DEVELOPMENT OF OVERHEAD SUBMERGED WELDING METHOD

By

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Major Project Report

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For the Degree of
Master of Technology in Mechanical Engineering
(Computer Integrated Manufacturing)

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Declaration

This is to certify that

1. The thesis comprises my original work towards the degree of Master of Technology in Computer integrated manufacturing at Institute of Technology, Nirma University and has not been submitted elsewhere for a degree.

2. Due acknowledgment has been made in the text to all other material used.

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Certificate

This is to certify that the Major Project Report entitled "Development of overhead and vertical welding method" submitted by Divyesh patel (12MMCM24), Towards the partial fulfilment of the requirements for the award of Degree of Master of Technology in Mechanical Engineering (Computer integrated manufacturing) of Institute of Technology, Nirma University, Ahmadabad is the record of work carried out by him under our supervision and guidance. In our opinion, the submitted work has reached a level required for being accepted for examination. The result embodied in this major project, to the best of our Knowledge has not been submitted to any other University or Institution for award of any degree.

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Abstract

Anupam industries ltd. is known for Manufacturing of Large size cranes. The parts of the cranes are very huge and they are joining through the welding. They are using one of welding type ‘submerged arc welding’. Submerged arc welding is not feasible for overhead and vertical welding process. Then it is required to develop overhead welding process for that part which takes more time for adjusting for normal submerge welding operation

A technique for overhead submerged bend welding comprises in that flux at the wing site is weight bolstered to the joint being welded from underneath at diverse weights along the joint being welded, a consumable terminal is nourished through the flux from beneath and a circular segment is struck. A weldpool is framed thereat with a layer of fluid slagBut in overhead welding there was a defect in the continuous welding. We are reached only up to the spot joint in over head.

And in the vertical submerged arc welding change the movable torch position tilt it at 90^{o} and the make one box which from non conductive material for the storage of the flux. And change the moving position of the tractor horizontal to vertical. With the small diameter wire with low current can weld on the vertical position.

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Index

1. Introduction
    - Over view
    - Need for the project
    - Objective of the project
2. Literature survey
3. Methodology
4. Material selection
    - Material properties
5. Experimentation
    - Root pass
    - Hot pass
    - Overhead saw test
    - Vertical saw test
6. Test result
7. References

Chapter 1

Introduction

Competition within the manufacturing industry is increasing more and more, and therefore in order to stay in the market, companies are looking forward to produce their product at a faster rate but with better quality. Production and fabrication departments are very large and in big industries where huge products are manufacture, it is very difficult to handle heavy weight material and risk associate with it during handling. In fabrication department some kind of processes like welding, cutting and grinding are risky due to the lake of knowledge and lake of safety regarding materials. Today in fabrication department to reduce the accidents and risk during processes or in other words to eliminate risk and accidents, there are so many improvements in fabrication processes. In fabrication department so many changes have done and some others are under research

Submerged Arc Welding (SAW) process was invented simultaneously in U.S.A and U.S.S.R in 1930's. Submerged arc welding contributes to approximately 10% of the total welding. It is one of the most widely used processes for fabrication of pipes, thick plates, pressure vessels, marine vessels, rail tanks, ships, heat exchangers, offshore structure etc. It is characterized by higher metal deposition rate, deep weld penetration, excellent surface appearance, invisible arc and lower welding skill requirement. It is possible to weld thin sheet of steels at over 5 m/min with minimum emission of welding fume. Apart from joining, this process can also be used for cladding applications to increase corrosion and wear resistance on the surface. Welds produced are sound, uniform, ductile, and have good impact value. This process is commercially used for welding of low carbon steel, high strength low alloy steel, nickel base alloys and stainless steel.

Submerged Arc Welding

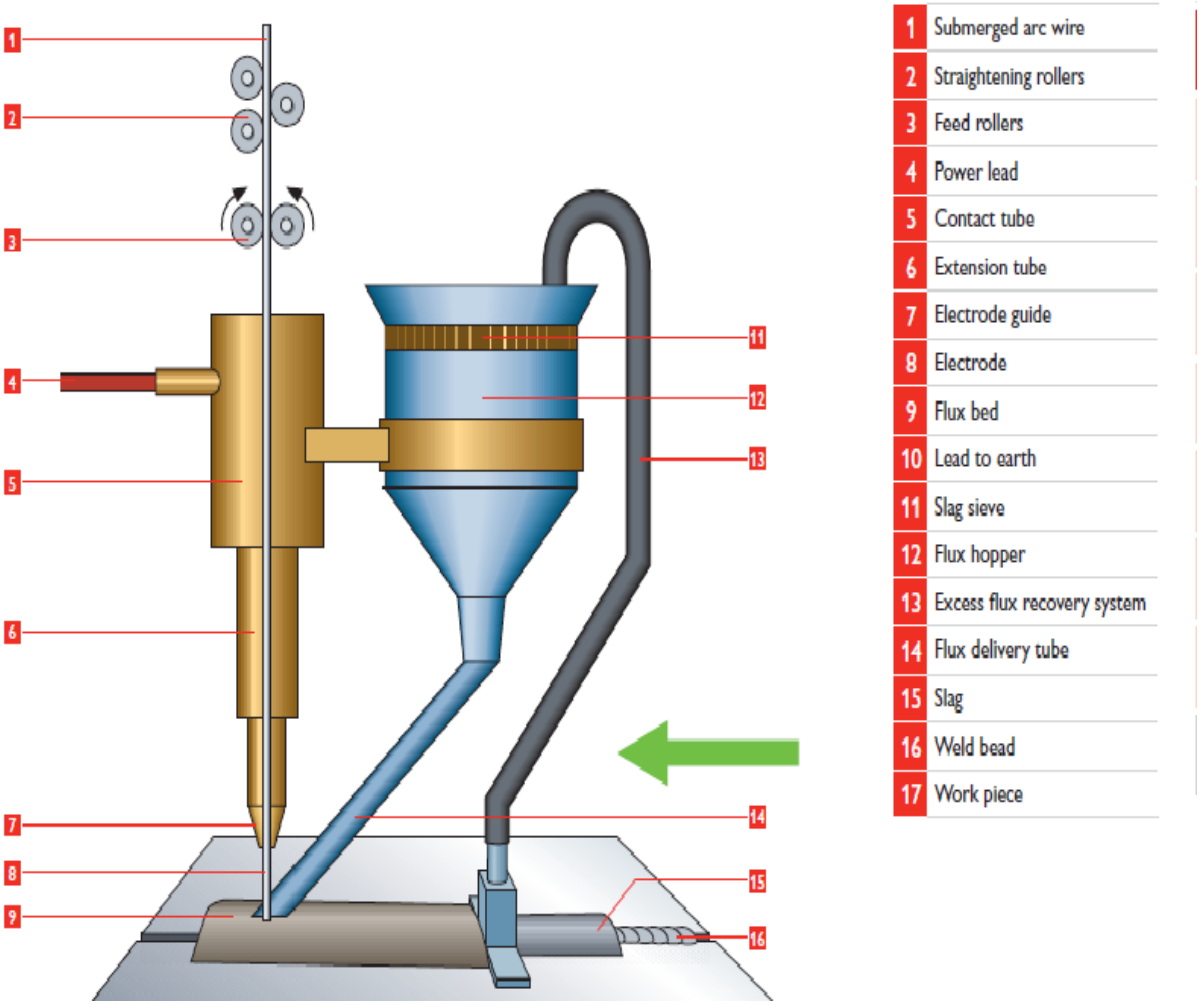


FIG.1 (SETUP FOR SUBMERGED ARC WELDING)[7]

ySubmerged arc welding is a making welds with currents up to 2000 amp, alternate current (AC) or direct current (DC), using single or multi (2 to 5) wires or film of filler metal. Although currents ranging from 300 to 2000 amperes are commonly utilized, currents up to 5000 amperes have also been reported used with multiple arcs. Constant Voltage welding power supplies are most commonly used, however constant current systems in combination with a voltage sensing wire-feeder are also available. The submerged arc welding process is mostly used because it has

advantages more than other. It is readily capable to use automatic part and can be carried out at speeds higher than those of other known most of the welding processes. SAW is mostly operated in the automatic or mechanized mode, other then, hand held SAW guns with pressurized or gravity flux feed delivery are also available. The process is normally limited to the Flat or Horizontal-Fillet welding positions (although Horizontal Groove position welds have been done with a special arrangement to support the flux).

Generally, submerged arc welding (SAW) requires a continuously fed consumable solid electrode. The molten metal and arc is protected from the atmospheric contact by using "submerged" under the fusible flux. The molten metal pool also cleans by flux of submerged arc welding, it favourably adjusts the concoction organization of the weld metal; and, it positively impacts the state of the weld dot and its mechanical properties. It additionally structures a promptly removable or free peeling intertwined slag to encourage cleaning after utilization. In molten state, the flux becomes conductive, and provides a current path between the electrode and the work.

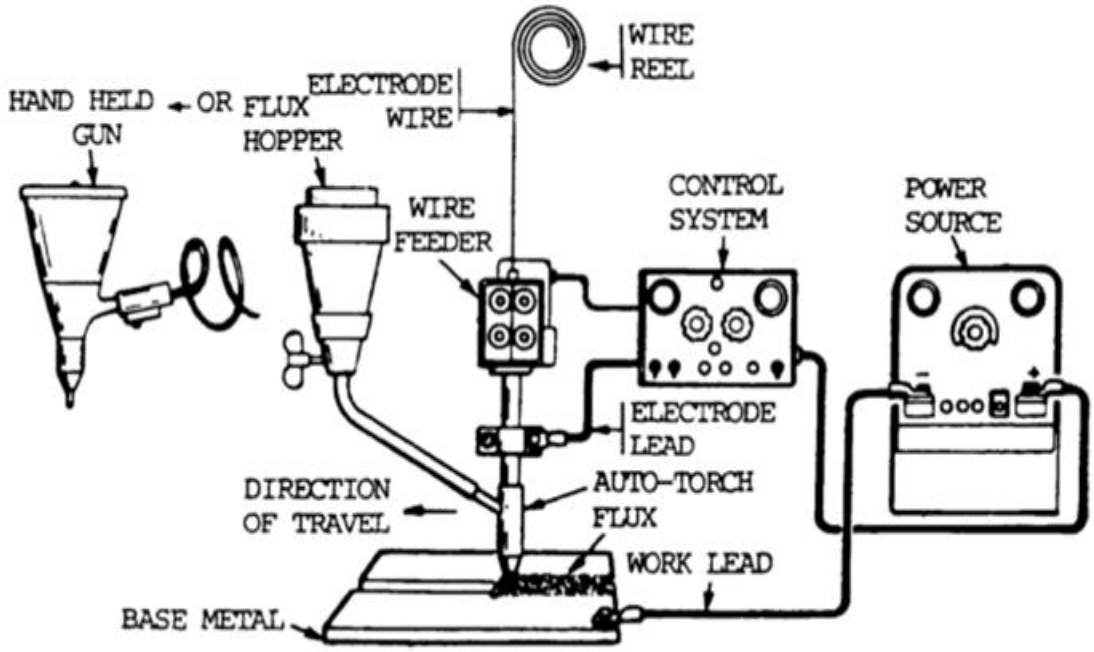


FIG.2 parts of saw (ref. figure)[6]

Equipments for SAW

Power Source

The power source is the first piece of equipment . Because the process is often fully automated, the power source must be capable of an output because the process is fulley automated. The thicknesses of the material to be welded will dictate the amperage requirements.

Controller System

The controller is used to control the welding current, voltage, wire feed and other parameter used in SAW process. Welder at the start of the welding set all the parameter in controller.

Welding Head

In SAW method welding head is used which contain the flux hopper and wire feeder system nozzle. The flux hopper is operated by welder through remote.

Wire Spool

Wire spool is the reel of the filler metal required for SAW. The total weight of wire spool is 25 kg.

1.3 Need for the Project

While doing submerged arc welding, place is required for placing all the equipments and seating for welder.In the existing setup the problem is that it consumes more time for setup and also more workers are required to make such type of platform. There is a need to develop new method which can minimize the setup time and hence increasing the productivity.

ANUPAM MHI industries Ltd. is involved in fabrication of varieties of cranes.

Fig 3 EOT(ELECTRIC OVERHEAD TRAVEL) CRANE

And may be an accident while tilting boxes. There is a need to study the current state of production firm and thus by using overhead or vertical SAW principles, try to propose a easy and less affordable activities.

1.4Objective of the Project

- Work study of the activity involve in fabrication shop.
- To carry a time analysis of existing SAW setup to find out the problem areas where improvement is needed.
- Analyzing the problem areas and to provided a workable solution considering productivity.
- Reduction in welding time for a box section of overhead cranes.
- To develop a method for the box section.
- Parametric study of developed method of submerged welding process.

Chapter 2

Literature Survey

2.1 Pal et al. [1]

In this paper to study the combined effect of flux and welding parameters on the weld metal chemical and mechanical properties utilizing statistical outline of experiment for mixtures in particular rotatable mixture design Increasing requirements for safety in welded structures have led to control its chemical composition in order to obtain consistently better mechanical properties of the weld metal. This might be achieved by better understanding of the underlying components that modify the weld pieces. In submerged arc welding.

2.2 Uwe et al. [6]

to pore formation. The laser beam-submerged arc hybrid welding method originates from the knowledge that, with increasing penetration depth, the laser beam process has a tends to pore formation in the lower weld areas. High deposition value SA process Combination of the laser beam reduces the tendency with the energy- efficient submerged arc welding. The hi, providing the appropriate choice of weld preparation. Than plates with a thickness more than 20° mm in a single pass, and the welding thicker plates with the double-sided single pass technique is possible.

2.3 **singha et al. [3]**

The slag created during submerged arc welding is called waste. Main problems of waste is storage, soil pollution, needs space for dumping etc. We cannot use it as a filler material in construction area. The Natural resources are also getting finished fast due to continuous consumption for minerals required to manufacture the fluxes. The proven development of recycling process that allows the application of slag as a fresh flux will surely reduce the above-mentioned problems. Slag was processed by replenishing it, with compatible alloying elements/deoxidizers by accumulation.

Recharged slag is referred as reused slag. Reused slag in mixture with filler wire EL-8was utilized within these examinations. The properties of weld metal saved with reused slag were examined. The mechanical properties were palatable and fulfilled AWS requirements.

by the above experiments, slag was modified in to the powder form .in this modifications slag was crushed and milled in a ball mill to change form. And added Alloying elements and mixed in ball mill for 30 min so that the ingredients could form a homogeneous mixture. And for the dry mixed powder 20% solution of potassium silicate binder was added to wet.

2.4 Kirana et al.**[4]**

Two-wire tandem submerged arc welding involves depositions from two filler wires with the leading wire attached to DC power source and the trailing wire attached to AC power source. welding speed and the leading and trailing wire current are affected on the weld bead profile and mechanical properties in the tandem saw. here present experimental study on the influence of leading wire , trailing wire current, and speed of welding on the weld bead

Of HSLA steel. It is realized that the weld bead penetration is affected by the heading wire current while the weld dab width and the fortification stature are touchy to the trailing wire current beats conversely, build in welding rate decreases the rate of hotness include consequently improving the cooling rate and the weld dab mechanical properties. A set of observational relations are produced to gauge the weld dab measurements and mechanical

properties as capacity of the welding conditions. The forecast from the empirical relations and the comparing measured results are seen to be in fair agreement.

2.5 Sui et al. [5]

the study on softening temperature, one of the flux high temperature properties
concerning the melting range, has not been reported yet. Softening temperature *T,* 1 has an important effect on the shape and appearance of the weld and slag detachability The impact of connection of blended flux parts Based on simplex calculation of ideal outline, the multi segment mixture relapse model was utilized to examine physical properties of submerged arc welding flux. The impact of complex association of seven segments in agglomerated flux on softening temperature was dissected.

2.6. Lu et al.[8]

In this paper, the selection and optimization of the process parameters for narrow gap SAW of A105 steel plates has been investigated. use of the small diameter welding wire check The effects of welding voltage, current and weld heat input on the A105 steel weld formation quality in saw .Through lots of experiments of surface overlaying on flat plates, the optimal data were obtained sequentially by mathematical analysis. And obtain optimal variation rang. The relationship of the weld heat input with the weld width was qualified to assure the

optimal weld appearance quality. At last, the optimal parameters were validated experimentally with narrow gap SAW.welding voltage and the stabilized welding current keep the reasonable matching relationship, which contents require fine slag detachability, the improved weld formation.

2.7 **yang et al.[9]**

Submerged arc welding is known for its high productivity. However, there is
a lack of capability to monitor and control weld penetration. Because penetration is believed to be primarily determined by base metal current, GMAW gun is added into the SAW process to bypass part of the total current. The base metal current directly reduced tand controls weld penetration, and the ability to adjust the base metal current to control weld penetration without reducing deposition rate is into SAW. To conveniently monitor weld penetration and acquire the needed feedback for weld penetration control, welding parameters and conditions affecting weld penetration were analyzed and specific variables subject to variation and fluctuation were identified. Experiments were conducted to see what parameters affect the weld penetration and what their significances are. It was found that the base metal current is the dominant parameter that determines weld penetration with a sufficient accuracy when other major parameters are in their stated ranges. A control system has been established to monitor and control weld penetration using a proportional integral derivative (PID) control algorithm. This algorithm is based on penetration feedback provided by the penetration model that correlates weld penetration depth to base metal current. Experiments on DH36 square butt joints verified the effectiveness of the proposed method.

2.8 Kwang[13]

A Welding Wire Weaving device for a submerged circular part Welding carriage incorporates a truck running in a Welding bearing, a control board controlling parameters required for Welding and Weaving operations, a Welding Wire reel mounting a Welding Wire therefore, a Welding Wire supplier supplying the Welding Wire to an upper a piece of a part to be Welded, a Weaver unit Weaving the Welding Wire transversely, a supplier supporting shaft supporting the Welding Wire supplier at an upper some piece of the truck,

and a Weaver unit association bar interfacing the Weaver unit to the supplier supporting shaft. The Welding Wire supplier incorporates a supply controlling roller, a compressive supplying roller, a Welding Wire package, a needle bearing, a Welding Wire pack and a separator separate between the needle bearing and the Welding Wire aide group.

Chapter 3

Methodology

- Work study of the fabrication of box section of overhead cranes.

Fig.4 (box section of overhead crane)

As shown in fig is the box section of the crane. And box is actual made of joining the metal sheets by fabrication (welding) work. Saw welding are doing on the this box, and mainly saw is work only in horizontal position . Then this box rotated 2 to 3 times for welding. Each box consume a 15 to 17 days for fabrication works.

- Time analysis for welding a box section
  1. As shown in the fig. There are **4 to 5 workers** required for the setup a box for SAW.
  2. Set up is consume a **1 to2 hour** for single time.
  3. For a single worker 2 hr. loss for box to single time set up
  4. Total 4 hr. loss for one box of single worker.
  5. All 4 workers time loss is **4×4=16 hr** for one box.

- To develop a method overhead and vertical submerged arc welding for the crane for reduction in setup time.

Chapter:4

Material selection for test:

- Base metal :- M S plate
- Filler metal classification :- E7018
- Flux :- active type

Material properties:-

- Base metal :-
  - **Mild Steel**

    1018 mild steel have a 0.18% carbon contain.

    - It is popular as “machinery steel”
    - High carbon steel do not have much ductility as compared with low carbon steels and medium carbon steel
    - High carbon steels are difficult to weld

- Filler metal :- E7018

E7018 is the most popular low hydrogen filler metal used in the field/shop to weld pressure equipment, storage tank, boiler, etc. made from carbon steel.

E = "Electrode"
70 = 70,000 PSI minimum tensile strength

1 = welding position, which is all positions (vertical, horizontal, overhead, flat)

8 = type of covering (flux) located all around the metal of the rod. Here, Low-Hydrogen, iron powder

Chapter:-5

Experimentation:-

5.1 Root pass:

in contrast to a welding process with solid wire electrodes, welding with stick electrodes or with flux-cored wires that require a multilayer weld to be done in several successive welding passes when the thickness of the material to be welded is more than 10mm.For the SAW. If thickness is less then 10 mm then high current of saw is burn the base plate. Therefore root pass and hot pass for the maintain the thickness.

Fig.5 MS plate with edge preparation

Parameter for root pass:

Plate thickness : 16mm

Root angle : 30’

(Current) A : 77 amp

(voltage) v: 68-80

Electrode dia : 2.5mm

Work dist.: 2mm

Fig.6 (root pass)

5.2Hot pass:

Hot pass is nothing but the layer for increasing the welding thickness. In the root pass is may be not possible increasing thickness up to 10mm. then, after the hot pass grinding the welding area for cleaning and surface smoothness, And the again welding. But now this time increasing the voltage.

Fig.7 grinding after root pass and prepare for the hot pass

Current (A): 77-80

Voltage(V): 120-150

Ele.dia: 2.5mm

Current: DCEP

Work dist.: 2mm

5.3 SAW in overhead position

The present method relates to an overhead submerged arc welding process wherein a flux for submerged arc welding is pressed onto the portion to be welded from the underside of the welding line of the plates to be welded and the welding is effected while feeding a consumable electrode from the underside of the plates to be welded.

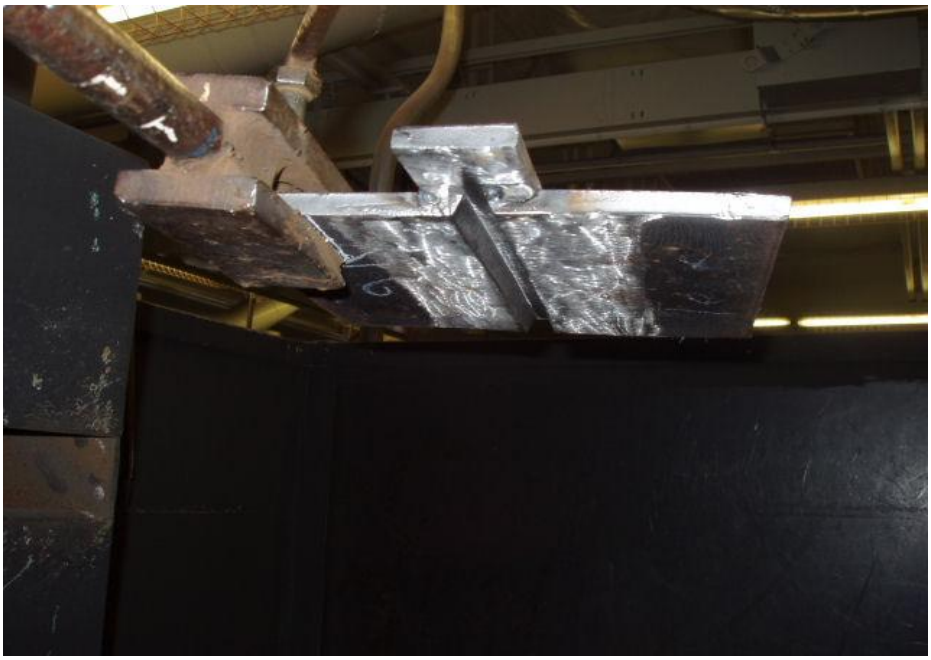


Fig.8 setup for overhead welding.

As shown in the figure. In this experiment the plate is hang with the clamp on some distance from ground floor. Over head submerged arc welding have a main difficulty of the flux retrainationTherefore make one support under the groove which should be a electrically insulating material. And fill the flux between groove and supporting material. Set the electrode in the groove. welding a joint having a root gap by means of an overhead one-side submerged arc welding process a flux containing iron powder and/or iron alloy powder is used as the flux for forming an upper bead thereby allowing the iron powders and/or iron alloy powders to bridge over the root gap along the line of magnetic force generated by a welding current so as help the flux for forming an upper bead and a flux for submerged arc welding is also supplied in the vicinity of the consumable electrode from the underside of the welding part and is pressed thereto. beads which are extremely intimately fitted with each other and which have good appearances may be formed, since the undersides of the plates to be welded are heated by the preceding flat welding operation and flux is continuously supplied in the vicinity of the, electrode wire for facilitating formation of the beads.

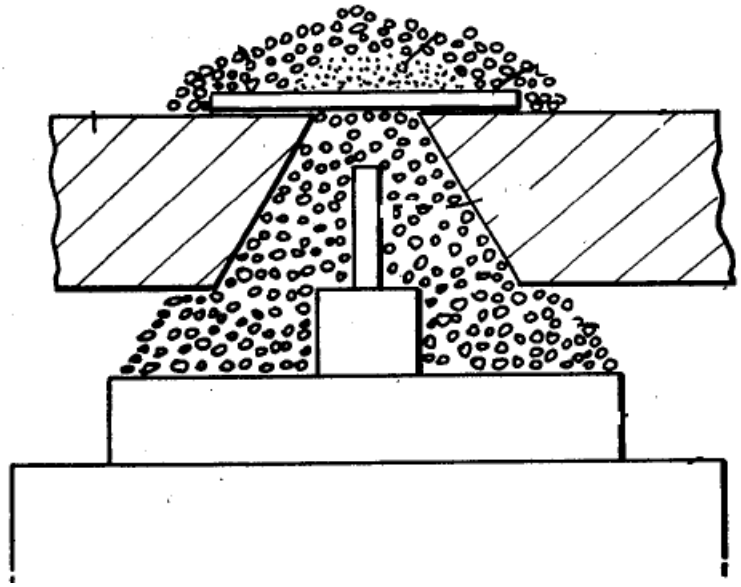


Fig.9 schematic diagram of an overhead one-side process for overhead SAW.

The flux for forming the upper bead is supplied onto the upper surfaces of the plates to be welded and positioned for wardly relative to the direction of the overhead submerged arc welding operation

Perameter of SAW test

Plate thickness: 16 mm

Current (A): 449

Voltage (V):29-30

Dia of electrode: 3.5 mm

Current: DCEP

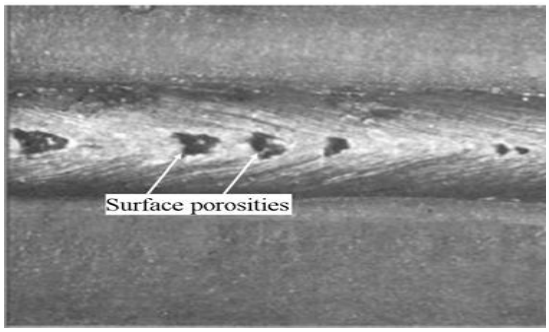
In the overhead SAW experiment set the above parameter. There are spot join are done in the overhead saw, as shown in the below figure. but the continues welding are defected. Spot welding is doing better, because wire is penetrate in the groove with flux cored. And then moving the setup is dismissing the flux and electrode wire comes contact with the atmosphere. And create the defect in the welding.

Figure.10 shows spot welding in overhead position.

Fig.11 Defect in continues welding in overhead position.

In the continues overhead SAW shown in the fig.11 there are defect in the welding like porosity and slag particles are in the weld metal

5.4 X-ray test of overhead SAW



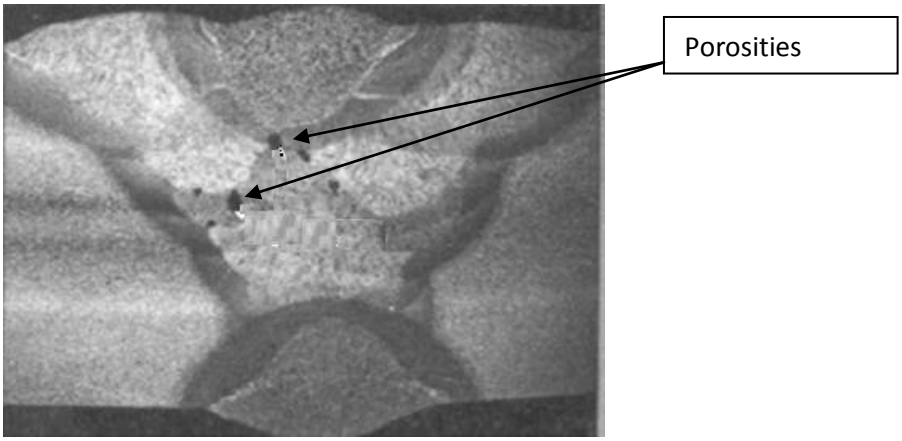


Fig.12 X ray of cross section welding part

Cross section of welded part and can see the slag particles in the weld pool And the surface porosities in the weld metal.

5.4 SAW in vertical position

Fig.13 setup for the vertical SAW.

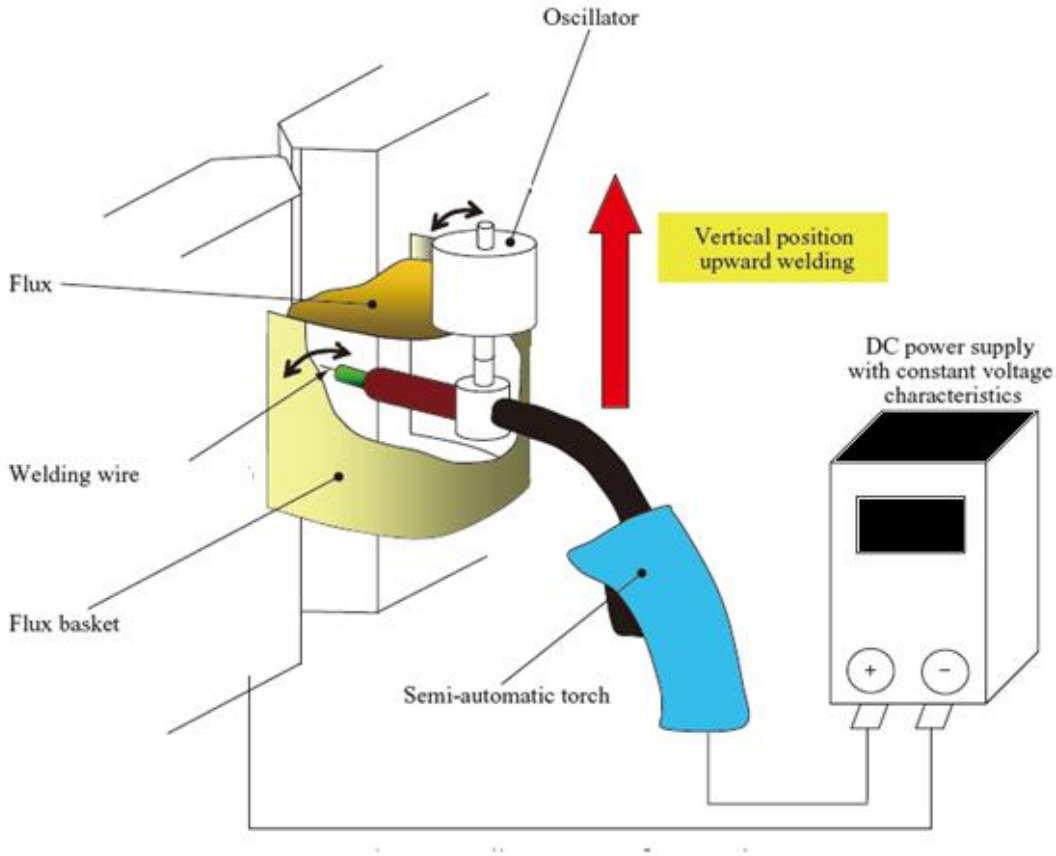


Fig.14 Schematic diagram for the vertical SAW

Figure shows the principle of vertical SAW. in the our experiment there are simple saw machine. We had changed the position of the welding torch. There are basket is used for the holding a flux, and basket is the mounted on the torch. preventing it from droping, flux basket, set to shield the joint going to welded. Nickel base plate (ASTMA553M-95 TYPE1) is use for the test. Direct power supply with general constant voltage characteristics is utilize as the welding power source. SAW is possible through using weaving, which rotate torch from one side to other side, if changing of the tractor motion horizontal to vertical then this operation may be convert in to semi automatic. With vertical submerged arc welding, a welding wire is automatically fed into the scattered granular flux and an arc is struck under the flux. In the experiment we had a wooden basket for flux stored.

Parameter for the vertical saw

Plate thickness: 16 mm

Current(A): 230-280

Voltage(V):25-30

Dia of electrode: 2 mm

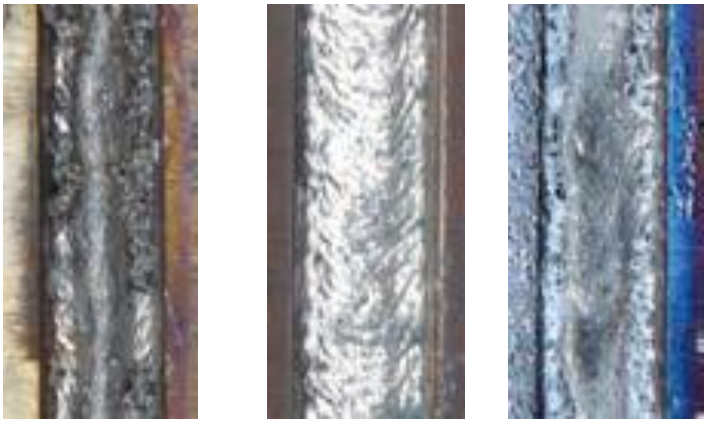
Current: DCEP

Table 1. mechanical prop. Of plate

Mechanical properties			
0.2% Yield strength (MPa)	Tensile strength (MPa)	Elongation (%)	Absorbed energy (–196°C) (J)
680	730	28.2	240
665	715	28.6	212

Comparison of commercial fluxes for usability

To the development of welding consumables, the welding usability of vertical SAW was carried out by commercial fluxe. The types of evaluation included with bead smoothness of, detachability of slag, and quality obtain by radiographic testing. In the test, the carbon steel plate used was of thickness 16 mm with the groove 20 mm wide and 10 mm deep. 2 mm nickel base wire. Figure.14 shows examples of the appearance of the beads when various fluxes were used. The best results of bead shape and slag detachability were obtained with Flux **(**b**)**. With Flux **(**a**)**, slag detachability was generally good, but the bead shape was convex. With Fluxes Fig. **(e)**, the bead shape was convex and the slag was deeply bit. In the flux No. (b) Use bond type flux and included a large amount of TiO2 and Al2O3.



(A) (B) (C)

Fig. 15 Effect of flux on bead shape

Table.2 Chemical properties of welding wires

Welding wire	Wire diameter (mm)	Chemical composition (wt%)							
		C	Si	Mn	Ni	Cr	Mo	W	Al
Wire 1	2.5	0.02	0.05	0.01	76.4	—	20.1	3.0	0.01 - 0.43
Wire 2	2.5	0.02	0.05	< 0.1	70.2	2.0	19.0	3.0	—

Table 3 Chemical components of fluxes

Flux	Main components	Particle size
Flux 1	TiO_2-MgO-CaF_2	12 × 100 mesh
Flux 2	MgO-ZrO_2-CaO-Al_2O_3-SiO_2	12 × 65 mesh

Chapter:6

Test result

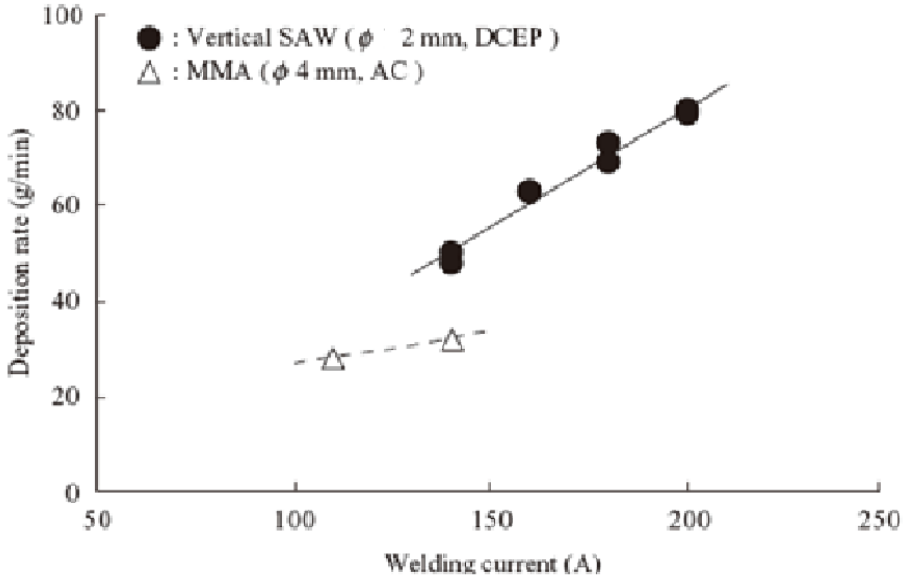


Fig.16 compare between manual metal arc and vertical SAW

As shown in the fig. 16 comparison between the manual metal arc and the vertical submerged arc welding. Deposition rate of the vertical SAW is 6o to 80 g/min.and we can improve the deposition rate by changing the electrode.

6.2 Brittle fracture test

Corresponding welds used for the overhead cranes are required sufficiently the better properties with protect from brittle fracture starts to conform that they don't grow to brittle fcracks, and it has properties to stop increment of crack before it eventually results in large scale breakage, if brittle cracking happens . Prevent brittle fracture initiation and required to arrest brittle crack reproduce for the welds by the fracture toughness. The fracture toughness needed to stop brittle fracture starting was evaluated by crack tip opening displacement (CTOD) at −165°C. The result in Fig. 17. The obtained CTOD values were large, more than 0.4 mm, all positions for the weld metal, weld interface and the heat affected zone (HAZ) at distances of 1mm, 3mm, and 5 mm from the weld interface. The results suggest that the low risk of brittle fractures occurring at the joint. However, these values are too large to be treated as CTOD values which can be utilized to evaluate brittle fracture initiation.

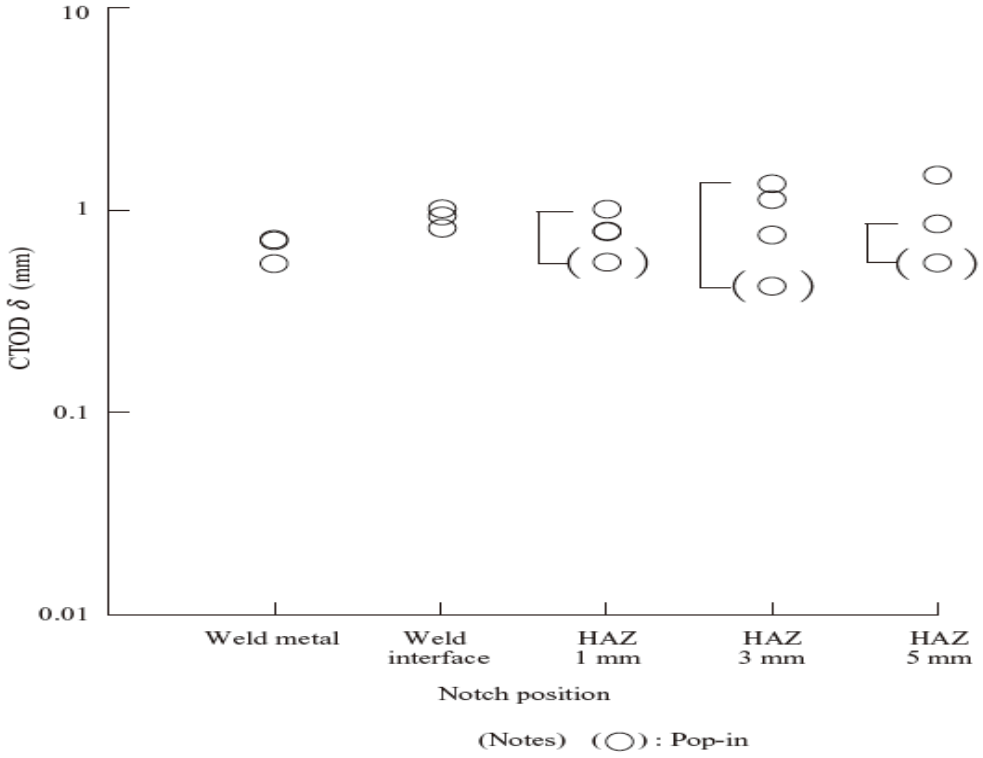


Fig.17 CTOD result of welding joint for vertical SAW

Table no.4 result of test (tensile and yield strength)

	Weld metal			Weld joint
Test contain	Yield strength (Mpa)	Tensile strength (Mpa)	Elongation (%)	tensile strength
Requirement	≥390	≥690	-	≥690
result	435 420	697 706	35 34	715

Table shows the value of the welding test as per the standard. And no hazardous defect shows in the welding.

Table 5. Bead bend test result

Bead bend test		
	Face bend test	Root bend test
requirement	>3mm	>3mm
result	Defect free	Defect free

Chapter:-7

Conclusion

- With the vertical SAW, continues welding can be performed in the stable condition.
- The utilization of the created welding system and consumable results about the joints attaining the requirement in joint acting test therefore, in the brittle fracture test there are low risk of developing brittle fracture.
- In the overhead position there are spot of welding obtain on the joint. But continuous welding was defected like porosity, impurities in weld metal.

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