

Experimental Investigation of Process Parameters of Stainless Steel Cladding on Mild Steel Plate

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ABSTRACT: The present study deals with cladding of stainless steel on mild steel. Cladding is a process of depositing a thick layer of filler material on a low carbon base metal. It finds application in repairing worn out parts for achieving good corrosion resistant surface. The process parameters have a direct influence on weld bead geometry which in turn has an impact on the properties of the metal. Stainless steel is found to have good corrosion resistance and depositing it on steel plate will ensure protection against corrosion. The project is carried out with the objective of studying the effect of process parameters on the weld quality and the properties. Welding current and welding speed are varied to find their effect on the properties of weld. Welding position is fixed. Experiments are conducted by varying the parameters. Microstructure and hardness values for different welding conditions are studied and the results are tabulated.

KEYWORDS: Cladding, Microstructure, Hardness

I. INTRODUCTION

Cladding is the application of one material over another to provide skin or layer intended to control the infiltration of weather elements, or for aesthetic purposes. Cladding does not necessarily have to provide a waterproof condition but is instead a control element. This control element may only serve to safely direct water or wind in order to control run-off and prevent infiltration into the building structure. This is also a control element to prevent noise from entering or escaping. Cladding applied to windows is often referred to as window capping and is a very specialized field.

II. STAINLESS STEEL CLADDING

The Carbon steel plate, bonded with the stainless steel plate on one or both sides produces a clad steel plate composite. The bonding of stainless steel with carbon steel provides not only an adequate strength but also the corrosion resistance to the metal. The standard method of producing clad steel is by rolling-press cladding method. A metallurgical bond form between the carbon steel and stainless steel during heating and rolling. There are various processes available for carbon steel cladding such as hot roll bonding, cold roll bonding, explosive bonding, brazing, weld cladding, weld overlays and centrifugal casting.

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Fig 2.1 Cladded Plate

Hot roll bonding is the general process used. In this process the clean plates of carbon steel and stainless steel are placed on each other, (single side cladding), or sandwiched between two stainless steel plates (double side cladding). The composite plates are hot rolled together. Stainless steel cladding process results bonding between the two metals. Another method of manufacturing includes explosive bonding. The bonding is produced by plastic deformation of metals because of intense collision during explosive bonding. Sometimes explosive bonding is followed by the hot rolling process to improve the bond between carbon steel and stainless steel. Clad carbon steel is used in the variety of applications such as chemical processes, oil refining, offshore oil production, etc. It is also used in power generation units, where there are high temperature and stress corrosion.



Fig 2.2 Stainless Steel Cladding

II.1. STAINLESS STEEL WELDING ROD

There are many different types of stainless steel welding rod has been used for weld overlaying. The stainless steel welding rods are have many compositions as per the required parameters.

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Fig 2.1.1 SS rod E 308L – 16

II.2. TYPICAL CHEMICAL COMPOSITION OF WELD METAL (%)

- Carbon (C) - 0.024
- Manganese (Mn) - 1.32
- Silicon (Si) - 0.58
- Phosphorus (P) - 0.030
- Sulphur (S) - 0.009
- Nickel (Ni) - 9.51
- Chromium (Cr) - 19.94

II.3. TYPICAL MECHANICAL PROPERTIES OF WELD METAL

- TS - 585 N/mm²
- EL - 41%

In this project the Stainless steel cladding on mild steel is occurred by different weld speeds and current. There are 9 different types of specimens has been cladded. The following parameters has been occurred for cladding.

- The position of the welding is constant.
 - The different Current is used

(100amp, 120amp, 80amp)

- The different weld speed has been used (20s, 40, 60s)

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Specimen	Weld Time (s)	Current (Amp)
1	40	120
2	40	100
3	40	80
4	60	120
5	60	100
6	60	80
7	20	120
8	20	100
9	20	80

Table 1.1 Specimen details

III. MILD STEEL PLATE

In this project the common Mild steel plate is been used for cladding process .The mild steel plate thickness is 5mm.And it has different chemical compositions.



Fig 3.1 Cladded specimen

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Fig 5.1 Belt grinding machine

IV. STAINLESS STEEL'S APPLICATIONS AND BENEFITS

There are many reasons that stainless steel is a great choice, although of course ultimately it does depend on whether the material is suited to your application and your client's budget, Here are some of the reasons why stainless steel cladding is becoming a more viable and popular choice amongst architects, designers.

V. POLISHING

The specimens are polishing and then the microstructure has been occurred each specimens. Initially the specimens are included with belt grinding Machine, This machine contains MI Sheet and the speed of the machine is varies. The specimens surfaces are clearly polished. And then the Disc polishing machine has been used. In disc polishing machine contains also MI sheet. The specimens are clearly polished and ready to find clear microstructure and hardness.



Fig 5.2 Disc Polishing Machine

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VI. MICROSTRUCTURE OF THE SPECIMENS

- Microstructure of cladded samples shows Austenitic grains + Acicular Ferritic microstructure in all the weld overlayed samples.
- Sample 1 to 3 shows coarse grain microstructure in the weld cladded surface
- Sample 4 to 9 shows fine grain microstructure in the weld cladded surface
- For cladding is concern, it should resist corrosion.

Note: Microstructure having higher density of fine grains posse's better resistance to pitting corrosion.

Similarly, Microstructure having coarse grains posses lowers resistance to pitting corrosion.

So we can expect better cladding properties at sample no 6, 7, 8 and 9.

- Dilution is amount of base metal melted and participated in weld metal.
- If the dilution % is less than 5 then there is chance of delamination to occur
- If it is greater than 10% then deterioration in properties of weld cladding may occur

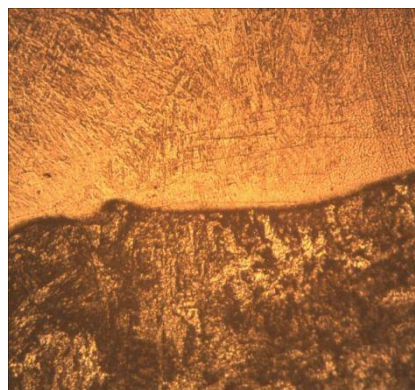


Fig 6.1 Microstructure of the specimen

VII. MACROSTRUCTURE

- Epitaxial mode of grain growth during solidification was observed all the weld cladded samples which show better metallurgical bond and integrity with substrate.
- Cladding samples is free from defects such as crack, pores.
- From sample no 1 to 9, the depth of penetration of weld bead is decreases.
- i.e. sample 1 has higher depth of penetration among all the samples.
 - Sample 9 posses least depth of penetration.

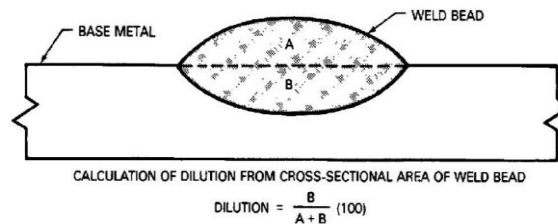
Note: If depth of penetration increases, dilution also increases because the formula for dilution is,

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So, we can expect better properties on clad samples particularly whose dilution % value is less.

VIII. DILUTION

- During weld overlaying, dilution is the predominant problem which needs to be addressed.

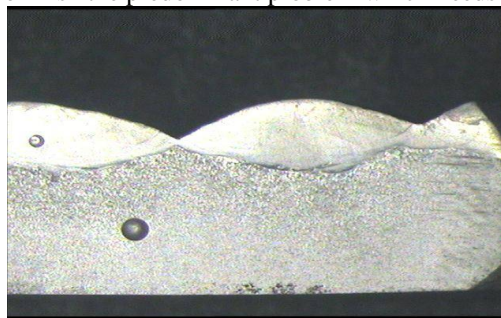


Fig 8.1 Macrostructure of the specimen

IX. HARDNESS

We are used Rockwell method to find the hardness. We are using B scale in the Rockwell hardness machine. The nine specimens have different hardness in stainless steel weld area. And the ball indenter has been used in this method. In this method 100kg load is applied.

IX.1. ROCKWELL HARDNESS METHOD

The determination of the Rockwell hardness of a material involves the application of a minor load followed by a major load. The minor load establishes the zero position. The major load is applied, and then removed while still maintaining the minor load. The depth of penetration from the zero data is measured from a dial, on which a harder material gives a higher number. That is, the penetration depth and hardness are inversely proportional. The chief advantage of Rockwell hardness is its ability to display hardness values directly, thus obviating tedious calculations involved in other hardness measurement techniques.

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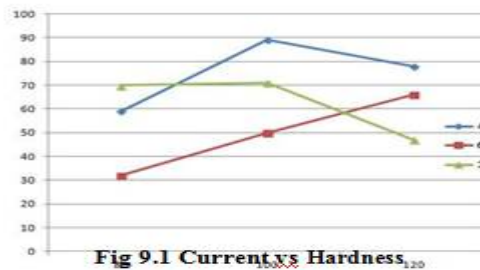


Fig 9.1 Current vs Hardness

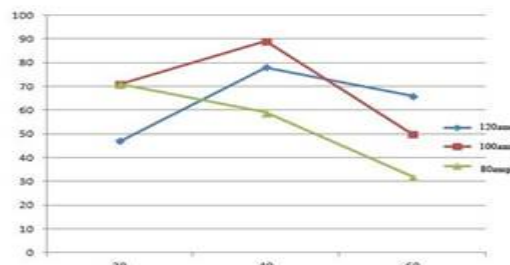


Fig 9.2 Weld Speed vs Hardness

X. CONCLUSION

The Stainless steel cladding on mild steel has been explained. The effect of process parameters on the weld quality and the properties. And the Microstructure and hardness values for different welding conditions are studied.

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