WIRE REINFORCEMENT INSTITUTE®

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Technical Blog

Weld Shear Requirements in ASTM A1064

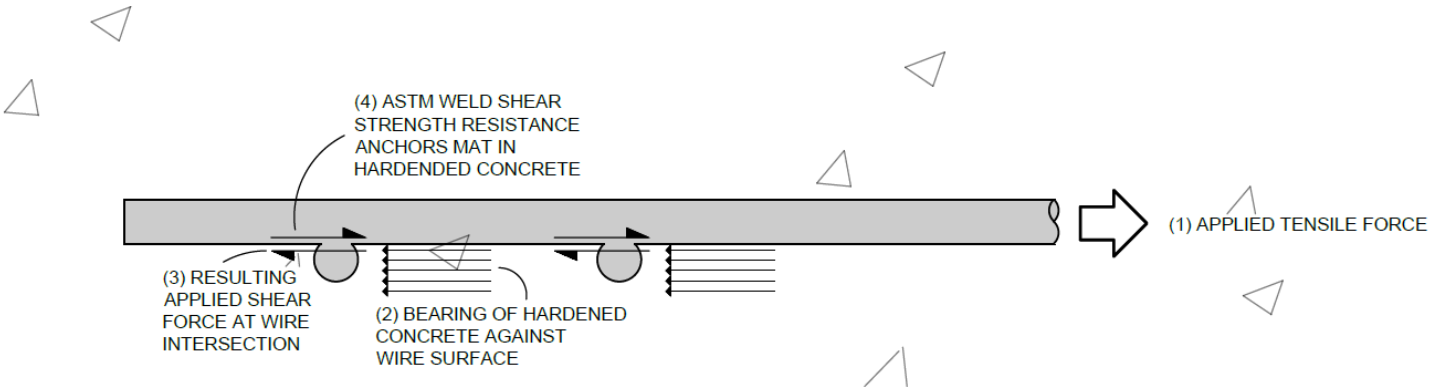
ASTM A1064 *Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete* states the following regarding the manufacture of welded wire reinforcement (WWR).

Section 6.2
…the wires shall be assembled by automatic machines or by other suitable mechanical means which will assure accurate spacing and alignment of all wires of the finished product…

Section 6.3
Longitudinal and transverse wires shall be securely connected at every intersection by a process of electrical resistance welding, which employs the principle of fusion combined with pressure.

WWR conforming to ASTM A1064[1], is accepted for structural usage across a broad spectrum of applications throughout design standards published by the American Concrete Institute (ACI) and the American Association of State Highway and Transportation Officials (AASHTO), among others. For several of these structural applications, the welded intersection is of critical importance to the intended structural performance of the WWR.

With the above in mind, ASTM A1064 defines "weld shear strength", which is the minimum shearing force capable of being resisted by the electrically-fused wires at their intersection, with the force oriented in a direction that is parallel to the shared plane of the wires. The illustration below shows the role played by weld shear strength in a structural application.



Generally speaking, the simplified interaction is summarized below:

1. A WWR mat embedded in hardened concrete is subjected to an applied tensile force.
2. Displacement / slippage of the mat in the direction parallel to the applied force is resisted by a bearing mechanism that develops between the hardened concrete and the surfaces of those wires that are oriented perpendicular to the applied force.
3. As a result of the bearing that occurs on the perpendicularly-oriented wires, a shear force develops between these wires and the wires parallel to the applied force.

4. ASTM A1064 minimum weld shear strength requirements are in place to ensure that the action noted in Item #3 above can be reliably achieved.

ASTM A1064 Section 8.3 establishes the following for plain WWR and deformed WWR.

For plain WWR:

- Where the smaller wire has an area of at least 40% that of the larger wire's area, the minimum average shear value (in pounds-force) at the welded intersection shall not be less than 35,000 multiplied by the nominal area of the larger wire in square inches.
- Where the smaller wire has an area less than 40% that of the larger wire's area, the WWR is not subject to a weld shear requirement. As such, there is no basis for a calculable weld shear strength to be defined.

For deformed WWR:

- Where the smaller wire has an area of at least 40% that of the larger wire's area, the minimum average shear value (in pounds-force) at the welded intersection shall not be less than 35,000 multiplied by the nominal area of the larger wire in square inches.
- Where the smaller wire has an area less than 40% that of the larger wire's area, the minimum average shear value at the welded intersection shall not be less than 800 lbf.
- No calculable weld shear strength is defined by ASTM A1064 for welded intersections comprised of wire(s) smaller than D4.0.

Below are tabulated examples of welded wire intersections to help illustrate the provisions in ASTM A1064 in effect.

PLAIN WELDED WIRE REINFORCEMENT				
Smaller Wire	**Larger Wire**	**Small/Large %**	**Required Weld Shear Strength**	**Remarks**
W1.4	W1.4	100%	35 ksi x 0.014 = 490 lbs	Weld shear strength as calculated
W2.1	W2.1	100%	35 ksi x 0.021 = 735 lbs	Weld shear strength as calculated
W2.9	W2.9	100%	35 ksi x 0.029 = 1,020 lbs	Weld shear strength as calculated
W4.0	W4.0	100%	35 ksi x 0.040 = 1,400 lbs	Weld shear strength as calculated
W2.1	W4.0	52.5%	35 ksi x 0.040 = 1,400 lbs	Weld shear strength as calculated
W1.4	W4.0	35%	No requirement	No calculable weld shear strength can be defined.
W8.0	W20.0	40%	35 ksi x 0.200 = 7,000 lbs	Weld shear strength as calculated
W7.0	W20.0	35%	No requirement	No calculable weld shear strength can be defined.
W12.4	W31.0	40%	35 ksi x 0.310 = 10,850 lbs	Weld shear strength as calculated
W31.0	W31.0	100%	35 ksi x 0.310 = 10,850 lbs	Weld shear strength as calculated

Notice that combinations of plain welded wire sizes in which the "40% rule" is violated end up with no calculable weld shear strength being defined by ASTM A1064. This is an important distinction because the predictability of plain welded WWR in a structural application is contingent entirely upon the presence of welded intersections that are capable of providing a quantifiable weld shear strength. If the ratio of wire areas is lower than 40%, then ASTM states that the mat is not subject to a weld shear requirement. Effectively, then, this means there is no ASTM mandate for testing that would verify that the appropriate weld shear strength exists. As such, plain WWR mats of this type are not suitable for structural use unless the design professional of record can show otherwise through independent validation.

DEFORMED WELDED WIRE REINFORCEMENT				
Smaller Wire	**Larger Wire**	**Small/Large %**	**Required Weld Shear Strength**	**Remarks**
D3.0	D7.5	40%	No calculation	No calculable weld shear strength can be defined.
D3.9	D9.7	40.2%	No calculation	No calculable weld shear strength can be defined.
D4.0	D10.0	40%	35 ksi x 0.100 = 3,500 lbs	Weld shear strength as calculated
D4.0	D12.0	33.3%	800 lbs	Weld shear strength as prescribed
D4.0	D20.0	20%	800 lbs	Weld shear strength as prescribed
D4.0	D31.0	12.9%	800 lbs	Weld shear strength as prescribed
D12.4	D31.0	40%	35 ksi x 0.310 = 10,850 lbs	Weld shear strength as calculated
D31.0	D31.0	100%	35 ksi x 0.310 = 10,850 lbs	Weld shear strength as calculated

For deformed WWR, because the wire surfaces are intentionally indented or ribbed, in many design applications, the wires are still capable of performing as structural reinforcement, even in the absence of a "structural" weld shear strength at the wire intersections. The WRI recommends that, when possible, designers include on the contract documents a means of delineating between applications requiring structural welds and those which are acceptable with non-structural welds. By providing this information, the WWR manufacturer's detailer can more easily make the following correlations:

a) "Structural welds" = those mats for which the 35 ksi weld shear strength is to be provided.
b) "Non-structural welds" = those mats for which the prescriptive minimum 800 lb "transport and placement" holding weld is acceptable.

What about WWR mats that contain both plain and deformed wires? ASTM A1064 acknowledges the possibility that a "mixed" WWR mat can be produced. Generally speaking, the following rules would apply:

- A mixed mat with a smaller wire area of less than 40% of the larger wire area, regardless of which of the wires is plain, is not subject to the weld shear requirement of ASTM A1064. As such, in the absence of an ASTM mandate on testing, there is no basis for a calculable weld shear strength to be defined. These mats

are not suitable for structural use unless the design professional of record can show otherwise through independent validation.

- A mixed mat with a smaller wire area of at least 40% of the larger wire area, regardless of which of the wires is plain, shall have a minimum average shear value (in pounds-force) at the welded intersection less than 35,000 multiplied by the nominal area of the larger wire in square inches.
- If the smaller wire is deformed, it shall not be smaller than a D4.0.

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1. *ASTM A1064-22 is the current edition of the specification at the time of blog publication.*

For more information on WWR, refer to www.wirereinforcementinstitute.org.