iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 3 **Issue:** IV **Month of publication:** April 2015

DOI:

www.ijraset.com Volume 3 Issue IV, April 2015
IC Value: 13.98 ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

A review paper on: friction Rivet welding

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Abstract: This paper provides survey on friction rivet welding process which is simple and better joining method of polymeric multi material structure(macro composites). This family of material is characterised by presence of solid interference, normally with sharp gradient properties. This lets the research & development market open for innovative joining techniques, such as the new friction riveting spot joining method developed and presented in the work, in a comprehensive technical and scientific way.

Key word- Friction rivets, friction rivet joining equipment, Kistler Instrument, Microcomposites, polymeric metal multi material joint*.*

I. INTRODUCTION

Since man realized in the early 20th century that steels were strong and tough but heavy, and ceramics strong but they are brittle, the efforts takes place by material science became focused on developing new materials of which is the same mechanical features of metals and ceramics but posses with low density and heigher workability. These efforts led to the development of the first synthetic polymers and polymeric composites in the 1910s and the first lightweight alloys, such as aluminium. Nowadays polymeric materials are as strong as or even stronger than some metallic alloys exhibiting the improved mechanical performance, also the chemical and corrosion resistance plus increased design freedom to manufactured products. On the other hand, lightweight alloys have become mechanically more reliable and also cheaper owing to the processing and fabrication advance supported by the fast development in some industrial sectors, particularly in the transportation industry. communities have started developing combinations of different classes of lightweight materials, such as fibre-reinforced thermoplastics and aluminium alloys, giving rise to so called multimaterials structures. Multi-materials are also known as macrocomposites; they are designed aiming at improving properties or reducing weight and costs.

This family of materials is characterized by the presence of solid interface, normally with a sharp gradient of properties. Particularly polymer-metal multi-material structures are being increasingly selected to be applied in real products within industry sectors such as automotive, shipbuilding , aerospace, railway and civil engineering. Nevertheless, the size of a component is usually limited by its production process, and in the case of multi-materials a “joint-free” concept is unrealistic. Hence, joints frequently exist in a multi-material structure. After an on current joining techniques for polymer-metal, presented it was identified that these methods are usually application-specific, presenting usually high operational costs related to pre- and post-joining procedures, or environmental threatening owing to post-joining chemical disposals. Furthermore, present techniques are still searching for their market niches, though without complete success. This lets the research & development market open for innovative joining techniques, such as the new friction riveting spot joining method developed and presented in this work, in a comprehensive technical and scientific way.

II. LITERATURE REVIEW

Niu [1] and Messler [2,3] was reported that the joining methods used for multi-material structures are mechanical fastening, adhesive bonding, and some advanced welding processes (the latter only for similar joints within the structure, e.g. metallic cover plate of a polymer-metal sandwich panel joined to a metallic stringer)

Kau,S.[4] was studied about the different welding process and they suggest a friction stir welding is solid phase bonding process used mostly in welding of aluminium.

According to Gourd, L.M.[5] Friction welding is mechanical solid phase welding process in which heat is generated by friction is used to create high-integrity joint between similar or dissimilar metals.

Paul Briskham and Nicholas Blundell [6] was studied the different joining process like Self-peercing riveting, Resistance spot welding, Spot friction joining and they conclude that the Spot friction joining (SFJ) uses a low amount of energy per joint and is an attractive process for applications where many similar joints are required in thin materials e.g. closure panels.

A. Suresh Babu and C. Devanathan[7] was suggest that- In the past two decades friction stir welding has been evolved as a successful welding technique for joining all hard materials and metal matrix composites in addition to aluminium, but FSP and FSSW are the two variants in friction stir welding. Former can becomea successful method to produce surface composites, super plastic forming, later can be a good alternate method to resistance spot welding.

III. PRINCIPLES OF THE TECHNIQUE

Friction Riveting, hence the name FricRiveting, is an innovative joining technique for polymer-metal hybrid structures, developed and patented by the Helmholtz Zentrum Geesthacht in Germany. Joining is achieved by mechanical interference and adhesion between a metallic rivet and polymeric joining partners. The process is based on the principles of mechanical fastening and friction welding; the joining energy is supplied by the rotation of the metallic rivet, in form of frictional heat.The process is primarily conceived to overlap joints, but can be better understood through the so called metallic-insert joint configuration. The process consists in rotating a cylindrical metallic rivet inserting it in a polymeric base plate fixed onto a backing plate. Heat is generated by the high rotational speed and the axial pressure. Due to the local increase of temperature, a molten polymeric layer is formed around the tip of the rotating rivet. By the end of the heating phase, the heat input rate increases to a higher level than the heat outflow, due to the low thermal conductivity of the polymer. The local temperature increases leading to the plasticizing of the tip of the rivet. While the rotation is decelerated, the axial pressure is concomitantly increased, the so-called forging pressure is applied and the plasticized tip of the rivet is being deformed. As a result there will be an increase of the original rivet diameter, whereby the deformed rivet tip will assume a parabolic pattern due to the opposite reactive forces related to the colder polymeric volumes. FricRiveting, winner of different innovation prizes worldwide, including IIW’s Granjon Prize Category A in 2009, was originally developed to join unreinforced thermoplastic by metallic rivets, but has the potential to fulfill the needs of the market of the composite/composite and polymer-metal multi-material structures by offering strong joints obtained in a simple, fast and more environmentally friendly way. The equipment used for FricRiveting consists of a commercially available friction welding system. The use of adapted milling machines and robotic applications is also envisaged. Different joint geometries and material combinations are possible, including hermetic lap configurations on aluminum, titanium, polyetherimide, polyetherketone, polycarbonate and different polyolefines, among others. FricRiveting can be used in the production of metallic inserts in plastic products and is being considered by the Europea aircraft industry to join of carbon fiber reinforced plastics part

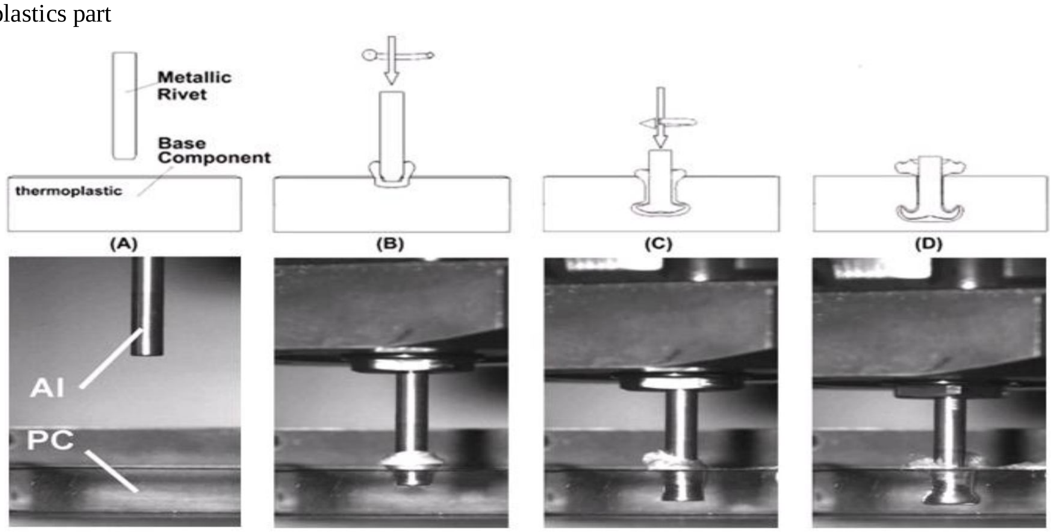

Fig. Schematic view of the friction riveting process

IV. FRICTION RIVET JOINING EQUIPMENT

The equipment used at GKSS for friction riveting consists of a friction welding system RSM200 manufactured by Harms & Wende GmbH & Co. KG . The machine was developed for joining steel, aluminium and non-ferrous alloys. The system is suited for flexible applications and for automation. Owing to the possibility of applying a pneumatic operated chuck the welding system is prepared for fully automatic installations. The summarized technical data regarding the friction riveting equipment used in this work is presented in Appendix 1. The modular friction welding system RSM200 consists mainly of three components, the modular welding head RSM20, the switch cabinet RSMS20 and the control panel RSMP20, which are presented in Figure.

Volume 3 Issue IV, April 2015
ISSN: 2321-9653
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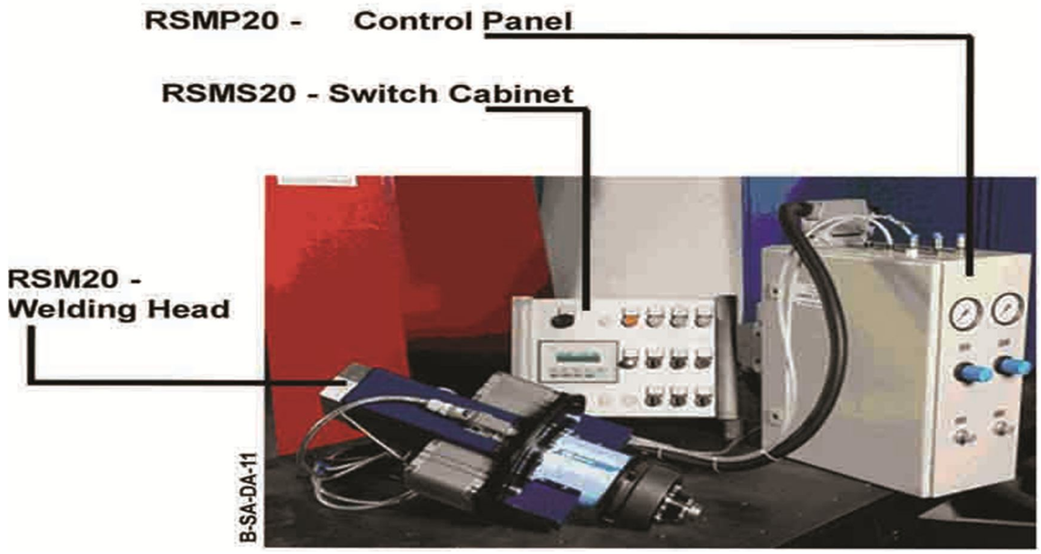
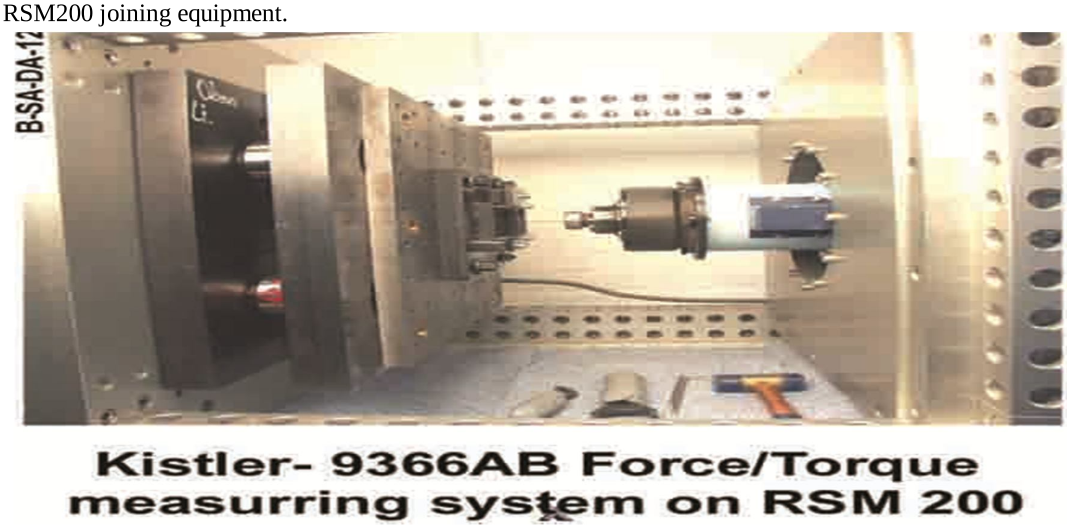
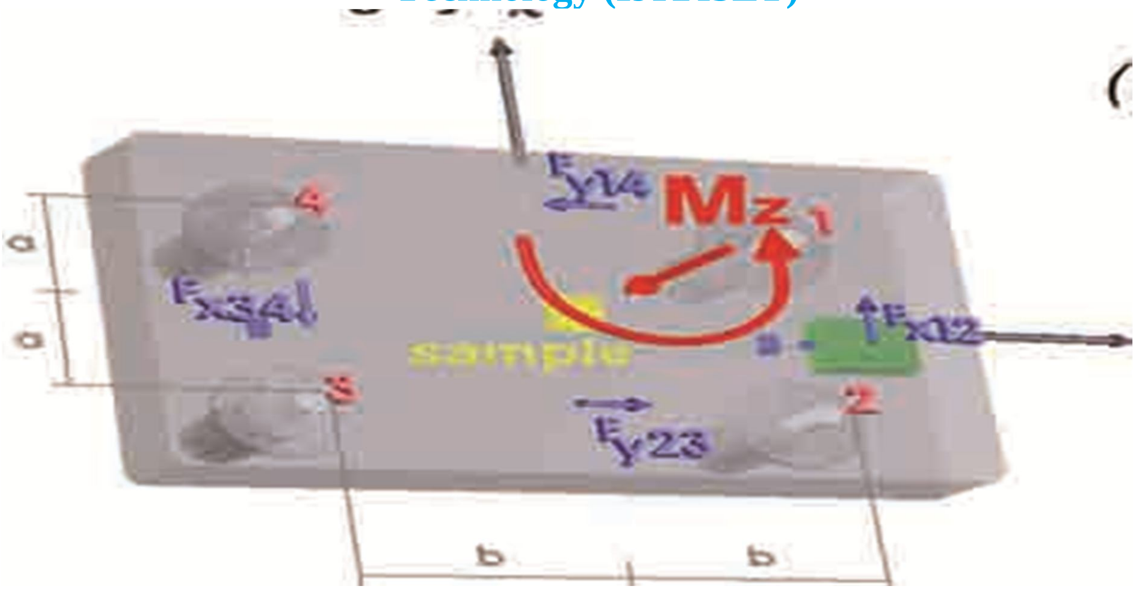


Figure.RSM 200 friction welding machine used for friction riveting.

The RSM200 experimental setup frame was specifically designed for GKSSForschungszentrum by Witte GmbH, Germany, in aluminium profiles. This set-up includes the welding head and all necessary cabinets. The welding head is placed horizontally in a fixed position, while the clamping-table can be moved backwards and forwards in 20 mm stages. Various sample clamping devices can be used, making possible the joining of different sample geometries. Due to the possibility of using high rotational speeds and the good flexibility of the set-up system the machine has been found adequate to the development of the friction riveting method. In addition to the RSM 200 system, a force measuring system was used for recording the frictional torque during friction riveting joining. The system was composed of a table supported by four quartz force sensors (mod. nr. 9366AB, Kistler Instrument AG) controlled by a multichannel charge amplifier specially designed for force and torque measurements (mod. nr. 5017B, Kistler Instrument AG) which were connected to a PC with controlling/evaluation software Dynoware (Kistler Instrument AG). For technical information regarding this force control system, please refer to . The torque measuring system was fixed vertically on the RSM 200 clamping-table in alignment with the centre of the spindle, so measured torque values could be direct translated to frictional torque (Mz) at the rivet tip. Figure 7A and B show thetorque measuring system coupled on the RSM200 joining equipment.





Figur. A) Major components of the torque measuring system in this work. B) Scheme of main forces and frictional torque (Mz) evaluated by the system.

V. JOINING PROCEDURE

A typical friction riveting joining procedure used in this work consists of the following steps: prior to joining, base materials are cleaned with acetone for removing machining fluids. The polymeric base plate is then firmly fixed over the Kistler force control table placed in the RSM 200's clamping table. Besides, the rivet is fixed in the spindle adapter. Joining parameters (rotation speed, time and pressure) are set in the RSM 200 equipment panel and both RQ-fuzzy and Dynoware control software is manually started. Following that, the machine is turned on, whereby the rotating spindle is moved forward, when programmed rotation speed is achieved. The rotating rivet touches down on the polymeric base plate, starting the joining process plunging. When the pre-set friction time is accomplished, rotation is stopped and forging pressure is applied up to the end of the joining time. Subsequently, the forging pressure is released and the joint removed from the clamping system. Finally, the samples are labelled and control data exported for further statistical treatment. In this study, all produced joints had their control data stored.

VI. ADVANTAGES

A. Little or absent surface cleaning / preparation.
B. No obligatory need of pre-holes.
C. Single side accessibility.
D. Joining is independent of position.
E. Short joining cycles (0.5 to 10 sec.)
F. A wide range of material and composites can be joined.
G. Hermatic sealed joined.
H. Simple and low cost machinery.
I. Robotics application is also possible.
J. Joined with a good tensile and shear performance.

VII. LIMITATIONS

A. Only spot like joined.
B. Not applicable for thermoset polymers, without selecting optimised joined geometry.
C. In the same fashion as for mechanical fastening, there is a minimum thickness of the polymeric base plate. Nevertheless this can be avoided by altering joined geometry.

VIII. CONCLUSION

A friction rivet welding is more efficient method of joining of polymer metal multi material than comparatively the other process by using adhesion bonding and some welding process. Also the material used for these process and there composition improves the mechanical features but light in weight is most important factor that's why this process is used in light weight industries for different applications. A friction rivet welding technique now a days used at various automobile industries as well as aeronautics application in this way we said that a lot of scope of this technique in a future.

IX. ACKNOWLEDGEMENT

I wish and thank to my institution, 'Jawaharlal Darda Institute of Engineering & Technology, Yavatmal' for giving me the golden opportunity to write a research paper. I special thanks to my Head of the Department, for encouraging me and to friends for his nice support and guidance throughout and without whom, this paper work would have not been possible.

I thank last but not the least, the authors of the various research papers that I have referred to, for the completion of this paper work.

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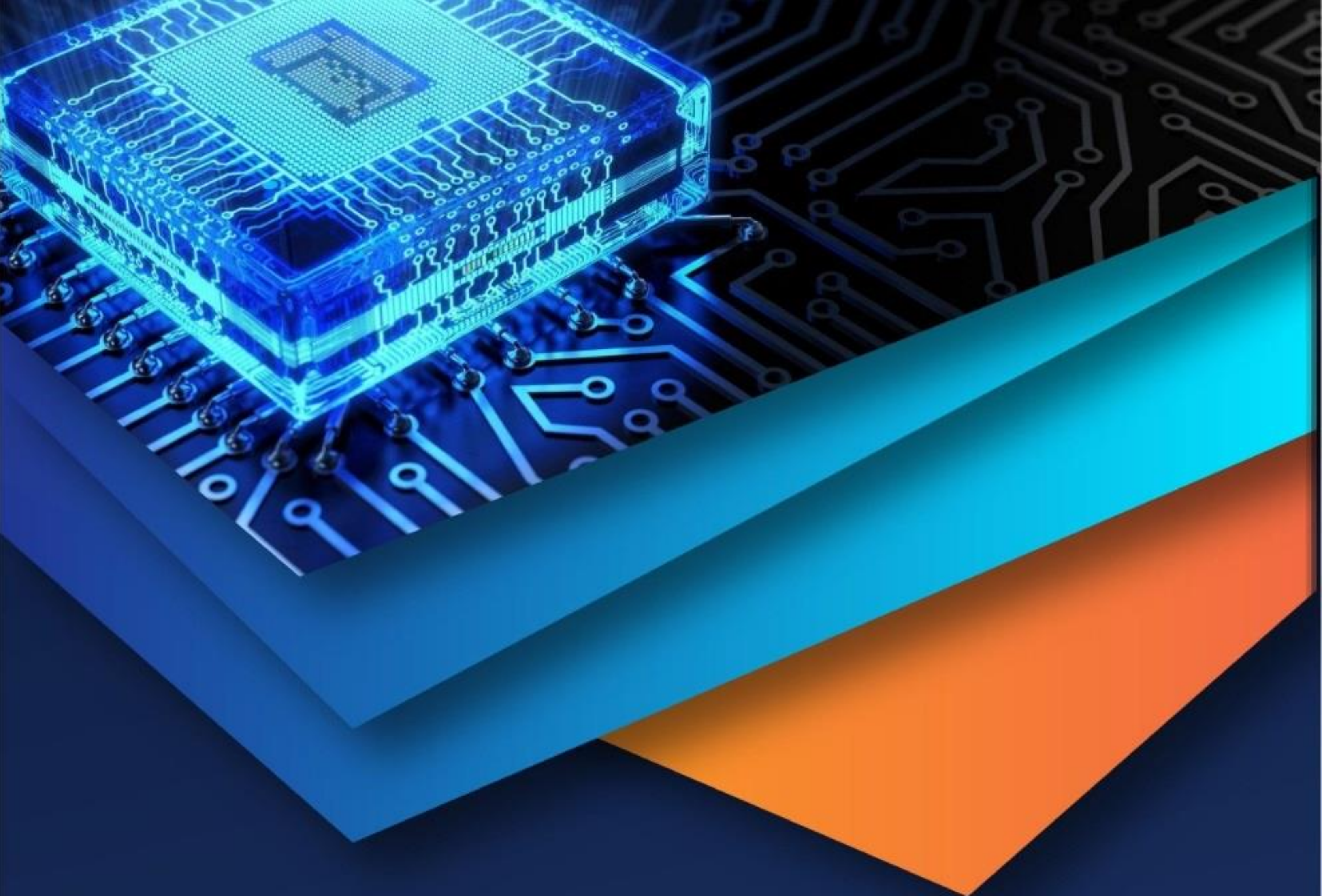

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