Coastal Building Successes and Failures

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HURRICANE RECOVERY ADVISORY *Recovery Advisory No. 4*

Purpose: To discuss how coastal construction requirements are different from those for inland construction. To discuss the characteristics that make for a successful coastal building.

Is Coastal Construction That Different From Inland Construction?

The short answer is, ***yes,*** building in a coastal environment is different from building in an inland area:

- ***Flood levels, velocities,*** debris, and ***wave*** action in coastal areas tend to make coastal flooding more damaging than inland flooding.
- Coastal ***erosion*** can undermine buildings and destroy land, roads, utilities, and infrastructure.
- ***Wind speeds*** are typically higher in coastal areas and require stronger engineered building connections and more closely spaced nailing of building sheathing, siding, and roof shingles.
- ***Wind-driven rain, corrosion,*** and ***decay*** are frequent concerns in coastal areas.

Figure 1. ***Poorly sited building on shallow foundation undermined by erosion.***

In general, homes in coastal areas must be designed and built to withstand ***higher loads*** and ***more extreme conditions***. Homes in coastal areas will require ***more maintenance*** and upkeep. Because of their exposure to higher loads and extreme conditions, homes in coastal areas will cost more to design, construct, maintain, repair, and insure.

Building Success

In order for a coastal building to be considered a "success," four things must occur:

- The building must be designed to withstand coastal forces and conditions.
- The building must be constructed as designed.
- The building must be sited so that erosion does not undermine the building or render it uninhabitable.
- The building must be maintained/repaired.

A well-built but poorly sited building can be undermined and will not be a success (see Figure 1). Even if a building is set back or situated farther from the coastline, it will not perform well (i.e., will not be a success) if it is incapable of resisting high winds and other hazards that occur at the site (see Figures 2 and 3).

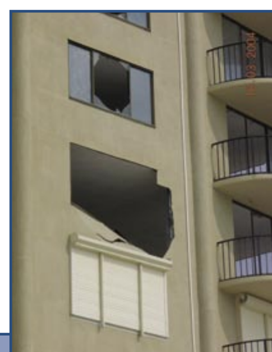


Figure 2. ***Well-sited buildings that still sustained damage due to building envelope and connection failures.***

Figure 3. Well-sited building that still sustained damage due to building envelope and connection failures.

Figure 4. Compliant building damaged when the flood elevation exceeded the BFE.

Similarly, a building compliant with the regulatory requirement that the lowest floor be elevated to the Base Flood Elevation (BFE) can still be damaged when the flood elevation exceeds the BFE (see Figure 4 and the discussion of lowest floor elevation in item 3 on the next page). The BFE is the expected elevation of flood waters and wave effects during the 100-year flood.

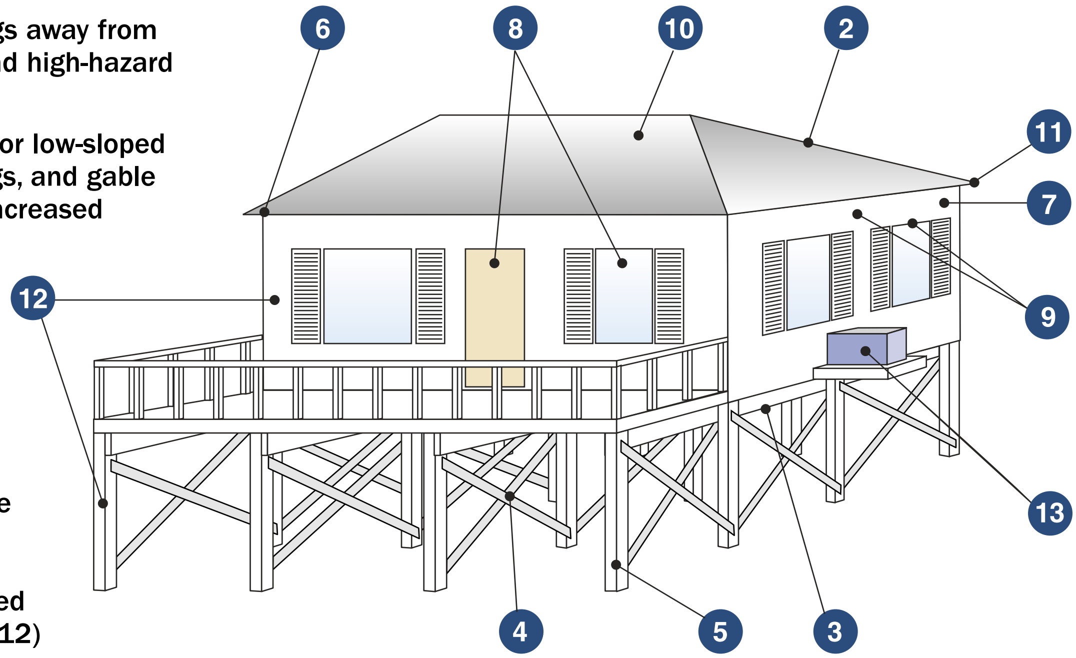
What Should Owners and Home Builders Expect From a "Successful" Coastal Building?

In coastal areas, a building can be considered a success only if it is capable of resisting damage from coastal hazards and coastal processes over a period of decades. This statement does not imply that a coastal residential building will remain undamaged over its intended lifetime. It means that the impacts of a design-level flood, storm, wind, or erosion event (or series of lesser events with combined impacts equivalent to a design event) will be limited to the following:

- The building **foundation** must remain intact and functional.
- The **envelope** (walls, openings, roof, and lowest floor) must remain structurally sound and capable of minimizing penetration by wind, rain, and debris.
- The **lowest floor** elevation must be sufficient to prevent floodwaters from entering the elevated building envelope during the design event.
- The **utility connections** (e.g., electricity, water, sewer, natural gas) must remain intact or be restored easily.
- The building must be **accessible** and **usable** following a design-level event.
- Any damage to **enclosures** below the Design Flood Elevation (DFE)* must not result in damage to the foundation, the utility connections, or the elevated portion of the building.

*The DFE is the locally mandated flood elevation, which will be equal to or higher than the BFE.

Recommended Practice



1. **Siting –** Site buildings away from eroding shorelines and high-hazard areas.

2. **Building Form –** Flat or low-sloped porch roofs, overhangs, and gable ends are subject to increased uplift in high winds. Buildings that are both tall and narrow are subject to overturning. Each of these problems can be overcome through the design process, but each must receive special attention. In the design process, chose moderate-sloped hip roofs (4/12 to 6/12) if possible.

3. **Lowest Floor Elevation –** Elevate above the DFE the bottom of the lowest horizontal structural member supporting the lowest floor. Add "freeboard" to reduce damage and lower flood insurance premiums.

   Freeboard is a factor of safety, usually expressed in feet above flood level, that is applied to compensate for unknown factors that could contribute to flood heights greater than those calculated for a selected flood. Freeboard is advisable in coastal areas where storms often cause flooding that exceeds the 100-year flood elevation.

4. **Free of Obstructions –** Use an open foundation. Do not obstruct the area below the elevated portion of the building. Avoid or minimize the use of breakaway walls. Do not install utilities or finish enclosed areas below the DFE (owners tend to convert these areas to habitable uses, which is prohibited under the National Flood Insurance Program and will lead to additional flood damage and economic loss).

5. **Foundation –** Make sure the foundation is deep enough to resist the effects of scour and erosion; strong enough to resist wave, current, and flood forces; and capable of transferring wind and seismic forces on upper stories to the ground.

6. **Connections –** Key connections include roof sheathing, roof-to-wall, wall-to-wall, and walls-to-foundation. Be sure these connections are constructed according to the design. Bolts, screws, and ring-shanked nails are common requirements. Standard connection details and nailing should be identified on the plans.

7. **Exterior Walls –** Use structural sheathing in high-wind areas for increased wall strength. Use tighter nailing schedules for attaching sheathing. Care should be taken not to over-drive pneumatically driven nails. This can result in loss of shear capacity in shearwalls.

8. **Windows and Glass Doors –** In high-wind areas, use windows and doors capable of withstanding increased wind pressures. In windborne debris areas, use impact-resistant glazing or shutters.

9. **Flashing and Weather Barriers –** Use stronger connections and improved flashing for roofs, walls, doors, and windows and other openings. Properly installed secondary moisture barriers, such as housewrap or building paper, can reduce water intrusion from wind-driven rain.

10. **Roof –** In high-wind areas, select appropriate roof coverings and pay close attention to detailing. Avoid roof tiles in hurricane-prone areas.

11. **Porch Roofs and Roof Overhangs –** Design and tie down porch roofs and roof overhangs to resist uplift forces.

12. **Building Materials –** Use flood-resistant materials below the DFE. All exposed materials should be moisture- and decay-resistant. Metals should have enhanced corrosion protection.

13 **Mechanical and Utilities –** Electrical boxes, HVAC equipment, and other equipment should be elevated to avoid flood damage and strategically located to avoid wind damage. Utility lines and runs should be installed to minimize potential flood damage.

14 **Quality Control –** Construction inspections and quality control are essential for building success. Even "minor" construction errors and defects can lead to major damage during high-wind or flood events. Keep this in mind when inspecting construction or assessing yearly maintenance needs.

Will the Likelihood of Success (Building Performance) Be Improved by Exceeding Minimum Requirements?

States and communities enforce regulatory requirements that determine where and how buildings may be sited, designed, and constructed. There are often economic benefits to exceeding the enforced requirements (see box). Designers and home builders can help owners evaluate their options and make informed decisions about whether to exceed these requirements.

Adopting and enforcing modern building codes (e.g., IBC, IRC, and FBC) and educating residents, businesses, contractors, and community officials on "best construction practices" with regard to the design of new structures and the mitigation of hazards to older structures are recommended.

Benefits of Exceeding Minimum Requirements

- Reduced building damage during coastal storm events
- Reduced building maintenance
- Longer building lifetime
- Reduced insurance premiums*
- Increased reputation of builder

Next Steps

To improve coastal construction practices, consider the following:

- Contact your local building official to obtain the latest applicable building code requirements for coastal construction.
- Review best practices guidelines and recommendations contained in FEMA's *Coastal Construction Manual*. The *Coastal Construction Manual* is available in Adobe® Portable Document Format (PDF) on CD-ROM (FEMA 55CD) and as a print publication (FEMA 55). Both versions are available from the FEMA Distribution Center. Call 1-800-480-2520 and request either FEMA 55CD or FEMA 55.

*Note: Flood insurance premiums can be reduced up to 60 percent by exceeding minimum siting, design, and construction practices. See the V-Zone Risk Factor Rating Form in FEMA's *Flood Insurance Manual* (http://www.fema.gov/nfip/manual.shtm).