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Study of surface profile of rotary blades

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ABSTRACT : Wear of soil engaging components occurs because the materials used are normally softer than the natural abrasives in the soil. Most of blades of rotavator are manufactured locally which are hardly at par with the standards in terms of material, shape and size which affects operational life of rotary tool. So, there was a need to study wear characteristics of rotary blades so as to provide the proper blades in the rotary tools. Study was conducted in rotary soil bin in loamy soil and sandy loam soil. L-Shape blade of four different makes was mounted on the two flanges and their speed varied from 140-150 rpm. Two rollers along their stand were mounted on soil bin for compressing the soil upto 4.5 – 5.0 kg/cm^2 compaction. The width of rotary blades was measured before and after the wear test. The profile change of rotary blades can also be used to determine the wear characteristics of tillage tools. The decrease in width of blade T_1,T_2, T_3 and T_4 at starting point of blade section were 10.65%, 13.95%, 3.68% and 4.36 %, respectively in loam soil while the decrease in width of blade T_1,T_2,T_3 and T_4 at starting point of blade section were 15.10%, 17.10%, 13.50% and 18.65 %, respectively in sandy loam soil.

KEY WORDS : Rotavator, Soil bin, Loam soil, Sandy loam

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Wear of soil engaging components occurs because the materials used are normally softer than the natural abrasives in the soil. It is important to understand the nature and mechanisms of the wear process through testing and evaluation of materials for soil engaging tools. The change in shape and size of rotary tillage blades due to wear leads to reduction its performance in the fields. Diminished performance leads to work stoppage through the replacement of worn parts. Such shutdowns can also be expensive and time consuming. Salokhe *et al.* (1991) conducted a study on wear testing of enamel coated M.S relative to those of uncoated M.S rings in sandy soil and on sand papers of silicon carbide to investigate wear characteristics The tests on sand papers showed that enamel coated rings wore faster than M.S rings. Singh *et al.* (1993) conducted a study on wear characteristics of reversible shovels of seed cum fertilizer drill. Wear test on five different samples of shovels *i.e.*, mild steel, spring steel, high carbon steel, coated mild steel and heat treated mild steel were conducted on rotary soil bin for 100 h. Three types of soil *i.e.*, light medium and heavy soils were used for tests. Based on comparative analysis heat treated M.S shovels is best keeping in view the life of shovels as compared to normal M.S shovels. Gupta and Pandey (1991) evaluated straight cutting edge and spiral cutting edge rotary tiller blades in soil bin. Four different rotary speeds with two modes of operation were used to conduct the study. The linear speed 1.33 km/h and the working depth 100mm were kept constant. The study revealed that blade with spiral cutting edge gave about 9.13 per cent higher performance index than straight cutting edge blade. Zhang and Kushwaha (1995) studied wear characteristics of several cultivator sweeps using a newly developed abrasive tester. Comparisons were made between the regular sweep and hard faced edge sweeps. The hard faced sweeps proved to have better wear resistance. The wear characteristics were also evaluated by measuring the profile change of the sweeps using the image analysis. The draft of new and worn sweeps was evaluated in conventional soil bin. The hard faced sweeps proved to have better wear resistance.

Most of the rotary blades are manufactured locally which are hardly at par with the standards in terms of material, shape and size which affects operational life of rotary tool. Therefore, there is a need to study wear characteristics of rotary blades so as to provide the proper blades in the rotary tools. The present study was planned to compare the surface profile of existing rotary tillage blades under different soil and working conditions.

METHODOLOGY

For studying the wear characteristics of rotary blades, the study was conducted in rotary soil bin (Fig.A).

Fig. A : Rotary soil bin

Fig. B shows the experimental setup to carry out the present study. Two flanges were mounted on the rotary soil bin. The diameter of each flange was 47 cm and the rpm of each flange were kept in the range of 140-150 rpm. Two rollers of diameter 33 cm and length 36 cm along with their stands were mounted on the soil bin for compressing the soil upto 4.5-5 kg/cm2. Compaction of soil was adjusted with the help of springs mounted on the rollers.

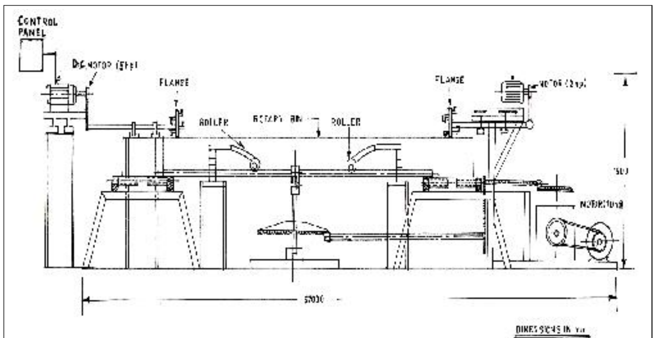

Fig. B : Experimental set up for the study

L-shaped blades of four different materials were used for the study (Fig. C). These blades were mounted on the two flanges (Fig. D). The material specifications of the blades are given in Table A.

Initially soil bin was filled with loam soil. The rotary blades were mounted on the two flanges. After running the blades for 50h, 100 h and 150 h in soil bin , surface profile of the blades were taken with help of surface profilemeter. The same procedure was followed with sandy loam soil. The width of rotary blades was measured before and after the wear test. The independent and dependent variables used in the study are given in Table B.

Fig. C : Different types of blades used in the soil bin

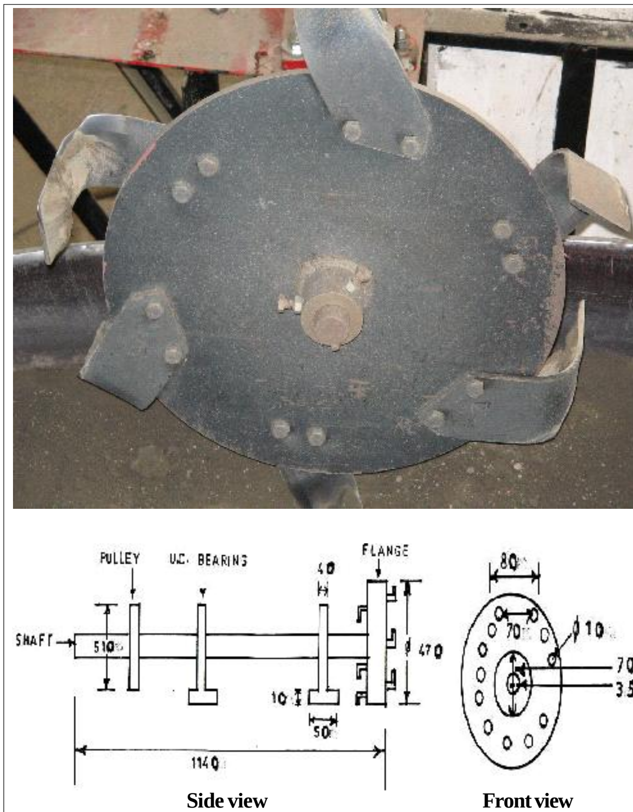

Fig. D : Detailed drawing of flange

Initially soil bin was filled with loam soil. The rotary blades were mounted on the two flanges. After running the blades for 50h, 100 h and 150 h in soil bin , surface profile of the blades were taken with help of surface profilemeter.

Table A : Material specifications of the blades

	Element concentration in percentage by weight (ferrous)							
Sr. No.	C	S	P	Si	Mn	Cr	Blade type	Material specification
1.	.290	.012	.018	.27	1.49	-	T_1	LCS (Low carbon steel)
2.	.280	-	-	-	1.37	.52	T_2	LAS (Low alloy steel)
3.	.640	.028	.039	.24	1.12	-	T_3	HCSS (High carbon spring steel)
4.	.250	.012	.012	.29	1.14	-	T_4	LCS (Low carbon steel)

Table B: Independent and dependent variables

Sr. No.	Independent parameters	Dependent parameters
1.	Soil type	Surface profile
2.	Blade type	
3.	Number of working hours	

The same procedure was followed with sandy loam soil. The width of rotary blades was measured before and after the wear test. The independent and dependent variables used in the study are given in Table B.

RESULTS AND DISCUSSION

The results of the present study as well as relevant discussions have been presented under following sub heads:

Effect on surface profile in loam soil :

Worn surface profiles of the blades have been shown in top views of the blades. It was observed that maximum wear loss in width was at starting point of blade section followed by bent section and minimum at end point of leg section.

Fig. 1 shows that the reduction in width of blade T_1 at starting point of blade section was 10.65%. After 30mm, 60mm, 90mm, 110mm reduction in width were 10.25%, 9.80%, 9.40%, 9.00%, respectively. Initially the width of the blade was 78.06mm. After 50h it reduced to 76.65mm, after 100h it was 72.91mm, after 150h it became 69.75mm. The width reduction for blade T_2 at starting point of blade was 13.95% followed by 13.55%, 13.10%, 12.70%, 12.55% at 30mm, 60mm, 90mm, 110mm, respectively. Initially the width at starting point of the blade was 71mm then after 50h it reduced to 69.15mm, after 100h of working period it reduced to 65.39 and after 150h it reduced to 61.10mm as shown in Fig. 2.

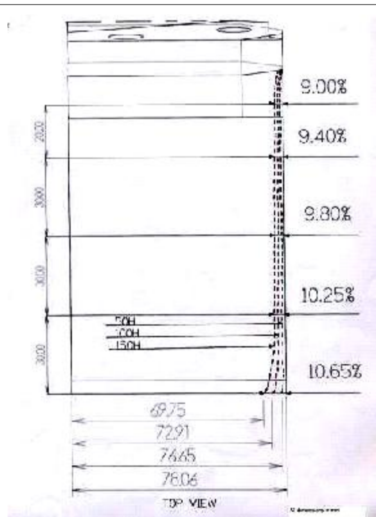

Fig. 1 : Worn surface profile of blade T_1

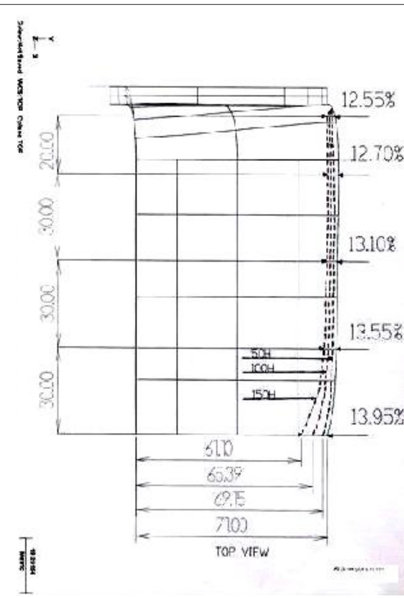

Fig. 2 : Worn surface profile of blade T_2

Fig. 3 shows that the reduction in width of blade T_3 at starting point of blade was 3.68% followed by 3.25%, 3.08%, 3.02%, 2.97% at 30mm, 60mm, 90mm, and 120mm, respectively. Initially the width of the blade was 68mm after 50h it reduced to 67.93mm, after 100h of working period width reduced to 66.71mm and after 150h of working period width became 65.50mm. The decrease in width of blade T_4 at starting point of blade was 4.36% followed by 4.28%, 4.20%, 3.80%, 3.65% at 30mm, 60mm, 90mm, 120mm, respectively. Initially the width of the blade was 70mm, after 50h of working period it reduced to 69.01mm, after 100h of working period it reduced to 67.83mm and after 150h it became 66.95mm as shown in Fig. 4.

Effect on surface profile in sandy loam soil :

It was found that maximum wear loss in width was at starting point of blade section followed by bent section and minimum at end point of leg section. Fig. 4 shows that the worn surface profiles have been shown in the top views of the blades. The decrease in width of blade T_1 at starting point of blade section was 15.10%. After 30mm, 60mm, 90mm, 110mm reduction in width were 14.65%, 14.20%, 13.80%, 13.70%, respectively. Before the start of the experiment width at starting point of blade was 78.06mm, after 50h, 100h, 150h and 200h width reduced to 76.56mm, 72.59mm, 69.86mm and 66.27mm, respectively (Fig. 5). The reduction in width at starting point of blade T_2 was 17.10% followed by 16.85%, 16.69%, 16.40%, 16.21% at 30mm, 60mm, 90mm, 110mm, respectively. Initially the width at starting point of blade section was 71mm. After 50h, 100h, 150h and 200h of working period width reduced to 68.79mm, 65.32mm, 61.34mm and 58.86mm, respectively as shown

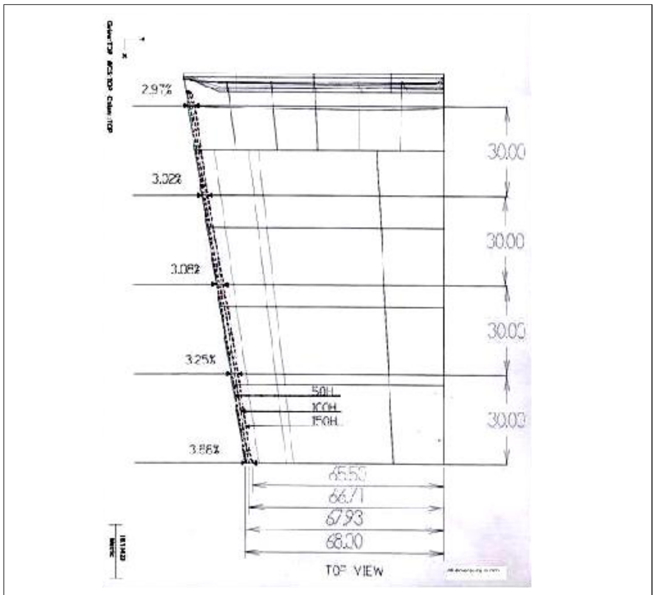

Fig. 3 : Worn surface profile of blade T_3

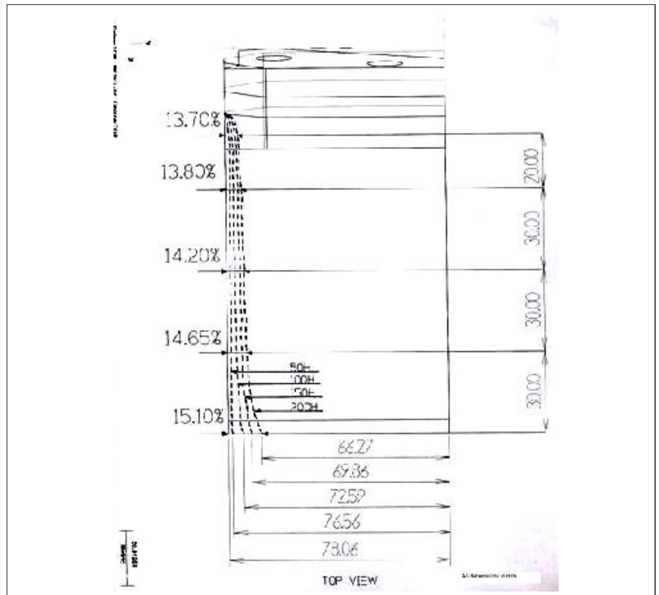

Fig. 5 : Worn surface profile of blade T_1

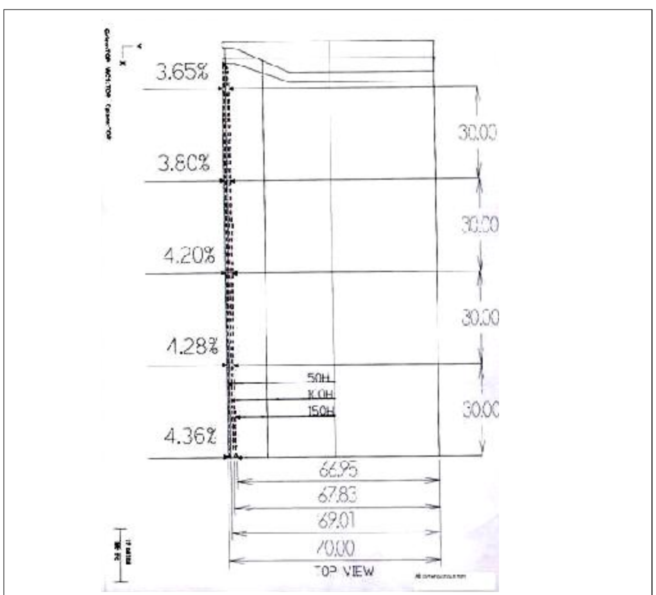

Fig. 4 : Worn surface profile of blade T_4

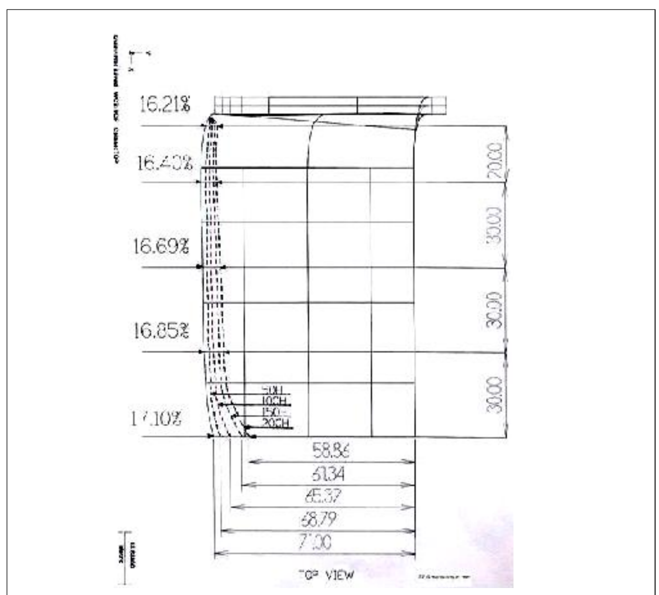

Fig. 6 : Worn surface profile of blade T_2

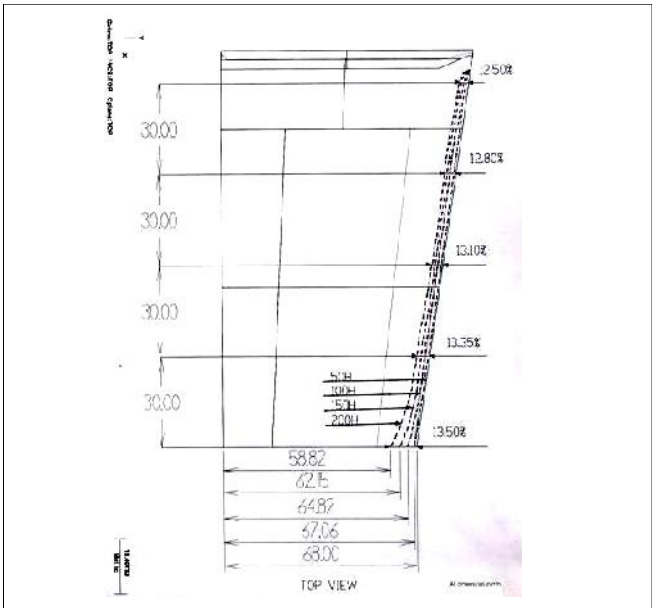

Fig. 7 : Worn surface profile of blade T_3

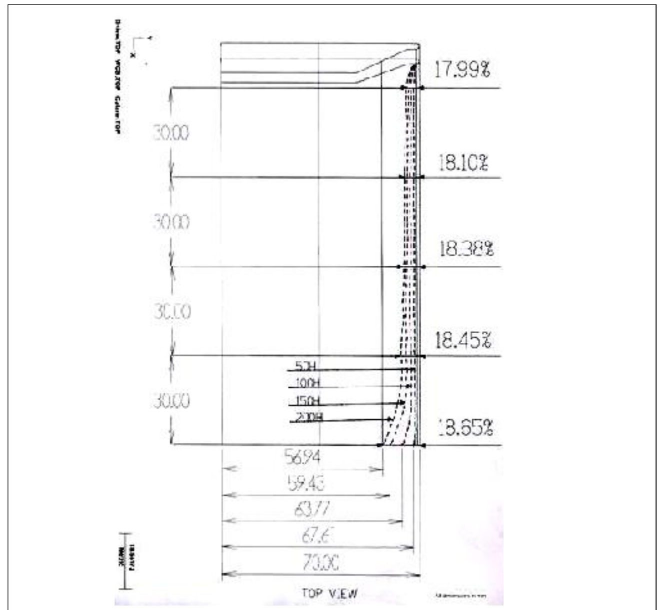

Fig. 8 : Worn surface profile of blade T_4

in Fig. 6.

Fig. 7 shows that the decrease in width at starting point of blade T_3 was 13.50% followed by 13.35%, 13.10%, 12.80%, 12.50% at 30mm, 60mm, 90mm, and 120mm, respectively. Before the start of the experiment width at starting point of blade section was 68mm. Width reduced to 67.06mm, 64.82mm, 62.15mm and 58.82mm after 50h, 100h, 150h and 200h of working period, respectively. The decrease in width at starting point of blade of quality mark T4 was 18.65% followed by 18.45%, 18.38%, 18.10%, 17.99% at 30mm, 60mm, 90mm, 120mm, respectively.The width reduced to 67.61mm, 63.77mm, 59.43mm and 56.94mm after 50h, 100h, 150h and 200h of working period, respectively as shown in Fig. 8.

Thus, it is concluded that the cutting edge of blade section was most susceptible to wear. Maximum wear occurred at the tip of starting point of the blade. The profile change of rotary blades can be used to evaluate wear caused by tillage process. The rotary blade T_3 was more suitable as compared to other blades as there was less reduction in the width of rotary blade section at different working hours.

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