How is cracking susceptibility estimated?

Cracking is associated with impurities, particularly sulphur and phosphorus, and is promoted by carbon whereas manganese and silicon can help to reduce the risk. To minimise the risk of cracking, fillers with low carbon and impurity levels and relatively high manganese content are preferred. As a general rule, for carbon-manganese steels, the total sulphur and phosphorus content should be no greater than 0.06%.

Weld metal composition is dominated by the consumable and as the filler is normally cleaner than the metal being welded, cracking is less likely with low dilution processes such as MMA and MIG. Plate composition assumes greater importance in high dilution situations such as when welding the root in butt welds, using an autogenous welding technique like TIG, or a high dilution process such as submerged arc welding.

In submerged arc welds, as described in BS 5135 (Appendix F), the cracking risk may be assessed by calculating the Units of Crack Susceptibility (**UCS**) from the weld metal chemical composition (weight %):

UCS = 230C* + 190S + 75P + 45Nb - 12.3Si - 5.4Mn - 1

C* = carbon content or 0.08 whichever is higher. Although arbitrary units, a value of <10 indicates high cracking resistance whereas >30 indicates a low resistance. Within this range, the risk will be higher in a weld run with a high depth to width ratio, made at high welding speeds or where the fit-up is poor. For fillet welds, runs having a depth to width ratio of about one, UCS values of 20 and above will indicate a risk of cracking. For a butt weld, values of about 25 UCS are critical. If the depth to width ratio is decreased from 1 to 0.8, the allowable UCS is increased by about nine. However, very low depth to width ratios, such as obtained when penetration into the root is not achieved, also promote cracking.

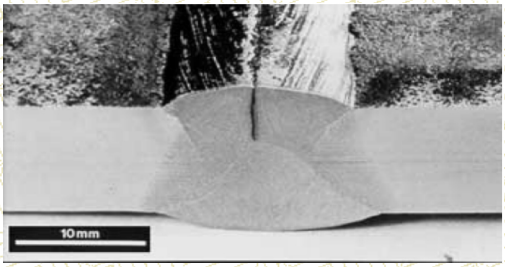
What is the best practice in avoiding solidification cracking?

Apart from the choice of material and filler, the principal techniques for minimising the risk of welding solidification cracking are:

Control joint fit-up to reduce gaps.

Before welding, clean off all contaminants from the material

Ensure that the welding sequence will not lead to a build-up of thermally induced stresses. Solidification crack along the centre line of the weld



Select welding parameters and technique to produce a weld bead with an adequate depth to width ratio, or with sufficient throat thickness (fillet weld), to ensure the weld bead has sufficient resistance to the solidification stresses (recommend a depth to width ratio of at least 0.5:1).

Avoid producing too large a depth to width ratio which will encourage segregation and excessive transverse strains in restrained joints. As a general rule, weld beads whose depth to weld ratio exceeds 2:1 will be prone to solidification cracking.

Avoid high welding speeds (at high current levels) which increase the amount of segregation and the stress level across the weld bead.

At the run stop, ensure adequate filling of the crater to avoid an unfavorable concave shape.

Detection and remedial action

Surface breaking solidification cracks can be readily detected using visual examination, liquid penetrant or magnetic particle testing techniques. Internal cracks require ultrasonic or radiographic examination techniques.

Most codes will specify that all cracks should be removed. A cracked component should be repaired by removing the cracks with a safety margin of approximately 5mm beyond the visible ends of the crack. The excavation is then re-welded using filler which will not produce a crack sensitive deposit.

Dr.R.Vaideeswaran, BHEL,Tiruchy14