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The Memorial Tunnel Fire Ventilation Test Program:

The Central Artery/Tunnel Project in Boston, Massachusetts

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ABSTRACT

The Central Artery/Tunnel (CA/T) project, currently under way in Boston, Massachusetts, is the largest interstate highway program in the United States. Estimated at $8 billion, the project will generate more than 50 lane-km of new vehicular tunnels and will accommodate more than 300,000 vehicles per day in design year 2010.

A direct result of the planning and design efforts on the CA/T is the Memorial Tunnel Fire Ventilation Test Program, recently completed in a full-size facility in West Virginia. The data from running 98 fires of various size under several ventilation configurations are available on a CD-ROM set for major design refinements and improved operational strategies on the CA/T project and other tunnel programs nationwide.

INTRODUCTION

The existing Boston Central Artery, an elevated section of Interstate 93 (I-93) running north-south through downtown Boston, was opened to traffic in 1959. Originally designed to carry 75,000 vehicles a day, the Central Artery presently handles more than 200,000 vehicles daily. The six-lane highway has 20 on- and off-ramps with no acceleration/deceleration lanes, making it one of the most dangerous sections of highway in the U.S., with an accident rate more than three times the national average.

Access to and from Boston's Logan International Airport is by two two-lane tunnels (Summer and Callahan) beneath the Boston Harbor, which connect with the Central Artery. As a result, almost all airport-bound traffic must travel on the downtown section of Interstate 93.

During weekdays, there are up to 8 hours of stop-and-go traffic, and 14 hours of congestion are predicted for the year 2010. To provide the needed increase in highway capacity and prevent the forecast suffocation of Boston's economy, state officials have planned a massive undertaking, the Central Artery/Tunnel (CA/T) project.

THE PROJECT

The CA/T project in Boston, Massachusetts, is the largest underground highway project ever undertaken in the United States. Estimated at US$8 billion and jointly funded by the Federal Highway Administration and the Massachusetts Highway Department, it is currently under construction and opened its first roadway segment, the Ted Williams Tunnel, on December 15, 1995. The project will result in more than 50 lane-km of highway tunnels, most of which will be part of complex interchanges, with multiple underground decision points.

When completed in 2005, this project will double the highway capacity with an underground, widened Central Artery and a new four-lane tunnel crossing under Boston Harbor to Logan International Airport. This will significantly improve traffic flow in one of the most congested areas in the United States.

The Central Artery/Tunnel project consists of a complex network of mainline urban highways, bridges, surface roadways, covered roadways, cut-and-cover tunnels, subaqueous tunnels, and covered ramps ranging from one to five lanes of traffic in any one direction. The project is composed of the following elements:

1. Construction of a widened, mostly underground, Central Artery (I-93) from just south of the Massachusetts Avenue Interchange on the Southeast Expressway (I-93) to north of the Central Artery-North Area Interchange (I-93/U.S. Route 1) in Charlestown.
2. Construction of a Seaport Access Highway and Third Harbor Tunnel (I-90) from the present terminus of the Massachusetts Turnpike extension (I-90) at the Southeast Expressway (I-93) in Boston to Logan International Airport and Route 1A in East Boston, via the South Boston waterfront area and Boston Harbor.

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3. Construction of a South Boston Bypass Road, a portion of which will be in the railroad right of way between the Southeast Expressway (I-93) frontage roads system and the Seaport Access Highway (I-90), designed to remove construction traffic from local streets.

Currently advancing toward final design and construction in certain sections, the project consists of more than 8 miles (13 km) of proposed mainline urban highway, including a new underground structure up to 10 lanes wide for the 1-mile (1.5-km) segment of I-93 in downtown Boston (the Central Artery) between Causeway and Summer Street.

The Seaport Access Highway will extend Interstate 90 from the existing Massachusetts Turnpike (I-90) terminus in South Bay, providing a 1 mile (1.5 km) long, two-way tunnel through South Boston, connecting with the Ted Williams Tunnel near the waterfront commercial pier area.

If all project roadways were put end-to-end, their total length would be more than 59 miles (95 km). Underground structures would account for 14 miles (23 km), bridges for 19 miles (30 km), surface roadways for 19 miles (29 km), and transition structures for 8 miles (13 km).

When calculated in lane-km (the length assuming a one-lane roadway), the total project length reaches 115 miles (185 lane-km), with more than one-fourth in underground structures (33 lane-mi [53 lane-km]) and one-third (39 lane-mi [63 lane-km]) in bridge structures.

The four major interchange systems (the I-93/I-90 Interchange, the South Boston Interchange, the East Boston Interchange, and the I-93/Route 1 Interchange) have a combined total of 79 bridges, 17 lane-mi (27 lane-km), 1.6 lane-mi (2.5 lane-km), 6.5 lane-mi (10.4 lane-km), and 15.3 lane-mi (24.7 lane-km) long, respectively. The project proposes 75 lane-km of mainline highway, serviced by 112 ramps totaling 59.6 lane-mi (96 lane-km).

As part of the CA/T project, engineering investigations of ventilation operating strategies and performance in full-scale fire situations were authorized to be performed in a suitable facility. the Memorial Tunnel Fire Ventilation Test Program represents a unique opportunity to evaluate and develop design methods and operational strategies leading to safer underground transportation facilities.

BENEFITS

This comprehensive test program, which started the initial fire tests in September 1993 and successfully completed a total of 98 tests, resulted in much-needed data acquired in a full-size facility, under controlled conditions, and over a wide range of system parameters. The results of the program are being made available to the professional community for use in the development of tunnel ventilation design and emergency operational procedures.

The most immediate benefits of the test program were realized by the Central Artery/Tunnel project when the local fire department allowed a projectwide reduction in the fire rating required for the ceiling finish panels in tunnels. With the accurate information on temperature levels during various fires available from the test program, the Boston Fire Department officials felt more confident to lower the initial requirements, allowing overall savings in labor and materials exceeding $20 million.

The program also initiated a design policy change by the Federal Highway Administration (FHWA). As a direct result of the program's findings, the use of jet fans for ventilation highway vehicular tunnels, within the parameters set by the test program, is now allowed in the U.S. This significant policy change resulted in substantial reductions in ventilation building and equipment size on the CA/T project, accounting for an estimated $25 million in additional savings.