C20 Evaluating Structural Damage in the Collapse of a Coastal Bulkhead System

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After attending this presentation, attendees will learn several factors determining the assessment of damage to a site containment structure, and how engineering principles were applied in a case involving the collapse of a bulkhead wall system containing a bayside residential building complex.

This presentation will impact the forensic science community by educating the public on some considerations engineers use to evaluate the damage caused by catastrophic events as well as differentiate it from pre-existing conditions in a building superstructure.

In this case, a 25-year-old site containment bulkhead collapsed at a seaside housing complex. The cause of the bulkhead collapse was determined to be an insufficient depth of the sheet piling system, which may have been intensified by scouring and an adjacent deepening of the bay navigation channel over several decades. Tidal variations and significant current velocities likely further saturated the retained fill, thereby increasing the hydrostatic pressure on the bulkhead, and eventually precipitating the collapse.

When the bulkhead wall collapsed, soil within the active pressure zone ruptured into the bay as well. One expert report claimed that the entire structure moved toward the water as a result of the soil movement, because the pilings inside the garage were all observed to be rotated at the top in the direction of the bay, as if to prevent the rest of the building from collapsing. No damage to the interior sheetrock finish was visible and/or documented, although it was alleged that the overall movement of the building complex may not have caused enough rotation to crack the finishes, even in the event of a structural collapse. Additionally, it is possible that the floor tiles may not have indicated visible cracking if the entire floor had moved together.

However, there were several factors that led to the different determination that the structural integrity of the building was not compromised by the bulkhead's collapse and that certain deficiencies were pre-existing.

First, the upper floors throughout the units did not contain significant cracking or lateral movement, which would be evidence of structural collapse or loss of building superstructure integrity. There was also no cracking observed in the hardened spray foam insulation in the garage and recent interior finish cosmetic work, which could be expected to show some displacement in the case of out-of-plane vertical displacement.

Second, the pilings that were observed to be rotated toward the site of the collapse were located farthest from the bay. If the collapse did cause the pilings to rotate, the pilings closest to the bay should have shown the most uniform rotation and the greatest lateral movement, which was not the case. The majority of the existing pilings were permanently set in two directions, and most of the pilings adjacent to the bay were actually measured to be laterally displaced away from the bay.

Finally, it was important to determine whether the observed structural conditions were due to a catastrophic event or related to original building as-built conditions. When constructing a residential structure, the initial process of connecting stringers to the pilings is a rough framing event with an inherent potential for rotation, so it is not unusual for wood pilings to be somewhat out of plumb. Specifically, if the rotation is random rather than uniform, this variation implicates an original as-built condition rather than one caused by a geotechnical failure event. Additionally, if the exterior sheathing is bowed and deformed around the existing piling butts above grade, this is similarly an indication that the pilings exist in an original as-built condition.

Overall, these factors led to the evaluation that the overall structural integrity of the superstructure was not compromised by the loss of the bulkhead in this case.

Bulkhead Collapse, Piling Rotation, Structural Integrity

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