Welded Wire Reinforcement

Shotcrete applications, slope paving, and other structure related items may require the use of welded wire fabric.

The Concrete Reinforcing Institute, *Manual of Standard Practice-Structural Welded Wire Reinforcement* (2018), Chapter 2, Welded Wire Reinforcement (WWR), provides information for specifying and estimating welded wire reinforcement and is included in Figures 1-6 for Structure Construction personnel.

Welded Wire Reinforcement

CHAPTER 2
Welded Wire Reinforcement (WWR)

2.1 Introduction

This chapter presents information for specifying and detailing welded wire reinforcement (WWR) used in building, highway, bridge, pipe, and other types of construction. Information on epoxy coated, galvanized and stainless-steel welded wire reinforcement appear in Sections 2.6, 2.7, and 2.8 respectively, in this chapter.

2.2 ASTM Specifications

Welded wire reinforcement consists of wires welded together at their intersections in a square or rectangular configuration. WWR must conform to ASTM A1064 whether made from plain wire, deformed or ribbed wire, or a combination of both. (ASTM A1064 replaced the previous A82 plain wire, A185 plain wire WWR, A496 deformed wire and A497 deformed wire WWR specifications). A1064 requires tensile, reduction of area (for plain wire only) and bend tests on the reinforcement. Additionally, shear tests are required on the welded intersections. A minimum yield strength of 65,000 psi is required for plain WWR and a minimum 70,000 psi for deformed WWR. A1064 specification details the requirements for the wire used for manufacturing welded wire reinforcement.

Welded wire reinforcement can be produced with high-strength wires of minimum yield strengths of 80,000 psi. Higher minimum yield strengths allow the use of less material in certain applications. Welded wire reinforcement can be fabricated to make beam stirrups and column ties, box culverts, and other applications.

2.3 WWR Style Identification

Plain wire is denoted by the letter "W" and deformed wire by the letter "D". The letter is followed by number indicating the cross-sectional area in hundredths of a square inch.

Welded wire reinforcement is usually shown on project drawings with the abbreviation WWR followed by the inch-spacing of longitudinal then transverse wires, and last by the sizes of the longitudinal then transverse wires.

Examples of style designation (see Figure 2-1) are:

6 x 12 W16.0/W8.0 Grade 65 for plain WWR;
6 x 12 D16.0/D8.0 Grade 70 for deformed WWR.

These designations identify a style of WWR in which:

Spacing of longitudinal wires = 6 inches

Spacing of transverse wires = 12 inches

Longitudinal wire size = W16.0, D16.0

Transverse wire size = W8.0, D8.0

A deformed WWR style would be designated in the same manner with the appropriate D number, wire spacing and size.

It is important to note that the terms "longitudinal" and "transverse" are related to the method of WWR manufacture and have no reference to the orientation of the wires with respect to the orientation of the reinforced concrete structure.

2.4 Specifying Welded Wire Reinforcement

The Architect/Engineer's selection of welded wire reinforcement styles should include production considerations as well as steel area requirements. Maximum economies in production and handling can be achieved by utilizing repetition of styles and duplication of sheet dimensions to the fullest extent possible.

Welded wire reinforcement is manufactured in the form of rolls and sheets. Rolls are commonly stocked in W1.4 to W2.9 for plain WWR and D1.4 to D2.9 for deformed WWR. Roll widths can vary from 5 to 8 feet. Lengths vary with application and convenience of handling and shipping. Most commonly stocked sheets vary from 5 to 8 feet wide. Welded wire reinforcement sheet widths to 13 feet can be manufactured. "W" or "D" sizes from 1.4 (0.134 dia.) to 31.0 (0.628 dia.), even up to 45.0 (0.757 dia.) are available. Welded wire reinforcement sheets greater than 8'-6" wide require permits commonly issued by state highway departments. Contact the WWR producer for complete size, width and length capabilities.

Development lengths and lap splice lengths for WWR must be specified by the Architect/Engineer in accordance with the ACI 318 Code.

Certain styles of WWR as shown in Table 2-1 have been recommended by the Wire Reinforcement Institute as common styles. However, producers of WWR can meet specific steel area requirements when ordered for designated projects, or in some localities, may be available from producer inventory.

2.5 Detailing Welded Wire Reinforcement

The quantity of welded wire reinforcement detailed and supplied should include the net area shown on the project drawings or required in the project specifications plus sufficient material to include lap splices.

Also, the "Grade" (minimum yield strength) of the wire should be included in the description appearing after "W" or "D" size designation.

2.5.1 Width

Width is defined as the center-to-center distance between the outside longitudinal wires. Overall width is defined as the width plus side overhangs.

The side overhangs of transverse wires should be no greater than one inch unless otherwise specified by the Architect/Engineer. Transverse wires may be specified to have a specific overhang or no overhang (flush sides).

Figure 1. Chapter 2, *Welded Wire Reinforcement*, Sections 1 to 2.5.1

Welded Wire Reinforcement

Table 2-1 Common Styles of Welded Wire Reinforcement

Style "W" or "D" Available	Area, ($in.^2/ft$)	Weight, ($lb/100\ ft^2$)
4 x 4 – W1.4 x W1.4	0.042	31
4 x 4 – W2.0 x W2.0	0.060	44
4 x 4 – W2.9 x W2.9	0.087	62
4 x 4 – W3.1 x W3.1	0.093	65
4 x 4 – W4.0 x W4.0	0.120	88
6 x 6 – W1.4 x W1.4	0.028	21
6 x 6 – W2.0 x W2.0	0.040	30
6 x 6 – W2.9 x W2.9	0.058	42
6 x 6 – W4.0 x W4.0	0.080	58
6 x 6 – W4.2 x W4.2	0.084	60
6 x 6 – W4.4 x W4.4	0.088	63
6 x 6 – W4.7 x W4.7	0.094	68
6 x 6 – W7.5 x W7.5	0.150	108
6 x 6 – W8 x W8	0.160	115
6 x 6 – W8.1 x W8.1	0.162	116
6 x 6 – W8.3 x W8.3	0.166	119
12 x 12 – W8.3 x W8.3	0.083	63
12 x 12 – W8.8 x W8.8	0.088	66
12 x 12 – W9.1 x W9.1	0.091	69
12 x 12 – W9.4 x W9.4	0.094	71
12 x 12 – W15 x W15	0.150	113
12 x 12 – W16 x W16	0.160	120
12 x 12 – W16.6 x W16.6	0.166	125
12 x 12 – W17.1 x W17.1	0.171	128

Example Calculations:

6 x 6 - W4.0/W4.0 Long. Wires (Table 2-2(a)) = 29.92
Trans Wires (Table 2-2(b)) = 28.11
Total = 58.03 = 58 lb/100 ft²

2.5.2 Length

Welded wire reinforcement in roll form can be manufactured in various lengths, up to the maximum weight per roll convenient for handling. The length of rolls can vary with individual manufacturing practices of the producer. Typical lengths are 100, 150, and 200 feet. Roll or sheet length is defined as the length, tip-to-tip, of longitudinal wires. This length is commonly, but not necessarily, a whole multiple of the transverse wire spacing.

The sum of the two end overhangs on either rolls or sheets are commonly equal to one transverse wire space, however exceptions do occur. Unless otherwise specified, each end overhang equals one-half of a transverse wire space.

2.6 ASTM Specification for Epoxy-Coated Wire and Welded Wire Reinforcement

Epoxy-coated wire and welded wire reinforcement are used in reinforced concrete construction as a corrosion protection system.

The ASTM specification A884 covers the epoxy coating of plain and deformed steel wire, and plain and deformed welded wire reinforcement. The specification includes requirements for the epoxy-coating material; surface preparation of the steel prior to application of the coating; the method of application of the coating; the limits on coating thickness; and acceptance tests to ensure that the coating was properly applied. All damaged areas of coating on the wires, which occur during manufacture and handling to the point of shipment to the jobsite, have to be repaired (touched-up) with patching material.

2.7 ASTM Specification for Zinc-Coated (Galvanized) Steel Welded Wire Reinforcement

Galvanized welded wire reinforcement is used in reinforced concrete construction as a corrosion protection system.

The ASTM specification A1060 covers the zinc-coating (galvanizing) of plain and deformed welded wire reinforcement. The specification includes requirements for the mass (weight) and thickness of the coating, finish and adherence of the coating, and acceptance tests to ensure that the coating was properly applied. Rust formations on the cut ends and at welded intersections are inherent characteristics of this material and should not be cause for rejection. Prior to shipment, all coating defects (except those noted above) should be repaired (touched-up) with a zinc-rich formulation.

2.8 ASTM Specification for Stainless-Steel Welded Wire Reinforcement

Stainless-steel welded wire reinforcement is used as concrete reinforcement for applications requiring corrosion resistance.

The ASTM specification A1022 covers stainless-steel wire and welded wire reinforcement for hot-rolled, drawn or rolled, plain or deformed or a combination of deformed and plain wire. Stainless-steel wire for welded wire reinforcement is generally at a 75 ksi yield strength however other strength levels can be manufactured and should be by agreement between the purchaser and manufacturer.

2.9 Rust

All carbon steel reinforcement for concrete, whether it is wire, welded wire reinforcement, or reinforcing bars, is subject to some degree of rusting before use. Research data has shown that a normal amount of rust increases the bond between the reinforcement and the concrete.

Figure 2. Chapter 2, *Welded Wire Reinforcement* continued, Sections 2.5.1 to 2.9

Welded Wire Reinforcement

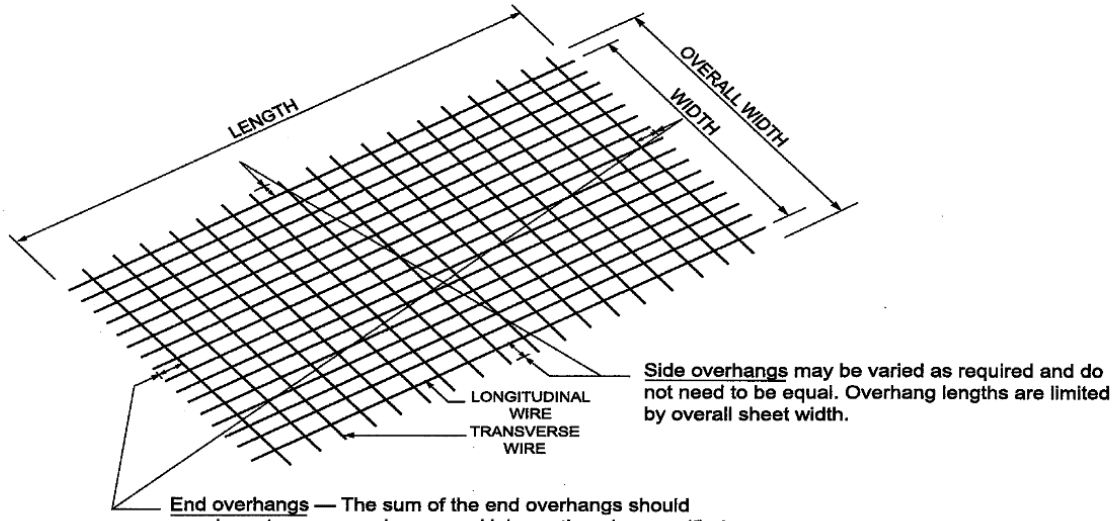
2.10 Handling, Shipping and Unloading

Welded wire reinforcement (WWR) is manufactured and shipped in two forms: rolls and sheets. If shipped in roll form, multiple rolls, generally from 7 to 18 depending on style and weight, are bundled together for efficient handling. Individual rolls are securely tied so uncurling will not occur when the bundle bands are cut. Welded wire reinforcement sheets are bundled in quantities, depending on size and weight, then shipped to either the customer location or to a customer jobsite. Most sheet bundles will weigh between 2,000 and 5,000 pounds.

Sheets are commonly bound together in bundles using wire, wire rod, or steel strapping. Rolls are bundled together using steel or plastic strapping. ***It is important to note that the wire, wire rod, steel or plastic strapping being utilized is for the sole purpose of holding the bundled rolls and/or bundled sheets together during transit and should never be used for lifting or handling.***

Sheets are commonly manufactured by flipping alternate sheets allowing the sheets to "nest". This allows for a greater number of sheets per bundle and the stacking of these "flipped" sheets provides additional stability during storage and transit.

Common pieces of equipment used for handling welded wire reinforcement are forklifts, overhead cranes and mobile cranes. Whenever welded wire reinforcement bundles require lifting equipment to unload in the plant or on the jobsite, extreme caution should be exercised and all safety regulations and practices must be observed.



Industry Method of Designating Style:

Example: 6 x 12—W16 / W18

Longitudinal wire spacing—6 in.	Longitudinal wire size—W16
Transverse wire spacing—12 in.	Transverse wire size—W8

Figure 2-1 Style Designation of Welded Wire Reinforcement.

Figure 3. Chapter 2, *Welded Wire Reinforcement* continued, Section 2.10

Welded Wire Reinforcement

Table 2-2(a) Unit of Weight of Longitudinal Wires For Welded Wire Reinforcement

Wire Size W or D	Nom. Dia. (in.)	Weight (lb/100 ft²) of Longitudinal Wires Per Inch Spacing (Based on 5' x 20' Sheet with 1" Side Overhang)								
		2	3	4	5	6	8	9	10	12
45.0	0.757	948.60	642.60	489.60	397.80	336.60	260.10	234.60	214.20	183.60
31.0	0.628	653.48	442.68	337.28	274.04	231.88	179.18	161.61	147.56	126.48
30.0	0.618	632.40	428.40	326.40	265.20	224.40	173.40	156.40	142.80	122.40
28.0	0.597	590.24	399.84	304.64	247.52	209.44	161.84	145.97	133.28	114.24
26.0	0.575	548.08	371.28	282.88	229.84	194.48	150.28	135.55	123.76	106.08
24.0	0.553	505.92	342.72	261.12	212.16	179.52	138.72	125.12	114.24	97.92
22.0	0.529	463.76	314.16	239.36	194.48	164.56	127.16	114.69	104.72	89.76
20.0	0.505	421.60	285.60	217.60	176.80	149.60	115.60	104.27	95.20	81.60
18.0	0.479	379.44	257.04	195.84	159.12	134.64	104.04	93.84	85.68	73.44
16.0	0.451	337.28	228.48	174.08	141.44	119.68	92.48	83.41	76.16	65.28
14.0	0.422	295.12	199.92	152.32	123.76	104.72	80.92	72.99	66.64	57.12
12.0	0.391	252.96	171.36	130.56	106.08	89.76	69.36	62.56	57.12	48.96
11.0	0.374	231.88	157.08	119.68	97.24	82.28	63.58	57.35	52.36	44.88
10.5	0.366	221.34	149.94	114.24	92.82	78.54	60.69	54.74	49.98	42.84
10.0	0.357	210.80	142.80	108.80	88.40	74.80	57.80	52.13	47.60	40.80
9.5	0.348	200.26	135.66	103.36	83.98	71.06	54.91	49.53	45.22	38.76
9.0	0.339	189.72	128.52	97.92	79.56	67.32	52.02	46.92	42.84	36.72
8.5	0.329	179.18	121.38	92.48	75.14	63.58	49.13	44.31	40.46	34.68
8.0	0.319	168.64	114.24	87.04	70.72	59.84	46.24	41.71	38.08	32.64
7.5	0.309	158.10	107.10	81.60	66.30	56.10	43.35	39.10	35.70	30.60
7.0	0.299	147.56	99.96	76.16	61.88	52.36	40.46	36.49	33.32	28.56
6.5	0.288	137.02	92.82	70.72	57.46	48.62	37.57	33.89	30.94	26.52
6.0	0.276	126.48	85.68	65.28	53.04	44.88	34.68	31.28	28.56	24.48
5.5	0.265	115.94	78.54	59.84	48.62	41.14	31.79	28.67	26.18	22.44
5.0	0.252	105.40	71.40	54.40	44.20	37.40	28.90	26.07	23.80	20.40
4.5	0.239	94.86	64.26	48.96	39.78	33.66	26.01	23.46	21.42	18.36
4.0	0.226	84.32	57.12	43.52	35.36	29.92	23.12	20.85	19.04	16.32
3.5	0.211	73.78	49.98	38.08	30.94	26.18	20.23	18.25	16.66	14.28
2.9	0.192	61.38	41.58	31.68	25.74	21.78	16.83	15.18	13.86	11.88
2.1	0.162	44.02	29.82	22.72	18.46	15.62	12.07	10.89	9.94	8.52
1.4	0.134	29.76	20.16	15.36	12.48	10.56	8.16	7.36	6.72	5.76

NOTE: *This table should be used for estimating purposes only. Actual weights of WWR will vary from those shown above, depending on the width of rolls or sheets and lengths of overhang. No allowance is made in this table for the extra weight of reinforcement required for lap splices.*

Figure 4, Unit of Weight of Longitudinal Wires for Welded Wire Reinforcement

Welded Wire Reinforcement

Table 2-2(b) Unit of Weight of Transverse Wires for Welded Wire Reinforcement

Wire Size W or D	Nom. Dia. (in.)	Weight (lb/100 ft²) of Transverse Wires Per Inch Spacing (Based on 5' x 20' Sheet with 1" Side Overhang)								
		2	3	4	5	6	8	9	10	12
45.0	0.757	948.66	632.44	474.33	379.46	316.22	237.17	210.81	189.73	158.11
31.0	0.628	653.52	435.68	326.76	261.41	217.84	163.38	145.23	130.70	108.92
30.0	0.618	632.44	421.63	316.22	252.98	210.81	158.11	140.54	126.49	105.41
28.0	0.597	590.28	393.52	295.14	236.11	196.76	147.57	131.17	118.06	98.38
26.0	0.575	548.12	365.41	274.06	219.25	182.71	137.03	121.80	109.62	91.35
24.0	0.553	505.95	337.30	252.98	202.38	168.65	126.49	112.43	101.19	84.33
22.0	0.529	463.79	309.19	231.89	185.52	154.60	115.95	103.06	92.76	77.30
20.0	0.505	421.63	281.08	210.81	168.65	140.54	105.41	93.69	84.33	70.27
18.0	0.479	379.46	252.98	189.73	151.79	126.49	94.87	84.33	75.89	63.24
16.0	0.451	337.30	224.87	168.65	134.92	112.43	84.33	74.96	67.46	56.22
14.0	0.422	295.14	196.76	147.57	118.06	98.38	73.78	65.59	59.03	49.19
12.0	0.391	252.98	168.65	126.49	101.19	84.33	63.24	56.22	50.60	42.16
11.0	0.374	231.89	154.60	115.95	92.76	77.30	57.97	51.53	46.38	38.65
10.5	0.366	221.35	147.57	110.68	88.54	73.78	55.34	49.19	44.27	36.89
10.0	0.357	210.81	140.54	105.41	84.33	70.27	52.70	46.85	42.16	35.14
9.5	0.348	200.27	133.52	100.14	80.11	66.76	50.07	44.51	40.05	33.38
9.0	0.339	189.73	126.49	94.87	75.89	63.24	47.43	42.16	37.95	31.62
8.5	0.329	179.19	119.46	89.60	71.68	59.73	44.80	39.82	35.84	29.87
8.0	0.319	168.65	112.43	84.33	67.46	56.22	42.16	37.48	33.73	28.11
7.5	0.309	158.11	105.41	79.06	63.24	52.70	39.53	35.14	31.62	26.35
7.0	0.299	147.57	98.38	73.78	59.03	49.19	36.89	32.79	29.51	24.59
6.5	0.288	137.03	91.35	68.51	54.81	45.68	34.26	30.45	27.41	22.84
6.0	0.276	126.49	84.33	63.24	50.60	42.16	31.62	28.11	25.30	21.08
5.5	0.265	115.95	77.30	57.97	46.38	38.65	28.99	25.77	23.19	19.32
5.0	0.252	105.41	70.27	52.70	42.16	35.14	26.35	23.42	21.08	17.57
4.5	0.239	94.87	63.24	47.43	37.95	31.62	23.72	21.08	18.97	15.81
4.0	0.226	84.33	56.22	42.16	33.73	28.11	21.08	18.74	16.87	14.05
3.5	0.211	73.78	49.19	36.89	29.51	24.59	18.45	16.40	14.76	12.30
2.9	0.192	61.38	40.92	30.69	24.55	20.46	15.35	13.64	12.28	10.23
2.1	0.162	44.02	29.35	22.01	17.61	14.67	11.01	9.78	8.80	7.34
1.4	0.134	29.76	19.84	14.88	11.90	9.92	7.44	6.61	5.95	4.96

NOTE: *This table should be used for estimating purposes only. Actual weights of WWR will vary from those shown above, depending on the width of rolls or sheets and lengths of overhang. No allowance is made in this table for the extra weight of reinforcement required for lap splices.*

Figure 5. Unit of Weight of Transverse Wires for Welded Wire Reinforcement

Welded Wire Reinforcement

Table 2-3 Cross-Sectional Area and Weight of Welded Wire Reinforcement

Wire Size W or D	Nom. Dia. (in.)	Nom. Wt (lb/ft)	Area (in.²/ft) Per Wire Spacing (in.)						
			2	3	4	6	8	10	12
45.0	0.757	1.530	2.700	1.800	1.350	0.900	0.675	0.540	0.450
31.0	0.628	1.054	1.858	1.239	0.929	0.619	0.465	0.372	0.310
30.0	0.618	1.020	1.800	1.200	0.900	0.600	0.450	0.360	0.300
28.0	0.597	0.952	1.680	1.120	0.840	0.560	0.420	0.336	0.280
26.0	0.575	0.884	1.558	1.039	0.779	0.519	0.390	0.312	0.260
24.0	0.553	0.816	1.441	0.961	0.721	0.480	0.360	0.288	0.240
22.0	0.529	0.748	1.319	0.879	0.659	0.440	0.330	0.264	0.220
20.0	0.505	0.680	1.202	0.801	0.601	0.401	0.300	0.240	0.200
18.0	0.479	0.612	1.081	0.721	0.541	0.360	0.270	0.216	0.180
16.0	0.451	0.544	0.959	0.639	0.479	0.320	0.240	0.192	0.160
14.0	0.422	0.476	0.839	0.559	0.420	0.280	0.210	0.168	0.140
12.0	0.391	0.408	0.720	0.480	0.360	0.240	0.180	0.144	0.120
11.0	0.374	0.374	0.659	0.439	0.330	0.220	0.165	0.132	0.110
10.5	0.366	0.357	0.631	0.421	0.316	0.210	0.158	0.126	0.105
10.0	0.357	0.340	0.601	0.400	0.300	0.200	0.150	0.120	0.100
9.5	0.348	0.323	0.571	0.380	0.285	0.190	0.143	0.114	0.095
9.0	0.339	0.306	0.542	0.361	0.271	0.181	0.135	0.108	0.090
8.5	0.329	0.289	0.510	0.340	0.255	0.170	0.128	0.102	0.085
8.0	0.319	0.272	0.480	0.320	0.240	0.160	0.120	0.096	0.080
7.5	0.309	0.255	0.450	0.300	0.225	0.150	0.112	0.090	0.075
7.0	0.299	0.238	0.421	0.281	0.211	0.140	0.105	0.084	0.070
6.5	0.288	0.221	0.391	0.261	0.195	0.130	0.098	0.078	0.065
6.0	0.276	0.204	0.359	0.239	0.179	0.120	0.090	0.072	0.060
5.5	0.265	0.187	0.331	0.221	0.165	0.110	0.083	0.066	0.055
5.0	0.252	0.170	0.299	0.200	0.150	0.100	0.075	0.060	0.050
4.5	0.239	0.153	0.269	0.179	0.135	0.090	0.067	0.054	0.045
4.0	0.226	0.136	0.241	0.160	0.120	0.080	0.060	0.048	0.040
3.5	0.211	0.119	0.210	0.140	0.105	0.070	0.052	0.042	0.035
2.9	0.192	0.099	0.174	0.116	0.087	0.058	0.043	0.035	0.029
2.1	0.162	0.071	0.124	0.082	0.062	0.041	0.031	0.025	0.021
1.4	0.134	0.048	0.085	0.056	0.042	0.028	0.021	0.017	0.014

NOTES:

1. *The above listing of plain and deformed wire sizes represents wires normally selected to manufacture welded wire reinforcement to specific areas of reinforcement. Other wire sizes not shown above are available upon request.*
2. *The nominal diameter of a deformed wire is equivalent to the diameter of a plain wire having the same weight per foot as the deformed wire.*
3. *The ACI 318 Code requirements for tension development lengths and tension lap splice lengths of welded wire reinforcement are not included in this chapter. These design requirements are covered in "Reinforcing Bars: Anchorages and Splices" available from CRSI. For additional information, see "Manual of Standard Practice - Structural Welded Wire Reinforcement" and "Structural Detailing Manual", both published by the Wire Reinforcement Institute.*

Figure 6. Cross-Sectional Area and Weight of Welded Wire Reinforcement