2.3.11 SEAWALLS

The BPAT observed widespread failure of seawalls and bulkheads along the Gulf of Mexico shoreline (see Figure 2-15). Damage figures from the State of Florida revealed that over 3 miles of seawalls and bulkheads were destroyed by Hurricane Opal, including 1.3 miles of concrete walls, 1.0 mile of concrete block walls, and 0.8 mile of timber walls (FDEP 1995). Failed walls contributed to damage of buildings, pools, and other structures, due to loss of backfill and generation of debris.

Many walls appeared to have failed because wing walls or return walls were flanked by erosion and scour. Many seawall returns flanked by erosion and scour were no more than 20 to 30 feet long, although some longer returns (50 feet to 75 feet) were also flanked.

Seawalls were usually destroyed when backfill was washed from behind the walls because of overtopping, insufficient wall embedment, or return wall flanking. Habitable structures founded on slabs or shallow foundations, swimming pools, and other structures that relied on seawalls to retain supporting soil, were frequently undermined and destroyed when seawalls failed.

The BPAT noted that retaining walls constructed of concrete blocks were particularly vulnerable to damage by Hurricane Opal. Walls most likely to have survived were observed to have:

- reinforced concrete slab or sheetpile construction
- sufficient wall height or backfill protection to prevent significant overtopping and loss of backfill

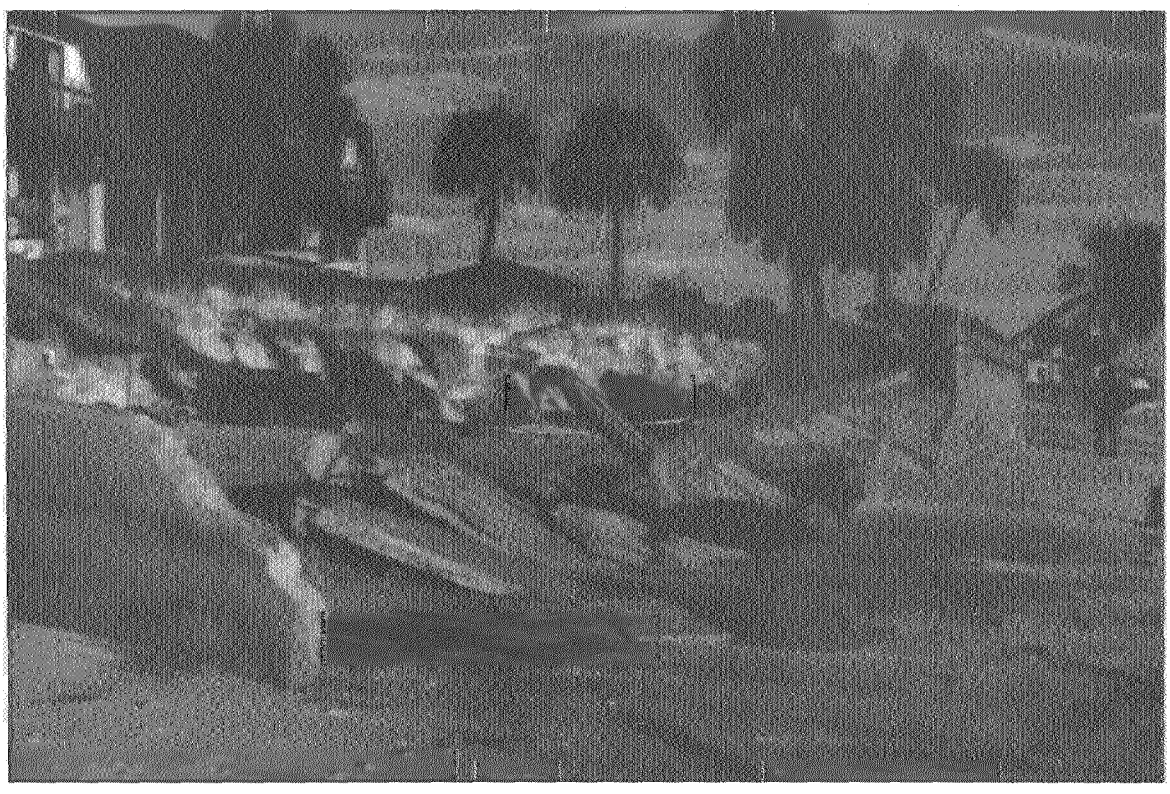

Figure 2-15 Fractured seawall, damaged by storm forces. Note the erosion of the bank behind the wall

- sufficient anchorage and embedment to prevent collapse from seaward rotation of the cap or toe
- return walls extending landward of the seaward face of the building or structure being protected and landward of the effects of erosion and scour

2.3.12 Drainage and Drainage Structures

The BPAT observed the remains of several new stormwater discharge structures adjacent to or between multifamily buildings. These structures consisted of large-diameter corrugated plastic pipes, probably intended to carry stormwater runoff from parking areas and other impervious areas to the beach. Unfortunately, the seaward portions of these pipes were destroyed during the storm and their pre-storm configurations are not known with certainty.

It did appear, however, that erosion beneath habitable structures near these damaged discharge pipes was more severe than at areas away from the pipes, possibly a result of direct discharge of upland stormwater runoff adjacent to or beneath the habitable structures. It is likely that the pipes failed because of erosion and scour caused by the storm or because of the loss of protective seawalls and bulkheads. It is possible, but not known for certain, that the pipe failures and discharge adjacent to the multifamily buildings contributed to foundation damage at those buildings.

2.4 Incorporation of Pre-FIRM Construction into New Construction

Many single-family structures appeared to have been constructed above or adjacent to portions of older pre-FIRM structures and probably resulted from efforts to expand and/or reconstruct older, smaller structures. This type of construction is vulnerable to storm damage because the foundations of the pre-FIRM and post-FIRM sections can respond differently to storm forces and erosion. For example, the BPAT found a damaged house in Mexico Beach that was supported by two types of foundations. One part of the house was supported on concrete block piers placed on the old pre-FIRM slab-on-grade. The remainder of the house, which extended beyond the original pre-FIRM footprint, was supported on timber piles set in concrete encasements. Although the piles and slab survived the storm, the concrete block piers did not. With the loss of the piers, the house listed to the unsupported side and the floor beams separated from the newer, pile foundation. Had the entire house been supported on timber piles, it may have survived with little or no damage.

2.5 Design, Construction, and Workmanship

After observing hundreds of damaged or destroyed structures, the BPAT has concluded that many structures seem either to have been built without the aid of detailed design plans (prepared by a design professional) or not to have been built in accordance with plans that were available. Failure of non-engineered or poorly designed foundations, structural systems, and critical connections often led to major damage or complete loss of structures. Such losses are preventable.

Numerous instances of poor workmanship were also noted by the BPAT during its inspections. In particular, the BPAT found several examples of misalignment of timber foundation piles and poor framing practices in platform-type construction. The BPAT also noted recurring problems with concrete construction. For example, reinforcing steel was missing from or misplaced in slabs, footers, and wall grade beams, and welded wire fabric reinforcement was frequently at the bottom of, not centered in, the slabs. Although no damage was observed that could be definitively linked to these examples of poor workmanship, such practices should be avoided in any construction, especially in areas subject to coastal storm forces.