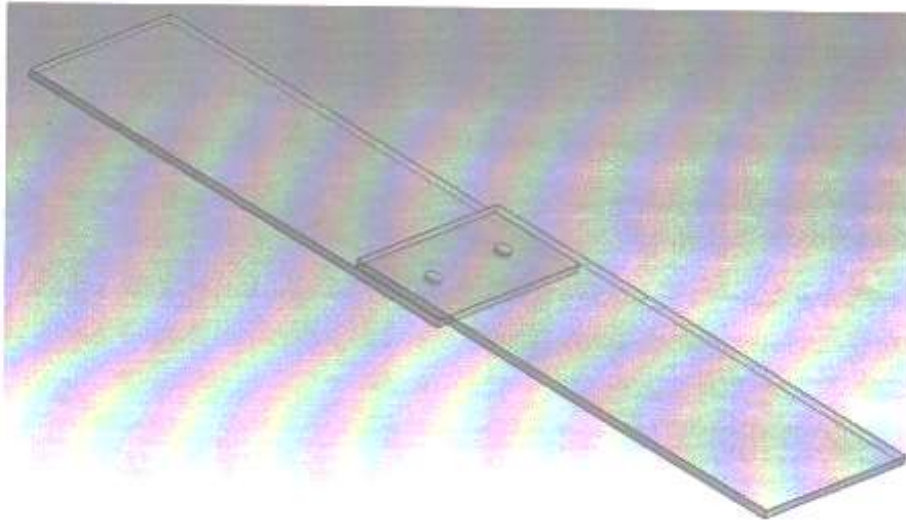


Technical Bulletin No.: 226

Weld Bonding of Aluminum Sheets



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Technical Bulletin - 226

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First edition,

Published by

Department of Industrial and Production Engineering

College of Technology

GBPUA&T, Pantnagar- 263145

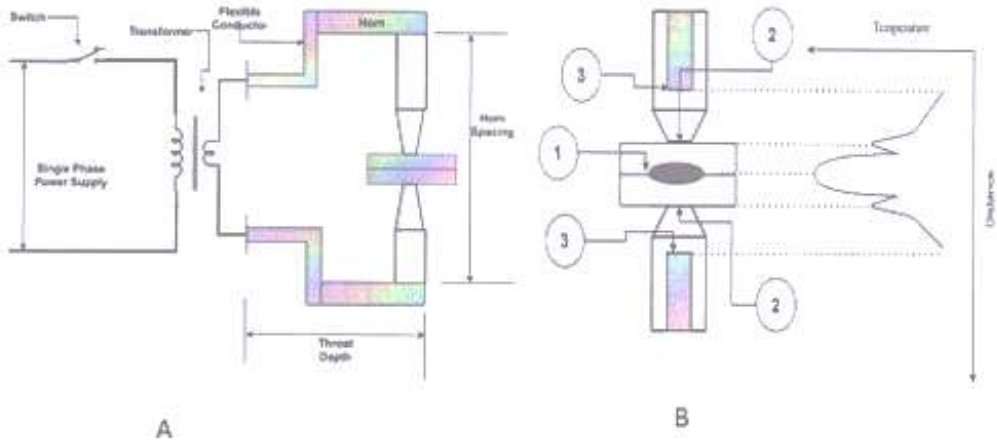
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Weld Bonding of Aluminium Sheets

Introduction

Sheet metals are abundantly used in small and micro level enterprises as well as large scale industries. Conventionally steel has been used as a sheet material in making of cup boards, boxes or chassis of automobiles. Resistance spot welding is conventional method of joining these sheet metals of steel. It is a fusion welding technique in which contact resistance between the joint surface i.e. electrode and sheet and in between two sheets is used to generate heat. The heat between the electrode and sheet is dissipated away by water cooled electrodes however the heat between the sheets reaches the melting temperature of steel as demonstrated by Fig. 1.



1-Sheet-Sheet Interface, 2- Electrode-Sheet Interface, 3- Water Channel Inside the Electrode

Fig 1: (A) Set-up of joint in RSW process. (B) Weld nugget development between two sheets in RSW process

Aluminium is a metal which can be a good substitute to steel alloys due to its light weight and inherent anti-corrosive nature. However, resistance spot welding of aluminium sheets does not produce strong joints, so a hybrid resistance spot welding can be a good

substitute. Weld bonding being an adhesive joint is comparatively stronger than conventional spot welded joint.

Weld-Bonding of Aluminium Alloys

The process of weld bonding involves a layer of adhesive, either in paste or film form being applied to the metal members to be joined. The sheet metals are then placed in lap joint configuration and the assembly is clamped gently. After being cured at ambient atmosphere, the assembly is resistance spot welded to form a weld bonded joint which is multiple times stronger having high static and fatigue strength compared to adhesive and resistance spot welded joint alone. The process of weld bonding which can be prepared by two methods is demonstrated in Fig.2.

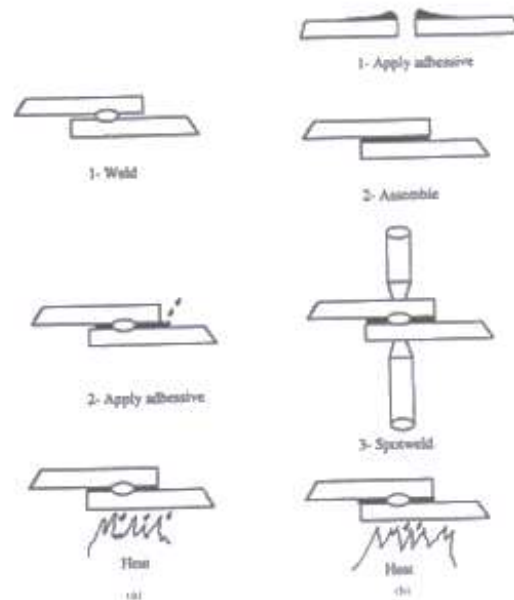


Fig. 2. Weld-bonding Techniques (a) Flow-in and (b) Weld-through.

Detailed Steps For Preparation of Weld Bonded Joint

The weld bonding of aluminum alloys requires few more steps than the basic resistance spot welding or adhesive joining of Al-sheets. The following steps are required

in the preparation of weld bonded joint-

1. Surface Preparation

The following steps are followed for cleaning of the surface of Al-sheet metal before adhesive is applied:

- **Pre-Cleaning:** The first is to remove loose deposits such as dirt, scale, flaking paint, and any foreign matter that impedes the wetting of the base material.
- **Mechanical Surface Pre-treatment:** Mechanical surface pre-treatment includes blasting, abrading, machining, and scouring with sandpaper. Emery papers of grade 400 and 600 are used to clean the surface mechanically.
- **Surface Degreasing:** It is essential that materials to be bonded are free from grease. Organic chemicals commonly employed for degreasing bonding areas include trichloroethylene, perchloroethylene, acetone and petrol. Best results are obtained by degreasing in a vapour bath.
- **Chemical Pre-treatment:** Chemical method consists of the application of organic or inorganic reagents which alter the surface composition or increase the surface area. The following chemicals given below are used for chemical pre-treatment of aluminum. Sulphuric acid-sodium dichromate treatment (pickling process according British Aircraft Process Specification DTD 915B)-pickle for 30 min at 60 to 65° C in the following solution: 27.5% conc. H₂SO₄, 7.5%Na₂Cr₂O₇.2H₂O, 65% Water. Wash thoroughly in tap water and rinse with distilled water.

2. Application of Adhesive

The sheets of aluminium are adhesive bonded by application of epoxy-based adhesive consisting of equal amount of resin and hardener by weight. The resin here consists of monomers or short chain polymers with an epoxide group present at either end. Most common epoxy resins are produced from a reaction between epichlorohydrin and bisphenol-A, though the latter may be replaced by similar chemicals. The hardener consists of polyamine monomers, for example Triethylenetetramine (TETA). When these compounds are mixed together, the amine groups react with the epoxide groups to form a covalent bond. Each NH group can react with an epoxide group, so that the resulting polymer is heavily cross linked, and is thus rigid and strong. The curing is a polymerization process that can be

controlled through temperature and choice of resin and hardener compounds. After the sheets are thoroughly cleaned, the prepared adhesive is applied on the overlapped length and mechanically held for a brief period in lap joint configuration, subsequently cured at high temperature of 120^o C to obtain adhesive joint.

3. Resistance Spot Welding

The resistance spot welding of the adhesive joint obtained in the previous step is performed subsequently to obtain a weld bonded joint. For large scale industries like aerospace and automobile, robotic welding is performed as there are 3000- 7000 spots have to be made for a single car chassis. But for small scale and micro-scale industries producing automobile ancillaries, almirahs or boxes conventional stationery resistance spot welding machine is enough. The flow chart describing step by step procedure for carrying out weld bonded joint is shown in Fig.3 and 4.

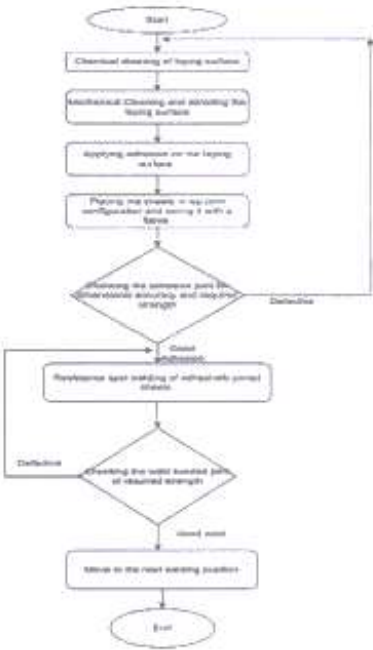


Fig 3: Flow chart describing step by step procedure for carrying out weld bonded joint

The weldability of aluminium of grades 5000- 6000 series is satisfactory and mainly used for adhesive bonding. The minimum overlap length should be 25 mm and the weld nugget size should be greater than $4\sqrt{t}$, where 't' is thickness of sheet material. The parameters which govern the strength of the weld joint and weld nugget size are weld current, weld time and weld pressure. The optimum range of parameters required to weld aluminium sheets are 10-24 KA of welding current, weld time of 8-12 cycles and weld pressure of 4kg/cm².



Fig 4: Stationary Resistance spot welding machine (CSP- 100PR) and operations performed on it to get a weld bonded joint and a fractured weld bonded joint.

Advantages of Weld Bonded Joint

Weld bonded joints in comparison of adhesive bonded as well as resistance welded joints has increased nugget strength due to stress softening at the edges of joint. The application of adhesive also makes the joint anti-corrosive in nature due to leakage of moisture or presence of moisture.

Limitations of Weld Bonded Joint

In spite of lot of advantages, the process has few disadvantages as well. For application of adhesive, the faying surfaces have to be abraded mechanically for good adhesion and then adhesive needs to be applied which would require new set-up in the production line and it would overall increase the production cost. The use of adhesive can be hazardous at the work place, so special care has to be taken while applying adhesive to the joint.

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