Extreme Weather Events and State DOTs

Date: August 25, 2014
Committee: SASHTO
Presenter: Michael Meyer, Parsons Brinckerhoff
Best Practices for Extreme Weather Management

- It pays to be ready and pre-plan
- Practice, practice, practice
- Know what is out there
- Use all forms of communication media
AASHTO’s Center for Environmental Excellence Initiative

Update on Federal Programs and Recent Research

SOM
SCOE
NASTO
WASHTO
SASHTO

SCOH SCOM STEICS SOD SOC
Transportation System Management and Operations

- Contingency Plans
- Evacuation and Emergency Routes
- Traveler Information
- Drill and Test
- Pre-position Materials & Equipment
- Back-up Communications
Transportation System Management and Operations

- Risk Reduction Strategies
- Early Warning Indicators
- Harden the System
- Workforce Protection
WHAT DOES THIS MEAN FOR CONSTRUCTION?

- Construction Season
- Construction Needs (Force Majeure)
- Construction Scheduling
- Construction Site Safety
- Contingency Plans
- Resilient Power Supply
WHAT DOES THIS MEAN FOR CONSTRUCTION?

- Back up Communications
- Work Zone Safety
- Workforce Training
- Future Protection
Climate Change Impacts in the United States
HIGHLIGHTS

U.S. National Climate Assessment

National Climate Assessment
(2014)
Changing climatic conditions and extreme weather events are affecting the reliability and capacity of the U.S. transportation system in many ways.

Major coastal impacts, including both temporary and permanent flooding.

Extreme weather events currently disrupt transportation networks in all areas of the country; projections indicate that such disruptions will increase.

Impacts can be reduced through a wide range of adaptive actions.
STUDIES & RESEARCH ON EXTREME WEATHER & THE TRANSPORTATION SYSTEM

NCHRP REPORT 750
Strategic Issues Facing Transportation
Volume 2

Climate Change, Extreme Weather Events, and the Highway System
Practitioner’s Guide and Research Report

NCHRP 750, VOL. 2
KEY QUESTIONS

• How Could Changes in Temperature Affect Road Assets?
• How Could Changes in Precipitation Affect Road Assets?
• How Could Sea-Level Rise Affect Road Assets?
• How Could Greater Hurricane Intensity Affect Road Assets?
• How Could Stressors Affect Ecological Systems?
• What Are the Types of Adaptation Strategies that Can Be Considered by Transportation Agencies?
Adaptation

“Actions by individuals or systems to avoid, withstand, or take advantage of current and projected climate changes and impacts. Adaptation decreases a system’s vulnerability, reduces risk and/or increases its resilience to impacts.”
Concepts

- Asset vulnerability
- System resiliency
- Adaptation
- Risk
- Flexible design
- Operations/maintenance
To view relevant engineering information, please tell us about your project.

1. What is your project’s asset type?
   - Bridge
   - Culvert
   - Pavement
   - Slope or Wall
   - Stormwater Infrastructure

2. If it is an existing asset?

3. Which climate stressors are of interest?
   - View climate projections for your region.

Based on the asset type you specified above, the following climate stressors might impact your project:

Please choose options above to view applicable climate stressor options.

View relevant engineering information
1. What is your project's asset type?
   - Slope or Wall

2. Is your project for a new or an existing asset?
   - New asset
   - Existing asset

3. Which climate stressors are of interest?
   - Check all
   - Precipitation
     - More extreme rainfall events
     - Erosion and mass wasting
     - Floodplain extent and elevation
     - Higher average precipitation
     - Increased vegetation growth
     - Direct effects
     - Greater snowfall depths
     - Snow melt amounts
   - Temperature
   - Water level/Chemistry
   - Wind

View climate projections for your region.
Based on the asset type you specified above, the following factors are relevant:
- Precipitation
- More extreme rainfall events
- Erosion and mass wasting
- Floodplain extent and elevation
- Higher average precipitation
- Increased vegetation growth
- Direct effects
- Greater snowfall depths
- Snow melt amounts
- Temperature
- Water level/Chemistry
- Wind
Precipitation

- More extreme rainfall events
- Erosion and mass wasting
- Floodplain extent and elevation
Use of enhancement of stormwater conveyance away from slope face

<table>
<thead>
<tr>
<th>Design Option</th>
<th>Cost</th>
<th>Special Considerations</th>
<th>E-mail Suggestions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use or enhancement of stormwater conveyance away from slope face</td>
<td>$ - $$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flatter slope inclinations</td>
<td>$ - $$$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Use of (deeper) catch ditches (and/or ditches with modified shapes) along with (higher) rock fences to retain increased volume and velocity of rock fall and landside debris</td>
<td>$ - $</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Use of slope face protection such as shotcrete, walls, wire mesh, etc.</td>
<td>$ - $</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Installation of landslide warning systems</td>
<td>$ - $</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enhanced maintenance regime in specs</td>
<td>$ - $</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Suggest a new option</strong></td>
<td></td>
<td></td>
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**Alternative Design Options**

<table>
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<tr>
<td>Construct tunnel instead of road cut</td>
<td>$$$$ - $$$$$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Obtain ROW for future expansion and access</td>
<td>$ - $$</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Suggest a new option</strong></td>
<td></td>
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**Climate influenced design inputs**

**Simulations**

<table>
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<th>Traditional Data Source</th>
<th>Preferred Projected Data Source</th>
<th>Alternative Projected Data Source</th>
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</thead>
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<tr>
<td>IDF curves</td>
<td>NOAA Atlas 14, TP-40, or state specific sources</td>
<td>Utilize IDF curves reflecting projected climate change if available</td>
<td>Use relative increases in precipitation totals following the Clausius-Clapeyron relationship</td>
</tr>
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- Climate influenced design inputs

Simulations

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+ Floodplain extent and elevation

+ Higher average precipitation

+ Greater snowfall depths

References

Climate Change Construction Considerations: Michigan DOT

- More intense storms – protect motorists, workers, and the environment from hazards created in work zone by strong weather events
- Stronger specifications for protection of work under construction

Gregory C. Johnson, Michigan Department of Transportation, November 17, 2012
• Encourage more night/cooler weather work to prevent damage such as slab curling, premature cracking, loss of air entrainment in concrete pavements, rutting, and flushing in asphalt pavements

• Stronger specifications that require contractor response plans for work zone impacted by high intensity storms
More closely monitor moisture in aggregate piles
Incorporate materials whose performances are less variable in weather extremes
Modify vegetation planting periods to ensure optimal growth and survival
Stronger specifications for dust control and wind erosion
Worker safety during extreme heat periods must be addressed.
California

Climate Tools
Local Snapshot, Temperature, Snowpack, Precipitation, Sea Level Rise, Wildfire

VIDEO TOUR
This short video walks you through the different tools and data available in Cal-Adapt. See how you can explore and share information on California climate change.

LOCAL CLIMATE SNAPSHOTS
The Local Climate Snapshot tool has been developed to provide quick access to some of the most basic climate change data for a given location. Just enter an address or click on the map and you will get simple figures and statistics for your area.
Highways Agency (England)

Vulnerability of Pavement Asset

http://www.highways.gov.uk/publications/climate-change-mitigation/
### Highways Agency: Design Implications

<table>
<thead>
<tr>
<th>Design and construction of new or replacement assets</th>
<th>Pavements</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Materials specification and construction details</td>
</tr>
<tr>
<td></td>
<td>Design of foundations</td>
</tr>
<tr>
<td>Structures (including gantries)</td>
<td>Wind actions (loads) applied to superstructure</td>
</tr>
<tr>
<td></td>
<td>Design for increased scour risk for foundations</td>
</tr>
<tr>
<td></td>
<td>Design of bearings and expansion joints</td>
</tr>
<tr>
<td>Drainage</td>
<td>Surface Water Drainage Systems</td>
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<tr>
<td></td>
<td>Attenuation</td>
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<tr>
<td></td>
<td>Outfalls</td>
</tr>
</tbody>
</table>

Priorities for Adaptation of Highways Agency Assets

Figure 13: Design Life of Highways Agency Assets
Priorities for Adaptation of Highways Agency Assets
Final Report

Vulnerability of Transportation System and Evacuation Plan for Coastal Flooding in Climate Change

Performing Organization: The City College of New York, CUNY

February, 2014

Sponsor:
University Transportation Research Center - Region 2

University Research
AASHTO RESOURCES

• Transportation and Climate Change Resource Center (See especially State DOT Climate Change Programs)

  http://climatechange.transportation.org/


• Impacts of Extreme Weather on Transportation: National Symposium Summary, 2013
Transportation Research Board Efforts

• NCHRP 25-25 (94): *Integrating Extreme Weather and Adaptation into Transportation Asset Management Plans*

• ACRP SYNTHESIS 33, *Airport Climate Adaptation and Resilience A Synthesis of Airport Practice*

• *Risk-Based Adaptation Frameworks for Climate Change Planning in the Transportation Sector*, Research Circular E-C181

• *Adapting Transportation to the Impacts of Climate Change: State of the Practice 2011*
NCHRP SYNTHESIS 454

Response to Extreme Weather Impacts on Transportation Systems

A Synthesis of Highway Practice

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

TRANSPORTATION RESEARCH BOARD
OF THE NATIONAL ACADEMIES
With respect to construction....
• Fully repairing key areas using emergency contractors and working with the planning side of the house for on-call design contracts

• Acceleration of the drafting and letting of contracts for repair work so that repairs could begin as soon as inspections were completed

• Rebuilding 4 miles of a washed-out interstate, using predetermined contract rates, incentive clauses, and contracted inspection services
• Giving consideration to developing “off-the-shelf” contractual terms for emergency situations

• Enabling shifts in construction schedules to accommodate new priorities

• Adopting an approach to rebuilding that completely closes a road or bridge for safer and faster construction, rather than choosing a partial closure (that maintains access during construction)
• Articulating the existing technical and policy foundation for projects that support better resiliency (e.g., rewriting hydraulic manual to underscore existing practices)

• Exploring new construction techniques—for example, prefabrication of structure components, advanced new materials, and new contract/management techniques

• Supporting the burial of utility lines to avoid downed utility poles on the highway right-of-way
EXTREME WEATHER &
THE TRANSPORTATION SYSTEM RESOURCES

U.S. DOT:
http://climate.dot.gov/

FHWA:
http://www.fhwa.dot.gov/environment/climate_change/index.cfm

USGS:

Georgetown Climate Center:
http://www.georgetownclimate.org/resources/transportation-and-climate-change-clearinghouse-tccc

EU:
http://ec.europa.eu/clima/policies/adaptation/index_en.htm
Questions?/Comments?