Design and Fabrication of Portable Automatic Spot-Welding Machine

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Abstract: Resistance spot welding is getting significant importance in car, bus and railway bodies etc due to automatic and fast process. There are many spot-welding machines available in the market, most of them are for industrial purposes and are costly. There is a need to develop low-cost spot-welding machine for students in higher institutions. The major factors controlling this process are current, time, electrode force, contact resistance, property of electrode material, sheet materials, surface condition etc. the quality is best judged by nugget size and joint strength. This study presents a systematic approach to determine effect of process parameters like electrode force, weld time and current.

In this project, the effect of welding time on the tensile-shear strength and tensile-peel strength of the welding joints in electrical resistance spot welding of mild steel plates having 1.0 mm thicknesses were investigated. The plates are welded by electrical resistance spot welding by fixing electrode form, materials type and electrode force while changing welding current and time (second). The welding current was fixed at 4 kA. The electrode pressure was fixed at 6 kN while the welding time were changing at 2, 4, 6, 8, and 10 sec. The welding joints were exposed to tensile-shear and tensile-peel test and the effect of the welding time on tensile test were being investigated using related period diagram. The optimum welding times for tensile-shear test obtained at 4 sec and for the tensile-peel test also obtained at 4 sec.

Keywords: Spot Welding Machine, Automation, Fabrication.

1. INTRODUCTION

Welding is a common process for joining metals using a large variety of applications. Welding occurs in several locations, from outdoors settings on rural farms and construction sites to inside locations, such as factories and job shops. Welding processes are fairly simple to understand, and basic techniques can be learned quickly. Welding is the joining of metals at a molecular level. A weld is a homogeneous bond between two or more pieces of metal, where the strength of the welded joint exceeds the strength of the base pieces of metal. At the simplest level, welding involves the use of four components the metals, a heat source, filler metal, and some kind of shield from the air. The metals are heated to their melting point while being shielded from the air, and then a filler metal is added to the heated area to produce a single piece of metal. It can be performed with or without filler metal and with or without pressure. There are several types of welding that are used today. Gas Metal Arc Welding (GMAW) or MIG, Gas Tungsten Arc Welding (GTAW) or TIG, Flux Core Arc Welding, and Stick Welding are the most common found types in industrial environments.

1.2 AUTOMATION

Automation as “the technique of making an apparatus, a process, or a system operate automatically.” We define automation as "the creation and application of technology to monitor and control the production and delivery of products and services.”

II METHODOLOGY

Taguchi parametric design methodology was adopted. The experiments were conducted using L18 Orthogonal Array (OA) with three parameters (electrode force, weld current, weld time) with three levels (level 1, level 2 and level 3). The process parameters, their symbols and their values at different levels are shown in the table. Optimization of process parameters is the key step in the Taguchi method to achieving high quality without increasing cost. This is because optimization of process parameters can improve quality and the optimal process parameters obtained from the Taguchi method are insensitive to the variation of environmental conditions and other noise factors. An advantage of the Taguchi method is that it emphasizes a mean performance characteristic value close to the target value rather than a value within certain specification limits, thus improving the product quality. Additionally, Taguchi's method for experimental design is straight and forward and easy to apply to many engineering situations, making it a powerful yet simple tool. The main disadvantage of the Taguchi method is that the results obtained are only relative and do not exactly indicate what parameter has the highest effect on the performance characteristic value.

Also, since orthogonal arrays do not test all variable combinations, this method should not be used with all relationships between all variables. A large number of experiments have to be carried out when the number of the process parameters increases. To solve this task, the Taguchi method uses a special design of orthogonal arrays to study the entire process parameter space with only a small number of experiments. Using an orthogonal array to design the experiment could help the designers to study the influence of multiple controllable factors on the average of quality characteristics and the variations in a fast and economic way.

BLOCK DAIGRAM

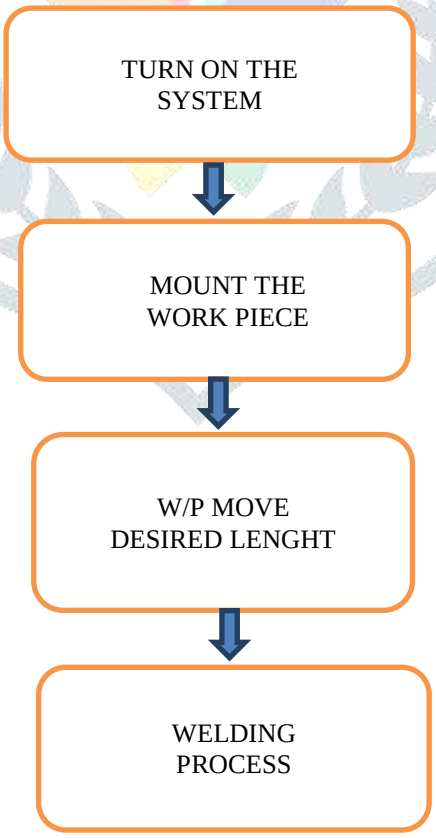
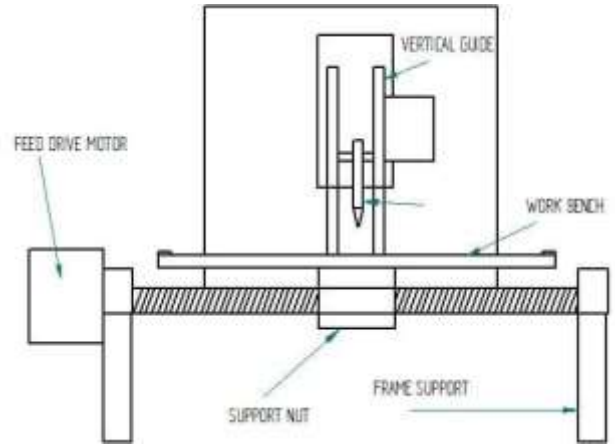


Fig:1. Working process

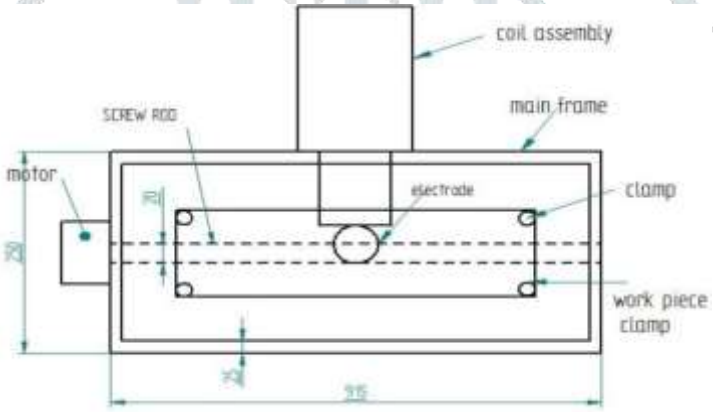
III. DESIGN AND CALCULATON:

2D model



FRONT view

Fig.2. 2D working model



TOP view

Fig.3. 2D working model

3D model

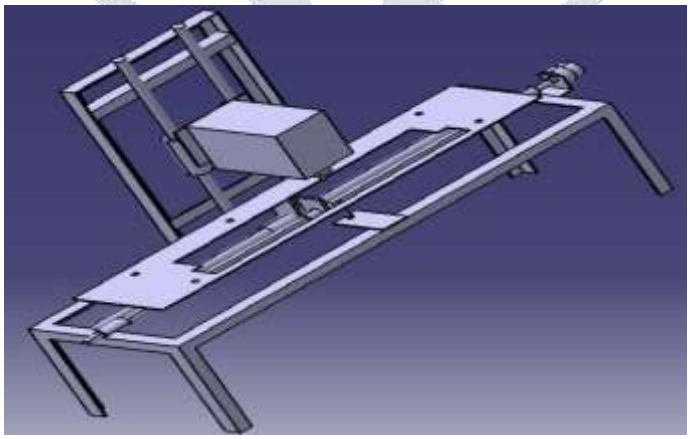


Fig.4. 3D working model

IV. CALCULATION:

CONSTRAINTS:

1. Yield strength of mild steel= 250 MPa
2. Density of mild steel= 7700 kg/m3

ASSUMPTION

Width of mild steel	=	152.4 mm
Thickness of mild steel	=	0.8 mm
Length of mild steel	=	609.6 mm
Weight of workpiece holder	=	2-3 kg

- Mass of workpiece Mass = Density X Volume

  = 7700 X 0.8 X 152.4 X 609.6 X 10^-9

  = 0.5722 kg

- Torque equation

  1. Torque = ($load\ (kg)\ X lead\ (m)$)/ (2 X π X efficiency)

  2. Efficiency = 35%

  3. Torque = 1.068X10-3 kg-m

  = 10.4735 X 10-3 N-m

- Speed of work bench Speed of work bench = motor speed X lead

  = 0.1 X 1 = 0.1 m/s

- Electrode diameter

  Diameter = 5 X (t) ^.5

  = 5 X (0.5) ^.5 = 3.53 mm

  Selecting Electrode of diameter of range 6 to 8 mm.

- Speed of Lead Screw Pitch of Lead

  Screw = 1 mm Motor speed = 100 rpm

  Speed of work table = Pitch X Motor speed

  = 1 X 100 mm/min = 100/60 = 1.66 ≈ 2 mm/sec

- Heat

  VP = 230 V IP = 5A

  VP/□□ = □□/□□

  IS = (□□□□□)/ □□= (230 □ 5) /6

  IS = 191.38

- Heat generated

H = I^2 x R x t

H= 191.38^2x 1 x 10^-9 x 3 = 1.098 J

V. FABRICATION PROCESS:

- Selecting the proper material to fabricate by considering the cost and durability of material. The mild steel angle plate is sufficient for the making of basic structure or frame of the spot-welding machine.
- Machining the mild steel angle plate to fabricate as per the dimension I e 915*250CM
- Joining the machined mild steel angle plate as per the required dimension and the measuring the angle of the placing of electrode.
- The screw rod plays a vital role in portable automatic spot-welding machine the lead screw helps to move the workpiece on the adjacent side of the machine and the vertical lead screw is placed or attached to the lower part of the frame to move the workpiece horizontally and the vertical lead screw is place vertically on the angle plate to move the copper electrode vertically.
- Placing of the step-down transformer on the frame and welding machine is very crucial because of the high current.
- Placing of two electrodes oppositely plays major role in the fabrication process the certain factor like
  - Movement of electrode.
  - Speed of electrode.
  - And proper heat generating point by the joining in opposite directions.

  By considering the above factor the copper electrode are placed at the mild of the frame. One electrode is placed by an extended angle plate parallelly to horizontal frame other electrode is placed in the bottom frame by giving the point of electrode in upward direction.
- For making the spot-welding process automatically the microcontroller aurdino UNO plays high role the aurdino UNO is detectable and attachable connections as per the requirement. Embedded c programmed as per the requirement of the process.
- The two DC motor is placed as per the horizontal lead screw an done for the vertical lead screw.
- By done the above process the portable automatic spot welding machine is fabricated.

Fig.5. 4D, model

VI RESULTS:

- Fabrication is done according to the design and dimension.
- Spot welding of mild steel sheet of thickness 0.6mm has been achieved

- The auto feed mechanism is done by using arduino UNO which helps in nugget formation exactly at 1cm distance between them.
- The drawback of the machine is, the weld is of low strength.

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