

Chetogeta Mountain W&A Railroad Tunnel

By Edwin Brady

Historical restoration/preservation is not only a challenging field of construction but also one that offers the special reward of preserving history for future generations, along with the social and cultural impact that a structure has contributed to in its lifetime. The Chetogeta Mountain W&A Railroad Tunnel Restoration is just that type of project and structure.

History

This tunnel, located in Tunnel Hill, GA, just 90 miles (145 km) north of Atlanta, is a 1477 ft (450 m) long clay brick arch tunnel. Completed in 1850 (Fig. 1), it is one of the oldest railroad tunnels in the world and the first one in the United States south of the Mason-Dixon Line. The first railroad tunnel was reportedly built in Germany in 1840.

Much of Central Georgia in 1850 was still part of the Cherokee Territory. Construction of this tunnel completed the railroad commissioned by the state of Georgia to connect Chattanooga, TN, to the Atlantic Ocean at the port at Savannah, GA.

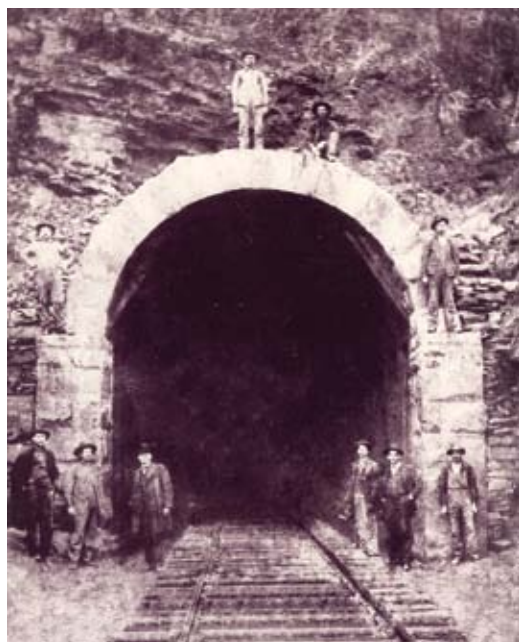


Fig. 1: Workmen, engineers, and others at the completion of the tunnel in 1850. Perhaps no other single transportation facility, prior to the age of aviation, has had more of an impact on the economic development of Georgia than this tunnel

The Tennessee River in Chattanooga provided easy access to the Cumberland, Mississippi, Ohio, Arkansas, and Missouri Rivers and effectively opened the entire country from the Eastern Rocky Mountains to the Western Appalachians with the first trade route through the Appalachian Mountains and on to the Atlantic Coast. It has been said that perhaps no other single transportation facility, prior to the age of aviation, has had more of an impact on the economic development of Georgia than this tunnel.

The tunnel is 1477 ft (450 m) long, 12.5 ft (3.8 m) wide at the bottom, and 16 ft (4.9 m) tall at the crown of the arch. Its side walls are constructed of large quarried limestone blocks and are approximately 3 ft (0.9 m) thick by 8 ft (2.4 m) tall, with a brick arch approximately 2 ft (0.6 m) thick resting on top. As locomotives became larger and heavier, the tunnel cross section became more and more restrictive. Trains began to scrape the sides of the tunnel. Several trains even became stuck, which required the tunnel lining to be demolished around the train (and later reconstructed) to allow for its removal. Finally, in 1928 (Fig. 2), a larger tunnel was constructed adjacent to the original tunnel and all train traffic was diverted to the new structure.

Over the next 70 years, little maintenance was performed and the original tunnel fell into a gross state of disrepair. When railroad crews began to close off its entrances in the mid-1990s, local residents, historians, and preservationists were enraged. They rapidly banded together and through cooperation with the Whitfield County Board of



Fig. 2: Original tunnel built in 1850 (right) with "new" tunnel built in 1928 (left)

Commissioners were successful in obtaining a Federal Intermodal Surface Transportation Efficiency Act Grant (ISTEA) for \$1.5 million to fund a full-scale historical restoration project.

Design and Construction Team

The Atlanta office of ARCADIS was hired as the design engineering firm to lead the project. Initial condition investigations revealed:

- Extensive water infiltration had resulted in the failure and collapse of large areas of the brick arch;
- A large number of failed mortar joints had allowed bricks to fall out; and
- Other areas of the tunnel had experienced distortions of the cross section due to sustained earth pressure.

All these conditions combined threatened a general collapse of the tunnel. Edwin Brady Construction Co., Inc., was selected as the general contractor to perform the restoration work, along with Miles Miller, owner of Miller Rochester Restoration, the subcontractor that performed repointing and plastering of the masonry surfaces.

Scope of Work

In all, 2745 gal. (10,400 L) of hydrophobic polyurethane chemical grout (HPCG) was injected into and behind the brick arch to cut off the water infiltration. Over 12,000 ft² (1100 m²) of brick and stone were repointed with a lime-based mortar custom-formulated to match the original mortar in color, strength, and texture; 60 yd³ (46 m³) of dry-process shotcrete was placed to restore areas of the brick arch that failed and collapsed; and approximately 2000 ft² (190 m²) of custom-formulated plaster rendering was applied over the shotcrete surfaces to match the surrounding original brick.

Grouting and Masonry Repointing

Water infiltration was prevalent throughout the entire tunnel. HPCG was specified to seal this infiltration, and the product chosen was Mountain



Fig. 4: Large repair area prior to shotcrete

Grout Classic as manufactured by Green Mountain International. Small-diameter holes (3/8 in. [10 mm]) were drilled through the mortar joints (Fig. 3), and then plastic packers were installed to inject the grout. HPCG expands when in contact with water. This produces a flexible closed-cell foam that not only seals but also fills voids and provides stability to the aging and deteriorating brick arch. Upon completion of the injection grouting, the plastic packers were broken off flush with the surface of the mortar; Miller Rochester Restoration repointed approximately 12,000 ft² (1100 m²) of the brick arch with a custom-formulated mortar made with vertically hydrated lime and a local sand matching what was originally used in 1850.

To prevent the buildup of hydrostatic pressure behind the brick arch and limestone walls, perforated drainage pipes were installed on approximately 10 ft (3 m) centers along the springline of both sides of the tunnel. These drainage pipes were 2 in. (50 mm) polyvinyl chloride (PVC) with a perforated section wrapped with a nonwoven geotextile fabric to prevent sediments and soil from entering the pipes. Three inch (75 mm) diameter holes were cored through the brick arch, allowing the drainage pipes to be placed and then sealed at the surface of the brick with the HPCG. A total of 280 drainage pipes were installed.

Shotcrete

Repair of areas where the brick arch had failed (Fig. 4) were patched with a prepackaged silica



Fig. 3: Trailer-mounted core-drilling setup for drilling holes for drainage pipes. Also note the freshly repointed brick mortar joints



Fig. 5: Shotcrete being placed

fume-enhanced dry-process shotcrete. Gunitite microsilica (MS) with alkali-resistant (AR) glass fibers from Quikrete was used. Approximately 60 yd³ (46 m³) of shotcrete was placed (Fig. 5) through an Allentown GRH600 to an average thickness of 10 in. (250 mm), with some areas being over 2 ft (0.6 m) thick. Scaffolding was erected on a 20 ft (6 m) trailer with an air compressor and generator beneath the working deck to allow for easy mobilization throughout the tunnel. Bulk bags (3000 lb [1360 kg]) of the pre-packaged shotcrete material were emptied into a portable hopper set over the shotcrete machine.

Shotcrete offered the only feasible means to make these repairs. It would have been cost-prohibitive to manufacture brick to match the original construction, not to mention the tremendous task of attempting to place them into these irregular repair areas. With shotcrete, these repairs were very straightforward and efficient in producing a structurally sound repair. It fully bonded to the substrate and was able to be finished to the exact profile of the existing tunnel surface.

After the shotcrete was placed, it was cut back by hand (Fig. 6) to about 3/8 in. (9.53 mm) deeper than the face of the adjacent brick. Overspray was washed from the surface of the adjacent brick and a plaster coat of custom-colored mortar was placed over the shotcrete flush to the face of the original brick. “Fake” mortar joints were struck into the plaster and a black “wash” was applied to more closely resemble the “sooted” surface of the original brick after years of smoke from steam locomotives (Fig. 7).



Fig. 6: Shotcrete being cut back to finish grade



Fig. 7: Completed repair



Fig. 8: Sesquicentennial Celebration of the first train through the tunnel on May 9, 1850

Sesquicentennial Celebration

The project was completed just in time for the celebration of the 150th anniversary of the first train to travel through the tunnel (Fig. 8).

Awards

Upon completion of this project, multiple awards ensued.

- ARCADIS: State Award of Excellence—Consulting Engineers Council of Georgia; and
- Edwin Brady Construction Co., Inc.: 2000 Award of Excellence—Associated Builders and Contractors, Kentuckiana Chapter; and 2000 Honorable Mention in the Repair of Special Projects—International Concrete Repair Institute.

Community Embraces Restored Tunnel

I recently contacted Mike Babb, Chairman of the Whitfield County Board of Commissioners. He was pleased to inform me of many developments since the completion of our work. He stated, “Your work was the first step. Once you made the tunnel structurally stable, dry, and historically restored, there has been an outpouring of public



Fig. 9: Current entrance to the Chetoogeta Mountain Tunnel

support. Nearly 100 acres of adjoining land has been donated, a Heritage Center with a museum has been constructed, walking trails constructed, and currently the original train depot is being restored (which has likewise been donated to the county). This has become a major tourist attraction and revived the public interest in our history and heritage” (Fig. 9).

Author’s Note: Historical Restoration Produces Multiple Rewards and Benefits

This project was clearly very successful and rewarding for all who participated, and it exhibited the effective and efficient use of shotcrete for historical restoration. The real success, however, is best realized by the way this project has restored a sense of pride in the rich history and heritage that exists in this small north Georgia community. This project not only restored a 150-year-old landmark but also revived an entire community, which stepped up to donate land, volunteer time, and make use of its history to provide a better quality of life. I encourage everyone traveling on I-75 in north Georgia to visit Tunnel Hill, which

is just 5 minutes off the interstate, and walk through the historically restored Chetogeta Mountain Tunnel of the old W&A Railroad, visit the museum in the Tunnel Hill Heritage Center, take in a bit of history, and reflect on how it can continue to benefit us in the future.



Edwin Brady, PE, President of Edwin Brady Construction Co., Inc., has over 20 years of experience in wet- and dry-process shotcrete, including over 3000 hours of nozzleman experience, concrete repair, and specialty grouting projects on four continents and throughout the United States. Brady received his BSCE from the University of Kentucky, Lexington, KY, in 1980 and has done extensive graduate work toward his MSCE from the University of Houston, Houston, TX. He is an ACI Certified Nozzleman (wet- and dry-process, vertical, and overhead); an ACI Certified Examiner (wet- and dry-process); and a licensed professional engineer in Kentucky and Colorado.