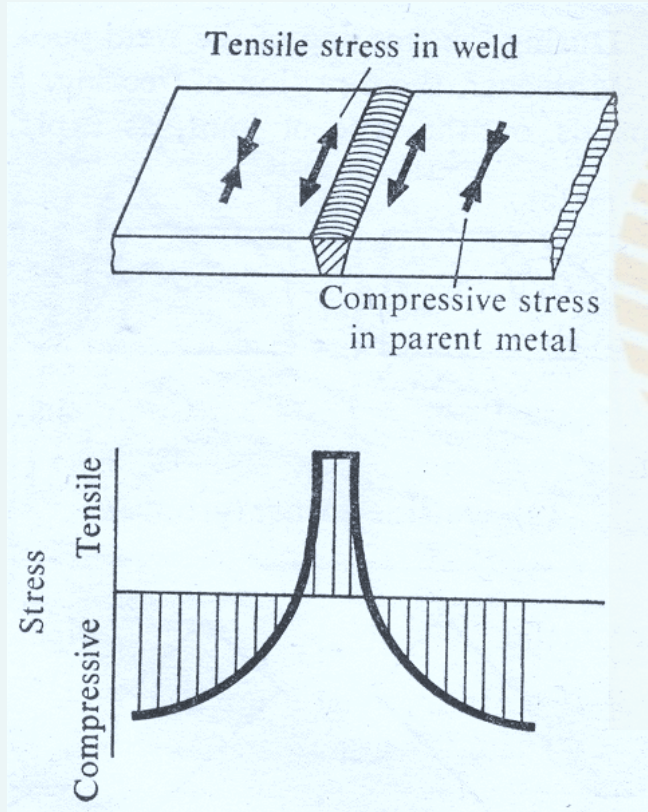


Solidification of Weld

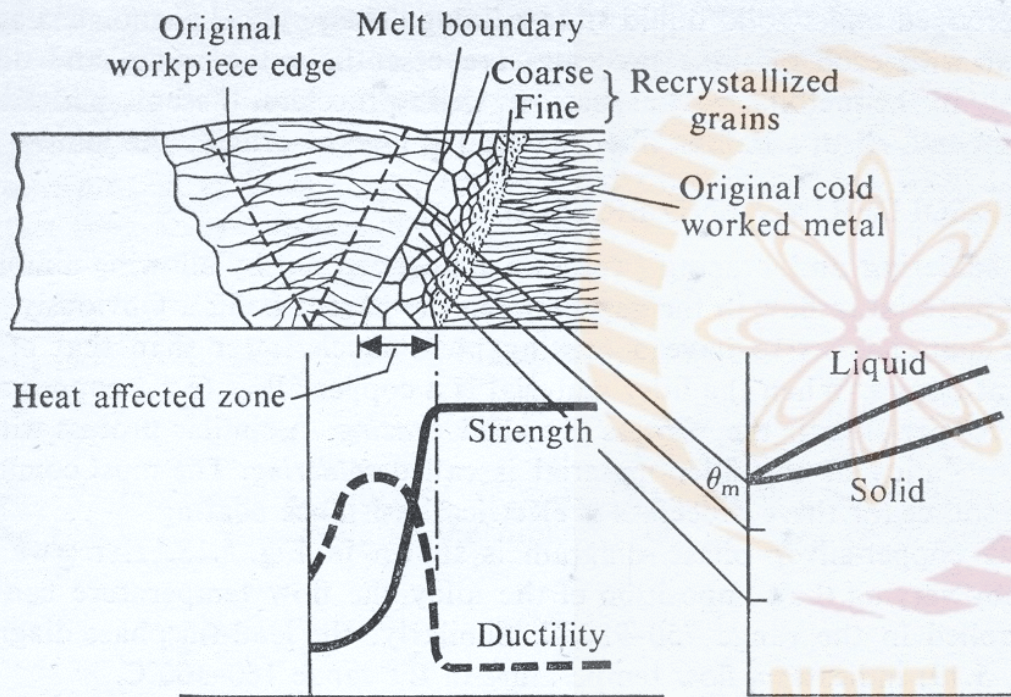
Residual Stresses:



- During welding, a long narrow zone is subjected to elevated temperatures, while plates are at room temperature
- During cooling, heat from the weld zone dissipates laterally into the plates, while the weld area cools
- Welded length tends to contract, while the base metal tends to expand longitudinally
- Weld area in very high residual tension (as contraction restricted by base metal) and base metal in compression

Solidification of Weld

Metallurgical Changes:



These changes occur due to the heating and subsequently cooling of the weld and the heat affected zone of the parent metal.

An increase in strength occurs due to quenching effect or rapid heat transfer to the cold parent metal.

- HAZ may be the weakest area of the weld
- Size of HAZ increases with
 - Lower heat input rate processes
 - LBW (HHI); SMAW, GMAW (MHI); Gas welding (LHI)
 - Decreased welding speed
 - Increased thermal conductivity of the base metal
 - Decrease in the base metal thickness
- HAZ can be minimized by
 - Heat treatment

Various Welding Processes

SOLID-STATE (Phase) WELDING

- Liquid phase is not present
- High temperature promotes bonding
- Pressure promotes bonding by plastic deformation
- Does not require consumable electrodes, shielding gases or flux

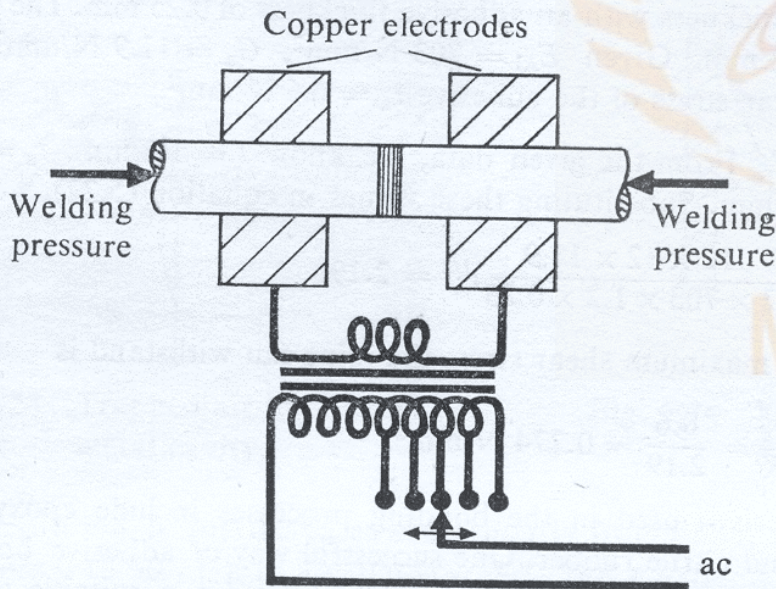
Various Welding Processes

Solid Phase Welding:

1. **Forge Welding** : Parts to be welded are heated in a furnace and then hammered together to form the weld.

2. **Butt Welding** :

- Surfaces are brought into contact
- Heated by electrical current
- Axially compressed

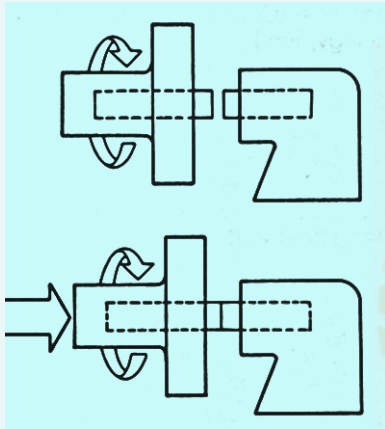


Compression results in a lateral flow of the surface layers (oxides) and brings the clean metals in contact.

Various Welding Processes

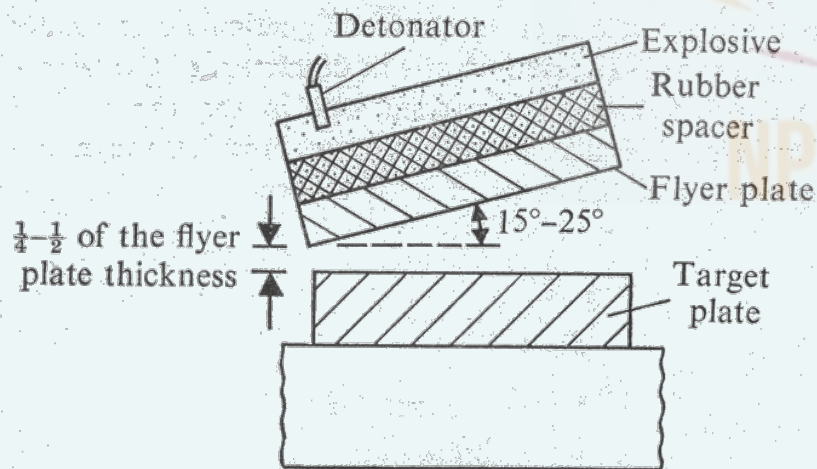
Solid Phase Welding

3. Friction Welding:



The required heat is generated through friction. One of the members remains stationary while the other is rotated at a high speed. The two members to be joined are then brought into contact under an axial force.

4. Explosion Welding



Plates' kinetic energy striking the mating member produces a wavy interface. This impact mechanically interlocks the two surfaces.

Detonation Speed: 2400-3600 m/s

Various Welding Processes

Solid Phase Welding

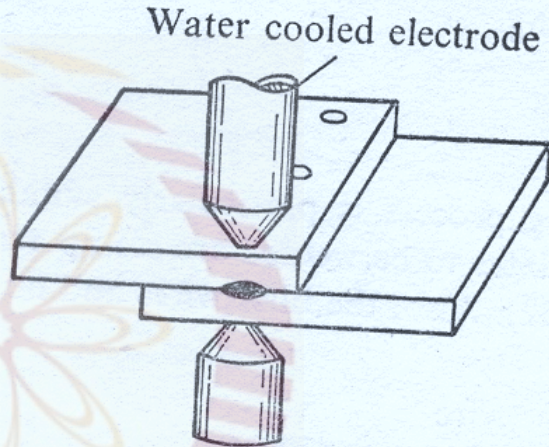
5. Resistance Welding

- The process uses the electrical resistance between the two members to be joined as the heat source.
- Heat Generated, $H = I^2Rt$
- For high heat generation at the junction, w/p-w/p contact resistances should be kept high, and the rest should be kept low.

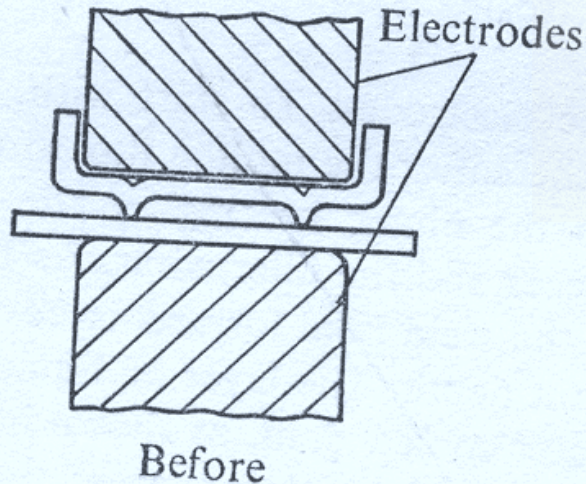
Various Welding Processes

Solid Phase Welding

Resistance Spot Welding



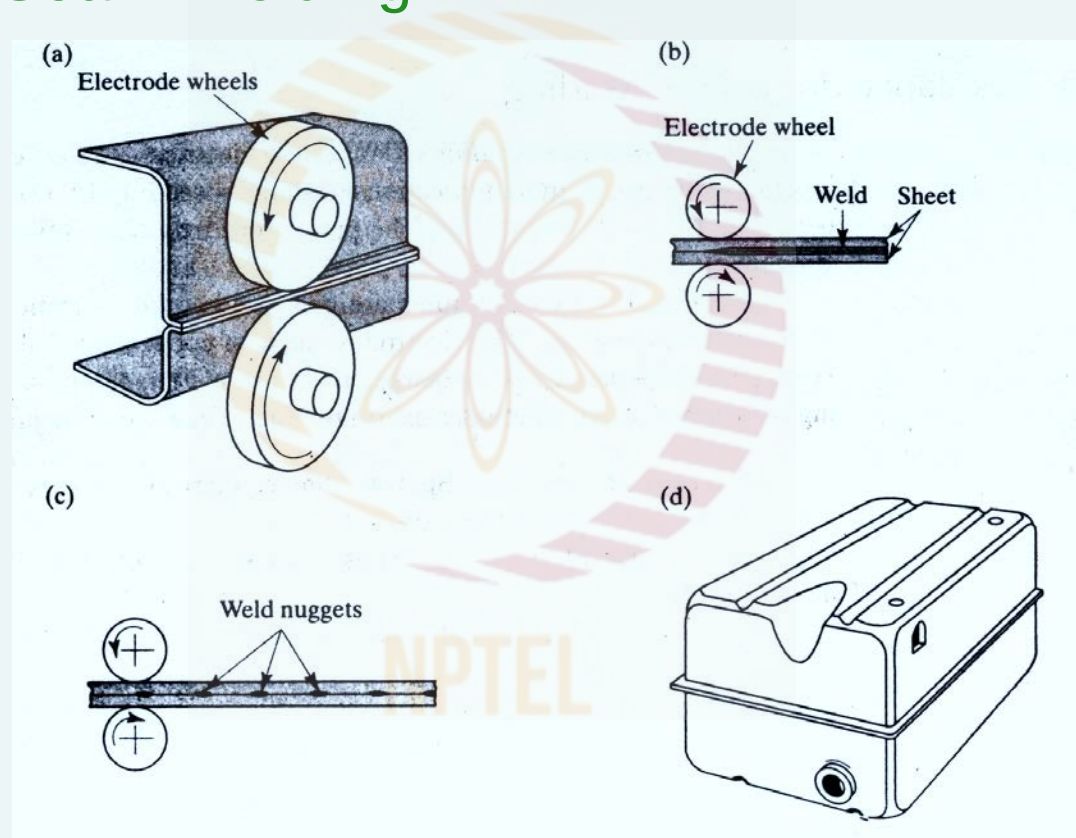
Projection Welding



Various Welding Processes

Solid Phase Welding

Resistance Seam Welding



(a) Wheel electrodes, (b) Overlapping spot welds, (c) Spot weld, (d) Resistance welded gasoline tank