Point of View

Support Requirements for Welded-Wire Reinforcement in Slabs

Unless supports are very closely spaced, sheets of light-gauge wire aren't likely to remain in the specified position during concrete placement

BY JOSEPH NEUBER

Construction drawings for concrete slabs-on-ground often show welded-wire reinforcement sheets placed 2 in. (50 mm) below the slab surface or within the upper third of the slab thickness. When the required depth of sawed contraction joints is a third of the slab thickness, drawings may show the welded-wire reinforcement at mid-depth of the slab. This positioning is in general agreement with the statements in ACI 302.1R-04[1] that:

> "For maximum effectiveness, temperature and shrinkage reinforcement in slabs-on-ground should be positioned in the upper third of the slab thickness. The Wire Reinforcement Institute (WRI) recommends that welded-wire reinforcement be placed 2 in. (50 mm) below the slab surface or within the upper third of slab thickness, whichever is closer to the surface."

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Specifications commonly require that the contractor support welded-wire reinforcement during placing of concrete to maintain positioning in the slab.[2]

Support spacing is the key to meeting this requirement, as is also indicated in ACI 302.1R-04:[1]

> "When welded-wire reinforcement is used, its larger flexibility dictates that the contractor pay close attention to establishing and maintaining adequate support of the reinforcement during the concrete placing operations. Welded-wire reinforcement should not be placed on the ground and pulled up after placement of the concrete, nor should the mats be walked in after placing the concrete. Proper support spacing is necessary to maintain welded-wire reinforcement at the proper elevation; supports should be close enough that the welded-wire reinforcement cannot be forced out of location by construction foot traffic."

The term "proper support spacing" is critical, especially when light gauge (W4.0 or smaller) welded-wire reinforcement is specified, as is often the case. What support spacing is needed to give a reasonable expectation that the wire reinforcement will be in the top half of the slab?

TABLE 1:
COMMON STOCK WELDED-WIRE REINFORCEMENT SHEETS STUDIED

Current designation	Previous designation	Metric designation
6 x 6-W1.4 x W1.4	6 x 6-10 x 10	152 x 152-MW9 x MW9
6 x 6-W2.0 x W2.0	6 x 6-8 x 8	152 x 152-MW13 x MW13
6 x 6-W2.9 x W2.9	6 x 6-6 x 6	152 x 152-MW19 x MW19
6 x 6-W4.0 x W4.0	6 x 6-4 x 4	152 x 152-MW26 x MW26
4 x 4-W2.9 x W2.9	4 x 4-6 x 6	102 x 102-MW19 x MW19
4 x 4-W4.0 x W4.0	4 x 4-4 x 4	102 x 102-MW26 x MW26

TABLE 2:
DISTANCE FROM THE BASE TO THE BOTTOM OF THE WELDED-WIRE REINFORCEMENT UNDER A 180 LB (82 KG) LOAD

Wire size	Support spacing, ft						
	6.0	5.0	4.0	3.0	2.0	1.5	1.0
6 x 6-W1.4 x W1.4	0	0	0	0	0	3/4 in.	1-1/4 in.
6 x 6-W2.0 x W2.0	0	0	0	0	0	1-1/4 in.	2-1/2 in.
6 x 6-W2.9 x W2.9	0	0	0	0	1 in.	2 in.	2-3/4 in.
6 x 6-W4.0 x W4.0	0	0	0	0	1-1/2 in.	2 in.	2-7/8 in.
4 x 4-W2.9 x W2.9	0	0	0	1/2 in.	1-3/4 in.	2-3/8 in.	3 in.
4 x 4-W4.0 x W4.0	0	0	5/8 in.	1-5/8 in.	2-1/2 in.	2-7/8 in.	3 in.

Note: 1 ft = 0.305 m, 1 in. = 25.4 mm



Fig. 1: Sheets of welded-wire reinforcement were supported by 3 in. (75 mm) high slab bolster upper bar supports at varying spacings and held in place by 50 lb (23 kg) bags of dry grout mixture

For welded-wire reinforcement sheets with W4.0 wires spaced less than 12 in. (300 mm) apart, WRI suggests a support spacing of 2 to 3 ft (0.6 to 0.9 m). For sheets with wires smaller than W4.0 and spaced less than 12 in. (300 mm) apart, the WRI suggested spacing is 2 to 3 ft (0.6 to 0.9 m) or less.[3] Will these support spacings keep the reinforcement at or near the proper elevation? Testing provided some data to help answer that question.

MATERIALS USED AND TEST CONDITIONS

The six common stock styles of welded-wire reinforcement sheets listed in Table 1 were tested. Because many constructors still refer to the older system, both the current numbering system and the previous one are given for each style. For a 6 in. (150 mm) thick slab, with drawings showing the reinforcement to be at mid-depth, sheets would have to remain 3 in. (75 mm) off the base. To meet this requirement, 5 x 10 ft (1.5 x 3.0 m) sheets were placed on four 3 in. (75 mm) high, 5 ft (1.5 m) long slab bolster upper (SBU) bar supports, with a 6 in. (150 mm) overlap at the perimeter edges of the sheets. The SBUs rested on a concrete pavement, and the sheets were held in place by four 50 lb (23 kg) bags of dry grout mixture (Fig. 1).

Spacing of SBUs along the 10 ft (3.0 m) side of the sheets was varied in 1 ft (0.3 m) increments from 6 to 1 ft (1.8 to 0.3 m), and one test was also conducted with the SBUs spaced at 1.5 ft (0.46 m). At each spacing, a man weighing 180 lb (82 kg) stood in the center of the sheet to simulate a construction worker walking across the area before concrete placement. With the man standing on both feet on the sheet, the distance from the base to the section of wire beneath his feet was measured (Fig. 2).

TEST RESULTS

As shown in Table 2, the welded-wire reinforcement remained 3 in. (75 mm) off the base only when W2.9 or W4.0 sheets with wires spaced at 4 in. (100 mm) were supported by SBUs at a 1 ft (300 mm) spacing. If a 1/4 in. (6 mm) tolerance were allowed, 6 x 6-W2.9 x W2.9 or 6 x 6-W4.0 x W4.0 supported by SBUs at 1 ft (300 mm) spacing would work, as would 4 x 4-W4.0 x W4.0 at a 1.5 ft (460 mm) spacing. For all other combinations of wire size and spacing, the sheets had deflected enough to be well outside the location shown on the drawing. These results indicate that even the rather tight support spacing suggestions of the WRI won't keep light-gauge sheets at mid-depth in a 6 in. (150 mm) thick slab.

If the bolsters had sunk into the base course, results would have been even worse. Results might have been better if the sheets had been partially supported by concrete during placement, but workers would still have to walk on the mesh as the concrete was being struck off, and the amount of springback wouldn't be known.

TABLE 3:
COST COMPARISON FOR DIFFERENT BOLSTER SPACINGS

Cost for 6 x 6-W2.9 x W2.9 sheets		
Ironworker's hourly rate	SBUs at 3 ft (0.9 m) spacing	SBUs at 1 ft (0.3 m) spacing
$15	$4045	$7765
$30	$4285	$8485
$45	$4525	$9205

Assumptions: 10,000 ft² (930 m²) slab; SBUs cost $0.45 USD/lineal ft ($1.48 USD/lineal m); 6 x 6-W2.9 x W2.9 sheets cost $19 USD/100 ft² ($204.50 USD/100 m²); 15% allowance for laps

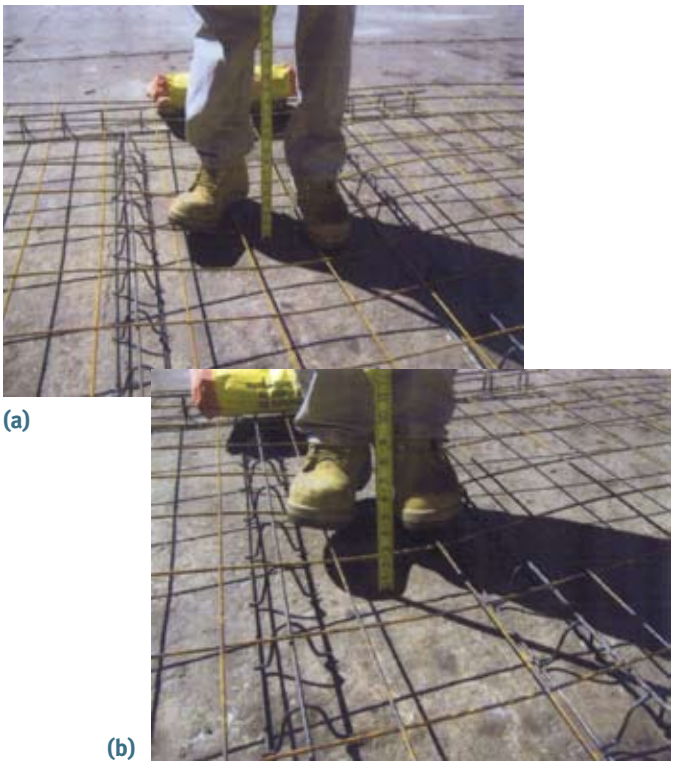
WHAT DOES IT COST?

Contract requirements that I often see call for 6 in. (150 mm) thick slabs with 6 x 6-W2.9 x W2.9 sheets supported 3 in. (75 mm) above the base. Table 3 gives a cost comparison for bolsters placed 3 ft (0.9 m) apart, as suggested by WRI, and 1 ft (0.3 m) apart, as is needed to keep the sheets in position based on Table 2.

For the 3 ft (0.9 m) SBU spacing, a slab 50 ft (15.2 m) wide and 200 ft (61 m) long would require eighteen 200 ft (61 m) long rows of 3 in. (75 mm) high SBUs, or 3600 lineal ft (1098 lineal m) of bolsters. Material cost for the bolsters is estimated at $0.45 USD/lineal ft ($1.48 USD/lineal m) or about $1620 USD. Estimated cost for the 6 x 6-W2.9 x W2.9 sheets is $19.00 USD/100 ft² ($204.50 USD/100 m²) for 11,500 ft² (1070 m²) including a 15% allowance for laps, or about $2185 USD. Labor for setting the bolsters and simply loose laying the sheets is estimated at 16 hours. Depending on the hourly rate for the area in which construction is done, this adds anywhere from $240 to $720 USD to the cost.

If supports were 1 ft (0.3 m) apart, the material cost for the SBUs would triple to about $4860 USD, and the estimated labor time would increase to perhaps 32 hours. As shown in Table 3, using this spacing increases the materials and labor cost by as much as 83%.

For the 10,000 ft² (930 m²) slab used in the example, and for labor costs that are typical in the areas where my company works, using bolster spacings that will keep the welded-wire reinforcement reasonably close to the designated position will increase cost by about $0.47 USD/ft² ($5.00 USD/m²). Other options include using heavier gauge sheets or bars supported by sand chairs. No estimates have been made for these options because the point of this article is simply this: unless supports are very closely spaced, sheets of commonly specified sizes of welded-wire reinforcement aren't likely to remain in the specified position during concrete placement. Keeping the sheets reasonably close to the specified position will significantly increase the cost of the floor.



(a)

(b)

Fig. 2: Deflection of the wire reinforcement was measured with a 180 lb (82 kg) man standing in the center of the bolsters: (a) with bolsters 2 ft (0.6 m) apart, the 6 x 6-W2.9 x W2.9 sheet deflected 2 in. (50 mm); and (b) with bolsters 1 ft (0.3 m) apart, it deflected 1/4 in. (6 mm)

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References

1. ACI Committee 302, "Guide for Concrete Floor and Slab Construction (ACI 302.1R-04)," American Concrete Institute, Farmington Hills, MI, 2004, pp. 8-9.

2. ACI Committee 301, "Specifications for Structural Concrete (ACI 301-05)," American Concrete Institute, Farmington Hills, MI, 2005, p. 15.

3. "Supports Are Needed for Long-Term Performance of Welded-Wire Reinforcement in Slabs-on-Grade," Tech Facts TF-702-R-03, Wire Reinforcement Institute, Hartford, CT, 2003, p. 5.

Selected for reader interest by the editors.



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