BULLETIN

News from *SubTerra, Inc.*®

Construction of the Alki Tunnel Using a Soft Ground EPBM
West Seattle, Washington

The West Seattle Alki Tunnel project was a component of the King County METRO Alki CSO (combined sewer overflow) project. It involved construction of an approximately 10,000 ft.-long, 12-ft. outside diameter tunnel for sewage effluent transport by gravity flow, constructed at depths of up to 400 ft. The potential for settlement of overlying houses and other structures was a major concern.

Anticipated ground conditions for the project consisted generally of hard clays, dense granular soils, and some mixed soil conditions. Actual ground conditions varied widely, ranging from hard dry clay to flowing silty sands mixed with boulders, reflecting the overconsolidated and interglacial soil deposits of the region. Groundwater was present throughout the length of the tunnel, with a maximum hydrostatic head of sixty feet in the low permeability Lawton Clay unit. Not surprisingly, consistency of the muck varied greatly on the project, ranging from dry clay to a silt and cobble "soup".

The 157-in. OD tunnel boring machine (TBM) used for tunnel construction was designed specifically to meet the project requirements by being able to operate in any one of three modes: 1) open mode with a belt conveyor and flood doors; 2) semi-EPB (earth pressure balance) mode (with belt conveyor, flood doors and pressure relieving gates), and; 3) full EPB mode with a screw conveyor.

SubTerra, Inc. performed a settlement analysis using a method that combined standard prediction techniques with probability functions, rather than relying on single point parameter values. As a result, predictions were made for a range of potential conditions, not just the worst possible. Settlement analysis results were used to determine the required muck balance for the different soil types, and confirm that the tunnel could be completed without resorting to full EPB mode.

The tunnel liner was a single pass concrete segment system designed to take a uniform load of 375 times the excavated diameter. The segments were gasketed and bolted to meet the water tightness requirements of the contract.

Grouting of the crowns of the arches was done coincident with mining. The volume of grout pumped equaled 75% of the theoretical void space calculated for the clay and silty materials. There were no problems with settlement or movement of the lining segments.

SubTerra, Inc. developed a program of ground additives that contributed significantly to the job's success. Foam, a coagulating polymer, and bentonite were alternately used, allowing the entire tunnel to be mined without the screw conveyor, and minimizing settlement and ground loss.

Although construction of the tunnel was difficult and challenging, the probabilistic settlement analysis and use of soil additives helped ensure successful project completion.

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