Simulation and Optimization of Weld Bead Geometry of Cladding Process in Gas Metal Arc Welding

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***Abstract*—Cladding is a process of depositing a thick layer of corrosion resistance material over carbon steel plate with the application of heat source and produce good wear and corrosion resistance properties to improve the surface quality of metal .GMAW was used to optimize process parameters (welding current, welding voltage, welding speed and wire feed rate) which includes solid filler wire of (SS304L) stainless steel of dai.1.2mm upon 10mm thick low carbon steel (mild steel) using different process parameters. The perfect results give up in experimentation and Design matrix. The effects of different parameters was represented in the form of response surfaces. This study would be beneficial in enriching the data bases for the defects, porosity and which also damage the weld metal. Hence, MIG welding has been coated with wire of electrode, therefore, shielding gas is given to protect the weld. Where Surfacing was played a role in Pressure vessel industry, chemical industry, petroleum and hydrogen storage industry.**

***Keywords*—GMAW machine, Mild steel plate, SS304 filler wire, Process parameters, reinforcement of weld.**

I. INTRODUCTION

Manufacturing industry produce products which have contributed to the requirements of human, to development and efficient performance to welding process, the universally accepted method of permanently joining of metals and producing weld of structures efficiently and economically. Stainless steel are used as filler wire in MIG welding and welded materials, due to the realness that they can be manufacturing in large amounts to exact and have an encompassing range of mechanical properties. surfacing technique refers to method of depositing a metal on the surface of base metal plate in required dimension. The propose of this paper is to save money, wear and corrosion resistance. The impart of surface properties Varied to fulfill the requirements of industrial areas. The aim of this paper to highlights these situations are to material by cutting costs and reducing the consumption of expensive metals.

A. Gas malet arc welding

In this welding process, consumable electrode is used to weld on base plate. The arc is being produced between a consumable electrode and the work pieces. The electrode provides the filler metal in the form of wire of small diameter, and hence no additional field is required. Shielding gas like as helium, carbon dioxide and oxygen are being used for surrounding the arc. This gas protect the molten metal pool the atmospheric contaminants like dirt, dust, metal oxides, etc. affect the welding system and parameters.

B. Welding Torch and wire feeder

This equipment consists of a variety of number of Parts such as control switch, a contact tip, an electrode conduit, power cable, a gas nozzle liner and a gas hose. When the operator work on it to press the control switch or the trigger, of the torch and when he adjust all parameters of MIG welding like as welding current, welding voltage, welding speed and wire feed rate and the shielding gas flow then wire feeder control electrode feed rate, To the material of electrode such as stainless steel, aluminum etc.

C. Electrode

The electrode selection should depend upon the type of metal and process ,the mechanical properties of the area to be joint we used to be welded well. it is a type of the conditions of the metal surface and design joint the electrode is the main part of this project for determining the weld quality.

D. Shielding gases

In MIG welding, Shielding gases played a main role for welding propose. which protect to make weld and cover surfaces from the environment; gases like nitrogen, oxygen The gas which chances of making fusion defects, porosity to damage the weld pool this has number of gases like as helium, argon and carbon dioxide, for used to welding. Hence, the electrode wire has been coated with flux, therefore a shielding gas is given to safeguard the weld. The gas flow rate play a most powerful role in welding system.

II. EXPERIMENTAL PROCEDURE AND METHODOLOGY

A. Methodology

The D-optimal method has been used to analysis of data of weld bead. This method relate to response surface methodology. The surface methodology was used for carrying out the design of experiments, the analysis of variance, and the empirical modeling. The D-optimal was developed to select design points in a way of minimizes the variance in data of weld bead with the estimates of specified model coefficients. This method is also called central composite design (a conventional response surface method).It demands to be conducted smaller number of experiments and also process parameters included in the experimental design. The steps are for achieving the objectives:

- This method consists of design matrix based on D-optimal to include data collection. The experiments will be conducted on mild steel plate using 304 stainless steel electrodes.
- Modeling refers to Development of empirical model with optimum process parameters this have relationship between gas metal arc welding responses and process parameters.
- TheTest of developed model used to be for adequacy Checking of model significance, model terms significance. This empirical model will helpful in optimum conditions of GMAW parameters.

The complete experimental procedure is shown in the fig. 2.1 below

Fig. 2.1 welding setup

B. *Optimization of process Parameterss*

The D-optimal method was found to the best suitable optimization technique for experimental work as satisfied by the literature review. This experimental design have taken four process parameters as numeric form such as welding current, welding voltage, welding speed and wire feed rate being identified for my experimental work. This experimental work Based upon the problem formulated or discussed above the objectives were following.

1. Optimization of process parameters of bead geometry parameters, bead width, bead height.

C. *Materials and equipment's used*

1) Base material: Mild steel plates of 10 mm thickness of size 150x 75 x 10(mm) which were cut from the flats using power hacksaw after that each blocks being used as the substrate material for cladding process.

2) Filler wire: The austenitic stainless steel solid wire which diameter 1.2 mm and of type 304is being used in the present work. The physical and chemical properties of the ASS type 304 are as follows:

TABLE I. CHEMICAL COMPOSITION OF SOLID WIRE 304

Mtrl	C	MN	S	P	Si	Cu	Ni
%	0.018	1.709	0.0008	0.029	0.287	0.173	9.13

Ti	Cr	Mb	V	Tu	Al	Fe
0.004	19.281	0.078	0.119	0.037	0.006	68.912

TABLE II. COMPOSITION OF M. S. BEING USED(WT%)

Mtrl	C	Si	Mn	P	S	Ni
MS	0.14	0.17	0.59	0.026	0.023	0.021

Cr	Al	Fe
0.045	0.029	balance

3) Shielding gas: The gas flow rate was the main factors to use for investigate to each run of experiments.Industrially pure Argon to be flowed in welding. The shielding gas flow rate was kept constant and for each experiment.

4) Ranges of process parameters: The experimental set up consists the optimum range of process parameters to identify and improve on this weld quality. The process parameters such as wire feed rate, constant current, welding voltage and welding speed which will affect the weld bead dimensions being identified. Various initial trial runs being carried out in order to find the operating range of this process variables . This is the following table , which was is being comes out of the trial runs, shows the range of the process parameters at two level higher and lower levels as per the demand of requirement of design matrix.

TABLE III. PROCESSPARAMETERS VARIED AT TWO LEVELS

Input parameters	units	low(-)	High(+)
Constant current	Amp	200	200
welding voltage(V)	Volts	16	28
Weldingspeed(s)	Cm/min	30	50
Wire feed rate(f)	m/min	6	14

5) Design of experiments: This experiment work produce the design and important tool for experimenters which helpful to solve them the complexities of technical investigations. It works as a systematic approach to the collections of data's in form of information. The design of expert is the selection of process to number of trials and terms &conditions of running to solving out the given problem set by the required terms. we considered a best method for designing of experiments among various research techniques being used based on the quantitative approach. Factorial technique of designing experimental method is being used in

my present work. This method is recommended as a one of the best method of statistical technique in engineering study for design of experiments.

TABLE IV TABLE OF DESIGN MATRIX

	Process parameter				response	
run	Constant current	Welding voltage	Welding speed	Wire feed rate	Bead height	Bead width
1	200	32	40	6	2.23	3.12
2	200	29	30	8	2.07	4.79
3	200	22	20	9	2.98	3.89
4	200	16	60	11	1.56	4.08
5	200	28	30	7	2.32	4.21
6	200	17	20	12	4.41	3.99
7	200	22	40	15	3.34	4.10
8	200	15	30	10	4.11	4.95
9	200	18	40	9	3.21	3.68
10	200	21	50	8	1.94	4.23
11	200	11	30	9	3.92	3.27
12	200	23	40	10	2.12	3.25
13	200	14	20	11	4.81	4.91
14	200	15	30	9	4.43	5.13
15	200	19	40	14	3.12	3.92

III. RESULTS AND DISCUSSION

A. Effect of welding speed on Bead height:-

The effect of changing the welding speed keeping the other parameters constant can be explained on basis of following graphs.

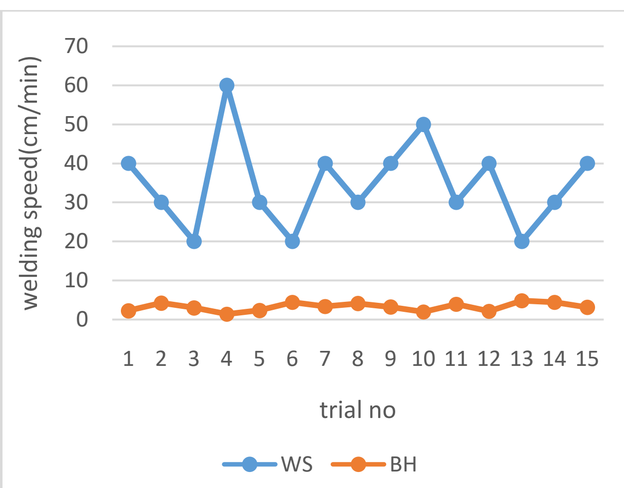

Fig. 2.Bead height vs. welding speed for 50cm/min

B. Effect of welding speed on bead width

The effect of change in welding speed on bead width can be observed from following graph.

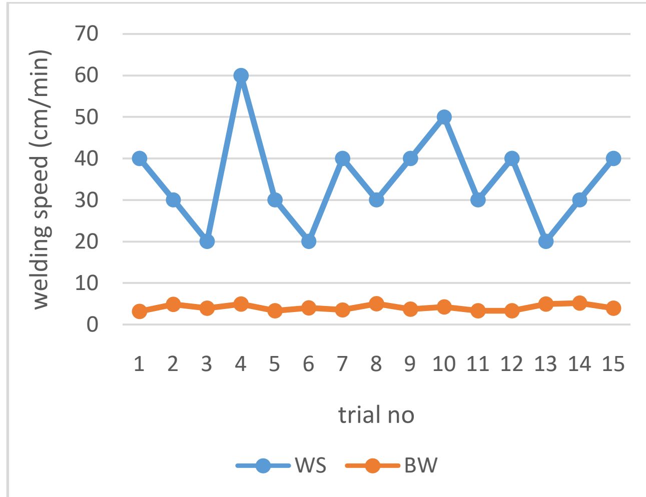

Fig. 3.Bead width vs. welding speed for 50cm/min

C. Effect of welding speed

The effect of welding speed on bead height/width,the following graph are provided.

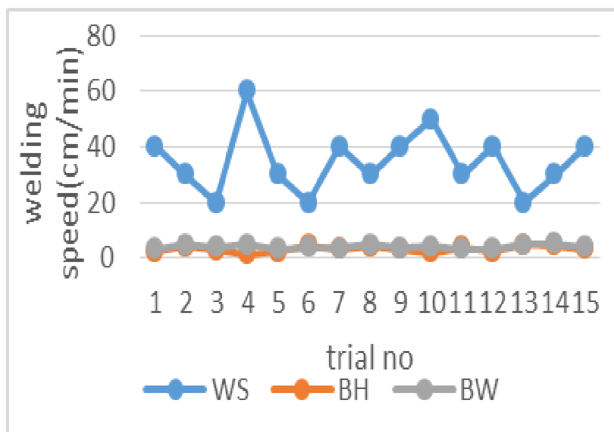

Fig. 4.Bead height/width vs. welding speed for 50cm/min

The above graphs reveal the for welding speed of 50cm/min, bead height to 1.94mm bead width to 4.23mm,for 60cm/min bead height/width decrease 1.56mm and 4.08mm respectively.

D. Effect of wire feed rate:-

The effect of Changing the wire feed rate keeping other Parameters constant can be explained on basis of following graph.

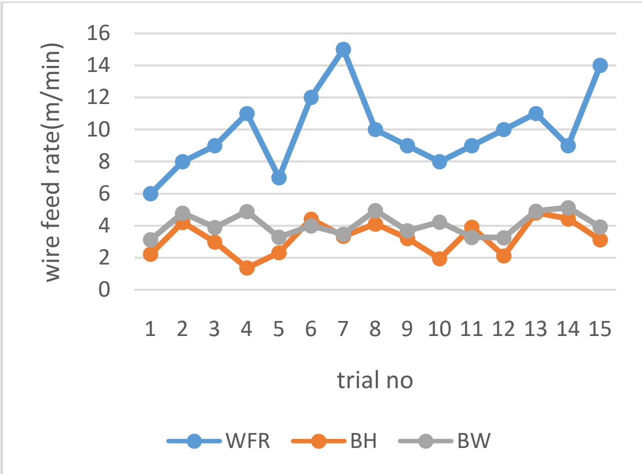

Fig.5 bead height/width vs. wire feed rate for 14m/min

The above graph reveal that for wire feed rate of 14m/min bead height to 3.12mm bead width to 3.91mm for 15m/min bead height/width increase3.34mm and 4.11mm respectively.

E. Effect of open circuit voltage:-

The effect of changing the open circuit voltage keeping the other parameters constant can be explained on basis of following graph.

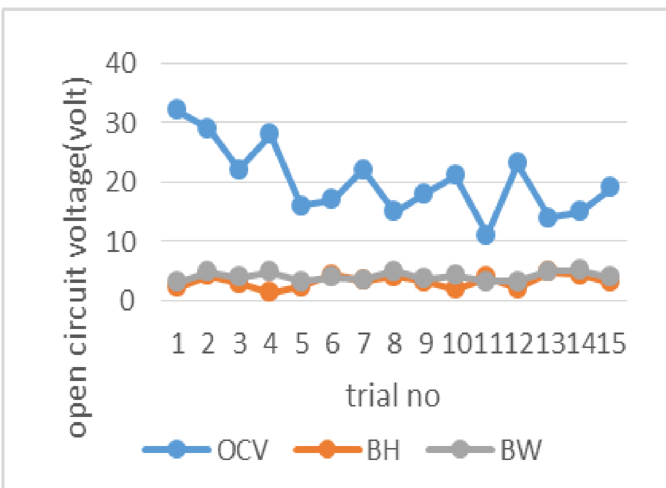

Fig. 6. bead height/width vs. open circuit voltage

The above graph reveal that for open circuit voltage of 28V bead height to 2.32mm, bead width to 4.21mm. For 29V bead height decrease to 2.07mm, bead width increase to 4.79mm.

IV. CONCLUSION

Based on the above study it can be observed that the developed model can be used to predict bead width/height with in the applied limits of process parameters. In the case of any cladding process bead geometry plays an important role in determining the properties of the surface and reducing cast of manufacturing. in the study, width, height of bead of weld metal increase with increasing the wire feed rate, width, height of bead decrease with increase welding speed from 30 to50 cm/min .The percentage of error for bead width/height are very small. The following step were applied for prediction of stainless steel clad bead geometry using GMAW(a) data collection using experiment studies (b)analyzing and processing of data.

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