

PROJECT OF THE YEAR AWARD

Metro Gold Line Eastside Extension Tunnels deemed UCA project of the year

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Hailed as a model for America by U.S. Transportation Secretary Ray LaHood, the successfully delivered Metro Gold Line Eastside Extension (MGLEE) celebrated its grand opening Nov. 14, 2009. The line extends the Los Angeles County Metropolitan Transportation Authority's (Metro) light rail system to the densely populated and continuously growing East Los Angeles communities. Much of the alignment consists of at-grade track, but the project also features a 2.7-km (1.7-mile) underground segment in cut-and-cover and twin-bored tunnel structures. For the first time, Metro specified, the use of pressure face tunnel boring machines (TBM) to advance the tunnels through soft ground. The tunnel design, construction management and construction methods adopted resulted in the successful completion of the tunnel segment with virtually no surface impact.

Tunnel design

The design of tunnels and underground stations in the Los Angeles area has always included special considerations for seismic design and subsurface gas exclusion. All Metro subway tunnel designs have included two-pass lining systems. Typically, they use an initial lining comprising expanded precast concrete segments with a final cast-in-place concrete lining. High-density-polyethylene material placed between the linings was added to further protect against gas inflow. Operating systems also include gas detection and automatic ventilation systems. All soft ground Red Line tunnels used open face shields, the traditional soft ground tunneling method in Los Angeles. The MGLEE design included new challenges, given some settlement issues on prior tunnels and the discovery

The completed Metro Gold Line tunnel extends the line to East Los Angeles, adding 9.7 km (6 miles) to the system.

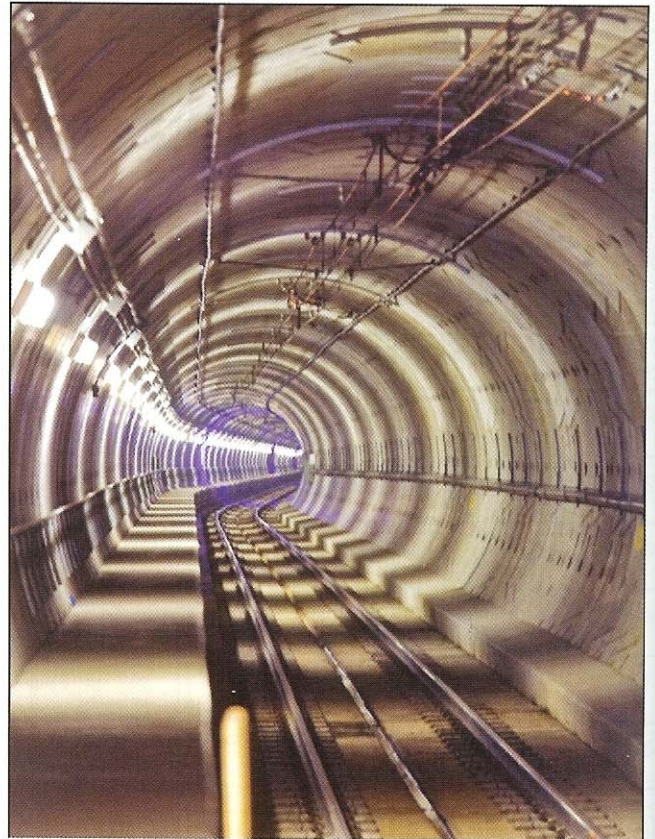
of a new, potentially active seismic feature in addition to the regional seismic and naturally occurring gas conditions. For the tunnel liner, Metro designed a double-gasketed, precast segment system to add redundancy to the gas exclusion system. The segments have convex radial joints designed to flex during earthquakes, so that the tunnel will remain sealed.

Considering the potential for settlement

and the growing use of pressure-face machine (PFM) technology worldwide, Metro specified PFMs. For additional settlement control in some areas, a program of compensation grouting injected above the tunnel crown from the surface during tunneling was designed to reduce settlement to acceptable levels.

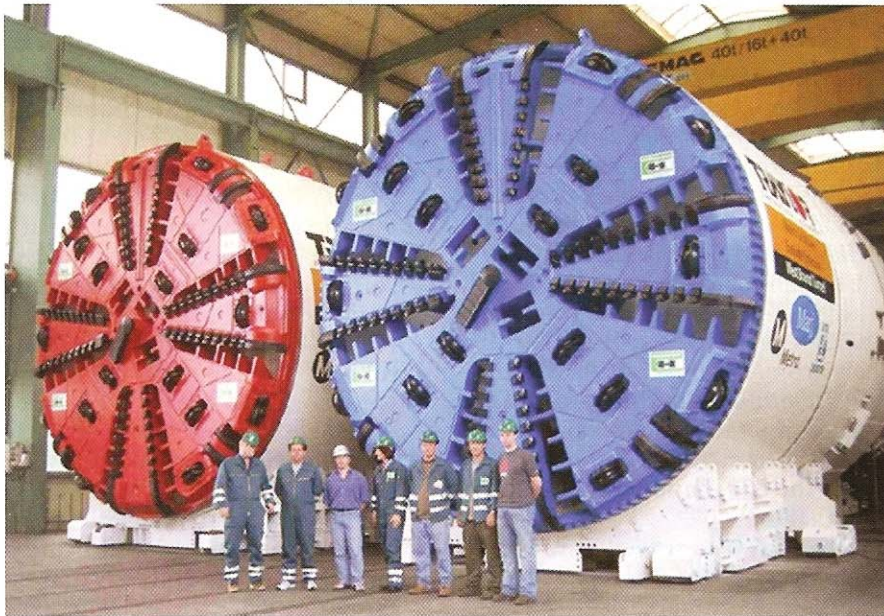
Contract packaging

Design bid build (DBB) was used for the tunnels and underground station excavations and design build (DB) for the at-grade and station structures. Both contracts were awarded to Eastside LRT Constructors, a joint venture of Washington Group International, Obayashi and Shimmick, with the tunnels subcontracted to Traylor



Brothers and Frontier-Kemper in joint venture. Traylor Brothers and Frontier-Kemper subcontracted ground improvement to Hayward Baker. Metro issued a notice to proceed in July 2004, with a total contract value of \$600.5 million for the combined DBB and DB contracts. Metro also implemented an integrated project management office (IPMO). This separate project office included Metro and consultant technical and project management staff as an integrated team at the jobsite. The IPMO for the underground segment was comprised of Metro management, designer Eastside LRT Partners (Parsons Brinckerhoff, Barrio Planners, JGM) and KBR with Carter & Burgess for the construction management. One measure of success of this system

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TBMs at Herrenknecht's plant in Schwanau, Germany.

was the response time on the contractor's submittals and requests for information (RFIs). As of November 2008, the contractor made more than 5,000 submittals and 1,000 RFIs (DB and DBB contracts). The average response time was about 12 work days on each.

Tunnel construction

Construction began in July 2004, with TBM tunneling accomplished between February 2006 and December 2006. Tunnels were completed using two new Herrenknecht earth pressure balance TBMs. Among the unique features of the machines was the 58.9-m (193-ft) long screw conveyor, designed to discharge into the train muck cars, well away from the segment erection and working areas. The overall schedule for TBM tunneling was 10 months. The best daily production rate for the east bound tunnel was 27.8 m/d (91 ft/day), with an average of 11.3 m/d (37 ft/day). The production rate for the west bound tunnel averaged 13.4 m/d (44 ft/day), with a best day of 29.2 m/d (96 ft/day).

As with most American tunneling projects, variations of the design

to accommodate the contractor's means and methods are often proposed. Of note was the compensation grouting program. The plans indicated grout holes to be drilled from public right-of-way, from the streets or alleys fronting the buildings. This called for more than 200 grout pipes to be installed for full coverage of all the structures. Instead of the surface installation, Hayward Baker proposed use of

directionally drilled grout pipes installed from either the project worksites or smaller areas within the street. The final number of pipes installed was 35, which significantly reduced neighborhood impacts. Ultimately, no settlement was measured that would require grouting to be initiated.

Implications of successful tunneling

Success of the project has allowed Metro planners to add underground alternatives on future lines. During completion of the MGLLE project, legislation prohibiting tunneling in the Methane Zone (westside of Los Angeles) was reversed. Plans for new projects, such as the Westside Subway Extension, Regional Connector Transit Corridor and the Crenshaw/LAX Transit Corridor, now includes tunnels or tunnel alternatives. Further enabling these projects, Los Angeles County voters passed Measure R, a 0.5 cent sales tax to help fund transportation projects, including subways. In addition to its technical achievements, the MGLLE project achieved more than four million man hours worked with no lost-time accidents. ■

Double-gasketed segment at the heading.

