ROCK AND SAND REMOVAL AT TSB'S KOMATI MILL

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Abstract

Field cut and loaded sugar cane which is presented to a sugar mill for further processing is at times notorious for the amount of rocks, sand and other extraneous matter it contains. This material, if not removed prior to processing the cane, causes extensive damage to cane crushing equipment and boiler plant with associated high maintenance costs and loss of production time. The operating principle of a rock removal system (RRS) which has been developed to remove a large proportion of rocks, sand and other foreign material on a continuous basis prior to processing the cane is described.

Introduction

Cane destined for TSB's new Komati mill will be field handled in the same manner as for the Malelane mill, namely burning followed by manual harvesting, packing in windrows and in-field loading into cane trucks by means of push-pilers. It was envisaged that this method of handling, together with the fact that a portion of the cane will be from newly planted fields, would result in large amounts of rock and sand being delivered to the mill along with the cane.

As a result of this, it was foreseen in the conceptual design stage that a RRS of some form would have to be employed in order to minimize damage to cane preparation equipment by rocks and other extraneous material. It was therefore decided to design a suitable RRS for Komati mill.

Initial research

Visit to Mauritius and Reunion

During a visit to Mauritius and Reunion in June 1992, rock removal systems were inspected as summarized below.

Beaufonds, Reunion. The system basically consists of two inclined steel deck conveyors, with levellers. Whole stick cane, together with any rocks, is loaded onto the first inclined conveyor/feeder table with a slope of 35-40 degrees. This cane is then transported by means of above-deck chains and slats to the top of the table where it then tumbles down onto the deck of the second inclined conveyor. This conveyor is of the moving deck type and its angle of incline is slightly less than that of the first.

Due to their mass and shape the rocks roll rearwards down the deck, through two heavy-duty curtains of plastic sheets and metal strips and end up against a catch plate towards the tail end of the deck. The operator then stops the intake, climbs onto the deck and manually removes the rocks.

Cane lying on the deck of the second conveyor is transported up towards the top of the deck and is combed back by a leveller set only about 100 mm above the deck. Any large rocks are combed back by this leveller.

Disadvantages of this system are:
- Non-continuous operation.
- Sand and small rock removal not optimal.

Medine, Mauritius. An above-deck chain and slat feeder table feeds cane onto a horizontal moving deck conveyor. Any large rock falling onto this second table makes sufficient noise to alert the operator who then switches to another feed table while the stone is manually removed.

Other desk-top study information

A desk-top study on systems in use in other parts of the world (Lucht, 1992) revealed information on the following types of separation equipment:

Pneumatic separation. One of the first rock and sand removal plants formed part of a cane dry cleaning plant and was installed at Laupahoehoe Sugar Company in Hawaii in 1970 (McElhoe and Lewis, 1972). This plant operated on the pneumatic concept and achieved separation by passing a high velocity air stream through the falling cane and separating the components by means of their differing trajectories.

Shaker table. Cane is transported onto a vibrating shaker table with elongated openings of 2,5 m × 100 mm. Cane stalks fall through the openings onto a suitable conveyor while large rocks exceeding 100 mm are left on top of the table. The slightly inclined table with its upwards and sideways vibratory motion directs these rocks into a gutter situated on the lower edge of the table. Small rocks and sand fall into a chute situated below the shaker table. A conveyor underneath the chute then carries all rocks, sand and lost cane to a reclaimer where the cane is reclaimed and sand and rocks are removed.

Revolving drum. This concept is similar to the unit at Komati except that at the base of the inclined feeder table and drum intersection a longitudinal screw conveyor picks up the rocks and conveys them to the end of the feed table to discharge them through the sides of the machine. A reclaiming plant redirects any lost cane into the system while removing rocks and sand.

All the systems described above are reportedly subject to operational and maintenance problems to varying degrees.

Design requirements and specifications

The followings concepts were to be incorporated into the design of the RRS, based on desirable parameters obtained from the initial research:
- Continuous operation as opposed to stop-start operation
- Removal of the maximum possible amount of rocks, sand and other extraneous material
- Low power consumption
- Uniform orientation of the cane feed onto the main carrier
- Cater for whole stick cane
- Robust construction
- Ease of maintenance
- Convenient disposal of removed rocks and sand
- Ability to be by-passed in case of mal-operation
- Simple construction

Development of system

Based on the above requirements and using various novel concepts, a RRS was designed, basically consisting of a sloped feeder table, a horizontal tyned rotating drum, a curved wiper plate and equipment for removal of rocks from the machine.

A full-scale working prototype was built at Malelane mill in order to test initial ideas and minimize potential commissioning problems on the system installed at the Komati mill.

Development work consisted mainly of the following aspects:

- Optimization of cane flow pattern over drum
- Optimization of tyne pattern on drum
- Optimization of angle of inclined slide plate
- Optimization of drum rotational speed
- Experimentation with rock exit doors at ends of drum

The prototype was extremely successful as a means of studying cane flow patterns over the drum and rock separation problems.

General description of Komati mill RRS

Whole stick cane, all transported to the mill by means of 25 ton road trucks with side-tipping bins, is unloaded by means of a hydraulic truck tippler, which discharges the cane onto a 11 metre wide, moving slat feeder table (A), shown in Figure 1. It is then conveyed to the top of the feeder table and is fed onto an inclined slide plate (B). A scratcher (C) situated above the headshaft of the feeder table combs out any bundles of cane to ensure a uniform thickness of cane on the slide plate.

The cane stalks on the slide plate are continuously presented to the revolving tyned drum (D) and are combed up and over the drum and into the main cane carrier (E). The pattern in which the tynes are attached to the drum is such that cane goes over the drum while very large rocks are directed to the rock exit doors (F) at each end of the drum.

These large rocks lie on the bottom end of the sliding table and are progressively combed towards the ends of the drum where they exit the machine through suitable doors.

Smaller rocks (>350 mm), pebbles, sand and other unwanted material roll down into the gap between the drum and the curved wiper plate (G) and are discharged onto a belt conveyor (H) below the drum.

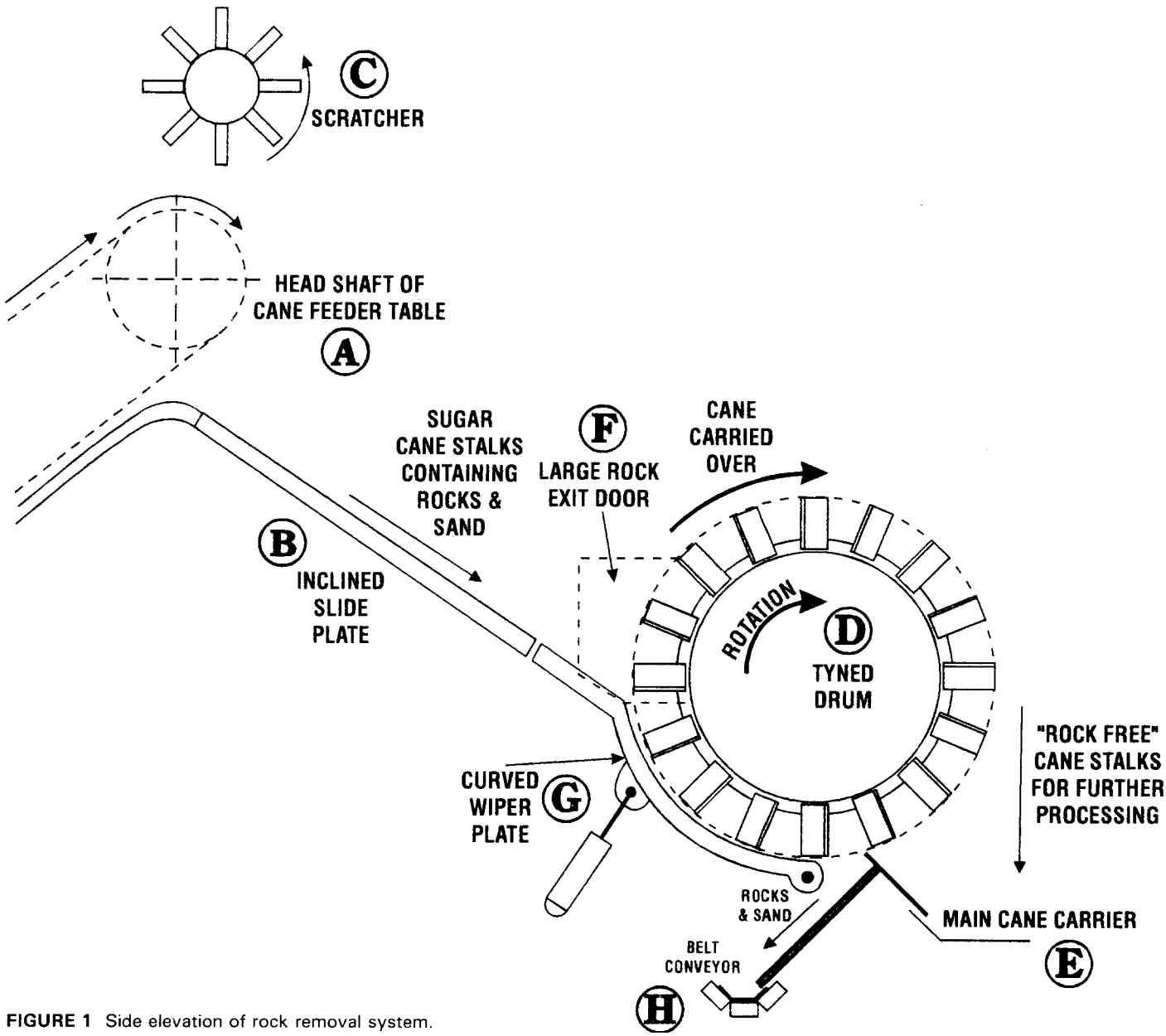

FIGURE 1 Side elevation of rock removal system.

FIGURE 2 A view of the rock removal system showing the feeder table with scratcher, inclined side table and tyned drum. The cane preparation line can be seen in the background.

Provision is made for any jammed rocks or foreign material to be cleared automatically by means of diverging openings and automatic adjustment of the curved wiper plates.

The drum diameter is larger in the center and gets progressively smaller towards the ends, thereby creating a divergent opening between the drum surface and the wiper plate. This also facilitates the clearing of a jammed rock.

The wiper plate consists of two halves, each half supported at the bottom by a hydraulic cylinder. By regulating the operating pressure in the hydraulic system, the point at which the wiper plate will give way can be set. In the event of a jam, the wiper plate moves away from the drum and the jam is cleared automatically.

Observations during practical operation

A photograph of the system in operation is shown in Figure 2. Although the rock removal machine has only been in operation for a short while, certain observations have been made:

- It is evident that the machine is extremely successful as a small rock and sand remover.
- It is estimated that more than 90% of all large rocks (> 350 mm) in the cane are removed.
- Some further development work on the large rock exit doors is in progress.
- A reclaimer system to reclaim the small quantity of lost cane from rocks and sand is needed.
- Uni-directional orientation of the cane onto the main cane carrier is not achieved.
- Cane bundles are combed out into a more or less homogeneous mat on the main cane carrier.
- The machine does not handle cane billets well. These pass out along with small rocks.
- Operation of the machine is simple and maintenance is expected to be minimal.

Conclusions

It is expected that the machine will contribute greatly to reducing the wear and tear on knives and shredder hammers with the associated decrease in maintenance costs due to its rock removal capabilities. Decreased stops on the cane preparation line will increase time efficiency and thereby benefit the subsequent extraction processes.

Removal of clayey and/or organic soils will contribute to reducing processing problems in the factory.

Erosion of boiler tubes and other sections in contact with the flue gas will be greatly reduced due to the large amount of sand removed.

The machine in operation at the Komati mill is still undergoing final development and its full potential will only be reached later. However, results of tests conducted thus far are extremely promising. TSB has patented the system and looks forward to its use in the sugar industry at large.

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