



# Silane Technologies for Sustainable Road Infrastructure

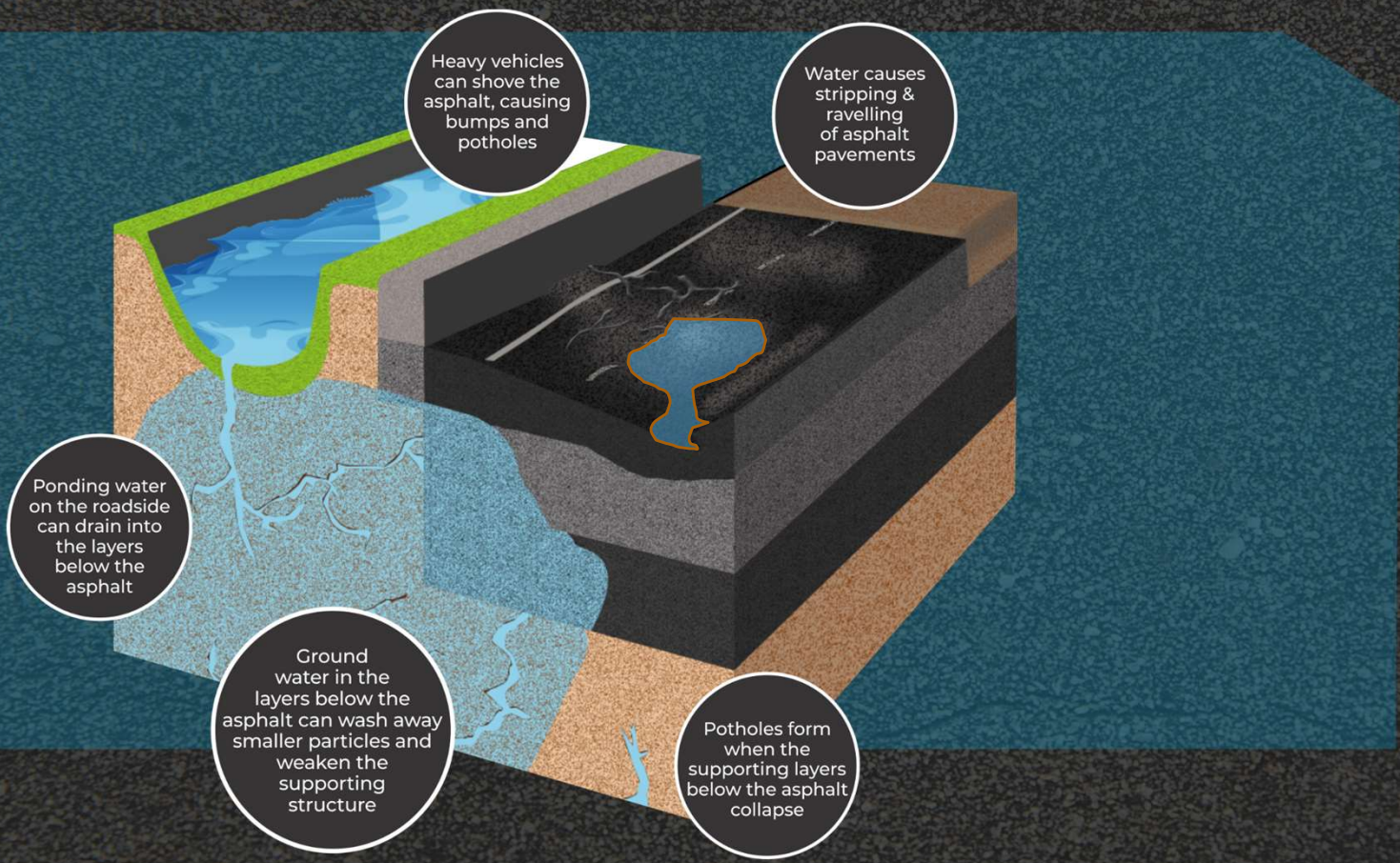
Feb 29, 2024 New Delhi

# Why Sustainability?

- Bitumen Layers asset erosion costs \$ 3.5 - 4 Million every day
- Pre-mature failures - huge indirect cost on health and economy's GDP
- Adverse impact on terrestrial & aquatic flora and fauna
- High Carbon Footprint / Emissions
- ✓ Technology solutions required for constructing durable and sustainable pavements

“The greatest threat to our planet is the belief that someone else will save it.” - Robert Swan

# Water Ingress



# Pavement Distress

## Weakening of Soil Sub Layers

- Water weakens the underlying soil. Traffic then fatigues and breaks the poorly supported asphalt surface in the affected area
- Freeze Thaw cycles lead to the formation of cavities in the soil sublayers, leading to failure

## Weakening of Asphaltic Layers

- Water causes delamination between the bitumen and aggregate, leading to stripping and raveling of the pavement
- Delamination of various asphalt layers due to intrusion of moisture into the tack coat

# Sustainable Bitumen

- Longer life and higher performance of bitumen products are imperative as flexible pavements today undergo higher & heavier traffic, are expected to have longer life
- Modified bitumen's PMB's, HIMA, VG40, CRMB have an excellent opportunity. Client mandate, scaling cost barrier, resolve stickiness / workability issues
- Bitumen mixes use RAP, tire's rubber, waste plastics, lime / cement filler. Technology innovation with newer class of chemicals required for raising performance
- Ensure client mandate's and also up's the test standards for assessing damage from moisture, oxygen & heat from time T 0 to T 10 / 20 years

# Innovations

- Organo-silanes → enhance performance of bitumen mixes - PMB's, CRMB's and VG Grades, extend life cycle of pavement and also lower maintenance costs
- Product to Service → Incorporate service quotient to every mix ton paved. Build terminals to control bitumen supply chain & quality for end users coupled with laboratories for mix design's
- User Consolidation & / or mandate HMA mix production quality
- Carbon footprint definition – include end of life equation rather than carbon footprint at the time of production
- Bitumen mix ravelling – contamination in the environment, prevent leaching by silanes

# Silanes

Advanced active materials, work at interface of bitumen binders, aggregates and soils. Positively affect interactions between metal and binder, and reduce the kinetics of oxidation in bitumen binder, close to aggregate surface

- Resolve issues of stickiness in PMB / SMA mixes, reduce operating temperatures and give desired compaction densities
- Excellent modifiers for bitumen mixes using non modified bitumen's
- Warm mixes + anti-strip + cross linkers at interface + micellize asphaltenes
- Enhance life span of roads and reduce maintenance requirements

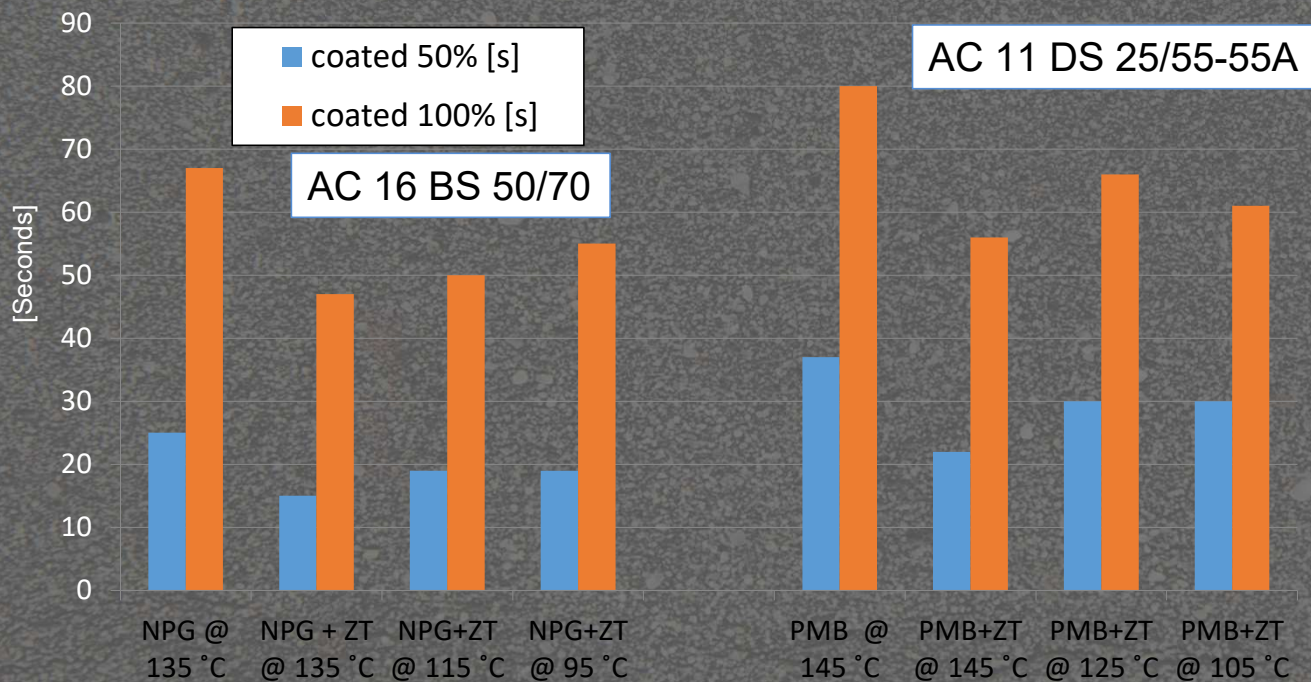
# PMA with Silane's





# Bitumen Mixes

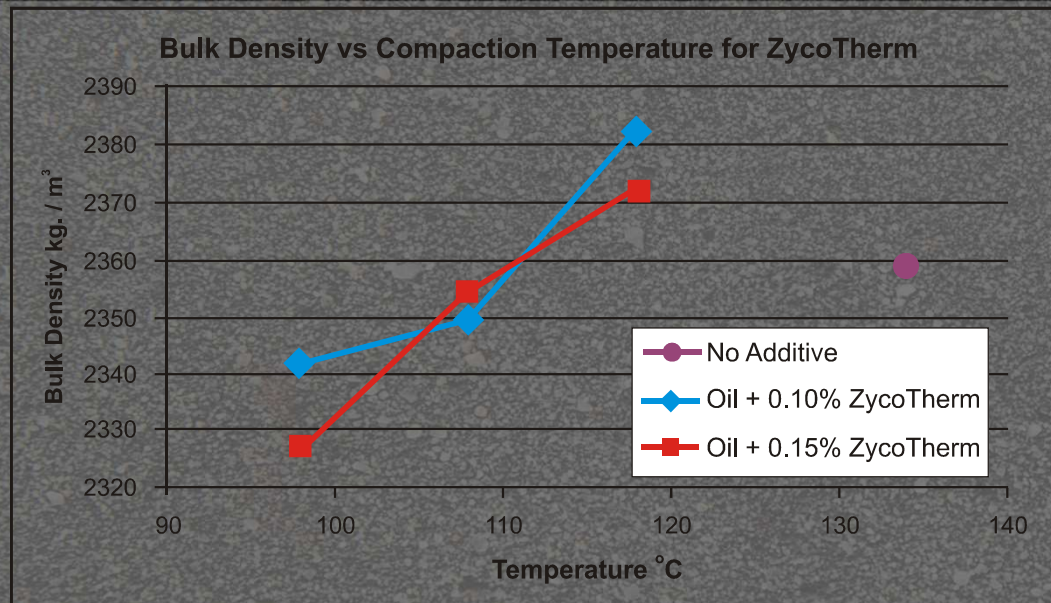
## Faster Coating at Lower Temperatures



20 % less time is required, even at 40 °C lower mixing temperature

# Bitumen Mixes

## Compaction at Lower Temperatures



Compaction temperatures for unmodified PG 58-22 in the range of 131-136 °C in Nova Scotia, AMEC Americas Ltd



# Highway

Goa – Karnataka Border –  
NH 66



# Tack Coat

## Seamless Monolithic Membrane

- Silane Nanotechnology added to CRSI reduces surface tension of emulsion to spreading to give finer spray, 100 % coverage and seamless membrane
- Chemically bonded tack coats
- Nearly eliminates tire pick-up
- sets quickly and reduces slippage
- Higher inter-layer bond strength



# Prime Coat

**Quick Set : 1-2 Hours**

Organosilane is added to Cationic Bitumen Emulsion CSS1 for ensuring quick priming within 2 hours (conventional 10 -12 hours)

- Finer spray, Faster Penetration, 100 % Coverage and Seamless membrane
- Nearly eliminates Tire Pick-up and Reduces Slippage
- Lowers Residual Bitumen, Saves CAPEX
- Eliminates Nozzle Clogging



# Sustainable Bases

- Construct soil bases with aggregates in combination with cement and additives to get strength, reduced permeability and flexibility
- Re-construct existing highways with FDR technique to save on aggregates
- Create moisture proofed separation layers on top of Subgrades will prevent damage to the top of the GSB layers
- Encourage extensive use of technology additives in service roads and carriage widths
- Tweak codes to address the issue of water damage

# Water Resistance

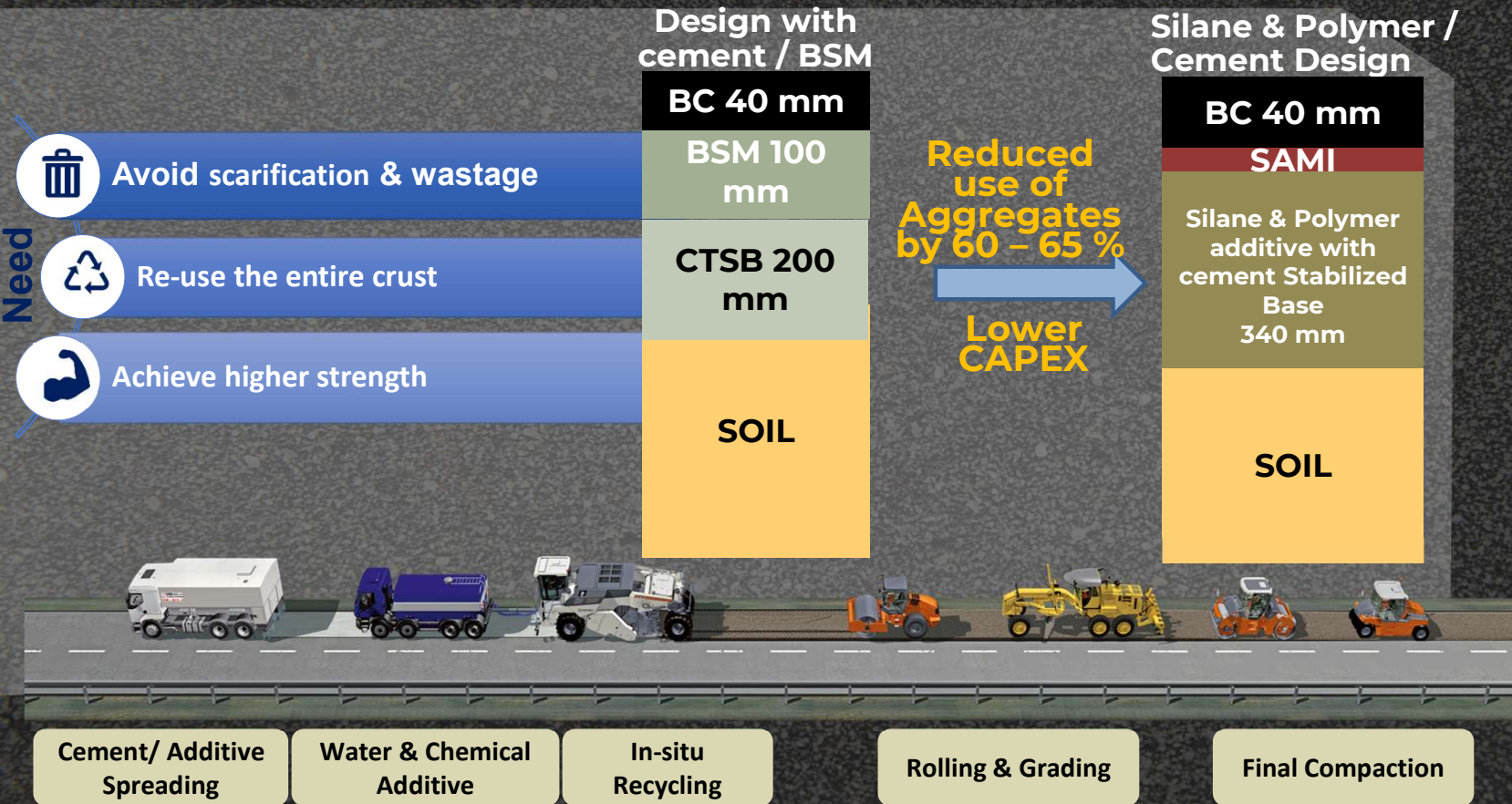
## Bonded Stabilized Bases New / FDR

- Organosilane additive is UV & heat stable reactive soil nano modifier, reduces swelling and imparts water resistance and enhances strength      Unaffected by wet dry cycles
- Nano acrylic co-polymer (70- 80 nm) is UV, heat stable imparts flexibility and prevents propagation of shrinkage cracks



# Design

## Base Stabilization – Effective Subgrade CBR 8% and 20 MSA Traffic





# Water Resistant Stabilized Base



Monsoon  
2022

# Thank You!!

## Reimagine Roads Globally

**'Prosperity Corridors, Economy Force Multiplier'**

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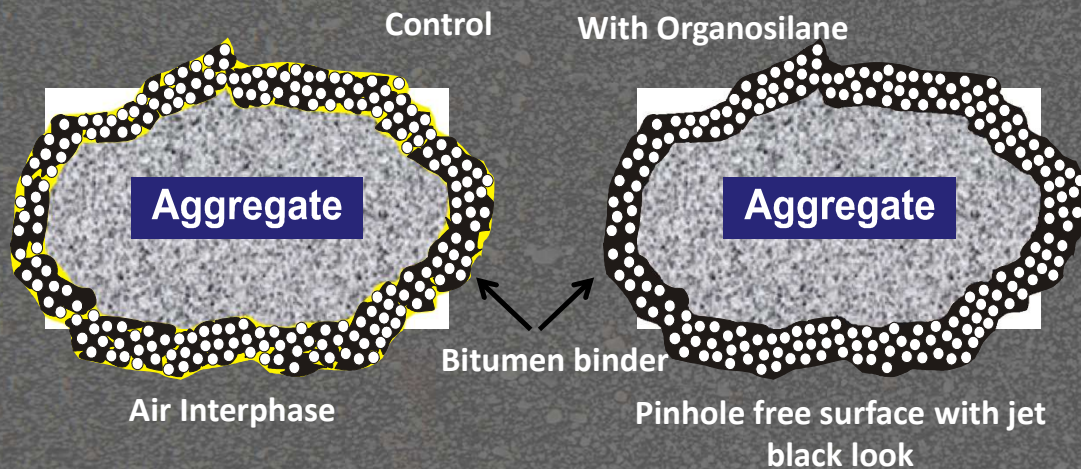
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# Bitumen Mixes

## Faster Coating at Lower Temperatures



30 % reduced Coating time 47 sec against 67 sec

**ITUBS**

Innovationsgesellschaft  
Technische Universität

unschweig mbH

- Faster coating, wetting & saturation of bitumen in micro pores & crevices of aggregates and fines
- Eliminates air interface at aggregate surface – higher oxidation resistance

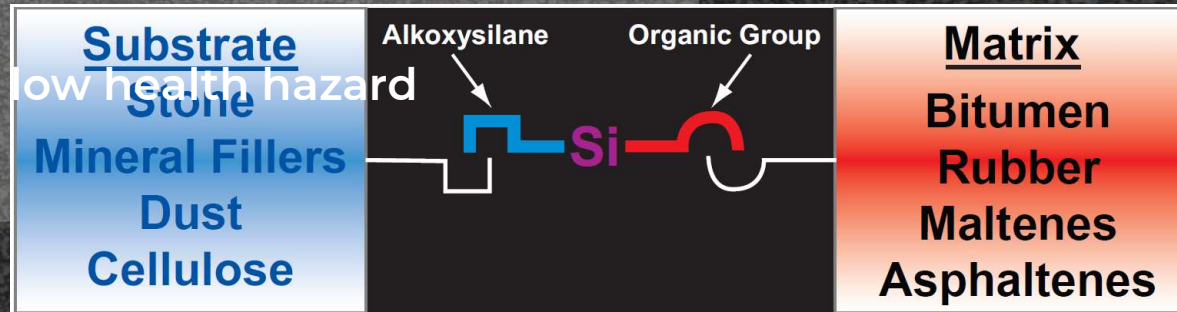
# ORGANO SILANES

## Chemical Modification of Siliceous Substrates

Organosilanes convert the surface of material so as to maintain adhesion even if subjected to severe environmental conditions (e.g., high temperature, underwater immersion or UV radiation)

Silicon containing compounds that can chemically bridge organic and inorganic materials (ex: bitumen emulsion and milled surface to be tacked)

Non corrosive, non odorous and very low health hazard



# Soil Stabilization

## Sustainability Impacts

### Faster

- High productivity due to use of in-situ application
- Reduced logistics lead time
- Enhanced output

### Cost Effective

- **Recycle the existing materials** and reduce crust thickness
- **Stronger pavements** - Economical life cycle cost
- Approximately **15% cheaper than conventional design**

### Sustainable

- **Make use of locally available resources**
- **Stronger subgrade and bases** - Helps in long pavement life
- **Green Technology** - Reduced mining/Logistics/Transportation & Emissions

# Highway

NH 208 Oct 2023

