WIRE REINFORCEMENT INSTITUTE®

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Technical Blog

## Code Acceptance of Welded Wire Reinforcement (WWR) and Welded Rebar Mats

The Wire Reinforcement Institute quite frequently receives requests for clarification on the various types of welded reinforcement mats intended for use in concrete, with specific interest in the similarities and differences between WWR and welded rebar mats. This month's blog entry seeks to provide some commentary on the topic.

There are essentially three different types of welded reinforcement mats available for use in concrete, as listed below.

1. Welded wire reinforcement (WWR): a structural reinforcement comprised of plain or deformed wire that is cold-worked from hot-rolled rod, with wires assembled into mat form using a controlled fabrication process carried out by programmable automated electric resistance welding machines. Production of WWR is strictly governed by ASTM A1064 and is commonly referenced in standards such as ACI 318 and the AASHTO LRFD Bridge Specifications. WWR is manufactured in yield strengths up to 80 ksi.

2. Welded deformed steel bar mats: a reinforcement mat comprised of ASTM A615 reinforcing bars (grade 40) or ASTM A706 reinforcing bars (grade 60) that is *manually* assembled using welding processes outlined in AWS D1.4. The finished mat form of the product is referenced as having limited acceptability in ACI 318. Welded deformed steel bar mats must be produced in accordance with ASTM A184.

3. Machine-welded rebar mats: as per CRSI's ETN-M-9-16 "Assembling Reinforcing Bars by Fusion Welding in the Fabrication Shop", using automated electric resistance welding machines to assemble individual deformed reinforcing bars (rebar) into welded mat form is an emerging practice. The machines used for this process are very similar, if not identical to those used in the production of WWR; however, currently, there is no ASTM standard for machine-welded rebar mat production.

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### Contrasting ASTM A184 welded deformed steel bar mats and ASTM A1064 WWR

It is noteworthy that, despite the existence of an ASTM standard and an explicit reference to AWS D1.4 therein regarding welding to be used for welded deformed steel bar mats, the specifics of the bar mat welding methodology itself are largely left up to the designer to define given that D1.4 itself does not provide detail on what constitutes an acceptable cross-welded joint. This can create a grey area between design and manufacturing-related liability, considering a project's design professional of record (DPOR) is typically not equipped to be the authority on manufacturing practices for construction material being used in the design. As such, the matter deserves special attention on the part of the DPOR: simply stating that the material must conform to ASTM A184 and that the associated welding must conform to AWS D1.4 is theoretically insufficient guidance.

For more information on the distinction between WWR and ASTM A184 rebar mats, see the November 2021 WRI Technical Blog titled *"The engineer's responsibility in the production of ASTM A184 deformed steel bar mats"*.

In contrast to welded deformed steel bar mats, the material and welding methodology used to produce WWR is explicitly governed by ASTM A1064, with no need for deferral of responsibility to the DPOR for guidance on manufacturing practices.

Contrasting machine-welded rebar mats and ASTM A1064 WWR

The only published guidance on the production of machine-welded rebar mats exists in the form of CRSI's ETN-M-9-16 "Assembling Reinforcing Bars by Fusion Welding in the Fabrication Shop". There is no ASTM standard for this product, nor is there explicit reference to this product in ACI 318 or the AASHTO LRFD Bridge Specifications.

That ASTM A706 reinforcing bars are an acceptable constituent material for use in the production of welded reinforcement mats is not in question. ASTM A706 rebar on its own is a highly ductile reinforcement with well-established controlled tensile properties. The grey area with machine-welded rebar mats, then, is largely procedural, as there exists no ASTM-based guidance on production-related attributes such as those listed below:

1. Terminology
2. Purchaser-defined ordering information
3. Minimum pre-weld and post-welded mechanical properties
4. Type and interval/frequency of testing, including sampling procedures
5. Dimensions and permissible geometric variations
6. Rules for rejection and re-test
7. Standard of certification
8. Standardized packaging and marking

CRSI makes an effort to provide general guidance by stating the following:

***"Shop-welded assemblies of reinforcing bars should be permitted in reinforced concrete construction provided that":***

- ***The reinforcing bars conform to ASTM Specification A706/A706M.***
- ***The holding wires conform to ASTM Specification A1064/1064M.***
- ***Shop welding is performed by machines under a continuous, controlled process.***
- ***Quality control tests are performed on shop-welded specimens, and the test results are available, upon request, to the Architect/Engineer.***

While the spirit of this CRSI commentary seems well-intended, it does not constitute a formal standard nor does it represent a sufficiently-developed set of regulatory measures. As such, there continues to be an absence of necessary, formalized control over machine-welded rebar mats as a plant-manufactured product. This, in turn, leaves open the possibility for inconsistent and unregulated manufacturing practices and by association, an increased potential for liability exposure on the part of both the manufacturer and the DPOR.

It is not enough to point to ASTM A1064 as the standard by which machine-welded rebar mats should be produced, as this particular specification has been developed with a strict focus on cold-worked wire and welded wire. So while there are certainly some similarities between rebar and structural wire, there exists enough difference to warrant the development of a separate formalized standard that is specific to the machine-welded rebar mats. Without such a standard in place, the "manufacture" and distribution of this product essentially constitutes an unregulated practice. The WRI encourages DPORs, along

with the entities that manufacture this product in the absence of a formally established standard, to carry out their due diligence and to proceed with extreme caution. Specifically, the DPOR should acknowledge and fulfill their obligation to define and verify all attributes of the manufacturing process, including but not limited to the eight (8) items listed above.

ASTM standards and specifications exist to provide coordinated, repeatable, and reliable waypoints for the processes, materials, and products that are utilized throughout households and industry. If the machine-welded rebar mat product described in this commentary is to continue to be used in the construction landscape, it is the position of the WRI that specifiers and producing entities alike have an obligation to ensure its use is sufficiently and formally regulated.

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

*References:*


1. ACI Committee 318, "Building Code Requirements for Structural Concrete (ACI 318-19) and Commentary (ACI 318R-19)," American Concrete Institute, Farmington Hills, MI, 2019 (Reapproved 2022).

2. "Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete (ASTM A1064/A1064M-22)", ASTM International, West Conshohocken, PA, 2022.

3. "Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement (ASTM A184/A184M-19)", ASTM International, West Conshohocken, PA, 2019.

4. "ETN-M-9-16 Assembling Reinforcing Bars by Fusion Welding in the Fabrication Shop", Concrete Reinoforcing Steel Institute (CRSI), Schaumburg, IL, 2014.