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# Experimental Wear Life Analysis of Water Quenched Rotavator Blade using pin-on-disk Apparatus

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***Abstract:*** As we know that Rotavator blade is used for soil tillage in the agricultural sector. Normally the life of the blade is max. 50-60 hours, this is a major concern for farmers. The basis of this research is to improve the life of the rotavator blade. For improving the life of blade, we are going to perform a certain set of tests to find out their mechanical properties. We are going to check the Hardness by Wear resistance check on "Pin-on-disk" On the basis of properties the heat treatment (tempering, quenching etc.) processes has been performed in order to improve the life of the blade. The main objective of the research is to increase the life of rotavator and ultimately will be beneficial to the agriculture sector.

***Index Terms* – Rotavator, wear, blade, hardness, pin-on-disc.**

## I. INTRODUCTION

A rotavator is a specialized mechanical gardening tool used to plough the land by a series of blades which are used to swirl up the earth. They are typically used for gardening and vegetation. Gardeners or farmers will greatly benefit from the use of rotavators because firstly, they can efficiently plough the soil no matter what the soil type is. This is because a rotavator can be adjusted according to the specific requirements of the soil. For example, if a gardener wants the soil to be very fine, he or she can just adjust the trailing board to give maximum tillage [1]. This is known as the crumbling effect because a rotavator allows the soil to be crumbled to a fine density that is best suited for vegetable gardening. Rotavator Produces a fine seed bed with one or two passes on wet or dry land. Stubble & Residue of old corps is chopped and thoroughly mixed in soil forming organic manure. It retains Soil Moisture and increases germination and growth of the crop. Rotavators are sturdy and strong enough to work in any conditions. Extremely helpful in sugarcane, banana, paddy, and vegetable cultivation. Rotavators versatile design avoids tire slipping & reduces diesel consumption. Rotavators have a sturdy body and heavy-duty gear box but still light enough for medium heavy tractors. A "Zero" maintenance and full satisfaction assured by high-quality design and component used for its manufacturing high-quality Italian blade. Gearbox, high tensile Nut bolts, and high-quality steel used for making of world class products. Secondly, rotavators can also be used on various land sizes. If the size of your land is extremely large, then a rotavator which is run on petrol or gas can be used. If the land area is smaller in size, for example, a vegetable Patch, then a rotavator powered by electricity will be more efficient. Thirdly, a rotavator is best suited to farming and gardening technique known as residue mixing. This procedure involves the mixing of different soil components while ploughing [2–9]. When a rotavator is used to carry out this method, a clean soil surface is issued to make the amalgamation of organic substances into the soil easier. A rotavator also allows maximum mixing of manure, vegetable residues, etc. Lastly, the use of a rotavator accords the soil to be spread evenly, preparing a perfect bed for seed planting. The small blades attached to a rotavator enable utmost breakages of huge clods in the soil in order to prepare a smooth bed. This makes it easier to plant seeds. In addition to this, the more the soil is ploughed with a rotavator, the more fertile the soil becomes. Aside from what have been mentioned above, rotavator also increases the soil's filtration capacity. The blades of a rotavator also work at an angle, thus overcoming the possibilities of blockages and ensuring that no residue is left stuck on the blades [10,11]. Some of the predominant work by the selection of suitable materials had been carried out by Joshi et al. [10,12–19].

## II. METHODOLOGY

There are various steps included. First of all, we select the material for which we have to check the composition [20]. We take three samples in different medium. A Wear resistance test has been performed on material for composition test. On comparison of the result obtained, final conclusion will be made as per the method given. The working methodology of present work are depicted into Fig. 1.

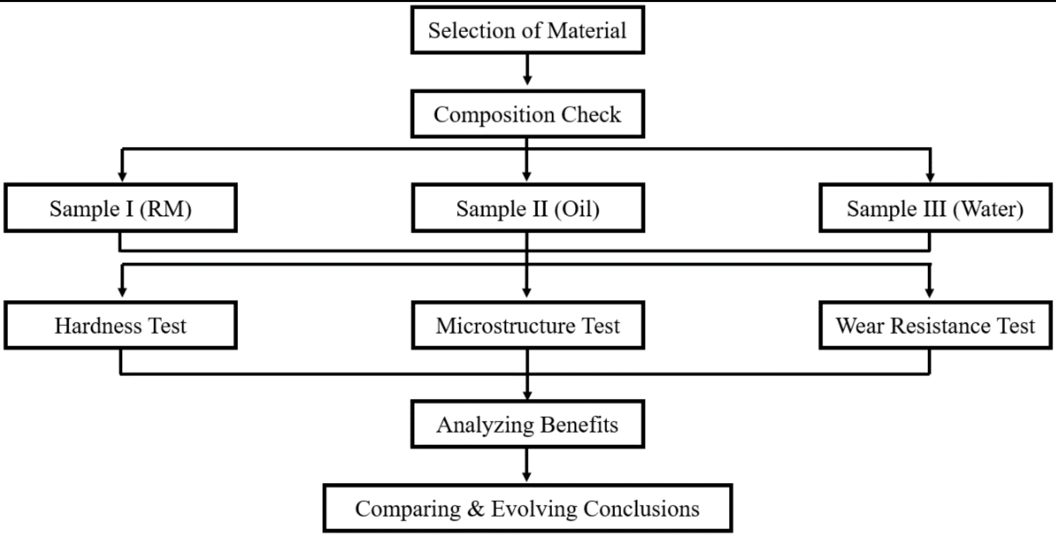



Fig. 1. Working methodology.

Calculation procedure of wear resistance formulas are given as:

$$\text{Wear volume} = \text{weight loss (g)} \div \text{density(g/cm}^3) \quad (1)$$

Density = 7.86 g/cm3

$$\text{Wear Rate} = \text{Wear Volume} \div \text{sliding distance} \quad (2)$$

$$\text{Sliding Distance} = V \times \text{Time} = \pi \times D \times N \times T/60 \quad (3)$$

where:
D = Track diameter of abrasive disc
N = Speed of rotation of disc in rpm
T = Time in seconds
$\pi = 3.14$

$$\text{Wear Resistance} = 1/\text{wear rate} \quad (4)$$

## III. INTRODUCTION

### 3.1Material selection

The raw material sample as well as a rotavator blade of required dimensions has been purchased from the local market. Raw material for blade and disk are depicted into Fig. 2. A chemical analysis has been done for the confirmation of the material composition using an optical emission spectroscope the result obtain is listed in Table 2 given below. After confirming the material, various specimens have been prepared according to the requirement and subjected to appropriate treatment as per ASTM standards. The material for disc has been chosen in such a way that its hardness should not exceed 62 HRC [21].

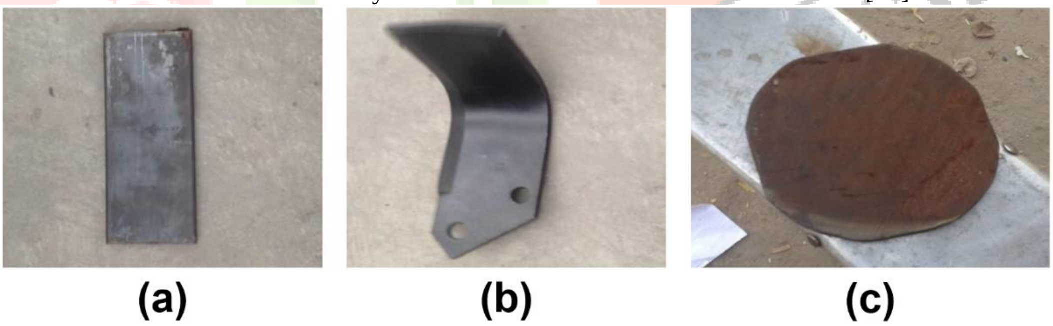



Fig. 2. (a) Raw material; (b) Rotavator blade; (c) Disk raw material.

### 3.2Preparation of specimen

The test specimens for analyze of Wear resistance has been prepared as per ASTM. Test specimens were prepared from sample I, sample II and sample III to test its wear resistance (depicted in Fig. 3). The dimensions of the specimens prepared are illustrated in Table 1.[22].

Table 4.1: Specimen Description

| Test | Sample I | Sample II | Sample III |
|---|---|---|---|
| Wear Resistance | Length = 47.8 mm | Length = 48 mm | Length = 49.5 mm |
| | Diameter = 6 mm | Diameter = 6mm | Diameter = 6 mm |

(a) (b) (c)

Fig. 3. Test specimen, (a) Sample I; (b) Sample II; (c) Sample III.

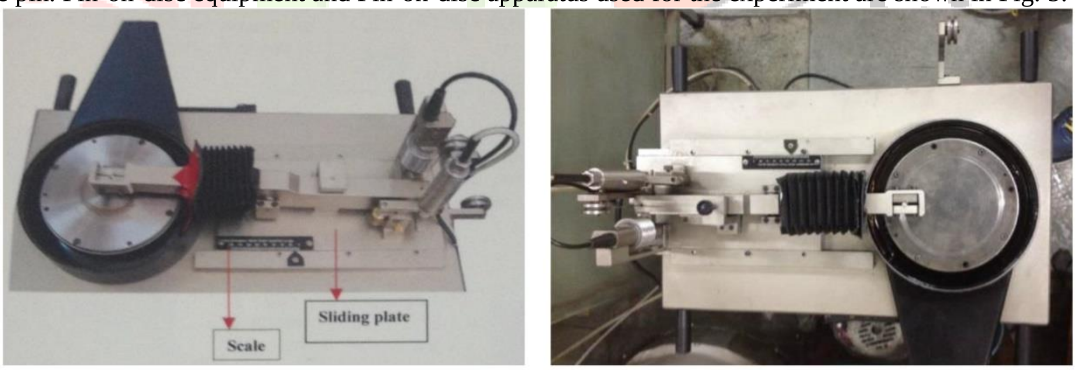
**3.3Preparation of disc**

Raw material for disc has been purchased from local market having dimension diameter=185mm, thickness=12mm & hardness approx. 30 HRC. The disc of required dimension (diameter =165 mm, thickness = 8 mm) was prepared on central lathe machine from raw material. To increase the hardness of prepared disc up to 62 HRC, induction hardening process has been employed as shown in Fig. 4.

Fig. 4. Disc for wear resistance test.

**3.4Wear resistance test**

This test has been performed on pin on disc wear testing machine. Where in the sample pin was rubbed on the disc at fixed rpm, fixed sliding distance & variable load for a given time and track diameter. The wear of pin is measured in terms of weight loose of sample pin. Pin-on-disc equipment and Pin-on-disc apparatus used for the experiment are shown in Fig. 5.




(a) (b)

Fig. 5. (a) Pin-on-disc equipment with LVDT; (b) Pin-on-disc apparatus.

## IV. RESULTS

This test was performed on the pin on disc wear resistance machine. The result of pin on disc wear resistance test is given below Table 4.1-4.3.

Table 4.1: Pin-on-Disc Test Results (Sample I)

| Sr. No. | Weight 1 (gm) | Weight 1 (gm) | Speed (rpm) | Load (N) | Time (sec) | Track Dia. (mm) |
|---|---|---|---|---|---|---|
| 1 | 10.4180 | 10.4148 | 800 | 49.05 | 368 | 130 |
| 2 | 10.4148 | 10.4125 | 800 | 78.48 | 398 | 120 |

Table 4.2: Pin-on-Disc Test Results (Sample II)

| Sr. No. | Weight 1 (gm) | Weight 1 (gm) | Speed (rpm) | Load (N) | Time (sec) | Track Dia. (mm) |
|---|---|---|---|---|---|---|
| 1 | 10.7633 | 10.7622 | 800 | 49.05 | 435 | 110 |
| 2 | 10.7622 | 10.7617 | 800 | 78.48 | 468 | 100 |

Table 4.3: Pin-on-Disc Test Results (Sample III)

| Sr. No. | Weight 1 (gm) | Weight 1 (gm) | Speed (rpm) | Load (N) | Time (sec) | Track Dia. (mm) |
|---|---|---|---|---|---|---|
| 1 | 10.6948 | 10.6936 | 800 | 49.05 | 531 | 90 |
| 2 | 10.6936 | 10.6934 | 800 | 78.48 | 598 | 80 |

From using equations (4.1), (4.2) & (4.3) the required results of Wear volume, Wear rate, Wear resistance are obtained and given below in the Table 4.4-4.6.

Table 4.4: Wear Results (Sample I)

| Sr. No. | Weight 1 (gm) | Weight 1 (gm) | Speed (rpm) | Load (N) | Time (sec) | Track Dia. (mm) |
|---|---|---|---|---|---|---|
| 1 | 10.4180 | 10.4148 | 800 | 49.05 | 368 | 130 |
| 2 | 10.4148 | 10.4125 | 800 | 78.48 | 398 | 120 |

Table 4.5: Wear Results (Sample II)

| Sr. No. | Weight 1 (gm) | Weight 1 (gm) | Speed (rpm) | Load (N) | Time (sec) | Track Dia. (mm) |
|---|---|---|---|---|---|---|
| 1 | 10.4180 | 10.4148 | 800 | 49.05 | 368 | 130 |
| 2 | 10.4148 | 10.4125 | 800 | 78.48 | 398 | 120 |

Table 4.6: Wear Results (Sample III)

| Sr. No. | Weight 1 (gm) | Weight 1 (gm) | Speed (rpm) | Load (N) | Time (sec) | Track Dia. (mm) |
|---|---|---|---|---|---|---|
| 1 | 10.4180 | 10.4148 | 800 | 49.05 | 368 | 130 |
| 2 | 10.4148 | 10.4125 | 800 | 78.48 | 398 | 120 |

## V. CONCLUSION

From the various results obtained during the research work it can be concluded that the average wear rate of Sample III is slightly less than the average wear rate of Sample II & the average wear resistance of Sample III is more than that of Sample II. Hence the life hours of Sample III are more than that of Sample II.

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