By Tanya Wattenburg Komas, Ph.D. and Richard Burt, Ph.D.

The Concrete Industry Management (CIM) Program at California State University, Chico, working with an existing Texas A&M University project, had the honor of participating in a unique research opportunity that was partially made possible through student travel sponsorship generously offered by NRMCA. In March 2008, Tanya Wattenburg Komas, Ph.D., faculty with the Chico State CIM program, traveled to Normandy, France, to conduct non-destructive testing of the concrete structures at the historic World War II D-Day landing site at Pointe du Hoc with five CIM students, including Chad Golden, Andrew Billingsley, Courtney Sheehan, Alexx McAvoy and Robert Hostettler. Larry Olson, PE, owner and president of Olson Engineering, volunteered the use of his company’s equipment and his time for on-site student training so they could complete the testing. Involvement of Chico State in the project began as a result of the need to determine foundation depths for use in Texas A&M University’s work to document and evaluate the overall site and cliff.

Significance of the Site

Pointe-du-Hoc is the most culturally important historic site of the 1944 World War II Normandy invasion. Celebrating the 40th anniversary of D-Day, President Reagan, on top of the Observation Post remarked that “Their mission was one of the most difficult and daring of the invasion: to
climb these sheer and desolate cliffs and take out the enemy guns.” (Brinkley, 2005) President Reagan was referring to the early morning of June 6, 1944, when Lt. Col. James Earl Rudder led elements of the 2nd Ranger Battalion in one of the most famous and heroic actions of D-Day. Their mission was to destroy 155mm cannon capable of firing on troops and ships landing on Utah and Omaha beaches (Ambrose 1989, Historical Division, U.S. War Department 1946, Lane 1994, McDonald 2000). (Figure 1).

Pointe-du-Hoc is a medium coastal battery consisting of a variety of structures such as gun emplacements, casemates and personnel and ammunition bunkers. Constructed as part of Hitler’s Atlantic Wall campaign, it was strategically placed between the Utah and Omaha invasion beaches. The site was designated a class A Historic Site by the French Government on 28 February 1955. The site was formally transferred to the American Battle Monuments Commission (ABMC), a small, independent agency of the Executive Branch of the U.S. federal government, for perpetual care and maintenance on January 11, 1979, and remains a monument to those who sacrificed on that fateful day (Figure 2).

The Question of Concrete Quality

At the height of the construction of the Atlantic Wall from mid-1942 to mid-1944 over 13,234,500 m³ of concrete was placed by the Todt Organization (Saunders, 2001) in what was considered at the time one of the greatest construction undertakings since Roman times (Handbook of the Organization Todt, 1945). The urgent need to construct the defenses led to construction continuing through the winter and increasing allied bombing led to scarcity of high quality cement and coarse aggregate (Saunders 2001, Dorsch 1979, Schmetzer 1979). These are all factors that would affect the quality of the concrete.

Construction was underway at Pointe du Hoc in August 1942 when the battery was spotted by aerial reconnaissance and was continuing at the time of the invasion in June 1944 (Allied Central Interpretation Unit, 1944). There appears to be two distinct phases of construction. The first phase involved the construction of the six circular gun emplacements for the 155mm guns and the support buildings (Personnel, Ammunition, Anti-Aircraft and Hospital Bunkers and the Observation Post or Fire Control Post). The second phase involved the construction of four gun casemates that were intended to replace the open gun emplacements.

From 25, April 1944, the site was subject to intensive bombing from medium and heavy bombers dropping 500, 1000 and 2000 lb. bombs. The easy identification of the Pointe resulted in accurate attacks during daylight raids. Destruction of the site continued on D-Day when the site was subjected to naval bombardment from several ships, including the 14 inch guns of USS Texas. Photographs taken after the battle show the site virtually covered with bomb and shell craters that are still clearly present today (Figure 3).
Several questions remain regarding the concrete fortifications at Pointe du Hoc. What are the differences in the quality of the concrete between the different structures and different construction phases? How did the quality of concrete affect the amount of damage sustained during Allied bombing? How much deterioration of the concrete and corrosion of the rebar has occurred since D-Day, especially given the location in the high chloride environment near the ocean?

Concrete Evaluation Project

Setting the stage for the concrete evaluation was ongoing survey and documentation work and cliff evaluation by the team from Texas A&M University funded by a grant from the American Battle Monuments Commission (ABMC). That work at the site began in September 2003 with the goal of producing a comprehensive site plan and determining the conditions of the eroding cliff face.

Observations of the remains of the structures noted during the survey and documentation work suggested anomalies that raised concerns about the consistency and quality of the concrete and thus questions about the future stability of the structures. Among the noted anomalies were that some of the structures were remarkably intact while others showed very little damage as a result of the bombing; the concrete may not have cured completely at the time of the invasion, and differences in aggregate types and grading.

Chico State became involved in the project because of their expertise in historic concrete evaluation and repair as part of the CIM program. While the on-site testing began because of the need to determine foundation depths, the project afforded the CIM students the opportunity to become proficient at operating the Olson Engineering state-of-the-art non-destructive testing equipment while collecting valuable data about the overall existing conditions of the concrete and reinforcing in several key structures. It also allowed the students to compare the use of newer equipment with more traditional units such as the Schmidt Hammer. (Figure 4).

Research Method

There have been three components to the concrete research to date, including laboratory testing, historic document research, and on-site testing.

Laboratory tests were completed in December 2006 at Construction Technology Laboratories (CTL), Chicago. CTL donated the use of its laboratory facilities and allowed the faculty from CSU Chico to work with its professional personnel to conduct laboratory testing of concrete and cement samples from the Pointe du Hoc site. The tests were undertaken to determine the mix proportions and compressive strengths of two samples of concrete from different structures built at different times. Tests were
also performed to determine the cement composition from a sample obtained from a hardened sack of cement that remained on the site from the date of original construction. The cement appears to have been intended for use in completing a new concrete block casemate that was destroyed by a bomb prior to completion (Figures 5 & 6). The combined tests revealed similarities and differences between the concrete samples.

Locating and evaluating historic documents related to the concrete materials and construction at the site is on-going. This research has revealed such historic documents as those from the Ministry of Supply’s Advisory Council on Scientific Research and Technical Development “Anti-Concrete...
Committee” organized by Allied Forces in 1944 to “review and co-ordinate existing work on methods of destroying or breaching concrete and reinforced concrete structures.” The documents contained information on the composition of other similar concretes tested in or around 1944-5. A comparison of current research results and data obtained from the historic documents showed similarities in concrete characteristics between the concrete tested in 1944-5 and that tested from Pointe du Hoc in 2006.

Although the necessarily small samples tested in the lab yielded important information, the on-site testing was essential to better understand the condition of the concrete at the site. Non-destructive tests that were performed for three structures of particular interest included visual inspection, rebound hammer, pulse velocity (Figures 7 & 8), impact echo (Figure 9), and rebar location/size/cover (Figure 4). Data from this effort is currently being analyzed in terms of the historical data and accepted concrete industry repair practice. Tests that were discussed but not performed during this phase of the project due their destructive nature and limitations of time, manpower, and other factors included extent of carbonation, chloride intrusion, and embedded reinforcement corrosion (Corrosion was assessed visually where possible).

Conclusion

It is the hope of the collaborative Texas A&M University and California State University, Chico teams and many others that the important work of surveying, evaluating, and preserving the landscape and structures at Pointe du Hoc will continue. The importance of this endeavor cannot be understated, particularly as it relates to the younger generations. For the faculty and student researchers from both institutions, their hands-on experiences with this project have not only enabled them to learn a great deal about site and structural documentation and evaluation, but also given them the life-changing experience of having participated in honoring the individuals who sacrificed so much at that pivotal point in the history of the world. The continued presence and accessibility of sites such as Pointe du Hoc promise to help keep alive the memories and lessons of this and other such important sites along the Normandy Coast and throughout the world.

Further Information

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About the Authors

Dr. Tanya Wattenburg Komas holds a Ph.D. in Architecture from Texas A&M University, a Certificate in Historic Preservation from Texas A&M University, an MS in Historic Preservation from Columbia University, New York, a BS in Landscape Architecture from the University of California, Davis, and is a member of the International Concrete Repair Institute and the Association for Preservation Technology International. Dr. Komas is on the faculty of the Concrete Industry Management program at CSU, Chico, and is an invited Corresponding Fellow of the Center for Heritage Conservation, College of Architecture, Texas A&M University. Dr. Komas has extensive experience in building design and preservation, directs academic and professional research in concrete repair and preservation and in the development of computer graphic methodologies for use in many areas of the building professions.

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