Explosive Welding

1 Welding

Welding

Welding is a fabrication process that joins metals. This is often done by melting the work pieces and adding a filler material to form a pool of molten material (the weld puddle) that cools to become a strong joint, with pressure to produce the weld.

Solid state welding

Solid state welding is a group of welding processes at temperatures essentially below the melting point of the materials being joined, without the addition of filler metal. Bonding of the materials is a result of diffusion of their interface atoms.

2 Explosive welded products

Explosive welding is a solid state joining process, which uses a controlled explosive detonation to force two metals together at high pressure. The resultant composite system is joined with a durable, metallurgical bond.

Figure 1, Bi-metallic boss (3/4" diameter)

Figure 2, Aluminium/Stainless Steel ring (3" diameter)

Suggested project topic:
Search the internet and find out some other explosive welded products. Discuss the manufacturing process.

3 Explosive welding

Setup
Two plates are separated by a stand-off gap. The flyer (top) plate is covered by an explosive layer. Upon detonation the explosive accelerates the top plate against the parent (bottom) plate. In this way a welding front is established.

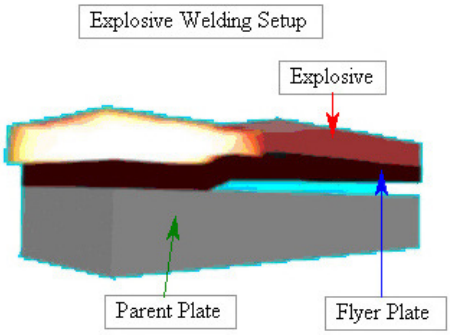

Figure 3, Explosive welding setup

Suggested project topic:
How does stand-off gap affect the welding effect?

Jetting
When an explosive is detonated on the surface of the flyer plate, a high pressure pulse is generated. This pulse propels the flyer plate at a very high rate of speed. If this piece of metal plate collides at an angle with the parent metal plate, welding may occur.

For welding to occur, a jetting action is required at the collision interface. This jet is the product of the collision of two metals surfaces. This jet cleans the metals and allows two pure metallic surfaces to join under extremely high pressure.

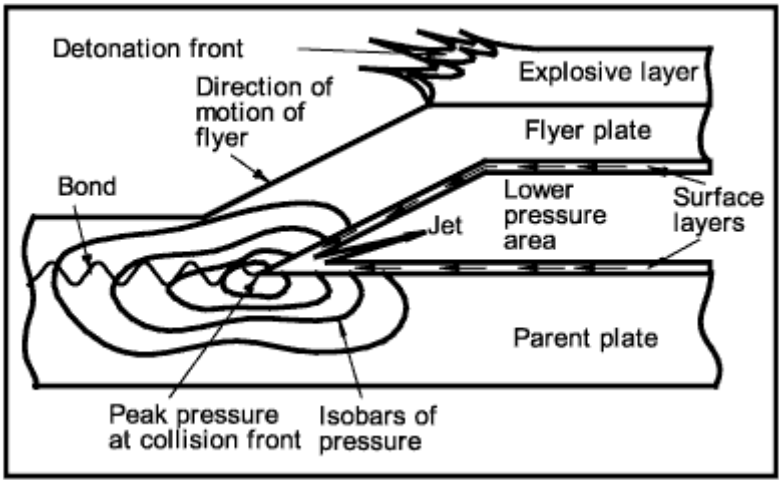

Figure 4, Jetting at the collision front.

Pressure contour

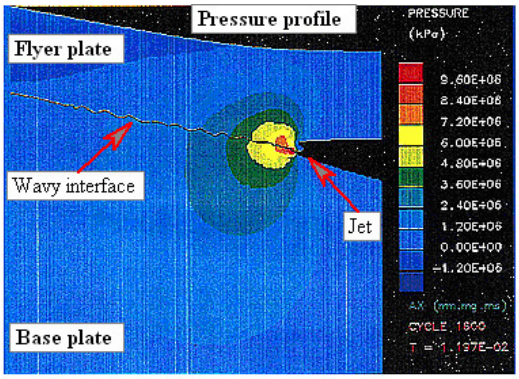

Figure 5. Pressure contours in the flyer and base plates during explosive welding.

Wavy interface

In explosive welding, materials are usually bonded together in an undulating wave form.

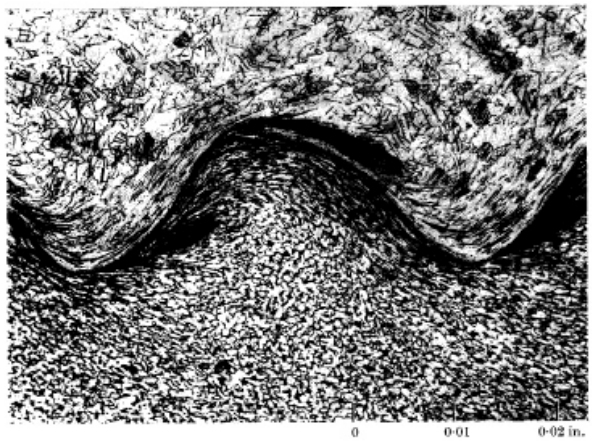

Figure 6. Microstructure of wavy interface in explosive welding (steel/steel). The top plate is the flyer plate, and the welding is from right to left.

Suggested project topic:
Wavy interface generation is an interesting characteristic of explosive welding. How are wave interfaces generated?

Suggested project topic:
How do wavy interfaces affect the welding effect?

Controllable variables in explosive welding

- Detonation velocity
- Standoff distance
- Impact energy
- Bend angle

Features

- Can bond many dissimilar, normally unweldable metals.
- Minimum fixturing/jigs.
- Simplicity of the process.
- Extremely large surfaces can be bonded.
- Wide range of thicknesses can be explosively clad together.
- No effect on parent properties.
- Small quantity of explosive used.

Suggested project topic:
Search the internet and find companies specialized in explosive welding. Describe their products.

Limitations

- The metals must have high enough impact resistance, and ductility.
- Noise and blast can require operator protection.
- The use of explosives in industrial areas will be restricted by the noise and ground vibrations caused by the explosion.
- The geometries welded must be simple – flat, cylindrical.

4 Explosive welding in tubular geometries

For the tubular geometry, the explosive is placed in the centre and detonation is initiated at the top. The inner tube is welded to the outer tube.

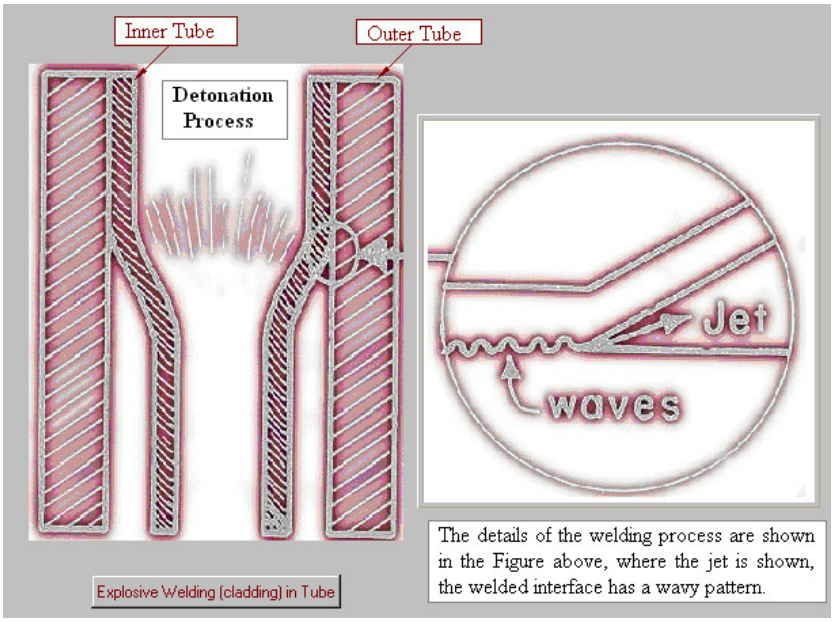

Figure 7, Explosive welding in tubular geometries.