Weld Joint Design

Weld Joint Design

Selection of a correct weld joint design is critical to the successful fabrication of HASTELLOY® and HAYNES® alloys. Poor joint design can negate even the most optimum welding conditions. The main consideration in weld joint design of Ni-/Co-base alloys is to provide sufficient accessibility and space for movement of the welding electrode or filler metal. Slightly different weld joint geometries are required compared to those for carbon or stainless steel; in particular, a larger included weld angle, wider root opening (gap), and reduced land (root face) thickness are typically required.

The most important characteristic that must be understood when considering weld joint design is that Ni- and Co-base molten weld metal is relatively "sluggish", meaning that it does not flow or spread out as readily to "wet" the sidewalls of the weld joint. Therefore, care must be taken to ensure that the joint opening is wide enough to allow proper electrode manipulation and placement of the weld bead to achieve proper weld bead tie-in and fusion. The welding arc and filler metal must be manipulated in order to place the molten metal where it is needed. The joint design should allow for the first weld bead to be deposited with a convex surface. An included weld angle or root opening that is too narrow promotes the formation of a concave weld bead that places the weld surface in tension and promotes solidification cracking in the weld metal.

Additionally, weld penetration is significantly less than that of a typical carbon or stainless steel. This characteristic requires the use of reduced land thickness at the root of the joint compared to carbon and stainless steel. Since this is an inherent property of Ni-/Co-base alloys, increasing weld current will not significantly improve their shallow weld penetration characteristics.

Typical butt joint designs that are used with the gas tungsten arc welding (GTAW), gas metal arc welding (GMAW), and shielded metal arc welding (SMAW) processes are: (i) Square-Groove, (ii) Single-V-Groove, and (iii) Double-V-Groove, as shown in Figure 1. Gas tungsten arc welding is often the preferred method for depositing the root pass for square-groove or single-V-groove joints, where there is access to only one side of the joint. The remainder of the joint can then be filled using other welding processes as appropriate. For groove welds on heavy section plates greater than 3/4 inch (19 mm) thick, a J-groove is permissible. Such a joint reduces the amount of filler metal and time required to complete the weld. Other weld joint designs for specific situations are shown in Figure 2.

Various welding documents are available to assist in the design of welded joints. Two documents that provide detailed guidance are:

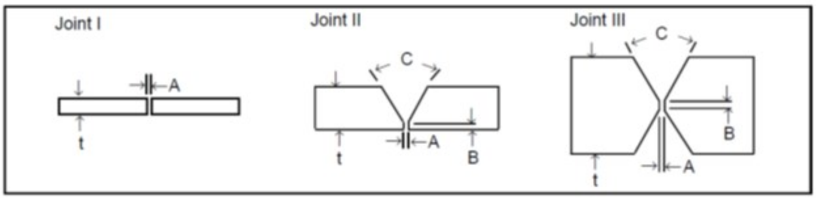
Welding Handbook, Ninth Edition, Volume 1, Welding Science and Technology, Chapter 5, Design for Welding, pg. 157-238, American Welding Society, 2001.

ASM Handbook, Volume 6, Welding, Brazing and Soldering, Welding of Nickel Alloys, pg. 740-751, ASM International, 1993.

In addition, fabrication codes such as the ASME Pressure Vessel and Piping Code may impose design requirements.

The actual number of passes required to fill the weld joint depends upon a number of factors that include the filler metal size (electrode or wire diameter), the amperage, and the travel speed. The estimated weight of weld metal required per unit length of welding is provided in Figure 1.

Figure 1: Typical Butt Joints for Manual Welding



Material Thickness (t)		Preferred Joint Design	Root Opening (A)		Land Thickness (B)		Included Weld Angle (C)	Approx. Weight of Weld Metal Required	
in	mm	-	in	mm	in	mm	degrees	lbs/ft	kg/m
1/16	1.6	I	0-1/16	0-1.6	N/A		None	0.02	0.03
3/32	2.4	I	0-3/32	0-2.4	N/A		None	0.04	0.06
1/8	3.2	I	0-1/8	0-3.2	N/A		None	0.06	0.09
1/4	6.3	II	1/16-1/8	1.6-3.2	1/32-3/32 (0.8-2.4)		60-75	0.30	0.45
3/8	9.5	II	1/32-5/32 (0.8-4.0)				60-75	0.60	0.89
1/2	12.7	II					60-75	0.95	1.41
1/2	12.7	III					60-75	0.60	0.89
5/8	15.9	II					60-75	1.40	2.08
5/8	15.9	III					60-75	0.82	1.22
3/4	19.1	II					60-75	1.90	2.83
3/4	19.1	III					60-75	1.20	1.79

Figure 2: Other Weld Joint Designs for Specific Situations