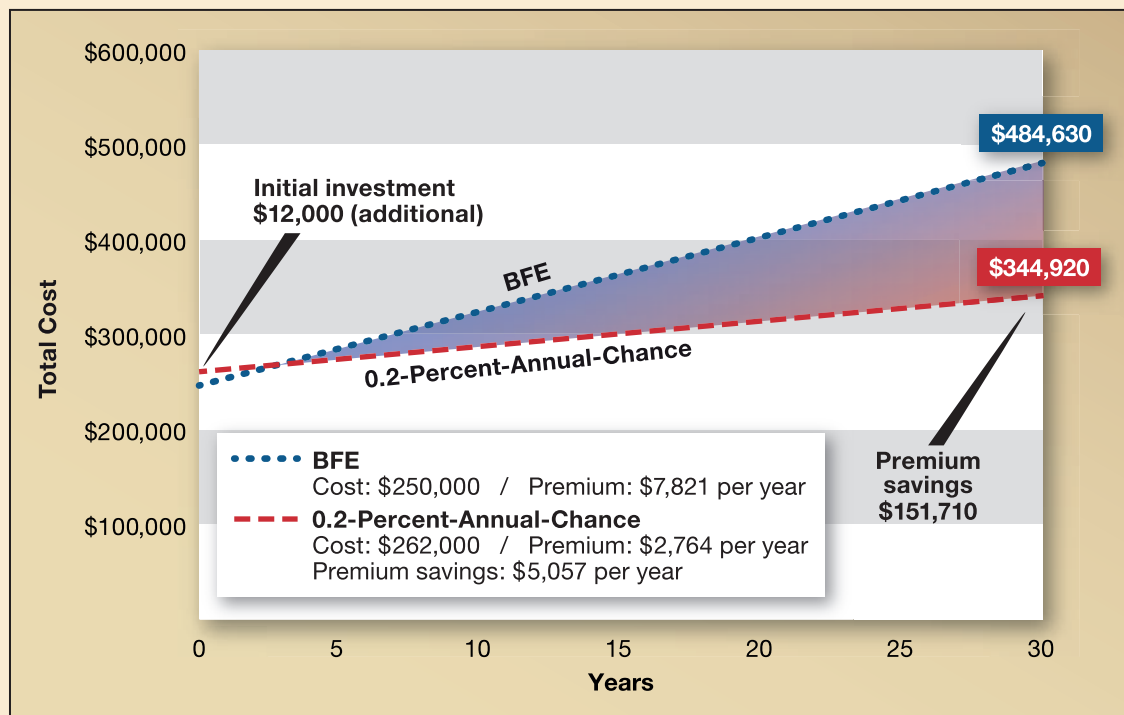


Illustration B:
Comparison of the total cost over a 30-year period for a house elevated to the BFE (dotted line) and a house elevated to the 0.2-annual-chance flood elevation (dashed line)

Note:
This example includes the cost of adding 3 feet of freeboard above the BFE, elevating the house to the 0.2-percent-annual-chance flood elevation. The difference in elevation between the BFE and the 0.2-percent-annual-chance flood actually varies by location.

Example premiums calculated using the NFIP Flood Insurance Manual, May 1, 2011, for a Zone V structure free of obstructions. Premiums include building (\$250,000), contents (\$100,000), and associated fees including Increased Cost of Compliance.

6.4 References

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