# ABSTRACT

The manufacture of rotavator tynes used in power tillers is largely carried out by the small-scale industries. Due to improper heat treatment the quality of tynes is not met as per Bureau of Indian Standards resulting in high wear rates and reduced life. A project was, therefore, undertaken to study their wear characteristic under varying tool and soil parameters and suggest remedial measures to increase their working life.

In the first phase, the wear loss of cylindrical test specimens was studied against bonded abrasive on a pin-on-disc wear test set-up (ASTM standard G 99) with a view to determine wear loss of tyne materials (spring steels) under varying material properties and operational parameters. The carbon content of the material was varied from 0.41 to 0.6 per cent (3 levels) and hardness from Rc 40.6 to 60.8 (5 levels). The tests were conducted using four levels of abrasive particle size (300, 425, 505 and 738 μm) and three levels of normal pressure (0.5, 1 and 1.5 $kg/cm^2$). The test specimens (8 mm diameter and 20 mm length) used in this experiment were subjected to heat treatment to obtain the desired hardness levels. The heat treatment was accomplished in two stages, hardening and tempering. The hardening temperature and soaking time for specimens of different carbon contents were decided on the basis of the phase diagram and size of the specimen respectively. After the heat treatment the hardness attained by the specimens was measured by using a Rockwell Hardness tester (ASTM standard E 18). Keeping in view the required tempering time and ease of process control the different combinations of tempering temperature and time were selected to get the desired levels of hardness in test specimens.

The second phase of the study was conducted in a circular soil bin of the abrasive lap type with soil as the abrasive medium. The two types of rotavator tynes (C- and L- type) under varying material properties (carbon content - 0.41 to 0.6%; hardness - Rc 40.6 to 60.8) were tested in four types of soil (clay loam, sandy clay, sandy clay loam and sandy loam). The tyne velocity ratio was maintained at 7.978. The radius of C- type tynes was kept at 245 mm and L- type tynes at 250 mm. The heat treatment parameters for the tynes were selected based on the data obtained in the first phase of the study. A completely randomized design with two replications was followed for the experiment. The C-type tynes were tested at 10-12% soil moisture, whereas L- type tynes were tested under saturated soil conditions. A uniform soil condition was maintained before conducting each test. Each test was conducted for 15 hours duration and the weight of the tyne before and after the test was taken to the nearest 0.1 g. The difference in weight was used to calculate the total specific wear loss, defined as the wear loss of tyne per unit contact area of tip section per km contact length with the soil. Also, the sectional specific wear loss, defined as the loss of weight from a section per unit contact area over unit km contact length of that section with the soil, was used to study the wear distribution pattern in different types of soil.

Based on experimental data obtained in the first phase, an empirical equation was developed to estimate specific wear loss of tyne material ($mg/cm^2.km$) on bonded abrasive within the range of test parameters. The total specific wear loss was found to decrease with increase in material hardness for both C- and L- type tynes at all levels of carbon content and in all four types of soil tested. The total specific wear loss was higher for C- type tynes as compared to L- type tynes for all the test conditions. For each tyne, the wear loss was found to be highest in sandy clay loam followed by sandy loam, sandy clay and clay loam soils in that order.

An empirical equation was developed to predict the total specific wear loss ($mg/cm^2.km$) of tynes. About 95 per cent of the total wear loss was found to be concentrated within 23 per cent of peripheral length of curved section of the C- type tynes and 24 per cent of length of edge portion of the L- type tynes. On the basis of this wear pattern selective heat treatment was recommended to the specified sections of rotavator tynes instead of providing heat treatment to the whole tyne.

**Key Words:** rotavator tynes, heat treatment, soaking time, tempering temperature, tempering time, bonded abrasives, types of soil, material hardness, velocity ratio, normal pressure, total specific wear loss, sectional specific wear loss, wear distribution pattern.