

EXPLANATION OF TERMS RELATING TO...

MECHANICAL PROPERTIES OF WELD METAL

*Testable and quantifiable characteristics, the mechanical properties of a metal describe its suitability for any given application and provide a performance forecast. Mechanical properties are of the utmost concern in welding consumable qualification since weld deposits must provide service characteristics equal to or better than those of the base metal. The properties considered most often (and those that are frequently cited in Welding Consumable Specification requirements) are **Strength, Hardness, Ductility and Impact Resistance.***

1. Strength:

A metal's "strength" is its capacity to withstand external forces without breaking. In a tension test, under stretch loading, a specimen reveals several features - including elastic limit, elongation, yield point, yield strength, tensile strength and reduction in area. During the test, load is increased gradually and the specimen stretches in direct proportion to the load until it reaches its **Yield Point**. At any point up to the yield point, if the load is relaxed, the specimen will return to its original dimensions. Beyond the yield point, the specimen continues to elongate without an increase in load. An increase in load after the yield point brings the specimen to another critical point - **Tensile Strength**, or **Ultimate Tensile Strength** - at which the specimen breaks. Yield point and tensile strength values (in psi or MPa) are obtained by dividing the load at these points by the original cross-sectional area of the specimen.

2. Hardness:

A metal's hardness is its capacity to resist surface indentation by a contacting medium. Measuring the indent size of a hardened steel ball or a diamond upon the surface of a specimen assigns value to a metal's hardness. Indent size is translated to a hardness value. Typical units of measure being **Rockwell Hardness** (HR_A, HR_B & HR_C Scales), **Vickers Hardness** (HV₂₀ & HV₃₀ Scales) and **Brinell Hardness**.

3. Ductility:

Ductility is the characteristic of metal that allows it to withstand stretching and other deformation without breaking and to hold a new shape after external forces have been removed. Determined in a tensile test, **Percent of Elongation** is the measure of ductility. Gauge marks are made 50 mm (2 inches) apart, bounding the point at which fracture will occur, on a test specimen. The increase in gauge length, divided by the original length, x 100, equals the elongation percentage. Ductility can also be measured in a bend test.

4. Impact Resistance

This property is assessed in terms of **Impact Strength** or **Impact Toughness**, determined most often in a **Charpy Vee Notch (CVN) or Charpy Test**. The specimen, a beam with a notch at its centre ("V-notch" preparation is most common), is supported at both ends and struck with a pendulum on the side opposite the notch. Measuring the energy absorbed during the test, (weight of pendulum x height of pendulum upon release x height to which pendulum swings after striking specimen) gives an impact-strength value in **joules or foot-pounds**. Since steels often become more brittle (less able to absorb energy) at lower temperatures, impact tests are often carried out at a range of low temperatures.

TERMS & DEFINITIONS IN WELDING

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| A. | ▲ Arc Blow | The deflection of an arc from its normal path because of magnetic forces. Normally occurs on DC current when welding carbon steel. |
| | ▲ Arc Voltage | The voltage across the welding arc. |
| | ▲ Arc Length | The distance from the tip of the welding electrode to the adjacent surface of the weld pool. Also known as "Arc Gap". |
| | ▲ Arc Time | The time during which an arc is maintained in making an arc weld. |
| | ▲ As-welded | Pertaining to the condition of weld metal, welded joints and weldments after welding, but prior to any subsequent thermal, mechanical or chemical treatments. |
| | ▲ Autogeneous Weld | A fusion weld made without filler metal. |
| B. | ▲ Back bead | A weld resulting from a back weld pass. Also known as "Back Filling" or "Backing Pass" |
| | ▲ Backgouging | The removal of weld metal and base metal from the weld root side of a welded joint to allow complete fusion and complete joint penetration upon subsequent welding from that side. |
| | ▲ Backing Strip | A material (metal, carbon, ceramic etc.) for backing up a joint during welding to help obtain a sound weld. |
| | ▲ Backing Ring | As above, but in the form of a ring, generally used in pipe welding. |
| | ▲ Backstep Sequence | Weld passes are made in the opposite direction to the progress of welding. |
| | ▲ Base Metal | The metal alloy that is being welded. Also known as "Base Material" or Work Piece". |
| | ▲ Bevel Angle | The angle formed between the prepared edges of two plates. |
| | ▲ Build up | Layers of weld metal deposited when surfacing material to achieve a required dimension. Also known as "Buttering" and "Cladding". |
| | ▲ Buffer Layer | Layers of weld metal on components which prevent crack formation or dilution effects in subsequent weld layers. See also "build up". |
| C. | ▲ Consumable insert | Preplaced filler metal that is completely fused into the root of a joint and becomes part of the finished weld. |

TERMS & DEFINITIONS IN WELDING cont.

- ▲ Crater A depression at the termination of the weld bead.

- D.
 - ▲ Deposition Efficiency The ratio of the weight of filler metal deposited in the weld metal to the weight of filler metal melted, expressed in percent.
 - ▲ Deposition Rate The weight of material deposited in a unit of time.
 - ▲ Depth of Fusion Distance that fusion extends into the base metal from the surface being welded.
 - ▲ Dilution A chemical composition change of the deposited weld metal due to admixture of the filler metal and base metal.
 - ▲ Direct Current Electrode Negative The electrode lead and welding electrode are connected to the negative pole on the welding machine. Also known as DC - or DCEN and DC straight polarity (Negative = 1/3 Heat)
 - ▲ Direct Current Electrode Positive The electrode lead and welding electrode are connected to the positive pole on the welding machine. Also known as DC+ or DCEP and DC reverse polarity. (Positive = 2/3 Heat)

- E.
 - ▲ Edge Preparation The surface prepared on the edge of a joint for welding.
 - ▲ Electrode Lead Conductor between source of current and electrode holder.

- F.
 - ▲ Flux Fusible material coated onto electrodes for removal of oxides impurities and to create gas for shielding and slag for shape and contour.
 - ▲ Fusion The melting together of filler metal and base metal or a base metal only to produce a weld.

- G.
 - ▲ Ground Lead The electrical conductor between the arc welding current source and work piece connection. Also known as "Work Lead".

- H.
 - ▲ Hardfacing The process of covering a surface with wear-resistant metal by welding to reduce wear.
 - ▲ Heat affected Zone The region beneath or around the weld bead which has not melted, but whose mechanical properties or microstructure has been altered by the heat of welding.

- I.
 - ▲ Infra-Red Radiation Electromagnetic energy with wavelengths from 770 to 12,000 nanometers.
 - ▲ Intermittent Welding Is welding wherein continuity is broken by recurring unwelded spaces.

TERMS & DEFINITIONS IN WELDING cont.

	▲ Interpass Temperature	In a multiple run weld, the lowest temperature of deposited metal before the next pass is started. Normally measured 25mm from the weld metal centre line.
L.	▲ Liquidus	The lowest temperature at which a metal or an alloy is completely liquid.
	▲ Longitudinal Sequence	The order in which weld passes of a continuous weld are made along its length.
M.	▲ Melt-Through	Is the visible root re-inforcement obtained in a one sided weld joint.
O.	▲ Open Circuit Voltage	The voltage between terminals of a power source when no current is flowing.
P.	▲ Parent Metal	Same as "Base Metal".
	▲ Peening	The mechanical working of metals by light hammering.
	▲ Penetration	The depth a weld extends into a joint from the metal surface
	▲ Post-heating	Application of heat to the weldment after welding is completed.
	▲ Preheating	Application of heat to the base metal before welding commences.
	▲ Procedure Qualification	To establish that welds made by a detailed method can meet prescribed standards.
R.	▲ Residual Stress	Stress that is present in a joint member or material that is free of external forces.
	▲ Root Bead	A weld which is part or all of the root joint.
	▲ Root Bend Test	A test in which the root surface is bent around a specified radius.
	▲ Runoff / Runon Weld Tab	Is additional plate that extends beyond the end of the weld joint on which the weld is finished or started. (Also known as an End Tab)
S.	▲ Seal Weld	A weld made primarily to seal a joint for tightness against leakage.
	▲ Short Arc (short circuiting) transfer	Is metal transfer where molten metal from an electrode is deposited during repeated short circuits.
	▲ Sidewall	The surface of a joint wall included inside the preparation of a butt weld.
	▲ Side Bend Test	A test in which the side of a transverse section of the weld is bent around a specified radius.

TERMS & DEFINITIONS IN WELDING cont.

- ▲ Slag Inclusion Non-metallic solid material trapped in weld metal or between weld and base metal.
- ▲ Spatter Metal particles expelled during welding which do not form part of the weld.
- ▲ Spray Transfer Metal transfer where molten metal from an electrode is propelled across the arc in small droplets.
- ▲ Stringer Bead A weld bead made without weaving.
- ▲ Suck-Back A concave root surface.
- T. ▲ Tack Weld A small weld made to hold parts in proper alignment until final welds are made.
- U. ▲ Underbead Crack A crack in the heat affected zone which may or may not extend to the surface of the base metal.
- ▲ Underfill A depression on the weld face dropping below the surface of the base metal.
- V. ▲ Vertical-down Downhill direction.
- ▲ Vertical-up Uphill direction.
- W. ▲ Weave Bead A weld bead made with slow oscillation motion of the electrode, best limited in width to 2-3 times the diameter of the electrode.
- ▲ Welder Certification Written verification that a welder has produced welds meeting a prescribed standard of welder performance.
- ▲ Welding Arc A controlled electrical discharge between the electrode and the work piece that is formed and sustained by the establishment of a gaseous conductive medium, called an arc plasma.
- ▲ Welding Procedure Qualification Record (WPQR) A record of welding variables used to produce an acceptable test weld and the results of the tests conducted on that weld which qualify a welding procedure specification.
- ▲ Welding Procedure Specification (WPS) A document providing the detailed variables for a specific welding application to ensure reproduction by trained welders.
- ▲ Work Lead The conductor between source of current and the work piece or work table.
- ▲ Work Piece The job, part or component being welded.