7 Conclusions and Recommendations

The BPAT's conclusions and recommendations are presented in this section. The conclusions presented in Sections 7.1 and 7.2 are drawn from the building successes and damages observed by the BPAT during the field assessment and based on a collaborative evaluation of the observations. Sections 7.3 and 7.4 provide technical guidance for mitigating damage from future storms.

7.1 Successful Building Performance

This section summarizes the factors that contributed to the successful performance of buildings subjected to the flood and wind forces of Hurricane Georges.

Engineered structures constructed in accordance with current building codes, such as the SBC, the NFIP compliant local floodplain management requirements, and additional state and local standards performed well.

Buildings built to these requirements sustained less damage than pre-FIRM structures. The post-FIRM structures were able to withstand Hurricane Georges' increased wind and flood loads.

Elevating buildings to the NFIP requirements substantially reduced the damages in both riverine and coastal areas. Elevated residential structures and public structures such as the Mobile Convention Center received considerably less damage than they would have if they had not been elevated. NFIP requirements mandate that structures built in V-Zones, as shown on the FIRMs, must be elevated so that the lowest horizontal structural member is at or above the BFE and the area below the building is free of obstructions. In Coastal A-Zones and in riverine A-Zones, a building's lowest floor must be elevated to or above the BFE.

Communities that recognized and required buildings be designed for the actual hazards present in their area, sustained reduced damages.

Some communities recognize the actual hazards and mandate more stringent siting and building standards. For example, under the jurisdiction of the Santa Rosa Island Authority, the City of Pensacola Beach enforces V-Zone construction standards for single family residential structures in all of the barrier island areas shown as A-Zones on the current FIRM. These requirements and others reflect the actual risk on Pensacola Beach and helped to significantly reduce the extent of damage to buildings on the city's barrier island A-Zones. The application of the V-Zone standards is credited with significantly reducing damages to A-Zone buildings caused by Hurricane Opal and Hurricane Georges.

On Dauphin Island, Alabama, the implementation of more stringent local requirements for installation of asphalt/composition roofing shingles resulted in only minimal damage to roofs. The local building code requires that shingles be attached using six nails and mastic on the first two rows of shingles (Figure 7-1). In addition, the local building code requires pile embedments to extend to a minimum of 10 feet below mean sea level (msl) or to a depth equivalent to the height of the lowest floor above msl.

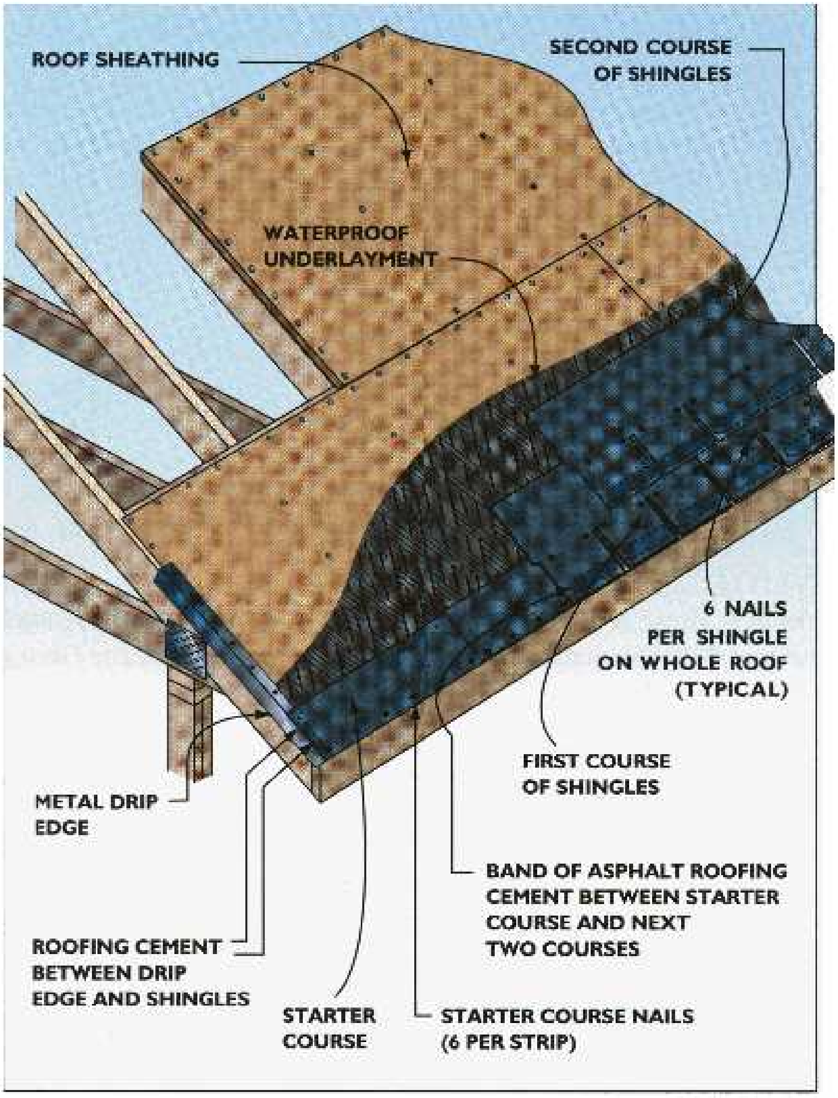

Figure 7-1 Shingle installation technique implemented on Dauphin Island, Alabama.

Home builders have learned from past hurricanes and implemented appropriate construction techniques to reduce future damages. One example was the widespread observation that minimal enclosures were constructed below structures in V-Zones. On Dauphin Island, Alabama, builders used V-Zone construction standards on many homes located in coastal A-Zones on the landward side of the island. Even though the area is shown as an A-Zone, the area is subject to some velocity wave action and overwash as evidenced by the observed scour and debris damage. Construction to

V-Zone standards allowed floodwaters and debris to flow freely under the houses, resulting in reduced damage.

Manufactured homes with reinforced concrete or reinforced masonry piers and proper anchoring performed well.

Manufactured homes in the Florida Keys with reinforced concrete or masonry piers and properly installed anchoring systems yielded lower damages. A manufactured home installer training program is successfully promoting proper installation techniques in Florida.

Specialized building materials designed for higher wind speeds performed well.

New building materials, including fiber-reinforced concrete building siding and metal roofs, withstood Hurricane Georges' wind forces. New materials warrant further study to determine long-term reliability and functionality.

Publicly financed flood mitigation programs and planning activities clearly had a p ositive impact on the communities where they were implemented.

Elevation of floodprone buildings proved to be a cost-effective technique to break the cycle of damage to repetitive loss properties along the Fish and Dog Rivers in Alabama.

Furthermore, most public facilities retrofitted for wind hazard mitigation, such as police stations, fire stations, and public buildings, performed very well and operated without disruption during Hurricane Georges.

In addition to the mitigation projects already completed or underway, communities in the region are demonstrating further commitment to hazard mitigation through the planning process. For example: the South Alabama Regional Planning Commission is preparing a regional hazard mitigation plan for Baldwin, Mobile, and Escambia Counties, both Dauphin Island and Gulf Shores, Alabama are preparing comprehensive plans that include provisions for hazard mitigation; and Pascagoula, Mississippi will develop a post-hurricane recovery plan to identify long-term solutions to its flood problems. This activity follows upon the hazard mitigation plan prepared prior to Hurricane Georges under FEMA's Project Impact Initiative.

7.2 Factors Contributing to Building Damage

This section summarizes the factors that contributed to the observed building damages described in Sections 3 through 6 of this report.

Riverine flooding in many areas exceeded the 100-year flood level. Structures built to post-FIRM building standards in SFHAs are still exposed to a residual risk of flood damage. In many of the areas affected by Hurricane Georges, flooding exceeded the BFE (see Figure 2-4, Section 2). When this occurred, structures built within the SFHA sustained damage. Likewise, structures built outside the SFHA, where no NFIP floodplain management requirements apply, were also flooded and sustained damage.

Inadequate pile embedment depths on coastal structures. Piling foundations of residential structures, including decks that were not built to withstand the forces of the storm surge, failed. Erosion and scour combined to affect coastal piling foundations, causing them to be undermined and ultimately fail in several cases. Beachfront homes are most at risk from pile embedment failure.

Inadequately elevated and protected on-site utility systems. Many electrical meters, air conditioners, and heat pumps were damaged or destroyed although the buildings themselves received little or no damage. Individual costs of these items often exceeds several thousand dollars, but the potential loss of habitability is of greater concern when these utilities are damaged. The BPAT observed many cases in coastal V-Zones where air conditioners and heat pumps were elevated, but their platforms were destroyed because they were supported by inadequate piles or posts. In some cases the air conditioners and heat pumps were properly elevated but still sustained damage because the units were not properly anchored to the platform.

Inadequate designs for frangible concrete slabs below elevated buildings in coastal areas subject to wave action. Many concrete slabs-on-grade were either too thick, connected to the piles, or steel-reinforced and did not allow for the proper break-up of the slab when affected by the storm surge, erosion, and scour. The BPAT observed significant pile damage caused by debris impact from improperly designed slabs.

Impact from waterborne debris on coastal structures. Debris from ancillary structures such as docks, porches, decks, and stairways damaged adjacent structures. In many cases, the failure of ancillary structures from front-row houses contributed to damage to houses properly set back.

Siting of houses that did not consider localized impacts of coastal erosion and scour. As observed on Dauphin Island, Alabama, roads perpendicular to the shoreline provided a preferred flow path for coastal surge and overwash resulting in a concentration of significant erosion and scour on the back bay side of the island. Houses built in these areas were severely damaged or destroyed due to eroded foundation systems and waterborne debris impact.

Corrosion of hurricane straps on coastal structures. Although the BPAT could not directly attribute coastal building failure to hurricane strap failures, many houses observed had severely corroded or completely failed hurricane straps. These corroded straps leave buildings highly vulnerable to damage from future storms

Site-built attachments to manufactured homes. A significant amount of damage to older manufactured homes was attributed to attachments such as awnings, decks, and porches that became detached by wind or flood forces. These attachments either damaged the home in the process of being separated from the home or by becoming waterborne or windborne debris.

Improperly installed manufactured home anchors. Many cases of anchor problems were observed on older manufactured homes. Either improper anchors were used or the anchor was not properly installed.

7.3 Recommendations

The following recommendations address the factors described in Section 7.2, and when implemented, will reduce future storm damage.

7.3.1 Flood Mitigation Programs and Planning

Development of hazard mitigation plans are critical to the implementation of a comprehensive and effective hazard mitigation program. State and local governments, as well as regional planning commissions and authorities should continue development and maintenance of hazard mitigation plans.

Publicly financed mitigation projects, such as elevation or acquisition of repetitive-loss properties in SFHAs and placement of door and window shutters on public buildings to reduce wind damage need to continue. Selection of any mitigation project must include a thorough benefit-cost analysis to ensure that maximum benefit from available funds is achieved.

7.3.2 Mitigating Residual Flood Risk

Exceeding the minimum lowest floor elevation requirements of the NFIP can reduce residual flood risk. Structures should be built higher than the BFE by mandating at least 1 foot of freeboard to further reduce the risk of future damages. For example, a house that was elevated 1 foot above the BFE in Jackson County, Mississippi, was successfully protected from four recent flooding events However, flooding from Hurricane Georges exceeded the 100-year flood level and resulted in 3 inches of water in the building's first floor. A requirement of an additional foot of freeboard (raising the house two feet above the BFE), would have prevented significant damage. The cost of elevating the house the extra foot would have been minimal compared to the total cost of elevating the house. In addition, a benefit to homeowners elevating above the BFE is reduced flood insurance premiums.

Elevation of manufactured homes is more critical than site-built homes. Typically, when inundated by flood waters, even at minimal levels, manufactured homes suffer substantial damage. Therefore, elevation above the BFE is strongly recommended.

Replacement manufactured homes placed in existing manufactured home parks, such as those assessed in the Florida Keys, are highly susceptible to severe flood damage. As described in Section 5.3, minimum NFIP requirements for placement of replacement homes in existing manufactured home parks (unless substantially damaged by a flood) only require elevation to the BFE or 36 inches, whichever is lower. This means that when the BFE results in a flood depth greater than 36 inches, the first floor of the home is below the 100-year flood level. It is therefore recommended that all replacement homes be elevated above the BFE.

7.3.3 Pile Foundation Systems

It is important that coastal foundations be designed to survive the anticipated amount of erosion and scour (Figure 7-2). Erosion and scour combine to impact coastal piling foundations in three distinct ways. First, in the absence of crossbracing, the loss of soil adjacent to a thin vertical foundation member, such as a pile, results in a longer unsupported length. The increase in unsupported length allows for greater deflection of the vertical member. Second, the loss of soil adjacent to pilings leaves less soil to counteract lateral loads applied to the pilings by the structure above, the velocity flow of the storm surge, wave action, and debris impact. Third, pilings, which rely on friction between the piling and the adjacent soil to transfer loads into the ground, lose some of the resisting friction when the adjacent soil is eroded and scoured (Figure 7-3). The loss of friction reduces the ability of the piling to resist uplift loads from wind.

The BPAT recommends that, in the absence of State or local requirements based on detailed engineering studies or the historical performance of coastal buildings subjected to base flood conditions, piling for structures in areas subject to erosion and scour be embedded to –10 feet below mean sea level. Piles also should not be encased in concrete

collars since this causes further scour around the pile.

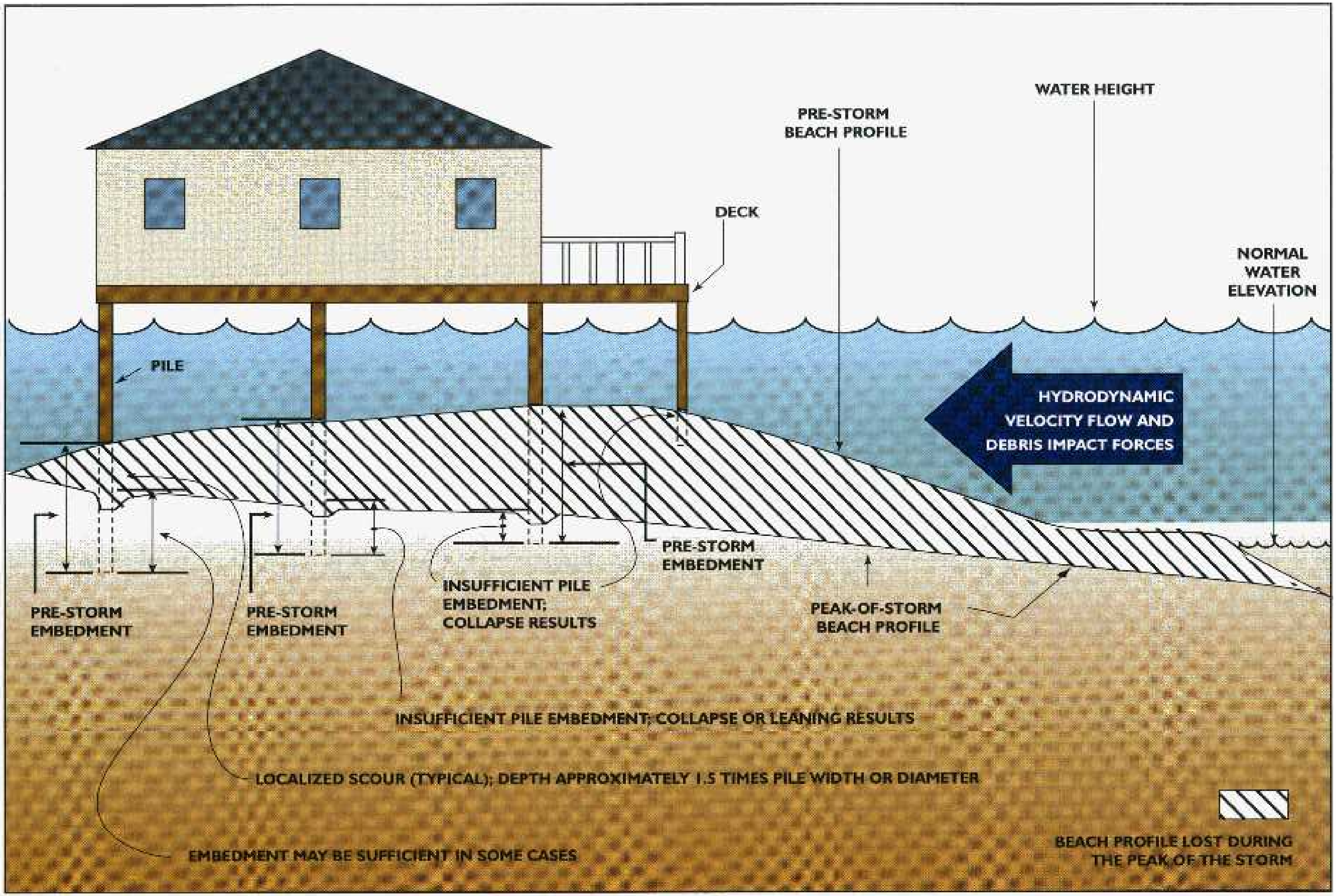

FIGURE 7-2 Typical collapse mechanism of post-FIRM buildings due to storm-induced erosion and scour.

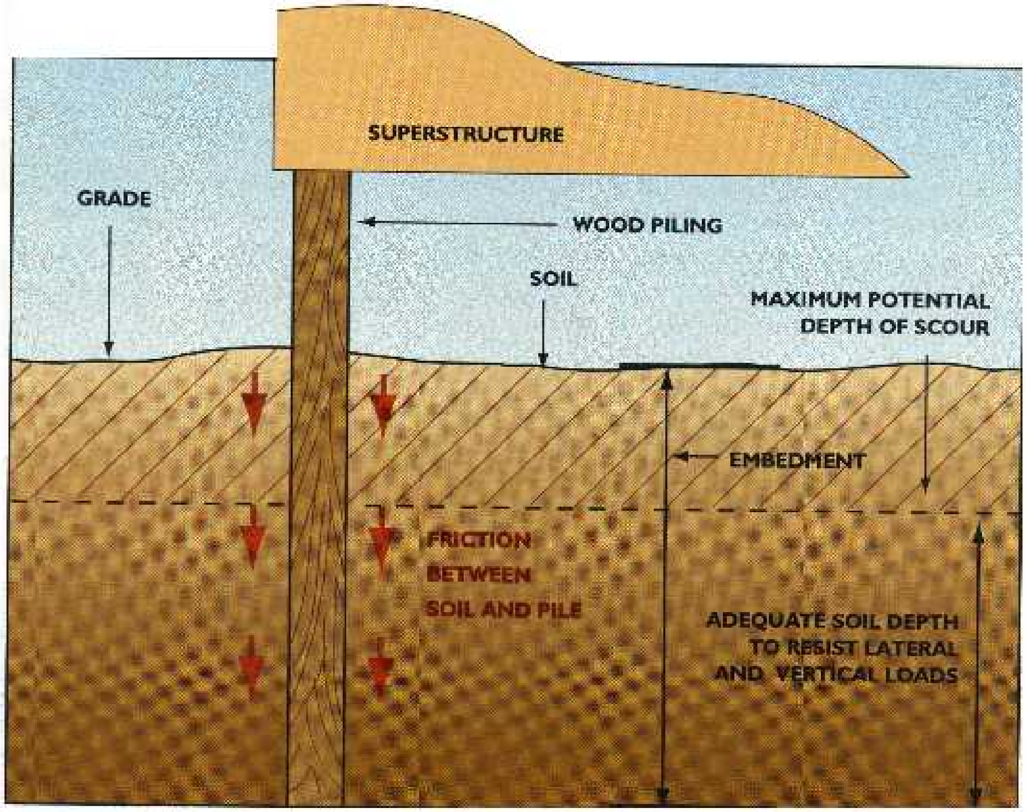

FIGURE 7-3 The depth of pile embedment provides stability by enabling the pile to resist lateral and vertical loads through passive earth pressure. Soil depth below maximum potential depth of scour must be adequate to withstand lateral and vertical loads during the base flood.

7.3.4 On-Site Utility Systems

On-site utilities should be installed with much greater attention to the potential effects of riverine and coastal flooding. NFIP regulations require that if a proposed building site is in a floodprone area, all new construction and substantial improvements shall be constructed with electrical, heating, ventilation, plumbing, air conditioning equipment, and other service facilities that are designed and/or located so as to prevent water from entering and accumulating within the components during conditions of flooding. Elevation provides the preferred method of preventing water from damaging utilities in both coastal and riverine floodprone areas. In some cases, such as placement of electrical meters, installation should be coordinated with local public utility companies. Installation of other items, such as septic systems, may fall under the jurisdiction of local or State Health Departments.

7.3.4.1 Air Conditioner/Heat Pump Compressor Platforms

Platforms that support air conditioner/heat pump compressors must be designed to withstand the forces associated with the base flood. In coastal V-Zones, the best way to avoid damage to these platforms is to employ the method used for the protection of buildings — elevation. Therefore, the bottom of the lowest horizontal structural member of the platform should be elevated to or above the BFE. Ideally, air conditioner/heat pump compressor platforms should be cantilevered from an elevated floor diaphragm (Figure 7-4). This design would be most appropriate for structures subjected to coastal storm surge. An alternative is to support the platform partially or completely on piling (Figure 7-5). Note that specific pile embedment depths must be implemented depending upon whether the site is subject to erosion. Vertical foundation members for platforms should meet the same requirements as the main building support system. Air conditioner/heat pump compressors in riverine areas that are not subjected to significant erosion or scour can be reasonably elevated 3 to 4 feet on a solid platform (Figure 7-6).

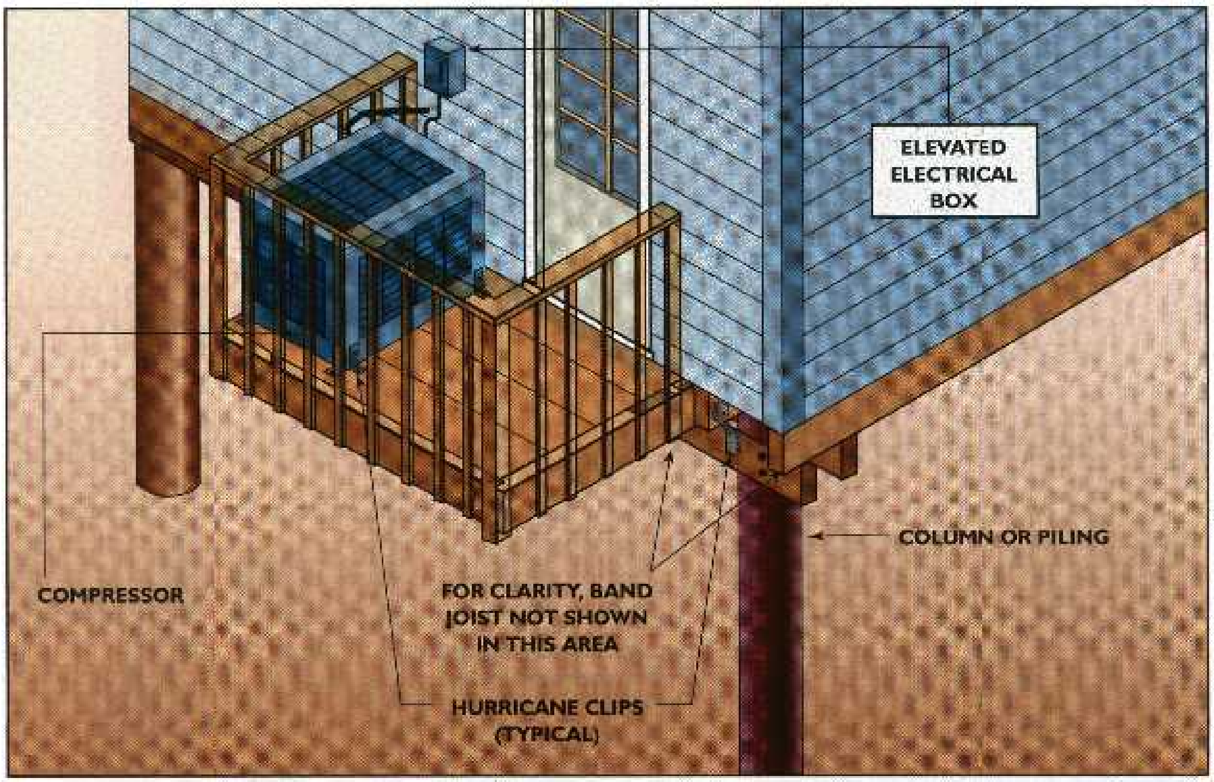

FIGURE 7-4 Cantilevered air conditioner/heat pump compressor platform.

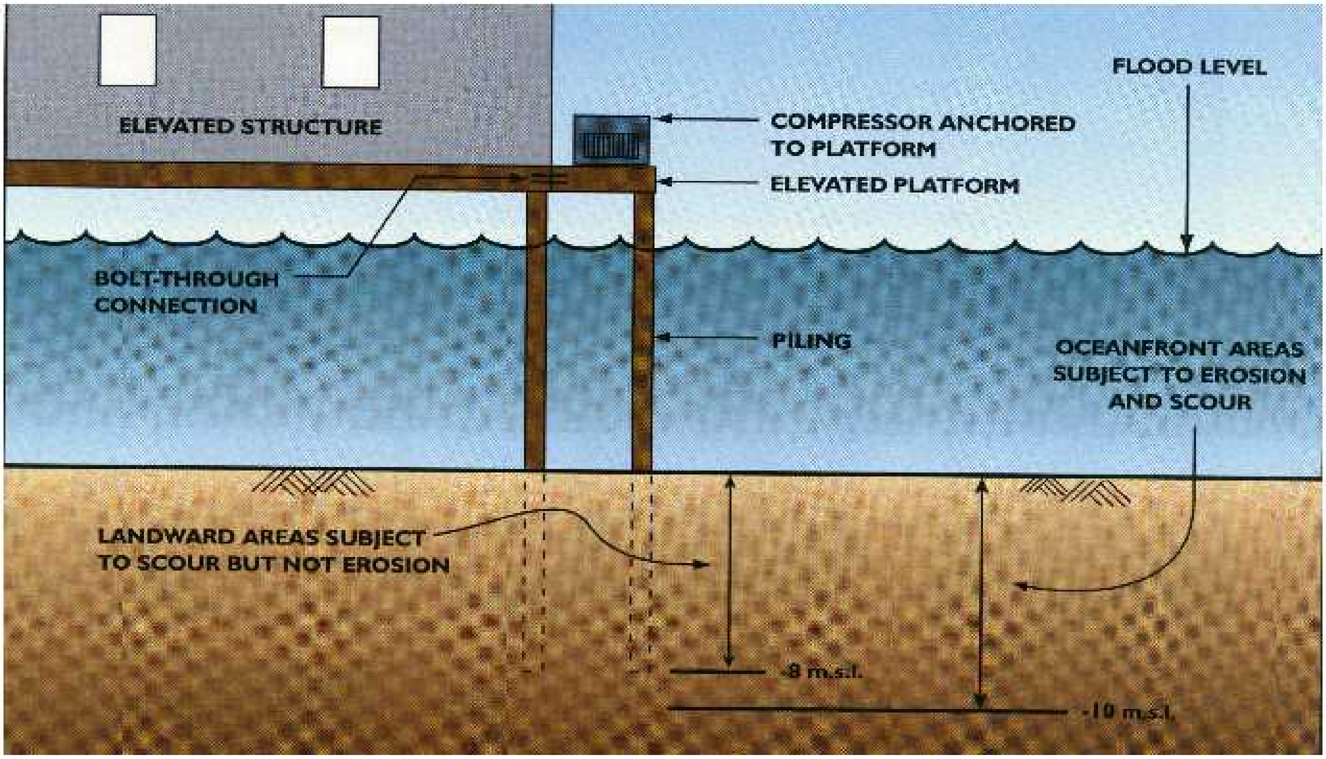

FIGURE 7-5 Air conditioner/heat pump compressor platform supported by pilings.

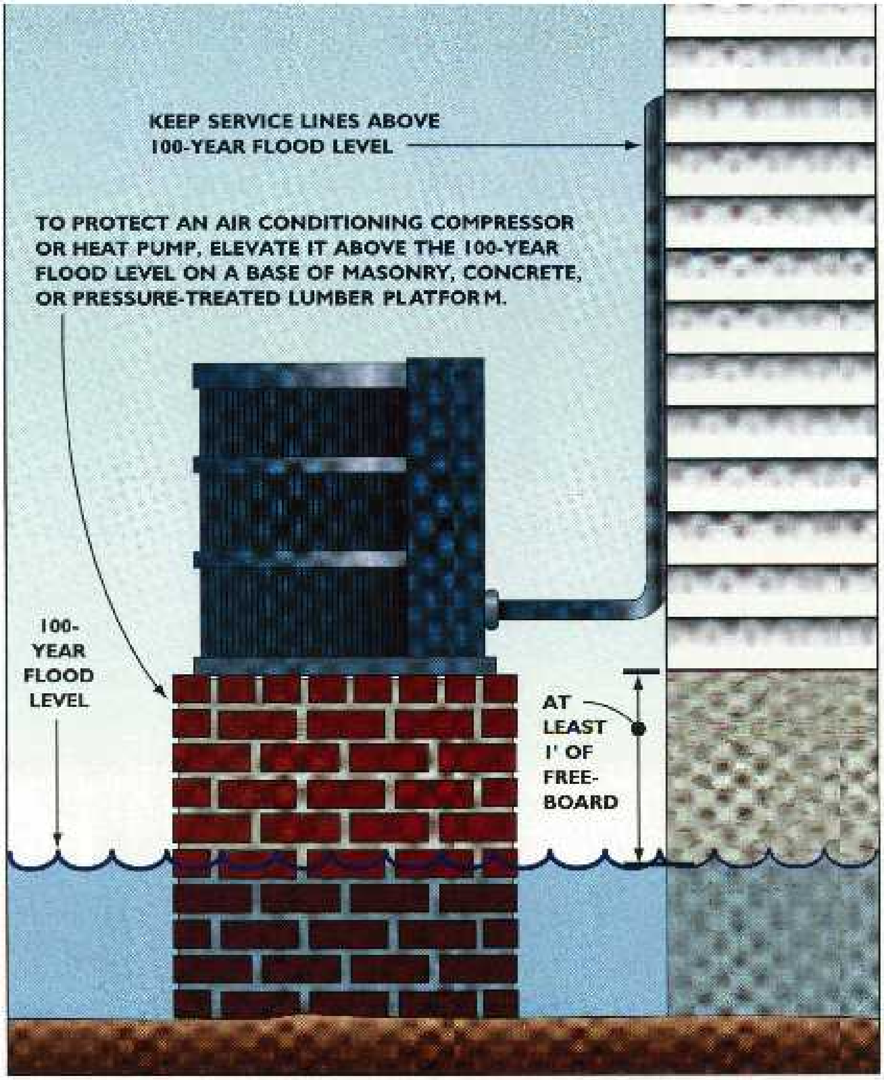

FIGURE 7-6 Elevated air conditioner/heat pump compressor in an A-Zone area not subject to significant velocity flow and debris impact.

Platforms designed and constructed with vertical foundation members must be protected from localized scour and, in oceanfront areas, protected from erosion so that the foundation members can resist the velocity flow, wave action, and debris impact found in coastal areas. When a vertical foundation member loses its ability to support the platform, the platform collapses, becoming waterborne debris that is then carried into the structure or nearby structures. Because of the cost of the compressor, often $2,000 or more, the potential loss of habitability when the compressor is rendered inoperable, and the debris the platforms generate once they collapse, these platforms cannot be considered sacrificial.

7.3.4.2 Placement of Utilities Adjacent to Vertical Support Members

Utilities installed on the landward side of vertical foundation members are shielded by the foundation members against damage from velocity flow and debris impact. Service connections such as electrical meters, telephone junction boxes, and cable junction boxes that must be exposed to flooding should be placed on the landward side of the most landward vertical foundation member (Figure 7-7). Vertical utilities such as sewer and water risers should also be placed on the landward side of vertical foundation members.

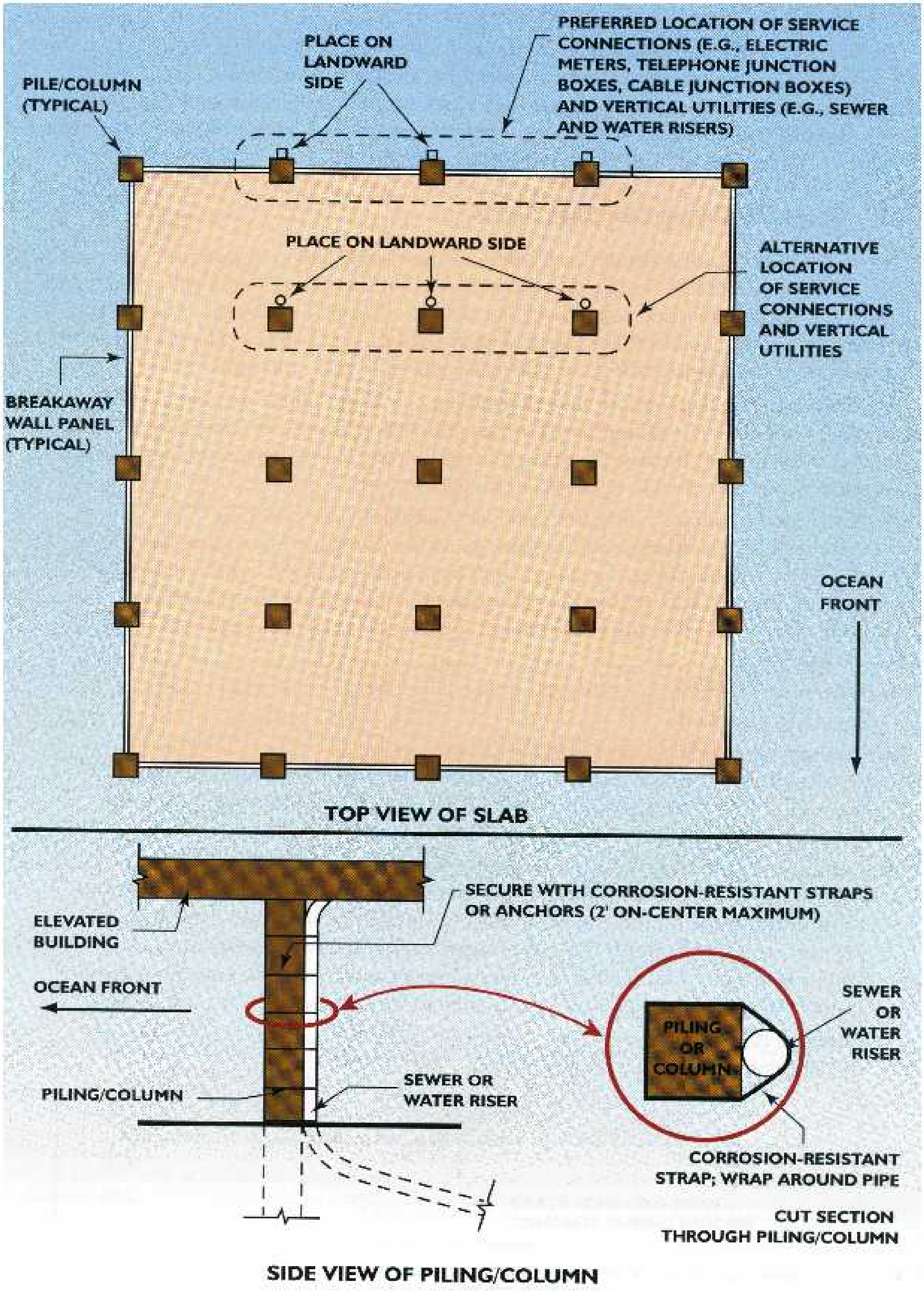

FIGURE 7-7 Proper location of utilities.

7.3.4.3 Septic Tanks

Septic tanks should be installed as far landward as practical and permitted by the authority having jurisdiction. Before septic tanks are installed, local and State Health Departments should be consulted concerning whether such tanks are permissible and how and where they should be installed. Further guidance may be found in the International Private Sewage Disposal Code, Section 303 [International Code Council 1995].

7.3.5 Below-Building Concrete Slabs

When a slab-on-grade is constructed below an elevated building in a coastal area subject to wave action, it should be designed and constructed in such a way that it will not damage the building foundation when acted on by flood forces (Figure 7-8). Issues requiring special consideration include the thickness of the slab, slab joints, and construction practices that are not appropriate for coastal flood hazard areas subject to erosion and scour:

- **Slab thickness** - Slabs below elevated buildings in areas subject to erosion and scour should be no thicker than 4 inches. Thicker slabs present two problems: they are harder to break into small pieces and each piece weighs more per unit of surface area than a same-sized piece of a thinner slab.
- **Slab joints** - Contraction joints are the most important for ensuring the frangibility of below-building slabs. As shown in Figure 7-8, contraction joints should be cut into the surface of the slab from piling to piling in both directions across the entire slab. Expansion and isolation joints should be installed as appropriate in accordance with standard practice or as required by State and local codes.
- **Wire mesh** - Wire mesh retards the ability of the slab to break apart and therefore should not be used.
- **Connecting the slab to the vertical foundation members** - Slabs should never be connected to vertical foundation members when the slab is underlain by granular soil in areas subject to erosion and scour. This practice unnecessarily threatens the stability of the foundation system of elevated buildings.
- **Casting concrete grade beams and slabs-on-grade monolithically** - Grade beams and slabs-on-grade should never be cast monolithically in areas subject to erosion and scour. In these areas, grade beams must be designed to be self-supporting (to account for the loss of supporting soil from erosion and scour) and to withstand velocity flow and debris impact as well as stiffen the foundation system. All slabs-on-grade must be designed to act separately from grade beams.
- **Concrete collars** - In areas subject to erosion and scour, concrete collars should not be placed around foundation pilings.

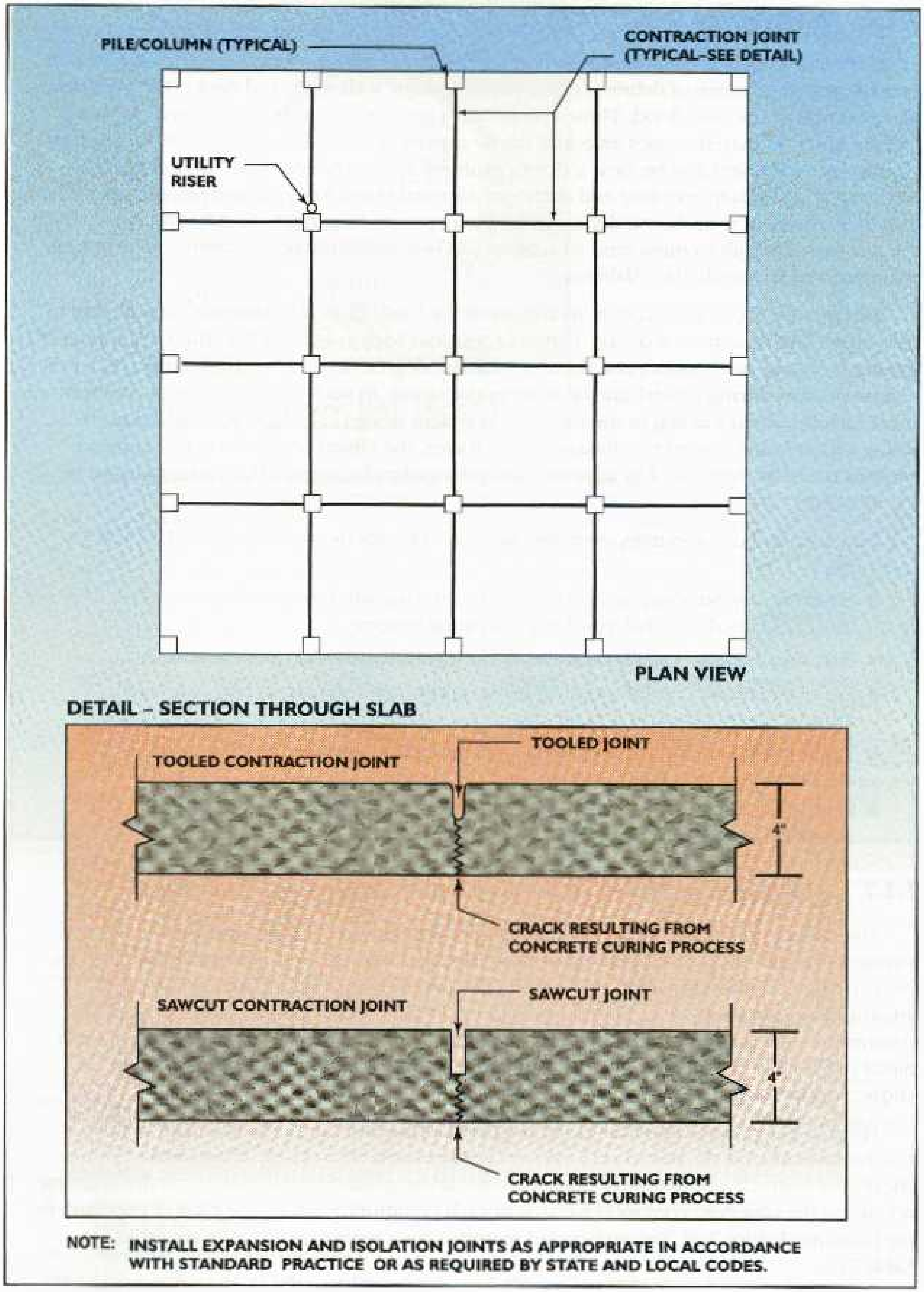

FIGURE 7-8 **Recommended contraction joint layout for frangible slab-on-grade below elevated building.**

7.3.6 Waterborne Debris Impact

Debris or impact loads are imposed on a building by objects carried by moving water. In coastal areas the source of debris is often wooded stairs, walkways, and decks that are below the elevation of the base flood. These components are often considered sacrificial in coastal V-Zone areas. In extreme cases an entire house may be separated from its foundation system during a severe storm and become a debris problem as was observed in Dauphin Island, Alabama. Inadequately elevated and anchored air conditioner/heat pump compressors can also be a source of waterborne debris. In addition, private boat docks and fishing piers, which are not typically highly engineered structures, can become a source of waterborne debris, as was observed in Mobile Bay, Alabama.

Designing a foundation system to withstand the loads caused by debris is difficult due to the unpredictable nature of debris. However, in areas such as Mobile Bay where hundreds of fishing piers and boat docks exist, there is a known degree of certainty that significant debris will be present during a hurricane or other major storm. In such cases the design engineer must include debris loading in the foundation system design calculations. In addition to sizing a foundation system to withstand these forces, the effects of debris on pile support systems could be minimized by armoring the piles or by placing sacrificial piles seaward of the structure.

Communities can also mitigate debris impact problems by curbing debris. This can be accomplished by:

- Ensuring that buildings are constructed with adequate foundation systems so these systems do not fail, resulting in floating houses;
- Ensuring that stairs, walkways, and decks have adequate foundation systems;
- Ensuring that air conditioner/heat pump compressor platforms have adequate foundation systems and that the compressor is properly anchored to the platform;
- Limiting the size and placement of building components below the lowest floor of the home such as stairs, walkways, and decks; and
- Regulating the size, placement, and construction of docks, fishing piers, and accessory buildings and sheds.

7.3.7 Protection of Metal Structural Components from Corrosion

Maintaining the design strength of all structural components is critical. Any loss of strength can lead to structural failure during subsequent hurricanes. Special attention to the proper type of metal connectors should be considered because of the harsh, corrosive environment of coastal areas. For exposed exteriors near the shoreline, stainless steel connectors or connectors with thick galvanizing should be used. Standard galvanized sheet metal connectors should be replaced with either stainless steel or thick galvanized connectors as soon as partial rusting appears.

For many connector applications in corrosion-prone buildings, the use of corrosion-resistant materials is the best choice for new construction. The choice of alternative connector material or coating specifications should be guided by the location of the building relative to the observed corrosion hazards in each community and by the class of exposure in the building (Figure 7-9). Recommended materials for a typical community are listed in Table 7-1.

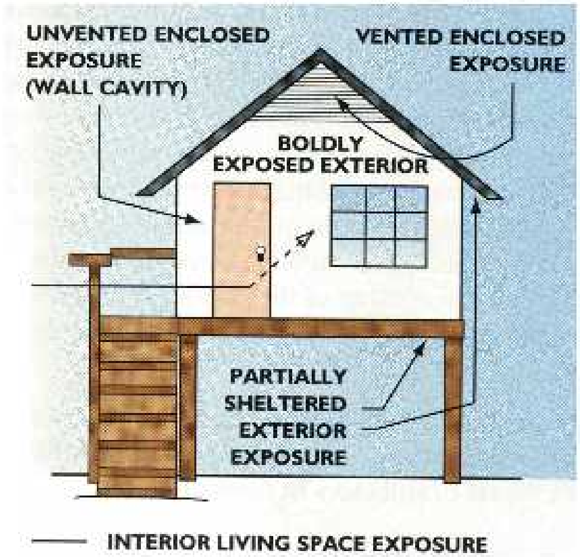

FIGURE 7-9 The locations of the five classes of exposure.

Table 7-1 Recommendations for Corrosion-Resistant Materials and Methods*

Location Class of Exposure **	Oceanfront Buildings (300 feet or less from the shoreline)***	Intermediate Rows of Buildings in Corrosion-Prone Areas (300 to 3,000 feet from the shoreline)***	Buildings Farther Inland (Greater than 3,000 feet from the shoreline)***
Partially sheltered exteriors	1. Avoid sheetmetal connectors where possible. 2. Use stainless steel connectors. 3. Use connectors with thicker galvanizing and replace them when necessary.	Use connectors with thicker galvanizing. (Optional: stainless steel)	Use connectors with standard galvanizing. (Optional: thicker galvanizing)
Boldly exposed exteriors	1. Avoid sheetmetal connectors where possible. 2. Use stainless steel connectors. 3. Use connectors with thicker galvanizing and replace them when necessary.	Use connectors with thicker galvanizing. (Optional: stainless steel)	Use connectors with standard galvanizing. (Optional: thicker galvanizing)
Vented enclosures	1. Use connectors with thicker galvanizing. (Optional: stainless steel) 2. Use TPI**** paints on truss plates (Option for truss plates: thicker galvanizing, TPI paints over thicker galvanizing, or stainless steel)	1. Use connectors with thicker galvanizing near vents. 2. Use TPI paints on truss plates near vents. (Optional: thicker galvanizing for all connectors)	Use connectors with standard galvanizing (Optional: thicker galvanizing)
Unvented enclosures	1. Use connectors with thicker galvanizing. 2. Use TPI paints on truss plates. (Optional for truss plates: thicker galvanizing)	Use connectors with standard galvanizing. (Optional: thicker galvanizing)	Use connectors with standard galvanizing. (Optional: thicker galvanizing)
Interior living space	Use connectors with standard galvanizing. (Optional: thicker galvanizing)	Use connectors with standard galvanizing. (Optional: thicker galvanizing)	Use connectors with standard galvanizing. (Optional: thicker galvanizing)

* Recommendations are based on the available research and are subject to change in future Technical Bulletins.

** See Figure 7-9 for exposure classes.

*** Distances may vary considerably depending on local climate. The width of the corrosion hazard area relative to the ocean should be determined in each community from field observations and any existing corrosion studies.

**** Truss Plate Institute

In Table 7-1, building locations are categorized as oceanfront buildings, intermediate rows of buildings in corrosion-prone areas, or buildings near the coast but far enough away from the ocean that excessive corrosion is not anticipated. In most communities, connectors on oceanfront buildings can be expected to corrode at high rates. Corrosion rates should approach inland levels 300 to 3,000 feet (roughly 100 to 1000 meters) landward of the ocean in most communities. Types of connector exposures in a building are listed in Table 7-1 in order of decreasing severity of location. Truss plate treatments are noted separately, based on TPI recommendations for corrosive environments. Recommendations in the table are in some cases based on limited research. When the severity of the exposure is unknown, selecting more corrosion-resistant materials is prudent. Optional materials for superior corrosion resistance are noted also.

Additional guidance regarding the selection, installation, and maintenance of metal connectors, such as truss plates and hurricane straps, can be found in FEMA's NFIP Technical Bulletin No. 8, *Corrosion Protection for Metal Connectors in Coastal Areas.*

7.3.8 Attachments to Manufactured Homes

Typical attachments such as decks, porches, or awnings should be minimized for manufactured homes in SFHAs. These homes are typically not designed to withstand loads to walls or floor systems that may be exerted by attached decks, porches, or awnings. These features should be designed and anchored to the same standards as the manufactured house. Site-built decks, porches, or overhead awnings must not be permitted except as standalone units. Additionally, if a standalone porch or deck is going to be added, design criteria for vertical foundation members on the addition should be equivalent to those for the foundation system of the main structure to prevent damage to the main structure or adjacent structures.

7.3.9 Manufactured Home Anchoring Systems

Manufactured homes in SFHAs must be placed on foundation systems that will resist flotation, collapse, and lateral movement. There are several ways to anchor the homes to these foundation systems. The support chassis of the home can be connected directly to the reinforced concrete or masonry piers by using metal "L" brackets or the home can also be anchored using straps. It should be noted that anchoring using straps would not be appropriate for homes elevated more than 3 to 4 feet where an engineered, permanent foundation may be required. Figure 7-10 shows the attachment of typical anchoring straps. Anchoring straps can be connected to the chassis by being wrapped around the support beam or the straps can be bolted to the support beam. The straps are connected to the ground by attaching to anchors encased in the concrete foundation or by attachment to earth auger or cross drive rock anchors.

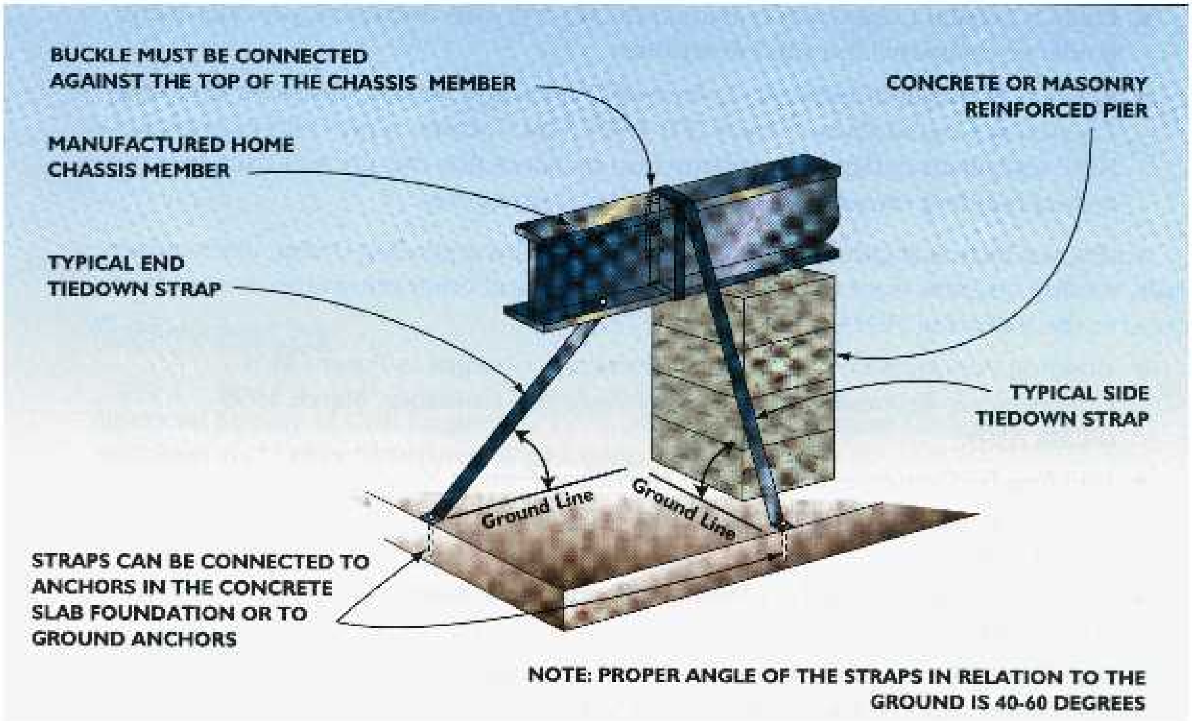

FIGURE 7-10 Typical manufactured home anchoring straps.

Chassis configuration varies among manufactured home manufacturers. Installation in a SFHA area may require manufactured homes to be installed on permanent, engineering foundations. Therefore, selection and installation of all anchoring systems must be performed in accordance with the manufacturer's installation instructions and/or engineered design criteria. In addition, anchoring straps must be properly installed by a qualified installer and in accordance with the strap manufacturer's installation instructions. As mentioned earlier straps may not be appropriate if the home is elevated more than 3 to 4 feet. Straps must also be properly tensioned and require periodic maintenance to ensure that proper tension is maintained. For these reasons it is preferred that the manufactured home be connected directly to the support piers using metal connectors. Any metal connectors used should be adequately protected from corrosion. Finally, metal connectors used in anchoring systems must be adequately protected from corrosion.

7.4 Other Mitigation Guidance

Supplemental technical guidance for designers of coastal foundations can be found in the following documents:

The ASCE standard *ASCE 7-95, Minimum Design Loads for Buildings and Other Structures*. This standard includes criteria for determining flood loads and for combining flood and other loads to determine load factors for buildings that experience simultaneous wind and flood loads. This standard meets, or exceeds, the minimum requirements of the NFIP for determining loads.

The ASCE standard *ASCE 24-98, Flood Resistant Design and Construction*. This standard provides prescriptive requirements regarding the design and construction of buildings that are located in floodprone areas. This standard also meets, or exceeds, the minimum requirements of the NFIP.

- FEMA's *Coastal Construction Manual (FEMA 55)*. This document provides further guidance on coastal foundation systems.
- FEMA's Technical Bulletin No.5, *Free-of-Obstruction Requirements for Buildings Located in Coastal Hazard Areas (TB 5-96)*. This document provides information on NFIP-compliant design and construction practices that can prevent damage to coastal building caused by below-building obstructions.

Additional technical guidance and recommendations regarding design of breakaway walls, roofing systems, door and window protection, and other mitigation measures can be found in the following FEMA publications:

- *Building Performance Assessment: Hurricane Georges in Puerto Rico, Observations, Recommendations, and Technical Guidance*, March 1999 (FEMA 339).
- *Building Performance Assessment: Hurricane Fran in North Carolina – Observations, Recommendations, and Technical Guidance*, March 1997 (FEMA 290).
- *Hurricane Opal in Florida, A Building Performance Assessment*, August 1996 (FEMA 281).
- *Building Performance Assessment: Hurricane Iniki – Observations, Recommendations, and Technical Guidance*, January 1993 (FIA 23).
- *Building Performance Assessment: Hurricane Andrew in Florida – Observations, Recommendations, and Technical Guidance*, December 1992 (FIA 22).
- *FEMA's Technical Bulletin No. 2, Flood Resistant Materials Requirement for Buildings Located in Special Flood Hazard Areas.*
- *Homeowner's Guide To Retrofitting: Six Ways To Protect Your Home From Flooding*, June 1998 (FEMA 312).
- *Engineering Principals and Practices for Retrofitting Flood Prone Residential Buildings*, January 1995 (FEMA 259).

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To order FEMA publications, call 1-800-480-2520, or write: FEMA Distributional Facility, P.O. Box 2012, Jessup, Maryland 20794-2012.

FEMA NFIP Technical Bulletins may also be downloaded from FEMA's website: www.fema.gov/mit/techbul.htm.

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