International Journal of Scientific Research & Engineering Trends
Volume 7, Issue 6, Nov- Dec-2021, ISSN (Online): 2395-566X

Fatigue Analysis of Welded Joint Using Ansys: A Review Study

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Abstract- Fatigue failures in welded structures result in fatalities and significant financial losses. The adoption of different standards and fatigue design rules has been proposed as a solution to this problem. The foundations of such codes, in some instances, are based on outdated ideas that are difficult to convert to the output of current computer programmes and are also restricted to relatively simple structures.The purpose of this article is to investigate the fatigue strength of welded joints using a fracture mechanics method that takes into consideration welded joint fatigue behaviour. The technique assists in determining the fatigue crack propagation rate as a function of the difference between the applied driving force and the material crack propagation threshold, which is a function of fracture length. Failure of welded structures or machine components results in a variety of direct losses, including the cost of repair, the cost of effort to prevent future failure, accident compensation, and a reduction in output. Because joints are the weakest component of any building or machine, they are likely to fail first. As a result, it's critical to investigate why certain joints are failing. Understanding the causes of failure and how they spread can help you appreciate welded joints from a reliability standpoint. Some purpose activities or failure causes may be essential, and they may be reduced at the layout or manufacturing stage, resulting in combined failure minimization.

Keywords- Fatigue, Welded joint, Stress Concentration factor, Life cycle.

I. INTRODUCTION

Welding is one of the numerous connecting methods utilised in steel constructions for a variety of reasons. This has to do with the amount of time needed to complete the procedure as well as a reasonable price that is reliable. Due to the external environment, these structures are exposed to changing load components during their entire cycle (such as wave and wind impact).

It's difficult to ensure structural strength when welded connections are used in constructions that are exposed to fatigue stresses. This scenario necessitates a deeper understanding of welded joint fatigue behaviour. The most accurate way for estimating this behaviour is to use fatigue testing; nevertheless, this solution involves a considerable investment of time and money, making it unaffordable for the vast majority of steel construction industry players.

Welding is a materials joining technique that involves heating materials to appropriate temperatures, either with or without the use of pressure, and with or without the use of filler material, and with or without the use of filler material. Welding is used to create permanent connections.

Automobile bodywork, aeroplane frames, railway carriages, machine frames, structural works, tanks, furniture, boilers, general repair work, and shipbuilding are all made using it.

Welding is a manufacturing or artistic method that causes fusion between materials, typically metals or thermo plastics, as opposed to lower-temperature metal-joining processes like brazing and soldering, which do not melt the base metal.

A filler material is frequently added to the joint in addition to the base metal to create a pool of molten material (the weld pool) that cools to make a junction that is as strong as the base metal. Pressure may be used alone or in combination with heat to create a weld.

II. DEFINITION OF WELDING

"Welding is the process of joining together two pieces of metal so that bonding takes place at their original boundary surfaces". When two parts to be joined are melted together, heat or pressure or both is applied and with or without added metal for formation of metallic bond.

1. Need for Welding:
Fully mechanized or automated welding methods have become more popular in the welding industry as the need for both high production rates and high accuracy grows. The pace at which automation is being brought into the welding process is astounding, and it is possible that by the end of this century, welding production facilities may have more automated equipment than workers.

Furthermore, computers play an important part in automating welding operations, and the instructions sent by the computer are derived from programmes, which need welding variable algorithms in the form of mathematical equations. To make efficient use of automated systems, a high level of confidence in predicting weld parameters is required to produce the necessary mechanical strength in welded connections.

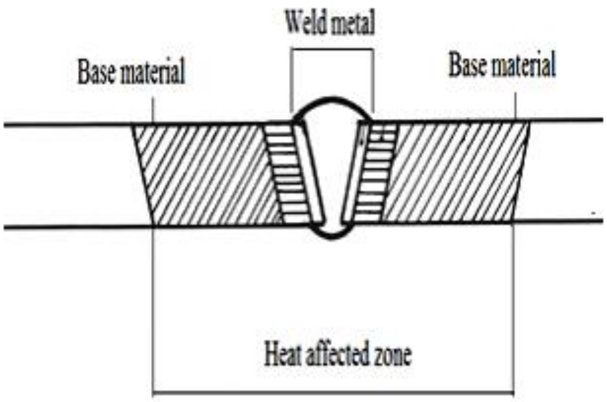

Figure 1: Weld Zones

III. WELDING CLASSES

B, C, and D are the general welding courses offered. The weld class shows the number of flaws in the weld as well as internal and exterior misalignments of the base material components. Welding Class B has the least number of misalignments and, in theory, needs post-treatment.

Class B is utilized when there are a lot of fatigue loads, a lot of danger zones, and a lot of brittle fractures. After welding, Class C does not need any post-treatment. It requires less time than class B. At BT Products, welding class C is standard. Welds that are not exposed to significant loads are classified as Class D.

IV. CLASSIFICATION OF WELDING PROCESSES

There are many types of welding techniques used to join metals. The welding processes differ in the manner in which temperature and pressure are combined and achieved. The welding process is divided into two major categories: Plastic Welding or Pressure Welding and Fusion Welding or Non-Pressure Welding.

1. Pressure Welding:
When the metal piece acquires plastic state on heating, external pressure is applied. In this process, externally applied forces play an important role in the bonding operation. “A group of welding processes which produces coalescence at temperatures essentially below the melting point of the base materials being joined without the addition of a filler metal” is Pressure Welding Process. Without melting the base metal, due to temperature, time and pressure coalescence is produced. Some of the very oldest processes are included in solid state welding process. The advantage of this process is the base metal does not melt and hence the original properties are retained with the metals being joined.

2. Fusion Welding or Non-Pressure Welding:
The material at the joint is heated to a molten state and allowed to solidify. In this process the joining operation involves melting and solidification and any external forces applied to the system do not play an active role in producing coalescence. Usually fusion welding uses a filler material to ensure that the joint is filled. All fusion welding processes have three requirements: Heat, Shielding and Filler material.

V. WELDING OF DIFFERENT MATERIALS

Aluminum is the most excellent source of iron in the earth's crust, whereas steel is the most often utilized metal. Aluminum alloys are increasingly displacing steel in industrial applications. When compared to steels, aluminium alloys have a low density of approximately one-third. When compared to structural steels, several of these materials offer for considerable weight savings. Aluminum alloys are crucial for the fabrication of components and structures that need great strength, low weight, or the ability to conduct electric current in order to fulfil their service requirements.

Aluminum alloys, unlike steel, can withstand oxidation, water corrosion, and salt corrosion. Aluminum and its alloys have many desired characteristics, including low weight, appearance, fabrication ability, strength, and corrosion resistance, and are therefore utilized in a broad range of applications. These characteristics allow energy efficient operation in aircraft, rail, and road vehicles. Materials having a high strength-to-weight ratio, such as aluminium alloys, are needed in aircraft applications.

Although the manufacturing of aluminium alloy components is not difficult, the combining of these materials may sometimes create severe difficulties. 6XXX is one of the most important aluminium alloys in the aerospace sector. When compared to other series of aluminium alloys, they have excellent formability, weldability, machinability, corrosion resistance, and strength, making them popular in aerospace applications. As a result, these alloys were selected for the FSW procedure in this study.

1. Defects in welding:
The lack of training to the operator or careless application of welding technologies may cause discontinuities in welding. In aluminum joints obtained by fusion welding, the defects such as porosity, slag inclusion, solidification

cracks etc., are observed and these defects deteriorates the weld quality and joint properties.

2. Common welds defects found in welded joints:
These defects mayresult in sudden failures which are unexpected as they give rise to stress intensities. The common weld defects include Porosity, Lack of fusion, Inclusions, Cracking, Undercut and lamellar tearing.

VI. ALUMINUM ALLOYS DESIGNATION CRITERIA

Based on the ability to respond to thermal and mechanical treatment, the aluminum alloys are characterized into number of groups. Aluminum alloys may be divided into two broad classes: Cast and Wrought products. These two classes can be further subdivided into families of alloys based on chemical composition and finally on temper designation. To identify the condition of the alloy, the heat treatment condition, the amount of cold work it has undergone i.e. the temper designation is used.

1. Alloying Elements:
Copper, silicon, lithium, zinc, magnesium, and manganese are the most common alloying elements, with titanium, chromium, scandium, and zirconium available in tiny amounts for particular characteristics. Other undesirable elements, known as residual or tramp elements, are also present as contaminants. Producers make an effort to remove these remaining characteristics from their goods.

Ingots for remelting are designated by the prefix AB, whereas cast products are designated by the prefix AC, cast master alloys are designated by the prefix AM, and wrought products are designated by the prefix AW. Characteristics such as capacity to react to heat and mechanical treatment are identified when numbering or contemplating the identification scheme for aluminium alloys.

Wrought aluminium has a four-digit system, whereas the others use a three-digit system with one decimal place. The first digit in the wrought aluminium identification system denotes the main alloying element, the second individual number denotes particular alloy modification, and the third and fourth digits are arbitrary numbers used to identify distinct alloys in the series.

VII. INTRODUCTION OF FATIGUE

Fatigue is a condition in which a material progressively degrades and ultimately fails due to cyclic stress. In regions with significant local stress, the process begins with fracture initiation and progresses to crack propagation.

Because fatigue fractures are a local phenomena characterised by tiny plastic deformations, they may be difficult to detect.

The fatigue life of a welded design is influenced by a variety of variables whose effects are difficult to estimate. As a result, fatigue strength is considered as an empirical discipline, and expertise in the field has been accumulated via intensive testing.

The number of cycles, the distribution and intensity of loads, and the degree of notch action has the greatest effect on fatigue strength. Static strength, surface quality, weld flaws, mean stress, residual stresses, plate thickness, temperature, and corrosion are all variables to consider. Fatigue failure in welded designs is most often caused by flaws in the weld root, weld end, and transition zone between the base material and the weld.

Crack initiation, crack propagation, and residue fracture are the three major stages of the fatigue process. When the started crack is exposed to dynamic loadings, crack initiation and propagation commence. The first step is fracture initiation, in which tiny fissures appear in the microscopic structure of the material.

Loads, damages, and/or machining, among other things, may cause cracks. High cycle fatigue is caused by two major factors: stress concentrations and dislocation pile-up, both of which are linked to the metallurgical microstructure. Inclusions, early cracks, pores, grains, and corrosion pits, among other things, create stress concentrations. The process of dislocation pile-up is due to persistent slip bands that form the core of fractures, resulting in increasing stress levels locally. This causes a localised loss of fatigue strength. The dominant initiating reasons are determined by the material's purity, stress, surface roughness, and surface defects/scratches, among other factors.

The fatigue process will proceed into the following step, fracture propagation, after the crack has been started. Stress intensity range, stress intensity ratio, and stress history are the three most significant variables for fracture propagation.

Environmental factors, mainly corrosion, sometimes known as corrosion fatigue, and temperature, have an impact on fatigue life. Corrosion fatigue will produce fractures owing to stress concentrations in corrosion pits. Corrosion fatigue tests show that fatigue strength has been significantly reduced. The fatigue strength is also reduced when the service temperature is high.

Fatigue cracks are sensitive and occur mostly during tensile stress or alternating stresses, but fatigue cracks have occurred during compressive loads due to positive residual stresses [12]. The fatigue process is cumulative, the material do not recover when rested. [9]

1. Fatigue class:
Fatigue class (FAT) also known as property classes, is defined as the characteristic fatigue strength at constant stress range at 2·106 load cycles. The characteristic fatigue strength has the unit N/mm2. The fatigue class value can be referred to as FAT or C, dependent on literature. Property classes have been developed through fatigue testing of various welded joints. Test results have been complied over time, which has formed the property classes. Property classes are mainly used for fatigue life calculations with the Nominal stress method. [1]

2. S/N Curve:
The S/N curve, also called Wohler curve, is a diagram that illustrates fatigue strength, see Figure. The S/N curve shows the number of load cycles to failure as a function of certain stress range. The stress range is more appropriate to use for welded joints than the stress amplitude, and therefore, stress range is used hereafter. The S/N curve is created based on test results plotted in a logarithmic diagram. In order to obtain reliable values, at least five identical specimens should be tested at each stress range. [9]

The assumption of using stress range instead of stress amplitude for welds is because of the residual stresses in the weld. Residual stresses can occur in both tension and compression, which leads to difficult calculations of how the loading and the residual stress counteract or contribute to each other. Calculations made with the stress range give a more conservative fatigue life result. [13]

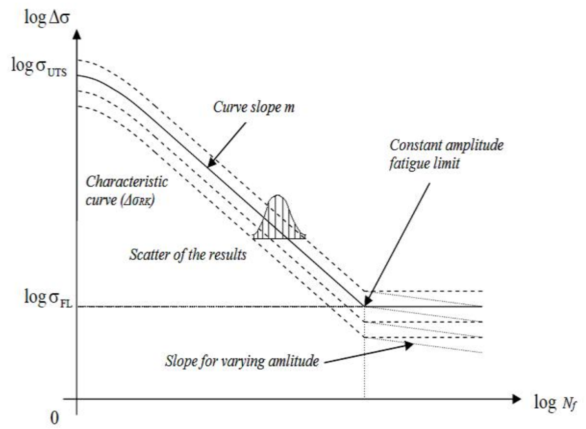

Fig 2. S/N curve with key positions.

The quantities in Figure are, the number of load cycles to failure, N_f, the fatigue limit, σ_{FL} , the ultimate strength, σ_{UTS} , the stress range, $\Delta\sigma$, and the curve slope, m.

The S/N curve is used to design the fatigue life of a certain component, either dependent on dimensioning for a certain fatigue life, e.g. infinite life, or for a given stress range.

3. Crack Initiation:
After welding, the crack initiation phase is already fully or partially passed due to the residual stresses. When calculating the weld's fatigue life the crack initiation phase is usually ignored. This is a conservative assumption for the fatigue life of the weld toe. An initial crack will occur between the bonded plates. The cracks length and placement are dependent on the welded design etc. Fatigue fracture possibilities are shown in Figure 9. Statistics indicate that the fractures occur more often in the weld toe than in the root.

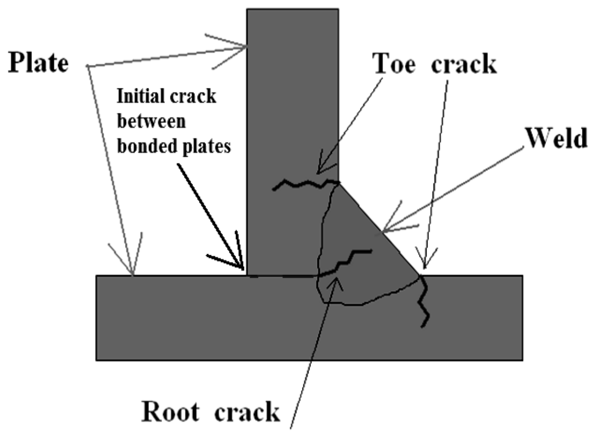

Fig 3. Fatigue fracture modes in a fillet weld.

VIII. WELDS AFFECT IN STRUCTURES

Welded joints strength at static load is generally regarded and assumed as the base materials' properties. One important exception is if the weld is exposed to an instability phenomenon, e.g. buckling. The problem is the residual stresses in the welded area. It causes decreased stress limits for an instability phenomenon. Dynamic loads have a significant effect on the welds fatigue life and it needs to be considered while dimensioning.

After the welding process the base material's properties have been changed and cracks have been initiated in the welded area. Different types of defects and discontinuities are also formed in and around the weld. Welds have often naturally sharp notch radii, which cause high notch stresses in the transition zone between the weld and the base materials. Therefore, a welded design will never achieve the same fatigue life as the unprocessed base material.

IX. WELDS EFFECT ON FATIGUE LIFE

It is in reality hard and almost impossible to precisely determine the fatigue life of a welded joint. The main reason for this is that there are never two welds that are equal. The welded joints never obtain exactly the same geometry and properties. The weld receives custom characteristics due to various factors that affect each other in a complex way and affecting the fatigue life of the weld.

The five factors with the greatest impact on the fatigue life are:

- Stress range
- Mean stress and residual stresses
- Material properties (Crack propagation/Crack initiation)
- Geometric stress concentrations
- Size and location of weld discontinuities

The factors effect depending on welded geometry, weld dimensions, the residual stresses and discontinuities size and type. The weld has geometric details that cause stress concentrations, especially at the weld ends, toes, root and internal defects. These stress concentrations leads to crack propagation and eventually fracture.

Tensile residual stresses can occur even in compressive loads due to micro cracking. Therefore, crack propagation and fracture also occur in compression due to positive residual stresses [12]. The crack propagation rate is basically independent of the material's strength. Thus, the weld's fatigue life is almost independent of the material's strength.

X. LITERATURE REVIEW

The welding of aluminum and its alloys has always represented a great challenge for researchers and technologists. Welding is a process that has produced low cost and high quality joints of aluminum alloys. For carrying out research work in any area, the first and an important phase is to review the available literature for the selected topic and the research problem can be formulated with clear objectives.

In order to formulate the present research problem along with the methodology that could be adopted for accomplishing this research work, the selective review of the relevant literature surveyed is presented briefly in following categories.

- Effect of Weld bead geometry profile on fatigue strength.
- Welding joint parameter.
- Fatigue analysis of joint.
- Effect of materials on weld strength.

1. Effect of Weld bead geometry profile on fatigue strength.

V. Caccese et. al. (2006) the effect of weld geometric profile on fatigue life of laser-welded HSLA-65 steel is evaluated. Presented results of cruciform-shaped fatigue specimens with varying weld profiles loaded cyclically in axial tension–compression. Specimens with a nearly circular-weld profile were created at 133 cm/min, as part of this effort, with a hybrid laser gas-metal-arc welding GMAW (L/GMAW) process. The ability of the laser-welding process to produce desirable weld profiles resulted in fatigue life superior to that of conventional welds.

Comparison of finite-element analyses, used to estimate stress-concentration factors, to the hot spot and mesh insensitive approaches for convergent cases with smooth weld transitions is presented in relation to the experimental results.

Vijay Kumar et. al. (2016) parametric study has been carried out, overlap length and gap size are selected as parameters to be varied during experimentation. The range of parameters is decided by referring literature. Design and validation of fixture is carried out for testing purpose. Specimens are prepared with greater accuracy and tests were carried out using UTM.

The results obtained from experimentation are compared with result obtained from simulation. Various design parameters are considered and effect of these parameters on tensile strength of lap welded joint is discussed. Analytical design procedure was adopted for designing fixture to hold the specimen. The specimen dimensions were finalized and specimens were prepared by varying overlap length and gap size.

K. V. Sastry et. al. (2015) conducted a simulation analysis of weld joint by varying its weld bead size. The T – joint Structural and fatigue analysis are done in solid works simulation. By observing the structural analysis results, all the joints are withstanding the applied pressure as the analyzed stress values are less than the yield strength of steel.The finite element analysis is used for the analysis of joints in the plane – stress condition, under static load. Fatigue analysis is done to analyze the fatigue usage by applying cyclic loading. By observing the analysis results, the fatigue usage is more for Butt Joint, so the life of the Butt Joint is less than other two joints.

Akkas et. al. (2013) experimental study has been performed to obtaining a relationship between the values defining bead geometry and the welding parameters and also to select optimum welding parameters. The welding parameters such as the arc current, arc voltage, and welding speed which have the most effect on bead geometry are considered, and the other parameters are held as constant. Four, three, and five different values for the arc current, the arc voltage, and welding speed are used, respectively.

So, sixty samples made of St 52-3 material were prepared. The bead geometries of the samples are analyzed, and the thickness and penetration values of the weld bead are measured.

Then, the relationship between the welding parameters is modeled by using artificial neural network (ANN) and neuro fuzzy system approach. Each model is checked for its adequacy by using test data which are selected from experimental results. Then, the models developed are compared with regard to accuracy. Also, the appropriate welding parameters values can be easily selected when the models improve.

P. J. Mistry et. al. (2016) analyzed the effect of welding arc current, voltage, welding speed, and the contact tube to work distance on weld bead geometry such as weld penetration, weld bead width, and height of reinforcement. It is essential to assess the effect of process parameters on specific bead geometry and shape relationships. The result of this study helps in improved understanding of applying control methods in forecasting the quality of Weldments during electric arc welding. The weld bead shape of a welded joint determines the mechanical properties of the joint.

Weld joint is considered to be sound and economical if it has a maximum penetration, bare minimum bead width, reinforcement and dilution. Enhancement in voltage will increase bead width, penetration, and reinforcement.

Voltage has a positive effect while welding speed has a negative effect on weld bead width. The relationship between current, voltage, speed and contact tube to work distance with penetration, bead width, reinforcement height, WRFF, WPSF and dilution is explained. It is evident that a correct fine-tuning of welding process parameters yields a sound weld.

Yajima et. al. (2011) evaluated the toughness against unstable brittle fracture from fatigue crack, which is initiated and propagated from the surface of the butt-welded joints of heavy-thick steel plates. Centre-notched small size tension test specimens were made from butt-welded joints of 70 mm heavy-thick steel plates and employed for the tests using this plate thickness as the specimen width.

In this paper, the test results are evaluated and investigated. When the tested electro gas-welded joint is applied to a large welded structure such as a mega-container ship, the allowable surface fatigue crack length along the welded bead is determined to be about 100 mm, when a nominal yield stress (460 N/mm2) is applied to the structure at -10 °C.

2. Welding joint parameter:

R.S. Sharma et. al. (2009) conducted fatigue analysisof advanced high strength steels (AHSS) that are essential to meet the demands of safety and fuel efficiency in vehicle. Fatigue tests show that TRIP:MS combinations exhibited excellent fatigue life, with fractures occurring in the base metal region of mild steel at values approaching the tensile strength of mild steel The fusion zone was free of defects such as cracks, porosity, voids, inclusions and others.

Hongtao Zhang et. al. (2014) Studied about Traditional gas metal arc welding process, that was modified to change the fluid flow in the molten pool by the rotary motion of filler metal (wire) accompanied by downward feeding process. The rotary motion of the wire transfer red additional momentum in to weld pool and best owed the latter with rotating fluid flow characteristics.

The rotating fluid flow of the weld pool decreased the penetration of the weld and refined the weld micro structure directly. The finer micro structure of the weld noticeably increased the tensile strength of the weld metal.

M Nagy et. al. (2017) focused on the application of numerical simulation to the design of welding parameters for the circumferential laser welding of thin-walled exhaust pipes from the AISI 304 steel for automotive industry.

Using the developed and experimentally verified simulation model for laser welding of tubes, the influence of welding parameters including the laser velocity from 30 mm.s−1 to 60 mm.s−1 and the laser power from 500 W to 1200 W on the temperature fields and dimensions of fusion zone was investigated using the program code ANSYS. Based on obtained results, the welding schedule for the laser beam welding of thin-walled tubes from the AISI 304 steel was suggested.

Chaudhari et. al. (2014) the effects of welding process parameters of Gas Metal Arc Welding (GMAW) on tensile strengths are found out..The GMAW process is an important in many industrial operations. Experiments have been conducted as per central composite design matrix to find the effect of process control parameters: voltage, wire feed rate, welding speed and gas flow rate on tensile strength.

The tensile testing of the welded joint is tested bya universal tensile testing machine and results are evaluated. MINITAB software is used to draw the direct and interactive graphs which show the effect of welding input process parameters on tensile strength.

Patel et. al. (2014) presents the influence of welding parameters like welding current, welding voltage, welding speed on ultimate tensile strength (UTS) of AISI 1030 mild steel material during welding. A plan of experiments based on Taguchi technique has been used. An Orthogonal array, signal to noise (S/N) ratio and analysis of variance are employed to study the welding characteristics of material & optimize the welding parameters.

The result computed is in form of contribution from each parameter, through which optimal parameters are identified for maximum tensile strength. From this study, it is observed that welding current and welding speed are major parameters which influence on the tensile strength of welded joint.

3. Fatigue analysis of joint:

Z. Barsoum et. al. (2009) a welding simulation procedure is developed using the FE software ANSYS in order to predict residual stresses. The procedure was verified with temperature and residual stress measurements found in the literature on multi-pass butt welded plates and T-fillet welds. The predictions show qualitative good agreement with experiments. The welding simulation procedure was then employed on a welded ship engine frame box at MAN B&W.

A subroutine for LEFM analysis was developed in 2D in order to predict the crack path of propagating fatigue cracks. The objective was to investigate fatigue test results from special designed test bars from the frame box where all test failed from the non penetrated weld root.

A subroutine was developed in order to incorporate the predicted residual stresses and their relaxation during crack propagation by ISO parametric stress mapping between meshes without and with cracks, respectively. The LEFM fatigue life predictions shows good agreement with the fatigue test result when the residual stresses are taken into account in the crack growth analysis.

F. Pakandam et. Al. (2010) they evaluated fatigue damage of different welded joints under uniaxial loading condition and its response on fatigue lifetime. The main variables influencing the fatigue life of a welded joint are: applied stress amplitude, material properties, geometrical stress concentration factor. Energy approaches were employed to evaluate the fatigue damage of various weld joints under uniaxial loading conditions.

Energy-fatigue life (W-N) curves were further discussed and comported for their capabilities in assessing fatigue life of various joints through different parameters including curve slope, life data scatter, and how readily coefficients/constants are determined and employed in the energy methods. The critical plane/energy approach was found to be the most suitable energy-based approach for fatigue damage and life assessment of welded joints by offering sharper W-N curves and less life scatter.

This approach also allowed employing readily available material coefficients/ properties as compared with the notch stress-intensity energy approach.

Hamza Khatib et. al. (2016) estimates the fatigue life of the weld bead. The results obtained using this approach will be used to analyze the notch effects on the fatigue life of welded joints. Two joint configurations are analyzed at the end of this paper. The paper include two main parts, the first section will focus on calculating the fatigue curve (S-N) of the welded joint. These calculations are based on the local deformations approach (S-N) that requires fatigue parameters related to material strength. Determination of these parameters will be provided through a set of correlation formulas and static characterization tests. At the end of this part, the calculated fatigue curves (S-N), will be compared to other curves of three different materials in order to evaluate the accuracy of results.

F. R. Mashiri et. al. (2002) Investigation of welded thin-walled (t=4 mm) hollow sections in the manufacture of lighting poles, traffic sign supports, swing ploughs, linkage graders, trailers, and haymakers. These structures are subjected to fatigue loading.

A review of current fatigue design guidelines showed that there is a lack of design rules for nodal joints made up of thin-walled (t<4 mm) hollow sections. This paper describes the tests carried out on welded thin-walled (t<4 mm) tube-to-tube T connections made up of square hollow sections under cyclic in-plane bending. Different failure modes were obtained during fatigue testing.

P. Selvakumar et. al. (2013) evaluated the fatigue performance using finite element analaysis, where the calculated stress can vary according to element sixze, type, etc. to overcome these challenges, battelle has developed a novel, mesh insensitive structural stress method. the stresses are calculated using the balanced nodal forces and moments obtained at the weld toe location from the finite element solutions.

Working with industry partners, Battelle has also developed a unified master S-N curve that combines the effects of joint geometry, loading modes and thicknesses.

T. Marin et. al. (2009) presented a structural stress approach to fatigue assessment of welded joints that integrates well with finite element modeling. The implementation in a post-processor program was successful and showed the potential for becoming a useful tool for the design and assessment of welded structures subjected to fatigue.

The mesh-insensitivity was confirmed; even coarse meshes provide adequate structural stress estimates so the method can be used in modeling complex structures. The procedure was applied to three different specimen geometries subjected to constant amplitude loading and predicted the correct location of the fatigue cracks. Finally, the use of the ASME master S-N curve proved to give accurate fatigue life predictions.

4. Effect of materials on weld strength:

Uygur et. al. (2014) evaluated effects of the shielding gas composition on tensile behavior, R=-1fatigue response and various temperature impact result of MIG welded low

International Journal of Scientific Research & Engineering Trends
Volume 7, Issue 6, Nov- Dec-2021, ISSN (Online): 2395-566X

carbon steel. In tensile test, the strength values are increased with increase of CO_2content, whereas the ductility decreased. In the fatigue test, the fatigue strength and number of cycles to failure enhanced as the content of CO_2 increased.

On this basis, an increase in CO_2 content causes improvement in the tensile strength where as the ductility is decreased. In the fatigue tests, S-N curves are quite similar in argon and CO_2 media, however they are shifted down and the fatigue strength is decreased CO_2 content is increased in the shielding gas.

Mitsuhiro Okayasu, et. al. (2013) they studied the fatigue and tensile properties of SPCC low carbon steel joints prepared by metal inert gas welding. the mechanical properties of the welded component in several localized regions, e.g., weld metal, heat affected zone(HAZ) and base metal, were investigated.

The tensile and fatigue properties of the weld metals were high compared to the other areas (base metal and HAZ) due to the precipitated Ti containing oxide inclusions in acicular ferrite containing oxide inclusions in acicular ferrite. The fatigue strength of our samples has been analyzed to provide a direct prediction of the fatigue life with modified Goodman diagrams.

S. Bhattacharya et. al. (2013)investigation on joining C45 medium carbon steel specimens using gas metal arc welding employing 100% carbon dioxide as the shielding gas, and to find out the optimal set of process parameters utilizing the AHP.

Three process parameters, weld speed, weld voltage and weld current were varied to evaluate the best combination of process parameters corresponding to an experimental run within the domain of the present work. As these process parameters have varying influence on weld quality, the AHP was employed to discover the experimental run(s) giving the desired quality of weld.

Ranjit et. al. (2016) presented fatigue analysis of a 3-D model of weld structure using ANSYS 15 FE Software. The study was carried on welding of two dissimilar materials in which SA106 and STS 304 are parent materials and M 309 is used as a filler material. Butt welded joint specimen using gas metal arc welding (GMAW) process was analyzed to cyclic loading. The specimen was modeled in ANSYS 15 Workbench. At first thermal analysis is done by giving a heat input which is equivalent to the heat generated by a GMAW welding process. In the next step, a structural analysis was carried out to obtain the mechanical response of the structural model, where the temperature history obtained from the first step was employed as a thermal load in the analysis. Then on the same specimen, fatigue analysis is conducted by applying cyclic loading.

XI. TYPES OF LOADING

Welding joints are applicable in wide range of engineering approach such as structural andmechanical engineering. There are various loading condition according to change in application such as the failure of welded joint due to torsion can be seen in flange welded to the hub transmitting torque.

In structural application such as bridges the joints are subjected to static as well as fatigue loading. In both the case of structural application the failure mode may be different due to change in loading condition (i.e. Reason for crack initiation in both the cases is different and life span of welded joint too.

Automobile uses spot welding for joining various frame components. During a high speed collision, these welded joints are subjected to impact loading. Lot of research has shown that the some kind of welded join behaves in different manner for different kind of loading condition and by keeping the joint geometry as it is. It gives different values of strength for different kinds of loading.

1. Welding Geometry:
Welding geometry is also affecting factor on the strength of the welding joint. In that, curvature radius affects on Stress concentration phenomenon. It is found that, the value of stress decreases when curvature radius increases. It is experimentally proved that, the curvature radius influenced on the variation of stress and fatigue life. A welding process having greater penetrating power calls for a narrow groove, lesser heat affected zone and distortion and lesser filler metal consumption.

Due to full penetration lead to decrease in quality. The over penetration of electrode causes the melting or burning away of the base metal at the toe of the weld this resulting from fundamental difficulties in a welding operation such as cracking and porosity. In some research paper it is found that, stress also decreased by increasing welding angle. Too great travel angle results into a bead with poor penetration. The quality of the weld metal may be determined to a marked degree by the angular deposition of the electrode to the work.

2. Specimen Preparation:
Lot of research has been carried out for finding the effect of varying various parameters onstrength of welded joint. These parameters are loading conditions, welding defects, environmental effects and process parameters. Maximum results are obtained with the help ofANSYS software.

Very less amount of work carried out experimentally. It is observed that in some literature, the researcher worked on the weld geometry in which varying the gap size and overlapping length for same plate and same loading conditions gives different tensile strength.

XII. CONCLUSION

The mechanisms of fatigue failure in various kinds of structures, as well as preventative strategies, were addressed in this literature review. Because fatigue is so important in applications with repeated loads. It assists in identifying regions of failure and, as a result, correctly forecasting the service life of the application in which the welded structure will be employed.

Welded joint fatigue life may be assessed with more precision, allowing designers to design with a better-known fatigue safety factor. As a result of the methodology, lighter military vehicles with appropriate fatigue performance may be designed and built. It also allows for cars to have greater supportability qualities and to be owned at a lower cost.

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