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THE TRUTH ABOUT SAND AND SALT FOR WINTER MAINTENANCE

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Abrasives play an important role in snow and ice control operations throughout the U.S. Research and practice clearly indicate that abrasives can improve traction on icy or snow-covered roads. They can be a very effective treatment in environmental and temperature conditions where deicing chemicals don't work. In addition, abrasives can be used to maintain safety at hills, curves and intersections on unpaved and low volume roads. Using chemicals on unpaved roads is ineffective and damages the surface, while many low volume roads do not merit the level of service provided by chemicals.

Unfortunately, abrasives are poorly understood and often misused, resulting in wasted material and money, and reduced safety for the traveling public. The following discussion is intended to help agency managers think about their abrasive policies and practices.



HOW THEY WORK

First, let's be clear about how salt and abrasives work. Salt melts snow and ice. The best uses of salt and other deicing chemicals are to prevent ice from bonding to the pavement and to aid in removing it from the pavement once it is stuck there.

Plowing, when it can be done, is by far the best winter maintenance tool. Nothing is more effective than plowing to remove snow and slush from the pavement. However, many storm conditions develop that make it difficult or impossible to prevent snow pack or ice from developing on

the pavement. This is where a deicing chemical is needed if you want to quickly restore clear pavement conditions. Salt melts snow and ice so we can plow the pavement clear.

What do abrasives do? They increase friction, providing better traction and control for vehicles. Abrasives do not melt snow and ice. An inert piece of stone or slag will not melt anything!

Furthermore, for an abrasive to actually improve traction it must remain between the tire and the ice. It does no good when it is buried in the snow or is blown off the pavement. Research has shown it is difficult to maintain good traction with abrasives when there is any significant traffic. Vehicle traffic tends to work the abrasive into the snow and/or pick it up in the tires and blow it off the pavement. A paper by Professor Wilfird Nixon has a good discussion of the research relating to abrasives testing (1).

continued on page 2

Do abrasives have much real value in promoting safety? Yes, because abrasives are often the only reasonable option we may have. Low temperatures or freezing rain conditions, for example, limit the effectiveness of chemicals. However, abrasives are far from efficient as a method for snow and ice control. Many agencies follow long time practices, especially in using only a salt/abrasive mix, that don't reflect the reality of how these materials work.

MIXING SALT WITH ABRASIVES

First, it is true that if you are going to use abrasives in winter, you need to add some salt. All sand piles have moisture, even those in desert environments. When this moisture freezes, lumps form and that interferes with distribution.

How much salt is needed? Just enough to keep the moisture from freezing. Practice has shown that

50-100 pounds of salt per cubic yard of abrasive is sufficient. This is about 2%-4% by weight. If your abrasive is very wet, you are in a very cold environment, or your stockpile is uncovered, you may find it necessary to use 175 pounds (7%). Also, if the abrasive is dirty, the larger volume of fines will tend to collect more moisture and therefore it takes more salt to prevent freezing.

Many states regulate salt and sand storage to protect surface and ground water. In Wisconsin, any en-

tity storing more than 1000 pounds of bulk road salt must pile it on an impermeable pad and keep it securely covered year round. A sand mixture that is 5% salt by weight or less is exempt. Any mixture with more salt must comply.

Uncovered abrasives piles with salt are also susceptible to leaching with any significant amount of snow or rain during the winter. One study showed that 10 inches of precipitation leached out 50% of the salt. While it is difficult to keep salt/sand piles covered, doing so — with a tarp or preferably a building — would



save salt and reduce leaching into the environment.

Many agencies have a tradition of mixing more than 5% salt in their abrasives. Blends of 10% to 50% can be found in use in nearly every state in the U.S. Why? The thinking goes: "if salt works well under some conditions and abrasives are helpful in others, why not mix them together for the best results?" In fact, salt and abrasives do different things and can actually oppose each other! The following sections explore some of the common explanations for these practices and their actual effective-

ness in providing safety and producing bare pavements.

1. ANCHOR IT TO THE ROAD

A common belief is that salt will anchor the sand, and/or sand will anchor the salt to the road. Actually, sand and dry salt particles are separate and are not in any way tied or anchored together. As long as they remain dry, wind and traffic will quickly move both of them off the pavement.

Some salt may become brine from moisture in the sand or from melting ice on the pavement. In theory, a small amount of moisture will help embed the sand in the surface of the snow and then refreeze to create a sandpaper effect. This is a nice picture, and it can be done, but not very often.

Research on friction on pavements treated with abrasives shows that

there is little benefit when traffic is present. In general, traffic quickly carries or blows all materials off the road. If there is very much melting, it is not likely that the abrasive will float and stay on the surface. More likely it will settle, or be pounded by traffic, down into the melting snow mixture. Now it is no longer "anchored" to the surface and provides little value for traffic safety.

2. SAND WILL PROVIDE SAFETY UNTIL THE SALT HAS A CHANCE TO WORK

People often use this approach when temperatures are too cold for salt to work. The object is to maintain traction until it warms up and the salt can go to work. This is true IF the sand stays in place and IF the salt also stays in place until it can do its job of melting. The challenge is to keep the dry salt on the road. With any volume of traffic it will either be blown off the surface or mixed too far down into the snow to be effective.

If crews do any plowing before the temperature rises, this approach is a complete waste. The salt will be plowed off before it can possibly work. Any salt that remains may turn to brine and melt some of the ice on the road. This liquid on top of the ice actually makes the surface more slippery. Then, when the air temperature remains low it will likely refreeze the water, making the road surface ice covered. This leads to more salt applications and the process is repeated, wasting materials and not improving traffic safety very much.

3. WE SAVE SALT BY MIXING IT WITH ABRASIVES

Bulk salt is more costly than bulk abrasives, so the idea is to "extend" the salt by mixing it with abrasives. However, if you are using a blend to achieve clear pavements, then salt and plowing are doing the work. Very likely most of the abrasive is wasted because blending salt and abrasives does not actually produce a different material. In fact, research has also shown that mixing sand with salt actually reduces the salt's melting ability. One study

documents over 20% loss of ice melting capacity when salt is mixed with sand (2).

Spreading rates also differ between straight salt and an abrasives/salt mixture. Straight salt is usually spread at 100-300 pounds per lane mile. Spread rates for mixtures often run over 500 pounds per lane mile. If you are using a 3 to 1 blend by volume (sand to salt), the blend by weight is actually 20% salt (sand weight of 2700 lb/cu. yd. and salt weight of 2000 lb/cu. yd.). Spreading 500 pounds of this mixture per lane mile actually applies 100 pounds of salt per lane mile. A 50-50 blend by volume means that the salt is 43% by weight, giving a salt spread rate of 212 pounds. Because of the differences in spread rates, it may cost about the same or even more to spread an abrasive/salt mixture. Studies often show that abrasive/salt mixtures cost more than straight salt especially if any clean-up is required.

4. SAND IS VISIBLE, AND THE PUBLIC EXPECTS IT

You bet! It is nice to spread something the public can see so they stop calling and complaining. You can add law enforcement to the group that likes to see sand on the road. Very likely our own operators and managers also feel the same way. Sand becomes a security blanket for everybody.

If the abrasive is really working, this approach is fine. However, there is a growing list of negative environmental concerns with abrasives. These include: air pollution from the fines, stream bed pollution impacting fish reproduction, and corrosion from the salt included with the sand. In addition, problems with claims for

windshield damage and chipped paint make the use of abrasives a source of public criticism.

Spreading abrasives mostly to be seen is very costly and not good for the environment. You are paying a high price to have sand just to look at. I doubt the public would be very supportive if they understood the situation.

5. WE DO NOT WANT THE COMPLICATION AND EXPENSE OF USING MORE THAN ONE TYPE OF MATERIAL

Yes, it takes more effort and training to use both straight salt and abrasives with 2%-4% salt. However, it will not cost more in the long run. In fact agencies are making this change all over the country at the state and local level. A realistic review of your total costs for spreading and cleaning up abrasives will likely show the benefits. Change is not easy, but many agencies feel it is worth the effort to make this improvement.

SUMMARY

In this day and age of new and exotic chemicals, anti-icing, RWIS and GPS, is there a place for good old sand? Yes. If, however, your agency is using a high percentage blend of salt with abrasives, you do have an opportunity to review your practice and seek improvements.

An abrasive mixed with enough salt to freeze-proof it, has a place on unpaved roads, low volume roads, and in conditions where chemicals cannot work. Straight salt can both prevent ice from bonding to the pavement and create slush which allows plows to clear the road. This mix of strategies will serve most agencies well into the future. We owe the public nothing less.

REFERENCES

1. **The Use Of Abrasives In Winter Maintenance Final Report Of Project TR 434**, Wilfred A. Nixon, IIHR Technical Report No. 416, Iowa Institute of Hydraulic Research, University of Iowa, March 2001.
2. **De-icing Chemicals and Abrasives: State of the Art**, J. Hode Keyser, Highway Research Record 425, p. 36-51 (1973).

WINTER MAINTENANCE TECHNICAL PEER EXCHANGE CAPTURES EXPERIENCES

In mid-March, Alan Gesford, technology transfer specialist at Penn State's Institute for State and Regional Affairs, with support from the Federal Highway Administration, hosted a dozen winter maintenance experts from ten states in Harrisburg, PA for a 2-day peer exchange on improving winter highway operations. The Salt Institute will either Web-post or link to the final report when it is produced, but here are some products and conclusions of the peer exchange:

1. A guideline for snowfighting agencies to develop appropriate policies and strategies to meet their winter maintenance responsibilities.

2. Identification of three basic training strategies: using outside trainers, training your own trainer and sending your trainer to "train-the-trainer" workshops.
3. A plan to develop "winter storm scenarios" to test training effectiveness.
4. Trainers should make the Salt Institute website their jumping-off point in identifying training materials or researching questions on winter maintenance.
5. LTAP centers and state DOTs should exert more leadership in encouraging municipal agencies to receive training and utilize technical publications.
6. Abrasives have a role, but it is often misunderstood, resulting in wasting both sand and the salt mixed into it (see main story in this issue of *Salt and Highway Deicing*).
7. Tort liability and risk management require knowledge of legal requirements, clear policies and diligent adherence to those policies; a guideline is available.
8. Implementing new technologies should consider bang-for-buck prioritization. Some changes can be made inexpensively and cost-effectively including adoption of appropriate strategies, calibrating spreaders, using hand-held infrared thermometers, using

- third-part RWIS data and using air puffers to keep rear-facing lights clear of snow and ice.
9. Fabric roof salt storage is a proven technology and often an economical option.
10. New NCHRP reports on materials usage (Report 526, available online at http://gulliver.trb.org/publications/nchrp/nchrp_rpt_526.pdf and materials selection to mitigate environmental impacts (active project, see <http://www4.trb.org/trb/crp.nsf/e7bcd526f5af4a2c8525672f006245a/02cd6676cc88f2ec85256b990044a3a5> OpenDocument for background) are useful tools for snowfighting managers.

The peer-exchange initiated the since-implemented NLTAPA listserv and recommended development of model local winter maintenance plans, a program of educating drivers in winter driving skills and a training video for plowing operations; and research is needed, the group agreed, on how to quantify the benefit of ground speed controls and how to compare salt brine and other liquid chemicals. ■



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