© 2017 IJSRST | Volume 3 | Issue 7 | Print ISSN: 2395-6011 | Online ISSN: 2395-602X
Themed Section: Science and Technology

Study on Finite Element Analysis of Resistance Spot Welding to Study Nugget Formation

Dr. R. Ramachandra

Principal & Professor, Department of Mechanical Engineering, SKD Engineering College, Gooty, Andhra Pradesh, India

ABSTRACT

Resistance Spot Welding is being used inside the enterprise for sheet becoming a member of system in particular within the automobile and aerospace industry. The complicated behavior of this system must be analyzed to set the choicest parameters to get the choicest weld great. This paper affords the FEA simulation of the RSW procedure. It requires modelling of complex interactions among electrical, thermal, metallurgical and mechanical phenomena. A 2d axis symmetric FEM model has been evolved to examine the temporary thermal behaviors of technique the usage of ANSYS software and matched structural thermoelectric evaluation is done by means of the usage of superior coupled field detail PLANE223 to simulate the thermal characteristics of RSW technique. The targets of this evaluation is to understand physics of the system and to expand a predictive device lowering the range of experiments for the optimization of welding parameters.

Keywords: RSW, Coupled Analysis, weld nugget, Temperature distribution

I. INTRODUCTION

Resistance welding is the maximum commonly used method for becoming a member of metallic sheets. An electro conductive touch surface is created among the work pieces with the aid of pressing them together. Watercooled electrodes made from alloyed copper are utilized in resistance welding. Electrodes convey a urgent pressure to the joint and direct the welding cutting-edge to the joint in the correct manner. After welding, the electrodes swiftly cool down the welded joint. Resistance spot welding is a complicated system in which coupled interactions exist among electric, thermal, mechanical, metallurgical phenomena and even floor behaviors. in the recent years, finite detail method has provided a effective device in reading these interactions and lots of related works have been carried out at the FEM modelling of RSW. Nied developed the primary FEA version for RSW technique, investigated the impact of the geometry of electrode on workpiece and anticipated the deformation and stresses as a function of temperature. Moreover, many researchers developed extra state-of-the-art FEA fashions that considered temperature established cloth properties, touch reputation, section changing and paired discipline effects into the simulation of RSW. To clear up the coupled hassle, iterative answer process is an regularlyfollowed approach. first of all the pressure subject and call status are received from the thermalmechanical analysis and then the temperature field is obtained from the completely coupled thermalelectrical analysis primarily based at the contact vicinity on the electrode workpiece interface and faying floor. The calculated temperature subject is then exceeded again to the thermalstructural analysis to update the stress discipline and speak to popularity. The goal of this paper is to expand a multi-coupled technique to analyse the thermal and mechanical behaviors of RSW technique, reduce the computing time with the minimal lack of accuracy and get more ok facts of the method.

1.1 Spot Welding Cycle

Figure 1 indicates the spot welding system. The RSW process is composed of four levels as follows; a) Squeeze cycle time for the duration of which the upper electrode is introduced in contact

IJSRST1737136 | Received : 01 Oct 2017 | Accepted : 15 Oct 2017 | September-October-2017 [(3) 7: 693-698]

with the sheets and a force is exerted at the region that wishes to be welded. b) Weld cycle time in the course of which contemporary is turned on and resistance to modern-day waft on the sheet interface produces a nugget. c) keep cycle – time for the duration of which the modern-day is grew to become off and the fully grown nugget is permitted to chill and solidify slowly beneath constant pressure. d) Off cycle time at some point of which the electrode is raised from the welded sheets. Watercooled electrodes made from alloyed copper are used in resistance welding. After welding, the electrodes swiftly quiet down the welded joint. The three fundamental welding parameters are: a) contemporary b) force and c) weld time. these kind of parameters need to be controlled successfully with a purpose to produce a good fine weld.

II. Finite Element Analysis

2.1 FEA model and mesh

FEA model of RSW process is shown in Fig 3 and 4, which is axisymmetric about y axis since only half portion of the complete model is analysed. The x axis is the contact surface of the two sheets called as faying surface. The model is meshed using three elements; PLANE223, CONTA172 AND TARGE169. The element PLANE223 with structural thermoelectric capabilities has eight nodes with up to four degrees of freedom per node. It has UX, UY, TEMP and VOLT degrees of freedom. The other elements are contact elements consisting of contact pair of CONTA172 and TARGE169. Contact occurs when the element surface penetrates one of the target segment elements (TARGE169) on a specified target surface. Any translational or rotational displacement, forces, moments, temperature, voltage and magnetic potential can be imposed on the target segment element. [6] [7]

2.2 Material models and welding conditions

Temperature various properties are considered for copper electrode and slight metallic sheets. The residences assigned are thermal conductivity, resistivity, young's modulus, coefficient of thermal growth, yield stress, specific heat and phone resistivity. Those temperature structured homes are assigned inside the range of 21ºC to 1204ºC [4]. In modelling RSW manner with the complex thermoelectric behavior, several bodily phenomena have to be considered. It is of brilliant significance to define the parameters effectively to obtain correct results. Considering that electric powered present day has terrific have an effect on on the first-rate of RSW procedure, the enter cutting-edge in this simulation is 50 Hz sine wave AC modern of 10 kA, applied for two hundred ms. The cutting-edge is imposed as an electric load at the top floor of higher electrode. To simulate the cooling system of the welding, the hold time is taken as 60 ms. A force of 3000 N is implemented on the higher electrode that is equal to the pneumatic pressure applied at the sheets. The maximum important property within the simulation of RSW process is the contact resistivity of faying surface. To simplify the problem, the contact resistivity is considered as a function of temperature.

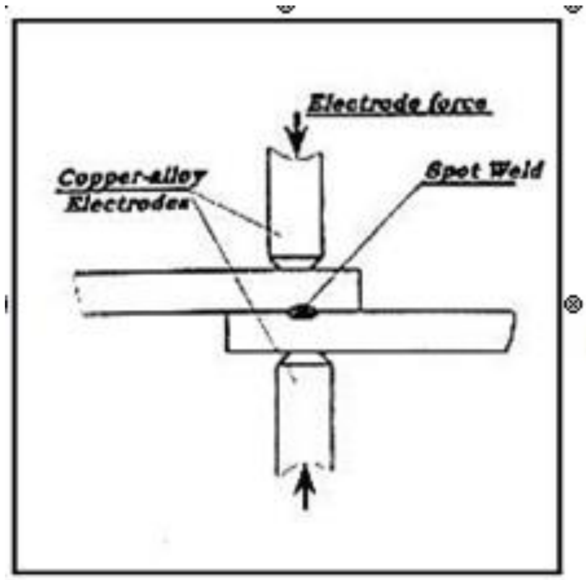

Figure 1: Spot welding process

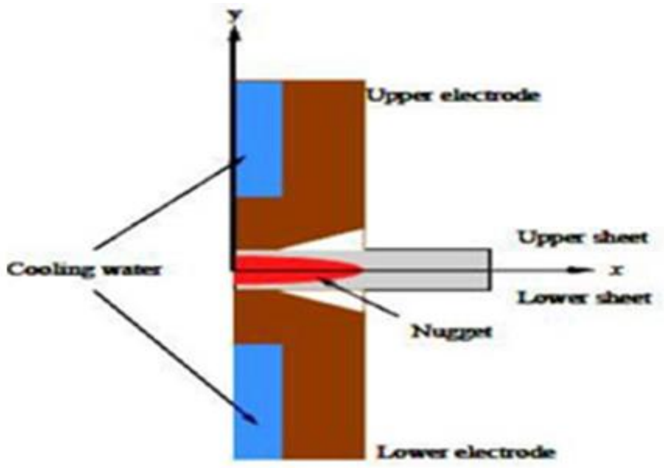

Figure 2: FEA model of RSW process

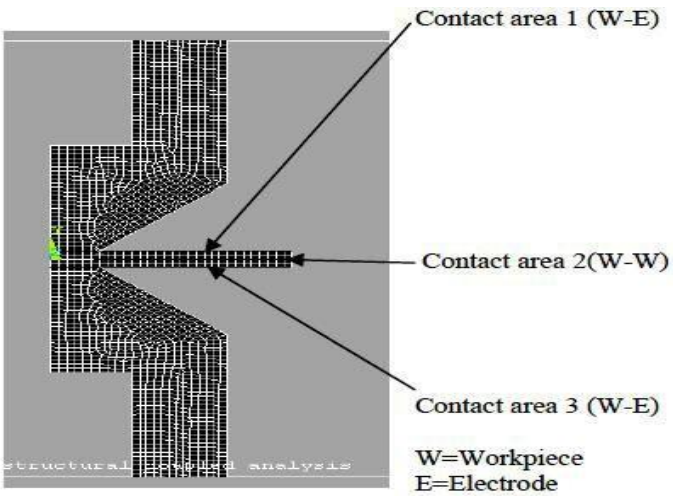

Figure 3: Mesh of the FEA m

2.2 Boundary conditions

Figure 4 shows the boundary conditions imposed for the analysis. The upper face of top electrode and lower face of bottom electrode are constrained in x and y directions. A voltage difference is applied across the top face of upper electrode and bottom face of lower electrode. The convection coefficient of air (21 W/m^2 ºC) is applied on faces of electrode and sheet which are open to environment. The convection coefficient of water (300 W/m^2 ºC) is applied on the inner faces of electrodes which are in contact with the circulating cooling water with initial temperature of 10ºC [5].

III. Results And Discussions

The FEM version is hired to simulate the RSW technique as a way to quantitatively recognize the outcomes of the method parameters on temperature distribution and the nugget length at exceptional cycles. The strain and stress fields in the weldment all through the RSW method are very complex due to the aggregate of temperature and electrode pressure. at the squeeze degree, the electrodes and work portions are deformed below the utility of the burden.

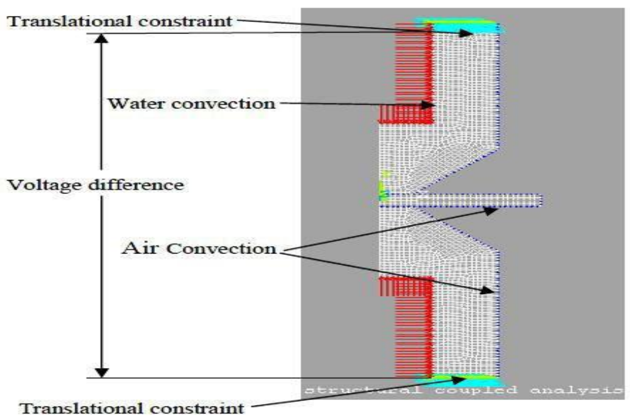

Figure 4: Boundary conditions

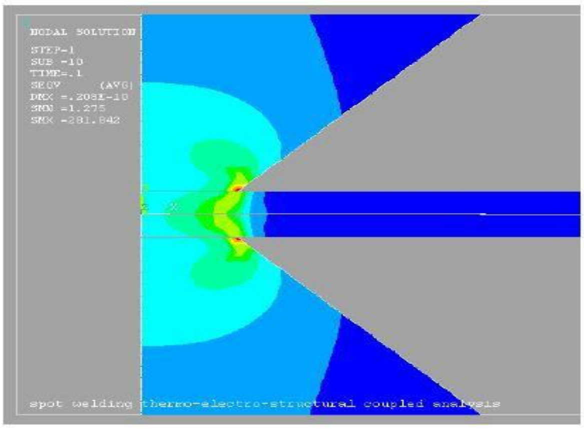

Figure 5: Distribution of Von Mises stress during squeeze stage

Figure. 5 shows the Von Mises stress distribution after the squeezing stage. The most stress (281 MPa.) happens at the edge of the touch floor between the electrode and the work piece. The touch pressure on the WE interface is reasonably uniformly in most people around the axis and inside the area near the electrode part, there is intense stress awareness. The welding residual pressure is produced in welded joint as a result of plastic deformation caused by nonuniform thermal enlargement and contraction because of non-uniform temperature distribution within the welding procedure. The deformation at the stop of keep step is extremely massive than that of the squeeze step. This means a great deal deformation is produced within the RSW process due to the thermal growth. Fig 6 suggests the temperature profile and nugget growth at the time when nugget begin to form. On the start of the welding process, the temperature on the center of faying surface will increase very fast. The highest temperature remains at the middle of the faying floor for the duration of the complete welding method. Melting first occur on the faying floor after which increase to the fabric near it. Because of the resistance presented to the go with the flow of cutting-edge on the faying surfaces, Joule warmth is generated at this surfaces that's extra than the heat generated at other points on the weld surfaces. The nugget is formed within the 10 th cycle of the welding process assuming 1530 ºC because the melting factor of moderate metal. The spot nugget vicinity seems as crimson in colour. The weld nugget is close to the elliptical form. The best temperature usually remains within the middle of the workpiece and the temperature away form the faying surface decreases due to transfer of heat by convection of air and cooling water. By changing the welding conditions, the temperature profile could be varied which in turn changes the nugget size i.e. the welding quality. During the holding time in which the current is set to zero, convection and squeezing forces are only external loads in the thermo mechanical model. The final nugget size is obtained at the end of holding time because there is some deformation in the welding zone when the weldment cools due to the electrode pressure and material shrinkage. As the electric current ceases at 0.3 s, the weldment starts to cool down. In a very short time, the temperature of the nugget center decreases. The temperature at the center of electrodeworkpiece interface decreases more slowly but continuously. Fig 7 shows the temperature distribution at the end of the hold period i.e. after the weld current is switched off.

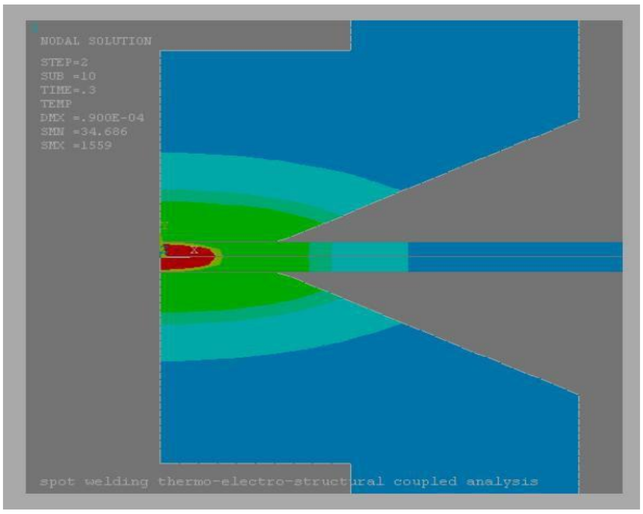

Figure 6: Temperature distribution at the time nugget started to form

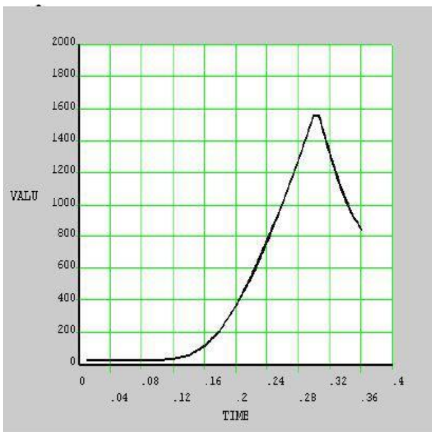

Figure 7: Temperature distribution at the end of hold time

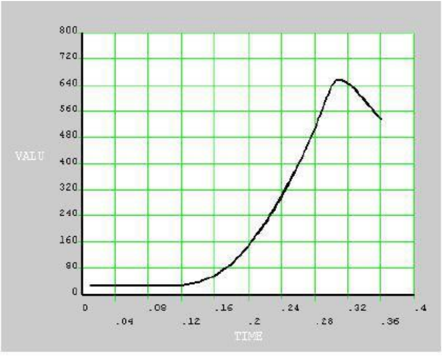

Figure 8: Temperature variation along the faying surface

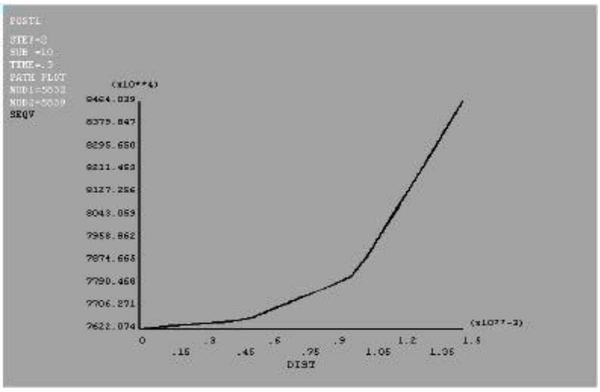

Figure 9: Temperature variation along the workpieceelectrode interface
Distribution of Von mises stresses along the faying surface

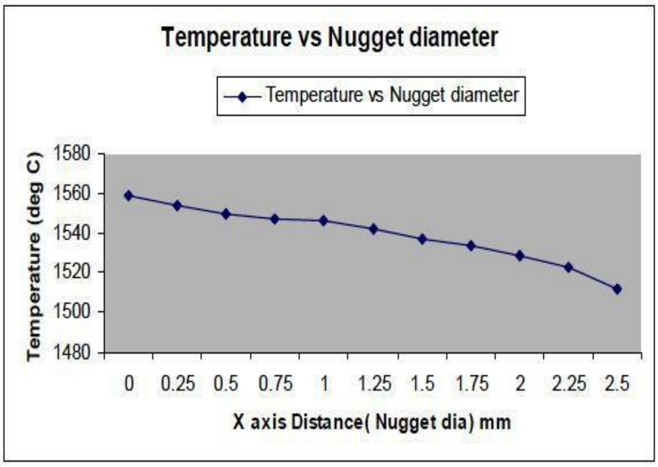

Figure 11: Variation of nugget diameter with temperature

The size of the weld nugget decreases slightly as compared to the size at the end of weld cycle. This is because the heat generation is stopped due to switching off the weld current. Also there is convective heat transfer from the heated surfaces of the sheets and the electrodes. Figure 8 shows the temperature variation along the contact surfaces of the two mild steel sheets i.e. faying surface. In the first stage of the process, since only force is applied on the surfaces, there is no heat generation and hence the temperature remains constant. After the current is passed through the electrodes, there is generation of heat due to Joule effect and the temperature at the contact surfaces starts increasing. The temperature keeps on increasing till the time current flows through the electrodes. The maximum temperature of 1559 ºC is obtained at the end of 10^{th} weld cycle. After this time, the current is switched off and there is decrease in temperature due to loss of heat by convection of air and cooling water. At the end of hold period, the temperature reached is 842ºC. Figure 9 shows the variation of temperature along the workpiece-sheet interface. The nugget size obtained is 2.75 mm. Figure 10 shows the distribution of Von mises stress along the faying surface and Figure 11 shows the variation of nugget diameter with temperature.

IV. CONCLUSION

A multicoupled structural thermoelectric analysis is accomplished on the RSW procedure. This multi-coupled method can successfully provide sufficient details of RSW process and increase the great monitoring and method control of RSW. Because of the mixture of temperature and electrode force, the strain and pressure fields are very complex inside the weldment. During the welding cycles there's compressive stress within the touch place of faying floor, that's beneficial for suitable metallurgical shape, forming a condensed weld nugget. Through the thermal histories and temperature distributions obtained from this evaluation, the geometry and dimensions of the nugget can be calculated.

V. REFERENCES

[1]. Guo Zhong, "Finite element analysis of resistance spot welding process", 9781 424427239/09, 2009 Chinese Control and Decision Conference (CCDC 2009), P 57995802.

[2]. Vural, A. Akkus¸, B. Ery¨urek, "Effect of welding nugget diameter on the fatigue strength of the Resistance spot welded joints of different steel sheets", Journal of Materials Processing Technology,176(2006) 127–132

[3]. H. Zhigang , I.S. Kim , J.S. Son , H.H. Kim , J.H. Seo, K.C. Jang,D.K. Lee, J.M. Kuk, "A study on numerical analysis of the resistance spot welding process", Vol 14, Issue 12, Journal of achievements in materials and manufacturing engineering, JanuaryFebruary 2006.

[4]. Hou Zhigang, Wang Yuanxun, Li Chunzhi, Chen Chuanyao, "A multicoupled finite element analysis of resistance spot welding process", Acta Mechanica Solida Sinica, Vol. 19, No. 1, March, 2006.

[5]. Hamid Eisazadeh , Mohsen Hamedi, Ayob Halvaee, "New parametric study of nugget size in resistance spot welding process using finite element method", Journal of Materials and design, Elsevier, 31 (2010) 149 157.

[6]. Zhigang Hou, IllSoo Kim,Yuanxun Wang , Chunzhi Li, Chuanyao Chen, "Finite element analysis for the mechanical features of resistance spot welding process", Journal of Materials Processing Technology 185 (2007) 160165.

[7]. Ansys 11.0 Documentation manual, 2010.