10-8-2003

Bridge Design Guide : October 2003 Update

Maine Department of Transportation

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Bridge Information Form

Project

PIN ______________________________ Bridge Number ________
Location ______________________________
Bridge Name ______________________________

Project Manager ______________________________
Lead Designer ______________________________
Lead Technician ______________________________
Resident ______________________________

Design Code

☐ LRFD ☐ LFD ☐ Other (explain)____________________

Bridge Parameters

Number of Spans	________	
Multiple Span Configuration	________	
Number of Sidewalks	________	
Bridge Length (CL Brg Abut to CL Brg Abut)	________	FT
Buried Structure Total Span Length (use clear spans)	________	FT
Skew	________	°
Bridge Width (Fascia-to-Fascia)	________	FT
Roadway Width (Curb-to-Curb or Rail-to-Rail)	________	FT
Buried Structure Barrel Length	________	FT
Beam Spacing	________	FT
Slab Thickness	________	IN
Approach Length (inc. buried structure, but exc. bridge)	________	FT

Scope

☐ BIKEWAY
☐ BRIDGE CONSTRUCTION-NEW
☐ BRIDGE CULVERT REHABILITATION
☐ BRIDGE CULVERT REPLACEMENT
☐ BRIDGE DECK REHABILITATION
☐ BRIDGE DECK REPLACEMENT
☐ BRIDGE IMPROVEMENT
☐ BRIDGE PAINTING
☐ BRIDGE RAIL & CURB IMPROVEMENT
☐ BRIDGE REHABILITATION
☐ BRIDGE REMOVAL
☐ BRIDGE REPLACEMENT
☐ BRIDGE SUBSTRUCTURE REHAB.
☐ BRIDGE SUPERSTRUCTURE REPLACE.
☐ BRIDGE WEARING SURFACE REPLACE.
☐ BRIDGE WIDENING
☐ TEMPORARY BRIDGE
☐ Other (explain)

____

Work Attribute

☐ Consultant LARGE
☐ Consultant MEDIUM
☐ Consultant SMALL
☐ Over Water Replace. X-LARGE
☐ Over Water Replace. LARGE
☐ Over Water Replace. MEDIUM
☐ Over Water Replace. SMALL
☐ Over Water Replace. X-SMALL
☐ Overpass Replace. LARGE
☐ Overpass Replace. MEDIUM
☐ Rehab X-LARGE
☐ Rehab LARGE
☐ Rehab MEDIUM
☐ Rehab SMALL
☐ Paint SIMPLE
☐ Paint COMPLEX
☐ Other (explain)

____

Bridge Information Form

Estimated Quantities

Volume of Abutment Concrete	______________	CF
Volume of Pier Concrete	______________	CF
Volume of Rigid Frame Concrete	______________	CF
Volume of Structural Slab Concrete	______________	CF
Total Length of Concrete Beams/Girders	______________	FT
Weight of Structural Steel	______________	LB
Weight of Bituminous on Bridge	______________	LB
Weight of Substructure Rebar	______________	LB
Weight of Superstructure Rebar	______________	LB

Buried Structure Type

☐ Structural Steel Pipe or Pipe Arch
☐ Structural Steel Plate Arch or Frame with CIP Footings
☐ Structural Steel Frame with Metal Footings or Bottom Plate
☐ Structural Aluminum Pipe or Pipe Arch
☐ Structural Aluminum Plate Arch or Frame with CIP Footings
☐ Structural Alum. Frame with Metal Footings or Bottom Plate
☐ Precast Concrete Frame on Concrete Footings
☐ Precast Concrete Box
☐ Cast-in-Place Rigid Frame or Arch
☐ Plastic Pipe
☐ Other (explain)______________________________

Superstructure Type (Primary Load-Carrying Members)

☐ Steel - Rolled Beam
☐ Steel - Welded Constant Depth Girder
☐ Steel - Welded Haunched Girder
☐ Steel - Rolled Beam and Welded Girder
☐ Steel - Welded Box Girder
☐ Precast Prestressed Voided Slab
☐ Precast Prestressed Nonvoided Slab
☐ Precast Prestressed Butted Box Beam
☐ Precast Prestressed Spread Box Beam
☐ Precast Prestressed New England Bulb Tee
☐ Precast Prestressed AASHTO I Girder
☐ CIP Concrete - Slab
☐ CIP Concrete - T-Beam
☐ CIP Concrete - Open Spandrel Arch
☐ Post-Tensioned Concrete - Segmental Box
☐ Inverset

☐ Suspension
☐ Cable-Stayed
☐ Steel - Through Truss
☐ Steel - Pony Truss
☐ Steel - Deck Truss
☐ Timber - Through Truss
☐ Timber - Pony Truss
☐ Timber - Deck Truss
☐ Timber - Covered
☐ Timber - Solid Sawn Beam
☐ Timber - Glulam Beam
☐ Timber - Glulam Direct Span
☐ FRP Reinf. Glulam Beam
☐ Other (explain)
____

Wearing Surface Type

☐ Bituminous with Membrane Waterproofing
☐ Bituminous with HP Membrane Waterproofing
☐ Concrete - Integral
☐ Concrete - Unreinforced
☐ Concrete - Reinforced

☐ Rosphalt
☐ Timber
☐ Other (explain)
____

Bridge Information Form

Deck Type

- ☐ CIP Concrete
- ☐ CIP Concrete with Precast Deck Panels
- ☐ Precast Concrete
- ☐ Open Steel Grid
- ☐ Concrete-Filled Steel Grid
- ☐ Orthotropic
- ☐ Exodermic
- ☐ Timber
- ☐ Glulam
- ☐ Other (explain)

Composite Deck Design

- ☐ Yes
- ☐ No

Bridge Rail Type

- ☐ 2-Bar Steel Rail
- ☐ 3-Bar Steel Rail
- ☐ 4-Bar Steel Rail
- ☐ 2-Bar & 4-Bar Steel Rail
- ☐ Texas Classic Concrete Rail
- ☐ Maine Concrete Rail
- ☐ Concrete Barrier
- ☐ Concrete Barrier with Mounted Steel Rail
- ☐ Concrete Barrier with Mounted Aluminum Rail
- ☐ Bridge-Mounted Guardrail
- ☐ Bridge-Mounted Thrie Beam
- ☐ 2-Bar Aluminum Rail
- ☐ 4-Bar Aluminum Rail
- ☐ Timber and Steel Rail
- ☐ Timber Rail
- ☐ Other (explain)

____

Abutment Type

- ☐ Stub Cantilever
- ☐ Medium Cantilever (5' < Wall < 15')
- ☐ High Cantilever (Wall >15')
- ☐ Mass
- ☐ Integral
- ☐ Semi-Integral
- ☐ Other (explain)

____

Pier Type

- ☐ Mass
- ☐ Pile Bent
- ☐ Hammerhead
- ☐ Shaft
- ☐ Multiple Column
- ☐ Other (explain)

____

Abutment Foundation Type

- ☐ End-Bearing H-Pile
- ☐ Friction H-Pile
- ☐ End-Bearing Pipe Pile
- ☐ Friction Pipe Pile
- ☐ Rock-Socketed H-Pile
- ☐ Rock-Socketed Pipe Pile
- ☐ Spread Footing on Bedrock
- ☐ Spread Footing on Soil
- ☐ Drilled Shaft
- ☐ MSE Wall
- ☐ Other (explain)

____

Pier Foundation Type

- ☐ End-Bearing H-Pile
- ☐ Friction H-Pile
- ☐ End-Bearing Pipe Pile
- ☐ Friction Pipe Pile
- ☐ Rock-Socketed H-Pile
- ☐ Rock-Socketed Pipe Pile
- ☐ Spread Footing on Bedrock
- ☐ Spread Footing on Soil
- ☐ Drilled Shaft
- ☐ Other (explain)

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Comments:

northern Maine is bounded by an isoseismal of A = 0.10g. Bridges located in areas where the horizontal acceleration coefficient is less than or equal to 0.09 will be assigned to Seismic Performance Category (SPC) A. Bridges located in areas where 0.09 < A < 0.19 will be assigned to SPC B. AASHTO Standard Specifications Division I-A has not clearly defined the location of the 0.09 isoseismal for Maine, but Figure 3-4 provides this information. In this figure, an interpretation of the location of the 0.09 isoseismal was made through information provided by the Maine Geologic Survey. In general, SPC B will require a higher level of seismic performance analysis than SPC A.

3.7.1.2 Geotechnical Characteristics of the Site

Soil conditions must be known to determine the seismic site coefficient for the bridge. In the AASHTO Standard Specifications Division I-A there are four soil profiles defined and a site coefficient is assigned to each profile. Additionally, potential hazards and seismic design requirements related to slope stability, liquefaction, fill settlement, and any increase in lateral earth pressures as a result of earthquake motion need to be identified. If required, the Geotechnical Designer will provide recommendations for site stabilization and design earth pressures.

3.7.1.3 Functional Importance

Bridges located on the NHS should be recognized as essential. Refer to AASHTO Standard Specifications Division I-A Section 3.3.

3.7.1.4 Major or Minor Structures

Bridges are divided into two groups based on economics. Major bridges will be defined as those with bridge construction costs in excess of $10 million. All other bridges will be considered minor bridges.

3.7.1.5 Structure Type and Detail

Certain bridge types (e.g. multiple simple spans), or details (e.g. high rocker bearings) that are more vulnerable to earthquake damage should be avoided based on the probable severity of damage and the impact on the serviceability of the structure.

have low speeds, good geometric characteristics, and low CRF may be considered for a decreased bridge width. When AADT<250, 22 foot bridge widths may be considered. When AADT is between 250 and 750, 24 foot bridge widths may be considered. When AADT <2000, 26 foot bridge widths may be considered.

5. When AADT is less than 1000, the traveled way width may be reduced to 20 feet, with bridge widths remaining at 28 feet.

6. When AADT is 1000-4000, the traveled way width may be reduced to 20 feet, with bridge widths reduced to 28 feet.

7. When AADT is 6000-8000, the traveled way width may be reduced to 22 feet, with bridge widths reduced to 34 feet.

8. When AADT is greater than 8000, the traveled way width may be reduced to 22 feet, with bridge widths reduced to 36 feet.

9. When the bridge rail and approach guard rail lengths are continuous for greater than 1000 feet on each side, and AADT is between 2000-4000, consideration should be given to widening the rail to rail width to 32 feet to minimize conflict for snowplowing operations.

c. Abutment dead load
12 feet x 7.0 feet x 0.15 k/ft^3 x 2.5 feet = 31.5 k
d. Pile dead load = 0.089 k/ft x 15 feet = 13.4 k
e. Secondary thermal effects = 4.0 k/feet of
abutment from Figure 5-6 = 4.0 k/feet x 7.0 feet = 28.0 k
TOTAL 149.9 k

Step 7. Pile design: Check pile capacity as a column.

From Figure 5-5:

HP 10 x 42 = 185 k allowable > 149.9 k OK
HP 14 x 89 = 405 k allowable > 149.9 k OK

Both piles are acceptable.

Step 8. Pile design: Piles must be capable of transferring loads to the ground.

Pile capacity for 12,500 psi (FS = 4), refer to also Table 5-6.

Capacity HP10 x 42 = 155 k (from Table 5-6) > 149.9 k OK

Step 9. Pile design: Check live load rotation demand.

The pile stress from girder live load rotation $\le$ 0.55 Fy

0.55 Fy = 0.55 (50 ksi) = 27.5 ksi

a. Beam end rotation:

$$R = \frac{W \cdot L_S^2}{24 \cdot E_S \cdot I_S}$$

W = 31.3 k x 2 = 62.6 k
L_S = 85 feet x 12 in/ft = 1020 inches
E_S = 29,000 ksi
I_S = 29,750 in^4

$$R(radians) = \frac{62.6 \cdot kips \cdot (1020 \cdot in)^2}{24 \cdot 29000 \cdot ksi \cdot 29750 \cdot in^4} = 0.0032 \cdot rad$$

b. Rotation induced moment for HP 10 x 42:

$$M = \frac{4 \cdot E_p \cdot I_p \cdot R}{L_e}$$

E_p = 29,000 ksi
I_p = 71.7 in^4
R = 0.0032 radians

bearing systems, as discussed in Section 10.9 Seismic Retrofit. A widened structure should be fitted with the same bearing type as that installed on the remaining structure for each substructure unit.

10.4 Expansion Devices

On a wearing surface replacement or deck rehabilitation project, the bridge expansion devices (joints) should be examined to determine their condition. The joint armor may be damaged, or the seal may be gone. The value of replacing the seal, repairing the joint armor, or replacing the entire joint should be assessed for each project. The Designer must consider the potential damage to the structure below if repairs or modifications are not made, as well as the expected life of the structure before full bridge replacement is warranted.

Often the joint must be modified or raised to accommodate the increase in grade created by additional pavement. If the joint armor is not damaged beyond repair, and a compression seal can be used, the joint should be modified by welding a round bar to the top of the joint armor. If the joint armor is damaged, the affected steel can be cut out and replaced with a new piece. Keeper bars should be added to the joint armor if not part of the existing joint configuration.

To select a new seal, field measurements must be taken to determine which manufacturer's seal will fit. The existing joint opening should be measured, along with the temperature and the location of the keeper bars if applicable. With this information, the maximum and minimum expected joint opening can be determined. The Designer should then use the manufacturer's literature from the two suppliers listed in Table 4-7 to determine the minimum installation opening and seal depth. A seal can be selected to fit within the given parameters (depth of seal, minimum installation opening, and movement rating) by using Table 4-7 Elastomeric Joint Seal Movement Ratings or the following link: http://www.state.me.us/mdot/planning/products/compressionseals.htm. The depth from top of new joint to top of seal should comply as closely as possible with the Standard Detail 520(10) minimum of 1/2".

For bridges with differential movement, excessive rotation at the joint, or if the joint space is measured and found to be uneven from one side of the bridge to the other, a gland seal may be selected instead of a compression seal.

In some cases, the existing seal type may be changed without modification of the existing joint armor. Prequalified seals listed in Section 4.8 Deck Joints and Expansion Devices should be evaluated for use inside existing joint armor.

If a prefabricated seal cannot be found to fit the existing joint armor, self-leveling joints can be considered. For the approved list of self-leveling joints refer to the following link to the MaineDOT product approval web page:

Composite fiberglass/epoxy wrapping: This technique involves an FRP fabricated on-site and wrapped around the column. When the FRP cures, the system confines the column.

3. Concrete jacketing: This involves the addition of a thick layer of reinforced concrete.

4. External hoops: This technique uses external hoops that are tensioned around columns using turnbuckles.

10.10 Buried Structures

MaineDOT has hundreds of steel culverts that are considered minor spans or bridges. Many of these steel culverts are reaching the end of their design life of 45 to 55 years. Instead of culvert replacement, another option to consider is culvert rehabilitation. MaineDOT began rehabilitating culverts in the early 1990s.

If culvert rehabilitation is a feasible option, the final decision to rehabilitate or replace usually depends upon one of the following issues:

- Maintenance of traffic
- Right-of-Way impacts
- Utility impacts
- Environmental impacts, including fish passage (short & long term)
- Constructability
- Maintenance
- Cost (first cost and life cycle)

10.10.1 Invert Lining

Culvert invert lining consists of placing a minimum of 5 inches of reinforced concrete in the bottom and sides of a pipe or pipe arch that has a rusted or missing bottom. The Contractor has the option of using shotcrete or cast in place concrete. The top of the concrete invert lining should extend a minimum of 6 inches above the limit of the rust line or the proposed location of shear studs, whichever is higher. The estimated life for a concrete invert lining is about 25 years.

Culvert invert lining is a feasible alternative if all of the following statements are true: