



Florida Department of Transportation

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STRUCTURES DESIGN BULLETIN 16-05

(FHWA Approved: April 15, 2016)

DATE: April 15, 2016

TO: District Directors of Transportation Operations, District Directors of Transportation Development, District Design Engineers, District Construction Engineers, District Structures Design Engineers, District Structures Maintenance Engineers, Structures Manual Holders

FROM: Robert V. Robertson, P.E. State Structures Design Engineer

COPIES: Brian Blanchard, Phillip Gainer, Tim Lattner, David Sadler, Rudy Powell, Amy Tootle, Daniel Scheer, Bruce Dana, Gregory Schiess, Trey Tillander, SDO Staff, Jeffrey Ger (FHWA)

SUBJECT: Stirrups in Reinforced or Prestressed Concrete Beam Members

This bulletin addresses the design and detailing of stirrups in reinforced or prestressed concrete beam members with particular emphasis on the lateral/transverse spacing of stirrup legs in wide beam members.

REQUIREMENTS

1. Add the following new paragraph to *Structures Design Guidelines*, Section 3.11.4:
 - C. See *SDG* 4.1.4 for additional requirements.
2. Replace *Structures Design Guidelines*, Section 4.1.4 with the following:
 - A. When calculating the shear capacity, use the area of stirrup reinforcement intersected by the distance $0.5d_v \cot \theta$ on each side of the design section, as shown in *LRFD* [Figure C5.8.3.2-2].
 - B. Use twin leg closed stirrups or multiple sets of twin leg closed stirrups as shear reinforcement in beam members except where open stirrups are required to avoid conflicts with other components, e.g. in pile bent caps directly over the tops of the piles and in post-tensioned beams where access is required for PT tendon installation. Do not use single leg stirrups.

C. Use the following methodology to determine the transverse spacings of shear reinforcement in beam members:

Nominal Shear Stress Range	Maximum Transverse Spacing of Stirrup Legs S_w as shown in Figure 4.1.4-1
$v_n \leq 0.08\sqrt{f'c}$	$S_w \leq 42"$
$0.08\sqrt{f'c} < v_n \leq 0.16\sqrt{f'c}$	$S_w \leq d_v$ or 24", whichever is less
$v_n > 0.16\sqrt{f'c}$	$S_w \leq 0.5d_v$ or 12", whichever is less

Where: v_n = Nominal shear stress = $V_n / b_v d_v$

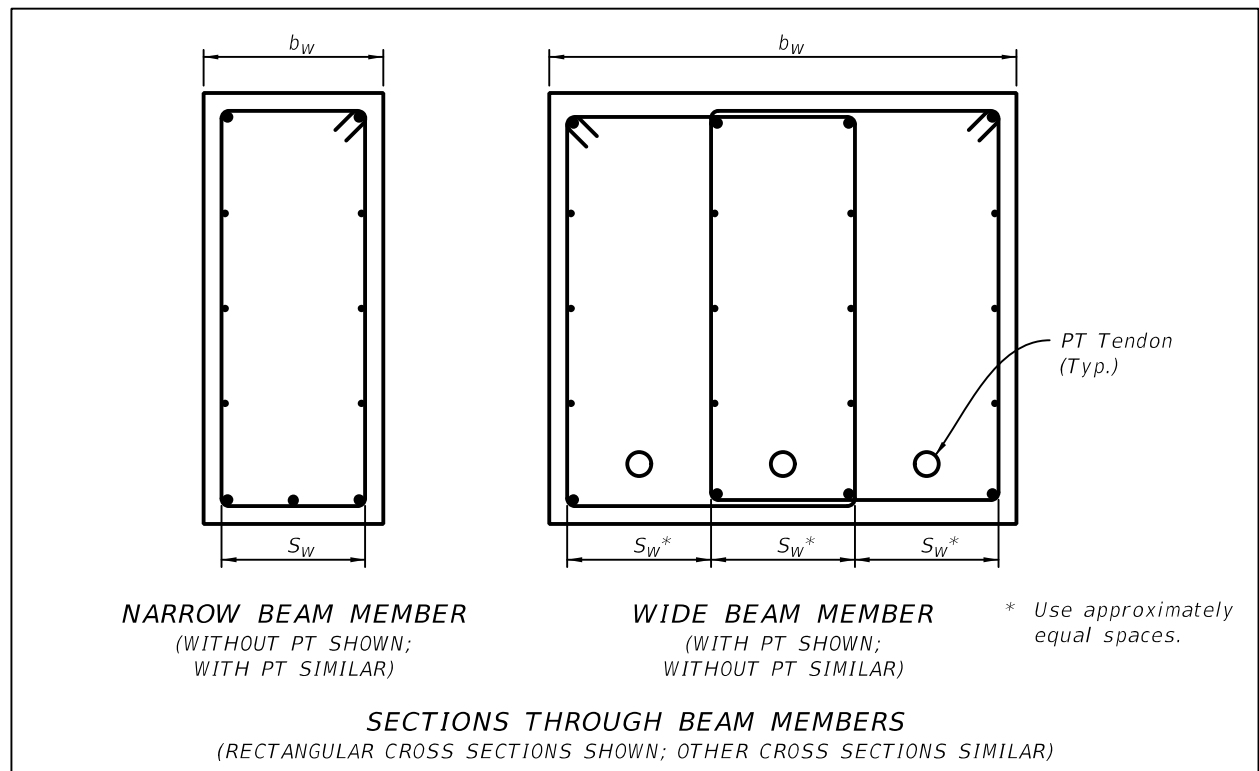
V_n = Nominal shear resistance of the section considered per *LRFD* Chapter 5

b_v = Effective web width per *LRFD* Chapter 5

d_v = Effective shear depth per *LRFD* Chapter 5

$f'c$ = Compressive strength of concrete per *LRFD* Chapter 5

Figure 4.1.4-1 Shear Reinforcement Layout in Beam Members



COMMENTARY

The AASHTO *LRFD Bridge Design Specifications* and ACI-318 *Building Code Requirements for Structural Concrete and Commentary* have no provisions for the lateral spacing of shear reinforcing in wide beams. Early research entitled “The Stuttgart Shear Tests, 1961” by F. Leonhardt and R. Walther (translation made by C.V. Amerongen, Cement and Concrete Association, 1964) suggested transverse spacing of stirrup legs across the width of a beam should be minimized to adequately anchor and suspend the diagonal compression struts associated with the truss analogy in shear design.

The requirements stated in this bulletin are based on recent research on this issue entitled “[Shear Reinforcement Spacing in Wide Members](#)” by Adam S. Lubell, Evan C. Bentz, and Michael P. Collins (*ACI Structural Journal*, Volume 106, Issue Number 2, March-April 2009) which provided recommendations on the limitation of transverse spacing of shear reinforcement. The recommendations in this article have been supplemented to allow greater stirrup leg spacings in members with low shear stresses, e.g. pile bent caps where the piles are located directly beneath the beams.

IMPLEMENTATION

These requirements are effective on design-bid-build projects that have not been let.

These requirements are effective immediately on all design build projects for which the final RFP has not been released. Design build projects that have had the final RFP released are exempt from these requirements unless otherwise directed by the District.

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