11-6-2003

Bridge Design Guide : November 2003 Update

Maine Department of Transportation

3. 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.

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

5. 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:

Appendix D Standard Notes

The notes on the following pages should be used on the plans where they apply.

D.1 Title Sheet

These notes should appear on the title sheet of the plans, or if a title sheet is omitted, on the general plan.

SPECIFICATIONS

DESIGN: Load and Resistance Factor Design per AASHTO LRFD Bridge Design Specifications 1998 and interim specifications through 200X.

DESIGN: Allowable Stress Design per AASHTO Standard Specifications for Highway Bridges 1996, and all supplementals thereto.

TRAFFIC DATA

Current (200X) AADT = XXXX
Future (20XX) AADT = XXXX
DHV - % of AADT = XX %
Design Hour Volume = XXX
Heavy Trucks (% of AADT) = XX %
Heavy Trucks (% of DHV) = XX %
Directional Distribution (% of DHV) = XX %
18 Kip Equivalent P 2.0 = XX
18 Kip Equivalent P 2.5 = XX
Design Speed = XX mph

DESIGN LOADING

LIVE LOAD: HL-93 Modified

MATERIALS

CONCRETE:	Structural Wearing Surface	Class LP
	Barriers, Curbs, Sidewalks, End Posts	Class LP
	Seals	Class S
	Precast	Class P
	Fill	Fill
	All Other	Class A

REINFORCING STEEL: ASTM A615, Grade 60

PRESTRESSING STRANDS: AASHTO 203 (ASTM A416), Grade 270, Low Relaxation

STRUCTURAL STEEL:

All Material (unless otherwise noted)	ASTM A709, Grade 50W (unpainted)
High Strength Bolts	ASTM A325, Type 3

BASIC DESIGN STRESSES

CONCRETE:	f'_c = 4,350 psi	
PRECAST CONCRETE:	f'_c = XX psi f'_{ci} = XX psi	
REINFORCING STEEL:	f_y = 60,000 psi	
PRESTRESSING STRANDS:	f_u = 270,000 psi	
STRUCTURAL STEEL:	ASTM A709, Grade 50W	F_y = 50,000 psi
	ASTM A709, Grade 36	F_y = 36,000 psi
	ASTM A325	F_u = 120,000 psi

HYDROLOGIC DATA

Drainage Area = _______sq mi
Design Discharge (Q50) = _______cfs
Check Discharge (Q100) = _______cfs
Headwater Elev. (Q50) = _______ft
Headwater Elev. (Q100) = _______ft
Discharge Velocity (Q50) = _______fps
Discharge Velocity (Q100) = _______fps
Headwater Elev. (Q1.1) = _______ft
Discharge Velocity (Q1.1) = _______fps
Mean Lower Low Water (MLLW) = -X.XX ft
Mean Low Water (MLW) = -X.XX ft
Mean Tide Level (MTL) = X.XX ft
Mean High Water (MHW) = X.XX ft
Mean Higher High Water (MHHW) = X.XX ft
20__ Predicted High Tide = X.XX ft

(The following note is used only when a Coast Guard Permit is required, and should be the only note to be put on the plans in reference to permits.)

COAST GUARD PERMIT REQUIRED

D.3 Standard Notes Abutments

1. Reinforcing steel shall have 2 inches cover in the walls and 3 inches cover in the footings unless otherwise noted.

2. Cover joints in accordance with Standard Detail 502 (01) where waterstops are not required.

3. Place 4 inch diameter drains in breastwall and wings at XX feet maximum spacing. Exact location to be determined by the Resident in the field.

4. Construct french drains behind the abutments and wings in accordance with Standard Specification Section 512, French Drains.

5. Structural Earth Excavation, Abutments and Retaining Walls, required below Elevation XX will be paid for at one and a half times the contract unit price for Item 206.081, Structural Earth Excavation.

6. Abutments, wings, and their footings shall be backfilled with granular borrow. Pay limits will be the structural excavation limits in cut areas and a vertical plane located 10 feet behind the walls and 1 foot behind the footings in fill areas.

7. Maximum calculated footing pressure is XX tsf.

(The need for the following note is currently under re-evaluation. It was developed to be used with pile-supported integral abutments, in response to the frequent discovery of the loss of soil around the top of the piles during subsequent inspections, exposing the piles to air. Since this note was developed, some changes have been incorporated in integral abutment details that may be a better solution to this problem. The other contributing factor to this problem is improper construction – not following the integral abutment details correctly. The Structural Designer, Geotechnical Designer, and Resident should discuss and use good engineering judgment in using this note and in addressing this issue on a project by project basis.)

8. Excavate a 2 foot diameter by one foot deep hole around the centroid of each pile. The depth is measured from the bottom of abutment elevation. Fill the hole with abutment concrete. Payment will be incidental to related Contract items.

D.4 Standard Notes Piles

1. Piles marked thus H→, shall be battered XX% in the direction of the arrow.

2. Maximum calculated pile loads: XX kips (including XX kips allowed for negative skin friction).

3. Estimate of piles required:

Abutment Number 1:	XX-HP XX x XX	@ XX ft
Abutment Number 2:	XX-HP XX x XX	@ XX ft
Pier Number 1:	XX-HP XX x XX	@ XX ft
Pier Number 2:	XX-HP XX x XX	@ XX ft

(The following note is used for integral abutments with steel stringers.)

4. Piles shall not be out of position shown by more than 2 inches in any direction.

(The following two notes are used for pile-supported foundations. The Geotechnical Designer will make a recommendation for their use or exclusion. The Structural Designer should determine the appropriate pay item and the Geotechnical Designer determine the number of dynamic tests.)

5. The Contractor shall perform and submit a wave equation analysis for review and acceptance by the Resident. The Contractor shall determine a stopping criteria based on the wave equation analysis. The stopping criteria shall include the blows per inch and the number of 1 inch intervals at which pile installation may be terminated. The cost of performing the wave equation analysis will be considered incidental to pay Item 501.92, Pile Driving Equipment Mobilization.

6. The Contractor shall perform XX dynamic load test(s) to confirm the ultimate capacity of the piles. The ultimate capacity shall be the maximum calculated design load times 2.25 per LFD Specifications. The dynamic test shall be performed on the first production pile driven.

7. All piles shall be equipped with a pile tip in accordance with Standard Specification Section 501.10, Prefabricated Pile Tips.

8. H-pile material shall be ASTM A572, Grade 50.

9. Pipe pile material shall be ASTM A252, Grade 2 or 3.

D.16 Standard Notes CIP Box Culverts

1. Form a 1 inch V-groove at the front face of vertical contraction and construction joints.

2. Reinforcing steel shall have 2 inches concrete cover unless otherwise noted.

3. Place 4 inch diameter drains in the walls and wings at XX feet maximum spacing. Exact location to be determined by the Resident in the field.

4. Granular Borrow shall meet the requirements of Subsection 703.19, Material for Underwater Backfill.

5. Granular Borrow under the bottom slab may be reduced or omitted if the Resident determines that the existing material is suitable.

6. Cover the vertical contraction and construction joints on the back in accordance with Standard Detail 502(1). Cover the contraction joints in the top slab in the same manner, but without recessing the concrete.

load section provided by the composite steel and concrete section, the pipe pile should be used for strength. If the pipe pile is used for strength, it should extend to the point of fixity below streambed. The pipe pile should be coated with fusion-bonded epoxy paint.

In corrosive environments, cathodic protection should be used and applied on the downstream side of the piles within 5 feet of the streambed.

A. Pipe Piles

A fusion-bonded epoxy protective coating should be applied to a minimum of 10 feet below streambed or 2 feet below the total scour depth.

Cathodic protection should be used in addition to the fusion-bonded epoxy coating in corrosive environments such as salt water.

B. Precast/Prestressed Concrete Piles

Concrete cover for rebar should be a minimum of 2 inches for fresh water locations and 3 inches for salt water locations.

5.5.2.5 Pile Bent Pier Design Criteria

Pile bents should consist of a concrete pile cap supported by a single row of piles, multiple rows of piles, or a braced group of piles.

A. Pile Length

The unsupported length, L_{us}, is defined by the following:

$$L_{us} = K \cdot (L_u + L_e)$$

where,

K = Effective Length Factor. Refer to AASHTO LRFD Section 4.6.2.5 and Table C4.6.2.5-1.

L_u = Exposed pile length above ground.

L_e = Effective pile length from ground surface to the point of assumed fixity below ground, including scour effects. Refer to Figure 5-9 and Figure 5-10.

The depth to fixity shown in Figure 5-9 and Figure 5-10 was determined using the Davisson and Robinson procedure (National Corporative Highway Research Program 1991) and assumes no lateral loading on the pile. Where piles used for pile bent piers are subjected to lateral loading or where the embedment length is less than $3L_e$, a detailed analysis by the Designer using actual loading and soil conditions is required.

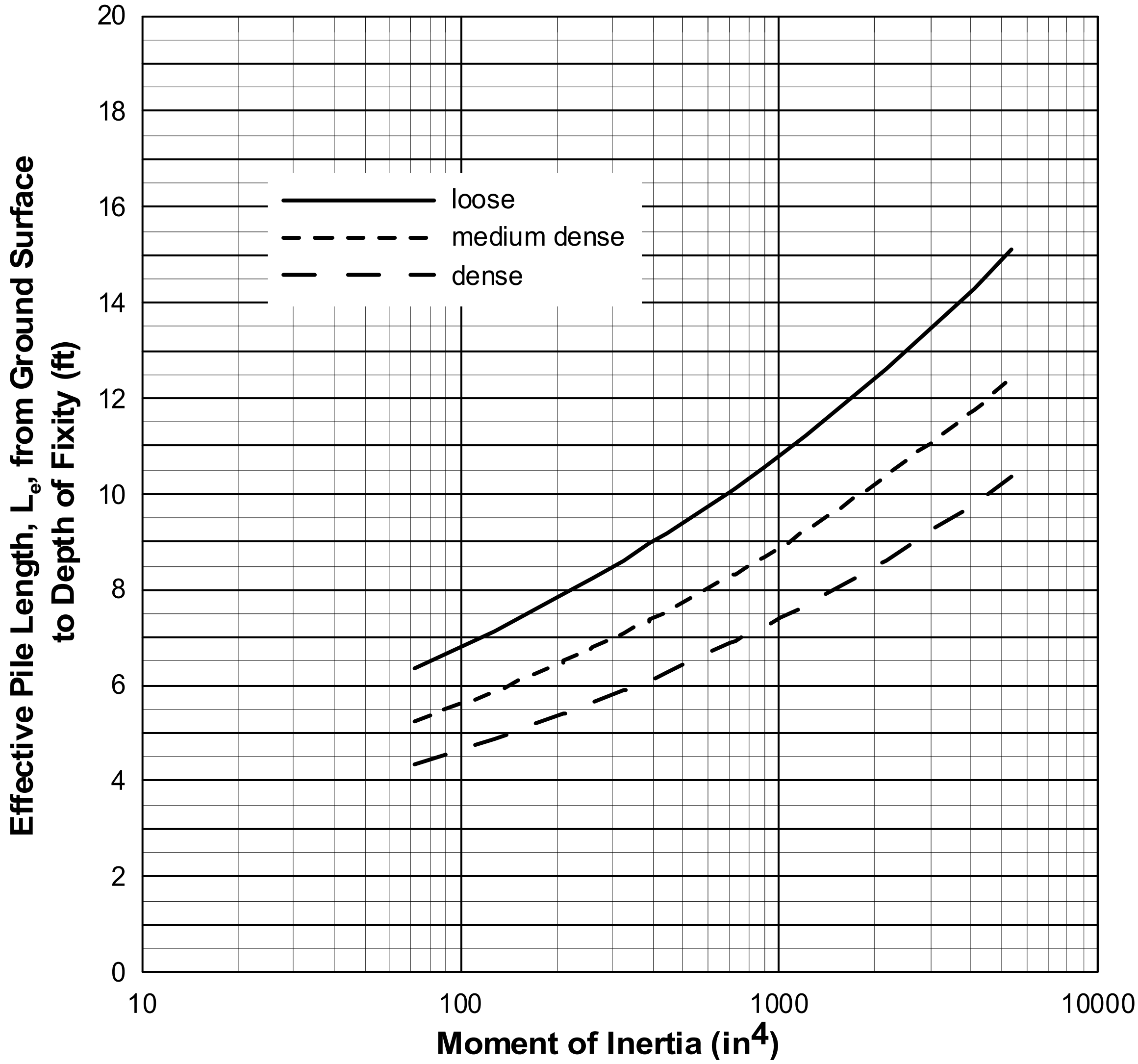

Figure 5-9 Effective Pile Length for Piles in Sand

From Ground Surface to Depth of Fixity

Axially Loaded