NDOT STRUCTURES MANUAL
REVISION 2011-1
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Revision Summary

Page(s)	Manual Subsection	Description
2	10.4.7	Revise to reflect current design specification.
3	14.3	Revise drilled shaft diameters in Figure 14.3-B.
4	14.3.1.5.2	Revise LRFD Specification references.
5-6	14.5.3.3	Provide for additional stirrup tie reinforcement in post-tensioned box girder structures.
7	14.5.3.11	New subsection: Provide for inclusion of access openings in soffits of post-tensioned box girder structures.
8	15.5.4.1	Revise guidelines for orienting cross frames on skewed structures.
9	23.6.1.1	Revise to reflect current design specification.
9	23.6.1.3	New subsection: Add requirements for protective screening for pedestrian/bicycle bridges.
9	23.6.2	Revise to reflect current design specification.

Revisions indicated by underscored text.

10.4.7 Guide Specifications for Design of Pedestrian Bridges

10.4.7.1 Description

The AASHTO *LRFD Guide Specifications for the Design of Pedestrian Bridges* applies to bridges intended to carry primarily pedestrian traffic and/or bicycle traffic. This document is based upon the LRFD design methodology and provides additional guidance on the design and construction of pedestrian bridges in supplement to the *LRFD Specifications*.

10.4.7.2 Department Application

The AASHTO *LRFD Guide Specifications for the Design of Pedestrian Bridges* shall be used by the designer for the design of pedestrian bridges in conjunction with the *LRFD Specifications.* In addition, the AASHTO *Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals* shall be used for implementation of wind and fatigue loading provisions.

Structural Element or Condition		**Minimum Concrete Cover**
Concrete Deck Slabs	Top	2½″
	Bottom	1½″
Exposed to Deicing Salts (Barrier Rails, Approach Slabs, Top of Pier Caps, Abutment Seats)		2½″
Top of Pier Caps not Exposed to Deicing Salts		2″
Drilled Shafts (Diameter ≥ 5′)		6″
Drilled Shafts (Diameter < 5′)		4″
Stirrups and Ties		1½″
Reinforced Concrete Boxes	General	2″
	Against Ground	2½″
Formed Concrete Not Exposed to Ground		1½″
Formed Concrete Exposed to Ground		2″
Concrete Cast Against Ground		3″
Precast Members (Mild Reinforcement)		1½″

CONCRETE COVER

Figure 14.3-B

14.3.1.5.2 Drilled Shafts

The reinforcing steel cage for drilled shafts shall extend the full length of the pile.

The length of the plastic hinge confinement reinforcement shall be determined by appropriate analysis but shall not be less than the requirements of LRFD Article 5.13.4.6.3b.

The designer should maximize the size of longitudinal and transverse reinforcement to increase the openings between all reinforcement to allow concrete to pass through the cage during placement. The maximum spacing requirements of LRFD Article 5.13.4.6.3d shall be maintained.

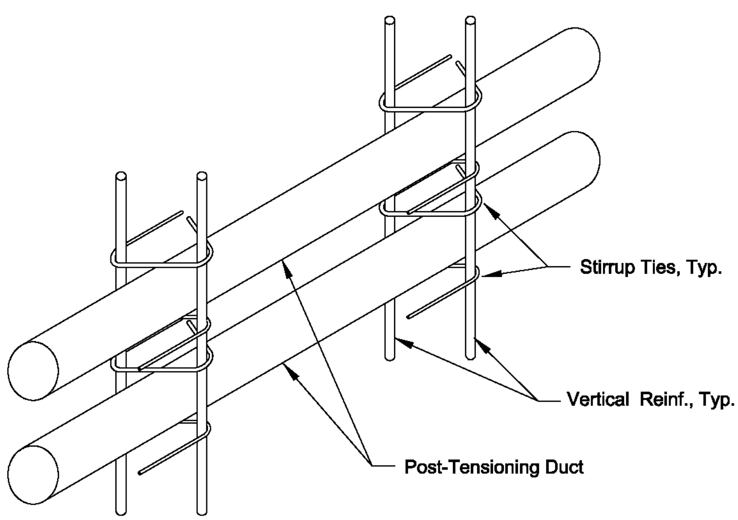
14.5.3.3 Tendon Profile and Confinement

The geometry of a typical tendon profile is predominantly composed of second-degree parabola curved segments. The tendons are essentially straight segments near the anchorages. The tendon group center of gravity and the bridge's neutral axis should coincide at the following locations — at the centerlines of abutments, hinges and points of dead-load contraflexure.

Show offset dimensions to post-tensioning duct profiles from fixed surfaces or clearly defined reference lines. In regions of tight reverse curvature of short sections of tendons, offsets shall be shown at sufficiently frequent intervals to clearly define the reverse curve.

Curved ducts that run parallel to each other, ducts in curved girders, ducts in chorded girders where angle changes occur between segments, or ducts placed around a void or re-entrant corner shall be sufficiently encased in concrete and reinforced as necessary to avoid radial failure (pull-out into the other duct or void). Similarly, the radial force effects resulting from vertical curvature in the tendon profile shall be evaluated and addressed. LRFD Article 5.10.4.3 provides methodology for determining the "in-plane" and "out-of-plane" force effects resulting from tendon curvature. When a tendon curves in two planes, the in-plane and out-of-plane forces shall be added together vectorially to determine the required amount of confinement reinforcement. For exterior box girder webs, the radius of curvature is calculated in the plane of the web, resulting in larger deviation forces for the exterior girders due to their typical sloped configuration.

In post-tensioned box girder construction, post-tensioning operations are typically performed on all tendons in a girder prior to grouting resulting in significant internal bursting forces between the ducts that may result in splitting of the girder concrete. The effects of duct air pressure testing and elevated grouting pressures may also contribute to potential concrete splitting. Stirrup ties consisting of a minimum #4 tie bar on 24" maximum centers shall be detailed to provide resistance for these potential effects. Stirrup ties shall be detailed with 90° and 135° hooks that engage the girder stirrup reinforcing and shall be provided above and below each duct as illustrated in Figure 14.5-X-1.



Stirrup Tie Detail

Figure 14.5-X-1

For webs of box girders for which the calculated value of the out-of-plane force effect ($F_{u\text{-}out}$) exceeds 3 k/ft per tendon, a more rigorous analysis shall be performed to determine the appropriate level of stirrup tie reinforcing. The analysis should consider duct diameter, duct spacing, tendon geometry, and effects of tendon air pressure testing and anticipated grouting pressures.

The stirrup tie reinforcing prescribed herein shall be provided in addition to the duct ties in the flares of girder stems as indicated in the Standard Plans.

14.5.3.11 Inspection Access

New, cast-in-place, post-tensioned box girder bridges shall be detailed with soffit access openings to allow inspection of the superstructure interior. Provide access openings in all box girder cells. For bridge spans of less than 100 ft in length, provide access openings at one end of each span. For bridge spans with a length of 100 ft or more, provide access openings at each end of each span. Detail intermediate diaphragms to similarly accommodate inspection access.

Do not locate access openings over travel lanes or railroad tracks and, preferably, not over shoulders or maintenance roads. They should be located such that the general public cannot gain easy entrance. The dimensions of the soffit and intermediate diaphragm access openings should be a minimum 2 ft by 2 ft square. Unless restricted by box girder geometry, detail access hatches to open upward into the interior of the box girder cells.

15.5.4.1 General

The following applies to diaphragms and cross frames:

2. Skew. Place all intermediate diaphragms and cross frames perpendicular to the girders for structures in which the skew angle exceeds 20°. Locating cross frames near girder supports on bridges with high skews requires careful consideration. When locating a cross frame between two girders, the relative stiffness of the two girders must be similar. Otherwise, the cross frame will act as a primary member supporting the more flexible girder. This may be unavoidable on bridges with exceptionally high skews where a rational analysis of the structural system will be required to determine actual forces.

23.6.1.1 Geometrics

The geometrics of the bridge and the approach transitions shall meet the requirements of the AASHTO *LRFD Guide Specifications for the Design of Pedestrian Bridges*. A minimum vertical clearance of 18′-0″ is required over NDOT highway facilities. Clearances over other facilities will be determined on a project-by-project basis. For pedestrian/bicycle bridges over waterways, the Hydraulics Section will determine the necessary hydraulic opening.

23.6.1.3 Protective Screening

In addition to pedestrian railing/fencing, supplemental protective screening shall be provided when the District Engineer determines there to be a need to protect underlying facilities from objects or debris dropped, thrown or discharged from the overhead structure. Protective screening shall consist of either partial-enclosure or full-enclosure screening as determined by the District Engineer. Partial-enclosure screening shall be a minimum 8'3" in height with a curved or angled top with a horizontal projection of not less than 3'-0".

In the event immediate, full-enclosure protection is not warranted, the final design shall include provision for adding full-enclosure protective screening at a future time. Include details for potential future full-enclosure screening in the project plans.

23.6.2 Final Design

The design shall conform to the latest edition of the AASHTO *LRFD Bridge Design Specifications*, except as modified by the AASHTO *LRFD Guide Specifications for the Design of Pedestrian Bridges* and as noted herein.