Application of Prewetted Snow and Ice Control Materials

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Interest in the use of prewetting systems for the application of snow-and-ice-control materials is growing within the United States. This interest has been facilitated by activities in the Strategic Highway Research Program, the cooperative efforts between the Minnesota Department of Transportation and Scandinavian countries, the Federal Highway Administration study on anti-icing technology, and recent travel by U.S. maintenance engineers to Europe and Japan. Prewetting of snow-and-ice-control materials may be an important element in improving the efficiency and effectiveness of snow-and-ice-control processes. However, there is a need to evaluate the operational and economic impacts of prewetting systems on winter road maintenance activities. Once evaluated, prewetting systems for snow-and-ice-control materials could become an effective tool in a roadway agency's winter maintenance operation.

Each year, about $1.5 billion is spent on roadway snow-and-ice-control programs in the United States, and approximately one-third of these funds are used for chemicals. Because of improved weather information systems, pavement condition information systems, and material spreader controls, there is a need to evaluate the winter maintenance processes used in the application of snow-and-ice-control materials. By improving material application processes, material use can be reduced and improvements achieved in the level of service.

Interest in using prewetting systems for the application of snow-and-ice-control materials is growing within the United States. This interest has been facilitated by such activities as Strategic Highway Research Program (SHRP) Project H-208 on Development of Anti-Icing Technology (*1*); cooperative efforts between the Minnesota Department of Transportation and Scandinavian countries; the Federal Highway Administration's Test and Evaluation Project 28 on Anti-Icing Technology; and the March 1994 International Winter Maintenance Technology Scan trip to Europe and Japan sponsored by the American Association of State Highway and Transportation Officials, the Federal Highway Administration, and the National Cooperative Highway Research Program of the Transportation Research Board.

Prewetting systems for snow-and-ice-control materials should be investigated to determine the efficiency and cost-effectiveness of their use under winter conditions. In determining the prewetting system of choice, all of the factors that influence the winter road maintenance operation should be evaluated. These factors include, among other things, management policy, climatic conditions, snow-and-ice-control material properties, equipment, personnel, and funding. Since salt (sodium chloride, or NaCl) is the predominant snow-and-ice-control chemical used on roadways, it will be the focus of this paper. However, other materials may receive similar benefits from prewetting operations.

Prewetted Salt

What is prewetted salt? Generally, prewetted salt refers to salt that is moistened shortly before spreading. Why use prewetted salt, as opposed to traditional, dry-salt application processes? Under many conditions prewetted salt will adhere to the road surface better than dry salt, the reaction time is less, the temperature range of effectiveness is increased, and control of material distribution is improved.

Prewetted salt will stick to the road surface better than dry salt under many conditions (*2*). By reducing the mate-

rial lost to the roadside, less material is needed for each application. With less material used, the following benefits may be realized: less material will enter the environment; the size of the spreading routes for each truck will be increased, resulting in fuel savings and less downtime spent heading back to reload; and the labor and equipment needs could decrease. Improved material effectiveness will also be realized because more of the prewetted material will remain on the road surface compared with the same spread rate of dry material. This is especially true when combating black-ice conditions or when the roadway is damp and the potential exists for the development of a slippery condition.

Salt requires moisture to dissolve into a solution to become effective. However, at temperatures below freezing, there may be little unfrozen moisture available to facilitate the transformation of the solid salt to a solution. Prewetted salt has moisture supplied from an external source, which allows the salt to dissolve into a solution and become effective more quickly than dry salt. Besides having a quick reaction time, prewetted salt is more effective at lower temperatures than dry salt from an operational perspective. From experience, when the temperature is lowered to about -7°C (19°F), the time needed for the melting process to begin is longer than acceptable for operations. With prewetted salt, a solution is present from the outset, even at temperatures below -7°C (19°F).

When using prewetted salt, the spreading width of the material on the pavement can be controlled better since the material will bounce less than dry salt. The reduction in bouncing may also allow the spreading vehicle to travel at a greater speed, which will reduce the differential speed between the spreading vehicle and the traveling public.

If designed properly, a prewetted salt system can decrease cost and increase effectiveness compared with conventional dry-salt systems.

Factors to Evaluate

Changing to a prewetted salt operation requires more than just adding moisture. There are other factors to consider. All aspects of winter road maintenance operations must be reviewed when a change is being considered for one component of the system. An evaluation is needed to determine how each change will affect the rest of the system. Some areas that should be reviewed to achieve the potential benefits of prewetting salt are particle size, prewetting liquid, liquid manufacturing and storage requirements, and prewetting methods.

The conventional salt gradation was developed several years ago for deicing operations that required the dry particle to penetrate into snowpack. With the addition of a liquid, the particle will embed in the snowpack more efficiently, facilitating the penetration of the particle to the pavement surface. As the profession moves toward a more preventive approach as opposed to the conventional reactive mode of operation, the particle size will be a factor that should be evaluated. Anti-icing is such a preventive approach. In implementing anti-icing strategies, many highway agencies are opting to apply snow-and-ice-control material early in storms and follow up with additional applications in a timely manner during the storm to prevent the formation of a bond between the snow and ice and the pavement surface. This approach requires a change in the material application process. A finer gradation of salt will allow more moisture to be added to the dry salt, reduce the time for the salt to go into solution, and reduce the undesirable scattering of large salt particles during both the application process and subsequent wind turbulence caused by passing vehicles.

As noted, prewetted salt is salt with moisture added. However, questions such as what liquid should be used to supply the needed moisture and how much moisture is appropriate need to be addressed. The answers to these questions will depend on the conditions existing at the site. The more moisture available, the less time it will take for the salt to dissolve into solution. If moisture is readily available from slush on the pavement surface, for example, a different amount of moisture may be necessary than if the pavement surface were dry. As mentioned earlier, the salt particle size is another factor that should be considered in determining how much moisture to add. In general, the amount of prewetting liquid is from 5 to 30 percent by weight. If the only important characteristic of the liquid is that it wet the salt during the spreading operations, water will suffice. However, the material-handling requirements of water below freezing temperatures may not make it the most appropriate material. Because of the potential problems associated with water, a low-cost liquid with better low-temperature handling characteristics may be more appropriate, such as NaCl brine, which in a saturated solution has a eutectic temperature of -21°C (-6°F). If the prewetted material is applied to prevent a black-ice condition from occurring, use of calcium chloride ($CaCl_2$) may be appropriate. The hygroscopic properties of $CaCl_2$ will cause it to retain moisture better on spread material at lower relative humidities than NaCl. Other liquid materials, such as magnesium chloride, calcium magnesium acetate, and potassium acetate, should also be reviewed.

Factors to consider when selecting the liquid type are the manufacturing, storage, and handling requirements. The following questions should be addressed.

- Will the liquid be manufactured on-site or delivered ready for use?
- What is the quality of the liquid needed?
- What percentage of nonsolubles is acceptable?

- What are the potential hazards associated with material handling?
- What are the storage requirements? Do they require indoor storage, external heat, or agitation?
- How much time is acceptable to reload the spreader?

These questions and others must be answered, and the results will differ depending on the sites' specific conditions.

There are several acceptable methods for moistening salt. Some common examples are as follows:

- Inject liquid into the salt in the loader bucket during loading of the spreader hopper.
- Shower or inject liquid on or in the salt in the spreader hopper during loading or after loading is completed.
- Shower or inject liquid on or in the salt at the spreader auger on the tailgate spreaders.
- Shower liquid on the salt as it is transferred from the hopper onto the spreader chute where the prewetted salt will be conveyed to the spreading disk.
- Apply liquid to the salt as the materials come in contact with the spreading disk.

There are advantages and disadvantages to each method. Among the factors that will influence the decision are the liquid-to-solid ratio, available resources, liquid capacity on spreader vehicle, efficiency of material handling, and liquid type.

SUMMARY

The winter maintenance policy for a highway is provided by the assignment of a level of service. The maintenance engineer has many options available to achieve the prescribed level of service. Systems for prewetting snow-and-ice-control materials are improving and should be evaluated. They could become additional tools for winter road maintenance operations.

REFERENCES

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