Applied Research and Innovation Branch

Fire Emergency Preparedness at the Eisenhower-Johnson Memorial Tunnels, CO

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Colorado School of Mines

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16. Abstract

The Department of Mining Engineering at the Colorado School of Mines (CSM) has been charged by the Colorado Department of Transportation (CDOT) to evaluate fire life safety at the Eisenhower-Johnson Memorial Tunnels (EJMT), particularly with the recent completion of a fixed fire suppression system (FFSS) for the tunnel interior. Over the past year, a research team at CSM conducted a detailed examination of the policies, methods and infrastructure related to response to fire emergencies at the tunnel complex. Researchers utilized a risk assessment model and computational fluid dynamics (CFD) modeling for fire dynamics simulation. With this detailed evaluation process, researchers developed a series of recommendations and conclusions for facility and process improvements at the EJMT.

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Final Report

Fire Emergency Preparedness at the Eisenhower-Johnson Memorial Tunnels, CO

SPRINKLER OPERATION IN EISENHOWER TUNNEL

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Contents

Introduction

The Department of Mining Engineering at the Colorado School of Mines (CSM) has been charged by the Colorado Department of Transportation (CDOT) to evaluate fire life safety at the Eisenhower-Johnson Memorial Tunnels (EJMT), particularly with the recent completion of a fixed fire suppression system (FFSS) for the tunnel interior. Over the past year, a research team at CSM conducted a detailed examination of the policies, methods and infrastructure related to response to fire emergencies at the tunnel complex. Researchers utilized a risk assessment model and computational fluid dynamics (CFD) modeling for fire dynamics simulation. With this detailed evaluation process, researchers developed a series of recommendations and conclusions for facility and process improvements at the EJMT.

Research Objectives and Scope

Background

A devastating fire occurred in the Montblanc tunnel crossing the French – Italian border in the Alps claimed 38 fatalities in 1999 (Miliarium 2015). Nearly 12 km (7 miles) long, the Montblanc is one of the longest road tunnels in the world. The fire was started when a truck loaded with flour and margarine suffered an engine fire that eventually caught the entire load on fire. The fire spread across several vehicles and burned for 53 hours. The Montblanc fire lead to worldwide revisions of fire prevention and emergency response procedures. One of the main lessons learned was that cargo that was not labeled as hazardous materials (margarine, flour) can provide nearly equivalent amounts of fire energy as a fully loaded fuel tanker truck, as occurred in the 1982 Caldecott and other severe tunnel fires. The fire hazard was aggravated by insufficient ventilation, inadequate emergency response, lack of video surveillance and communication, and poorly designed escapeways for drivers and passengers of the vehicles crossing the tunnel.

Objectives

The Eisenhower and Johnson Memorial Tunnels have been retrofitted with an advanced, water deluge-type fire suppression system in 2016. While this system is expected to greatly enhance fire safety, researchers proposed this project to look at the overall system response to a variety of fire and ventilation scenarios, including ventilation controls and escape management, in connection with the fire suppression installation.

Through computational fluid dynamics (CFD) fire modeling, researchers developed strategies and best practices for response to fire emergencies at the Eisenhower and Johnson Memorial Tunnels with the goal to protect human life and property.

Scope

This research project is focused primarily on response to fire emergencies, with limited focus on other in-tunnel emergencies such as traffic accidents, hazardous materials or vehicles. No discussion or evaluation of emergency circumstances or threats to continued tunnel operations are included, particularly from a homeland security or law enforcement perspective.

Evaluation Methodology

Researchers used a comprehensive and multidisciplinary approach to develop an understanding of the fire life safety systems at EJMT.

Literature Survey

Researchers have completed a comprehensive international literature search associated with fires in tunnels in general, specific tunnel fires, such as the Mont Blanc disaster, fire design, CFD associated with tunnel fires, fixed fire suppression systems, emergency response, emergency management, risk analysis risk management, lessons learned, and human factors.

The Team documented the results of the literature search by logging the nature of each search including the source, the key words used to search, and the results. Researchers identified over 6,000 publications as a result of 44 separate searches.

On each publication of interest, Researchers captured an electronic copy and filed it in a document management system based on a primary topic, such as FFSS or Risk Analysis. Researchers reviewed each document assigned a ranking of High - Medium - Low priority. High and Medium priority papers were assigned a secondary review. Of the publications searched, the project team deemed 156 sufficiently important to warrant further review. Researchers reviewed these publications in detail in search of relevant case study information to assist in formulating research questions, fire and emergency scenarios and best practices in emergency preparedness and response.

Documentation Review

The researchers received numerous documents from CDOT on the design of the facility and the Fixed Fire Suppression System in the form of design and as-built drawings, design reports, safety and operational plans. Each source of documentation was review by select team members and relevant information was extracted.

In addition to those CDOT personnel interviewed that the EJMT facility, CSM project team members have also had the opportunity to meet and discuss various project and design issues with Stephen Harelson, CDOT West Program Engineer, and with BCER, engineers of record for the FFSS, representatives Steve Rondinelli and Jason Miller. The research team has used these valuable discussions and insights to assist in formulation of the research questions and fire scenarios.

Facilities Examination and Interviews

Team members Jürgen Brune, Kirk McDaniel, Richard Gilmore and Chris Enright visited the EJMT facility in early January 2016. The team had an opportunity to learn about the capabilities of the facility, equipment, operations and personnel. The team witnessed the facility staff respond to a vehicle in distress inside the tunnel and observed several over-height vehicles, which were stopped before entering the west bound tunnel. The team also had the opportunity to access the tunnel ventilation ducts to examine the installation of the Fixed Fire Suppression System and the design of the inlet and exhaust portals.

Researchers conducted a second site visit in July of 2016 to observe testing of the fixed fire suppression system along with the ventilation system. This test was part of the prescribed system testing done as part of the commissioning of the fire suppression system, with some of the primary emergency responders for the EJMT participating in the testing. During this test, several key observations were made:

- Sprinkler system effectively distributes water into the air, with nearly immediate activation when triggered.
- Sprinkler water mist resulted in nearly complete visual obscuration of the tunnel, where only headlights of vehicles on the opposite side were visible, see Figure 1.
- Attempts to ramp ventilation to emergency mode resulted in a failure of the intake ventilation plenum double doors on the north tunnel; this was explained at the time as a priority repair to be made.

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DATE: May 2017

RE: Access to Research Report # 2017-06.pdf
"Fire Emergency Preparedness at the Eisenhower-Johnson Memorial Tunnels

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