International Journal of Trend in Scientific Research and Development (IJTSRD)
International Open Access Journal
ISSN No: 2456 - 6470 | www.ijtsrd.com | Volume - 2 | Issue – 4

Mechanical Investigation and Comparison of Coated Curved Tiller Shovels (Va, Mo, B, Ti) By Hardfacing

Er. Satish Kumar, Er. Kamaljeet Bhambri, Er. Ajay Rana

Department of Mechanical Engineering, Shaheed Udham Singh College of Engineering & Technology, Mohali, Punjab, India

ABSTRACT

The shovels used in cultivators are largely manufactured by the small scale industries. Due to improper material and surface hardening treatments, the quality of shovels does not conform to the Bureau of Indian Standards resulting in high wear rates and reduced life. It leads to Farmer's complaint about the high wear rate of tiller shovels and agricultural equipments in dry land areas. This high wear rate increases the cost of part replacement, downtime and labour. The objective of this study was to improve the wear resistance of tiller shovel with four different hardfacing electrodes (Va, Co, B & Ti). Shield Metal Arc welding was used for depositing the layers of hardfacing alloy on tiller shovels. Rubber wheel abrasive test apparatus was used for Comparative wear tests on a regular tiller shovel and four hardfaced tiller shovels, where the effect of hardfacing alloys on the extent of wear and the wear characteristics of shovels were examined. In this study wear rate and hardness of regular tiller shovel and hardfaced tiller shovels, where studied. Regular tiller shovels gives the maximum wear and reduced 3 to 5 times with the help of hardfacing alloys.

Keywords: *Hardfacing, Wear, SMAW, Electrodes, tiller shovel*

I. INTRODUCTION

India is an agricultural based country, majority of the people are professionally Farmers. Now a day Agriculture is totally mechanized, so in the present study wear rate of the tiller shovel is studied and minimized with the application of hardfacing technique.

Agriculture is the main source of earning and living for most of the Asian countries. In Agriculture the role of mechanization is very important but it also increases the wear and tear of equipments which increase the cost of down time and production.

Power Tillers the production of power tillers started in 1961.The manufacturers started offering these to framers in various states covering upland and wetland farming conditions. Their introduction coincided with that of agricultural tractors which were more suitable for upland work and provided more comfortable work environment to the operators.

Hardfacing Hard facing is the process of depositing, by one of various welding techniques, a layer or layers of metal of specific properties on certain areas of metal parts that are exposed to wear. By expanding this definition a little further, it can be seen that hardfacing has more to offer than most other wear prevention treatments:

1. It is performed by welding.
2. A layer or layers of metal can be deposited. This means that hardfacing provides protection in depth.
3. Metal of specific properties is deposited.
4. Hardfacing is applied only to specific areas of metal parts that are exposed to wear.

Hardfacing is a particular form of surfacing that excludes the application of materials primarily for corrosion prevention or resistance to high temperature scaling or the application of low hardness, friction over-lays to prevent galling - e.g. bronze surfacing.

It also excludes the hardening of surfaces solely by heat treatments such as flame hardening, or Nitriding. Extensive work in research has resulted in the development of a wide range of alloys and welding procedures. The optimum alloy selection is made considering the component service conditions and feedback of the service performance. For each industrial application and wear phenomena, there is a welding electrode to provide wear resistance.

Hardfacing can be deposited by various welding methods:

- Shielded Metal Arc Welding (SMAW)
- Gas Metal Arc Welding (GMAW), including both gas-shielded and open arc welding
- Oxyfuel Welding (OFW)
- Submerged Arc Welding (SAW)
- Electroslag Welding (ESW)
- Plasma Transferred Arc Welding (PTAW), also called Powder Plasma welding system
- Thermal spraying
- Cold polymer compounds
- Laser Cladding
  - Hardpaint

Hard facing Techniques

- Thermal Spraying
- Cladding
- Welding

Benefits of Hard facing

- Most Versatile
- Reduce downtime
- Any Steel Material
- Desired Properties
- Longer service life
- Higher productivity
- Reduce Cost
- Reduce Inventory of spare parts

Applications of Hard facing

- Agriculture Industry: Harrower teeth, Tiller blades, Ploughshare points
- Automotive Industry: Trucks Exhaust manifolds, Pumps, Clutches
- Building Construction Industry: Mixing machine blades, Fuller Screw, Crushing Cylinders
- Chemical Industry: Pump shafts and sleeves, Valves, Mixer Blades
- Food Processing Industry: Corn and sugar cane cutting equipments
- Metal Working Industry: Conveyor rollers, Die equipments, Shear blades
- Mining Ore Industry: Crusher blades, Scraper blades, Cut off blades
- Paper Industry: Roll cylinders, Drying cylinders, Mixers
- Petroleum Industry: Blowers and Ventilators, Pumps, Heat exchangers, Rods

II. PROCESS USED Welding

Welding is a metal joining process in which fusion is obtained by application of heat and/or pressure. Combination of these two variables may be high temperature with no pressure, high pressure with no rise in temperature or both high temperature and pressure.

Classification of Welding:-

In general, various welding and allied processes are classified as follows:-

- Gas Welding
- Arc welding
- Resistance Welding
- Solid State Welding
- Thermo-chemical Welding Processes
- Radiant Energy Welding Processes

III. EXPERIMENTATION:

A. BASE METAL OF SPECIMEN

Cultivator shovels used for ploughing agricultural fields are taken. Spectroscopy technique is used for analyzed the composition of the base metal. a sample of 20 mm diameter is taken from the cultivator shovel for testing. From the Steel Hand Book, it is found that this commercially available material is Ni-Cr Steel as the composition includes 0.1 % each of Ni and Cr.

The chemical composition of the cultivator shovel specimen without hardfacing (Obtained from spectro-analysis technique) is as given below:-

TABLE 1: CHEMICAL COMPOSITION OF SPECIMEN

C	MN	P	S	Si	Ni	Cr	V	Mo	Co	Ti	W	Al	Cu
0.65	0.7	0.004	0.021	1.686	0.109	0.137	0.625	0.664	0.027	0.014	0.137	0.019	0.042

TABLE 2. CHEMICAL COMPOSITION OF HARDFACED ALLOY

	Hard Alloy (Mo)	Hard Alloy (B)	Hard Alloy (Va)	Hard Alloy (Ti)
% C	0.95%	0.95%	0.14%	1.7%
% Mn	0.6%	0.6%	1.9%	1.6%
% Si	0.9%	0.9%	0.8%	0.5%
% Cr	6.5%	6.5%	2.2%	7.5%
% Mo	3.5%	3.5%	0.3%	1.3%
% B	----	1.5%	-----	----
% Va	----	----	1.5%	----
% Ti	----	----	-----	5.3%
% Fe	Balance	Balance	Balance	Balance

- **LAB TEST**

A specimen of 25mm x 25mm size is cut from the hardfaced shovel with the help of diamond cutter and surface grinding (magnetic table) machine and then the specimens are fixed in the vice one by one on the Abrasive Wear Testing Machine and the wear test is done. All the four lateral surfaces of the specimen are made at right angles using surface grinding machine, so that it can be better held in vice on the Abrasive Wear Testing Machine. The size of the specimen is limited to 25 mm x 25 mm due to the holding capacity of vice jaws and axial width of rubber wheel of Abrasive Wear Testing Machine. The specimen is held in the vice in vertical position, with hardfacing surface facing the rubber wheel. Same dry sand is put in the hopper of Abrasive Wear Testing Machine and it falls in between the hardfaced surface and rubber wheel, and rotating wheel rubs the sand against the hardfaced surface and material wears.

Fig. 1 HARDFACED SPECIMEN

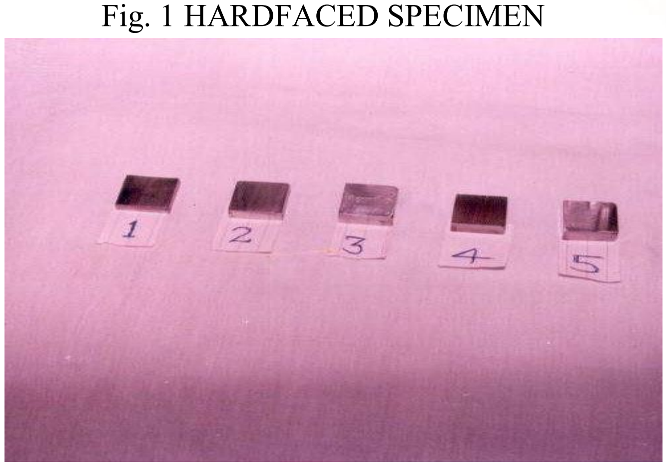
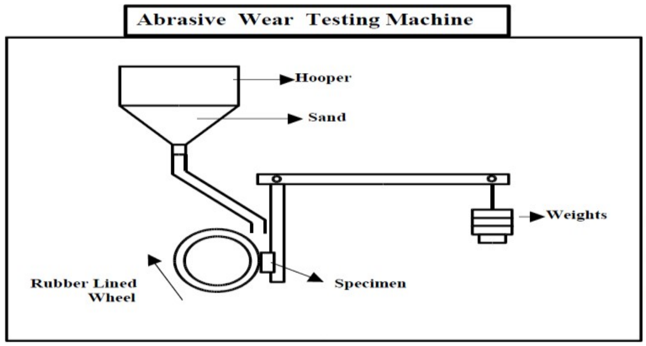
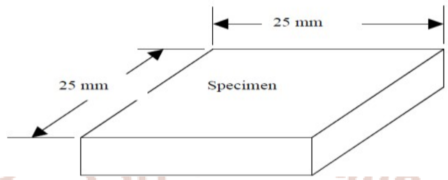


Fig. 2 ABRASIVE TESTING





IV. RESULTS AND DISCUSSIONS

A. WEAR RATE

All the samples of cultivator shovels were initially weighted before test and final weight of shovel after test is taken with electronic weighing machine having least count of 2 grams. As per samples observations of each cultivator shovel are taken and then average initial and final weights are calculated. The wear rates of the cultivator shovels samples are taken in Lab test on the Abrasive Wear Testing Machine. A sample of 25 mm x 25 mm size is taken from the cultivator shovels and then tested on Abrasive Wear Testing Machine. The results obtained from the lab test are tabulated below. The wear rate in grams per hour in lab test clearly shows that the wear rate of cultivator shovel without hardfacing is maximum and the wear rate of HardFacing Alloy coated cultivator shovel is least.

TABLE 3: WEAR RATE

Sample	Surface Type	Wear Rate in gm/hr
Sample 1	Unhard surface	2.50
Sample 2	Hard Alloy (Mo)	1.71
Sample 3	Hard Alloy (B)	1.25
Sample 4	Hard Alloy (Va)	1.06
Sample 5	Hard Alloy (Ti)	0.75

B. MICROHARDNESS TESTED BY THE MICROHARDNESS TESTER (in BHN)

A sample of size 25x25 mm square is cut from the cultivator shovel with the help of surface grinding machine. All the four lateral faces of samples are made parallel and then ground to right angles. Then the surface is prepared for micro hardness testing on Micro hardness Tester. The sample preparation for micro hardness includes

(i) Grinding for parallel surfaces by Surface Grinding Machine.

(ii) Surface is finished by finishing operation on Grinding Machine.

TABLE 4: HARDNESS OF TEST SPECIMENS

Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
293	330	345	504	516
291	221	337	491	501
291	317	325	487	498
290	280	315	470	471
291	285	315	420	455
291	292	292	293	298

Micro hardness of the test specimens are tested with Micro hardness Tester from the hardfaced surface to deep into the base metal at a distance of 1 mm as shown in figure , readings are taken and then graphs are plotted. It is found that the hardness is maximum at the hardfaced surface and it decreases towards the base metal.

IV. CONCLUSIONS

In the present experimental work, the following conclusions can be made:

1. Standard composition of materials are commercially not available in the market to fabricate components used in the agricultural implements, So hardfacing alloy should be applied on surface.
2. Selection of work material should be done before selecting a particular hardfacing alloy,
3. The outcome of the experimental work will be helpful for reducing the wear rate and downtime of cultivator shovels 3 to 5 times which save the time and money.

V. SCOPE FOR FUTURE WORK

The present work done on agricultural implement i.e. cultivator, it can be studied for other agricultural implements also e.g. Harrow, Planer and harvester parts. In present study dry sand is used for experimental work but in future wet send sullary is used for wear rate calculations. In future more hadfacing alloy used for comparative study ie: Tungsten, Tungsten Carbide etc.

REFERENCES

1. Amardeep Singh Kang , Gurmeet Singh Cheema , Shivali Singla “Wear behavior of hardfacings on rotary tiller blades” Procedia Engineering 97 (2014) 1442-1451
2. E.O.Correa N.G.Alcântara et.al “The effect of microstructure on abrasive wear of a Fe–Cr–C–Nb hardfacing alloy deposited by the open arc welding process” Surface Volume 276, 25 August 2015, Pages 479-484
3. Erich Sigolo Juliano Soyama Guilherme Zepon Claudio Shyinti Kiminami Walter José Botta Claudemiro Bolfarini “Wear resistant coatings of boron-modified stainless steels deposited by Plasma Transferred Arc” Surface and Coatings Technology Volume 302, 25 September 2016, Pages 255-264
4. Amardeep Singh Kang , Gurmeet Singh Cheema , Shivali Singla “Improving wear resistance via hardfacing of cultivator shovel” materialstoday proceedings Volume 4, Issue 8, 2017, Pages 7991-7999
5. Sukhraj Singh Jonny Garg Prabhjot Singh Gurprit Singh Kaushal Kumar Jashanpreet Singh Satish Kumar Jatinder Pal Singh “Effect of hard faced Cr-alloy on abrasive wear of low carbon rotavator blades using design of experiments” proceedings Volume 5, Issue 2, Part 1, 2018, Pages 3390-3395
6. Hein Zaw Oo, Prapas Muangjunburee “Wear behaviour of hardfacing on 3.5% chromium cast steel by submerged arc welding” materialstoday proceedings Volume 5, Issue 3, Part 2, 2018, Pages 9281–9289