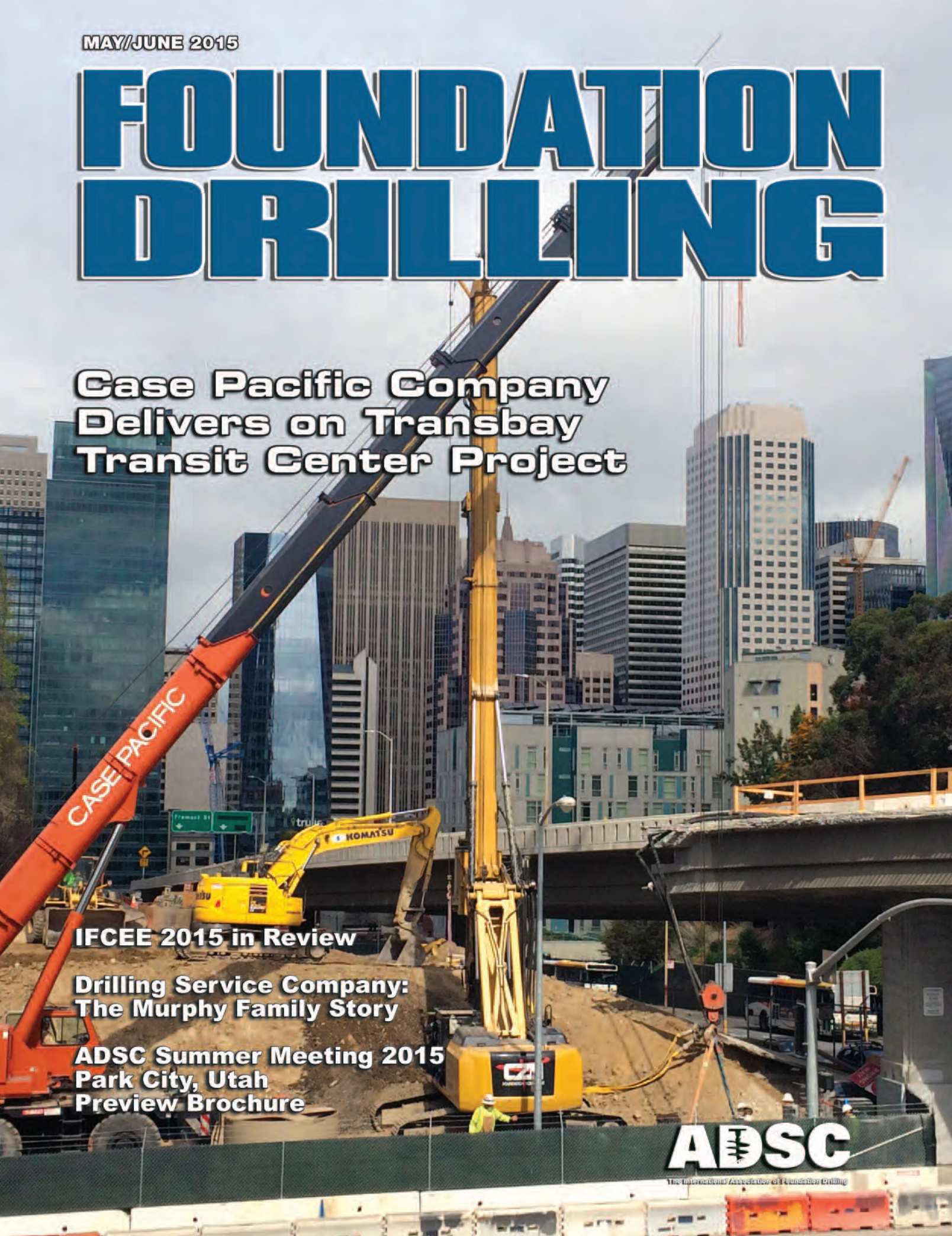
MAY/JUNE 2015

FOUNDATION DRILLING

Case Pacific Company Delivers on Transbay Transit Center Project



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Case Pacific Company Delivers on the Transbay Transit Center Bus Ramps Project

By Will Gehrke, Case Pacific, Paso Robles, California

Introduction

The Transbay Transit Center, also known as the "Grand Central Station of the West," is located near the South Beach and Rincon Hill sections of San Francisco at 175 Beale Street and about a block away from the terminus of Interstate 80 (Bay Bridge) at the Fremont Street exit. Nearby cross streets include Beale, 1st Street, 2nd Street, Howard and Natoma.

The Transbay Transit Center will transform transportation in California and stimulate the economy by connecting eight counties in the Bay Area. The Transit Center will accommodate eleven transit systems from the Bay Area and Southern California including AC Transit, Amtrak, BART, Caltrain, Golden Gate Transit, Greyhound, MUNI, SamTrans, WestCAT Lynx, Paratransit and the California High Speed Rail. The transportation network created by this project will connect more than 100,000 passengers per day to the San Francisco Bay Area and will serve up to 45 million passengers per year. The transit center will be the

This project is one of the largest transit projects under construction in the Western United States.

northern terminus for the California High Speed Rail and will be one of the first modern high speed rail stations in the United States. This project is one of the largest transit projects under construction in the Western United States.

Project Description

The project consists of three interconnected elements:

1. Replacing the outdated Transbay Terminal at First and Mission Streets.
2. Extending Caltrain and California High Speed Rail underground from Caltrain's current terminus at 4th and King Streets into the new Transit Center.
3. Creating a new neighborhood with homes, offices, parks, and shops surrounding the new Transit Center.

Phase 1 Transit Center

The first phase of the project will be to construct a new five story Transit Center with one above-grade bus level, ground-floor concourse and two below-grade rail levels serving Caltrain and the future California High Speed Rail.

Phase 1 Bus Ramps

Phase 1 will also construct new bus ramps that will connect the Transit Center to a new off-site bus storage facility and the San Francisco-Oakland Bay Bridge. The new bus ramp will replace the ramp which formerly connected the terminal to the Bay Bridge and which was demolished in the fall of 2011. The proposed access ramp consists of three major segments: (1) the Harrison Street overcrossing, (2) the bus ramp viaduct, and (3) retaining wall Nos. 1 and 2 at the embankment section between the two aerial structures.

The Harrison Street overcrossing is proposed to replace the 1930s era bridge over Harrison Street. The new crossing is a twin structure with one-lane inbound traffic on the right bridge and one-lane outbound traffic on the left bridge. Both bridges are single-span structures that will be simply supported on the abutments. The proposed bus ramp viaduct will replace the 1930s era elevated roadway. It is an approximately 1,030 foot long structure between the Transit Center and abutment No. 1, located at the southeast corner of Folsom Street. The viaduct deck will accommodate two lanes for inbound and one lane for outbound bus traffic from Tehama Street to

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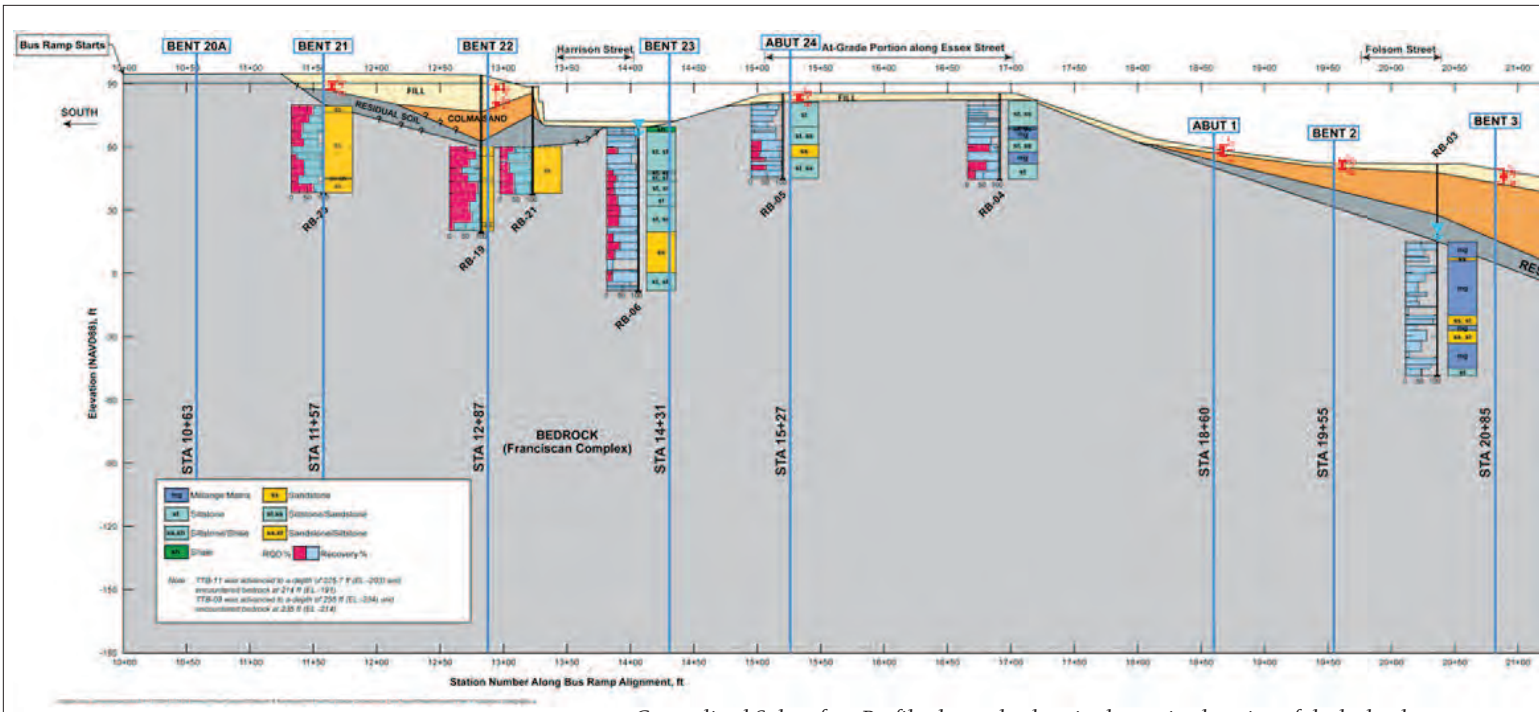
Bent 20 Permanent casing installation.



Generalized Subsurface Profile shows the drastic change in elevation of the bedrock.

the terminal. A circular ramp will be integrated into the main structure over Clementina Street as the roundabout for inbound vehicles to reroute into the bus storage facility. A 14 foot long shoulder between the roundabout and the terminal will be designated for temporary bus storage during peak hours.

Case Pacific Company's Scope of Work

Case Pacific Company was subcontracted by Shimmick Construction, Inc.*, the projects Bridge Subcontractor, to install Cast-In-Drilled-Hole (CIDH) Concrete Pilings for the new Bus Ramp that connects the Fremont Street exit of the Interstate 80 to the Transit Center. The Bus Ramp includes widening of the existing Fremont Street off ramp and extending the off ramp with a new bridge into the Transit Center. The new bus ramp starts at Interstate 80 at the Fremont Street off-ramp and heads northwest to the new Transit Center located on the north side of Howard Street. The new bridge is located between 1st and 2nd Streets and spans over Harrison, Folsom, Clementina, Tehama and Howard Streets.

Case Pacific Company was subcontracted to install a total of 21 large diameter drilled shafts and 8 each small diameter drilled shafts consisting of:

Bents 2-7	13 each – 108" Diameter x 93'0" Average Depth Drilled Shafts, max depth 123'0"
Bent 8	4 each – 96" Diameter x 150'0" Deep Drilled Shafts
Bents 20-23	4 each – 84" Diameter x 29'0" Average Depth Drilled Shafts, max depth 39'0"
Abutment 24	8 Each – 24" Diameter x 12'0" Deep Drilled Shafts

South Elevation, Bus Ramp rendering looking South towards the I-80 from the terminus of the Bus Ramp at the Transit Center.

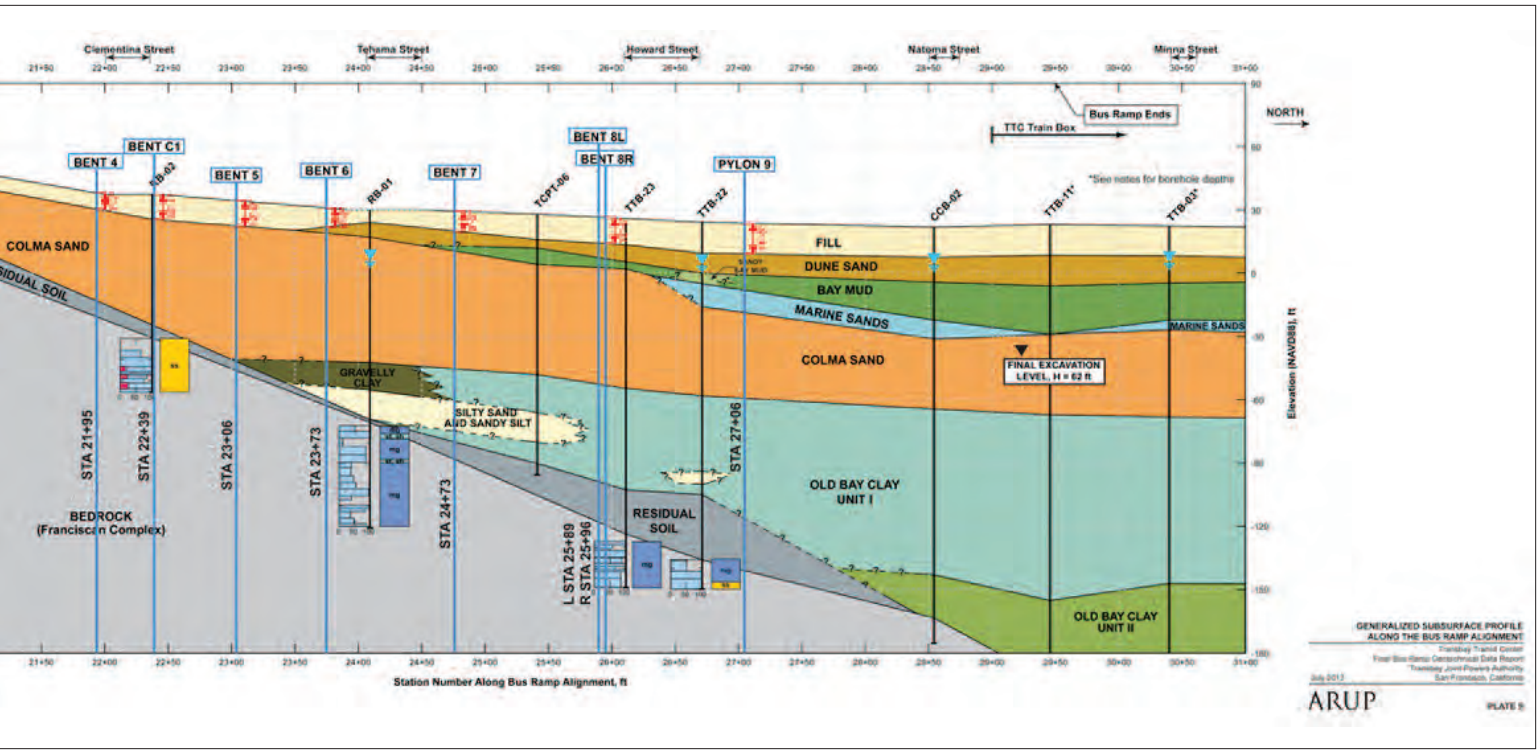
Subsurface Soil Conditions

The subsurface soil data was provided by Arup North America Ltd for the Transbay Joint Powers Authority, "Geotechnical Data Report for Bus Ramps," dated July 2012.

The site elevation varies from approximately +95 feet at the southern end to approximately +22 feet at the northern end.

The subsurface stratigraphy varies considerably from south to north. Thick soil deposits are present in the northern end of the bus ramps. The top of the bedrock was encountered at a depth greater than 200 feet at this part of the site. The depth to the top of the bedrock rapidly decreases in the southern direction and begins to surface between Harrison Street and Folsom Street.

The soil deposits in the northern end of the project consist of



a sequence of sediments, including fill, dune sand over Bay Mud, which overlies marine sands and Colma Sand, followed by the Old Bay Clay, sometimes over residual soil over bedrock. The soil deposits at the southern end of the project consist of fill over bedrock to approximately Harrison Street. South of Harrison Street, the subsurface strata consist of fill, Colma Sand, and residual soil over bedrock.

Beneath all the soil is the bedrock. The bedrock is of the Franciscan complex and more particularly is part of the Alcatraz Terrane, which is comprised of sandstone, siltstone, and shale. The sedimentary rock is commonly described as greywacke. At some

Uniaxial Compressive Strength Tests were performed on intact rock samples of 4 to 6 inches long to determine the compressive strength. The compressive tests showed a range of results from the low end of 710 psi to the high end of 12,210 psi.

boreholes, the rock consisted of very soft, heavily sheared siltstone and shale, referred to as mélange matrix.

Uniaxial Compressive Strength Tests were performed on intact rock samples of 4 to 6 inches long to determine the compressive strength. The compressive tests showed a range of results from the low end of 710 psi to the high end of 12,210 psi. These results are consistent with the variable rock hardness that can be found within the Franciscan complex.

Design

Bents 2-8, 17 total piles, consisting of the 96" and 108" diameter CIDH Concrete piling were all designed with a minimum embedment 10'0" to a maximum embedment of 60'0" into competent bedrock which varied at each pile location. All 17

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4100 Crane with 200-6 vibratory hammer holding 120" diameter x 30'0" long casing to be installed in Bent 5.

Mixing and De-sanding Bentonite Slurry System.

piles were designed with an optional construction joint 18'0" below the top of pile elevation to facilitate the column reinforcement embedment requirement into the pile reinforcement.

Bents 20-23, 4 total piles, consisting of 84" diameter CIDH Concrete Pilings were all designed with a minimum of 10'0" embedment into competent bedrock. The 4 piles were designed with permanent and isolation casings ranging from 19'0" to 30'0" in total length. These piles had a mandatory construction joint 12'0" below the top of pile elevation to facilitate the column reinforcement embedment into the pile reinforcement.

Construction

Construction on the drilled shaft foundations began in October 2014, with the last shaft successfully being installed in April 2015.

Construction began with the installation of the permanent casings for Bents 2-8 which were ¾" wall 120" diameter x 30' permanent steel casings. The permanent casings were installed with a 200-6 vibratory hammer, supplied by American Pile Driving Equipment,* with the assistance of a Manitowoc 4100 crane. The vibratory method was used to install the casing because of the instability of the ground conditions within the layers of the existing fill and dune sand layers. On the southern end of the project, Bents 20-23, the permanent casing was installed in open hole drilled shafts; bedrock was encountered at the top of the shafts which made this method feasible.

Upon completion of the installation of the permanent steel casings, the shafts were drilled to pile tip elevations using a CZM EK-250* Drill Rig. We used bentonite slurry to help maintain the shaft stability during the drilling operations. Bentonite slurry was very successful in maintaining the shafts side walls through the varying subsurface conditions. Some of the shafts took multiple days to drill due to the varying hardness of the rock within the Franciscan complex.

On completion of drilling, the shafts drilling slurry had to be re-circulated and cleaned by the de-sanding tank to be re-used in future shafts. Once the shaft was fully recirculated, the bentonite was tested to ensure the slurry specifications were met and the shaft was ready to pour. The rebar cage was set and the shafts were poured.

Concrete Placement.

Testing Requirements

In addition to the standard gamma gamma testing and Cross-Hole Sonic Logging, all shafts were required to be checked for verticality by using Sonic Caliber Equipment provided by Loadtest USA*. All verticality tests were conducted by Case Pacific Company.

The project specifications stated, "Contractor to use sonic caliper method to determine the verticality of each shaft. At a minimum, perform test immediately after completion of the excavation and after the shaft has been cleaned of suspended sediments and has been made ready for concreting."

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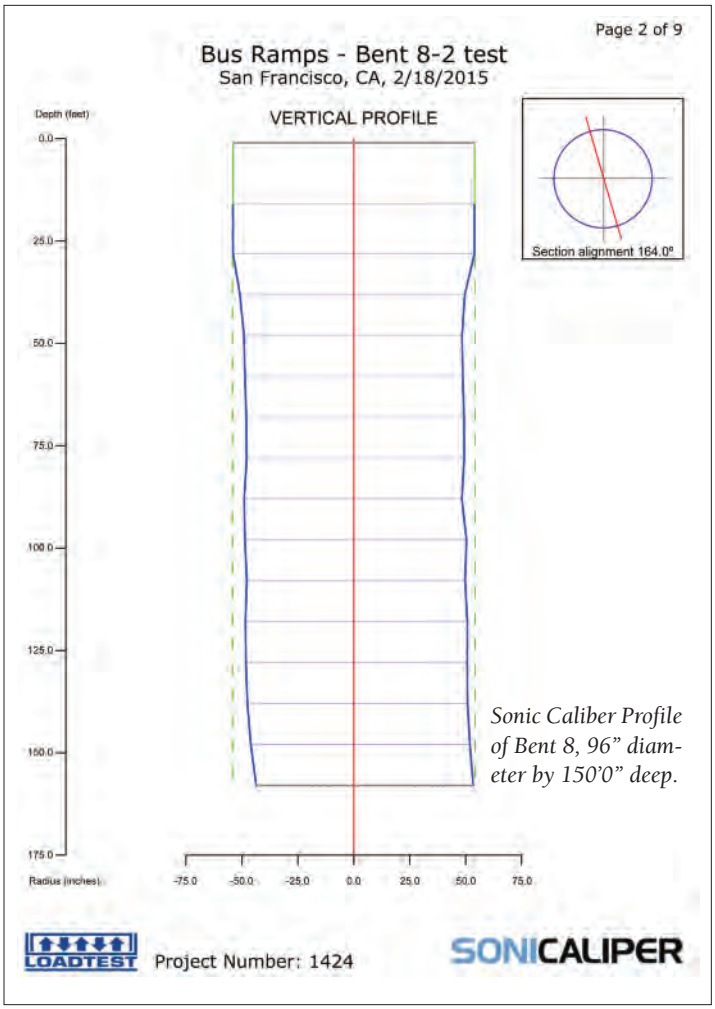
The verticality tolerance was stated as, "the axis of the drilled hole must not deviate from plumb more than 6 inches per 100 feet of length," which is only 0.5% out of plumb.

Due to the very strict tolerances of the verticality, great care was taken during the drilling operations to continually monitor the shafts alignment and plumbness. All shafts were accepted and met the project specifications.



Sonic Caliber Profile of Bent 8, 96" diameter by 150'0" deep.

Rebar cages being hoisted into the air within only a few feet clearance from neighboring properties.

Access

Downtown San Francisco along with many metropolitan areas create havoc in planning and performing the work. Equipment and material deliveries had to be planned out weeks in advance for permitting, lane closures and noise restrictions.

A typical lot had four to six large diameter piles with the typical lot size 150' long x 100' in width. Not only were the lots congested, but the drastic elevation change from the southern end of the project to the northern end made leveling up the large equipment a constant issue.

Working in a metropolitan area makes all phases of work a challenge. Not only was the project located in a congested downtown area, the overall working areas were very small for the size and amount of piles to be completed.

The site access was broken up into different lots which were

(Continued on page 23)

CASE PACIFIC COMPANY Contd.

Rebar cages being hoisted into the air with limited clearance from nearby properties.

Dismantling of the 4100 Crane in limited access.

separated by public streets, residential towers, commercial properties and the existing Fremont Street off ramp. A typical lot had four to six large diameter piles with the typical lot size 150' long x 100' in width. Not only were the lots congested, but the drastic elevation change from the southern end of the project to the northern end made leveling up the large equipment a constant issue.

Whether we were drilling the shafts, setting the rebar cage or pouring concrete, all activities had to be pre-planned to ensure public safety and a productive work day.

Constant communication was key for a successful and safe project, Case Pacific Company along with Shimmick Construction, Webcor/Obayashi, and the Transbay Joint Powers Authority all communicated on a daily basis with regards to the deep foundation construction schedule and access needs.

A successful project starts with pre-planning and developing a "method to the madness" especially working in a metropolitan area with sloping limited access. Our management staff along with the Field Superintendent performed very difficult, tight access large diameter shafts successfully. Our crews and especially our Superintendents years of experience played a vital role in this large and complex project.

Most drilled shafts projects are controlled by the subsurface conditions but for this project access and restrictions working in the city seemed to control a lot of our construction methods and schedule. Although the subsurface conditions were variable and difficult, we pre-planned and successfully executed the plan with the end results being completing all shafts without any mitigation and on schedule.

A clear vision of the work to be completed and understanding of the project needs, schedule and specifications are necessary for a complex drilling project.

**Indicates ADSC Members.*

Project Team

Owner:	Transbay Joint Powers Authority
General Contractor:	Webcor/Obayashi, Joint Venture
Bridge Contractor:	Shimmick Construction Co., Inc.*
Specialty Foundation Contractor:	Case Pacific Company*

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