2017 Association of State Floodplain Managers Annual Conference:
Managing Flood Risk in the Heartland
*April 30th – May 5th*
*Kansas City, Missouri*

Development and Implementation of Dry Flood Proofing Stored at the Point of Use

**ILC Dover LP**
www.ilcdover.com
Dry Flood Proofing

• Dry Flood Proofing
  • Structure or device above the base flood elevation with a substantially impermeable barrier to prevent the ingress of water and debris

• Dry Flood Proofing Benefits
  • Other means such as elevating may not be feasible
  • Street access required into the building
  • Historic areas cannot be modified
  • Densely populated areas restricted on property uses

Dry Flood Proofing Issues

• Requires active deployment
• Maintenance
• Training
• Storage/Transit for deployment
Resilient Tunnel Plug

• Designed to rapidly isolate tunnel sections in response to flooding, smoke / fire, or release of CB agents (functions like an automotive airbag)

• Deployable plug technology
• Fixed in tunnel or transportable
• Frictional plug contours to irregular surfaces
• Robust design for challenging environments
• Very little tunnel modification required
• Scalable design (4ft to 16 ft dia tested)
• Verified to hold 38ft water head

Currently working 1st installation in US Transit system
• ILC work with webbing based structures directly led to the development of the Resilient Tunnel Plug

• Webbings provide a redundant, resilient design that can withstand damage and impact
  • Explosive testing at White Sands demonstrated the minimal change in tension of the webbings due to friction

• Resilient Tunnel Plug took this design to the next level by creating a full webbing net structure
Hurricane Sandy
October 29th, 2012

Costliest U.S. Atlantic hurricanes
Cost refers to total estimated property damage

<table>
<thead>
<tr>
<th>Rank</th>
<th>Hurricane</th>
<th>Season</th>
<th>Damage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Katrina</td>
<td>2005</td>
<td>$108 billion</td>
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<tr>
<td>2</td>
<td>Sandy</td>
<td>2012</td>
<td>$65 billion</td>
</tr>
<tr>
<td>3</td>
<td>Ike</td>
<td>2008</td>
<td>$29.5 billion</td>
</tr>
<tr>
<td>4</td>
<td>Andrew</td>
<td>1992</td>
<td>$26.5 billion</td>
</tr>
<tr>
<td>5</td>
<td>Wilma</td>
<td>2005</td>
<td>$21 billion</td>
</tr>
<tr>
<td>6</td>
<td>Ivan</td>
<td>2004</td>
<td>$18.8 billion</td>
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<tr>
<td>7</td>
<td>Irene</td>
<td>2011</td>
<td>$15.6 billion</td>
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<td>8</td>
<td>Charley</td>
<td>2004</td>
<td>$15.1 billion</td>
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<td>9</td>
<td>Rita</td>
<td>2005</td>
<td>$12 billion</td>
</tr>
<tr>
<td>10</td>
<td>Frances</td>
<td>2004</td>
<td>$9.51 billion</td>
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</tbody>
</table>

Source: National Hurricane Center
NY MTA Deployment Demonstration
South Ferry Station - NYC
Transit authorities, end users, commercial property owners, and flood experts all provided input on the key requirements for flood proofing:

- Easy to use
  - Minimal training
  - Intuitive system that people will use
- Fast to deploy and fast to retract
  - Opening up a transit system is often just as critical as closing it down
- Can be used multiple times
- Technology can be used in different size and types of openings
  - It must be scalable to different head pressures and types of openings
- Low cost
Enabling Technology for Flood Protection

- Textile/membrane structures can be stowed in small volumes
- Small stowage volume enables “point of use storage”
- Point of use storage enables rapid deployment/retraction
- Rapid deployment/retractions enables cost & risk reduction
  - Keep facility operational as long as possible
  - Minimizes productivity/safety impact
  - Reduces operational cost (storage/transport/# people)
  - No risk of lost parts in storage/transport
  - Simplifies training & yearly testing
- Minimal mechanical parts to reduce maintenance time and cost

Simple Intuitive Technology

- Deploys like roll-up doors, shower curtains, etc.
- Requires minimal training
- Scalable to any DFE and application (size & shape)

Flexible Technology Products Provide the Lowest Life-Cycle Cost Possible
ILC Dover Flood Protection Products

Resilient Tunnel Plug  
Plugs tunnels

Flex-Gate® Stairwell  
Seals stairwells

Vertically Deployed Flex-Wall®  
Protects entrances / perimeters

Flex-Cover®  
Seals vent shafts

Pipe Plugs  
Plugs pipes

Flex-Gate® Portal  
Seals vertical openings

Side Deploy Flex-Wall®  
Protects entrances / perimeters

VaporGuard™  
Fugitive emissions covers
General system attributes

- Point of use storage
- Low maintenance (few moving parts)
- Self-contained system
- Simple operation
- Deploy in <5 min by 1 person
- 75 yr life (membrane replacement at 25 yrs)
- Withstand up to 14ft water head
- <0.5gal/min/ft perimeter seepage
- Stainless Steel / Kevlar / CSM
- Certified to NY MTA DG312
- Scalable design
- Can be operated in high winds
- Resists environmental & chemical exposure

24 Systems installed (Canal St. NYC) (8-Stations). Follow-on 8 & 9 Stations contracts pending (~66 total).
Stairwell Flex-Gate®

A deployed system in NYC

NYCT system testing
Portal Flex-Gate®

General system attributes

- Point of use storage
- Low maintenance (few moving parts)
- Closed and Opened by push-button drive motor
- Hand actuation capable in power outage situation
- Resist 35’+ of water
- Deploy in under 20 minutes (2 people)
- <0.5 GPM/ft of perimeter
- Can be operated in high winds
- Resists debris impact & hydrodynamic loading
- Can adapt to uneven ground surfaces or portal skew
- Can be faced to match architecture
- 25 year time between refurbishment
- Fire resistant (self-extinguishing materials)
- Resists environmental & chemical exposure
- Adaptable to signal cables
- Certified to NY MTA DG312

Design studies complete/in-progress for NYCT rail yard systems, Holland Tunnel, HCT/QMT, DOT Tunnels. Also, commercial & municipal properties (garages, WTC VSC).
Installed 58 openings at NYC power company. Studies complete / waiting procurement on NYCT locations (207th rail yard, BBT/QMT, buildings, WTC VSC & memorial, etc.). Also waiting procurement on NYU Hospital and many US commercial properties.

General system attributes

- Point of use storage
- Low maintenance (few moving parts)
- Self-contained system
- Simple operation
- Deploy in <5 min by 2 people (20ft)
- 75 yr life (membrane replacement at 25 yrs)
- Withstand up to 14ft water head
- <0.5gal/min/ft perimeter seepage
- Stainless Steel / Kevlar / Coated Fabric
- Certified to NY MTA DG312
- Scalable design
- Can be operated in high winds
- Resists environmental & chemical exposure
Side Deployed Flex-Wall®

Stored in a container next to the opening.
Deploy like a shower curtain. Spans &
seals the opening when deployed.

**Container** (houses the stowed flexible wall)

**Receiver** (what the flexible wall connects & seals to)
Side Deployed Flex-Wall®

**Flexible Wall** (water impermeable barrier)  
**Skirt** (seals to ground - clamped version shown)  
**Cable** (simplifies deployment)
Side Deployed Flex-Wall®

Many configuration options are possible
Vertically Deployed Flex-Wall®

- **Trench Covers** (protect stowed system)
- Stored in a trench. Raise like a sail. Creates a sealed barrier in front of or around buildings/equipment.
- **Posts** (support flexible wall)
- **Flexible Wall** (water impermeable barrier)

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ILC Dover
Vertically Deployed Flex-Wall®

Packed in Trench

Mount Posts

Remove Covers

Raise Flexible Wall
ILC has invested in a test facility to validate, demonstrate, and train potential customers on deployable flood barriers.

- Full scale portal and subway tunnel designed to match install profiles.
- Additional test capabilities added for full scale side deploy wall testing.

Cut View of Tunnel Structure

Subway Tunnel Profile  Portal Flex-Gate™ Testing  Horizontal Flex-Gate™ Testing  Flex-Wall™ Testing
Side Deployed Flex-Wall™

Factory Acceptance Testing
- Wall is intentionally contoured
- Scalable test facilities
- Measure performance attributes
- 3rd party witnessing

- Impact attenuation (100lb log @ 5fps)
- Weighted skirt seepage <0.42 GPM/LF of seal
- Clamped skirt seepage <0.09 GPM/LF of seal (commercial goal is 0.08 GHP/LF of seal)

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Vertically Deployed Flex-Wall™

Deployment testing at ILC

Log impact testing at ILC
Testing Flex-Gate™

- 6.9 psi proof test (~16ft water or 1.25x operational pressure)
- Leakage at operational pressure was below the requirement

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
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<tbody>
<tr>
<td>Flex-Gate (Softgoods)</td>
<td>~70lbs.</td>
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<tr>
<td>Top Plate</td>
<td>7,500 lbs.</td>
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<tr>
<td>Water</td>
<td>~1500 gal. (12,500 lbs.)</td>
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Implementation

- Flex-Gate® and Flex-Wall® systems have been installed and tested in several locations
- Currently, 23 stairwells Flex-Gate® systems have been installed for NYCT
  - First prototype system has been installed for several years and evaluated in the stowed configuration
- Several Flex-Wall® systems have been installed in multiple locations
  - Several types of systems have been installed and tested
    - Emergency egress – Alcove created in front of an opening
    - Span – Prevent water intrusion in an opening
    - Water Barrier – Non-structural system which water proofs a wall
- Education of structural requirements and flood loading
• ILC continues to work with customers to determine needs and update designs

• Softgoods technology offers many benefits that allow ILC to respond to customer needs
  • Low stowed volumes *(Fits in tight places)*
  • Conformal Materials *(Adaptable to any opening)*
  • Scalable *(Can size to fit location and loading)*
  • Low maintenance *(Minimal mechanisms)*
  • High reliability *(Simple designs based on proven technology in the harshest environments)*
Questions

• ILC was founded in 1947 and has been developing products for flood protection since 2008

• ILC is a solution provider – we solve life-critical problems with our technology and experience

• We leverage our core technology from space suits / airships into industrial applications like flood protection

• We have developed a line of flexible flood protection solutions that are stored at the point of use

• These products are easy to use and offer low life-cycle cost to transit, municipal and commercial property clients
Company Overview

ILC Dover est. 1947
Origins from International Latex Corporation est. 1937, which became ILC Dover and Playtex

650 Skilled Employees

Quality Oriented Systems
- Registered to ISO 9001:2008
- NHB-5300.4 (1D-2)
- AS 9100 Registered

Extensive Facilities
- >500,000 sq ft
  (118,000 sq ft High Bay Production)
Development, Test Lab, Fabrication and Production Facilities

Worldwide Sales Team
Core Competencies

Materials Development
- Structural containment for use in extreme environments
- Barrier films
- Coated /laminated materials

Engineering / Design
- Using softgoods to solve life critical problems
- Designing softgoods to replace traditional rigid elements
- Designing articulated softgood pressure vessels

Manufacturing
- Production, inspection and testing of inflated structures
- Precise, reliable sealing for critical applications
Capabilities Overview

1. Collaboration to Address Demanding Requirements
2. Computer Aided Design and non-linear structural analysis
3. Advanced Materials Development – customized to your application
4. Qualification and Certification Testing
5. Process Controlled Fabrication – heat sealing, sewing, and cementing
6. In Field Support

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