



REVERSE CIRCULATION DRILLING USED ON MICROPILES RICHMOND SAN RAFAEL BRIDGE

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San Francisco, California - Unique drilling procedures were developed by AGRA Foundation, Inc., (AGRA) of Richmond, California, for the seismic retrofit of foundation elements on the Richmond San Rafael Bridge. The bridge, which spans the northern portion of the San Francisco Bay, extends from Contra Costa on the east to Marin Counties on the west. The project entails installing high-capacity micropiles through existing concrete belled piers supported on H-piles. A total of 31 two-bell piers will be retrofitted. Between 12 and 32 micropiles will be installed at each pier (6 to 16 micropiles per bell). AGRA also is installing 66-inch and 150-inch-diameter end-bearing piles at select locations. The California Department of Transportation (Caltrans) is the bridge owner and the designer of the retrofit elements. Tutor-Saliba-Koch-Tidewater Joint Venture is the Prime Contractor on this project. Project completion is scheduled for December 2003.

AGRA's drilling equipment, slurry system, support equipment, and supplies are situated on prefabricated work platforms installed around existing bridge piers. A prefabricated steel template is installed at each pier prior to work platform installation. Precise placement of the templates is necessary to guide coring and drilling equipment through the existing reinforced concrete bells and between the existing H-piles that support the bells.

Drilling Method

Reverse circulation drilling with dual wall drill rods is used to advance through alluvium and bedrock. At the beginning of the drilling process, a temporary 20-inch-diameter conductor casing is extended from the work platform deck to the top of the concrete bell. The concrete bell is cored after which a permanent 12-inch-diameter casing is lowered through the cored bell to mudline. Drill rods equipped with a tricone bit are advanced through the permanent casing to the mudline. The bit and permanent casing are advanced in tandem through alluvium (consisting of scour protection, Bay Mud, sand, and clay) to Franciscan Formation bedrock, thereby casing off alluvium from bedrock and the micropile rock socket. Permanent casing is seated in the Franciscan Formation which consists primarily of interbedded graywacke sandstone and shale of highly variable rock quality. The micropile rock socket is then drilled by advancing the drill rod and tricone bit beyond of the tip of the permanent casing using synthetic slurry as drill fluid. As a rock socket is advanced, a constant head of drilling slurry is maintained. Once a rock socket is completed, the synthetic slurry inside the socket is replaced with fresh slurry to help maintain the integrity of the socket between the time that socket drilling is completed and the micropile is grouted. AGRA is using Shore Pac GCV synthetic slurry by CETCO to meet the viscosity and pH requirements of the contract specifications.



Drill platform with drill rig.



Slurry Cleaning Tank with Desander.

Slurry Closed System



A closed circulation system is used to advance through alluvium and bedrock. Clean drill slurry is introduced into the system at the drill head at a rate of about 13 gallons per minute. The resulting slurry/air mix flows through continuous air channels located in the wall of the drill rod. The air channels extend from the drill head (at deck level) to discharge ports located about 12 inches above the top of the tricone bit. A metal “skirt” above the discharge ports prevents backwash of slurry up the annular space between the rock socket wall and the drill rods. Drill cuttings are carried up the center of the drill rod to a hopper located on the work platform deck. “AGRA is responsible for slurry QA/QC and associated documentation.” says Bob Bishop, AGRA’s drilling superintendent. “It is important to maintain viscosity and pH parameters and also keep the Shore Pac slurry under a constant pressure head to prevent air from coming up the annular space between the rock socket wall and the drill rod.”

Slurry Recycling & Usage

Shore Pac slurry is stored in three 4,000 gallon dedicated slurry tanks located below the deck of a work platform. One tank is used for recycled slurry and two are kept full of fresh slurry. Stored slurry is pumped via hose to the drill head of the CMV MK 1200 DT drill rigs that AGRA is using on this project. A return hose conveys slurry with rock cuttings from the rock socket into a cyclone de-sander elevated above a dual wall cuttings tank. Weirs on the inner wall of the cuttings tank allow slurry to flow out of the inner chamber containing the cuttings and into a perimeter chamber, thereby isolating solids from slurry fluid. The spent slurry is then pumped back into one of the dedicated holding tanks beneath the work platform deck where it is “built up” and retested prior to reuse. Locating the tanks below the platform deck allows for more work space for personnel, cranes, drill rigs, and supplies. Work space is at a premium as fully equipped platforms allow for about 8,000 square feet of useable space. According to Mr. Bishop, “Because of the environmental sensitivity of this high profile project, and the logistics of moving drilling spoils to land, we chose a drilling slurry that could be recycled and would generate relatively dry spoils.”



View of the Richmond San Rafael Bridge.



Bridge with view of Drill Platform and Barges