Welding defects

Cracks

- Cracks may be of micro or macro size and may appear in the weld metal or base metal or base metal and weld metal boundary.
- Different categories of cracks are longitudinal cracks, transverse cracks or radiating/star cracks and cracks in the weld crater.
- Cracks occur when localized stresses exceed the ultimate tensile strength of material.
- These stresses are developed due to shrinkage during solidification of weld metal.

Cracks may be developed due to poor ductility of base metal, high sulphur and carbon contents, high arc travel speeds i.e. fast cooling rates, too concave or convex weld bead and high hydrogen contents in the weld metal.

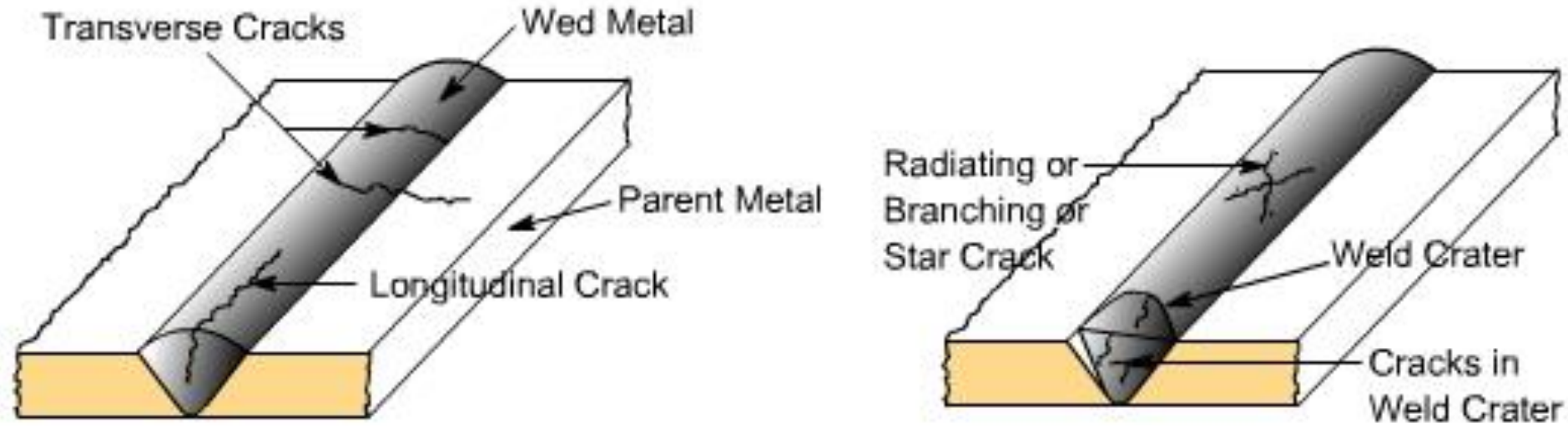


Fig. Various Types of Cracks in Welds

HAZ Cracking

- Cracking in heat affected zone may be caused by:

  (i) Hydrogen in welding atmosphere

  (ii) hot cracking

  (iii) low ductility

  (iv) high residual stresses

  (v) brittle phase in the microstructure

Hydrogen Induced Cracking

- Due to the presence of moisture, grease, rust etc., hydrogen may enter the weld pool and get dissolved in the weld metal.
- During cooling hydrogen diffuses to the HAZ.
- Cracking may develop due to residual stresses assisted by hydrogen coalesence.
- The factors that determine the probability of hydrogen induced embrittlement and cracking of weld are:

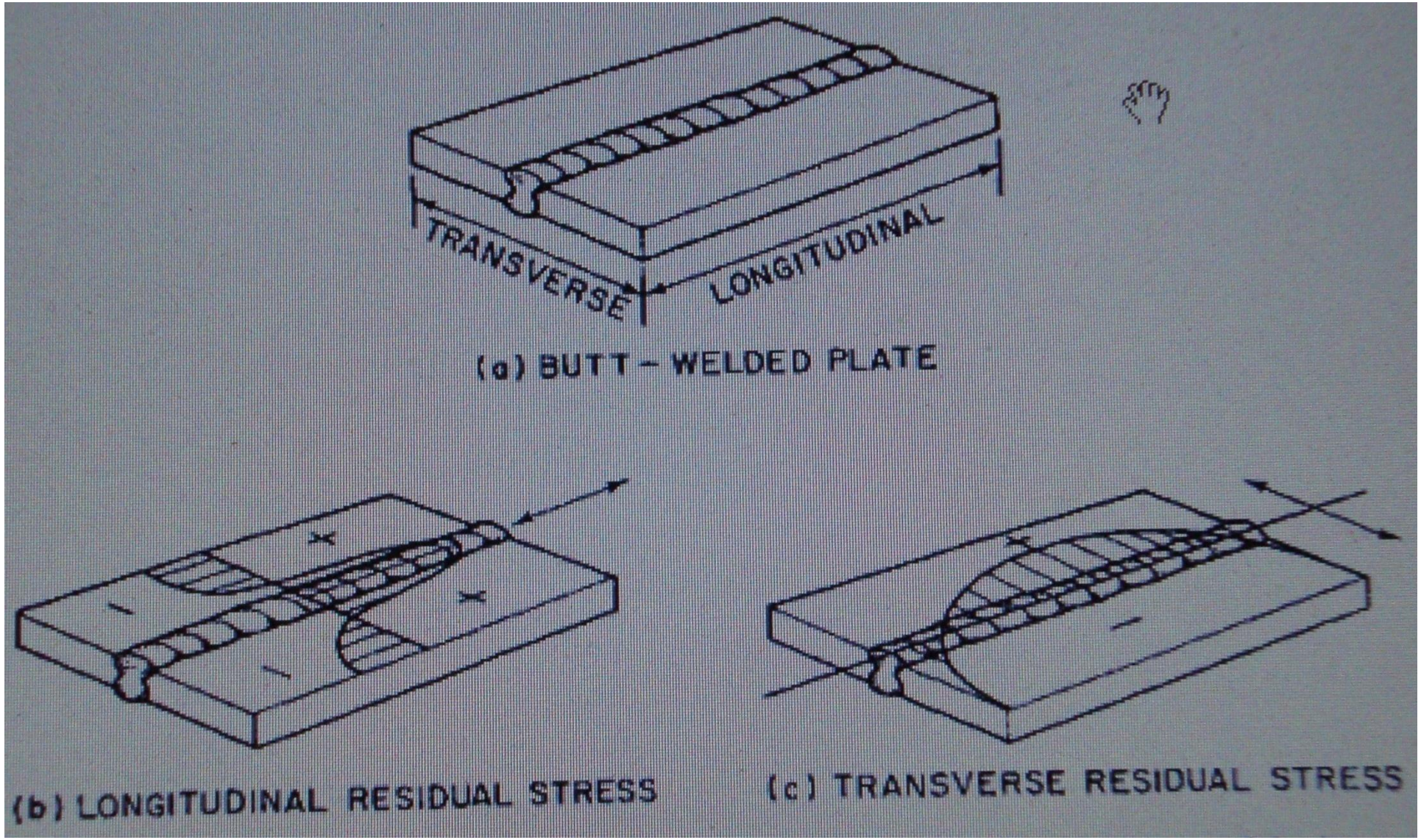
  (a) Hydrogen content

  (b) fracture toughness of weld and HAZ

  (c) stress to which the joint is exposed as a result of the weld thermal cycle.

Residual stress

- The residual stresses result from the restrained expansion and contraction that occur during localized heating and cooling in the region of weld deposit.
- The magnitude of residual stresses depends on the weldment design, support and clamping of the components being welded, their materials, welding process used, part dimensions, welding sequence, post weld treatment, size of the deposited weld beads, etc.
- Residual stresses should not have a harmful effect on the strength performance of weldments, reduces fatigue strength, May cause distortion. This residual stress may result in the cracking of a brittle material and is not important as far as a ductile material.


TRANSVERSE
LONGITUDINAL
(a) BUTT - WELDED PLATE
(b) LONGITUDINAL RESIDUAL STRESS
(c) TRANSVERSE RESIDUAL STRESS

Porosity

- Porosity results when the gases are entrapped in the solidifying weld metal.
- These gases are generated from the flux or coating constituents of the electrode or shielding gases used during welding or from absorbed moisture in the coating.
- Porosity can also be controlled if excessively high welding currents, faster welding speeds and long arc lengths are avoided flux and coated electrodes are properly baked.

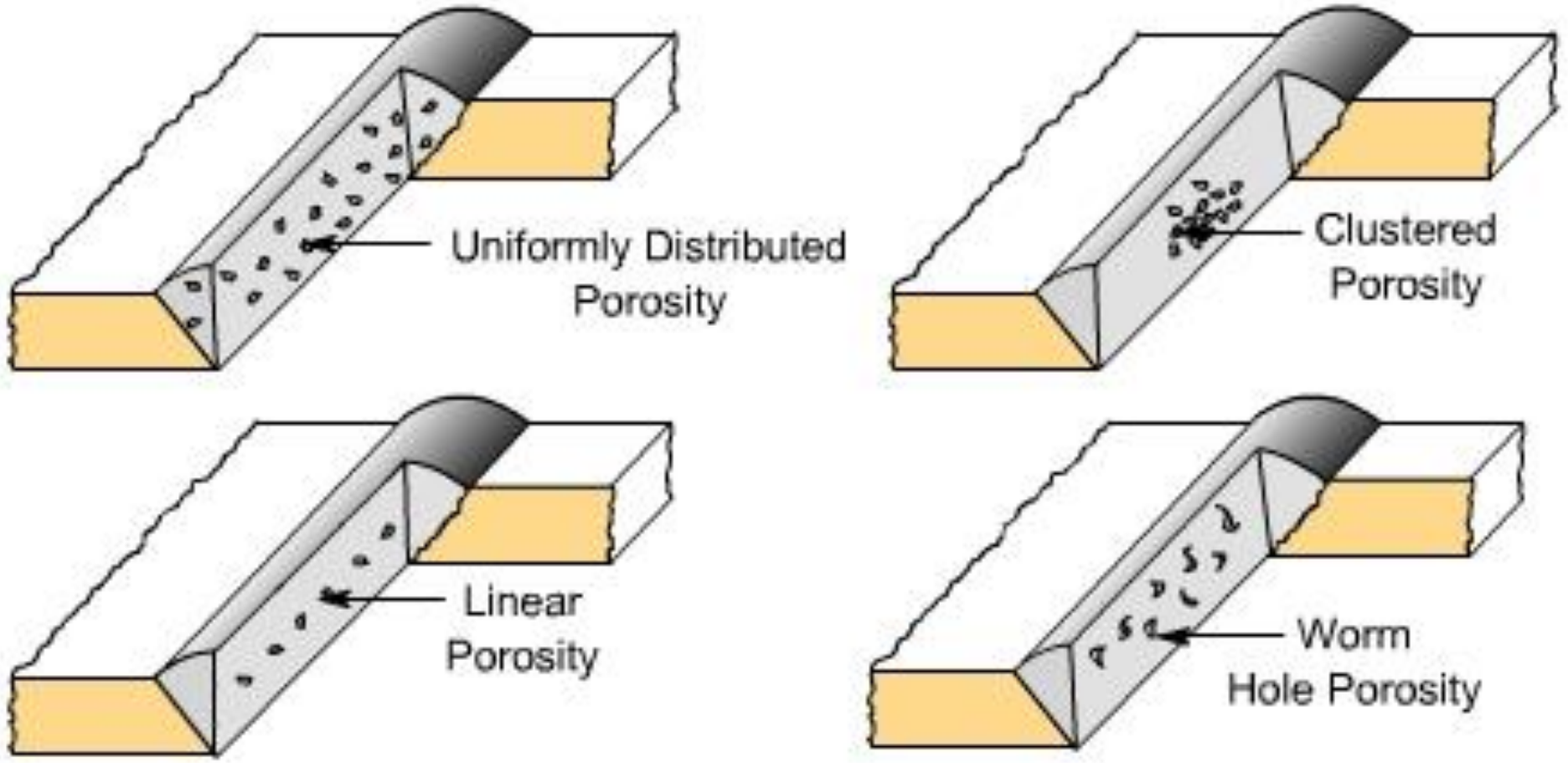


Fig. Different Forms of Porosities

Solid Inclusion

- Solid inclusions may be in the form of slag or any other nonmetallic material entrapped in the weld metal as these may not able to float on the surface of the solidifying weld metal.
- During arc welding flux either in the form of granules or coating after melting, reacts with the molten weld metal removing oxides and other impurities in the form of slag and it floats on the surface of weld metal due to its low density.
- Slag inclusion can be prevented if proper groove is selected, all the slag from the previously deposited bead is removed, too high or too low welding currents and long arcs are avoided.

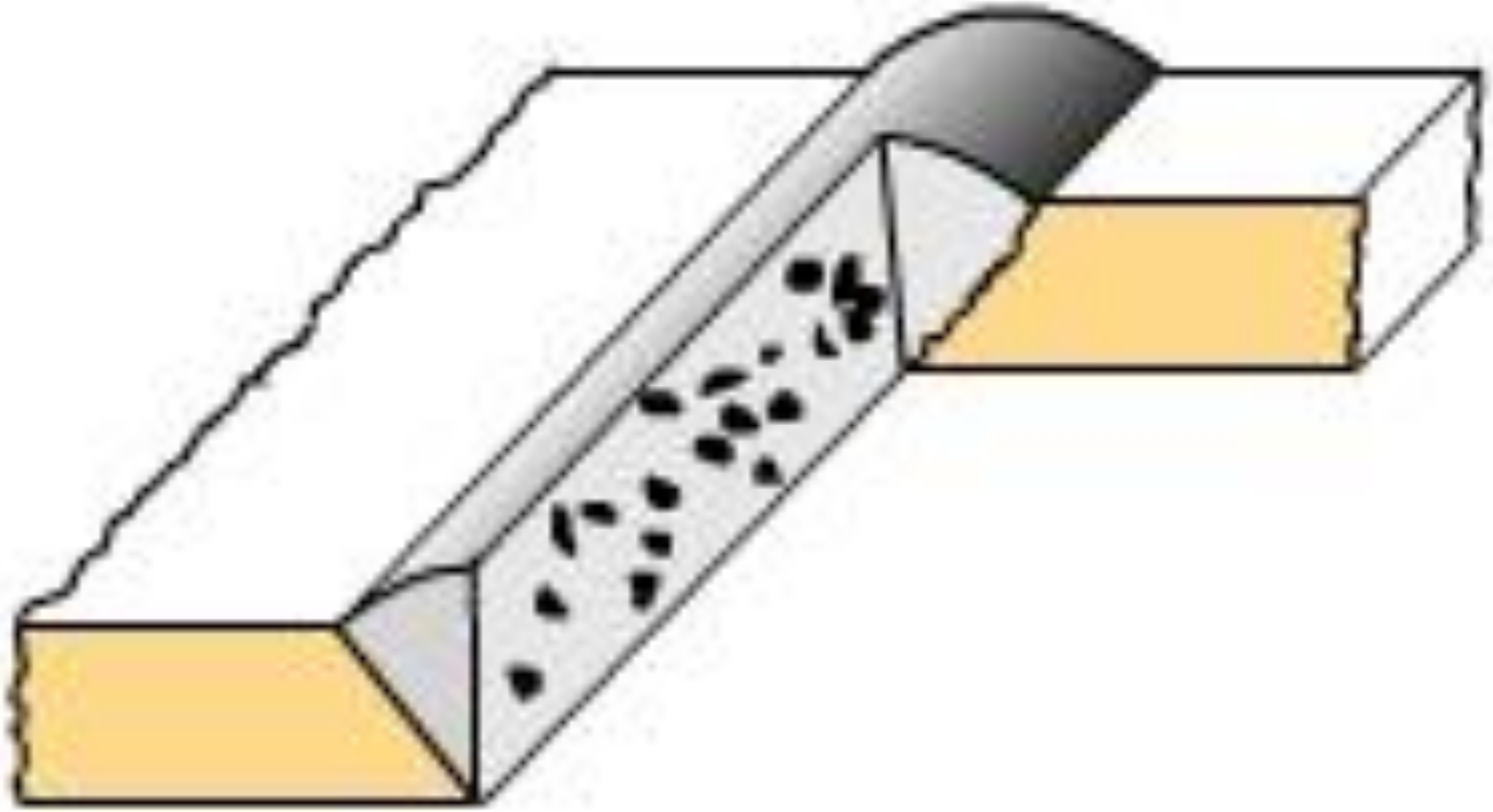
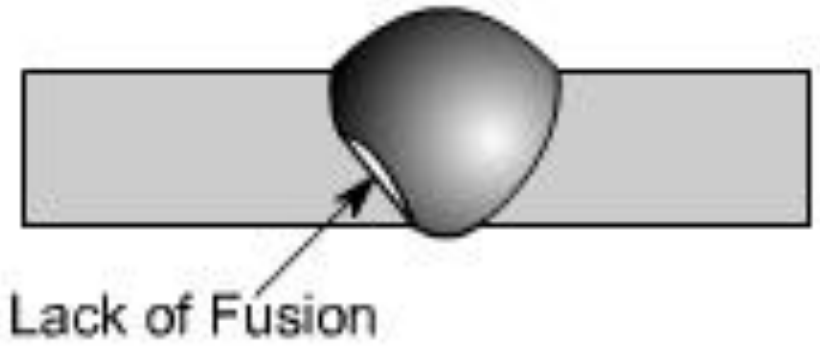
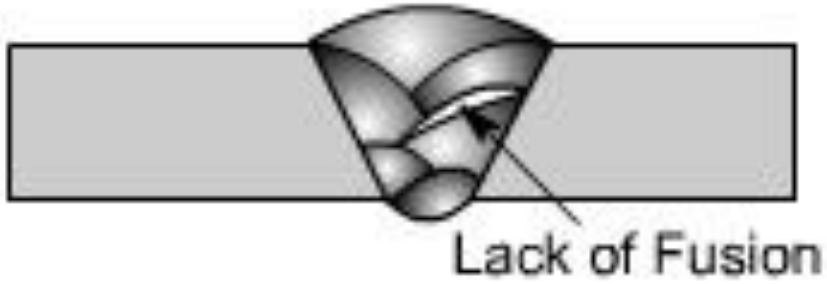


Fig. Slag Inclusion in Weldments

Lack of Fusion

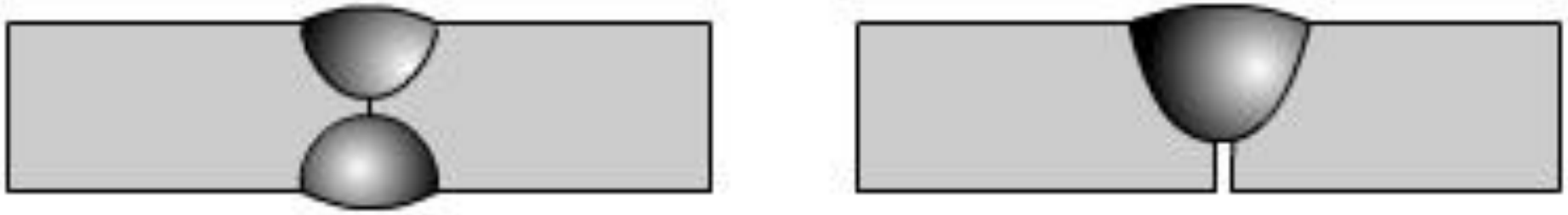
- Lack of fusion is the failure to fuse together either the base metal and weld metal or subsequent beads in multipass welding because of failure to raise the temperature of base metal or previously deposited weld layer to melting point during welding.
- Lack of fusion can be avoided by properly cleaning of surfaces to be welded, selecting proper current, proper welding technique and correct size of electrode.





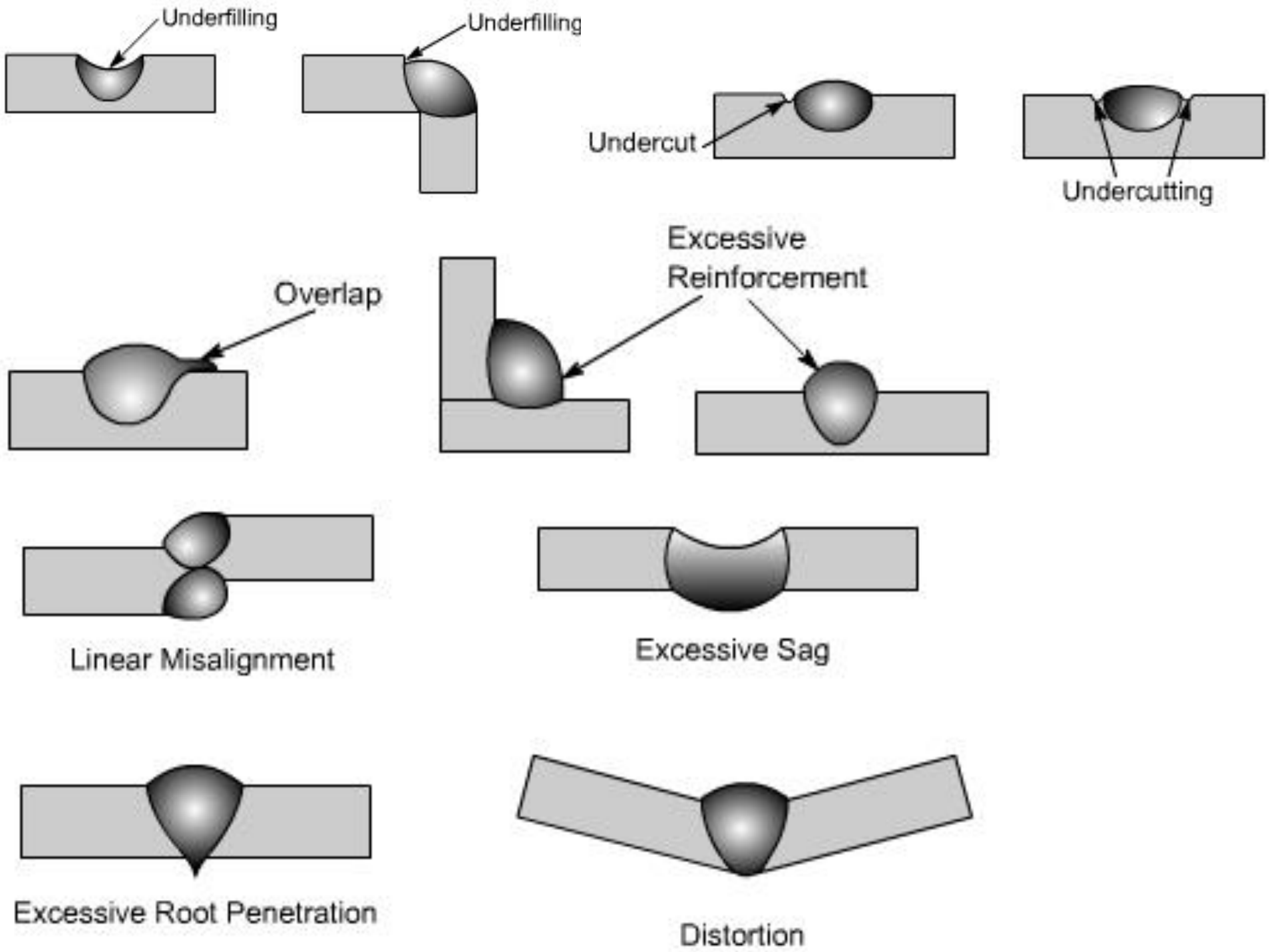
Incomplete Penetration

- Incomplete penetration means that the weld depth is not upto the desired level or root faces have not reached to melting point in a groove joint.
- If either low currents or larger arc lengths or large root face or small root gap or too narrow groove angles are used then it results into poor penetration.



Imperfect Shape, Distortions

- Imperfect shape means the variation from the desired shape and size of the weld bead.
- During undercutting a notch is formed either on one side of the weld bead or both sides in which stresses tend to concentrate and it can result in the early failure of the joint. Main reasons for undercutting are the excessive welding currents, long arc lengths and fast travel speeds.
- Underfilling may be due to low currents, fast travel speeds and small size of electrodes. Overlap may occur due to low currents, longer arc lengths and slower welding speeds.
- Excessive reinforcement is formed if high currents, low voltages, slow travel speeds and large size electrodes are used. Excessive root penetration and sag occur if excessive high currents and slow travel speeds are used for relatively thinner members.
- Distortion is caused because of shrinkage occurring due to large heat input during welding.


Underfilling
Underfilling
Undercut
Undercutting
Overlap
Excessive
Reinforcement
Linear Misalignment
Excessive Sag
Excessive Root Penetration
Distortion