LESSON PLAN

Date_____ Trade:- Welder

Name_____ Week No:- seventeen

Subject :- weld ability of metals, importance of pre-heating, post –heating and maintenance of inter pass temperature.

Motivations:- in previous week we learned about Electrodes, types, function of flux, coating factor, sizes of electrode. Coding of electrodes as per BIS, AWS. Moisture pick up of electrode. Storage and baking of electrodes. Special purpose electrode and their application.

PREPARATION: - Teaching Aids:-Chalk, Charts,

INTRODUCTION: -weld ability is the structure of metal. In this point we assure that the job is ready to weld or not. Pre-heating and post heating balance the metal's structure.

PRESENTATION:-

Weldability

The weldability, also known as **joinability**,[1] of a material refers to its ability to be welded. Many metals and thermoplastics can be welded, but some are easier to weld than others (see Rheological Weldability). A material's weldability is used to determine the welding process and to compare the final weld quality to other materials. Weldability is often hard to define quantitatively, so most standards define it qualitatively. For instance the International Organization for Standardization (ISO) defines weldability in ISO standard 581-1980 as: "Metallic material is considered to be susceptible to welding to an established extent with given processes and for given purposes when welding provides metal integrity by a corresponding technological process for welded parts to meet technical requirements as to their own qualities as well as to their influence on a structure they form." Other welding organizations define it similarly.

Preheating can be defined as the application of heat to the base metal or substrate before welding. Gas torches, electric heaters, or infra-red radiant pane heaters can all be used to apply preheat, which decreases the weld cooling speed and thereby prevents cold cracking in welds. Figure 1 shows how an increase of preheating temperature affects the cooling rate of welds. For example, where heat input is constant (e.g., 20 kJ/cm), a 50-degree-C preheat results in an approximate cooling rate of 17°C/sec, while a preheat of 250°C decreases the cooling rate to approximately 3°C/sec. Decreasing the cooling rates prevents the formation of brittle weld structures, and removes diffusible hydrogen, which in turn prevents the occurrence of cold cracking in welds.

Postheating can be defined as the application of heat to an assembly after welding. Postheating includes postweld heat treatment (PWHT), immediate postweld heating (IPWH), normalizing, quenching, and tempering (aging). The main purposes of these operations in welding fabrication are as follows:

- PWHT: relieves residual stresses
- IPWH: relieves diffusible hydrogen
- Normalizing: refines microstructures deformed by hot forming (e.g., applied on the end plate of vessels)
- Quenching: hardens welds by rapid cooling, using water, air, or mist (e.g., applied on surfaced shafts)
- Tempering (Aging): stabilizes microstructures after quenching or welding

Among these heating or heat treatments, PWHT and IPWH are the most common procedures used in welding. The others are used for limited applications in some welding fabrication fields. The purposes and procedures of PWHT are detailed in Kobelco Welding Today, Vol. 4, No. 2, April 2001. IPWH is usually carried out with gas torches, on welds right after welding is finished, while the weld still maintains the preheat temperature, by using comparatively lower temperatures and shorter heating times (250-350°C x 0.5-1h), prior to PWHT. IPWH decreases diffusible hydrogen to an adequate level (though higher than with PWHT as shown in Fig. 3) to prevent cold cracking.

Material	Arc welding	Oxy-acetylene welding	Electron beam welding	Resistance welding	Brazing	Soldering	Adhesive bonding
Cast iron	C	R	N	S	D	N	C
Carbon steel and low-alloy steel	R	R	C	R	R	D	C
Stainless steel	R	C	C	R	R	C	C
Aluminum and magnesium	C	C	C	C	C	S	R
Copper and copper alloys	C	C	C	C	R	R	C
Nickel and nickel alloys	R	C	C	R	R	C	C
Titanium	C	N	C	C	D	S	C
Lead and zinc	C	C	N	D	N	R	R
Thermoplastic†	N	N	N	N	N	N	C
Thermosets	N	N	N	N	N	N	C
Elastomers	N	N	N	N	N	N	R
Ceramics	N	S	C	N	N	N	R
Dissimilar metals	D	D	C	D	D/C	R	R

†Heated tool = R; Hot gas = R; Induction = C
Key: C = Commonly performed; R = Recommended; D = Difficult; S = Seldom; N = Not used

Interpass temperature is a range of temperature between passes on a multiple pass weld.

It can be measured using a temperature stick. You can also use a infrared temperature gun.

Going above the temperature can cause the microstructure of a material to change and loose characteristics of the material for example a hardened steel like QT plate will loose its hardness or stainless steel can loose its corrosion resistance.Welding below the temperature can cause lack of penetration or cracking from the shock of stress caused by the sudden increase in heat which is usually a problem on thicker materials. Same reason for a pre heat.

With mild steel interpass temperature usually isn't a big deal because Heat wont cause a dramatic change in the materials characteristic. It becomes very critical with hardened materials, stainless steel, High carbon content material, materials with high alloy content, ect...

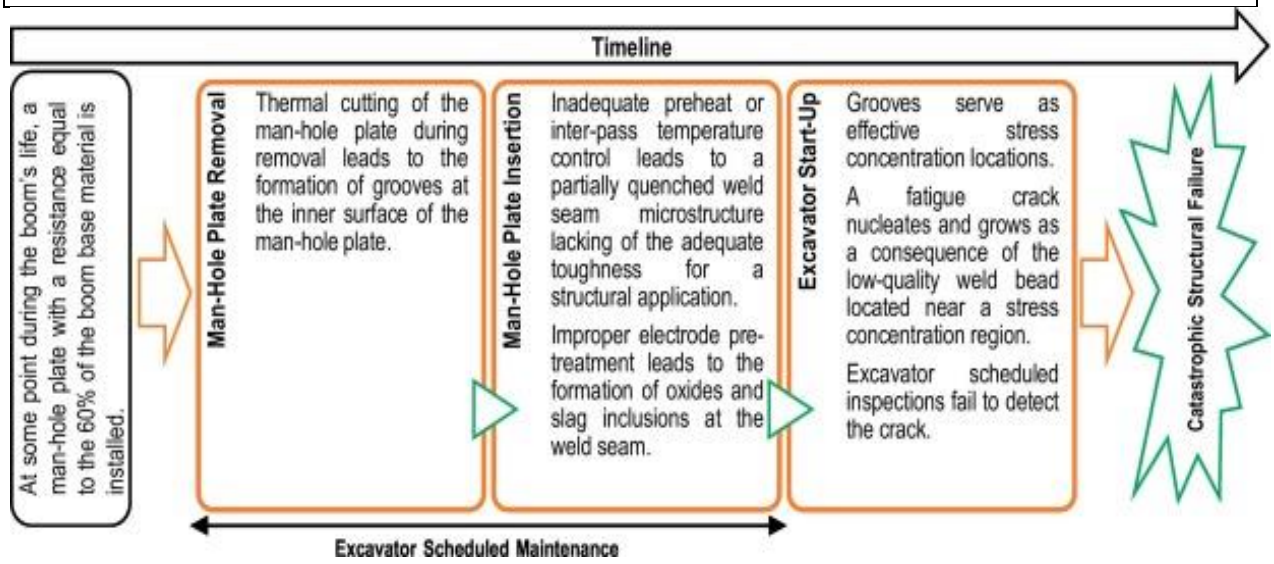
If the material you are welding has a specified interpass temperature stay within it, it is critical to maintain that temperature so the weld metal will have proper fusion to the sound material and maintains its material characteristics (Strength, hardness, corrosion resistance, flexibility)
“Interpass temperature” refers to the temperature of the material in the weld area immediately before the second and each subsequent pass of a multiple pass weld. In practice, the minimum specified interpass temperature is often equal to the minimum specified preheat temperature, but this is not required according to the definition.

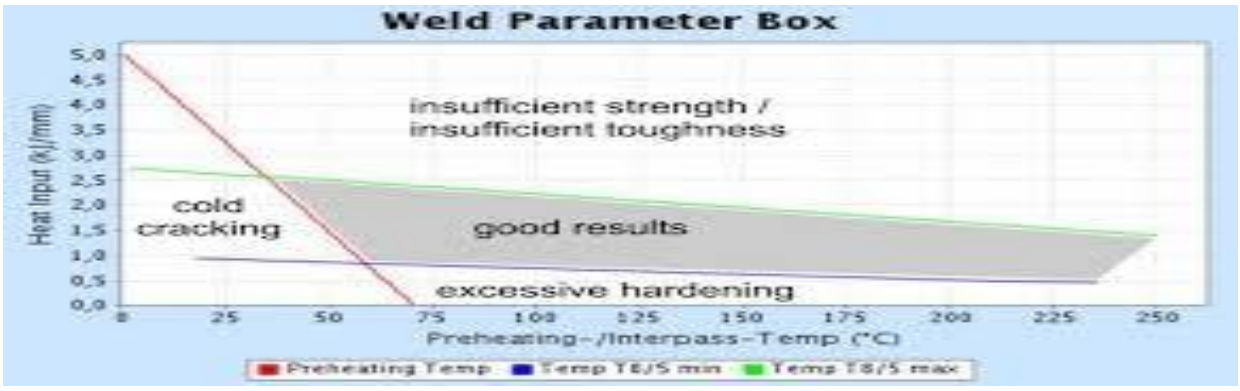
PREHEATING AND INTERPASS TEMPERATURE

Recommended Maximum Interpass Temperatures:

Material Group	Maximum Interpass Temperature
P1(Carbon steels)	600 °F (315 °C)
P3-P5A-P5C (Low alloy steels)	500 °F (250 °C)
P5B (Alloy steel)	600 °F (315 °C)
P6 (410/410S)	600 °F (315°C)
P6 (type 405)	500 °F (250°C)
P6 (CA6NM)	650 °F (345°C)
P8 (Austenitic stainless steel)	300 °F (175°C)
P 10H (Duplex stainless)	300 °F (150°C)*
P41, P42	300 °F (150°C)
P43, 44 and 45	350 °F (175°C)

* Note: interpass temperature may vary depending on material grades.





Welding Metallurgy

Preheating;

- Prior to welding, the entire weld joint area should be heated through the metal thickness to the desired minimum temperature. To obtain uniform temp. through the metal thickness, the temp. measurement is desirable to locate on opposite surface. When it is impossible to measure on opposite side. The preheating time prior to welding is to be considered.

Interpass temperature limitation;

- An Interpass temperature limitation may need to be considered for many materials (i.e. low alloy steels with impact requirements). In such case, the weld area must be checked prior to deposit the next bead.
- Depending upon the metallurgical or mechanical properties of weldment, preheating and interpass temp. may be specified as follows;
  - Minimum temp. only (i.e. Cast steel, Normal and high strength Steels)
  - Maximum temp. only (i.e. aluminum and nickel alloyed)
  - Minimum and maximum temp. (i.e. low alloy steels with impact requirements).

Post Welding Heat Treatment;

- Heating the weldment above the Upper transformation Temperature and holding it long enough in that range to achieve complete transformation into Austenite. Depends on the cooling rate, following specified name assigned to the heat treatment;
  - Annealing: cooled slowly, as in furnace, it produces the softest or "dead soft" steel.
  - Normalizing: cooled at a moderate rate, as in air. Increase strength
  - Quenching: cooled at an accelerated rate, as in water or oil

Questions:-

1. What is weldability and its role in welding?
2. What is pre heating?
3. What is post heating and interpass temprature?

Next Lesson: - Classification of steel.welding of low, medium, high carbon and alloy steel.

Assignment:- weld ability of metals, importance of pre-heating, post –heating and maintenance of inter pass temperature.

Checked by…… Instructor……..