Illinois Department of Corrections Infrastructure Renovations: Phase 3 Tunnel Restoration

By Ralph T. Brown

The buildings that comprise the campus of the Cook County Illinois Correctional Facility are commonly known as the Cook County Jail. Located on the south side of Chicago, the first building was completed in 1929. Today, the buildings on the site house over 9000 inmates.

The campus buildings are connected by a series of underground service tunnels. These tunnels are the means by which the power plant is connected to the various other structures. The tunnels are secured areas used to connect the buildings with steam lines; conventional electrical wiring; optical communication lines; and heating, ventilation, and air conditioning (HVAC) components. All of these systems had to remain in service throughout the restoration of the tunnel. The $4 million dollar project was started in December of 2005 and was substantially completed on schedule and under budget in June of 2006.

Reasons for Repair

Over the years, cracks had developed in the tunnel as a result of settlement and corrosion. Over time, problems with the concrete grew more severe.

View of the maximum security exercise area above the tunnel where the air vents are located

Expansion joint seals had also failed, allowing more water into the tunnel. Periodically, spot repairs were made in the tunnel in an attempt to patch the spalled and delaminated concrete and to reduce the water infiltration. The water also caused damage to insulation on the steam lines and the steel structures used to support them.

In 2005, the county hired an engineer to investigate the tunnel and provide a condition survey and a structural review. Based on this investigation, project bid documents were developed that called for extensive concrete repairs using shotcrete along with mechanical and electrical upgrades.

Accessing the tunnel with workers and equipment in itself was a challenge. The tunnel could only be entered through the high-security buildings that are connected to it. There are no elevators going to the tunnel. To get into and through the tunnel, the craftsmen had to walk down flights of stairs. Once inside the 1000+ ft (300+ m) long tunnel, the crew also had to climb up and down permanent steel ladders and concrete stairs to get from one end to the other. All of the equipment and material used in the restoration project had to be brought into the tunnel by hand. And, once inside the tunnel, the crew was faced with the extreme conditions within. Water-damaged insulation on portions of the live steam lines raised the ambient temperature in parts of the tunnel to above 130 °F (54 °C).

Challenging Scope of Work

These were a few of the major challenges that had to be overcome to complete the concrete restoration of this 1000 ft (300 m) long tunnel. The restoration work included the demolition and replacement of over 150 yd^3 (115 m^3) of partial depth cast-in-place concrete with over 15,000 ft^2 (1400 m^2) of shotcrete. Hydrodemolition was specified as the final demolition and detailing of all surfaces receiving shotcrete. Shotcrete equipment that could be disassembled and carried in by hand was designed and fabricated specifically for the project.

The concrete restoration contract also called for a number of other items including:

- Over 1/2 mile (0.8 km) of polyurethane crack injection;
- 1440 linear ft (427 m) of expansion joints;
- Installation of supplemental steel beams and columns;
- Replacement of 300 steam pipe hangers and 60 structural steel pipe supports;
- A new 480 V electrical service;
- A new lighting system;
- A new emergency lighting system; and
- A new HVAC system and controls, three new sump pumps, and a new sump pit.

Upon completion of the restoration, the entire tunnel was to be washed down with high-pressure equipment. The contract called for the restoration work being substantially completed in 180 calendar days.

Safety was the Priority

Creating a reasonable and safe work environment for the crew was the top priority. A system had to be designed that addressed the high temperatures and the poor ventilation while also providing improved lighting in the tunnel. Industrial hygienists were added to the team. They were consulted regarding the air quality in the tunnel and on the remediation of the lead paint that had been identified in portions of the tunnel. Research was done to locate specialized high-volume, high-speed fans to move and exchange the air in the tunnel.

The environmental system also included temporary electrical service to power the air exchangers, chiller units, power tools, and lighting. Nine temporary steel security cages were designed and fabricated to be mounted over the existing tunnel vent shafts that were located inside the inmates' exercise yard. Once assembled and installed over the tunnel vent shafts, they maintained security and allowed for the removal of the permanent steel security bars in the shafts. Nine of the specialty high-volume, high-speed fans were strategically located throughout the tunnel to move and draw cooled fresh air from the ventilation shafts. Portable commercial chiller units were obtained that could cool the outside air during the warm months before it was moved into the tunnel through the vent shafts. The hygienists tested to confirm that the air exchange system used in the tunnel was effective. They also directed and monitored site-specific methods and procedures for the remediation of the lead paint in the tunnel.

Later in the course of the project, OSHA representatives came to the site and monitored the air quality in the tunnel while the craftsmen worked. After a number of days of this monitoring, OSHA's testing confirmed the efficacy of the site-specific means and methods that had been developed and implemented for the project. This effort ensured that the air quality and overall environment within the tunnel was safe for the people onsite.

Example of the conditions in the tunnel at the beginning of the project

Difficult-to-access deteriorated concrete behind steam lines and above exposed loose communications wiring

Another example of the existing conditions that restricted access to the concrete restoration areas

Damaged concrete wall during preparation and a new supplemental steel beam with columns

Final hydrodemolition preparation prior to applying shotcrete

Nozzleman applying shotcrete

Repair Project

The greatest challenge the contractor faced was the concrete restoration. All of the equipment and material required for the project had to be carried into the tunnel by hand. The construction debris that was generated during the restoration would have to be brought out of the tunnel. The equipment used in the tunnel had to be sized so that it could be carried in by hand, such as customized shotcrete equipment. Extremely compact high-volume fans were located and purchased for the air exchange system that could by carried in by hand. The structural steel members required for the project were fabricated as components and brought in as pieces. The pieces were once again sized so that the workers could carry them into the tunnel.

It was also decided that all the concrete debris would be broken into fist-sized pieces or smaller in order to use vacuum trucks. The trucks were then able to remove the concrete debris through the ventilation shafts. Over 140 yd^3 (107 m^3) of concrete debris were removed using this process. The abandoned deteriorated steel pipe supports were cut into pieces that could be also be hand-carried out of the tunnel.

The steam lines and the other utilities that run through the tunnel and were mounted to the concrete also had to be protected and kept in service throughout the project. Temporary pipe supports had to be employed to hold up the steam lines while the concrete that many of the permanent supports were mounted to was replaced. The steam pipe insulation had to be protected from damage by the falling overhead concrete debris and other construction activities. The concrete restoration throughout the length of the tunnel had to be accomplished while working around these utilities that remained in place. Mechanical demolition using hammers was followed by hydro-demolition, edge detailing, and installation of supplemental reinforcement. The concrete surfaces that were in need of restoration were primarily located above or behind the steam lines and the other utilities. This made the placement, finishing, and curing of the shotcrete very difficult.

Illinois Dept. of Corrections Phase 3 Tunnel

Owner
Cook County Office of Capital Planning
Chicago, IL

Project Engineer
Soodan & Associates
Chicago, IL

Repair Contractor
National Restoration Systems, Inc.
Rolling Meadows, IL

Having such limited access to the repair areas was a true challenge for the craftsmen that executed the restoration.

Though challenging, the project was completed on schedule and under budget. This project will long be remembered by the people involved in the restoration.

Ralph T. Brown *is Vice President of National Restoration Systems, Inc. He received his BS from Central Missouri University and his MS from Northern Illinois University. In addition to being a member of ICRI, he is a member of the American Concrete Institute (ACI), serves on several committees, and is a Past President of the ACI Illinois Chapter. Brown is also a member of the International Parking Institute; the National Parking Association; and the Sealant, Waterproofing and Restoration Institute.*

View of a completed segment in the tunnel showing new steel pipe supports and hangers, repaired concrete surfaces, repaired steam pipe insulation, and new lighting