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The Effects of Welding Processes and Microstructure on 3 Body Abrasive Wear Resistances for Hardfacing Deposits

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--ABSTRACT--
Wear is the predominant factor that controls the life of any machine part. Metal parts often fail their intended use not because they fracture and wear which causes them to lose dimension and functionally. Different categories of wear exit, but most typical modes are abrasion,impact,Hardfacing is one of the most useful and economic ways to improve the performance of components submitted to severe wear conditions. A study was made to compare the microstructure and abrasion resistance of hardfacing alloys reinforced with primary chromium carbides. The hardfacing alloys were deposited onto M.S. plate by shielded metal arc welding (SMAW) process. Two different commercial hardfacing electrodes were employed to investigate the effect of the microstructure. The abrasion tests were carried out in a dry sand-rubber wheel abrasion machine according to the procedure A of ASTM G65 standard. Microstructure characterization and surface analysis were made using optical and scanning electron microscope. The result shows that the wear resistance is determined by the size, shape, distribution and chemical composition of the carbides, as well as by the matrix microstructure. The best abrasion resistance was obtained in microstructure composed of chromium carbide alloy. Hardfacing is a deposition of different metal over the parent metal to achieve required properties.

KEYWORDS: *Abrasion resistance, Hardfacing alloys, Microstructure characterization, Wear mechanism, welding.*

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I. INTRODUCTION

Hardfacing is also known as Hardsurfacing is the application e specialized alloys by means of welding process to resist abrasion, corrosion, high temperature, or impact. Such an alloy may be deposited on the surface, an edge, or merely the point of a part subject to wear. Hardfacing deposits can functionalize surfaces and reclaim components by extending their service life. Hardfacing is a key technology to fulfill these requirements and to apply different hardfacing alloys on the base metals. Hardfacing increases the service life of a part and there by extend the life time of machinery equipment efficiently.Core components such as crushers are exposed to heavy wear and require efficient surface protection measures to avoid costly downtimes and to reduce costs for expensive spare parts. Hardfacing is a commonly employed method to improve surface properties of agriculture tools, components for mining operation, soil preparation equipments and earth moving equipments [1], [2]. This process has been also adopted across many industries such as Cement, Mining, Steel, Petro-chemical, Power, Sugar cane and Food. An alloy is homogeneously deposits onto the surface of a soft material by welding with the purpose of increasing loss in ductility and toughness of the substrate. A wide variety of hardfacing alloys are commercially available for protection against wear. Deposits with a microstructure composed by disperse carbides in austenite matrix are extensively used for abrasion applications and are typically classified according to the expected hardness. Nevertheless, the abrasion resistance of a hardfacing alloys depends on many other factors such as the type, shape and distribution of hard phases, as well as the toughness and strain hardening behavior of the matrix[3].

Chromium-rich electrodes are widely used due to low cost and availability; however, more expensive tungsten or vanadium-rich alloys offer better performance due to a good combination of hardness and toughness. Complex carbides electrodes are also used; especially when abrasive wear is accompanied by other wear mechanisms [4].Several welding techniques such as oxyacetylene gas welding (OAW), gas metal arc welding (GMAW), shielded metal arc welding (SMAW) and submerged arc welding (SAW) can be used for hardfacing. The most importance differences among these techniques lie in the welding efficiency, the weld plate dilution and the manufacturing cost of welding consumables [5]. SMAW, for example, is commonly used due to the low cost of electrodes and easier application. The present investigation aims to study two commercial electrodes in terms of their chemical composition, microstructure, hardness and abrasive wear resistance.

II. EXPERIMENTAL PROCEDURE

Base Metal : The selection of base metal is very essential in deciding what alloy to use for hardfacing deposit. Since welding procedure differs according to the base metal. Mild steel was selected as the base metal for the study which composes the main elements of carbon, silicon, manganese, sulphur, and phosphorous. The chemical composition is given in Table 1.

Hardfacing Alloys : In the study, two different commercial hardfacing alloys were used for overlaying. These are basically iron – based alloys having varying amount of chromium, carbon, silicon and other alloying elements as they are more suitable for shielded metal arc welding process. Chemical compositions of two electrodes are presented in table 2.

Table 1: Chemical Composition of Base Metal (In Weight Percentage)

C	Si	Mn	S	P	Fe
0.18	0.32	1.47	0.013	0.029	Bal

Table 2: Chemical Composition of Hardfacing Alloy (In Weight Percentages)

Electrode	C	Si	Mn	S	P	Cr	Mo	Ni	V	Fe
Hardfacing-1	0.33	0.28	1.15	0.014	0.025	2.22	-	-	-	Bal
Hardfacing-2	0.1	0.38	1.51	0.024	0.03	2.15	0.745	1.09	0.103	Bal

Welding Conditions

The standard size of test specimens of 16 nos. with the dimensions of 250×100×12 mm was selected for the experiment.

The following precautions are taken before hardfacing:

- The electrodes are perfectly dried in the furnace and baked at 250°C one hour before the use
- Area of the weld is properly cleaned
- Preheated the hardfacing area to a minimum of 200°C

2.4 Machine specifications

Name: TORNADO MIG 630 Arc welding machine
Current: 100-630 A
Input Voltage: 415 V ± 10% / 50-60 Hz / 3 Phase
Machine Capacity: 50 KVA

2.5 Stages of Experiment

The experiment was carried out in three stages to investigate the effect of welding parameters such as current, travel speed and voltage on hardfacing electrodes and the corresponding hardness was determined by using Vickers hardness testing machine.

1) In first stage, voltage (V) and travel speed (S) were kept constant and current (A) was increased.
2) In second stage, voltage (V) and current (A) were kept constant and travel speed (S) was increased.
3) In third stage, current (A) and travel speed (S) were kept constant and voltage (V) was increased

III. RESULTS OF THE EXPERIMENT

Hardness test

The specimens were cut to a size of 100x30x12mm for hardness testing and were polished using standard metallographic procedure. Hardness testing of different welding deposits was carried out in Vickers hardness testing machine using SHIMADZU HMV-2000 Micro Hardness Tester, The load applied is 500 Gms, dwell time is 13 Sec with a square base diamond pyramid of opposite face angle 136° ±0.5°. The test method adopted is as per IS: 1501-2002. Micro hardness surveys were made on these specimens using Vickers hardness tester along the direction of thickness from the top surface towards the base metal after every 0.5 mm. These surface values are plotted in the form of a graph shown in figure 1. The results of the hardness survey of heat affected zone (HAZ) samples for every 0.5mm depth indicate that the hardness values are more on the weld surface and decrease towards the base metal and remain constant on the base metal. Based on welding parameters such as current, travel speed and voltage the micro hardness surveys were made on the each specimens using Vickers hardness tester along the direction of thickness from the top surface towards the base metal after every 0.5 mm are illustrated in the cumulative graph for all the 16 specimens are shown in figure 1 for comparison.

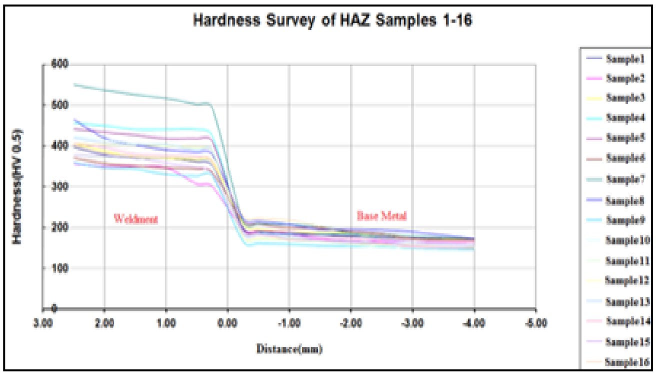

Figure1. Hardness survey of heat affected zone (HAZ) for 16 samples

Alloy (hardfacing 1) is the main martensitic with some kinds of austenite. Fine primary chromium carbides are well distributed throughout the micro section. The hardness on the Weldment and HAZ towards the base metal has been surveyed for every 0.5 mm depth and the values are plotted in figure 1. The chemistry of the Fe/Cr carbides is reported for hypereutectic FeCrC alloys in literature to M_7C_3 structure [6-9]. The hardness values of the ledeburitic matrix which are determined to about 500 HV 0.5 are close to previous investigations from Fischer [10] and Buytoz [11]. Beside small and evenly distributed primary chromium carbide at a volume content of approximately 5% can be detected which are supposed to be of major importance for increasing the resistance against abrasion due to their high hardness. While observing the alloy of hardfacing 2 the constituents of primary chromium carbides are not well distributed throughout the micro structure. After the dry sand abrasion test comparisons were made between electrode 1 and electrode 2, the electrode 1 is more wear resistance than electrode 2.

A closed net or skeleton of brittle Fe/Cr carbides is clearly surrounds the primary dendrites. Higher welding amperage, higher arc travel and higher voltage leads to decreasing hardness. Overall the chromium carbides are irregularly distributed. There is a higher density of original carbides close to the fusion line, whereas at the surface only rests of carbides are visible. BAIRD spectroscope is used to analyze the microstructure of the specimens. Cross sections of the weld were polished and etched with kalling's and Nital 2%. Different types of carbides present in the microstructures were first identified on the basis of their morphologies and confirmed by micro hardness measurements. The wear resistance is in fact proportional to the volume fraction in hypereutectoid Steels [12]. Furthermore, the original orientation of the colony and the mean inter lamellar spacing have effects on wear resistance [13]. Several authors investigated that the relationship between wear resistance and hardness is affected by microstructure [13, 14].

Wear resistance increased in the structural sequence from spheroidite to pearlite and from tempered martensite to bainite [12, 15]. Microstructure shows pearlite with subsequent formation of interdendritic carbides. However, the carbide content in the weld deposit made with welding parameters at current 200A, travel speed 21.4cm/min and voltage 25V is higher than that with weld deposit made with welding parameters at current 300A, travel speed 23.1 cm/min and voltage 25V for the same electrode. Furthermore coarser microstructure are observed in weld deposit made with higher heat input at higher amperage current and travel speed for the same electrode keeping more or less similar microstructural constituents. These microstructural characteristics are also reflected in the hardness values. Higher amount of carbide and finer structure, in general resulted in higher hardness, whereas lower hardness values were recorded in weld deposits with less amount of carbides and coarser structure. Several Authors [16, 17] have suggested that abrasive wear resistance increases in direct relationship with the volume of the hard constituent. It is interesting to note that weld deposits made with high heat input with higher amperage of current for the same alloy system possess higher wear resistance. Apparently one would expect lower wear resistance in the weld deposit made with high heat input, due to lower hardness value. Alloy mainly martensitic with some islands of austenite. Chromium Carbides are well distributed throughout the micro section (specimen 5, 8, 12). (Ledeburitic matrix).

Major importance is an increasing resistance about abrasion due to their higher hardness and free from defects. The distribution of hard phases in the specimen 7 is quite uniform. These is a higher density of original carbides close to the fusion line, whereas at the surface only rests of carbides are visible. While observing the microstructure of all the 16 specimens, specimen 3, 4 and 7 were having defects noticed through optical microscope on the weld surface deposit. Specimen no. 3 which contains network of grain boundary cracks and several blow holes. Specimen no. 4 having several blow holes observed within the weldment. Specimen no. 7 having microcracks within weldment.

Dry sand abrasive test : In the present study, sample of 75x26x6 mm size were used for testing as shown in figure 2 as per ASTMG65 standards. Specimens were ground using surface grinder to make the surface flat. Before the abrasive wear test all the specimens were cleaned with acetone and then weighed on an electronic balance with an accuracy of ± 0.1 mg. The three-body abrasive wear tests were conducted using a dry sand/rubber wheel abrasion tester as per ASTM G65-04 (2010) shown in figure 3. The sand particles of AFS 60 grade (figure 4) were used as abrasives and they were angular in shape with sharp edges. The sand particles were sieved (size 200–250 µm), cleaned and dried in an oven for 6 h at 40 ^{0}C. In this test, samples were held against a rotating rubber wheel under the constant flow of abrasives in between the sample and the rubber wheel under predetermined load.

Figure 2. Standard test specimen (75×26×6 mm)

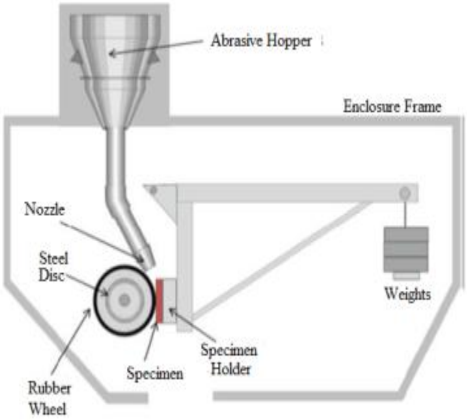

Figure 3. Dry sand/rubber wheel abrasion Tester

Test conditions
Speed: 200 ± 5 rpm
Sample test duration: 15 and 30 min.
Abrasive: loose silica sand having particle size 200 - 250 µm
Load is kept constant at 130.5 N for all the samples. After each test, the samples were cleaned with acetone and then weighed on the electronic balance. The wear loss was calculated as weight losses in Gms.

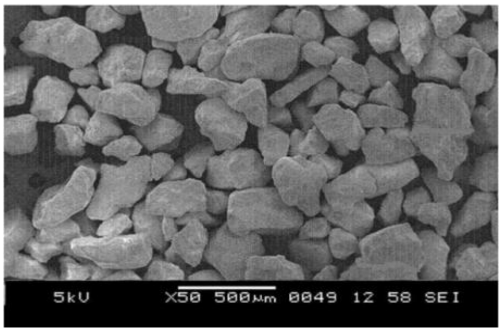

Figure 4. SEM picture of silica sand (200-250 µm)

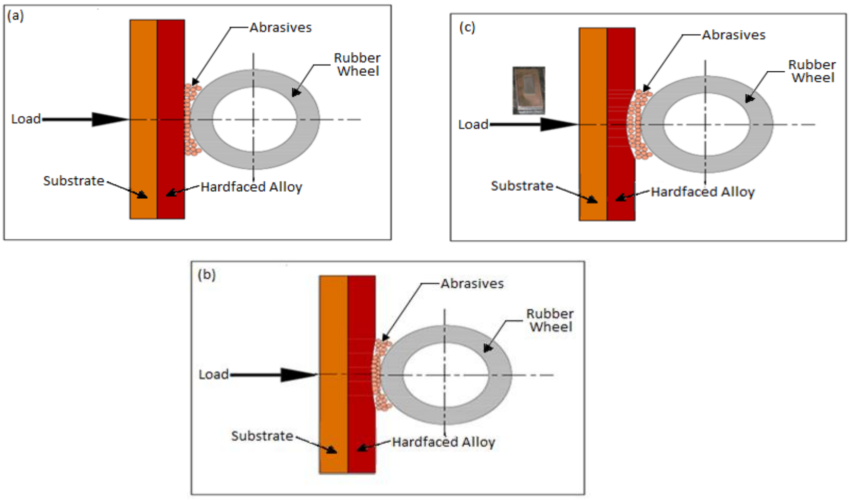

Figure 5. Stages of abrasion; a) initial, b) middle and c) end of tests

In three-body abrasion, the sand particles behaved in one of the following ways. From free fall, the sand particles gained energy from the rubber wheel (figure 5.a) and then struck the sample surface, which would result in the formation of pits. Secondly, the abrasive particles were embedded in the rubber wheel, transforming the three-body abrasion into multi-pass Two-body abrasion (figure 5.b). Thirdly, the particles roll at the interface causing plastic deformation to the hardfaced alloy (figure 5.c). These stages are illustrated in figure 5.a-5.c respectively.

Wear is generally a complex process, which is influenced by the many system variables, such as materials properties, environment and mode of loading. In this study, two Fe-Cr-C hardfaced alloys of different composition and microstructure were investigated under three-body abrasion.Various researchers have been demonstrated that the application of hardfaced alloy on cast iron/mild steel significantly increases the surface hardness and results in increased resistance to abrasive wear [18-19], it has been shown in this work that the hardness of two hardfaced alloys were very different, their wear loss were dissimilar under the same test conditions. This indicates that the importance of microstructural parameters, such as the amount and size of the carbides, weld parameters, toughness and type of phases in determining the wear resistance [20-22].

The development of Fe-Cr-C hardfacing has been based around the understanding that good wear resistance is obtained with materials that have a high volume fraction of hard phases that are supported in a tough matrix. Both hardfacing 1 (type 1 electrode) and hardfacing 2 (type 2 electrode) are composed of similar phases; however, hardfacing 1 has a significantly larger amount of carbide phases than hardfacing 2.

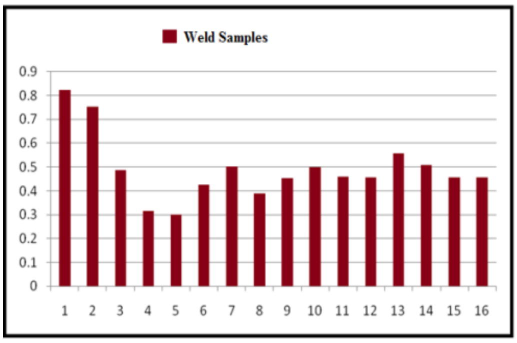

Figure 6. Wear loss of weld sample 15 min

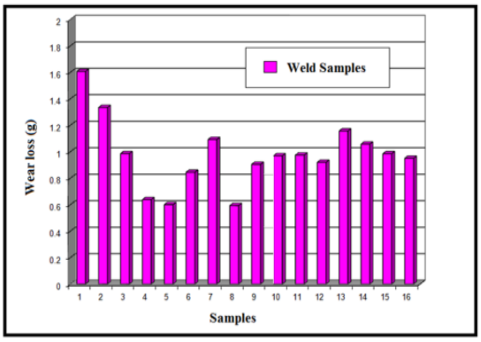

Figure 7. Wear loss of weld samples 30 min

The wear resistance increases with increase in chromium, carbon and silicon present in the hardfaced alloy 1. The experimental results are in agreement with those reported [23-24] on hardfacing alloys tested under low stress against a rubber wheel. Meanwhile, decrease in the wear resistance with decreasing chromium, carbon and silicon were observed in type 2 electrode and is in consistent with other published works.

The reduction of the wear resistance with type 2 electrode could be due to the fact that the surface hardness was greatly reduced as compared to type 1 electrode. Higher hardness of samples increasing the apparent contact area allows a large number of sand particles to encounter the interface and share the stress. This, in turn, leads to a steady state or reduction in the wear rate.

The wear test results of the type 1 electrode deposited hardfaced alloy indicate that a better wear performance. In type 2 electrode deposited hardfaced alloy, the wear resistance is poor compared to those obtained for type 1 hardfacing alloys. In type 2 electrode deposited hardfaced alloys, the abrasion was simultaneously initiated on the hard and soft phases of the weld material. In this situation, soft surface was continuously exposed to the interface throughout the entire test. It can be clearly seen from figures 6 and 7, that the presence of lower chromium and silicon in the interface increases the wear rate. On the other hand, in the case of the rich chromium, and silicon, the abrasion started through contact with the hard phase. This contributed to marginal damage and surface topography using atomic force microscopy (AFM) are shown in figures as shown in Fig. 8 and 9 for type 1 electrode deposited samples (Samples 1 and 5).

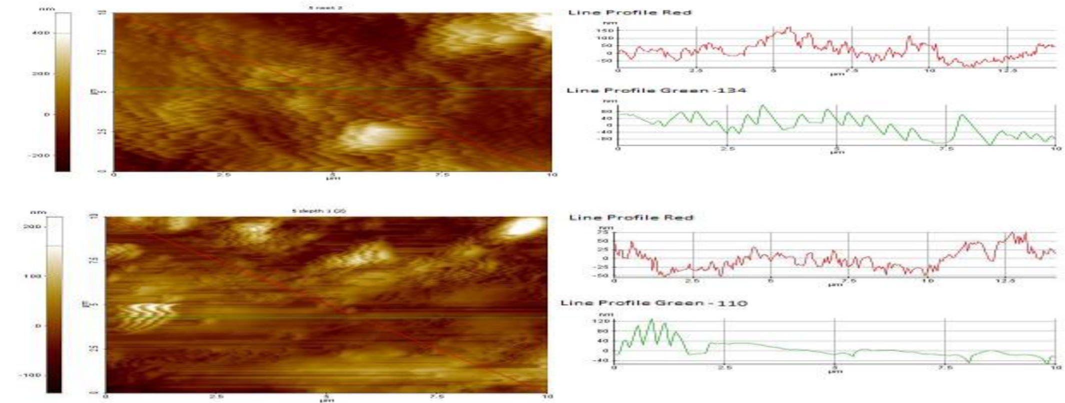

Figure 8. AFM images for type 1 electrode deposited sample 1:
a) Before wear test and b) After wear test

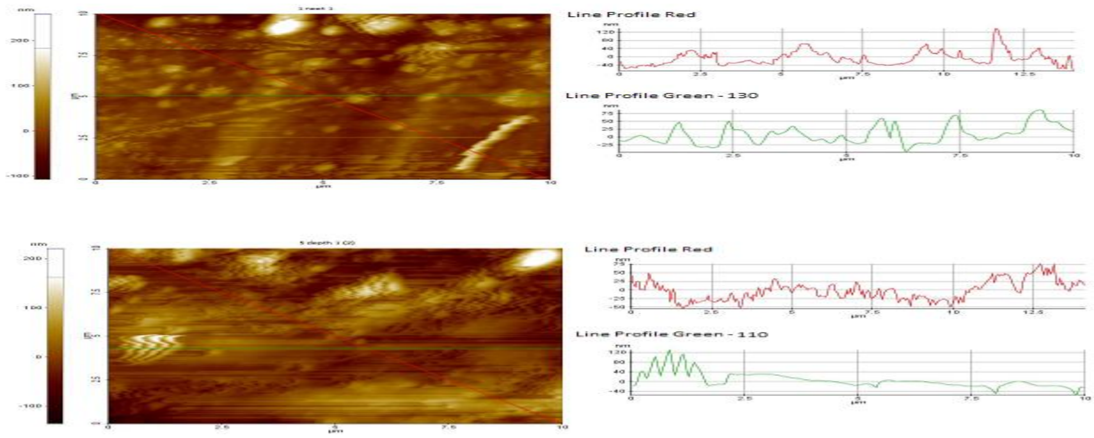

Figure 9. AFM images for type 1 electrode deposited sample 5:
a) Before wear test and b) After wear test

Scanning probe microscopy constitutes a family of advanced techniques for surface analysis of hardfaced alloys. Although scanning probe microscopy was invented first, the current progress in scanning probe microscopy of metallic alloys for atomic force microscopy (AFM). Surface roughness of metallic alloys affects the wear behaviour of hardfaced alloys. Therefore, in this work, before conducting the abrasive wear tests, selected sample surface topography were examined using AFM and the surface images of the samples are shown in figure 8 and 9 respectively.

The worn surface topography measured by AFM showed lower roughness values for type 1 electrode deposited hardfaced alloys (sample 5) and AFM images are shown in figure 9 when compared to sample 1 (figure 8). From these data in can be concluded that the damage is relatively low in sample 5 than that of sample 1. Scanning electron micrographs and surface topography by AFM taken from worn surfaces of the type 1 electrode deposited samples give an idea about the particular mechanisms involved in the wear process. Under the attack of irregular sand particles, the individual grains penetrate deeply into the surface of the sample investigated, subsequently removing material from the surface by an extensive micro-ploughing process.Mechanical properties influence the abrasive wear performance of a material. When considering the properties individually, it has been found that the hardness played a main role in controlling the abrasive wear. The compression strength could have a stronger influence on the abrasive wear property than the tensile strength thereby the load is applied in the form of compression thereby pressing the specimen toward the sand particles at the interface. This attracted the attention to explore the possibility of a correlation between the selected mechanical properties and the wear loss of the hardfaced alloys.

Table 3 shows the wear loss as well as the hardness of all the samples. From the table it can be seen that when considering the hardness alone, the wear resistance of all the hardfaced alloys tested, a better correlation was obtained in the present work. The higher the hardness, the lower was the wear loss. From wear testing data under various conditions of the parameters, it can be stated that type 1 electrode deposited hardfaced alloys are more wear resistant than the type 2 electrode deposited hardfaced alloys. The work summarizes that type 1 electrode deposited by considering optimum weld parameters i.e., current 200 Amps, travel speed of 21.3 cm/min and potential difference of 15 volts of hardfaced alloys has beneficial effect on the three-body wear as well as on the hardness, thus re-emphasizing the fact that the introduction of rich Cr, C and Si in type 1 electrode has got the advantage of enhancing the properties.Will be less in wear and wear resistance is increase from specimen 3 to 5. Also results indicate that the wear resistance increases with increasing hardness. The wear loss will be 1.6075 grams for the specimen 1 which is at 377 HV0.5 is decreased by 0.6007 of the specimen 5 which is hardness 418 HV. It is clearly observed both from wear results and microstructures. The wear resistance increased by 62 percent by varying welding current and travel speed and keeping welding parameter is constant. The structure and properties of weld metal varies with varying welding parameters. Sample 1 shows ductile structure along with ferrite, which gives because of low current and travel speed of 23.1 cm/min. Whenthe current increase the structure will be hard and grain size will decrease both in weldment and heat affected zone.

Table 3. Relation between hardness and abrasion resistance

Sample Number	Load (N)	Weight loss (g)	Hardness (Hv0.5)
1	130.5	1.6075	377
2	130.5	1.3345	318
3	130.5	0.9861	380
4	130.5	0.638	417
5	130.5	0.6007	418
6	130.5	0.8454	356
7	130.5	1.0923	537
8	130.5	0.5934	390
9	130.5	0.9051	330
10	130.5	0.9698	416
11	130.5	0.9746	370
12	130.5	0.9205	406
13	130.5	1.1571	388
14	130.5	1.0576	377
15	130.5	0.9852	357
16	130.5	0.9506	401

The sample welded at 250A, 25V and 23.1 cm/min speed having more wear resistance compare to sample 1 welded at 200A, 25V and 23.1 cm/min. Similarly sample 6, 7 and 13 shows large grain structure and has low strength, hardness and low wear resistance. Hence more wear loss occurs on these samples. Samples 4, 5 and 8 shows small grain structure with hard micro constitutions and has high wear resistance. Hence, these metals along with welding parameters are suitable for wear resistance applications. The HAZ is defined as the area of base metal where the microstructure and material properties have been altered by the welding process. The heat from the welding process and subsequent re-cooling causes these change from the weld interface to the termination of the sensitizing temperature in the base metal.

The extent and magnitude of property change depends primarily on the base material, the weld filler metal, and the amount and concentration of heat input by the welding process. The thermal diffusivity of the base material plays a large role if the diffusivity is high, the material cooling rate is high and the HAZ is relatively small. Alternatively, a low diffusivity leads to slower cooling and a larger HAZ. The amount of heat inputted by the welding process plays an important role as well, as processes high heat input and increase the size of the HAZ. A heat affect zone structure of all samples shows more ferrite (white grain) than the coated materials. The properties of these structures are ductile and low hardness.

IV. SCANNING ELECTRON MICROGRAPHS OF DIFFERENT WORN SURFACES

Scanning Electron Microscopy Analysis : The SEM photographs shown in figures 10, 11 and 12 reveals the worn surfaces of specimens 1, 3 and 5 (table 3) after dry sand abrasion test. The worn out specimens consists of low, medium and high abrasion resistance at the entry and exit. Examination of the wear scars indicate that morphologies for all the samples were similar consisting of three zones, a short entrance and exit area and the main wear zone in middle. At the entrance and exit zones where the pressure applied to the abrasive is lowest, the damage morphologies were consistent with particle rolling. In the center of wear scar, parallel grooves were formed, typical of particle sliding, a result of the higher pressure forcing abrasives into rubber wheel. The worn surfaces are characterized by shallow continuous grooves and micro cuttings given in figures 10, 11and 12 (a & b) respectively. Characterization of microstructure has been done with optical microscopy and scanning electron microscopy. In the present research, quantitative analysis of the microstructure was carried out by the use of intronic image C software. Quantitative wear characterization has been done by gravimetric mass loss of the testing specimen during wear testing. Qualitative characterization of worn surfaces and worn edges has been carried out by evaluating of macroscopic and cross section images and by SEM investigations. Typical micro structures of weld deposits made with different electrodes have been shown and discussed.

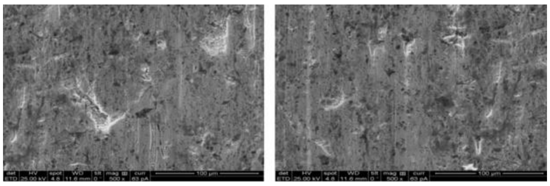

Figure 10. Worn surface features of sample 1- (a) 15 min (b) 30 min

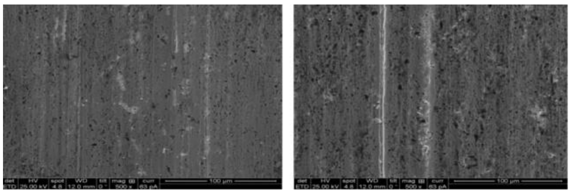

Figure 11. Worn surface features of sample 3- (a) 15 min (b) 30 min

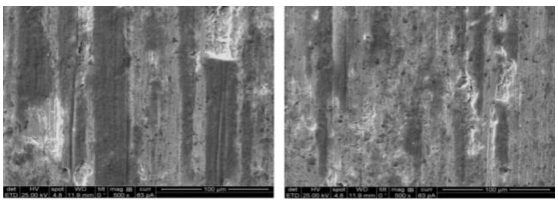

Figure 12. Worn surface features of sample 5- (a) 15 min (b) 30 min

Abrasive wear resistance and mass removal mechanism

SEM microscopy of the worn surfaces of samples 1, 3 and 5 are shown in Figures 10, 11 and 12 respectively. Figure 10(a & b) shows the worn surface features of sample 1, where micro-ploughing and micro-cutting are the main abrasive wear mechanisms. Figure 11 (a & b) shows the surface of sample 3, where micro-cutting and wedge formation were the main abrasive mechanisms: this deposit presented lower abrasion resistance. The worn surfaces of samples 1 and 3 clearly shows obvious evidence of cutting and ploughing (Figure 10 and 11), however, no obvious plastic deformation can be found on the worn surface of sample 5 (Figure 12 (a) & (b)) although there are some slight traces of ploughing to be seen on the matrix area, these cease when elements such as carbides are encountered, indicating that the silica and chromium elements effectively stop the abrasive form cutting or ploughing into the surface layer during the wear process, thereby noticeably lowering the wear loss. However, the grooves were not deeper than samples 1 and 3. This hardfacing deposit presented higher abrasion resistance, because the large quantity of carbides rich in titanium, uniformly distributed in the matrix, blocked the abrasive particles. Further, the resistance of silica, manganese and chromium elements to the abrasive could be attributed to its higher hardness. Further observations of Figure 12 also provide evidence of cutting and cracking of the carbides. This is due to the hardness of the carbide groups in the sample 5 being lower than that of abrasive SiO_2. It is reasonable to believe that the wear resistance of the materials will increase if the hardness of the hardfacing alloy is improved.

Analysis of Fractography of worn out specimens : The Fractography analysis has been done for low, medium and high worn out specimens based on welding parameters such as current (200 and 300 A) and travel speed (21.4 cm/min) after dry sand abrasion testing. Figures 10-12 shows the scanned electron fractography of chromium hard faced with welding technology using varying welding current. All samples shows directional solidification after welding chromium as hardfacing on low carbon steel specimens. Figure 10(a & b) reports chromium hard faced mild steel using 200 ampere current but it shows more wear loss compared to other two specimens and both sample shows a fair amount of scraches since the size of test sand is bigger and harder than that of surface coatings. Similarly the figures 11 (a & b) shows the chromium hard faced mild steel using 200 ampere current and at normal running speed, indicated that more wear resistance compared to figure 10 (a & b). Figure 12 (a & b) shows randomly distrbuted pits approximately 10 to 20 micrometer which is close to matrix. Surface coating using 300 ampere and normal welding speed is decrease gradually as welding current increases.

The chromium plated using 300 ampere and at moderate travel speed shows the high wear resistance compared other two samples. The rate of wear of chromium welded using 200 ampere and moderate speed almost is twice than the other samples prepared using 300 ampere as shown in the figures 10 and 12 respectively. This wear loss is predicted through the fractography of rubber wheel abrasion test as shown in the figure 10 and 12 (a & b) respectively. It is clearly indicated that, the wear track will be small and narrow indicates there will be less in wear and wear resistance is increased from the specimen 8 & 5 respectively. Also, results indicate that, the wear resistance increases with increasing hardness. The wear loss will be 1.6075 grams for the specimen 1 which is at 377 HV 0.5 is decreased by 0.6007 of the specimen 5 which is hardness 418 HV 0.5. It is clearly observed both from wear results and fractography, the wear resistance is increased by 62% by varying welding current and travel speed and keeping welding parameters is constant.

V. CONCLUSION AND FUTURE WORK

SEM photographs showing as weld dendritic structure of the Fe-Cr-C hardfacing alloy, eutectic carbides, mapping elements Fe-Cr-C of austenite and eutectic carbide. Fractography analysis was conducted to worn-out specimens of low medium and high abrasion resistance. Results showed that small and narrow wear track clearly indicates there will be less in wear and the wear resistance increases with increasing hardness. It is clear that a significant effect of primary carbides in the weld deposits leading to improved abrasive wear. Microstructure plays an important role in the abrasive wear of the weld deposits, though a linear relationship between wear resistance and hardness has been observed for similar microstructural characteristics, microstructure having coarser carbide and less grain boundary area, possesses better wear resistance than microstructure containing fine carbide and fine grain size resistance. ASTM G-65 is a reliable low stress abrasion test to assess the performance of the hardfacing deposits used in actual service conditions.Results reveal that weld metal chemistry, welding heat input and test duration have significant influence on abrasion resistance. Hardness can be used as a predictor of wear resistance only for weld deposits having similar microstructural characteristics.Wear resistance increases with increase in chromium, silicon and carbon content of weld deposit as well as with increase in heat input.The hardness mainly depends on process parameters such as welding current, speed of arc travel and voltage.

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