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HARDFACING USED TO INCREASE HARDNESS OF ANY OBJECT TO REDUCE WEAR

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Abstract

The purpose of the research is to investigate the performance of hardfaced object and compare its performance with without hardfaced object in this excavator nail is used for experiment. The present work was carried out to study experimentally, the effect of three weld hard facing deposits made through the use of different fillers using weld hard facing on the wear performance of the substrate i.e. low carbon alloy steel. To meet the objectives set forth as mentioned previously, the experimental work was planned in two phases. In the first phase, trial runs were conducted based upon which, using DOE approach, wear modeling was done for the base and variable filler combinations, and in the second phase real time assessment of the wear performance of the bucket's nails was carried out so as to check the efficacy of the hard facing procedures that were developed through this work.

I. INTRODUCTION

Wear is a common problem in all industrial areas like sugarcane industry, cement Industry, crushers etc. and all engineers and researchers are concerned about improving wear resistance of components that are subjected to wear. In this present work, hardfacing technique is used to deposit the weld metal on substrate to enhance its wear resistance. Study was carried out to reduce the abrasive wear on excavator bucket nails caused by the soil and abrasive particles.

Wear

Wear is sideways displacement of material from its original position on a solid surface performed by the action of another surface. Wear is related to interactions between surfaces and more specifically the removal and deformation of material on a surface as a result of mechanical action of the opposite surface. Wear can also be defined as a process where interaction between two surfaces or bounding faces of solids within the working environment results in dimensional loss of one solid, with or without any actual decoupling and loss of material.

Hard facing

It is a metalworking process where harder or tougher material is applied to a base metal. It is welded to the base material, and hardfacing material is in form of specialized electrodes for arc welding or filler rod for oxyacetylene and TIG welding. Hard facing may be applied to a new part during production to increase its wear resistance, or it may be used to restore a worn-down

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surface. Hard facing by arc welding is a surfacing operation applied to extend the service life of industrial components, new components, or used as a part of maintenance program. The result of significant savings in machine down time and production costs has meant that this process has been adopted across many industries such as steel, cement, mining, and petrochemical, power, sugar cane etc.

II. LITERATURE REVIEW

Review of published literature

J. E. Ramirez (2014) - Different Fe-X-Ti weld overlays were deposited using the controlled short-circuit gas metal arc welding (CSC-GMAW) process alone or in combination with the pulsed gas tungsten arc welding (GTAW-P) process. The overlays were characterized before and after post weld heat treatment (PWHT) using optical and scanning electron microscopy, electron probe microanalysis, and micro hardness testing.

S. Kou (2015) -The present study proposed to use the maximum $|dT/d(fS)1/2|$ of an alloy as a simple index for its susceptibility to solidification cracking. The index was based on a recent criterion for cracking that considered the phase diagram, solidification shrinkage, strain rate, cooling rate, and liquid feeding. However, other factors may also affect the susceptibility, e.g., the dihedral angle and secondary phases

P. Yu, x. Chai, d. Landwehr, and s. Kou (2016)- Nickel cladding reinforced with hard tungsten carbide particles was deposited on steel by both conventional gas metal arc welding (GMAW) and GMAW controlled short circuiting (GMAWCSC). Single bead hard facing was deposited at various heat inputs. The current/voltage waveforms were recorded during welding. It was found that the window of welding parameters for making a smooth cladding without much spatter was significantly wider with GMAWCSC than conventional GMAW. While the cladding dilution by steel increased with increasing heat input as expected, the dilution increase was less with GMAWCSC than conventional GMAW. A low cost 3D printer based.

III. PRESENT WORK

In view of the importance of metal surfacing used for reclamation, repairing or enhancing or improving the service of various engineering components it was thought of initially to look into the wear issues related to excavators. While carrying out the preliminary survey, it was found that the nails of the excavators bucket were more prone to wear as indicated in Fig. Then the possibility for exploring its wear protection through welding was examined and finally it was decided that this problem could be systematically undertaken as a part of this research work.

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Worn Out Excavator Bucket's Nail

Experimentation

The present work was carried out to study experimentally, the effect of three weld hard facing deposits made through the use of different fillers using weld hard facing on the wear performance of the substrate i.e. low carbon alloy steel. To meet the objectives set forth as mentioned previously, the experimental work was planned in two phases. In the first phase, trial runs were conducted based upon which, using DOE approach, wear modeling was done for the base and variable filler combinations, and in the second phase real time assessment of the wear performance of the bucket's nails was carried out so as to check the efficacy of the hard facing procedures that were developed through this work.

Bucket's nail material

A specimen was cut from bucket's nail and spark emission spectrosopic analysis was carried out. The chemical composition of elements present in bucket's nail is shown in Table 3.1.

TABLE- COMPOSITION OF EXCAVATOR'S BUCKET NAIL

Elements	C	Si	Mn	Cr	Mo	P	S	N	Cu	Fe
Wt %	0.30	1.28	1.27	0.74	0.05	0.025	0.015	0.06	0.04	Balance

Hardfacing electrodes

Since the actual service conditions of the excavator involve largely abrasive wear conditions, so it was planned to use three different hard facing electrodes having variable composition such that hardfacing deposits having three different hardness levels could be obtained. This could facilitate studying of the effect of these deposits under the same wear testing laboratory conditions as well as actual working condition such that quantitative comparisons in terms of wear characteristics of these deposits could be made. So in view of this, three electrodes viz. HB 600 HT, HB 60 and HB 65 with different chemical compositions as mentioned were selected to be used as hardfacing deposits.

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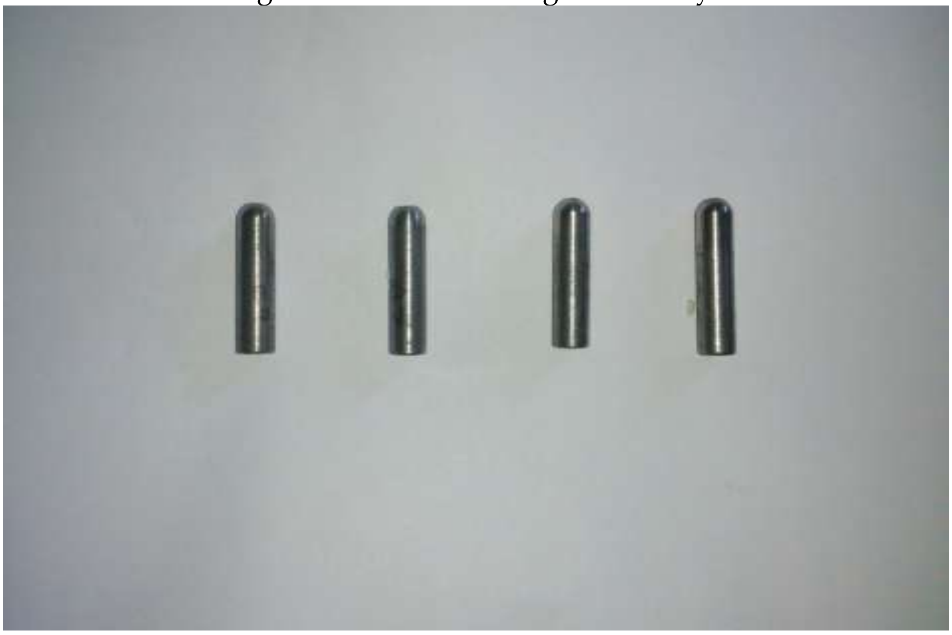
IV. RESULTS AND DISCUSSION

This chapter discusses the procedural details of the methods used for mechanical testing (viz. wear testing) and metallurgical studies (viz. microhardness and microstructural studies), which the hardfaced specimens were subjected to with an aim of generating data for further analysis.

Testing of Hardfaced Specimens

For accomplishing the formulated objectives and as a part of adopted methodology, different types of testing was carried out on the welded specimens fabricated using different conditions as mentioned previously in Chapter 3. This section discusses the details about the mechanical testing of different welded samples. In order to determine the wear properties of the welded specimen, wear test was carried out to investigate the wear rate of the specimens. Fig. 4.1 shows the pins (test specimens) used in wear test.

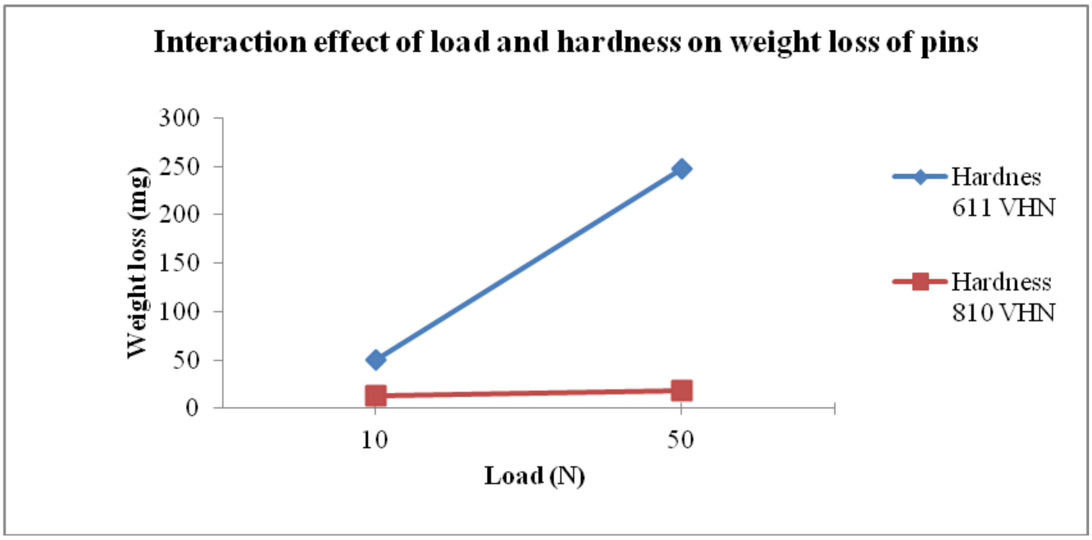
Test pins having 8 mm diameter and 30 mm length were taken out from hardfaced layers. These pin were prepared on lathe machine and grinding machine. Pins were rubbed against the rotating abrasive wheel on wear testing machine thus leading to a 2-body wear mechanism condition.



Test Specimens (Pins) For Wear Test

Interaction effect of load and hardness on weight loss of pins

As seen from the ANOVA Table 4.3 and represented in Fig. 4.15, interaction term of load and hardness has a significant influence on the variability of the empirical model. As seen from this Fig. 4.15 at lower combinations of load and hardness the weight loss of the pins is relatively less,



V. CONCLUSIONS

Based upon the present studies (for the base metal, filler metal, process and parametric combination used), few important conclusions could be drawn which are mentioned as below:-

1. Hardness of the weld deposits was found to be directly dependent upon their chemical composition. For instance hardfacing deposit C (electrode HB 65) possessed maximum hardness (810.3 VHN) owing to the presence of high C, high Cr, besides high Mo content, followed by deposit B (HB 60) with hardness of 710.2 VHN and deposit A (HB 600 HT) with hardness of 611.2 VHN respectively, which possessed relatively lower C and Cr contents. It was further observed that higher the alloying addition of the carbide forming elements, higher was the hardness possessed by the respective hardfacing deposits. Microstructural studies of the weld metal/zone show that the presence of intermetallic carbides formation controls the microhardness and hence the wear resistance of the respective deposits.
2. Wear modeling using DOE technique shows that for the parameters studied, load exerted the highest influence on the weight loss of the pins followed by speed and hardness of the surface tested. It was further found that these wear variables/parameters follow a two way interaction, thus affecting the overall weight loss of the pins.
3. Wear studies as conducted during actual service applications i.e. excavation work carried out for seventy hours, indicate that as compared to the conventional nail of the bucket that is uncoated or untreated, the weight loss due to wear in case of deposit A, B and C was 63.63%, 54.54% and 36.36% respectively.
4. Finally, it could be recommended that although the three hardfacing electrodes used in the present work increased the hardness of the substrate material, but electrode HB 65 despite of being expensive of all electrodes used, performed better in terms of wear applications, both in the laboratory as well as field application i.e. excavation work.

VI. SCOPE FOR FUTURE WORK

1. This study can be extended for developing hardfacing procedures for other components that are exposed to such abrasive conditions e.g. earth moving machinery, minerals and mining industry.
2. The microstructural characterization of the hardfacing deposits can be supplemented further using SEM and XRD techniques

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