NCHRP 15-54
Proposed Modifications to AASHTO Culvert Load Rating Specifications
AASHTO T-18 Update

MARK MLYNARSKI, P.E. – MICHAEL BAKER INTERNATIONAL
CHAD CLANCY, P.E. – MODJESKI AND MASTERS
TOM MURPHY, PH.D, P.E. – MODJESKI AND MASTERS
TIM MCGRATH, PH.D, P.E.
MIKE KATONA, PH.D.
Disclaimer

“This investigation was sponsored by TRB under the NCHRP Program. Data reported are work in progress. The contents of this presentation has not been reviewed by the project panel or NCHRP, nor do they constitute a standard, specification, or regulation.”
NCHRP 15-54
Panel Members

TIM ARMBRECHT, CHAIR, ILLINOIS DOT
REGINALD ARNO, DISTRICT DOT
THOMAS KOCH, NORTH CAROLINA DOT
YI QIU, TEXAS DOT
HOLLY THOMAS
BRAD WAGNER, MICHIGAN DOT
JAMES WITHIAM
WASEEM DEKELBAB, NCHRP
LUBIN GAO, FHWA
Overview of research effort

- Phase I – Survey/Literature review
- Phase II – Analysis/Field Testing Plan (Draft Report just submitted)
- Phase III - Field testing/ further analysis
- Phase IV - Recommendations
- Q&A
Phase III – Interim Report#3

- Report submitted end of June
- Phase IV – Proposed Modifications to AASHTO Specs
- Begins on NCHRP approval of Phase II
Field Testing

- Matrix of Desired Culvert Types/Characteristics was developed
- Suitable candidates for each desired type identified working with cooperating DOTs and culvert vendors
- In total 7 culverts were selected for field testing from available pool
- Test culverts located in Massachusetts, Pennsylvania, Ohio and Maryland
- All culvert field tests have been completed and 3D models generated in LUSAS
- Calibration between 3D and Field testing being finalized
## Phase III - Field Testing

<table>
<thead>
<tr>
<th>Model</th>
<th>Structure Type</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>RC Box (Single)</td>
<td>PA</td>
</tr>
<tr>
<td>2</td>
<td>RC Box (Multiple Cell)</td>
<td>MD</td>
</tr>
<tr>
<td>3</td>
<td>RC Box (Precast-New)</td>
<td>PA</td>
</tr>
<tr>
<td>4</td>
<td>Three-sided arch concrete</td>
<td>OH</td>
</tr>
<tr>
<td>5</td>
<td>Metal Arch</td>
<td>PA</td>
</tr>
<tr>
<td>6</td>
<td>Metal box culvert</td>
<td>PA</td>
</tr>
<tr>
<td>7</td>
<td>Deep corrugated metal culvert</td>
<td>MA</td>
</tr>
</tbody>
</table>
Model 1 – RC BOX
Single Cell
Model 2 – RC Box Twin Cell
Model 3 – RC Box
New Precast

BMS ID 55 0281 0590 2521
Model 4 – RC Concrete
3 sided Arch
Model 5 – Metal Arch
Model 6 – Metal Box
Model 7 – Metal Culvert
Deep Corrugated

Available for load testing with and without pavement

Attleboro, MA
Field Tested (Later)
Field Testing

- Cooperating State DOTs providing access to culverts weighed load truck, and traffic control
- When available, tandem and tridem axle loads run separately while collecting data
- Culverts instrumented using appropriate strain gauging and string potentiometers for deflections
- Massachusetts model on I-95 was new construction allowing for testing both with and without pavement
2D and 3D Model Calibration

- Following calibration of field test data, corresponding 2D models in CANDE allow for parametric studies with variants of field tested models.
- 3D models being used to verify proposed load spreading models and effects of pavement on loads passing into soil and the culvert.
- One objective is to remove the discontinuity in live load through fill at 2 feet.
- Determine common causes for low load ratings in culverts performing well in the field.
Load Testing
Load Testing
Load Testing
Analysis Models

- 2D models
  - CANDE – CANDE Toolbox
  - AASHTOWare BrDR

- 3D models
Analysis Models (2D)

- CANDE
  - Updated with NCHRP 15-28
  - 2D element/ soil interaction
  - Does not perform LL analysis
  - Modeling can be difficult at Level 3
  - CANDE Toolbox
Analysis Models (2D)

- CANDE Toolbox
  - Generate Level 3 model from Level 2
  - Add pavement elements to a Level 3 model
  - Simulate live loading
  - Calculate a rating factor
  - Part of the final delivery
CANDE: Culvert-soil interaction

Shows lower pressures at center of top and bottom slabs.
Concrete Box Culverts

- Many current rating problems
- Older code – no check for shear
- Analysis/design variations among programs
  - Haunch stiffness
  - Design location with haunches
  - Treatment of thrust
  - Load redistribution (culvert/soil interaction)
- Load change at 2 ft (slab vs culvert loading)
Concrete Box Culverts

- Developing continuous LL distribution equation for all depths of fill
- Developing guidance on evaluating analysis/design programs
- Determining depth at which rating is not required
BrDR Processing

- Caltrans has provided 400 + culverts for testing
- Using the Regression Tool delivered with the BrDR Software
- BrDR produces output
- Modifications to the way data is read and processed
- Modifications allow for comparative studies
- Study results will be included in the 3rd Interim Report
- Future regression testing
BrDR Processing

Sample Regression Data

Header
Describes the culvert, version of the software, spec used, etc.

Data
Contains Report ID Location along structure Value
BrDR Processing

Regression Tool: Allows for comparison between two events

\[ V_n \]

Report ID # 50043

T. J. McGrath, Ph.D.  M.G. Katona, Ph.D.
Questions?