

# Foundation Walls



FEMA



**Purpose:** To discuss the use of foundation walls in coastal buildings.

## Key Issues

- Foundation walls include stemwalls, cripple walls, and other solid walls.
- Foundation walls are prohibited by the National Flood Insurance Program (NFIP) in V zones.\*
- Use of foundation walls in A zones in coastal areas should be limited to locations where only shallow flooding occurs, and where the potential for erosion and breaking waves is low.
- Where foundation walls are used, flood-resistant design of foundation walls must consider embedment, height, materials and workmanship, lateral support at the top of the wall, flood openings and ventilation openings, and interior grade elevation.

## Foundation Walls – When Are They Appropriate?

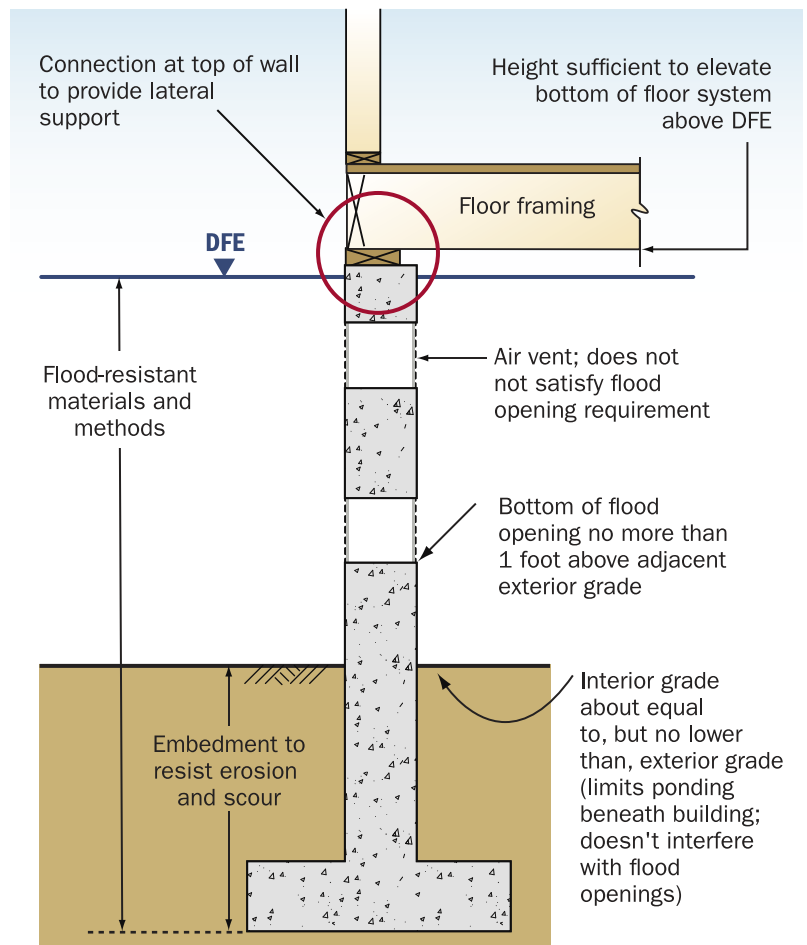
Use of foundation walls – such as those in crawlspace and other solid-wall foundations – is potentially troublesome in coastal areas for two reasons: (1) they present an obstruction to breaking waves and fast-moving flood waters, and (2) they are typically constructed on shallow footings, which are vulnerable to erosion. For these reasons,

**their use in coastal areas should be limited to sites subject to shallow flooding, where erosion potential is low and where breaking waves do not occur during the Base Flood.**

The NFIP prohibits the use of foundation walls in V zones\*. This *Home Builder's Guide to Coastal Construction* recommends against their use in many A zones in coastal areas.

**Deeply embedded pile or column foundations are recommended** because they present less of an obstruction to floodwaters and are less vulnerable to erosion.

\* Note that the use of shearwalls below the Design Flood Elevation (DFE) may be permitted in limited circumstances (e.g., lateral wind/seismic loads cannot be resisted with a braced, open foundation. In such cases, minimize the length of shearwalls and the degree of obstruction to floodwaters and waves, orient shearwalls parallel to the direction of flow/waves, do not form enclosures). Consult the authority having jurisdiction for guidance concerning shearwalls below the DFE.



Foundation walls – flood-resistant design considerations

## Design Considerations for Foundation Walls

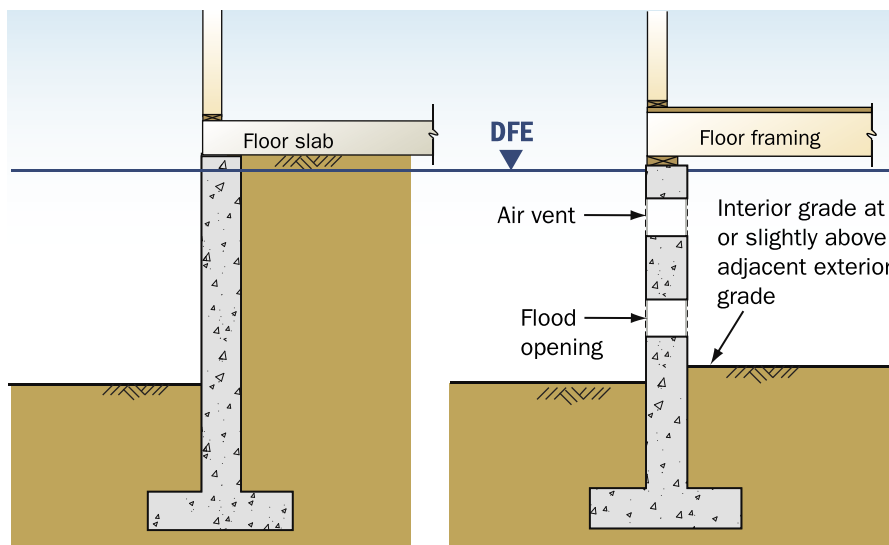
The design of foundation walls is covered by building codes and standards (e.g., *Standard for Hurricane Resistant Residential Construction*, SSTD 10, by the Southern Building Code Congress International). For flood design purposes, there are six additional design considerations: (1) embedment, (2) height, (3) materials and workmanship, (4) lateral support at the top of the wall, (5) flood openings and ventilation openings, and (6) interior grade elevation.

**Embedment** – The top of the footing should be no higher than the anticipated depth of erosion and scour (this basic requirement is the same as that for piers; see figure at right and Fact Sheet No. 14). If the required embedment cannot be achieved without extensive excavation, consider a pile foundation instead.

**Height** – The wall should be high enough to elevate the bottom of the floor system to or above the DFE (see Fact Sheet No. 4).

### Materials and Workmanship –

Foundation walls can be constructed from many materials, but masonry, concrete, and wood are the most common. Each material can be specified and used in a manner to resist damage due to moisture and inundation (see Fact Sheet No. 8). Workmanship for flood-resistant foundations is crucial. Wood should be preservative-treated for foundation or marine use (aboveground or ground-contact treatment will not be sufficient). Cuts and holes should be field-treated. Masonry should be reinforced and fully grouted (see Fact Sheet No. 16 for masonry details). **Concrete** should be reinforced and composed of a high-strength, low water-to-cement ratio mix.



**Floor slab atop backfilled stemwall foundation**

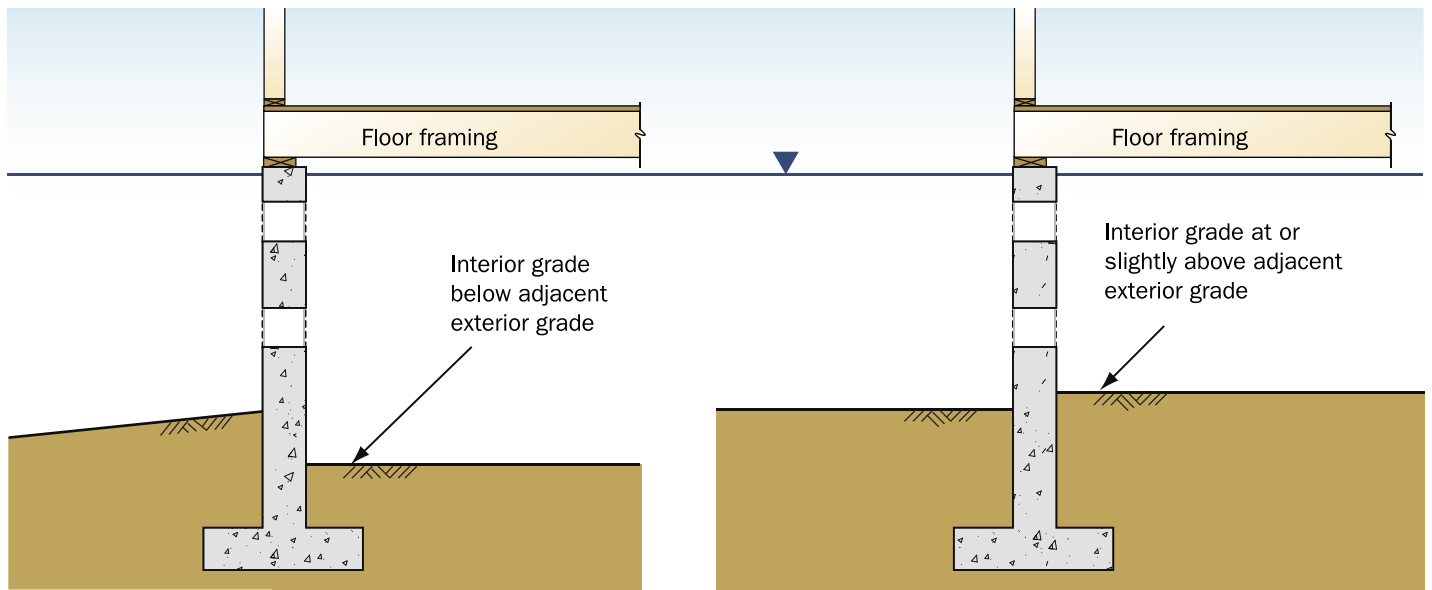
**Floor joist system and crawspace**

**Lateral Support at the Top of the Wall** – Foundation walls must be designed and constructed to withstand all flood, wind, and seismic forces, as well as any unbalanced soil/hydrostatic loads. The walls will typically require lateral support from the floor system and diaphragm, and connections to the top of the walls must be detailed properly. Cripple walls, where used, should be firmly attached and braced.

**Flood Openings and Ventilation Openings** – Any area below the DFE enclosed by foundation walls must be equipped with openings capable of automatically equalizing the water levels inside and outside the enclosure. Specific flood opening requirements are included in Fact Sheet No. 27. Flood openings are not required for backfilled stemwall foundations supporting a slab. **Air ventilation openings required by building codes do not generally satisfy the flood opening requirement**; the air vents are typically installed near the top of the wall, the flood vents must be installed near the bottom, and opening areas for air flow may be insufficient for flood flow.

**Interior Grade Elevation** – Conventional practice for crawspace construction calls for excavation of the crawspace and use of the excavated soil to promote drainage away from the structure (see left-hand figure on page 3). This approach may be acceptable for non-floodplain areas, but in floodplains, this practice can result in increased lateral loads (e.g., from saturated soil) against the foundation walls and ponding in the crawspace area. If the interior grade of the crawspace is below the DFE, NFIP requirements can be met by ensuring that the interior grade is at or above the lowest exterior grade adjacent to the building (see right-hand figure on page 3). When floodwaters recede, the flood openings in the foundation walls allow floodwaters to automatically exit the crawspace. FEMA may accept a crawspace elevation up to 2 feet below the lowest adjacent exterior grade; however, the community must adopt specific requirements in order for this type of crawspace to be constructed in a floodplain.

If a stemwall and floor slab system is used, the interior space beneath the slab should be backfilled with compacted gravel (or such materials as required by the building code). As long as the system can act monolithically, it will resist most flood forces. However, if the backfill settles or washes out, the slab will collapse and the wall will lose lateral support.



Conventional practice - not recommended

Recommended practice

**Crawlspace construction: interior grade elevation for A zones not subject to breaking waves and erosion**