Hardness and Impact Strength Value of Submerged arc Welding Flux: A comparative study through Regression model

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Abstract:

This study deals the application of regression analysis to evaluate the effect of hardness and impact strength on low carbon steel plates using submerged arc welding. Six types Flux was developed by using Red mud as base ingredient and TiO_2, CaO , MnO_2 , CaF_2 as alloying ingredient with varying percentage of 3% to 16% through agglomeration technique. Bead on plate welding technique were carried out to evaluate mechanical behavior of weld material. Regression analysis was conducted using statistical package for social science (SPSS) software to evaluate the mathematical equation for hardness and impact value. From the comparison between the formulated values through regression analysis with tested result, it is found that 5% error in impact value and 7% error in hardness.

Keywords **— Submerged arc welding, Regression model, Hardness value, Impact strength**

I. INTRODUCTION

Submerged arc welding is the very commonly used welding techniques because of its high strength and toughness value in welding bead. This high strength and toughness value is depends upon the proper selection of flux, wire and welding parameters of a base materials [13]. From the research it is found that hardness and impact strength can be increased by the addition of small amount of alloying elements like as Mn, Ni, Si,V, B, C, Ti and Ca[12].

Submerged arc welding flux plays important role on welding process about 50% cost carried out by this flux. Red mud is by waste of aluminium industries, about 35-40% red mud produced from aluminium production. Red mud have some important industrial compounds such as Fe_2O_3 (30- 60 wt%), Al_2O_3 (10-20 wt%), SiO_2 (3-50 wt%), Na_2O (2-10 wt%), CaO (2-8 wt%), and TiO_2(0-25 wt%) [1,2] which created a hazardous problem to the environment. It creates some environmental problems due to disposal problem and alkaline nature (pH 10-12.5)[1]. From the previous research it is found that red mud can be used for making building material[4], tiles[5], ceramic material[4], coating material[10], mortars[5,8] and as an adsorbent for waste water treatment[7],

Regression analysis in order to optimize Nd-YAG laser welding parameters (nozzle type, rotating speed, title angle, focal position, pumping voltage, pulse frequency and pulse width) to seal an iodine-125 radioisotope seed into a titanium capsule[13]. Regression analysis is also used to determining the process parameters for submerged arc welding process[14].

In this research work submerged arc welding flux is developed using industrial waste (red mud) and a bead on plate welding were carried-out on MS plate to evaluate the mechanical behaviours of welded material and compared the results from regression analysis.

II. EXPERIMENTATION:

In the process of experimentation the agglomeration technique is used to prepare a flux based on red mud and alloying elements. The composition of red mud that was used in the preparation of basic material of a flux is as mentioned in the table 1.

Table 1: Composition of red mud[3]

Sr. No.	Compound	Content (Wt %)
1	Fe_2O_3	35.5-36.2
2	Al_2O_3	17.5-19.0
3	TiO_2	14.5-16.3
4	SiO_2	7.0-8.5
5	Na_2O	5.0-6.0
6	CaO	3.2-4.5
7	LOI	10.7-12.0

The percentage of red mud with alloying elements that were used in the preparation of flux for submerged arc welding was as per the following table No. 2. The water glass was used as a binder to prepare the flux for submerged arc welding process.

Table 2: Red mud with alloying elements

Sr. No	Red mud	TiO_2	MnO	CaO	CaF_2	water glass
1	35	16	6	10	-	33
2	35	15	9	9	3	29
3	35	11	11	9	4	30
4	35	16	5	15	5	29
5	35	11	6	15	4	29
6	35	9	9	10	8	29

Welding was carried out on Mild steel material of size 55mm×25mm×5mm. The welding technique carried out with withdrawn speed of 20mm/min. it was cleaned and perfectly polished with send paper to remove surface roughness and other defects. A broad hip was put in substrate and welding electrode penetrated over it. There were welding techniques performed so many times for getting good weld bead and to find better test results.
The hardness test was done by 3000kg and 10 mm carbide ball indenter and this test result were evaluated by Brinell hardness chart. Similarly the impact test was carried out on Izod impact testing machine and test result were evaluated.

III. REGRESSION ANALYSIS

Regression technique is used to determine the relationship among the dependant and independent variables. For this the linear equation method is used in the following form:

$$Y = a+b_1X_1+b_2X_2+b_3X_3+\dots\dots+b_kX_k \quad \dots\dots(1)$$

Where Y is the dependent variable that are required to predict; $X_1,X_2,X_3,\dots\dots X_K$ are the known variables on which the predictions are to be made and $a,b_1,b_2,b_3,\dots..b_k$ are the coefficients, that values are determined by the method of least squares.
This regression analysis is used to determine the relationship between the dependant variables of TiO_2, CaO, CaF_2 and MnO. The regression analysis was done using statistical package for social science (SPSS) software. The regression analysis of the input parameters is expressed in the linear equation as follows:

Hardness Value:

$$-5.778+3.988\times TiO_2+10.963\times MnO+5.802\times CaO-0.975\times CaF_2 \quad \dots\dots (2)$$

Impact Strength:

$$-108.630+4.052\times TiO_2+16.827\times MnO+9.523\times CaO-7.433\times CaF_2 \quad \dots\dots (3)$$

IV. RESULTS AND DISCUSSION

Developed flux were heterogeneous mixture of various element as per table no 2 and after that hardness and impact evaluation were done and this value was analyze with regression model that comparison result are shown below:

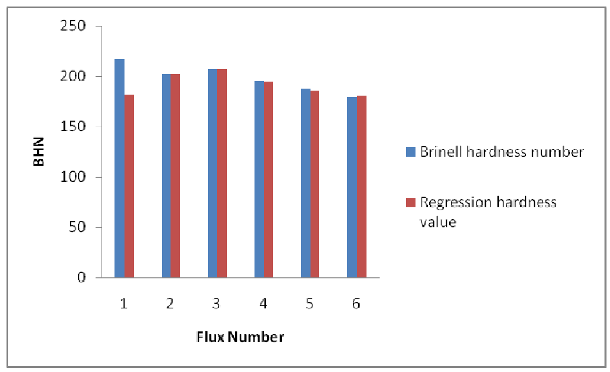

Fig. 1 Comparison between BHN and Regression Hardness

From the fig. 1 it is analysed that 5% error found in hardness value based on brinell hardness number. This error may be due to welding setup and environmental condition and also it's found that hardness value of flux number 1 is higher and flux number 6 is lower because flux 1 content highest percentage of TiO_2 and CaO which reduce the oxygen affinity and increase toughness and tensile strength value.

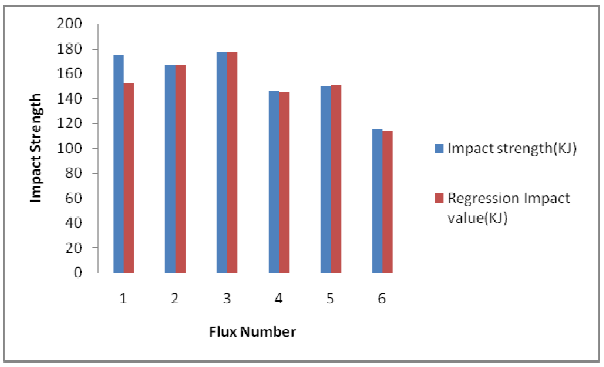

Fig. 2 Comparison between Impact Strength and Regression Impact Strength

From the fig. 2 it is analysed that 7% error found in Impact Strength compare with Regression impact strength. From fig. 2 also it is also found that Impact strength value for flux number 6 is lower due to highest percentage of CaF_2 which possess negative impact on weld and also increases the oxygen affinity and reduces the impact strength.

V. CONCLUSION

Flux are successfully developed by using red mud and other ingredient and its mechanical behavior was checked on the basis of brinell hardness and impact strength and these analysis are formulated with Regression model and found that this model can be used for further analysis on flux behavior on weld material and also this research emphasis the use of red mud (industrial waste) which reduces the environmental problem.

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