

A MECHANISED VIBRATOR SYSTEM FOR DISCHARGING FCD BOTTOM-DUMP RAIL TRUCKS AT THE SUGAR TERMINAL IN DURBAN

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Abstract

The design and development of an hydraulically operated clamping device, incorporating an electrically driven rotary vibrator, for effectively discharging raw sugar from FCD bottom-dump rail trucks, at low cost is discussed.

Introduction

Type FCD bottom-dump rail trucks were first introduced into service by the S.A. Transport Services at the beginning of the milling season in 1975. They were designed primarily for the transportation of bulk raw sugar and have proved to be successful. They have a capacity of 50 tons, compared with 38 tons for their predecessor, the 'C' type truck. This represents a reduction of some 25% in the number of trucks to be handled. The FCD bottom dump trucks have weather-proof hoppers, therefore tarpaulin covers are not required, resulting in a substantial saving of labour.

However, considerable difficulty is often experienced when discharging the bottom dump trucks at the Sugar Terminal due to sugar sticking to the sides of the hoppers. It is well known that this problem arises from a combination of factors such as, moisture content and temperature of the sugar when loaded at the factory, ambient temperatures, length of journey etc.

An investigation was carried out at that time at the Sugar Terminal in order to assess various methods for removing the sugar effectively. These included vibrators of various types, pneumatic hammers, mallets etc.

Vibrators were found to be effective, but a means of application was not commercially available. Pneumatically operated reciprocating hammers were also found to be effective, so this system was adopted because the hammers could be applied to the truck hoppers by hand, thus overcoming the immediate problem of application. This system was still in use last season, but it had become increasingly expensive because three hammer operators were required on each of the three daily shifts. This work was arduous and unpleasant and was a source of dissatisfaction. It was therefore decided to carry out an investigation of equipment commercially available in order to find a system which could replace the existing one effectively.

Initial Investigations

Tests were carried out with vibrators of different types, both electrically and pneumatically driven and of various intensities and frequencies of vibration. It was found that vibrators of high frequency and relatively low intensity were much more effective and also had less mass.

The vibrators on test were bolted to the truck body by means of adaptor plates fabricated in the workshops.

Various electromagnetic type adaptors were tested and were found to be unsuitable because they could not attach 'themselves' with sufficient force, apparently because of the low iron mass of the main chassis members of the truck.

Commercially available attachments and adaptors were also investigated because they are used in many parts of the world and are apparently most effective. However, if this system were

to be used, it would be necessary to fit four such attachments to each of the 600 FCD trucks in service. The cost would be very high, so this method was rejected because of the present economic climate.

It was obvious that some form of clamping device was required at the Sugar Terminal intake station, which could effectively hold the vibrator in position on the truck. It would be necessary to mechanise the application of the device for safety and for effective operation. This type of equipment was, however, not commercially available, so it would have to be designed and developed.

Design Criteria and Development

It had been decided during the test programme, that two vibrators would be required. It was also found that placing the vibrators diagonally, or on the same side of the truck chassis, made little difference to their effect. It was, therefore, decided for operational reasons, to place both vibrators on the same side of the truck.

The electrically driven, rotary vibrators would have the following specifications:

Shaft mounted eccentric mass type	
Vibrations per minute	3 000
Centrifugal force (adjustable)	
	14 kN max.
Input power	1 kW

The vibrators would be applied to the chassis frame of the FCD bottom-dump truck.

The important criteria for the proposed design of the clamping device were identified as follows:-

- (1) The device would be required to accommodate the maximum force of 14 kN exerted by the vibrator.
- (2) The possibility of vibration forces reaching the adjacent concrete structures was not acceptable.
- (3) The possibility of vibration forces reaching the truck axle bearings was not acceptable.
- (4) The physical difference of 38 mm in height between full and empty trucks would have to be accommodated.
- (5) Approval would be required by the S.A. Transport Services for the use of the equipment.

Because of the intensity of the vibration and therefore, the large clamping force required, it was decided to use an hydraulic system.

Several prototype clamping devices were built in the workshops and tested with increasing success. These devices were mounted on the concrete walkway adjacent to the rail truck. However, there was great difficulty in meeting the requirements of criteria 2 and 4. These problems were subsequently overcome by introducing a flexible strap into the design which would effectively support the clamping device, while isolating the vibration forces.

A Mechanised Clamping Device

The structural arrangement of the device is discussed as follows, see Figures 1 and 2.

The main supporting frame 'F' is bolted directly to the concrete walkway at about rail level. The boom-arm 'B' is mounted on bearings at the top of the supporting frame 'F'. The boom-arm is operated by means of a hydraulic cylinder 'H'. The clamping device is suspended from the end of the boom-arm, by means of a flexible strap 'S'. The hydraulic cylinder, 'H' which provides the clamping force required, is shown in the 'clamped' position on the chassis frame of the FCD truck. The vibrator 'V' is bolted to the clamping device.

The mechanised hydraulic clamping device satisfies all of the design criteria as follows:-

- (1) Because of the nature of the operation, it was decided to keep the hydraulic pressure to a maximum of 20 MPa (3 000 psi). The maximum output of the vibrator is 14 kN, therefore an hydraulic cylinder of 50 mm diameter is adequate. The cylinder has a double action to ensure positive release and full retraction of the piston after every operation cycle.
- (2) The possibility of vibration forces reaching the adjacent concrete structures is prevented by means of the flexible strap 'S', which effectively isolates the vibration forces, thus preventing them from reaching the boom arm and the concrete structure. See Figure 2.
- (3) The possibility of vibration forces reaching the truck axle bearings was ruled out during preliminary tests with the bolt-on type adaptor plates, when it was found that the

main springs forming the bogey suspension, absorbed the forces, thus effectively protecting the bearings.

- (4) The flexible strap was designed to accommodate the increase in height of the FCD truck while it was being unloaded. See Figure 1.
- (5) Approval was granted by S.A. Transport Services during the earlier stages of development.

Operation and Safety Devices

In order to ensure the satisfactory operation of the equipment, the following requirements must be met:

- (a) The truck must be accurately positioned every time.
- (b) It is essential to ensure that the truck cannot be moved while the mechanised vibrators are clamped on.

The safety devices and sequence of control which satisfy the above requirements are briefly described as follows:

- (1) The full FCD truck is accurately positioned in the intake station by the electric locomotive, which is equipped with an infra-red type location device.
- (2) The full truck is uncoupled and the locomotive leaves with the empty truck, thus moving clear of the 'no-go' zone. It is now possible to initiate the application of the mechanised vibrators. The operator initiates the application, and the signal lights for shunting, change from green to red.

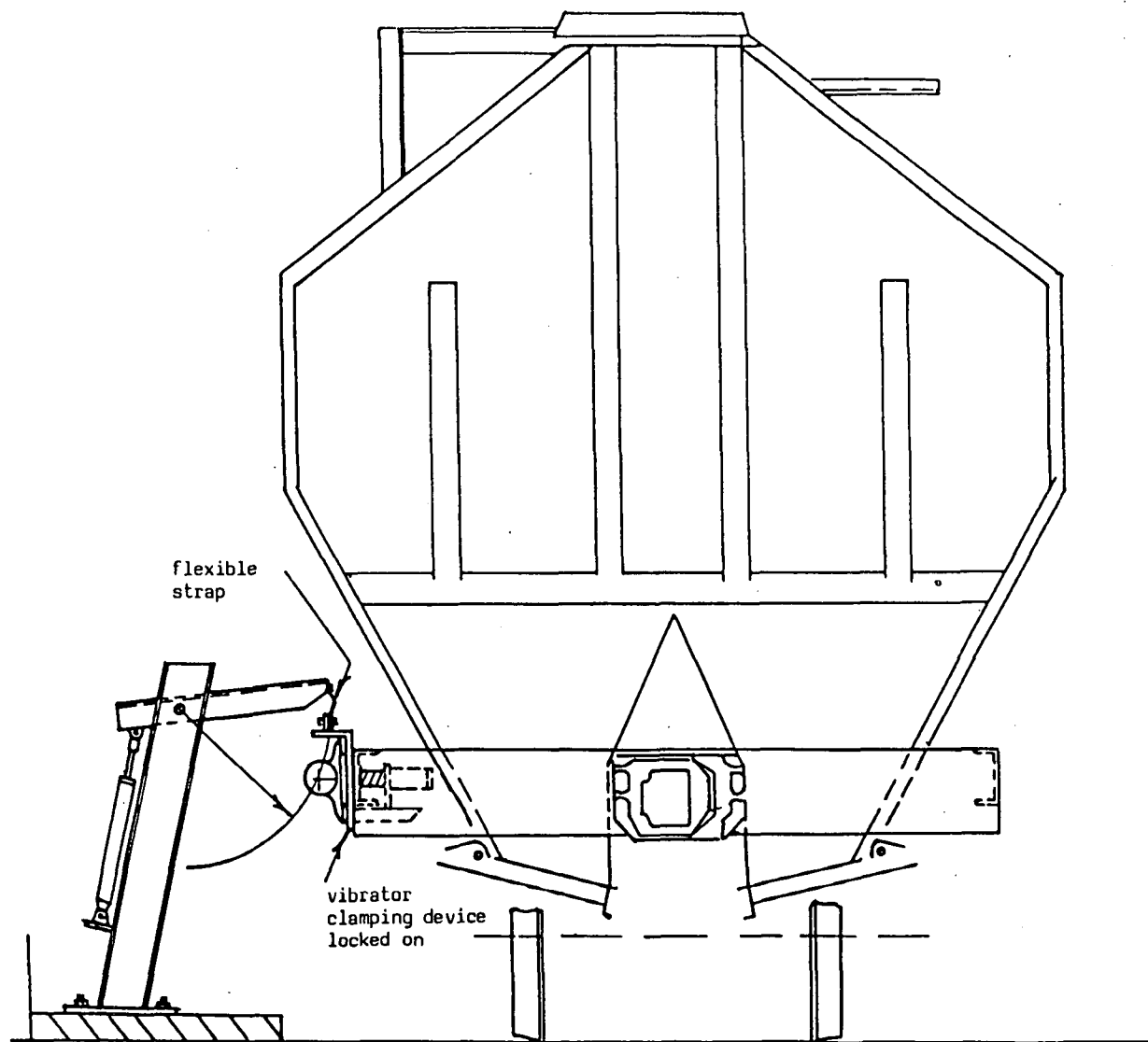


FIGURE 1 Mechanised vibrator device applied to FCD rail truck

- (3) The bottom-dump truck doors are opened and the vibrating cycle is initiated by the operator. It should be noted that the controls for the mechanised vibrators are situated in a position which provides visual supervision of both mechanised vibrator units by the operator at all times.
- (4) The duration of the vibration period is controlled by a timing device. However, the operator can extend the time when necessary, to ensure that the sugar is completely discharged.
- (5) The operator initiates the removal of the mechanised vibrators and proceeds to close the bottom-dump truck doors. The signal lights for shunting change from red to green and the whole operation recommences.
- In addition to the above safety devices, it was thought necessary to install a pressure switch on the hydraulic system, which immediately stops the operation when there is a fall of pressure. A transducer was also fitted to the clamping device, making operation of the electric vibrators possible only when the clamping device is locked onto the truck.

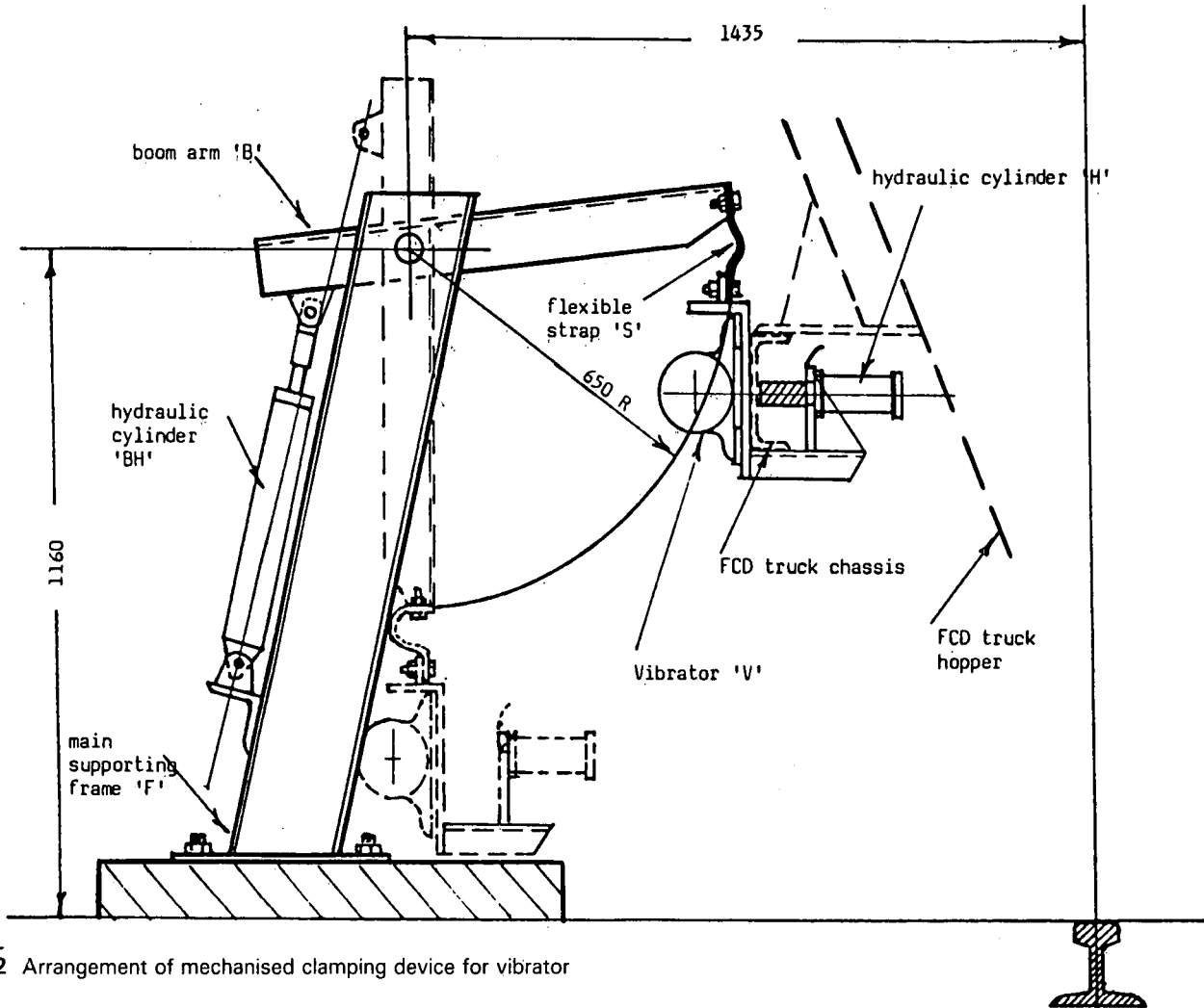


FIGURE 2 Arrangement of mechanised clamping device for vibrator

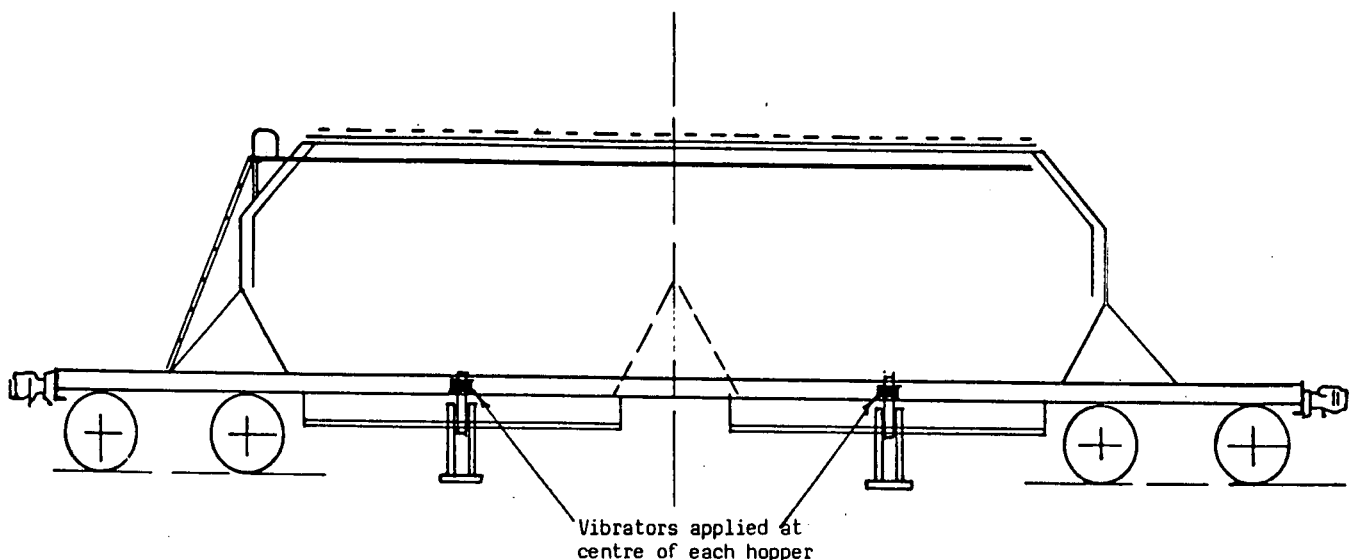


FIGURE 3 Application of two mechanised vibrators to FCD rail truck

Conclusion

At the time of writing, the 1984/85 milling season has not commenced, and experience has not yet been gained in discharging a large number of rail trucks. However, based on last season, it is anticipated that the full scale application of the mechanised vibrator system for discharging FCD type bottom-dump rail trucks, will prove to be a most successful project. It will result in the speedy and effective discharge of raw sugar consignments. It will replace the manually operated system of

pneumatic hammers which was not satisfactory. It will reduce the total labour requirement by six operators, resulting in substantial cost savings.

Acknowledgements

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