Bergen sets a rehabilitation standard

Bergen tunnel on the New Jersey Transit network has been transformed from a damp, water-drenched safety hazard to a clean, dry, relined element of public infrastructure. As the oldest of two rail tunnels passing through strong but fractured granitic diabase, the 4,400ft long x 27ft wide x 24ft high double-track, horseshoe tunnel was built more than 120 years ago in the 1870s. "Over the years water ingress through cracks and fissures in the maximum 70ft overburden has caused severe problems particular in winter with sheets of ice falling onto passing trains and icicles and water inflows causing power arc explosions across the overhead catenary system," explained Jim Galvin, Site Manager for the engineering and construction department of NJ Transit. "There have been many attempts to grout off the ground water ingress - the most extensive carried out in the early 1980s - but all have failed. In 2000 NJ Transit decided to undertake major structural rehabilitation and the 18-month, $56 million civil contract was awarded to the Merco/Obayashi JV in February 2001."

Rehabilitation of the oldest of two Bergen Tunnel tubes.

In early August 2002 when T&TNA visited the site, the Merco/Obayashi team was about six months away from handing over to NJ Transit whose own construction forces will reinstall the tracks, signal and catenary systems. The full $80 million rehabilitation program is due to be completed by April 2003 when commuter train services, currently running on adjacent tracks, will divert back into the revitalized structure.

For Merco/Obayashi, work started with stripping out the 22-36in thick brick lining applied to some 70% of the rock tunnel and enlarging the original profile to take the new 12in thick reinforced in-situ concrete lining and drainage system. "Excavation of the old brick work and the rock in the unlined sections required blasting," said Mike Mergentime, Vice President of Merco. "We are only a few miles away from the work going on at Exchange Place for PATH (see p40), but the granitic diabase of this formation is up to 50,000psi in compressive strength. Too hard for roadheaders. We used drill+blast to excavate about 300,000ft^3 of material in the arch and over about 75% of the invert that needed to be lowered."

Immediate support comprised systematic radial bolting using 15ft resin anchored bolts. "We also installed more than 800, 15ft long spiling bolts to presupport the weaker, more weathered portal zones and at the four intermediate portals where the tunnel daylights into two large open sections of about 40ft long each," explained Steve Mergentime, Project Manager for the JV. One of these open sections is believed to have been part of the original design but the other may have developed from a collapse.

In addition there are five oval shaped ventilation shafts on the tunnel, enclosed on the surface by small brick buildings. These vent shafts are being backfilled and the brick buildings, except for one, retained by the local historical society. At the shaft locations, a heavy pattern of rock anchors was required to support the brick lining of the shafts before breaking out the lining of the tunnel on which the shaft lining was supported.

The two large openings are retained for tunnel ventilation, for emergency escape stairways, and to house new power and electrical system substations.

Once excavated, the design called for installation of lattice girders on 6ft centers to provide a guide for layers of wet mix shotcrete to create a smooth profile for attaching the waterproofing system. It soon became apparent however that filling voids found behind the brick lining was increasing the volume of shotcrete dramatically. "By working with the JV, their NATM engineer Geosol, and our specialist design consultants, the Dr Sauer Company and the URS/Jacobs JV, it was agreed to eliminate the girders, apply the waterproofing membrane to a smoothing layer of shotcrete, and to take up the overbreak as part of the less expensive in-situ concrete lining," said Galvin. "This saved a substantial amount of time and money."

The wet mix smoothing shotcrete was applied using a Meyco Suprema with a robotic nozzle boom and a second Reed machine with a hand held nozzle. The final lining is being cast using two 50ft long forms supplied by Efco Economy Forms of Des Moines.

In addition, NJ Transit has engaged lead design engineers, URS/Jacobs JV, to review rehabilitation of the adjacent tunnel tube. Built in the early 1900s and separated from its older twin by a rock pillar of about 25ft, the newer tunnel has a concrete lining and was excavated to a larger cross section. Rehabilitation is expected to involve patching the existing lining, installing a waterproofing/drainage system and new fire-life systems.

WEEHAWKIN REHABILITATION

In the same area, about two miles away, the 1.25km long Weehawkin Tunnel is also being modified from its former single-track freight rail past to serve as a twin-track facility on Phase 2 of the Hudson-Bergen Light Rail Transit System in New Jersey. Modification includes drill+ blast excavation of an underground station at about mid point with some widening of the running tunnel, installation of waterproof membranes in certain areas and excavation of three high-speed elevator shafts to link passengers to a bus station on the surface, some 100ft (30m) above.

Designed by lead consultants Parsons Brinckerhoff for the private LRT system developers, the modification contract was awarded in May to the Frontier Kemper/Shea/Beton und Monierbau JV as one of a list of pre-qualified bidders for the negotiated subcontract.

Excavation of the hard rocks of New Jersey for the PATH, Bergen and Weekhawkin projects is being watched carefully by the designers working on the major East Side Access, 2nd Avenue Subway, and West Side extension of the 7 Line Subway in Manhattan which must also be excavated beneath important urban areas using TBMs, drill+blast, and roadheaders if suitable. ■

New bolt trials at Bergen

In February 2002 a shipment of XPANDX bolts were supplied to the Bergen Tunnel project to undergo US proving trials. The XPANDX rockbolt, developed in the UK by specialist steel manufacturer Romtech Ltd, provides a new, cost effective means of rapid support for both temporary and permanent applications. Tensioning the bolt to its full working load by a simple action of tightening the nut against a faceplate causes the outer sleeve of the rockbolt to expand and grip the sides of the hole compressing the strata along its entire embedded length.

For the tests at Bergen, 4m long standard rockbolts were installed in 45mm diameter holes. The bolts were pre-tensioned to 4 ton to fully expand them and the entire pre-tensioning load was then removed before applying the pull-out load. The bolts achieved a maintained pull-out resistance in excess of 11 ton.

More recently the bolts were successfully site tested at a major coal mine in Utah and are presently scheduled to undergo formal laboratory trials at NIOSH in Bruceton, Pennsylvania to confirm tests carried out by the Royal School of Mines in the UK.

Following successful tests, American Commercial Inc entered an agreement to manufactured and supply XPANDX bolts to the North American market under license. A variety of bolts to suit a range of ground conditions and applications include coupled, fully groutable and corrosion resistant versions. ■