

Hardfacing and Wear Resistant Use

Welding Notes

To obtain the ideal hardfacing result and minimize cracking, carefully select the proper alloyed hardfacing filler metal and welding procedure is recommended; Pay attention to the following additional points :

1. base metal preparation

Surface corrosive and impure material such as grease, dirt, etc. must be removed; otherwise blow holes will most likely to occur. In addition, when the base metal has racked already, the weld metal will continue to suffer cracks as well; thus, the defects on the base metal must be removed before welding.

2. Heat input and temperature control

In order to lessen cracking occurring, consult the following guidance :

a. Pre-heat and inter pass temperature control

This is one effective step to avoid cracking. The chart lists base metal's carbon equivalent (Ceq) and the recommended preheat and inter pass temperature. During actual welding, the work's size, thickness, filler metal and welding process should be taken into consideration.

Table 1 : base metal carbon equivalent and preheat & inter pass temperature reference value

Steel Type	Carbon Equivalent	pre-heat and inter pass temperature
Carbon Steel	≤ 0.3	$\leq 100^{\circ}\text{C}$
	> 0.3 but ≤ 0.4	$\geq 100^{\circ}\text{C}$
	> 0.4 but ≤ 0.5	$\geq 150^{\circ}\text{C}$
	> 0.5 but ≤ 0.6	$\geq 200^{\circ}\text{C}$
	> 0.6 but ≤ 0.7	$\geq 250^{\circ}\text{C}$
	> 0.7 but ≤ 0.8	$\geq 300^{\circ}\text{C}$
	> 0.8	$\geq 350^{\circ}\text{C}$
Mn Steel (13%Mn)	No need to pre-heat, but inter pass temperature must be controlled below 260°C .	
Austenite Stainless Steel	No need to pre-heat, inter pass temperature is below 150°C .	
High Alloy Steel (high Chromium Carbide)	Above 400°C .	

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Remark :

1. $C_{eq} \% = C + Mn / 6 + Si / 24 + Cr / 5 + Mo / 4 + Ni / 15$.
2. Post weld heat treatment is needed according to base metal alloy contents or carbon equivalent.
 - a. The 300 series' austenite stainless steel not included in the high alloy steel section.

b. Post heating after welding

Recommending 300~350°C post heating immediately after welding and sustain 10-30 minutes to avoid cracking. Do not over heating or might cause hardness decline.

c. Post Weld Heat Treatment

Post weld heat treatment of 550~750°C can effectively avoid cracking, less deformation and improve weld metal characteristics. Make sure hardness criteria is reasonable prior to post weld heat treatment.

3. Buffer layer

When base metal requires a layer of extreme hard high alloy content weld metal, make sure to weld on a layer of lower alloy content buffer layer to avoid cracking.

4. Penetration

During hardfacing welding operation, the weld metal's characteristics will be changed according to the degree of penetration from filler and base metal's mutual dilution. Usually the filler metal's chemical composition differs from the base metal; to achieve ideal hardness and characteristics for the weld metal, use as often as possible multi-passes technique in order to avoid high penetration and high dilution.

5. Welding deformation

To decrease work piece's deformation, use short bead, intermittent technique, symmetric welding technique, or fasten the work piece into stationary position before welding.