2.7 Dry Floodproofing in Coastal A Zones

One unusual building in Wrightsville Beach is worth noting. The building is a slab-on-grade hotel that was renovated several years ago. During the renovation of the conference rooms, the owner reconstructed the exterior walls to make them watertight and installed tracks in the door openings for the placement of removable flood shields (see Figure 2-40). The flood shields were approximately 3 feet high and were manufactured by a firm that specializes in producing flood shields. Each shield was equipped with a pneumatic gasket that could be inflated to seal the gap between the track and the edge of the shield (see Figure 2-41). Construction of a solid masonry wall inside the exterior walls of the conference rooms completed the floodproofing.

The BPAT interviewed the hotel manager and engineer during the site investigation. Both were directly involved in the renovation of the hotel. Both said that the floodproofing was worth the effort but that they wished the shields had been 1 foot higher. While the shields prevented the storm surge from entering the protected area, some water splashed over the tops of the shields. The water that passed over the top flooded the conference rooms to a depth of 4 inches. It damaged the carpeting and mildewed the wall paper. However, in the remaining portions of the hotel, which were not floodproofed, the depths of flood waters reached 18 inches. In these areas, the water damaged the sheetrock and left over 2 inches of sand on the floor. Both the manager and the engineer stated that keeping sand out of the conference area was, in itself, justification for the expense of the floodproofing.

Figure 2-40 *Engineered flood shield installed over opening to large dry floodproofed commercial building.*

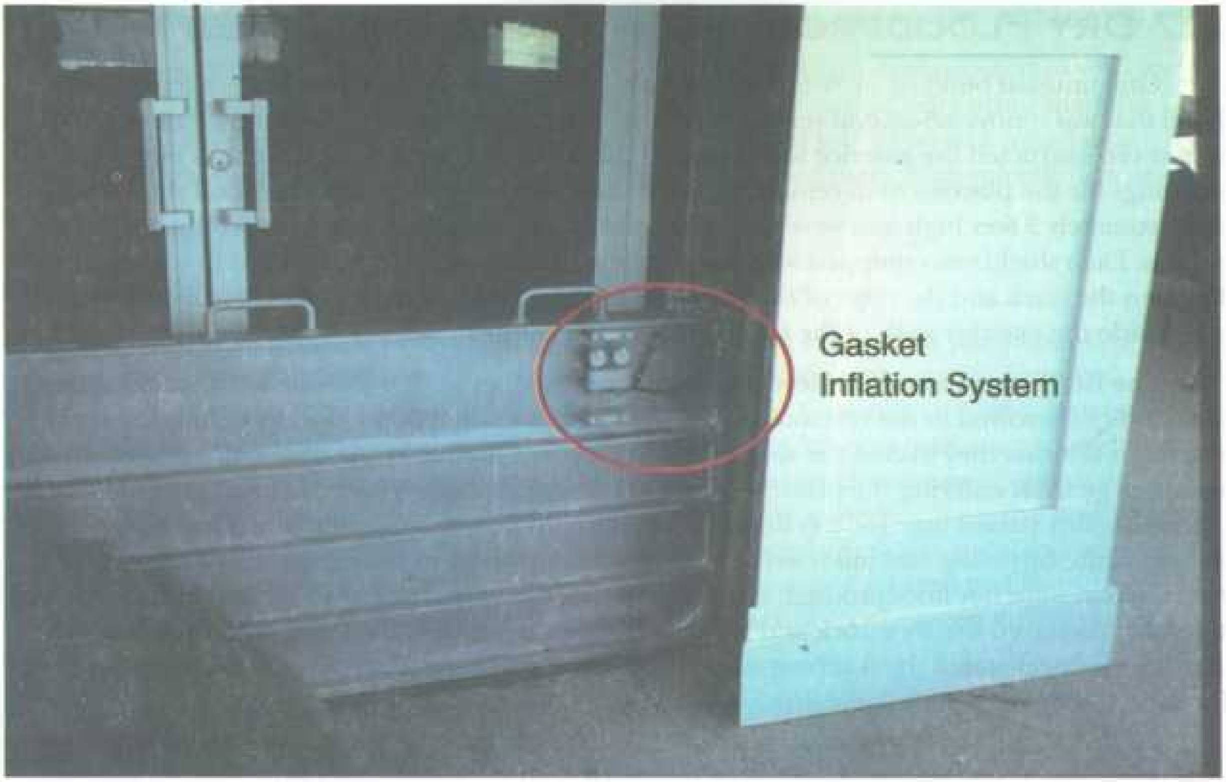

Figure 2-41 *Buildings that are floodproofed require extensive engineering detailing. Note that this flood shield is sealed with a pneumatic gasket.*

Although flood shields and other elaborate floodproofing measures can be quite effective, they often require extensive human intervention to function properly (see Figure 2-42). It should be noted that very few floodproofed buildings in coastal A zones are known to be subject to wave action. Floodproofing in areas known to be subject to wave action presents special challenges that must be addressed in the design, installation, and operation of the components of the floodproofing system.

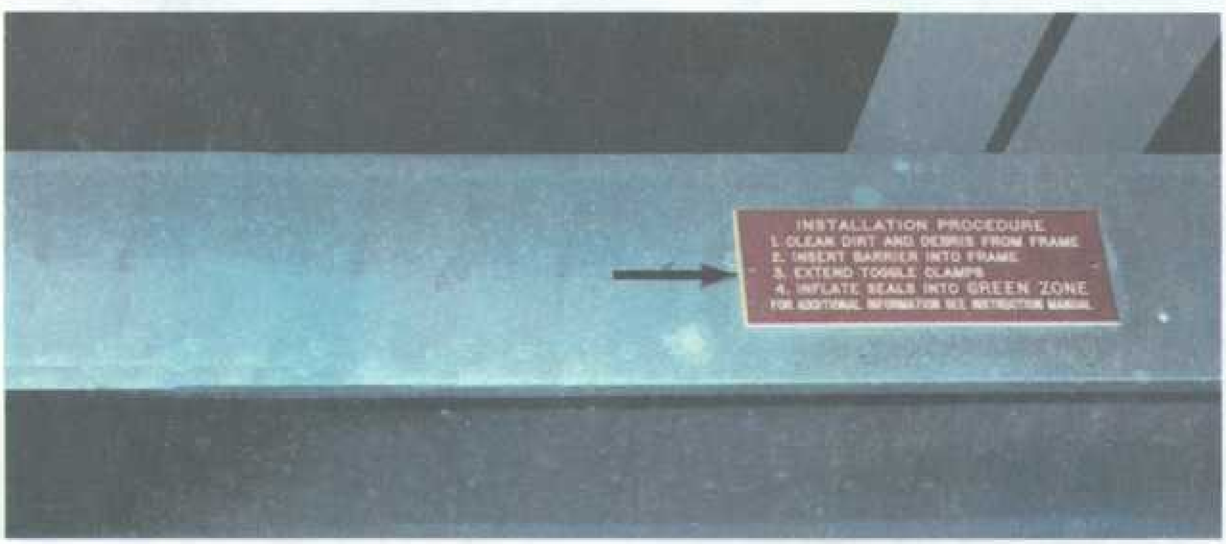

Figure 2-42. *Dry floodproofing often requires extensive human intervention. Note the detailed instructions affixed to this flood shield.*

2.8 Wind Damage

Although the BPAT focused on flood damage, the team also observed wind damage to many buildings. Porch roofs and large overhangs often failed because of poor connections, particularly base and roof connections of support columns. Porch and overhang failures often caused severe damage to otherwise well-connected main roofs. An additional contributor to observed wind damage was the failure of corroded metal connectors.

2.9 Corrosion of Structural Metal Components

The BPAT continued to see a trend toward the increased use of partially exposed metal structural components, such as hurricane straps and clips, stamped metal plates on floor diaphragm trusses, and manufactured home and RV tiedowns (see Section 2.3.8), in coastal structures. With this trend, comes a trend toward an increase in the observed corrosion of these components. Components that are partially exposed, i.e., those that are exposed to direct contact with ambient exterior air but not cleansing rainfall, continued to show the highest rate of corrosion.

Examples of such components are shown in Figures 2-43, 2-44, and 2-45. The presence of rust indicates an obvious loss of galvanization on metal components observed in both oceanfront and landward structures in the study area and may indicate that the connectors are nearing the end of their useful life.

As noted in Section 2.8, the team observed wind damage to some structures that was due in part to the failure of corroded metal connectors.

2.10 Concerns Regarding the Effective FIRMs for North Carolina Coastal Communities

Throughout the damaged oceanfront area, the effective FIRMs for the affected communities do not account for the effects of dune erosion, wave setup, or wave runup. Prior to Hurricanes Fran and Bertha, the V-zones were located on the ocean beach, well seaward of building locations. Oceanfront dunes were identified as B and C zones, outside the influence of 100- and 500-year flooding. Fran caused severe erosion in the oceanfront row of buildings and allowed waves greater than 3 feet high to extend several rows of buildings farther landward. Smaller waves swept the entire barrier island in many locations.

In addition to the false sense of safety that results when erosion is neglected, the FIRM deficiencies allowed finished underhouse enclosures in oceanfront B and C zones to be constructed on slab foundations not supported by the piling foundation. In areas like Kure Beach, erosion and wave damage caused significant damage to the finished enclosures. Without the application of FEMA models for dune erosion, wave setup, and wave runup, the wave model used in the preparation of the existing FIRMs underestimates the wave heights above the stillwater elevations. This results in BFEs that are lower than those needed to avoid wave damage to coastal construction.

[Editor's note: FEMA Region IV in Atlanta has issued advisory flood hazard maps for several communities severely impacted by Hurricane Fran and has begun the preparation of revised FIRMs. The communities have adopted the advisory maps and will use them until FEMA issues the revised FIRMs.]

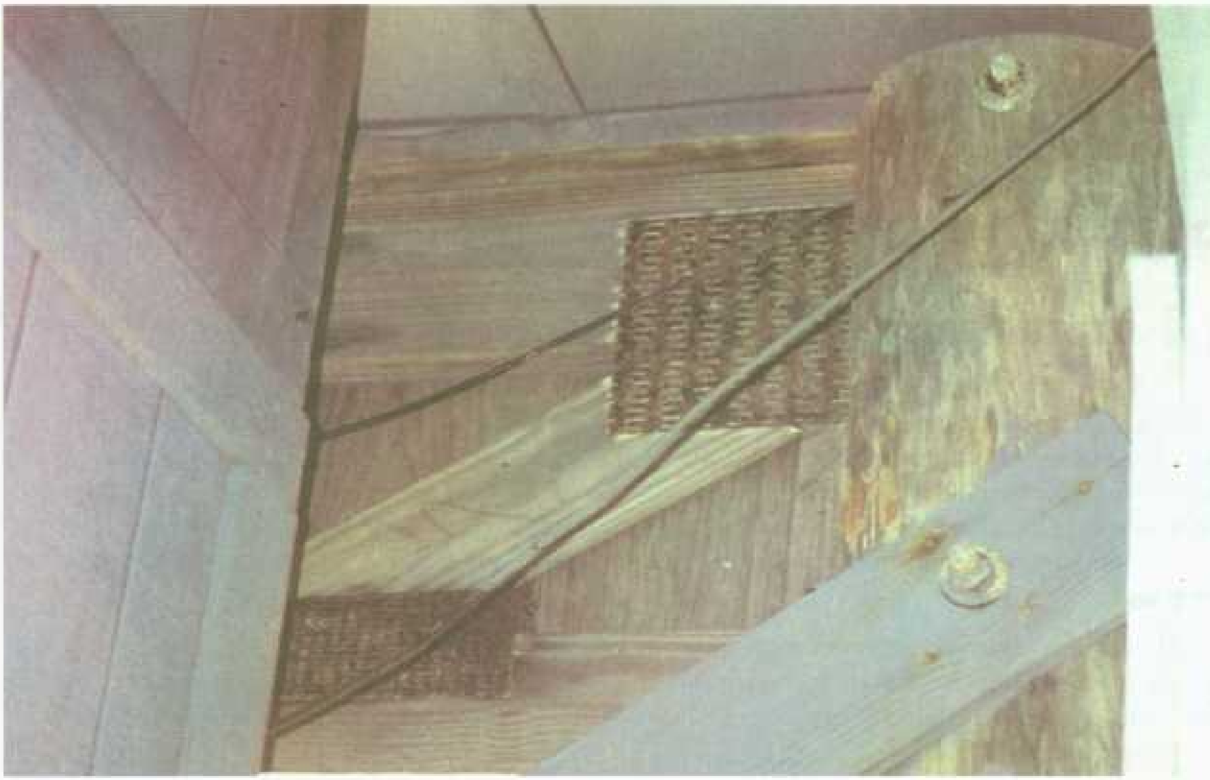

Figure 2-43 *Corrosion of galvanized floor truss plates was observed in many buildings.*

Figure 2-44 *Corrosion of galvanized floor truss plates was observed in many buildings. Note that painting does little to slow the process of corrosion in coastal environments*

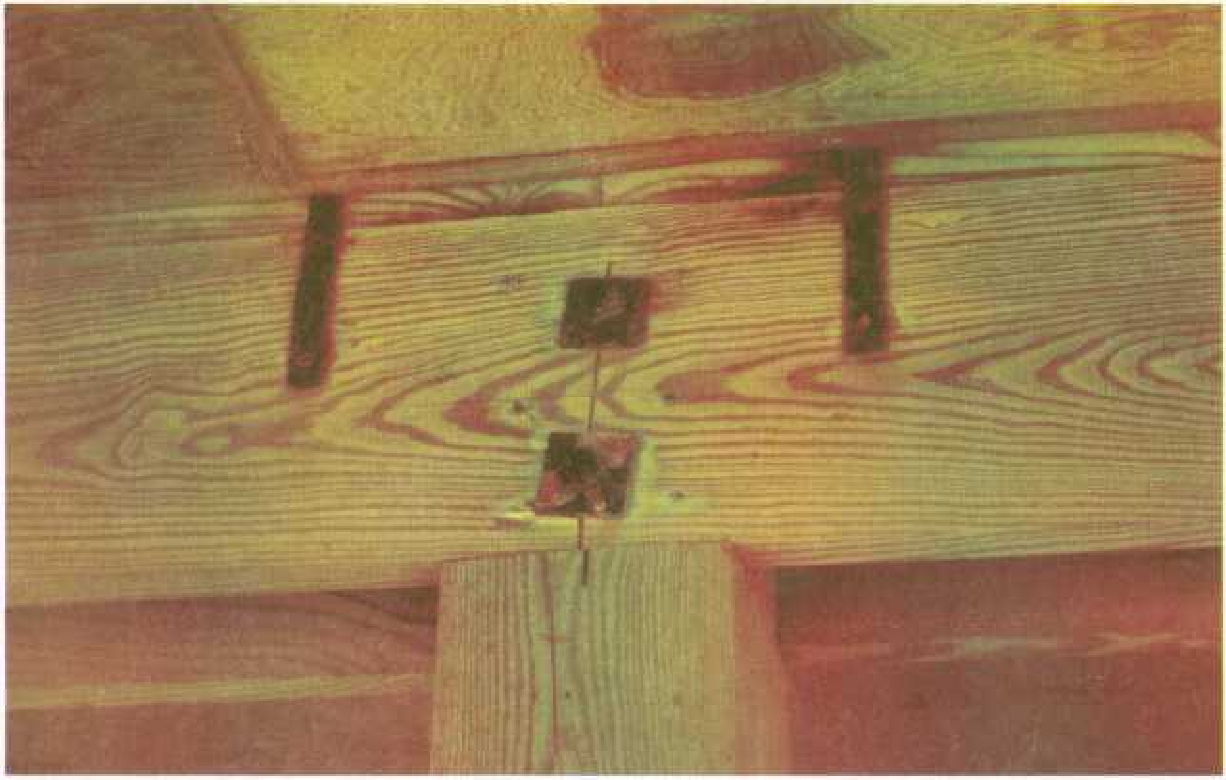

Figure 2-45 Corrosion of hurricane straps and steel plates was also observed in many locations.

2.11 Building Performance Successes

The shift in construction from low floor elevation with shallow footings to elevated piling foundations with underhouse parking, as described in Section 1.3.1, significantly reduced the flood damage to buildings landward of any erosion. Where not subject to erosion, second row and more landward buildings on pilings consistently survived wave heights of at least 3 feet and overwash deposition of up to 3 feet of sand under the building. The use of 8-inch x 8-inch square pilings embedded 8 feet below grade was successful in protecting landward three-story buildings elevated up to 10 feet above grade. Outside of areas impacted by erosion, the BPAT did not observe a single piling failure. Since most landward building sites in the beach communities are not subject to erosion, the piling standards initiated by the by the State Building Code in the 1960's were extremely successful. However, underhouse non-load-bearing enclosures below the elevated floor were regularly flooded and when used as finished living space were often severely damaged.

The shift in the State Building Code to require longer pilings for erosion-prone buildings along the ocean was generally successful. As noted by W-C (see Appendix C), of the 205 post-1986 oceanfront structures on Topsail Island, over 90 percent sustained no significant foundation damage. Only a few were seriously damaged or destroyed. In comparison, adjacent oceanfront houses on shallow pilings were often destroyed when the foundation was undermined by erosion. The current requirement is for piling embedments to -5.0 feet m.s.l. or 16 feet below grade, whichever is less. As noted in Section 2.3.1, the natural grade on most of the eroded lots was relatively low, allowing the -5.0-foot m.s.l. requirement to control the design. In those conditions, the piling standard was usually adequate. However, on higher dunes where the requirement for

16 feet below grade applies, the required depth is too shallow to keep buildings stable after erosion of the dune and beach profile.

It is also important to note that the BPAT observed few situations in which the performance of breakaway walls below an elevated building may have resulted in structural damage to the building. Successful building performance during Hurricane Fran also demonstrates the value of compliance with elevation and setback requirements, the use of flood-resistant construction materials and techniques, such as in engineered concrete buildings, and compliance with other coastal design and construction requirements (see Figures 2-46, 2-47, and 2-48).

Beach nourishment with construction of a hurricane protection dune substantially reduced damage in Wrightsville Beach and Carolina Beach. In these areas, the manmade dune eroded but prevented erosion failures and reduced wave damage to structures. Such dunes are considered expendable but require periodic maintenance and replacement after the worst storms.

Figure 2-46 *While this house experienced 6 feet or more of vertical erosion and scour, as well as the loss of breakaway wall panels, the foundation and superstructure performed as designed.*

Figure 2-47 *As shown by this post-Fran photograph taken at Emerald Isle, North Carolina, proper elevation and setback from the oceanfront in conjunction with substantial protection afforded by dunes resulted in little or no flood damage to the oceanfront row of buildings.*

Figure 2-48
This large, engineered oceanfront structure performed as designed.