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Optimization of Process Parameters of Shielded Metal Arc Welding (SMAW) For Stainless Steel Welding

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Abstract

Among the welding processes for stainless steel, shielded metal arc welding (SMAW) or stick welding is the most common. This process is used for stainless steel welding all over the country. The aim of this project was to find out the optimum current for stick welding. For this reason, a survey has been conducted in the welding workshops of Dhaka, Khulna and Chittagong to gather information about the most common electrode size and current they use to weld 12mm stainless steel rod. From the collected data welding has been performed on 12mm diameter stainless steel rod by using electrode size of 10 and 12 under different current levels. After performing the welding, tensile and bending test has been done for the welded joints. By analyzing the results from these two tests the optimum current for electrode size 10 and 12 has been determined for better welding performance.

Keywords: *stick welding, Shielded Metal Arc Welding, Stainless Steel welding, current for stick welding.*

1. Introduction

Welding is a fabrication or sculpture process that joins materials, usually metals or thermoplastics, by causing coalescence. Coalescence is produced by heating to suitable temperatures with or without the use of either pressure or filler metal. Heat is generally produced by supplying alternating or direct current. Stainless steel is a form of steel which does not stain, corrode or rust by atmosphere like ordinary steel. In metallurgy, stainless steel, also known as inox steel or inox from French “Inoxydable”, is defined as a steel alloy with a minimum of 10.5 or 11% chromium content by mass. In Khulna region stainless steels are welded by Shielded Metal Arc Welding process in most of the welding shops. Shielded metal arc welding (SMAW) is also known as manual metal arc (MMA) welding, flux shielded arc welding or informally as stick welding. This is a manual arc welding process that uses a consumable electrode, coated in flux to lay the weld. An electric current, in the form of either alternating current or direct current from a welding power supply, is used to form an electric arc between the electrode and the metals to be joined. This is the cheapest process to weld stainless steel. There are some other standard processes to weld stainless steel like MIG and TIG. But these processes are expensive and need expertise to perform welding operation. So, it is essential to study the effects of various process parameters of Shielded metal arc welding (SMAW) on weld quality and to optimize the process parameters to obtain good quality weld of stainless steel by using Shielded metal arc welding (SMAW) process.

2. Objectives

The objectives of this project work were given below:
i) To study about Shielded metal arc welding (SMAW) process.
ii) To gather information about the local Shielded metal arc welding (SMAW) techniques used in Khulna region to weld stainless steel.
iii) To gather information about various types of welding process and electrodes used in other region of Bangladesh for stainless steel welding.
iv) To optimize the Shielded metal arc welding (SMAW) parameters for proper stainless steel welding.

3. Plan of Work

The objectives of this project work has been fulfilled by the following steps:
i) Studying about Shielded metal arc welding (SMAW) process.
ii) Studying about various types of electrodes that can be used in Shielded metal arc welding (SMAW) to weld stainless steel.
iii) Visiting the local welding shops to gather information about their welding processes and equipments used in stainless steel welding. Also to collect similar information from other regions of Bangladesh
iv) Welding of stainless steel at various welding conditions by Shielded metal arc welding (SMAW) process and determination of the weld characteristics and mechanical properties.
v) Optimization of the Shielded metal arc welding (SMAW) process for stainless steel welding.

4. SMAW-Shielded Metal Arc Welding

SMAW is an electric arc welding process in which heat for welding is generated by an electric arc between a covered metal electrode and the base metal. The electrode coating provides shielding. The welding equipments for this process are currently the most inexpensive compared to the other welding methods. However, electrodes do create some inefficiency, such as stub loss and a slag coating, which must be removed.

To strike the electric arc, the electrode is brought into the contact with the work piece by a very light touch with the electrode to the base metal then is pulled back slightly. This initiates the arc and thus the melting of the work piece and the consumable electrode and causes droplets of the electrode to be passed from the electrode to the weld pool. As the electrode melts, the flux covering disintegrates, giving off shielding gases that protect the weld area from oxygen and other atmospheric gases. In addition, the flux provides molten slag which covers the filler metal as it travels from the electrode to the weld pool. One part of the weld pool, the slag floats to the surface and protect the weld from contamination as it solidifies. Once hardened, it must be chipped away to reveal the finished weld. As welding progress and the electrode melts, the welder must periodically stop welding to remove the remaining electrode stub and insert a new electrode into the electrode holder. This activity, combined with chipping away the slag, reduced the amount of time that the welder can spend laying the weld, making SMAW one of the list efficient welding processes. In general, the operator factor, or the percentage of the operators time spent laying weld, is approximately 25%. The actual welding technique utilized depends on the electrodes, the composition of the work piece and the position of the joint being welded. The choice of electrode and welding position also determine the welding speed. Flat welds required the least operator skill and can be done with the electrode that melt quickly but solidifies slowly. This permits higher welding speed. A slope, vertical or upside down welding requires more operator skill and often necessitates the use of an electrode that solidifies quickly to prevent the molten from flowing out of the weld pool. However, this generally means that the electrode melts less quickly, thus increasing the time required to lay the weld.

5. Experimental Procedure

The project work has been completed by several activities in a sequential way. First of all information about stainless steel, electrodes, welding parameters and details about shielded metal arc welding process has been gathered. This information has been gathered from several books, previous year thesis paper and also from various sites in internet. For this project work data have been collected from various shops in three different cities (Dhaka, Chittagong and Khulna) of Bangladesh. From these shops data for required current and electrode size for lap joining of two 12mm stainless steel rod have been collected. The amount of current and electrode size varies from shop to shop depending on worker's skill. Some collected data are given in a tabular form below:

Table-1: Data collected from various shops in three different cities:

Number of observations	Khulna		Dhaka		Chittagong	
	Electrode size	Current (amp)	Electrode size	Current (amp)	Electrode size	Current (amp)
01.	10	200	10	150	12	160
02.	12	80	12	80	12	140
03.	12	80	10	200	10	80
04.	12	100	10	140	10	140
05.	12	80	10	100	10	180
06.	10	150	12	70	12	120
07.	14	120	12	170	12	70
08.	10	140	10	130	12	100
09.	10	100	10	150	10	120
10.	12	160	12	100	10	180

After gathering the information about shielded metal arc welding process for stainless steel, the welding has been performed by using the data for particular electrode with particular current level that has been collected from various cities. The welding was performed on stainless steel rod of 12mm diameter. The electrodes used in this welding were from a company named Gemini. During the welding the gap between the rods was equal to the diameter of the electrode. The welding have been performed by using electrode of size 10(3.20mm) and 12(2.6mm) and current range was 70amp-190amp at an interval of 30amp. Total 20 specimens have been welded with10 specimens for each size of electrode. For different tests the lengths of the rods were 1 meter for 10 specimens and 0.5 meter for 10 more specimens. To achieve the optimum result welding time has been kept constant. Welding has been performed by professional person with good quality machines.

After the completing the welding the welded rods were brought to the laboratory for different tests. In this project tensile strength and bending strength have been measured. These two test have been performed by using Universal Testing Machine. The 1 meter long specimens were used to perform tensile test and 0.5 meter long specimens were used to perform bending test. The data collected from this two experiments are presented and compared in the given graphs below:

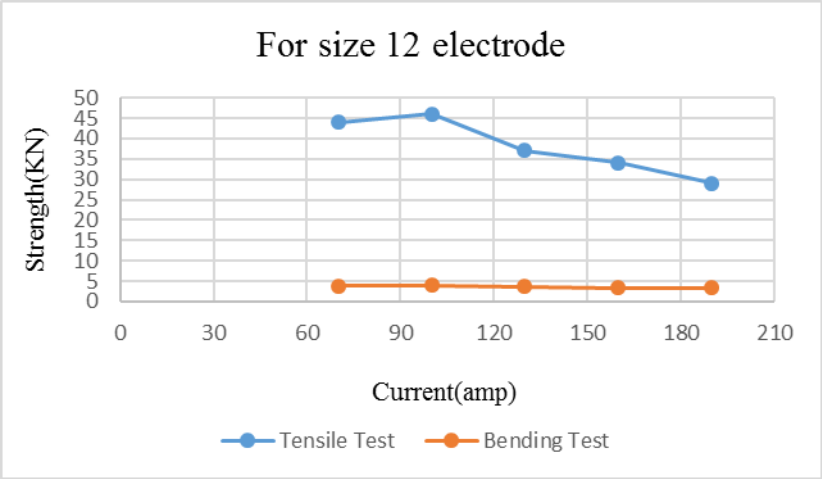

Figure-1: Change of strength with current for electrode size 12

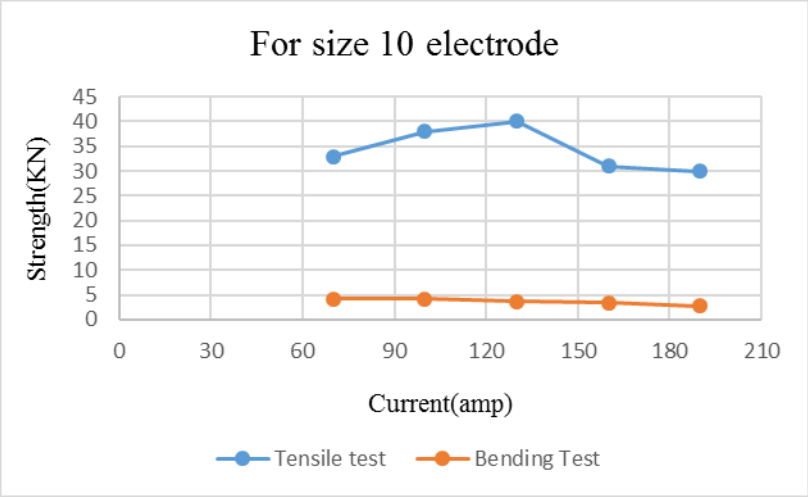

Figure-2: Change of strength with current for electrode size 10

6. Result

By analyzing the graphs it is observed that to get high quality welding for 12mm diameter of stainless steel rod by using size-10 electrode about 100amp current would be optimum current. To get high quality welding for 12mm diameter of stainless steel rod by using size-12 electrode around 100amp current would be optimum current. From the experimental data it is noticed that at low current such as at 70A current the strength of joints are relatively low. By the increase of current the strength of joints improves but again it starts to fall if the current is further increased. This is because, at low current supply the fusion doesn't occur properly. Incomplete fusion fails to produce sufficient heat to melt the filler metal properly thus the join remains weak. During high current supply excessive heat is produced. This excessive heat causes void, crack formation and partially spurt out molten metal. Thus the strength of joint decreases.

7. Conclusion

The data for this project has been collected from local road side welding shops. These shops use different current and electrode size for same purpose. They change the current and electrode size depending on their experience and skill without knowing which is appropriate. This type of attempt may cause some damage to the welded material. Improper welding can cause various problems in future. The aim of this project was to improve the welding quality in the road side shops by optimizing the welding parameters without increasing their cost. This project mainly deals with the welding current. By this project work, it has been observed that without changing the machineries, only optimizing the welding current it is possible to get good quality of welding.

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