Winter Highway Maintenance Operations: Connecticut

Balancing Concerns and Safety

July 22, 2015
Study Mandate

➢ Connecticut trucking industry concerned about corrosion to truck fleet

➢ CT General Assembly adopts legislation – mandates CTDOT to conduct study

➢ Connecticut Academy of Science and Engineering (CASE) engaged – independent perspective on issues

➢ Follow-up to CASE 2006 Winter Highway Maintenance Study
Connecticut General Assembly mandated CTDOT to conduct an analysis of the corrosive effects of chemical road treatments on

1. state snow and ice equipment vehicles;
2. state bridges, highways and other infrastructure; and
3. the environment

The analysis shall determine the cost of corrosion created by road treatments; and shall include an evaluation of alternative techniques and products, such as, but not limited, to rust inhibitors, with a comparison of cost and effectiveness
The Process

- **Research Team:** Connecticut Transportation Institute, UConn
  - James Mahoney, Executive Director (Study Manager) with professors and staff

- **CASE Staff**

- **Study Committee** [includes Brown (MA), Burne (ME), Mills (WA), Nelson (AASHTO), Smithson (IA), Turner, Ex-Officio (FHWA) & others]

- **Study Reviewers**

- **Study Contacts/Stakeholders**
The Study

- Overview of Snow and Ice Control Operations on Connecticut Roadways: CTDOT and Municipalities
- Deicing Chemicals Currently in Use in North America
- Winter Highway Maintenance Practices in Surrounding States
- Environmental Impacts and Mitigation of Deicing Chemical Applications for Winter Highway Maintenance
- Effects of Deicer Corrosion on Infrastructure & Vehicles
- Best Practices and New Technologies
- Winter Highway Safety Analysis and Overview of Economic and Societal Impacts
- Summary of Findings
- Conclusions and Recommendations
Overview of Snow & Ice Control Operations

- Connecticut is the third smallest state (almost a rectangle 100 miles wide by 50 miles tall)
- Wide variation of winter weather
  - SE CT averages 20-25 inches of snow per year — NW CT averages 90+ inches of snow
- CTDOT maintains 10,800 lane miles — municipalities maintain 35,200 lane miles
- No county or regional agencies maintaining roadways
Overview of Snow & Ice Control Operations

- CTDOT: 632 plow trucks; ~ 200 contractor trucks available
- Before winter of 2006/7 — CTDOT used sand/salt (sodium chloride) mix
- Starting with winter 2006/7 — CTDOT adopted anti-icing strategy and moved to eliminate sand
- Began pre-wetting rock salt with 32% calcium chloride solution with corrosion inhibitor (1 gallon per 200 pounds rock salt per lane-mile)
Overview of Snow & Ice Control Operations

- After 2 years — inhibitor dropped due to issues with storage, clogged nozzles and reports of low oxygen levels in streams receiving runoff
- Began transition to 30% magnesium chloride solution in 2010/11; completed in 2012/13
- CTDOT pretreats bridges and problematic areas with a sodium chloride brine
Deicing Chemicals in Use in North America

- Examined various deicing chemicals used in North America

- Found alternatives to the chlorides exist, but they come with own set of concerns that include:
  - Some attack different metals, are not as effective or easy to use, and are extremely expensive ($1 per pound)
  - Potential environmental impacts
Winter Highway Maintenance Practices: Surrounding States

- Requested information from DOTs in New England States, New York and New Jersey regarding use of deicing chemicals

- Worth noting — each state is responsible for different types of roads, traffic, service levels and climate

- Found chlorides were virtually all that was used in region

- When total chlorides used were divided into lane-miles, CTDOT had the third lowest yearly application rate per lane-mile in the region
Using historical data, average chloride levels in CT groundwater increased from 2 ppm to 20 ppm during the past century.

Since 2014, 10 cases of well water with elevated concentrations of chlorides (primarily) have been reported to the Department of Public Health.

Currently in CT only one chloride impaired waterway (due to mining) listed as part of Federal Clean Water Act.
Effects of Deicer Corrosion
Infrastructure & Vehicles

- All chloride deicing chemicals accelerate rate of corrosion of steel
- Average age of passenger vehicles in 1969 — 5.1 years
- Average age of passenger vehicles in 2013—11.4 years
- Elimination of hexavalent chromium as corrosion resistant coating on vehicle parts around 2006
Effects of Deicer Corrosion
Infrastructure & Vehicles

- Magnesium chloride more destructive to concrete than calcium chloride or sodium chloride
- Need to work towards reducing penetration of chlorides into concrete
  - Sealers such as silanes and methacrylate to seal concrete and microcracks
- Bridge washing/rinsing to remove chlorides and debris that hold moisture & induce corrosion
Effects of Deicer Corrosion
Infrastructure & Vehicles

- Protection of infrastructure and vehicles is a shared responsibility
- Transportation agencies should use the least amount of deicing chemicals as needed to maintain safe travel and level of service goals
- Vehicle owners need to periodically wash vehicles to remove salt from undercarriage
- Inspection of infrastructure and vehicles to identify issues before they become significant
Best Practices and New Technologies

- Provide for safety of the public as best as possible
- Provide highest level of service for the conditions
- Maximize effectiveness of winter highway operations through efficient use of resources
- Minimize environmental impacts
- Test new technologies that are being considered for implementation (*many enhancements available*)
  - Salt slurry generators
  - Underbody scraper blades
Winter Highway Safety Analysis & Overview of Economic & Societal Impacts

- Analyzed number of crashes with injuries that occurred for 7 years before and after adoption of anti-icing strategy
- Found decrease in number of crashes greater than would be expected from trend of fewer crashes
- Given data available — not possible to definitively conclude anti-icing responsible for drop in number of crashes occurring during winter months
- Decrease in crashes with injuries after anti-icing implemented compared to before anti-icing = 2,449
Winter Highway Safety Analysis & Overview of Economic & Societal Impacts

- Using NHTSA estimates cost of a crash with a non-incapacitating injury = $276,000

- Assuming all injury crashes resulted in non-incapacitating injuries — savings to Connecticut from reduction of 2,449 crashes = $676 million

- For each crash with critically injured survivors, costs jump to $1 million per survivor
Winter Highway Safety Analysis & Overview of Economic & Societal Impacts

Number of Winter Season Vehicle Crashes Involving Injuries

Winter Seasons (November 1 - April 30)

- ALL CRASHES (Sand Years)
- ALL CRASHES (Salt Years)
- Linear Trend (Sand Years)
- Actual Linear Trend (Salt Years)
- Projected Linear Trend (Salt Years)
Winter Highway Safety Analysis & Overview of Economic & Societal Impacts

Vehicle Crashes Involving Injuries
Surface Condition Equal to Snow/Slush or Ice CTDOT Roads

Winter Seasons (November 1 - April 30)

- Surface Snow/Slush/Ice CRASHES (Salt Years)
- Surface Snow/Slush/Ice CRASHES (Sand Years)
- Actual Linear Trend (Salt Years)
- Linear Trend (Sand Years)
- Projected Linear Trend (Salt Years)
Summary of Findings

- Chloride based deicing chemicals will be standard for the foreseeable future.
- There is a need for everyone to understand that winter highway maintenance is a shared responsibility for dealing with effects of deicing chemicals.
- There is limited *peer-reviewed* literature on effectiveness of corrosion inhibitors for non-application vehicles.
- Vehicle washing is best line of defense.
- Magnesium chloride/calcium chloride ~ 1% of chlorides applied by CTDOT over last five years.
Conclusions

- CTDOT’s anti-icing strategy has reduced number of injury crashes during winter weather events — possibly by speeding up cleanup after event

- Pretreating with sodium chloride brine is adequate — no need to use magnesium chloride or calcium chloride for pretreatment

- There are many variables associated with winter weather events that make them difficult to compare

- Salt neutralizing washes and wash additives may or may not be effective at recommended dosage rates
Recommendations

- CTDOT should continue to use sodium chloride as primary deicing chemical

- If uninhibited calcium chloride is available — CTDOT should consider using it as pre-wetting solution to protect concrete

- CTDOT should play leadership role in working with municipalities to ensure technology transfer and adoption of best practices as municipalities are responsible for majority of lane-miles in CT
Recommendations (continued)

- Implement bridge washing/rinsing program
- Use corrosion resistant steel such as stainless for high volume structures
- Use polymerized concrete wearing surfaces to reduce chloride penetration
- Inspect vulnerable areas on bridges and make proactive repairs to limit water penetration through joints, etc
- Re-establish a bridge painting program for steel structures
Recommendations (continued)

- Need to educate public on need to wash personal vehicles including undercarriage
  - It is unclear what the salt concentration is in recycled wash water in commercial car washes

- Should have undercarriage inspected periodically for signs of corrosion damage

- Need for better undercoatings and paints to prevent corrosion

- Implement designs that prevent materials from collecting in “dead” areas
Recommendations (continued)

- Need to maximize the effectiveness of use of deicing chemical applications

- Identify chloride sensitive areas and consider reduced application rates or alternate chemicals

- Ensure private suppliers of deicing chemicals cover their stockpiles *(CTDOT and municipalities have covered salt sheds)*

- Require annual reporting of deicing chemical usage by CTDOT and municipalities — make information available online *(website)* for comparative analysis and continuous improvement
Recommendations (continued)

- Education of the public and media regarding practices and materials used
- Communication of conditions and what the public should expect in terms of road conditions in near term
- Development of a voluntary certification program for private contractors applying deicing chemical
- Stay abreast of new technology and best practices
- Communication and coordination with other states and municipalities regarding winter weather events and winter highway maintenance
Thank You

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