Stainless Steel Reinforcement

Stainless steels extend the lifetimes of reinforced concrete structures.

When it comes to building or repairing reinforced concrete structures so that **life-cycle costs** are minimized, many authorities are specifying the use of **stainless steel reinforcing bars** (rebars) instead of the traditional carbon steel rebars.
Stainless steels containing molybdenum (Mo) are the alloys of choice when "stainless rebar" is specified. Molybdenum is added to several grades of stainless steel to improve corrosion resistance, particularly pitting and crevice corrosion resistance in chloride-containing solutions. Commonly specified alloys for rebar are shown below (nominal compositions in weight %, balance iron):

Grade	Types	UNS No.	Cr	Ni	Mo	N	C (max.)	Resistance to chlorides
Type 316	austenitic	S31600	17	12	2.5		0.08	Good
Type 316L	austenitic	S31603	17	12	2.5		0.03	Better when welded
Type 316LN	austenitic	S31653	17	12	2.5	0.13	0.03	Better when welded
Alloy 2205	duplex	S31803	22	5	3.0	0.14	0.03	Best

These alloys can provide long-term corrosion resistance when concrete is exposed to chloride-containing environments, e.g., road salts and sea water. They have been used as rebar in highway bridges, ramps & barrier walls, parking garages, tunnels, sea walls & marine facilities, building foundations and restorations.

The US Federal Highway Administration (FHWA) organized extensive corrosion testing to find rebar materials that could extend the lifetime of reinforced concrete bridges to 75-100 years, when the concrete was contaminated with chlorides. Their 1998 report (FHWA-RD-98-153) concluded that Type 316 stainless steel rebars would be capable of providing that required lifetime.

Stainless steel components for concrete reinforcing: rebar, U-bent rebar, threaded rebar, tie-wire and rebar coupler. (Photo Courtesy of F. N. Smith)

Installation of stainless steel rebar at the French Creek Bridge, Chautauqua Co., NY. (Photo Courtesy of Dunkirk Specialty Steel)

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In Europe, Mo-containing stainless steel rebars have been widely used since the mid-80s. In North America, their use in highway bridges has been steadily growing since the mid-90s, with many large bridges being constructed or extensively repaired. Listed below are just a few examples of projects that have utilized stainless steel rebar.

Bridge on I 696, near Detroit, MI (1984)	Type 304 rebars (33t; 29,900 kg)
Underpass, near Newcastle, Tyneside, UK (1995)	Type 316 rebars (265t; 240,000 kg)
Bridge on Highway 407, near Toronto, Canada (1996)	Type 316LN rebars (12t; 11,000 kg)
Highway project near Ajax, Ontario, Canada (1998)	Type 316LN rebars (150t; 136,000 kg)
Ramp for Garden State Parkway, New Jersey (1998)	Alloy 2205 rebars (165t; 150,000 kg)
Smith River Bridge, Oregon (1998)	Type 316LN rebars (122t; 111,000 kg)
Haynes Inlet Slough Bridge, Oregon (2002-3)	Alloy 2205 rebars (400t; 363,000 kg)
Broadmeadows Bridge, Ireland (2003)	Type 316 rebars (186t; 169,000 kg)
French Creek, Chautauqua Co., NY (2003)	Type 316LN rebars (17t; 15,900 kg)
South Work St. Bridge, Falconer, NY (2004)	Alloy 2205 rebars (40t; 36,300 kg)
Bridge on I 29, Sioux Falls, South Dakota (2004)	Alloy 2205 rebars (37t; 34,000 kg)
Belt Parkway Bridge, Brooklyn, NY (2004)	Alloy 2205 rebars (200t; 181,440 kg)
Driscoll Bridge, NJ (2004-5)	Mostly Alloy 2205 (approx. 1300t)
Thorold Tunnel, Ontario, Canada	Type 316LN rebars (60t; 54,450 kg)
Woodrow Wilson Bridge linking Virginia and Maryland	Type 316LN & Alloy 2205 specified (approx. 1100t)
Parking garage, Brighton, MA	Type 316LN & Type 304L (21t; 18,640 kg)

Stainless steel rebar is substituted for carbon steel rebar only in critical parts of the structure that will experience corrosive conditions. For bridges, experience now indicates that the total project cost can increase by only 3% when using stainless steel rebar. The actual cost increase will, of course, depend on the size and complexity of the bridge.

Stainless steel rebars are produced according to ASTM A955. Depending on the stainless steel grade selected, yield strengths > 75 ksi (520 MPa) and tensile strengths >100 ksi (690 MPa) can be achieved.

The use of Mo-containing stainless steel rebar is expected to continue to increase as Federal, State, Provincial and local governments demand much lower maintenance costs, fewer disruptions and longer lifetimes for their bridges and other important concrete structures.

Along with stainless rebar, other stainless steel components such as tie-wire, rebar couplers, dowels and welded-wire mesh are available to complete the corrosion resistant system.

Please visit **www.stainless-rebar.org** for additional information on stainless steel rebar.

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