North American Stainless Rebar Data Sheet

Background:

For construction in the most demanding environments, including roadway structures exposed to road salt, marine, coastal, chemical processing plants, and wastewater treatment facilities, stainless steel rebar is the only material that can provide a 100 plus year service life. Its success is well-documented, with type 304 stainless steel rebar used in the construction of the Progreso Pier in 1941, and which still remains operational today. In contrast, a carbon steel pier built alongside it in 1969, only lasted 20 years and is no longer standing.

Not only is stainless steel rebar extremely corrosion resistant but it is ideal for various specialized applications. Its non-magnetic austenitic properties make it suitable for low magnetic permeability environments like MRI facilities. Its excellent ductility and toughness are advantageous in seismic zones. And its ability to maintain mechanical properties across a wide temperature range makes it a strong choice for LNG plants.

The modern stainless steel alloys of ASTM A955, listed below, offer enhanced strength without sacrificing corrosion resistance, thanks to improvements in both chemistry and manufacturing processes over the traditional stainless steel grades like 304 and 316.

What is Stainless Steel:

By definition stainless steel is an iron based alloy that needs to have a minimum 10.5% chromium content and maximum 1.2% carbon content. The minimum chromium is needed in order to form a passive chrome oxide layer which acts as a protective surface for the steel. In general there are five families of stainless steel (austenitic, ferritic, martensitic, duplex, and precipitation hardening), but only two of these are currently used in rebar applications.

Most of the rebar alloys produced to ASTM A955 have a carbon content less than 0.03%, which is well below the maximum 1.2% defined for stainless steel. This low level of carbon effectively prevents the formation of carbides that can adversely affect the corrosion resistance of the material. Additional alloying elements such as molybdenum and nitrogen are also added to improve the pitting resistance in chloride containing environments.

Chemical Composition of Rebar Alloys:

North American Stainless Produces the following ASTM A955 Alloys:

UNS	AISI	C	Mn	P	S	Si	Cr	Ni	Mo	N	Other
S24100	XM28	0.15	11.0 - 14.0	0.045	0.030	1.00	16.5 - 19.0	0.50 - 2.50	…	0.20 - 0.45	…
S31653	316LN	0.030	2.00	0.045	0.030	1.00	16.0 - 18.0	10.0 - 13.0	2.00 - 3.00	0.10 - 0.16	…
S32304	2304	0.030	2.50	0.040	0.030	1.00	21.5 - 24.5	3.0 - 5.5	0.05 - 0.60	0.05 - 0.20	Cu 0.05 - 0.60
S32205	2205	0.030	2.00	0.030	0.020	1.00	22.0 - 23.0	4.5 - 6.5	3.0 - 3.5	0.14 - 0.20	…

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Austenitic Alloys

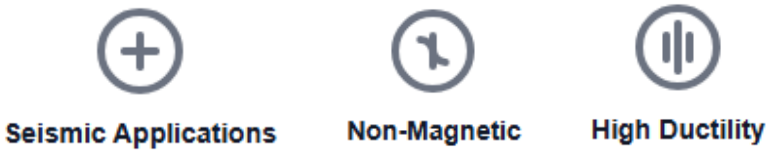
Are characterized by their higher chromium and nickel content with a face centered cubic structure that contributes to the materials non magnetic properties. These alloys can not be strengthened by heat treatment but their hardness can be improved through cold working.

XM28 (UNS S24100): The Seismic Austenitic

Austenitic stainless steel with manganese substituted in the place of nickel. The addition of nitrogen provides significantly higher tensile and yield strength without compromising its exceptional ductility. This makes it particularly suitable for applications in seismically active areas and for roadway infrastructure.

Recommended Use:

- Bridges and roadways in less severe corrosive environments
- Structures in seismic regions where high ductility is critical
- Projects requiring non magnetic material



316LN (UNS S31653): The Cryogenic Austenitic

Traditional low-carbon, nitrogen-strengthened, austenitic stainless steel. The addition of molybdenum and nitrogen significantly improves its corrosion resistance, making it one of the most effective grades for challenging environments. Its non-magnetic nature and excellent toughness at cryogenic temperatures make it an ideal choice for specialized applications.

Ideal for:

- Bridges and roadways in moderately corrosive environments
- Structures in seismically active regions where high ductility is crucial
- Projects requiring a non-magnetic material
- Material needing elevated strength at cryogenic temperatures

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Duplex Alloys

A duplex structure in stainless steel refers to a dual-phase microstructure composed of roughly equal parts of ferrite and austenite. Duplex alloys are balanced in such a way to have approximately 50% austenite and 50% ferrite. Compared to austenitic stainless steels they tend to have higher chromium and lower nickel. The ferritic phase consists of a body centered cubic structure and makes the material slightly magnetic. Overall, duplex stainless steels are characterized by their high strength and excellent corrosion resistance.

2304 (UNS S32304): The Workhorse

Low-alloy, lean duplex stainless steel with a balanced microstructure of approximately 50% ferrite and 50% austenite. This grade offers a higher yield and tensile strength than traditional austenitic grades, making it a strong choice for structural applications where a balance of strength and corrosion resistance is needed. Ideally suited as the workhorse of the rebar industry.

Recommended for:

- General construction and infrastructure in non-coastal areas
- Concrete structures where a strong balance of strength and corrosion resistance is needed

2205 (UNS S32205): The High Performance Duplex

Duplex stainless steel with molybdenum additions that combine the high strength of ferritic grades with the excellent corrosion resistance and toughness of austenitic grades. This dual phase microstructure provides outstanding mechanical and corrosion-resistant behavior, making it a preferred choice for harsh, highly corrosive environments.

Recommended In:

- The most demanding corrosion resistant environments including roadway structures laden with road salt, marine, and coastal.
- Concrete structures where a strong balance of strength and corrosion resistance is needed

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Corrosion Resistance:

Compared to other corrosion-resistant reinforcement, all rebar alloys manufactured to ASTM A955 offer outstanding corrosion resistance. However their relative corrosion resistance can be compared by using the PREN metric.

The Pitting Resistance Equivalent Number (PREN) indicates the stability of the passive layer when exposed to corrosive agents, particularly chloride. A higher PREN value signifies a more stable passive layer that corresponds with its corrosion resistance.

PREN = Cr + 3.3Mo + 16N (or 30N for Duplex material)

- **XM28 - 20 to 26** (suitable for less corrosive environments)
- **316LN - 25 to 30** (used in moderate to aggressive environments)
- **2304 - 23 to 32** (general purpose alloy for moderate environments)
- **2205 - 36 to 41** (alloy for most aggressive environments including marine and coastal)

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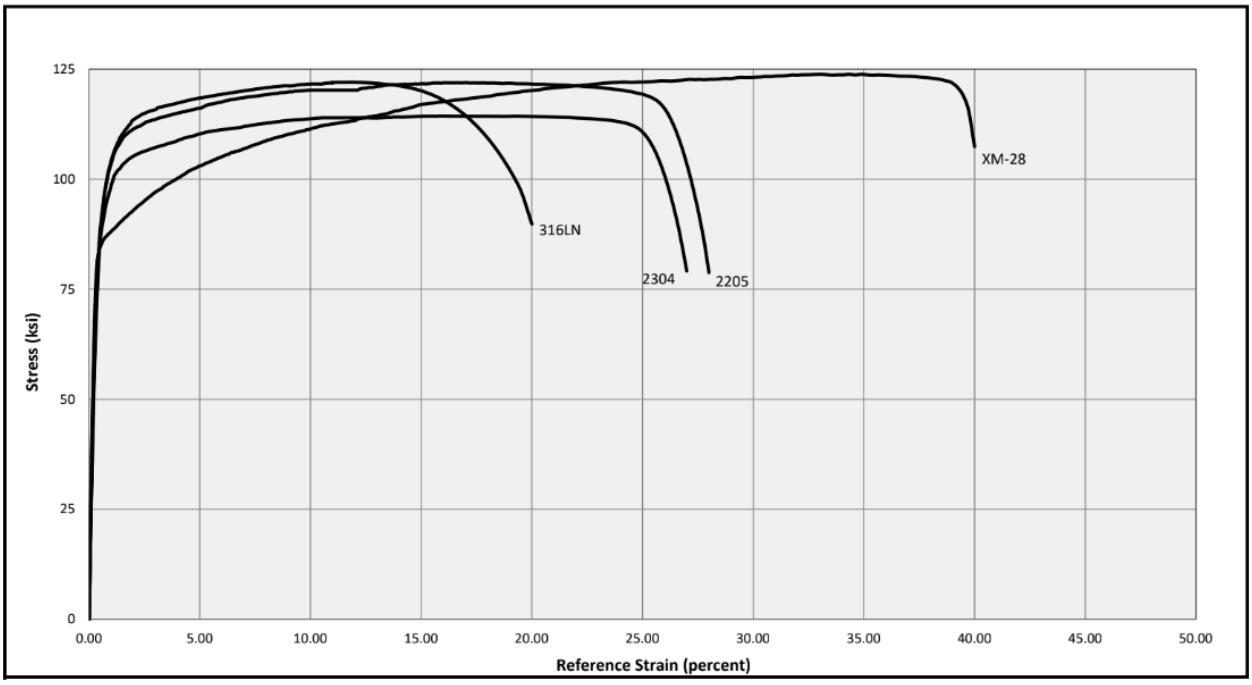
Mechanical Properties:

Rebar Grade	Yield Strength 0.2% (ksi)	Tensile Strength (ksi)	Elongation (%)	Tensile to Yield Ratio
Grade 60	60	90	20	1.20
Grade 75	75	100	20	1.20
Grade 80	80	100	16	1.20

*Minimum unless otherwise noted

Typical Stress Strain Curve:



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Bar Designations and Sizes:

- Bar sizes available from ASTM #7-#18 and CSA 20M -55M in lengths from 40-50 feet
- Coil sizes available from ASTM #3-#11 and CSA 10M-35M
- Metric sizes available upon request

USA (ASTM)	Canada (CSA)	Diameter		Bar Designation
		Inches	Millimeters	
#3		0.375	9.53	3
	10M	0.4449	11.30	10M
#4		0.500	12.70	4
#5		0.625	15.88	5
	15M	0.6283	15.96	15M
#6		0.750	19.05	6
	20M	0.7677	19.50	20M
#7		0.875	22.23	7
	25M	0.9921	25.20	25M
#8		1.000	25.40	8
#9		1.128	28.65	9
	30M	1.1772	29.90	30M
#10		1.270	32.30	10
	35M	1.4055	35.70	35M
#11		1.410	35.82	11
#14		1.693	43.00	14
	45M	1.7205	43.70	45M
	55M	2.2205	56.40	55M
#18		2.257	57.30	18

Certifications:

NAS produces reinforcement bar to the following:

- ASTM A955 and ASTM A276 (chemistry)
- Material is melted and manufactured in the USA and complies with the Build America, Buy America (BABA) Act
- AASHTO Product Evaluation Program
- AS9100 Quality Management System
- ISO 9001 Quality Management System
- ISO 17025 Chemistry and Mechanical Labs
- CPR (Construction Products Regulation)