Design and development of simplified fixture for FSW.

Design and development of fixture for single as well multi pass Friction stir welds as butt weld and bobbin tool weld.

KAUSHAL BHAVSAR,DR. G.D. ACHARYA

[1]Research scholar,[2]Principal-A.I.T.S.
[1]Engineering and technology-Mechanical Engineering,
[1]Kadi Sarva Vishwavidyalaya, Gandhinagar,[2]Rajkot ,Gujarat,India.

Abstract : Friction stir welding process have been well accepted in the field of Welding. While performing FSW on experimental basis the plate size considered is 100 x 100 x T, here T is thickness of plate. The facts found while designing and experimenting were interesting. The development phase have given exposure to points which have not been considered while constructing fixtures for holding plates while carrying experimentations. The effects found on plate while changing parameters have also changes the results. Here design have been trialed for various experiments and on basis of practical understanding of problem physics one design have been finalized for further experimentations. Experimentations have been carried and with Multiphysics problem have been solved. On basis of practical and Multiphysics data design have been presented.

IndexTerms **- Fixture; FSW Fixture; load cell fixture FSW, 3axis tool dynamometer for FSW.**

I. INTRODUCTION

FSW have been trialed by various scientists to gain various quality welds in different ferrous and nonferrous materials. Here standard procedure suggests to clamp a plates on milling machine bad or they clamp it by mechanical means like holding clamps. To design FSW fixture study have been carried on basis of experiments with sensor systems and load cells. Here design and development is presented with understanding of problem physics. FSW physics.

FSW is process which needs less resources as compared to other welding processes. The design of fixture involves trial testing to gain data for loading during plunge, dwell, feed and retrieval of tool from plate. The temperature of weld plate have also been measured before, during and after weld. The FSW represents multiple physics at same time. It starts with frictional heat addition in plate while plunge. At same time stirring of base material occurs. Here the load developed within plate and tool tries to move plates in vertical downward direction, lateral direction and moving advancing side as well retrieving side plates. The forces will further develop onswitching on feed. The heat due to friction increases rapidly. The material available at region of plunge and tool travel path get plasticized and getting stirred in the region with change in its grain size as well in microstructure. Different phases have been developed which are stir zone, Heat effected zone, TMAZ, Base material. Heat is generated and dissipated through the material plate as well through the fixture base plate and other constructions.

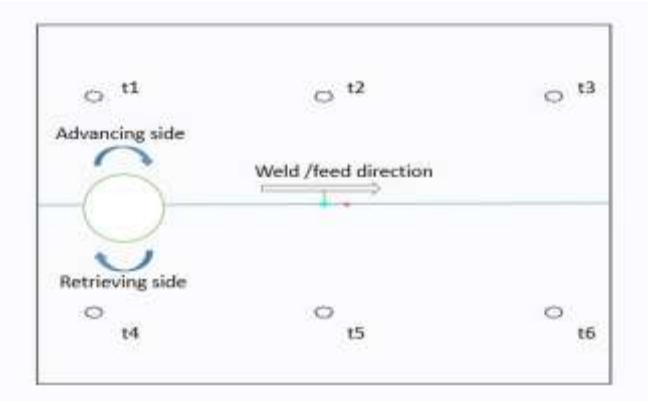


Figure 1 friction stir welding process presentation with plate.

Here figure 1 represents welding phenomena on plates. Available methods for clamping plates:

a) *Clamping plates on guideway of milling machine:*

The available method was the general method to hold plate to perform sheet metal operations. Here the drawback involved is we have to place clamps properly to hold the plate tightly on milling bad. The clamp height while placement may create movement problems for tool. And miner misalignment while placement create major defect in plate. This formation is not appreciated for Bobbin tool FSW.

b) Fixture plates :

The fixture plates are produced by generating cavity in side metal plate of specific material (i.e. SS, Die steel).it contains cover plates to hold material in the cavity. This formation helps to do FSW as well measure load during plunge and processing in Vertical direction. But it is difficult to measure load produced in longitudinal as well transverse direction. This formation also not helps in Bobbin tool FSW.

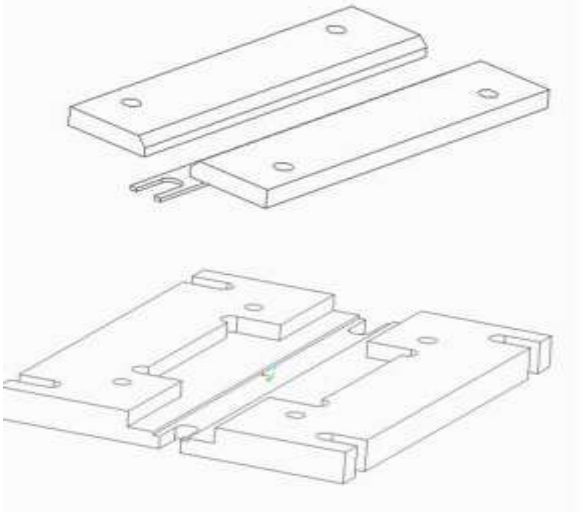
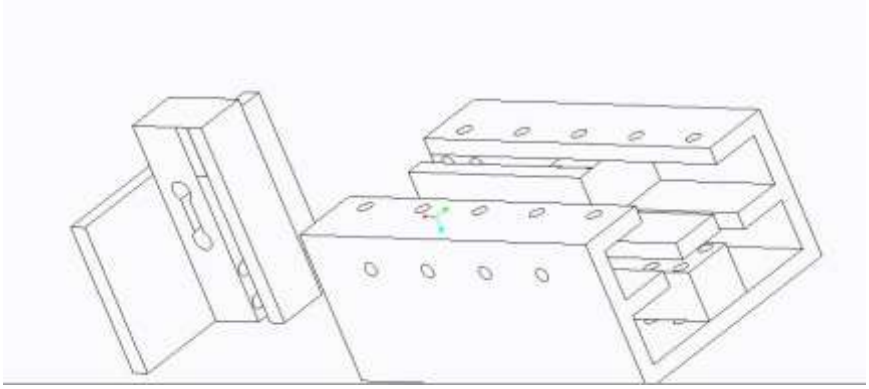


Figure 2: Flat Plate type fixture

Here new approach have been designed to hold the plates for clamping them firmly with the base of FSW machine with measurement capabilities.

II. DEVELOPMENTS IN DESIGN

Here development in design have been proposed as shown below.



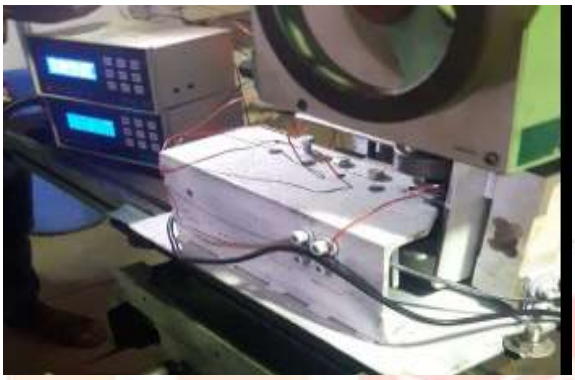


Figure 3: Developed experimental fixture with sensors and load cell.

The fixture proposed here is good for experimental investigation carried to investigate the processbut the industry need simple and manufactural product ,due to this the development have been carried to develop fixture which is simple in manufacturing as well easily mountable on all kinds of milling machines bad. Due to this concept of easy manufacturability following development have been defined.

The result plot have been presented here.

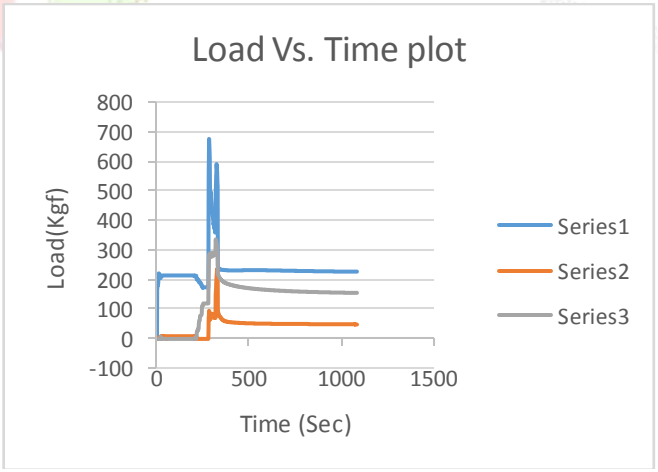


Figure 7: load sensor results by experimental investigations

In this plot series 1 shows measurement of Plunge load, series 2 represents feed load and series 3 presents transference load.

From the plot we can present the phenomena of load distribution within the plates and fixture series 1 represents the plunge load acting in vertical downwards direction. Pick what it achieve is for 2 pass. For first pass of weld the maximum load achieved is about 600kgf. The transverse load faced by plates is about 300kgf and the feed force developed during plate is about 200kgf.
On basis of same the development of simplified fixture have been carried. And as a result this fixture is developed. Presented in fig. 4, 5 and 7.

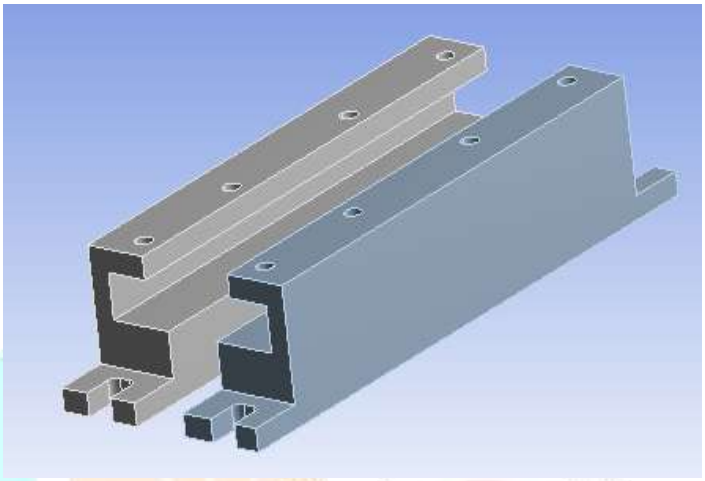


Figure 4 : 3D model of simplified fixture for FSW.

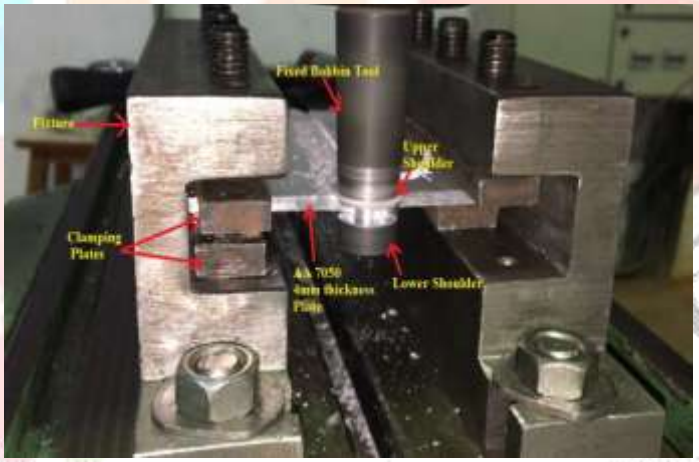


Figure 5: Developed fixture with bobbin tool weld application

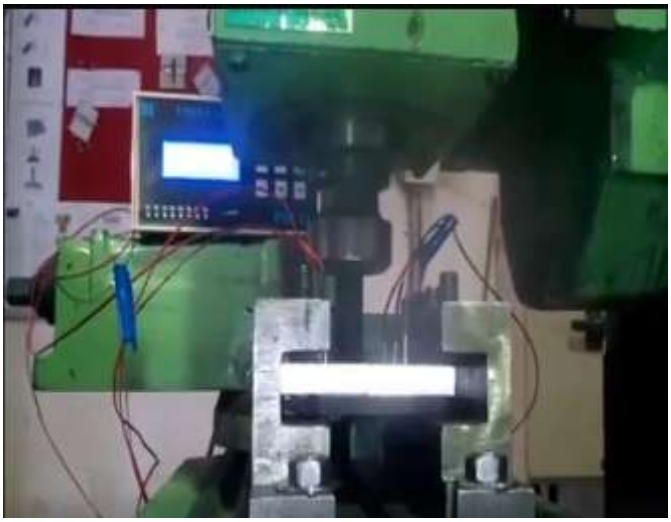


Figure 6: developed fixture model and butt weld application

RESULTS AND DISCUSSION:

The development phase have given load plots for plunge, feed and transverse direction. On basis of that the design thickness have been finalized. The draft have been tested with FEA software and then design have been accepted with major tolerances for variations in thickness. various set of experiments have been done to observe the loadings on fixture body.

CONCLUSION:

The design development have begun with concept and here solution is presented. The article also represents 3 axis dynamometer to measure load on plate while performing FSW. The experimental study have given direction to design a fixture with effective clamping of plate for processing/Welding of material with FSW. The developed design have been utilized to have trials for butt welding with FSW as well bobbin tool FSW. The developed design have shown improved as well flexible and cost effective solution to carry various FSW operation i.e. Butt weld, Lap Weld, Bobbin tool welds.

References:

[1]Thomas, W.M., Nicholas, E.D., Needham, J.C., Murch, M.G, Temple-Smith, p., Dawes, C.J.:Improvements, relating to friction Stir welding. US patent NO. 5,460,317 (1991).

[2] Thomas,WM; Nicholas, ED; Needham, JC; Murch, MG; Temple-smith, P;Dawes, CJ. Friction-stir butt welding, GB patent No. 9125978.8, International patent application No. PCT/GB92/02203, (1991).

[3] Dickerson, T. L., & Przydatek, J. (2003). Fatigue of friction stir welds in aluminium alloys that contain root flaws. International Journal of Fatigue, 25(12), 1399–1409.

[4] Mishra, R. S., & Ma, Z. Y. (2005). Friction stir welding and processing. Materials Science and Engineering R: Reports, 50(1–2), 1–78.

[5] Eladio A maro Camacho Andrade, Instituto superior Technico, lisoba,Portugal. Development of bobbin-tool for friction stir welding characterization and analysis of aluminum alloy processed AA 6061-T4(2010).

[6] Pedro vilaca and wayne Thomas : Friction stir welding Technology. DOI: 10.1007/8611_2011_56 (10 April 2011)

[7] Cao, X., & Jahazi, M. (2011). Effect of tool rotational speed and probe length on lap joint quality of a friction stir welded magnesium alloy. Materials and Design, 32(1), 1–11.

[8] Yuan, W., Mishra, R. S., Webb, S., Chen, Y. L., Carlson, B., Herling, D. R., & Grant, G. J. (2011). Effect of tool design and process parameters on properties of Al alloy 6016 friction stir spot welds. Journal of Materials Processing Technology, 211(6), 972–977.

[9] Puviyarasan, L. K. M., & Kumar, S. S. (2012). Experimental Studies on Ffriction stir welding of AA2011 and AA6063 Aluminium Alloys. International Journal of Advanced Engineering Technology, III(IV), 144–145.T. Sriveerakul, S. Aphornratana, K. Chunnanond, "Performance Prediction of Steam Ejector Using Computational Fluid Dynamics: Part-2. Flow Structure of a Steam Ejector Influenceds by Operating Pressures and Geometries" International Journal of Applied Sciences, Issue 46 (2007)823-833

[10] Devanathan, C., & Babu, A. S. (2013). Effect of Plunge Depth on Friction Stir Welding of Al 6063. 2nd International Conference on Advanced Manufacturing and Automation (INCAMA-2013), (March), 482–485.

[11] Sahu, P. K., & Pal, S. (2014). Effect of Shoulder Diameter and Plunging Depth on Mechanical Properties and Thermal History of Friction Stir Welded Magnesium Alloy, (Aimtdr), 12–17.

[12] Chen, J., Ueji, R., & Fujii, H. (2015). Double-sided friction-stir welding of magnesium alloy with concave-convex tools for texture control. Materials and Design, 76, 181–189.

[13] Bi-directional FSW of 10mm thick AA6351 and evaluation of impact strength null hypothesis rejection. Dr.G.D.Acharya , MR.K.H.Bhavsar, Afro asian international conference, Bharuch 2k15(013): 28 march 2015.

[14] Karami, S., Jafarian, H., Eivani, A. R., & Kheirandish, S. (2016). Engineering tensile properties by controlling welding parameters and microstructure in a mild steel processed by