State DOT Seismic Resiliency Assessment Process and Mitigation Program

Bruce Johnson, Otak
10-Step Process for Resiliency Planning

1. Assess Vulnerability of Assets (bridges and landslides)
2. Identify bridge damage states and landslides/rockfall dynamic stability
3. Validate Design Criteria consistency with risk
4. Estimate cost of mitigation (retrofit or replace)
5. Identify Lifeline Routes and Priority Routes for rescue, recovery
6. Estimate impact to rescue efforts and economy
7. Prioritize a plan for mitigation, considering condition of assets
8. Establish Resiliency Investment options
9. Develop triage approach for reduced level of mobility
10. Coordinate investment plan statewide with other modes/sectors through DHS/TSA Regional Resiliency Assessment Program (RRAP)
Cascadia Subduction Zone Earthquakes

Earthquake of Magnitude 9+ (fault breaks along entire subduction zone)
Earthquake of Magnitude 8+ (fault breaks along southern half of subduction zone)

(Modified from Goldfinger et al. (in press) by adding magnitude estimates and some labels)
FOCUS ON HIGHWAY BRIDGES
Cascadia Subduction Zone Earthquake (Magnitude 9.0)
From REDARS (similar to Hazus)

6 complete collapses
64 extensive
106 major
164 slight

Estimates Loss:
- $1,080 million for bridge repair and replacement
- Significant Economic losses (travel time related losses)

<table>
<thead>
<tr>
<th>Route</th>
<th>Damage States</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Slight</td>
</tr>
<tr>
<td>I-5 (MWC)</td>
<td>4</td>
</tr>
<tr>
<td>I-5 (MLL)</td>
<td>16</td>
</tr>
<tr>
<td>I-5 (DJJ)</td>
<td>27</td>
</tr>
<tr>
<td>I-84</td>
<td>13</td>
</tr>
<tr>
<td>US-101</td>
<td>7</td>
</tr>
<tr>
<td>US-26</td>
<td>7</td>
</tr>
<tr>
<td>I-205</td>
<td>8</td>
</tr>
<tr>
<td>I-405</td>
<td>7</td>
</tr>
<tr>
<td>US-30</td>
<td>4</td>
</tr>
<tr>
<td>US-20</td>
<td>5</td>
</tr>
<tr>
<td>OR-38</td>
<td>3</td>
</tr>
<tr>
<td>OR-42</td>
<td>4</td>
</tr>
<tr>
<td>Others</td>
<td>59</td>
</tr>
</tbody>
</table>

Total 164 106 64 6
“Life Safety” (no collapse) connects beams to the columns.

“Serviceability” strengthens the substructure for use within 72 hours after an event. (Building code – “Immediate occupancy”)

Hazard Level - Recurrence Interval for Highway Bridges


Oregon Code – Design for “no collapse” at a 1000-year recurrence interval using 2014 USGS Hazard Maps and “Serviceability” Design for usability within 72 hours after a CSZ Scenario event, 2014 (USGS). (2-level design criteria)
# Retrofitting Progress Dashboard

First 15 years since vulnerability was identified

<table>
<thead>
<tr>
<th>Years</th>
<th>Actions</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1994/1997</td>
<td>Prioritized total bridge needs</td>
<td>1155</td>
</tr>
<tr>
<td>1985-2012</td>
<td>Phase 1 retrofit added to projects (STIP &amp; OTIA III program) bridges addressed</td>
<td>355</td>
</tr>
<tr>
<td>Future</td>
<td>Bridges still needing retrofitting (Over 200 years at current funding)</td>
<td>800</td>
</tr>
</tbody>
</table>
Available on the ODOT Bridge Engineering Section website at:

http://egov.oregon.gov/ODOT/HWY/BRIDGE/

November 2009
Transportation Resiliency depends on Landslides, as well as Bridges
Recommended Lifeline Routes
{Essential, Critical, Normal}

- 2012 – Seismic Lifelines evaluation
- 2012 – First “Full” (Phase 2) seismic retrofit project for ODOT
## Total Seismic PLUS Program Cost

<table>
<thead>
<tr>
<th>Program Phases</th>
<th>Total Bridge Cost</th>
<th>Landslides/Rockfalls Cost</th>
<th>Total Seismic PLUS Program Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$738 Million</td>
<td>$197 Million</td>
<td>$935 Million</td>
</tr>
<tr>
<td>2</td>
<td>$632 Million</td>
<td>$272 Million</td>
<td>$904 Million</td>
</tr>
<tr>
<td>3</td>
<td>$612 Million</td>
<td>$483 Million</td>
<td>$1,095 Million</td>
</tr>
<tr>
<td>4</td>
<td>$640 Million</td>
<td>$126 Million</td>
<td>$766 Million</td>
</tr>
<tr>
<td>5</td>
<td>$1,432 Million</td>
<td>$0</td>
<td>$1,432 Million</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$4.1 Billion</strong></td>
<td><strong>$1.0 Billion</strong></td>
<td><strong>$5.1 Billion</strong></td>
</tr>
</tbody>
</table>
Major Seismic Event: “Islands of Isolation”

Total economic loss: $350 B
Isolated Zones: Full Seismic Program

Reduce economic loss by: $84 B
Cost = $5.1 Billion
Economic Loss Avoided = $84 Billion
# Overall Seismic Resiliency Triage Strategy

## Southern Oregon triage
(bridges and unstable slopes on I-5 and OR 140)
- [ ] Astoria
- [ ] Newport
- [ ] Coos Bay

## Coastal forward supplies & seismic response kits
- Astoria
- Newport
- Coos Bay

## Local ODOT triage
(address strategic ODOT and local bridges/major river crossings)

## Seismic Options Report
(not part of $200 M total above)
- Phase 1 – partially funded
- Phase 2
Southern Oregon Triage Routes

Interstate 5 and OR 140

- I-5 and OR 140 (key lifeline routes)
- 17 bridges
- 7 unstable slopes
- $35 million (Mainline cost would be $350 M)
Local Agency Seismic Triage Project

Local Agency Seismic Resilience - ODOT Support Schedule

Seismic Plus Routes

- Phase 1
- Phase 2
- Phase 3
- Phase 4

State Highways

Miles

Updated February 19, 2019
Other Modes Coordination

1. **The Redmond Airport will be the nexus of relief supplies entering Oregon (Other states may have their own supply issues and may not be able to help)**

2. **Relief supplies will come overland to the valley and the coast**
Post-Earthquake Response

The Oregon Resilience Plan
Reducing Risk and Improving Recovery for the Next Cascadia Earthquake and Tsunami
Report to the 77th Legislative Assembly from Oregon Seismic Safety Policy Advisory Commission (OSSPAC)

Salem, Oregon
February 2013
ODOT Resiliency Planning
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Thanks for your attention.

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Former State Bridge Engineer, ODOT

Acknowledgement:
Albert Nako, ODOT Seismic Stnds Engr
- Oregon Highway Seismic Options Report

- Identify strategic lifeline routes
- Minimize long term economic damage
- Estimate Cost to address overall bridge condition
Facilitate:

- **Rescue** – Emergency response to treat casualties and evacuate survivors

- **Relief** – Provide basic necessities, restore social equilibrium, and assess damage

- **Recovery** – Restoring commerce and the economy; bring things back to “normal”
Lifeline Goals

1. Support Survivability and Emergency Response Efforts Immediately Following the Event

2. Provide Transportation Facilities that are Critical to Life Support Functions for an Interim Period After the Event

3. Support Statewide Economic Recovery
By the numbers:

- 138 bridges to be replaced
- 390 bridges to be retrofitted
- 190 bridges to be rehabilitated and retrofitted
- 1185 landslides and rockfalls to be mitigated

Program Cost ~ $5.2B
Take Home Learnings... Next Steps

- Bridge condition – include seismic
- Bridge funding
- Engage local communities for Triage Approach
Example: $500 million/yr from HB2017
State funds: $250 million
Seismic: $61 million/yr ($31 bridges, $15 unstable slopes and $15 facilities)

• Goal is to complete Phase 1 in 25 years
  • Study Triage Approach using lower cost alternative local routes for Phases 2-5
• Earmarked funding for Southern Oregon Triage and Center Street Bridge in Salem
Rogue Valley Triage Lifeline Routes
Operational Airports After EQ-Tsunami – Valley

Legend:
- Portland Int'l Airport
- Category I Airport
- Category II Airport
- Category III Airport
- Category IV Airport
- Category V Airport

Zone 1:
- Portland International
- Scappoose Industrial
- Portland Regional
- Tillamook

Zone 2:
- Salem Municipal
- Albany Municipal
- Eugene-McMinnville
- Salem Municipal
- Independence
- Florence Municipal
- Roseburg Regional
- Myrtle Creek Municipal
- Grants Pass
- Rogue Valley International
- Klamath Falls

Zone 3:
- Astoria Municipal
- Brookings
- Coos Bay
- Bandon
- Cape Blanco State
Columbia River Ports
Coastal Ports
Interdependency of Transportation Modes

RAILROADS 2012

Legend
BNSF Railway Co.
Union Pacific
Short Lines

The Dalles

Chemult

2,376 Route Miles
2 Major Carriers (UP & BNSF)
20 Short Lines
1,039 Oregon Lifeline Miles
Union Pacific = 810 Miles
BNSF = 229 Miles
Damage to Other Sector Lifelines and **interdependency** will slow restoration of services and rebuilding of the economy.
Key Finding – Liquid Fuel Dependency

• Liquid Fuel vulnerability is a key issue for transportation