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Welded Wire Reinforcement (WWR) in Concrete Pan Joist Slab Construction

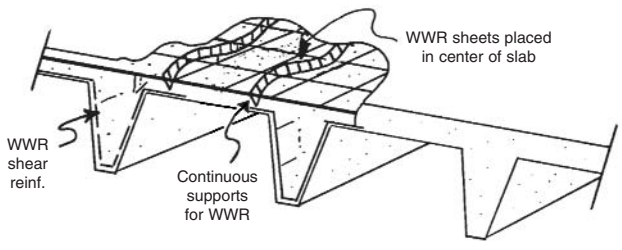
Cast-in-place pan joist slabs can provide economical concrete roof and floor construction. They are cast above reusable metal pans, foam panels, fiberglass or plastic pans, concrete or clay tiles, or other forms. The reusable pans are most frequently used. The ribs may run in one or two directions. This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

Supporting members may be walls, beams, and girders of concrete with the reinforcement continuous over the support. In some cases, particularly with two-way systems, supporting beams are made 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 for reinforcing in the top slabs of both one-way and two-way pan joist slabs, minimum steel (that required for temperature and shrinkage crack control) is necessary, as indicated in the 1989 ACI Building Code.

ACI 318, Section 7.12 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 (measured at a strain of 0.35%) 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 nor 18 inches. Table 1 combines these requirements.



The maximum spacings and minimum steel areas (see ACI 318, Section 7.12) 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 7.5.3) 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.)	Maximum1 Steel Area (sq. in. per ft.)	Minimum1 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

[1] Minimum steel area is based on a shrinkage and temperature reinforcement ratio of 0.0018 for WWR with 60 ksi yield strength. When WWF with greater than 60 ksi is used, a reduced shrinkage and temperature ratio is used in accordance with ACI 318, Section 7.12.

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 0.35% strain. (Testing of wire to ASTM standards measures yield strength at 0.50% strain.)

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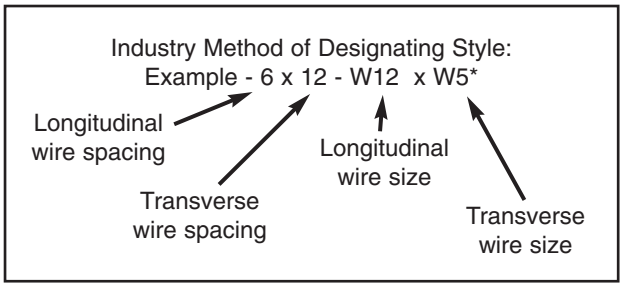
Table 2 shows two columns of suitable styles that can be compared by engineers and contractors to measure the cost savings using high strength wire. Many times the cost benefit can be 20 - 25% less cost for the high strength reinforcing. WWR styles in Table 2 show wire areas that are best suited for current manufacturing efficiencies and exceed minimum area requirements in Table 1. 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 advise on the most economical styles available.

TABLE 2
One-Way and Two-Way Pan Joist Slab Reinforcing

Slab Thickness	Suitable WWR Styles To Provide Minimum Steel for One-Way and Two-Way Pan Joist*	
(in.)	60 ksi	80 ksi[2]
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 - W6.5 x W6.5	12x12 - W5.0 x W5.0
3 1/2	12x12 - W7.6 x W7.6	12x12 - W5.9 x W5.9
4	12x12 - W8.6 x W8.6	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

[1] *Minimum steel areas are controlled by the minimum ratio 0.0014 (see ACI 318, Section 7.12).*



** 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.*

Structural Welded Wire Reinforcement

If flexural computations indicate requirements greater than the minimum areas set out in Table 1 then Table 2 will be inadequate. The engineer will need to specify the required WWR styles with wire sizes designed to resist flexural stresses and thermal and shrinkage stresses. See Figure 1 below for an example of structural WWR.

Similarly, for two-way pan joist slabs, styles giving minimum areas to resist thermal and shrinkage stresses in accordance with ACI 318, Section 7.12 can be selected from Table 2.

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 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.

FIGURE 1
I = Sheet of WWR 3x6 - W9 x W4.5
H = Sheet of WWR 6x6 - W4.5 x W4.5