ISSN:1991-8178

Australian Journal of Basic and Applied Sciences

Journal home page: www.ajbasweb.com

Mathematical Design of Solid state Welding Machine by Friction Force

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ARTICLE INFO

Article history:
Received 16 March 2015
Accepted 28 May 2015
Available online 22 June 2015

Keywords:
Friction welding; friction pressure; moving object; stationary object; automobile; aerospace

ABSTRACT

This work is a model and a simplified version of friction welding on a mini Centre Lathe Machine and has been made under the constraints of space, time and resources available. The friction welding has been fused onto a cylindrical workpiece. The two cylindrical work pieces are joined to each other, when the two faces of the work pieces remain in contact with the two round faces. The friction welding method is one of the most simple, economical and highly productive methods in joining similar and dissimilar metals. It is widely used in the automotive, aircraft, aerospace, maritime and heavy industrial applications. In the present work, a cylindrical work piece is friction welded to another cylindrical workpiece. On the other hand, cylindrical work pieces were machined down using a lathe machine to the required dimensions. The diameters of the cylindrical work pieces were both 15 mm respectively. It is the strength of welded joints, which is a fundamental property to the service reliability of the welded work pieces. Rotational speed and axial pressure are the two major parameters which can influence the strength. Thus the axial pressure and rotational speed were taken as welding parameters, which reflect the mechanical properties. Rotational speeds for friction welding were around 700 rpm. A friction pressure was manually applied.

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To Cite This Article: Dinesh ram G, Afthab ahamed S and Umanath K, Mathematical Design of Solid state Welding Machine by Friction Force. ***Aust. J. Basic & Appl. Sci.,*** *9(11): 928-933, 2015*

INTRODUCTION

The term welding is used to cover a wide range of bonding techniques. Now-a-days many processes of welding have been developed and probably there is no industry which is not using a welding process in fabrication in its products in some form or other. One such welding process is Friction welding. Friction welding is considered as a solid state welding process that generates heat through mechanical friction between a moving work piece and a stationary component, with the addition of lateral force called “upset” to plastically displace and fuse the materials. Technically, because no melt occurs, friction welding is not actually a welding processing the traditional sense, but a forging technique. However, due to the similarities between these techniques and traditional welding, the term has become common. Even metal combinations not normally considered compatible can be joined by friction welding, such as aluminum to steel, copper to aluminum, titanium to copper and nickel alloys to steel. As a rule, all metallic engineering materials which are forgeable can be friction welded, including automotive valve alloys, steel, tool steel, alloy steels and tantalum. In addition, many castings, powder metals and metal matrix composites can also be welded (Fuji, 1997; Kiran Kumar).

Friction welding is a recent technique that utilizes a non-consumable welding tool to generate frictional heat and plastic deformation, thereby resulting in the formation of weld joint. The principle advantages of friction welding being a solid state process are less defects, low distortion, no filler, and cost. Friction welding is most rapid and easiest way of fabrication and assembly of metal parts. The research carried in this field has given various ways and methods to weld practically all metals. Means have also been found out to weld dissimilar metals. In comparison with other processes, friction welding gives better strength of joints and it is relatively easy and quick process. This process is being used in Automobile industry; aircraft machine frames, structural works, sports goods, etc. The recent applications of friction welding are welded for submarine rescue, aerospace, Production of micro cutting tools like drills, taps etc. Many of cost products is now-a –days being fabricated by welding various parts together (Ihsan Kirik). Direct Drive Friction Welding otherwise called as Conventional friction welding is a variation of friction welding in which the energy required to make the weld is supplied by the welding machine through a direct

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motor connection for a preset period of the welding cycle. In Direct Drive Friction Welding, one of the work pieces is attached to a motor-driven unit while the other is restrained from rotation (Imran Bhamji; MuminSahin).

Design of portable friction welding machine:

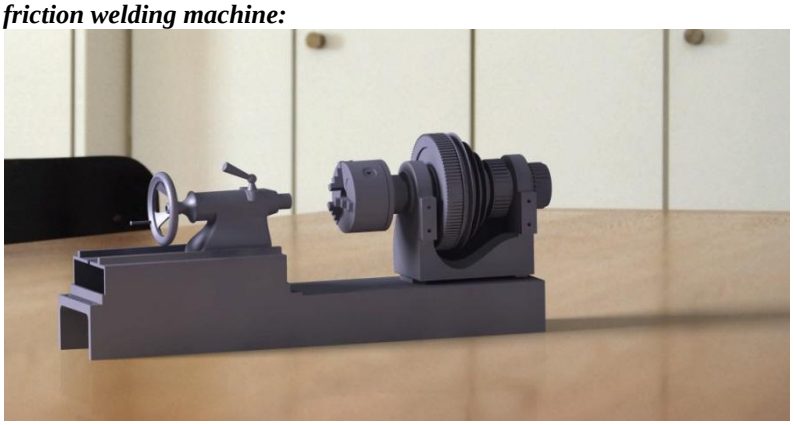

Fig. 1: 3D View of portable friction welding machine.

Drafted images of portable friction welding machine:

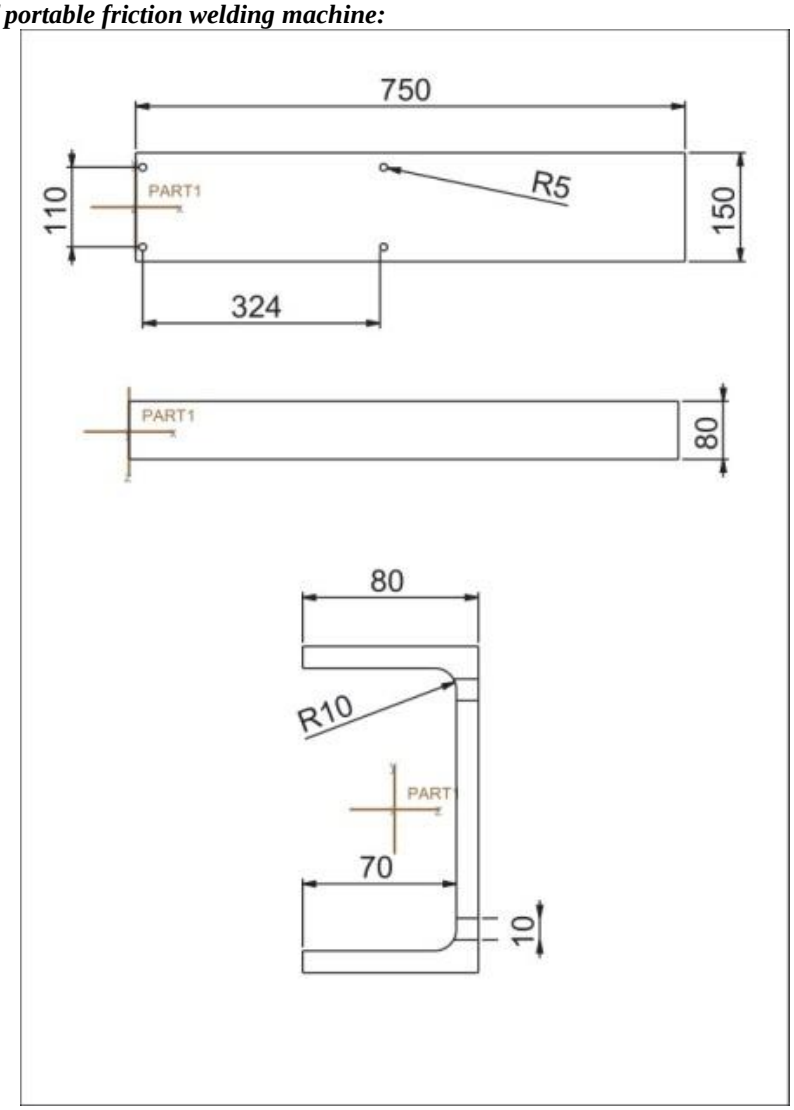

Fig. 2: Drafted image of C section beam.

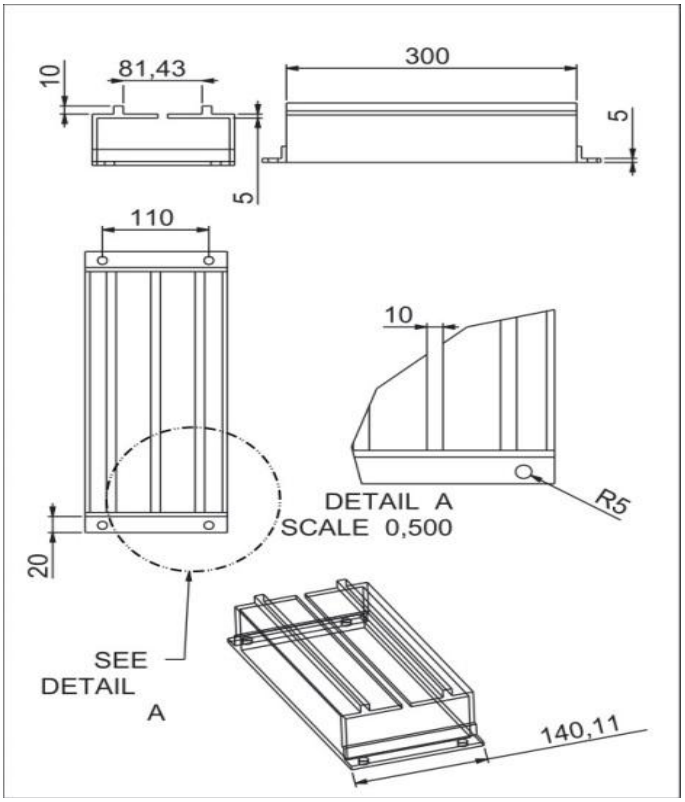

Fig. 3: Drafted image of guide ways.

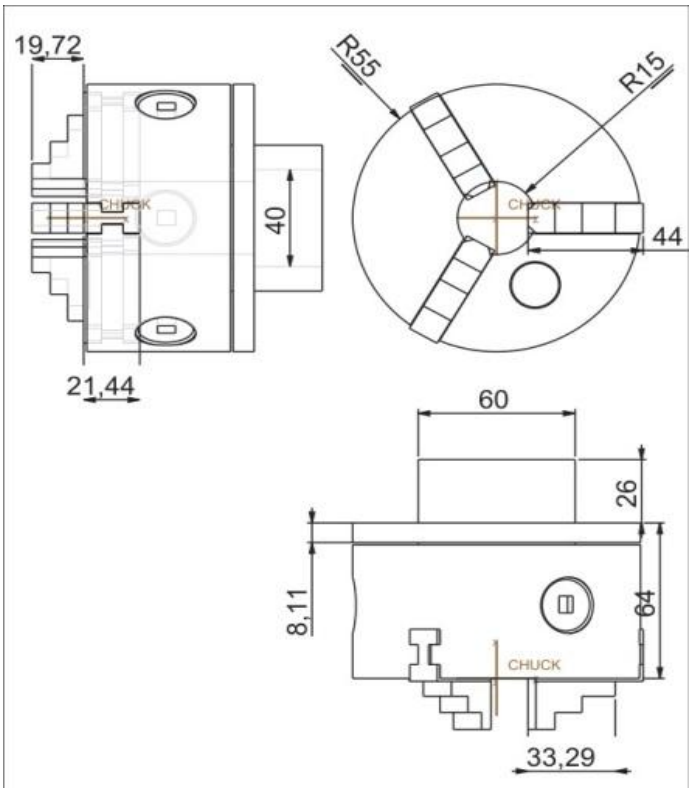

Fig. 3: Drafted image of 3jaw chuck.

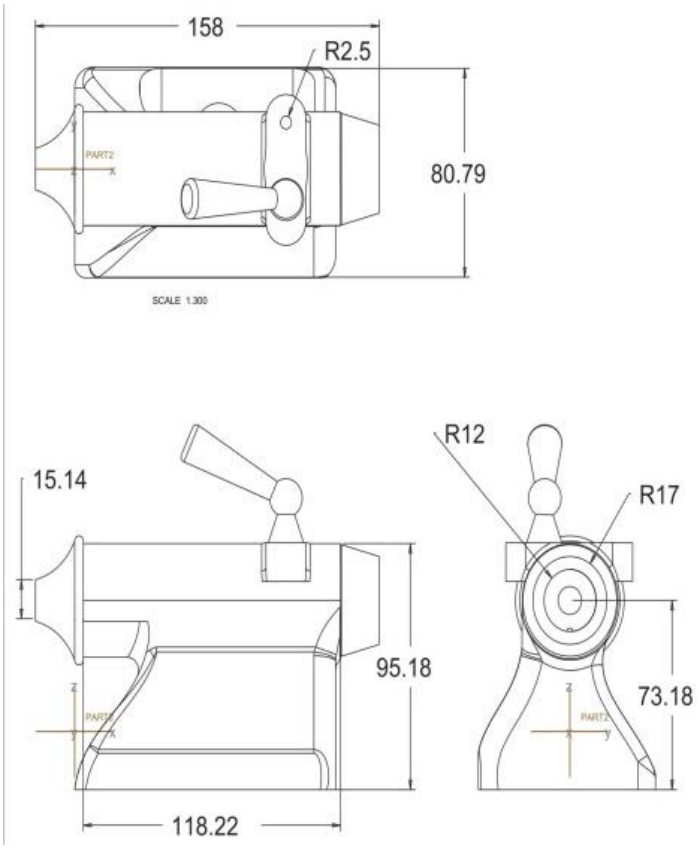

Fig. 4: Drafted image of tail stock.

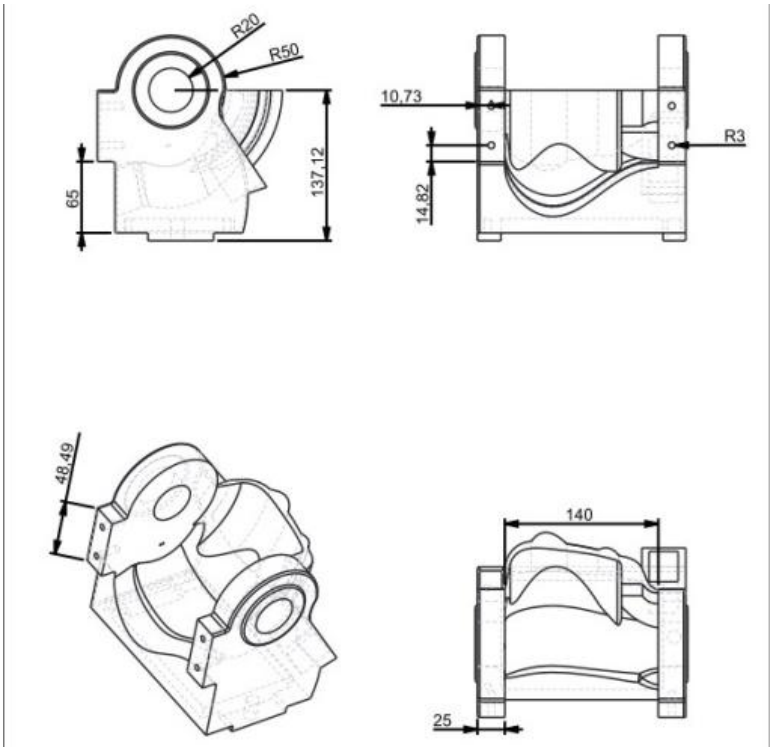

Fig. 5: Drafted image of head stock.

Design calculations of machine:

Specifications of motor:

a) Power: 0.37 KW
b) Speed of Motor, N1= 1420 RPM
c) Calculation of Torque:
d) $P=2*\pi*N1*T/60$
e) $T= P*60/2*\pi*N1 = 0.37*10^3/(2*\pi*1420)$
f) T= 2.488 N-m.

Calculation of V-Belt:

To find the Larger diameter(D) and Smaller diameter pulley(d):

a) Circumference of Larger Pulley Diameter $=2*\pi*R$ = 400mm
b) $R=400/2*\pi$
c) R=63.66mm
d) D = R*2 =63.66*2=127≥130 mm
e) Circumference of Smaller Pulley Diamater $=2*\pi*r$ =170 mm.
f) r =27 mm.
g) d= 2*27=54 mm.

Calculation Of Centre Distance(C):

a) i=D/d=N1/N2
b) i=130/54=2.40=1420/2.40=592 rpm
c) Using standard PSG Data Book pg.no.7.61
d) i=D/d=2.40=C/D=1.1=1.1*130=143 mm.

Determination of Nominal Pitch Length(L):

a) $L=2*C+(\pi/2)*(D+d)+(D-d)^2 /4*C$
b) $L= 2*143+(1.57075)+(130-54)^2 /4*143$ =585 mm.

Selection of Various Modification Factors:

a) Length Correction Factor:

Fc =0.80 (from PSG data book pg.no 7.58)

b) Correction Factor for Arc of Contact (Fd):

Arc Of Contact Factor $= 180^0 –(D-d/C) *60^0$

$= 180^0 –(0.531*60^0)$

$= 147.95= 148^0$

c) Service Factor(Fs):

(Using data book pg.no 7.69 for using upto 10hr)

Fs =1.0

Calculation of Maximum Power Capacity (KW):

a) Using formula for cross section-A
b) $KW=(0.45*S^{-0.09}-19.62/d_e -0.765*10^{-4}*S^2)*S$
c) $S= \pi*d*N_1/60$ =4.07 m/s
d) $d_e= d_p*F_b= 54*10^{-3}*1.13$= 0.06102 m.
e) KW= 2.269

Wrap Angle of Contact of Pulleys(α):

a) Wrap Angle for Smaller Pulley,
b) $A_s= 180^0- 2* \sin^{-1}((130-54)/(143*2))=149.178^0$
c) Wrap Angle For Larger Pulley,
d) $A_L= 180^0+ 2*\sin^{-1}((130-54)/(143*2))= 210.82^0$.

Nominal Top Width of Belt(W):

w= 13 mm. (using standard data book for cross section-A)

Nominal Thickness(T):

T= 8 mm.

Fabrication of portable friction welding machine:

The Portable Friction Welding Machine was constructed with the basic idea of lathe. In this experiment, the friction welding machine has been fabricated over a mini lathe setup. The headstock assembly and tailstock were mounted over a base channel considering the centre distance. A single phase electric motor was mounted on to the base channel and was coupled to pulley in the headstock assembly through a V-belt. The centering of the headstock and tailstock was done by adjusting their heights accordingly.

RESULTS AND DISCUSSIONS

In general terms, the present invention is dependent on continuous drive where one piece is in rotation & other in linear motion, where both faces of the weld joint are in motion during the heating phase of the operation; the motions are brought into rest when the conditions of the joint are appropriate.. Friction welding technology brings substantial advantage to the area of joining of similar and dissimilar materials. It is safe on this machine to perform the friction welding up to bar diameter of 13mm with good mechanical properties. For light loads and soft work pieces, the Portable Friction Welding Machine on a mini lathe setup is much better and less expensive for welding moderate sized work pieces when compared to CNC controlled Friction Welding Machine. The two cylindrical work pieces were friction welded together successfully. Optimum welding parameters should be properly selected in the friction welding of parts. Availability of data required for design of Friction Welding technology processes in open literature is limited, but provides a sufficient base to estimate roughly possible benefits of the usage of the technology. Information about basic welding parameters is sufficient to be used as starting values for optimization process for materials and tools. Friction welding is an indispensable tool for welding dissimilar metals. With the increase in rpm, the torque and coefficient of friction increases. This causes higher financial requirements for new adopters of the technology. This basic experimental study of friction welding leads us to a variety of scopes in the future like microscopic study of weld, testing of weld, welding of dissimilar materials.

Conclusions:

1 It is safe & less expensive on the portable lathe machine to perform the friction welding up to work pieces of diameter 13mm.
2 With the increase in rpm, the machine would be suitable for welding materials of higher melting points.

ACKNOWLEGMENT

The authors hope to be grateful Vel Dr. R. Rangarajan., Chancellor, Veltech Hightech Dr.R.R. and Dr.S.R. Engineering College, for the support and services provide for the preparation of this manuscript.

REFERENCES

Fuji, A., M. Kimura, T.H north, K. Ameyama, M. Aki, 1997. Mechanical Properties of titanium alloy friction joints", Material science technology, 13: 673-678.

Ihsan Kirik, Niyazi Ozdemir, "Examination of microstructure and mechanical properties of friction welded joints of medium carbon steel to austenitic stainless steel".

Imran Bhamji, Michael Preuss, "Linear friction welding of AISI 316 l stainless steel".

Kiran Kumar, G., K. Kishor, "Investigating the capabilities of medium duty lathe machine for friction welding", Department of Mechanical engineering, Hyderabad. India.

MuminSahin, "Joining with friction welding of H.S.S and medium carbon steel", Mechanical Engineering Department of Trakya University, turkey.