Ancillary Structures

MDOT/ACEC Partnering Conf. 2/6/2020

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VISION:
TO BE WELL-REGARDED AS SPANNING AND CONNECTING LIVES, SAFELY AND EFFICIENTLY.

MISSION:
THE BUREAU OF BRIDGES AND STRUCTURES IS DEVOTED TO THE EFFICIENT AND INNOVATIVE DESIGN, CONSTRUCTION, AND ACTIVE PRESERVATION OF TRANSPORTATION STRUCTURAL ASSETS, INSPIRED BY SAFETY, RESILIENCY, AND MOBILITY.
**Bureau Strategic Objectives**

- **_reduction** in the number of MDOT scour critical bridges, through the use of new technology, mitigation techniques, and managing the risk profile on an individual project basis.

- **improve** initial bridge and structure design, fabrication and construction quality on all projects, while focusing on constructability and lifecycle durability and resiliency.

- Overall **structural expertise** proficiency in the bridge design and construction areas, along with knowledge management, leadership development, and an overall broad perspective of “bridge birth”.

- **improve** quality of Local Agency Bridge Inspections, Load Ratings, and overall Bridge Management. Improve overall network condition – Bridge Bundling.

- **reduction in** the number of open Bridge Requests for Action (RFA), and annual utilization of the Bridge Priority Preservation Funding (BPPF) template in achievement of condition goals.

- **development of** ancillary structure design, construction, maintenance and management for a comprehensive asset management.
Development of ancillary structure design, construction, maintenance and management for comprehensive asset management
Ancillary Structures

- **Critical** to roadway network *operations*
- **Significant** in size and complexity
- Potential failure could have immediate, severe, and even *catastrophic impacts* to life safety of the public
# Bridge and Ancillary Structure Asset Valuations:

### National Bridge Inventory:
- MDOT bridges = $21 billion
- Bridge Authorities = $1.2 billion
- Local Agency bridges = $14.1 billion

**Total Value** = $36.3 billion  
**Total Count** = 11,126

<table>
<thead>
<tr>
<th>Ancillary Structure Asset</th>
<th>Quantity</th>
<th>Unit</th>
<th>Replacement Cost</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sign Cantilever</td>
<td>815</td>
<td>each</td>
<td>$125,000</td>
<td>$101,875,000</td>
</tr>
<tr>
<td>Communication Tower</td>
<td>22</td>
<td>each</td>
<td>$1,255,000</td>
<td>$27,610,000</td>
</tr>
<tr>
<td>Dynamic Message Sign (DMS) Support Structure</td>
<td>264</td>
<td>each</td>
<td>$85,000</td>
<td>$22,440,000</td>
</tr>
<tr>
<td>Environmental Sensor Station (ESS) Lattice Tower</td>
<td>86</td>
<td>each</td>
<td>$25,000</td>
<td>$2,150,000</td>
</tr>
<tr>
<td>Lighting Tower</td>
<td>79</td>
<td>each</td>
<td>$20,000</td>
<td>$1,580,000</td>
</tr>
<tr>
<td>Noise Barrier Wall</td>
<td>347,533</td>
<td>ft</td>
<td>$1,000</td>
<td>$347,533,000</td>
</tr>
<tr>
<td>Retaining Wall</td>
<td>188,035</td>
<td>ft</td>
<td>$10,000</td>
<td>$1,880,350,000</td>
</tr>
<tr>
<td>Spun Concrete Pole</td>
<td>270</td>
<td>each</td>
<td>$55,000</td>
<td>$14,850,000</td>
</tr>
<tr>
<td>Steel Strain Pole</td>
<td>377</td>
<td>each</td>
<td>$10,000</td>
<td>$3,770,000</td>
</tr>
<tr>
<td>Sign Tri-chord Truss</td>
<td>511</td>
<td>each</td>
<td>$200,000</td>
<td>$102,200,000</td>
</tr>
<tr>
<td>Culverts less than 10'</td>
<td>51,000</td>
<td>each</td>
<td>$50,000</td>
<td>$2,550,000,000</td>
</tr>
</tbody>
</table>

| Estimated Total Count  | 53,400 | each  | Total Value      | $5.05 billion |
MDOT’s Fiscal Year 2020 Enacted Budget Summary Highlights
October 4, 2019

MDOT’s Fiscal Year 2020 appropriation bill was signed on September 30, 2019. The Fiscal Year 2020 MDOT appropriation bill is provided for in Public Act 66 of 2019, Enrolled Senate Bill 149.

The Enacted budget includes the following FY2020 program highlights:

- Additional funding for Ancillary Structures Inspections - $10 million (STF)
Program Manager Consultant – Phase 1

Inventory
Inspection
Design
Asset Management / Reporting
Maintenance Support
Emergency Response

Structure Preservation Section
Eric Burns

Culvert Specialist
Therese Kline

Ancillary Specialist
Vacant

Steel Ancillary Structure Quality Assurance
Susan Taylor

Concrete Ancillary Structure Quality Assurance
Tom Zurburg
Topics

Ancillary Structures

Structural Bolting Issues
Ancillary Structure Hits:
Concrete Spun Poles
More Ancillary Structure Hits
• 1990 Cantilever failures. Fatality.
• Revised standards & Biennial Inspections
• 2018-2019: loose high strength bolts found during biennial inspections.
• 2036 loose bolts.
  • Four different contractors
  • Lack of MDOT Construction Inspection
  • Meeting with industry
  • Payment retainage
  • Elimination of lock washers
  • Hands on biennial inspections
  • MDOT Field Manual for Bolting
  • Annual bolting class
Current Efforts to Ensure Public Safety Regarding Ancillary Structure Construction and Maintenance

- Construction Inspection
- “Final Inspection”
  - Payment Retainage 40% → 25% → 0%
  - National Consultant Firms with Subject Matter Experts
- Regularly Scheduled In-service Inspection
- Increased BOBS Resources
Turn of Nut (TON) Tensioning and Why it’s Important

• Clamping Force
• Slip Critical Connections
• Torque does not equal Tension
• Fatigue Resistance
AFTER "SNUG" TIGHT WITH REQUIRED FELT PEN MARKS

1/3 TURN

Position of final rotation

AFTER PROPER ROTATION
(120° minimum to 150° maximum)

1/3 TURN

Position after snugging - mark nut and bolt end

Verifies that bolt did not rotate

AFTER "SNUG" TIGHT WITH REQUIRED FELT PEN MARKS

1/2 TURN

Position of final rotation

AFTER PROPER ROTATION
(180° minimum to 210° maximum)

1/2 TURN

Position after snugging - mark nut and bolt end

Verifies that bolt did not rotate
There is no reason for this mark to be on the bolt threads. If a contractor is marking fraudulently after the fact to save time, they usually nick the threads.

No mark on the end of the bolt to show it did not turn during tensioning.
Three Keys to Successful Bolting for Contractors and Inspectors

• 1- Bolt Verification testing
• 2- Bolt Verification testing
• 3- Bolt Verification testing
Skidmore-Wilhelm Device

- Relates Rotation to Bolt Tension
b. **Bolt Tension.** Tighten each fastener in accordance with Table 707-4.

Tighten bolts using the turn-of-nut method in accordance with subsection 707.03.D.7.c. If required because of bolt entering and wrench operation clearances, tighten by turning the bolt while preventing the nut from rotating.

If using impact wrenches, provide wrenches sufficient to tighten each bolt in approximately 40 seconds. Perform verification testing, witnessed by the Engineer, on a representative sample of at least three bolt assemblies of each diameter, length, and heat or lot. Test at the beginning of work in a device that shows bolt tension. Show that the method for estimating the snug tight condition, and controlling the turns from snug tight, develops a tension of at least 5 percent greater than the tension specified in Table 707-4, when performed by the bolting crew. Perform periodic retesting if directed by the Engineer.

c. **Turn-of-Nut Tightening.** Bring enough bolts to a snug tight condition to ensure parts of the joint fully contact. Snug tight is the tightness attained by a few impacts of an impact wrench, or the full effort of a person using an ordinary spud wrench. Place bolts in remaining holes in the connection and bring to snug tightness. Mark each bolt to reference the rotation required for tightening. Tighten all bolts in the joint by rotating the nut in accordance with Table 707-5. Tighten systematically from the most rigid part of the joint to the free edges. Ensure parts, not turned by the wrench, do not rotate during tightening operations. If using impact wrenches, provide wrenches sufficient to tighten each bolt in approximately 10 seconds.

Do not reuse ASTM A 325 bolts and nuts. Do not reuse AASHTO M 164 bolts and nuts. The Engineer will not consider re-snugging previously tightened bolts loosened by the tightening of adjacent bolts, as reuse.
Process Improvements

• Hands-on Inspection on all “Final Inspections”
• Quicker Disbursement of Reports
  • Clear Grading System for Deficiencies
• Pre-Con Boilerplate Language
  • Emphasis on Bolting Requirements
  • More Resources for Project-Level Q’s
SPECIAL PROVISION
FOR
INSTALLATION, INSPECTION, REPORTING, AND PAYMENT SCHEDULE FOR
OVERHEAD SIGN SUPPORT STRUCTURES, TRAFFIC SIGNALS, AND LIGHTING

STR:JSW  1 of 2  APPR:POJ:JIF:03-07-19
FHWA:APPR:03-18-19

a. Description. This special provision sets forth the requirements for installation inspection,
reporting, and payment schedule for overhead sign support structures, traffic signals, and lighting
which have had anchor bolt tightening performed in accordance with subsection 810.03.N.2 of
the Standard Specifications for Construction witnessed by the Engineer. This includes but is not
limited to the following structures:

1. Cantilever Sign Support Structures
2. Truss Sign Support Structures
3. Traffic Signal Mast Arm Poles
4. Dynamic Message Sign (DMS) Support Structures
5. Frangible Light Standards
6. Non-Frangible Light Standards
7. Tower Lighting Unit

b. Inspection. Complete MDOT form 1459 and submit to the Engineer and the MDOT
Structural Fabrication Unit (MDOT-StructuralFabrication@mdot.state.mi.us), requesting installation
inspection. The Structural Fabrication Unit will schedule the inspections and the Engineer will
have 14 calendar days from receipt of the written request to complete each inspection cycle.

c. Reporting. The Structural Fabrication Unit will provide the inspection reports to the
Engineer within the 14 calendar day inspection period. The Engineer will review the reports for
any nonconformances and ensure any issues noted in the inspection reports are corrected in
accordance with subsections 810.03 and 819.03-G.4 of the Standard Specifications for
Construction at no cost to the Department. Once the corrections have been made, notify the
Engineer requesting another inspection. An additional 14 calendar day inspection period will be
required and repeated until inspection of the item is in conformance with the contract.

d. Measurement and Payment.

1. Initial Disbursement. The Engineer will pay an amount up to 75 percent of the total
contract value for all pay items associated with the following items of work once complete:
Additional Bolting Issues
Resources

- Chris Davis 517-930-3730
- Bob Otremba 989-233-6826
- Nick Puroll 517-242-8201
- Matt Filcek 517-282-9137
- Don Gunderman 616-262-0080
- Dave Ponder 248-508-4078
- John Belcher 517-937-7400
- Peter Jansson 517-899-0246

Questions???
Types of Structures

- Ancillary Structures
  - Cantilever (sign structure)
  - Truss (sign structure)
  - DMS supports (Dynamic Message Sign)
  - Traffic Signal Mast Arms and Poles
  - Strain Poles
  - Light Standards (frangible, non-frangible)
  - High Mast Tower Lighting
Types of Inspection

- **Final Inspection** – performed after construction and TSC inspection is completed
- **Maintenance Inspection** – performed every 2 years
- Performed following MDOT inspection procedures for each structure type
Types of Inspection

Main pending changes in current procedures:

- Both Final and Maintenance inspections will be performed using a bucket truck for a hands on inspection
- Standard plan revisions will be removing lock washers in tensioned bolted connections
• **12SP-810A:** Installation, Inspection, Reporting, and Payment Schedule for Overhead Sign Support Structures, Traffic Signals, and Lighting
  
  o **Contractor submits final inspection notice to TSC:** Ideally the Contractor and MDOT would work together to facilitate a reasonable quantity of inspections while traffic control is in place.

  o **TSC notifies MDOT fabrication unit**

  o **MDOT fabrication unit schedules final inspection**

  o **Final Inspection completed within 14 days of notice**
References

• MDOT / Bridges and Structures - website
• MDOT Structures Construction Section
  o Current Installation Inspection Procedures
  o Manuals and Guides
  o MDOT Section contact information
• MDOT Standard Plans and Special Details - website
References

Structure Construction

The Structures Construction Section provides statewide construction support to department projects with structural elements including, but not limited to, bridges, retaining walls, and sign and lighting support structures. Structures Construction also provides statewide support in the areas of advanced structural analysis, structure instrumentation, vibration monitoring, coatings and other material evaluations, and is responsible for implementing MDOT’s quality assurance program for fabrication of steel and concrete structural elements.

Peter Jansson, Chief Bridge Construction Engineer
517-899-0246

Carol Casteel, Administrative Assistant
517-636-5703

Structural Fabrication

Matthew Flagg, Structural Fabrication Manager
References

Cantilever, Type E
Installation Inspection Procedure

Cantilever, Type J
Installation Inspection Procedure

Truss, Type C & D
Installation Inspection Procedure

Dynamic Message Sign Support Structure
Installation Inspection Procedure

Mast Arm, Cat I, II, and III
Installation Inspection Procedure
Form 1454 Cantilever
Form is completed and submitted to MDOT Fabrication Unit and TSC
Example Inspection Detail

Inspection Detail
Details provided in each inspection procedure based off standard plan details for each structure type.
Final Inspector qualifications

• American Welding Society (AWS) Certified Welding Inspector

• American Standard for Non-Destructive Testing (ASNT) Ultrasonic Testing Level II

• Approved and Authorized by MDOT Fabrication Unit
Inspection

• Equipment/Tool List
  o MDOT inspection report form (specific for ancillary structure type)
  o Ultrasonic Unit with straight beam probe
  o 8-10” calibration anchor bolt with 1/8” side cut reference
  o Couplant and rags
  o Cold galvanizing or Zinc-rich paint
  o Grinder
  o 4 foot level
  o Binoculars
  o Tape measure
  o 24 oz. hammer
  o ID tags and paint marker
  o MDOT standard plans (specific for ancillary structure type)
  o Bucket truck
Inspection

Example Inspection steps (Cantilever)

• Record Inspection on form 1454 and follow Inspection procedure

• Record sign and location information (GPS, project etc...)

• Visual (VT) – sign connections (U-bolts, rubber pads, condition)

• VT – arm connections (A325 hardware, TON markings, sound with hammer, gusset welds for indications)

• Record Upright lean (in relation to the roadway)
Example Inspection steps continued (Cantilever)

- VT structure base (anchor bolts/nuts, welds, concrete, condition)
- Mark anchor bolt plan numbers on upright (inspection detail)
- Record anchor bolt ID stamped in end of anchor bolts
- VT TON markings on anchor bolts/nuts and upright initial and 48 recheck dates/initials completed by contractor and TSC
- Sound the anchor nuts with hammer (sharp ring sound is ideal)
- Record anchor bolt projection, standoff, any gaps or concerns
Inspection

Example Inspection steps continued (Cantilever)

• Anchor Bolt Ultrasonic Testing (UT)
  o Follow inspection procedure for calibration and anchor bolt testing
  o Grind anchor bolt ends to remove galvanizing
  o Apply couplant and UT test each anchor bolt. Test the top 10 inches of each anchor bolt for indications. Record results
  o Clean and apply cold galvanizing or zinc-rich paint to the end of each anchor
Example Pictures

Maintenance inspection – crack indication in Cantilever gusset weld
Maintenance inspection – crack indication in Cantilever gusset weld
Example Pictures

Typical Anchor bolt/nut 1/6 and 1/3 TON markings and ID stamp in end of anchor.

Markings on bolt, nut and base plate.

MDOT specification has no +/- tolerance for these connections. Accurate markings are ideal.
Incorrectly marked anchor bolt/nut 1/6 and 1/3 TON markings

Markings on bolt, nut and base plate in multiple locations.

MDOT specification has no +/- tolerance for these connections. Accurate markings are ideal.
Debris conditions around base can cause corrosion of anchors
Example Pictures

Typical galvanizing handling damage
THANK YOU