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Experimental Investigation of the Wear Behaviour of Excavator Bucket Teeth by Hardfacing Technique

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ABSTRACT

An excavator bucket is a connecting part for heavy equipment machinery which is designed and manufactured to be used for work in site excavation, mining and construction sites. Wear associated failure of machinery components number as one of the chief reasons for unproductive working of machines in a diversity of engineering applications. Associated with wear resistant applications in the field, in the last decade hardfacing become an issue of extreme development. Hardfacing is the method of welding consumable electrode having high wear resistance on the bucket teeth. Using DC arc welding process layers of hardfaced material is deposited on the bare bucket teeth. Field trail was conducted for 10 hours in the field. Weight measurement was done before installing bucket teeth on JCB and after the field trail. The difference in weight is analyzed to measure the wear rate of hardfacing material i.e. HAB-90 and bare tooth. Micro-hardness of the cross-section cutted from the hardfaced samples and un-hardened sample was also studied using Brinell Hardness Testing Machine. Scanning Electron Microscopy was done to analyze the morphology of the surfaces of hardened and un-hardened surfaces of samples.

***KEYWORDS:** Excavator bucket, Hardfacing, Consumable electrode, SEM, X-Ray Diffraction*

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INTRODUCTION

Excavator buckets are manufactured of steel or alloy steel and generally present teeth projecting from the cutting edge of the machine, to disorder the hard material so as to avoid wear-and-tear of the bucket.[1]

Figure No. 1.1: Excavator Bucket-teeth [2]

The changing of bucket teeth is mainly due to the wear factor occurring in this component and very rarely due to failure of the component. [3]

Hardfacing are welded or layered as the protective layers, deposited on matrix form to the base material component. [4]

Different alloying elements can be introduced into the base metal in the form of weld consumables to achieve any favourable properties i.e. hardness, wear resistance.[5]

Micro hardness characteristic of hard facing decreases with increase in welding current of the process. Micro hardness increases with number of layers of the hard faced material. Micro hardness increases with types of electrodes having high chromium and nickel compositions.[6]

To change the microstructure of weld metal from ferrite-pearlite phase to martensite phase with retained austenite is not possible only with the Chromium and C, Mn, Mo, and Nb elements in addition are essential to add alloying elements.[7]

There is not any specific number of times a part is hard faced and wears out and again hard faced. It merely a comparison between the cost assigned with hard facing and the new part.[8]

It is experimental that the life of teeth hard faced with H1 alloy is improved roughly by 15 times as compared to un-hard faced teeth.[9]

The material will fail also if the applied stress is more than the ultimate strength of the part. The position of middle tooth of the machine should be changed from time to time so that the wear in the teeth will takes place uniformly.[10]

From the research work it was concluded that proper assortment of the filler material (the accurate type of electrodes), optimization of the hardfacing parameters i.e. welding current, voltage, welding speed, input heat, the number of layers, order of layers and pattern of hard facing is must.[11]

Chromium and Nickel are having high quality of wear resistance. Nickel gives a little outcome on abrasive resistance with stable condition of austenite matrix.[12]

The success of this engineering depends on the selection of hard material and the processes involved in the hard facing techniques.[13]

The investigation showed that the most important variable to improve abrasion resistance is the microstructure of hardfacing deposits, where the carbides act as barriers to abrasive particle cutting.[14]

Experimentation

In the present research work the bucket teeth of excavator made of low alloy steel are used. To increase the wear resistance HAB-90 hardfacing electrode was used for hard facing of bucket teeth.

Figure No.1.1: Bucket Teeth of Excavator

Table No. 1.1: Composition of Bucket Teeth

Element	Percentage%
Carbon-C	0.24%
Nickel-Ni	1.2%
Chromium-Cr	0.55%
Silicon-S	0.20%
Manganese-Mn	0.7%

For the present research work, bucket teeth were taken from JCB and fitted back after the hardfacing of bare teeth by HAB-90 hardfacing material to study and analysis of wear mechanism.

HAB 90 is the hard facing electrode used with arc welding process for the protection of low carbon alloys and austenitic manganese steels. The Chromium and Nickel rich composition of HAB-90 make it highly resistant to abrasive wear at elevated temperatures. For hardfacing the 5mm in diameter and 450mm in length electrode was used.

Figure No.1.2:HAB-90 Electrode

Table No. 1.2: Composition of HAB-90 Electrode

Element	Percentage %
Carbon-C	2.93%
Manganese-Mn	0.73%
Silicon-Si	1.06%
Sulphur-S	0.002%
Chromium-Cr	20.5%
Phosphorous-P	0.035%
Nickel-Ni	6.55%
Molybdenum-Mo	3.76%

The D.C. arc welding process was used to apply hard-facing on the substrate material. The DC arc welding process machine is used for hard facing of the materials at Yadvindra College of Engineering Talwandi Sabo. Straight polarity is used with 25 Volts and 180 Amperage of current for welding process.

During Field Trail weight measurement was done after the hardfacing before the teeth were mounted over JCB for field trails. After the hardfacing process the bucket teeth were fitted on JCB to study the wear behaviour of hardfaced teeth and bare teeth. The field trail was conducted for 10 hours at Aadhaar hospital, Hisar, Haryana to study the mechanism of wear. Weight measurement of teeth was done after field trail.

Figure No.1.3: Hardfaced tooth and Field test at Aadhaar hospital, Hisar

After the execution of field trails, tests were performed on the hardened and un-hardened teeth. For the testing the bucket teeth were cut into samples of size 12mm X 12mm X 6mm. Brinell Hardness and SEM analysis were done on the teeth samples.

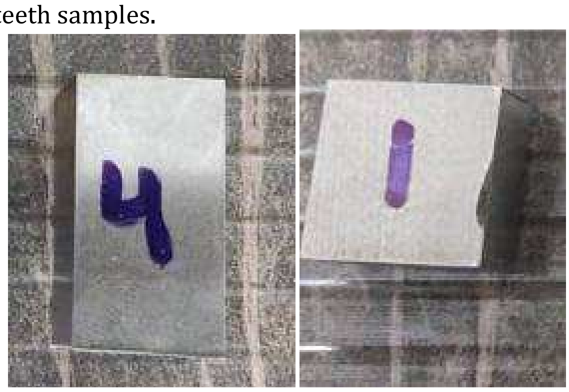


Figure No.1.4:No. 1- HAB-90 Sample, No.4- bare tooth sample

Results and discussion

Brinell Hardnesswas done to find out the harness of the un-hardened and HAB-90 hardfaced bucket tooth specimenThe Brinell Hardness was done at Strength of Materials Lab at JCD Engineering College, Sirsa.

Table No. 1.3: Diameter of indent on specimens

Specimen	Load (Kgf)	Dia. Of Indentation Ball (mm)	Dia. Of indent on specimen (mm)
Base Material	1000	5	1.90
HAB-90 hard faced specimen	1000	5	1.72

Table No. 1.4: Brinell Hardness of specimens

Specimen	BHN
Base material	339
HAB-90 hard faced specimen	417

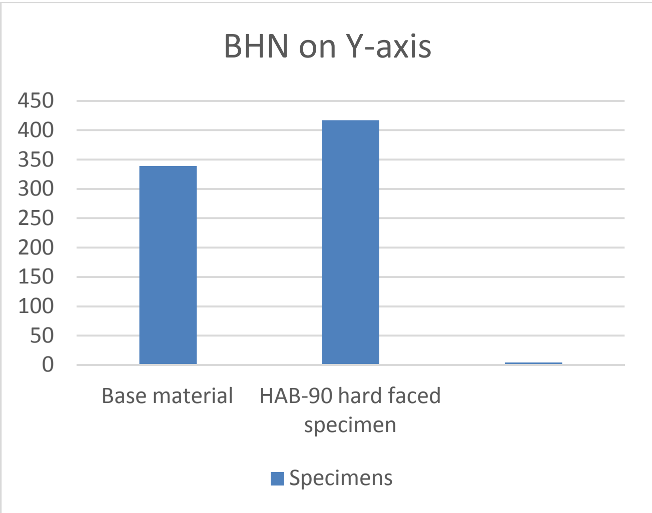


Figure No.1.5: Bar Chart showing BHN

Table No. 1.5: Rockwell Hardness of specimens

Specimen	HRC
Base material	36
HAB-90 hard faced specimen	44

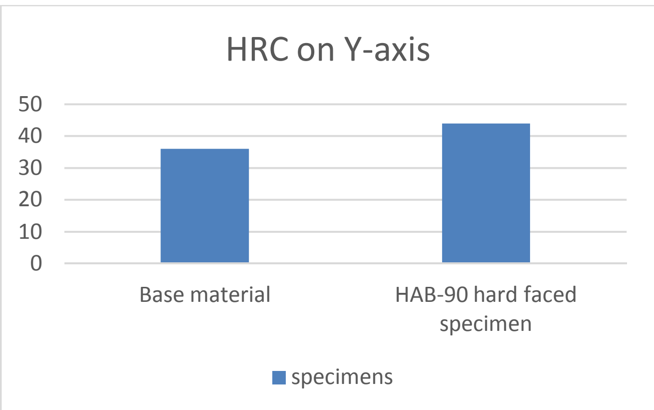


Figure No.1.6:

Bar Chart showing HRC From the extensive literature review it was found that magnitude of Manganese (Mn) have high influence on the hardness of the base material in a bucket teeth. Manganese is a harder and brittle material. Effect on hardenability of Manganese is higher than any other alloying material. The percentage of Manganese is high in HAB-90 hardfacing material and hence the hardness achieved is high.[3]Chromium is highly used constituent than other higher carbide forming elements i.e. tungsten and titanium in hardfacing applications because the cost associated with the resulting hardness is best for Chromium.[8] Field test was conducted to find out the wear rate of the different hard faced specimens. The hardened and un-hardened teeth were installed on JCB. Field test was conducted for 10 hours. The weight measurement of the teeth was measured before the trail was started and after 10 hours of working. The weight loss measurement was done.

Table No. 1.6: Field Trail Weight Measurements

Material	Initial weight (in grams)	Weight After 10 hours (in grams)
Base material	1240	1188
HAB-90 hard faced specimen	1413	1368

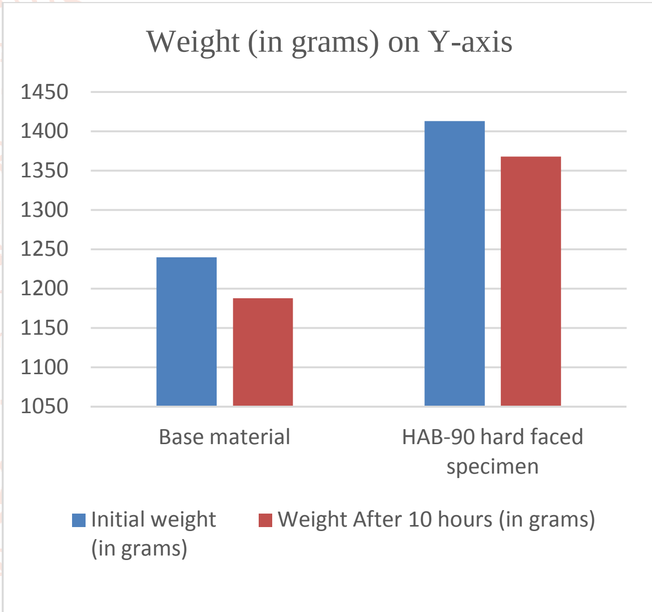
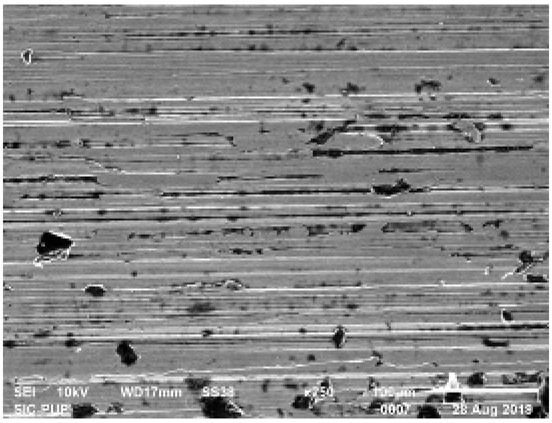


Figure No.1.7: Bar Chart showing weights

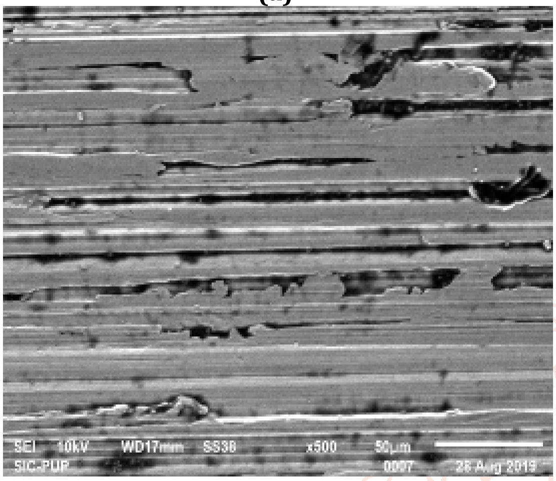
Table No. 1.7: Weight loss during Field Test

Material	Weight loss (in grams)	Weight loss (in %)
Base material	52	4.19
HAB-90 hard faced specimen	45	3.18

Scanning Electron Microscopy was done to analgise the morphology of the specimens.A scanning electron microscope (SEM) is a form of electron microscope that produces images of a sample whose microscopy is required by scanning the surface with a focused beam of electrons on the surface. The SEM of the bare teeth material and all the three hardfaced samples at different magnification was done and analysed. The SEM analysis was done at different magnifications i.e. 200,250,400,500.

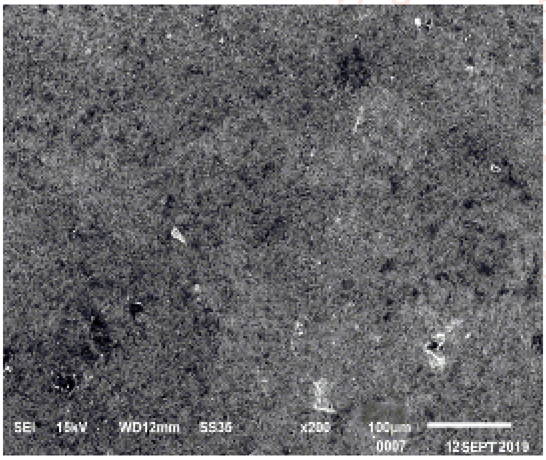


(a)

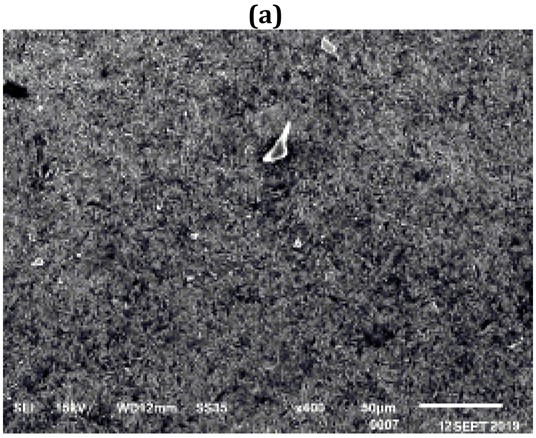


(b)

Figures No. 1.8: SEM analysis at (a)250 magnification (b)500 magnification of Base material.

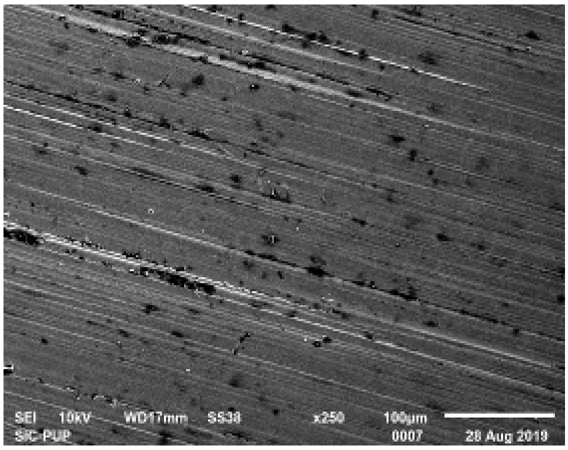


(a)

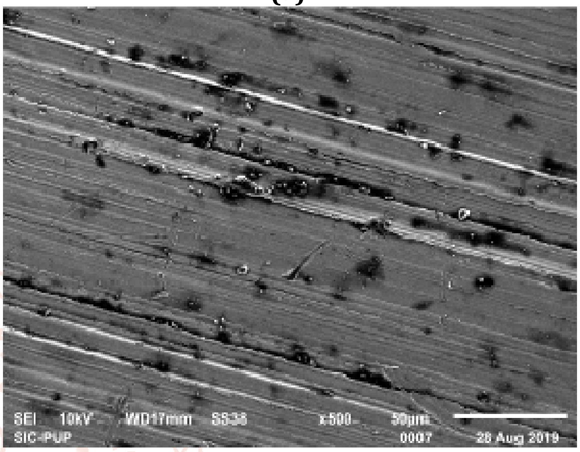


(b)

Figures No. 1.9: SEM analysis at (a)200 magnification (b)400 magnification of HAB-90 hardfaced specimen before trail.



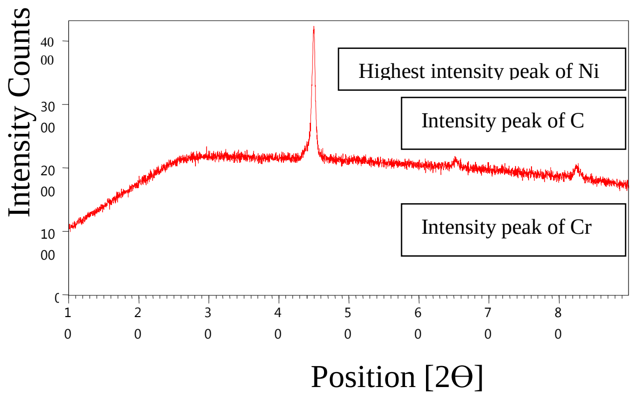
(a)



(b)

Figures No. 1.10: SEM analysis at (a)200 magnification (b)400 magnification of HAB-90 hardfaced specimen after trail.

X-Ray Diffraction was done for the composition analysis of base material.X-ray powder diffraction (XRD) is a rapid analytical technique primarily used for phase identification of a crystalline material and can provide information on unit cell dimensions. The analyzed material is finely ground, homogenized, and average bulk composition is determined. XRD was done at Panjab University, Chandigarh.



Figures No. 1.11: XRD of bare tooth sample

Conclusion

Hard facing is a best and cheapest process to avoid the replacement of new bucket teeth after wear by abrasive particles in the field at different environment conditions. The hardfacing process with the electrodes of hardfacing material was efficient in dropping the wear on the bucket teeth. It is probable to decrease the wear by hardfacing the bucket teeth by different welding processes. The wear rate is associated with both the hardness and chemical composition of the hard facing materials. The hardfacing alloys having high percentage of Chromium and Nickel have high wear resistance and are beneficial to increase the life span of the product. DC arc welding process is cheap and easily available for hardfacing. SEM and XRD were used to analyze the phenomenon.

References

[1] Shivali Singla, Vineet Shibe and J.S. Grewal, “Performance Evaluation of Hard Faced Excavator Bucket Teeth against Abrasive Wear using MMAW process” International Journal of Mechanical Engineering Applications Research, pages 73-77, vol. 02, issue 02, Aug.-Dec. 2011.

[2] http://www.investmentcastchina.com/bucket-teeth

[3] S. Hadi Suryo, A.P. Bayuseno, J. Jamari1, Muhammad Arief Rahmat Ramadhan “Analysis of AISI material power of AISI 4140 bucket teeth excavator using influence of abrasive wear" AIP Conference Proceedings 030022, pages 1-9, 2018.

[4] B.Venkatesha, K.Srikera, VSV Prabhakar, “Wear characteristics of hardfacing alloys: state-of-the-art” ELSEVIER, Science Direct, pages 527-532, Procedia Materials Science 10, 2015.

[5] Gowrishankari.L, Dr. B. Shanmugarajan, Dr. B. Anandavel3 Sundararaj.P, “A Review Paper on Research Work Done in Hardfacing of Stellite-6 Alloy” International Journal for Scientific Research & Development|, pages 1652-1654, vol. 07, issue 01, 2019.

[6] A.K.Rude, Mr. D.S. Pimpalgaonkar “Optimization Of Process Parameter In Hardfacing By Shield Metal Arc Welding (SMAW)” International Research Journal of Engineering and Techonology (IRJET),pages 232-236, vol. 05, issue 01, Jan. 2018.

[7] Buntoeng Srikarun, Prapas Muangjunburee “The effect of iron-based hardfacing with Chromium powder addition onto low carbon steel” ELSEVIER, ScienceDirect, pages 9272-9280, The 10th TIMETC, Materials Today: Proceedings 5, 2018.

[8] C. Okechukwu, O. A. Dahunsi, P. K. Oke, I. O. Oladele and M. Daudaand M. Dauda “ Review on Hardfacing as method of improving the service life of critical components subjected to wear in service” Nigerian Journal of Technology (NIJOTECH), pages 1095-1103, vol.36, issue 04, Oct. 2017.

[9] Gagandeep Singh, Ramandeep Singh, Ravinder Singh “Experimental Investigation inline enhancement of Rotavator Blade against abrasive wear by Hardfacing”, International Journal of Engineering Research and General Science, pages 851-859, vol.4, issue 03, May-June 2016.

[10] Dr. Sabah Khan1, Sheikh Mohashin “Comparative Analysis of Wear for Excavator Bucket Tooth Using Different Materials” International Journal of Research and Science, pages 1819-1822, Vol. 5, Issue 5, May 2016.

[11] VukiLazi , Aleksandar Sedmak, Ru`ica R. Nikoli, Milan Mutavd`i, Srbislav Aleksandrovi, Bo`idar Krsti, Dragan Milosavljevi “Selection of the most appropriate welding technology for hardfacing the bucket teeth” Research Gate, pages 165-172, Materials and technology 49, 2015.

[12] B.Venkatesha, K.Srikera, VSV Prabhakar “Wear characteristics of hardfacing alloys: state-of-the-art”, ELSEVIER, Science Direct, pages 527-532, Procedia Materials Science 10, 2015.

[13] Vineet Shibe, Vikas Chawla “An overview of research work in hardfacing”Research Gate, pages 105-110, vol. 2, No. 3, April-May 2013.

[14] John J. Coronado, Holman F. Caicedo, Adolfo L. Go´mez “ The effects of welding processes on abrasive wear resistance for hardfacing deposits”, Tribology International 42, pages 745-749, 2009.