Design and Construction in Coastal A Zones

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HURRICANE IKE RECOVERY ADVISORY

Purpose: To recommend design and construction practices in coastal areas where wave and flood conditions during the base flood will be less severe than in V zones, but still cause significant damage to typical light-frame construction.

Key Issues

- Recent post-storm investigations have shown that typical A-zone construction techniques (e.g., wood-frame, light gauge steel, or masonry walls on shallow footings or slabs, etc.) are subject to damage or destruction when exposed to less than 3' waves, which is the current threshold for V-zone conditions.
- Coastal A-zone buildings that employ typical residential and light commercial walls to elevate and support habitable space above the flood level will be susceptible to flood damage (Figure 1). Laboratory tests and recent field investigations confirm that breaking wave heights as small as 1.5' will cause failure of these types of walls (Figure 2).
- Other flood hazards associated with coastal waves (e.g., floating debris, high velocity flow, erosion and scour) also damage A-zone type construction in coastal areas (Figure 3).
- National Flood Insurance Program (NFIP) flood hazard mapping is generally divided into two categories, V and A zones. In coastal areas, the A-zone category could be subdivided into "Coastal A zone" and "A

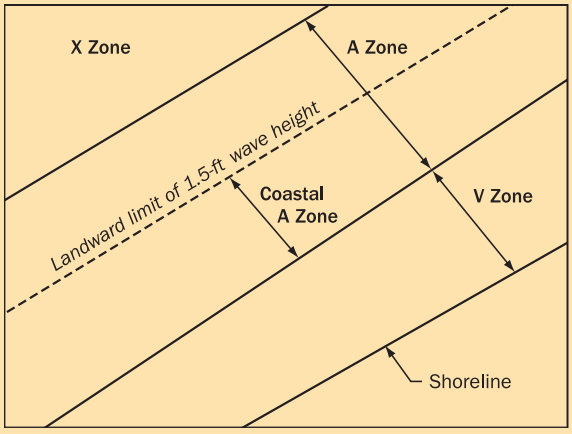
Figure 1. Failure of wood-frame walls used to support a coastal building, which was subjected to shallow flooding, small waves, and floating debris (Fort Walton Beach, FL, Hurricane Opal).

The Hurricane Ike Mitigation Assessment Team (MAT) observed small wave damage consistent with Coastal A-zone conditions throughout the area affected by Ike, including portions of west Galveston Island (Figure 4), communities situated along portions of Galveston Bay (Figure 5), Orange County (Figure 6), and portions of coastal Louisiana (Figure 7).

Coastal A Zone, Defined

Coastal A Zone: area landward of a V zone, or landward of an open coast without mapped V zones. In a Coastal A zone, the principal source of flooding will be astronomical tides, storm surges, seiches or tsunamis, not riverine flooding. During base flood conditions, the potential for wave heights between 1.5 and 3.0' will exist. At least 2 to 4' of stillwater depth is necessary to support these wave heights.

Coastal A-zone design and construction practices described herein are not mandated by the NFIP, but are recommended for communities that wish to adopt higher floodplain management standards. Community Rating System (CRS) credits are available for doing so. Note that some Coastal A-zone practices may be required by the International Building Code®, through its reference to ASCE 24, *Standard for Flood Resistant Design and Construction*.



Plan view showing a Coastal A zone landward of a V zone (source: ASCE 24-05).

zone." Base flood conditions in the Coastal A zone will be similar to, but less severe than, those in the V zone; base flood conditions in the A zone will be similar to those in riverine or lake floodplains.

- The Coastal A zone is not shown on the Flood Insurance Rate Maps (FIRMs) presently adopted by communities. Communities, designers, and owners will have to determine whether a site lies within a Coastal A zone, either by wave height estimation or by consultation with FEMA regarding the LiMWA (see text box).

> Flood insurance studies produced after Hurricane Katrina may include an advisory line indicating the limit of the 1.5' wave height during the base flood. This line is known as the Limit of Moderate Wave Action (LiMWA), and the area between this line and the VE zone boundary is the Coastal A zone.

- **In general, V-zone design and construction standards are recommended in Coastal A zones subject to erosion, high velocity flow, and/or wave heights greater than 1.5'.**

Figure 2. Failure of wood-frame wall, brick veneer, and windows as a result of 4' of stillwater flooding and small waves (Bay St. Louis, MS, Hurricane Katrina).

Figure 3. Failure of A-zone type foundation in coastal area, not subject to V-zone conditions (Topsail Island, NC, Hurricane Fran).

Figure 4. Coastal A-zone flood conditions are sufficient to cause failure of solid breakaway walls and garage doors (west Galveston Island, TX, Hurricane Ike).

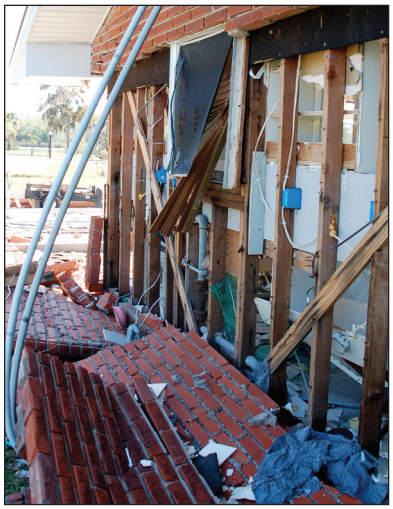


Figure 5. Damage to brick veneer walls due to shallow flooding, floating debris, and small waves. The damaged home was on a sheltered bay shoreline (Baytown, TX, Hurricane Ike).

V Zone

A Zones in Coastal Areas

Areas With Potential for Damaging Waves and Erosion During Base Flood

Areas With Shallow Flooding Only, Where Potential for Damaging Waves and Erosion Is Low

Figure 6. Damage attributed to small waves and approximately 5' of stillwater depth (Bridge City, TX, Hurricane Ike).

Figure 7. Damage believed to have resulted from Coastal A-zone conditions (Johnson Bayou, LA, Hurricane Ike).

Coastal A-Zone Construction Guidance

Because of the presence of damaging waves, V-zone design, construction, and certification practices are recommended for Coastal A zones.

Coastal A-zone construction should include:

- Use of open foundations (pile or pier) designed to resist all base flood conditions, including small waves, high velocity flow, erosion and scour, and floodborne debris (see Table 1).
- Elevation of the bottom of the lowest horizontal structural member supporting the lowest floor above the base flood wave crest elevation (Figure 8). Since waves and debris will be impacting on the floor joists and other foundation elements during the base flood, do not follow current NFIP minimum requirements that allow the lowest floor's walking surface to be set at the wave crest elevation in Zone A. **The 2009 International Residential Code® (IRC®) will require 1' of freeboard in V zones and Coastal A zones.**

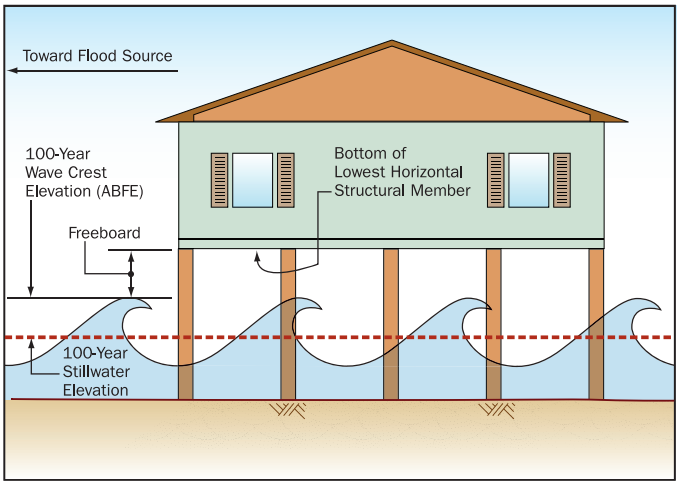


Figure 8. Recommended post-Katrina building standards in Coastal A zones.

- Use of flood-resistant materials above the level of the walking surface of the lowest floor (in the event that future flooding exceeds the lowest floor level and any freeboard incorporated into the building design).
- Specification of connections between the foundation and the elevated building that are capable of withstanding simultaneous wind and flood forces. Post-hurricane investigations typically find many foundation-to-building connections that are deficient.
- Use of space below the lowest horizontal structural member for parking, access, or storage only. Adding sufficient freeboard to allow parking beneath the building will not only reduce future flood damages, but will also lower flood insurance premiums.

- Use of screen, lattice, louvers, or solid breakaway walls if space below the elevated floor is enclosed (see Hurricane Ike Recovery Advisory, *Enclosures and Breakaway Walls*). Note: unless flood regulations are changed, solid breakaway walls in Coastal A zones must be equipped with flood openings.

Additional guidance for design and construction in Coastal A zones can be found in FEMA 499, *Home Builder's Guide to Coastal Construction* (http://www.fema.gov/library/viewRecord.do?id=1570). The publication is a series of 31 fact sheets that provide recommended design and construction practices for foundations, connections, building envelope, etc. Fact Sheet 2 summarizes recommended practices for Coastal A zones, and references other fact sheets that provide more details.

Table 1. Foundation Recommendations for Coastal A Zones (Users should read across from a foundation type to see under what soil and base flood conditions that foundation is acceptable. A foundation must be capable of resisting all base flood conditions likely to exist at the site, or it should not be used. For example, a properly constructed pier on a shallow footing will generally withstand 1.5 to 3.0' wave heights, but should not be used where soils are erodible, and where high velocity flow is possible.)

Foundation Type	Base Flood Condition Present	
	Wave Heights Between 1.5 and 3.0 Feet*	Velocity Flow, Erodible Soils
Fill	no	no
Slab on grade	no	no
Crawlspace, shallow footing	no	no
Foundation walls, shallow footing	no	no
Stem wall**	no	no
Pier, shallow footing	yes	no
Pier, deep footing***	yes	yes
Post, shallow embedment	no	no
Pile/Column, deep embedment***	yes	yes

* Wave heights greater than 3.0' mapped as V zone: fill, slab, crawlspace, wall foundations not permitted.

** Typical stem wall foundations are vulnerable to damage from small waves or undermining and are, therefore, not recommended for use in Coastal A zones.

*** Deep means sufficiently deep to withstand erosion and scour, including that induced by the presence of the foundation itself.

Identifying Coastal A Zones

Coastal A zones are not shown on present day FIRMs or mentioned in a community's Flood Insurance Study (FIS) Report. Those maps and studies show Zones VE, AE, and X (or older designations V1-30, A1-30, B, and C). Therefore, until Coastal A-zone designations or wave height contours are incorporated into FISs, the community official, designer, or owner will have to determine whether or not a site will be subject to Coastal A-zone conditions during the base flood.

In order for a Coastal A zone to be designated, two conditions are required:

1) a water depth sufficient to support waves between 1.5 and 3.0' high, and

2) the actual presence of wave heights between 1.5 and 3.0'.

Condition 1 requires stillwater depths (vertical distance between the 100-year stillwater elevation and the ground elevation) of at least 2 to 4' at the site.

Condition 2 requires wave heights at the shoreline greater than 1.5 to 3.0' (under the 100-year flood conditions), sufficient water depth between the shoreline and the site and few, if any obstructions (buildings, dense tree stands, etc.) that may block or dampen the waves, between the shoreline and the site.

Figure 9 illustrates the procedure that was used following Hurricane Katrina to estimate Advisory Base Flood Elevations (ABFEs) and corresponding Coastal A zones, knowing only the ground elevation and the 1-percent annual chance stillwater level.

Communities, designers, and owners can obtain the information necessary to make a post-Ike Coastal A-zone determination by observing the site and its surroundings, knowing site ground elevations, and using 1-percent annual chance stillwater elevations (from the FIS report or as determined by a government agency). Figure 10 shows how site and surrounding conditions would influence a Coastal-A zone determination.

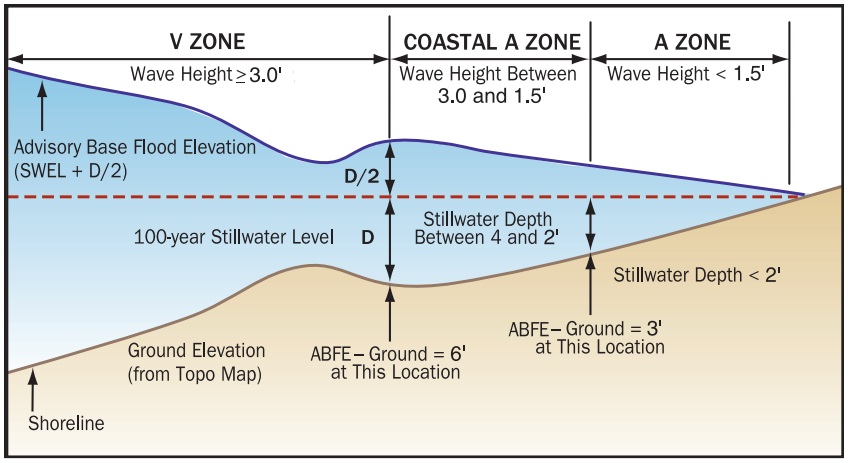


Figure 9. Post-Katrina Coastal A-zone methodology cross-section showing 1 percent annual chance stillwater elevation, stillwater depth and ABFE, and inland limits of an V zone and a Coastal A zone.

Figure 10. The site on the left is mapped Zone AE, and lies directly along the Gulf of Mexico shoreline. Limited obstructions to waves indicate the site could be classified as a Coastal A zone. The site on the right is over ½ mile from the Gulf shoreline, is mapped as Zone AE, and has a base flood stillwater level sufficient to support >1.5' wave heights – but obstructions to waves (e.g., trees and other buildings between the site and the shoreline) and distance from the source of flooding would indicate the area is not a Coastal A zone.

References

ASCE. 2005. *Standard for Flood Resistant Design and Construction*, ASCE 24-05.

FEMA. 2005. *Home Builder's Guide to Coastal Construction*, FEMA 499.

FEMA. 2009. *Hurricane Ike Recovery Advisory, Enclosures and Breakaway Walls*.

ICC 2006. International Building Code. 2006.

ICC 2009. International Residential Code. 2009.