Light Rail Tunneling Earns Hatch Mott MacDonald/Jacobs Engineering Top 2010 Engineering Excellence Award

Hatch Mott MacDonald/Jacobs Engineering took top honors for its deep tunneling design at the American Council of Engineering Companies (ACEC) of Washington’s 42nd annual Engineering Excellence Awards ceremony on Friday, January 22, 2010. The ceremony honored 42 projects representing a wide range of engineering achievements and demonstrating the highest degree of skill and ingenuity.

The Platinum Award was presented to Hatch Mott MacDonald/Jacobs Joint Venture (HMMJ) for Structural Systems Engineering for Seattle’s Beacon Hill Station and Tunnels, Sound Transit Central Link Light Rail Section 710. The new Beacon Hill station is positioned in a neighborhood that previously was a somewhat isolated urban environment, but now provides residents fast, efficient access to both Seattle and SeaTac Airport. The depth and dimension of these tunnels far exceeded anything done previously in soft ground in North America.

This award qualifies the project for entry into the national ACEC competition; National Award Winners and “Grand Conceptors” will be announced at the ACEC annual meeting in Washington DC in April.

Criteria for the award included such elements as: Original or Innovative Application of New or Existing Techniques; Future Value to the Engineering Profession; Perception by the Public; Social/Economic and Sustainable Design Considerations; Complexity; and Exceeding Owner/Client Needs.

Platinum Award

Hatch Mott MacDonald/Jacobs Engineering Joint Venture (HMMJ) - Sound Transit Central Link Light Rail Section 710 Beacon Hill Station and Tunnels

Owner: Sound Transit

HMMJ’s challenge - build a deep-mined transit station and one mile of twin rapid transit tunnels under Beacon Hill as part of the region’s new light rail system extending from downtown Seattle to SeaTac Airport. The tunnel needed to be deep to avoid disrupting businesses and traffic on the surface, plus it would involve construction in extremely unstable soils, including stratified silt, sand and clay. The station was designed with two shafts, a transverse two-level concourse tunnel and two platform tunnels.

For the Beacon Hill Station and Platform Tunnels, HMMJ-JV, in conjunction with the Dr. Sauer Company, employed a risk-based design approach in which the design team actually planned the complete excavation, including the initial and final support systems for the very large diameter shafts and very deep tunnels. In most projects of this size, the contractor hired to excavate designs the excavation plan. But in this case, the engineering design team used the Sequential Excavation Method (SEM) in order to carefully manage the multiple soil challenges. This approach to deep complex tunneling in very poor soils, at a depth and a diameter close to twice that previously done, resulted in the largest soft ground SEM tunnel in North America.

Initially, to confirm geotechnical assumptions made in the preliminary design, a 155-foot deep small diameter test shaft provided a three-dimensional finite element analysis of the tunnel excavation and the initial support required for it, plus final decisions on shaft and tunnel design and construction methods. Test shaft construction also led to the successful use of Slurry Wall construction for the time-critical vertical access shaft, and guided decisions on how to proceed with SEM tunnels, the use of still fiber reinforced concrete for large diameter tunnels, and the use of fiberglass reinforcing in slurry walls. This process proved to be a significant advance in the design of SEM tunnels.

Other key innovations in deep soft soils SEM included the Dual Side Wall Drift technique for the concourse tunnel and a Heading Bench invert approach for the platform tunnels. Running tunnels were excavated by an earth pressure balance tunnel boring machine (EPB-TBM), and lined with a single pass, pre-cast concrete liner, fitted with gaskets to ensure water tightness.

Despite the poor soils, the tunnels were completed with virtually no ground settlement or disruption to businesses and transportation above, plus the design optimization reduced the amounts of construction materials used.
"It is probably the most challenging construction project along the whole Link Light Rail line," according to Larry Phillips of the Metropolitan King County Council. "The methods used to mine out this station have never been used at this depth. We are standing here in an engineering and construction marvel that will be known through the world."

The project team was represented in the photo below by Steve Bichich (Jacobs), John Walser (ST), Don Phelps (HMM), John Sleavin (ST) and Steve Mauss (HMM).