wri
WIRE REINFORCEMENT INSTITUTE

DOCKET NUMBER
PROPOSED RULE PR 20
(64FR35090)

935

DOCKETED
USNRC

PO Box 450, Findlay, OH 45839-0450 e-mail: wwri@bright.net web site: www.wirereinforcementinstitute.org
(419) 425-9473 Fax: (419) 425-5741

'01 JUN -1 A8:52

OFFICE OF SECRETARY
RULEMAKINGS AND
ADJUDICATIONS STAFF

Office of the Secretary
Rulemaking and Adjudication Staff
Nuclear Regulatory Commission
One White Flint North Building
11555 Rockville Pike
Rockville, Maryland 20852

Re: NuRC Analysis and Review of Alternatives for Controlling the Release of Solid Materials from NuRC-Licensed Facilities

Dear Sir or Madam:

On behalf of the Wire Reinforcement Institute (WRI) we are writing to offer the following comments and observations regarding the Nuclear Regulatory Commission's (NuRC) consideration of regulations intended to manage the release of solid materials from NuRC-licensed facilities for recycling into consumer products.

The WRI is a 501(c)(6) non-profit trade association comprised of member companies that produce welded wire reinforcement used in concrete construction. WRI learned of the NuRC's ongoing review through a communication received from the Portland Cement Association (PCA). As welded wire reinforcement is very often a critical component of concrete construction, the WRI and its member companies have a significant economic interest in any efforts to promulgate regulations that have the potential to negatively impact the concrete and aggregate industries and public confidence in the use of concrete.

It is our understanding that under current procedures, the NuRC reviews licensee applications for release of these solid materials for disposal or recycling on a case-by-case basis. Through materials received from the PCA, including PCA's Comments on the December 7-8, 1999 Meeting Summary for the NuRC Workshop on Control of Solid Materials, WRI has learned that NuRC licensees have petitioned the NuRC to promulgate regulations that would establish a standard practice and acceptable level of radioactivity and which would allow for routine release and recycling of radioactive contaminated concrete, rebar and other materials generated from the routine maintenance and dismantling of licensee facilities. WRI wishes to express its opposition to any rulemaking that would provide for the recycled use of radioactive concrete and materials salvaged from NuRC-licensed facilities.

From an economic standpoint, regulations that would establish an "acceptable" level of radioactivity in recycled concrete and aggregate products pose a significant threat to the marketability of WRI member products. The public's well-entrenched perception that any level of radioactivity is harmful has the potential to cause a significant decline in public confidence in and willingness to purchase concrete and concrete-related components that might incorporate recycled radioactive materials. Examples of unacceptable recycling of radioactive materials into consumer concrete products

Template = SECY-067

SECY-02

include use of radioactive scrap metal in reinforcing bars and wire, or crushed demolition radioactive concrete as base for pavement or use as an aggregate in concrete itself.

Individuals or business entities concerned with the possibility of being supplied with radioactive contaminated concrete products will simply elect to buy alternative products. Furthermore, the concrete industry could be saddled with the additional and substantial burden of having to purchase and operate surveillance equipment to monitor the levels of radiation in concrete products, just as the metal recycling industry has done to monitor levels of radioactivity found in incoming shipments of scrap metal. Requiring such monitoring would place an excessive financial and procedural burden on members of the concrete industry.

The WRI would like to join with the PCA to suggest that concrete and associated industry organizations have some voice in the ongoing NuRC petition review and possible rulemaking process. Quite simply, the concrete and aggregate industries have little to benefit and much to lose from the promulgation of standards and regulations that would make it easier to incorporate radioactive materials in or under concrete products. As significant stakeholders with a keen economic interest in the outcome of this process, we believe that our input would be invaluable to the NuRC's complete and objective review and consideration of the licensees' petition for promulgation of regulations on this issue. In this instance, the WRI and its members respectfully submit that the NuRC should undertake a thorough examination of the potential short and long term effects of NuRC rulemaking on this issue before promulgating standards or regulations that have the very real potential to cause significant economic damage to those industries that would be receiving the licensees' contaminated solid waste materials.

We respectfully request the opportunity to actively participate in the ongoing NuRC review of this sensitive subject and to be kept advised of further rulemaking, open meetings and other opportunities to comment on the topic. On behalf of our membership, the WRI wishes to thank you for considering these comments and concerns. Should you require any additional information, please contact us at the Wire Reinforcement Institute.

Very truly yours,

WIRE REINFORCEMENT INSTITUTE

Roy H. Reiterman

Roy H. Reiterman, Technical Director

NuRCltr5/01rhr

wri TECH FACTS
WIRE REINFORCEMENT INSTITUTE • EXCELLENCE SET IN CONCRETE
TF-208-R-01

WWR For Structural Applications

A Discussion of Current Product Knowledge and Practices

INTRODUCTION

With its greater strength, generally higher ductility, and significantly lower placing and overall costs, Welded Wire Reinforcement (WWR) offers a highly practical and cost-efficient alternative to traditional rebar concrete reinforcement.

WWR may be used in virtually any structural application-buildings, bridges, highways, tunnels, pipelines and precast component systems, for instance - that typically would rely on rebar to fortify concrete. In fact, both ACI and AASHTO have considered WWR comparable to rebar for many years, and testing requirements - i.e., tensile, yield strength at various strain rates, and bend testing – are similar for both products. WWR, moreover, adheres to additional required tests, such as reduction of area (ROA) and wrap and weld shear testing (with 50% of the samples having the weld in the center of the gage length).

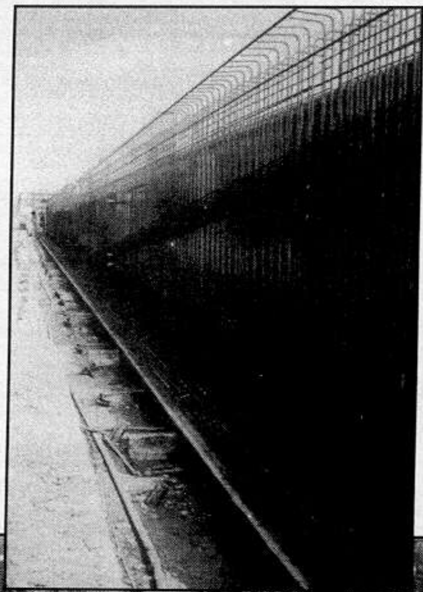
There are a great many examples of WWR used in structural applications throughout the country, and WRI has a number of research reports and case studies available that demonstrate how and where high strength and higher ductility WWR has been used.

WWR ductility – a measure of the steel wires flexibility and, therefore, one measure of its ability to withstand large strains and redistribute stress – compares very favorably with that of rebar. For example, McGill University (Montreal, Quebec, Canada) researcher Dr. Denis Mitchell, attested to WWRs ductility in a report in the March-April 1994 issue of ACI Structural Journal. "We can provide material which is over 80,000 psi yield strength and will test at 0.35% strain (as ACI has required for many years)", he wrote, "and it has ductility that matches or exceeds rebar ductility".

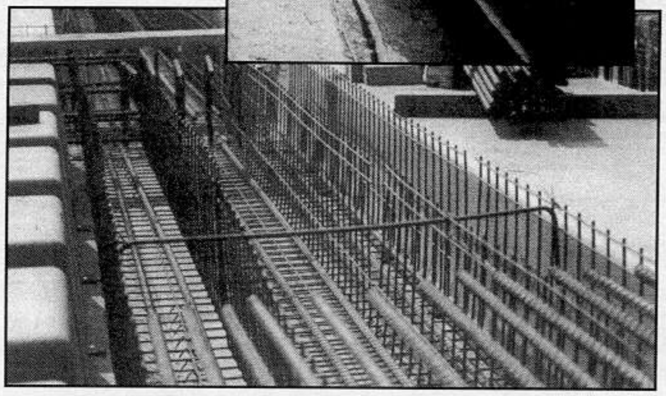
More recently, AASHTO-LRFD specifications now are recognizing higher strength reinforcement and AASHTO is considering updating its working stress design specifications to allow up to 80,000 psi yield strength. Ironically, this present-day testing agrees with the more than 17-year-old data of Allen B. Dove, a prolific engineer and honorary member of WRI. Reporting in the September-October 1983 issue of ACI Journal (Title No. 80-41), Mr. Dove commented:

> "...the wrap test is the best way to prove the full ductility of WWR. When you turn the reinforcement 360 degrees around a mandrel either the same size as the wire or twice the diameter of the wire, in accordance with the ASTM Standards, you extend the outer fibers of the wire more than 50%. That's a true test of wire ductility".

With better techniques for assessing ductility, as well as to increase this property's presence in the finished product, the trend in WWR is toward higher ductility wire and larger yield plateaus while maintaining the minimum desired yield strengths. In fact, recent production research has focused on using rod sizes that are closer to the finished wire sizes. This reduces the amount of cold-working needed to attain the desired wire size and that, in turn, raises the level of ductility.



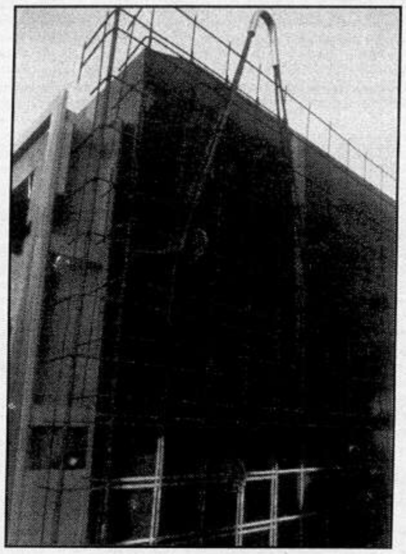
WWR Shear reinforcing with D4, D8 and D14 wire sizes, was used in the full length of the 150' bridge girder. - Lincoln, NE



Welded wire shear cages with D4 and D6.4 wire sizes for concrete girders in Jacobs Field Ball Park - Cleveland OH

C01

Wire Reinforcement Institute • P.O. Box 450 • Findlay, OH 45839-0450
(419) 425-9473 • FAX (419) 425-5741 • wirereinforcement.org



Wall reinforcing used for precast correctional cells - Adult Detention Center,

Fairfax County, VA

WWR's strength, flexibility and other advantages have long been relied upon by the precast industry, particularly for applications that may be subjected to high flexure and shear stresses. In recent years, with advances in assessment and manufacturing technologies, WWR's use in a broader base of structural applications is growing rapidly.

With respect to this greater interest in and growing use of WWR, the following discussion examines important aspects of this superior product, including manufacturing, specifications and applications, handling and unloading, placing, coated WWR and metric WWR.

MANUFACTURING

Frequently referred to as fabric or wire mesh, WWR is manufactured from hot rolled steel rods. The rods are cold drawn or cold rolled through a series of dies or carbide rolls to reduce the diameter and to increase the yield strength of the steel.

WWR for construction is usually manufactured in 5 to 8 foot-wide sheets and rolls. Sheets 12' wide and some larger are produced primarily for highway paving and precast components. Special widths can be furnished on request. Sheets can be provided up to 40 feet or more in length, but 12-foot 6-inch, 15-feet, 20-feet and 25-feet are the more common lengths for ease in shipping and placing. Pipe and standard building fabric are produced in roll form. Most standard building fabric is available in sheet form.

Wire sizes are available from W1.4-W45 and D4-D45. Other wire sizes are available and vary with individual manufacturers. The "W" for plain or "D" for deformed wire numbers are usually whole numbers. For a style designation of 12x12-D10xD10, the first set of numbers is the spacing of wires in inches for both the longitudinal and transverse directions, respectively. The second set is the cross sectional areas of the respective wires in square inches multiplied by 100 (.10 sq. in. x 100 = 10, etc.).

Spacings of longitudinal wires can vary from 2" to 16" (larger spacings are obtainable and vary with individual manufacturers). Transverse spacings are usually 4, 6, 8, 12, or 16". Wires can be cut flush or have overhangs on the sides of the welded wire. The ends will generally have overhangs of one-half the transverse spacing unless other multiples of the transverse spacing are requested, i.e. for 12-inch transverse spacing, 6" & 6" or 8" & 4" or 10" & 2", etc.

SPECIFICATIONS AND APPLICATIONS

WWR is manufactured in accordance with specifications by the American Society for Testing and Materials (ASTM). ASTM A82 and A496 specify the strength and manufacture of plain and deformed wire used in WWR. ASTM A185 and A497 specify the manufacture and testing of plain and deformed welded wire for concrete reinforcement.

WWR is manufactured with the wires in either square or rectangular patterns, referred to as styles, and is welded by electrical resistance at each intersection. The bond strength of WWR is provided by the welded intersections and deformations when specified.

Welded wire is commonly used to control temperature/shrinkage stresses and add reserve strength in slabs on grade. The more common or standard WWR styles are designated: 6x6-W1.4xW1.4, 6x6-W2.1xW2.1, 6x6-W2.9xW2.9 and 6x6-W4xW4. Heavier WWR styles utilizing wire diameters up to 1/2" (some manufacturers can exceed 1/2" diameter) can be used for structural applications.

The size and area of reinforcement required is specified by the engineer and depends on the slab thickness, the spacing of the construction and control joints, the type and density of the sub base, a friction factor for the sub-grade and the yield strength of the welded wire. There are a number of design methods used when the WWR is used for strength in the reinforced concrete slab or structure.

The ACI Building Code (ACI-318) assigns a minimum yield strength (fy) value of 60,000 psi to most steel reinforcing, but allows yield strengths up to 80,000 psi for many design applications.

C02

Wire Reinforcement Institute • P.O. Box 450 • Findlay, OH 45839-0450
(419) 425-9473 • FAX (419) 425-5741 • wirereinforcement.org

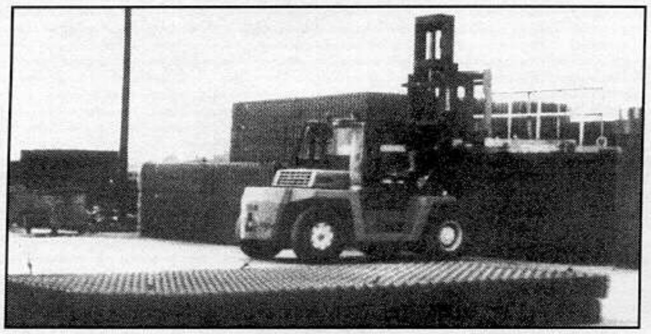
Welded wire reinforcement can be used as ties and stirrups for column, beam and joist cage (confinement) reinforcement. WWR cage reinforcement is also used for concrete encased columns. The WWR supplier uses a welded wire bending machine to shape the materials into required configurations. The placing drawings will identify the location and details of the cage assemblies.

When WWR is used for wall reinforcing, form support accessories are available to hold the sheets of WWR in place to provide the necessary cover.

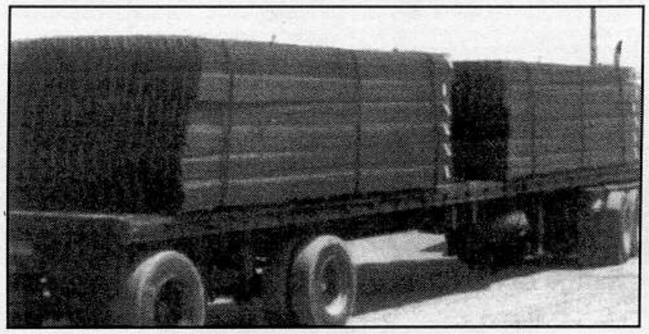
HANDLING AND UNLOADING

WWR is shipped in two forms – rolls, usually specified for light commercial and residential building construction or concrete pipe, and sheets for general commercial/industrial construction and precast components. If produced in roll form, a number of rolls are unitized in a bundle for ease of handling. Individual rolls are securely tied, so uncoiling will not occur when the bundles are cut.

Sheets are bundled in quantities depending on size and weight of sheets and in accordance with the customer's requirements. Generally, bundles of rolls or sheets will weigh between 2000 and 6000 pounds. Banding is used for shipping stability only. Bundles should never be lifted by the steel banding.



WWR Sheet being loaded for truck shipping.



WWR Sheet bundles in route for delivery.

If the rolls or sheets must be lifted by crane at the job site, the customer may request the WWR manufacturer to install lifting eyes.

Sheet bundles without lifting eyes are placed on dunnage (as specified by the customer) for easier unloading with either a forklift or a crane using a sling chain hooked or threaded through the bundle. At all times during off loading of materials, caution must be exercised and all safety regulations and practices must be observed.

PLACING

WWR rolls are unrolled, cut to proper length and turned over to prevent ends from curling. Flattening the material is best accomplished, mechanically; i.e., roller straightener, which will provide the necessary flatness to achieve proper positioning. All WWR should be placed on support accessories to maintain the required position and cover as specified by the engineer.

Splices or laps, either structural or temperature/shrinkage types, should be specified by the engineer and in conformance with the ACI Building Code. Typically, structural laps for welded wire fabric are a minimum length of 6" + overhangs for plain wire and 8" including overhangs for deformed wires. The Code requires that one or two cross wires, depending on type of wire, occur in structural laps of WWR. Deformed wire structural laps, when no cross wires are included in the splice region, are a minimum of 12". In areas of low stress, splice lengths can be reduced.

For slab on grade construction: With slab thicknesses less than 5", a single layer of welded wire is placed in the middle of the slab. For slabs 6" and greater, the top cover is 1/3 the depth of the slab.

When two layers are specified (usually over 8" thick), the top cover will be 1" to 2" depending on saw cuts

6x6 - W10 x W10 WWR used in bridge redecking. - Albany, NY

C03

Wire Reinforcement Institute • P.O. Box 450 • Findlay, OH 45839-0450
(419) 425-9473 • FAX (419) 425-5741 • wirereinforcement.org

(WWR is placed below the saw cuts). The bottom cover will be 1-1/2" min. on earth or 1" on vapor barriers. Support manufacturers produce concrete blocks or steel (coated and uncoated) and plastic chairs, bolsters, and WWF support accessories made specifically for either single layer or double layer reinforcing applications.

Placing WWR on appropriately spaced concrete blocks, steel or plastic supports with base plates and typing the WWR at laps is adequate to maintain it's position during concrete placement. WWR should not be placed on the sub grade and pulled up during concrete placement. Following is a suggested guide for spacing support accessories:

Heavy WWR styles - W9 or D9 and larger: . . . . . . .4'-6'*
Medium WWR styles -W5 or D5 to W8 or D8: . . . . . .3'-4'
Light WWR styles - W4 or D4 or less: . . .2'-3' or less**

Wide spaced 12x12 - D7xD7 WWR for slab on grade construction to obtain proper positioning in this auto parts distribution facility in Zanesville, OH.

** Spacing of supports for WWR with wires larger than W or D9 could possibly be increased over the spacings shown depending on the construction loads applied.*
***Consider using additional rows of supports when large deflections or deformations occur – also spacing of supports may be increased provided supports are placed and properly positioned as concrete is needed.*

COATED WELDED WIRE REINFORCEMENT

There are several types of coating specifications for welded wire reinforcement: one is a galvanized type (stated in ASTM A185) which is a hot-dipped process (in accordance with ASTM A641) applied to the cold drawn or cold rolled wire before welding the wires; hot dip galvanizing specification ASTM A 123 is used when galvanizing after fabrication is required. A second type of coating is epoxy powder, fusion bonded in accordance with ASTM A884 requirements.

METRIC WELDED WIRE REINFORCEMENT

Generally, when styles of WWR are converted from inch-pound to metric, both spacings and wire areas are soft metricated and rounded to whole numbers. Pipe fabric is an exception. There will be two lists for both spacings and wire sizes. One will be a call-out listing (rounded to whole numbers). The other is an actual spacing or wire size with numbers carried out to 0.1 decimal increments. Examples appear below.

In the future, when more styles are specified in metric, wire sizes can be in 5 or 10 square millimeter areas. Keep in mind, all manufacturers can produce wire sizes in 1 square millimeter increments (0.001 in^2). (See Tables 1 & 2)

Examples of styles converted from inch-pound to metric:

Metric Standard style (in-#):
152x152-MW 19 x MW 19 (6x6-W 2.9 x W2.9)

Metric Structural style:
305x305-MD 71 x MD 71 (12x12-D11 x D11)

Metric Pipe style, Call-out:
51x203-MW 77 x MW 32)2 x 8-W12 x W5)

Metric Pipe style, Actual:
50.8x203.2-MW 77.4 x MW 32.3 (2 x 8[W12 x W5)

Note: Conversion factors used: 25.4 mm = 1 inch, 645 mm^2 = 1 in^2 – A reminder, the inch-pound wire areas in the examples are in^2 multiplied by 100.

Note: Table 3 is included for use in selecting areas of steel with various wire spacings.

C04

Wire Reinforcement Institute • P.O. Box 450 • Findlay, OH 45839-0450
(419) 425-9473 • FAX (419) 425-5741 • wirereinforcement.org

TABLE 1 METRIC WIRE AREA, DIAMETERS & MASS WITH EQUIVALENT INCH-POUND UNITS ✧

Metric Units				Inch-pound Units (conversions)				Gage Guide
Size ✦ (MW=Plain) (mm^2)	Area (mm^2)	Diameter (mm)	Mass (kg/m)	Size ✦ (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	
MW120	120	12.4	.941	W18.6	.186	.487	.632	7/0
MW100	100	11.3	.784	W15.5	.155	.444	.527	6/0
MW90	90	10.7	.706	W14.0	.140	.422	.476	5/0
MW80	80	10.1	.627	W12.4	.124	.397	.422	
MW70	70	9.4	.549	W10.9	.109	.373	.371	4/0
MW65	65	9.1	.510	W10.1	.101	.359	.343	3/0
MW60	60	8.7	.470	W9.3	.093	.344	.316	
MW55	55	8.4	.431	W8.5	.085	.329	.289	2/0
MW50	50	8.0	.392	W7.8	.078	.314	.263	
MW45	45	7.6	.353	W7.0	.070	.298	.238	1/0
MW40	40	7.1	.314	W6.2	.062	.283	.214	1
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	
MW13	13	4.1	.102	W2.0	.020	.160	.068	8
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 ✧ -For other available wire sizes, consult other WRI publications or discuss with WWF manufactures.
Note ✦ -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).

C05

TABLE 2

COMMON STYLES OF METRIC WELDED WIRE REINFORCEMENT (WWR) WITH EQUIVALENT US CUSTOMARY UNITS[3]

	A[1] (mm^2/m)	Metric Styles (MW = Plain wire)[2]	Wt. (kg/m^2)	Equivalent US Customary Style	A[1] (in^2/ft)	Wt (lbs/CSF)
A[1 & 4]	88.9	102x102 - MW9xMW9	1.51	4x4 - W1.4xW1.4	.042	31
	127.0	102x102 - MW13xMW13	2.15	4x4 - W2.0xW2.0	.060	44
	184.2	102x102 - MW19xMW19	3.03	4x4 - W2.9xW2.9	.087	62
	254.0	102x102 - MW26xMW26	4.30	4x4 - W4.0xW4.0	.120	88
	59.3	152x152 - MW9xMW9	1.03	6x6 - W1.4xW1.4	.028	21
	84.7	152x152 - MW13xMW13	1.46	6x6 - W2.0xW2.0	.040	30
	122.8	152x152 - MW19xMW19	2.05	6x6 - W2.9xW2.9	.058	42
	169.4	152x152 - MW26xMW26	2.83	6x6 - W4.0xW4.0	.080	58
B[1]	196.9	102x102 - MW20xMW20	3.17	4x4 - W3.1xW3.1	.093	65
	199.0	152x152 - MW30xMW30	3.32	6x6 - W4.7xW4.7	.094	68
	199.0	305x305 - MW61xMW61	3.47	12x12 - W9.4xW9.4	.094	71
	362.0	305x305 - MW110xMW110	6.25	12x12 - W17.1xW17.1	.171	128
C[1]	342.9	152x152 - MW52xMW52	5.66	6x6 - W8.1xW8.1	.162	116
	351.4	152x152 - MW54xMW54	5.81	6x6 - W8.3xW8.3	.166	119
	192.6	305x305 - MW59xMW59	8.25	12x12 - W9.1xW9.1	.091	69
	351.4	305x305 - MW107xMW107	9.72	12x12 - W16.6xW16.6	.166	125
D[1]	186.3	152x152 - MW28xMW28	3.22	6x6 - W4.4xW4.4	.088	63
	338.7	152x152 - MW52x52	5.61	6x6 - W8xW8	.160	115
	186.3	305x305 - MW57xMW57	3.22	12x12 - W8.8xW8.8	.088	66
	338.7	305x305 - MW103xMW103	5.61	12x12 - W16xW16	.160	120
E[1]	177.8	152x152 - MW27xMW27	3.08	6x6 - W4.2xW4.2	.084	60
	317.5	152x152 - MW48xMW48	5.52	6x6 - W7.5xW7.5	.150	108
	175.7	305x305 - MW54xMW54	3.08	12x12 - W8.3xW8.3	.083	63
	317.5	305x305 - MW97xMW97	5.52	12x12 - W15xW15	.150	113

[1] Group A - Compares areas of WWR at a minimum f_y = 65,000 psi.
Group B - Compares areas of WWR at a minimum f_y = 70,000 psi
Group C - Compares areas of WWR at a minimum f_y = 72,500 psi
Group D - Compares areas of WWR at a minimum f_y = 75,000 psi
Group E - Compares areas of WWR at a minimum f_y = 80,000 psi
} with areas of #3 or #4 rebar at 12" o.c. at minimum f_y = 60,000 psi

[2] Wires may also be deformed, use prefix MD or D, except where only MW or W is required by building codes (usually less than a MW26 or W4). Also wire sizes can be specified in 1mm[2] (metric) or .001 in.[2] (US Customary) increments.
[3] For other available styles or wire sizes, consult other WRI publications or discuss with WWR manufacturers.
[4] Styles may be obtained in roll form. Note: It is recommended that rolls be straightened and cut to size before placement.

C06

Wire Reinforcement Institute • P.O. Box 450 • Findlay, OH 45839-0450
(419) 425-9473 • FAX (419) 425-5741 • wirereinforcement.org

Wire Reinforcement Institute • P.O. Box 450 • Findlay, OH 45839-0450
(419) 425-9473 • FAX (419) 425-5741 • wirereinforcement.org

U.S. CUSTOMARY (INCH-POUND) WIRE SIZES AND AREAS

TABLE 3 - 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"	16"
W45	.757	1.530	1.80	1.35	.90	.45	.34
W31	.628	1.054	1.24	.93	.62	.31	.23
W20	.505	.680	.80	.60	.40	.20	.15
W18	.479	.612	.72	.54	.36	.18	.135
W16	.451	.544	.64	.48	.32	.16	.12
W14	.422	.476	.56	.42	.28	.14	.105
W12	.391	.408	.48	.36	.24	.12	.09
W11	.374	.374	.44	.33	.22	.11	.083
W10.5	.366	.357	.42	.315	.21	.105	.079
W10	.357	.340	.40	.30	.20	.10	.075
W9.5	.348	.323	.38	.285	.19	.095	.071
W9	.338	.306	.36	.27	.18	.09	.068
W8.5	.329	.329	.34	.255	.17	.085	.064
W8	.319	.272	.32	.24	.16	.08	.06
W7.5	.309	.309	.30	.225	.15	.075	.056
W7	.299	.238	.28	.21	.14	.07	.053
W6.5	.288	.221	.26	.195	.13	.065	.049
W6	.276	.204	.24	.18	.12	.06	.045
W5.5	.265	.187	.22	.185	.11	.055	.041
W5	.252	.170	.20	.15	.10	.05	.038
W4.5	.239	.153	.18	.135	.09	.045	.034
W4	.226	.136	.16	.12	.08	.04	.03
W3.5	.211	.119	.14	.105	.07	.035	.026
W3	.195	.102	.12	.09	.06	.03	.023
W2.9	.192	.098	.116	.087	.058	.029	.022
W2.5	.178	.085	.10	.075	.05	.025	
W2.1	.162	.070	.084	.063	.042	.021	
W2	.160	.068	.08	.06	.04	.02	
W1.5	.138	.051	.06	.045	.03	.015	
W1.4	.134	.049	.056	.042	.028	.014	

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 Welded Wire Reinforcement Manual of Standard Practice and Structural Welded Wire Reinforcement Detailing Manual, both published by the Wire Reinforcement Institute.

C07

WRI Members and Phone Numbers

PRODUCER MEMBER COMPANIES	Address	Phone	Fax
U.S. PRODUCER MEMBERS			
Cargill Steel & Wire	4006 Beltline Road, Suite 280 LB16; Addison, TX 75001	972 716 6700	972 716 6710
Connecticut Steel Corporation	35 Toelles Rd.; Wallingford, CT 06492	800 221 0323	203 265-7676
Davis Wire Corporation	19411 80th Ave., South; Kent, WA 98032-1190	800 872 8920	253 395 3729
EWP, Inc.	1200 N. Warpole Street; Upper Sandusky, OH 43351	800 842 8581	419 294 1019
Insteel Wire Products	1373 Boggs Drive; Mt. Airy, NC 27030	800 334 9504	336 786 6682
Iowa Steel & Wire	1500 W. Van Buren; Centerville, Iowa 52544	515 856 6300	515 437 1667
Ivy Steel & Wire	515 W. Greens Rd., Suite 710; Houston, TX 77067	800 254 0080	281 876 1648
Oklahoma Steel & Wire Co., Inc.	PO Box 220 (Highway 70 South); Madill, OK 73446	800 654 4164	580 795 5841
CANADIAN PRODUCER MEMBERS			
Eastern Reinforcing Ltd.	80 Heri Dunant Street; Moncton, NB; E1E 1E6 Canada	506 857 8141	506 859 7295
Numesh, Inc.	3000 Francis Hughes; Laval, Quebec; H7L 3J5 Canada	450 663 8700	450 663 9049
Tree Island Industries, Ltd.	PO Box 50; New Westminster, BC; V3L 4Y1 Canada	800 663 8757	604 524 9638
OVERSEAS PRODUCER MEMBERS			
Acerocentro	Av. Gis S/N; Cd. Industrial; C.P. 37490 A.P. 1-939; Léon, Gto., Mexico	011 52 4 710 9100	011 52 4 710 9117
Anchor Wire Ltd.	PO Box 97855; South Auckland Mail Centre; Manukau City, New Zealand	011 64 9 266 6666	011 64 9 266 2992
Chain Link Fence & Wire Products	PO Box 11978; Caparra Heights Station; San Juan, PR 00922	787 251 1000	787 251 1011
Gerdau SA	Rua Cenno Sbrighi; 170 Centro Empresarial Iudice; Edifico II, 05036-010 A'Gua Branca; Sao Paulo SP, Brazil	011 55 113874 4130	011 55 113874 4211
Golik Metal Manufacturing Co., Ltd.	D.D. 77, Lot No. 187, Ping Che Rd.; Ping Yeung New Village, Fanling Nt; Hong Kong	011 852 2674 3580	011 852 2674 9585
Insular Wire Products	PO Box 457; Catano, PR 00963-0457	787 798 6666	787 798 5962
Tah Chung Steel Corporation	669 Sec.1, Hsiang Shang Road; Taichung, Taiwan	011 886 4 383 3333	011 886 4 383 2102
ASSOCIATE MEMBER COMPANIES	**Address**	**Phone**	**Fax**
3M – Corrosion Protection Products	2179 Stanich St.; N. Maplewood, MN 55109	651 770 7327	651 770 7328
A.W.M. sri Automatic Welding Machines	S.S. 13 Pontebbana – Km. 146; 33010 Magnano In Riviera (Udine); Italy	011 39 432 791939	011 39 432 791949
B.L. Downey Company, Inc.	2125 Gardner Road; Broadview, IL 60153	800 323 1206	708 345 8017
Clifford Machinery	55 Adams Circle; P.O. Box 1678, Russelville, KY 42276	270 725 8232	270 725 8852
EVG, Inc.	220 East 42nd St., Suite 3100; New York, NY 10017	212 697 0770	212 687 1586
Ferrostaal, Inc.	16510 Northchase Drive; Houston, TX 77060	281 999 9995	281 999 4143
Morgan-Koch Corp.	88 Cresant St.; Worcester, MA 01608	508 793 1945	508 793 2163
Dupont Powder Coating U.S.A., Inc.	9800 Genard Road; Houston, TX 77041	713 939 4000	713 939 4027
Impianti Industriali SPA	Zona Industriale Rivoli; 33010 Osoppo (Udine); Italy	011 39 432 98 1811	011 39 432 98 1810
Lane Enterprises	1244 Claremont Road; Carlisle, PA 17013	717 249 0245	717 249 4991

C08

wri CASE STUDY

WIRE REINFORCEMENT INSTITUTE • EXCELLENCE SET IN CONCRETE

CS-299-R-01

Pavement and Slabs Researched...

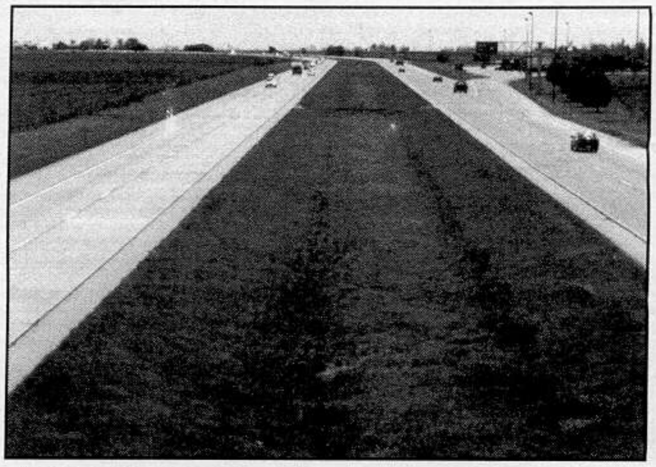
Studies Show Properly Covered WWR Produces High Performance Concrete

Three research studies have shown that properly covered welded wire reinforcement (WWR) produces high performing, durable concrete structures that continue to serve their owners well after as many as 30 years or more of use.

In fact, principal researcher, Professor Luke Snell of Southern Illinois University at Edwardsville, noted that research results in at least one study indicated the concerns some design professionals have about the use of WWR are not justified. Professor Snell, who conducted his research project for WRI, studied the performance of both concrete highway paving and industrial slabs-on-ground that were constructed using WWR.

A key element in these examinations was determining the depth of WWR and comparing the results to specifications at the time of construction. This was accomplished with the aid of a battery-powered cover meter that induces a magnetic field into the concrete through a hand-held probe. Steel in the pavement/slab will disturb the induced field, resulting in a variation of the field that is proportional to the depth of the steel. Past research has proven the equipment to be very accurate in determining the amount of cover. Another element in the examination was a visual inspection to determine the current state of the pavement/slabs.

In all three cases, Professor Snell's results showed that 95 percent or more of the WWR cover measurements were in compliance with the original specifications and that the cover for the reinforcement was determined to be acceptable. In the case of the 30-plus-year-old highway, Professor Snell found the pavement to be in good shape for its age. Some micro surface cracking existed, but no major stress cracks or displacement at joints or intermediate cracks existed. Both industrial slabs [one in excess of 10 years old, the other just under four] were judged excellent in overall appearance, despite "non-existent" maintenance.



The Illinois DOT test section on interstate I-57, south of Champaign, IL.

An expanded discussion of Professor Snell's work and findings is presented below.

Improved Durability
Properly Covered WWR Highway Pavement Still Serving Illinois More Than 30 Years Later

CASE STUDY 1

A 3-mile section of interstate route I-57, south of Champaign, IL, was chosen as a test subject for Professor Snell's research in part because the Illinois Department of Transportation (DOT) had elected to keep this portion of the highway open for study. Its original surface, therefore, has never had an overlayment.

Mr. Milt Sees, vice president of Southern Illinois Concrete Products, Inc., in Mt. Vernon, IL, designed the roadway over 30 years ago [mid 1960s] when he worked for the IL DOT. Mr. Sees, who is a past executive director of WRI, provided photos for this case study. The roadway he designed is reinforced with one layer of WWR 6 x 12-W8.6 x W8.6 (152 x 305-MW55 x MW55) which was placed in the top portion of the 10"

C09

Wire Reinforcement Institute • P.O. Box 450 • Findlay, OH 45839-0450
(419) 425-9473 • FAX (419) 425-5741 • wirereinforcement.org

The Illinois DOT has not added an overlayment to the test section so they can study it.

The Illinois DOT test section has given acceptable performance for over 30 years.

thick cross-section. The concrete was placed in two strikeoffs, one 7" (178mm) thick pour and the other 3" (76mm) thick. The sheets of WWR were placed in between the two strikeoffs.

The location of the WWR was within the depth tolerance that IL DOT specified, or 2.5" (64mm) ± 1" (25mm). The contractor actually placed the reinforcing with 3" (76mm) of cover. Forty locations were randomly selected to determine the cover of the pavement reinforcement, WWR. Test results showed an average cover of 3" (76mm) with a standard deviation of 0.07 inch. At all measured locations, the WWR was within the stated tolerance of 1-1/2 (38mm) to 3-1/2 (89mm) inches. Thus, 95% or more of the WWR cover measurements were within compliance. The cover for the reinforcement was determined to be acceptable.

Professor Snell's summary of his study stated: "Based on the research, the concerns some design professionals have about the use of WWR are not justified. The cover of WWR can be controlled within specification limits if the reinforcement is in sheet form and adequate supports are provided. The paving project has been in use for over 30 years and has given acceptable performance for the owners." Professor Snell found the paving to be in good shape for its age. Some micro surface cracking exists, but no major stress cracks or displacement at joints or intermediate cracks exists.

TWO WWR INDUSTRIAL BUILDING SLABS-ON-GROUND SHOW HIGH DEGREE OF DURABILITY FOR HEAVY LOADS.

Professor Snell's reported findings:

CASE STUDY 2

This first of two buildings researched for appropriate cover is a slab on ground at a large manufacturing plant in North Carolina constructed approximately 10 years ago. The specifications required welded wire reinforcement i.e., WWR14 x 14- D6 x D6 (356 x 356- MD39 x MD39) with a cover of 2 inches (52 mm). The design professional did not specify a tolerance limit. The contractor, Baker Construction of Monroe, Ohio, used a tolerance limit for the WWR of 1/3 to1/2 the depth of the slab thickness. The slab had a total depth of 6 inches (152 mm). In a conversation with the contractor's project manager, he stated that the WWR was placed on supports and that a great deal of attention was given to keeping the WWR at the correct depth.

Thirty locations were randomly selected to determine the cover of the WWR with Professor Snell's cover meter. The testing indicated that the average cover was 2.36 inches (60 mm) with a standard deviation of 0.11 inches (3 mm). At all measured locations, the

Professor Snell and the battery-powered cover meter used to detect placement of WWR reinforcement in the industrial slabs.

C10

- WRI MEMBER'S ADDRESSES, PHONES, FAXES, AND E-MAIL -

Click on underlined company names to visit their website

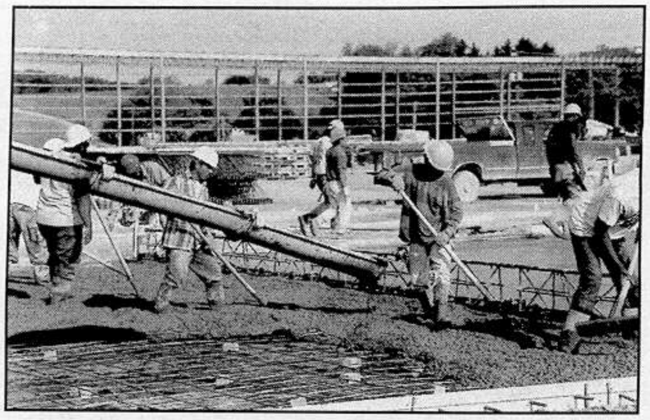
PRODUCER MEMBER COMPANIES	ADDRESS	PHONE	FAX	e-MAIL
U.S. PRODUCER MEMBERS				
Cargill Steel & Wire	4006 Beltline Rd, Suite 280 LB16 Addison, TX 75001	972-716-6700	972-716-6710	Mr. Larry Virtue
Connecticut Steel	35 Toelles Rd Wallingford, CT 06492	800-221-0323	203-265-7676	Mr. Alan White
Davis Wire Corp.	19411 80th Ave., South Kent, WA 98032-1190	800-872-8920	253-395-3729	Mr. Mike Quirk
EWP, Inc.	1200 N. Warpole Street Upper Sandusky, OH 43351	800-842-8581	419-294-1019	Mr. Phil Ross
Insteel Wire Products	1373 Boggs Drive Mt. Airy, NC 27030	800-334-9504	336-786-6682	Ms. Frankie Hatley
Insular Wire Products	PO Box 457 Catano, PR 00963-0457	787-798-6666	787-798-5962	- - -
Iowa Steel and Wire	1500 W. Van Buren Centerville, Iowa 52544	641-856-6300	641-437-1667	Mr. Scott Kelso
Ivy Steel and Wire	515 W. Greens Road, Suite 710 Houston, TX 77067	800-254-0080	281-876-1648	Mr. Mike McCall
Oklahoma Steel & Wire Co, Inc.	PO Box 220 (Hwy 70 S.) Madill, OK 73446	800-654-4164	580-795-5841	Mr. David Weinand
Protecto Manufacturing Corp.	PO Box 11978 Caparra Heights Station San Juan, PR 00922-1978	787-251-1000	787-251-1011	Mr. Rafael Nido, Jr.
CANADA PRODUCER MEMBERS				
Eastern Reinforcing Ltd.	80 Heri Dunant Street Moncton, NB E1E 1E6 Canada	506-857-8141	506-859-7295	Mr. Jim Kelly
Numesh, Inc.	3000 Francis Hughes Laval, Quebec H7L 3J5 Canada	450-663-8700	450-663-9049	Mr. Pierre Girard
Tree Island Industries, Ltd.	PO Box 50 New Westminster, BC V3L 4Y1 Canada	800-663-8757	604-524-9638	Mr. Ted Leja
MEXICO PRODUCER MEMBERS				
Acerocentro	Acerocentro S.A. DE C.V. Av. Gis S/N Cd. Industrial C.P. 37490 A.P. 1-939 Léon , Gto. México	011-52-4-710-9100	011-52-4-710-9117	Mr. Federico Zermeno Padilla
S. AMERICA PRODUCER MEMBERS				
Gerdau SA	Rua Cenno Sbrighi 170 Centro Empresarial Iudice Edifico II, 05036-010 A'Gua Branca Sao Paulo SP, Brazil	011-55-11-874-4132	011-55-11-874-4211	- - -
OVERSEAS PRODUCER MEMBERS				
Anchor Wire, Ltd.	PO Box 97855 South Auckland Mail Centre Manukau City, New Zealand	011-64-9-266-6666	011-64-9-266-2992	Mr. Lynton Russell
Golik Metal Manufacturing Co., Ltd.	D.D. 77, Lot No. 187,Ping Che Rd. Ping Yeung New Village, Fanling Nt Hong Kong	011-852-2674-3580	011-852-2674-9585	Mr. Robert Davies
Tah Chung Steel Corp.	669 Sec.1,Hsiang Shang Road Taichung, Taiwan	011-886-4-383-3333	011-886-4-383-2102	- - -
ASSOCIATE MEMBER COMPANIES	ADDRESS	PHONE	FAX	e-MAIL
U.S. ASSOCIATE MEMBERS				

B.L. Downey Company, Inc.	2125 Gardner Road Broadview, IL 60153 43351	800-323-1206	708-345-8017	Mr. Bernie Downey
Clifford Machinery	55 Adams Circle PO Box 1678 Russellville, KY 42276	270-725-8232	270-725-8852	Mr. Scott Liebenberg
EVG, Inc.	220 East 42nd St, Suite 3100 New York, NY 10017	212-697-0770	212-687-1586	Mr. Fred Bresani
Ferrostaal Inc.	16510 Northchase Drive Houston, TX 77060	281-999-9995	281-999-4143	Mr. Chris Stauffer
Dupont Powder Coatings U.S.A., Inc.	9800 Genard Road Houston, TX 77041	713-939-4000	713-939-4027	Mr. Fritz Herrmann
Lane Enterprises	1244 Claremont Road Carlisle, PA 17013	717-249-0245	717-249-4991	Mr. Bob Garretson
Morgan-Koch Corp.	88 Cresant St Worcester, MA 01608	508-793-1945	508-793-2163	Mr. Ronald Garceau
OVERSEAS ASSOCIATE MEMBERS				
A.W.M. srl Automatic Welding Machines	S.S. 13 Pontebbana - Km. 146 33010 Magnano In Riviera (Udine) Italy	011-39-0432-791949	011-39-0432-79139	- - -
Impianti Industriali SPA	Zona Industriale Rivoli 33010 Osoppo (UD) Italy	011-39-0432-98-1811	011-39-0432-98-1810	Mr. Guido Ricci

Back to INFO PAGE

Wire Reinforcement Institute • P.O. Box 450 • Findlay, OH 45839-0450
(419) 425-9473 • FAX (419) 425-5741 • wirereinforcement.org

WWR was between the 1/3 and 1/2 the depth (no measurements were out of tolerance limits). This testing indicated that 95% or more of the WWR cover measurements were within compliance and the cover for the WWR was acceptable.



Workers walk on or into wide spaced welded wire reinforcement without deflecting or displacing it during concrete placement.

CASE STUDY 3

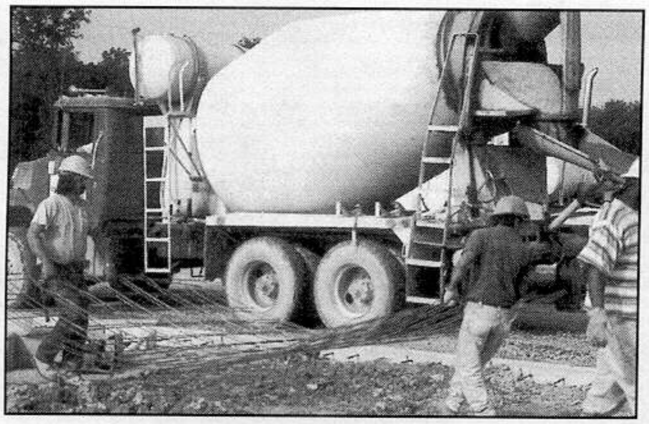
The second industrial building case history was a slab on ground of a large distribution facility built approximately 4 years ago. The slab is reinforced with WWR12 x 12-D8 x D8 (305 x 305-MD52 x MD52) with a cover of 2 inches (52 mm). The design professional did not specify a tolerance limit; thus a tolerance limit was set by the contractor, Murphy & Son, Southaven, MS for placement of the WWR to be in the upper 1/3 to 1/2 of the slab thickness. The slab had a depth of 6 inches (152 mm). During construction, there was an independent inspection of the construction, which indicated the WWR was uniformly supported with approximately 2 inches (50 mm) of cover.

Fifty two locations were randomly selected to determine the cover of the WWR. The testing indicated the average cover was 2.64 inches (66 mm) with a standard deviation of 0.25 inches (6 mm). Four values were outside of the tolerance limits (were not in the upper 1/3 to 1/2 the depth of the slab). The overall testing indicated that 95% or more of the WWR measurements were in compliance and that the cover for the WWR was acceptable.

A final note on the two industrial slabs – overall appearance of both projects was excellent. Intermediate cracking was minimal. No wide cracks were noticed, thus no displacement. No breakdown or excessive wear at contraction joints was observed. Both owners advised that maintenance on the slabs was non-existent and they both were very satisfied with their performance.

Professor Snell's report can be read in it's entirety by contacting the Hanley-Wood Group in Addison, Illinois. It is published in the July 1997 issue of Hanley-Wood's Concrete Construction periodical and is titled: "Cover of Welded Wire Reinforcement in Slabs and Pavements." We are very grateful to the Illinois DOT for their assistance in rerouting traffic and providing a safe working area to do the necessary research work. Also, the two owners of the industrial plants were very receptive and assisted in providing background materials for the studies. The WRI wishes to thank Professor Snell for his thorough research and the owners and contractors that provided input. WRI is very grateful to the Aberdeen Group for publishing the article referred to above.

Please turn the page for a listing of WRI Members and Associate Members.



It only takes two workers to easily carry two 8' x 15' sheets of WWR.

Workers walk on or into wide spaced welded wire reinforcement without deflecting or displacing it during concrete placement.

C11

WRI Members and Phone Numbers

PRODUCER MEMBER COMPANIES	Address	Phone	Fax
U.S. PRODUCER MEMBERS			
Cargill Steel & Wire	4006 Beltline Road, Suite 280 LB16; Addison, TX 75001	972 716 6700	972 716 6710
Connecticut Steel Corporation	35 Toelles Rd.; Wallingford, CT 06492	800 221 0323	203 265-7676
Davis Wire Corporation	19411 80th Ave., South; Kent, WA 98032-1190	800 872 8920	253 395 3729
EWP, Inc.	1200 N. Warpole Street; Upper Sandusky, OH 43351	800 842 8581	419 294 1019
Insteel Wire Products	1373 Boggs Drive; Mt. Airy, NC 27030	800 334 9504	336 786 6682
Iowa Steel & Wire	1500 W. Van Buren; Centerville, Iowa 52544	515 856 6300	515 437 1667
Ivy Steel & Wire	515 W. Greens Rd., Suite 710; Houston, TX 77067	800 254 0080	281 876 1648
Oklahoma Steel & Wire Co., Inc.	PO Box 220 (Highway 70 South); Madill, OK 73446	800 654 4164	580 795 5841
CANADIAN PRODUCER MEMBERS			
Eastern Reinforcing Ltd.	80 Heri Dunant Street; Moncton, NB; E1E 1E6 Canada	506 857 8141	506 859 7295
Numesh, Inc.	3000 Francis Hughes; Laval, Quebec; H7L 3J5 Canada	450 663 8700	450 663 9049
Tree Island Industries, Ltd.	PO Box 50; New Westminster, BC; V3L 4Y1 Canada	800 663 8757	604 524 9638
OVERSEAS PRODUCER MEMBERS			
Acerocentro	Av. Gis S/N; Cd. Industrial; C.P. 37490 A.P. 1-939; Léon, Gto., Mexico	011 52 4 710 9100	011 52 4 710 9117
Anchor Wire Ltd.	PO Box 97855; South Auckland Mail Centre; Manukau City, New Zealand	011 64 9 266 6666	011 64 9 266 2992
Chain Link Fence & Wire Products	PO Box 11978; Caparra Heights Station; San Juan, PR 00922	787 251 1000	787 251 1011
Gerdau SA	Rua Cenno Sbrighi; 170 Centro Empresarial Iudice; Edifico II, 05036-010 A'Gua Branca; Sao Paulo SP, Brazil	011 55 113874 4130	011 55 113874 4211
Golik Metal Manufacturing Co., Ltd.	D.D. 77, Lot No. 187, Ping Che Rd.; Ping Yeung New Village, Fanling Nt; Hong Kong	011 852 2674 3580	011 852 2674 9585
Insular Wire Products	PO Box 457; Catano, PR 00963-0457	787 798 6666	787 798 5962
Tah Chung Steel Corporation	669 Sec.1, Hsiang Shang Road; Taichung, Taiwan	011 886 4 383 3333	011 886 4 383 2102
ASSOCIATE MEMBER COMPANIES	**Address**	**Phone**	**Fax**
3M – Corrosion Protection Products	2179 Stanich St.; N. Maplewood, MN 55109	651 770 7327	651 770 7328
A.W.M. sri Automatic Welding Machines	S.S. 13 Pontebbana – Km. 146; 33010 Magnano In Riviera (Udine); Italy	011 39 432 791939	011 39 432 791949
B.L. Downey Company, Inc.	2125 Gardner Road; Broadview, IL 60153	800 323 1206	708 345 8017
Clifford Machinery	55 Adams Circle; P.O. Box 1678, Russelville, KY 42276	270 725 8232	270 725 8852
EVG, Inc.	220 East 42nd St., Suite 3100; New York, NY 10017	212 697 0770	212 687 1586
Ferrostaal, Inc.	16510 Northchase Drive; Houston, TX 77060	281 999 9995	281 999 4143
Morgan-Koch Corp.	88 Cresant St.; Worcester, MA 01608	508 793 1945	508 793 2163
Dupont Powder Coating U.S.A., Inc.	9800 Genard Road; Houston, TX 77041	713 939 4000	713 939 4027
Impianti Industriali SPA	Zona Industriale Rivoli; 33010 Osoppo (Udine); Italy	011 39 432 98 1811	011 39 432 98 1810
Lane Enterprises	1244 Claremont Road; Carlisle, PA 17013	717 249 0245	717 249 4991

C12