SOME CONVEYOR MODIFICATIONS AND EXPERIMENTS AT SIMUNYE

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Abstract

In an attempt to save on costs and utilize time more efficiently at the Simunye sugar mill, a number of modifications have been made to machinery during the past four years. These have involved converting the mud conveyors and the main bagasse carrier to round link chains and, together with a local manufacturer, a block link chain has been developed for intercarriers.

Part I: filter mud conveyor conversion

The original conveyor was a typical box-section carrier, 800 mm wide with two chains carrying steel slats (Figure 1).

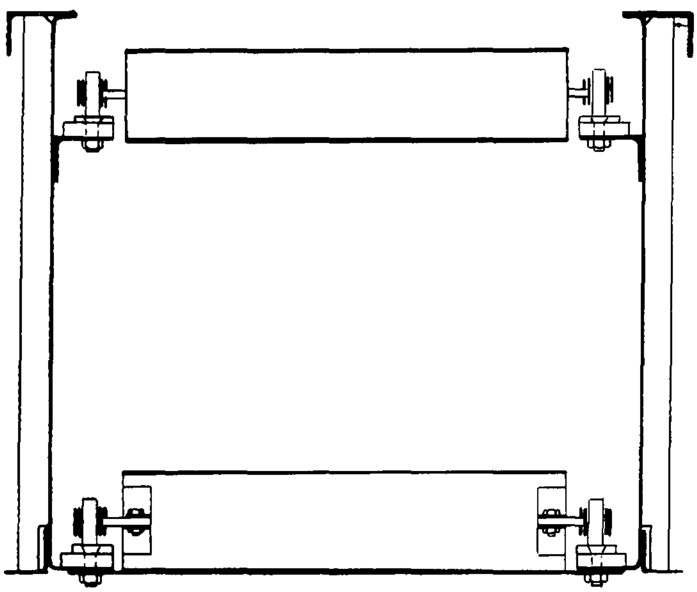

FIGURE 1 Sectional elevation of original mud conveyor

The riveted link roller chain wore out after two short seasons so was replaced with a cheaper 20 mm diameter × 100 mm pitch round link chain from McKinnon. Replacing identical roller chain at that time would have cost R85 m^{-1} (it now costs approximately R120 m^{-1}) while the round link chain cost R14 m^{-1}. Additional costs of modifying the carrier including the slats, totalled approximately R1 000.

Design

Because differential wear on two parallel strands was a problem, the design was modified so that only one central strand was used, thus reducing costs still further (Figure 2). The slats are made from 12 mm thick × 150 mm deep × 400 mm wide polypropylene sheet, are spaced at a pitch of 1 m and the speed is 20 m min^{-1}. To accommodate the narrower slats the sides were plated in to form a trough, which was lined with stainless steel one year later.

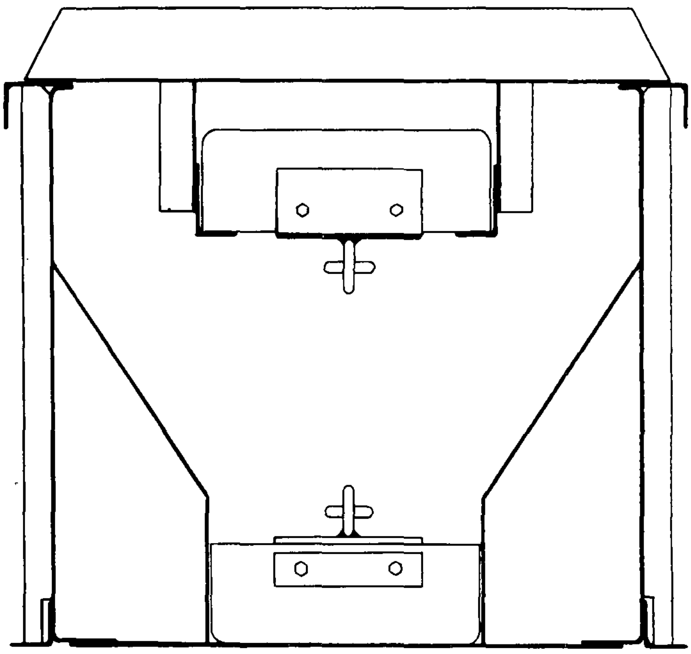

FIGURE 2 Sectional elevation of modified mud conveyor

Results

The chain needed replacing only after three full seasons. The conveyor proved to be adequate under the heaviest mud-load conditions. During the first year of its installation, there was only one minor problem when the chain became too slack. This caused the chain links carrying the slats to crank in the vertical plane and this allowed the slats to skid over the mud on the inclined conveyor (Figure 3).

Remarks

The way in which the slat conveyors were installed at first (as opposed to a belt) was not considered satisfactory, but the modified version can be recommended because:

- maintenance costs are minimal (approximately R20 running m^{-1} a^{-1});
- it is much cleaner than a belt;
- there are no problems with belts warping because of the mud.

This type of chain does however require regular maintenance checks and adjustments to ensure trouble-free operation.

Part II: main bagasse carrier conversion

One year after the mud conveyor had been converted, a decision was made to convert the boilerhouse or main bagasse carrier. The consequences of downtime on this carrier were far greater for mill operation.

This carrier is 80 m long and 2 m wide with a top deck 60 m long for returned bagasse. It is driven from the headshaft only at a speed of 40 m min^{-1}. The slats are steel channels 178 mm × 54 mm spaced at 1 m.

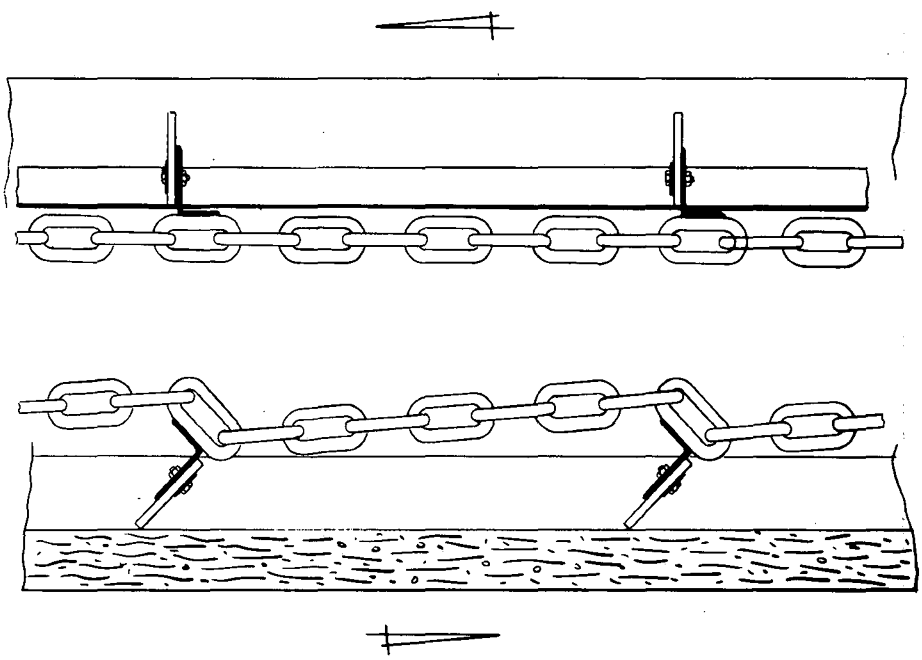

FIGURE 3 Sectional side elevation of mud conveyor showing slats cranking and skidding over the mud due to slack chain

Design

A 25 mm diameter × 100 mm pitch round link chain with a breaking strain of 850 kN was selected. The width of the carrier and the nature of the bagasse made it impossible to use a single strand of chain, as in the mud conveyor. Each chain strand comprises about 1 600 links with 3 200 wear points so the only cause for concern was how serious differential wear would become.

The modifications to the carrier consisted of moving the wear strips and fitting wear pads to the outside edges of the slats. The headshaft sprockets were redesigned with assistance from the chain manufacturer and grooved drums were installed on the tailshaft.

Operational experience

As expected, the chain did wear rapidly during the first few weeks but this gradually decreased as it bedded-in. The two chains did not bed-in equally and the tailshaft soon became misaligned by about 300 mm. Two long breakdowns resulted when the chain came off the taildrums and because this situation could not be tolerated, serious consideration was given to re-installing the roller chain.

Instead, independent tail stubshafts were designed to ensure that under any conditions of differential wear, the chains would always be in line when they approached the drums. Adjusting the drums inwards would have accommodated the cranking effect on the slats when the chains wore differently. Because the available hubs could not accommodate large spherical roller bearings, spherical plain bearings, (designation SKF 120CS-2Z), with forced moly-disulphide lubrication, were used. Although the use of these bearings in this application is not normally recommended they nevertheless lasted the whole season before they were replaced. The design of the stubshaft and taildrum is shown in Figure 4.

After the bedding-in period, the chain wore at a slower rate and lasted for two seasons, by the end of which the pitch of the chain had increased to 108 mm. This was considered to be unacceptably high for it to be used for a third season. It was therefore replaced with a slightly harder version.

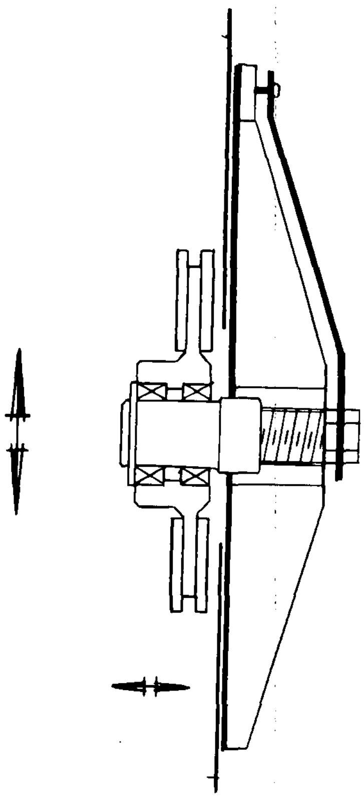

FIGURE 4 Individually adjustable stubshafts

Head sprockets

The design of the head sprockets is such that the teeth do the driving only, and adjacent to the teeth on both sides, anvil plates prevent the chain from digging down into the valley between the teeth (Figure 5).

If the pitch of the chain increases by 1 mm, then from geometric consideration the anvils and teeth need to be raised by 3,83 mm. They should therefore have been built-up progressively by about 30 mm. Unfortunately, during the last four months of the 1984 season, cane entering the mill at Simunye

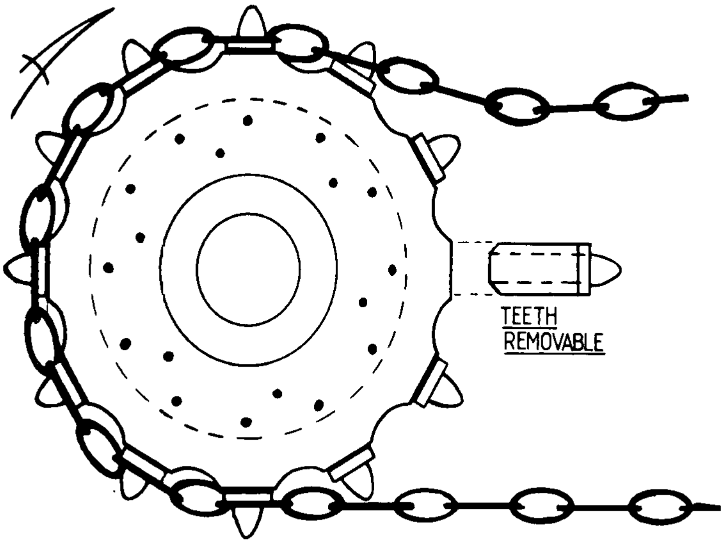

FIGURE 5 Headshaft sprockets

had an unusually high fibre content which resulted in a bagasse surplus. The boilers were therefore not stopped during the fortnightly maintenance stop and hence the sprockets received little attention and the result was a few lengthy breakdowns towards the end of the 1984 season. Fortunately this occurred during a period when cane supply was erratic so the season was not extended unduly.

The sprockets have been redesigned with replaceable anvil-cum-tooth blocks which can easily be removed, packed outwards, and replaced. Adjustability is designed for 40 mm which should account for up to 11 mm of wear in the chain. It is expected that with a harder chain and more regular and better maintenance, the new chain should easily last for three seasons.

Summary

This type of chain has proved to be very successful and is cost-effective. There was relatively little downtime, even during the development stages and there is no intention of reverting to a roller chain.

Estimates showed that if the chain lasted for a year, the costs would break even. The fact that the chain lasted two years meant that meaningful savings have been made and will be even greater after three years (Table 1). The smuts settling tank chains have also been changed to the round link chain and they appear to be lasting very well.

TABLE 1

Comparison of cost of different chains

Year	Round link chain (rands per metre)	Roller chain (rands per metre)	
		Style 1796	Style 09063
1983	29	70	80
1985	45 (higher specification)	85	100

The costs of converting the carriers, head sprockets and taildrums have not been taken into account because these are non-recurring costs and should theoretically be spread over a number of years. Similarly in estimating cost-effectiveness of the roller chain, its total life before replacement should be estimated and refurbishing costs during that period should be included.

Part III: developments of a block link chain for intercarriers

In 1982 an experimental block link chain was purchased from a local manufacturer. It comprised a slotted cast-iron block with stainless steel bushes and was designed to use standard style 1796 pins and outer side bars. Unfortunately, poor quality control during manufacture and poor material selection led to serious problems and the chain was discarded within six months. The basic concept of the chain was not forgotten as this was the main reason for purchasing it in the first place. If the major mechanical causes of intercarrier problems were analysed, it would be seen that the most common contributor is the weakness of the slat attachments, mostly of the AS2 type.

In the block link design these problems do not exist because the tongued end of the slat slides into the slot in the block and is extremely rugged compared with the AS2 attachment and there are also no pins or split-pins.

In 1983, imported chains had gained a major share of the market in the sugar industry. Most local companies had ceased to produce chains but one company was making a determined bid to re-establish itself on the local market. It is preferable, where possible, to deal with local companies because if any problems arise, it is quick and easy to get assistance from the factory; and price fluctuations caused by variations in the foreign exchange rate, can be avoided.

Discussions regarding the further development of a block link chain were held with staff of a factory in Benoni where quality control appeared to be of a high standard.

Description

The final design agreed upon (Figure 6) is essentially an 09063 style chain with a solid block replacing two rollers and the inner sidebars connecting them. Every third block has 75 mm × 25 mm slots to accommodate the slat end.

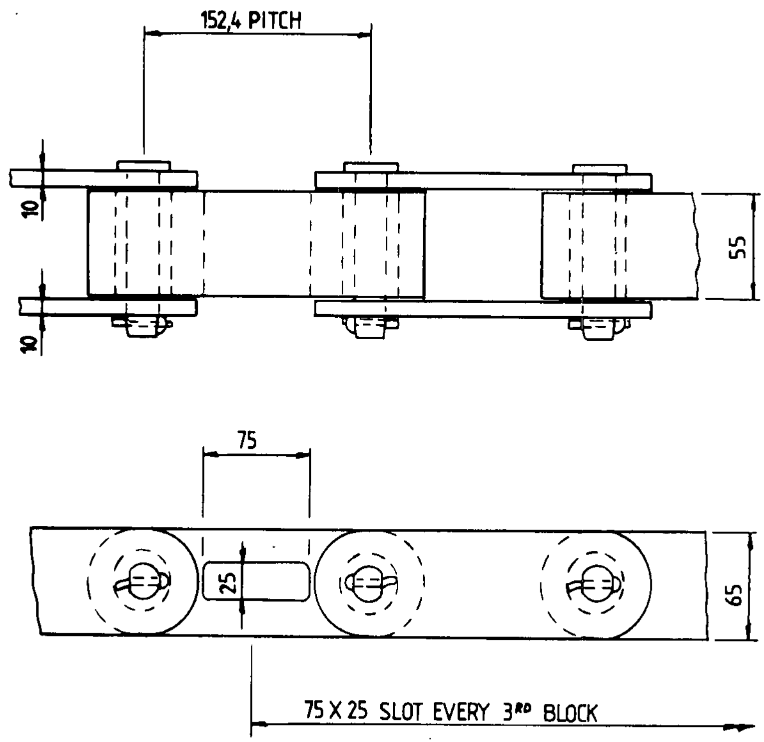

FIGURE 6 Block-link chain

Material specifications are as follows:

Block : 65 mm high × 55 mm thick flame cut from BS4360 grade 43A steel, carburized, hardened and tempered to 40–45 Rockwell C

Sidebars	:	65 mm × 10 mm EN19 through hardened and tempered to 250–300 Brinell hardness
Pins and bushes	:	420 stainless steel, through hardened and tempered to 40–42 Rockwell C
Minimum breaking load	:	600 kN

Performance to date

The chain was installed on the first two intercarriers, normally the most troublesome because of the nature of bagasse at the beginning of the tandem. The total downtime caused by these two intercarriers during the entire 1984 season was only two hours when a few cracked pins required replacing towards the end of the season. Subsequent tests on these pins showed that poor heat treatment caused their failure. There were no problems with chains actually separating or slats coming adrift. It was also noted that the sprockets which, because of the block link, have to be very open, do not become choked-up with bagasse.

Conclusions

This type of chain appears to be very heavy but it has proved to be extremely reliable and will be used to replace all the roller chain used in intercarriers at Simunye before the 1986 season starts. This chain does not result in an appreciable increase in load and its current cost is R96 per metre.