STAINLESS STEEL FOR STRUCTURAL APPLICATIONS
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DIRECTORY OF STAINLESS STEEL STRUCTURAL PRODUCERS inside back cover

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INTRODUCTION

Stainless steel is not a single alloy, but rather the name applies to a group of iron-based alloys containing a minimum 10.5% chromium. Other elements are added and the chromium content increased to improve the corrosion resistance, improve heat resisting properties, enhance mechanical properties, and/or to improve fabricating characteristics. There are over 50 stainless steel grades that were originally recognized by the American Iron and Steel Institute (AISI). Three general classifications are used to identify stainless steel. They are: 1. Metallurgical structure. 2. The AISI numbering system (200, 300 and 400 series numbers). 3. The Unified Numbering System, which was developed by the American Society for Testing Materials (ASTM) and the Society of Automotive Engineers (SAE) to apply to all commercial metals and alloys.

The various types of stainless steel are detailed in a designer handbook, “Design Guidelines for the Selection and Use of Stainless Steel” available from the Specialty Steel Industry of North America (SSINA). Several other publications are also available, including: “Stainless Steel Fabrication,” “Stainless Steel Fasteners,” “Stainless Steel Finishes,” “Stainless Steel Specifications,” and “Stainless Steel Architectural Facts,” to mention a few.
GENERAL INFORMATION ON STAINLESS STEEL

ALLOYS
The following grades of stainless steel are often used in structural applications:

- **304** has an austenitic metallurgical structure. It is the basic “18-8” alloy (18% chromium, 8% nickel UNS S30400), is the most readily available grade, and is often specified for “all-purpose” applications. It has excellent corrosion resistance and unusually good formability.
- **316** is basically a 304 grade with the addition of 2 to 3% molybdenum. It has greater corrosion resistance than 304 and is usually preferred for long term service in aggressive industrial, chemical and seawater atmospheres.
- **409** has a ferritic metallurgical structure. It is a straight chrome alloy (11 to 12% chromium UNS S40900). It has good ductility and corrosion resistance. It is mainly used for internal applications.
- **410-3** is a dual phase alloy (UNS S41003) with micro alloy element control that permits welding in up to 1 1/4 inches (30mm).
- **2205** has a duplex structure which is typically about equal parts of austenite and ferrite (21% chromium, 4.5% nickel, 2.5% molybdenum UNS 32304). It has excellent corrosion resistance and exhibits about twice the yield strength as conventional grades.

TABLE 1: CLASSIFICATION OF STAINLESS STEEL PRODUCT FORMS

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Thickness</th>
<th>Width</th>
<th>Diameter or Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sheet</td>
<td>Cc and coil lengths:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hot Rolled No. 1</td>
<td>under 0.1875” (4.76mm)</td>
<td>24.000” (609.6mm) and over</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>Cold Rolled No. 2, 2B, Bright Annealed, TR</td>
<td>under 0.1875” (4.76mm)</td>
<td>24.000” (609.6mm) and over</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>Polished No. 3, 4, 6, 7 &amp; 8</td>
<td>under 0.1875” (4.76mm)</td>
<td>24.000” (609.6mm) and over</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>Strip</td>
<td>Cc and coil lengths:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hot Rolled No. 1</td>
<td>under 0.1875” (4.76mm)</td>
<td>under 24.000” (609.6mm)</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>Cold Rolled No. 2, 2B, Bright Annealed, TR</td>
<td>under 0.1875” (4.76mm)</td>
<td>under 24.000” (609.6mm)</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>Polished No. 3, 4, 6, 7 &amp; 8</td>
<td>under 0.1875” (4.76mm)</td>
<td>under 24.000” (609.6mm)</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>Plate</td>
<td>Cc and coil lengths:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hot Rolled, annealed &amp; polished</td>
<td>0.1875” (4.76mm) and over</td>
<td>over 10.000” (254mm)</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>Polished available for special applications</td>
<td>0.1875” (4.76mm) and over</td>
<td>over 10.000” (254mm)</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>Bar</td>
<td>Straight lengths:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hot finished rounds, squares, octagons and hexagons</td>
<td>—</td>
<td>—</td>
<td>0.250” (6.35mm) and over</td>
<td></td>
</tr>
<tr>
<td>Hot finished flats</td>
<td>0.125” (3.18mm) and over</td>
<td>8.380” (213mm) to 10.000” (254mm)</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>Cold finished rounds, squares, octagons and hexagons</td>
<td>—</td>
<td>—</td>
<td>0.062” (1.59mm) and over</td>
<td></td>
</tr>
<tr>
<td>Cold finished flats</td>
<td>—</td>
<td>0.375” (9.53mm) and over</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>Rod</td>
<td>Hot Rolled (can may be annealed and/or slitted)</td>
<td>—</td>
<td>—</td>
<td>0.200” (5.08mm) and over</td>
</tr>
<tr>
<td>Wire</td>
<td>Cold finished only</td>
<td>—</td>
<td>—</td>
<td>0.062” (1.59mm) and over</td>
</tr>
<tr>
<td>Flat wire (coils only)</td>
<td>0.019” (0.49mm) to under 0.032” (0.81mm)</td>
<td>0.250” (6.35mm) and under</td>
<td>—</td>
<td></td>
</tr>
</tbody>
</table>

**Pipe & Tube**

- Several different classifications with differing specifications are available.

**Extrusions**

- Not considered “standard” shapes, but available.

**Structural**

- Currently limited to around 0.536” (13.6mm) diameter circle, or structural tubes to 0.626” (16.0mm) diameter.

**Forging, Plate, Hot Rolled, Argyle and Rolled Shaped available.**
PRODUCT FORMS

The forms of stainless steel used in structural applications are: plate and sheet (often fabricated into structural shapes), extrusions, forgings, preformed products (tubes and angles), bar and rod, wire, and castings.

Plate:
Plate is defined as material that has a thickness of 3/16" or greater (Table 1). It is usually available in widths of 48, 60, 72, and 96". It can be supplied as individual flat plates or in "coil" form (some limits on thickness and width). Many structural shapes are produced by fabricating the plate into beams, angles and other components. For information, contact the "Steel Plate Fabricators Association" (708-298-0880).

Sheet:
Sheet is defined as material that has a thickness of less than 3/16" (Table 1), and is usually supplied in either 48 or 60" wide coils.

Extrusions:
Stainless steel can be extruded into several complex shapes as detailed in the Designer Handbook "The Selection and Use of Stainless Steel." Also contact: Al Tech Specialty Steel Corporation (716-366-1000), Plymouth Tube Company (1-800-323-9506).

Forging:
Stainless steel forgings are also available in several shapes. For information, contact the "Forging Industry Association" (216-781-0102).

Preformed Products:
Angles are available as a hot rolled product. Contact Slater Steel Corporation (219-432-2561).

 Wire is cold finished only, produced in coils, as round, square, octagon, hexagon, and flat wire (Table 1).

Castings:
Stainless steel casting can be produced for structural applications. For information, contact the "Steel Founders’ Society of America" (847-299-9160).

STAINLESS STEEL STRUCTURES

Fabrication:
Stainless steel can be fabricated by methods similar to those used for carbon steel. However, other considerations must be taken into account because of the difference in material properties, such as yield strength and rate of work hardening. The SSINA Designer Handbook "Stainless Steel Fabrication," has several suggestions on techniques for cutting, bending, forming and finishing the austenitic and ferritic stainless steels. For example, 304 requires 50% more power to bend it than carbon steel. Duplex grades like 2205 have roughly twice the yield strength of 304 or 316. Once the yield strength is exceeded, the plastic deformation takes place just as easily as with the austenitic material. Heavy gauge material (over 3/16") is usually fabricated into structural components such as "I" beams and angles. Tubular products are available in round tubes or square hollows. Table 2 shows the relative fabrication characteristics of the various grades of stainless steel.

Connections:
Stainless steel structures must be connected by using stainless steel fasteners. The SSINA has a Designer Handbook "Stainless Steel Fasteners A Systematic Approach to Their Selection" which details a method of selecting stainless steel fasteners.

Stainless steel is also readily "welded," although the welding rods and techniques are different from that of mild steel. The American Welding Society (800-443-WELD) and the Nickel Development Institute (416-591-7999) have information available on welding stainless steels.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Austenitic 304</th>
<th>Austenitic 316</th>
<th>Ferritic 409</th>
<th>Dual Phase 410L</th>
<th>Duplex 2205</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bending</td>
<td>E</td>
<td>E</td>
<td>G</td>
<td>G</td>
<td>G</td>
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<tr>
<td>Deep Drawing</td>
<td>E</td>
<td>E</td>
<td>E</td>
<td>E</td>
<td>F</td>
</tr>
<tr>
<td>Hot Forming</td>
<td>G</td>
<td>G</td>
<td>G</td>
<td>G</td>
<td>G</td>
</tr>
<tr>
<td>Cold Forming</td>
<td>G</td>
<td>G</td>
<td>G</td>
<td>G</td>
<td>F</td>
</tr>
<tr>
<td>Punching</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>Shearing</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>F</td>
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<tr>
<td>Welding</td>
<td>E</td>
<td>E</td>
<td>F</td>
<td>G</td>
<td>G</td>
</tr>
<tr>
<td>Machining</td>
<td>F</td>
<td>F</td>
<td>G</td>
<td>G</td>
<td>P</td>
</tr>
</tbody>
</table>

Code: E = Excellent  G = Good  F = Fair  P = Poor
Applications for Rebars:

• Supports for reinforced concrete (i.e., bridge decks)
• Marine construction, piers and wharfs
• Balconies and frames for front-elevation units
• Anchorages and any kind of joints
• Off-shore platforms
• Frames and anchorages for damp environments, tunnels, underpasses and subways
• Bridges, viaducts, overpasses
• Cement frameworks with amagnetic characteristics
• Frameworks which are prone to breaking up due to frost or because of low temperatures
• Concrete slabs for drainage in environments with corrosive agents
• Supports/restoration for statues, monuments, cement, stone and marble works
FABRICATED COMPONENTS

Stainless steel is becoming the material of choice for concrete reinforcement. It has a high resistance to corrosion, particularly in chloride-bearing concrete (from de-icing salts or seacoast exposure). Significant reductions in maintenance and repair will result in applications where the structure is subject to adverse corrosion.

An article, published in the May 1995 issue of "Concrete International," by D. B. McDonald, M. R. Sherman, D. W. Pfeifer, and Y. P. Virmani, concludes that both field and laboratory data have shown that stainless steel rebars are capable of maintaining excellent corrosion resistance in severe chloride environments, and that the chloride tolerance for stainless steel was shown to be significantly greater than that of mild steel. This article also concludes that the use of stainless steel may be warranted when guaranteed long-term corrosion resistance is required.

Applications for Fabricated Components:
- Columns and Pilars
- Walkways, Railings and Ladders
- Arches
- Storage Units
- Processing Vessels
- Structural Supports
- Wall and Ceiling Panels

Ladders and walkways and rails fabricated by ENERFAB, a Bishophic Company

Entrance hall of a stainless steel building in Japan

Arches, light covers and traffic signal poles (not in photo) were fabricated from 316L stainless steel by the Offenhauser Company. The project is in the Galleria area in Houston.

A showroom of an all-stainless steel building in Japan
Stainless steel is often used as a column “cover” where the outer skin is stainless; however, it can also be used as the load bearing member.

Stainless steel can be fabricated into several structural components from sheet, plate, bars or strip. There are many fabrication shops that are experienced in fabricating stainless steel (for more information contact the Steel Plate Fabricators Association 708-562-8750). Steel service centers also can perform some fabrication services such as brake forming and cutting custom shapes and sizes (contact the Steel Service Center Institute 216-694-3630).

Stainless angles were used to construct a Bar Screen (Series 1000 from Envirex, INC) for a water treatment application.
TUBULAR COMPONENTS

Stainless steel angles are produced by hot rolling, annealing, blast cleaning and chemical passivation. Angles can be formed from sheet and plate or rolled from billets creating various structural components. A popular use involves bending the angle into a ring and welding the ends together for use as:

- Space frames
- Trusses
- Bracing and end frames
- Lattices
- Load bearing member
- Light poles
- Overhead signs

Stainless steel trusses (20 meters) for bracing and end frames for skylight supports.

Structural tubes, filled with water, used as an external fire prevention system.

Tubular sections form the La Grande Arch structure in Paris.
BARS AND RODS

Applications for Bars and Rods:
• Structural members in tension
• Load transfer devices
• Tie rods
• Bridge pins

A continuous reinforced concrete slab supported by 44 stainless steel rods provides pedestrian and bicycle access over the Humber River in Toronto.

The Minnesota Department of Transportation replaced conventional low alloy steel with stainless steel hinge pins and hangers on the Blatnik Bridge in Duluth, Minnesota.

Stainless steel was used to support a lightweight PTFE-coated glass fiber woven fabric roof (not yet installed).

Stainless steel tie rods linked to stainless steel tubular columns to maintain the roof membrane in tension.

The Minnesota Department of Transportation replaced conventional low alloy steel with stainless steel hinge pins and hangers on the Blatnik Bridge in Duluth, Minnesota.
Stainless steel has been specified in bus and rail cars for internal frames and for the entire structure.

Applications for Frames:
- Bus and transit frames
- Coal cars
- Space frames
- Mirror mount frames

Applications for Castings:
- Anchors
- Support housings
- Joints

### Table 3: ANGLES

<table>
<thead>
<tr>
<th>Sizes</th>
<th>Condition</th>
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<tbody>
<tr>
<td>1 x 1 x 1/8</td>
<td>2 x 2 x 1/4</td>
</tr>
<tr>
<td>1 x 1 x 3/16</td>
<td>2 x 3 x 3/16</td>
</tr>
<tr>
<td>1 x 1/2</td>
<td>2 x 3/4</td>
</tr>
<tr>
<td>1-1/4 x 1-1/4 x 1/8</td>
<td>2-1/2 x 2-1/2 x 3/16</td>
</tr>
<tr>
<td>1-1/4 x 1-1/4 x 3/16</td>
<td>2-1/2 x 2-1/2 x 5/16</td>
</tr>
<tr>
<td>1-1/2 x 1-1/2 x 1/8</td>
<td>2-1/2 x 2-1/2 x 3/8</td>
</tr>
<tr>
<td>1-1/2 x 1-1/2 x 3/16</td>
<td>3 x 3 x 3/4</td>
</tr>
</tbody>
</table>

### INVESTMENT CASTING

Truck mirror frame.

Tubular supports for the roof structure of the Canadian Archives Building.

Complex stainless steel investment casting connecting the tubular structure with the glass wall.

Rail coal carriers fabricated from stainless steel.
WALL TIES AND ANCHORS

### sizing:
- 1½ x 1½ x 1/4
- 3 x 3 x 5/16
- 2 x 2 x 1/8
- 3 x 3 x 3/8
- 2 x 2 x 3/16

### Tolerance:
- Leg Tolerance: Length +1/8".
- Weight Tolerance: +7-1/2%
- Right Angle Tolerance: +2°
- Straightness or Camber: +1/8" in 5 ft

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#### BASIC SYSTEM

- Lewis bolts (top) and threaded inserts for hanging stone (bottom) show variety of stainless steel fastening devices used in stone and concrete anchoring systems.

#### MASONRY WIRE TIES

#### WIRE TIES FOR STONE VENEER

- Rectangular Eye & Dowel
- Modified_1_Ties

---

STONE PANEL VENEER

---

BASIC SYSTEM

---

WIRE TIES FOR STONE VENEER

---
### Channels

<table>
<thead>
<tr>
<th>Size</th>
<th>B (in)</th>
<th>C (in)</th>
<th>Approx. Wt. per Ft.</th>
<th>Lbs. per Ft.</th>
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<tbody>
<tr>
<td>1-1/2</td>
<td>3/4</td>
<td>3/16</td>
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<td>2 (T)</td>
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<td>2</td>
<td>3/16</td>
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<td>2 (T)</td>
<td>1</td>
<td>3/16</td>
<td>2.60</td>
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<td>2-1/2 (T)</td>
<td>5/8</td>
<td>3/16</td>
<td>2.40</td>
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<td>3/16</td>
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<tr>
<td>3 1-1/2</td>
<td>1/4</td>
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<td>4.75</td>
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<td>4 (T)</td>
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<td>6.69</td>
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<td>5 (T)</td>
<td>1-7/8</td>
<td>3/8</td>
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</table>

*(Note: Standard tapered sections are also available.)*

### Beams

<table>
<thead>
<tr>
<th>Size</th>
<th>B (in)</th>
<th>C (in)</th>
<th>Approx. Wt. per Ft.</th>
<th>Lbs. per Ft.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-1/2</td>
<td>1 3/16</td>
<td>2.02</td>
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</tr>
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<td>1-1/2</td>
<td>1 1/4</td>
<td>2.64</td>
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<tr>
<td>2</td>
<td>1 1/4</td>
<td>3.43</td>
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<td>2-1/2</td>
<td>1 1/2</td>
<td>4.22</td>
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<tr>
<td>3 (T)</td>
<td>2-3/8</td>
<td>1/4</td>
<td>6.60</td>
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<tr>
<td>4 (T)</td>
<td>2-3/4</td>
<td>1/4</td>
<td>8.44</td>
<td></td>
</tr>
</tbody>
</table>

*(Note: Standard tapered sections are also available.)*

### Specifications

Specifications can be applied to structural products:

- **ASTM A276 QQS-763**
- **ASTM A479**

**Grades:**

- 304
- 316
- 304L
- 316L

Other grades available upon request. Not all sizes available in all grades.

### Extrusions

Stainless steel can be extruded in many shapes including angles. Angles are produced with parallel surfaces on the legs. Typical sizes are listed in Table 4.
REFERENCES:
1. American Society of Civil Engineers: ANSI/ASCE 8-90: “Specification for the Design of Cold Formed Stainless Steel Structural Members”

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