

## Design Placement for WWR in Slabs-on-Ground

Where should reinforcement be located in a slab-on-ground?

The short answer is simple enough: **the specifier is responsible for defining location of reinforcement to suit the design intent.**

This only makes sense given that the role being played by the reinforcement varies from one application to the next. This could include, but would not be limited to, the following in ground-supported slab elements:

1. Sectional strength: flexural, shear, and axial effects in those instances where the slab is a participant in the structure's vertical and/or lateral load path to the extent that it is relied upon to transmit these effects from superstructure to the supporting soil.
2. Non-structural crack control: control of crack propagation arising from drying shrinkage and thermal effects.
3. Slab joint design feature: reinforcement for resistance to slab edge curling cracks and/or facilitator for enhanced aggregate interlock

Generally speaking, ground-supported slabs in the first category fall under the purview of ACI 318. Reinforcement should be located to most-efficiently resist flexural or axial tension force resultants while maintaining tension-controlled response that is characteristic of sufficiently ductile performance, all within ACI 318's prescriptions for clear cover. But there are also serviceability requirements in ACI 318 specific to shrinkage and temperature effects whereby a prescriptive minimum amount of reinforcement ( $0.0018 \times$  gross concrete area) is established. ACI 318's commentary section R24.4.3.2 says the following about shrinkage and temperature reinforcement:

*The minimum ratio of deformed bar or welded wire reinforcement area to gross concrete area of 0.0018 is empirical but has been used satisfactorily for many years. The resulting area of reinforcement may be distributed near the top or bottom of the slab, or may be distributed between the two faces of the slab as deemed appropriate for specific conditions.*

Intuitively enough, the Specification indicates that the reinforcement should be placed somewhere near the slab surface(s) as these locations are where cracks would be expected to form and tend to propagate. The details of reinforcement proximity and distribution, however, are again ultimately left up to the specifier.

For the second and third categories shown above, reinforcement location is not a hard-and-fast code prescription, though the general sentiment is that reinforcement should be located in proximity to surfaces where cracks will form so that their propagation can be controlled. Where would one look for information related to reinforcement location in non-structural slabs-on-ground? ACI 301, 302, and 360 are the likeliest candidates.

ACI 301 Specifications for Concrete Construction  
ACI 302 Guide to Concrete Floor and Slab Construction  
ACI 360 Guide to Design of Slabs-on-Ground

ACI 301 provides some guidance relative to design location of WWR, much of which is focused on the field placement operation necessary to achieve it.

- 3.3.2.1 Place, support, and fasten reinforcement to maintain its location during concrete placement in accordance with contract documents.
- 3.3.2.5(b) Place and support reinforcement before concrete placement to maintain location within tolerances indicated for nonprestressed reinforcement in ACI 117.

- 11.2.5 Supports shall be used at a spacing to result in reinforcement placement in accordance with Contract Documents.

ACI 302 provides some general guidance relative to design location of reinforcement:

- 5.2.9.3 Establishing slab joint spacing, thickness, and reinforcement requirements is the responsibility of the designer.

Reinforcement will not prevent cracking. If the reinforcement is properly sized and located, cracks should remain tightly closed.

- 5.3.12 Cracks in slabs-on-steel deck – as the concrete cures and shrinks, these cracks will open wide if not restrained by reinforcing steel – usually deformed or welded wire reinforcement – located near the top surface of the slab.

- 13.11.1 Minimizing slab edge curling – methods include: placing a generous amount of reinforcement in the top one-third of the slab

ACI 360 provides some general guidance relative to design location of reinforcement:

- 3.2.2 Slabs reinforced for crack-width control – bar and wire reinforcement should be stiff enough to be accurately located in the upper 1/3 of the slab.

Clearly, ACI guides and specifications lack specifics related to the design location of crack control and curing stress control reinforcement. But it is critical that the specifier not correlate the lack of explicit guidance to a perception that said reinforcement is unimportant. While there may be nominal applications in which the presence and location of reinforcement within a slab-on-ground do not have a heightened impact in comparison to, say, the concrete mix design, the subsurface preparation, moisture control measures, and the curing and finishing operations, there are numerous other applications in which reinforcement location is a bespoke consideration that must be tailored to the project's programming and end user's expectations for slab performance.

Design professionals of record (i.e. specifiers) have an obligation to work with the project stakeholders (including the end user / owner) to help establish a project's slab performance expectations, and in turn be able to either self-perform or responsibly delegate the design of the slab to that end. Proper location of reinforcement – including that for welded wire reinforcement – is an attribute of the design and targeted performance expectations, and it should not be trivialized as a “cookie-cutter” or “boiler-plate” item.

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For more information visit [www.wirereinforcementinstitute.org](http://www.wirereinforcementinstitute.org).

*References:*

1. ACI Committee 301, “Specifications for Concrete Construction (ACI 301-20)”, American Concrete Institute, Farmington Hills, MI, 2020
2. ACI Committee 302, “Guide to Concrete Floor and Slab Construction (ACI 302.1R-15)”, American Concrete Institute, Farmington Hills, MI, 2015
3. ACI Committee 318, “Building Code Requirements for Structural Concrete and Commentary (ACI 318-19, ACI 318R-19)”, American Concrete Institute, Farmington Hills, MI, 2022
4. ACI Committee 360, “Guide to Design of Slabs-on-Ground (ACI 360R-10)”, American Concrete Institute, Farmington Hills, MI, 2013

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