iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 7 **Issue:** XI **Month of publication:** November 2019

DOI: http://doi.org/10.22214/ijraset.2019.11136

www.ijraset.com

Call: 08813907089 | E-mail ID: ijraset@gmail.com

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.177
Volume 7 Issue XI, Nov 2019- Available at www.ijraset.com

Investigation of Fatigue Loading on Galvanized Iron AISI 4340 Sheet Metal using Spot Welded Joint in Finite Element Analysis

K. Vadivel[1], S. Nelson Raja[2], B. Ineesh Kumar[3], T. D. Choumya Devi[4]
[1, 2]*Assistant professor, Department of Mechanical Engineering, Chendu College of Engineering and Technology,Kancheepuram, Tamilnadu, India.*
[3] *PG Scholar, Department of Mechanical Engineering, Anna University (ACT CAMPUS), Chennai, Tamilnadu , India.*
[4] *PG Scholar (alumni), Department of Mechanical Engineering, Anna University Regional Campus, Tamilnadu , India.*

Abstract: ***Spot welding used in four wheeler fabrication and repair works. It is one of the essential area where the design plays a vital role in identifying the mechanical behavior of different structures which are joint together and to impose the static, fatigue and impact strength of this joints at computer aided engineering technique by identifying the works which are to be concentrated during fabrication. This work is about determining the fatigue life of spot welded joint which are introduced which some boundary condition which could be used in mechanical structural analysis using CAE. Here the life of nugget which is subjected to fatigue loading is determined. In order to carry out analysis of sheet thickness and spot diameter geometry is considered to be essential parameter for proceeding the above suggested research work. Here ANSYS workbench is used to solve the required problem by using finite element analysis technique. Static structural works space is used to carry out the basic structural analysis of the rigid member which is joint together. Workbench is considered to be a user friendly tool compared with that of ADPL. In order to determine the fatigue life of spot welded joints before undergoing fabrication works this kinds of studies are carried out over here. The results acquired can be plotted in stress strain graphs where the characteristic curve helps as in solving our engineering constrains. The modeling of the part work are carried out the CREO software***
Keywords: Sheet metal; Fatigue Analysis; Spot welding; AISI 4340; Fatigue life; ANSYS

I. INTRODUCTION

Fatigue life is one of the most important properties when designing such components. The majority of structural components under actual conditions, in the customer's environment, are subjected to random amplitude service loading, during their lives. The spot welds in automotive components are subjected to complex service loading conditions; various specimens have been used to analysis fatigue lives of spot welds. The welding strengths at static condition is determined. The bonding of spot weld is in terms of the specimen geometry, welding parameter, welding schedule, base metal strength, testing speed and testing configuration. Stress intensity factors for crack propagation through the thickness of plate are calculated numerically by utilizing finite element analysis. There are works in which fracture mechanics approach using the stress intensity factor is adopted to model the experimental results on the strength of spot welds in U-tension specimens under combined tension and shear loading conditions. Stalin et al [1] Analysis the mechanical property with respect to the load and boundary conditions. To attain the result from design of experiment. Rahman et.al [2] to obtain the spot weld fatigue analysis butt joint and lab joint. The results were predicted durability and fatigue strength with the different thickness and diameter to the spot of critical location. Park et al [3] to find the ling life criteria of structure with spot-welds, accurate stress analysis and systematical fatigue strength assessment. Gawai et al [4] To Analysis and Optimizing the Process Parameter of Resistance Spot Welding Process Using Response Surface Method. Process parameters are welding current, weld time, electrode force and electrode geometry effects on the response variables such as tensile strength, hardness, and nugget size. Venkatasudhahar et al [5] a spot welded joint on a Galvanized Iron (STEEL 4340) sheet metal was analyzed using Finite Element Analysis. The variables selected for the study were sheet metal thickness is 1.5 mm, 2 mm and 3 mm, diameter of the spot weld is 2 mm and 3 mm and fatigue load. Shrutinaik et al [6] to observe from the input parameters affecting the strength of multiple

spot-welded joints are spot Welding pressure, current and weld time. The spot welds withstand much best shearing force than normal forces. Vineeth Kumar et al [7] Conducted to spot welded joints when subjected to fatigue loading. The study to predict the fatigue life of spot-weld joint under loading conditions. It is carried out to observe the effect of sheet thickness spot diameter on the fatigue life of spot welded joints and it is seen that fatigue life of the sheet metal increases with the increase in spot diameter and sheet thickness. Mahmoud Shariati et al [8] The crack propagation is numerically examined by using the stress intensity factor value was achieved from finite element analysis. The modified Paris and Forman–Newman–De Koning models are used to estimating the fatigue crack growth rate. The parameters are obtained to the knowledge to above the literatures. The analytical parameters are Equivalent stress, Equivalent strain, Directional deformation, Total deformation, Factor of safety and fatigue life.

II. METHODOLOGY

Spot welding is the essential methods used in fabrication work in automobile industries for manufacturing its components. Since spot welding of automobile parts are introduced to critical loading conditions, various specimens have been used to analysis fatigue lives of spot welds It is important for the automotive design engineers to understand the mechanical behaviors of different joints and moreover, to organize the static, impact, and fatigue strength of these joints in the early design stage using computer aided engineering and design tools. Although more and more joints are being used in vehicle assemblies, very limited performance data on joints have been analyzed.

A. To determine the fatigue life of spot-welded component under critical loading conditions.
B. To determine the spot weld diameter along with sheet metal thickness on fatigue life of the spot welded joint.

The following are the variables that have been varied accordingly for the analysis considered. Spot weld diameter Thickness of the plates Load values the mechanical features are important aspects of resistance spot welding process since they have great influences on the properties of the welded specimen with proper quality in welding structure such as the failure strength, fatigue life and so on. The mechanical behavior of the spot weld is determined using finite element analysis. The finite element model of a spot welded joint is used to find the stress at joint. Spot welds with 3000- 5000 spots cannot be used in finite element manipulations Instead of the detailed modeling of the spot welds, a commercial spot welded specimen is choosing for the fatigue analysis. The arrangement of spot welded structure under investigation carried out by repeatedly loading the geometry to predefined time steps.

Table I. Material Properties

Property	Value
Young's modulus	2 E11 Pa
Density	7850 kg/m3
Poisson's Ratio	0.3
Tensile strength	744.6 x 106 Pa
Yield strength	472.3x 106 Pa

III. ANALYSIS PROCESS

The following steps which are involved in fatigue analysis techniques are as follows:

1) *Process 1:* Modeling Creo parametric 4.0 platforms are utilized over here to build the model of plate with the following input data. Length of the sheet is 155 mm, Width of the sheet is 50 mm, Lapped length is 40 mm, Diameter of the hole is 5mm and applied load is 0-120N
2) *Process 2:* Assemble to the model The next step is assembling in the sheets using CREO parametric 4.0 to the assembly module tools. The required parts to be assembled is imported into assemble layout and fixed with proper reference in a fully constrained manner.
3) *Process 3: Create the spot weld*
a) Enter Assembly mode and retrieve the assembly.
b) Click Applications to choose Welding. The WELDING Menu appears.
c) Set up the welding environment.

d) Choose Spot from the WELD ROUTE menu.
e) The weld features that are needed to be defined is shown in the dialogue box.
i) Spot Ref- Specify geometric references for the weld.
ii) Penetration-Specify the penetration depth.
iii) Measurements- Measurements which are used to control welding parameters
f) Locate the weld by referencing datum points. Create datum points for locating the Weld using options in the SELECT POINT menu. Select Create option and Select the datum points, or pick the existing datum points.
g) After picking the reference points, choose done from FEATURE REFS menu.
h) Enter to the penetration distance.
i) If the feature is created, Select OK in the dialog box.
4) Process 4: Meshing
5) Process 5: Fatigue analysis

The fatigue parameter is evaluated based on stress life method. Stress Life is based on total life but it does not distinguish initiation and propagation. The decision tree in the general flow of decision required to perform a fatigue analysis.

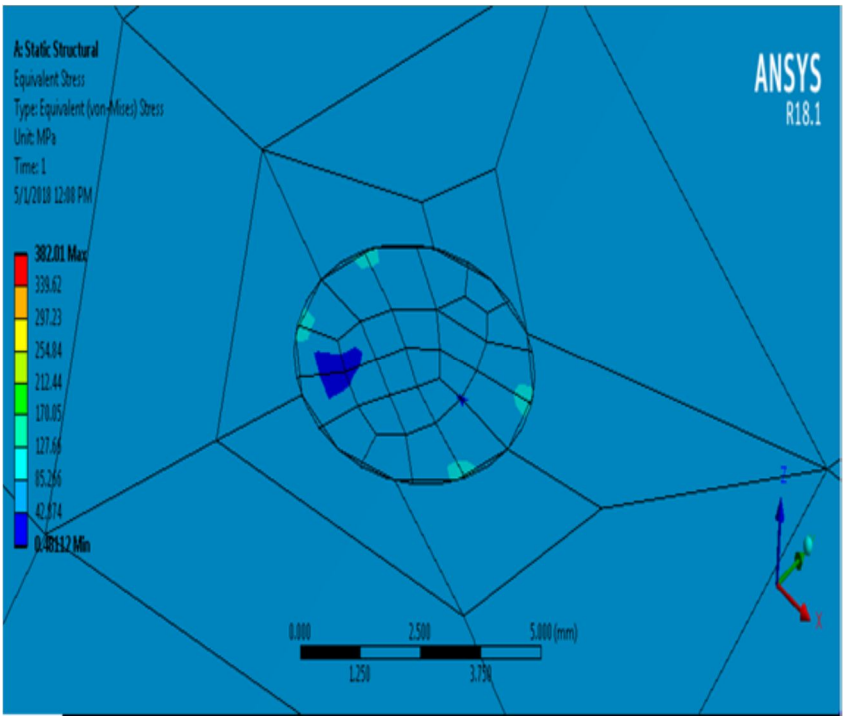


Figure 1: Stress value around the nugget

IV. RESULTS AND DISCUSSION

The finite element analysis is conducted to simulate the life of spot welded joints when subjected to fatigue loading. A finite element layout is created using the ANSYS Workbench software. The stress distributions along with its loading conditions are determined for the weldment model and their changes during the loading condition are determined. Stress and strain results are determined in fatigue analysis with the aid of workbench. The obtained maximum equivalent stresses are used to determine the fatigue life analysis. The stress propagation of the spot welded joint is represented in Figure 1.The stress value around the nugget to the maximum value is 343.85 Mpa and the minimum value is 0.43486 Mpa.

A. Effect of Spot Diameter

The number of cycles to failure is plotted against sheet metal for various load values. The loads are vary to the 0 - 120 N. From Fig 2, it is clearly seen that the S-N curve of the specimen increases with the increase of the spot diameter. The S-N curve plots are predicted by the gradual loading to the sheet metal. The applied life cycle of the sheet metal has to increase the diameter the result of fatigue life is increase with the loads.

Table II
Graphical results

Property / Range	Equivalent stress (Mpa) (Maximum)	Equivalent stress (Mpa) (Minimum)	Equivalent strain (Maximum)	Equivalent strain (Minimum)	Directional deformation (mm) (Maximum)	Directional deformation (mm) (Minimum)	Total deformation (mm) (Maximum)	Total deformation (mm)	Factor of safety
Maximum	422081	0.57718	0.0021144	8.3466e-6	28.281	0.0	28.287	0.0	15.0
Minimum	343.85	0.43486	0.0017193	6.707e-6	23.112	0.0	23.117	0.0	0.65443
Error	0.0006549	0.0016003	4.9759e-9	5.3846e-9	1.540e-5	0.0	1.4854e-5	0.0	-

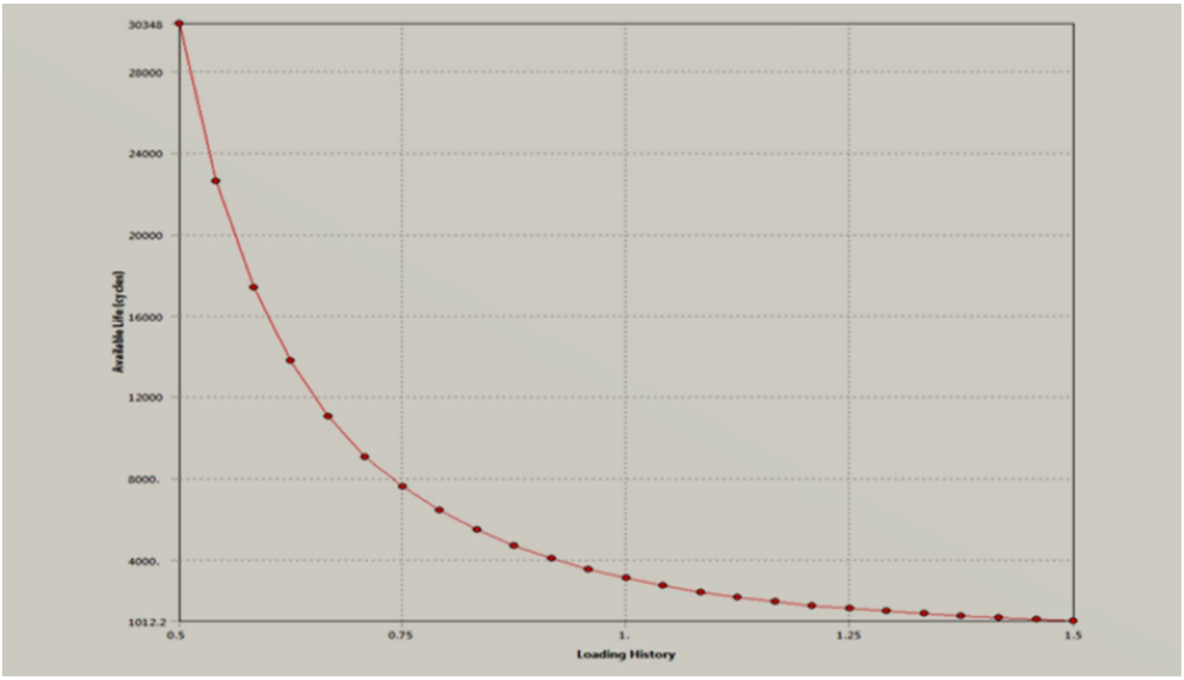


Fig 2: S-N curve

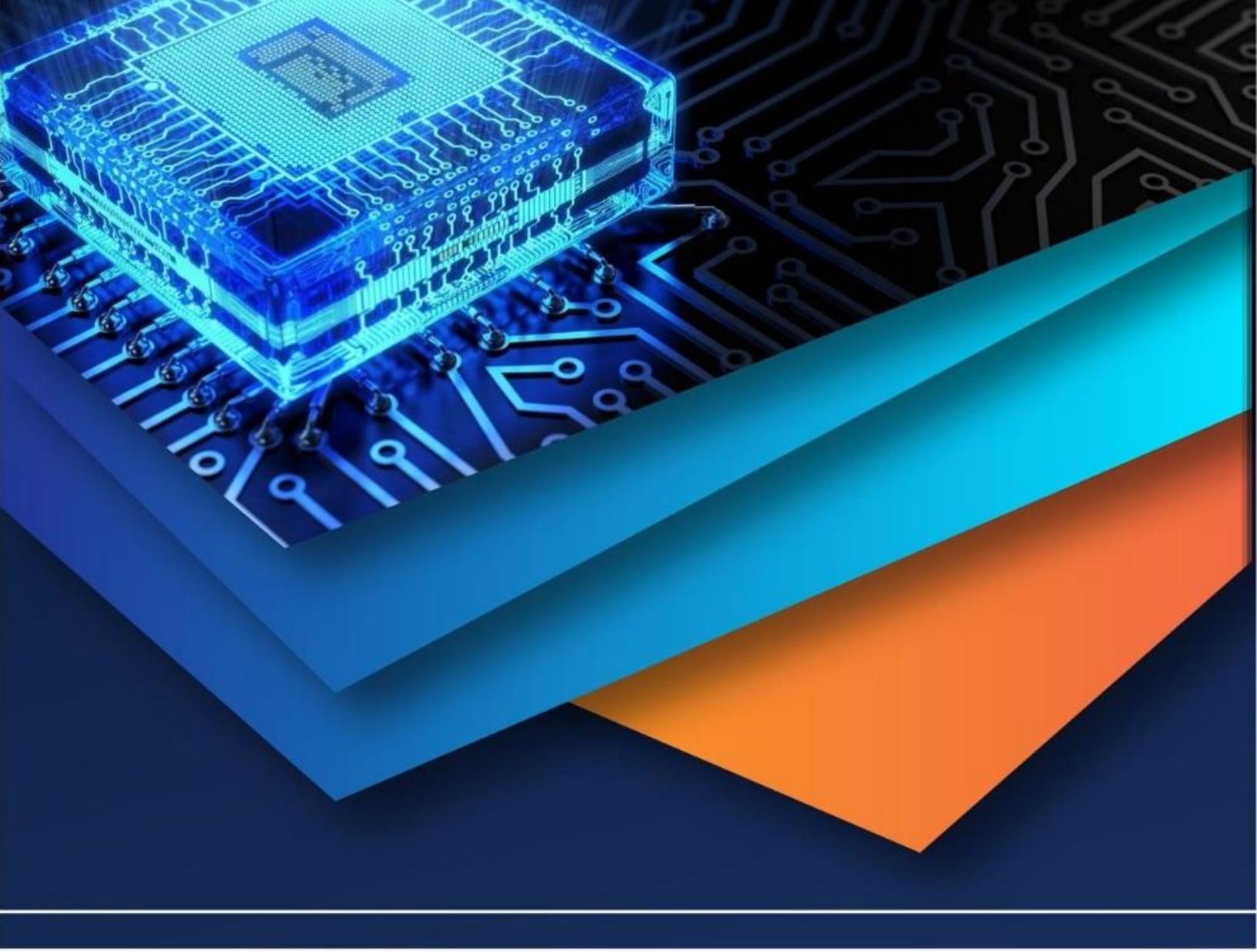
V. CONCLUSIONS

Analytical study to predict the fatigue life of spot-weld joint under imposed loading conditions is showed. The work has been carried out to observe the effect of sheet spot diameter on the fatigue life of spot welded joints and it is seen that fatigue life of the specimen increases with the increase in spot diameter of sheet metal. But the model clearly needs to be tested against more set of data of different dimensions and more importantly need to be tested experimentally in a variety of situations, so that the ANSYS results can be validated. Further the work can be carried out to examine the fatigue life spot welded joint having similar metal sheets and sheets of diameter.

A. Fatigue life of the specimen increases with the increase in spot diameter.
B. Elastic range of the sheet metal is highly effect the weld of the sheet metal.
C. The fatigue life was studied under the critical loading conditions with the equivalent elastic stress of the welded sheet metal

REFERENCES

[1] Stalin B, Vadivel K, Saravanavel S, Ravichandran M. Finite element analysis of lap joint through RSM technique. International Journal of Advanced Technology and Engineering Exploration. 2018 Nov 1;5(48):440.
[2] M. M. Rahman, A.K. Arrifin, M. J.M. Nor and S. Abdullah. "Fatigue Analysis of Spot-Welded Joint for Automative Structures", Tech Science Press SDHM, vol.4, no.3, pp.173-180, 2008..
[3] Y. S. Park, I. S. Sohn and D. H. Bae. "Fatigue strength assessment including welding residual stress of spot welded joints subjected to cross-tension loads", International Journal of Automotive Technology, Vol. 15, No. 5, pp. 765−771 2014.
[4] Mr. B.S. Gawai1, Mr. R.L. Karwande, Mr. Md. Irfan, and Mr. P.S. Thakre. "Analysis and Optimization of Process Parameters of Resistance Spot Welding Process Using Response Surface Method-A Review", *Vol. 6 Issue III, March 2018.*
[5] M.Venkatasudhahar, N.Dilipraja, P.Mathiyalagan, S.Venkata Subba Reddy, P.Sathyaseelan, K.Logesh. "Finite Element Analysis of Fatigue Life of Spot Welded Joint and the Influence of Sheet Thickness and Spot Diameter", International Journal of Mechanical & Mechatronics Engineering IJMME-IJENS, Vol.14, No.06, pp.76-82, 2014
[6] Shrutinaik, dr. M. Aruna devi, and dr. C.p.s. Prakash.,"A review on optimization of resistance spot welding of aluminum components used in automotive industry" International Journal of Innovative Research in Advanced Engineering (IJIRAE), Vol.4 pp.56-60, 2016.
[7] P.Vineeth Kumar, S.Ragunath and A.k Nachimuthu, "Numerical Study on Fatigue Life of Spot Welding using FEA" International Journal of ChemTech Research, Vol.9, No.04 pp 158-169, 2016.
[8] Mahmoud Shariati and Reza Masoudi Nejad, "Fatigue Strength and Fatigue Fracture Mechanism for Spot Welds in U-Shape Specimens", Vol.13, pp.2787-2801, 2016.



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY