Journal of Manufacturing Engineering, June 2020, Vol. 15, Issue. 2, pp 034-037

EFFECT OF ELECTRIC ARC WELDING ON IMPACT OF DIFFERENT MILD STEEL WELD GEOMETRIES

***Vaishak NL[1], Suhas [1], Vilas K Bhosle[2] and Prashanth T[3]**

[1] Department of Mechanical Engineering, Sahyadri College of Engineering and Management, Mangalore, Karnataka-575007, India
[2] Department of Mechanical Engineering, Birla Institute of Technology, Offshore campus, Ras-Al-Khaimah-41222, UAE
[3] Department of Mechanical Engineering, Global Academy of Technology, Bengaluru, Karnataka-560098, India
https://doi.org/10.37255/jme.v15i2pp34-37

ABSTRACT

The effect of welding parameters (current, electrode diameter) on the impact of low carbon steel specimens was investigated in this work. Two different geometries namely square butt welded joint and double V welded joint were created. The welding operation was carried out at three different current for welding currents of 90, 110 and 130 amps and electrode diameters of 2.5, 3.2 and 4mm respectively. A Charpy impact testing machine was used to evaluate the impact of the welded samples. It was observed that a low current of 90 Amps for all the welding electrode diameters produced high impact values for both the welding geometries. Also, the 3.2 mm electrode diameter was found to be more suitable for welding the square butt and the double V geometry as it yielded higher impact values. Additionally, the double V geometry showed better performance when compared to the square butt geometry for all the combinations of welding currents and electrode diameters.

Keywords: *welding, current, electrode diameter and Charpy impact test.*

1. Introduction

Welding is a material joining process incorporated for joining of dissimilar metals or thermoplastics by fusion. In welding process, heat is applied to melt the base metal and a filler material is generally added to the joints to frame a pool of liquid material that cools to shape a joint that is generally more dependent than the base material. Some best-known welding strategies which are generally employed in ventures are oxi-fuel welding, shield metal circular segment welding, TIG welding, MIG welding, and submerged welding. In spite of the fact that we are utilizing heat for joining of metal it causes some great and awful impact on the metal properties, likewise nature of a good weld relies on sort of welding material, electrode, welding method etc. [1, 2]. In this task we are utilizing SMAW with various welding strategy on steel plate with V-grove on it to check and examine the progressions in impact toughness of plate.

One of the confinements of the two welding forms said above is the low power density of the heat source [3]. The power thickness increments from a gas flame to an electric arc and high energy pillar beam. As the power thickness of the heat source expands; the warmth contribution to the work piece that is required for welding diminishes. The part of the work-piece material presented to a gas fire heats up so gradually that before any liquefying happens, a lot of heat is as of now directed away into the main part of the work piece. Unreasonable heat can make harm to the work-piece, including debilitating and bending [4]. Be that as it may, control of welding parameters, for example, welding current, electrode diameter, voltage and speed can decrease the measure of heat contribution to the weld. Furthermore, edge readiness preceding welding can altogether influence the nature of the weld.

Clearly, mild steel requests weld metal possessing predominant properties, i.e., a mix of high strength and high toughness. This is because of its organization that comprises of 0.001-0.1wt% of alloying components, for example, V or Ti [5]. An acicular ferrite in ield metals and gentle steels happen to be an attribute to its blend inducing high strength [5, 6, and 7]. It is additionally realized that the mechanical properties of welded steel duly rely upon a few parameters like level of carbon and others components, for example, sulfur for phosphorus. Low carbon steels that have funder 0.25% carbon, show great welding capacity, since they can be for the most part welded without unique safety measures utilizing the greater part of the accessible procedures. Concerning the past examinations identified with low carbon steel welding,

**Corresponding Author - E- mail: nlvaishak1989@gmail.com*

Gural et al. [8] have contemplated the heat treatment in two stages and its consequences for microstructure and mechanical quality subsequent to welding of the low carbon steel. Then again, Eroglu and Aksoy [9] explored the impact of grain measure on microstructure and toughness of inter-critical heat affected influenced zone of low carbon steel. Concerning the present examination, it has been researched the impact of welding on low carbon steel utilized for making of gas chambers. Based on the literature cited above, the authors observed that not much of research has been conducted on analyzing the impact toughness for different geometries. Therefore, the present study is one such attempt to determine the impact of low carbon steel for square butt and double V joint. The results obtained from these experiments could help in clearly revealing the energy, current, electrode sizes and material joints used for welding such as to help bring about changes in procedures and techniques to create green welding.

2. Materials and Methods

Welding operations have been carried out for two specimens, i) square butt joint and iii) double V joint. The dimensions of the specimens were 12 mm × 12 mm × 5.5 mm as shown in the Fig. 1. Prior to welding the specimens, the surfaces and edges were prepared by using a wire brush. The mild electrode has-been used to conduct welding operations. Well-equipped DC generators possessing rectifiers having the potential of supplying current up to and extent of 600 Amps were used. The material parts were abutted by leaving a 3mm gap in between. The gap is assumed to be filled by the root pass, hot pass, fill, cap and bead. The welding was done under controlled and varying welding variables. The slag deposited over the welded samples was removed by means of a hammer by tapping. This was done in order to ensure that the gap was filled perfectly. The completely filled welded joints were there after ground with grinding machine to standard dimension.

The samples were welded at constant voltage with the current being varies by giving power inputs and speed held constant. The currents used were 90 Amps, 110 Amps and 130 Amps. The diameters of the electrode were 2.5 mm, 3.2 mm and 4mm respectively. Amid welding, the electrode is made to pass through the groove until the point wherein the infiltration and advancement of the weld pool were accomplished to the thickness level of the bar. Post welding, the welded samples were cooled at atmospheric conditions and the slag covering the weld was removed by means of an iron brush. The welded samples were then subjected to impact test fracture as per ASTM E23 standards. The impact tests were conducted on the samples placed on the anvil. The pendulum was set to predetermined level 220ft.Ib (298.642 J) and released to strike and fracture the fusion zone of the welded sample. The value of energy impacted was taken and recorded.

3. Results and Discussions

The effect of welding current and welding electrode on impact energy for different welded joints has been examined. The impact test was carried out using the Charpy impact test rig. The welded junction on the face directly opposite to where the pendulum strikes the test piece. The energy absorbed in breaking the test piece is measured in joules.

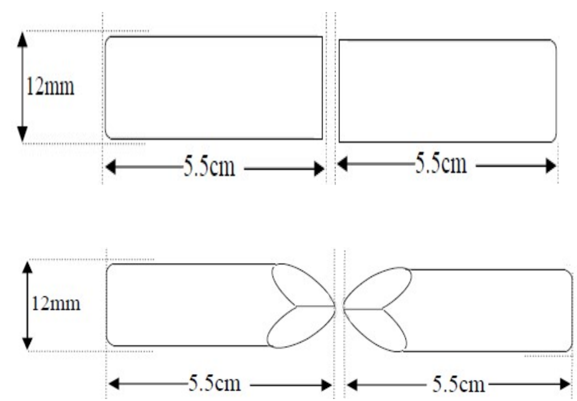
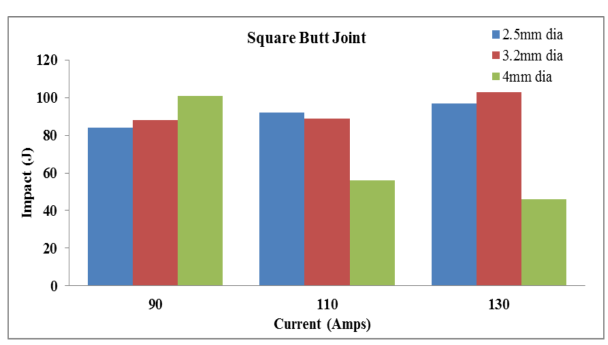


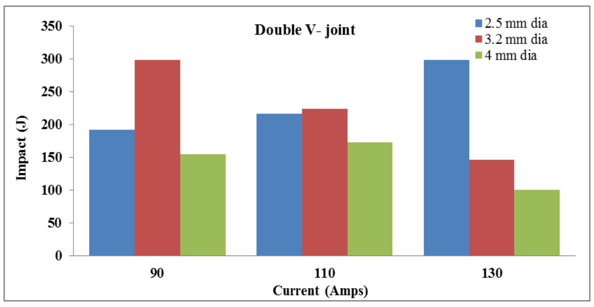
Fig. 1. Square butt and Double V welded specimen for impact testing.

Effect of current and electrode diameter on impact toughness of welded specimens

From Fig. 1(a) for a square butt joint, it has been observed that the impact of the welded specimen increased when the welding current was increased from 90 Amps to 130 Amps. For a combination of electrode diameter 3.2 mm and current of 130 Amps, maximum impact was observed.



(a)



(b)

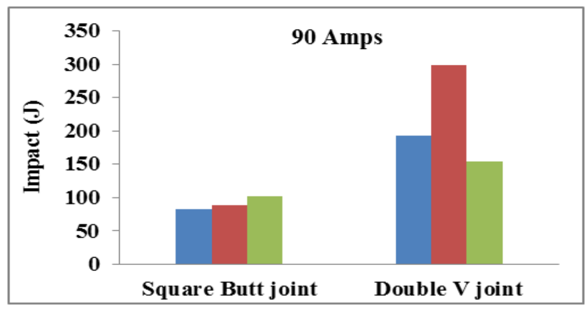
Fig. 1 Effect of current on the Impact of the welded joint, (a) Square Butt joint; (b) Double V joint.

On the other hand, the 4 mm electrode diameter observed the highest impact for a current of 90 Amps, however experienced a steep decrease of almost 45% and 55% for a current of 110 Amps and 130 Amps respectively. This decrease in the impact value may be due to high value of the electrode diameter. It is to be noted that, when a high diameter electrode is used for welding purpose, electrode fails to consume the space between the welded junctions, thereby leading to the creation of voids due to which the impact toughness of the weld drastically decreases [8, 9]. Moreover, the large diameter electrode for any combination of current tends to produce high amount of residual stresses in the heat affected zone of the welded junction. Thus, in most cases, it is favorable to conduct the heat treatment of specimens post welding and then subject them to impact testing [7, 9]. The 2.5 mm and 3.2 mm electrode diameters showed reasonably good and consistent impact values for all welding currents.

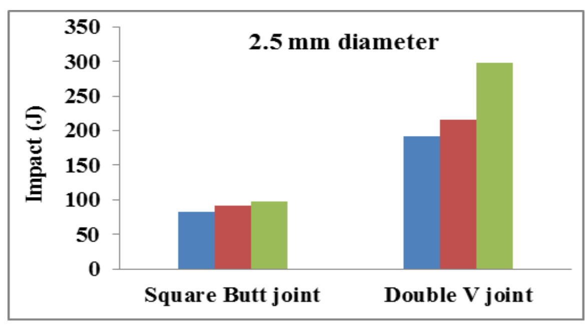
For a double V welded joint as shown in Fig. 1(b), the maximum impact was observed at for a combination of electrode diameter of 3.2 mm and welding current of 90 Amps. Additionally, the 4 mm electrode diameter observed a low impact for almost all the three welding currents implemented in the study. Moreover, as it was in the case of a square butt joint, the 2.5 mm and 3.2 mm electrode diameter showed a reasonably good impact values for all combinations of currents for the double V welded specimen. Therefore, from the above results, it can be thoroughly construed that, an electrode diameter of 3.2 mm and current of 90 Amps would prove to be ideal for gaining higher impact values for both the welded specimen of square butt and double V welded joints. Therefore, one should be careful on deciding the welding currents and welding electrode diameters as its effect will largely form the basis for conclusions regarding the sustainability of various joints to impact testing.

Performance evaluation of different welding geometries subjected to impact

Fig. 2 shows the effect of various weld geometry on the impact of current and electrode diameter. In order to facilitate this comparison, the impact values were recorded for the lowest value of current kept constant at (90 amps) with electrode diameters varied for 2.5, 3.2 and 4mm respectively shown in Fig. 2(a).



(a)



(b)

Fig. 2 Comparison of butt joint and double V joint for specific (a) welding current; (b) welding electrode diameter.

It is observed that the double V joint sample has the highest impact when compared to the square butt joint. In Fig 2 (b), the impact values were recorded for the lowest value of electrode diameter kept constant at (2.5 mm) with currents varied for 90, 110 and 130 amps respectively. A similar observation wherein the double V joint sample had the highest impact when compared to the square butt joint was observed.

4. Conclusions

The present study determines the impact of low carbon steel for square butt and double V joint. The following conclusions have been drawn:

i. When a low current of 90 amps is used with welding electrode diameters of 2.5mm, 3.2mm and 4mm, high impact values were recorded for the welded specimen of square butt and double V welded joints.
ii. The 3.2 mm diameter electrode was found to be more suitable for welding the square butt geometry the double V geometry as it yielded higher impact values.
iii. The double V joint sample has the highest impact when compared to the square butt joint for all combinations of currents and electrode diameters.

References

1. *Armentani E, Esposito R and Sepe R (2007), "The effect of thermal properties and weld efficiency on residual stresses in welding", J. Achievements Mater. Manufact. Eng., vol. 20: 319-322.*

2. *Jariyaboon M, Davenport A J, Ambat R, Connolly B J, Williams S W and Price D A (2007), "The effect of welding parameters on the corrosion behaviour of friction stir welded AA2024-T351", Corrosion Sci., vol. 49: 877-909*

3. *Kou S (2003), "Welding Metallurgy". 2nd Edition, John Wiley& Sons, Inc., Hoboken, New Jersey.*

4. *Gery H, Long P and Maropoulos E, (2005), "Effects of Welding Speed, Energy Input and Heat Source Distribution on Temperature Variations in but Joint Welding". J. Mater. Proc. Technol., vol. 167: 393-401.*

5. *Lee C H and Bhadeshia H K D H (2003), "Effect of plastic deformation on the formation of accicular ferrite", Mater. Sci. Eng. A, vol. 360: 249-257.*

6. *Yayla P, Kaluc E and Ural K (2007), "Effect of welding processes on the mechanical properties of HY 80 steel weldments, Mater. Des., vol. 28: 1898-906.*

7. *Weihua S, Guodong W, Jiming Z, Dianxiu X and Hao S (2009), "Microstructural characterization of high heat input welding joint of HSLA steel plate for oil storage construction", J. Mater. Sci. Technol., vol. 25: 857-60.*

8. *Güral A, Bostan B and Özdemir A T (2007), "Heat Treatment in Two Phase Region and its Effect on Welding of a Low Carbon Steel", Mater. Des., vol. 28: 897-903.*

9. *Eroglu and Aksoy M (2000), "Effect of Initial Grain Size on Microstructure and Toughness", Mater. Sci. Eng. A, vol. 286: 289-297.*

