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Process Development and Manufacturing of Tapping Tool using Friction Welding Technique

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Abstract— In today's scenario, the main weightage of investigation is to reduce the cost of product while upholding its strength and efficiency. To solve problem in this regard manufacturing technologies play an important role. In this project decreasing the cost of cutting tool is considered. The prominence of the project is to reduce the overall cost of cutting tool (tap) while maintaining its properties and strength using the friction welding technique. The design issues for this study area unit stress and deflection. Materials used are H11 chromium hot work tool steel. In the present work tensile strength and hardness testing of produced blank is carried out in UTM and Vickers hardness testing machine. The results obtained from calculations, experimental study in static load condition. In this work an attempt of Cost reduction has been made by using friction welding technique.

Keywords—Friction welding, Tapping Tool, Cost optimization

I. INTRODUCTION

In order to reduce the cost, conventional cutting tools can be replaced with composite cutting tools made with two different material having similar properties but different cost. By doing this, the cost of the tool can be reduced while maintaining the strength of the cutting tool. Friction welding (FW) is widely used solid state welding method for joining of similar or dissimilar metals. Friction welding requires rapid rotation of one component at high rpm and other component is brought into contact at high forging pressure to get upset. Two pieces rotate in contact and heat necessary for welding is generated on friction plane. The machine for the friction welding is similar to a vertical milling machine. The fundamental principle of friction welding is to use the heat generated through motional friction to produce a clean joint, without the formation of a liquid phase. This contact force first generates heat at the interface.

Once the material has become sufficiently soft, the forging pressure applied against the two components forces the heated interface material into the flash, removing any surface contaminants and producing a clean joint. The solid-state nature opens opportunities for joining materials previously considered to be unweldable and dissimilar materials. This rapidly easily controlled & easily mechanized process has been used extensively in the automotive industry such as half shafts and bimetallic weld. One important characteristic of friction welding is its ability to weld alloys and combination of alloys previously regarded as unweldable. One is placed in a rotating spindle and the other is positioned in a stationary clamp.

The major Objective is to implement joining process for steel alloy and HSS without affecting performance and quality of tool. For this friction welding process was employed. Major Reason for selection of friction welding process is:

1] Mechanical strength is high.
2] Creates narrow HAZ.
3] Low energy requirement.
4] No fluxes, filler material required.
5] Green process.

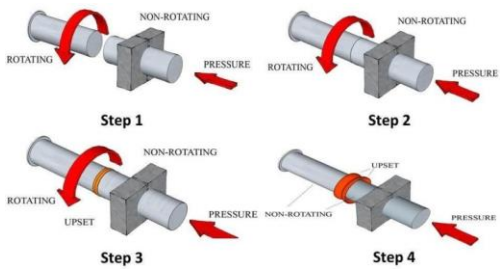

Figure 1 Friction Welding Process [8]

II. LITERATURE REVIEW

P. Kah et al, [1] studied various gradually developing welding materials and processes & we found that future growth of welding technique depends upon the adoption of new technologies and development in the material used **Andrzej Ambroziak et al**, [2] found that during the FW of Al & Fe long time & high temperature leads to formation of intermettalic phases which is reason for brittleness. Also in pure Al & steel welding phases are formed but mechanical properties of joints are good.

Innovative welding technology, impact on productivity of small and medium enterprises in Bulways.

Albert Makore et al. [3] investigated that there is a need of getting final product produced by improved welding technologies and previous studies required more investigation for collecting data with technique used.Evaluation of mechanical & metallurgical properties of dissimilar material by Friction Welding

Satish Kumar S. et al, [4] found that strength obtained by FW of stainless steel & Cu is varied with different speeds of rotation but strength was good and properties are also compatible with respect to parent material.

M.Kimuraa et.al, [5] Conducted a test by joining Al(Cp-Al) and austenitic and steel. Through the test it was observed that efficiency of the joint was high.

Zhida Liang et.al, [5] Studied a friction welded component of 2 metals SA33 Al alloy bar and AZ31B Magnesium alloy bar. The strength of joint increased when the friction time was increased.

Handa et.al, [5] made an experiment setup to friction weld austenitic stainless steel and low alloy steel. Axial pressure was the major parameter for the process with increase in axial pressure, tensile strength increased.

Sandeep Kumar et.al, [6] found that FW was successful to employ on 2 dissimilar metal. Tensile test and micro hardness of both materials are excellent and welded joint is strong.

Sirajuddin Elyas et.al, [7] studied that joint between two metal ss316 and EN8 is very good hence FW can be used for dissimilar metals

III. PROBLEM DEFINITION

Machine tap s are made from High speed steel material which is very costly material. Actual cutting parts in taps are only thread part. Shank body provides support and required cutting force while threading. Tap made from single rod is costly and this cost can be reducing using other steel alloy for shank body. Around 50 % HSS steel can be replace by lower cost die steel for shank body and the cost of bigger size tap can be reduce by 25 to 35 %.

IV. OBJECTIVES

Aim it to reduce cost of HSS by replacing portion of cutting tool with of another material while maintaining its strength. For selection of material it is necessary that selected material is compatible with heat treatment process and has similar behavior like HSS and achieve required hardness.\

V. MATERIAL STUDY

Tapping tools are generally made with HSS. Here the tool is made with ASP-2030. To save the cost 60% of shank material is replaced with low cost alloy steel which can withstand the same heat treatment process which HSS can undergo.

Following are the materials that can be used to replace the shank material-

	Material	Hardness (in HRC)	Remark
Shank	H11	52.5 at 982˚C 57 at 1080˚C	Surface Hardness almost similar to ASP2030
	H25	33.9	Surface Hardness quite similar to ASP2030
	H13	52max	Surface Hardness was very low
	EN8	26	Surface Hardness was very low
Cutting Part	ASP2030	62	-

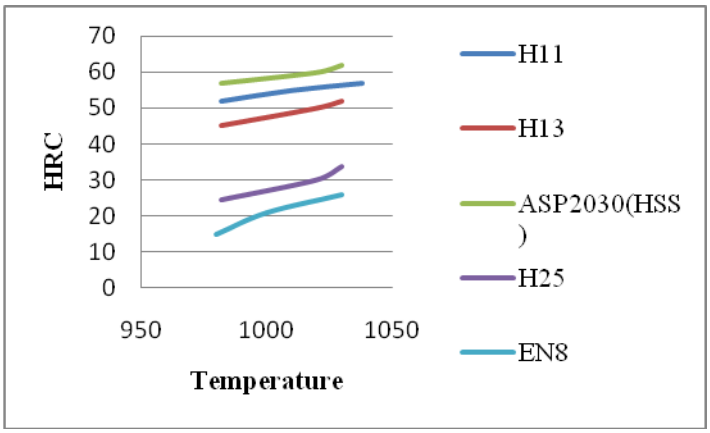

Figure 3 Graph of HRC vs Temperature

From the following materials H11 material is the most compatible material for shank part. After proper heat treatment H11 can be hardened up to 57HRC which is close to hardness of HSS which 62HRC.

VI. DESIGN

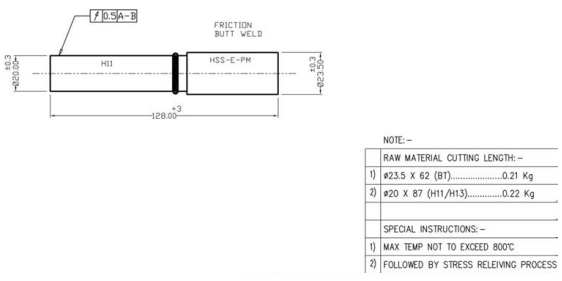

Figure 4 Design of Blank

VII. TESTING

- As testing plays a vital role in any product development testing, Testing can be done in various aspects of tool.
- Testing on Friction Welded tapping tool is done by following methods
  1. Tensile test
  2. Hardness test
  3. Functionality test

1) TENSILE TEST

- Two bars of HSS (ASP2030) and tool steel (H11) were welded to form a uniform bar.
- This uniform bar has flash which was removed by turning operation. This turned bar was tensile tested on a UTM machine to check whether the friction welding done on bar does not break at the friction welded portion.
- The experiment turned out to be successful and the bar broken near the friction welded portion and not at welded junction.

Figure 5 Tested Component on UTM

Results:

- The maximum force was 47.21 KN.
- The tensile strength of the bar was 671.40 N/mm^2
- The yield strength of the bar is 411.72 N/mm^2
- Percentage reduction in area was 55.07%
- The test turned out to be successful as the bar broke near the weld and not at the junction.

2) Hardness Test

- After the heat treatment of the component, Hardness of the welded component was check using Vickers hardness test .
- It is necessary that both the HSS and H11 material have same hardness range so sample were tested under Vickers hardness testing machine. Before hardness testing samples were cleaned and ground for better results.

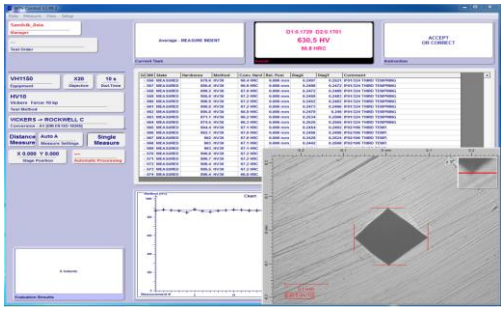

Figure 6 Hardness Test Result

Result:

- It was observed that, Vickers hardness of shank material is 56.8 HRC after heat treatment.
- The hardness of shank material was close to that of cutting material, hence almost uniform hardness was achieved in the tool.

3) Functionality Test

- Functionality test is used to identify the function of the process and to test the parameters
- Testing parameters:
  - Thickness of plate -20 mm
  - Hole diameter(drilled) – 17mm
  - Speed – 32m/min
  - Speed(RPM) – 510

Figure 7 Cutting Trials by Tap

Figure 8 Chip Formation

Result:

When a cutting trial has conducted with the friction welded tap it produced threads without any issue. When the tap entered the holes, a slight whistle produced which is normal for a new tap. The chip control was as per expectation , the finish size of thread was perfect.

In the second hole the tap slipped in the holder and was reached manually but the strength of the weld not compromised here. Thus the tool whistled all the forces without affecting the strength of the weld.

VIII. CONCLUSION

FRICTION WELDING process was employed to join the two different materials. The shank portion was replaced with H11 material. After different tests namely tensile test, hardness test, functionality test all the test results were

satisfactory. In future with further development in materials, friction welding technique we can increase cost saving, reduce set up time and can try different material than H11 to suite different operating conditions different applications.

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