MANUAL OF STANDARD PRACTICE

WIRE REINFORCEMENT INSTITUTE®

STRUCTURAL WELDED WIRE REINFORCEMENT

WIRE REINFORCEMENT INSTITUTE, INC.

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Manual of Standard Practice

Structural Welded Wire Reinforcement

Prepared under direction of the technical committees of the Wire Reinforcement Institute, Inc.

WIRE REINFORCEMENT INSTITUTE

Phone: (860) 240-9545
www.wirereinforcementinstitute.org

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WWR-500 • 9th Edition

Welded wire reinforcement (WWR) is a prefabricated reinforcement consisting of parallel series of high-strength, cold-drawn or cold-rolled wire welded together in square or rectangular grids. Each wire intersection is electrically resistance-welded by a continuous automatic welder, refer to Figure 1.1. Pressure and heat fuse the intersecting wires into a homogeneous section and fix all wires in their proper position. Plain wires, deformed wires or a combination of both may be used in WWR.

Welded plain wire reinforcement bonds to concrete by the positive mechanical anchorage at each welded wire intersection. Welded deformed wire utilizes deformations plus welded intersections for bond and anchorage.

Figure 1.1. Section at typical weld showing complete fusion of intersecting wires.

Concrete structures are being successfully and economically reinforced with high-strength, uniformly distributed wires in WWR. The smaller diameter, closely-spaced wires of WWR provide more uniform stress distribution and more effective crack control in slabs and walls. The wide range of wire sizes and spacings available makes it possible to furnish the exact cross-sectional steel area required. The welded crosswires hold the reinforcement in the proper position, uniformly spaced. The ease, refer to Figure 1.2, and speed with which WWR can be handled and installed considerably reduces placing time, resulting in reduced cost. Reduced construction time is of particular benefit to the owner by affording earlier occupancy and reducing total (project) cost. Material savings can be realized by specifying WWR with higher yield strengths as recognized by ACI 318 and ASTM. Consult the various WRI manufacturers for their high-strength capabilities.

This manual provides WWR product information, material specifications, design and detailing requirements, and various tables and design aids for those interested in the design and construction of reinforced concrete structures.

Figure 1.2. Placing a shear cage of welded wire reinforcement in a concrete girder for a sports stadium.

2.1 Item Description

In the welded wire industry, an “item” is the term used to designate a complete unit of WWR as it appears on an order form.

2.2 Wire Size Designation

Individual wire (plain and deformed) size designations are based on the cross-sectional area of a given wire. Gage numbers were used exclusively for many years. The industry changed over to a letter-number combination in the 1970’s. The prefixes “W” and “D” are used in combination with a number. The letter “W” designates a plain wire and the letter “D” denotes a deformed wire. The number following the letter gives the cross-sectional area in hundredths of a square inch. For instance, wire designation W4 would indicate a plain wire with a cross-sectional area of 0.04 sq. in.; a D10 wire would indicate a deformed wire with a cross-sectional area of 0.10 sq. in. The size of wires in welded wire reinforcement sheets is designated in the same manner. This system has many advantages. Since the engineer knows the cross-sectional area of a wire and the spacing, the total cross-sectional area per foot of width can easily be determined. For instance, a W6 wire on 4 inch centers would provide 3 wires per foot with a total cross- sectional area of 0.18 sq. in. per foot of width.

When describing metric wire, the prefix “M” is added. MW describes metric plain wire and MD metric deformed wire. The wire spacings in metric WWR are given in millimeters (mm) and the cross-sectional areas of the wires in square millimeters (mm^2).

Nominal cross-sectional area of a deformed wire is determined from the weight (mass) per foot of wire rather than the diameter. The weight (mass) may be calculated from the wire area multiplied by 3.4 (0.00784) to obtain weight per foot.

2.3 Style

Spacings and sizes of wires in WWR are identified by “style.”, see below and refer to Figure 2.1 for a typical style designation:

6 x 12 – W12 x W5

This denotes a unit of WWR in which:

- Spacing of longitudinal wire = 6” (152mm)
- Spacing of transverse wires = 12” (305mm)
- Size of longitudinal wires = W12 (0.12 sq. in.) (77mm^2)
- Size of transverse wires = W5 (.05 sq. in.) (32mm^2)

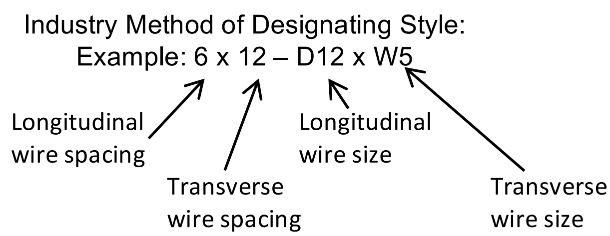


Figure 2.1. WWR Nomenclature

Thus, the style for the sample above would be expressed metrically as 152 x 305–MW77 x MW32. A welded deformed wire style would be noted in the same manner by substituting the prefix D for the W. Note that “style” gives spacings and sizes of wires only and does not provide any other information such as width and length of sheet.

WWR with non-uniform wire spacings is available. In this case, special information is added to the style designation to describe the reinforcement. Figure 2.2 illustrates the style dimensioning nomenclature and the style dimensioning is further defined in Section 2.4.

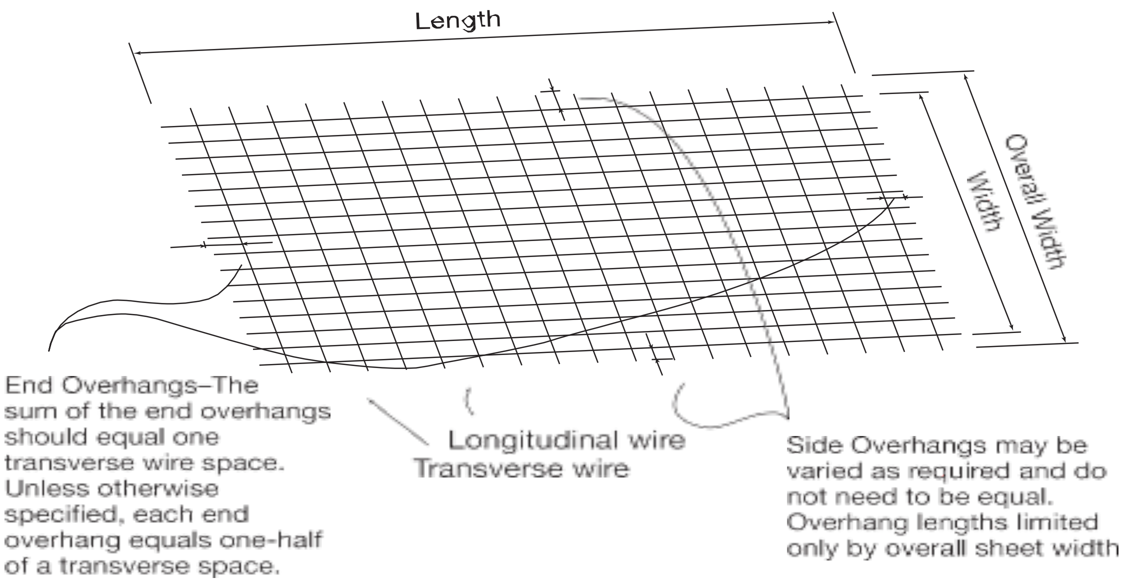


Figure 2.2 WWR Style Dimensioning Nomenclature.

It is very important to note that the terms longitudinal and transverse are related to the manufacturing process and do not refer to the relative position of the wires in a concrete structure. The WWR manufacturing process is discussed in detail in section 3.1. Transverse wires are individually welded at right angles as the longitudinal reinforcement advances through the welder. In some WWR machines, the transverse wire is fed from a continuous coil; in others they are precut to length and hopper fed to the welding position. Table 1 illustrates several means of ordering welded wire reinforcement.

2.4 Dimensions

Description of width, length and overhang dimensions of sheets follow:

Width	=	Center to center distance between outside longitudinal wires.This dimension does not include overhangs.
Side Overhang	=	Extension of transverse wires beyond centerline of outside longitudinal wires. If no side overhang is specified, WWR will be furnished with overhangs on each side, of no greater than 1 inch (25 mm). Wires can be cut flush (no overhangs) specified thus: (+0", +0"). When specific overhangs are required, they're noted as: (+1", +3"), (+6", +6") or (+0.5", 12") etc..
Overall Width	=	Width including side overhangs, in. (or mm). In other words the tip-to-tip dimension of transverse wires.
Length	=	Tip-to-tip dimension of longitudinal wires. Whenever possible this dimension should be an even multiple of the transverse wire spacing. [The length dimension always includes end overhangs.]
End Overhangs	=	Extension of longitudinal wires beyond centerline of outside transverse wires. Unless otherwise noted, standard end overhangs are assumed to be required. End overhangs are needed and shall be specified. Standard styles with prior agreed upon end overhangs may not need to be specified. Non-standard end overhangs may be specified for special situations; preferably the sum of the two end overhangs should equal to the transverse wire spacing.

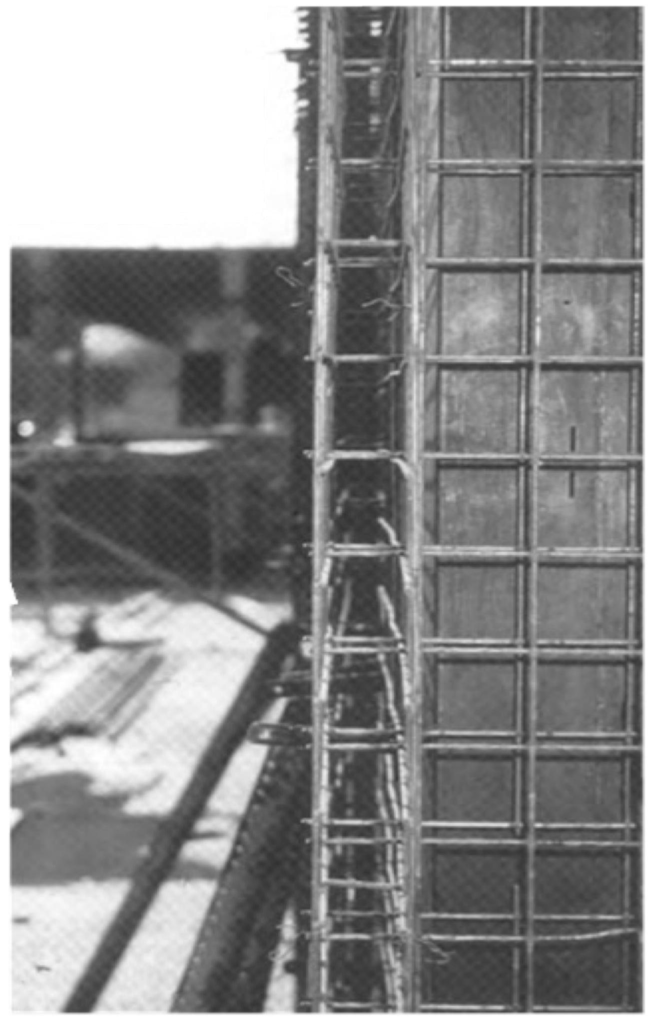


Figure 3. (Above) Inner and outer vertical face of wall reinforcement

NOTE: It is recommended that quantities and complete Style Descriptions including Width, Side Overhangs, Length, and Length End Overhangs be provided with the ordering information.

Table 2.1. Welded Wire Reinforcement Sample Order

The following example of welded wire reinforcement items illustrates how a typical order using the nomenclature described might appear:

Item	Quantity	Style	Width (inches)	Side Overhangs (inches)	Lengths (feet–inches)	End Overhangs (inches)
1	1000 sheets	12 x 12 – W11 x W11	90"	(+6", +6")	15'-2"	(+1", +1")
2	150 sheets	6 x 6 – W4 x W4	60"	(+0", +0")	20'-6"	(+3", +3")
3	500 sheets	6 x 12 – D10 x D6	96"	(+3", +3")	18'-0"	(+6", +6")

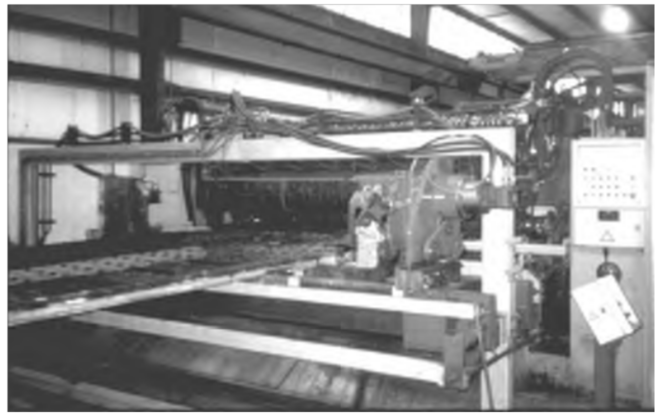
A sample metric order may appear as follows:

Item	Quantity	Style	Width (mm)	Side Overhangs (mm)	Lengths (meters)	End Overhangs (mm)
1	1000 sheets	305 x 305 – MW71 x MW71	2286	(+152, +152)	4.623 m	(+12.5mm, +12.5mm)
2	150 sheets	152 x 152 – MW26 X MW26	1524	(+0, +0)	6.248 m	(+10mm, +10mm)
3	500 sheets	152 x 305 – MD65 x MD39	2438	(+76, +76)	5.486 m	(+152mm, +152mm)

3.1 Manufacturing Process

The wire used in welded wire reinforcement is produced from controlled-quality, hot-rolled rods. These rods are cold-worked through a series of dies or cassettes to reduce the rod diameter to the specified diameter; this cold-working process, increases the yield strength of the wire. Chemical composition of the steel is carefully selected to give proper welding characteristics in addition to desired mechanical properties.

WWR is produced on automatic welding machines which are designed for consistent manufacturing of a specific style. Longitudinal wires are straightened and fed continuously through the machine. Transverse wires, entering from the side or from above the welder, are individually welded at right angles to the longitudinal wires each time the longitudinal wires advance through the machine a distance equal to one transverse wire spacing.



WWR is manufactured with the following variables:

1. Longitudinal wire spacing
2. Longitudinal wire size
3. Width
4. Side and end overhangs
5. Transverse wire size
6. Transverse wire spacing
7. Length

These variables may be changed in the manufacturing process with different amounts of time required depending on the type and extent of the change (or combination of changes). The above listing is in the general order of time involved, with the most time-consuming operation listed first. For example, a change in longitudinal wire spacings from one item to another requires the repositioning of all welding heads, wire straighteners and feed tubes while a change in length requires only an adjustment in the timing sequence of the shear which cuts the sheet to proper length.

For economy the more difficult machine changes require minimum quantities per item in order to offset the additional production time required. Consult manufacturers for stocked quantities or minimum quantities of special styles.

WWR used in highway median barriers

3.2 Minimum Quantity Requirements

The use of welded wire reinforcement becomes more efficient and economical as the amount of repetition in reinforcement increases. Economy is governed by the manufacturing process as described in Section 3.1 and by the industry practice of carrying certain common welded wire reinforcement items in stock or inventory.

The following two sections outline the minimum quantity requirements for stock (inventoried) items and non- standard items.

3.3 Common Sizes

Certain items of welded plain or deformed WWR are carried in stock by many WRI members either at the producing mills or warehousing points. While practice varies somewhat between manufacturers and localities, many of the items listed in Table 3.1 3.2 are usually available.

3.4 Individual Project Needs

Individual projects will require non-standard WWR sizes and styles in order to meet specific reinforcing needs. Minimum quantity requirements for non-standard orders vary by producer but the following guidelines for maximizing economy of orders can be used.

1. the most important factor affecting economy is to minimize the number of longitudinal wire spacings. An example of using wide spaced wires, is placing 1/2 size, closely spaced wires at edges, in the splice zones to obtain the required steel area per foot or meter.
2. The second most important factor is controlling the number of different wire sizes. Many welding machines have variable spacing capabilities. This feature becomes important in manufacturing of sheets with steel required in the varying amounts across the length or width of the manufactured sheets. This capability allows the use of one longitudinal and one transverse wire when the area varies across the section.

Table 3.1: Common US sheet sizes are:

	Customary	Metric
	in. ft.	mm M
U.S. (except west coast)	96 x 20	2438 x 6.1
	96 x 15	2438 x 4.6
	96 x 12.5	2438 x 3.8
	60 x 10	1524 x 3.1
U.S. (except west coast)	90 x 20	2286 x 6.1
	96 x 20	2438 x 6.1
	84 x 25	2134 x 7.6
	84 x 20	2134 x 6.1

Table 3.2: Common Canadian sheet sizes are:

	Customary	Metric
	in. ft.	mm M
Canada	96 x 20	2438 x 6.1
	96 x 16	2438 x 4.6
	96 x 14	2438 x 3.8
	60 x 10	1524 x 3.1
	48 x8	1219 x 2.4

Examples Using Various Minimum Yield Strengths for Economy - Consider

Grade 60 wire by style 12 x 12 - W31 x W31 (Standard)

Grade 75 wire by style 12 x 12 - W25 x W25 (20% savings)

Grade 80 wire by style 12 x 12 - W23 x W23 (25% savings)

Common stock wire size styles: W1.4 (10 ga.), W2.1 (8 ga.), W2.9 (6 ga.), W/D4 (4 ga.)

4.1 Specifications

The American Society for Testing and Materials (ASTM) has established specifications for plain and deformed wires as well as welded plain and deformed wire reinforcement. The Canadian Standards (CSA) were withdrawn and replaced with applicable ASTM standards for use in Canada (See Table 4.1). Some governmental agencies have special specifications, which will control.

TABLE 4.1

Specifications Covering Welded Wire Reinforcement

U.S. and Canadian Specification	Title
ASTM A1064*	Standard Specification for Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
* - Formerly known as: ASTM A82, ASTM A185, ASTM A496, ASTM A497	
ASTM A1022	Standard Specification for Deformed and Plain Stainless Steel Wire and Welded Wire for Concrete Reinforcement

4.2 Yield Strength

The yield strength values shown in Table 4.2(a) are ASTM requirements for minimum yield strength measured at a strain of 0.005 in/in or 0.2% offset method. The 0.2% offset method is consistent with the ACI 318 Building Code, Chapter 20, and states that yield strength values greater than 60,000 psi (420 MPa) may be used, provided the yield strength is measured accordingly. Higher yield strength welded wire WWR is available and can be specified in accordance with ACI code requirements or AASHTO LRFD bridge specifications requirements. Higher strength welded wire can be used in many other concrete element applications, such as slabs, bridge girders and other elements with the relevant agency's approval.

The ASTM A1064 standard provides tables for both plain (smooth) and deformed WWR. The tables in ASTM A1064 and summarized below, in Table 4.2(a), give required grade for yield strength and corresponding tensile strengths as well as minimum reduction of area (%) for a given wire size range for both the plain (smooth) and deformed wire and welded wire reinforcement.

Elongation test criteria on maximum strength (or maximum stretch) is shown in tables 4.2(b) and 4.2(c). Maximum stretch can be defined as total elongation which is a test in A370, A4.4.2, measuring both the elastic & plastic extension.

The testing done here and recorded in the Tables 4.2(b) & 4.2(c) correlate with other testing/research done by some major universities. They have found that high strength WWR is capable of developing significant strains and exhibits sufficient ductility to redistribute the strains to avoid brittle shear failure.

4.3 Weld Shear Strength

The values shown in Tables 4.2 (a), (b) and (c) are the ASTM requirements for weld shear strength which contribute to the bond and anchorage of the wire reinforcement in concrete.

A maximum size differential of wires being welded together is maintained to assure adequate weld shear strength. For both plain and deformed wires, the smaller wire must have an area of 40 percent or more of the steel area of the larger wire.

Larger Wire Size	Smaller Wire Size
W20 (MW 129)	W8 (MW 52)
W15 (MW 97)	W6 (MW 39)
D20 (MD 129)	D8 (MD 52)

TABLE 4.2(a) Minimum Requirements of Steel Wires in Welded Wire Reinforcement

WELDED PLAIN WIRE REINFORCEMENT ASTM A1064

Wire Size	Tensile Strength psi	Yield Strength psi	Weld Shear Strength
W1.2 & over	75,000 (520 MPa)	65,000 (450 MPa)	35,000 (240 MPa)
Under W1.2	70,000 (480 MPa)	56,000 (390 MPa)	-

WELDED DEFORMED WIRE REINFORCEMENT ASTM A1064

Wire Size	Tensile Strength psi	Yield Strength psi	Weld Shear Strength
D 4 thru D45	80,000 (550 MPa)	70,000 (480 MPa)	35,000 (240 MPa)
Under D 4	80,000 (550 MPa)	70,000 (480 MPa)	-

4.4 WWR Coatings

There are two types of coatings used on welded wire reinforcement. One is galvanized, applied to the cold-drawn wire before or after it is welded. The hot-dipped galvanizing process is specified in ASTM A1060 for both wires and welded wire reinforcement. The other type of coating is epoxy. The application of the epoxy coating occurs after the sheets have been welded. The requirements for epoxy-coated welded wire reinforcement are provided in ASTM A884.

TABLE 4.2(b) Test of Elongation (total - Elastic & Plastic) for various Wire Sizes

Gauge Length	Wire Size	Elongation Mean (%)	Elongation Std. Dev.	f_y @ 0.35% Strain (ksi)	f_t Ultimate Tensile @ Fracture (ksi)
4"	W3	7.2	1.1	87	100
	W4	10.5	1.59	80	91
6"	W3.5	7.9	0.05		
	W6.5	8.6	0.90	84	100
	W10	7.4	0.74	80	92
7"	W5.5	7.3	0.67	78	96
	W6	8.7	0.67	83	98
	W8	8.9	0.05	73	87
	D12	13.4	0.49	88	98

TABLE 4.2(c) Summary of test Criteria in table 3(b) (27 Samples Tested)

f_y Range @ 0.35% of Strain	f_t Range (ult)	%Elongation total* A370, A4.4.2	%Elongation Permanent A370, A4.4.1
73-88ksi	91-102 ksi	6-14%	4-6%
		Mean - 8.9%	5%

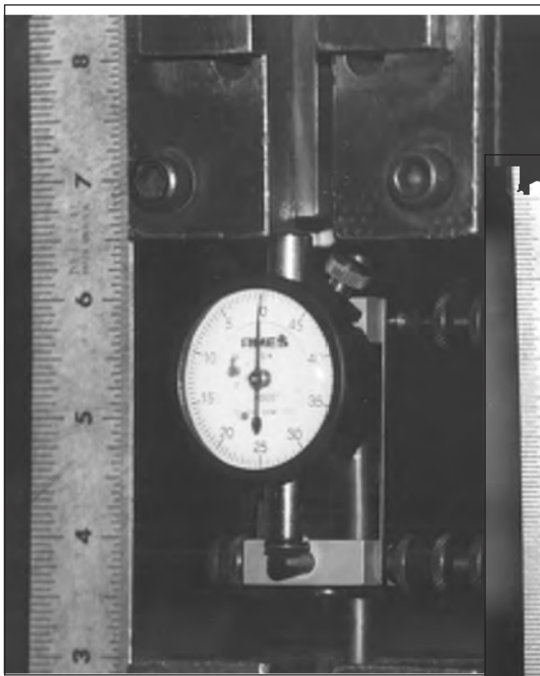
* Maximum strength or maximum stretch is the full measure of extension before fracture. It is the true measure of elongation (total). Research background for this testing can be found in the ACI discussion paper, Disc.88-S60 in ACI Structural Journal, July - August 1992.

Note 1

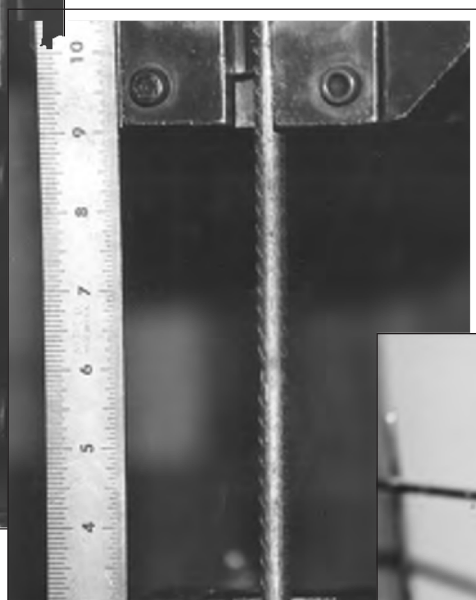
3 samples of each size were tested from the same heat of steel rod
7" was the max. gauge length for the testing machine used.
Rod (f_t) is 55 - 60 ksi
Rod type is 1006 - 1008 carbon steel.
Rate of speed for loading samples was a min. of 10,000 psi / minute in accordance with A370, 7.4.3

Note 2

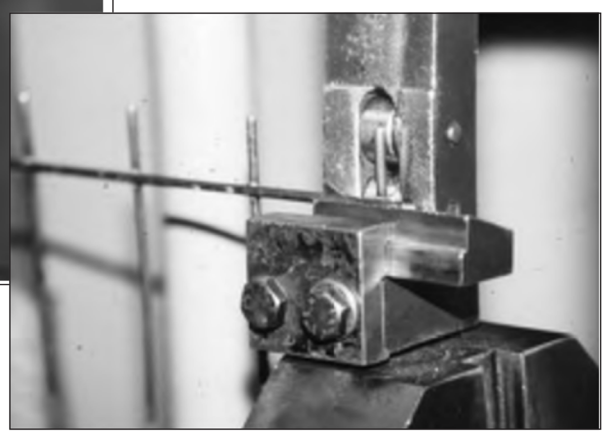
Recent testing of strain at ultimate strength provided the following data. 7 samples tested - wire sizes tested - W2.9, D8, D15. Range of ultimate or tensile strength results at 0.0050 in/in - 82.5 - 103ksi. Range of ultimate or tensile strength results at 0.0035 in/in - 77.5 - 93ksi. Range of strain results at ultimate strength were 0.0075 - 0.0090 in/in, which shows that strain of both wire and welded wire at ultimate strengths are 2 - 2.5 times the ACI 318 requirement of strain to be 0.0035 in/in at minimum yield strengths. This research shows there is a substantial safety factor for wire and welded wire reinforcement. (Charts and graphs are available on request)

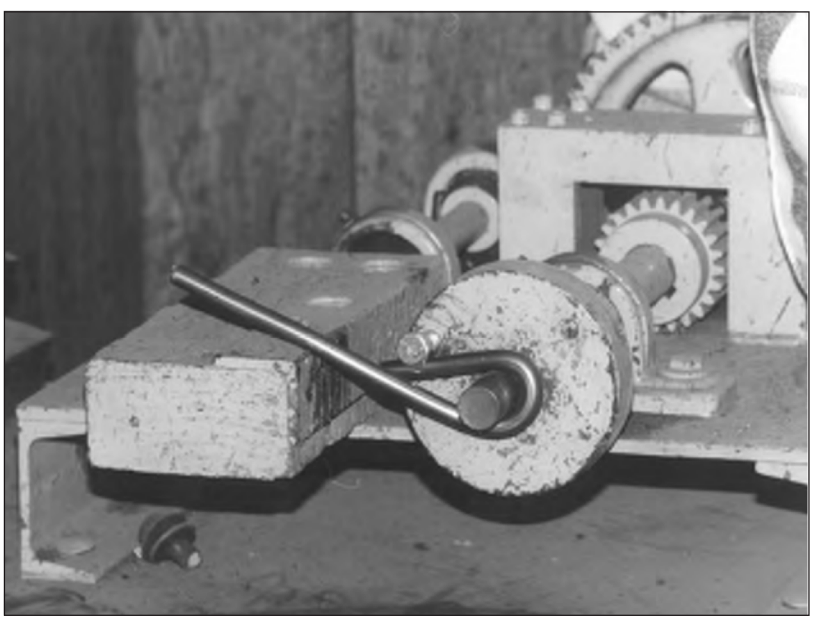


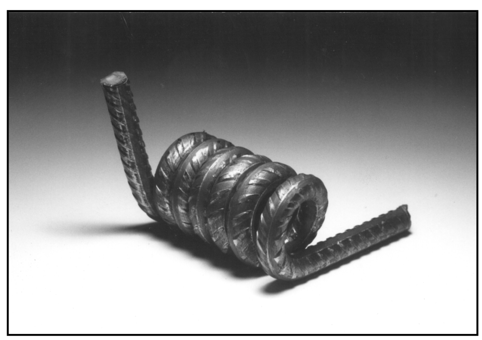
External Measuring of Elongation



Weld Shear Testing







Wrap Testing

BUILDING CODE REQUIREMENTS FOR REINFORCED CONCRETE (ACI 318)

The tabulated information shown below is intended to serve as a supplemental technical cross-reference for design and construction professionals. Information is compiled in such a manner so as to highlight content that is pertine*nt to welded wire reinforcement as currently presented in the Building Code Requirements for Structural Concrete, ACI 318-14, and Commentary on Building Code Requirements for Structural Concrete, ACI 318R-14*.

Note that in most cases, only excerpts from the ACI 318 reference are shown. This format is intended to encourage the reader's direct use of the reference itself. Decisions impacting design and construction must be based on the full text of the ACI 318-14 and ACI 318R-14 documents.

ACI 318-14 USAGE OF ASTM A1064 AND A1022 DEFORMED REINFORCEMENT

USAGE	APPLICATION	MAXIMUM VALUE OF f_y PERMITTED FOR DESIGN CALCULATIONS	ACCEPTANCE	
			DEFORMED WWR	DEFORMED WIRE
FLEXURE; AXIAL FORCE; SHRINKAGE AND TEMPERATURE	SPECIAL SEISMIC SYSTEMS	60 KSI	NO	NO
	OTHER	80 KSI	YES	YES
LATERAL SUPPORT OF LONGITUDINAL BARS; OR CONCRETE CONFINEMENT	SPECIAL SEISMIC SYSTEMS	100 KSI	YES	YES
	SPIRALS	100 KSI	NO	YES
	OTHER	80 KSI	YES	YES
SHEAR	SPECIAL SEISMIC SYSTEMS	60 KSI	*YES [1]*	YES
	SPIRALS	60 KSI	NO	YES
	SHEAR FRICTION	60 KSI	YES	YES
	STIRRUPS, TIES, HOOPS	60 KSI *[2]*	YES	YES
		80 KSI *[2]*	YES	NO
TORSION	LONGITUDINAL AND TRANSVERSE	60 KSI	YES	YES

NOTES

[1] NOT PERMITTED WHERE THE WELD IS REQUIRED TO RESIST STRESSES IN RESPONSE TO CONFINEMENT, LATERAL SUPPORT OF LONGITUDINAL BARS, SHEAR, AND OTHER ACTIONS.

[2] 60 KSI IS MAXIMUM FOR WELDED PLAIN WIRE. 80 KSI IS MAXIMUM FOR WELDED DEFORMED WIRE.

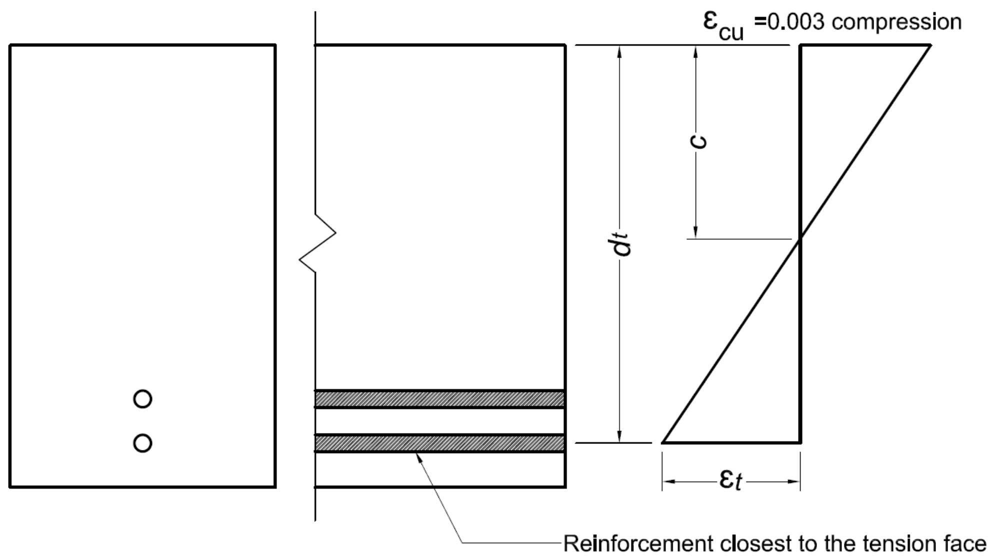
ACI 318-14 USAGE OF ASTM A1064 AND A1022 PLAIN WIRES

USAGE	APPLICATION	MAXIMUM VALUE OF f_y PERMITTED FOR DESIGN CALCULATIONS	ACCEPTANCE
LATERAL SUPPORT OF LONGITUDINAL BARS; OR CONCRETE CONFINEMENT	SPIRALS IN SPECIAL SEISMIC SYSTEMS	100 KSI	YES
	SPIRALS	100 KSI	YES
SHEAR	SPIRALS	60 KSI	YES
TORSION IN NONPRESTRESSED BEAMS	SPIRALS	60 KSI	YES

[ABOVE INFORMATION TAKEN FROM ACI 318-14 TABLE 20.2.2.4 (a) and (b)]

A. MATERIAL SPECIFICATION AND USAGE

PROVISION	ACI 318-14
DEFINITIONS OF DEFORMED REINFORCEMENT AND PLAIN REINFORCEMENT	2.3
YIELD STRENGTH IS MEASURED USING THE OFFSET METHOD WITH OFFSET OF 0.2% IN ACCORDANCE WITH ASTM A370, OR BY HALT-OF-FORCE METHOD PROVIDED THE NONPRESTRESSED BAR OR WIRE HAS A SHARP-KNEED OR WELL-DEFINED YIELD POINT.	20.2.1.2
WIRE AND WELDED WIRE SHALL CONFORM TO (a) ASTM A1064 (CARBON STEEL) OR (b) ASTM A1022 (STAINLESS STEEL).	20.2.1.7
PLAIN WIRE IS PERMITTED ONLY FOR SPIRAL REINFORCEMENT AND IN WELDED PLAIN WIRE REINFORCEMENT, THE LATTER OF WHICH IS CONSIDERED DEFORMED.	R20.2.1.7
DEFORMED WIRE SIZES D4 THROUGH D31 SHALL BE PERMITTED	20.2.1.7.1
DEFORMED WIRE SIZES LARGER THAN D31 SHALL BE PERMITTED IN WELDED WIRE REINFORCEMENT IF TREATED AS PLAIN WIRE FOR CALCULATION OF DEVELOPMENT AND SPLICE LENGTHS.	20.2.1.7.2
EXCEPT IN STIRRUP APPLICATIONS, SPACING OF WELDED INTERSECTIONS IN WELDED WIRE REINFORCEMENT IN THE DIRECTION OF CALCULATED STRESS SHALL NOT EXCEED 16” FOR WELDED DEFORMED AND 12” FOR WELDED PLAIN WIRE REINFORCEMENT. ***NOTE TO READER*** *THERE ARE NUMEROUS INSTANCES WHERE PROJECT-SPECIFIC CONSIDERATIONS WARRANT WIDER SPACING INTERVALS THAN THOSE DEFINED IN THIS SECTION. AN EXAMPLE OF THIS IS THE USE OF TWO SEPARATE “ONE-WAY” WWR MATS THAT, ONCE INSTALLED PERPENDICULAR TO ONE ANOTHER, ACCOMPLISH THE ORIGINALLY-SPECIFIED “WHOLE SYSTEM” REINFORCEMENT REQUIREMENTS IN EACH OF THE TWO ORTHOGONAL DIRECTIONS.* *IT IS THE POSITION OF THE WIRE REINFORCEMENT INSTITUTE THAT, PROVIDED PRESCRIPTIVE MINIMUM AND MAXIMUM SPACING REQUIREMENTS DEFINED ELSEWHERE IN ACI 318-14 ARE SATISFIED FOR THE “PRIMARY” DIRECTION UNDER CONSIDERATION (I.E., FLEXURAL, SHRINKAGE & TEMPERATURE, ETC.) FOR A GIVEN MAT, THE REINFORCEMENT IN THE SECONDARY DIRECTION CAN BE CONFIGURED AT SPACING INTERVALS EXCEEDING THOSE DEFINED IN 20.2.1.7.3.* *IN ALL CASES, THE WELDED WIRE REINFORCEMENT MAT MUST COMPLY WITH DIMENSIONAL TOLERANCES DEFINED IN ASTM A1064.*	20.2.1.7.3
YIELD STRENGTH LIMITATIONS	SEE TABLES
PERMITTED STRUCTURAL USAGE AND APPLICATIONS	SEE TABLES
WIRE AND WELDED WIRE REINFORCEMENT TO BE EPOXY-COATED SHALL CONFORM TO 20.2.1.7(a)	20.6.2.3
IN SLABS WITH SPANS NOT EXCEEDING 10 FEET, WELDED WIRE REINFORCEMENT WITH WIRE SIZE NOT EXCEEDING W5 OR D5 SHALL BE PERMITTED TO BE CURVED FROM A POINT NEAR THE TOP OF SLAB OVER THE SUPPORT TO A POINT NEAR THE BOTTOM OF SLAB AT MIDSPAN, PROVIDED SUCH REINFORCEMENT IS CONTINUOUS OVER, OR DEVELOPED AT, THE SUPPORT.	7.7.3.7
INSIDE DIAMETER OF BEND IN WELDED WIRE REINFORCEMENT FOR STIRRUPS AND TIES SHALL NOT BE LESS THAN $4d_b$ FOR DEFORMED WIRE LARGER THAN D6 AND $2d_b$ FOR ALL OTHER WIRES. BENDS WITH INSIDE DIAMETER OF LESS THAN $8d_b$ SHALL NOT BE LESS THAN $4d_b$ FROM NEAREST WELDED INTERSECTION	25.3.3

B. DESIGN ASSUMPTIONS – FLEXURE AND AXIAL LOADS	
PROVISION	**ACI 318-14**
ANALYTICAL PROCEDURES SHALL SATISFY COMPATIBILITY OF DEFORMATIONS AND EQUILIBRIUM OF FORCES	4.5.1 22.2.1.1 13.2.6.2
SECTIONAL STRENGTH REQUIREMENTS SHALL BE SATISFIED. STRAIN IN CONCRETE AND REINFORCEMENT SHALL BE ASSUMED PROPORTIONAL TO THE DISTANCE FROM THE NEUTRAL AXIS. MAXIMUM USABLE STRAIN AT THE EXTREME COMPRESSION FIBER OF CONCRETE IS 0.003.  	22.1.2 22.2.1.2 22.2.2.1
STRESS IN REINFORCEMENT BELOW f_y SHALL BE TAKEN AS E_s MULTIPLIED BY STEEL STRAIN. FOR STRAINS GREATER THAN THAT CORRESPONDING TO f_y, STRESS IN REINFORCEMENT SHALL BE CONSIDERED INDEPENDENT OF STRAIN AND EQUAL TO f_y. $when\ \varepsilon_s < \varepsilon_y: \quad A_s f_s = A_s E_s \varepsilon_s$ $when\ \varepsilon_s \geq \varepsilon_y: \quad A_s f_s = A_s f_y$	20.2.2.1
TENSILE STRENGTH OF CONCRETE SHALL BE NEGLECTED IN FLEXURAL AND AXIAL STRENGTH CALCULATIONS	22.2.2.2
THE RELATIONSHIP BETWEEN CONCRETE COMPRESSIVE STRESS AND STRAIN SHALL BE REPRESENTED BY A RECTANGULAR, TRAPEZOIDAL, PARABOLIC, OR OTHER SHAPE THAT RESULTS IN PREDICTION OF STRENGTH IN SUBSTANTIAL AGREEMENT WITH RESULTS OF COMPREHENSIVE TESTS. THE EQUIVALENT RECTANGULAR CONCRETE STRESS DISTRIBUTION IN ACCORDANCE WITH 22.2.2.4.1 THROUGH 22.2.2.4.3 SATISFIES 22.2.2.3.	22.2.2.3 22.2.2.4
SECTIONS ARE TENSION-CONTROLLED IF THE NET TENSILE STRAIN IN THE EXTREME TENSION STEEL, ε_t, IS EQUAL TO OR GREATER THAN 0.005 WHEN THE CONCRETE IN COMPRESSION REACHES ITS ASSUMED STRAIN LIMIT OF 0.003. SECTIONS WITH ε_t BETWEEN THE COMPRESSION-CONTROLLED STRAIN LIMIT AND 0.005 CONSTITUTE A TRANSITION REGION.	R21.2.2

C. DESIGN ASSUMPTIONS – SHEAR LOADS	
PROVISION	**ACI 318-14**
WELDED WIRE REINFORCEMENT WITH WIRES LOCATED PERPENDICULAR TO LONGITUDINAL AXIS OF MEMBER SHALL BE PERMITTED FOR SHEAR REINFORCEMENT PROVIDING ONE-WAY SHEAR STRENGTH.	22.5.10.5.1
NOMINAL ONE-WAY SHEAR STRENGTH AT A SECTION, V_n, SHALL BE CALCULATED BY $V_n = V_c + V_s$, WHERE: $$V_s \geq {V_u}/{\varphi} - V_c$$ $$V_s = \frac{A_v f_{yt} d}{s}$$ $$A_v/s = (V_u - \varphi V_c)/\varphi f_{yt} d$$	22.5.1.1 R22.5.10.5 22.5.10.1 22.5.10.5.3
NOMINAL STRENGTH FOR TWO-WAY MEMBERS WITH SHEAR REINFORCEMENT OTHER THAN SHEARHEADS SHAL BE CALCULATED BY $v_n = v_c + v_s$. FACTORED SHEAR STRESS IN TWO-WAY MEMBERS DUE TO SHEAR AND MOMENT TRANSFER IS CALCULATED IN ACCORDANCE WITH THE REQUIREMENTS OF 8.4.4.	22.6.1.3 8.4.4
SINGLE- OR MULTIPLE-LEG STIRRUPS FABRICATED FROM BARS OR WIRES SHALL BE PERMITTED TO BE USED AS SHEAR REINFORCEMENT IN SLABS AND FOOTINGS.	22.6.7.1
FOR TWO-WAY MEMBERS WITH STIRRUPS, v_s SHALL BE CALCULATED BY: $$v_s = \frac{A_V f_{yt}}{b_o s}$$	22.6.7.2

D. MINIMUM REINFORCEMENT REQUIREMENTS	
PROVISION	**ACI 318-14**
MINIMUM SHEAR REINFORCEMENT, $A_{v,min}$, FOR ONE-WAY SLABS (CHAPTER 7), BEAMS (CHAPTER 9), COLUMNS (CHAPTER 10), WALLS (CHAPTER 11), AND SPECIAL STRUCTURAL WALLS (CHAPTER 18).	7.6.3 9.6.3 10.6.2 11.6 18.10.2
MINIMUM FLEXURAL REINFORCEMENT, $A_{s,min}$, FOR NONPRESTRESSED ONE-WAY SLABS AND PRESTRESSED ONE-WAY SLABS WITH UNBONDED TENDONS (CHAPTER 7), NON-PRESTRESSED TWO-WAY SLABS (CHAPTER 8), AND NONPRESTRESSED BEAMS (CHAPTER 9).	7.6.1 7.6.2.3 8.6.1 9.6.1
MINIMUM NONPRESTRESSED SHRINKAGE AND TEMPERATURE REINFORCEMENT	7.6.4 24.4.3

E. BOND AND DEVELOPMENT – DEFORMED WIRE REINFORCEMENT, WELDED DEFORMED WIRE REINFORCEMENT, AND WELDED PLAIN WIRE REINFORCEMENT IN TENSION

<table>
<tr><th>PROVISION</th><th>ACI 318-14</th></tr>
<tr><td>

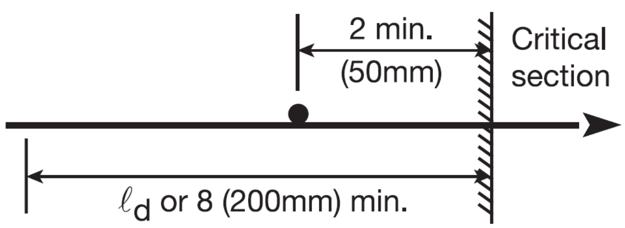
DEVELOPMENT LENGTH l_d FOR <u>DEFORMED WIRE IN TENSION</u> SHALL BE CALCULATED PER ***EQUATION E1*** BELOW, BUT NOT LESS THAN 12”.

$$l_d = \left[\frac{3}{40}\frac{f_y}{\lambda\sqrt{f'_c}}\frac{\psi_t\psi_e\psi_s}{\left(\frac{c_b + K_{tr}}{d_b}\right)}\right]\times d_b$$

DEVELOPMENT LENGTH l_d FOR <u>WELDED DEFORMED WIRE REINFORCEMENT IN TENSION</u> SHALL BE CALCULATED PER ***EQUATION E2*** BELOW.

$$l_d = \left[\frac{3}{40}\frac{f_y}{\lambda\sqrt{f'_c}}\frac{\psi_t\psi_e\psi_s}{\left(\frac{c_b + K_{tr}}{d_b}\right)}\right]\times d_b\times\psi_w$$

FOR <u>WELDED DEFORMED WIRE REINFORCEMENT IN TENSION</u> WITH AT LEAST ONE WIRE WITHIN l_d THAT IS AT LEAST TWO INCHES FROM THE CRITICAL SECTION (ILLUSTRATED BELOW), ψ_w SHALL BE THE GREATER OF $(f_y - 35{,}000)/f_y$ OR $(5d_b/s)$ BUT NEED NOT BE GREATER THAN 1.0.



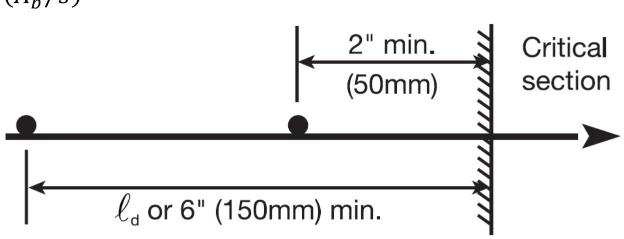
FOR <u>WELDED DEFORMED WIRE REINFORCEMENT</u> WHERE NO WIRES OCCUR WITHIN l_d OR WITH A SINGLE WIRE LESS THAN 2” FROM THE CRITICAL SECTION, ψ_w SHALL BE TAKEN AS 1.0.

FOR <u>WELDED DEFORMED WIRE REINFORCEMENT</u>, WHEN $\psi_w = 1.0$, DEVELOPMENT LENGTH l_d SHALL NOT BE LESS THAN 12”. WHEN $\psi_w < 1.0$, l_d SHALL NOT BE LESS THAN 8”.

</td><td>25.4.2.1
25.4.2.3
25.4.2.4
25.4.6.1
25.4.6.2
25.4.6.3
25.4.6.4</td></tr>
<tr><td>

DEVELOPMENT LENGTH l_d OF <u>WELDED PLAIN WIRE REINFORCEMENT IN TENSION</u> (AS WELL AS DEFORMED WIRES LARGER THAN D31) MEASURED FROM THE CRITICAL SECTION TO THE OUTERMOST CROSS WIRE SHALL REQUIRE TWO CROSS WIRES WITHIN l_d AND SHALL BE THE GREATEST OF THE FOLLOWING:

a. 6”
b. SPACING OF CROSS WIRES + 2”
c. $0.27\left[f_y/\left(\lambda\sqrt{f'_c}\right)\right](A_b/s)$



(ZINC-COATED (GALVANIZED) WELDED DEFORMED WIRE REINFORCEMENT SHALL BE DEVELOPED PER 25.4.7)

</td><td>25.4.7
25.4.6.5
25.4.6.6</td></tr>
</table>

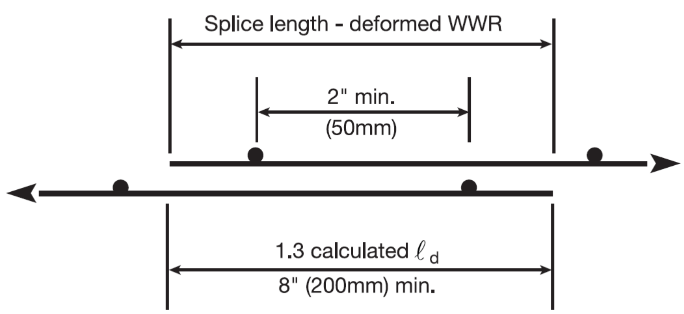
F. SPLICES - DEFORMED WIRE AND WELDED DEFORMED WIRE REINFORCEMENT IN TENSION

PROVISION	ACI 318-14
TENSION LAP SPLICE LENGTH l_{st} OF DEFORMED WIRES IN TENSION SHALL BE IN ACCORDANCE WITH TABLE SHOWN BELOW, WHERE l_d IS IN ACCORDANCE WITH 25.4.2.1(a). NOTE THAT PROVISION FOR "MINIMUM l_d" EQUAL TO 12" REFERENCED IN 25.4.2.1(b) IS OMITTED WHEN ENTERING TABLE WITH l_d.	25.5.2

$A_{s,provided}/A_{s,required}$ Provided over splice length	Maximum percent of A_s spliced within required lap length	Splice type	Lap splice length, l_{st}	
≥ 2.0	50	CLASS A	Greater of:	$1.0l_d$ and 12"
	100	CLASS B	Greater of:	$1.3l_d$ and 12"
< 2.0	ALL CASES	CLASS B		

PROVISION	ACI 318-14
TENSION LAP SPLICE l_{st} OF WELDED DEFORMED WIRE REINFORCEMENT IN TENSION WITH CROSS WIRES WITHIN THE LAP SPLICE LENGTH SHALL BE THE GREATER OF $1.3l_d$ AND 8", WHERE l_d IS CALCULATED IN ACCORDANCE WITH ***EQUATION E2*** (SEE WWR-500 SECTION E "BOND AND DEVELOPMENT") AND THE FOLLOWING CONDITIONS ARE SATISFIED:	25.5.3.1 25.5.3.1.1 25.5.3.1.2 25.5.3.1.3

a. OVERLAP BETWEEN OUTERMOST CROSS WIRES OF EACH REINFORCEMENT SHEET SHALL BE AT LEAST 2"
b. WIRES IN THE DIRECTION OF DEVELOPMENT LENGTH SHALL ALL BE DEFORMED D31 OR SMALLER



IF CONDITION (a) ABOVE IS NOT SATISFIED, l_{st} SHALL BE CALCULATED IN ACCORDANCE WITH 25.5.2.

IF CONDITION (b) ABOVE IS NOT SATISFIED, l_{st} SHALL BE CALCULATED IN ACCORDANCE WITH 25.5.4.

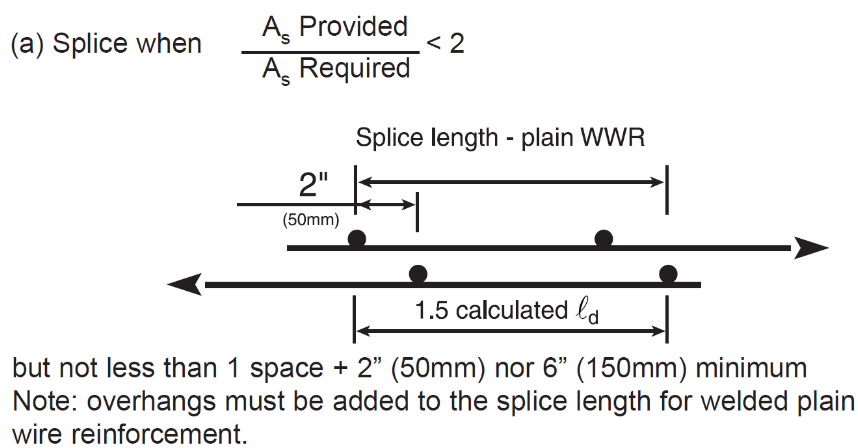
IF THE WELDED DEFORMED WIRE REINFORCEMENT IS ZINC-COATED (GALVANIZED), l_{st} SHALL BE CALCULATED IN ACCORDANCE WITH 25.5.4.

G. SPLICES – WELDED PLAIN WIRE REINFORCEMENT IN TENSION

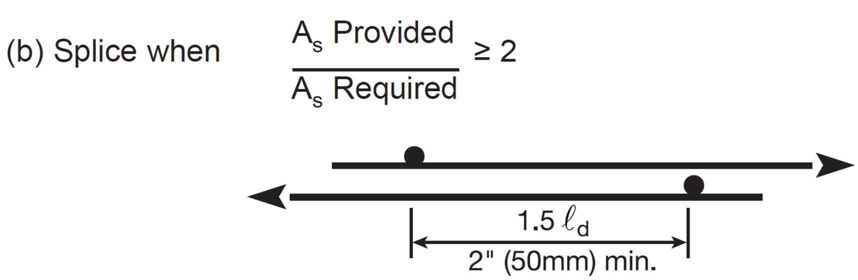
<table>
<tr><th>PROVISION</th><th>ACI 318-14</th></tr>
<tr><td>

TENSION LAP SPLICE LENGTH l_{st} OF WELDED PLAIN WIRE REINFORCEMENT IN TENSION BETWEEN OUTERMOST CROSS WIRES OF EACH REINFORCEMENT SHEET SHALL BE THE GREATEST OF (a) THROUGH (c):

a. CROSS WIRE SPACING + 2”
b. 1.5 X l_d, WHERE $l_d = 0.27\left[f_y/\left(\lambda\sqrt{f'_c}\right)\right](A_b/s)$
c. 6 INCHES



WHERE $A_{s,provided}/A_{s,required}$ ≥ 2.0 OVER THE LENGTH OF THE SPLICE, l_{st} MEASURED BETWEEN OUTERMOST CROSS WIRES OF EACH REINFORCEMENT SHEET SHALL BE PERMITTED TO BE THE GREATER OF 1.5 X $\left\{0.27\left[f_y/\left(\lambda\sqrt{f'_c}\right)\right](A_b/s)\right\}$ AND 2”.

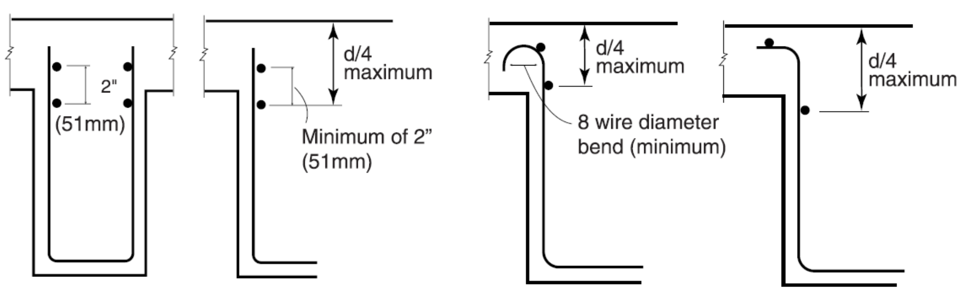
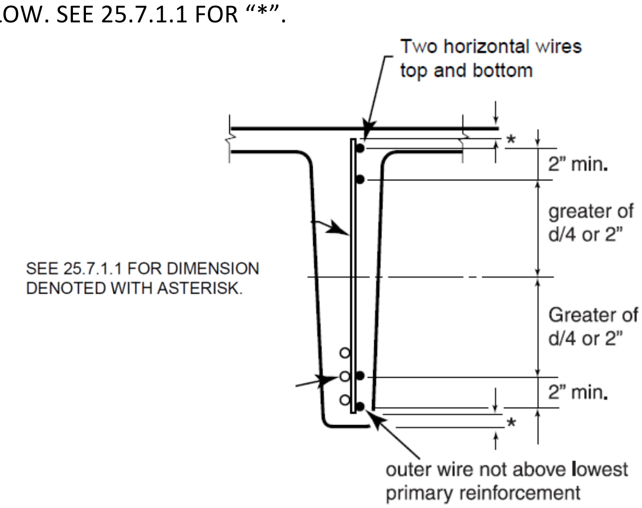


</td><td>25.5.4</td></tr>
</table>

H. WIRE REINFORCEMENT SPACING

PROVISION	ACI 318-14
MAXIMUM SPACING OF DEFORMED REINFORCEMENT IN ONE-WAY SLABS SHALL BE THE LESSER OF 3h AND 18", WHERE h = SLAB THICKNESS. MAXIMUM SPACING OF DEFORMED SHRINKAGE AND TEMPERATURE REINFORCEMENT SHALL BE THE LESSER OF 5h AND 18", WHERE h = SLAB THICKNESS. SPACING OF BONDED REINFORCEMENT IN NONPRESTRESSED AND CLASS-C PRESTRESSED ONE-WAY SLABS AND BEAMS SHALL NOT EXCEED THE LESSER OF: $15\left(\frac{40{,}000}{f_s}\right) - 2.5c_c$ $12\left(\frac{40{,}000}{f_s}\right)$	7.7.2.3 7.7.6.2.1 24.3
MAXIMUM SPACING OF DEFORMED LONGITUDINAL REINFORCEMENT IN NONPRESTRESSED TWO-WAY SOLID SLABS SHALL BE THE LESSER OF 2h AND 18" AT CRITICAL SECTIONS, AND THE LESSER OF 3h AND 18" AT OTHER SECTIONS, WHERE h = SLAB THICKNESS.	8.7.2.2
WALL LONGITUDINAL REINFORCEMENT: MAXIMUM SPACING OF LONGITUDINAL REINFORCEMENT IN CAST-IN-PLACE WALLS SHALL BE THE LESSER OF 3h AND 18", WHERE h = WALL THICKNESS. IF SHEAR REINFORCEMENT IS REQUIRED FOR IN-PLANE STRENGTH, SPACING SHALL NOT EXCEED 1/3 X WALL LENGTH. MAXIMUM SPACING OF LONGITUDINAL REINFORCEMENT IN PRECAST WALLS SHALL BE THE LESSER OF 5h AND 18" (EXTERIOR WALLS) OR 30" (INTERIOR WALLS), WHERE h = WALL THICKNESS. IF SHEAR REINFORCEMENT IS REQUIRED FOR IN-PLANE STRENGTH, SPACING SHALL NOT EXCEED THE SMALLEST OF 1/3 X WALL LENGTH, 18", AND 3h.	11.7.2.1 11.7.2.2
WALL TRANSVERSE REINFORCEMENT: MAXIMUM SPACING OF TRANSVERSE REINFORCEMENT IN CAST-IN-PLACE WALLS SHALL BE THE LESSER OF 3h AND 18", WHERE h = WALL THICKNESS. IF SHEAR REINFORCEMENT IS REQUIRED FOR IN-PLANE STRENGTH, SPACING SHALL NOT EXCEED 1/5 X WALL LENGTH. MAXIMUM SPACING OF TRANSVERSE REINFORCEMENT IN PRECAST WALLS SHALL BE THE LESSER OF 5h AND 18" (EXTERIOR WALLS) OR 30" (INTERIOR WALLS), WHERE h = WALL THICKNESS. IF SHEAR REINFORCEMENT IS REQUIRED FOR IN-PLANE STRENGTH, SPACING SHALL NOT EXCEED THE SMALLEST OF 1/5 X WALL LENGTH, 18", AND 3h.	11.7.3.1 11.7.3.2

<table>
<tr><th colspan="2">I. LATERAL REINFORCEMENT</th></tr>
<tr><th>PROVISION</th><th>ACI 318-14</th></tr>
<tr><td>LATERAL SUPPORT OF COMPRESSION REINFORCEMENT IN BEAMS

TRANSVERSE REINFORCEMENT SHALL BE PROVIDED THROUGHOUT THE DISTANCE WHERE LONGITUDINAL COMPRESSION REINFORCEMENT IS REQUIRED. LATERAL SUPPORT OF LONGITUDINAL COMPRESSION REINFORCEMENT IS PERMITTED TO BE PROVIDED BY DEFORMED WIRE OR WELDED WIRE REINFORCEMENT IN CLOSED STIRRUPS OR HOOP CONFIGURATIONS.</td><td>9.7.6.4</td></tr>
<tr><td>TRANSVERSE STIRRUP REINFORCEMENT IN BEAMS AND JOISTS SHALL EXTEND AS CLOSE TO THE COMPRESSION AND TENSION SURFACES OF THE MEMBER AS COVER AND PROXIMITY TO OTHER REINFORCEMENT PERMITS. STIRRUPS SHALL BE ANCHORED AT BOTH ENDS. WHERE USED AS SHEAR REINFORCEMENT, STIRRUPS SHALL EXTEND A DISTANCE d FROM EXTREME COMPRESSION FIBER.</td><td>25.7.1.1</td></tr>
<tr><td>BETWEEN ANCHORED ENDS, EACH BEND IN THE CONTINUOUS PORTION OF A SINGLE-U OR MULTIPLE-U STIRRUP AND EACH BEND IN A CLOSED STIRRUP SHALL ENCLOSE A LONGITUDINAL BAR OR STRAND.</td><td>25.7.1.2</td></tr>
<tr><td>ANCHORAGE OF <u>DEFORMED WIRE</u> USED AS TRANSVERSE STIRRUP REINFORCEMENT,
SINGLE-U AND MULTIPLE-U CONFIGURATIONS:
• FOR D31 AND SMALLER, STANDARD HOOK AROUND LONGITUDINAL REINFORCEMENT
• IN JOIST CONSTRUCTION, FOR D20 AND SMALLER, A STANDARD HOOK TERMINATION</td><td>25.7.1.3</td></tr>
<tr><td>OPTIONS FOR ANCHORAGE OF EACH LEG OF <u>WELDED WIRE REINFORCEMENT</u> FORMING A SINGLE U-STIRRUP ARE ILLUSTRATED BELOW:

</td><td>25.7.1.4</td></tr>
<tr><td>ANCHORAGE OF EACH END OF A SINGLE LEG STIRRUP OF WELDED WIRE REINFORCEMENT SHALL BE AS ILLUSTRATED BELOW. SEE 25.7.1.1 FOR "*".

</td><td>25.7.1.5</td></tr>
<tr><td>FOR NON-TORSIONAL APPLICATIONS, CLOSED STIRRUPS ARE PERMITTED TO BE MADE USING PAIRS OF U-STIRRUPS SPLICED TO FORM A CLOSED UNIT WHERE LAP LENGTHS ARE AT LEAST 1.3 X DEVELOPMENT LENGTH.</td><td>25.7.1.7</td></tr>
</table>

RELEVANT TERMS USED IN BUILDING CODE REQUIREMENTS FOR REINFORCED CONCRETE (ACI 318)

A_b	=	area of individual wire to be developed or spliced, sq. in. (mm^2)
A_s	=	area of nonprestressed tension reinforcement, sq. in. / 1ft. (mm2 / m)
d	=	distance from extreme compression fiber to centroid of tension reinforcement, in (mm)
d_b	=	nominal diameter of bar, wire, or prestressing strand, in. (mm)
f'c	=	specified compressive strength of concrete, psi. (MPa)
√f'c	=	square root of specified compressive strength of concrete, psi. (MPa)
f_s	=	calculated stress in reinforcement at service loads, psi. (MPa)
f_y	=	specified yield strength of nonprestressed reinforcement, psi. (MPa)
h	=	overall thickness of member, in. (mm)
K_{tr}	=	transverse reinforcement index, see 12.2.3, Chapter 12
l_d	=	development length, in. (mm)
S_w	=	center to center spacing of longitudinal reinforcement
S_t	=	center to center spacing of transverse reinforcement
l	=	lightweight factor
Ψ_t	=	location factor
Ψ_e	=	coating factor
Ψ_s	=	reinforcement size factor

* However, $\Psi_t (\Psi_e) \leq 1.7$

U.S. CUSTOMARY (INCH-POUND) WIRE SIZES AND AREAS
TABLE 6.1 - SECTIONAL AREAS OF WELDED WIRE REINFORCEMENT

Wire Size Number* (area of steel x 100) Plain	Nominal Diameter Inches	Nominal Weight Lbs./Lin. Ft.	Area in Sq. In. Per Ft. Of Width For Various Spacing				
			Center-To-Center Spacing				
			3”	4”	6”	12”	18”
W45	.757	1.530	1.80	1.35	.90	.45	.30
W34	.658	1.160	1.36	1.02	.68	.34	.23
W31	.628	1.054	1.24	.93	.62	.31	.21
W25	.564	.850	1.00	.75	.50	.25	.17
W23	.541	.782	.92	.69	.46	.23	.15
W20	.505	.680	.80	.60	.40	.20	.13
W18	.479	.612	.72	.54	.36	.18	.12
W16	.451	.544	.64	.48	.32	.16	.11
W15	.437	.510	.60	.45	.30	.15	.10
W14	.422	.476	.56	.420	.28	.14	.090
W12	.391	.408	.48	.360	.24	.12	.080
W11	.374	.374	.44	.330	.22	.11	.073
W10.5	.366	.357	.42	.315	.21	.105	.070
W10	.357	.340	.40	.300	.20	.10	.068
W9.5	.348	.323	.38	.285	.19	.095	.063
W9	.338	.306	.36	.270	.18	.090	.060
W8.5	.329	.329	.34	.255	.17	.085	.057
W8	.319	.272	.32	.240	.16	.080	.053
W7.5	.309	.309	.30	.225	.15	.075	.050
W7	.299	.238	.28	.210	.14	.070	.047
W6.5	.288	.221	.26	.195	.13	.065	.043
W6	.276	.204	.24	.180	.12	.060	.040
W5.5	.265	.187	.22	.185	.11	.055	.037
W5	.252	.170	.20	.150	.10	.050	.033
W4.5	.239	.153	.18	.135	.09	.045	
W4	.226	.136	.16	.12	.08	.040	
W3.5	.211	.119	.14	.105	.07	.035	
W3	.195	.102	.12	.09	.06	.030	
W2.9	.192	.098	.116	.087	.058	.029	
W2.5	.178	.085	.100	.075	.050	.025	
W2.1	.162	.070	.084	.063	.042	.021	
W2	.160	.068	.080	.060	.040	.020	
W1.5	.138	.051	.060	.045	.030	.015	
W1.4	.134	.049	.056	.042	.028	.014	

Examples Using Various Minimum Yield Strengths for Economy - Consider:

- Grade 60 wire by style 12X12 - W31/W31 (Standard)
- Grade 75 wire by style 12X12 - W25/W25 (20% savings by weight & steel area)
- Grade 80 wire by style 12X12 - W23/W23 (25% savings by weight & steel area)

Note: The above listing of plain wire sizes represents wires normally selected to manufacture welded wire reinforcement styles to specific areas of reinforcement. Wires may be deformed using prefix D, except where only W is required on building codes (usually less than W4). Wire sizes other than those listed above may be available if the quantity required is sufficient to justify manufacture.

*The number following the prefix W identifies the cross-sectional area of the wire in hundredths of a square inch.

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.

Refer to ACI 318 for The ACI Building Code requirements for tension development lengths and tension lap splices of welded wire reinforcement. For additional information see the Structural Welded Wire Reinforcement Detailing Manual, published by the Wire Reinforcement Institute.

TABLE 6.2M METRIC WIRE AREA, DIAMETERS & MASS WITH EQUIVALENT INCH-POUND UNITS

Metric Units				Inch-pound Units (conversions)				Gage Guide
Size F (MW=Plain) (mm^2)	Area (mm^2)	Diameter (mm)	Mass (kg/m)	Size F (W=Plain) (in^2x100)	Area (in^2)	Diameter (in)	Weight (lb./ft.)	
MW290	290	19.22	2.27	W45	.450	.757	1.53	
MW200	200	15.95	1.57	W31	.310	.628	1.054	
MW130	130	12.9	1.02	W20.2	.202	.507	.687	7/0
MW120	120	12.4	.941	W18.6	.186	.487	.632	6/0
MW100	100	11.3	.784	W15.5	.155	.444	.527	5/0
MW90	90	10.7	.706	W14.0	.140	.422	.476	
MW80	80	10.1	.627	W12.4	.124	.397	.422	4/0
MW70	70	9.4	.549	W10.9	.109	.373	.371	3/0
MW65	65	9.1	.510	W10.1	.101	.359	.343	
MW60	60	8.7	.470	W9.3	.093	.344	.316	2/0
MW55	55	8.4	.431	W8.5	.085	.329	.289	
MW50	50	8.0	.392	W7.8	.078	.314	.263	1/0
MW45	45	7.6	.353	W7.0	.070	.298	.238	1
MW40	40	7.1	.314	W6.2	.062	.283	.214	
MW35	35	6.7	.274	W5.4	.054	.262	.184	2
MW30	30	6.2	.235	W4.7	.047	.245	.160	3
MW26	26	5.7	.204	W4.0	.040	.226	.136	4
MW25	25	5.6	.196	W3.9	.039	.223	.133	
MW20	20	5.0	.157	W3.1	.031	.199	.105	
MW19	19	4.9	.149	W2.9	.029	.192	.098	6
MW15	15	4.4	.118	W2.3	.023	.171	.078	8
MW13	13	4.1	.102	W2.0	.020	.160	.068	
MW10	10	3.6	.078	W1.6	0.16	.143	.054	
MW9	9	3.4	.071	W1.4	.014	.135	.048	10

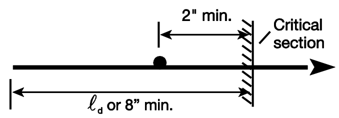
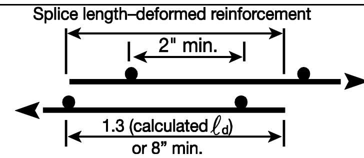
*Metric wire sizes can be specified in 1 mm^2 increments. **Inch-Pound sizes can be specified in .001 in^2 increments. Note G - For other available wire sizes, consult other WRI publications or discuss with WWR manufactures.

Note F - Wires may be deformed, use prefix MD or D, expect where only MW or W is required by building codes (usually less than MW26 or W4).

TABLE 6.3◆ Customary Units (in.-lb.) Welded Deformed Wire Reinforcement

Typical Development and Splice Length, inches

Welded Deformed Wire Reinforcement f_y = 60,000 psi f'_c = 4,000 psi

Wires to be Developed or Spliced			 Splice length when sum of overhang is *:			
Wire Size	S_W, spacing in.	ℓ_d	0"	6"	8"	12"
D4	4	8	8	8	10	14
	6	8	8	8	10	14
	12	8	8	8	10	14
D5	4	8	8	8	10	14
	6	8	8	8	10	14
	12	8	8	8	10	14
D6	4	8	8	8	10	14
	6	8	8	8	10	14
	12	8	8	8	10	14
D7	4	8	8	8	10	14
	6	8	8	8	10	14
	12	8	8	8	10	14
D8	4	8	8	8	10	14
	6	8	8	8	10	14
	12	8	8	8	10	14
D9	4	8	8	8	10	14
	6	8	8	8	10	14
	12	8	8	8	10	14
D10	4	8	8	8	10	14
	6	8	8	8	10	14
	12	8	8	8	10	14
D12	4	8	8	8	10	14
	6	8	8	8	10	14
	12	8	8	8	10	14
D14	4	8	8	8	10	14
	6	8	8	8	10	14
	12	8	8	8	10	14
D16	4	8	8	8	10	14
	6	8	8	8	10	14
	12	8	8	8	10	14
D18	4	8	9	9	10	14
	6	8	8	8	10	14
	12	8	8	8	10	14
D20	4	8	10	10	10	14
	6	8	8	8	10	14
	12	8	8	8	10	14
D31	4	12	15	15	15	15
	6	8	10	10	10	14
	12	8	8	8	10	14
D45**	4	17	44	50	52	56
	6	11	29	35	37	41
	12	8	15	21	23	27

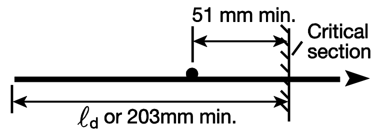
* Splice length determined using calculated l_d.
** D45 Splices considered as Plain(Smooth Wire)

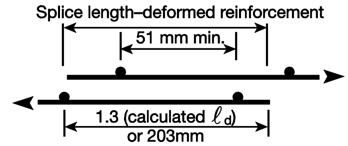
◆ Assumed 3/4" concrete cover.

TABLE 6.4M◆ Metric Units (mm) Welded Deformed Wire Reinforcement

Typical Development and Splice Length, millimeters f_y = 414 MPa f'_c = 28 MPa

WIRES TO BE DEVELOPED OR SPLICED





Wire Size	S_w, spacing in.	ℓ_d	Splice length when sum of overhang is *: 0 mm	152 mm	203 mm	305 mm
MD 26	102	203	203	203	254	356
	152	203	203	203	254	356
	305	203	203	203	254	356
MD 32	102	203	203	203	254	356
	152	203	203	203	254	356
	305	203	203	203	254	356
MD 39	102	203	203	203	254	356
	152	203	203	203	254	356
	305	203	203	203	254	356
MD 45	102	203	203	203	254	356
	152	203	203	203	254	356
	305	203	203	203	254	356
MD 52	102	203	203	203	254	356
	152	203	203	203	254	356
	305	203	203	203	254	356
MD 58	102	203	203	203	254	356
	152	203	203	203	254	356
	305	203	203	203	254	356
MD 65	102	203	203	203	254	356
	152	203	203	203	254	356
	305	203	203	203	254	356
MD 77	102	203	203	203	254	356
	152	203	203	203	254	356
	305	203	203	203	254	356
MD 90	102	203	203	203	254	356
	152	203	203	203	254	356
	305	203	203	203	254	356
MD 103	102	203	203	203	254	356
	152	203	203	203	254	356
	305	203	203	203	254	356
MD 116	102	203	229	229	254	356
	152	203	203	203	254	356
	305	203	203	203	254	356
MD 130	102	203	254	254	254	356
	152	203	203	203	254	356
	305	203	203	203	254	356
MD 200	102	305	381	381	381	381
	152	203	254	254	254	356
	305	203	203	203	254	356
MD 290	102	432	1118	1270	1321	1422
	152	279	737	889	940	1041
	305	203	381	533	584	686

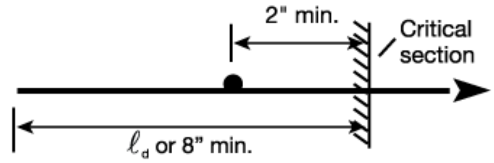
* Splice length determined using calculated l_d.

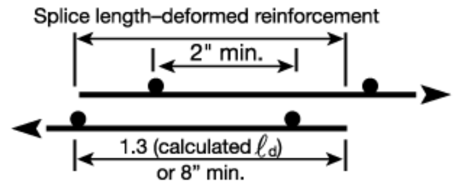
** MD290 Splices considered as Plain (Smooth Wire)

◆ Assumed 20 mm concrete cover.

TABLE 6.5 Customary Units (in.) Welded Plain Wire Reinforcement

Typical Development and Splice Lengths, inches f_y = 60,000 psi f'_c = 4,000 psi





WIRES TO BE DEVELOPED OR SPLICED		Development length when cross-wire spacing is:				Splice length when cross-wire spacing is:			
Wire Size	**Sw, spacing in.**	**4”**	**6”**	**8”**	**12”**	**4”**	**6”**	**8”**	**12”**
W1.4 to W5	4	6	8	10	14	6	8	10	14
	6	6	8	10	14	6	8	10	14
	12	6	8	10	14	6	8	10	14
W6	4	6	8	10	14	6	8	10	14
	6	6	8	10	14	6	8	10	14
	12	6	8	10	14	6	8	10	14
W7	4	6	8	10	14	7	8	10	14
	6	6	8	10	14	6	8	10	14
	12	6	8	10	14	6	8	10	14
W8	4	6	8	10	14	8	8	10	14
	6	6	8	10	14	6	8	10	14
	12	6	8	10	14	6	8	10	14
W9	4	6	8	10	14	9	10	10	14
	6	6	8	10	14	6	8	10	14
	12	6	8	10	14	6	8	10	14
W10	4	7	8	10	14	10	10	10	14
	6	6	8	10	14	7	8	10	14
	12	6	8	10	14	6	8	10	14
W12	4	8	8	10	14	12	12	12	14
	6	6	8	10	14	8	8	10	14
	12	6	8	10	14	6	8	10	14
W14	4	9	9	10	14	14	14	14	14
	6	6	8	10	14	9	9	10	14
	12	6	8	10	14	6	8	10	14
W16	4	11	11	11	14	16	16	16	16
	6	7	8	10	14	11	11	11	14
	12	6	8	10	14	6	8	10	14
W18	4	12	12	12	14	18	18	18	18
	6	8	8	10	14	12	12	12	14
	12	6	8	10	14	6	8	10	14
W20	4	13	13	13	14	20	20	20	20
	6	9	9	10	14	13	13	13	14
	12	6	8	10	14	8	8	10	14
W31	4	20	20	20	20	30	30	30	30
	6	14	14	14	14	20	20	20	20
	12	7	8	10	14	10	10	10	14
W45	4	29	29	29	29	44	44	44	44
	6	19	19	19	19	29	29	29	29
	12	10	10	10	10	15	15	15	15

TABLE 6.6M Metric Units (mm) Welded Plain Wire Reinforcement

Typical Development and Splice Lengths (millimeters) **f_y = 414 MPa f1c = 28 MPa**

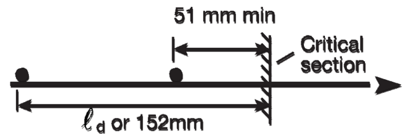
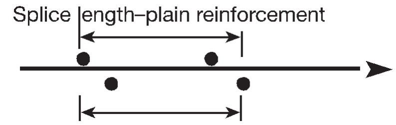
WIRES TO BE DEVELOPED OR SPLICED		 Development length when cross-wire spacing is:				 Splice length when cross-wire spacing is:			
Wire Size	**mm**	**102mm**	**152mm**	**203mm**	**305mm**	**102mm**	**152mm**	**203mm**	**305mm**
MW9	102	152	203	254	356	152	203	254	356
to	152	152	203	254	356	152	203	254	356
MW32	305	152	203	254	356	152	203	254	356
MW39	102	152	203	254	356	152	203	254	356
	152	152	203	254	356	152	203	254	356
	305	152	203	254	356	152	203	254	356
MW45	102	152	203	254	356	178	203	254	356
	152	152	203	254	356	152	203	254	356
	305	152	203	254	356	152	203	254	356
MW52	102	152	203	254	356	203	203	254	356
	152	152	203	254	356	152	203	254	356
	305	152	203	254	356	152	203	254	356
MW58	102	152	203	254	356	229	254	254	356
	152	152	203	254	356	152	203	254	356
	305	152	203	254	356	152	203	254	356
MW65	102	178	203	254	356	254	254	254	356
	152	152	203	254	356	178	203	254	356
	305	152	203	254	356	152	203	254	356
MW77	102	203	203	254	356	305	305	305	356
	152	152	203	254	356	203	203	254	356
	305	152	203	254	356	152	203	254	356
MW90	102	229	229	254	356	356	356	356	356
	152	152	203	254	356	229	229	254	356
	305	152	203	254	356	152	203	254	356
MW103	102	279	279	279	356	406	406	406	406
	152	178	203	254	356	279	279	279	356
	305	152	203	254	356	152	203	254	356
MW116	102	305	305	305	356	457	457	457	457
	152	203	203	254	356	305	305	305	356
	305	152	203	254	356	152	203	254	356
MW130	102	330	330	330	356	508	508	508	508
	152	229	229	254	356	330	330	330	356
	305	152	203	254	356	203	203	254	356
MW200	102	584	584	584	584	864	864	864	864
	152	381	381	381	381	584	584	584	584
	305	203	203	254	356	305	305	305	305
MW290	102	838	838	838	838	1270	1270	1270	1270
	152	559	559	559	559	838	838	838	838
	305	279	279	279	356	432	432	432	432

TABLE 6.7 Wire Size Comparison (When customary units are specified)

W & D Wire Size* Plain*	W & D Metric Wire Size (Conversion) Plain**	CUSTOMARY UNITS			METRIC UNITS (conversions)		
		Area (sq. in.)	Diameter (in.)	Nominal Weight (lb./ft.)	Nominal Area (mm^2)	Nominal Diameter (mm)	Nominal Mass (kg/m)
W45	MW 290	.45	.757	1.530	290	19.23	2.28
W31	MW 200	.31	.628	1.054	200	15.96	1.57
W20	MW 130	.200	.505	.680	129	12.8	1.01
	MW 122	.189	.490	.643	122	12.4	0.96
W18	MW 116	.180	.479	.612	116	12.2	0.91
	MW 108	.168	.462	.571	108	11.7	0.85
W16	MW 103	.160	.451	.544	103	11.5	0.81
	MW 94	.146	.431	.495	94	10.9	0.74
W14	MW 90	.140	.422	.476	90	10.7	0.71
	MW 79	.122	.394	.414	79	10.0	0.62
W12	MW 77	.120	.391	.408	77	9.9	0.61
W11	MW 71	.110	.374	.374	71	9.5	0.56
W10.5	MW 68	.105	.366	.357	68	9.3	0.53
	MW 67	.103	.363	.351	67	9.2	0.52
W10	MW 65	.100	.357	.340	65	9.1	0.51
W9.5	MW 61	.095	.348	.323	61	8.8	0.48
W9	MW 58	.090	.338	.306	58	8.6	0.45
	MW 56	.086	.331	.292	55.5	8.4	0.43
W8.5	MW 55	.085	.329	.289	54.9	8.4	0.43
W8	MW 52	.080	.319	.272	52	8.1	0.40
W7.5	MW 48	.075	.309	.255	48.4	7.8	0.38
W7	MW 45	.070	.299	.238	45	7.6	0.35
W6.5	MW 42	.065	.288	.221	42	7.3	0.33
	MW 41	.063	.283	.214	41	7.2	0.32
W6	MW 39	.060	.276	.204	39	7.0	0.30
W5.5	MW 36	.055	.265	.187	35.5	6.7	0.28
	MW 35	.054	.263	.184	34.8	6.7	0.27
W5	MW 32	.050	.252	.170	32	6.4	0.25
	MW 30	.047	.244	.158	30	6.2	0.24
	MW 29	.045	.239	.153	29	6.1	0.23
W4	MW 26	.040	.226	.136	26	5.7	0.20
W3.5	MW 23	.035	.211	.119	23	5.4	0.18
W2.9	MW 19	.029	.192	.098	19	4.9	0.15
W2.0	MW 13	.020	.160	.068	13	4.1	0.10
W1.4	MW 9	.014	.135	.048	9	3.4	0.07

* For deformed wire, change W to D.
** For deformed wire (metric) change MW to MD.

TABLE 6.8M Wire Size Comparison (When Metric Units are specified)

Metric Units				Inch-pound Units (conversions)				Gage Guide
Size * (MW=Plain) (mm^2)	Area (mm^2)	Diameter (mm)	Mass (kg/m)	Nominal Size * (W=Plain) (in^2x100)	Area (in^2)	Diameter (in)	Weight (lb./ft.)	
MW290	290	19.23	2.28	W45	.450	.757	1.53	
MW200	200	15.96	1.57	W31	.310	.628	1.054	
MW130	130	12.9	1.02	W20.2	.202	.507	.687	7/0
MW120	120	12.4	.941	W18.6	.186	.487	.632	6/0
MW100	100	11.3	.784	W15.5	.155	.444	.527	5/0
MW90	90	10.7	.706	W14.0	.140	.422	.476	
MW80	80	10.1	.627	W12.4	.124	.397	.422	4/0
MW70	70	9.4	.549	W10.9	.109	.373	.371	3/0
MW65	65	9.1	.510	W10.1	.101	.359	.343	
MW60	60	8.7	.470	W9.3	.093	.344	.316	2/0
MW55	55	8.4	.431	W8.5	.085	.329	.289	
MW50	50	8.0	.392	W7.8	.078	.314	.263	1/0
MW45	45	7.6	.353	W7.0	.070	.298	.238	1
MW40	40	7.1	.314	W6.2	.062	.283	.214	
MW35	35	6.7	.274	W5.4	.054	.262	.184	2
MW30	30	6.2	.235	W4.7	.047	.245	.160	3
MW26	26	5.7	.204	W4.0	.040	.226	.136	4
MW25	25	5.6	.196	W3.9	.039	.223	.133	
MW20	20	5.0	.157	W3.1	.031	.199	.105	
MW19	19	4.9	.149	W2.9	.029	.192	.098	6
MW15	15	4.4	.118	W2.3	.023	.171	.078	8
MW13	13	4.1	.102	W2.0	.020	.160	.068	
MW10	10	3.6	.078	W1.6	0.16	.143	.054	
MW9	9	3.4	.071	W1.4	.014	.135	.048	10

Note * Wires may be deformed, use prefix MD or D, except where only MW or W is required by building codes (usually less than MW26 or W4). For other available wire sizes, consult other WRI publications or discuss with WWR manufacturers.

LRFD BRIDGE DESIGN SPECIFICATION REQUIREMENTS (AASHTO)

The tabulated information shown below is intended to serve as a supplemental technical cross-reference for design and construction professionals. Information is compiled in such a manner so as to highlight content that is pertinent to welded wire reinforcement as currently presented in the *2012 AASHTO LRFD Bridge Design Specification, Sixth Edition*.

Note that in most cases, only excerpts from the AASHTO reference standard are shown. This format is intended to encourage the reader's direct use of the reference standard itself. Decisions impacting design and construction must be based on the full text of the *2012 AASHTO LRFD Bridge Design Specification, Sixth Edition.*

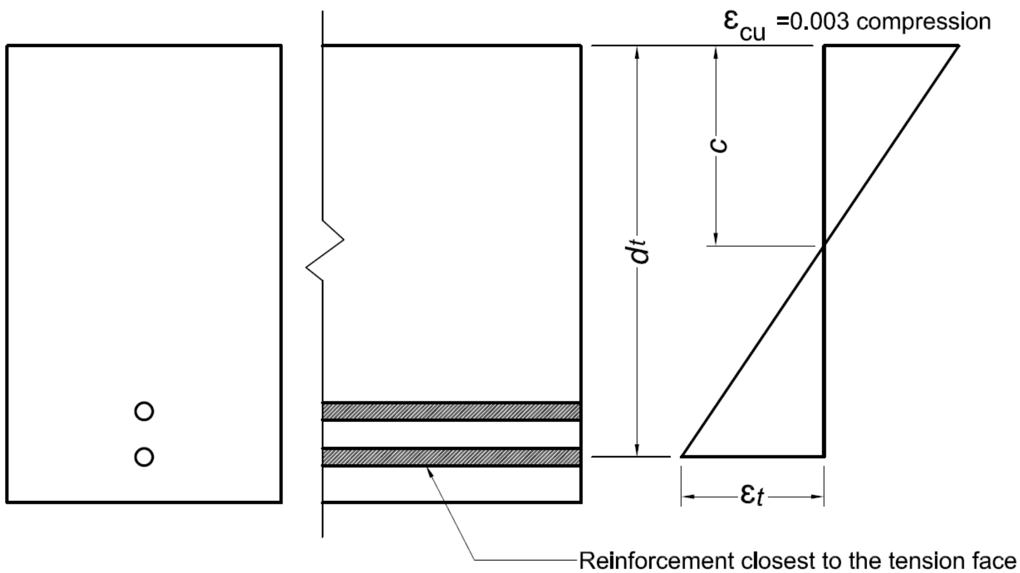
The AASHTO Specification uses the term "fabric" interchangeably with "reinforcement" when describing welded wire reinforcement, deformed or plain.

A. MATERIAL SPECIFICATION AND USAGE

PROVISION	AASHTO
FOR CONCRETE BRIDGE AND RETAINING WALL STRUCTURES IN ACCORDANCE WITH SECTION 5, WELDED WIRE REINFORCEMENT IS PERMITTED FOR USE.	5.1
SPECIFIC REFERENCE TO YIELD STRENGTH MEASUREMENT IS NOT FOUND IN THE BODY OF *AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS.* INSTEAD, VIA REFERENCE IN THE *AASHTO LRFD BRIDGE CONSTRUCTION SPECIFICATIONS*, THE AASHTO M 225 STANDARD SPECIFICATION DICTATES YIELD STRENGTH MEASUREMENT AT AN EXTENSION OF 0.5 PERCENT OF GAUGE LENGTH. YIELD STRENGTH FOR "HIGH-STRENGTH WIRE" IS DETERMINED AT AN EXTENSION UNDER LOAD OF 0.35 PERCENT.	**
DEFORMED WIRE AND WELDED WIRE SHALL CONFORM TO AASHTO M 225 AND M 221 STANDARD SPECIFICATIONS, RESPECTIVELY. PLAIN WIRE AND WELDED WIRE SHALL CONFORM TO AASHTO M 32 AND M55 STANDARD SPECIFICATIONS, RESPECTIVELY. [NOTE THAT, AT THE TIME OF PUBLICATION OF THIS DOCUMENT, THE AFOREMENTIONED AASHTO STANDARD SPECIFICATIONS STILL CITE WITHDRAWN ASTM STANDARDS A496, A497, A82, AND A185 AS PARALLEL REFERENCES, AND MAKE NO REFERENCE TO THE ASTM A1064 SPECIFICATION THAT REPLACES THEM.]	**
DEFORMED WIRE, COLD-DRAWN WIRE, WELDED PLAIN WIRE FABRIC, AND WELDED DEFORMED WIRE FABRIC ARE PERMITTED FOR USE AS REINFORCING STEEL. YIELD STRENGTHS IN EXCESS OF 75 KSI SHALL NOT BE USED FOR DESIGN PURPOSES.	5.4.3.1
THE DESIGN YIELD STRENGTH OF NONPRESTRESSED TRANSVERSE REINFORCEMENT SHALL BE TAKEN EQUAL TO THE SPECIFIED YIELD STRENGTH WHEN THE LATTER DOES NOT EXCEED 60.0 KSI. FOR NONPRESTRESSED REINFORCEMENT WITH YIELD STRENGTH IN EXCESS OF 60 KSI, THE DESIGN YIELD STRENGTH SHALL BE TAKEN AS THE STRESS CORRESPONDING TO A STRAIN OF 0.0035, BUT NOT TO EXCEED 75.0 KSI.	5.8.2.8
INSIDE DIAMETER OF BEND IN WELDED WIRE REINFORCEMENT FOR STIRRUPS AND TIES SHALL NOT BE LESS THAN $4d_b$ FOR DEFORMED WIRE LARGER THAN D6 AND $2d_b$ FOR ALL OTHER WIRES. BENDS WITH INSIDE DIAMETER OF LESS THAN $8d_b$ SHALL NOT BE LESS THAN $4d_b$ FROM NEAREST WELDED INTERSECTION	5.10.2.3
FOR BURIED STRUCTURES, REINFORCEMENT SHALL COMPLY WITH 5.4.3. FOR PLAIN WIRE AND PLAIN WELDED WIRE FABRIC, YIELD STRENGTH MAY BE TAKEN AS 65 KSI. FOR DEFORMED WELDED WIRE FABRIC, THE YIELD STRENGTH MAY BE TAKEN AS 70.0 KSI.	12.4.2.7

B. DESIGN ASSUMPTIONS – FLEXURE AND AXIAL LOADS

PROVISION	AASHTO
FACTORED RESISTANCE OF CONCRETE COMPONENTS SHALL BE BASED ON THE CONDITIONS OF EQUILIBRIUM AND STRAIN COMPATIBILITY, RESISTANCE FACTORS, AND THE PROVISIONS IN THIS SECTION.	5.7.2.1
IN COMPONENTS WITH FULLY BONDED REINFORCEMENT, STRAIN IS DIRECTLY PROPORTIONAL TO THE DISTANCE FROM THE NEUTRAL AXIS. MAXIMUM USABLE STRAIN AT THE EXTREME COMPRESSION FIBER OF SUFFICIENTLY-CONFINED CONCRETE IS 0.003. TENSILE STRENGTH OF CONCRETE IS NEGLECTED.	



YIELD STRENGTH f_y MAY REPLACE f_S WHEN, USING f_y IN THE CALCULATION, THE RESULTING RATIO c/d_s DOES NOT EXCEED 0.6. IF c/d_s EXCEEDS 0.6, STRAIN COMPATIBILITY SHALL BE USED TO DETERMINE THE STRESS IN THE MILD STEEL TENSION REINFORCEMENT. $For\ c/d_s \leq 0.6 \rightarrow \varepsilon_s \geq \varepsilon_y:\quad A_s f_s = A_s f_y$ $For\ c/d_s > 0.6 \rightarrow \varepsilon_s < \varepsilon_y:\quad A_s f_s = A_s E_s \varepsilon_s$ d_s = DISTANCE FROM EXTREME COMPRESSION FIBER TO CENTROID OF NONPRESTRESSED TENSILE REINFORCEMENT IN QUESTION (NOT NECESSARILY EQUAL TO d_t)	
THE CONCRETE COMPRESSIVE STRESS-STRAIN DISTRIBUTION IS ASSUMED TO BE RECTANGULAR, PARABOLIC, OR ANY OTHER SHAPE THAT RESULTS IN A PREDICTION OF STRENGTH IN SUBSTANTIAL AGREEMENT WITH TEST RESULTS.	
SECTIONS ARE TENSION-CONTROLLED IF THE NET TENSILE STRAIN IN THE EXTREME TENSION STEEL IS EQUAL TO OR GREATER THAN 0.005 JUST AS THE CONCRETE IN COMPRESSION REACHES ITS ASSUMED STRAIN LIMIT OF 0.003. SECTIONS WITH NET TENSILE STRAIN IN THE EXTREME TENSION STEEL BETWEEN THE COMPRESSION-CONTROLLED STRAIN LIMIT AND 0.005 CONSTITUTE A TRANSITION REGION. SECTIONS ARE COMPRESSION-CONTROLLED WHEN THE NET TENSILE STRAIN IN THE EXTREME TENSION STEEL IS EQUAL TO OR LESS THAN THE COMPRESSION-CONTROLLED STRAIN LIMIT AT THE TIME THE CONCRETE IN COMPRESSION REACHES ITS ASSUMED STRAIN LIMIT OF 0.003.	

C. DESIGN ASSUMPTIONS – SHEAR LOADS

PROVISION	AASHTO
TRANSVERSE REINFORCEMENT TO RESIST SHEAR MAY CONSIST OF WELDED WIRE REINFORCEMENT WITH WIRES PERPENDICULAR TO THE LONGITUDINAL AXIS OF THE MEMBER, PROVIDED THAT THE TRANSVERSE WIRES ARE CERTIFIED TO UNDERGO A MINIMUM ELONGATION OF FOUR PERCENT, MEASURED OVER A GAGE LENGTH OF AT LEAST 4.0 INCHES INCLUDING AT LEAST ONE CROSSWIRE.	5.8.2.6
EXCEPT FOR SLABS, FOOTINGS, AND CULVERTS, TRANSVERSE REINFORCEMENT SHALL BE PROVIDED WHERE: $$V_u > 0.5\varphi\left(V_c + V_p\right)$$	5.8.2.4
NOMINAL SHEAR RESISTANCE, V_n, SHALL BE CALCULATED BY LESSER OF $V_n = V_c + V_s + V_p$ AND $V_n = 0.25f'_c b_v d_v + V_p$ IN WHICH: $$V_c = 0.0316\beta\sqrt{f'_c}b_v d_v$$ $$V_S = \frac{A_v f_y d_v(\cot\theta + \cot\alpha)\sin\alpha}{s}$$ APPLICABLE IF 5.8.3.4.1 SIMPLIFIED PROCEDURE OR 5.8.3.4.2 GENERAL PROCEDURE ARE USED.	5.8.3.3
THE SHEAR STRESS ON THE CONCRETE SHALL BE DETERMINED AS: $$v_u = \frac{\left\|V_u - \varphi V_p\right\|}{\varphi b_v d_v}$$	5.8.2.9

D. MINIMUM REINFORCEMENT AND REINFORCEMENT SPACING REQUIREMENTS

<table>
<tr><th colspan="2">PROVISION</th><th>AASHTO</th></tr>
<tr><td>WHERE TRANSVERSE REINFORCEMENT IS REQUIRED, AREA OF STEEL SHALL SATISFY:
$$A_v = 0.0316\sqrt{f'_c}\frac{b_v s}{f_y}$$</td><td>MAXIMUM SPACING OF TRANSVERSE SHEAR REINFORCEMENT SHALL NOT EXCEED THE MAXIMUM PERMITTED SPACING, s_{max}, DETERMINED AS:
IF $v_u < 0.125f'_c$: $s_{max} = 0.8d_v \leq 24.0\ inches$
IF $v_u \geq 0.125f'_c$: $s_{max} = 0.4d_v \leq 12.0\ inches$</td><td>5.8.2.5
5.8.2.7</td></tr>
<tr><td colspan="2">UNLESS OTHERWISE SPECIFIED, AT ANY SECTION OF A NONCOMPRESSION-CONTROLLED FLEXURAL COMPONENT, THE AMOUNT OF TENSILE REINFORCEMENT SHALL BE ADEQUATE TO DEVELOP A FACTORED FLEXURAL RESISTANCE, M_r, AT LEAST EQUAL TO THE LESSER OF:
$$1.33M_u$$
$$M_{cr} = \gamma_3[(\gamma_1 f_r + \gamma_2 f_{cpe})S_c - M_{dnc}(S_c/S_{nc} - 1)]$$
PRIMARY REINFORCEMENT OF WALLS AND SLABS: UNLESS OTHERWISE NOTED, THE SPACING OF THE REINFORCEMENT SHALL NOT EXCEED 1.5X THE MEMBER THICKNESS AND 18 INCHES.</td><td>5.7.3.3.2
5.10.3.2</td></tr>
<tr><td colspan="2">CONTROL OF CRACKING BY DISTRIBUTION OF REINFORCEMENT FOR ALL CONCRETE COMPONENTS EXCEPT SELECTED DECK SLABS DESIGNED IN ACCORDANCE WITH ARTICLE 9.7.2.
THE SPACING s OF MILD STEEL REINFORCEMENT IN THE LAYER CLOSEST TO THE TENSION FACE SHALL SATISFY THE FOLLOWING:
$$s \leq \frac{700\gamma_e}{\beta_s f_{ss}} - 2d_c$$</td><td>5.7.3.4</td></tr>
<tr><td colspan="2">REINFORCEMENT FOR SHRINKAGE AND TEMPERATURE STRESSES SHALL BE PROVIDED NEAR SURFACES OF CONCRETE EXPOSED TO DAILY TEMPERATURE CHANGES IN STRUCTURAL MASS CONCRETE
THE AREA OF WELDED WIRE FABRIC PER FOOT, ON EACH FACE AND IN EACH DIRECTION, SHALL SATISFY:
$$A_s \geq \frac{1.30bh}{2(b+h)f_y}$$
$$0.11 \leq A_s \leq 0.60$$
• SPACING SHALL NOT EXCEED 3X THE COMPONENT THICKNESS OR 18”.
• SPACING SHALL NOT EXCEED 12 INCHES FOR WALLS AND FOOTINGS GREATER THAN 18 INCHES THICK.
• SPACING SHALL NOT EXCEED 12 INCHES FOR OTHER COMPONENTS GREATER THAN 36 INCHES THICK.
• SPACINGS LISTED APPLY FOR REINFORCEMENT PLACED IN EACH FACE OF COMPONENT THICKER THAN 6 INCHES, AND FOR SINGLE LAYER OF REINFORCEMENT PLACED IN COMPONENT NOT GREATER THAN 6 INCHES THICK.</td><td>5.10.8</td></tr>
<tr><td colspan="2">SPIRALS AND TIES FOR COMPRESSION MEMBERS AND FLEXURAL MEMBER COMPRESSION REINFORCEMENT: CENTER-TO-CENTER SPACING BETWEEN THE WIRES OF THE SPIRAL SHALL NOT EXCEED 6X LONGITUDINAL BAR DIAMETER OR 6 INCHES. SPACING OF TIES ALONG THE LONGITUDINAL AXIS OF THE MEMBER SHALL NOT EXCEED THE LEAST DIMENSION OF THE MEMBER OR 12 INCHES. WHERE TWO OR MORE LONGITUDINAL BARS LARGER THAN #10 ARE BUNDLED TOGETHER, THE SPACING SHALL NOT EXCEED HALF THE LEAST DIMENSION OF THE MEMBER OR 6 INCHES.</td><td>5.10.6.2
5.10.6.3
5.10.7</td></tr>
</table>

E. BOND AND DEVELOPMENT – DEFORMED WIRE REINFORCEMENT AND WELDED DEFORMED WIRE FABRIC

<table>
<tr><th>PROVISION</th><th>AASHTO</th></tr>
<tr><td>THE TENSION DEVELOPMENT LENGTH, l_d, SHALL NOT BE LESS THAN THE PRODUCT OF THE BASIC TENSION DEVELOPMENT LENGTH, l_{db}, AND THE MODIFICATION FACTORS SPECIFIED IN ARTICLES 5.11.2.1.2 AND 5.11.2.1.3.

FOR <u>DEFORMED WIRE</u>, THE BASIC TENSION DEVELOPMENT LENGTH, l_{db}, IN INCHES SHALL BE TAKEN AS:

$$\frac{0.95 d_b f_y}{\sqrt{f'_c}}$$

ARTICLE 5.11.2.1.2 OUTLINES MODIFICATION FACTORS WHICH INCREASE l_d.
ARTICLE 5.11.2.1.3 OUTLINES MODIFICATION FACTORS WHICH DECREASE l_d.

THE TENSION DEVELOPMENT LENGTH, l_d, SHALL NOT BE LESS THAN 12.0 INCHES, EXCEPT FOR LAP SPLICES SPECIFIED IN ARTICLE 5.11.5.3.1 AND DEVELOPMENT OF SHEAR REINFORCEMENT SPECIFIED IN ARTICLE 5.11.2.6.</td><td>5.11.2.1.1
5.11.2.1.2
5.11.2.1.3</td></tr>
<tr><td>FOR <u>WELDED DEFORMED WIRE FABRIC</u> APPLICATIONS OTHER THAN SHEAR REINFORCEMENT, THE DEVELOPMENT LENGTH, l_{hd}, IN INCHES, MEASURED FROM THE POINT OF CRITICAL SECTION TO THE END OF WIRE, SHALL NOT BE LESS THAN EITHER (A) OR (B):

A. THE PRODUCT OF BASIC TENSION DEVELOPMENT LENGTH ($l_{basic\ without\ CW}\ or\ l_{basic\ with\ CW}$) AND APPLICABLE ARTICLE 5.11.2.2.2 MODIFICATION FACTORS. BASIC TENSION DEVELOPMENT LENGTHS CALCULATED AS FOLLOWS:

→ $l_{basic\ with\ CW}$ = BASIC TENSION DEVELOPMENT LENGTH FOR WELDED DEFORMED WIRE FABRIC WITH NOT LESS THAN ONE CROSS WIRE WITHIN THE DEVELOPMENT LENGTH AT LEAST 2.0 INCHES FROM THE POINT OF CRITICAL SECTION, SHALL SATISFY:

$$\leq 0.95 d_b \frac{f_y - 20.0}{\sqrt{f'_c}}$$
or
$$\leq 6.30\ \frac{A_w f_y}{s_w \sqrt{f'_c}}$$

→ $l_{basic\ without\ CW}$ = BASIC TENSION DEVELOPMENT LENGTH FOR WELDED DEFORMED WIRE FABRIC WITH NO CROSS WIRES WITHIN THE DEVELOPMENT LENGTH; SHALL BE DETERMINED IN ACCORDANCE WITH ARTICLE 5.11.2.1.1

B. 8.0 INCHES, EXCEPT FOR LAP SPLICES, AS SPECIFIED IN 5.11.6.1.</td><td>5.11.2.5.1</td></tr>
</table>

F. BOND AND DEVELOPMENT – WELDED PLAIN WIRE FABRIC

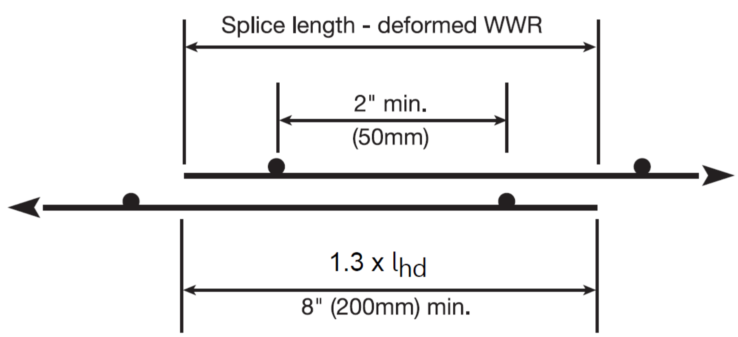
PROVISION	AASHTO
THE YIELD STRENGTH OF WELDED PLAIN WIRE FABRIC SHALL BE CONSIDERED DEVELOPED BY EMBEDMENT OF TWO CROSS WIRES WITH THE CLOSER WIRE NOT LESS THAN 2.0 INCHES FROM THE POINT OF CRITICAL SECTION. OTHERWISE, THE DEVELOPMENT LENGTH, l_d, MEASURED FROM THE POINT OF CRITICAL SECTION TO OUTERMOST CROSS WIRE SHALL BE TAKEN AS: $$8.50\frac{A_w f_y}{s_w\sqrt{f'_c}}$$ THE DEVELOPMENT LENGTH SHALL BE MODIFIED FOR REINFORCEMENT IN EXCESS OF THAT REQUIRED BY ANALYSIS AS SPECIFIED IN ARTICLE 5.11.2.4.2, AND BY THE FACTOR FOR LIGHTWEIGHT CONCRETE SPECIFIED IN ARTICLE 5.11.2.1.2, WHERE APPLICABLE. DEVELOPMENT LENGTH, l_d, SHALL NOT BE TAKEN LESS THAN 6.0 INCHES, EXCEPT FOR LAP SPLICES AS SPECIFIED IN ARTICLE 5.11.6.2.	5.11.2.5.2

G. SPLICES - DEFORMED WIRE AND WELDED DEFORMED WIRE FABRIC IN TENSION

PROVISION	AASHTO
FOR DEFORMED WIRE, THE LENGTH OF LAP FOR TENSION LAP SPLICES SHALL NOT BE LESS THAN EITHER 12.0 INCHES OR THE FOLLOWING FOR CLASS A, B, OR C SPLICES: CLASS A SPLICE = 1.0 X l_d CLASS B SPLICE = 1.3 X l_d CLASS C SPLICE = 1.7 X l_d THE TENSION DEVELOPMENT LENGTH, l_d, FOR THE SPECIFIED YIELD STRENGTH SHALL BE TAKEN IN ACCORDANCE WITH ARTICLE 5.11.2. THE CLASS OF LAP SPLICE REQUIRED FOR DEFORMED WIRES IN TENSION SHALL BE AS SHOWN IN TABLE BELOW.	5.11.5.3.1

Ratio of $A_{s,provided}/A_{s,required}$ Provided over splice length	Percent of A_s spliced within required lap length		
	50	75	100
≥ 2.0	A	A	B
< 2.0	B	C	C

PROVISION	AASHTO
WHEN MEASURED BETWEEN THE ENDS OF EACH FABRIC SHEET, THE LENGTH OF LAP FOR LAP SPLICES OF WELDED DEFORMED WIRE FABRIC WITH CROSS WIRES WITHIN THE LAP LENGTH SHALL NO BE LESS THAN 1.3l_{hd} OR 8.0 INCHES. THE OVERLAP MEASURED BETWEEN THE OUTERMOST CROSS WIRES OF EACH FABRIC SHEET SHALL NOT BE LESS THAN 2.0 INCHES.	5.11.6.1



LAP SPLICES OF WELDED DEFORMED WIRE FABRIC WITH NO CROSS WIRES WITHIN THE LAP SPLICE LENGTH SHALL BE DETERMINED AS FOR DEFORMED WIRE IN ACCORDANCE WITH THE PROVISIONS OF ARTICLE 5.11.5.3.1.

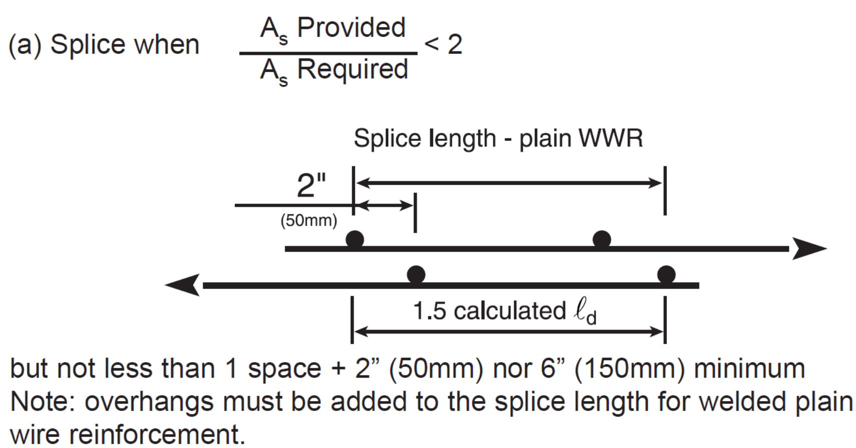
H. SPLICES – WELDED SMOOTH (PLAIN) WIRE FABRIC IN TENSION

PROVISION	AASHTO
FOR WELDED PLAIN WIRE FABRIC, WHERE THE AREA OF REINFORCEMENT PROVIDED IS LESS THAN TWICE THAT REQUIRED AT THE SPLICE LOCATION, THE LENGTH OF OVERLAP MEASURED BETWEEN THE OUTERMOST CROSS WIRES OF EACH FABRIC SHEET SHALL NOT BE LESS THAN:	5.11.6.2

d. CROSS WIRE SPACING + 2”

e. 1.5 X l_d, WHERE l_d IS DEVELOPMENT LENGTH PER ARTICLE 5.11.2.5.2

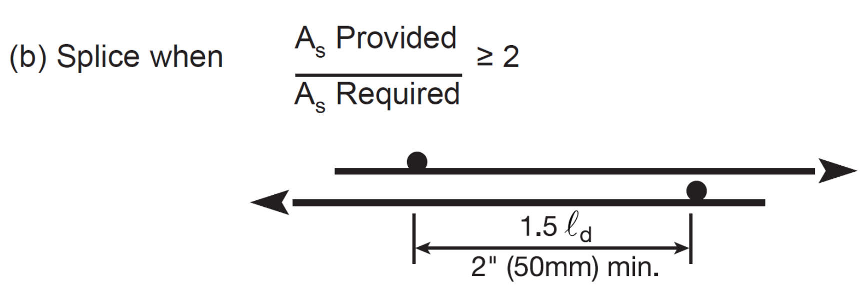
f. 6.0 INCHES



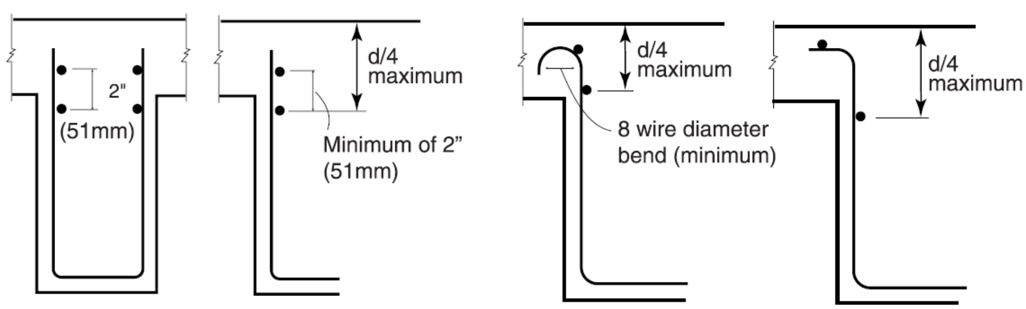
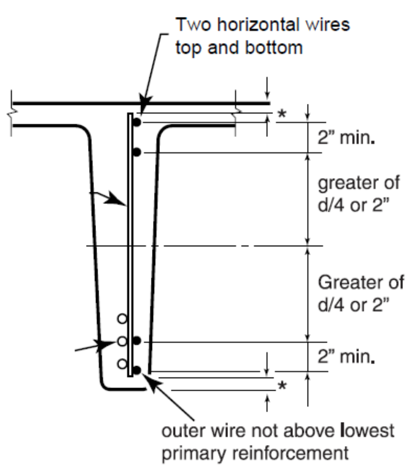
WHERE THE AREA OF REINFORCEMENT PROVIDED IS AT LEAST TWICE THAT REQUIRED AT THE SPLICE LOCATION, THE LENGTH OF OVERLAP MEASURED BETWEEN THE OUTERMOST CROSS WIRES OF EACH FABRIC SHEET SHALL NOT BE LESS THAN:

a. 1.5 X l_d, WHERE l_d IS DEVELOPMENT LENGTH PER ARTICLE 5.11.2.5.2

b. 2.0 INCHES



I. SHEAR REINFORCEMENT

PROVISION	AASHTO
SHEAR REINFORCEMENT SHALL BE LOCATED AS CLOSE TO THE SURFACES OF MEMBERS AS COVER REQUIREMENTS AND PROXIMITY OF OTHER REINFORCEMENT PERMIT. STIRRUPS SHALL BE ANCHORED AT BOTH ENDS. WHERE USED AS SHEAR REINFORCEMENT, STIRRUPS SHALL EXTEND A DISTANCE *d* FROM EXTREME COMPRESSION FIBER. BETWEEN ANCHORED ENDS, EACH BEND IN THE CONTINUOUS PORTION OF A SIMPLE U-STIRRUP OR MULTIPLE U-STIRRUP SHALL ENCLOSE A LONGITUDINAL BAR OR STRAND.	5.11.2.6.1
FOR DEFORMED WIRE OF SIZE D31 AND SMALLER, USED AS SHEAR REINFORCEMENT, THE ENDS OF SINGLE-LEG, SIMPLE U-, OR MULTIPLE U-STIRRUPS SHALL BE ANCHORED BY A STANDARD HOOK AROUND LONGITUDINAL REINFORCEMENT.	5.11.2.6.2
OPTIONS FOR ANCHORAGE OF EACH LEG OF WELDED WIRE FABRIC FORMING A SINGLE U-STIRRUP ARE ILLUSTRATED BELOW: 	5.11.2.6.3
ANCHORAGE OF EACH END OF A SINGLE LEG STIRRUP OF WELDED WIRE FABRIC SHALL BE AS ILLUSTRATED BELOW. ASTERISK INDICATES OVERHANG DIMENSION TO BE CONFIGURED SO AS TO MAINTAIN SPECIFIED CONCRETE COVER DIMENSION. 	5.11.2.6.3
FOR NON-TORSION APPLICATIONS, PAIRS OF U-STIRRUPS OR TIES THAT ARE PLACED TO FORM A CLOSED UNIT SHALL BE CONSIDERED PROPERLY ANCHORED AND SPLICED WHEN LENGTHS OF LAPS ARE NOT LESS THAN 1.7 X DEVELOPMENT LENGTH, WHERE DEVELOPMENT LENGTH IS CALCULATED PER APPROPRIATE 5.11.2 SUB-ARTICLE. IN MEMBERS NOT LESS THAN 18.0 INCHES DEEP, CLOSED STIRRUP SPLICES WITH THE TENSION FORCE RESULTING FROM FACTORED LOADS, $A_b f_y$, NOT EXCEEDING 9.0 KIPS PER LEG, MAY BE CONSIDERED ADEQUATE IF THE STIRRUP LEGS EXTEND THE FULL AVAILABLE DEPTH OF THE MEMBER.	5.11.2.6.4

J. SPECIFIC PROVISIONS FOR STRUCTURE OR COMPONENT

<table>
<tr><th>PROVISION</th><th>AASHTO</th></tr>
<tr><td>STIRRUP REINFORCEMENT IN CONCRETE PIPE SHALL SATISFY THE PROVISIONS OF ARTICLE 12.10.4.2.7 AND SHALL NOT BE REQUIRED TO SATISFY THE PROVISIONS OF ARTICLE 5.11.2.6.1.</td><td>5.11.2.6.1</td></tr>
<tr><td>FOR EMPIRICALLY DESIGNED CONCRETE DECK SLABS, FOUR LAYERS OF ISOTROPIC REINFORCEMENT SHALL BE LOCATED AS CLOSE TO THE OUTSIDE SURFACES AS PERMITTED BY COVER REQUIREMENTS. THE MINIMUM AMOUNT OF REINFORCEMENT SHALL BE 0.27 IN^2/FOOT FOR EACH BOTTOM LAYER AND 0.18 IN^2/FOOT FOR EACH TOP LAYER. SPACING OF STEEL SHALL NOT EXCEED 18.0 INCHES. REINFORCING STEEL SHALL BE GRADE 60 OR BETTER.</td><td>9.7.2.5</td></tr>
<tr><td>THE DIRECT DESIGN METHOD FOR REINFORCED CONCRETE PIPE IS CARRIED OUT AT THE STRENGTH LIMIT STATE. STRUCTURE SPECIFIC REQUIREMENTS ARE OUTLINED IS AASHTO AS FOLLOWS:

a. FLEXURAL RESISTANCE AT THE STRENGTH LIMIT STATE (12.10.4.2.4)
b. MINIMUM FLEXURAL (CIRCUMFERENTIAL) REINFORCEMENT WITH STIRRUPS (12.10.4.2.4b)
c. MINIMUM FLEXURAL (CIRCUMFERENTIAL) REINFORCEMENT WITHOUT STIRRUPS (12.10.4.2.4c)
d. REINFORCEMENT FOR CRACK WIDTH CONTROL (12.10.4.2.4d)
e. MINIMUM CONCRETE COVER (12.10.4.2.4e)
f. SHEAR RESISTANCE WITHOUT STIRRUPS (12.10.4.2.5)
g. SHEAR RESISTANCE WITH RADIAL STIRRUPS (12.10.4.2.6)</td><td>12.10.4.2</td></tr>
<tr><td>THE INDIRECT DESIGN METHOD FOR REINFORCED CONCRETE PIPE IS CARRIED OUT AT THE SERVICE LIMIT STATE. STRUCTURE SPECIFIC REQUIREMENTS ARE OUTLINED IN AASHTO AS FOLLOWS:

a. D-LOADS DETERMINED FOR A PARTICULAR CLASS AND SIZE OF PIPE PER AASHTO M242 (12.10.4.3.1)
b. BEDDING FACTORS (12.10.4.3.2)</td><td>12.10.4.3</td></tr>
<tr><td>DEVELOPMENT OF QUADRANT MAT REINFORCEMENT FOR REINFORCED CONCRETE PIPE</td><td>12.10.4.4</td></tr>
<tr><td>FOR CAST-IN-PLACE BOX AND ARCH STRUCTURES, REINFORCEMENT SHALL NOT BE LESS THAN THAT SPECIFIED IN ARTICLE 5.7.3.3.2 AT ALL CROSS-SECTIONS SUBJECT TO FLEXURAL TENSION, INCLUDING THE INSIDE FACE OF WALLS.

TEMPERATURE AND SHRINKAGE REINFORCEMENT SHALL BE PROVIDED NEAR THE INSIDE SURFACES OF WALLS AND SLABS IN ACCORDANCE WITH ARTICLE 5.10.8.</td><td>12.11.4.3.1</td></tr>
<tr><td>FOR PRECAST BOX STRUCTURES, AT ALL CROSS-SECTIONS SUBJECTED TO FLEXURAL TENSION, THE RATIO OF PRIMARY FLEXURAL REINFORCEMENT IN THE DIRECTION OF THE SPAN TO GROSS CONCRETE AREA SHALL BE NOT LESS THAN 0.002. SUCH MINIMUM REINFORCEMENT SHALL BE PROVIDED AT THE INSIDE FACES OF WALLS AND IN EACH DIRECTION AT THE TOP OF SLABS OF BOX SECTIONS HAVING LESS THAN 2.0 FEET OF COVER.

THE PROVISIONS OF ARTICLE 5.10.8 SHALL NOT APPLY TO PRECAST CONCRETE BOX SECTIONS FABRICATED IN LENGTHS NOT EXCEEDING 16.0 FEET. WHERE THE FABRICATED LENGTH EXCEEDS 16.0 FEET, THE MINIMUM LONGITUDINAL REINFORCEMENT FOR SHRINKAGE AND TEMPERATURE SHOULD BE IN CONFORMANCE WITH ARTICLE 5.10.8.</td><td>12.11.4.3.2</td></tr>
</table>

Welded wire reinforcement sheets are bundled in quantities depending on size of sheets and corresponding weights in accordance with customers' requirements and capacities then shipped. Most bundles will weigh between 2,000 and 5,000 pounds.

Figure 8.2.Stacking of Welded Wire Reinforcement for shipping.

The bundles are bound together using steel strapping or wire rod ties. It is very important to note that the strapping or wire ties are selected and installed for the sole purpose of holding the sheets together during shipping and unloading and should NEVER be used to lift the bundles.

Bundles are commonly assembled by flipping alternate sheets allowing the sheets to "nest". This allows for a greater number of sheets to be stacked and provides additional stability

Once sheets are bundled, they are transported, refer to Figure 8.1, to storage or loading areas by forklift trucks or by overhead cranes. Bundles of relatively short sheets can be handled by either forklift trucks with sheet dollies, roller conveyors or overhead cranes to the storage and loading areas. Many times a combination of material handling equipment is used to move material through the plant and to the storage and loading areas.

Generally, shorter sheets are loaded onto flatbed trailers using forklifts. Longer sheets are usually loaded with an overhead crane or forklift truck using a spreader bar or sheet pick-up frame with a 6-point pick-up so that longer sheets will not deflect or bend excessively when lifted. Cables or chains are passed through the bundles and fastened to the bottom wires.

After the sheet bundles are loaded onto the flatbed trailers, refer to Figure 8.2, they are secured to the flatbed using chains and binders, nylon straps, steel strapping, or a combination of these devices, in accordance with applicable federal, state and local safety regulations.

Figure 8.1. Welded Wire Reinforcement load on truck for shipping.

At the shipping destination (either job site or storage facility), the bundles are removed in much the same manner in which loaded. Where forklifts are not available, front end loaders equipped with lifting chains may be used. Similar to the overhead cranes used for lifting bundles at the manufacturer's plant, truck cranes, tower cranes or hydraulic cranes may be used for off-loading at the job site or storage facility.

At all times during off-loading of materials requiring lifting equipment, extreme caution should be exercised and all safety regulations and practices must be observed.

The engineer specifies the amount of reinforcement required and the correct position for the reinforcement within a wall or slab. To ensure proper performance of the reinforcement, it is essential that the welded wire reinforcement sheets be placed on supports to maintain their required position during concrete placement.

The supports (either concrete blocks, steel or plastic "chair" devices, or a combination of these) must be appropriately spaced in order to work effectively, refer to Table 9.1.

The various codes and standards do not give advice on spacing of supports for WWR. The WRI Tech Fact, TF 702 R2 does have guidelines for support spacing based on many years of experience. The TF can be downloaded from the publications listing on the WRI website. Simply stated recommended support of WWR spacing are:

Table 9.1 Welded Wire Recommended Support Spacing

Wire Size	Recommended For Wire Spacing	Support Spacing *
Larger than W/D9*	12" and greater	4 - 6 ft.
W/D5 to W/D9	12" and greater	3 - 4 ft.
Larger than W/D9*	Less than 12"	3 - 4 ft.
W/D4 to W/D9	Less than 12"	2 - 3 ft.
Less than W/D4**	Less than 12"	2 - 3 ft. or less

The above guidelines for WWR support spacings can be used for supported concrete slabs whether formed or placed on composite metal decks.

* Spacing of supports for WWR with wire sizes larger than W or D9 could be increased over the spacings shown depending on the construction loads applied.

**Consider additional rows of supports when permanent deformations occur - on the other hand - spacing of supports may be increased provided supports are properly positioned just as concrete is being placed.

Types of Supports - There are a variety of supports made specifically for WWR. The TF 702 R2 has photos of some of them. The same companies that sell rebar supports will usually handle those shown in the TF as well. Call the WRI if you need the references to any specific support and manufacturer

.

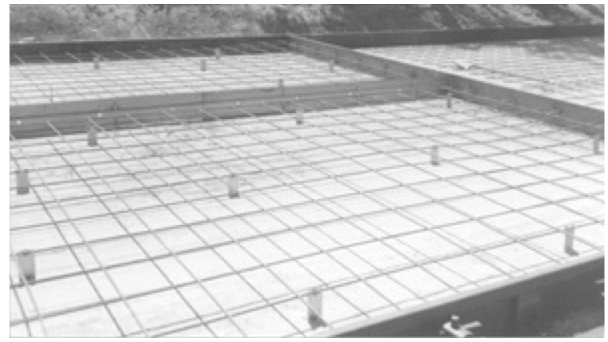


Figure 9.1. Cut every other wire at contraction joints. While maintaining continuity, restraint is relieved, when some area of reinforcing is reduced for slabs on ground.

Figure 9.2. Welded wire is supported on steel wire chairs. Note stiffness of WWR.

Figure 9.3. Welded wire used in repairing the Ohio Turnpike.

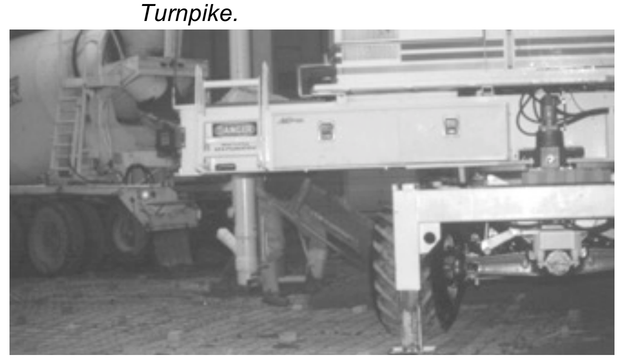


Figure 9.4. Laser screeds can ride over supported WWR. Maintain proper positioning when WWR is displaced.

Welded Wire Weight (Mass) Calculations

Calculated actual weight of a reinforcement item is determined by computing the weights of longitudinal and transverse wires separately, then adding the two results:

Calculated actual weight = Longitudinal weight + transverse weight

Longitudinal weight = Wt_l x N_l x L (round to 1 decimal place)

Transverse weight = Wt_t x N_t x OW (round to 1 decimal place)

where: Wt_l = Unit weight of one longitudinal wire (lbs./ft. or kg/m)

Wt_t = Unit weight of one transverse wire (lbs./ft. or kg/m)

N_l = Number of longitudinal wires

N_t = Number of transverse wires

L = Length of sheet (ft. or m)

OW = Overall width = length of transverse wires (ft. or mm)

$N_l = \frac{\text{Width (inches or mm)}}{\text{Longitudinal spacing}}$ +1 for uniformly spaced reinforcement

$N_t = \frac{\text{Length (inches or mm)}}{\text{Transverse spacing}}$ for uniformly spaced reinforcement

Guidelines for Calculating Wire Area Weight (Mass) and Diameter

Cross-sectional area of wire is taken as nominal area. Weight and nominal diameter are based on area figure.

Symbol	Description	Units	Metric
A	= Cross-sectional area of one wire	sq. in.	mm2
Wt	= Unit weight of one wire	lbs./ft.	kg/m
d	= Nominal diameter of one wire	in.	mm

A = "W/D" designation ÷ 100

A_m = "MW/MD" designation x 0.00785

Wt = A x 3.4 A_m

$$d = \sqrt{\frac{A}{.7854}}$$

Mass (kg/m) Mass = Area in mm2 x 0.00785

Example of Weight (Mass) Calculations

Item 1. 6 x 8-W10 x D12–96" (+0", +6") x 20'-8" sheets
Item 2. 6 x 6-W2.9 x W2.9–72" (+0, +0") x 20'-0" sheets

Item 1M.

152 x 203–MW65 x MD77–2438 (+0 +152) x 6.3m

Item 2M.

152 x 152–MW19 x MW19–1830 (+0 +0) x 6.1m

Calculated Unit Weights (Customary Units)

	Wire Size	Wt (lb/ft)	N	L or OW (ft.)	Calc. Weight
Item 1					
Longitudinal Wires	W10	.340	17	20.67	119.5 lbs
Transverse Wires	D12	.408	31	8.50	107.5 lbs
Calc. Weight					227.0 Lbs./Sheet
Item 2					
Longitudinal Wires	W2.9	.099	13	20.00	25.7
Transverse Wires	W2.9	.099	40	6.00	23.8
Calc. Weight					49.5 Lbs./Sheet

Calculated Actual Mass (Metric Units)

	Wire Size	Mass (kg/m)	N	L or OW (m)	Calc. Mass
Item 1M					
Longitudinal Wires	MW65	.506	17	6.3	54.2 kg.
Transverse Wires	MD77	.607	31	2.59	48.7 kg.
Calc. Mass					102.9 Kgs./Sheet
Item 2M					
Longitudinal Wires	MW19	.147	13	6.1	11.7
Transverse Wires	MW19	.147	40	1.83	10.8
Calc. Mass					22.5 Kgs./Sheet

Calculated Unit Weights

	Calc. weight ÷	Area*	X100=#/csft
Item 1	227.0	20.67 x 8.50 = 175.70	129
Item 1	49.5	20.00 x 6.00 = 120.0	41

* Item 1. Area = length x overall width
Item 2. Area = length x width
Round #/100 Sq. Ft. to full number

Calculated Unit Mass

	Calc. mass ÷	Area*	=kg.m2
Item 1	102.9	6.3x2.59=16.32	6.31
Item 1	22.5	6.1x1.83=11.2	2.0

* Item 1. Area = length x overall width
Item 2. Area = length x width

TABLE 10.1 Weight of Longitudinal Wires - Weight in Pounds per 100 Sq. Ft. for all Styles

NOTE: Based on 60” width center to center of outside longitudinal wires and uniform spacing of wire.

WIRE SIZE (W or D)	NOMINAL DIAMETER INCHES	SPACING AND WEIGHT OF LONGITUDINAL WIRES										
		2”	3”	4”	5”	6”	8”	9”	10”	12”	16”	18”
45	0.757	948.60	642.60	489.60	397.80	336.60	260.10	234.40	214.20	183.60	145.35	132.98
31	0.628	653.48	442.68	337.28	274.04	231.88	179.18	161.68	147.56	126.48	100.13	91.28
30	0.618	632.40	428.40	326.40	265.20	224.40	173.40	156.46	142.80	122.40	96.90	88.33
28	0.597	590.24	399.84	304.64	247.52	209.44	161.84	146.03	133.28	114.24	90.44	82.44
26	0.576	548.08	371.28	282.88	229.84	194.48	150.28	135.60	123.76	106.08	83.98	76.55
24	0.553	505.92	342.72	261.12	212.16	179.52	138.72	125.17	114.24	97.92	77.52	70.67
22	0.529	463.76	314.16	239.36	194.48	164.56	127.16	114.74	104.72	89.76	71.06	64.78
20	0.504	421.60	285.60	217.60	176.80	149.60	115.60	104.31	95.20	81.60	64.60	58.89
18	0.478	379.44	257.04	195.84	159.12	134.64	104.04	93.88	85.68	73.44	58.14	53.00
16	0.451	337.28	228.48	174.48	141.44	119.68	92.48	83.45	76.16	65.28	51.68	47.11
14	0.422	295.12	199.92	152.32	123.76	104.72	80.92	73.01	66.64	57.12	45.22	41.22
12	0.391	252.96	171.36	130.56	106.08	89.76	69.36	62.58	57.12	48.96	38.76	35.33
11	0.374	231.88	157.08	119.68	97.24	82.28	63.58	57.37	52.36	44.88	35.53	32.39
10.5	0.366	221.34	149.94	114.24	92.82	78.54	60.69	54.76	49.98	42.84	33.91	30.92
10	0.356	210.80	142.80	108.80	88.40	74.80	57.80	52.15	47.60	40.80	32.30	29.44
9.5	0.348	200.26	135.66	103.36	83.98	71.06	54.91	49.55	45.22	38.76	30.69	27.97
9	0.338	189.72	128.52	97.92	79.56	67.32	52.02	46.94	42.84	36.72	29.07	26.50
8.5	0.329	179.18	121.38	92.48	75.14	63.58	49.13	44.33	40.46	34.68	27.46	25.03
8	0.319	168.64	114.24	87.04	70.72	59.84	46.24	41.73	38.08	32.64	25.84	23.56
7.5	0.309	158.10	107.10	81.60	66.30	56.10	43.35	39.11	35.70	30.60	24.23	22.08
7	0.298	147.56	99.96	76.16	61.88	52.36	40.46	36.51	33.32	28.56	22.61	20.61
6.5	0.288	137.02	92.82	70.72	57.46	48.62	37.57	33.90	30.94	26.52	21.00	19.14
6	0.276	126.48	85.68	65.28	53.04	44.88	34.68	31.29	28.56	24.48	19.38	17.67
5.5	0.264	115.94	78.54	69.84	48.62	41.14	31.79	28.69	26.18	22.44	17.77	16.19
5	0.252	105.40	71.40	54.40	44.20	37.40	28.90	36.08	23.80	20.40	16.15	14.72
4.5	0.240	94.86	64.26	48.96	39.78	33.66	26.01	23.47	21.42	18.36	14.54	13.25
4	0.225	84.32	57.12	43.52	35.36	29.92	23.12	20.87	19.04	16.32	12.92	11.78
3.5	0.211	73.78	49.98	38.08	30.94	26.18	20.23	18.26	16.66	14.28	11.31	10.31
3	0.195	63.24	42.84	32.64	26.52	22.44	17.34	15.65	14.28	12.24	9.69	8.83
2.9	0.192	61.13	41.14	31.55	25.64	21.69	16.76	15.13	13.80	11.83	9.37	8.54
2.5	0.178	52.70	35.70	27.20	22.10	18.70	14.45	13.04	11.90	10.20	8.08	7.36
2.1	0.162	44.27	29.99	22.85	18.56	15.71	12.14	10.95	10.00	8.56	6.78	6.18
2	0.159	42.16	28.56	21.76	17.68	14.96	11.56	10.44	9.52	8.16	6.46	5.89
1.5	0.138	31.62	21.42	16.32	13.26	11.22	8.67	7.83	7.14	6.12	4.85	4.42
1.4	0.134	29.51	19.99	15.23	12.38	10.47	8.09	7.30	6.66	5.71	4.52	4.12

NOTES:

(1) This table is to be used for estimating purposes only. Exact weights of welded wire reinforcement will vary from those shown above, depending upon width of sheets and length of overhangs.
(See example, Section 10, Weight Calculation.)

(2) Deformed wires (D prefix) usually are not produced in sizes smaller than D4.

TABLE 10.2M Mass of Longitudinal Wires (Mass in kg/m^2 for all styles)

Based on 1524mm width center to center of outside longitudinal wires

meters = m
millimeters = mm

W or D	Wire Size *MW or MD*	Nominal Diameter	SPACING AND WEIGHT OF LONGITUDINAL WIRES										
			51 mm	76 mm	102 mm	127 mm	152 mm	203 mm	229 mm	254 mm	305 mm	406 mm	457 mm
45	290.0	19.23	46.31	31.37	23.90	19.42	16.43	12.71	11.44	10.46	8.96	7.10	6.47
31	200.0	15.96	31.94	21.59	16.45	13.37	11.31	8.74	7.89	7.20	6.17	4.89	4.46
30	194	15.70	30.84	20.89	15.92	12.93	10.94	8.36	7.63	6.96	5.97	4.75	4.33
28	181	15.16	28.79	19.50	14.86	12.07	10.22	7.89	7.12	6.50	5.57	4.43	4.04
26	168	14.61	26.73	18.11	13.80	11.21	9.49	7.33	6.61	6.04	5.17	4.11	3.75
24	155	14.05	24.68	16.72	12.74	10.35	8.76	6.77	6.15	5.57	4.78	3.79	3.46
22	142	13.44	23.60	15.32	11.67	9.49	8.03	6.20	5.60	5.11	4.38	3.47	3.17
20	129	12.80	20.56	13.94	10.61	8.62	7.30	5.84	5.09	4.64	3.98	3.16	2.88
18	116	12.14	18.51	12.54	9.55	7.76	6.57	5.07	4.58	4.23	3.58	2.84	2.59
16	103	11.46	16.45	11.14	8.49	6.90	5.84	4.51	4.07	3.71	3.18	2.52	2.30
14	90	10.72	14.39	9.75	7.43	6.04	5.11	3.95	3.55	3.25	2.79	2.20	2.01
12	77	9.91	12.34	8.38	6.37	6.17	4.38	3.38	3.05	2.79	2.39	1.88	1.72
11	71	9.50	11.31	7.66	5.81	4.74	4.01	3.10	2.80	2.55	2.19	1.74	1.58
10.5	68	9.30	10.80	7.31	5.57	4.53	3.83	2.96	2.67	2.44	2.09	1.66	1.52
10	65	9.04	10.27	6.96	5.31	4.31	3.65	2.82	2.54	2.32	1.99	1.59	1.45
9.5	61	8.84	9.77	6.62	5.04	4.10	3.47	2.68	2.42	2.21	1.89	1.49	1.36
9	58	8.59	9.25	6.27	4.78	3.88	3.28	2.54	2.29	2.09	1.79	1.42	1.29
8.5	55	8.38	8.74	5.82	4.56	3.66	3.10	2.40	2.16	1.97	1.69	1.35	1.27
8	52	8.10	8.23	5.57	4.25	3.45	2.92	2.26	2.04	1.86	1.59	1.27	1.16
7.5	48	7.85	7.71	5.22	3.98	3.23	2.74	2.11	1.91	1.74	1.49	1.17	1.07
7	45	7.57	7.20	4.88	3.71	3.02	2.55	1.97	1.78	1.63	1.39	1.10	1.00
6.5	42	7.32	6.68	4.53	3.45	2.80	2.37	1.83	1.65	1.51	1.29	1.03	0.94
6	39	7.01	6.17	4.18	3.18	2.59	2.19	1.69	1.53	1.39	1.19	0.95	0.87
5.5	36	6.78	5.65	3.83	2.92	2.37	2.01	1.55	1.40	1.28	1.09	0.88	0.80
5	33	6.40	5.14	3.48	2.65	2.18	1.82	1.41	1.27	1.18	0.99	0.81	0.74
4.5	29	6.07	4.63	3.13	2.39	1.94	1.64	1.27	1.14	1.04	0.90	0.71	0.65
4	26	5.72	4.11	2.79	2.12	1.72	1.46	1.13	1.02	0.93	0.80	0.64	0.58
3.5	23	5.35	3.60	2.44	1.86	1.51	1.28	0.99	0.89	0.81	0.70	0.56	0.51
3	19	4.95	4.06	2.09	1.59	1.29	1.09	0.85	0.76	0.70	0.60	0.47	0.42
2.9	19	4.88	2.98	2.09	1.59	1.29	1.09	0.85	0.76	0.70	0.60	0.47	0.42
2.5	16	4.53	2.57	1.74	1.33	1.08	0.91	0.70	0.64	0.58	0.50	0.39	0.36
2.1	13.5	4.15	2.15	1.46	1.11	0.90	0.76	0.59	0.53	0.49	0.42	0.33	0.30
2	13	4.04	2.06	1.39	1.03	0.87	0.73	0.56	0.51	0.46	0.40	0.32	0.29
1.5	10	3.51	1.54	1.04	0.82	0.65	0.55	0.42	0.38	0.35	0.30	0.24	0.22
1.4	9	3.39	1.44	0.97	0.74	0.60	0.51	0.39	0.35	0.32	0.28	0.22	0.20

NOTES: **(1)** This table is to be used for estimating purposes only. Exact weights of welded wire reinforcement will vary from those shown above, depending upon width of sheets and length of overhangs. (See example, Section 10, Weight Calculation.)

(2) Deformed wires (D prefix) usually are not produced in sizes smaller than D4.

TABLE 10.3 Weight of Transverse Wires - Weights in pounds per 100 sq. ft.

NOTE: Based on 62'' lengths of transverse wire (60'' width plus 1''overhang each side) and uniform spacing of wires.

WIRE SIZE (W or D)	NOMINAL DIAMETER INCHES	SPACING AND WEIGHT OF TRANSVERSE WIRES										
		2"	3"	4"	5"	6"	8"	9"	10"	12"	16"	18"
45	0.757	948.6	632.40	474.30	379.44	316.20	237.15	210.75	189.72	158.10	118.57	105.41
31	0.628	653.48	435.65	326.74	261.39	217.83	163.37	145.22	130.70	108.91	81.68	72.61
30	0.618	632.40	421.40	316.20	252.96	210.80	158.10	140.53	126.48	105.40	79.05	70.27
28	0.587	590.24	393.49	295.12	236.10	196.75	147.56	131.17	118.05	98.37	73.78	65.59
26	0.575	548.08	365.38	274.04	219.23	182.70	137.02	121.80	109.62	91.34	68.51	60.90
24	0.553	505.92	337.28	252.96	202.37	168.64	126.48	112.43	101.18	84.32	63.24	56.22
22	0.529	463.76	309.17	231.88	185.50	154.59	115.94	103.06	92.75	77.29	57.97	51.53
20	0.504	421.60	281.06	210.80	168.64	140.53	105.40	93.69	84.32	70.26	52.70	46.84
18	0.478	379.44	252.96	189.72	151.78	126.48	94.86	84.32	75.89	63.24	47.43	42.16
16	0.451	337.28	224.85	168.64	134.91	112.43	84.32	74.95	67.46	56.21	42.16	37.48
14	0.422	295.12	196.76	147.56	118.05	98.37	73.78	65.58	59.02	49.19	36.89	32.79
12	0.391	252.96	168.64	126.48	101.18	84.32	63.24	56.21	50.59	42.16	31.62	28.11
11	0.374	231.88	154.59	115.94	92.75	77.29	57.97	51.53	46.38	38.65	28.98	25.77
10.5	0.366	221.34	147.56	110.67	88.54	73.78	55.34	49.19	44.27	36.89	27.87	24.59
10	0.356	210.80	140.53	105.40	84.32	70.27	52.70	46.84	42.16	35.13	26.35	23.42
9.5	0.348	200.28	133.51	100.13	80.11	66.76	50.07	44.50	40.05	33.38	25.03	22.25
9	0.338	189.72	126.48	94.86	75.89	63.24	47.43	42.16	37.94	31.62	23.71	21.08
8.5	0.329	179.18	119.45	89.59	71.67	59.73	44.80	39.82	35.84	29.86	22.40	19.91
8	0.319	168.64	112.43	84.32	67.46	56.21	42.16	37.48	33.73	28.11	21.08	18.74
7.5	0.309	158.10	105.40	79.05	63.24	52.70	39.53	35.14	31.62	26.35	19.76	17.57
7	0.298	147.56	98.37	73.78	59.02	49.19	36.89	32.79	29.51	24.59	18.44	16.40
6.5	0.288	137.02	91.35	68.51	54.81	45.68	34.26	30.45	27.41	22.84	17.13	15.23
6	0.276	126.48	84.32	63.24	50.59	42.16	31.62	28.11	25.30	21.08	15.81	14.05
5.5	0.264	115.94	77.30	57.97	46.38	38.65	28.99	25.77	23.19	19.33	14.49	12.88
5	0.252	105.40	70.27	52.70	42.16	35.13	26.35	23.42	21.08	17.57	13.17	11.71
4.5	0.240	94.86	63.24	47.43	37.95	31.62	23.72	21.08	18.97	15.81	11.86	10.54
4	0.225	84.32	56.21	42.16	33.73	28.11	21.08	18.74	16.86	14.05	10.54	9.37
3.5	0.211	73.78	49.19	36.89	29.51	24.60	18.45	16.40	14.76	12.30	9.22	8.20
3	0.195	63.24	42.16	31.62	25.30	21.08	15.81	14.05	12.65	10.54	7.90	7.03
2.9	0.192	61.13	40.75	30.57	24.45	20.38	15.28	13.55	12.23	10.18	7.64	6.79
2.5	0.178	52.70	35.13	26.35	21.08	17.57	13.18	11.71	10.54	8.78	6.59	5.86
2.1	0.162	44.26	29.51	22.13	17.71	14.76	11.07	9.81	8.85	7.38	5.53	4.92
2	0.159	42.16	28.11	21.08	16.86	14.05	10.54	9.37	8.43	7.03	5.27	4.68
1.5	0.138	31.62	21.08	15.81	12.65	10.54	7.91	7.03	6.32	5.27	3.95	3.51
1.4	0.134	29.51	19.67	14.76	11.80	9.84	7.38	6.54	5.90	4.92	3.69	3.28

EXAMPLE: Approximate weight of 6 x 6 – W4 x W4

Longitudinal = 29.92

Transverse = 28.11

58.03 lbs. per 100 sq. ft.

TABLE 10.4M Mass of Transverse Wires (Mass in kg/m² for all styles)

Based on 1575mm lengths of transverse wire (1524mm plus 25.4mm overhang on ea. side)

W or D	Wire Size *MW or MD*	Nominal Diameter *mm*	SPACING AND WEIGHT OF TRANSVERSE WIRES										
			51 mm	76 mm	102 mm	127 mm	152 mm	203 mm	229 mm	254 mm	305 mm	406 mm	457 mm
45	290.0	19.23	46.31	30.87	23.15	18.52	15.43	11.58	10.28	9.26	7.72	5.76	5.15
31	200.0	15.95	32.36	21.25	15.94	12.75	10.62	7.97	7.08	6.37	5.31	3.99	3.46
30	194	15.70	30.84	20.56	15.52	12.34	10.28	7.71	6.85	6.17	5.14	3.86	3.43
28	181	15.16	28.79	19.19	14.44	11.52	9.60	7.20	6.40	5.76	4.80	3.60	3.20
26	168	14.61	26.73	17.82	13.37	10.69	8.91	6.68	5.94	5.35	4.46	3.35	2.97
24	155	14.05	24.88	16.45	12.34	9.87	8.23	6.17	5.48	4.93	4.11	3.09	2.75
22	142	13.44	22.62	15.08	11.31	9.06	7.54	5.65	5.03	4.52	3.77	2.83	2.52
20	129	12.80	20.66	13.71	10.28	8.23	6.85	5.14	4.57	4.11	3.43	2.57	2.29
18	116	12.14	18.51	12.34	9.25	7.40	6.17	4.63	4.11	3.70	3.08	2.32	2.06
16	103	11.46	16.45	10.97	8.23	6.58	5.48	4.11	3.66	3.29	2.74	2.06	1.83
14	90	10.72	14.39	9.60	7.20	5.76	4.80	3.60	3.20	2.88	2.40	1.80	1.60
12	77	9.91	12.34	8.23	6.17	4.93	4.11	3.08	2.74	2.47	2.08	1.54	1.37
11	71	9.60	11.31	7.54	5.65	4.52	3.77	2.83	2.52	2.26	1.89	1.42	1.26
10.5	68	9.30	10.80	7.20	5.40	4.32	3.60	2.70	2.40	2.16	1.80	1.35	1.20
10	65	9.04	10.28	6.85	5.14	4.11	3.43	2.57	2.28	2.06	1.71	1.28	1.14
9.5	61	8.84	9.77	6.51	4.88	3.91	3.26	2.44	2.17	1.95	1.63	1.22	1.09
9	58	8.59	9.25	6.17	4.63	3.70	3.08	2.31	2.06	1.85	1.54	1.16	1.03
8.5	55	8.36	8.74	5.83	4.37	3.50	2.91	2.19	1.94	1.75	1.46	1.09	0.97
8	52	8.10	8.24	5.48	4.11	3.29	2.74	2.06	1.83	1.65	1.37	1.03	0.92
7.5	48	7.85	7.71	5.14	3.86	3.08	2.57	1.93	1.71	1.55	1.29	0.96	0.86
7	45	7.57	7.20	4.80	3.60	2.88	2.40	1.80	1.60	1.44	1.20	0.90	0.80
6.5	42	7.32	6.68	4.45	3.34	2.67	2.23	1.67	1.49	1.34	1.11	0.84	0.74
6	39	7.01	6.17	4.11	3.08	2.47	2.00	1.54	1.37	1.23	1.03	0.77	0.68
5.5	36	6.73	5.65	3.77	2.83	2.26	1.89	1.41	1.26	1.13	0.94	0.71	0.63
5	33	6.40	5.14	3.43	2.57	2.06	1.71	1.29	1.14	1.03	0.86	0.64	0.57
4.5	29	6.07	4.63	3.08	2.31	1.85	1.54	1.16	1.03	0.93	0.77	0.58	0.51
4	26	5.72	4.11	2.74	2.06	1.65	1.27	1.03	0.91	0.82	0.69	0.51	0.46
3.5	23	5.36	3.60	2.40	1.80	1.44	1.20	0.90	0.80	0.72	0.60	0.45	0.40
3	19	4.95	3.08	2.08	1.54	1.23	1.03	0.77	0.69	0.62	0.51	0.39	0.34
2.9	19	4.88	2.98	1.99	1.49	1.19	1.00	0.75	0.66	0.60	0.50	0.37	0.33
2.5	16	4.52	2.57	1.76	1.29	1.03	0.86	0.64	0.57	0.51	0.43	0.32	0.29
2.1	13.5	4.15	2.16	1.44	1.08	0.86	0.72	0.54	0.48	0.43	0.36	0.27	0.24
2	13	4.04	2.06	1.37	1.03	0.81	0.69	0.51	0.46	0.41	0.34	0.26	0.23
1.5	10	3.51	1.54	1.03	0.77	0.62	0.51	0.39	0.34	0.31	0.26	0.19	0.17
1.4	9	3.39	1.44	0.96	0.72	0.58	0.48	0.36	0.32	0.29	0.24	0.18	0.16

EXAMPLE: Approximate mass of 152 x 152 – MW26 x MW26

Longitudinal = 1.46

Transverse = 1.27

2.73 kg/m² (based on 6m length)

NOTES

WIRE REINFORCEMENT INSTITUTE

Welded wire, sometimes called fabric or mesh is what we refer to today as "STRUCTURAL WELDED WIRE REINFORCEMENT (WWR)" for concrete construction. The U.S. Patents covering its production were issued in 1901. The Wire Reinforcement Institute, Inc. (WRI) was founded in 1930 and has in its Library a hard covered book on triangular wire reinforcement which was published in 1908 by the American Steel & Wire Company (AS&W). In 1911 welded wire machinery arrived and the industry began a new product line for welded wire reinforcement. Considering the time and state of the art of reinforced concrete, the publications printed in those early years were very sophisticated and used by many engineers and contractors on some well-known building and paving projects. We are continuing that trend today by keeping you current on the latest materials, technologies and practices.

Activities

- The Institute develops marketing strategies and promotional materials for the purpose of expanding applications and increasing usage of welded wire reinforcing. In addition;
- Prepares reports, presentations, literature, and brochures on the applications and proper use of WWR.
- The Institute provides technical service to users and specifiers of WWR reinforcement such as consulting engineers, architects, developers, contractors, governmental department engineers and others.
- The Institute is involved in cooperative programs with other technical associations with similar interests to advance the use of reinforced concrete.
- WRI provides technical and research service to code bodies and actively participate on various codes and standards committees.
- The Institute library is a source of information on welded wire reinforcement, its proper use and placement.
- The Institute develops programs for the general advancement of the industry involving market studies, research, technical, engineering and promotional work.

Photo captions (next page)

1. Structural WWR used in box culverts.
2. Large cages of WWR confinement reinforcement for high rise buildings.
3. Bridge "I" girders have WWR shear reinforcement the full length.
4. A skip pan joist and slab floor system with high strength WWR.

WIRE REINFORCEMENT INSTITUTE

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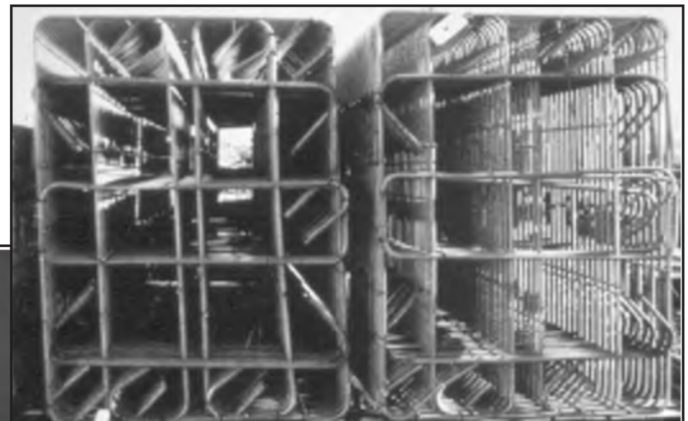

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