BETTER ROADS

STATE-OF-THE-ART TECHNIQUES IN CRACK DETECTION AND UTILIZING INNOVATIVE MATERIALS FOR THE REPAIR AND MAINTENANCE OF ROADS

HASSAN ABBAS KHAWAJA
QUALITY OF ROADS

- Essentials Part of country's economy

- World Economic Forum ranked Norway in 2015-16: 67th Globally (Index 4.1)
  (Where 1 = Extremely Underdeveloped; 7 = Extensive and Efficient by International Standards)

- Countries with similar terrains
  - Switzerland – 7th (Index 6.0)
  - Finland – 12th (Index 5.7)
  - Sweden – 21st (Index 5.3)
CONSTRUCTION LAYERS

- Asphalt wearing course
- Asphalt binder course
- Asphalt base course
- Base course
- Sub-base
- Embankment
- Shoulder/Erosion protection
- Filter
- Core/lining
- Ballast
- Natural ground
CRACKS AND POTHoles
CRACKS AND POTHOLES CONT....
INSPIRATION

We cannot solve our problems with the same thinking we used when we created them.

Albert Einstein
DETECTION TECHNOLOGY

- Thermography
- Geological Survey
- Ultrasound

In Support with Infrared, Spectroscopy and Numerical Modelling Research Group at The Arctic University of Norway
REMEDI: ICEFREE®/ISFRI® FILLER MATERIAL

- Lab Tested - UiT, Tromsø, Norway
- Environmentally Certified (According to ISO Standards)

Found to be reliable and effective solution.
PRELIMINARY EXPERIMENTS

Layer of ice

Corresponding IR Image
NON-STUDDED WINTER TIRE

*Courtesy of Kåre Edvardsen
TIRE PASSED AT DEAD SLOW SPEED

Ice fractures and separates

Drive Direction

Drive Direction
Geometric Model

ICEFREE®/ISFRI® Filler Material

Ice

Pulled!
Pulled!
Pulled!

Higher stresses

Lower stresses
Geometric Model

Pulled!

Lower stresses

Higher stresses

ANSYS® SIMULATION

Ice

Concrete

Pulled!

13
CONCLUSION

- Ice fractures and separates from ICEFREE®/ISFRI® Filler Material

- Ice is twice as stiff and thirty times as weak in tensile strength than ICEFREE®/ISFRI®.

<table>
<thead>
<tr>
<th>Materials</th>
<th>Young’s Modulus</th>
<th>Tensile Yield Strength</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ice</td>
<td>1-4 GPa</td>
<td>2 MPa</td>
</tr>
<tr>
<td>Concrete</td>
<td>14-41 GPa</td>
<td>5 MPa</td>
</tr>
<tr>
<td>ICEFREE®/ISFRI®</td>
<td>0.069-0.69 GPa</td>
<td>69 MPa</td>
</tr>
</tbody>
</table>
ROAD REPAIRS

- Simple and Effective
- Long Lasting
- Water Proof
- Withstand up to -45 °C
- Lesser Erosion than Concrete
- Guaranteed for 5-10 Years
COATED ROADS

- Long Lasting
- Water Proof
- Withstand up to -45 °C
- Lesser Erosion than Concrete
- No PM-10 Pollutants
- Self De-Icing
COLLABORATION

Statens Vegvesen

(Norwegian Highways Authority)
SUPPORTING PARTNERS

MULTIPHYSICS

norinova TECHNOLOGY TRANSFER

China Institute of Water Resources and Hydropower Research

Centre for Sustainable Development and Innovation of Water Technology (CSDI)

SINTEF
Thank you
and
Drive safe