Cement Sails to the Rescue

Hurricane Isabel caused a significant amount of damage to the mid-Atlantic states when it roared ashore in mid-September 2003. The Outer Banks of North Carolina were hit with a severe tidal surge and many hours of relentless storm pounding. Particularly vulnerable was Ocracoke Island, which lies just east of the path taken by the hurricane's eye.

NC 12 is the North Carolina state highway that runs the length of Ocracoke, with NCDOT ferry service being the only way for public transportation to reach the island. On the morning of September 19, it was clear that NC 12 had sustained major damage, and in certain locations was completely undercut and washed away.

With NC 12 being the vital lifeline of the Outer Banks, NCDOT needed to act fast to get the highway operational. Making this task more daunting were the logistics of getting construction materials and equipment there by ferry. A plan was needed where a stable road could be constructed by using a minimum amount of material hauled to the site. Asphalt plants and sources of crushed stone were too far away, and would involve too much hauling, which would not only cause logistical problems, but would be extremely expensive.

NCDOT decided to use the material they had plenty of on site—beach sand—and use portland cement to stabilize it into a sturdy roadbed. They did not feel they were taking a risk in making this choice, since a soil-cement base had been used when NC 12 was previously reconstructed in 1991. The road had performed well over the past 12 years, and survived several hurricanes (Emily in 1993, Bertha in 1996, and Dennis and Floyd in 1999).

Kevin Sebold, a NCDOT Project Engineering Geologist based in Raleigh, was on-site during the construction of the original soil-cement base on Ocracoke in 1991. The decision to use soil-cement again was "primarily based on economics, logistics, and the good performance we've had from the old soil-cement base" said Sebold. In fact, the destroyed sections of NC 12 had broken up under Isabel because the entire roadway had been undercut and fractured, not because of erosion of the soil-cement. This fact is evident in viewing pictures of the road debris piles, where the soil-cement is still intact and attached to the asphalt surface.

Hurricane Isabel undercut and fractured the pavement structure, but the soil-cement remained largely intact and bonded to the asphalt.

The road reconstruction project involved cement stabilization of approximately 15,000 square yards of road base, built seven inches thick. Seventy-two pounds of portland cement per square yard was selected for construction, the same soil-cement treatment used when the road was reconstructed in 1991. Of course, this necessitated the hauling of nearly 525 tons of cement over the ferries, not to mention the construction equipment.

Site Prep, Inc. of North Carolina was contracted to perform the cement stabilization work, but logistics was not the only obstacle. A larger CMI RS-800 reclaiming machine was used in those locations where sections of the old pavement were still intact. In those sections, the old soil-cement base and asphalt surface had to be pulverized with full-depth reclamation, and re-treated with cement. That operation was slow going, even for the 800-horsepower reclaimer.

The soil-cement base was topped with a bituminous surface treatment, which temporarily completed the pavement structure. NCDOT waited until Spring 2004 to pave the asphalt surface course, when better supply routes were operational. This completed the rebuilding of NC 12, providing the lifeline needed for the Outer Banks of North Carolina.

Cement-Treated Base

Cement-Treated Base (CTB) is a mixture of aggregate material and/or granular soils combined with measured amounts of portland cement and water. After compaction and curing, it hardens to form a durable paving material. A bituminous or portland cement concrete wearing course is placed on the CTB to complete the pavement structure. CTB is widely used as a pavement base for highways, roads, streets, parking areas, airports, and materials handling and storage areas.

In CTB construction the objective is to obtain a thorough mixture of an aggregate/granular material with the correct quantity of portland cement and enough water to permit maximum compaction. The completed CTB must be adequately cured to both let the cement hydrate and to harden the cement-aggregate mixture. The fundamental control factors for quality CTB are:

1. Proper cement content
2. Adequate moisture content
3. Thorough mixing
4. Adequate compaction
5. Proper curing

CTB thicknesses are less than those required for granular bases carrying the same traffic because CTB is a cemented, rigid material that distributes the load over a large area. Its slab-like characteristics and beam strength are unmatched by granular bases that can fail when interlock is lost. This happens when wet subgrade soil is forced up into the base by traffic loads. Hard, rigid CTB is practically impervious. It resists cyclic freezing, rain, and spring-weather damage. CTB continues to gain strength with age even under traffic. This reserve strength accounts in part for CTB's excellent performance.

More Information

PCA offers broad range of resources on soil-cement and roller-compacted concrete applications for pavements. Visit our Web site at www.cement.org/pavements for design and construction guidelines, technical support, and research on cement-modified soils, soil-cement base, cement-treated base, and full-depth reclamation.

For local support, tap into the cement industry's network of regional groups covering the United States. Contact information is available at www.cement.org/local.

In some locations the old soil-cement base was still in place, and had to be reclaimed with 800-hp machinery.

To avoid hauling aggregate materials to the island, crews compacted a mixture of beach sand and portland cement to form a sturdy roadbed.

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An organization of cement companies to improve and extend the uses of portland cement and concrete through market development, engineering, research, education, and public affairs work.