

Combined Method for Bridge Deck Preservation:

Surface Preparation and Micro/Macro Texturing for Friction Enhancement in Conjunction with Lithium treatment of ASR and/or Surface Hardening/Salt Screening

Western Bridge Preservation Partnership Meeting
December 1, 2010

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Concrete Industry Management & CA Pavement Preservation Center

■ CIM

- BS degree in CIM with minor in Business Administration
- 5 universities
- Industry Involvement
- Chico: CIM for the West
 - Western University Exchange (WUE)
 - Applied Concrete Sustainability
 - Concrete Repair

■ CP2

- Expertise and exposure to national and international knowledge
- Fast-track technology transfer
- Training and deployment of pavement preservation innovations
- Timely solutions
- Solid working relationships and partnerships with industry, academia and other public agencies
- Credible technical advice and consultations

Unique Academic/Industry/Government Partnerships



Chico State Highlights: Pointe du Hoc

Non-Destructive and Destructive Testing, Structural Evaluation, Historic Structure Reports



Chico State Highlights: Alcatraz Field School



Chico State Highlights: Alcatraz Field School





Lithium Nitrate for Treatment of ASR

- Plethora of available ASR research
- Potential of Lithium
 - Goal: Prevent further ASR damage for extended service life
 - Challenges:
 - How to get lithium into hardened concrete at functional depth
 - How to prevent additional alkali penetration

Combined Method:

ASR Treatment + Surface Preparation

■ Methods of Surface Preparation – Delaware DOT study

– Shot Blasting

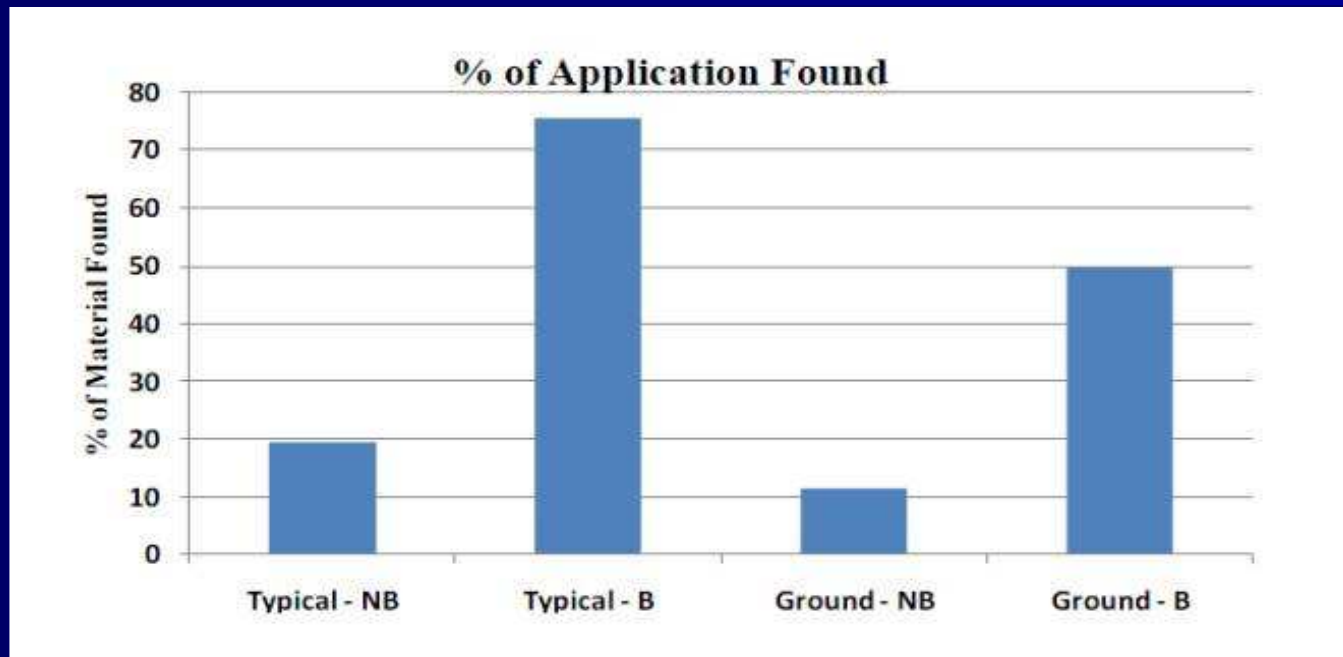
- *“These results showed a marked increase in penetration in the blasted areas compared with non-blasted areas” **

– Diamond Grinding

- *“The diamond ground areas were less than the non-ground areas, . . . , the [addition of] surface blasting significantly increased penetration.”**

* FMC extrapolated information from results in “Lithium Content of Concrete,” Tourney Consulting Group, 6/17/10, from study conducted with Delaware DOT

Combined Method: ASR Treatment + Surface Preparation



*NB = Not Blasted
B = Blasted
Ground = Diamond
Ground*

*FMC extrapolated information from results in "Lithium Content of Concrete,"
Tourney Consulting Group, 6/17/10, from study conducted with Delaware DOT*

Combined Method:

ASR Treatment + Surface Preparation
+ Friction Enhancement/Bonding

- Increased penetration
 - ASR treatments
 - Densifiers
- Increased bonding of surface applied treatments
 - Sealers
 - Overlays
- Added benefit of texturing surface for friction enhancement

Friction Enhancement for Increased Highway Safety

Pavement skid resistance is perhaps the most important engineering component of the road from a safety standpoint.

"During the period 1995-2001, nearly a half a million injuries and over 6,000 fatalities were attributed to roadway accidents caused by slippery pavements."

- "Life Cycle Cost Analysis of Surface Retexturing with Shotblasting as a Pavement Preservation Tool," Douglas D. Gransberg, PhD, PE, University of Oklahoma. Quoted from Noyce, D.A., Bahia, H.U. Yambo, J.M. and Kim, G. "Incorporating Road Safety into Pavement Management: Maximizing Asphalt Surface Friction for Road Safety Improvements," Midwest Regional University Transportation Center, Madison, Wisconsin, 2005.

Friction Enhancement for Increased Highway Safety

"Slippery pavements are the result of several causes, chief of which is the loss of both pavement surface micro and macrotexture.

A recent European study found that increasing the pavement's macrotexture not only reduced total accidents under both wet and dry conditions but also reduced low speed accidents"

- "Life Cycle Cost Analysis of Surface Retexturing with Shotblasting as a Pavement Preservation Tool," Douglas D. Gransberg, PhD, PE, University of Oklahoma. Quoted from Roe, P.G., A.R. Parry, and H.E. Viner. "High and Low Speed Skidding Resistance: The Influence of Texture Depth." TRL Report 367. Crowthorne, U.K, 1998.

Friction Enhancement for Increased Highway Safety

"Pavement managers must not only manage the structural condition of their roads but also their skid resistance.

In fact it is possible for a structurally sound pavement to be rendered unsafe due to a loss of skid resistance due to polishing of the surface aggregates."

- "Life Cycle Cost Analysis of Surface Retexturing with Shotblasting as a Pavement Preservation Tool," Douglas D. Gransberg, PhD, PE, University of Oklahoma. Quoted from National Cooperative Highway Research Program. *Evolution and Benefits of Preventative Maintenance Strategies*. Synthesis of Highway Practice No. 153, National Cooperative Highway Research Program, Transportation Research Board. Washington, DC, 1989.

Surface Texture

Surface Texture Types

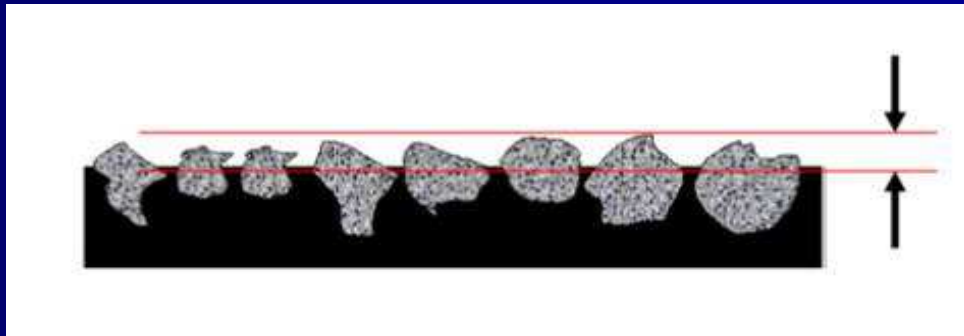
(Megatexture - surface profile; how flat the surface is)

- Macrotexture
- Microtexture

Surface Texture

MACROTEXTURE: space or voids between aggregate particles

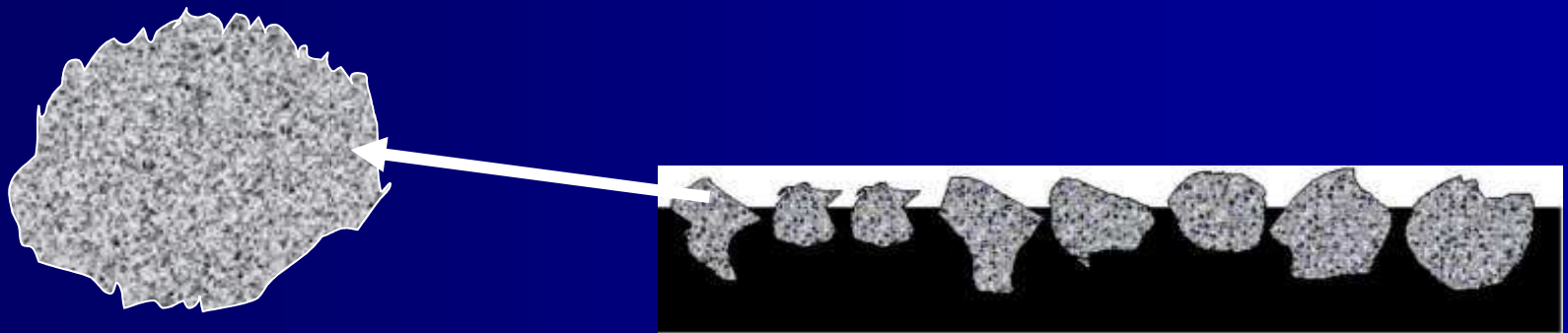
Allows water to drain away from surface and greatly contributes to skid resistance in wet conditions



Surface Texture

Microtexture: provided by roughness or texture of surface of individual aggregate particles

Main contributor to providing grip or skid resistance with tires, particularly at low speeds



Shot Blasting Summary

- Increased penetration of ASR and other surface applied treatments for extending service life
- Friction enhancement for safety
- Environmentally friendly
 - Shot is reused
 - Clean/efficient capture of shot dust
 - Research uses for shot dust

Shot Blasting Summary

Doug Gransberg's study

- Economic analysis of a typical highway to determine the life cycle costs of using various options for a hypothetical project.
- Utilized Federal Highway Administration pavement life cycle cost methodology
- "shotblasting is an economically viable alternative to traditional methods for restoring lost skid resistance. It also allows the desired engineering objective to be achieved without the consumption of additional materials thus making it an environmentally sustainable alternative as well."

- "Life Cycle Cost Analysis of Surface Retexturing with Shotblasting as a Pavement Preservation Tool," Douglas D. Gransberg, PhD, PE, University of Oklahoma.

CalTrans & I80 Donner Pass/Tahoe



Industry/Academic/Public Partnership:

Less than one month from CalTrans meeting to completed application on Donner Pass

CalTrans & I80 Donner Pass/Tahoe



Initial test area at Chico State

CalTrans & I80 Donner Pass/Tahoe



Transil: Surface wear protector in conjunction with shot blasting (or Diamond Grinding) to reintroduce friction and protect from chlorides and moisture. New technology in partnership with Dow Corning.

Testing for Surface Profile



Sand Patch



Flow Meter



One Year Later . . .



Options

Option 1: \$42,000/lane mile asphalt overlay,
Expected service life?

Option 2: \$21,000/lane mile shot blast plus
surface treatment

Expected service life?



Recent Testing & Next Steps

Drilled cores, test results expected

Visual acceptance

Ruler test

What's next? Additional pavement preservation treatments for crack repair, etc., as part of tool box system for new and older surfaces.



Stadium Software

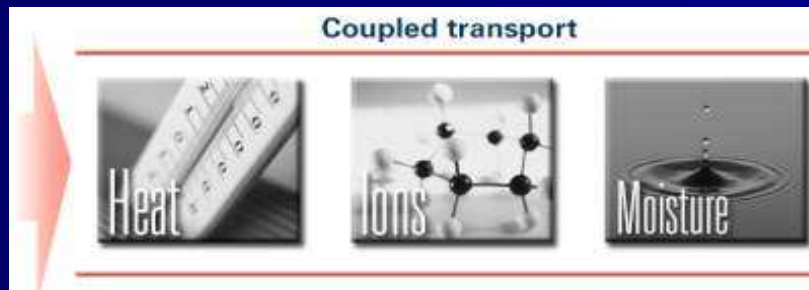


STADIUM® is a comprehensive software solution that can predict the degradation of cement-based materials exposed to aggressive environments (de-icer salts, seawater, sulfate bearing soils, etc.).

Development initiated through SUMMA Consortium:

- Seven industrial partners
- Three government partners

Over 10 years of validation work



Stadium Software

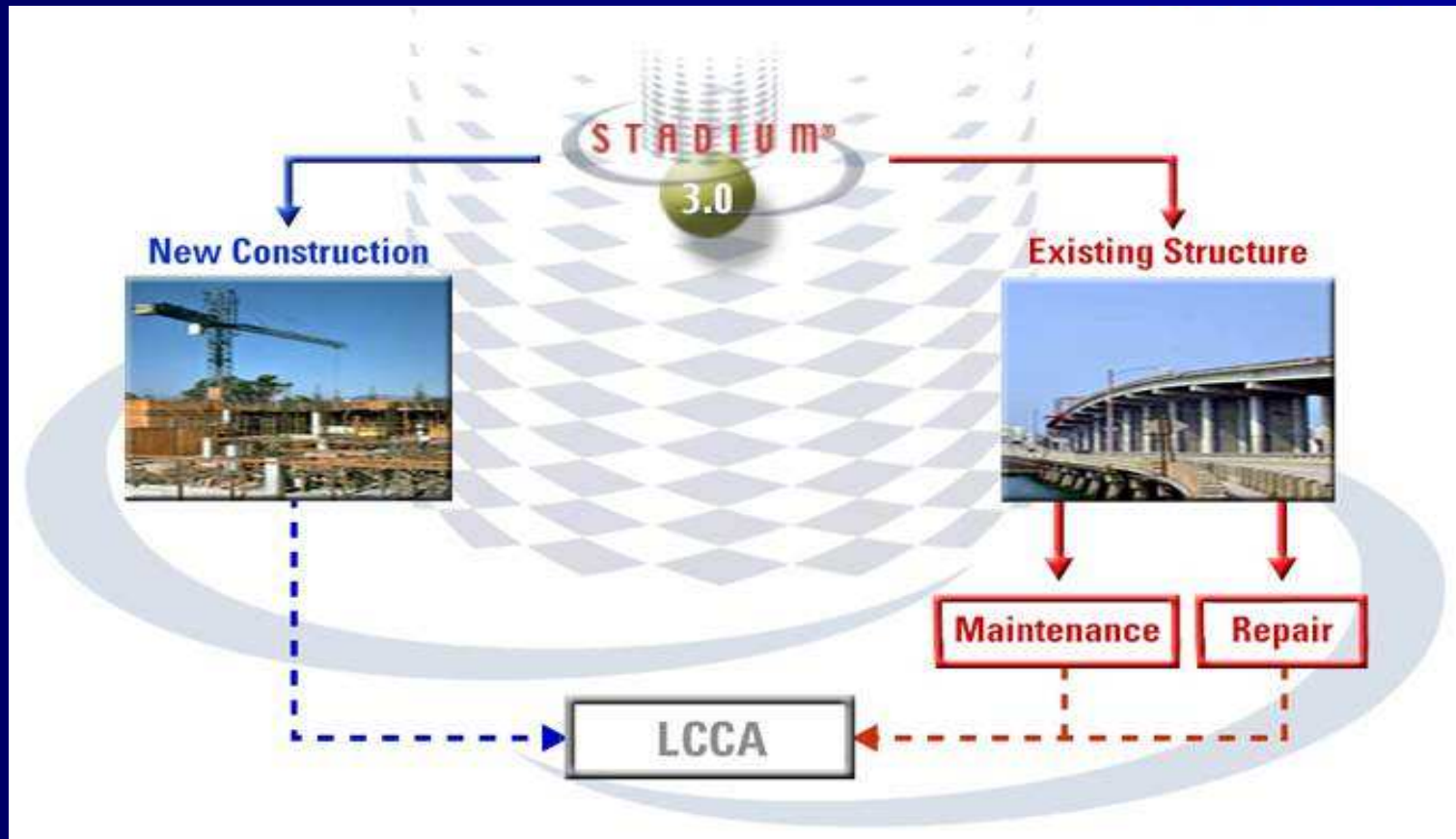
STADIUM[®] is a web-based user-friendly application for New or Existing concrete structures that considers local exposure conditions element by element, the material properties and chemistries, protection solutions, rehabilitation scenarios and much more.

The collage features several key elements:

- Local Exposure Conditions:** Two photographs showing construction sites with rebar and concrete structures.
- Properties of Materials:** Two photographs showing concrete and steel reinforcement.
- Protection Solutions:** A photograph of a worker in a yellow safety vest applying a protective coating to a concrete surface.
- Chemical Degradation:** A photograph showing a concrete surface with significant surface erosion and exposed aggregate.
- Steel Corrosion:** A photograph showing three pieces of steel reinforcement bars (rebar) that are heavily rusted and pitted.
- Moisture Emission:** A photograph showing a close-up of a concrete surface with a dark, wet area, indicating moisture emission.
- STADIUM III:** The central logo for the software, featuring the text "STADIUM III" in a stylized font, with "Registered Program" and the "SIMCO Technologies inc." logo above it.

Stadium Software

STADIUM® is linked to a Life-Cycle-Cost-Analysis module to provide answers both in terms of duration and cost.



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