RUTGERS
Center for Advanced Infrastructure and Transportation
A U.S. Department of Transportation University Transportation Center

Bridge Evaluation and Accelerated Structural Testing Lab
One of only five USDOT-designated University Transportation Centers, providing transportation infrastructure systems education and research in safety, mobility, economic growth, human and natural environments, and national security.

**CAIT: CENTER FOR ADVANCED INFRASTRUCTURE AND TRANSPORTATION**

**BEAST: Bridge Evaluation and Structural Testing laboratory**
*World’s first facility rapidly simulates bridge deck deterioration testing*

**RABIT: Robotics Assisted Bridge Inspection Tool**
*Collects and analyzes bridge surface conditions*
BEAST: Mission

For the first time, will allow the scientific study of deterioration processes on full-scale bridge decks in a rapidly compressed time. The lines of innovation:

» Calibrate field data with BEAST data to estimate/forecast remaining service life for much larger population of bridges

» Develop reliable deck deterioration models

» Evaluation of numerous technologies, materials and components

» Validating new technologies being developed to augment bridge deck inspection
BEAST: Site Features

Access to major routes:
- Route I-95 – 6.5 miles
- Route I-287 – 5.5 miles
- NJ Route 18 - 2 miles
- NJ Route 1 - 5 miles

Fabrication, instrumentation, and casting yard

Existing CAM Labs

BEAST Lab Location

New Lab Space
<table>
<thead>
<tr>
<th>Specification</th>
<th>Bridge Deck Tester</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bridge Specimen Size</td>
<td>50-ft span by up to 28-ft wide</td>
</tr>
<tr>
<td>Specimen Superstructure Depth</td>
<td>Up to 60 inches above floor</td>
</tr>
<tr>
<td>Overall Length (ft)</td>
<td>Approximately 125 feet</td>
</tr>
<tr>
<td>Overall Weight (lb)</td>
<td>120,000 lb</td>
</tr>
<tr>
<td>Max Normal Load (lb) Normal</td>
<td>60,000</td>
</tr>
<tr>
<td>Min Normal Load (lb) Normal</td>
<td>10,000</td>
</tr>
<tr>
<td>Trafficking Speed (mph)</td>
<td>0 to 20</td>
</tr>
<tr>
<td>Primary Drive System</td>
<td>Electric winch</td>
</tr>
<tr>
<td>Drive System Power (hp)</td>
<td>400 HP</td>
</tr>
<tr>
<td>Axle Size</td>
<td>Two Full 30,000 lb capacity each</td>
</tr>
<tr>
<td>Portability</td>
<td>Lateral movement provided between loading cycles</td>
</tr>
<tr>
<td>Bi-directional Loading</td>
<td>Yes</td>
</tr>
<tr>
<td>Electrical Power</td>
<td>3 Phase 480 Volt</td>
</tr>
</tbody>
</table>
## Testing Capabilities: Bridge Systems, Components & Materials

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Concrete</strong></td>
<td>Any concrete bridge deck mix design, corrosion inhibitors, supplemental cementing materials, and additives</td>
</tr>
<tr>
<td><strong>Decking Systems</strong></td>
<td>Open, filled, partially-filled or unfilled grid decks such as exodermic bridge deck systems; orthotropic or other metal deck systems; prefabricated deck systems; precast slabs; and others</td>
</tr>
<tr>
<td><strong>Rebar</strong></td>
<td>Steel, epoxy coated, galvanized, stainless steel, steel clad, glass and carbon fiber polymer, etc.</td>
</tr>
<tr>
<td><strong>Prestressing &amp; Post-tensioning Strands</strong></td>
<td>Bar, wire, strands, couplers, anchorages, ducts, and other components</td>
</tr>
<tr>
<td><strong>Coatings &amp; Sealants</strong></td>
<td>Latex-modified concrete, joint sealants, epoxy waterproofing seal coating, etc.</td>
</tr>
<tr>
<td><strong>Superstructure Frames</strong></td>
<td>Structural steel, reinforced concrete, precast concrete, prestressed concrete, and timber</td>
</tr>
<tr>
<td><strong>Joints</strong></td>
<td>Preformed joint filler, elastomeric joint assemblies, strip seal expansion dams, modular bridge joint systems, longitudinal joints, shear locks, and others</td>
</tr>
<tr>
<td><strong>Bearings</strong></td>
<td>Bearing pads, reinforced elastomeric bearing assemblies, high-load multi-rotational bearing assemblies, and others</td>
</tr>
<tr>
<td><strong>Deck Drainage</strong></td>
<td>Scuppers, inlets, downspouts, grates, and other drainage elements</td>
</tr>
<tr>
<td><strong>Safety Devices</strong></td>
<td>Striping paint, pavement reflectors, auditory safety devices (e.g., Bott's dots, rumble strips, etc.), ITS devices and sensors, traffic cams, signage materials, and more</td>
</tr>
</tbody>
</table>
Summary of Protocol

• Mean Stage - Two days at 65F
• Min Stage - Five days at 0F
• Mean Stage - Two Days at 65F
• Max Stage - Five Days at 104F
• 1% Brine solution applied during Min Stages

Features

• Estimated to produce 15 to 20 years of environmentally induced deterioration in 6 months
• Accommodates periodic assessments during median temperature cycles

Repeat
Live Loading Protocol

Loading Magnitude
- Full 60 kip – results in roughly twice the force effects and local stresses of a typical, legal truck
- Half 30 kip – most realistic

Loading Frequency
- Maximum is approximately 20,000 cycles per day
- Over 6 months this results in 3.65 million cycles
- Corresponds to 15 years of truck traffic on a bridge with ADTT of 650

Loading Configuration
- Stationary – worst case, unrealistic
- Roving – Options 1 and 2 changed during Mean Temperature Cycles
Questions?

Thank you!

cait.rutgers.edu

Thank you!
Live Loading Protocol (Option 1) >>

Maximum, Realistic Deck Force Effects

6 ft.

7 ft. (typ)
Live Loading Protocol (Option 3) >>

Maximum, Unrealistic Deck Force Effects

6 ft.

7 ft. (typ)
### Potential Fixed Instrumentation

(low spatial resolution, high temporal resolution)

#### Global
- A series of RGB cameras, including live load mounted
- A series of IR cameras

#### Deck
- Groups of embedded VW strain gages and thermistors
- Curing, dead load, temperature, live load stresses
- Redistribution of stresses due to shake-down, deterioration
- Uniform grid of chloride and corrosion sensors

#### Girders, Diaphragms
- Groups of 3 to 4 longitudinal VW strain gages, thermistors, and displacement sensors: ¼- Mid-, ¾ - Span
- Dead load, curing, temperature and live load stresses
- Location and migration of N.A. (dead load, temperature, live load)
- Initial and changes in transverse load distribution (dead load, temperature, live load)
- Fiber Optic WIM to capture shear forces
Periodic Data Collection >>
(high spatial resolution, low temporal resolution)

Carried out on a base interval during Mean Temperature Cycles and based on sensor responses or thresholds

- Comprehensive, multi-modal NDE scanning (RABIT)
- Modal impact testing to estimate frequencies and mode shapes (THMPR)
- NBIS Bridge Inspection
- Inspection as per LTBP Protocols
Potential Payload Projects

Long-term Performance of...
- Sensing and data acquisition
- Utilities and conduit
- Roadway condition sensors

More Fundamental Projects
- Development and validation of approaches to integrate NDE, SHM, and visual inspection
- Reliability of NDE, sensing, etc.
- Development and validation of mechanistic-based simulation modeling of deterioration
- Quantification of the reliability of model-experimental correlation approaches