



Column Ties for Nonseismic Applications

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In its 2019 meeting, the American Association of State Highway and Transportation Officials (AASHTO) Committee on Bridges and Structures (COBS) approved three changes to Section 5 of the *AASHTO LRFD Bridge Design Specifications*.¹ In the Fall 2019 issue of *ASPIRE*[®], this column included in-depth review of two of those three changes. This article covers the third change, which relates to detailing of ties for columns that are not designed for plastic hinging, referred to herein as nonseismic applications. Although this topic was covered in my Fall 2019 article, bridge engineers raised questions about the exact nature of the revisions. More specifically, department of transportation engineers who contacted our *ASPIRE* team wanted to ensure that their new designs were compliant with the new specifications and would minimize issues for the next generation of bridge engineers.

Detailing requirements for column ties used in nonseismic applications were revised to make them consistent with

the original intent of the 1980 Interim Revisions to the *AASHTO Standard Specifications for Highway Bridges*² and the underlying research.³ The revised Article 5.10.4.3 in the ninth edition of the *AASHTO LRFD specifications*⁴ includes the following language:

For columns that are not designed for plastic hinging, the spacing of laterally restrained longitudinal bars or bundles shall not exceed 24.0 in. measured along the perimeter tie. A restrained bar or bundle is one which has lateral support provided by the corner of a tie having an included angle of not more than 135 degrees. Cross-ties with a 135-degree hook at one end and a 90-degree hook at the other end shall be alternated so that the 90-degree hooks are not adjacent to each other both vertically and horizontally.

Where the column design is based on plastic hinging

capability, no longitudinal bar or bundle shall be farther than 6.0 in. clear on each side along the perimeter tie from such a laterally supported bar or bundle and the tie reinforcement shall meet the requirements of Articles 5.11.4.1.4 through 5.11.4.1.6.

Where the longitudinal bars or bundles are located around the periphery of a circle, a complete circular tie may be used with the splices in the circular ties staggered and without the need for cross-ties.

Ties shall be located vertically not more than half a tie spacing above the footing or other support and not more than half a tie spacing below the lowest horizontal reinforcement in the supported member.

The commentary to the specification (Article C5.10.4.3) was revised to include an illustration (**Fig. 1**) that provides two examples intended to clarify how the

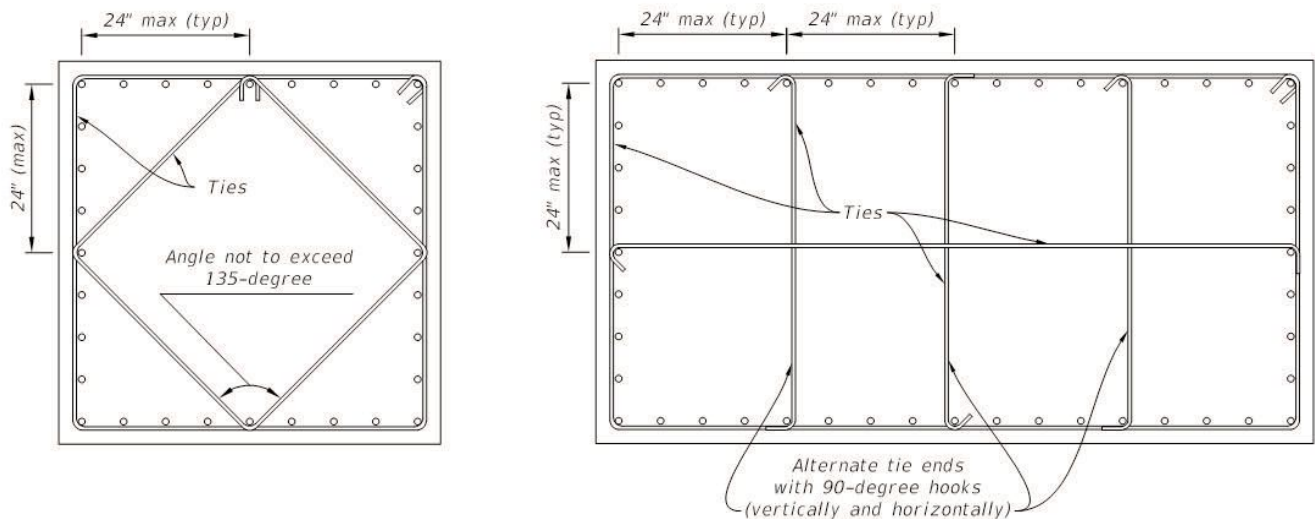


Figure 1. Detailing of column ties in locations not designed for plastic hinging. Reproduced by permission from AASHTO (2020).

new column tie detailing rules are to be applied. An examination of the cross sections shown in the figure shows the simplicity with which the new detailing rules can be summarized visually. Verbal descriptions, though essential in the context of mandatory language of specifications, may be more difficult to digest without the help of an illustration. The remaining detailing rules in Article 5.10.4.3 remain unchanged.


It is worth noting that the 24.0-in. limit in the updated specification has been revised a number of times since 1974. Until 1974, the AASHTO standard specifications used the 24-in. limit. In 1974, this limit was made more stringent and consistent with the American Concrete Institute's *Building Code Requirements for Reinforced Concrete* (ACI 318-71)⁵ detailing rules. In 1980, the 24.0-in. limit was reinstated to address constructability issues encountered with the more stringent limits. The 2007 AASHTO LRFD specifications⁶ increased this limit to 48 in., the least restrictive limit in decades.

As noted previously, the ninth edition of the AASHTO LRFD specifications returns the limit to 24.0 in.

The changes made to the detailing rules will improve the effective lateral support provided to longitudinal bars in column cages. Furthermore, the effectiveness of the confining forces provided to the structural core will also improve compared with designs controlled by the detailing rules of the eighth edition of the AASHTO LRFD specifications. Because the 24.0-in. limit was previously used in bridge columns, the changes summarized in this article are not expected to have adverse effects on constructability. Finally, the potential plastic hinge regions of reinforced columns and seismic detailing rules remain unchanged in the ninth edition of the AASHTO LRFD specifications.

References

1. American Association of State Highway and Transportation Officials (AASHTO). 2017. *AASHTO LRFD*

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3. Pfister, J.F. 1964. "Influence of Ties on the Behavior of Reinforced Concrete Columns." *American Concrete Institute Journal Proceedings* 61 (5): 521–538.
4. AASHTO. 2020. *AASHTO LRFD Bridge Design Specifications*, 9th ed., Washington, DC: AASHTO.
5. American Concrete Institute (ACI) Committee 318. 1971. *Building Code Requirements for Reinforced Concrete* (ACI 318-71). Farmington Hills, MI: ACI.
6. AASHTO. 2007. *AASHTO LRFD Bridge Design Specifications*, 4th ed., Washington, DC: AASHTO. 

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Dispelling a Myth about Lightweight Concrete

ESCSI electronically publishes quarterly the Lightweight Design eNews. In the Spring 2020 issue, a new series of articles was introduced called "Engineer's Corner: Myths and Misconceptions." In each issue, the series will address a common myth or misconception about lightweight aggregate or lightweight concrete.

The first myth discussed was that the absorption of a lightweight aggregate, or the type of raw material from which it is made, is a primary factor that defines the physical properties of the aggregate and the strength, durability, and soundness of structural concrete in which the lightweight aggregate is used.

To address this myth, data were presented from a study completed by Byard and Schindler in 2010. The study compared performance of lightweight concrete made using lightweight aggregate from three types of sources: shale, clay, and slate. The performance of these mixtures was compared to a normal weight concrete made with river gravel commonly used for concrete bridge decks in Alabama. Three lightweight concrete mixtures were made using lightweight aggregate from each source: an internally cured mixture with partial replacement of sand with prewetted lightweight aggregate; a sand lightweight concrete mixture with lightweight coarse aggregate and conventional fine aggregate; and an all lightweight concrete mixture with

only lightweight aggregate and the lowest density. For this discussion, only sand lightweight concrete data are presented.

The table presents data for the control mixture and each sand lightweight concrete mixture. The first two rows of the table (see shaded cells) include the factors that Myth #1 identifies as defining characteristics for performance of a lightweight aggregate: the type of raw material from which the lightweight aggregate is manufactured and its absorption.

The data show shale and clay lightweight aggregate absorptions are higher than for slate lightweight aggregate. Those who believe Myth #1 expect that the higher absorption aggregates would have reduced properties compared to slate. However, data in the table show the compressive and splitting tensile strength data for concrete with shale and clay aggregates are not significantly different from the slate aggregate; in fact, the splitting tensile strength for the slate aggregate is the lowest of the three mixtures.

These data, therefore, demonstrate that aggregate absorption or raw material type are not effective criteria for selecting the type of lightweight aggregate to be used for a bridge project.

Additional discussion and references can be found in the full eNews article at www.escsi.org/e-newsletter/.

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