

Resilient Tunnel Project: Protecting our Nation's Critical Infrastructure

Tunnel floods cause billions of dollars of damage

Mass transit agencies normally focus on keeping things moving, but when it comes to tunnel floods, stopping flow becomes the number one priority. For example, in 2012, Hurricane Sandy caused massive flooding in New York City's extensive subway system impacting seven tunnels and several stations. The South Ferry station, which flooded with 15 million gallons of salt water, was closed for almost five years with restoration costing \$350 million.



The tunnel plug conforms to the shape of a subway tunnel, as seen in this photo. When deflated, the plug can be stored on the sides of the tunnel without interfering with tunnel operations.

DHS explores ways to prevent flooding

The U.S. Department of Homeland Security (DHS) Science and Technology Directorate (S&T), through its Resilient Tunnel Plug project, is developing technologies that prevent or limit flooding in subway tunnels. S&T partnered with the Department of Energy's Pacific Northwest National Laboratory, West Virginia University, and ILC Dover, a textile company that manufactures spacesuit fabrics, to create an inflatable tunnel plug that is capable of isolating and sealing tunnel sections to limit damage.

Withstanding the high-pressures of flood waters

S&T's tunnel plug is made of high-strength Vectran® fabric, which ILC Dover previously used for the landing pods of the Mars Rover. During testing of an early prototype, scientists found that a single layer of Vectran fabric was insufficient, so S&T developed a tri-layer version with a

webbed fabric outer layer. In March 2017, S&T successfully completed three full-scale validation tests of the tunnel plug in a test tunnel designed to closely replicate an actual subway tunnel. Following plug deployment and inflation, the test tunnel was flooded and pressurized to simulate real-world flooding conditions. The tests evaluated performance of the plug itself, storage container, inflation pumps, and control systems. A "long duration" test, where water pressure was continuously applied for 21 days to mimic an extended flooding event, was also successful.

Tunnel Plug Impact

S&T designed the tunnel plug to be pre-installed, in a custom-designed, compact container, at strategic locations in underground transportation tunnels. When needed, the tunnel plug can be inflated quickly to halt flooding.

In addition, S&T's investment in the tunnel plug directly resulted in development of several "spin-off" technologies, including covers for subway stairwells, fabric flood walls, and flexible flood gates. Stairwell covers are now deployed in lower Manhattan, as part of the New York City subway's Hurricane Sandy recovery efforts.



The plug uses special high-strength textiles to withstand the pressures of a flooded tunnel.

Throughout the project, S&T has working closely with transit agencies and the Transportation Security Administration to ensure that tunnel plugs meet operational requirements and can be efficiently installed in subway tunnels.

