

Fire Engineering[®]

Construction Concerns: Concrete Reinforcing Steel

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By Gregory Havel

For www.fireengineering.com

Photos by author.

Concrete is composed of large aggregate (gravel), small aggregate (sand), Portland cement, and water. It can be classified as either cast-in-place or precast concrete.

Reinforced cast-in-place concrete is a composite material of concrete and steel reinforcement wire, cable, or steel bars; fiber-reinforced plastic bars; or plastic or steel fibers (fiber-mesh) that are mixed in the concrete.

Nineteenth-century rebar was made of cast iron or wrought iron in square, flat, or round shapes. Deformation (grooves or ridges) was added to help bond the concrete to the rebar. By the 1890s, most rebar was steel with a square cross-section, although some round rebar was available in small sizes. Steel is an excellent reinforcing material for concrete; both have the same coefficient of expansion when heated. However, steel rebar loses its tensile strength at relatively low temperatures and must be surrounded by concrete to make it fire resistive.

Photo 1 shows two sections of 1930s square steel rebar with a 1¼-inch (32 mm) square cross section. Photo 2 shows one end of a 1930s reinforced concrete beam that is being removed during the renovation of a theater. The large steel rebar has a 1¼-inch (32 mm) square cross section, while smaller rebar and stirrups that connect them have a ½-inch (12.5 mm) square cross section. Note that the ridges and grooves that were rolled into the rebar are widely spaced and shallow when compared to modern rebar.

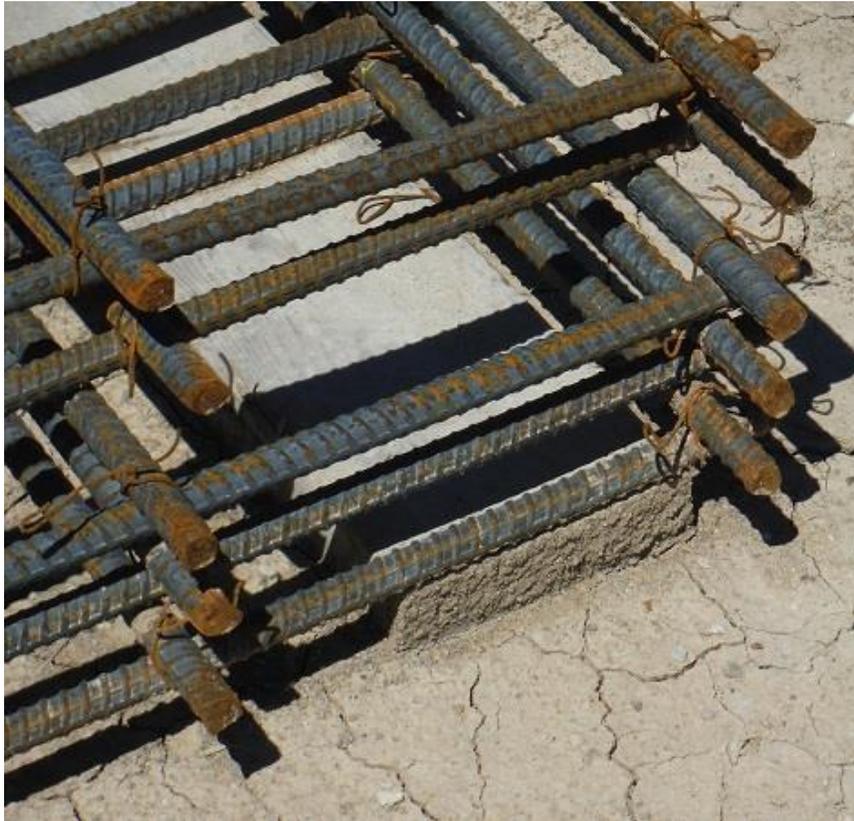


(1)



(2)

Modern rebar is usually round (photo 3) with ridges rolled into them both lengthwise and circumferentially. It is tied at connection points with uncoated steel wire. The most common is carbon steel, although other alloys including stainless steel are available. Some of these alloys have higher tensile and shear strength when compared to carbon steel rebar and, although they are more expensive than carbon steel per pound, you can use and install smaller sizes with less labor while achieving the same structural strength and some cost savings.



(3)

Some rebar is coated for corrosion resistance, including galvanizing (zinc coating) and epoxy coating. Photo 4 shows epoxy-coated rebar that will be embedded in concrete to form part of an outdoor platform supported by steel-reinforced columns. Note that epoxy-coated rebar is tied with uncoated steel wire and sprayed with epoxy paint when the connections are finished. The epoxy-coated rebar in photo 4 includes several sizes, from #4 [$\frac{1}{2}$ -inch (12.5 mm) diameter] to #11 [$1\frac{1}{2}$ -inch (32 mm) diameter]. You can tie galvanized steel rebar with galvanized steel wire or with uncoated steel wire and spray it with a zinc-based paint after tying.



(4)

Some modern rebar is nonmetallic and made of fiber- or glass-reinforced plastic. These are highly corrosion resistant and used where the reinforced concrete will be submerged in water or exposed to salt (which is corrosive) as it is in bridges, piers, seawalls, and breakwaters. These are also frequently used in the Middle East, where fresh water, sand, and gravel often contain salt. Fiber reinforced plastic rebar often has higher tensile strength and less stiffness when compared to carbon steel. It also has less fire resistance and requires deeper embedment in concrete to provide the same level of fire resistance as steel rebar.

In the United States and some other countries, smaller sizes of rebar are numbered by the 1/8-inch increments in its diameter, and larger sizes are numbered according to the cross-sectional areas of the older square rebar that have been replaced by round rebar. Rebar sizes in most other nations are based on metric measurements, while a few have their own numbering systems. See the table below for U.S. and metric rebar sizes.

STEEL REINFORCING BARS FOR CONCRETE							
DIMENSIONS							
U.S. "Imperial" Bar Size	Metric Size	Weight per foot (lb/ft)	Mass per meter (kg/m)	Nominal Diameter (inches)	Nominal Diameter (mm)	Nominal Area (in ²)	Nominal Area (mm ²)
#3	#10	0.376	0.561	0.375	9.525	0.110	71
#4	#13	0.668	0.996	0.500	12.700	0.200	129
#5	#16	1.043	1.556	0.625	15.875	0.310	200
#6	#19	1.502	2.240	0.750	19.050	0.440	284
#7	#22	2.044	3.049	0.875	22.225	0.600	387
#8	#25	2.670	3.982	1.000	25.400	0.790	509
#9	#29	3.400	5.071	1.128	28.650	1.000	645
#10	#32	4.303	6.418	1.270	32.260	1.270	819
#11	#36	5.313	7.924	1.410	35.810	1.560	1006
#14	#43	7.650	11.410	1.693	43.000	2.250	1452
#18	#57	13.600	20.284	2.257	57.330	4.000	2581
Source: www.harrissupplysolutions.com							

For more information on steel reinforcement for concrete, visit the Concrete Reinforcing Steel institute Web site at www.crsi.org or do an internet search for "reinforcing steel," "reinforced concrete," and "rebar."



Gregory Havel is a member of the Town of Burlington (WI) Fire Department; retired deputy chief and training officer; and a 30-year veteran of the fire service. He is a Wisconsin-certified fire instructor II, fire officer II, and fire inspector; an adjunct instructor in fire service programs at Gateway Technical College; and safety director for Scherrer Construction Co., Inc. Havel has a bachelor's degree from St. Norbert College; has more than 30 years of experience in facilities management and building construction; and has presented classes at FDIC.

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