A SIMPLIFIED HEAVY-DUTY SAND SPREADER, PHASE I—DESIGN CONCEPT

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INTRODUCTION

Driving a heavily-loaded tandem-axle truck over a mountain pass on an icy road in a blizzard is no easy chore. Adding the simultaneous tasks of plowing snow and spreading sand makes it even more difficult. To increase the comfort and safety of operators, Oregon Department of Transportation (ODOT) has in recent years purchased trucks with enhanced rear suspensions. These trucks have proven their worth on the road, but increased suspension travel has resulted in greater bed height, which in turn has caused some difficulties in loading sand. A lack of desire to go back to our old truck suspensions, along with a general dissatisfaction with some of our sand spreaders, led us to investigate the possibility of solving the loading problem, as well as some other problems, by changing the sander design.

RECOGNIZING THE PROBLEM

Three things cause sand loading problems for ODOT. The first is bed height. Another is loaders with limited reach, which includes most currently available articulated loaders and tool carriers. The first two problems would not be so noticeable were it not for the third problem, which is the gratings, or "grizzlies," on top of the sander. The grizzlies do not allow the loader bucket to drop down and dump the load into the sander without some persuasion. Loader operators commonly hammer the lip of the loader bucket on the grizzlies to shake the load into the sander. This results in a long loading cycle and damage to the grizzlies.

The purpose of the grizzlies is to prevent damage to the sander conveyor from large stones and to prevent such stones from being deposited on the highway by the sand spreader. The grizzlies are sloped upward to allow stones to fall off after the smaller material has fallen into the sand spreader. This slope makes the sander even higher and loading even more difficult. Some maintenance units have tried ramps to increase the loader height, while others have experimented with pits to lower the sander height, neither of which has proven completely satisfactory. Other units have requested that our office design extensions for the loader arms, which does not seem to be a reasonable solution. Yet others have asked for loaders with more reach. More reach would be a solution except that those loaders with sufficient reach tend to be so large and heavy as to create a transportability problem. After considerable study it seemed that the best solution would be to remove the grizzlies and solve the large stone problem by some other means.

Other problems with sand spreaders have been tunneling, stalling, excessive downtime, and the difficulty of unloading the sand spreader in the event of a failure. A relatively minor problem associated with unloading is the difficulty of removing stones and other debris from the sander should it somehow get past the grizzlies.

Tunneling occurs more often with auger conveyors than with chain types. The auger bores a nice round hole in the sand and tends to compact the walls of the tunnel so that the sand doesn't cave in and get transported by the auger. Chain conveyors dig a wide rectangular hole in the sand, which caves much easier than a round hole, so that chain conveyors tunnel only with sticky or semi-frozen material. Both the width and the speed of the conveyor affect tunneling. A wide slow conveyor will tend not to tunnel, whereas a narrow fast conveyor will tunnel easily.

Stalling is affected by the configuration, available power and the sanding material. Given the same available power, a chain sander conveyor will stall quicker than an auger conveyor. Any conveyor will stall with frozen material. Sticky or semi-frozen material might more easily be expelled by an auger conveyor were it not for the tunneling problem.

Downtime is a major problem with slip-in sanders regardless of the type of conveyor. The experience at ODOT has been that presently available auger sanders are less reliable than those with chain conveyors. This might be at least partly caused by ODOT's use of volcanic ash as sanding material and partly due to auger speed. Volcanic ash abrades chains and augers alike, but auger pipe walls seem to be especially vulnerable, especially so since they are usually only 6 millimeters thick.

PROPOSED SOLUTION

ODOT engineers recognized that sand spreaders evolved from agricultural spreaders designed for fertilizer, manure,

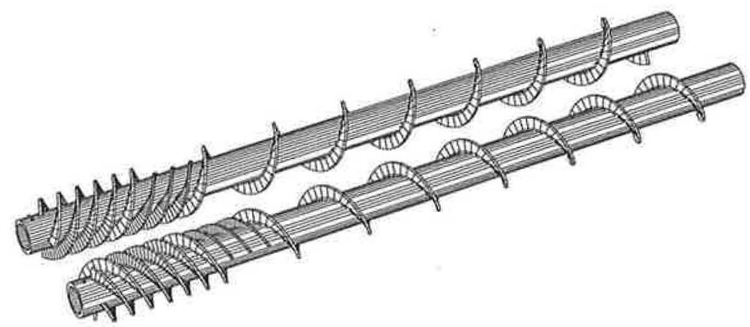

FIGURE 1 Dual augers.

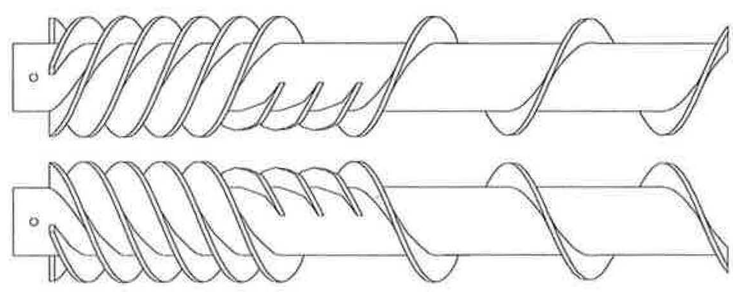

FIGURE 2 Rock rejectors.

or lime and not specifically for heavy, abrasive materials used for traction enhancement. Augers present the best potential for conveyor efficiency if tunneling and wear problems can be solved. Augers presently used in sanders were designed for feed mixers instead of volcanic ash. It was necessary to approach auger design with volcanic ash as the intended product to be transported. This required drastic changes in materials and configuration. Tunneling required either an anti-tunneling agitator, a shaker, or a wider tunnel. The choice was creating a wider tunnel by using dual counter-rotating augers.

Wear is a universal concern for engineers, and can be reduced by lubrication, lower speeds, lighter loading, and more resistant materials. In the case of the dual auger sander, lower speeds are possible by using two augers instead of one, and by increasing the pitch of the flights. The auger pipes are Schedule 160 steel pipe with a nominal outside diameter of 168 millimeters and a nominal wall thickness of 18 millimeters. The flights have a thickness of 13 millimeters and a height of 64 millimeters. Flight material is Scandia or Formalloy steel with minimum indicated hardness of 4900 newtons per square millimeter measured by the Brinell method. Greater pipe wall thickness allows better flight weld penetration and also prevents excessive pipe flexing. Flight pitch has been increased to 381 millimeters to permit a further decrease in speed.

The two augers are set on 356 millimeter centers and are counter-rotating. The present design calls for a single 918 cubic centimeter hydraulic gear motor producing 1,512 newton-meters torque. The augers are geared together and turn at a nominal 15 revolutions per minute. An open question at this time is whether to continue with a single motor and synchronized augurs, or to change to two motors and a more random pattern of rotation.

At the discharge end of each auger three short flights are placed between the regular flights, with a gradual ramp up to full height, see Figures 1 and 2. The augers are placed so that each auger discharges sand through a hardened steel hoop. This is the rock rejector feature of the sander, which allows the sander to be used without grizzlies. A specially designed tailgate allows rocks and other debris to be dumped without removing the sander. The spinner chute is made from rubber belting material so that it can flex during dumping.

The ability to raise the truck bed while the sander is installed is an important feature of this design. In addition to the flexible spinner chute, the sander is equipped with an exhaust "hat" which fits over the exhaust pipe of the truck much in the same manner as an aircraft in-flight refueling nozzle. This automatically connects and disconnects the sander heater as the bed is lowered and raised. The a specially designed rain cap is opened and closed by the sander exhaust receiver.

The augers are supported at the front inside of the sander box by a bearing box or "hot box" which also serves as a junction for the truck exhaust. The exhaust is routed through channels underneath the augers to aid in heating the sand. The channels form part of the skeletal structure of the sander and provide some of the required rigidity. The hot box is bolted to the truck bed through a cross member.

The most significant departure from previous sander design is in not attempting to contain all of the sand within the sander itself. Conventional philosophy has centered in spreading all of the sand contained in the truck before reloading. ODOT believes that this is not necessary and leads to excessive cost and complexity. By simply filling the bed with sand and spreading all the sand that the augers will discharge, it is possible to spread as much sand as a carefully designed conventional slip-in sander will spread. If, near the end of a sanding patrol, the operator were to raise the bed and concentrate the remaining sand towards the rear of the bed, it is possible to spread even more sand than a conventional sander. This should be possible with this design. Therefore, ODOT proposes to eliminate the sides, front and back of the sander and install only the working portion plus a special tailgate.

Eliminating the sheet metal and using heavy duty mechanical components should increase the reliability and decrease downtime of sanders. In addition, the ability to apply an extra portion of sand will increase the productivity. ODOT intends to continue with this project, and measure the costs and benefits next sanding season.

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