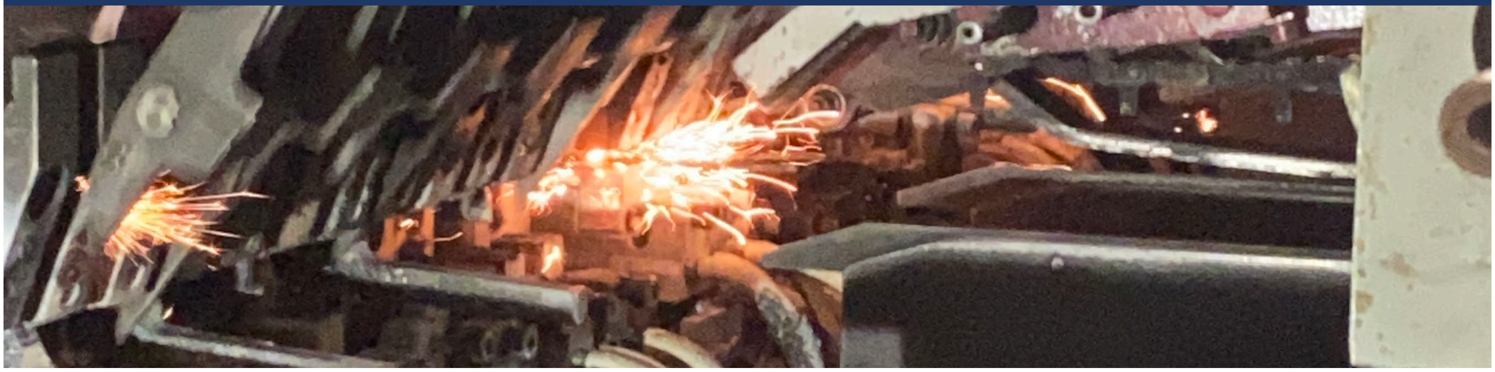
Chapter Three

Manufacture of Welded Wire Reinforcement



3.1 Process and Nomenclature

The definition of welded deformed wire reinforcement can be derived from content in ASTM A1064 *Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete* and presented as follows:

A product consisting of cold-worked, surface-deformed steel wires, assembled into orthogonal mats by automatic welding machines that assure accurate spacing and alignment of all wires of the finished product.

Hot-rolled steel rod (from billets) is cold-worked by either cold-rolling or cold-drawing the wire to a specified diameter. Deformations can be indented or raised rib (protrusion) type. Wire size and wire spacing on a particular WWR mat can be varied to suit the requirements of the detailed structural design. Welding is carried out using electrical resistance welding which employs the principle of fusion combined with pressure to produce a weldment.

Contrast between production of traditional reinforcing bars and WWR is shown below:

REINFORCING BARS	WELDED WIRE REINFORCEMENT
Metal scrap in electric ARC furnace	Metal scrap in electric ARC furnace
Molten steel cast into rectangular billets	Molten steel cast into rectangular billets
Billets hot rolled to standardized, deformed diameters: • #3 to #18 • Straight or coiled	Billets hot rolled to standardized, smooth rod diameters: • AISI 1018, AISI 1020, etc. • Variable diameters (7/32” - 11/16”) • Coiled
Finished product: ASTM A615 OR ASTM A706 rebar	Hot-rolled rod is run through a series of dies or cassettes for reduction and deforming: • Specific “design” diameter achieved • Surface deformation achieved
	Cold-Worked Wires Ready for Feeding to Automatic Welding Machine
	Finished product: ASTM A1064 welded wire reinforcement

Figure 3-1: Production Comparison Chart

Wire size varies from on the order of 1/8” diameter, up to 5/8” diameter, the latter which is equivalent in size to a #5 reinforcing bar. While larger wire sizes up to 3/4” diameter can be produced, current ACI 318 provisions require these to be analyzed using welded plain wire reinforcement restrictions. As such, anything larger than 5/8” diameter is excluded from the scope of *The Guide* considering any demand that might exist for heavy plain WWR in cast-in-place building structures would be extremely low.

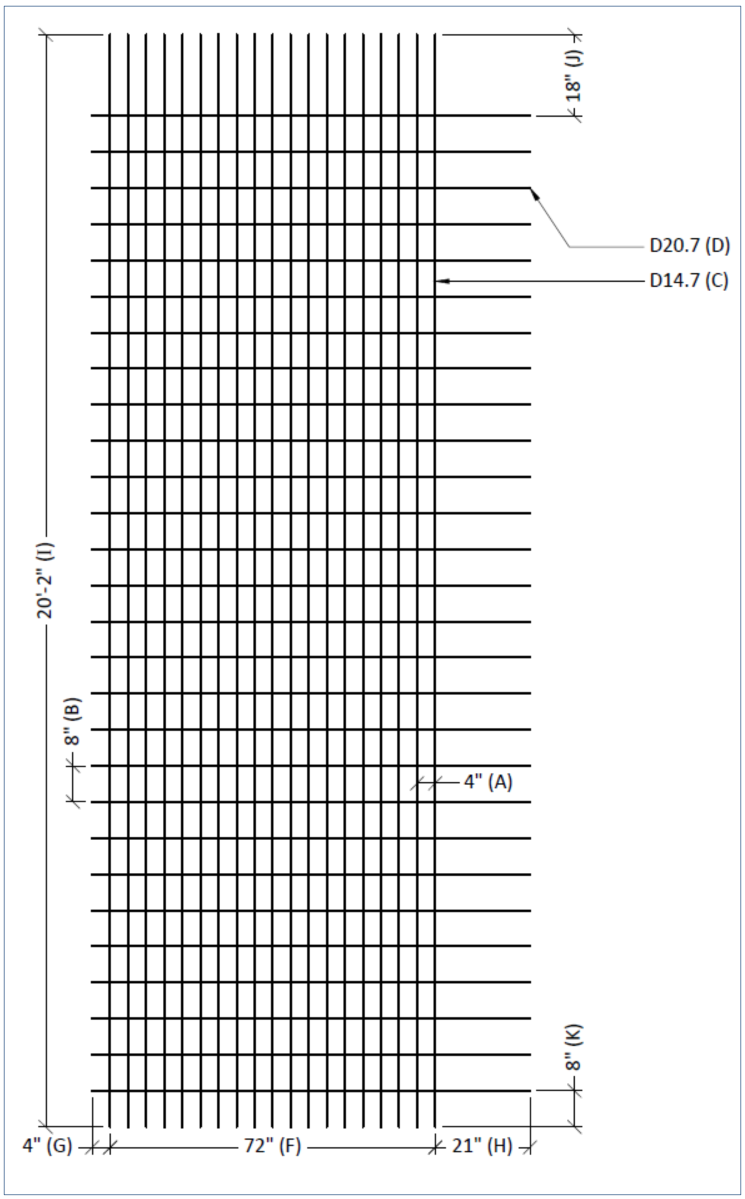
For individual deformed wires, the nomenclature is quite intuitive: the cross-sectional area is built right into the designation:

A wire with cross sectional area equal to 0.247 in^2 → D24.7

A wire with cross sectional area equal to 0.144 in^2 → D14.4

A wire with cross sectional area equal to 0.280 in^2 → D28.0

These wires are in turn welded together to form highly customizable geometries of orthogonal WWR mats. The basic nomenclature form used to describe a WWR mat configuration (or “style”) is shown below.



4x8 D14.7/D20.7 72” (+4”,+21”) x 20’-2” (18,8)

⬇

AxB C/D F (G,H) x I (J,K)

A: linewire spacing (inches)

B: crosswire spacing (inches)

C: linewire size (in^2 x 100)

D: crosswire size (in^2 x 100)

F: WWR mat width excluding overhangs (inches)

G: left-side overhang (inches, positive if past leftmost linewire)

H: right-side overhang (inches, positive if past rightmost linewire)

I: WWR mat length including overhangs (ft-in)

J: front end overhang (inches)

K: back end overhang (inches)

E: yield strength of WWR mat

(not shown here as part of mat style)

As was introduced in Section 1.3 of Chapter 1, there are some attributes associated with WWR nomenclature that are generally more relevant to manufacturing interests than they are to a structural engineer's design interests. Distilling the aforementioned mat style down to information that is pertinent to a structural detail found on a set of contract drawings reveals the following:

4 x8 **D14.7** /D20.7 72" (+4",+21") x 20'-2" (18,8)

➔ **0.147 in^2 @ 4" oc (0.441 in^2/foot) running in the long direction**

4x **8** D14.7/ **D20.7** 72" (+4",+21") x 20'-2" (18,8)

➔ **0.207 in^2 @ 8" oc (0.331 in^2/foot) running in the short direction**

4x8 D14.7/D20.7 **72" (+4",+21") x 20'-2" (18,8)**

➔ **What the WWR detailer has to do to provide a mat geometry that satisfies the engineer's detailed design intent**

Depending on various geometric and spatial considerations inherent to reinforcement layouts presented on structural contract drawings, the manufacturing nomenclature method described above might prove to be insufficient in capturing a design-compatible reinforcement layout. In this case, the WWR detailer will likely rely on illustrative communication than trying to resolve all of the subtleties of a WWR configuration in a single string of numerical characters. Below is an example of a WWR mat configured to reflect stagger of primary reinforcement.

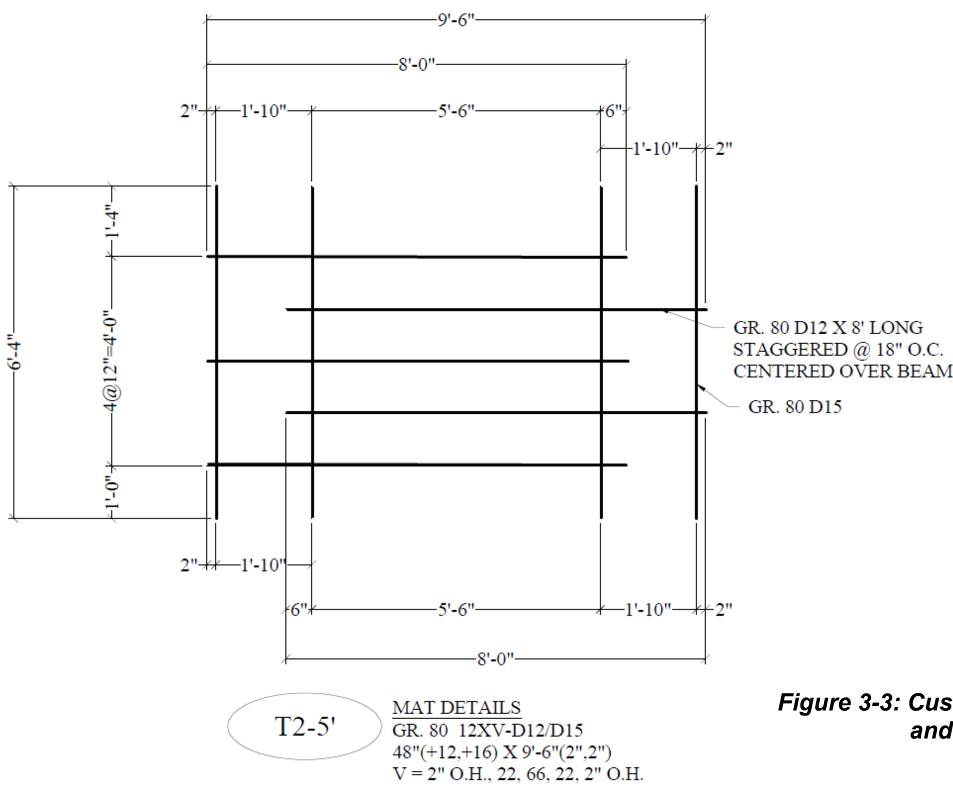


Figure 3-3: Custom WWR Mat Geometry and Nomenclature

To further illustrate WWR variability captured through the combination of mat detail and designation, the figure below is provided. While it is unlikely that the specific arrangement shown in this figure is representative of a structural reinforcement layout that would be commonly encountered on a cast-in-place concrete building structure, it shows the customizable nature of the product and how it is documented internally by the manufacturer.

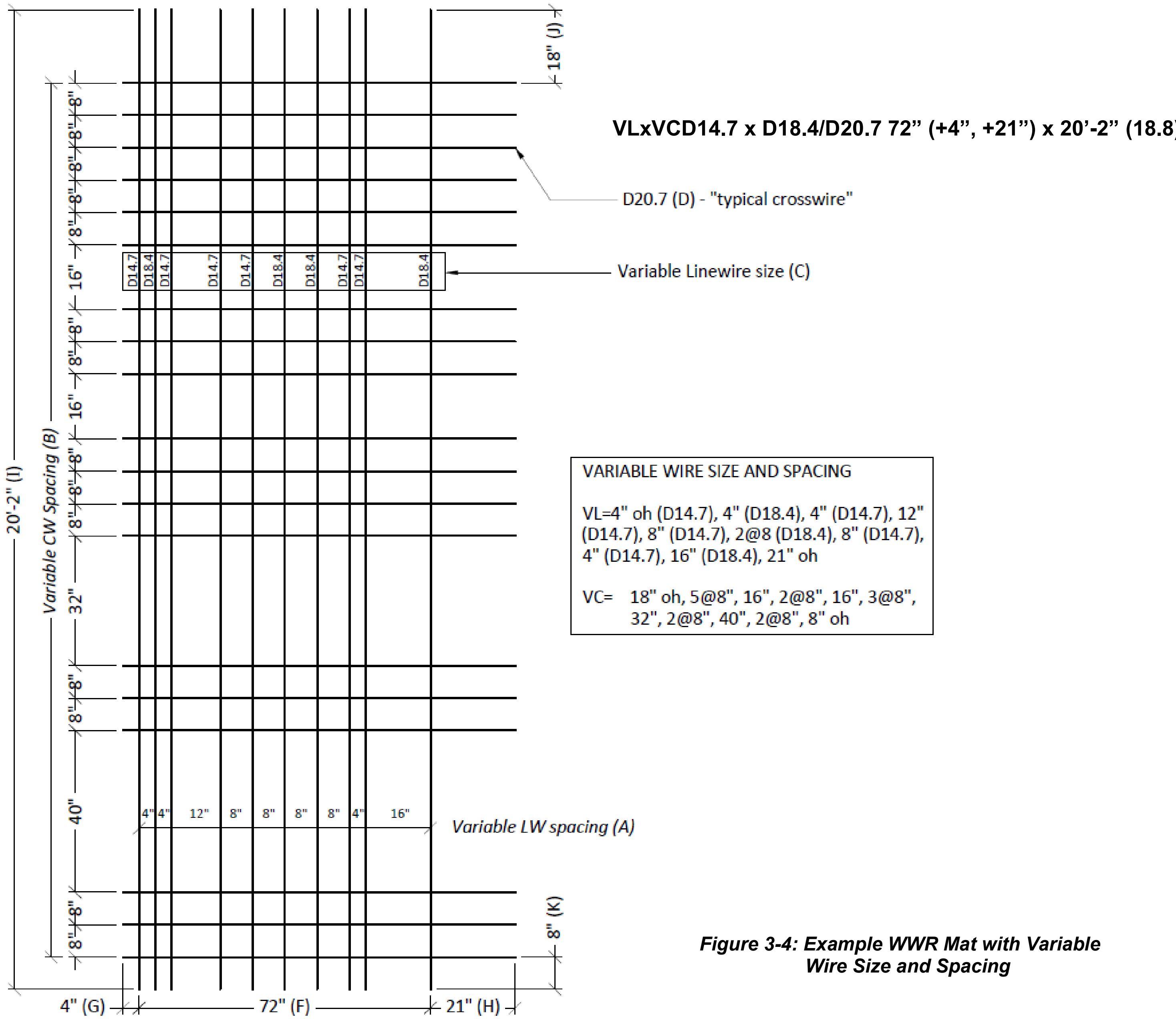


Figure 3-4: Example WWR Mat with Variable Wire Size and Spacing

A design professional would not be expected to derive the specifics of the above mat configuration and present it on a set of contract drawings, but would instead simply be responsible for informing the manufacturer/fabricator of attributes already commonly defined for rebar: steel area (size), spacing, position, and curtailment (hooks, etc.). Similarly, a contractor’s life is made simpler by the WWR manufacturer’s provision of detailed placement drawings and accompanying simplified mat nomenclature (MAT-1A, SHEET-1A, etc.). Examples presented in Chapter 5 through 10 illustrate this very clearly.

3.2 Notes on Manufacturing Tolerances

The manufacture of welded deformed wire reinforcement draws guidance from ASTM A1064 *Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.*

ASTM limitations placed on dimensional variation of flat WWR mats are presented below. For other manufacturing attributes, refer to ASTM A1064 directly in conjunction with the WRI *Manual of Standard Practice – Structural Welded Wire Reinforcement* (WWR-500).

Mat Width – ASTM A1064 Article 10.1

The width of welded wire reinforcement shall be considered to be the center-to-center distance between outside longitudinal wires. The permissible variation shall not exceed 0.5 in. greater or less than the specified width. In case the width of flat sheets are specified as the overall width (tip-to-tip length of transverse wires), the width shall not vary more than ±1 in. from the specified width.

These tolerances apply to a flat sheet, as measured just prior to loading for shipment and delivery to the jobsite.

Mat Length – ASTM A1064 Article 10.2

The overall length of flat sheets, measured on any wire, shall not vary more than ±1 in. or 1%, whichever is greater.

These tolerances apply to a flat sheet, as measured just prior to loading for shipment and delivery to the jobsite.

Transverse Wire Overhang – ASTM A1064 Article 10.3

Overhang of the transverse wires shall not project beyond the centerline of each longitudinal edge wire more than a distance of 1 in. unless otherwise specified. When transverse wires are specified to project a specific length beyond the center line of the longitudinal edge wire, the permissible variation shall not exceed 0.5 in. greater than or less than the specified length.

Wire Spacing – ASTM A1064 Article 10.6

The average spacing of wires shall be such that the total number of wires contained in a sheet or roll is equal to or greater than that determined by the specific spacing, but the center-to-center distance between individual wires shall not vary more than 0.25 in. from the specified spacing. Sheets of welded wire reinforcement having the specified length shall not be required to contain an identical number of transverse wires, and therefore, shall be permitted to have various lengths of longitudinal overhang.

The specifying designer is encouraged to utilize Article 4.2 of ASTM A1064, where they are permitted to define special requirements governing the WWR material and physical properties that the purchasing contractor would report to the manufacturer as condition of the reinforcement material order

3.3 Bending of Welded Wire Reinforcement

One of the greatest benefits of WWR is the manufacturer's ability to fabricate it to bent geometries. Bending criteria for WWR are established in ACI 318-19, wherein Section 25.3.1 defines standard hook geometry for reinforcing bar curtailment that are in turn adopted by WWR manufacturers in the fabrication of bent mats, while Section 25.3.3 defines explicitly the bend requirements for WWR used as stirrups or ties.

For a more extensive discussion of welded wire reinforcement bending capabilities and examples, refer to WRI's *Bending Welded Wire Reinforcement* (WWR-400).

Figure 3-5: Hydraulic or pneumatic machines are used to fabricate WWR bent mats

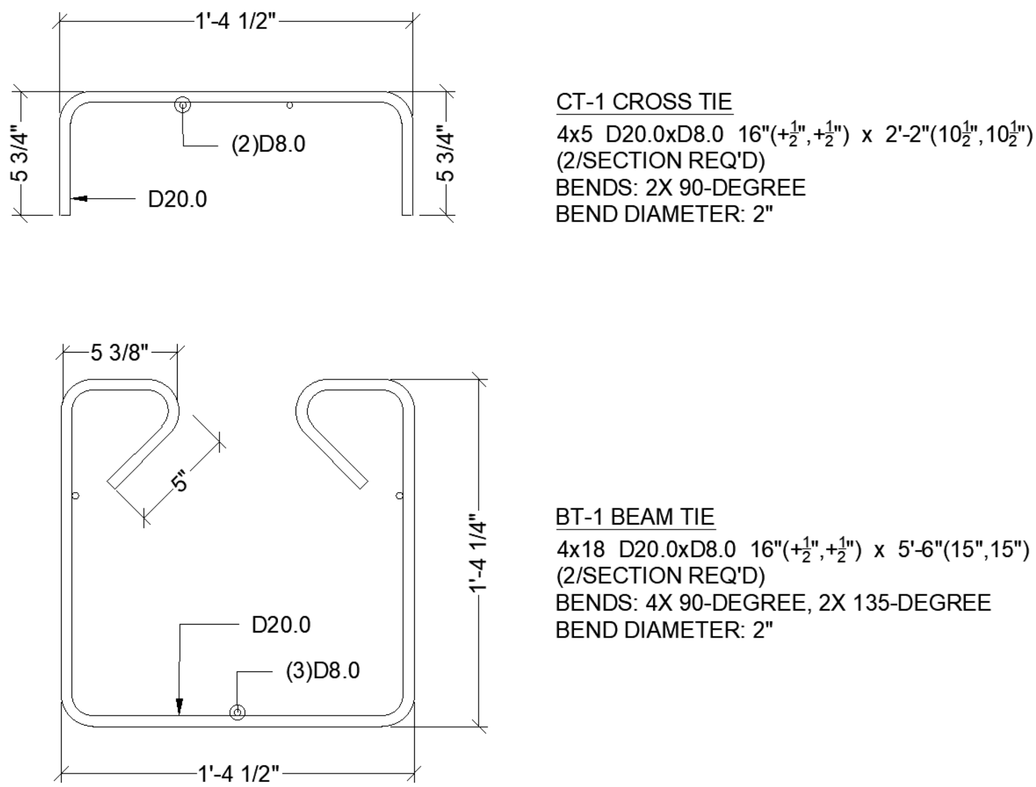


Figure 3-6: An example of an application-specific bend drawing prepared by the manufacturer