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FORMABILITY OF LASER WELDING JOINTS OF BRASS ALLOY USING HYDROPUNCH

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ABSTRACT

In this paper, Laser Beam Welding was carried out on brass alloy using different power. The effect of power on the form ability of welded blanks were investigated. The brass alloy with laser welding is formed by hydro punch in deep drawing process. Three power of laser pulsation is used (100, 150, 200) Watt. On the 1 mm thickness brass alloy. It can be concluded that plate has laser welding with 200 W is succeed in forming with hydropunch whereas the other cases had been crack at welding region i.e fracture mode I. Ansys is used to simulate the hydropunch process. Good agreement is evident between experimental and numerical results with 5.4% discrepancy.

Keywords: Deep drawing process, Brass alloy, Laser welding, Butt joint, Formability, hydropunch, ANSYS.

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1. INTRODUCTION

Welding viaLaser can be regarded as a rare source in the thermal energy, it is control in the metal joining intensity and location. In welding, the beam of laser should be concentrated to a small point size to generate a huge–intensity, therefore in certain cases laser welding provided technical advantage [1], so it is regarded to be a suitable manufacturing process for thin sheet brass structures [2]. Laser Beam Welding (LBW) is capable of welding many types of metals such as aluminum, copper, stainless steel, tool steel, carbon steels etc. The application of laser welding in combining aluminum, steel, copper, and brass plates, the components of transmitting and members of chassis via productive process[3].LBW regarded as a balancing between heating and cooling within a special positioned volume over-lapping two solids like the pool of liquid is made and still stable till solidification. Unacceptable joining is get if the pool of melt is very large or very small or vaporization occurs whereas it is exist. The accuracy of the resulting welding may be consisted of vaporization of the components of alloy, exceed the gradients of thermal which lead to cracks on the volume and geometry which is solidification and instabilities in of the pool of weld which can results in the porosity and forming of void. Fixing the balancing between the input of the heat and the output of the heat depending on constant absorption for radiation of laser and uniform heat dissipation inside the work piece. Constant dissipation of heat during the workpiece in the existence weld pool requires a stable geometry between the fusion front and the surrounding metal. There are two principal modes of the welding of laser (1) welding via Conduction and (2) welding by Keyhole or penetration. The basic different between these modes are that the weld pool 'ssurface of the rest unbroken via conduction and opening up to permit to enter the laser beam to the melt pool in keyhole welding. The mechanism of the welding of laser is a process of fusion which metals are combing via the interface melting between them and permitting for solidification. This processes results three regions: the base metal that is material has not been different via the welding process, the fusion zone (weld pool), consists of material which was melted via welding, and heat affect zone (HAZ) consists of base metal which has been altered in some measurable kindvia welding [4 ,5]. When a beam of laser is concentrated on a surface of a target, manyevents happens. The essential part of the laser beam may be reflected away. The small percentage which is absorbed heats up the surface, increasing its temperature. The absorptivity of the surface raises with temperature's increased [6]. In welding, the best efficient way of welding is called deep penetration or keyhole welding. To achieve keyhole welding with a laser , the lens are utilized to concentrate the beam onto the work piece surface of a metal. The focus heats of beam for the metal beyond its point of melting. The liquid is a good absorber than the solid. The vaporized of metal is opened the cylinder (called a keyhole) down via the work piece supporting back the liquid of surrounding with the pressure of vapor. That vapor makes ionized and it absorbs the incoming radiation, becoming incandescent and radiating energy to the molten metal along the side of the keyhole. The metal at the hole'sedge also absorbs energy from the laser beam. Deep penetration can be achieved because energy is transferred to the work piece along the entire depth of the keyhole. Relative motion for the welding head and workpiece generate a welding through the moving of the keyhole via the materials. As the keyhole moves liquid metal flows from its forward surface to the back which it solidification. This flow is moved using temperature – induced alternation in the surface tension of the molten metal [4]. During the welding it has been observed that the fluid flow is driven by a combination of forces [5].G. Phanikumaret al. [6] in 2000 have studied laser welding of dissimilar copper-nickel, iron-copper and iron-nickel both experimentally and numerically. G. Serraet al. [7] , in 2007 welded low carbon steel to aluminum 6000 alloy in a steel – on – aluminum overlap by using continuous Nd :YAG laser. Baohua Chang et al . [8], in 2010 reported the results of an experimental study of the effect of pulse power'slaser , duration'spulse , and the distance of defocusing , on the joint sizes and behavior of mechanical during pulsed Nd :YAG laser spot welding of an NdFeB magnet with a low carbon steel.M. J. Torkamany et al. [9] , in 2010 tested the influence of laser peak power , duration ofpulse , and the factor of overlapping via pulsed Nd:YAG laser welding in keyhole mode of carbon steel to 5754 aluminum alloy in keyhole mode at the configuration of steel – on - aluminum overlapped. The present work goal, is the formability for joining brass alloy 1 mm thickness by Nd:YAG laser welding using hydropunch.

2. MATERIALS USED

The material used to be combined using pulsed Nd:YAG laser in the present paper, was Brass. Its chemical composition was analyzed using spectrometer type Spectromax, in the Specialized Institute for Engineering Industries, as shown in Figure 1. Table.1 illustrated the chemical composition.

Figure 1: Material analyzer (spectrometer) type spectromax

Table.1: The chemical composition of specimen

Zn%	Pb%	Sn%	P%	Mn%	Fe%	Ni%	Si%	Cr%	Al%	Cu%
32.83	0.0044	0.0054	0.0041	<.0005	0.0805	0.0073	<0.001	0.0013	0.0199	Bal.

The mechanical properties for the selected material is existence in Table 2.

Table.2: The Mechanical Properties of specimen

Ultimate Stress (Rm) N/mm^2	Yield Strength (Re) N/mm^2	Elongation %
383	180	50

Specimen Preparation and Joint Design

The preparation steps that followed for brass of 1 mm thickness can be listed as follow:

1- Cutting the metal sheets into small sheets of (100mm ×50 mm).

2- Cleaning the metals sheets by pure alcohol for removing the dirt and oil.

3- Grinding the metal sheets using different grads of abrasive silicon carbide papers of rang (400, 1000 and 1200) grain / cm^2, for removing the films of oxide and reducing the roughness in order to perform the good position between the surfaces welding.

4- Cleaning a metal sheets using HCL solution 50 % concentration in order to get very clean surface, and then washing by distilled water [12].

5- Washing the metal sheets by pure alcohol and then drying to prevent surface oxidation for longer time as possible before welding.

Butt joint design were made in the present work as shown in Figure 2. , where two brass sheets of (100 mm× 50 mm ×1 mm) is placed beside one[13]. At the welding joint the stress is transferred between the jointed components and throughout the welded assembly. The kind of the applied force of the weld ment, effects on the selection of the joint design. A clamping device was designed to clamp the metals sheets during welding operations, in order to ensure better contact between the sheets and overcome any gap may occur between them , were the gap between the welded partners is a very critical factor in butt joint design.

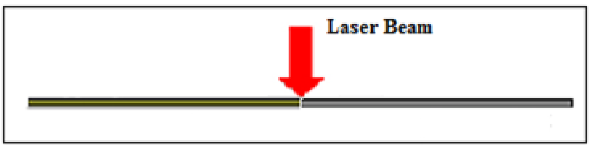


Figure 2 Joint design of the present work (Butt joint).

Also the clamping device prevents the deformation due to thermal effects, caused by the input of heat to the metals sheets via the process of welding. The designed clamping device is presented in Figure 3.

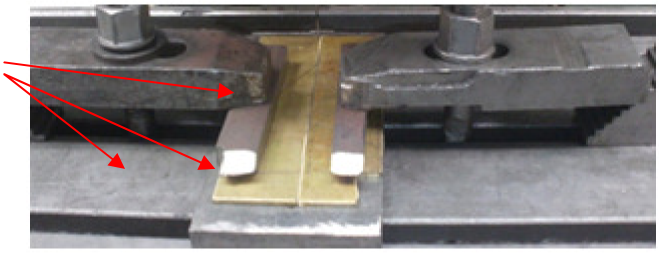
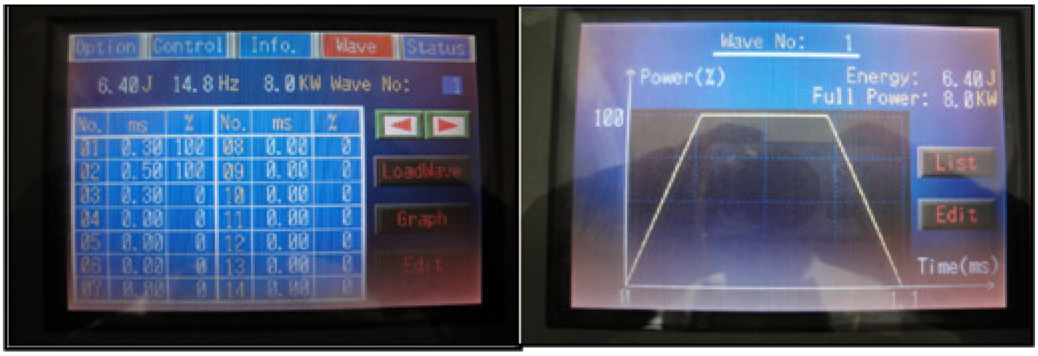


Figure 3: The designed clamping device

Laser Welding

A pulsed Nd:YAG laser system class four 1.064μm model PB 80 made by Han's Laser Technology Co. Ltd. Figure 4 was employed with maximum (Peak) power of 8kW. The laser pulse system has adjustable power shaping within a laser that offers high flexibility in optimizing the weld parameters to achieve defect free joints , where the waveform can be divided into fourteen segments as shown in Figure 4a . For the present work the pulse time was chosen in a manner that it consists of three segments that are 0.3ms of the pulse with 100% power as preheating, main pulse time with 100% power, and 0.3ms of the pulse with 0% power as cooling , as shown in Figure 4b. The output energy was measured with a built-in power measurement unit . Also the pulsed Nd:YAG laser system was achieved with a synchronized robotic laser setup to employ welding genius process .



(a) (b)

Figure 4 (a) the pulse segments, (b) the pulse shape

For the welding purpose, three levels of peak power (100,150,200) Watt, at one second exposure time (time on).As shown in Figure 5.

(a) 100 Watt (b) 150 Watt (c) 200 Watt

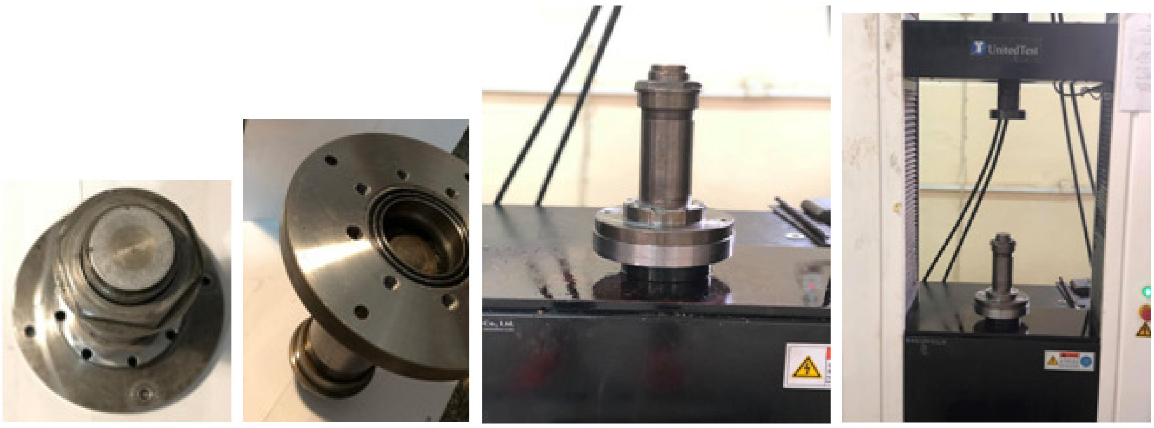
Figure 5: Laser welding Joint of Brass for different power

After computing the optimum welding conditions which has the formability test was achieved using the change of the power's peak values (for the good conditions of welding), saving the pulse energy as a constant, to investigate the influence of peak power on the strength's joint and the geometry of weld pool during hydro-deep drawing process.

Formability Test

Brass plates was utilized as base materials (BM) in this paper. Table 1 illustrated the chemical compositions for the base material. Table 2 illustrated the mechanical properties for the base material. The LBW was done on the blank of brass on both sides fixed on the table by bolts and clamps to constrain the movement of blanks via welding.

After welding, the welded specimens have been formed using hydropunch deep drawing process using 50 ton hydraulic press with 10 mm/s. The hydropunch apparatus and toolset arrangements are designed and manufactured in this work as shown in Figures.6(a) and (b),respectively. The specimens (100 mm × 100 mm× 1 mm) were manufactured from the blanks for biaxial condition and were drawn by a hydropunch till the fracture. The hydropunch load and dome height values were recorded and stored in the data logger via the forming process.



(a) Hydropunch Die (b) Hydraulic press

Figure 6: The Die Assembly of Hydro punch Deep drawing

Fracture Modes

Although the fracture does not affect formability, it is related to the ductility of the blanks being deformed, as fracture modes depend on the material combination. There are essentially three types of fracture modes seen in the forming of LBW. The types of fracture are mentioned in Table 3.

Table 3 Summary of the fracture modes types of [14]

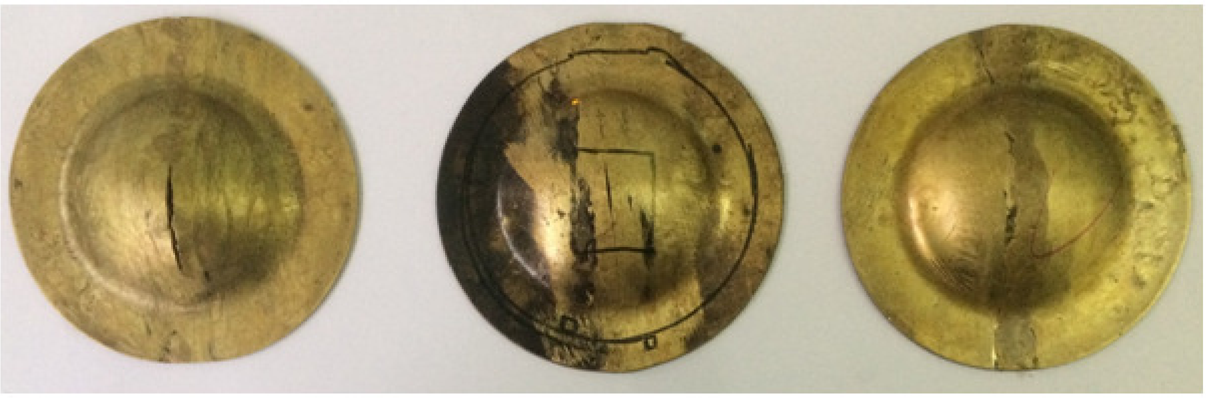
	Mode I	Mode II	Mode III
Fracture location	Across the weld	Parallel to the weld in the base metal	Parallel to the weld in the HAZ
Reason for fracture	Low weld ductility as the weld is stretched along the major strain direction	Base metal is stretched past its forming limit	Local drop in hardness in the HAZ [9]
Types of LBW combination fracture occurs	Similar thickness and material properties	Dissimilar thickness and material properties	Dual phase steels

In the present paper the cracks occurs in the case of (100W and 150W) and the fracture type is mode I. This is because the sufficient heat created by the pulsating of laser action via the welding operation.

3. RESULTS AND DISCUSSION

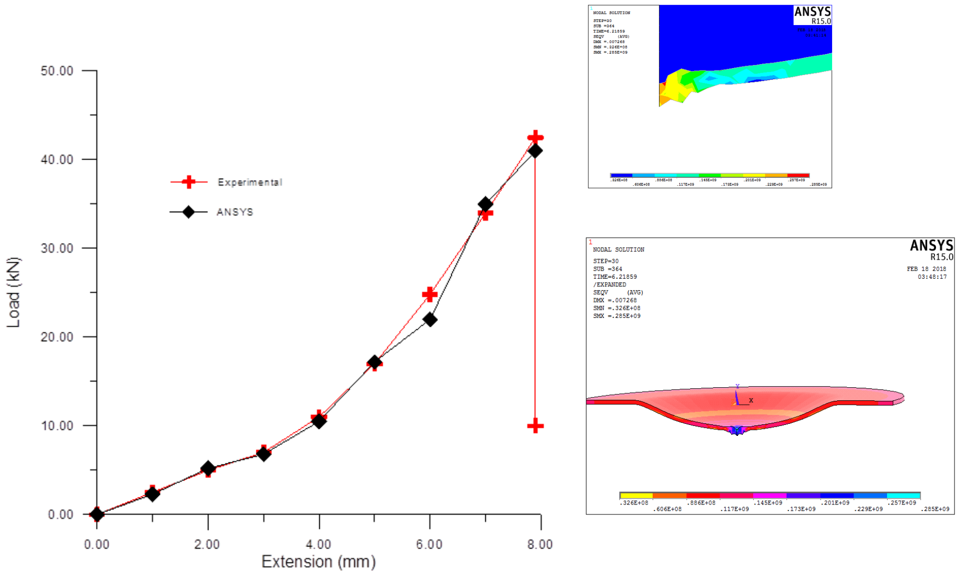
The formability for the blank is depended on the “work hardening exponent” and “the work hardening capacity” too. In order to get the best formability, blanks requires huge work hardening exponent.

Figure 7 shows the deformed welded blanks after formability investigation. The fracture occurred on the region of welding since the low ductility of brass alloy. Figure 8 shows the influence of hydro-punch load on the blank’s deformation in deep drawing test. The welded blanks is manufactured with three different power (100, 150,200) Watt with stood higher hydro punch loads and led to higher deformation.

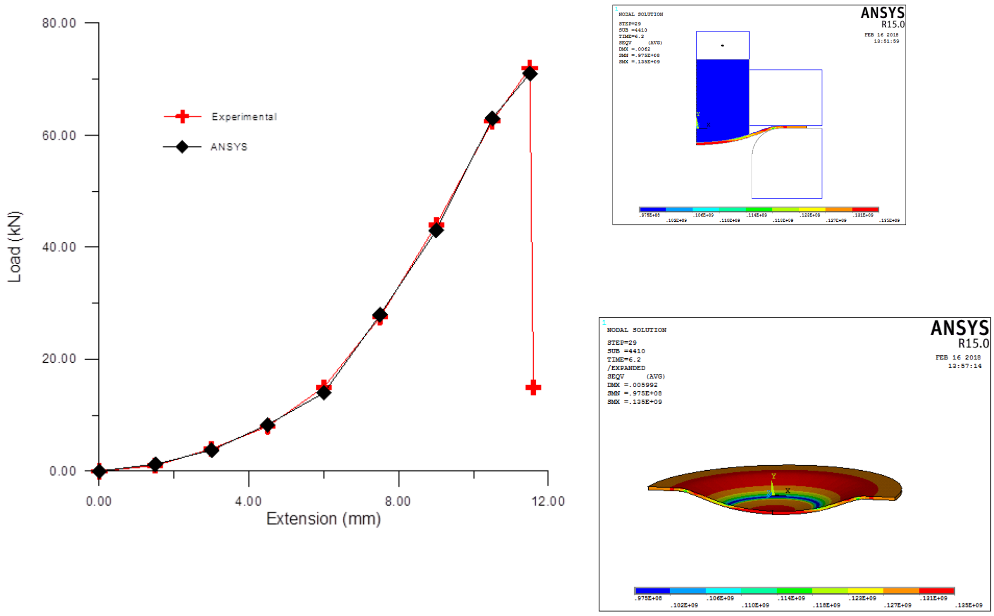


100 W 150 W 200W

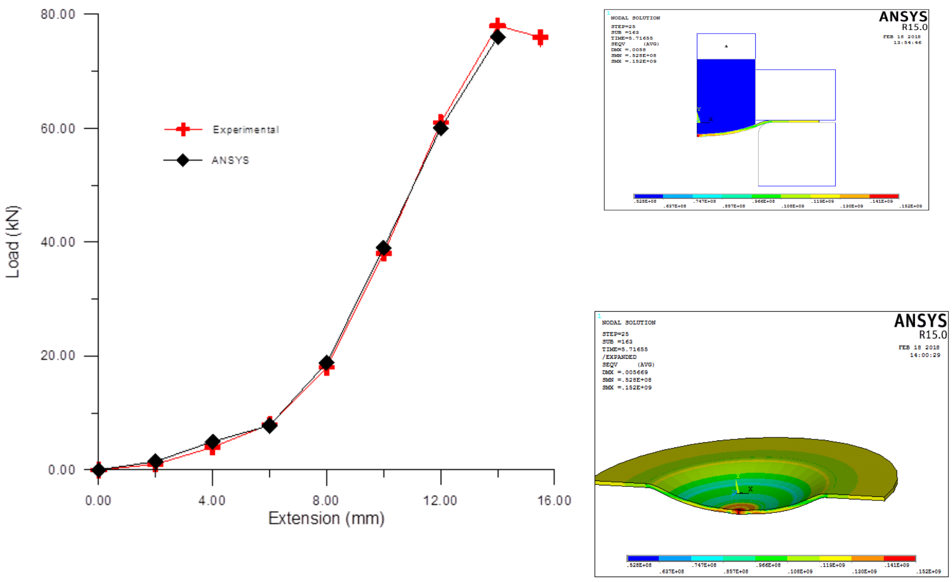
Figure 7: Hemispherical cups after forming with different laser power



Laser power 100 W



Laser power 150 W



Laser power 200 W

Figure 8: The influence of Hydro-punch load on deformation

4. CONCLUSIONS

In the present investigation, hydropunh formability of Laser Beam Welding was carried out on brass alloy using different power. The effect of power on the form ability of welded blanks were investigated. The action of pulsating of the laser beam in the zone of weld generates fine grains, leading to an improvement in properties in the zone of weld. It can be concluded that plate has laser welding with 200 W is succeed in forming with hydro punch whereas the other cases had been crack at welding region with fracture mode I. Good agreement is evident between experimental and numerical method with 5.4% discrepancy .

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