AN EXPERIMENTAL INVESTIGATION TO STUDY THE PARAMETRIC EFFECT OF ULTRASONIC WELDING

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Abstract: - in modern era, because of magnificent characteristics such as low density, high corrosion resistance and high strength, copper and its alloy are replacing other materials and metals. Welding of copper and its alloys by traditional methods is difficult as they causes defects such as porosity and hot cracks. But with help of Ultrasonic welding these defetcs can be avoided as the temperature produced during this process is one third of the melting temperature of the alloy. It is a new and quick method to join different metals like copper and its alloy and composites.

Keywords: **Welding, Tensile strength**

1. Introduction

It is a modern system where high frequency vibration is given at work-piece such that both piece connected to each other at high pressure to make a solid weld. We use this technique for dissimilar material and plastic. In this technique , there is no requirement of soldering materials, nail or bolts to join the material together. Both parts are placed between anvil and sonotrode and this is attached to transducer, transducer is used to emit low-amplitude vibrations.**Elangovan *et al.*[1]** developed a model which is used to predict temp.and stress distribution during welding and its influence at the workpiece, anvil and sonotrode. The effects of material thickness, clamping force and friction coefficient at the time of heat generation. **Siddiq and Ghassemieh[2]** used thermal and acoustic softening effects for thermomechanical analysis of ultrasonic welding. **Konchakova *et al.* [3]** worked to join CFRP composite with aluminium alloy. **De vries[5]** discussed the mechanism and mechanics of ultrasonic welding . Here a mechanics based model is developed to measure the tangential force at the time of welding , this force acts at the weld surface and correlate it to weld quality. **Fuat kara et al.[6]** used artificial neural network , to predict cutting temp. in orthogonal machining. This experiment is based on 60 numerical data computed through FEA are prepared for training and testing data of the artificial neural network **Girish et al.[7]** have modeled ANN to predict roughness at surface . Genetic algorithm is coupled with this model to optimize parameters of machining. **Girish et al.[8]** developed a model, artificial neural network is used to predict energy consumption in machining . To test the neural network, 27 experimental data are used. **Sebahattin et al.[9]** designed an ANN model , to measure compression strength in heat treated woods. It compares with multi linear regression model. The author conclude that this technique used to predict values in short time and low error than regression model. **Dessinger and suich[10]** introduced simultaneous optimization of several variable. They described desirability function in this we find value of desirability. On the basis of desirability value we can find best parameter.**YosukeTamada [11]** worked on welding welding parameters of Al and Cu plate,he used planar vibrations by dumbbell shape ultrasonic complex vibration.

1.2. RESEARCH OBJECTIVE

we study the effects on tensile strength by changing three variable-pressure, amplitude and weld time.

1. Effect of weld time on tensile strength.
2. Effect of amplitude on tensile strength.
3. Effect of pressure on tensile strength.

2. EXPERIMENTATION TECHNIQUE

2.1 Response Surface Methodology

It is used to make a relation between various controllable variable to the one or more response. K.B.Wilson and G.E.P. Box introduced this method. Many experiments are performed in order to find good set of parameter that gives optimum results for response variable. There are two type of polynomial order, if response variable depend liner with the factors, then there is first order polynomial .A second order polynomial is used if there is curvature in the surface. Z is a response variable, A second order polynomial is

$$Z = \pm a_0 \pm a_1 x \pm a_2 y \pm a_3 x^2 \pm a_4 y^2 \pm a_5 xy \pm e$$

where:

Z = response variable, $a_0, a_1, a_2 \ldots$ = coefficient

e =experimental error , x, y =controllable factors

To conduct the experiment, there are three controllable factors selected -pressure, welding time and amplitude.

In table 2.1 factors and their levels are given

Factors	Units	Level		
		-1	0	+1
Pressure	Bar	1.6	1.7	1.9
Weld-time	Second	0.5	0.44	0.51
Amplitude	µm	23	25	28

Table 2.1:**factors and their levels**

2.2 Experimental Procedure

The experiment performs on the copper sheet having thickness is 0.8mm, set up of the experiment is depicted in diag. 2.1 .compressor is used to give required pressure in the welding. Max. value of the pressure is 17bar prior to welding. At the time of the welding knurl pattern makes at the surface of sonotrode and anvil in order to prevent sliding of work piece. In diag.3.1, specimen prepare for ultrasonic welding. Joint strength can be affected by the surface impurity so we cleaned the specimen with acetone prior to welding, such that surface impurity can be removed. For each combination, we generate three trials of specimen and their avg. is also calculated, and these are shown in table 2.2, Ultrasonic welded specimen of copper sheet having thickness 0.8mm is shown in diag.2.2

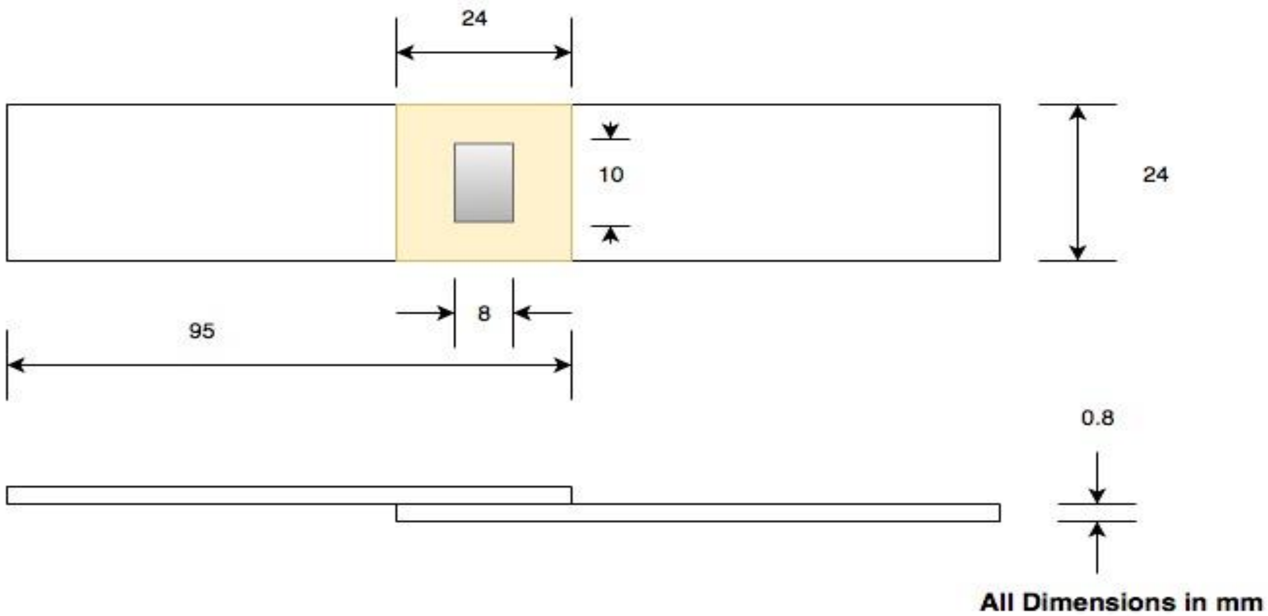

Fig. 2.1 specimen for ultrasonic welding

Table 2.2

	Pressure (bar)	**Amplitude** (µm)	**Weld Time (sec.)**	**Tensile Strength(MPa)**			
				Trial 1	**Trial 2**	**Trial 3**	**Avg**
1.	**1.6**	**22**	**0.5**	**171.53**	**172.63**	**174.25**	**172.80**
2.	**1.8**	**23**	**0.4**	**173.95**	**174.82**	**176.43**	**175.07**
3.	**1.6**	**26**	**0.5**	**174.93**	**176.83**	**177.27**	**176.34**
4.	**1.8**	**26**	**0.5**	**185.45**	**186.54**	**187.64**	**186.54**
5.	**1.6**	**22**	**0.45**	**187.78**	**188.87**	**189.72**	**188.79**
6.	**1.6**	**26**	**0.45**	**177.62**	**177.82**	**178.43**	**177.96**
7.	**1.8**	**23**	**0.4**	**176.74**	**178.76**	**179.43**	**178.31**
8.	**1.6**	**26**	**0.45**	**182.43**	**183.73**	**185.42**	**183.79**
9.	**1.4**	**22**	**0.45**	**185.26**	**186.37**	**188.85**	**186.83**
10.	**1.8**	**25**	**0.45**	**171.56**	**172.65**	**174.32**	**172.84**
11.	**1.8**	**23**	**0.4**	**173.48**	**174.84**	**176.73**	**175.02**
12.	**1.4**	**28**	**0.40**	**185.67**	**186.76**	**188.53**	**186.99**
13.	**1.4**	**26**	**0.5**	**173.89**	**174.72**	**175.27**	**174.63**
14.	**1.8**	**23**	**0.4**	**177.47**	**179.21**	**171.23**	**175.97**

Experimental Table

Computer Tensile testing m/c is used to meassure the tensile strength of the joint .We observe there is a ductile fracture except a few specimen which have poor quality . In dia. 2.2 some fracture specimen given

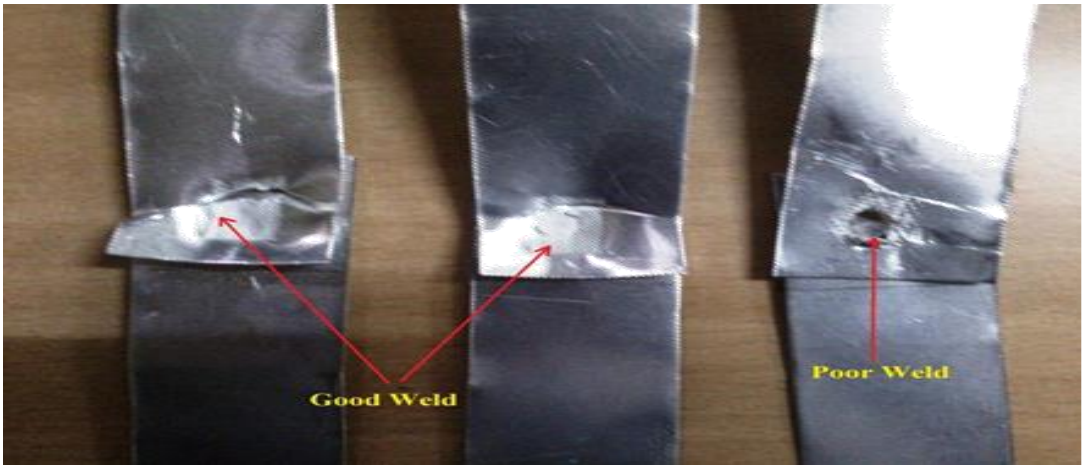

Fig. 2.2 Fractured specimens

4. RESULTS AND DISCUSSION

A comprehensive analysis carry out for three trial value of tensile strength and their average. Here tensile strength depend upon three factors-pressure, amplitude and weld time. We plot three different graph ,in first graph we see tensile strength at different pressure. Here tensile strength vary from 172.80MPa to 188.79MPa and pressure vary from 1.4 bar to 1.8 bar.In second graph, we see tensile strength at different amplitude.Here tensile strength vary from 172.80MPa to 188.79MPa and amplitude vary from 22µm to 28µm.In third graph ,we see variation of tensile strength at different weld time. Here minimum value of tensile strength is 172.80MPa and maximum value is 188.79MPa and weld time vary from 0.40second to 0.50second.

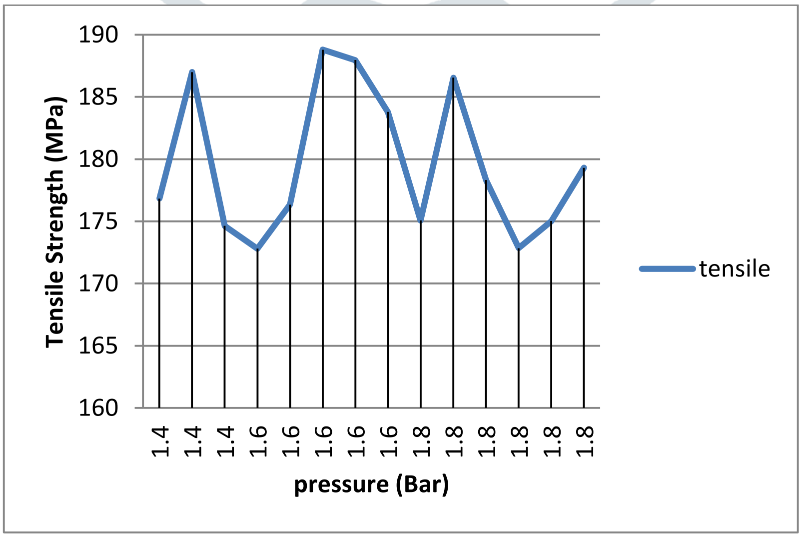

Fig 4.1 Tensile strength vs pressure

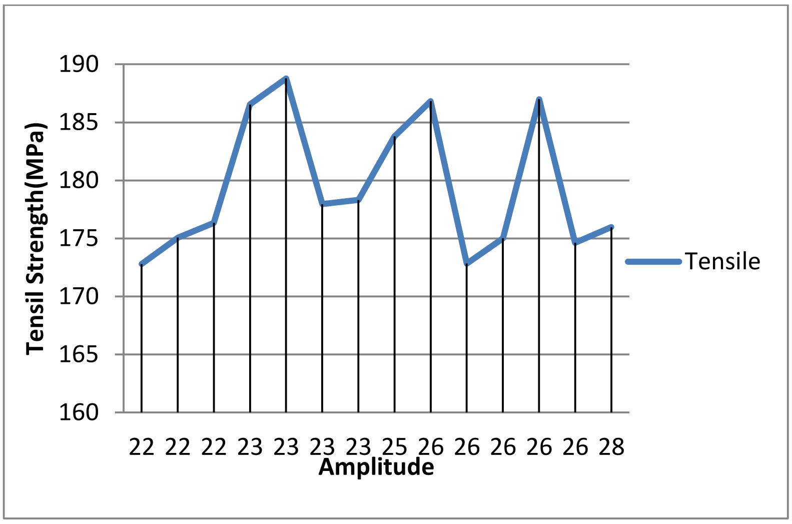

Fig4.2 Tensile strength vs Amplitude

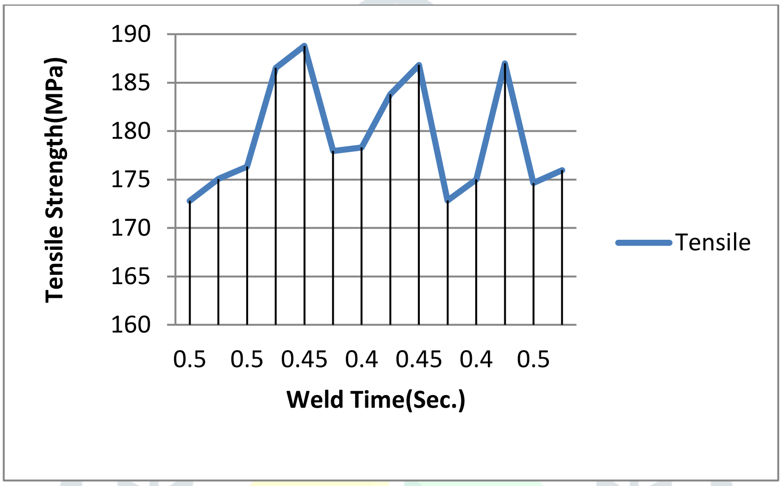

Fig4.3 Tensile strength vs weld time

OPTIMIZATION USING DESIRABILITY FUNCTION

Derringerand Suich introduce this method . Individual response is changed into compairing desirability values and range of its values lie between zero and one.when value is one it means response is at target value.If value is zero it means it is not desired and response is outside its tolerance value.this formula is used to find individual desirability value

$\hat{y} \leq y_{min}$, $d_i=0$
If $y_{min} \leq \hat{y} \leq y_{max}$, $d_i=(\hat{y}-y_{min}/y_{max}-y_{mix})^r$
If $\hat{y} \geq y_{max}$, $d_i=1$

Number	Pressure (Bar)	Amplitude (µm)	weld time (Sec.)	Tensile Strength (MPa)	Desirability
1	1.8	23	0.4	175.07	0.22
2	1.6	26	0.5	176.34	0.22
3	1.8	26	0.5	186.54	0.86
4	1.6	26	0.45	179.96	0.32
5	1.8	23	0.4	178.31	0.34
6	1.6	26	0.45	183.79	0.69
7	1.4	22	0.45	186.83	0.88

8	1.8	25	0.45	172.84	0.002
9	1.8	23	0.40	175.02	0.14
10	1.4	25	0.40	186.79	0.89
11	1.4	26	0.50	174.63	0.11
12	1.8	23	0.40	175.97	0.198

Here y^represents the value of responses y_{min} represents the lower acceptable limit of y^ , y_{max} represents the upper acceptable limit of y^ and r represents desirability function index.We observe that optimal values for tensile strength are weld time 0.40 second, amplitude 25µm and 1.4 bar pressure. At optimal parameter setting tensile strength is 186.79MPa have desirability value 0.89.

5. Conclusion

The research work gives best way to choose parameters such that we achieved desired tensile strength.

When we optimize by desirability function then weld time 0.40 sec., amplitude 25µm and 1.4 bar pressure. At optimal parameter setting tensile strength is 186.79MPa have desirability value 0.89

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