

## Welded Wire Reinforced (WWR) in Concrete Pan Joist Slab Construction



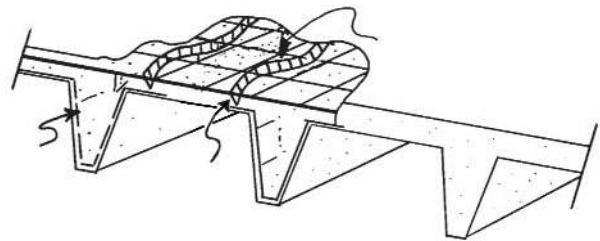
Cast-in-place pan joist slabs can provide economical concrete roof and floor construction. They are cast above reusable metal pans, foam panels, fiberglass or plastic pans, concrete or clay tiles, or other forms. Reusable pans are most frequently used. The ribs may run in one or two directions. This slab construction is generally known as "one-way pan joists" or "two-way pan joists."

Supporting members may be walls, beams, and concrete girders, with continuous reinforcement over the support. In some cases, particularly with two-way systems, supporting beams are made at the same depth as the slab, forming a structure that is essentially a ribbed flat slab, often called a "waffle slab" or "dome slab". Usually, at the columns, there is a square or rectangular area where the slab is solid, comparable to the drop panel in normal flat-slab construction.

### Minimum WWR Requirements

Welded wire has long been used to reinforce the top slabs of one-way and two-way pan joist slabs; minimum steel (required for temperature and shrinkage crack control) is necessary, as indicated in the 2014 ACI Building Code.

ACI 318, Section 24.4 specifies a shrinkage and temperature reinforcement ratio,  $A_s/A_g$ , of 0.0018 for 60 ksi yield strength WWR and a reduced shrinkage and temperature reinforcement ratio where WWR with yield strength exceeding 60 ksi is used, but not to be less than 0.0014. It also specifies that reinforcing members shall not be spaced farther apart than 5 times the slab thickness or 18 inches. **Table 1** combines these requirements.



The maximum spacings and minimum steel areas (see ACI 318, Section 24.4) in Table I are for wires in both directions.

Sheets of WWR may be curved from a point near the top of the slab over the support to a point near the bottom of the slab at midspan (see ACI 318, Section 7.7.3.7) or remain in a flat position ( $1/2$  distance from the top of the slab but not lower than the center of the slab).

**Table 1**

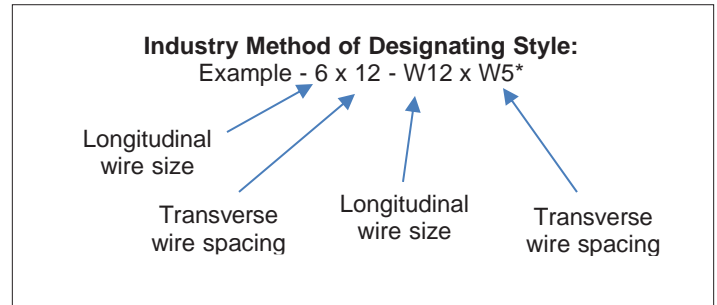
Slab Thickness, h (in.)	Maximum <sup>1</sup> Steel Area (sq. in. per ft.)	Minimum <sup>1</sup> Steel Area (sq. in. per ft.)
1 1/2	7.5	0.032
2	10	0.043
2 1/2	12.5	0.054
3	15	0.065
3 1/2	17.5	0.076
4	18	0.086
4 1/2	18	0.097
5	18	0.108
5 1/2	18	0.119

<sup>1</sup>Minimum steel area is based on a shrinkage and temperature reinforcement ratio of 0.0018 for WWR with 60 ksi yield strength. When WWR with greater than 60 ksi is used, a reduced shrinkage and temperature ratio is used in accordance with ACI 318, Section 24.4.

See **Table 2** for suitable WWR styles for one-way and two-way pan joist slabs.

It is advantageous to utilize the benefit that high-strength wire for WWR offers. Cold working increases the yield strength of low-carbon steel rod. ACI 318 allows the use of high strength reinforcement when tests show that the specified yield strength (usually 70, 72.5, 75, & 80 ksi) is developed at 0.2% offset strain. (Testing of wire to ASTM standards also measures yield strength at 0.50% strain.)

**Table 2** shows two columns of suitable styles that can be compared by engineers and contractors to measure the cost savings using high-strength wire. The cost-benefit can often be 20 - 25% less for the high-strength reinforcing. WWR styles in Table 2 show wire areas best suited for current manufacturing efficiencies and exceed minimum area requirements in Table 1. The capabilities of producing the various levels of high-strength wire as well as the different wire sizes, vary between manufacturers. Check with your nearest WRI manufacturer for advice on the most economical styles available.



\* Note - The prefix *W* is for plain wire but may also be deformed wire with a prefix *D* when areas exceed 0.04 sq. in.

Welded wire reinforcement can also be used to advantage as negative steel over the supporting beam or solid portion of the slab. Here the wires placed parallel to the beam provide minimum slab steel (or that indicated by flexure for the span between ribs), and the wires perpendicular to the beam provide the negative slab steel, as indicated by design calculations. Figure 1 shows a layout for such a situation. Note that the styles and sizes of wire indicated fit a particular load situation and may not be suited for other applications. Consult your structural engineer on design for specific project applications.

**Table 2**

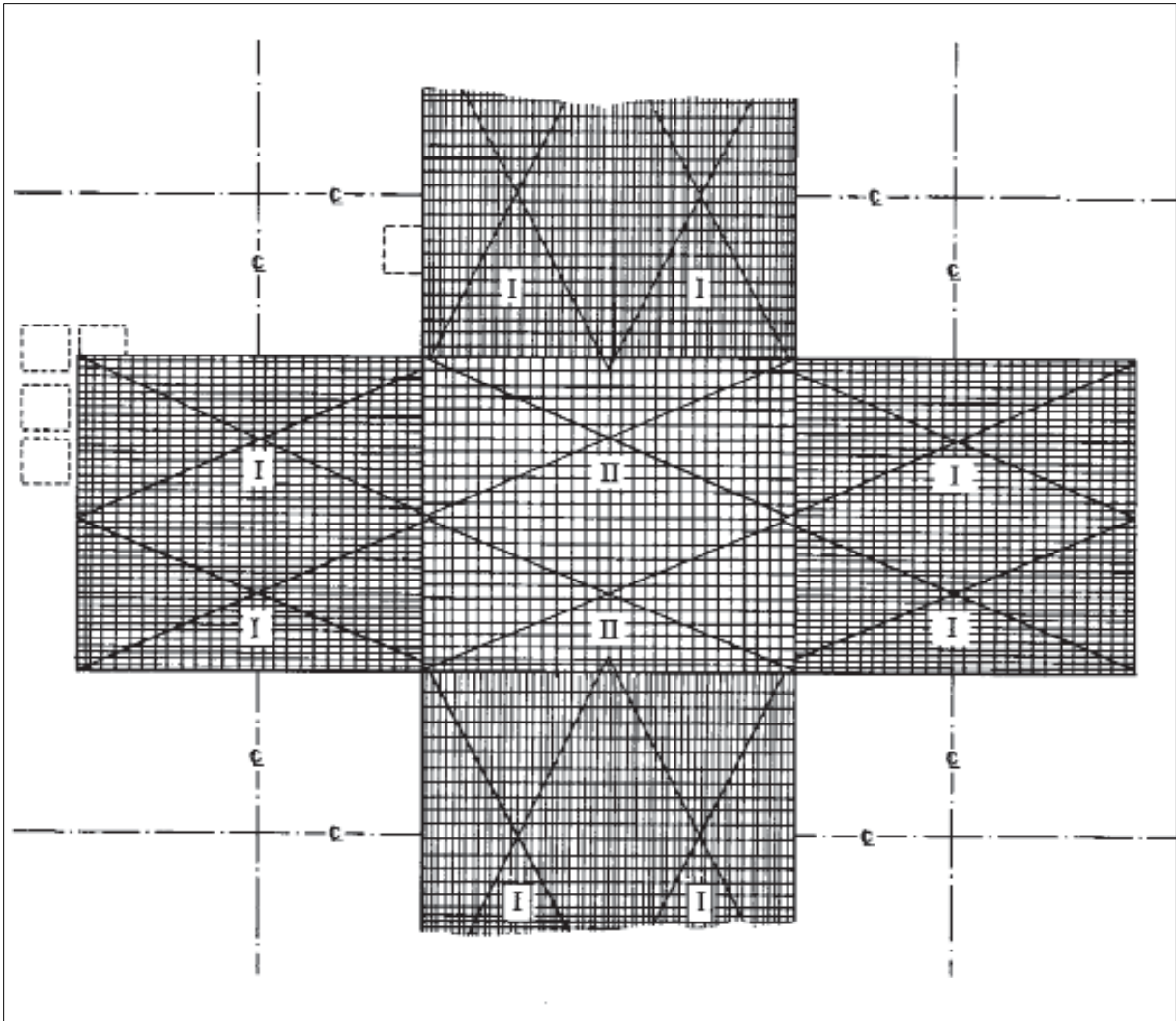
One-Way and Two-Way Pan Joist Slab Reinforcing

Slab Thickness (in.)	Suitable WWR Styles To Provide Minimum Steel for One-Way and Two-Way Pan Joist*	
	60 ksi	80 ksi <sub>2</sub>
1 1/2	12x12 - W3.2 x W3.2	12x12 - W2.5 x W2.5
2	12x12 - W4.3 x W4.3	12x12 - W3.4 x W3.4
2 1/2	12x12 - W5.4 x W5.4	12x12 - W4.2 x W4.2
3	12x12 - W5.4 x W5.4	12x12 - W5.0 x W5.0
3 1/2	12x12 - W7.6 x W7.6	12x12 - W5.9 x W5.9
4	12x12 - W7.6 x W7.6	12x12 - W6.7 x W6.7
4 1/2	12x12 - W9.7 x W9.7	12x12 - W7.6 x W7.6
5	12x12 - W10.8 x W10.8	12x12 - W8.4 x W8.4
5 1/2	12x12 - W11.9 x W11.9	12x12 - W9.3 x W9.3

\* Minimum steel areas are controlled by the minimum ratio 0.0014 (see ACI 318, Section 24.4).

**FIGURE 1**

- I = Sheet of WWR 3x6 - W9 x W4.5
- H = Sheet of WWR 6x6 - W4.5 x W4.5



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