Surface Aggregate Stabilization with Calcium Chloride

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Discussion Points

- What is calcium chloride
- Forms of calcium chloride
- Methods and benefits of calcium chloride stabilization
- WFL history with calcium chloride
- Key Components

Calcium Chloride

- A salt that draws moisture from the air.
- Liquid or Solid
- Liquid has lower concentration rates (<40%)
- Solid has higher concentration rates (>90%)

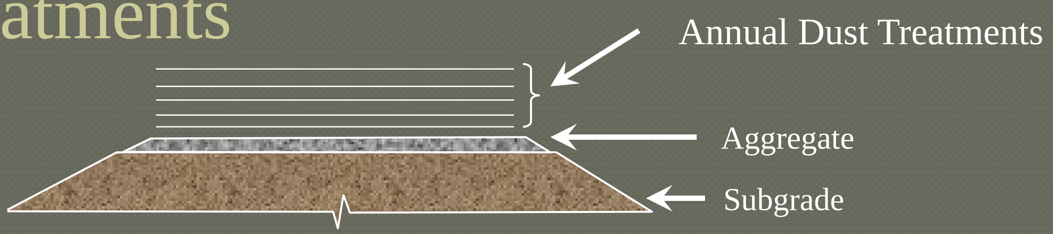
Liquid Form

Solid Form

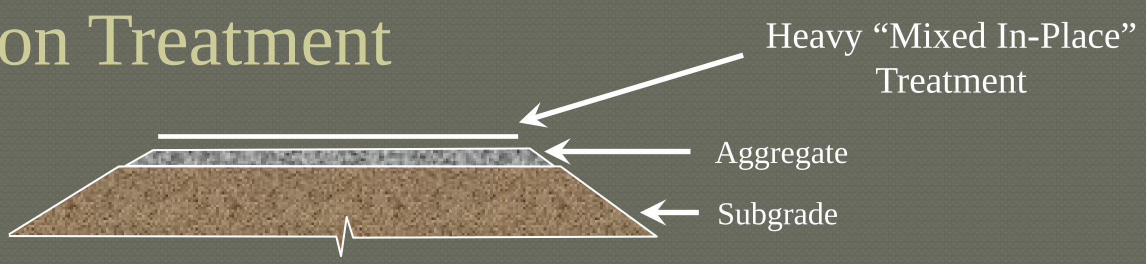
Chloride Treatment Techniques

- Purpose
  - Reduce dust
  - Reduce rock resource depletion
  - Reduce costs (less blading & rock replacement)

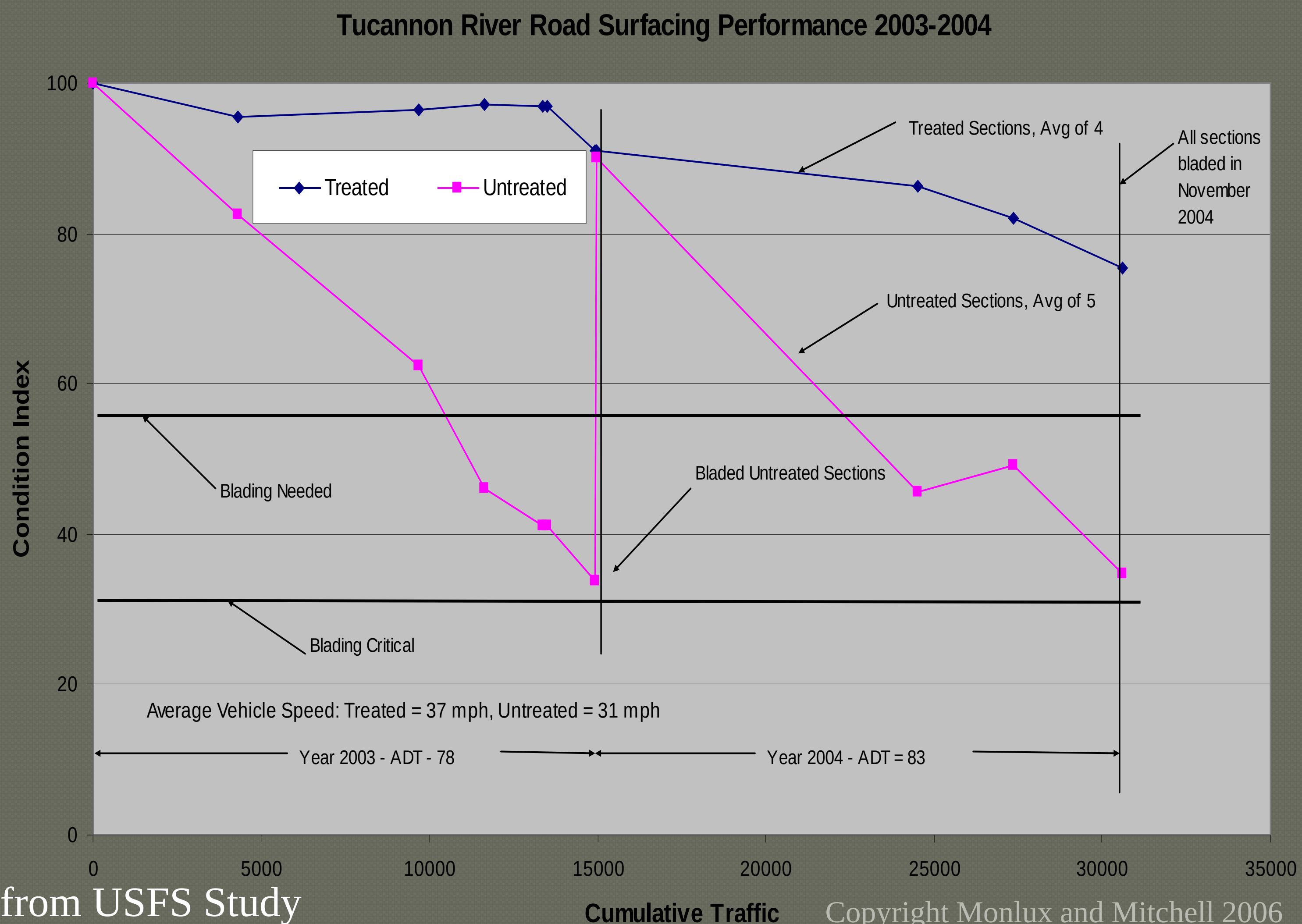
- Annual Dust Treatments



- Heavy Stabilization Treatment



Benefits



Data from USFS Study

Use on Projects

- Test Sections – 2008 & 2009
- Trial Contract - 2009
- Implementation – 2010 & 2011
- Expanded Use – 2012 and 2014

Test Sections

2008 – 3 sections of 650 ft length; $CaCL_2$ rates from 1.7 - 2.7% added to in-situ aggregate @ 4" depth

Test Sections

2009 – 2 segments of one mile length; $CaCL_2$ rate of 2% added to in-situ aggregate @ 3" depth.

Trial Contract

2009 – 12 miles/4 routes; $CaCL_2$ rate of 2% mixed into imported (new) surface aggregate.

Implementation

2010 & 2011 – 55 miles/11 routes; $CaCL_2$ rate of 2.7% mixed into new surface aggregate.

Implementation

Implementation

Implementation

Implementation

Implementation

Implementation

Implementation

Success

Performance of Segments Constructed in 2010

Performance of Segments Constructed in 2010

Performance of Segments Constructed in 2010

Performance of Segments Constructed in 2010

2010 Constructed Roads

2010 TREATED

2010 UN-TREATED

2010 Constructed Roads

2010 TREATED

2010 UN-TREATED

Use on Projects

- Manley Hot Springs Community – Alaska
- Akiak Roads – Alaska
- McGrath Road Reconstruction – Alaska
- Missile Base Roads 2014 – Montana
- Rock Creek Road 2014 - Montana

Key Components

Know your aggregate properties

Not enough fines

Key Components

Know your aggregate properties

Too many fines

Aggregate Properties

- Testing of insitu aggregate
- Specifications for virgin aggregate
- Dense graded
- Non-plastic fines 11% to 17%
- Plastic fines 8% to 12%

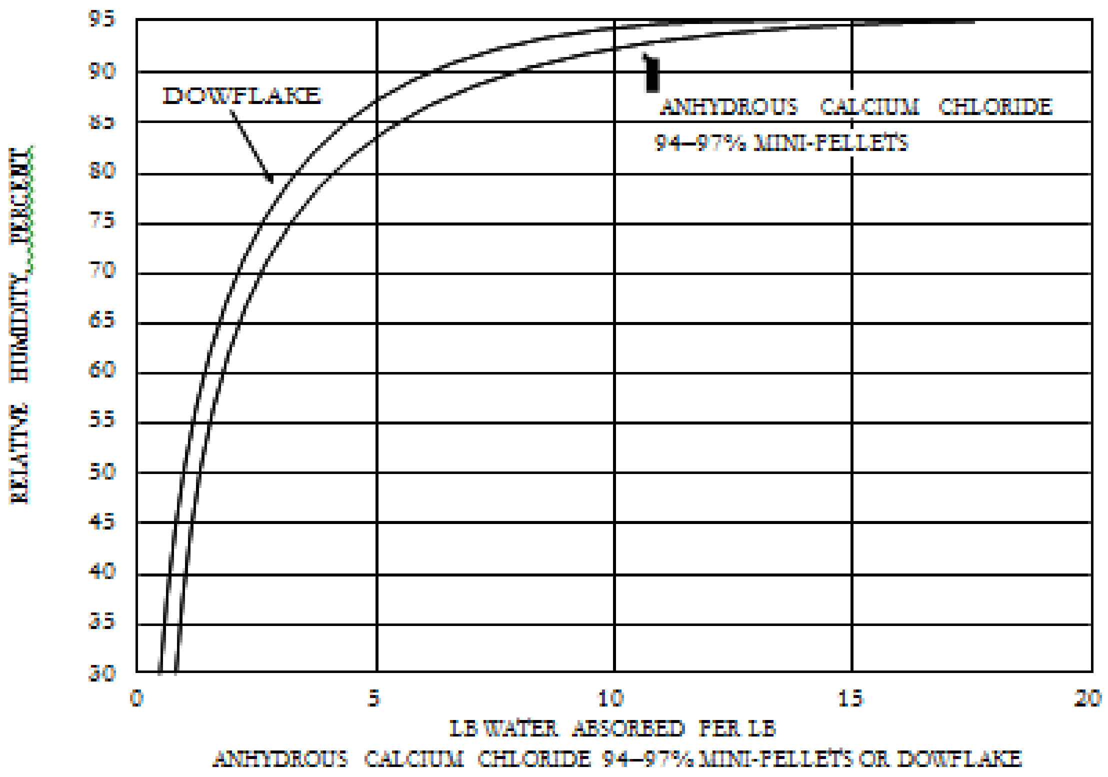
Key Components

Control Calcium Chloride Content

More is not better

Calcium Chloride Water Absorption

Figure 7 — Atmospheric Humidities in Equilibrium with Anhydrous Calcium Chloride 94–97% Mini-pellets and DOWFLAKE Calcium Chloride at 25°C (77°F)



Key Components

- Use stationary mixing (pugmill) for virgin materials with interlock metering
- Use rotary mixers for existing aggregate
- Spread and incorporate within one hour
- No blade mixing

Specification Improvements

- Tolerance on calcium chloride (1.5 to 1.9%)
- Tolerance on water content (2% below to optimum)
- Add water at point of rotary mixing
- Shape to 4% crown to reduce pothole formation
- Compact prior to end of shift
- Monitor weather conditions

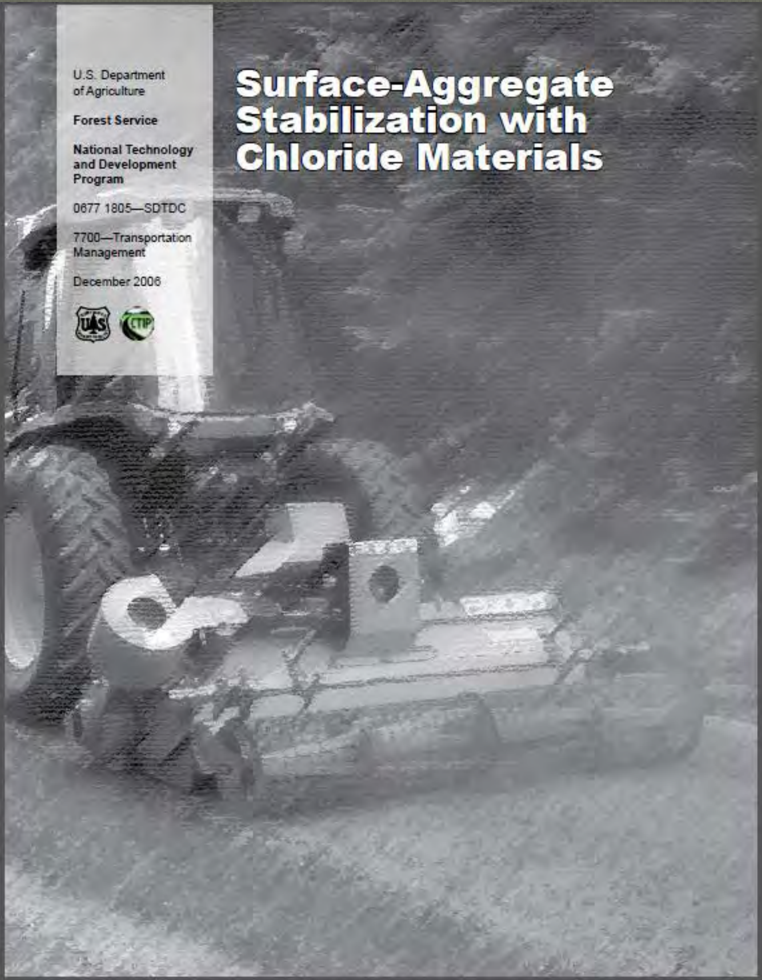
Example Cost Data

Item	$/ton	**Bid Total**
Aggregate Surface Course	$16.00 140,000 tons	**$2,240,000**
$CaCl_2$	$492.00 2,400 tons	**$1,180,800**

Summary

- Chloride stabilization is cost effective
- Need analysis of aggregate
- Control the amount of calcium chloride (<2%)
- Moisture control is critical
- Need thorough mixing
- Immediate compaction to lower permeability
- Proper crown to prevent potholing and loss of chloride

References


U.S. Department of Agriculture
Forest Service
National Technology and Development Program
0677 1805—SDTDC
7700—Transportation Management
December 2006
Surface-Aggregate Stabilization with Chloride Materials

References

Chloride Stabilization of Unpaved Road Aggregate Surfacing

Stephen Monlux and Michael Mitchell

There are few alternatives for improving long-term performance of aggregate surfacing materials in dry climates other than annual dust abatement treatments. In-place stabilization of properly graded aggregate with chloride additives is cost-effective and provides performance and intangible benefits. Similar results are achieved by mixing additives with aggregate during crushing. This 2-year study identifies conditions in which chloride-stabilized roads have a projected life of 10 years or more if properly maintained. The greatest benefits are realized in projects with high aggregate surfacing replacement costs and average daily traffic volumes that exceed 100. Stabilization provides a higher standard of road surface performance by improving ride quality and reducing dust, corrugations (washboarding), and raveling (loose aggregate). Other intangible benefits include reduced sedimentation in streams, reduced aggregate resource depletion, reduced health hazards from dust, and increased road-user safety. This project developed guidelines for chloride stabilization of various aggregate surfacing materials in semiarid to arid environments. Performance and cost-effectiveness of chloride stabilization were measured on 12 projects and monitored for two seasons in four western states; monitoring included construction and maintenance costs, road surface deterioration, traffic, weather conditions, environmental effects, and materials testing. Treated surfaces needed blading after 25,500 vehicles, whereas untreated surfaces needed blading after only 3,200 vehicles. Environmental effects on trees, streams, and roadside soils were insignificant. Many tools were developed to assist in the proper implementation of chloride stabilization of road surface aggregates.

Each year, most low-volume road agencies maintain thousands of miles of unpaved aggregate-surfaced roads by surface blading. Blading is a costly activity that is done frequently and lasts a short time on heavily traveled roads. Road surface conditions can deteriorate so rapidly that blading is often recognized as an ineffective but politically necessary activity. Blading also contributes to the increase of stream sediments and contamination and to loss and breakdown of expensive aggregate surfacing.

When used correctly, road surface stabilization with magnesium chloride and calcium chloride materials reduces blading significantly, increases road quality, and saves money (*1*). These two chlorides absorb moisture from the air and retain the moisture because they are deliquescent and hygroscopic. They promote an increase in density and capillary tension of fines in aggregate surfacing that helps bond the materials together. Application rates used for stabilization are three to five times the normal application rate used for dust abatement.

The goal in road selection was to obtain a broad cross section of roads that were in relatively dry climates in three U.S. Department of Agriculture (USDA) Forest Service Western Regions. Twelve roads were selected in four states. Each road had three types of test sections. Some were maintained according to usual practices, others were mixed with chloride materials, and some were untreated control sections. Test sections were constructed with different forms of chloride materials and monitored for 2 years.

Performance monitoring, measurements, and testing were a significant part of this project. Road surface defects were measured three or four times each season to develop deterioration curves and to determine the effective life of each test section. Deterioration curves using a condition index were the basis for performance measurement and life prediction. The primary inputs for a life-cycle cost analysis were treatment life and costs for aggregate loss, construction, maintenance, and the road user. Environmental effects were measured before and after construction by testing chloride concentration in roadside soils, trees, and adjacent streams. Continuous on-site traffic and weather monitoring was conducted on all projects for the 2-year period. Extensive testing was done to define aggregate characteristics on all projects.

The following intangible benefits were identified: (*a*) increased standard of road surface, (*b*) reduced stream sediment, (*c*) reduced resource damage from aggregate sources, (*d*) increased road-user safety, (*e*) reduced health hazard from inhalation of airborne particulate, and (*f*) improved public relations.

Thirty-eight appendices (*1*) provide cost and performance analysis, testing protocols and results, an implementation guide, and construction and maintenance specifications. This work is based on field performance and not on engineering analysis of stabilized materials. This paper provides a summary of the findings from that report, which contains extensive information; it can be obtained from the USDA Forest Service (*1*).

PROJECT SCOPE AND OBJECTIVES

Between 1995 and 2000, the USDA Forest Service completed three projects using in-place stabilization (*2*). This project replicates these practices on a larger scale by including other types and forms of magnesium chloride and calcium chloride, additional construction practices, different aggregates, and different climates. Monitoring efforts were intensified and more detailed analysis was done. The primary objective was to provide guidelines and tools for effective implementation of the technology.

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Questions?

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