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Improved Visibility for Snowplowing Operations

An NCHRP digest of the findings from the final report on NCHRP Project 6-12, "Improved Visibility for Snow Plowing Operations," conducted by Rensselaer Polytechnic Institute. Drs. Mark S. Rea and Brian E. Thompson served as Principal Investigators.

INTRODUCTION

This digest describes several means, identified in NCHRP Project 6-12, that could improve visibility for snowplowing operations.

In many parts of the United States, snow and ice control may be the most hazardous duty faced by highway maintenance crews on a regular basis. Visibility is reduced during snowplowing operations because of reflected headlight glare, obscured windows, and blowing snow. In addition, this type of work frequently requires long working hours and is often performed at night during extreme weather conditions. The factors affecting visibility depend on climactic conditions and are often influenced by the features of the plow, the vehicle, and the lighting system. Because poor visibility reduces operational safety and contributes substantially to the hazards faced by snowplow operators and motorists, there is a need to identify features that would improve visibility for both the snowplow operator and the motorists in proximity of the snowplowing vehicle. NCHRP Project 6-12 was initiated to address this need.

The research was conducted under NCHRP Project 6-12, "Improved Visibility for Snow Plowing Operations," by Rensselaer Polytechnic Institute. The research, completed in late 1999, identified several means for improving visibility for snowplowing operations. However, limited tests were conducted in this project to fully evaluate the merits of these means or the practicality of their unlimited use by highway agencies. This digest provides a summary of the work performed in this research. The material included in this digest is extracted from the final report on NCHRP Project 6-12.

FINDINGS

The project included a review of existing and proposed approaches for improving visibility for snowplowing operations, the identification and development of potential means for improving these operations, and the conduct of limited field tests to evaluate the potential benefits of these means. In performing this work, consideration was given to the visibility of the snowplow operator (forward visibility) and the visibility of the snowplow by the drivers of other vehicles. Forward visibility is affected by the glare caused by back-scattered light reflected from falling snow, rain, and fog. Visibility of the snowplow by other drivers is influenced by the splash of snow and other debris and the snow cloud that occur behind the snowplow truck.

SNOWPLOW TREATMENTS

Several treatments and design alternatives of the front plow for reducing plowover (i.e., the splash on the top of the plow blade that impairs visibility through the windshield) were investigated. Among these alternatives are the use of deflectors or shields to direct splash away from the windshield and mirrors

and the modification of the snowplow geometrical configuration to reduce the amount of snow directed over the top of the plow. Another treatment is the use of a "packing flap" to direct downward the snow particles exiting the front plow discharge and to repack the loose debris at the edge back into the main discharge stream, thus eliminating the potential for creating a snow cloud in windy conditions.

WING PLOW TREATMENTS

When a wing plow is used in snowplowing operations, a snow cloud could form from the snow debris escaping through the gap between the front and wing plows. The use of a "junction flap" to cover the gap between the front plow and the wing plow will help reduce the potential for snow spillage and snow-cloud formation. A junction flap that completely seals the gap between the front and wing plows and smoothly deflects the plow discharge slightly downward would provide the most reduction in snow-cloud formation. However, such a flap will need to be designed in such a manner that it would not restrain the movement of the wing plow or the front plow and impede the plowing operation.

TREATMENTS OF THE REAR OF THE TRUCK

The snow cloud that forms behind the snowplow truck obscures visibility of the truck by other drivers. Several configurations of deflectors and airfoils, which would reduce the size of the snow cloud behind the plow truck and also would prevent buildup of snow and ice on the rear of the snowplow, have been investigated. These configurations included curved vanes and straight-edged deflectors mounted on the rear of the sides of the snowplow truck. The gap between the vane and the truck is usually kept small to avoid interference with the snowplow operator's view of the side mirrors.

FORWARD LIGHTING

The reflected light from snow, rain, and fog toward the snowplow operator during inclement weather contributes to glare and decreased visibility. The impact on visibility is influenced by the different aspects of the light source (e.g., mounting location, aiming angle, beam spread, and spectral power distribution or color). These factors have been investigated in a number of studies.

REAR LIGHTING AND SIGNALING

Rear lighting of snowplow vehicles provides two distinct functions: a conspicuous signal to other drivers to indicate that the plow is on the road and cues about the plow's operating speed and distance relative to other vehicles. Generally, features that enhance one of these functions would often adversely influence the other function. For example, highly conspicuous signals, such as strobe lights, are often poor means for providing speed and distance cues. For this reason, finding a balance between rear lighting and signaling is essential for improving snowplowing operations.

Mounting rear lights as high as possible to clear the cloud behind the truck would permit visibility from the farthest distance. Flashing lights, up to 15 flashes per second, would provide greater brightness than would steady-burning lights. Although conspicuity may be greater when rear lighting systems with a rate of 5 to 9 flashes per second are used, the ability to make accurate judgements of speed and distance is generally impaired when flashing or strobe lights are used. The ability to accurately estimate relative speed and distance depends on the spatial and size characteristics of the light source. For example, a single light source provides poor speed and distance cues while a wide spatial array of sources provides good cues. For this reason, the use of an array of lights with sufficient intensity is more effective than a single light source.

FIELD DEMONSTRATIONS

Extensive laboratory and limited field tests of several snowplow treatments and rear lighting configurations were conducted in this project. Snowplow treatments evaluated and observed in the field included a one-way front plow fabricated of a rolled steel sheet with a 55° cutting angel and a 50° trap angle, a lightweight deflector, packing flaps, and wing plows. Image analysis techniques were used to quantify the improvement in visibility of following drivers. This improvement was estimated to be about 50 percent. Rear lighting configurations included commercial lighting similar to that used by the New York State Department of Transportation, indirect edge delineation using flood lights, two pairs of alternating high-mounted flashing lights (amber and red), and a light bar using light emitting diodes (LEDs) in a steady configuration. An assessment by snowplow operators suggested that the LED light bar configuration provided the highest visibility and confidence in the overtaking of the snowplow by other motorists. Based on this assessment, an amber light configuration that employs an array of LED marker lights was developed and used in further field demonstrations.

CONCLUSIONS

The need to identify features that would provide for safer snowplowing operations through improvements of visibility for the snowplow operators and the other motorists in the proximity of the snowplowing vehicle has been recognized by the state highway agencies and other organizations

involved in snow and ice control. This research identified and evaluated in limited field tests several potential features for improving visibility. The following is a summary of these evaluations:

- Front plows, or front plows used with plow-mounted deflectors, with a trap angle of about 50° will reduce the amount of material blown over the plow and onto the windshield.
- Front plows equipped with packing flaps at the discharge ends of the plow reduce the size of the snow cloud around and behind the snowplow vehicle.
- When wing plows are used, closing the gap between the front plow's discharge end and the intake end of the wing plow will reduce the size of the snow cloud around and behind the snowplow vehicle.
- Side vanes with a 20° angle to the snowplow's body, mounted on the rear of the vehicle, will reduce snow and ice accumulation on surfaces and on the rear lighting of the snowplow vehicle.
- During snowfall, switching off the driver-side headlamp and using an auxiliary passenger-side headlamp will reduce the back-scattered light seen by the operator.
- Shielded headlamps, louvered or cut-off type, that reduce stray light above the horizontal plane will reduce back-scattered light.
- Steady-burning light bars, mounted along the rear edges of the snowplow truck, will improve drivers' ability to detect changes in the snowplow vehicle's speed and will provide an indication of the vehicle's width.

Although the features evaluated in this research yielded some 50-percent improvement in visibility for motorists following the snowplows, it should be recognized that this and other research findings were based on limited field demonstrations. Further field evaluations, and possibly modifications, would be required to make these features practical for the wide range of vehicles used in large-scale snow and ice control operations.

FINAL REPORT

The agency's final report, titled "Improved Visibility for Snow Plowing Operations," gives a detailed account of the project, the findings, and the conclusions. The report, which was distributed to NCHRP sponsors (i.e., the state departments of transportation), is available for loan on request to the National Cooperative Highway Research Program, Transportation Research Board, 2101 Constitution Avenue, N.W., Washington, DC 20418.

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