Tunneling in the Park

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Tunnels have always been an effective means of getting public access into the remote areas of mountainous parks. Several tunnels were constructed during the original National Park road-building era in the early 1900s. Over the years, some of these tunnels became bottlenecks and safety hazards because the number and size of vehicles now using them exceeded what was envisioned during the early era of the automobile. This was the case for some tunnels in the Great Smoky Mountains and Zion National Parks.

Great Smoky Mountains National Park Tunnels

The Great Smoky Mountains National Park was established in 1934. Located within the southern Appalachian Mountains in Tennessee and North Carolina, it wraps around 800 square miles of virtually unspoiled mountain wilderness. The Park boasts the highest visitation rate of any in the National Park System. Newfound Gap Road is a 22-foot wide, two-lane, two-way road that traverses north/south through the Park for 33 miles between Gatlinburg, TN and Cherokee, NC. The Road serves as the main access route for visitors to the Park, with traffic counts averaging between 1,700 and 15,000 vehicles per day, depending on the season.

The Morton Mountain and Chimney Tops Mountain tunnels are located on the Tennessee side of Newfound Gap Road. These 253- and 286-foot long tunnels were built in the 1930s when vehicle heights and traffic volumes were lower than today. While commercial vehicles are prohibited on this road, many tour buses and RV's are now approaching the maximum legal height of 13'-6". This was problematic because the vertical clearance in both arch-roofed tunnels was 12'-2" at the edges of the 10-foot wide striped lane. Drivers of buses, RV's, and trailers close to the legal height tended to "hug," and cross the centerline into the opposing lane to avoid the low clearance at the lane-edge, thus creating a potential for head-on collisions (Figure 1). The situation was aggravated by sharp curves inside the tunnels that restricted visibility from one end of the tunnel to the other. Frequently, taller vehicles struck the tunnel roofs, peeled off sidewall reflectors, and on at least one occasion collided with another vehicle in one of the tunnels.

As traffic increased during the 1980s and early 1990s, the low clearance of the tunnels became a greater concern. In the mid-1990s, a number of options were reviewed to address this concern. They included: 1) abandoning the tunnels and relocating Newfound Gap Road around each tunnel, 2) removing the top of each tunnel with an open cut, and 3) lowering each tunnel by removing rock out of the floor of the tunnels. But regardless of the option selected, portions of the road would have to be closed for a period of time during construction. During an early meeting with community officials, it became clear that an Environmental Assessment (EA) would be required to close the road for any period of time. The EA was the avenue for involving the local communities in the decision-making process and obtaining their consent on the project.

Figure 1. Condition prior to improvements – this is intended to be a two-way highway.

Because Newfound Gap Road is the primary scenic route that links Tennessee and North Carolina, and because the gateway communities depend on tourism for their revenue, considerable public opposition mounted to closing the road or detouring traffic around the Park for socio-economic reasons. To alleviate opposition, a public involvement campaign was enacted that included four public information meetings held in North Carolina and Tennessee.

The project team sought new and innovative ways to complete construction in a timely fashion and to minimize impacts to the natural environment. These included:

- milling bedrock along a test section as a potential method for lowering the tunnel floor
- using ground penetrating radar to better evaluate the rock quality below the tunnel floor
- performing a sample tunnel lining installation to improve drainage behind the lining
- carrying out a Contractor Market Survey for suggestions in reducing time and cost
- encapsulating sulfidic material (the bedrock is pyrite-bearing and acid drainage from excavated material is a concern)
- obtaining detailed traffic counts for a six month period in conjunction with traffic modeling to determine potential traffic impacts during construction.

In addition, the Newfound Gap Road corridor has been nominated for the National Register of Historic Places. The tunnel portals, stone guardwalls, and scenic vistas are contributing elements to this nomination. Throughout the project development process, the project team sought out a large number of partnerships with community and regulatory agencies. FHWA signed a Memorandum of Agreement with the State Historic

Preservation Officer to ensure that the final construction product was in keeping with the character of the historic corridor and Park values.

A Tight Schedule

The Park selected an alternative that required all construction activities to be completed in approximately 144 working days under various periods of full, one-lane, and nighttime road closures. The maximum number of days that the road could be completely closed to through traffic was 42 days, with some additional allowances for nighttime closures. To encourage timely compliance with this schedule, the construction contract included incentives of up to $300,000 for early completion, and disincentives up to $50,000 per day for late completion. Prior to construction, a brochure was developed and placed in strategic locations throughout the park to notify visitors, business owners, and the surrounding communities about what to expect during construction and who to contact for additional information or to express concerns. Minimizing the construction schedule and developing an acceptable traffic control plan that did not deter visitors from traveling to the area was critical.

To obtain a 13'–6" minimum vertical clearance at each tunnel sidewall, the Park opted to lower the grade in the tunnel floor by 4 to 5 feet. The approach roadways were lowered to transition into each side of each tunnel. The contractor used controlled blasting techniques to excavate the rock and lower the grade, and installed rock bolts to stabilize the existing tunnel walls during construction. The tunnel linings were repaired and painted, and new drainage lines were installed. The riding surface was constructed of asphalt pavement with new striping and reflectors for improved visibility. The guard walls along the approach roadways were reconstructed using a concrete core and new stone masonry facing. The finished product looks much the same as the original, yet with greatly improved capacity and safety (Figure 2).

Figure 2. Finished Morton Mountain tunnel with lowered grade and new approach walls to match historic masonry.

Zion National Park Tunnels

Tunnels within Zion National Park, in southern Utah, experienced similar safety issues to those tunnels in the Great Smoky Mountains National Park. The Mount Carmel tunnel (5,600-feet long) and the East "Short" Tunnel (490-feet long) were constructed with conventional drill and blast methods in the 1920s and had since become safety hazards for the large recreational vehicles trying to pass through. The FHWA and NPS completed widening of the shorter, East Tunnel as an initial phase of improvement. A roadheader was used to excavate the sandstone tunnel walls (Figure 3). Enlargement of the tunnel was restricted to nighttime hours during winter to reduce impact on the traveling public. The lack of handcrafted and historic portal structures – and the softer rock – made this widening project considerably less complex than the Great Smoky Mountains project.

The Mount Carmel tunnel is more spectacular and longer than the tunnel widened by roadheader. It was constructed through Navajo sandstone very near the canyon wall and has several open galleries to the canyon, originally used as construction access. Vertical jointing in the Navajo sandstone has led to numerous collapses along canyon walls within the park and at the tunnel. Figure 4 shows the view west along the canyon wall from Gallery 3, where in 1958 a canyon wall collapse occurred. The collapse caused a local tunnel failure and exposed tunnel lining (most of the tunnel is unlined) as seen in the figure. In this more critical geologic setting, work is proceeding more slowly here than it did for the East Tunnel. At this time we have begun evaluating the feasibility of either widening the original tunnel or constructing a new one. Seismic reflection tomography was used to map large rock fractures immediate to the existing tunnel and in the pillar of rock between the tunnel and the near-vertical canyon wall. The technique satisfied the criteria of speed and low impact, using a sledgehammer as an energy source and geophones affixed to the tunnel walls, but provided more limited information on rock quality beyond tunnel walls than anticipated.

Figure 3. Road header used at Zion National Park for conventional tunnel widening.

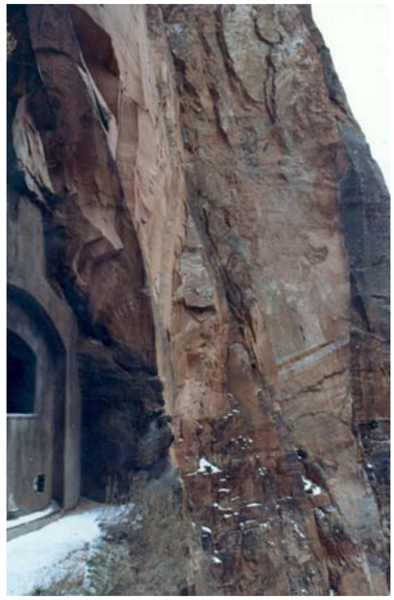

Figure 4. Column collapse at Gallery 3, Mt. Carmel tunnel, Zion National Park.

Overview

Needs for roadways within our National Parks evolve and conditions change. Tunnels are an effective means of providing public access, but their adaptation to changing needs can be challenging. Innovative investigation, design, and construction techniques must be utilized to minimize impacts to the natural, historic, cultural, and socio-economic resources of the Parks and surrounding communities. As these tunnel projects demonstrate, early involvement by the gateway communities during the project development process is critical to their success, especially projects that impact the traveling public.

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