TO STUDY THE EFFECT OF WELDING ELECTRODES SIZE ON VARIOUS MECHANICAL PARAMETERS IN ELECTRIC ARC WELDING BY USING DIFFERENT CURRENT RANGE ON MILD STEEL

Er. Surinder Kumar[1] | Er. Deepak sharma[2]| Er. Hardeep Kumar[3]

[1](Research Scholar, Dept. of Mechanical Engineering, LRIET, Solan H.P., H.P. Technical University)

2(Astt. Prof., Dept. of Mechanical Engineering, KCEIT, Una, Himachal Technical University)

3 Astt. Prof., Dept. of Mechanical Engineering, KCEIT, Una, Himachal Technical University

(1992surinder@gmail.com)[1](er.shdeepak@gmail.com)[2](hardeep.saini415@gmail.com)[3]

Abstract— *Welding is a skill that takes much practice to be a master, and selecting the correct electrode and current value for the job can be equally challenging. Electrodes are available in a wide range of sizes and types, each of which provide different mechanical properties and joint strength and operate with a specific type of welding power source. The selection of a correct type of welding electrode for specific application is a very important consideration in metal arc welding. Metal welding electrodes are used for various applications such as in the construction and repair of structures, bridges, agriculture, food and oil industries etc. The welding process is widely used in industry to join two metals with the help of fusion of two same metals or it can be different. In this research the effect on welded joint at different current range on its tensile strength, impact strength, hardness, Weld bed width, and Weld bed height properties of MILD STEEL was studied. To achieve the objective single-pass welds of Mild Steel plates having 10 mm and 12 mm thickness were fabricated by using different size of electrodes at two different current range (100 amps and 150 amps) by manual electric arc welding which is the most widely used welding methods because of its relatively high productivity, low maintains cost, easy operation and low running cost also. First the preparations of samples are done then they are welled under these various variables. Then cut in required dimensions for the tests like tensile, impact test, Weld bed width and Rockwell hardness. The tensile strength, Weld bed width and hardness properties of MS welded samples were evaluated under the required testing machines like universal testing machine for tensile test and charpy impact testing machine for impact strength and Rockwell hardness tester. It was found that the reduction in tensile strength (UTS) of the lap joint samples increases with increase in current range. Also, the best welding rod size is 6 mm, for tensile, impact strength and hardness but 3.5 mm rod where min Weld bed height is required for welding of mild steel. It is recommended that the observations of this work can be applied in the agriculture, food and oil industries where MS are predominantly used. It is also found that at the depth of penetration will increase with increasing in current and also found to be maximum tensile, impact strength and hardness is can be achieved by the use of 6 mm size with higher welding current.*

Keywords—arc weld, GMAW,AMPS,HAZ

1. Welding is a permanent joining process used to join different materials like metals, alloys or plastics, together at their contacting surfaces by application of heat and or pressure with diffusion of both work piece. During welding, the work-pieces to be joined are melted with heat produced at the interface and after solidification a solid joint can be formed. Sometimes a filler material is added to form a weld pool of molten material which after solidification gives a strong joint between the materials. Weld ability of a material depends on different factors like the metallurgical changes that occur during welding, changes in hardness in weld zone due to rapid solidification, extent of oxidation due to reaction of materials with atmospheric oxygen and tendency of crack formation in the joint position.

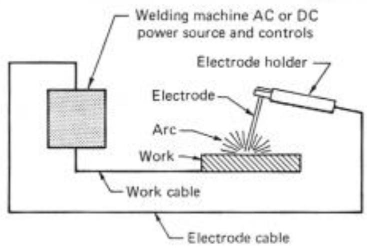

Figure No.1.1: Arc welding setup

2. Literature Review

Chandel presented theoretical predictions of the effect of current, electrode polarity, electrode diameter and electrode extension on the melting rate, bead height, bead width and weld penetration in Submerged Arc Welding. They indicated that the melting rate in SAW can be increased by using (i) higher current (ii) straight polarity (iii) a smaller diameter electrode and (iv) A longer electrode extension. The percentage difference in melting rate, bead height, bead width and bead penetration has been found to be affected by the current level and polarity used.

They have concluded that when a smaller diameter electrode is used, the increase in the current level does not make a significant effect on the percentage change in the weld bead geometrical parameters.

Chandel and Seow , presented the mathematical prediction of the effect of current, polarity used, electrode diameter and its extension on the melting rate, bead height, bead width and weld penetration in SAW. They concluded that for a given current (heat input) the melting rate can be increased by using electrode negative polarity, longer electrode extension, and smaller diameter electrodes. There are two other ways to increase the deposition rate without increasing the heat input; these are: (i) using a twin-arc mode and (ii) adding metal powders.

Chandel ,Yang and Bibby while investigating the effects of process variables on the bead width of submerged-arc weld deposits concluded that bead width is affected by the electrode polarity, electrode diameter, electrode extension, welding current, welding voltage and welding speed. A positive electrode polarity, a large electrode diameter, a small electrode extension and a high welding voltage encourages a large bead width in most cases. The bead width is not affected significantly by the power source used (i.e. constant voltage or constant current) when an acidic fused flux is used. However, when a basic fused flux is used, constant-current operation gives somewhat larger bead widths.

3. Working Principle of welding transformer

Welding Transformers are used in AC machines to change alternating current from the power line into a low-voltage, high amperage current in the secondary winding. A combination of primary and secondary taps on the welding transformer is commonly used to provide a macro adjustment of the welding current, as well as adjustment of secondary voltage. Transformer ratings for AC machines are expressed in KVA (kilovolt-amperes) for a specified duty cycle. This duty cycle rating is a thermal rating, and indicates the amount of energy that the transformer can deliver for a stated percentage of a specific time period, usually one minute, without exceeding its temperature rating. The RMS Short Circuit Secondary Current specification indicates the maximum current that can be obtained from the transformer. Since heating is a function of the welding current, this parameter gives an indication of the thickness of the materials that can be welded.

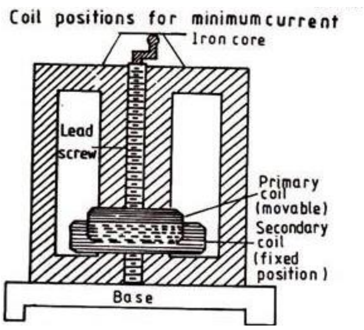

Figure 4.1: A moving coil welding transformer

4. Objectives

1. To determine the suitable welding process for mild steel with respect to different current range.
2. To predict the higher tensile strength of welded joints in different welding process
3. To determine optimum Weld bed width in the case of Mild Steel Workpiece.
4. To predict the higher impact strength of welded joints in different welding process
5. To determine the suitable welding process and current range for mild steel with respect to higher Weld bed width.

.5. PRESENT WORK

In the present study it has been proposed to develop a set up for welded joint at different current range on its tensile strength, impact strength, Rockwell hardness, Weld bed width and height of MILD STEEL was studied. To achieve the objective single-pass welds of Mild Steel plates of size (76*76 mm) and having 10 mm and 12 mm thickness were fabricated by using three different size of electrodes at two different current range by electric arc welding which is the most widely used welding methods because of its relatively high productivity, low maintains cost, easy operation and low running cost also.

First the preparations of samples are done then they are welled under these various variables. Then cut in required dimensions for the tests like tensile, impact test, Weld bed width and Rockwell hardness.

6. Observations

The data is obtained by using various machines like universal testing machine, impact testing machine, Rockwell hardness tester and vernier clipper. By using the different size of welding electrodes at two different current ranges 100 and 150 amps the is obtained:.

Table 6.1: Tensile strength w.r.t. Dia of Electrode, Current Range, and Specimen Thickness

Sr. no	electrode	TS Workpiece 1		TS Workpiece 2	
		Current range		Current range	
		100 amps	150 amps	100 amps	150 amps
1	6 mm	51	55	57.5	60.1
2	4 mm	50.5	52.3	52	55
3	3.5 mm	48.2	50	53	50.5

Table 6.2: Impact strength w.r.t. Dia of Electrode, Current Range, and Specimen Thickness

Sr. no	electrode	IS Workpiece 1		IS Workpiece 2	
		Current range		Current range	
		100 amps	150 amps	100 amps	150 amps

1	6 mm	407	430	421	425
2	4 mm	403	414.5	396	472
3	3.5 mm	400	418	423	469

Table 6.3: RHN w.r.t. Dia of Electrode, Current Range, and Specimen Thickness

Sr. no	electrode	RHN Workpiece 1		RHN Workpiece 2	
		Current range		Current range	
		100 amps	150 amps	100 amps	150 amps
1	6 mm	96	106	94	106
2	4 mm	84	69	88	94
3	3.5 mm	89	80	96	94

Table 6.3: Weld bed width w.r.t. Dia of Electrode, Current Range, and Specimen Thickness

Sr. no	electrode	WW Workpiece 1		Ww Workpiece 2	
		Current range		Current range	
		100 amps	150 amps	100 amps	150 amps
1	6 mm	7.26	9.1	6.28	8
2	4 mm	7.46	9.2	6.88	7.3
3	3.5 mm	8.44	10	6.1	6.9

Table 6.3: Weld bed height w.r.t. Dia of Electrode, Current Range, and Specimen Thickness

Sr. no	electrode	WH Workpiece 1		WH Workpiece 2	
		Current range		Current range	
		100 amps	150 amps	100 amps	150 amps
1	6 mm	1.7	1.1	4.02	3.9
2	4 mm	2	1.3	2.02	2.36
3	3.5 mm	2.2	1.7	1.6	2

7. Results and analysis

In this study it is observed that which diameter of electrode performed well at which current range for what thickness of specimen because in now a days the electric arc welding most common type of welding which is mostly used in agriculture, constructions and other heavy projects in India as well As in other countries. In this study it is find that at higher current rage the smaller diameter electrode is having higher value of tensile strength and in case of hardness the larger diameter of electrode at higher current range is having higher hardness then others.

These tests were conducted by selecting the mechanical parameters which are affecting the strength of selected materials are discussed below.

5.1 Effect on Tensile strength w.r.t. Diameter of Electrode.

Figure 5.1 and 5.2 Shows status of UTS w.r.t. Diameter of Electrode, Current Range and Specimen Thickness of 10 mm and 12 mm. The maximum tensile strength is calculated 60.1 MPa in the case of current range of 150 amps and size of electrode is 6 mm in 12 mm workpiece, in the case of current range of 100 amps the max UT strength is also found in use of 6 mm electrode. This means a large size diameter electrode perform better at higher and medium current range.

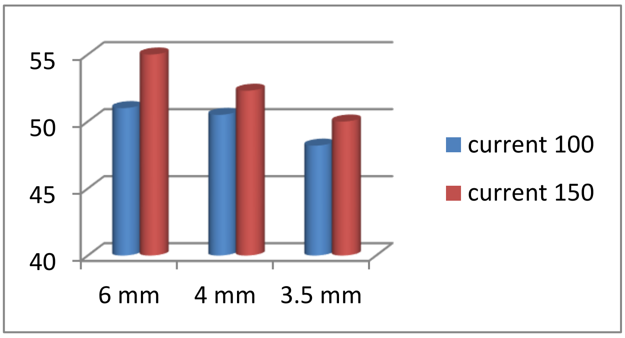

Figure 5.1: Shows status of Ultimate Tensile Strength w.r.t. Dia of Electrode, Current Range, and Specimen Thickness of 10 mm.

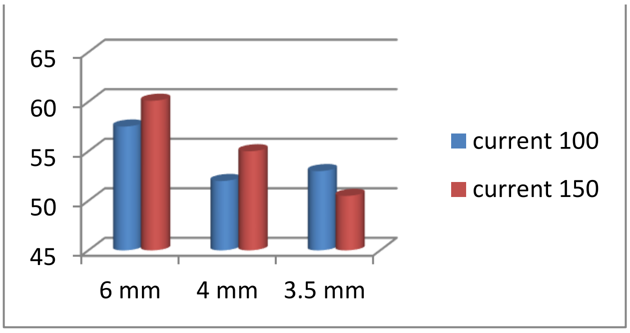

Figure 5.2: Shows status of Ultimate Tensile Strength w.r.t. Dia of Electrode, Current Range, and Specimen Thickness of 12 mm

Figure 5.3 Shows status of UTS w.r.t. Diameter of Electrode, Current Range and Specimen Thickness of 10 mm and 12 mm at both current ranges that 6 mm and 4 mm dia electrodes are having highest value of tensile strength 60.1 and 55 MPa but in overall performance 6 mm electrode having the higher value of impact UTS.

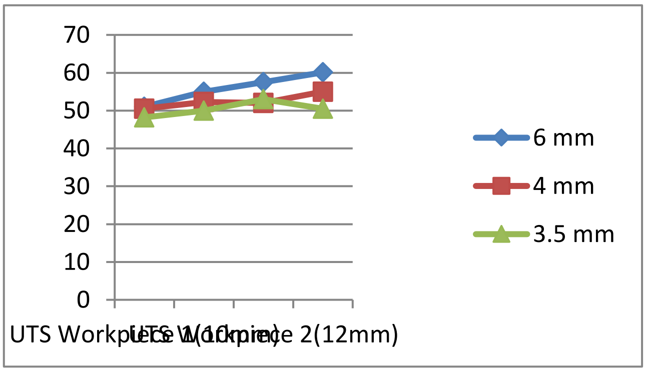

Figure 5.3: Shows status of Ultimate Tensile Strength w.r.t. Diameter of Electrode, Current Range and Specimen Thickness at both current ranges

5.2 Impact strength w.r.t. Diameter of Electrode, Current Range, and Specimen Thickness

Figure 5.4 and 5.5 Shows status of impact strength w.r.t. Diameter of Electrode, Current Range and Specimen Thickness of 10 mm and 12 mm. The maximum Impact strength is found at the position of 430 Jm2 in the case of current range of 150 amps and size of electrode is 6 mm, in the case of current range of 100 amps the max impact strength is also found in use of 6 mm electrode. This means a large size diameter electrode perform better at higher range in the case of mild steel 10 mm thickness as compare to lower current range it is not performed well.

But as shown in the fig. 5.4 the maximum Impact strength is found at the position of 472 Jm2 in the case of current range of 150 amps and size of electrode is 4 mm, in the case of current range of 100 amps the max impact strength is also found in use of 4 mm electrode but it is found that the 3.5 mm electrode is also having the great impact strength having the value of 469 Jm2.

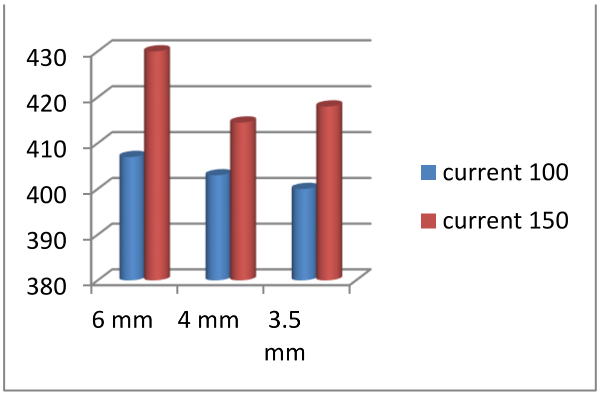

Figure 5.4: Shows status of impact strength w.r.t. Dia of Electrode, Current Range, and Specimen Thickness of 10 mm

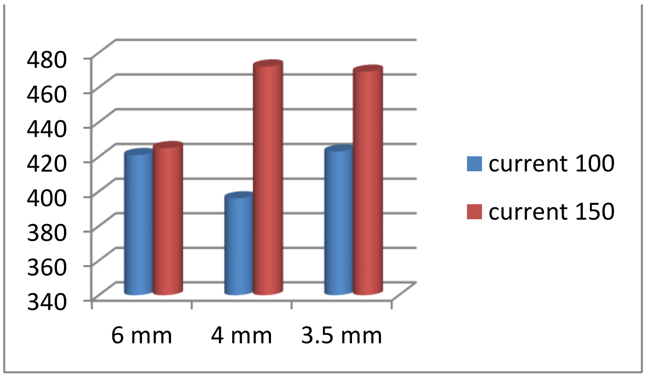

Figure 5.5: Shows status of impact strength w.r.t. Dia of Electrode, Current Range, and Specimen Thickness of 12 mm

Figure 5.6 Shows status of impact strength w.r.t. Diameter of Electrode, Current Range and Specimen Thickness of 10 mm and 12 mm at both current ranges that 3.5 mm and 4 mm dia electrodes are having highest value of impact strength 469 and 472 but in overall performance 6 mm electrode having the higher value of impact strength that means 4 and 3.5 mm rod is only suitable for the job of 12 mm thickness plate at 150 amps current

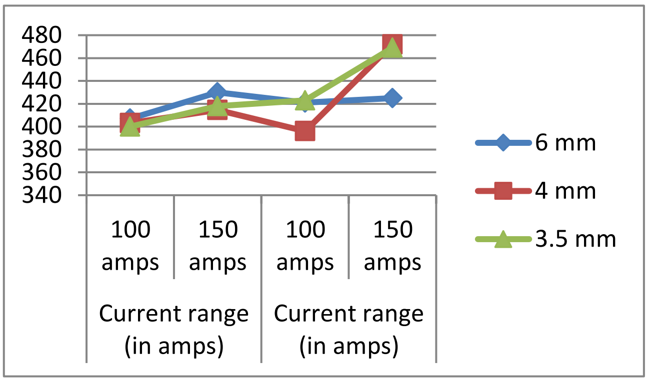

Figure 5.6 Shows status of impact strength w.r.t. Diameter of Electrode, Current Range and Specimen Thickness at both current ranges

5.3 Rockwell Hardness w.r.t. Dia of Electrode, Current Range, Specimen Thickness

Figure 5.7 indicating the effect of Shows status of Rockwell hardness w.r.t. Dia of Electrode, Current Range, Specimen Thickness of 10 mm and 12 mm. In this research it is observed that Rockwell hardness has maximum value can be obtained by the use of 6 mm electrode at 150 amps current range in both cases 10 mm thickness mild steel plate and 12 mm thickness mild steel plate, so it is very clear that the large diameter electrode is performed better for hardness in both cases either in 10 mm thickness or in 12 mm thickness in both current range 100 amps and 150 amps.

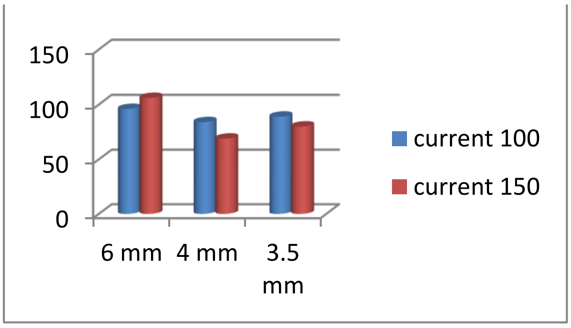

Figure 5.7: Shows status of Rockwell hardness w.r.t. Dia of Electrode, Current Range, and Specimen Thickness of 10 mm

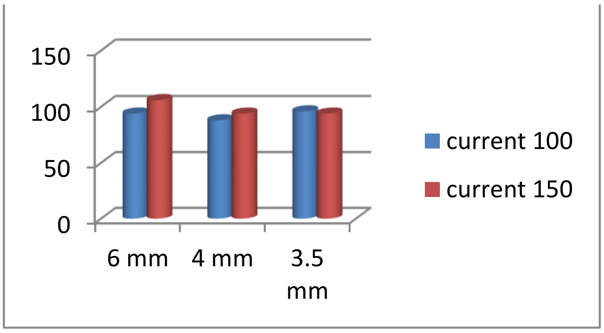

Figure 5.8: Shows status of Rockwell hardness w.r.t. Dia of Electrode, Current Range, and Specimen Thickness of 12 mm

Figure 5.9 indicating the effect of Shows status of Rockwell hardness w.r.t. Dia of Electrode, Current Range, Specimen Thickness at both current ranges from the image it is clear that max hardness is obtained by the use of 6 mm electrode at 150 amps current in both work pieces so that for the jobs of MS 10 and 12 mm thickness the 6 mm rod diameter is much suitable for hardness as compare to other dia welding electrodes.

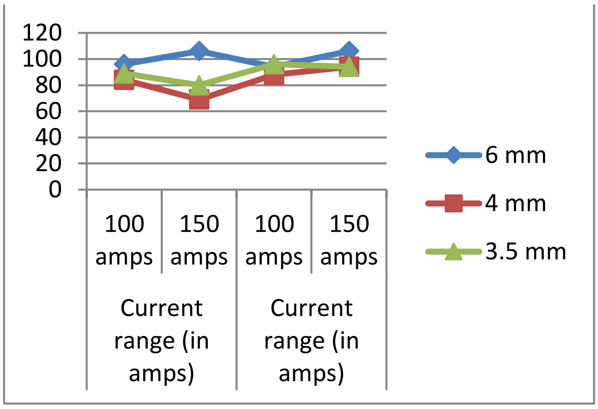

Figure 5.9 indicating the effect of Rockwell hardness w.r.t. Dia of Electrode, Current Range, Specimen Thickness of 10 mm and 12 mm.

5.4 Weld bed width w.r.t. Dia of Electrode, Current Range, and Specimen Thickness

Figure 5.10 showing the effect of Weld bed width w.r.t. Dia of Electrode, Current Range, Specimen Thickness of 10 mm and 12 mm. The maximum Weld bed width is measured by the use of 3.5 mm electrode in both current ranges 100 and 150 amps this means where large width is needed we have to use a smaller diameter Electrode. In other cases the use of 100 amps current range the value Weld bed width is slightly increasing by the use of smaller diameter electrode

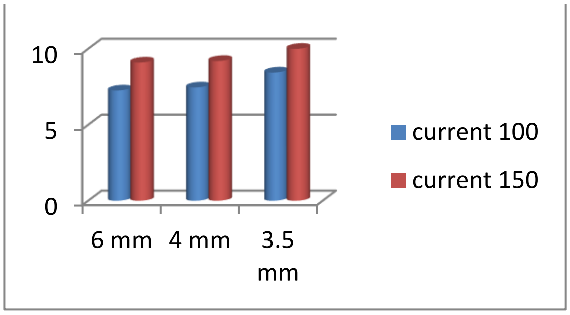

Figure 5.10: Shows status of Weld bed width w.r.t. Dia of Electrode, Current Range, and Specimen Thickness of 10 mm

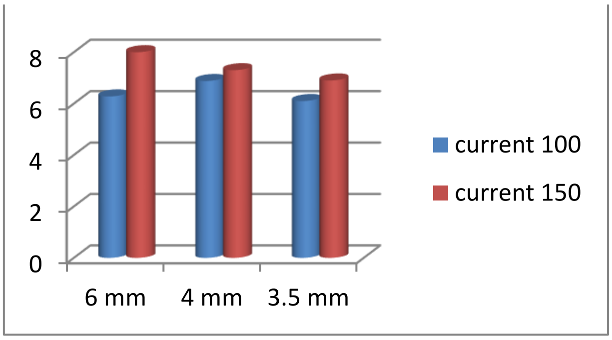

Figure 5.11: Shows status of Weld bed width w.r.t... Dia of Electrode, Current Range, Specimen Thickness of 12 mm

Figure 5.12 showing the effect of Weld bed width w.r.t... Dia of Electrode, Current Range, Specimen Thickness of 10 mm and 12 mm at both current ranges that overall 3.5 mm diameter electrode performed well in case of 10 mm thickness Workpiece but in case of 12 mm work it had not make a wide weld at 100 amps at 150 amps current 6 mm make a wide weld of 8 mm but it is not so large as compare to 3.5 mm rod that means a smaller dia electrode performed well in smaller thickness work pieces.

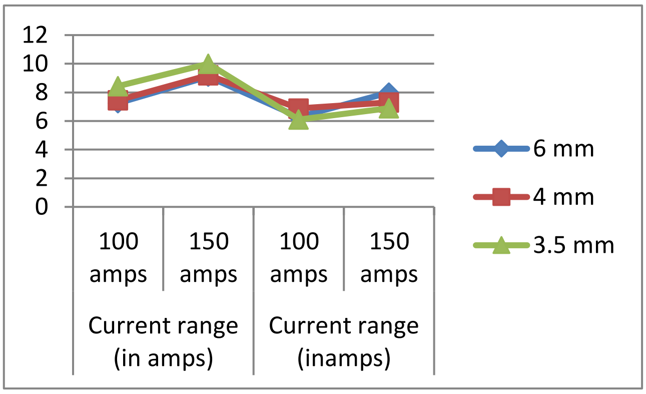

Figure 5.12 showing the effect of Weld bed width w.r.t. Dia of Electrode, Current Range, and Specimen Thickness at both current ranges

5.5 Weld bed height w.r.t. Dia of Electrode, Current Range, and Specimen Thickness

Figure 5.13 It is cleared from the image that minimum value of Weld bed height is obtained by the use of 6 mm Electrode by 150 amps current range this means the large diameter electrode is much suitable were small Weld bed height is required in all cases the higher current range is obtained minimum value of wild height in the case of 10 mm thickness and 12 mm thickness.

But in other case the plates having 12 mm thickness the 4 mm electrode and 5m electrode is also having small Weld bed height as compared to 6 mm thickness so it is very clear that the large diameter electrode is not suitable where small Weld bed height is required in the case of higher current ranges in 12 mm thickness MS

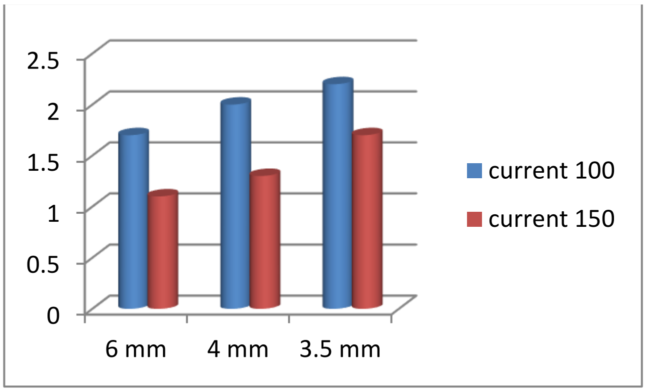

Figure 5.13: Shows status of Weld bed height w.r.t. Dia of Electrode, Current Range, and Specimen Thickness of 10 mm

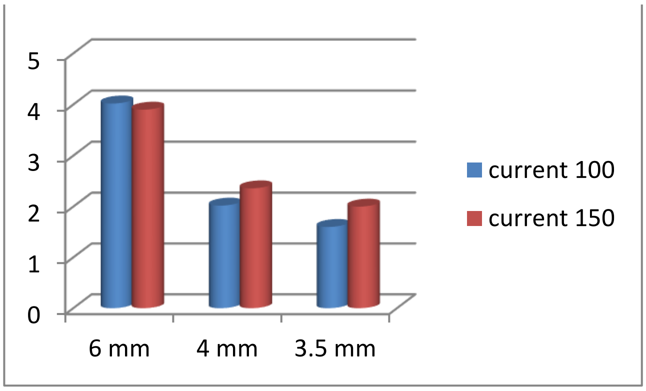

Figure 5.14: Shows status of Weld bed height w.r.t. Dia of Electrode, Current Range, and Specimen Thickness of 12 mm

Figure 5.15: Shows status of Weld bed height w.r.t. Dia of Electrode, Current Range, Specimen Thickness at both current ranges it is cleared from the image that 6 mm welding electrode is having highest value of Weld bed height and 3.5 mm rod having the least value of height in overall performance in all cases that for surfaces which are under a motion with any other surface there 6 mm electrode is not suitable for operation with 12 mm thickness work piece because it is having a height about 4 mm which is not suitable for ant relative motion.

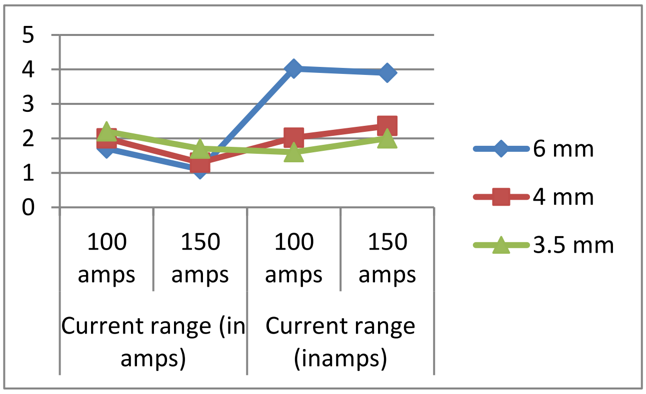

Figure 5.15 showing the effect of Weld bed height w.r.t... Dia of Electrode, Current Range, Specimen Thickness at both current ranges

8. Conclusions

This research work shows the effect on tensile strength, impact strength, hardness width and height, in whole study it is observed that the large diameter electrodes(6mm) are performed well in all cases except one or two cases in both current range(100 amps and 150 amps) and both size of workpiece 10 mm and 12 mm whether it is tensile strength or it is impact strength in all other cases like hardness and Weld bed width and Weld bed height the larger diameter electrode is performed well then smaller the 6 mm electrode having higher value of tensile strength, impact strength, hardness and world width but in the case of Weld bed height the 6 mm electrode is also having the minimum value of the Weld bed height that is much suitable for all Mild Steel jobs

1. From this experiment it was found that maximum Impact strength is found at the position of 430 Jm2 in the case of current range of 150 amps and size of electrode is 6 mm.
2. It was also found that Rockwell hardness has maximum value can be obtained by the use of 6 mm electrode at 150 amps current range in both cases 10 mm thickness mild steel plate and 12 mm thickness mild steel plate.
3. This research study shows the effects on various mechanical properties like tensile and impact strength, hardness by use of different size electrodes with different current ranges.

9. Future Scope

The future scope of the present work can be done in following directions:

1. In the present study author have consider different welding electrodes, current range and their effects to test tensile strength, Weld bed width and heights.
2. The study can be extended by considering other parameters like arc time, weld angle & welding speed types as a future scope over other mechanical properties like compressive and fatigue strength on other different steels and mechanical materials in metal arc welding process.
3. The work could be extended to other welding processes like Resistance and Laser Beam Welding.
4. The work on Arc Welding can be extended by choosing the input process parameters other than what have been considered in this work.
5. Work can also be done on other materials and of different thicknesses.

10. References

1. Advances in Welding Science and Technology," edited by S. A. David, ASM International, Materials Park, Ohio, 1986.

2. "Recent Trends in Welding Science and Technology," edited by S. A. David and J. M.Vitek, ASM International, Materials Park,Ohio, 1990.
3. A.Mujumdar of NIT Agartala, Tripura (west) , „Study of the effect of Bevel angle & welding heat input on Mchanical properties of Mild Steel wldments‟. A international journal of Mechanical & Material Engineering, Volume 6, No.2 (June 2011) , pg 280-290
4. V. Gunarajandn and Murugan, " Prediction of Heat-Affected Zone Characteristics in Submerged Arc Welding of Structural SteelPipes", Welding Journal, January 2002]
5. Ravindra pal singh, R.K.Garg & D.K.Shukla of NIT, Jalandhar, Panjab, "Parametric effect on mechanical properties in Submerge arc welding process‟, in international journal of Engg.science & Technology (IJEST) volume 4, No.02, feb.2012. "
6. S Sun and C S Wu , "Effects of welding heat input on microstructure and hardness in heat-affected zone of HQ130 steel".
7. Lee et al, "Effect of Welding Parameters on the Size of Heat Affected Zone of Submerged Arc Welding", Division of Material Engineering, School of Applied Science Nanyang Technological University, Singapore.
8. Lee, C. S., Chandel, R. S. and Seow, H. P. (2000) 'Effect of Welding Parameters on the Size of Heat Affected Zone of Submerged Arc Welding', Materials and Manufacturing Processes, 15: 5, 649 — 666.
9. Weisman C, American Welding Society, Welding Handbook: Fundamentals of Welding, Seventh Ed. vol. 1. 1976.
10. Easterling, K. Introduction to physical Metallurgy of Welding, 2 edition, 1992(Butterworth-Heinemann Limited, Oxford)
11. Ravindra pal singh, R.K.Garg & D.K.Shukla of NIT, Jalandhar, Panjab, "Parametric effect on mechanical properties in Submerge arc welding process‟, in international journal of Engg.science & Technology (IJEST) volume 4, No.02, feb.2012.