Global Journal of Pure and Applied Mathematics (GJPAM) ISSN 0973-1768 Volume 12,Number 4 (2016)


# *Fatigue behavior of AZ31B Magnesium alloy in FSW joints*

*R. Manikandan*
Department of Mechanical Engineering,
University College of Engineering Pattukkottai
Tamil Nadu, India.
Email: mani131990@gmail.com

*G. Elatharasan**
Department of Mechanical Engineering,
University College of Engineering Pattukkottai,
Tamil Nadu, India.
Email: elatharasan@yahoo.co.in

***Abstract-*** **FSW of a weldment joints often required different structure and assembled structures. FEA model to moderate the experimental structures but it will only base on varies stress states. FEA, now a days most widely used upon a traditional approaches in modern engineering. The main Purpose of this research work is Friction stir welding (FSW) of weldment joints, to investigate the effect of cyclic loading condition and life time feasibility of the AZ31B magnesium alloy with thickness 3 mm. This criteria of fatigue analysis has done by using Finite Element Method. A 3D model plotted in Ansys workbench and design of experiment was carried out and investigate the effect of different parameters such fatigue life, force, stress life etc. Simulation results has a good agreement with the theoretical results for the cyclic loading conditions. This analysis of a model deformation well suited for the fatigue behavior. The fatigue strength of 106 cycles and alternating stress around 160 Mpa for axial loading conditions. The deformation of loading condition on fully reversed state and good relation with the soderberg approaches. Design of experiment has done by the analysis in ansys 14.5. This effect of causes to enhanced with the relationship between the input and output parameters. It can be the results of response surfaces good agreement with the structural results.**

***Keywords-Fatigue, FSW, FEM, Soderberg, AZ31B Magnesium***

## I. INTRODUCTION

Friction stir welding is a solid state welding process and it generate enough yield strength of the various similar and dissimilar alloys [1, 2]. This investigation described the modeling and optimization of a similar alloys as various optimized parameters. Magnesium (AZ31B Mg) is a demand material in engineering materials. It has density of 1.74 g/cm3, lighter than aluminium density of 2.74 g/cm3, and more than four times lighter than steel density of 7.86 g/cm3 [3]. This magnesium alloys has high strength and low weight compare to other than materials. It has good vibrating characteristics and high specific strength, high corrosion resistance, good mechanical properties, and very economically. Now a day's lot of research was done on with magnesium alloys. This measurement of elastic plastic strain to investigate the ductility of the material [4, 5]. Most of the analysis to create a high strength material combinations. Mackenzie, reported as a dynamic and static recrystallization of magnesium alloys [5-7]. Ogarrevic and Stephens have established the fatigue data between the year 1923 and 1990 [8]. These alloys of fatigue behavior to affect the shape and size of the standard size

Specimen. [9-10]. Mechanical properties of AZ31B Mg as shown in table 1.

| **Yield strength($N/mm^2$)** | **Ultimate Tensile Strength($N/mm^2$)** | **Elongation (%)** | **Hardness at load 0.05 kg** |
|---|---|---|---|
| 212 | 267 | 8 | 77 |

Table 1. Mechanical properties of AZ31B Mg alloy

Fatigue is an important issue for a subjected to repeat cyclic loading conditions of an indeterminate structures. Any products need a fatigue life, it does a historical primary consideration of the robust designs [12-16]. This type of design to required depending upon the enormous range of limitations as surface finish, size, type of loading, temperature, corrosive, and other aggressive environments, mean stresses, residual stresses, and stress concentrations [11]. Additional factors influencing S-N behavior such as Microstructure, Size Effects, Surface Finish, and Frequency. Simultaneously microstructure includes chemistry, heat treatment, cold working, grain size, anisotropic, inclusions, voids/porosity, and other discontinuities or imperfections. Generally fatigue limits based an alternating stress [17, 18]. This alternating stress may vary as nature of polishing 180 Mpa, axial load 160 Mpa etc. That range from 1 to 70 % does lie in the largest tensile strength. Most of the product life to chosen S-N curve approaches compare to other than two approaches [19, 20]. The mean stress is an essential part of the S-N curve, it may vary fully reversed loading condition, for measuring fatigue life data's.

This paper presents investigation on influence of fatigue failure over an entire cyclic loading conditions. It shows the endurance limit of an AZ31B Magnesium alloys. The standard dimension of the specimen could prepared and life, damage, equivalent alternate stress has done by using finite element method in ANSYS 14.5. Design of experiment was done by the finite element method. The simulation result

*Corresponding author.

This paper was presented by the first author in the National Conference on *Advances in Mathematics and its Applications to Science and Engineering* (AMASE-2016) conducted in Department of Mathematics, University College of Engineering Pattukkottai, Thanjavur, Tamil Nadu, India, on 22nd January 2016.

good agreement with the theoretical results. And also fatigue results using design of experiment to shows the impact and critical damage on the model. This investigation prevents a life of the AZ31B Magnesium alloys.

## II. Mathematical Modeling

The static and dynamic load history very typical in engineering situations. Fatigue includes the effect of mean stress amplitude between the ratio of maximum stress and minimum stress. These alternating stress using three more approaches as Soderberg, Goodman and Gerber parabola approaches for the schematic curve representation shows that figure 1.

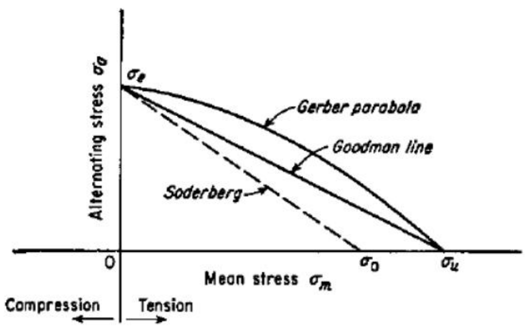


Figure 1. Goodman approach

The straight line to represent the safe zone for the material as a Goodman diagram. The Goodman diagram is typically preferred in engineering design. Actual data can vary around lines by being either concave or convex. Points below Goodman line are considered safe, points above line are considered failed. Most of the fatigue life tested in air environment fully reversed uniaxial fatigue strength or fatigue limits noted upto 106 cycles. For axial loaded unnotched specimen of the nominal stress does not exist, and the average maximum normal stress and mean stress are taken into account. And the following equation is related to fatigue life data.

Soderberg equation

$$\frac{1}{n} = \frac{\sigma_m}{\sigma_y} + K_f \, \frac{\sigma_s}{\sigma_{-1}} \ldots\ldots\ldots\ldots\ldots \; (1)$$

Goodman equation

$$\frac{1}{n} = K_t \left[\frac{1}{n} = \frac{\sigma_m}{\sigma_y} + \frac{\sigma_s}{\sigma_{-1}}\right] \ldots\ldots\ldots\ldots\ldots \; (2)$$

Mean load

$$\sigma_a = \frac{\sigma_{max} + \sigma_{min}}{2} \;\; = 0\, N \ldots\ldots\ldots\ldots (3)$$

Variable load

$$\sigma_a = \frac{\sigma_{max} - \sigma_{min}}{2} \;\; = 20000\, N$$

Mean stress $\boldsymbol{\sigma}_{m\,=}$ 0 N/mm$^2$

Most of the applications soderberg equation preferred for the fatigue designs. Endurance limit $\boldsymbol{\sigma}_{-1}$ to working as a fully reversed cycle can sustain the variable stress for an infinite number of cycles without failure. From the design data approximately the endurance limit of the metal and alloys are $\boldsymbol{\sigma}_{-1=}$0.45 $\boldsymbol{\sigma}_{u.}$ (For tension).

$\boldsymbol{\sigma}_{-1\,=}$ 314 N/mm$^2$

$$\frac{D}{d} = 1.4 \quad , \frac{r}{d} \;\; = 0.3$$

From the design datebook PSGDB

Stress concentration factor (Kt$_)$ = 1.875

Fatigue factor $K_f$ = 1+ q ($K_t$ – 1) = 1.656

Modified endurance limit $\sigma_{-1m} \; = \frac{\sigma_{-1} \times K_R}{K_f}$

= 152 N/mm$^2$

For completely reversed loading condition

$\boldsymbol{\sigma}_{m\,=}$ 0 N/mm$^2$$A = \frac{\pi}{4}\,(d^2)$

$A = 153\; mm^2$

Using Soderberg equation

$$\frac{1}{n} = \frac{\sigma_m}{\sigma_y} + K_f \, \frac{\sigma_s}{\sigma_{-1}}$$

P = $\boldsymbol{\sigma}_a$ = 23.256 KN

Load for infinite life = 23.256 KN

To increasing load gradually $\boldsymbol{\sigma}_a$ = 2 × 152 = 304 N/mm$^2$

Endurance strength for N =10$^3$ cycles = 0.75 $\sigma_u$ = 200 N/mm$^2$

Endurance strength for N=10$^6$ cycles = 152 N/mm$^2$

N cycles can be found in S-N curve respectively to form a triangle.

Taking logarithmic value for the above load cycles using triangle law to found the value of load cycles.

Log (200) = 2.301, Log (152) = 2.181, Log (153) = 2.48

Global Journal of Pure and Applied Mathematics (GJPAM) ISSN 0973-1768 Volume 12,Number 4 (2016)


$$\frac{2.301 - 2.08}{2.301 - 2.181} = \frac{\log N - 3}{6 - 3}$$

N= 36856 cycles.

## III. NUMERICAL MODELING

Axial load tensile test strength has improved by the AZ31B Magnesium alloy in the ambient temperature. The same way tensile properties were investigated in numerical modeling of analysis system. It will support a fatigue life over a cyclic loading conditions. This proposal of fatigue data is examined from the axial loading of a structural system as Life, Damage, and Biaxiality Indication, factor of safety, fatigue sensitivity curve. The fatigue strength of $10^6$ cycles around 160 Mpa is taken from the datebook. This analysis of two applying fully reversed loading condition for the given input into the tensile specimen as shown in figure 2. S-N curve is based on stress life to update the full life cycles. And more than $10^5$ cycles is used compare to strain life, similarly using high fatigue life cycles. This reverse loading condition used to calculate the alternating values and mean stress. This stress variation due acting second load to first load. (Equal and opposite load). This way used to find out the critical fatigue locations. Constant amplitude loading condition for the lowest alternating stress will use minimum life of the tensile specimen. This will helps to adding factor of safety of the material do not exceed the endurance limit.

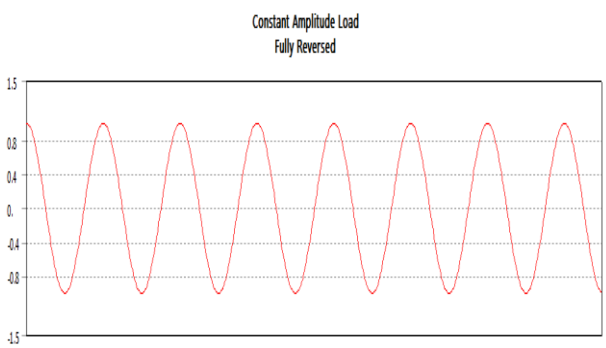


Figure 2. Fully reversed condition

And the soderberg diagram as shown in figure 3. Most of the analysis the engineers using this method for a better capability for the mean stress correction theory.


Figure 3. Soderberg mean correction theory

Stress life based on characterized by a loading type, mean stress effect, multiaxial stress correction and fatigue modification factor. This fully reversed loading condition database based on the alternating stress as shown in the table 2. It is the ratio of difference between the maximum stresses to minimum stress (1 to -1). This approach identifies the critical fatigue locations. From above the soderberg correction theory the value of yield below the triangle material is safe, otherwise it will be some deformation as an unsafe zones. And applying scale factor used to reduce the effect of changing magnitude of loads. Using soderberg equation when the value of infinite life of the AZ31B Magnesium alloy is 23.256 KN. We can avoid the damage to set infinite life of a material alternating stress is beyond the limit of the S-N curve. For higher value of fatigue life will make small damage occur many times.

**Table 2. Alternating stress**

| S.No | Cycles | Alternating Stress (MPa) |
|---|---|---|
| 1 | 10 | 1150 |
| 2 | 20 | 1050 |
| 3 | 50 | 950 |
| 4 | 100 | 850 |
| 5 | 200 | 730 |
| 6 | 2000 | 640 |
| 7 | 10000 | 540 |
| 8 | 20000 | 450 |
| 9 | 100000 | 320 |
| 10 | 200000 | 250 |
| 11 | 1000000 | 160 |

The welded specimen could be drawn by using workbench model and the figure as shown in figure 4(a) and (b). The finite element model using triangle mesh the element size 50400 and node 231813 for the purpose of high accuracy. And there is a no mesh failure for the standard specimen for the quality meshes.

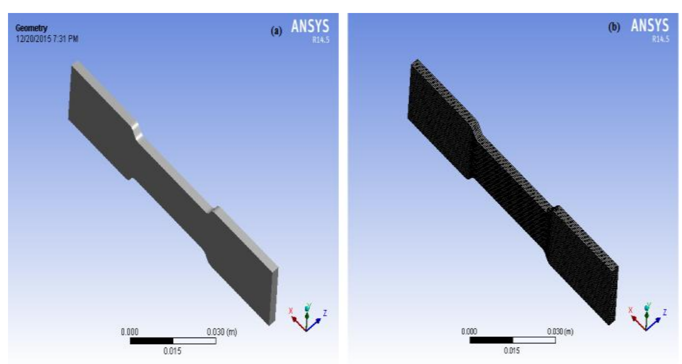


Figure 4. (a) Solid geometry (b) mesh model

## IV. DESIGN EXPERIMENT

Design of experiment is a Multiphysics system, it has a different input variable the results amount of output results are predicted and minimize the optimized parameters. In this parameters investigate the optimized key parameters to create a graphical response surfaces. This experiment the force magnitude is an input variable and different outputs are to responses a given fatigue data's. This response surface using central composite design used to derive a various types of design points. This DOE of design points are given an important role. For various output updating the design points are very essential one. The collective design points to show local sensitivity of the life time for the various cyclic loading conditions. Design points has showed in the table 3.The central composite design force magnitude 20000 KN as an input condition and 12 outputs. Central composite design is a five factorial design .There are three types of CCDs that arecommonly used in experiment designs: circumscribed, inscribed, and face-centered CCDs. The five-level coded values of each factor are represented by [-α, -1, 0+1, +α], where [-1, +1] corresponds to the physical lower and upper limit of the explored factor space. It is obvious that [-α, +α] establishes new "extreme" physical lower and upper limits for all factors. The value of [1,-1] varies depending on design property and number of factors in the study. For the circumscribed CCDs, considered to be the original form of Central Composite Designs, the value of +α is greater than 1.

| Name | P12 | P7 | P6 | P5 | P3 | P8 | P9 | P10 | P11 |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 20000 | 0.228928301 | 22.89209526 | 394.1078336 | 893.9555985 | 8.939851284 | 78.02220074 | 12816864.82 | 0.178979806 |
| 2 | 20000 | 0.228928301 | 22.89209526 | 394.1078336 | 893.9555985 | 8.939851284 | 78.02220074 | 12816864.82 | 0.178979806 |
| 3 | 20000 | 0.228928301 | 22.89209526 | 394.1078336 | 893.9555985 | 8.939851284 | 78.02220074 | 12816864.82 | 0.178979806 |
| 4 | 20000 | 0.228928301 | 22.89209526 | 394.1078336 | 893.9555985 | 8.939851284 | 78.02220074 | 12816864.82 | 0.178979806 |
| 5 | 20000 | 0.228928301 | 22.89209526 | 394.1078336 | 893.9555985 | 8.939851284 | 78.02220074 | 12816864.82 | 0.178979806 |
| 6 | 18000 | 0.206035472 | 20.60288589 | 354.6970384 | 804.5600328 | 8.045866489 | 137.8666393 | 7253386.353 | 0.198866453 |
| 7 | 22000 | 0.251821123 | 25.18130508 | 433.5185991 | 983.3511659 | 9.833836555 | 39.99465023 | 25003344.06 | 0.162708914 |
| 8 | 18373.9321 | 0.210315652 | 21.03089011 | 362.065514 | 821.2739764 | 8.213011265 | 123.938353 | 8068527.422 | 0.194819274 |
| 9 | 18373.9321 | 0.210315652 | 21.03089011 | 362.065514 | 821.2739764 | 8.213011265 | 123.938353 | 8068527.422 | 0.194819274 |
| 10 | 18373.9321 | 0.210315652 | 21.03089011 | 362.065514 | 821.2739764 | 8.213011265 | 123.938353 | 8068527.422 | 0.194819274 |
| 11 | 18373.9321 | 0.210315652 | 21.03089011 | 362.065514 | 821.2739764 | 8.213011265 | 123.938353 | 8068527.422 | 0.194819274 |
| 12 | 21626.0679 | 0.247540947 | 24.75329977 | 426.1501235 | 966.637222 | 9.666691303 | 45.00883341 | 22217860.9 | 0.165522283 |
| 13 | 21626.0679 | 0.247540947 | 24.75329977 | 426.1501235 | 966.637222 | 9.666691303 | 45.00883341 | 22217860.9 | 0.165522283 |
| 14 | 21626.0679 | 0.247540947 | 24.75329977 | 426.1501235 | 966.637222 | 9.666691303 | 45.00883341 | 22217860.9 | 0.165522283 |
| 15 | 21626.0679 | 0.247540947 | 24.75329977 | 426.1501235 | 966.637222 | 9.666691303 | 45.00883341 | 22217860.9 | 0.165522283 |

Table 3. Data Points

## V. RESULT AND DISCUSSIONS

The mechanical characteristics of AZ31B Magnesium alloy in friction stir welding of a process material in which yield strength, ultimate and fatigue sensitivity in which evaluated by using mathematical and numerical modeling. The boundaries condition was applied same for the experimental rules. Finite element method of investigation was done on with welded specimen. This effect boundaries to causes a nature of stress effects as shown in various figures. The relation between the stress, strain and deformation as shown in figure 5. Structural results for obtained results the load starts from 0 to 20 KN linearly. This static analysis does not change with direction and magnitude of the force vector. As the obtained results good agreement with the design of experiment of a response surfaces.

However the 3D model developed along with the weldment thickness pate 3mm and investigate the mechanical behavior of an AZ31B Magnesium alloys. From the figure 5 value of Total deformation, stress and strain has 0.04379 m, 228.9 $N/mm^2$ and 8.93 for the force magnitude 20KN. It has a uniform deformation and all the values can obtained below of AZ31 B Magnesium maximum values as an efficiency of ultimate strength has 85.6%. This stress of a maximum limit beyond the limit of the AZ31B Magnesium alloy. Equivalent von-misses stress takes sign of the maximum principle stress. From figure 5 shows the red color mark is a maximum stress limit and blue color is a minimum limit, otherwise enabling the different colors depending upon the stress variation.

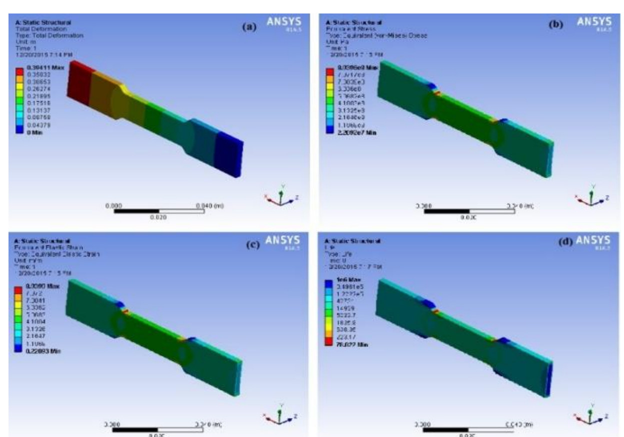

Figure 5. (a) Total deformation (b) Equivalent stress (c) Equivalent strain (d) Life

Global Journal of Pure and Applied Mathematics (GJPAM) ISSN 0973-1768 Volume 12,Number 4 (2016)


The fatigue data of the AZ31B Magnesium alloys followed by the date book. This data based calculating alternating stress was acting 106 load cycles. The stress life approach is very difficult compared to the strain life behaviour. The damage was calculated along the fatigue strength factor $K_f$=1. The fatigue factor does not affect the alternating stress. This loading history of 1 cycle to referred as a 1 day for an every load cycles. S-N curve approaches is important one for using mean stress theory. The fatigue load is applied a fully reversed loading condition the value amplitude is -1. Most of the test procedures using completely reversed loading conditions and strength of axial loading condition based on unnotched specimen was failure upto the range as $10^6$ cycles. To finding the nature of stresses are very beneficial in this method for the S-N data as a required alternating stress as shown in figure 6.

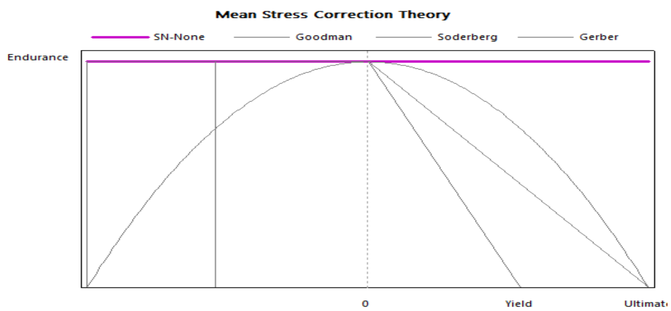


Figure 6. S-N curve approach

The fatigue sensitivity and life, damage, factor of safety, biaxiality indication as shown in figure 7. Constant amplitude loading condition of the minimum value considered as fatigue curve of a last point compared to the non-amplitude loading conditions. The load condition 1 cycle was considered equal to one day over an entire fatigue life of a system. Fatigue damage is a ratio of design life to available life in which the value of damage to reached greater than one the product to indicate the failure before reached the design life. The measurement of factor of safety varied, it belongs to the fatigue failure for the given life. This investigation factor of safety obtained the value of 15 as damage and life has scoped for this analysis. The FOS value less than one to indicate the failure when reached the design life. Generally material characteristics based on biaxiality indication. Biaxiality indication is a type of indicating stress as ratio of minimum principle stress to maximum stress. The value 0 to indicate the uniaxial stress.

Fatigue sensitivity to visualize the fatigue behavior to change the loading on critical location on the model as shown in figure 8. For sensitivity factor using lower deviation 50 % to upper deviation 150 % .It based on life, damage, and factor of safety. As a value of 2.19E+4 is critical location on the model. And equivalent alternating stress used to investigate the effect S-N curve after the cyclic loading conditions. It relate to the fatigue life to stress state. This S-N curve mainly focused on fatigue loading type, mean stress effects, multiaxial effects, and any other factors in the fatigue analysis.

When the stress calculated after the design life determination is possible otherwise it will not suitable for non-constant amplitude loading conditions. The Equivalent alternating stress of maximum value 2.282 pa obtained from the analysis.

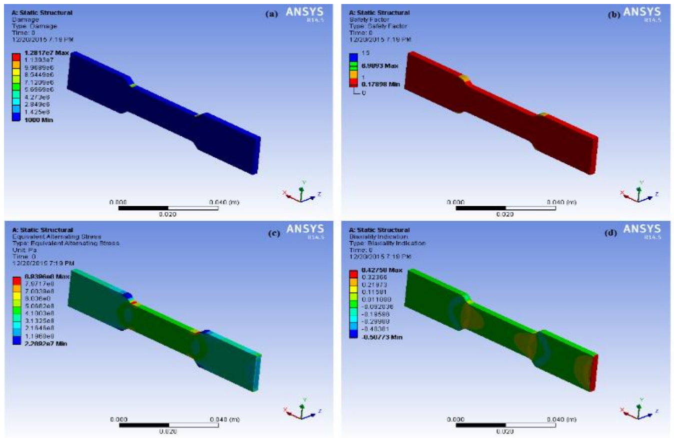


Figure 7. (a) Damage (b) safety factor
(c) Equivalent alternating stress (d) Biaxiality indication

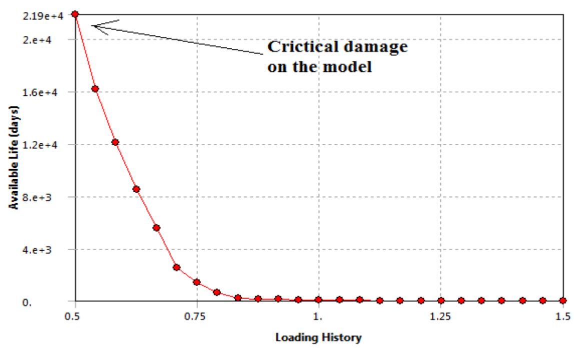


Figure 8. Fatigue sensitivity

Design of experiment of the data has collected from the fatigue behavior of uniaxial loading conditions as $10^6$ cycles. This DOE using a single response and to predict various responses of 12 outputs. This design will interpolate the multidimensional space. It can found to visualize the 3D model of a design variable and design performance. For the given response for the design exploration system where created as a collected data points used to a parameters set and to get the output parameters. Using central composite design to update the amount of output parameters. This collection of data points after the updating to relate the other responses for various multi-space dimensions. This analysis basically used 12 parameters for the parallel chart as shown in figure 9.

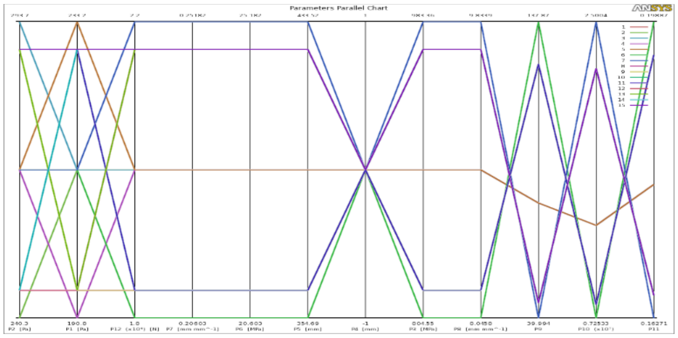


Figure 9. Parameters parallel chart

From the observation of a parameters parallel chart to enabled the different colors in ellipse shape. The goodness for fit using a verification point for whether to checking the response calculating number of verification point chosen 1. This analysis for the goodness for fit curve for various responses as shown in table 3.The next one response surface for the impact of graphical results life, stress, deformation, damage, as shown in figure below 10(a)-10(d).

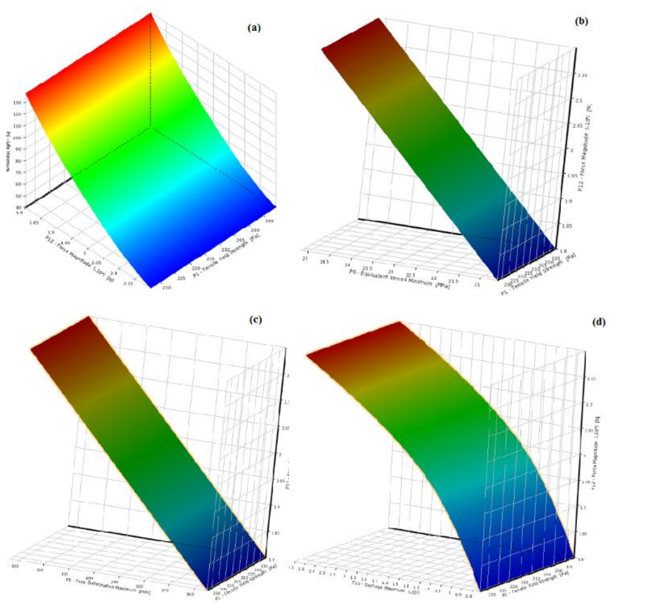


Figure 10. Response surface (a) Life (b) Equivalent stress (c) Total deformation (d) Damage

Figure 10 (a) shows a graphical impact of a life parameters decrease gradually while the effect of force magnitude. Similarly figure 10 (d) shares a maximum life while the effect of force magnitudeand critical load on the model as aresponse point of severe damage is 2.29 in terms of logarithmic values.

| Name | P7 | P6 | P5 | P4 | P3 | P8 | P9 | P10 | P11 |
|---|---|---|---|---|---|---|---|---|---|
| Goodness Of Fit | | | | | | | | | |
| Coefficient of Determination (Best Value = 1) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Adjusted Coeff of Determination (Best Value = 1) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Maximum Relative Residual (Best Value = 0%) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Root Mean Square Error (Best Value = 0) | 4.66E-12 | 1.52E-07 | 1.96E-07 | 0 | 3.05E-06 | 3.01E-10 | 1.07E-06 | 0.04022 | 5.40E-10 |
| Relative Root Mean Square Error (Best Value = 0%) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Relative Maximum Absolute Error (Best Value = 0%) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Relative Average Absolute Error (Best Value = 0%) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Table 4. Goodness for fit response

| |
|---|
| P3 - Equivalent Stress Maximum |
| P4 - Total Deformation Minimum |
| P5 - Total Deformation Maximum |
| P6 - Equivalent Stress Minimum |
| P7 - Equivalent Elastic Strain Minimum |
| P8 - Equivalent Elastic Strain Maximum |
| P9 - Life Minimum |
| P10 - Damage Maximum |
| P11 - Safety Factor Minimum |

Spider chart once to solve the response surface it will appeared automatically. This chart will show the impact of various output parameters. Once to changing response the output to change a shape and dimensions. The red color to show the response point and various output factor for the spider shows that figure 11(b). Local sensitivity curves the surface parameters are a single sensitivity curves. This curve to calculate the amount of output while changing input as a single parameters curve. The changing output varied for a given inputs, that curve referred as a local sensitivity. And the local sensitivity curve of the figure 11(c)-11(d) shows relation of a life, damage, and stress in figure 13. Above the graph shows different variation of life where occurring damage to decrease gradually. The response point shows life over a 75 cycles to undergoing the damage found in 2.28. This response surface life is a completely reversed loading condition good agreement with the severe damage of red color identification mark. Goodness for fit in table 4 of various output parameters very fit for the best values.

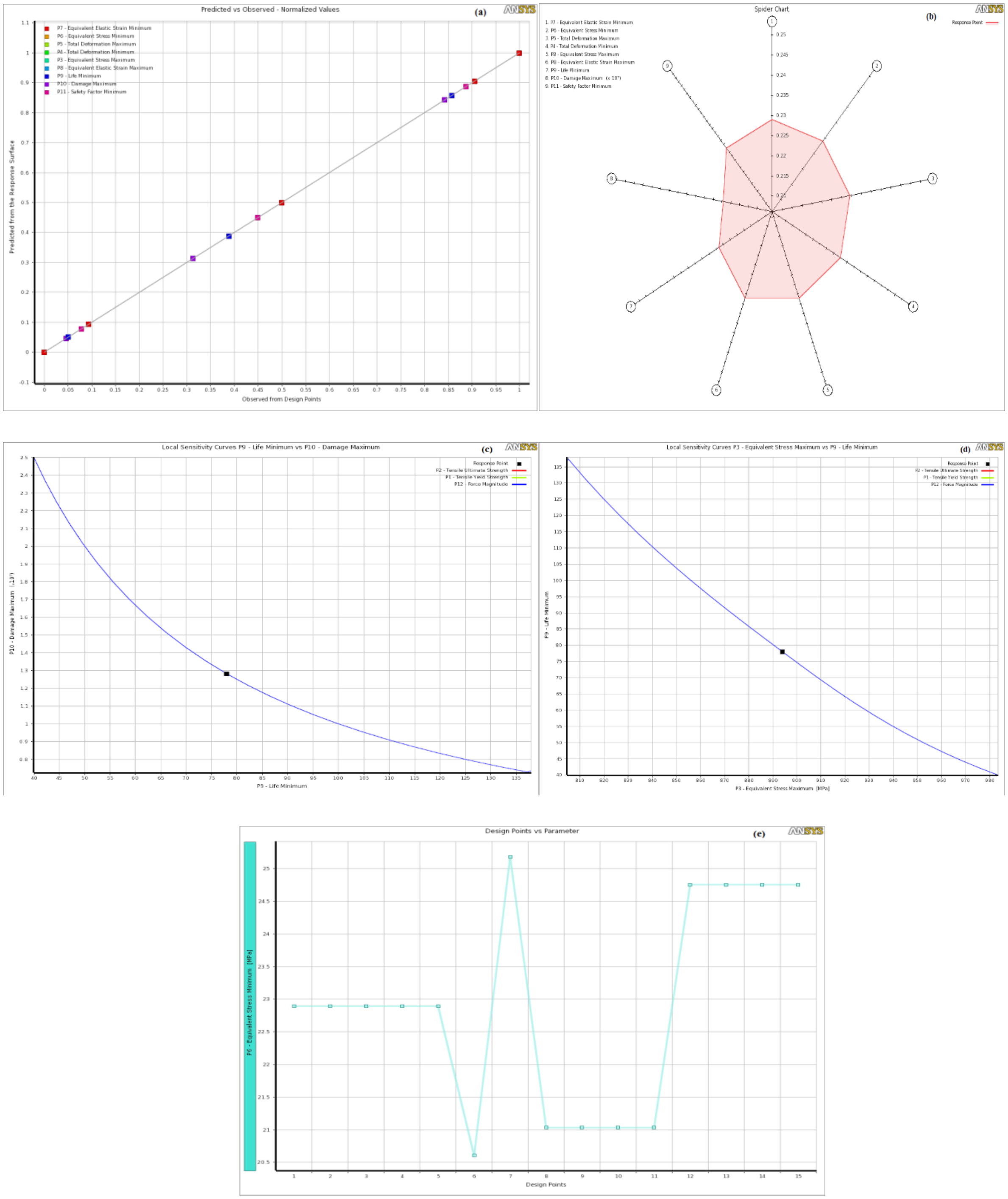


Figure 11.

(a) Goodness for fit
(b) Response surfaces of a spider chart
(c) Local sensitivity curve Life $V_s$ Damage
(d) Local sensitivity curve Life $V_s$ Damage
(e) Design points $V_s$ Equivalent stress

The stress life has constant amplitude reverse loading condition of equivalent alternating stress is lower than the user defined alternating stress in S-N curve that point will be used and also same response point to update the parameters. These all the response surface and local sensivity curves will be formulated by the interpolation equation using log-log, Semi-log, Linear. The interpolation equation to query the S-N curve as data of a stress value not same in the life stress value. It can be used interpolate the appropriate value. And alternating stress calculated by the fatigue strength factor. This factor accounted the differences between the parts from the tested conditions.

## VI. CONCLUSION

In this paper, to investigate the fatigue behaviour of a weldment plate as a material of AZ31 B magnesium alloy. Friction stir welding of a weldment joint has a good tensile strength has proved from this analysis. Here optimized parameters like transverse speed, rotational speed, and axial load to provide an important role in friction stir welding. From above the tensile simulation result make sure, it has a good fatigue strength for over $10^6$ load cycles as a stress limit of 160 Mpa. The plate thickness 3mm of a deformation of the tensile specimen 0.04379m, equivalent alternate stress 228.9 $N/mm^2$, strain 8.93 within the limits of AZ31B Magnesium alloys.

The fatigue life of a tensile specimen has to get an expected life over an entire load of 20000 N. This simulation of graphical image to shows the location of various stresses and behavior of plastic deformations. And fatigue sensivity of available life in tensile specimen 2.29E4 to attend the critical damage. Equivalent alternating stress has good loading capacity after the loading histories. It prevent the nature of stress were found after the loading has 228.9 $N/mm^2$.

Design of experiment of tensile behavior has done by the ANSYS simulation. The above structural results good responses with of a design of experiment. This experiment of a various inputs and outputs to create a large number of data points. This data points responses of a various responses such as parameters parallel chart, goodness for fit, max-min search, and local sensitivity curve and 3D response surfaces. Local sensitivity curve clearly defined life of a welded specimen to lose a life due to increasing damage for a constant loading condition. The graphical view of 3D response surfaces to shows the good impact of outputs for a given input as a force magnitude.

## REFERENCES

[1] Elatharasan G, Senthil Kumar V.S mar, Modeling and optimization of friction stir welding parameters of dissimilar alloys using RSM Procedia Engineering 38 (2012) 3477 – 3481.

[2] Elatharasan G, Senthil Kumar V.S Corrosion behaviour of fsw AA7075 alloy by Nano alumina coating.Journal of Chemical and Pharmaceutical Sciences ISSN: 0974-2115.

[3] Mustafa Kemal Kulekci, Magnesium and its alloys application in automotive industry, Int J Adv Manuf Technol (2008) 39:851, DOI 10.1007/s00170-007-1279-2.

[4] Abu-Farha F, Khraisheh M, Deformation characteristics of AZ31 magnesium alloy under various forming temperature and stain rates, in: Proceedings of the English ESAFORM Conference on material forming, Cluj-Napoca Romania, 2005, pp, 627-630.

[5] TsaoL, Wu C,Chuang T Evaluation of superplastic formability of the AZ31 magnesium alloy, Mater.Res.Adv Tech 92(2001) 572-577.

[6] Mackenzie, L. W. F., Lorimer, G. W., Humphreys, F. J. and Wilks. T. Recrystallization Behavior of Two Magnesium Alloys. Mater. Sci. Forum, 2004, 467-482.

[7] Yi, S. B., Zaefferer, S. and Brokmeier, H.- G. Mechanical behavior and microstructural evolution of magnesium alloy AZ31 in tension at different temperatures, Materials Science and Engineering: A, 2006, 275-281, 424.

[8] Del Valle, J. A. and Ruano, O. A. Influence of texture on dynamic recrystallization and deformation mechanisms in rolled or ECAPed AZ31 magnesium alloy, Materials Science and Engineering: A, 2008,473-480, 487.

[9] Tokaji, K., Kamakura, M., Ishiizumi, Y. and Hasegawa, N. Fatigue behavior and fracture mechanism of a rolled AZ31 magnesium alloy, International Journal of Fatigue, 2004, 1217-1224, 26.

[10] Tokaji K, Ogawa T and Kameyama Y., The effects of stress ratio on the growth behaviour of small fatigue cracks in an aluminum alloy 7075-T6 (with special interest in stage I crack growth) fatigue frat Eng Mater Struct; 1990, 411-21, 13.

[11] Tokaji K, goshima Y., Fatigue behaviour of 6063 aluminium alloy in corrosive environments J soc Mater Sci Jpn; 2002,1441-6,51.

[12] Properties and Selection of Metals, Vol 1, Metals Handbook, 8th ed., American Society for Metals, 1961.

[13] Higgins, R.A. Engineering Metallurgy Applied Physical Metallurgy, 6th ed., Arnold, 1993.

[14] Meyers M.A. and. Chawla, K.K MechanicalMetallurgy—Principles and Applications,Prentice-Hall Inc., 1984.

[15] Laird C.M, STP 415, American Society forTesting and Materials, 1966, p 130.

[16] Anderson, T.L. Fracture Mechanics: Fundamentals and Applications, 3rd ed., Taylor& Francis, 2005.

[17] Collins J and Daniewicz, S. FailureConsiderations, Mechanical EngineersHandbook, John Wiley & Sons, Inc.,1998.

[18] Bhandari V.B., Design of Machine Elements (New Delhi, Tata McGraw-Hills, 2009).

[19] Atzori, B. Lazzarin, P. Tovo, R., Fatigue and Fracture of Engineering Materials and Structures, 22 (1999) 369.

[20] Dong P, Hong J. K, International Institute of Welding: IIW Doc. XIII-2036-04/XV-1173-04.

Radaj D. Design and Analysis of Fatigue Resistant Welded Structures, Abington Publishing, Cambridge (1990).