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

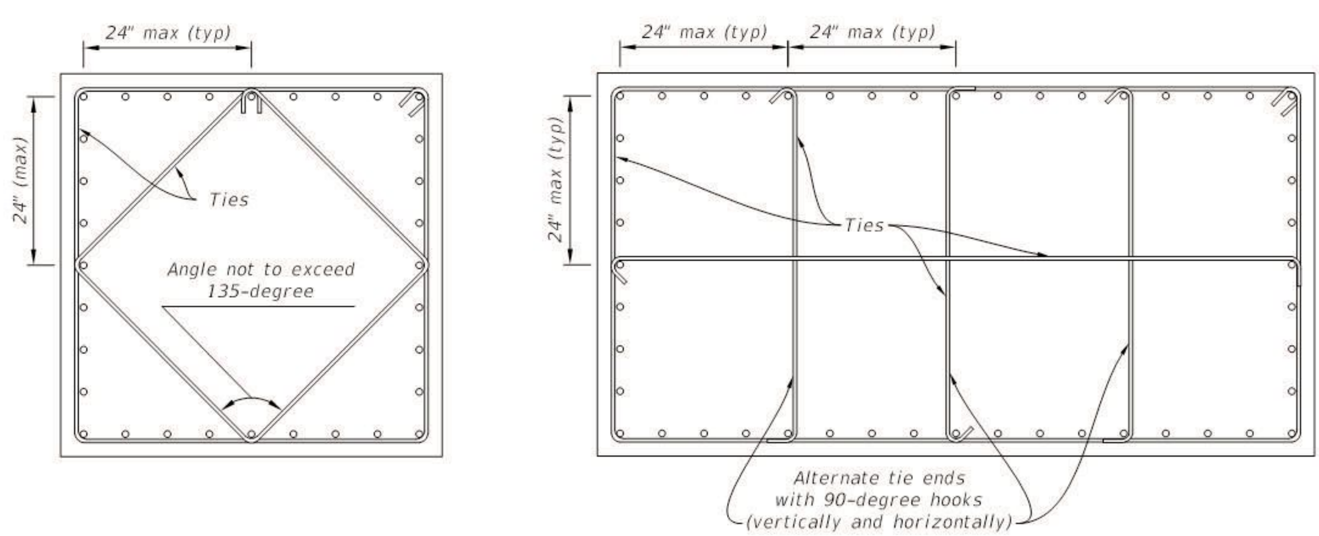

Figure 1. Detailing of column ties in locations not designed for plastic hinging. Reproduced by permission from AASHTO (2020).

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 reinstituted to address constructability issues encountered with the more stringent limits. The 2007 AASHTO LRFD specifications[6] 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

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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.
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