

O'Brien Steel Glossary of Terms

A

Abrasion-Resistant sheet and plate suitable for applications where the gradual removal of a surface as a result of contact with another material causes wear. Contact may be by sliding of one metal over another, the grinding of hard particles between metal surfaces, the impact of heavy hard materials such as rock, or the impact of high velocity dust particles on a metal surface.

Aging – Changes in physical and mechanical properties that occur when low carbon steel is stored for some time. Aging is also accelerated by exposure of steel to elevated temperatures. Stretcher strains and fluting can result from aging.

AISI – Abbreviation for American Iron and Steel Institute.

Alloy Steel – Steel containing significant quantities of alloying elements (other than carbon and the commonly accepted amounts of manganese, silicon, sulfur, and phosphorus) added to effect changes in mechanical properties by heat treatment.

Alloying Elements – Chemical elements added for improving the properties of the finished products. Some alloying elements are: nickel, chromium, manganese, molybdenum, vanadium, silicon and copper.

Annealing – A process of heating and cooling of hot rolled and cold rolled steel, applied to induce softening or to achieve a specific microstructure.

ASM – Abbreviation for American Society for Metals.

ASTM – Abbreviation for American Society of Metals for Testing and Materials.

B

Bands – The initial coil product produced by rolling a slab on a hot strip mill, generally to thickness $\frac{1}{2}$ inch and lighter. It is usually further processed as follows:

1. Rerolled into cold rolled sheets
2. Leveled and cut into plates ($\frac{3}{16}$ inch and over)
3. Leveled and cut into hot rolled flat sheets (lighter than $\frac{3}{16}$ inch)

Bar (Hot Rolled) – The term “bar” includes round, square, hexagonal and other cross-sectional shapes, $\frac{1}{4}$ inch (6.4mm) and greater, small standard shapes (angles, channels, tees) under 3 inches (76.2mm), flats 6 inches (152mm) and under in width and $\frac{1}{4}$ inch (5.2mm) and over in thickness, and flats over 6 inches (152mm) through 8 inches (200mm) in width, and .2300 inch (5.84mm) and over in thickness.

Basic Oxygen Process (BOP) – Steelmaking method in which substantially pure oxygen is introduced to facilitate the melting process.

Bearing Quality – Steels used for balls, rollers and races of antifriction bearings. Great hardness and resistance to crushing are the chief requirements.

Bend Tests – Various tests used to determine the ductility of sheet or plate that is subject to bending. These tests may include determination of the minimum radius or diameter required to make a satisfactory bend and the number of repeated bends that the material can withstand without failure when it is bent through a given angle and over definite radius.

Billet – A solid semi finished round or square product that has been hot worked by forging, rolling, or extrusion. An iron or steel billet has a minimum width or thickness of 1 ½ inches (38 mm) and the cross-sectional area varies from 2 ¼ square inches (1452 sq. mm) to 36 square inches (23, 225 sq. mm).

Bloom – A semi finished hot rolled product, square or rectangular in cross section, produced on a blooming mill. For iron and steel, the width is not more than twice the thickness, and the cross-sectional area is usually not less than 36 square inches (23,225 sq. mm).

Brinell Hardness Number - In the Brinell Hardness Test, the value obtained by dividing the applied load (in kilograms) by the surface area of the impression (in square millimeters) resulting from forcing a hard steel or carbide ball into the steel test sample.

C

Camber - Camber is the deviation of the side edge from a straight line, the measurement being taken on the concave side with a straight edge.

Carbide – Compound of carbon with one or more metallic elements.

Carbon Steel – Steel containing carbon up to 1% and only residual quantities of the elements except those added for deoxidation, with silicon usually limited to 0.60% and manganese to 1.65%.

Carburizing – Introduction of carbon into solid steel; the process consists of heating the steel to an elevated temperature in contact with carbonaceous gas, liquid or solid.

Case –Hardening – A process of hardening a ferrous alloy so that the surface layer or case is made substantially harder than the interior or core. Typical case-hardening processes are carburizing and quenches, cyaniding, carbonitriding, nitriding, induction hardening and flame hardening.

Charpy V-Notch – This is a test to measure the impact strength or notch toughness, of steel. It is of primary importance to evaluate steels for use where a brittle fracture hazard exists.

Chemical Composition – Different elements, or combinations of elements, help determine the characteristics of steel and are generally referred to as steel's chemical composition or chemistry.

Coil Breaks – Creases or ridges, which appear as parallel lines, transverse to the direction of rolling. They generally extend across the width of the sheet.

Cold Drawing – The process of pulling a hot rolled bar through a die of lesser size. Cold drawing gives the hot rolled bar a bright, clean, uniform surface and increases tensile and yield strength. Cold Drawing also increases torsional strength, surface hardness, wear resistance and imparts significant improvement in machinability. In some cases, cold drawn bars subsequently may be subjected to grinding and polishing operations.

Cold Rolled Products – Flat rolled products for which the approximate required thickness has been obtained by rolling without heating at approximately room temperature.

Commercial Quality (CQ) – Sheet of this quality is for uses involving simple bending or moderate drawing. Commercial Quality sheet can be bent flat upon itself in any direction at room temperature.

Corrosion Resistance – The ability of a metal to withstand attack in an environment that is conducive to chemical or electro-chemical reaction.

Critical Temperature Range – See transformation temperature range.

Crown – Crown, in plates, sheet or strip, is characterized by a greater thickness in the middle than at the edges. It may be caused by a deflecting (bending) of the rolls or by worn rolls. This latter is sometimes called "hollowness of the mill".

D

Decarburization – The loss of carbon from the surface of a steel product as a result of heating in an atmosphere that reacts with the carbon in the steel.

Deep Drawing – Forming shaped articles or shells by forcing sheet metal into a die.

Deoxidizing – The removal of oxygen from molten steel by use of suitable elements that react with oxygen readily.

Drop Forging – A forging made with a drop hammer.

Ductility – The ability of a material to deform plastically without fracturing, generally measured by elongation or reduction of area in a tensile test.

E

Edge Condition – Mill edge is the normal edge produced in rolling, and does not conform to any definite contour. A cut edge is one that has been cut after rolling. This may be done by shearing or flame cutting. A slit edge results when a coil is cut into multiple widths by means of a rotary knife.

Elastic Limit – The maximum stress which a material is capable of sustaining without any measurable permanent extension remaining after complete release of the applied force.

Elongation – In tensile testing, the increase in the gage length, measured after fracture of the specimen within the gage length, usually expressed as a percentage of the original gage length.

Extrusion - Shaping metal into a continuous form by forcing it through a die or appropriate shape.

F

Fatigue – The tendency for a metal to break under conditions of repeated cyclic stressing considerably below the ultimate tensile strength.

Finish – In the steel industry, refers to the type of surface condition desired or existing in the finish product. For cut plates, finish refers to the quality of an edge or surface required for the part to be acceptable.

Flame Annealing – A process of softening a metal by the application of heat for a high-temperature flame.

Flame Hardening - A process of hardening a ferrous alloy by heating it above the transformation range by means of a high-temperature flame, and then cooling as required.

Flattening – Standard commercial flatness is obtained by roller leveling. This consists in passing sheets singly or in packs through a machine having a series of small diameter rolls.

Forging – (1)As a noun: a metal product which has been formed by hammering or pressing, (2)As a verb: Forming hot metal into the desired shape by means of hammering or pressing.

G

Galvanizing – The process of applying a coating of zinc to the finished cold-reduced sheet or to fabricated parts made from strip products. The coating is applied by hot dipping or electrolytic deposition.

Galvannealed – An extra tight coat of galvanizing metal (zinc) applied to a soft steel sheet, after which the sheet is passed through an oven at about 1200 degrees Fahrenheit. The resulting coat is dull gray without spangle especially suited for subsequent painting.

Gas Cutting – Refers to a procedure used for cutting when maximum shearing limitation for thickness and chemical compositions are exceeded. Also known as flame cut or special cut edges plates.

Grain Size – A measure of the areas or volumes of grains in steel usually expressed as an average when the individual sizes are fairly uniform. Grain sizes are reported in terms of number of grains per unit area or volume, average diameter, or as a grain-sized number derived from area measurements as defined by ASTM.

Grinding and Polishing – Cold finishing the operation that may be applied to cold drawn or turned bars. The bars are first ground to close tolerance in centerless grinders and kept very straight during the operation. They are then saw cut on both ends to give a square true cut, and burnished to a brilliant bright finish. The results are bars with extremely close size tolerance, a high degree of straightness and a superior finish.

Grinding and polishing may be preceded by either a cold drawing or turning operation. The mechanical properties remain comparable to those of the original hot rolled bar except when preceded by cold drawing.

H

Half Rounds – Bars having a cross section that is a half circle.

Hardenability – In a ferrous alloy, the property that determines the depth to which hardness can be induced by austenitizing and quenching.

Hardness – Ability of a material to resist penetration.

Heat Treatment – Any process involving heating metal to an elevated temperature to obtain change in properties or metallurgical structure.

High-Strength Low-Alloy Steels (HSLA) – High strength low-alloy steel comprises a group of steels with chemical compositions specially developed to impart higher mechanical property values, and in certain of these steels, materially greater

resistance to atmospheric corrosion than is obtainable from conventional carbon structural steels.

Hot Forming – Working operations such as bending and drawing sheet and plate, forging, pressing and heading, performed on metal heated to temperatures above room temperature.

Hot Rolled – This term describes steel products that are brought to approximate finished size by rolling at elevated temperatures.

Hot Rolled as Rolled (HRAR) – A description of steel products that are rolled into finished thickness and not subsequently heat-treated.

H-Steels – Steels produced to end quench hardenability limits.

I

Impact Strength (Impact Value, Impact Energy) – The amount of energy required to fracture steel, usually measured by means of the Charpy or izod test. The type of specimen and testing conditions (temperature) affect the values and therefore should be specified.

Induction Hardening – A process of hardening a steel product by heating it above the transformation range using electrical induction, and then cooling as required.

Ingot – The solidified steel formed in a mold for subsequent rolling or forging.

J

Jominy Test – A test to determine how a steel will harden under specific heating and cooling conditions.

K

Kerf – That part of the material lost through processing.

Killed Steel – Steel deoxidized with a strong deoxidizing agent: e.g., silicon and/or aluminum, to reduce the oxygen content to such a level that no reaction occurs between carbon and oxygen during solidification.

L

Leveling – The flattening of steel plates and sheets. There are several methods, such as roller leveling and stretcher leveling.

Longitudinal Direction – The direction in a wrought metal product parallel to the direction of the working.

Lubricity – Slipperiness. The ability of steel sheet to slide in a forming die.

M

Machinability – The relative ease of machining a metal.

Machine Straightening – The straightening of the material using roll straighteners, machine straighteners or gag presses.

Machining – The cutting away of the surface of a metal product by means of power driven machinery; e.g., drills, lathers, planers, shapers, etc.

Magnetic Particle Testing – A means of detecting surface imperfections magnetizing the material and applying a prepared magnetic powder.

Mechanical Properties – The properties of a material that reveal its elastic and inelastic behavior when force is applied, indicating the material's suitability for mechanical application; e.g., tensile strength, modulus of elasticity, elongation, hardness, fatigue limit.

Merchant Quality – Bars produced for a wide range of uses, such as structural and similar miscellaneous applications, involving mild cold bending, mild hot forming, punching and welding. On merchant quality bars, there is no limit on deoxidation practice or chemical limits beyond standard limits for carbon, manganese, phosphorus and sulfur.

Mill Edge – Normal rounded edge produced in hot rolling of flat steel. Does not conform to any specified radius.

Mill Finish – A surface finish produced on sheet and plate, characteristic of ground finish on the rolls used to manufacture.

N

Nitriding - A process of case hardening in which a ferrous alloy is heated in a nitrogenous atmosphere to produce surface hardening by the absorption of nitrogen, without quenching.

Normalized - Condition of steel that has been heated to suitable temperature above the transformation range and cooled in air to a temperature substantially below the transformation range.

Notch Brittleness – Susceptibility of material to brittleness in areas containing a groove, scratch, sharp fillet or notch.

Notch Toughness – Property of steel, which allows it to absorb considerable energy before fracture.

O

Oiled – Application of a suitable oil to flat rolled steel to retard rusting. When surface is a consideration, it is also desirable in reducing friction scratches that may develop in transit. The oil coating is not intended to serve as a lubricant for subsequent fabrication.

P

Physical Properties – The properties that pertain to the physics of a material; e.g., density, electrical conductivity, thermal conductivity, thermal expansion and modulus of elasticity.

Pickling – Removing surface oxides from metals by chemical or electrochemical reaction.

Pipe (Imperfection) – The center void in wrought products resulting from the central cavity formed by contraction in metal, especially ingots, during solidification.

Plate – Plate comprises that group of flat, cut length hot rolled steel products with the size limits shown in the table below.

| Thickness Inches | Width Inches | Weight lbs. per sq. ft |
|--------------------|---------------------|------------------------|
| 0.2300 and thicker | Over 8 to 48 inches | 9.384 and heavier |
| 0.1800 and thicker | over 48 | 7.344 and heavier |

Porosity – The existence of fine holes (pores) in steel.

Press Forging – The Forging process in which metal stock formed between dies, usually by hydraulic pressure. Press forging is an operation that employs a single, slow stroke.

Pressure Vessel Quality – Sheets and plate suitable for applications in pressure vessels and similar purposes. Pressure vessel requirements replace the previously used flange and firebox qualities.

Q

Quench and Temper – The steel is rapidly cooled from above its critical temperature range (austenitizing) to a temperature far below this range. Water or oil is used to accelerate the cooling. In the as-quenched condition, the product is not suitable for most commercial applications because of its poor ductility and high hardness. The steel must, therefore, be tempered in order to soften it somewhat to improve its ductility and toughness and relieve internal stresses. Tempering is a reheating treatment done at temperatures usually in the range between 800 degrees Fahrenheit and 1200 degrees Fahrenheit.

Quench Cracking – The Development of fractures in the surfaces of steel parts as a result of heat treatment that involves rapid cooling.

Quenching – Rapid cooling of steel to induce specific microstructure and properties.

R

Reduction – Reducing thickness of sheet or strip by hot or cold rolling.

Rephosphorized Steels – Steels to which phosphorus has been deliberately added to improve machinability or increase work hardening characteristics.

Resquaring – A method of shearing to meet closer than standard width, length, and out-of-square tolerances.

Resulfurized Steels - Steels to which sulfur has been deliberately added to improve machinability.

Rimmed Steel – A low-carbon steel containing sufficient oxygen to give a continuous evolution of carbon monoxide while the ingot is solidifying resulting in a case or rim of metal virtually free of voids.

RMS – A means of measuring surface roughness – Root Mean Square. A surface with theoretical zero value has no surface deviations. As the value increases, the roughness increases.

Rockwell – Harness – A method of measuring the hardness of materials (resistance to penetration). Rockwell measures the hardness by pressing an indenter to the surface of the steel with a specific load, then measuring how far the indenter was able to penetrate. There are a number of Rockwell tests; the most common is Rockwell B.

Rounds – Bars having a circular or round cross section.

S

SAE – Abbreviation for Society of Automotive Engineers.

Scale – Complex forms of oxides of iron which form on the surface of hot steel.

Screw Stock – Ordinarily, free machining types of alloy, used for making screw machine products.

Semi-Finished Steel – Steel in the form of ingots, blooms, billets or slabs for forging or rolling into a finished products.

Semi-Killed Steel – Steel with properties intermediate between those of killed and rimmed steels. During the solidification of semi-killed steel, some gas is evolved and entrapped within the body of the ingot. This tends to compensate for the shrinkage which accompanies the solidification.

Sheared Edge – These plates have an edge produced by shearing (or gas cutting when plates are too thick to shear). “Sheared Plates” or “Sheared Milled Plates” are trimmed on all four edges.

Sketch Plates – Plates cut to shapes other than rectangular.

Slab – A semi-finished steel block having an oblong cross-section in which width is at least twice thickness. It differs from a bloom which has a square, or nearly square, cross-section.

Slitting – The production of narrow widths from wider sheet by means of a rotary knife or knives.

Spalling – The cracking and flaking of metal particles from a surface.

Spangle – The spangle of a galvanized sheet surface is the visual manifestation of zinc when it solidifies as a sheet emerges from the pot of molten zinc in a galvanize line. Similar appearances are developed when moisture freezes on a window. The zinc crystal or spangle varies in size, brightness, and appearance depending upon a number of factors, most of which are related to cooling rate.

Special Quality – Bars of Special Quality are used when the end use, method of fabrication, or subsequent processing requires characteristics not available in Merchant Quality bars. Some end uses or fabrication procedures can make necessary one or more additional characteristics, which may be specified as requirements.

Special Straightness – Material furnished to closer than standard straightness tolerances as set forth in the AISI manual.

Spot Welding – An electric-resistance welding process in which the fusion is limited to a small area. The pieces being welded are pressed together between a pair of water-cooled electrodes through which an electrical current is passed during a very short interval so that fusion occurs over a small area at the interface between the pieces.

Strain Hardening – An increase in hardness and strength caused by plastic deformation at temperatures lower than the recrystallization range.

Strength Properties – They are related to the steel's ability to resist applied forces. Strength properties are measured by the tension test. (tensile strength, yield point, or yield strength).

Stress – The load per unit of area.

Stress Relieving – A process of reducing residual stresses in a metal object to a suitable temperature and holding for a sufficient time. This treatment may be applied to relieve stresses induced by flattening, straightening, machining and welding.

Stretcher Flattening – A process for removing bow and warpage from sheet by applying a uniform tension between the ends so that the piece is elongated to a definite amount of permanent set.

Stretcher Leveled Standard – A standard of flatness associated with sheet more stringent than commercial standard of flatness; not necessarily obtained by performing stretcher leveling operations.

Stretcher Strains - Irregular surface patterns of ridges and valleys which develop during drawing.

Structural Quality – Material suitable for load-bearing applications and typically represents the quality of steel produced under regular or normal manufacturing conditions.

Sweep – Is the greatest deviation of a structural shape from a straight line in the direction of length parallel with its web. In referenced to wide flange (W) shapes, standard (S) beams, miscellaneous (M) shapes, and channels (C, MC), sweep denotes the curvature from the plane of the web in the length of these shapes.

T

Temper – A condition produced in sheet steel by mechanical, chemical or thermal treatment. A given steel may be in the fully softened or annealed temper, or it may be cold worked to the hard temper, or further to spring temper. Intermediate

tempers produced by cold working (rolling) are called “quarter-hard”, “half-hard” and “three-quarters hard” and are determined by the amount of cold reduction.

Tensile Strength - (See Ultimate Strength)

Tension Leveling – A process for improving flatness in coils by pulling in tension.

Thermal Stresses – Stresses in metal most often resulting from non-uniform or localized heating and cooling.

Through – Hardened – Description of a steel part that has been quenched to substantially the same hardness over its entire cross section.

TMW Pricing (Theoretical Minimum Weight) – A method of billing sheet and strip products at the theoretical weight calculated on the basis of the minimum specific thickness, width, and length.

Tolerance – Specified limits of deviation from a dimension.

Torsion – Strain created in a material by twisting action, correspondingly, the stress within the material resisting the twisting.

Toughness – Ability of steel to absorb considerable energy and deform plastically before fracturing.

Transformation Temperature Range – The temperature range within which definite microstructural changes take place in steel. It is bounded by temperatures known as the lower critical temperature and upper critical temperature.

Turning and Polishing – The process of cold finishing hot rolled bars by machining to the desired size on the lathe or turning machine, then polishing in by rotating them through hardened steel rolls.

Turning completely remove the bar surface and with it, decarburization, seams, slivers and other surface imperfections. Polishing produces a finer, brighter, smoother finish than is obtained by cold drawing.

In some cases turned bars may subsequently be subjected to grinding and polishing operators.

U

Ultimate Strength – The maximum conventional stress (tensile, compressive, shear) that a steel can withstand.

Universal Mill Edge (UM Edge) – This is an edge produced by vertical rolls that shape the edge during hot rolling. UM plates have two rolled edges and two trimmed ends.

V

Vacuum Treatment – Any of the number of processes designed to treat liquid or molten steel in the presence of vacuum. Such treatments are generally employed to remove undesirable gases and/or to improve the internal microcleanliness of the steel product.

W

Wear Resistance – The ability to withstand impairment or loss of material due to rubbing or other frictional action.

Welding – A process used to join metals by the application of heat. Fusion welding, which includes gas, arc and resistance welding requires that the parent metals be melted. This distinguishes fusion welding from brazing. In pressure welding joining is accomplished by the use of heat and pressure without melting.

Y

Yield Strength (Yield Point) – The stress at which steel exhibits a specified deviation from proportionality of stress to strain.