Vibro-Densification for Emergency Response of an Impoundment Dike Reconstruction

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The 2018 Category 1 Hurricane Florence made landfall along the coastal regions in North Carolina. Along with high wind speeds of 90+ mph, significant amounts of rain (having parts of NC received 40 inches of rain over a three-day period, nearly equaling the average annual rainfall) caused significant damage to structures. Following the hurricane and catastrophic flooding along the Cape Fear River, substantial portions of an impoundment dike of an industrial facility (including three breach sections; totaling approximately 1,400 LF) were breached. Under emergency responses, the project engineers provided personnel, materials and supplies to the site within 2 hours of dam breach observation. Temporary measures, such as placement of plugs by end-dumping riprap and sand bags below water, were taken to stop the flow of water out of the impoundment. Subsequently, a long-term repair of the dike was developed by the engineers, discussed with the state dam safety agency, constructed in fast tracks, and had the dike repair substantially completed in less than 3 months after the breach event, allowing the facility reopened for normal operations. Based on evaluation by the engineers and consultations with a geotechnical specialty contractor, ground improvement techniques were utilized to improve dike foundation stability. Vibro-densification was utilized to densify the saturated sand fill down to a maximum depth of 18 feet below the water level. To speed up the construction schedule, two sets of vibro-densification devices were used to densify sand fill columns in 10-ft by 10-ft grid patterns. To provide a stable working platform, the sand fill was placed to approximately 2 feet above the water level. The vibro-densification was performed during the day shift, followed by field density verification using cone penetration testing during the night shift. Upon completion of the vibro-densification, the dike sections were constructed with compacted structural fill and finished with reinforced concrete liners. The project also included construction of a stone fill crossing with four, eighty-foot long, eight-foot diameter culverts over the impoundment canal. The emergency responses and measures taken to reconstruction of the impoundment dikes were successfully executed through close communications and coordination among the client, engineers, and contractor. Having the reconstruction completed in less than 3 months and three weeks ahead of schedule, it allowed the facility to come back online for normal operations. Most importantly, all work was completed with zero OSHA recordable incidents or near-miss events.