Casting Forming and Welding Lab (ME39007)
Experiment No. 3: Resistance Welding

Introduction

Resistance spot welding (RSW) is a process in which faying surfaces are joined by the heat generated by resistance to the flow of electric current through work pieces that are held together under force by electrodes. The contacting surfaces in the region of current concentration are heated by a short-time pulse of low-voltage, high amperage current to form a fused nugget of weld metal. When the flow of current ceases, the electrode force is maintained while the weld metal rapidly cools and solidifies. The electrodes are retracted after each weld, which usually is completed in a fraction of a second. Compared to arc welding, this process uses no shielding gases, flux or filler material and the electrodes conducts very high electric power at the interface. The process is typically used to obtain a lap joint of sheet metal parts of low thickness using a series of spot welds, in situations where gas-tight or liquid-tight assembly is not required. Spot welding is the most widely used joining technique for the assembly of sheet metal products such as automotive body assemblies, domestic appliances, furniture, building products, enclosures and containers. The attachment of braces, brackets, pads, or clips to formed sheet-metal parts such as cases, covers, bases, or trays is another common application of RSW. Major advantages of spot welding include high operating speeds and suitability for automation and inclusion in high-production assembly lines. The heat energy supplied to the welding operation depends on the current flow, resistance of the circuit and length of time the current is applied.

Objectives

- To perform resistance spot welding (RSW) on two similar mild steel sheets of same gauge by varying the heat energy.
- To analyse the influence of heat energy on nugget dimensions.
- To correlate the joint strength with the various welding parameters.

Equipments

- Resistance Spot welding machine,
- Travelling microscope,
- Dial gauge,
- Displacement measuring setup etc.

Theory

- Generate heat through the resistance to the flow of electric current in parts being welded
- The parts are usually an integral part of the electrical circuit
- Contact resistance $\rightarrow$ heats the area locally by I^2R, $\rightarrow$ melting $\rightarrow$ formation of a nugget
- Contact resistance must be higher at the point to be welded than anywhere else.
- Usually used to join overlapping sheets or plates as lap joints, which may have same or different thicknesses

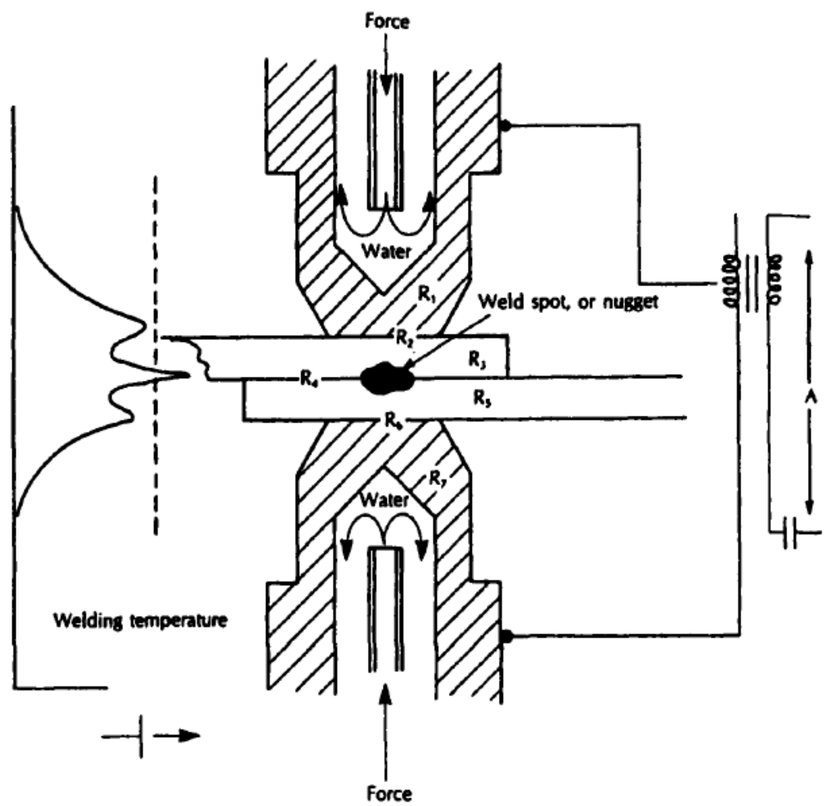

Figure 1. Resistance spot welding setup

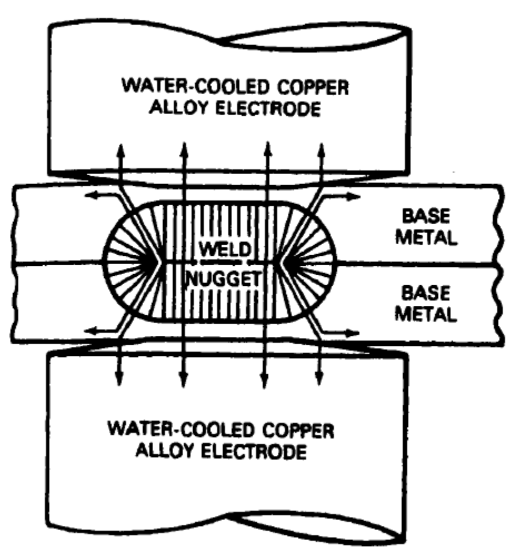

Figure 2. Nugget formation

Components and Process variables

- Pairs of water-cooled copper electrodes
- Apply pressure
  - To reduce the contact resistance at the electrode-to-workpiece interface
  - Contain the molten metal in the nugget
  - To literally forge the work surfaces together in the vicinity of the weld
- The principal process variables
  - welding current (several thousands to tens of thousands of amperes)
  - welding time (of the order of s)
  - electrode force and electrode shape
- DC power (provided from either single-phase or three-phase AC line 440-480 V using step-down transformer/rectifiers)

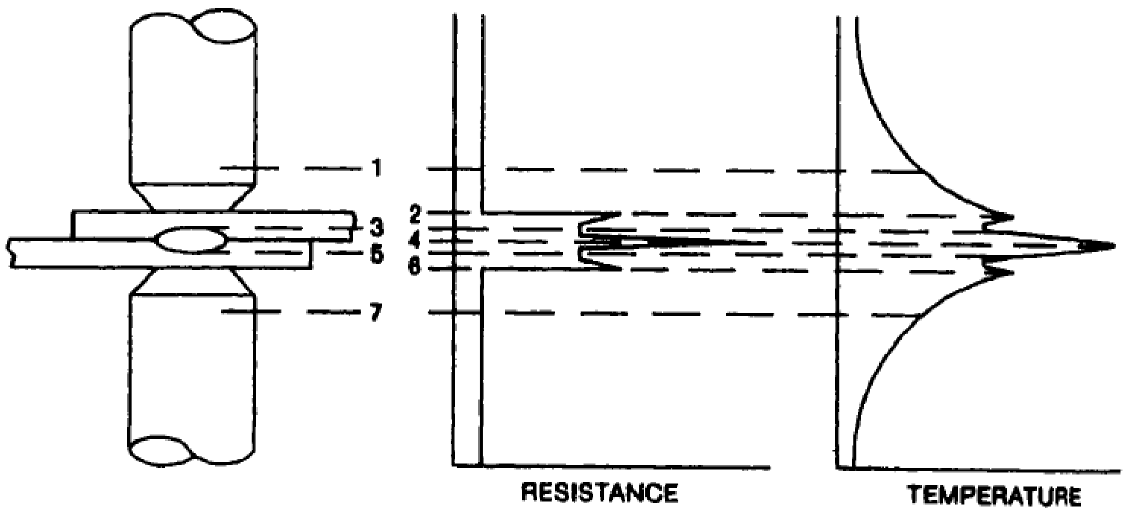

Figure 3. Temperature distribution in the weld zone

Resistance welding cycle

- Squeeze Time: Time interval between timer initiation and the first application of current needed to assure that electrodes contact the work and establish full force
- Weld time: The time for which welding current is applied (in single impulse welding) to the work
- Hold Time: The time during which force is maintained on the work after the last impulse of welding current ends to allow the weld nugget to solidify and develop strength.
- Off Time: The time during which the electrodes are off the work and the work is moved to the next weld location for repetitive welding.

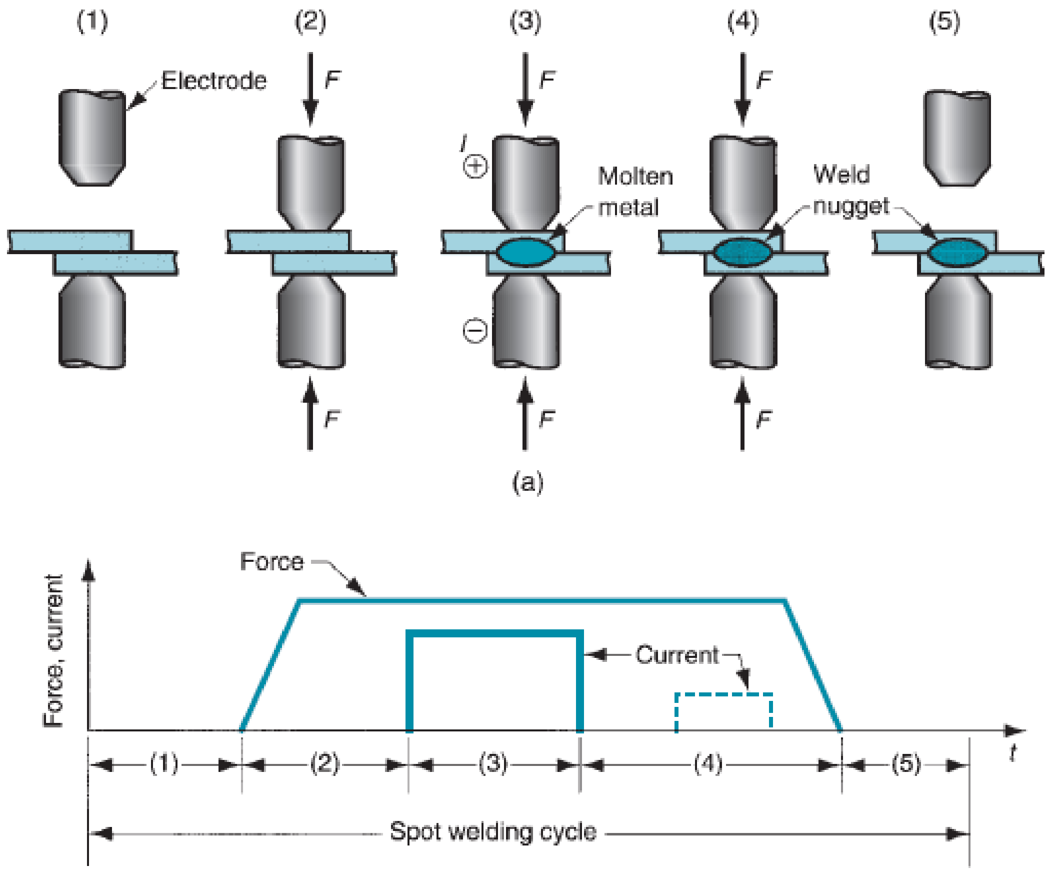

Figure 4. Resistance spot welding cycle

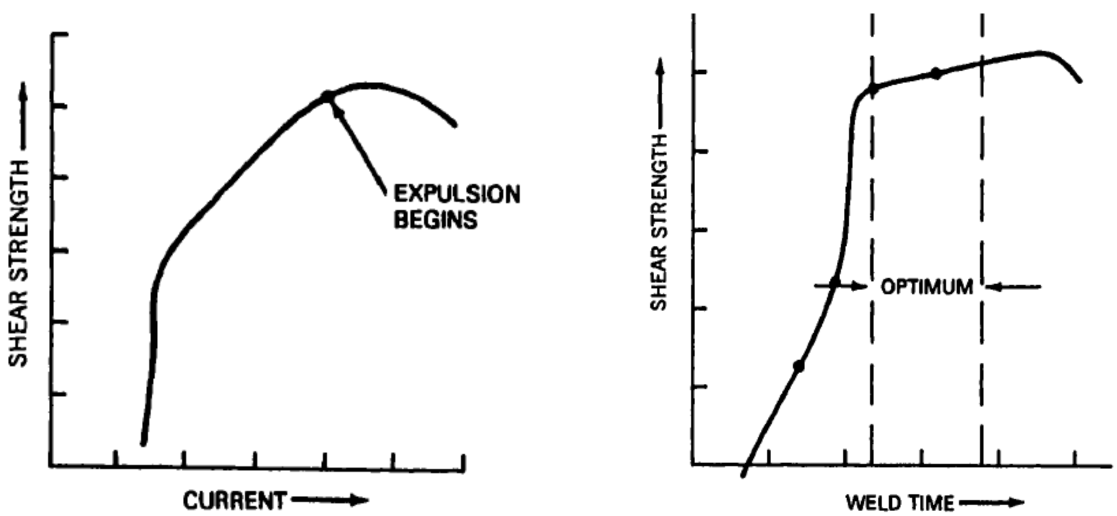

Figure 5. Influence of process parameters

Experimental Procedure

1. Prepare six pieces (three pairs) of sheet metals, mild steel of 1 mm thickness, of acceptable small size (50x20mm recommended).

2. Spot weld the three pairs of the prepared specimens. The percentage heat energy is to be set as 25, 30 and 35% of maximum heat energy available respectively for the three welds.

3. Measure the nugget dimensions with the help of a travelling microscope.

4. Measure the breaking displacement for the three spot welds.

Observation

Thickness of the sheet metal =
Least count of the travelling microscope =

Welding Parameters

Squeeze cycles = Weld cycles = Hold cycles = Off cycles =

Pressure =

Sl. No.	Heat Energy (%)	Nugget Diameter (mm)	Breaking Displacement(mm)
1			
2			
3			

Results & Discussion

- Fill the observation table with respective values measured.
- Interpret how the variation of heat energy is influencing the nugget geometry and weld strength.

Conclusions

Explain how a variation in heat energy is influencing the nugget dimensions, HAZ and joint strength.

Other Points for discussions

- What are the desirable properties of a metal that would provide good weldability in resistance welding?
- Discuss about other variants of resistance welding process.

APPENDIX

Current, Pressure, Time control chart for different thicknesses (for M.S/S.S sheets, for 35 KVA – Approximate settings)

Thickness of the sheet (mm)	Current Tap No.	Squeeze Time (Cycles)	Weld Time	Heat Energy (%)	Hold Cycles	Off Cycles	Pressure in PSI
30-40 GUAGE	1	50	5	15	30	30	28
25-30 GUAGE	2	50	8	20	30	30	30
20-25 GUAGE	3	50	10	30	30	30	32
15-20 GUAGE	4	50	12	40	30	30	34
12-15 GUAGE	5	50	15	45	30	30	40
10-12 GUAGE	6	50	20	50	30	30	45

The above settings are approximate for guidance only, which can be corrected by actual trial and error method.

Notes:

Cycles : In one second there are 50 cycles

Heat energy (%): It is a percentage of energy available at particular tap, say supposing at tap no 6 maximum available current is about 10000 amps, 50% means half of that i.e. 5000amps.