



# Wires and Strands for Prestressed Concrete

Raw Materials | Manufacturing Process



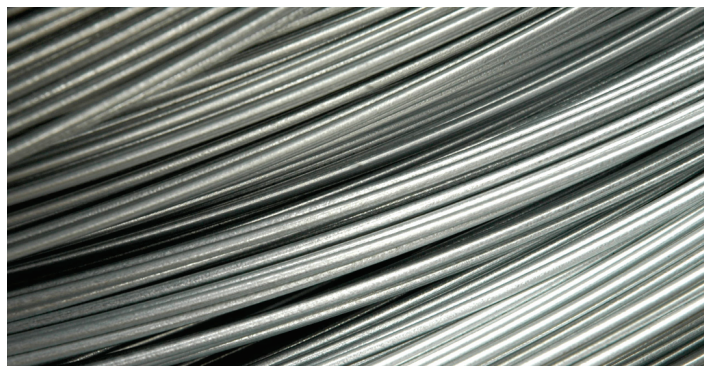
## 1 WIRES AND STRANDS FOR PRESTRESSED CONCRETE

### 1.1 Wires

EMCOCABLES® manufactures a wide variety of wires with a high carbon content in which there are wires for reinforced concrete used in structures of small and medium dimensions.

The base standards of the product are: ASTM A 421, NTC 159, UNE 36094, and ASTM A 881. The wires are manufactured either plain or deformed in accordance with their diameters and/or reference standard.

The wires are used specifically in prefabricated structures. (See Table 1)



WIRE MECHANICAL REQUIREMENTS FOR REINFORCED CONCRETE

TABLE 1

Nominal Diameter		Diameter Tolerance (+/-)		Indentation Depth (mm)		Min.	1% Min. Load		Min. Break load		Applicable Standards
in	mm	in	mm	Min.	Max.	%	lbf	kgf	lbf	kgf	
0.0985	2.50	0.001	0.03	N.A	N.A	3.5	1,555	705	1,877	851	ASTM A 421
0.118	3.00	0.001	0.03	N.A	N.A	3.5	2,255	1,023	2,644	1,200	ASTM A 421
0.157	4.00	0.002	0.04	0.051	0.127	3.5	4,190	1,900	4,740	2,100	ASTM A 421
0.197	5.00	0.002	0.05	0.076	0.152	4.0	6,286	2,850	7,166	3,250	ASTM A 421
0.207	5.26	0.002	0.05	0.101	0.180	3.5	7,211	3,272	8,485	3,850	ASTM A 421
0.236	6.00	0.002	0.05	0.076	0.152	4.0	8,710	3,950	9,923	4,500	ASTM A 421
0.276	7.00	0.002	0.05	0.101	0.203	4.5	11,466	5,200	13,120	5,950	ASTM A 421
0.198	5.03	0.003	0.08	0.076	0.152	3.0	5,882	2,667	6,920	3,138	ASTM A 881
0.216	5.50	0.003	0.08	0.076	0.152	3.0	6,545	2,968	7,700	3,492	ASTM A 881
0.196	4.98	0.002	0.05	0.076	0.152	4.0	6,155	2,791	7,241	3,284	ASTM A 421/ UNE 36094 *
0.250	6.35	0.002	0.05	0.076	0.152	4.0	10,013	4,541	11,781	5,342	ASTM A 421/ UNE 36094 *
0.276	7.01	0.002	0.05	0.076	0.152	4.0	11,950	5,420	14,059	6,376	ASTM A 421/ UNE 36094 *

\*UNE 36094 Applicable for drawing process and the ASTM A 421 for mechanical properties. For cross of rail-road ASTM A 881.

## 1.2 Strands

Generally the strands involve one central wire and six exterior ones, stranded helically around it. These strands are manufactured without a coating, with a zinc coating and/or high-density polyethylene, according to the specifications and applications defined by the client. Standards Post-Tensioning Institute (PTI) and ASTM A 416.

In addition to 7 wire strands, **EMCOCABLES®** manufactures two or three Bifilar strands, based on company and/or international standards. **EMCOCABLES®** also produces indented strands based on the ASTM A 886 standard.

The dimensions and properties of the strands are shown in the tables 2 and 3.

TABLE 2			
Diameter mm (in)	Min. Breaking Strength, kN (lbf)	Strand Steel Area mm <sup>2</sup> (in <sup>2</sup> )	Weight Kg/1000m (lb/1000ft)
Grade 1725 (250)			
6.40 (0.250)	40.0 (9,000)	23.2 (0.036)	182 (122)
7.90 (0.313)	64.5 (14,500)	37.4 (0.058)	294 (197)
9.50 (0.375)	89.0 (20,000)	51.6 (0.080)	405 (272)
11.10 (0.438)	120.1 (27,000)	69.7 (0.108)	548 (367)
12.70 (0.500)	160.1 (36,000)	92.9 (0.144)	730 (490)
15.20 (0.600)	240.2 (54,000)	139.4 (0.216)	1,094 (737)
Grade 1860 (270)			
9.53 (0.375)	102.3 (23,000)	54.80 (0.085)	432 (290)
11.11 (0.438)	137.9 (31,000)	74.2 (0.115)	582 (390)
12.70 (0.500)	183.7 (41,300)	98.70 (0.153)	775 (520)
15.24 (0.600)	260.7 (58,600)	140.0 (0.217)	1,102 (740)

TABLE 3			
Diameter mm (in)	Initial Load kN (lbf)	Min. 1% tension load	
		Low Relaxation KN (lb)	Regular Relaxation
Grade 1725 (250)			
6.40 (0.250)	4.0 (900)	36.0 (8,100)	34.0 (7,650)
7.90 (0.313)	6.5 (1,450)	58.1 (13,050)	54.7 (12,300)
9.50 (0.375)	8.9 (2,000)	80.1 (18,000)	75.6 (17,000)
11.10 (0.438)	12.0 (2,700)	108.1 (24,300)	102.3 (23,000)
12.70 (0.500)	16.0 (3,600)	144.1 (32,400)	136.2 (30,600)
15.20 (0.600)	24.0 (5,400)	216.2 (48,600)	204.2 (45,900)
Grade 1860 (270)			
9.53 (0.375)	10.2 (2,300)	92.1 (20,700)	87.0 (19,550)
11.11 (0.438)	13.8 (3,100)	124.1 (27,900)	117.2 (26,350)
12.70 (0.500)	18.4 (4,130)	165.3 (37,170)	156.1 (35,100)

**Note 1:** The ASTM A 416 standard applies to the mechanical properties of steel strand manufactured with normal wires. The ASTM A 886 applies for the mechanical properties of strands made from indented steel wires.

**Note 2:** To convert lb/1000ft into oz/ft, multiply by 0.016.

## 1.3 P.E Extruded Strand

### Physical and Mechanical Properties

Breaking load at 1% strain, lay length and diameter are the same required properties as the uncoated strand. These are properties that are established by the ASTM A 416 standard and shown in tables 2 and 3.

The specifications for the extrusion are, in accordance with the Post-Tensioning Institute (PTI) are described in the following numeral.

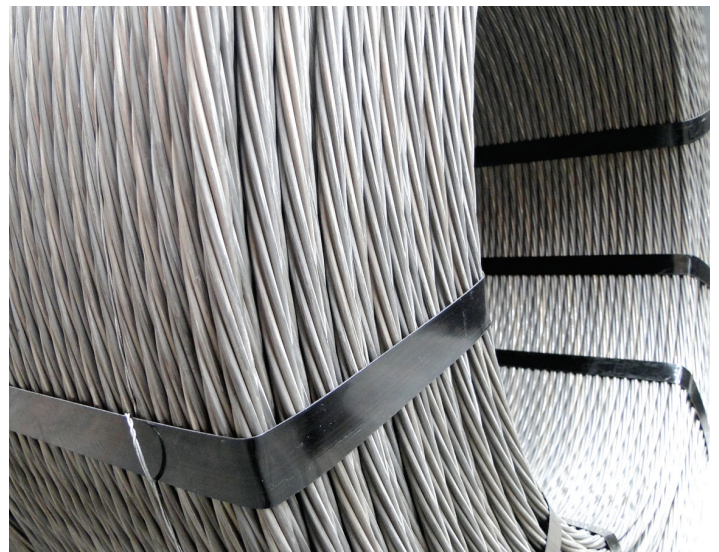
### P.E Extruded Properties

- Enough resistance and durability to avoid damage to the strand during manufacturing, transport, installation and or tensioning.
- Watertight over the entire jacketlength.
- Nonreactive with the concrete, the steel and the corrosion inhibited coating.
- The minimum thickness of the polyethylene jacket used shall not be less than 1.00mm (0.04 in)
- The minimum internal diameter of the jacket used shall be at least 0.76mm (0.030") greater than the maximum diameter of the strand.

### Corrosion Inhibiting Coating

The corrosion inhibiting coating material shall have the following properties:

- Chemically stable and nonreactive with steel, the jacket material and concrete.
- The coating shall have an appropriate polarity for displacing moisture.
- Provide suitable lubrication between the strand and the jacket.



## 1.4 Galvanized Strand

### Physical and Mechanical Properties

The physical and mechanical properties correspond to grade 270 and 250, as defined as ASTM A 416 standard for normal relaxation strands.

### Zinc Coating Properties

The zinc used to protect the wires of the strand must be of the steel high purity grade (SHG) [Special High Grade] in accordance with the standards set forth in the ASTM B 6 standard, to ensure adequate interface of Zinc-Iron with sufficient toughness, not fragile and suitable galvanic protection of steel.

The mass of the Zinc coating in g/m<sup>2</sup> should be homogenous throughout the length of the wires, thus complying with the required standards and/or specifications agreed with the client. For example, ASTM A 475, BS 183 (British Standard), ASTM A 363, EMCOCABLES® Standards and/or client standards.



# High – Carbon Wire Rod and other Raw Materials

## 2 | RAW MATERIAL

In order to insure a more consistant final product, it is critical that the base material has consistant and virgin properties. EMCO-CABLES S.A uses only wire rod produced from virgin iron ore that have above average purity levels of its iron ore content. The strict selection of our qualified wire rod producers insure that the grain size and homogeneity of the microstructure is consistant and replicable with each heat.

This is why EMCOCABLES S.A pc strand exhibits consistant results with each lot.

## 3 | MANUFACTURING PROCESS

### 3.1 Rod cleaning (Pickling)

In order to remove surface oxidation, the wire rod rolls are submerged in an ambient temperature acid solution. The time and concentration in the solution are highly controlled in order to avoid emvrittlement due to the absorption of hydrogen.

After the surface cleaning, the wire rod roll is cleaned with high-pressure water in order to remove any residual acid. The wire rod is neutralized with bórax and/or phosphate, compounds. That help in the subsequent drawing process. After this, is the neutralization with borax and/or phosphate, compounds that help with the following drawing process.

### 3.2 Drawing

This is a process of cold deformation that allows the reduction of diameter without cracks forming.

### 3.3 Stranding

Consists of helically stranded rolled steel wires around a core or nucleus, constituted by a wire with a greater diameter than the exterior wires.

### 3.4 Stress Relief

In order to relieve the deformations do to the cold working to the wires. The strands enter to stress relieving operation (low relaxation)

## 4 | PACKAGING

induction oven while specific load is applied to the strand, achieving a stable microstructure that guarantees less load loss when is used.

### 4.1 Wires

Wires are packed in coils and the weight of coils is previously agreed upon with the client.

### 4.2 Strands

Strands are packaged in reel-less coils, firmly strapped with steel belts and over a wooden crate.



## 5 | PROCESS CONTROL

The properties of the wires and strands are controlled during all stages of manufacturing, according to the quality control plan detailed in the flow chart below:



	ACTIVITIES	PARAMETERS TO CONTROL	MEASURING INSTRUMENTS
	Cleaning	1. Acid, Borax and Phosphate concentration grades	1. Neutralization, Acid-Base
	Drawing Process	1. Diameter 2. Break Load 3. Surface Condition	1. Micrometer 2. Tension Machine 3. Visual Inspection
	1. Transport to Stranding 2. Stress Relief (Wires to customers)	1. Identification 2. Diameter	1. Visual 2. Micrometer 3. Vernier
		1. Speed 2. Temperature 3. Break Load 4. Diameter	1. Turns of wheel/ watch 2. Pyrometer 3. Micrometer 4. Tension machine
	Enlistment of stranding machine	1. Dimensions of Tools	1. Gauges 2. Vernier
	Stranding	1. Lay Length 2. Direction of Length	1. Vernier 2. Visual
	Stress Relief	1. Temperature 2. Tension	1. Pyrometer 2. Ampmeter
	Final Wire Inspection	1. Diameter 2. Breaking Load 3. Bending 4. Depth of deformation	1. Micrometer 2. Tension Machine 3. Bending Device 4. Comparator
		1. Lay Length 2. Diameter 3. Load at 1% strain 4. Breaking Load 5. Relaxation Test	1. Calipers 2. Micrometer 3. Extensometer 4. Tension Machine 5. Relaxation Machine
	Final Strand Inspection		
	Storage and Dispatch	1. Quantity	1. Scale



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