Highway Deicing

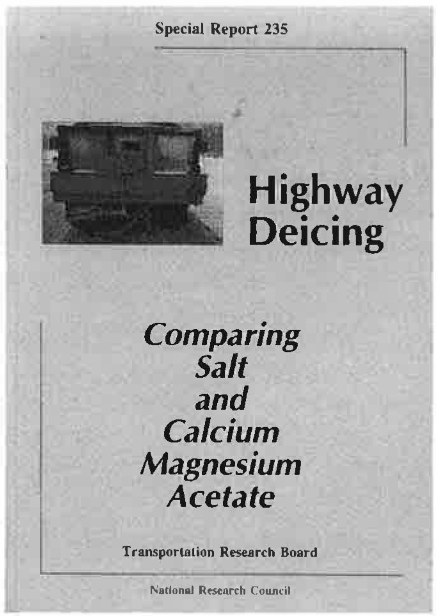
Comparing Salt and Calcium Magnesium Acetate

TRB Report on Comparative Costs

Each year about $1.5 billion is spent on highway snow and ice control in the United States. Chemical deicing accounts for about one-third of this expenditure. Sodium chloride, or common road salt, is by far the most popular chemical deicer because it is reliable, inexpensive, and easy to handle, store, and apply. An average of 10 million tons is applied in the United States each winter (Figure 1). Over the years, however, the widespread use of salt has been linked with many indirect costs, including damage to motor vehicles, infrastructure, and the environment. Whereas the direct cost of purchasing and applying salt is relatively low, the true cost may be much higher.

In 1980 the Federal Highway Administration identified calcium magnesium acetate as a possible replacement for salt. CMA has since undergone laboratory and field studies. Results have been promising, but a major impediment to CMA's use has been its price—20 to 30 times that of salt by weight.

The commercial availability of CMA, as well as continued concerns about the side effects of salt, underscores the need for more information about the total cost of chemical deicing. Recognizing this need, Congress requested an investigation of the true costs of both salt and CMA, including direct application costs and indirect costs to the environment, motor vehicles, and infrastructure. To carry out the study, the Transportation Research Board appointed a special committee of experts in chemistry, materials science, economics, environmental science, and highway maintenance and operations. The committee's findings are presented in *Special Report 235: Highway Deicing: Comparing Salt and Calcium Magnesium Acetate.*



Special Report 235: Highway Deicing: Comparing Salt and Calcium Magnesium Acetate **(price $22.00; $16.50 for TRB affiliates) is available from the Transportation Research Board, Box 289, Washington, D.C. 20055 (telephone 202-334-3213 or 3214).**

Much of the report is focused on defining the total cost of salt. Individual chapters are devoted to examining the effects of salt on motor vehicles and infrastructure, the environment, and drinking water. National costs are estimated for some effects, though not all, because of insufficient information, especially for environmental and drinking water effects. A summary of what is known about CMA, including its field performance, environmental effects, compatibility with automotive and highway materials, production technologies, and market price, is presented in one chapter. A discussion of the important cost and use issues that must be addressed by highway agencies during consideration of CMA for deicing is also presented.

Road Salt Damages and Costs

The last major studies quantifying the overall costs of road salt were conducted nearly 20 years ago. Today, however, many of the findings from those studies are no longer accurate because understanding of the adverse effects of salt has increased, and, in some cases, significant steps have been taken to control them. The lack of more up-to-date information has contributed to confusion about the benefits and savings that might be achieved by using less damaging but higher-priced alternatives to salt, such as CMA.

The major cost of road salt today is the more expensive corrosion-resistant materials and coatings used in new cars and trucks. Altogether, corrosion protection features that are potentially attributable to road salt have increased the cost of manufacturing new vehicles by approximately $2 billion to $4 billion per year. In recent years these protections have become very effective in eliminating corrosion in newer vehicles; however, persistent forms of cosmetic

Massachusetts highway treated with CMA.

corrosion from road salt still cost motorists an additional $1 billion to $2 billion per year in preventive maintenance (such as car washes) and reduced vehicle values, especially in the Northeast and Midwest (Figure 2).

Road salt also has caused more premature bridge deck deterioration than any other factor during the past 30 years. Because of salting, thousands of older decks are critically contaminated with chloride and will continue to deteriorate whether salt or noncorrosive deicers are used. Repair and restoration of these contaminated decks is likely to be a major, and largely unavoidable, expense for many years. Accordingly an urgent concern is to protect newer decks that are not already contaminated. During the next 10 years, the cost of installing this protection during the construction of new bridges and repairing damage to existing decks caused by continued salting will total about $125 million to $325 million per year. Likewise, an equivalent amount will be spent on the protection and repair of other bridge components affected by salt, such as structural components exposed to salt from splash and spray and poor deck drainage.

The effects of road salt on the environment can also be significant. However, they depend on a wide range of factors unique to each site. Adverse effects most frequently reported in the literature are damage to roadside vegetation and drinking water. Meaningful estimates of environmental damage can only be accomplished on a case-by-case basis by evaluating local circumstances in depth. Even when environmental damage can be quantified for a specific site, a monetary value can be highly subjective and difficult to assign.

CMA

Since 1980 numerous laboratory and field studies have been conducted to evaluate CMA's field performance, likely impacts on the environment and human health, compatibility with automotive and highway materials, and prospective production technologies and market price. In the selective and experimental situations in which it has been used in the field, CMA has often performed acceptably, although generally not as effectively or consistently as salt. In most cases it must be used in quantities 20 to 70 percent greater than salt and must be applied early in a storm to be effective. In freezing rain, dry snow, and light traffic, CMA is often less effective than salt. In laboratory tests, CMA has exhibited much greater compatibility with highway and automotive materials than has salt. It also has exhibited few adverse effects on the roadside environment. A remaining concern is the potential for large quantities of CMA to reduce dissolved oxygen in water. Hence CMA treatments near small, poorly flushed ponds and streams may require special monitoring and further study.

The price per ton of CMA is currently about $650. Research is being conducted to lower the price, but no breakthroughs appear imminent.

CMA Cost and Use Issues

The committee found that the widespread use of CMA is unlikely and probably unwarranted. Although widespread use of CMA might reduce corrosion of some motor vehicles and infrastructure components that are poorly protected and not already contaminated by salt, its use would have little effect on the corrosion of many older infrastructure components that are already contaminated by salt. Likewise, it is not clear that significant savings would result from reduced corrosion protection costs because automobile and bridge designers would continue to protect against other corrosion sources.

Given CMA's higher price and greater volume requirements—which would likely require substantially more storage space, spreading equipment, and manpower—expenditures by highway agencies on deicing material would increase by 20- to 30-fold if a widespread conversion to CMA were made.

continued on page 19

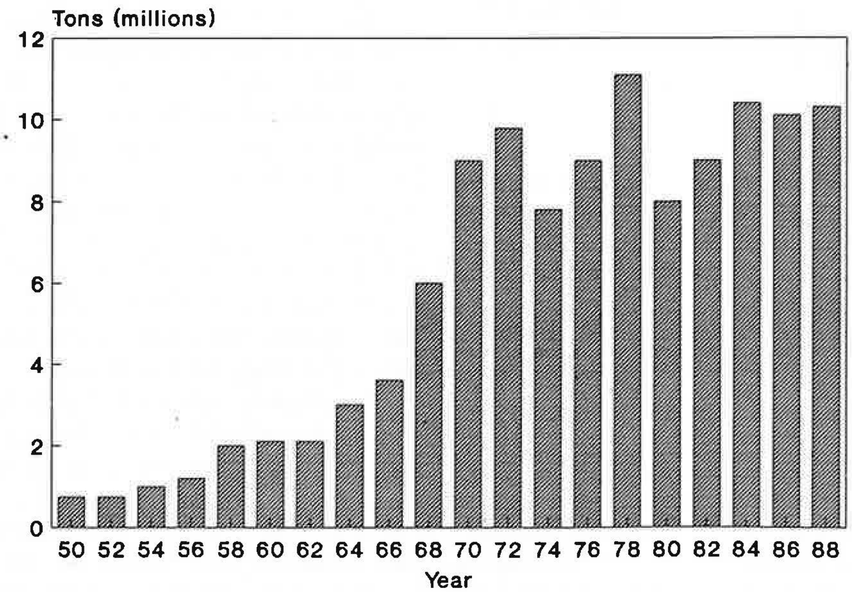


FIGURE 1 Trends in highway salt use, 1950–1988 (source: Salt Institute).

CMA is currently used selectively and in limited quantities, primarily in environmentally sensitive areas and on new corrosion-prone structures and highway sections. On the basis of existing information about the deicing performance and cost of CMA, the committee believes that such selective applications are likely to be the principal use for CMA in the future.

Outlook for Reducing Deicing Costs

More than 20 years after the adverse side effects of road salt first came to light, the total cost of salting continues to be high. However, major achievements in corrosion protection have helped control much of this cost, and continued improvements are expected. Carefully designed and located salt storage facilities and better-managed salting programs should help reduce environmental damage and water contamination.

In all likelihood, salt will continue to be the predominant highway deicer for many years. Highway agencies and private industry continue to refine and seek new ways to prevent and treat the adverse effects of salt, for example, by improving corrosion protection and developing new corrosion repair methods. Likewise, research continues aimed at reducing salt use by developing anti-icing technology, improving salt application techniques, and exploring additional alternatives. CMA is therefore one of many options available to highway agencies to mitigate the adverse effects of salt, and its future use and acceptance are likely to depend in large part on the progress made in other mitigation areas.

Reference

1. R. Turcotte and R. Baboian. *Development of Poultice Corrosion Tests for Automobiles.* Paper 383. National Association of Corrosion Engineers Annual Meeting, Boston, Mass., 1985.

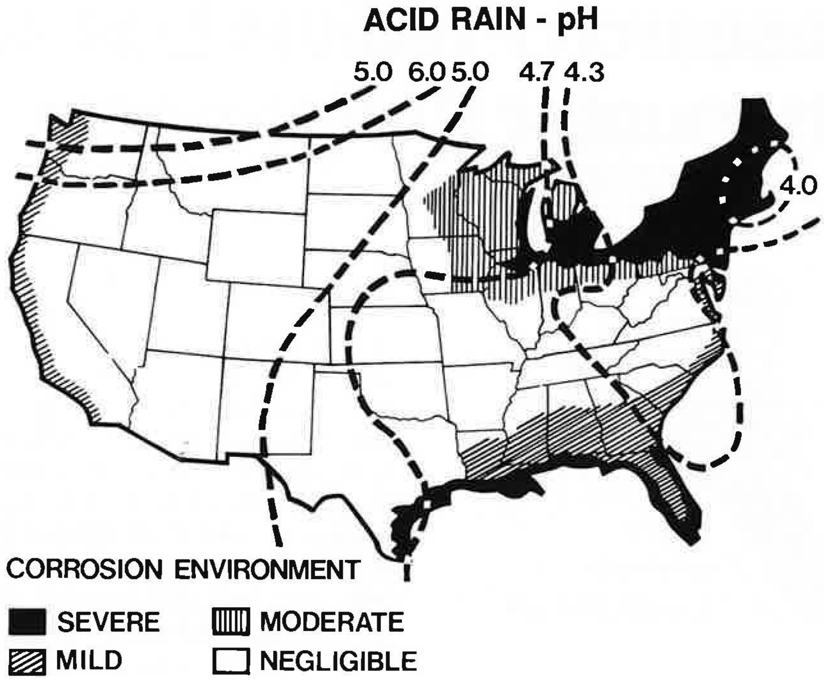


FIGURE 2 Corrosivity of the environment by region (*1*).

Committee on the Comparative Costs of Rock Salt and Calcium Magnesium Acetate (CMA) for Highway Deicing

John J. Henry, *Chairman*, Pennsylvania Transportation Institute, The Pennsylvania State University, University Park
Robert Baboian, Texas Instruments, Inc., Attleboro, Massachusetts
James W. Dunleavy, Oakland County Road Commission, Waterford, Michigan
Donald N. Geoffroy, New York State Department of Transportation, Albany
Jeffrey L. Gidley, California Department of Transportation, Sacramento
Richard R. Horner, University of Washington, Seattle
Maurice A. Larson, Iowa State University, Ames
David G. Manning, Ontario Ministry of Transportation, Downsview
Patrick S. McCarthy, Purdue University, West Lafayette, Indiana
L. Lee Piepho, General Motors Corporation, Milford, Michigan
Samuel L. Pollock, Massachusetts Department of Public Works, Wellesley Hills
Della M. Roy, The Pennsylvania State University, University Park
Donald L. Wise, Northeastern University, Boston, Massachusetts
Ronald L. Zook, Ohio Department of Transportation, Columbus