A Review on different process parameters of welding

[1]Chetan Chadokar, [2]Amit Kaimkuriya

[1,2]Millennium Institute of Technology, Bhopal

***Abstract*: The performance of the welded joints depends on the different process parameters of welding. Many parameters affect the weld ability of the material like base material, arc resistance, current and many others. Different researchers have performed numerical, experimental and analytical studies to optimize the different process parameters of welding. It is necessary to review the different parameters of welding. Here in this paper, it reviews the different parameters of welded joints.**

***Keywords*: welding, process parameters, review**

Introduction

Welding is a common process for joining metals using a large variety of applications. Welding occurs in several locations, from outdoors settings on rural farms and construction sites to inside locations, such as factories and job shops. Welding processes are fairly simple to understand, and basic techniques can be learned quickly. Welding is the joining of metals at a molecular level. A weld is a homogeneous bond between two or more pieces of metal, where the strength of the welded joint exceeds the strength of the base pieces of metal. At the simplest level, welding involves the use of four components: the metals, a heat source, filler metal, and some kind of shield from the air. The metals are heated to their melting point while being shielded from the air, and then a filler metal is added to the heated area to produce a single piece of metal. It can be performed with or without filler metal and with or without pressure. There are several types of welding that are used today. Gas Metal Arc Welding (GMAW) or MIG, Gas Tungsten Arc Welding (GTAW) or TIG, Flux Core Arc Welding, and Stick Welding are the most common found types in industrial environments. Welding is distinct from lower temperature metal-joining techniques such as brazing and soldering, which do not melt the base metal. In addition to melting the base metal, a filler material is typically added to the joint to form a pool of molten material (the weld pool) that cools to form a joint that, based on weld configuration (butt, full penetration, fillet, etc.), can be stronger than the base material (parent metal).

Pressure may also be used in conjunction with heat, or by itself, to produce a weld. Welding also requires a form of shield to protect the filler metals or melted metals from being contaminated or oxidized. Many different energy sources can be used for welding, including a gas flame (chemical), an electric arc (electrical), a laser, an electron beam, friction, and ultrasound. While often an industrial process, welding may be performed in many different environments, including in open air, under water, and in outer space.

Developments continued with the invention of laser beam welding, electron beam welding, magnetic pulse welding, and friction stir welding in the latter half of the century. Today, the science continues to advance. Robot welding is commonplace in industrial settings, and researchers continue to develop new welding methods and gain greater understanding of weld quality.

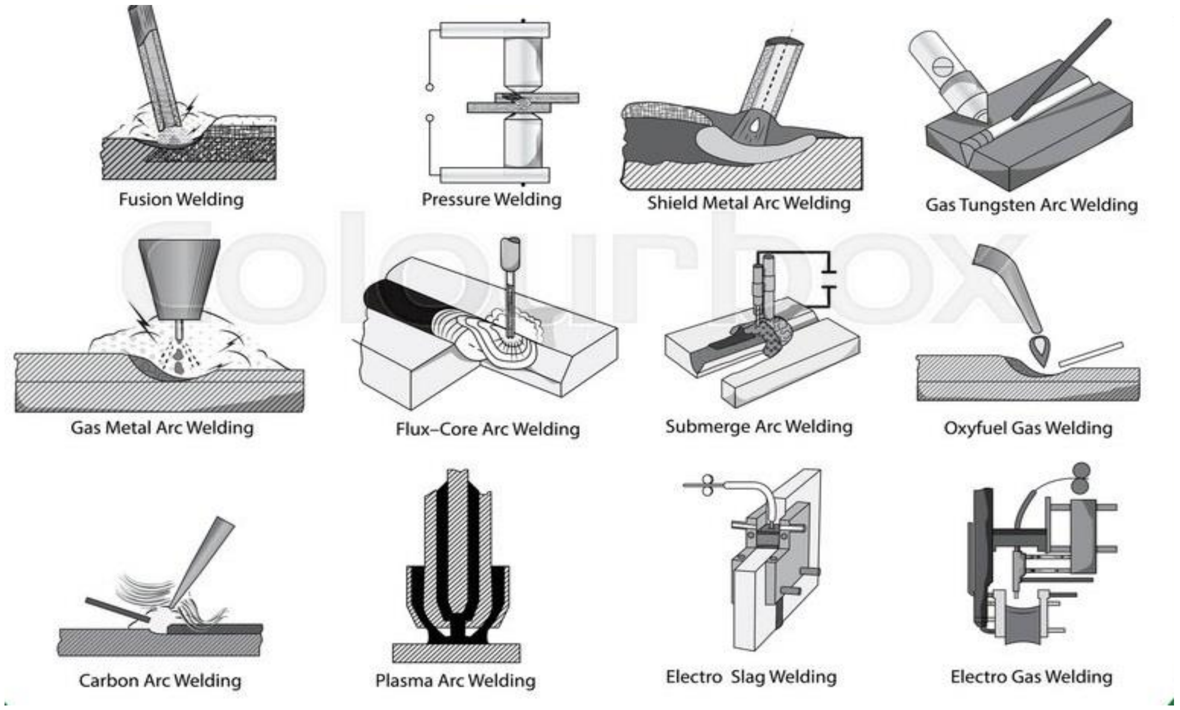

Fig 1. Schematic gives the diagram of different welding process.

Design of fillet weld

Fillet welds are broadly classified into side fillets and end fillets. When a connection with end fillet is loaded in tension, the weld develops high strength and the stress developed in the weld is equal to the value of the weld metal. But the ductility is minimal. On the other hand, when a specimen with side weld is loaded, the load axis is parallel to the weld axis. The weld is subjected to shear and the weld shear strength is limited to just about half the weld metal tensile strength. But ductility is considerably improved. For intermediate weld positions, the value of strength and ductility show intermediate values. In many cases, it is possible to use the simplified approach of average stresses in the weld throat. In order to apply this method, it is important to establish equilibrium with the applied load.

Existing Research work

Many of the researchers have perform different analysis to identify the different parameters of wielded joint, some of the work is concluded in the below section.

1. **Li et.al (2018)** This paper studies under traffic loads, orthotropic steel bridge slabs suffer from an obvious fatigue problem. In particular, fatigue cracking of diaphragms seriously affects application and development of orthotropic bridge slabs. In the paper, based on cracking status quoof an orthotropic deck diaphragm of a large-span bridge, experimental tests were formulated to test stress distribution states of the diaphragm. The finite element software ABAQUS was used to establish a finite element model of the orthotropic deck diaphragm; numerical simulation was conducted on the basis of the experiments.

2. **Pradana et.al (2017)** This paper presents two simplified procedures for the calculation of the Effective Notch Stress (ENS) on non-overlapping circular hollow section (CHS) K-joints. The proposed procedures aim to alleviate the modelling challenges associated with the traditional ENS calculation on joints with complex geometry, such as the CHS joints. The first procedure is an extension of the recently proposed extrapolation method, similar to the extrapolation in the widely-used Structural Hot-Spot Stress (SHSS) approach. The second procedure provides ENS estimations based on the parametric relationship between the ENS and SHSS. This paper proposes two simplified procedures for the calculation of the Effective Notch Stress (ENS) on non-over lapping CHS K-joints, with the aim of alleviating the difficulties in the modelling procedure associated with the traditional ENS calculation.

3. **Shen et.al (2017)** This paper puts forward a kind of calculation method of estimating fatigue crack initiation life by considering welding residual stresses as initial stresses. The numerical method could be used to quantitatively analyse the influence of residual stresses on the cumulative fatigue damage. In order to gain the distribution of weld-induced residual stresses, the FE analyses as well as measurements were carried out. Based on critical plane approach, analysis of damage parameters was performed considering both welding residual stress and biaxial loads. Subsequently, validity of the proposed numerical method is verified by analysing fatigue test results for several typical welded joints.

4. **Vodzyk et.al (2016)** In this paper welded joints are subjected to cyclic operational conditions tend to fail due to fatigue failure. This type of failure can occur at a stress level below the yield strength of the material. Design to resist such failures and the early detection of the internal flaws are the basic components of the damage tolerance design philosophy, which have significant impact in terms of saving time, money and people's lives. Computational analysis of welded structures has become a major tool in performing fatigue analysis of welded structures and conducting conventional experimental tests. The assessment of residual life of the welded structures in this thesis is done through development of an algorithm for performing fracture mechanics analysis and fatigue analysis using the VrSuite software. The objectives of this investigation included: Define an algorithm to automate the determination of the linear elastic stress intensity factors in welding components containing residual stresses due to welding in combination due to in-service loads.

5. **Yamada et.al (2015)**In this analysis, over 150,000 highway bridges exist in Japan and about 47 present of the bridges will be over 50 year sold in 2026. The Ministry of Land, Infrastructure, Transport and Tourism (MLIT) launched nation-wide projects toinspect and to establish maintenance plans. About one half of the highway bridges were steel bridges with concretes labs. Due to heavy truck traffics being operated in or between industrial cities, some of which were illegally overloaded, severe deteriorations to concrete slabs and fatigue cracks in steel girders have been observed. Fatigue cracks in orthotropic steel decks were also found. It is urgent to tackle such fatigue cracks observed in welded joints of steel bridges.

6. **Rong et.al (2014)** In the given review the orthotropic steel decks are used in beams and cable-supported bridges. Fatigue cracks of the vertical rib–deck welded joint have been found in some of the bridges. In this paper, the structural hot spot stress (SHSS) approach is applied to evaluate the rib–deck fatigue. Refined solid models are built using a multi-sub-model technique. Stress around the weld tip is analysed and effects of the weld profile, the weld toe radius and mesh size are discussed. The SHSS is analysed using the surface stress extrapolation method, the stress linearization method and the 1 mm stress method. Fatigue strength of the joint based on the SHSS is proposed. Results of this study show that the refined multi-sub-model considering the weld detail can reflect the mechanical behaviour of the rib–deck joint.

7. **Tecchio et.al (2012)** This paper analyses the effect of fatigue is particularly relevant in steel bridges since the influence of traffic load cycles on serviceability limit stress values is very high if compared to relatively low dead weights. Orthotropic steel decks, directly subjected to traffic loads, are very sensitive to fatigue: in most cases, fatigue defects appear as cracks in the top plates, longitudinal ribs and the bracing of the deck. In this paper the case study of a 20 years old box girder bridge affected by

fatigue problems is presented: the bridge has an orthotropic steel deck with three spans whose total length is 152m. The bridge is located in one of the busiest Italian highways, the "Milan-Venice" A4 highway, characterized by high volumes of heavy truck loads. From the inspections carried out, it was observed an extended crack scenario due to fatigue phenomena.

8. **Meneghetti et.al (2012)** This paper deals with the local approach based on the Notch Stress Intensity Factors (NSIFs) to analyse the fatigue behaviour of welded joints. In transverse load carrying fillet-welded joints, failure may occur either at the toe or at the root, depending on the geometry. At the toe, due to the flank angles that are usually encountered in practice, mode I local stresses are singular, while mode II stresses are not. Conversely, at the root of the particular joints analysed in the present paper both mode I and mode II stresses are singular and must be taken into account in fatigue assessments. Recently, a simplified finite element-based method to readily estimate the mode I NSIF and mode II SIF has been proposed (the so-called Peak Stress Method, PSM). In the present paper a link between the peak stresses and the strain energy density averaged in a structural volume has been shown.

9. **Aygul et.al (2012)** In this analyses the fatigue life estimation of orthotropic steel bridge decks using the finite element method is most frequently associated with the application of the structural hot spot stress approach or the effective notch stress approach, rather than the traditional nominal stress approach. The application of these approaches to a welded joint with cut-out holes in orthotropic bridge decks, where it is not easy to distinguish the non-linear stress caused by the notch at the weld toe from the stress concentration effect emanating from the hole in the detail, was investigated. The results of the finite element calculations were compared with the results of the fatigue tests which were carried out on full-scale specimens. In this paper, the applicability of the most common fatigue life assessment methods using the FEM was investigated on an orthotropic bridge detail.

10. **Sim et.al (2012)** This paper is about fatigue tests of full-scale orthotropic steel decks that were recently conducted to evaluate the fatigue performance of rib-to-deck partial joint-Penetration (PJP) groove welded joints. The test results indicated that rib-to-deck joints are more prone to fatigue cracks in the deck plate than in the rib wall. A shallower weld penetration (for example, an 80% PJP) also appeared to have a slightly higher fatigue resistance than a deeper one (for example, a 100% weld penetration).

11. **Saiprasertkit et.al (2011)** this paper deals between base metal and weld deposit were studied. Low and high cycle fatigue tests were performed on specimens with five matching conditions and two sizes of incomplete penetration. Observation of the specimens revealed thatcrack propagation paths differ by low and high cycle loading conditions and that failure life was dominated by crack propagation. Besides, it was found that the effect of the strength under matching on the fatigue strength becomes large in low cycle fatigue region by significantly reducing fatigue life of the specimen. Crack initiation life is very small, thus crack propagation is dominant in the total life. Crack propagation path of low and high cycle fatigue are different.

12. **Alam et.al (2009)**In this paper a simplified fatigue and fracture mechanics based assessment methods are widely used by the industry to determine the structural integrity significance of postulated cracks, manufacturing flaws, service-induced cracking or suspected degradation of engineering components under normal and abnormal service loads. In many cases, welded joints are the regions most likely to contain original fabrication defects or cracks initiating and growing during service operation. The welded joints are a major component that is often blamed for causing a structure failure or for being the point at which fatigue or fracture problems initiate and propagate. Recent trends of fracture research include dynamic and time-dependent fracture on nonlinear materials, fracture mechanics of microstructures, and models related to local, global, and geometry-dependent fractures.

13. **Sonsino et.al (2009)** In this analysis the structural durability of welded structures is determined by the interaction of different influencing parameters such as loading mode, spectrum shape, residual stresses and weld geometry among others. Examples from plant, offshore, transportation and automotive engineering show how these parameters influence the fatigue life and to what extent they are considered in design codes. Especially, under spectrum loading, the stress decreasing effect of tensile residual stresses is not as high as under constant amplitude loading; this knowledge benefits light weight design. The overloads harmed only the low strength joints under pulsating bending. Residual stresses and loading mode could be observed only for the low strength steel S355M under pulsating bending; the joints failed within the first load sequence with overloads.

14. **Baik et.al (2008)** In this analysis fatigue tests have been carried out on three types of non-load-carrying fillet welded joint subjected plate bending, such as single-side fillet welded joint, T-shaped fillet welded joint and cruciform fillet welded joint. Fatigue failure of each welded joint has been demonstrated. The test results show that fatigue crack forms flat semi-ellipse during crack propagation and propagates to about 80% of plate thickness before failure. The fatigue strength and life recorded under bending test have been examined and compared with the previous results obtained by tension test. The aspect ratio, a/c, decreases at the early stage of crack propagation and then maintain the lower values until failure, because small and multiple cracks coalesceat an earlier time before forming long and shallow semi elliptical cracks. A comparison of fatigue crack propagation life associated with a type of loading, tension and bending, shows that bending obviously contributes to the longer fatigue life than tension.
15. **Gustafsson et.al (2006)** In the present paper it is well known that the fatigue strength of welded joints decreases when plate thickness increases. This decrease in fatigue strength is known as the thickness effect. In many standards for fatigue design the thickness effect is taken into account for joints with plate thickness typically greater than 25 mm. Previous work has mainly

been focused on joints with plate thickness between 12-200 mm. less attention has been paid to thinner joints. Published investigations on joints with sheet thickness 2-12 mm show an increase of fatigue strength with decreasing sheet thickness. In the present study results from constant amplitude fatigue testing of non-load carrying welded joints in high strength steel of thickness 3-12 mm are presented.

Conclusion

Through literature it is found that, optimization of different parameters of wielding is very necessary to increase the strength of the wielded joint. The strength of the wielded joints depends mainly on the corner edge fillet profiles, which is created prior to welding.

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