

Determine the Potential Cost Benefits when Utilizing a Truck with a Tow behind Plow when compared to a Truck with a Standard Front Plow and a Mid-mounted Wing Plow.

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Given the current financial climate, it is essential to minimize costs while simultaneously maximizing efficiency, especially for state department of transportation maintenance operations. Therefore, evaluating new methods, equipment, and materials in order to reduce expenses in its winter maintenance budget is essential. One piece of equipment that is being considered is attaching a tow behind plow to a tandem axle truck (tow-plow). This tow-plow is a trailer unit equipped with a 27-foot snow plow and either a salt hopper or a brine tank. The trailer is capable of rotating out to an angle of up to 30 degrees, allowing the plow to clear a second travel lane when pulled behind a truck fitted with a front plow. An in-field assessment of a tow-plow is conducted within three Ohio Department of Transportation county garages. The tow-plow is compared to a standard tandem axle truck with a front and mid-mounted plow (standard). This assessment consists of evaluating the utilization of each truck, the level-of-service (LOS) provided by the tow-plow along with the LOS of the standard truck, cost benefit analysis, and the optimal implementation of the tow-plow truck.

The data methodology for this evaluation consists of gathering hourly National Oceanic and Atmospheric Administration weather data to determine weather severity. Along with vehicle speeds collected through a Bluetooth Node System to determine LOS and potential delays created by each truck. Each truck in the study as digital video recorder (DVR) and cameras to track the usage of each of snow removal systems is collected to determine the utilization the equipment in various weather severities.

Monte Carlo simulations are used to determine the annualized costs for both the tow-plow and the standard truck, as well as to determine the equivalence of the tow-plow to the standard truck. In the Monte Carlo, a set of functions is solved many times over while randomly changing the variables' values within the functions. Each variable is presented with an average and standard deviation of a normal distribution, which the simulation applies when the random variable is selected. Matlab, developed by MathWorks, is used to run the simulation and allows the simulation to be repeated the desired number of times. Reviewing the data collected from the three tow-plow, it is observed that the tow-plow is not always used during the entire event, and may not be necessary during less severe storms. In this study, the overall utilization rate of the tow-plow is found to have an average of 54%, while the standard truck is an average of 65%. These utilization rates, along with the capacity of each truck, are placed in a Monte Carlo simulation for a hundred thousand iterations. For each iteration, the simulation selects a random utilization rate in order to create a distribution of the observed number of standard trucks needed to equal the abilities of a single tow-plow unit. Using this determined ratio, the capital cost of each truck, the maintenance cost, fuel cost and economy, speed of truck, number and types of weather events per year, along with labor rates are used to determine the cost benefit of the tow-plow. The tow-plow has an annual savings averaging \$22,551 when comparing to the equivalent standard truck, based on the data collected during this evaluation.