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ANALYSIS OF THIN FILM COATING BY Ni-Cr IN ARC WELDING OF MILD STEEL

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ABSTRACT

Mild steel is an appealing alternative for auxiliary segments in industrial and mechanical applications because of its ease and high accessibility factors. Low carbon amalgams are anything but difficult to frame great structures. Weldability is the significant worry for joining the structural parts where it prompts micro-structure changes, variety in mechanical properties and more erosion when contrasted with a base metal. An endeavor is made to weld the base metal joining by utilizing combination welding procedures, for example, Shielded Metal Arc Welding (SMAW) and applied metal coating on the welded joint to beat the above said issues. Even though different coating materials are available, Ni-Cr is selected as coating material because of its good properties and having more elasticity. The coated weld specimen is tested for tensile strength on a universal testing machine by conducting tensile test. The tensile test results are analyzed and observed that there is an improvement in the tensile strength of the mild steel welded joints by Ni-Cr coating to a maximum thickness of 300microns on weld area when compared with non coated mild steel welded joints.

1. INTRODUCTION

It is the way toward joining two metallic pieces of comparative or unique with the use of warmth, with or without the utilization of weight and required warmth might be gotten by various ways viz. by concoction response, electric bend, electric opposition, frictional warmth, sound and light vitality. The welding processes which do not receive filler metal during welding is known referred as 'Autogenous welding process'. The primary use of welding with carbon cathode was created in 1885 while metal bend with exposed anode was licensed in 1890. In any case, these advancements were relevant for fix just yet end up being the significant base for current day manual metal circular segment welding and other bend welding forms.

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During the year 1886 in the USA the resistance butt welding was discovered in the meantime. Certain resistance welding methods, such as spot welding's and flash welding were developed around 1905 with manual load application. In 1902 oxy-acetylene welding became feasible in Europe in 1903 with the development of cheap oxygen. At the point when the covered cathodes were created in 1907, the manual metal arc welding forms become practical for creation and gatherings in the enterprises for huge scope.

The welding technique is widely being used in fabrication of pressure vessels, bridges, building structures, aircraft and space crafts, railway coaches and all general applications.

1.1.2 CLASSIFICATION

Welding forms are sorted into two significant classes 1. Fusion welding: The base metal is liquefied by methods for heat during this procedure. Regularly, a filler metal is applied to the liquid metal in combination welding tasks to facilitate the procedure and offer help for the metal joint. Combination welding forms which are generally utilized are:

I. Arc welding –

1. Shielded Metal Arc Welding (SMAW)
2. Submerged Arc Welding (SAW)
3. Thermit Welding.

2. Solid State Welding

In this process the joining of parts takes place by the application of pressure or an amalgamation of heat and pressure. No filler metal is used. Frequently used solid-state welding processes are

1. Diffusion Welding
2. Friction Welding
3. Ultrasonic Welding

2. LITERATURE

Low carbon steels are the outright most essential mechanical materials with alluring properties. Structural components can be prepared easily so that it is widely used in manufacturing industry, vehicle industry and some of the business purposes [11] .The use of coatings on materials is now widespread in global manufacturing for reducing production cost and improving productivity, all of which are essential if industry is to remain economically competitive. As

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preindustrial requirements materials may be get failed due to their mechanical properties like strength, hardness of these materials can be improved by coating. The durability of material depends on its quality. Good quality material is inherently durable. The durability can be increased by proper choice of materials propositioning, placing and curing. Another way of enhancing the durability of concrete is by applying a coating.

G.Arun Kumar (2018) and Y.D.S.S.Naveen, G.Pavan Kumar, P.Srinu Kameshwara Rao and R.Siva Sai Manohar carried out work and come on end of hardness of the weld region is more when compared to base metal and HAZ and carried out work on the electro-less deposition process of low carbon steel plated with Ni-TiO2 composite by colloidal route was made[1]. Arc welds of low carbon steel were tested for hardness and tensile strength. The thickness of coated film was found to be approximately 400 nanometers. Despite its high porosity, the coating with the presence of nano particles showed a good adherence to the substrate (weld surface) [12].

Manik, PK Halder, N Paul and Shamimar Rehman (2012) carried out work on effect of welding on the properties of mild steel and cast iron specimen and come on end from tensile test of mild steel and cast iron specimen before and after welding it is found that the stress of the mild steel and cast iron specimen decreases after welding [13] . After welding, the hardness of the mild steel and cast-iron increases because of rapid cooling. The yield stress and ultimate stress decreases but hardness increases because after welding when it is cooled, the molecules of the specimen become compact. Finally, from 27 result it can be said that the properties of mild steel and cast iron can be changed by welding.

Oluwasegun Biodun Owolabi, Sunday Christopher Aduloju, Chidiebere Sobechukwu Metu, Christian Ebele Chukwunyelu, Emeka Charles Okwuego (2016) carried out work and come on end as the welding current increases, hardness of the weld increases for the two samples 115A and 116A for mild steel and low carbon steel respectively but shows a decrease with a further increase in welding current. The experiment carried out on effects of welding

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current on mechanical properties of welded joints between mild steel and low carbon steel [14]. The ultimate tensile strength decreases with increase in welding current but increase in the welding current of 200A and 115A for mild steel and low carbon steel respectively. The yield strength and impact strength show a decrease for the two samples with increase in the welding current. The hardness increased purely due to distortion of the grain size and formation of martensite or bainite in the weldments when heat is applied. Heat treatment helps to relieve stresses set up in the material.

Vineet Shibe, Vikas Chawla (2013) carried out research work on surface coating [15] carried out work and come on end of surface coatings improves the life of the worn-out component and reduces the cost of replacement. It reduces down time by extending the service life and hence few shutdowns are required to replace them. The purpose of surface coating technology [16] is to produce functionally effective surfaces. A wide range of coatings improve the corrosion, erosion and wear resistance of materials [17].

Sunil Takalapally, Sumith Kumar, Sri Harsha Pusuluri and Manasa Palle (2016) carried out work on surface coatings for engineering materials and come on end in almost all cases these coatings must be retreated to get rid of their porosity. This is achieved by using self-fluxing alloys that are fused after spraying, heat treating or annealing. In many cases, the cost of retreated coatings is lower than the use of bulk materials and this is especially the case for the repair of parts [18].

P.Vijayanand, Amitesh Kumar, K.R.Vijaya kumar, Md.Nazir Hussain, P.Kumaran and K RameshBabu (2014) carried out work on effect of plasma spray nano composite coating on mild steel and come on end of effects of plasma sprayed coatings [19] have 28 different composition with different parameters analyzed. Addition of grapheme powder in the Al2O3, 13% Tio2 have shown lesser micro hardness and can be used in the application of bending work, if graphene content increases electrical conductivity and thermal conductivity is also increases.

Xizhang Chin, Arvind Singh, Sergey Konavalov, Juergen R.Hirschand Kai Wang carried out work on corrosion of materials

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after advanced surface processing, joining, and welding and concluded that welding process affect the corrosion resistance of the weld due the changes of metallurgical, physical and chemical properties [20].

2.1 GAP IDENTIFIED FROM LITERATURE

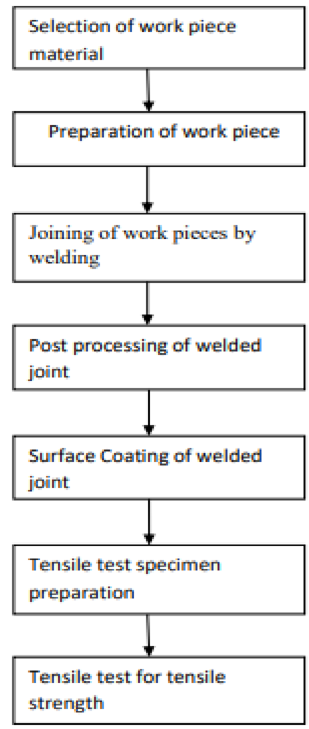
From, the literature survey, it is observed that few works have been taken on welding properties and plasma spraying coatings but no one has done work on analysis of Ni-Cr coating on weld zone. Hence, an attempt has been made to analyze the Ni-Cr coated welded joint.

2.2 OBJECTIVE

The main objective of the present work is to bring better strength by Ni-Cr coating on the weld surface of materials on comparing with non coating materials.

3 METHODOLOGY

From the literature work the information is gathered to implement the Ni-Cr coating to improve the strength of the welded area of base material (mild steel). The methodology followed for implementation is as follows:



4.EXPERIMENTAL PROCEDURE

4.1. Specimen preparation: The two mild steel plates are selected with the same dimension (250×47×5). These plates are reduced to require dimension according to the ASTM-E8 standards explains the standard dimensions of specimen. These standard proportions are mentioned in the table 4.1. The reduced size is (250×40×5).

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Table 4.1 Dimensions

	Standard Specimens		Subsize Specimen
	Plate type-40mm wide (mm)	Sheet type 12.5mm Wide (mm)	6mm wide
G- Gauge length	200.0 ± 0.2	50.0 ± 0.1	25.0 ± 0.1
W- Width	40.0 ± 0.2	12.5 ± 0.5	6.0 ± 0.1
T- Thickness	–	–	–
R- Radius of fillet	25	12.5	6
L- Overall length	450	200	100
A- Length of reduced section	225	57	32
B- Length of grip section	75	50	30
C-Width of grip section	50	20	10

The following procedure is down in the step by step process

1. **Welding**
2. **Grinding**
3. **Coating**
4. **Plasma Spray**:

4.1 Parameters of plasma spray:

- Gun - 3MB
- Nozzle - GH
- Current - 450A
- Voltage - 60-65V
- Powder feed - 120gms/min
- Spray distance - 4-6inches

Table 4.2 Parameters of Plasma spray coating

S.No	Gas	Pressure(psi)	Flow rate(SCFH)
1	Hydrogen	50	10-13
2	Argon	100-120	100-115

- Chemical composition:

Table 4.3 Chemical composition

S. No	Element	Percentage (%)
1	Ni	60
2	Cr	20
3	B, Al, Fe	20

4.2 Specifications of UTM: • All stored results and last test complete data with graph will be available. • On board over load relay for load safety and encoder over travel safety. • High speed latest micro controller-based technology.

4.3 Evaluation: Force (F) = KN Area (A) = l×b m2 Tensile strength = force (F)/area (A) MPa. The tensile strength of the workpiece is calculated by using the above formula.

5 RESULTS AND DISCUSSION

The specimen is prepared as per the ASTM-E8 standards. The tensile strength of the specimens can be evaluated by using the universal testing machine.

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5.1. Tensile test for non-coated specimen: The tensile test values are noted as below by using the ultimate load tensile strength is evaluated. Ultimate load = 116KN

Area = 800x10-6 m^2

Tensile strength = Force/Area

= 116x103 /800x10-6

= 145MN/m^2

5.2. Tensile test for coated specimen of 200microns thickness: The tensile test values are noted as

Ultimate Load = 118KN

Area = 800x10-6 m^2

Tensile strength = Force/Area

= 118x103 /800x10-6

= 147.5MN/m^2

5.3. Tensile test for coated specimen of 250 microns thickness: The tensile test values are noted as

Ultimate Load = 130KN

Area = 800x10-6 m^2

Tensile strength = Force/Area

= 130x103 /800x10-6

= 162.5 MN/m^2

5.4. Tensile test for coated specimen of 300 microns thickness: The tensile test values are noted as

Ultimate Load = 131KN

Area = 800x10-6 m^2

Tensile strength = Force/Area

= 131x103 /800x10-6

= 163.75MN/ m^2

Calculation of area for weld zone of specimen:

Length of the welded zone (L) = 20mm

Width of the welded zone (W) = 40mm

Area of the welded zone (A) = L x W

= 20x40

= 800mm^2

All the values evaluated are noted in the table below:

Table 5.1 Evaluated values

Type of specimen	Thickness(microns)	Applied Load(KN)	Tensile strength(MPa)
Mild steel(Non-coated)	–	116	145
Mild steel(coated) with Ni-Cr)	200	118	147.5
	250	130	162.5
	300	131	163.75

The beneath table demonstrates that the connected burden increments somewhat by contrasting and covered and uncoated examples.

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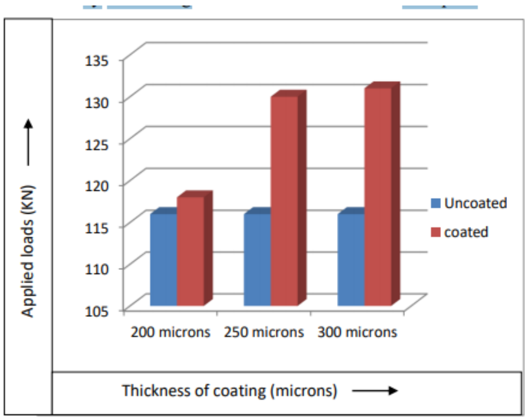

Figure 5.1 Applied loads (KN) Vs Thickness of coating

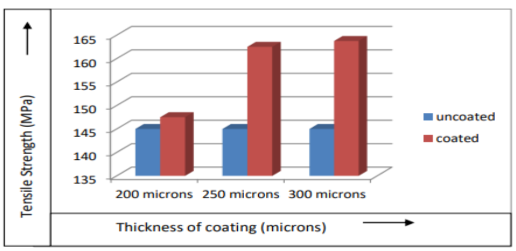

Figure5.2 Tensile strength (MPa) Vs Thickness of coating

From above tables it shows that there is an improvement in the tensile strength of the coated and uncoated specimen.

6. CONCLUSION

The welded joint of mild steel plates is coated with Ni-Cr [60%, 20%] by plasma spray coating process. After coating process, the workpiece is tested for tensile strength. Out of four specimens three specimens are coated with Ni-Cr mixture and one specimen is uncoated. The tensile strength of the coated specimen is slightly increased on comparing with the uncoated specimen with increasing coating thickness as 200, 250, 300 microns. But the thickness of coating cannot be increased beyond 300 microns (µm) as the coating may not adhered firmly to the work piece at higher coating thickness. The Tensile strength of uncoated specimen is 145MPa and tensile strength of the coated specimens is 147.5MPa, 162.5MPa, and 163.75MPa.for 200 µm, 250 µm, 300 µm respectively. Hence the strength of the welded joint is improved by coating with Ni-Cr mixture.

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