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Wear Behavior of Using Las Overlays on Bucket Teeth Excavators

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Abstract:- An excavator (dredging machine) is a hydraulic type heavy machinery operated by humans to dredge which is generally used continuously in large scale mining operations. However, in the process, the gear dredges on the engine will experience severe erosion. The aim of this work is to improve the service life of the excavator's dredging gear to reduce the free time needed to periodically return the dredging gear in excavation. This objective is carried out by coating the dredge gear excavator (with high-tension steel) with four wear-resistant alloys with manual arc welding. Comparative wear is tested on regular teeth and coated excavators are carried out in the field and laboratory (ASTM G-99),

I. INTRODUCTION

Use of soil material accompanied by moderate to high impact is often suffered by bucket loader teeth and trench diggers. The main cost for industrial operators and heavy equipment is tool downtime. This is followed by lost productivity and the cost of replacing parts. Abrasive wear results in premature failure of many components of the extraction machine with considerable economic costs.

The process by which excavator bucket teeth include impact, abrasion, chemical action, and fretting. In general, the life span of bucket teeth is determined by wear. Research to assess the wear of metal parts has largely been concentrated in industrial materials related to large industries. In the heavy equipment sector, especially the bucket excavator, there is little consideration in this field. Many researchers have developed several techniques over the years to improve abrasive wear resistance to soil binders in the agricultural sector such as surface coatings by Karoonbooyanan et al. (2007), Kang et al. (2012) and hardfacing by Bayhan (2006).

In this investigation, the MMAW process was chosen because its component size is relatively small and the process is an all-position process, very flexible and most economical. The purpose of this case study is to ascertain the wear characteristics and wear resistance of excavator bucket teeth coated with four different commercial hardfacing alloys with manual metal arc welding (MMAW) and compare them with standard heat treatment bucket excavator teeth under laboratory and operating field conditions . The level of wear obtained from the laboratory and field tests can then be used to predict the life of the bucket excavator's teeth. A comprehensive survey of related literature revealed that until now no effort had been made to increase the life of bucket excavator teeth.

II. RESEARCH METHODS

A. Metal Materials and Welding Overlays

The excavator gear used in the experiment was made of high strength steel (En-14B) with the composition given in Table 1. En-14B can be hardened and hardened to offer a combination of ductility and hardness combined with excellent shock resistance. In today's dental excavator applications, there is a great need for a combination of ductility and hardness with a maximum carbon of up to 0.3%. On the other hand, chisel steel also offers good wear resistance but there are conflicting consequences because the high hardness of chisel steel makes the material sensitive to indentations. This can cause large carbides which act as crack initiators in the fatigue process. Cracked fatigue occurs when material is exposed to alternating / throbbing loads. Too, sharp angles or sharp edges in combination with high hardness can also act as sites for crack initiation on fatigue loading as stated by Kang et al. (2012).

Class	% of constituents							
En-14B	C	M N	Si	S.	P.	Al	Cu	Cr
	0.24	1.29	0.27	0.024	0.032	0.03	0.14	0.34

Table 1:- The chemical composition (wt.%) Of high voltage iron (En-14B) was applied to bucket teeth.

Parameter	Hardfacing mixture			
	H33Cr	H23Cr	H6.25Cr	H2Cr
Electrode diameter (mm)	3.2	3.2	3.2	3.2
Arc voltage (V)	24	22	17	23
Welding current (A)	125	120	120	125
Welding Speed (mm / min)	100-200	100-120	100-120	100-120
Preheating for 1 hour (C)	180C	180C	180C	180C
Deposition rate (kg / h)	2.3	2.1	2.14	2.35

Table 2:- Welding parameters used in the test

To minimize dilution rates, during the hardfacing process, instead of single pass welding, three multi-pass multi-layered welding is carried out. Mainly, hardfacing is done as a 2 mm thick layer, and then the surfaces in the second and third layers are carried out with similar electrodes. Deposited stringer beads without transverse oscillation electrodes were used during a process that controls the rate of dilution within a limit as determined by Selvi et al. (2008).

B. Laboratory Test

Hard and hard media wear tests with four different hardfacing alloys were performed using pins on the disk wear test kit (TR-201, Ducom, India). The pins on the disc wear test equipment used in this study are shown in Figure 1. The wear test is carried out at ambient temperature under dry shear conditions according to ASTM G 99 standards.

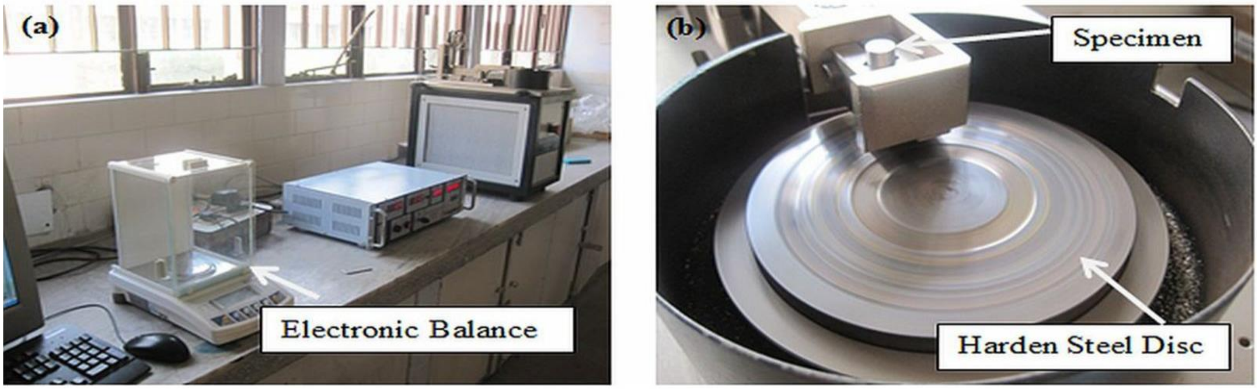

Fig 1:- Standard ASTM G 99 Wear Test Pin-On-Disc

Slide pins against hard steel disks (62 to 65 HRC) as shown in Figure 1. Before abd after testing, all specimens taken for analysis were cleaned and then weighed using an electronic balance with an accuracy of 0,0001 gm. The wear test is carried out at a linear speed of 1 m / s with a load of 30 N, 40 N and 50 N for a duration of 90 minutes.

III. RESULTS AND DISCUSSIONS

A. Laboratory Test Analysis

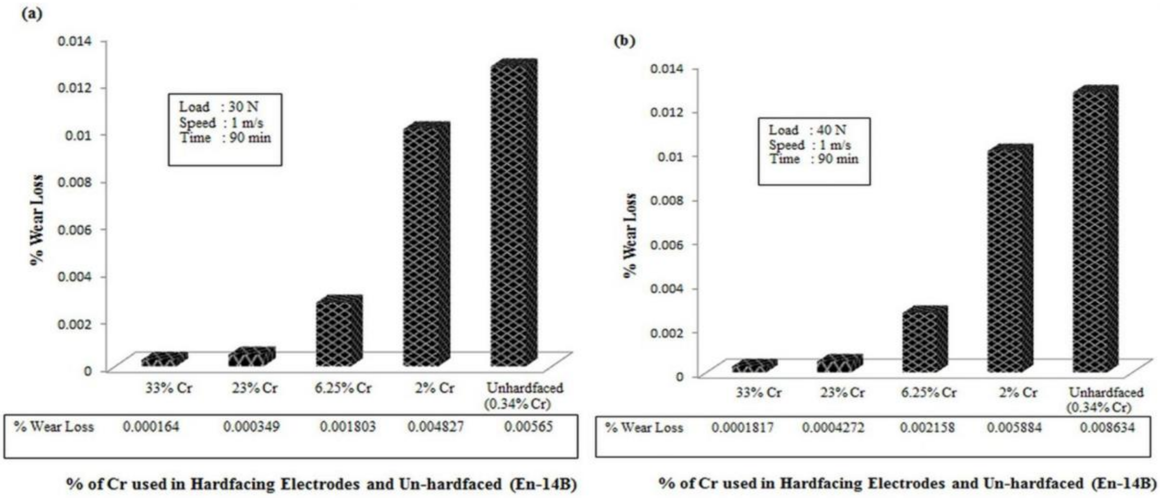

Fig 2:- Analysis of Usage Tests

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Figure 2 shows the results of the wear test experiments conducted on all specimens. The graph is plotted by taking the percentage of chronium content from the selected electrode and the percentage of wear loss. The results showed that the minimum wear in specimens confronted with electrodes had 33% Cr followed by 23% Cr, 6.25% Cr, 2% Cr and 0.34% Cr at different normal loads applied to the specimen. The tendency to lose wear shows that as the percentage of Cr increases, wear resistance in the weld layer increases. This increased wear resistance has been attributed to chronium surface alloys that are in accordance with Amirsadeghi & Sohi's (2008) investigation.

Weight loss accumulates from the teeth tested in the field at various intervals plotted against the duration of the field test as shown in Figure, to get the right level of wear of each tooth. Weight loss from unbranched teeth during the first 80 hours of the field test was 151 grams, whereas for teeth that were smoothed with H33Cr, H23Cr, H6.25Cr and H2Cr hardfacing alloys respectively were 8, 18, 78 and 121 gm.

WRI, which shows the superiority of the teeth tested compared to unbranched teeth is defined as the level of wear of unbranched teeth divided by the wear rate of hard-to-reach teeth. WRIs of the teeth tested are presented in Table 3.

Hardfacing type	**Wear rate (gm / hour)**	**WRI**
Tooth without blemishes	1906	1
H33Cr	0.120	15.88
H23Cr	0.247	7.71
H6.25Cr	0.929	2.05
H2Cr	1,437	1.32

Table 3:- Wear rates and WRI bucket teeth in field trials

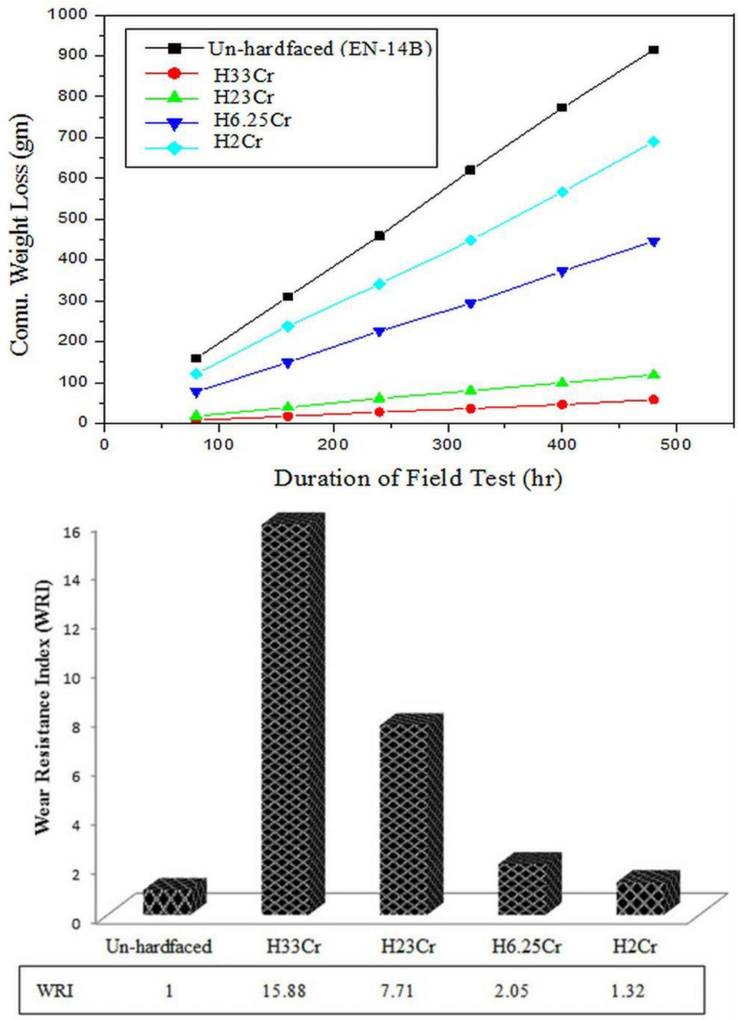

Fig 3:- Wear resistance of En-14B alloys

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The results from the field test show that H2Cr hardfacing cannot provide additional wear resistance to teeth due to the low hardfacing fracture toughness, causing continuous wear of the weld metal coating on the front edge. This shows only 1.32 times the superiority of unbranched teeth as tabulated in Table 3. Hardfacing H6.25Cr showed only a slight increase in wear resistance as shown in Fig. This shows superior wear resistance 2.05 times than unbranched teeth. Teeth with hard surfaces with H23Cr show a significant increase in wear resistance. This shows 7.71 times superior wear resistance than teeth without blemishes. Hardfacing H33Cr, on the other hand, shows superior wear resistance, with about 16 times better performance than non-abrasive teeth and more than 2 times the wear resistance provided by the H23Cr hardfacing alloy. For H33Cr hardfacing, wear does not reach the substrate, and the results show very small wear as shown in Figure 3. A quick display of the WRI comparison of the teeth tested is presented in Figure 3.

IV. CONCLUSION

The relatively abrasive wear behavior of commercially available hardfacing alloys has been studied for bucket excavator gear. This is a clear advantage in wear resistance provided by hardfacing alloys under conditions that are examined for laboratory and field tests.

- Hardfacing mass loss increases linearly with shear distances in dry conditions.
- The hardfacing process with electrodes is effective in reducing wear on bucket excavator teeth. It is possible to reduce wear on the excavator bucket teeth by coating it with the welding overlay mentioned above.
- All four hardfacing have higher hardness than ordinary bucket teeth which are heated (Un-hardfacing tooth).
- Normal teeth after field testing show significant weight loss due to abrasive wear which mostly occurs at the front end towards the tooth base.
- The H2Cr hardfacing alloy does not show many advantages in wear resistance, while the H6.25Cr alloy shows some increased wear damage compared to ordinary teeth.
- H23Cr shows very little wear damage, on the other hand hardfaced H33Cr shows wear damage that is almost negligible. This (H33Cr) shows more than 2 times superior wear resistance than that provided by H23Cr.
- It has been revealed from laboratory and field tests that the wear rate of overlay bucket excavator teeth is reduced because the percentage of chromium content increases in the welding layer.

Therefore it can be concluded that H33Cr hardfaced teeth show greater wear resistance than ordinary teeth. WR is for hard teeth Haced H33Cr, H23Cr, H6.25Cr respectively 15.88, 7.71, 2.05 and 1.32. Therefore, excavator-coated H33Cr bucket teeth will be more suitable and more reliable to increase bucket tooth life. This will greatly reduce the time spent replacing worn teeth, which in turn reduces labor costs significantly.

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