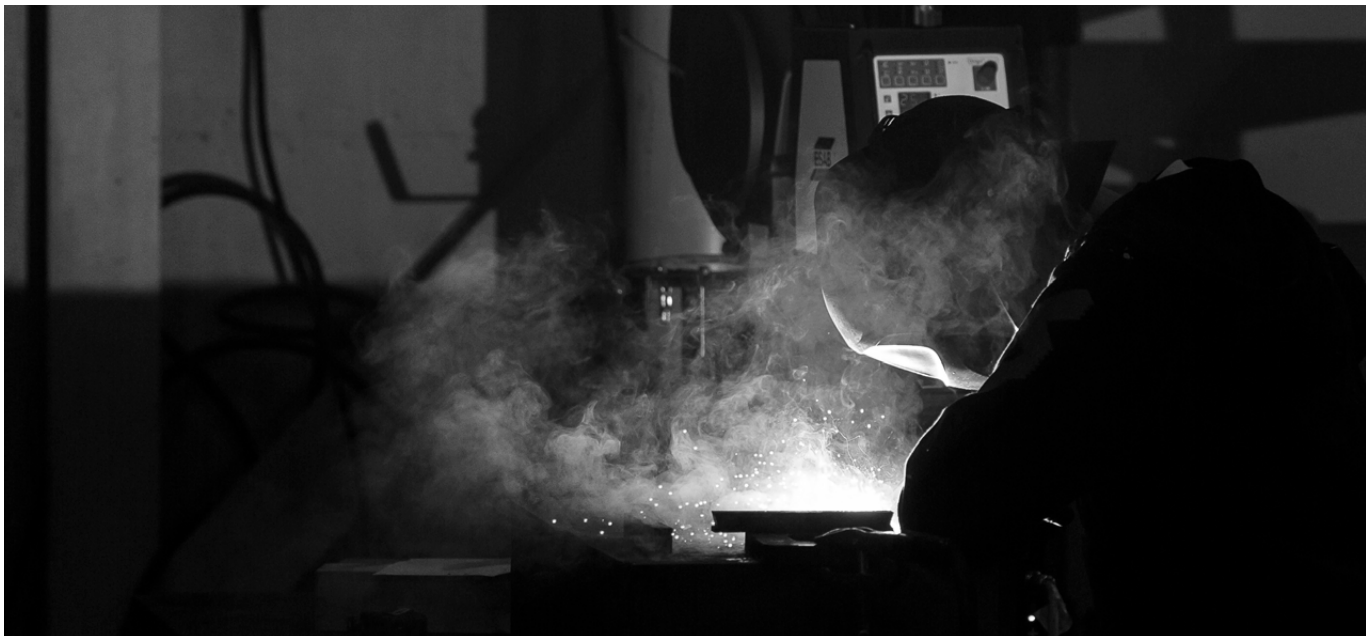

GENERAL RECOMMENDATION

All Swebor steels are low alloyed martensitic steel. As the martensitic structure is transformed to feritic during welding an fertitic, austenitic or austenitic - feritic (alloyed with Mn and Mo) welding material shall be chosen.

For Swebor Armor 550, 560 and 600 austenitic consumables are recommended.

Low strength - under matched material also prevent cracking in the weld by low stresses. It is important that the filler material shall be clean and dry in order to prevent hydrogen cracking.

The hydrogen content shall be maximum 3 ml / 100 g of weld.

All Swebor steels can be welded with other steel grades for example structural steels.

WELDING HYGIENE

A good welding hygiene is to be considered: Pollutants such as water, oil, dust, paint and rust shall at the most be removed.

INFLUENCE OF ALLOYING ELEMENTS

For being hardened steel Swebor steels has a relatively low alloying content with a good weldability as a result. Generally a higher alloying content require higher preheating and a higher heat input.

HYDROGEN CRACKING

Hydrogen cracking is a phenomena where hydrogen gas is formed in the material crating so high pressure in the ”bubbles” that they ”explode” and the material crating so high pressure in the ”bubbles” that they ”explode” and the material crack/fractures. Hydrogen cracking comes from:

1. Hydrogen in the weld/material
2. Stresses in the weld/material

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HOW TO AVOID HYDROGEN CRACKING

1. MINIMIZE THE HYDROGEN CONTENT IN THE WELD BY:

USE THE RIGHT PREHEAT AND HEAT INPUT
Use welding consumables with low hydrogen content (make sure they also are dry). In case of moisture and/or wet welding consumables material must be dried before use according to best practice from welding consumables producer or workshop experience (recommendation is baking at 350°C for 2 hours).

Vacuum packed electrodes can be used without baking but the package must be used in 8 hours after opening.

Keep impurities such as moist, snow, ice, water, oil, grease and paint of the welding area. Material must be cleaned using chemical and/or mechanical cleaning. Mechanical cleaning with brushing, grinding, sand or shot blasting is prefered followed by degreasing with suitable solvent and clean cloth.

2. MINIMISE THE STRESS IN THE WELD JOINT:

Do not use welding consumables of a higher strength than necessary - undermatching is recommended. Arrange the weld sequence so the residual stresses are minimized - backstep welding is recommended. Set the gap between the welded parts to a maximum of 3mm.

PREHEAT TEMPERATURES FOR SWEBOR STEELS

The lowest preheat temperatures during welding is shown in the table below. These values are valid for unalloyed and low alloyed welding consumables. There are two general rules to consider during preheating:

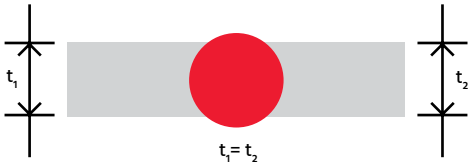
1. The thickest plate determine the preheat temperature
2. When welding plates of different alloying content the highest alloyed/requiring the highest prehat value determine the preheat temperature.

MINIMUM RECOMMENDED PREHEATING TEMPEATURES FOR DIFFERENT SINGLE PLATE THICKNESS (mm)

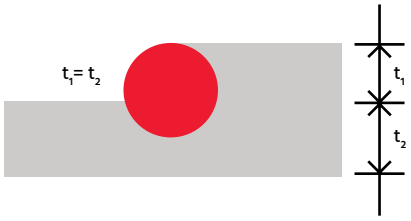
STEEL THICKNESS (mm)	10	20	30	40	50	60
Swebor Armor 400	RT / 20°C		75°C		100°C	175°C
Swebor Armor 440	RT / 20°C		125°C		150°C	175°C
Swebor Armor 500	RT / 20°C	175°C		200°C		
Swebor Amor 560	125°C	175°C		200°C		

Recommended minimal temperature of the plate before welding should be at least 15°C. When using austenitic welding consumables temperature of steel plate shall not be lower than room temperature.

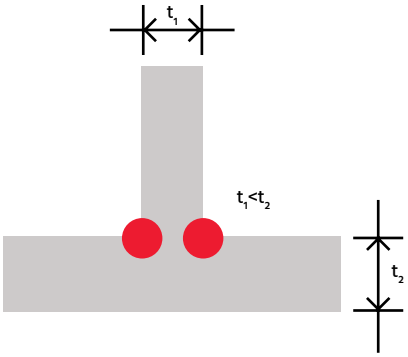
SINGLE PLATE THICKNESS



$t_1 = t_2$ The single plate thickness is t_1 or t_2, is provided that the same steel type is used



$t_1 = t_2$ The single plate thickness is t_1 or t_2, provided that the same steel type is used



$t_1 < t_2$ In this case, the single plate thickness is t_2, provided that the same steel type is used

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HEAT INPUT

The amount of thermal energy that is added in weld affects the final properties of the joint. A general rule is that the less energy used the better final properties. But without sufficient amount of energy in the weld it will be undpoducite and if so less energy is being used the weld will fail.

To weld Swebor steels the Heat input shall be between 0,6 and 3 kJ/mm of weld. To calculate the right heat input the formula below shall be used. As all welding environments and equipment are individually different the calculation must be verified by trials in your facility with your equipment.

$$Q = \frac{k \times U \times I \times 60}{v \times 1000\ [kJ/mm]}$$

Q = Heat input [kJ/mm]
U = Voltage [V]
I = Current [A]
v = Welding speed [mm/min]
k = Thermal efficiency [/]

Thermal efficiency k [/] values:
MM A 0.8
MAG, all types 0.8
SAW 1.0
TIG0.6

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