

Influence of Process Parameters on Physical and Mechanical Parameters of Friction Surfaced Deposits on Low Carbon Steel

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Abstract. Friction surfacing is the innovative technique employed for the reformation of a metal surface. Frictional heat produced between two interaction surfaces is utilized to deposit one metal above the other professionally. In this process, the quantity heat needed for depositing is essentially be influenced by on choice of process constraints such as friction force, revolving speediness of mechtrode, table speediness and reside duration. Stainless steel was selected for friction surfacing on mild steel in this experiment, the number of experiments were decided based on factorial design. Investigational task of friction surfacing was executed and the responses were quantified from the deposits which were accepted after thorough inspection. Through regression equations the impact of procedure features on each response was determined.

1. Introduction

Friction surfacing is a unique type of friction joining practice which is a solid phase welding procedure through which one metal layered over the other effectively. In this method, the portions are exposed to move relative to another under frictional force so that the frictional heat energy produced at the interface faying faces. The generated heat is employed to seem like or divergent metals.

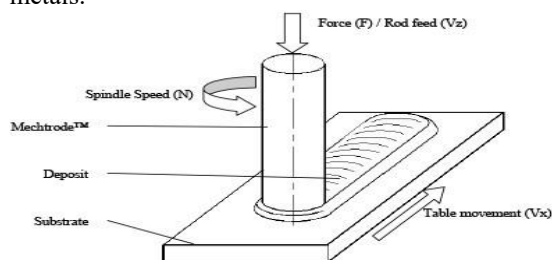


Fig. 1 Explain the principle involved id deposition of stainless over low carbon steel

This method is simply governable, repeatable, and consistent and is a modest machine tool expertise, having equivalent advantages like conventional joining procedures. It is observed that no slag inclusions, pores and

reductions on the deposit which are commonly encountered in conventional welding procedures. This procedure itself is eco-friendly, hence it is treated as green manufacturing technology. The Heat affected zone is comparatively very small. Henceforth further heat treatment process are not usually necessary for internal stresses induced.[1-4]

In this procedure, the mechtrode is made in the form of circular shaft and revolved at a pre- determined angular speed. It is moved with axial load towards base metal where the frictional heat is generated near the contact surfaces. When forging temperature is obtained, the base metal moves with a pre- determine velocity and certain percentage of plastic state of metal produced at contact surface is deposited on base metal with sufficient strength. The torque-time factors will play vital role in production of heat energy at the interface. It is observed that the physical characteristics of the deposit are influenced with the friction force, revolving speediness of mechtrode besides speediness of base metal moved and therefore these are termed procedure constraints. Diagram1, demonstrates the procedure and process parameters implicated in friction surfacing.

This method is employed to weld an extensive range of alike and divergent metals [11-13]. Aluminium and brass

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metals both can be used for joining due to high thermal conductivity of either metal [14]. In this investigation, stainless steel is used as deposit material on low carbon steel.

2. Experimentation

In present investigation, stainless steel material was chosen as the deposit material over low carbon steel. The values of the process constraints depends on characterization of weld as i) forging strength and diameter of mechtrode ii) frictional force and iii) physical and mechanical characteristics of mechtrode include base metal. Moreover, the ranges of process values were also influenced by the metallurgical properties of inter-metallic composites produced as a result of formation of mechtrode materials and base metal.

2.1 Selection of Friction Pressure

The heat produced is due to the friction force and revolving speediness of consumable, if the friction force is too high, there is chance of twisting of consumable rod, hence forging strength is important to fix the upper level of the friction pressure

2.2 Mechtrode's revolving speed

The temperature near the intersection of the mechtrode and base metal is nearer to the melting point of the mechtrode for getting desirable bond and good covering integrity. Since the upper limit of the friction force is subject to the forging strength of selected materials and the corresponding lesser value on revolving speediness is determined.

2.3 Selection of welding speed

Welding speediness effects on layer thickness than the layer width. It was found that 0.04% stainless steel which is heated malleable state was set down on low carbon steel during friction surfacing. The breadth of the coat is varying with process parameters, but average value is nearer to 0.75 times the span of stainless steel introduced. If the welding speed is high, height of the deposit is decreased and vice versa.

2.4 Dwell









Dwell time is selected about 5 seconds for stainless steel deposition above low carbon steel The parameters and levels of every parameters are represented in table 1.

Table1: Parameters used for deposit of stainless steel on low carbon steel

S. No	Factors	Notation	Unit	Level	
				Minimum (-1)	Maximum (+1)
1	Friction Force/Pressure	X1	MPa	26	49
2	Revolving speediness of the Consumable	X2	rpm	1400	2500
3	Table speediness	X3	mm/min	78	190

The statistical procedure methodology the 23 factorial designs i.e. with three factors and two levels for each is followed for experimental work. The design matrix showing 8 combinations for stainless steel deposition is shown in Table 2. 15 mm diameter of 304 stainless steel rods were made of 290 mm length pieces, which are used as mechtrodes to deposit over the base metal of low carbon steel by friction surfacing. The process constraints according to combination were set upon the computer for performing the experiments. With Reside interval of 5 seconds was maintained for deposition of stainless steel over the base metal. The layers of the deposited materials on the substrate is also shown in Table no 2 and figure no 2 shows the machine which was employed to execute the experimental work of friction surfacing.

Table 2: The deposited materials

Deposits number	Process Constraints			Deposition of SS on LCS
	Axial load (MPa)	Revolving speediness	Table speediness	
1	25	1350	75	
2	48	1350	75	
3	25	2400	75	
4	48	2400	75	
5	25	1350	180	
6	48	1350	180	
7	25	2400	180	
8	48	2400	100	

Results and Discussions

After completion of the experimentation the deposits were examined visually for the physical features and defectiveness happened before processing further tests. They were conducted on shop floor to identify the physical responses of the welded Layers like breadth, stature and surface roughness also the solidity of deposits such as shear

and tensile strength. The standard procedure ASTM 264 was followed to estimate the tensile strength. The specimens used for shear and ram tensile strength are shown in table 3. The calculated values for mechanical strength of the stainless steel deposits tabulated in table 4.

Table 3: The specimens of shear and tensile strength test





Stainless steel deposit	Deposit	
	Specimen before test	Shear strength test
	Specimen after test	
	Specimen before test	Tensile strength test
	Specimen after test	

Table 4: Responses of stainless steel deposit over low carbon steel

Expt. No.	Width (mm)	Height (mm)	Surface roughness (µm)	Shear Strength (MPa)	Tensile Strength (MPa)
1	10.9	1.4	6.82	72.5	297
2	12.45	2.6	2.63	85	326
3	11.52	1.5	6.25	156	456
4	14.15	1.6	1.94	155	448
5	10.44	1.1	6.10	172	518
6	12.47	1.2	7.83	162	484
7	10.76	0.9	6.65	350	586
8	13.25	1.5	9.68	150	360

2.5 Analysis of deposits by regression equations

The responses of the stainless steel deposits on low carbon steel obtained by means of eight combinations were analyzed in Minitab software. The regression equations the responses of stainless steel deposit above low carbon steel is summarized in Table 5. As the value of the each response is not same with all eight experiments. The mechanical properties like tensile strength increases with the three factor interactions of axial load, revolving and transverse speediness .But it decreases with the welding speed, the collective influence of friction force and revolving speediness, one more interaction of revolving speediness and table speediness.

Table 5: Regression equations for the responses of stainless

steel deposit over low carbon steel

S.No	Response	Regression Equations (Eliminated least significant terms)
1	Width	$y=11.9925+1.0875X1 +0.4275X2-0.2625X3+0.1925X1X2$
2	Height	$y =1.475+ 0.25X1 -0.075X1X2-0.3X3 +0.2X1X2X3$
3	Surface Roughness	$y =5.9875-0.4675X1 +1.5775X3+1.6575X1X3 + 0.4575 X2X3$
4	Tensile strength	$y = 437.625 -31.875X1X2-19.125X3-88.875 X2X3+52.375X1X2X3.$
5	Shear strength	$y =162.8125-24.8125X1 +39.9375X2-25.4375X1X2+45.6875X3 -27.6875X1X3$

3. Conclusions

In this project, stainless steel (304) as mechtrode plus low carbon steel introduced as consumable and base metals respectively.23 factorial design was used conducting experimental work. The values of each experiment, it was representing that parameters are played crucial role on each response. The influence of process parameters on the each response are determined by establishing, the regression equation. Finally, from the investigation it is found that at least one process parameter is proportional to each response of stature, shear strength physical properties as width, stature and mechanical properties like surface coarseness and shear strength of stainless steel deposit over low carbon steel. But none of the parameter was directly proportional to the response of tensile strength. The shear strength is increases with revolving speed and transverse speediness and is inversely relative to friction force and interactions of friction force, revolving speediness, and collective influence of three factors such as axial load, revolving and transverse speediness.

SALUTATIONS

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