Trucking Characteristics for an In-woods Biomass Chipping Operation

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Abstract

A study was implemented to evaluate the transportation of woody biomass. This paper reports on the results of transporting wood chips produced in the field from transpirationally dried trees. For the study, a stand of timber was felled and allowed to dry in the field for approximately six weeks. The timber was then chipped in the woods and transported to market. In order to maximize payload of the dry chips, larger capacity trailers were utilized along with the contractors existing chip trailers. The larger trailers (123 yd^3) contain 19% more volume than the traditional trailer (100 yd^3), but only increased payload by 10%. Additionally, the extra payload was still 16% below the legally allowed payload.

Introduction

Efficient transportation is a critical component to insure a viable woody biomass industry. New material specifications and transportation options ranging from dry chips and microchips to larger capacity trailers present more challenges and options to producers. A study was implemented to look at the various components of transporting woody biomass in order to identify bottlenecks in the system and potential solutions. The overall study will examine the dynamic between company owned and contract trucks, cycle time analysis for all transportation components and product classification and analysis. The contractor produces a variety of products, ranging from traditional clean and whole tree green chips/microchips to clean and whole-tree dry chips/microchips. Through the course of the study each transport system will be fully described including volumetric payload capacity, weight-limited payload configurations, trailer costs, tractor fuel consumption, and hourly owning and operating costs. In addition, time study and trip monitoring will be used to document a sample of transport cycles to measure travel time (speed) on different classes of typical southern roads, loading and unloading time, and the occurrence of delays and interruptions. This paper reports on the results of one aspect of the overall project, the transportation of transpirationally dried wood chips.

Study Background

As part of a larger woody biomass study, an approximately 30 acre stand of loblolly pine plantation in southeast Alabama was felled and bunched. The trees were left to dry in place for approximately six weeks. The trees were then skidded and chipped on site with a mobile disc chipper. The chips were blown into the trailers. An additional 7 acres of green trees from the stand were felled, skidded and processed following the chipping of the transpirationally dried trees. The goal of the study was to evaluate the potential moisture loss of the trees, and cost and productivity of the processing and transportation operations for drier chips. The green trees were harvested as a comparison and to represent industry standards of harvesting and processing green trees.

Results and Discussion

In anticipation of transporting drier (lighter) chips, larger capacity chip trailers were added to the trucking fleet. The larger trailers were 123 yd^3 (large), while the existing trailers were 100 yd^3 (regular) and 88 yd^3 (small). The goal of using the larger trailers was to maintain as close to a legal payload as possible with the drier chips.

Drier chips potentially have a higher value to end users due to the higher net energy content (BTU) gained by removing moisture. Moisture content was calculated for green and dried trees during the study. It was found that green trees had an average moisture content of 54% and the dried trees had an average moisture content of 39%, resulting in an average weight loss was 15%.

The load tickets for the tract were used to analyze load data. A total of 1393 tons (61 loads) were processed from the transpirationally dried trees. Table 1 shows the results of the load analysis. The large trailers were used to transport 934 tons on 39 loads. The regular and small trailers were used to transport 344 tons (16 loads) and 115 tons (6 loads), respectively. The Large trailers averaged a net payload of 23.96 tons, while the regular and small trailers averaged 21.51 tons and 19.24 tons, respectively. The maximum legal load, using a tare weight of 15.5 tons, was calculated at 28.5 tons. With an average of 23.96 tons/load the large trailers were 16% below the legal payload and the regular and small trailers were 24.5% and 32.5% below the legal limit, respectively. These figures represent a large increase in transportation cost due to lost payload capacity.

Table 1: Truck load data for transpirationally dried wood chips.

	Large-Dry	Regular-Dry	Small-Dry
Capacity (yd^3)	123	100	88
# Loads	39	16	6
Avg. Wt. (tons)	23.96	21.51	19.24
Min Wt. (tons)	20.67	20.11	17.72
Max Wt. (tons)	29.03	22.83	20.78
Avg. Tare Wt. (tons)	15.38	15.24	15.01
Avg. Density (lbs/ft^3)	14.42	16.00	16.23

A bulk density for each load was calculated by dividing the net weight of the load by the volume of the trailer. The void formed at the back of the trailer from the chips sloping down to the trailer gate was subtracted from the trailer volume. Otherwise, it was assumed the trailer was completely full. The calculated load density for the large trailer was the lowest of the three at 14.42 lbs/ft^3, which is 10% less than the density of the regular trailer. The regular trailer and small trailers averaged 16 and 16.23 lbs/ft^3, respectively. A paired t-test procedure was used to test for significant differences between the calculated load densities. It was found that the large load density was significantly (<.0001) different than the regular load density. The t-test also indicated that there was no significant difference (<.0001) between the densities of the regular and small trailer densities. These results indicate that a physical characteristic of the large trailer, chips, loading method or a combination of these is affecting load density. Possible reasons are that the large trailer is too long and the chips are to light and cannot be blown far enough. To achieve the legal payload with the large trailer would have required a load density of 17 lbs/ft^3. This exceeds the density achieved with the smaller two trailers and suggests that it is not feasible as the system is configured now. A net load of 26.6 tons could be realized if the load density of the large trailer could be increased to that of the regular trailer (16 lbs/ft^3). At a density of 14.42 lbs/ft^3 a trailer with a capacity of 146 yd^3 would be required to reach maximum payload.

The green chips transported from the tract were also analyzed (Table 2). On-board scales were not installed on any of the truck/trailer combinations used on the study. The large trailers were not filled to capacity in order to avoid surpassing the legal limit (44 tons gross). Therefore, this data is presented but is not included in the overall analysis of the results. The data from the regular and small trailers represent fully loaded trailers.

Table 2: Truck load data for green wood chips.

	Large-Green	Regular-Green	Small-Green
Capacity (yd^3)	123	100	88
# Loads	7	7	3
Avg. Wt. (tons)	24.94	25.81	25.20
Min Wt. (tons)	21.6	23.1	24.13
Max Wt. (tons)	28.46	28.47	26.3
Avg. Tare Wt. (tons)	15.49	15.16	14.13
Avg. Density (lbs/ft^3)	15.00	19.20	21.26

A total of 429 tons were produced from the green trees during the study. The regular trailers were used to transport 180 tons on 7 loads and the small trailers transported 75 tons on 3 loads. The resulting average load density was 19.2 lbs/ft^3 and 21.3 lbs/ft^3, for the regular and small trailers, respectively. A paired t-test was performed to determine if the density of the green loads (19.2 lbs/ft^3) was different than that for the dry loads (16.00 lbs/ft^3) on the regular trailer. The results showed that there was a significant difference (<.0001) between the densities. This result is expected considering the 15% weight difference between the green and dry chips. The results from a paired t-test procedure between the load densities of the regular and small trailers were found to be significant (0.047). Due to the low number of observations for the small trailer (n=3), no firm conclusions can be drawn from this result.

Conclusions

The use of larger trailers to haul transpirationally dried chips increased payload 10% over the regular chip trailers used by the contractor. The number of loads required to transport all chips from the site could have been reduced by 6 if the larger trailers had been used exclusively. This gain, however, was still 16% below the maximum legal load.

There was a significant difference between the bulk densities of the large trailer and the regular trailer when hauling dry chips. Although all trailers appeared to be completely full before departing, this cannot be confirmed. The lower density suggests that a characteristic of the trailer or a material property of dry chips is contributing to the reduced load density. The large trailer may be to long for the lighter chips to be blown and packed into the front of the trailer. This would indicate that a different trailer configuration or loading method might be required to achieve maximum density. Possible solutions include low profile tires that would allow for an increase in trailer height or top loading the trailers. The number of loads could have been further reduced by 12 if the large trailers could be loaded at a density of 16 lbs/ft^3. This equates to an increase in load size of 19% over the regular trailers.

Future Work

In order to determine the reasons for the lower load density measured in the large trailers additional work needs to be performed. This may involve modifying the trailers with view ports or adding instrumentation to allow observations of chip levels within the trailer. Additionally, alternative trailer configurations or loading methods might be evaluated. Work is presently under way to evaluate the logistics of transporting transpirationally dried long wood as an alternative to chips.

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