Alameda Corridor-East: San Gabriel Trench Project

The Alameda Corridor-East (ACE) Construction Authority awarded a $172.6 million contract to Walsh Construction Company (Walsh) for the construction of a 2.2 mi (3.5 km) long grade separation including a 1.4 mi (2.3 km) long trench that will allow Union Pacific Railroad (UPRR) and Amtrak passenger trains to operate below ground through the city of San Gabriel, Calif. The project is necessary as the ACE trade corridor accommodates approximately 60% of the shipping containers that move from San Pedro Bay, the busiest port facility in the western hemisphere, to the rest of the country via an extensive rail network. Rail traffic is expected to increase by as much as 160% by 2020, and the resultant delays to vehicular traffic is projected to increase by an estimated 300%. The San Gabriel Trench Project is designed to mitigate the effects of this increased train and vehicle traffic throughout the San Gabriel Valley. Malcolm Drilling Company (Malcolm) was selected by Walsh to perform the specialty foundation and ground improvement work for the San Gabriel Trench.

This project is part of ACE's program to create 22 grade separations and safety improvements at 39 grade crossings throughout the San Gabriel Valley. In addition to safety improvements that will eliminate crossing collisions and delays to emergency responders, the project will reduce vehicle congestion and emissions from passenger cars and trucks having to wait for passing trains, and the project will also reduce locomotive horn and crossing bell noise to local residents.

Construction of this portion of the project began in late 2012, and it is scheduled to be completed by the end of 2017, having created approximately 9,000 jobs during this period. The project is being funded from Proposition 1B transportation bonds approved by California in 2006, the Metropolitan Transportation Authority (MTA) Measure "R," and other local and federal funds. The overall project cost is estimated to be $313 million.

Aerial view of San Gabriel trench project

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Unearthing Artifacts

Prior to the start of construction, archaeologists excavated an area within the railroad right-of-way that was once a part of the historic San Gabriel Mission, founded in 1771. Thousands of historic artifacts from California's Mission period were found in the area, including pottery, arrowheads, remains of a historic mill, and human skulls and bones, which are believed to be Native American. Once construction commenced, an archaeologist and a representative of the local Native American tribe were required to be present during all excavation activities to examine the drill spoils for any artifacts.

Temporary Track Support

To support the temporary shoofly track, more than 5,600 lf (1,707 lm) of ground improvement work consisting of deep soil mixing (DSM) and the construction of two, 92 ft (28 m) deep drilled shaft piles that were 96 in (2.44 m) in diameter were performed using a Bauer BG 40 top drive drill rig. The DSM was an effective alternative to conventional sheet piling, eliminating potential vibration issues and providing much better support near the San Gabriel Mission and existing homes and businesses along the corridor. DSM allowed the project team to start excavation for the trench without having to wait to process sheets right next to the new shoofly track.

Secant Pile Wall Construction

The close proximity of the shoofly track on the west end of the project required the trench wall to be drilled in two phases. The first phase consisted of installing the south secant pile wall using a temporary shoring wall to the north to provide support for the shoofly track. The temporary shoring wall consisted of steel sheet piling and installation of 210 each, 3 and 4 strand tieback anchors. The second phase will consist of constructing the north trench wall after the train is lowered into the trench and the temporary shoofly track is removed.

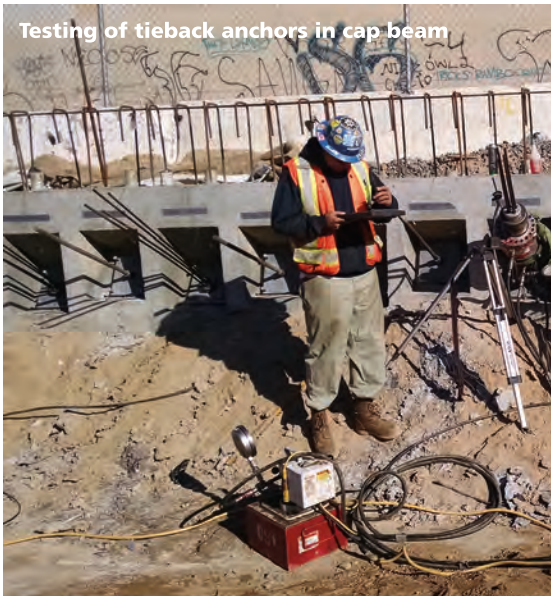
Once the temporary shoofly track was completed and train traffic diverted from the trench alignment, construction began on 15,600 lf (4,755 lm) of secant pile walls. The horizontal and vertical support components of the trench wall required 3,700 primary 18 in (457 mm) diameter unreinforced secant piles and 3,700 secondary 36 in (914 mm), 48 in (1,219 mm) and 60 in (1,524 mm) diameter reinforced secant piles. The piles were installed with extremely tight tolerances of 1 in (25 mm) on location and 0.5% for plumbness. Installation was accomplished using various lo-drill and top-drive drill rigs, which required over 54,000 cu yds (41,286 cu m) of concrete and cement slurry. Malcolm installed 3,700 structural secant piles with only two minor anomalies, both of which were repaired during trench excavation without delaying the project schedule.

Secant pile drilling operation next to historic San Gabriel Mission

Walsh followed the piling installation with construction of a 4 ft (1.2 m) thick reinforced concrete cap beam running the entire length of secant pile wall on both sides of the trench. More than 2,600 tiebacks were installed through the cap beam to provide lateral support to the secant pile walls. The tiebacks consisted of 8 in (203 mm) diameter tiebacks with different strand configurations depending on loading requirements (i.e., 4, 5, 6, 7, 8 and 10 strand) double corrosion protected anchors averaging about 43 ft (13.1 m) in length, and were structurally connected to the cap beam.

It was required that 2% of the tiebacks had to be performance tested to 200% of design load. The contract also required that two tiebacks of each type be extended creep tested to 200% of design load for a period of 10 hours. Stressing jacks were used with auto-grippers and power seating to expedite the testing procedure, and, on average, 30 tiebacks were tested a day with only two stressing jacks.

Once the excavation exposed the inside face of the secant piles, the exposed sides of the piles were ground off to accommodate a 6 in (152 mm) cast-in-place fascia wall. A John Deere 350GLC excavator with an Antraquip grinding wheel attachment was used for this work. More than 94,000 lf (28,651 lm) of exposed pile face had to be ground off using extra care to not to damage the reinforcing steel contained within the piles. To prevent the grinding wheel from damaging the concrete pile cap, the top 2 ft (0.6 m) of each pile were chipped off by hand, using a man lift to hoist personnel up to the pile cap.



Testing of tieback anchors in cap beam

The ends of the secant pile trench terminated with a permanent shoring wall on each side, where 210 each, 30 in (762 mm) diameter soldier piles were drilled to an average depth of about 40 ft (12.2 m) in length at the west approach to the trench. This portion of the site was a former landfill, which resulted in difficult drilling through the existing concrete, asphalt, steel and other debris. Before the installation of the soldier piles, the obstructions were cored and then removed to facilitate the pile installation. Because of the narrow work area, smaller drill rigs such as a Bauer BG 15 Top Drive and a Watson 1500 were utilized for coring through the debris. The east approach permanent shoring wall is scheduled to be constructed in early 2017, after the track is installed and the trench is fully operational.

Drilling of tiebacks with single flight auger

Value Engineering

A value engineering proposal was formalized and submitted to ACE that reduced the quantity of tiebacks from 4,400 to 2,600, while still resisting the same lateral forces needed to support the wall. To reduce the quantity of tiebacks, it was necessary to increase the required capacity of each tieback anchor. Given the tight right-of-way restrictions throughout the project alignment, bonded lengths were limited, resulting in anchor bond stresses of 6 to 7 ksf (287 to 335 kPa). Although the redesign required test bond stresses that exceeded 50 psi (345 kPa), the value engineering proposal proved to be successful, and all of the tiebacks on the project were installed without a single failure during testing. The value engineering reduced the overall construction duration and saved the project nearly $1.6 million.

Sequencing and Logistics

The compressed construction schedule required the mobilization of multiple drill rigs and cranes for the installation of the drilled shafts, secant piles and tiebacks concurrently to allow the excavation to proceed. The anticipated production goals were exceeded, where up to 13,800 strand-ft (4,206 strand-m) of anchor material were installed during a single rig shift. During the peak of pile production, up to 800 cu yds (611.6 cu m) of concrete/slurry were poured each day.

In addition, working in close proximity to live train traffic presented a significant safety challenge. Freight and passenger trains are in constant use of the rail line each day, and the north trench wall was constructed within 10 ft (3 m) of the temporary shoofly track. During the drilled shaft pile operation, drill rig and

Grinding of secant pile wall and installation of invert slab

Preparation and forming for the final fascia wall

crane operators had to ensure the equipment did not foul the track and worked under the supervision of railroad flagmen to provide worker safety from passing trains. As trains approached, all construction activity within 25 ft (7.6 m) of the track was directed to stop, and construction workers were required to clear the work area. Drilled shaft piles that were drilled on the north wall, parallel to the temporary shoofly track, had to be poured as soon as possible to eliminate open excavations adjacent to live train traffic. Despite these challenges, drilling operations did not adversely affect train traffic or schedules, and 81,000 total man-hours were completed on this project without incident or injury.

Summary

New bridge overcrossings to facilitate construction of the trench have already been completed at Ramona Street, Mission Road, Del Mar Avenue and San Gabriel Boulevard. In addition, the relocation of numerous sewers and trench drains is completed, which required both shored excavations with depths in excess of 40 ft (12.2 m) and directional drilling under existing bridges.

Multiple concurrent secant pile wall activities in a tight work zone

Construction of the trench will allow for pedestrians and nearly 90,000 vehicles per day to pass over the tracks at these major thoroughfares and through the City of San Gabriel. The project necessitated the excavation and removal of nearly 650,000 cu yds (496,961 cu m) of material and the need to both temporarily and permanently support the sides of the excavation to protect neighboring residences and businesses. The design of the excavation support system for the 65 ft (19.8 m) wide by 30 ft (9.1 m) deep trench required specialty foundation work and ground improvement work on the north wall to support passing trains on the temporary shoofly track. The temporary shoofly track was necessary to divert train traffic around the alignment of the trench.

Drilling operation in very close proximity to train traffic

Project Team

Project Name: San Gabriel Trench Project
Project Owner: Alameda Corridor-East Construction Authority
Consulting Engineer: Moffatt & Nichol
ACE Consultant: Jacobs Engineering
General Contractor: Walsh Construction
Specialty Contractor: Malcolm Drilling Company

Terry Tucker is executive vice president and vice chair at Malcolm Drilling Company. He has been in the drilling industry for 46 years, 14 of which have been with Malcolm Drilling.

David Peterson has been a project manager at Malcolm Drilling Company for 13 years, and has more than 28 years of experience in the construction industry.

Rafael Serrano has been a project engineer with Malcolm Drilling Company for 4 years, and has 8 years of experience in the construction industry.