TUNNELS

Safety and Technology Advances in the United States and Beyond

STEVE ERNST AND JEFF WESTERN

Ernst is Consultant, Miami, Florida, and Western is Principal, Western Management and Consulting, Madison, Wisconsin.

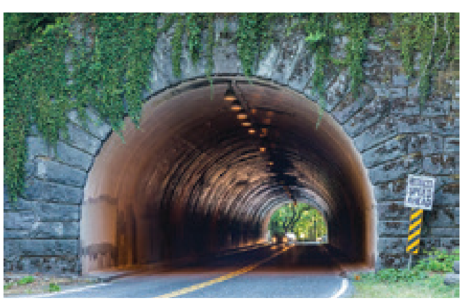

Photo: Tony Webster

Free-hanging flora and decades-old patina soften the stone masonry portal of the Northwest Cornell Road Tunnel in Portland, Oregon. In 1940, laborers hired by the Works Progress Administration cut through the basalt of West Hills to build the 500-foot-long, concrete-lined conduit.

Compared with much of the world, the United States has relatively few highway tunnels. Norway—its land area approximately the same size as New Mexico—has more than 900 roadway tunnels, while the entire United States has 503. But these tunnels are important links in the transportation network, providing routes through congested urban environments and reducing travel time in mountainous regions. Tunnels provide access and offer connections that have opened social and economic opportunities beyond what their small number implies.

Driving through a tunnel is a common experience in cities like Boston or Seattle, and drivers may be unaware of the complex nature of the concrete, steel, and operations needed to make tunnel travel safe and routine.

Transition lighting makes entering the tunnel at its portal a seamless event. The motorist sees a typical roadway, tunnel walls and a ceiling, lighting fixtures and signs, and perhaps a walkway and a few doors on the side. But these are just parts of the tunnel. Beyond the walls and ceiling and below the roadway are ventilation chambers, pumping systems, mechanical equipment and emergency systems, and the other unseen infrastructure that make up the tunnel structure. In addition, operational and emergency systems and teams of response professionals at or near the tunnel ensure efficient operation and safety.

This *TR News* theme issue reveals the many hidden aspects of tunnels and illuminates the benefits of tunnel technology to modern transportation systems. The articles here show how tunnels benefit the economy and how transportation operators use the best technology to keep tunnels efficient and safe.

As with much of the nation's infrastructure, the challenges of using tunnels in a road or rail network include relatively high first costs, the need for continuing maintenance and operational expenditures, and safety matters. Highway professionals have long recognized these challenges, and entities like the American Association of State Highway Transportation Officials (AASHTO), the Federal Highway Administration (FHWA), the Transportation Research Board (TRB), and the National Fire Protection Association—as well as firefighters, emergency responders, and the private-sector engineering community—are working to make sure tunnel technology addresses the needs for the growing and congested road network. Indeed, tunnels will be an increasing part of the solution to improved freight and passenger mobility.

Real-Life Examples

A good example of the potential of tunneling is the new Port of Miami tunnel in Florida, which removed port truck traffic from downtown Miami and allowed the port to renew and expand while relieving traffic congestion. Another is the Eisenhower–Johnson Memorial Tunnel on I-70 in Colorado, which eliminated the need to traverse Loveland Pass and opened commercial and recreational opportunities for a large portion of the western United States.

Tunnels in Boston, famously known as the Big Dig, restored the city by removing aboveground viaducts and by including 27 acres of green space and millions of square feet of commercial development. The new Alaskan Way Viaduct Replacement Tunnel (SR-99 tunnel) opened the Seattle waterfront and relieved crosstown congestion while removing a double-decker viaduct that was unsightly and vulnerable to earthquakes. The SR-99 tunnel is one of the most technologically advanced tunnels in the world, utilizing the latest innovations in fixed firefighting, emergency response, lighting, and operations.

The articles in this issue will elaborate on the newest, most advanced topics in tunnel design, construction, operation, and maintenance and will describe some of the groundwork that led to the best in tunnel science. For example, as part of Boston's Big Dig, the tunnel community undertook the Memorial Tunnel Fire Ventilation Test Program. A decommissioned tunnel in West Virginia was converted into a test laboratory, and the results from extensive testing were used by researchers around the world to advance the understanding of ventilation systems and smoke control in tunnels. This study is recognized as a landmark in tunnel technology—another legacy of the Big Dig.

Tunnels can be beautiful and—as with the Waterview Tunnel in Auckland, New Zealand—can be built with community involvement that improves the long-term benefit to users. This tunnel features skate parks at each portal, improvements to surrounding landscape and buildings, and other community-driven features that increased public willingness to pay for the expensive project.

International Research

In 1999, a tragic fire in the Mont Blanc Tunnel on the border of France and Italy in the Alps took 39 lives. This event prompted a European and worldwide effort to improve tunnel operations and advance technology for tunnel signing, areas of refuge, firefighter training, emergency operations, and human-factor engineering. In June 2006, FHWA, AASHTO, and TRB undertook a study and published the report *Underground Transportation Systems in Europe: Safety, Operations, and Emergency Response* to bring these advancements to the United States. Shortly thereafter, AASHTO established a technical committee on tunnels.

The U.S. tunnel community has responded to this information by incorporating safety technology in new construction, and they have refurbished many tunnels with improved lighting, signing, camera systems, and operational improvements. Several research studies have been completed and new ones initiated.

Recently, a joint global benchmarking study for highway tunnel fixed firefighting systems (FFFS) discovered that New Zealand and Australia are established world leaders in the use of FFFS in road tunnels, demonstrating an example of best practices for the safe operation of highway tunnels. Even before this study, several U.S. tunnel owners had incorporated similar systems, both new and retrofitted. The New Zealand and Australian experiences offer the exciting opportunity to incorporate operational excellence into U.S. tunnels to improve reliable long-term functionality of transportation systems.

Transportation researchers and policy makers must "think big" to justify expensive tunnels, knowing the potential of transformative commercial development to bring lasting economic benefit. Tunnels can be a cornerstone for effective community engagement and prosperity, can improve quality of life, and—most importantly—must be reliable and safe.

Photo: Pietro

Daylight-bright lighting, a fenced raised sidewalk, and maintenance doors line the Port of Miami Tunnel. It includes the latest safety features available in the United States, including automatic incident detection, active sprinkler fire suppression systems, and a system of 105 closed-circuit TV cameras along with a 110-foot video wall that displays the tunnel's entire interior in less than 15 seconds.

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