

Bundled No. 14 and No. 18 Bars

Q. *Section 25.6.1.3 in ACI 318-14 states: “Bars larger than a No. 11 shall not be bundled in beams.”¹ The Commentary indicates that this limit is for crack control and not due to strength concerns. Please confirm that the above interpretation is correct. Is there a reason that a multi-bar bundle of No. 14s or No. 18s should not be used in a drilled shaft, likely with permanent casing?*

A. Your interpretation is correct. Per Commentary Section R25.6.1.3 in ACI 318-14: “Conformance to the crack control requirements of 24.3 will effectively preclude bundling of bars larger than No. 11 as tension reinforcement.” ACI 318-14, Sections 16.3.5.4 and 25.5.5.3, however, permits the engineer “to lap splice No. 14 and No. 18 longitudinal bars, in compression only, with dowels satisfying 16.3.3.1,” which might require that each No. 14 or No. 18 bar be spliced to more than one dowel bar smaller than No. 14. The Code is silent on using bundled No. 14 and No. 18 bars in drilled piers or shafts, but AASHTO LRFD 2012² permits two-bar bundles for No. 14 and No. 18 bars in bridge girders.

However, ACI 318 does not address all possible design and construction methods. ACI 318-14, Section 1.10, allows the use of a special “system of design, construction, or alternative construction materials within the scope of this Code, the

adequacy of which has been shown by successful use or by analysis or test, but which does not conform to or is not covered by this Code.” Sponsors of a special system “shall have the right to present the data on which their design is based to the building official or to a board of examiners appointed by the building official.” The Code further states: “This board shall be composed of competent engineers and shall have authority to investigate the data...and formulate rules [that], when approved by the building official and promulgated, shall be of the same force and effect as the provisions of this Code.”

It is up to the engineer to use judgment and sound engineering reasoning for an alternative design or use construction methods, materials, or both.

For the development length calculation of bundled bars, refer to the April 2005 Concrete Q&A.³

References

1. ACI Committee 318, “Building Code Requirements for Structural Concrete (ACI 318-14) and Commentary (ACI 318R-14),” American Concrete Institute, Farmington Hills, MI, 2014, 519 pp.
2. “AASHTO LRFD Bridge Design Specifications,” sixth edition, American Association of State Highway and Transportation Officials, Washington, DC, 2012, 1661 pp.
3. “Concrete Q&A: Calculating Development Length of Bundled Bars,” *Concrete International*, V. 27, No. 4, Apr. 2005, p. 96.

Column Ties in Two-Way Slabs with Drop Panels

Q. *In a building with spread footings and two-way slabs with drop panels, is it required to extend column ties into the footings and drop panels?*

A. The answer depends on the building’s Seismic Design Category (SDC) and the lateral confinement provided to the column by the footing or slab. For all SDCs and confinement conditions, ACI 318-19, Section 10.7.6.2.1, requires that “...the bottom

tie or hoop shall be located not more than one-half the tie or hoop spacing above the top of footing or slab.”¹ Further, Section 10.7.6.2.2 requires the top tie or hoop to be “located not more than one-half the tie or hoop spacing below the lowest horizontal reinforcement in the slab, drop panel, or shear cap.” Similar requirements apply to other systems: “If beams or brackets frame into all sides of the column, the top tie or hoop shall be located not more than 3 in. below the lowest horizontal reinforcement in the shallowest beam or

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bracket.” Note, however, that per Section 15.3.2, corner and edge columns would require transverse reinforcement to be continuous through the slab-column joint, in accordance with Section 25.7.2.

For structures assigned to SDC B through F, ACI 318-19, Chapter 18, provides additional requirements that are applicable to two-way slabs. For intermediate moment frames, including those composed of two-way slabs without beams, Sections 18.4.4.6 and 15.3.2.1 require at least one layer of joint transverse reinforcement between the top and bottom slab reinforcement if the slab:

- Forms part of the seismic-force-resisting system; and
- Provides lateral support on fewer than four sides of the column.

For structures in SDC D, E, or F, Section 18.13.2.4 requires that transverse reinforcement extends into footings supporting columns or boundary elements of special structural walls that have an edge within one-half the footing depth from an edge

of the footing. That section also provides detailed requirements for the transverse reinforcement. As noted in the associated Commentary, the transverse reinforcement is needed to prevent an edge failure of the footing.

For design examples, you can refer to the “ACI Reinforced Concrete Design Handbook,”² which serves as a companion to ACI 318-19 and is also available in the ACI 318 PLUS platform.³

References

1. ACI Committee 318, “Building Code Requirements for Structural Concrete (ACI 318-19) and Commentary (ACI 318R-19) (Reapproved 2022),” American Concrete Institute, Farmington Hills, MI, 2019, 623 pp.
2. “ACI MNL-17(21): ACI Reinforced Concrete Design Handbook,” V. 1 and 2, American Concrete Institute, Farmington Hills, MI, 2021.
3. ACI 318 PLUS, <https://www.concrete.org/publications/aci318plus.aspx>.

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