FEDERAL OUTDOOR IMPACT LABORATORY FACT SHEET

Improving transportation safety through motor vehicle crash testing.

PURPOSE

The Federal Outdoor Impact Laboratory (FOIL) is a fully equipped outdoor crash testing laboratory and research facility used to support the Federal Highway Administration's (FHWA) Safety Research and Development (R&D) programs and other federally funded security initiatives. Researchers use the facility to extend their understanding of crash events by staging controlled, high-speed motor vehicle collisions. The facility typically is used to confirm the accuracy of computer-generated crash predictions. This ensures that tested roadside structures—structures that typically are located in close proximity to the Nation's roadways—function as intended when struck by a motor vehicle. Routine certification or compliance testing of roadside safety structures, including testing performed to ensure compliance with existing safety standards, is not conducted at the FOIL.

In addition to staged motor vehicle collisions, the FOIL is equipped with a large pendulum mass swinging from a support structure. This device enables researchers to conduct low-speed impact testing. Researchers also often use the pendulum to perform dynamic-impact testing of structural components. This type of testing provides researchers with information and data to help improve the accuracy of computer-generated vehicle collisions.

LOCATION

Federally owned and operated, the FOIL is located on the grounds of the Turner-Fairbank Highway Research Center (TFHRC) in McLean, VA, a suburb of Washington, DC. TFHRC is the home of FHWA's Office of Research, Development, and Technology.

The FOIL primarily is used in support of the R&D activities of the FHWA/National Highway Traffic Safety Administration- (NHTSA) funded National Crash Analysis Center (NCAC), which is located in nearby Ashburn, VA, on the Virginia campus of The George Washington University (GWU).

HISTORY

Constructed during the early 1980s, the FOIL commenced operations in the summer of 1985. Over the ensuing years, the facility's purpose and function has changed and adapted as newer technology has been introduced. When the FOIL opened, motor vehicle crash testing was the only method available to evaluate the crashworthiness of roadside structures and confirm the potential to mitigate occupant injuries during motor vehicle collisions into roadside structures. Examples of these structures include concrete median barriers, metal guardrails, breakaway sign and lighting supports, and energy-absorbing crash cushions.

During this early period, crash testing was the single preeminent technology used by engineers to better understand the crash event, which encompasses two complex interactions. The first interaction occurs when the motor vehicle collides with the roadside safety structure. The second interaction occurs when the vehicle occupants collide with the interior surfaces or the safety restraints inside the passenger compartment.

CHANGING ROLE OF THE FOIL

With the advent of high-speed, high-memory capacity computers in the early 1990s, technology reached the point where vehicle crash outcomes could be accurately predicted using the computer. Specialized finite-element software that is appropriate for depicting the physics of motor vehicle collisions is now used extensively to predict collision outcomes. Because of this new technology, during the early 1990s, the function of the FOIL changed substantially, and it is now used primarily to confirm the crash predictions obtained using computer-based crash technology.

BUILDING SECURITY – AN EMERGING USE OF THE FOIL

As a result of the terrorist attacks on September 11, 2001, building security has become a focus and priority for the U.S. government. The need to develop perimeter security devices and structures to prevent the unwanted intrusion of speeding motor vehicles into areas adjacent to government buildings and other critical facilities is now necessary and urgent. Examples of perimeter security devices and structures include crash resistant bollards, stanchions, concrete walls, large planters filled with soil and plants, and energy-absorbing fences, all of which must be capable of stopping a speeding heavy truck within an extremely short distance. Because of this urgent need, the FOIL has been enlisted to aid in the development of these structures.

The Turner-Fairbank Highway Research Center (TFHRC) has more than 24 laboratories for research in the following areas: safety; operations, including intelligent transportation systems; materials technology; pavements; structures; and human centered systems. The expertise of TFHRC scientists and engineers covers more than 20 transportation-related disciplines. These laboratories are a vital resource for advancing the body of knowledge created and nurtured by our researchers. The Federal Highway Administration's Office of Research, Development, and Technology operates and manages TFHRC to conduct innovative research to provide solutions to transportation problems both nationwide and internationally. TFHRC is located in McLean, VA. Information on TFHRC is available at ***www.tfhrc.gov****.*

FHWA-HRT-06-107 • HRDS-04/07-06(1M)E

CAPABILITIES

The FOIL features a state-of-the-science hydraulic propulsion system that is the first of its kind in the United States. The system includes a computer-controlled linear accelerator that can accelerate passenger vehicles up to impact speeds of 121 kilometers (75 miles) per hour. Heavy trucks weighing up to 8,165 kilograms (18,000 pounds) when fully loaded are limited to reduced speeds of 80 kilometers (50 miles) per hour. This is accomplished on a short concrete runway that is only 67 meters (220 feet) in length.

Prior to testing, the test vehicle's weight, the length of the runway up to the test structure, and the required collision speed is input into the computer that controls the propulsion system. Upon initiating a test, the computer automatically adjusts the flow rate of hydraulic fluid into two hydraulic motors that propel the test vehicle. This controlled flow into the motors precisely regulates the test vehicle's acceleration as it is powered up to the desired test speed. At impact into the test structure, the speed of the test vehicle is accurate to within 0.8 kilometers (0.5 miles) per hour of the desired collision speed. Just prior to impact, the propulsion system is disengaged from the test vehicle. At impact, the test vehicle is completely unconstrained and freewheeling. This unconstrained motion approximates the conditions associated with a "real-world" crash on the Nation's roadways.

A swinging pendulum structure also is available at the FOIL for impact testing of structural components. With a mass of up to 1,996 kilograms (4,400 pounds), this gravity-propelled pendulum can attain impact speeds in excess of 32 kilometers (20 miles) per hour. Dynamic-impact testing of structural components often is performed to assist in the development of accurate computer models of roadside structures and is subsequently used to enhance the accuracy of the computer-generated collisions.

Test instrumentation at the FOIL includes speed traps, accelerometers, angular motion rate gyroscopes, and load cells for determining the velocity, acceleration, roll, pitch, and yaw motions of test vehicles, and the impact loads resulting from high-speed collisions. Data collection from this instrumentation is accomplished using onboard, solid-state recording devices. A telemetry system is used to transfer data to the data processing center. Visual documentation and analysis of the test is achieved using high-speed, state-of-the-science digital cameras that enable researchers to visualize the impact and deformation of the test vehicles and structures. In addition, almost immediately after the test, researchers can review and analyze the visual information.

ACCOMPLISHMENTS

Over the past 20 years, the list of test programs performed at the FOIL has grown long and varied. Most recently, the FOIL, in conjunction with the research activities of the FHWA/NTHSA-funded NCAC, has contributed to the following research programs:

Roadside Safety Structures

Researchers have conducted the following projects on roadside safety structures to help mitigate or eliminate injuries during motor vehicle collisions:

- Optimum placement of cable median barriers in sloped roadway median areas to contain motor vehicles and prevent crossovers.
- Redesign of the connections between portable concrete barriers to ensure they do not disconnect during a motor vehicle collision.
- Determination of the tolerance range for W-beam guardrail heights to ensure proper functioning during a motor vehicle collision.
- Redesign of mailbox and small sign mounting supports to mitigate windshield penetration during a motor vehicle collision.
- Redesign of breakaway sign support legs to ensure they swing away and out of the path of motor vehicles during a collision.

Perimeter Security Devices and Structures

The following roadside perimeter security devices and structures were developed to ensure that a high-speed heavy truck cannot penetrate into areas adjacent to buildings and secure facilities:

- Fixed and removable roadside bollards and the associated reinforced concrete foundation.
- Energy-absorbing fencing and the associated reinforced concrete foundation.
- High- and low-rise reinforced concrete walls and the associated reinforced concrete foundations.
- Large planters used to restrict motor vehicle access, including collision resistant roadway or sidewalk attachments.

Structural Component Testing Using the Pendulum

Researchers at the FOIL performed structural component testing using the pendulum to accomplish the following:

- Quantify the response parameters of front and rear suspension system components for use in computer models of motor vehicle suspension systems.
- Quantify and understand the impact response of high-strength cables when used in perimeter security structures.
- Quantify and understand the response of guardrail posts made of wood and steel and mounted in soil for use in computer models of guardrails systems.
- Quantify the impact strength of motor vehicle windshields to calibrate vehicle computer models containing a laminated glass windshield.

CONTACTS

FHWA's FOIL Manager:
Martin Hargrave
202–493–3311
martin.hargrave@fhwa.dot.gov

FHWA's NCAC Manager:
Kenneth Opiela, Roadside Team Manager
202–493–3371
kenneth.opiela@fhwa.dot.gov

GWU's NCAC Director:
Cing-Dao (Steve) Kan
703–726–8511
cdkan@ncac.gwu.edu