

# REDUCING MAINTENANCE COSTS OF SHREDDER HAMMERS AND CANE KNIVES

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## Abstract

The rising maintenance costs for labour and materials for depither and shredder hammers and cane knives rose progressively at Gledhow, indicating that investigations were needed to reduce these costs where possible. The various stages of testing and the results achieved are discussed.

## Introduction

The prime purpose of these tests and results was to reduce material and labour costs, and if possible reduce the scheduled downtime by adopting more practical methods of handling and maintaining the equipment.

It was not the intention to increase the Clean Fibre Index (on depithers), the Preparation Index, or to reduce power required by the various prime movers and this fact must be borne in mind. The costs are present-day costs and the different types of materials used were to suit equipment and conditions at Gledhow. Changes in quality, quantity of materials and speed of machines naturally affect the results obtained to a great extent.

## Materials and Methods

### Depithers.

The three Western States depithers started continuous operation in 1976 and after the initial mechanical problems were overcome it was realised that one big problem remained. Depither hammers had to be changed every third day to maintain the clean fibre index of 80 plus.

The Western States type vertical depither is driven by a 300 kilowatt 1 000 rpm electric motor via a Voith coupling. The hammer tip speed is 75 m/sec and the weight is 1,15 kg.

Up to this stage the best electrode for hardfacing on the hammer was Cobalarc 9, and to change hammers required a crew of three, changing 64 hammers each time. In order to obtain a longer life, the hammers now fitted were designed with a dog leg which provided a self-adjusting head. Although they lasted about 5 days, these hammers were usually beyond repair after removal, especially the 30% situated at the top end of the depithers.

After liaising with industrial firms various types of hardfacing were tried unsuccessfully. Some hammers did not even survive a day's operation.

However, one firm provided a hard block (no material specifications were released, and it is only known as the "Apex" block) and by welding this block onto the cutting edge and then stress relieving it, fourteen days were obtained for a set of hammers. Labour costs remained high to fit these blocks to a whole batch of hammers so the decision was made to fit the blocks only in the two top rows. To make it even more economical, a cast hammer seemed to be the only solution to reduce workshop labour. SG 38 iron was tried because its characteristics are very similar to those of cast steel.

Minimum tensile strength is 380 MPa and its elongation is 17% with 180 Brinell hardness. This type of hammer proved to be the answer as no hammers were lost during operation except in severe cases where foreign matter entered the depithers. Another advantage of the SG 38 iron was that no bushes were needed because its characteristics gave very little wear on hammer shafts (mild steel or stainless steel).

The SG 38 iron however, as expected, proved to be far too soft, but was found to last under shock conditions and not break up.

Before hardfacing was started, the company supplying SG 38 iron suggested that SG 70 be tried and they were prepared to heat treat it further to their own specification. Minimum tensile strength was 710 MPa with 3% elongation and a Brinell hardness of 290–320. This turned out to be the right decision and after modifying the Mark 4 to the Mark 5, it is by far the best solution to date.

As can be seen the Mark 5 has more material where it is needed, with a bigger eye, and from an engineering point of view is sounder. (The hole was made small at first in order to reduce wastage when it was initially made out of mild steel flat bar).

In Table 1 the tremendous saving can be seen. Over 21 days the Mark 1 cost 7,36 times more to use than the Mark 5.

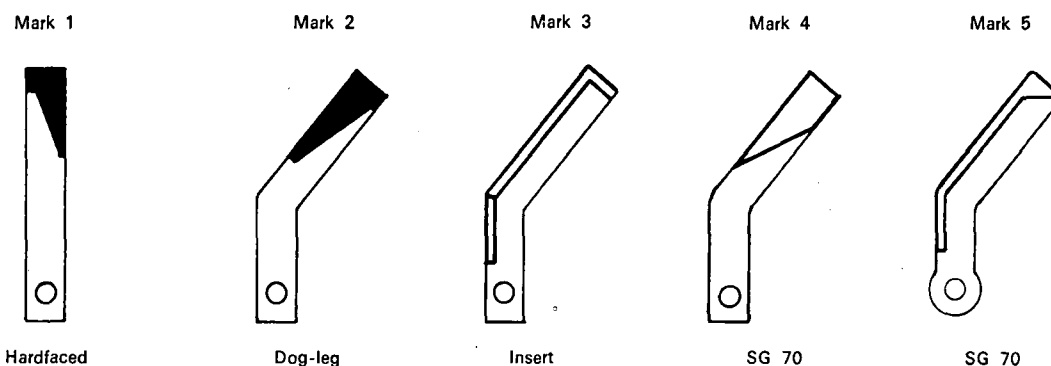


FIGURE 1 Different stages of depither hammer developing.

TABLE 1

Mark	1	2	3	4	5
(a) Operating days . . . . .	3	5	14	14	21
(b) Costs . . . . .	R4,00	R6,30	R8,00	R4,10	R3,80
Cost over 21 days . . . . .	R28,00	R26,50	R12,00	R6,15	R3,80

$$\frac{\text{Comparing over 21 days Mark 5}}{\text{Mark 1}} = \frac{28}{3,80} = 7,36$$

Now one machine is done each scheduled Monday (i.e. each third week because three machines are on line) compared to the stopping of one machine each third day.

**Shredder Hammers**

In October 1978, with the knowledge obtained on the depithers, the time was opportune to move investigations to the cane-shredders.

The Smithtech shredder is driven by an Elliott CYRPG turbine of 1 370 kilowatt via a Cardan shaft at 1 150 rpm. Hammer tip speed is 115 m/sec, with a hammer weight of 12,2 kg.

Initially only five SG 38 iron and SG 50 iron hammers were tested and these were hardfaced with Cobalarc 9 on only one side.

A time and motion study revealed that there was little to be gained if both sides were hardfaced as the hammer loses its shape after a time when hardfaced on both sides. At Gledhow balancing is a critical factor because to start up and run from one scheduled stop to another without stops the shredders have to be vibration free. This practice pays dividends and has increased mechanical time efficiency. Lost time was reduced as illustrated in Table 2.

TABLE 2

	Diffuser	Mill
1977 . . . . .	6h35	23h50
1978 . . . . .	3h00	0h50
1979 . . . . .	1h55	5h40

\* 2h00 for checking test block.

After several consecutive tests the hammers proved to be very satisfactory, and the 1979 crop was started with a complete set of hammers in each shredder (mill and diffuser). With a throughput of 1,55 million tons of cane only five hammers broke, due solely to tramp iron by-passing the magnet.

The SG 50 iron has very little advantage over the SG 38 iron and all production hammers are now made of SG 38

iron because it has a greater percentage elongation than SG 50 iron.

The hammers hardfaced with Cobalarc 9 lasted for about 60 000 tons of cane and building-up was done with manganese rods.

In the early weeks of 1979 a new hardfacing rod, Ticko, was tried which proved to give a better bonding, and more material was left intact after two weeks of running. The inserts that proved themselves on the depithers were now welded in for testing purposes on the shredder hammers. The "Apex" insert lasted for 90 000 tons of cane.

Removing the insert to install a new one created various practical problems. The idea was adopted in early June 1979 to test removable tips or inserts fitted to the hammers.

The first one was of SG 70 iron and had an integral cast pin on it with a split-pin at the back. This type had the disadvantage of having a taper on the pin (for casting purposes) and in addition this amount of material was wasted when the block was made redundant.

This led to the testing of a block with a bolt through it and a nut at the back, as well as one with a pin through it with a stainless split-pin at the back. The split-pin type was far more economical and quicker to remove and install. Under working conditions the centrifugal force and backward thrust kept the block in place.

The different heads are shown in Figure 2.

As long as the casting surfaces were reasonably flat (sharp edges were removed by hand grinding), no problems were experienced because of the non-machined faces. The drawback was that only 30 000 tons could be reached on one side or a total of 60 000 tons for one block using two cutting sides. It was also found that the preparation index fell with the last 30% of cane handled. By welding two runs on two opposite edges with Ticko, 30 000 tons of cane per cutting edge were obtained with no serious loss in preparation index.

Tests were stopped with other specially hardened blocks because they were either too expensive or too hard and disintegrated when foreign material came into contact with them.

Table 3 shows present maintenance costs per hammers as compared with the original costs (not including scrap re-sale value of old tips).

*Capital Costs.*

The cost for a 12 kg hammer cast steel was about R20,00 and for SG 38 about R9,70 per hammer.

**Cane Knives**

The biggest problems here were the labour and the time for changing knives. Material costs were already low because only the cutting tips (mild steel with Ticko) were removed and welded on from time to time. The tips last about 60 000 tons of cane per hardfacing of tip. The set of counter-

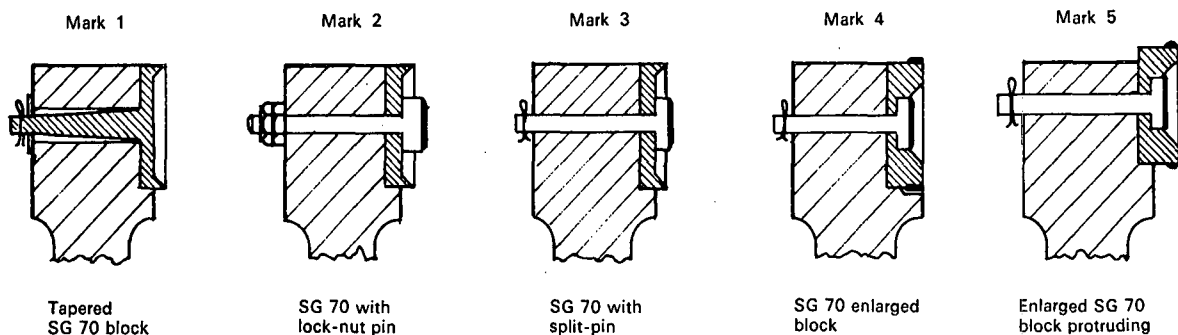


FIGURE 2 Shredder hammer with different inserts.

TABLE 3

	Cast Steel Hammer	SG 38 Hammer	New SG 38 Hammer with SG 70 Tips
Hardfacing	3 Cobalarc rods  R3,12 10 Ms rods  R2,20	2 Cobalarc rods  R2,08 8 Manganese rods R4,17	2 runs of Ticko on both cutting edges R0,55 SG 70 Tip  R1,30
Workshop Labour	55 min welding R3,05	40 min welding R2,10	6 min welding R0,30
Total . . .	R8,37	R8,35	R2,15

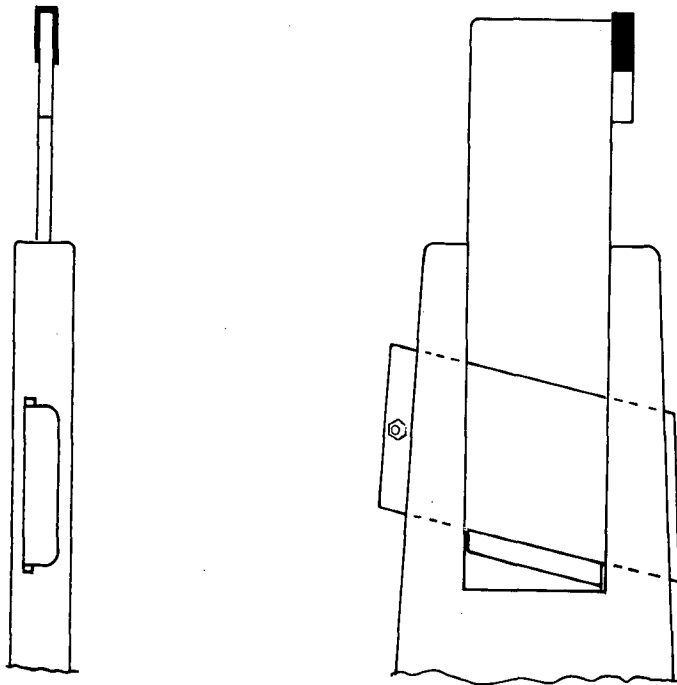


FIGURE 3 Front and side view of new knife palm.

rotating knives is driven by a 450 kilowatt motor at 490 rpm. Knife speed is 50 m/sec with a weight of 9,8 kg.

The Pongola design of palm was used with a blunt cutting edge, as a swinging palm did not work at all with this type of cutting edge.

The dove-tail principle of locking was abandoned because after two or more seasons the male section becomes worn out and is very difficult to repair. The knife is also weaker at this spot because of the reduced cross-sectional area.

To overcome this the knives were fitted with 20 mm square bar blocks welded on and stress relieved. At the same time the whole palm was re-designed and increased in width by about 20% to strengthen it. The sliding keep plate was widened and thickened.

In practice it was found that a 20 mm knife blade would bend when hitting a stone. The keep-plate however would still be straight enough and could be pulled out. With this design the knife can be a loose fit (about 0,5 to 1 mm).

When casting the new palms the only machining needed was for boring, keying and facing of the sides. The results of these changes were that a half set of knives was changed in 1,25 hours on a scheduled stop with two men. In the past it took four men five hours, which still included the risk of some of the bolts not being tightened.

**Conclusion**

Practice showed that on the cane and bagasse preparation side mechanical and overall efficiency could be increased, at the same time cutting costs of labour by about 60% and on materials by up to 70%. The depither hammers have been in operation for two seasons and the knives for one season).

The shredder hammers, as indicated in the centre section of Table 3, have been in operation for one season, but for the coming 1980 season have been completely converted to the design shown in the last section of Table 3, due to the favourable results obtained during previous test periods.