National Road Research Alliance Geotechnical Team March Meeting

Terry Beaudry
Reclamation/Grading Engineer

Agenda

1. Welcome and Introductions
    - New Members/New Attendees Introduction
2. General NRRA Update
    - Review of 2021-2022 NRRA Research and MnROAD Construction Request Timeline
3. Sharing Surveymonkey for Ideas Ranking - *All Members*
4. *Elevator Pitch* Presentations from Idea Champion(s)
5. Questions/Requests

General NRRA Update

- March Meeting:
  - Champion(s) of ideas provide an *elevator pitch* to Team
  - Surveymonkey (ranking/voting - All Members) after listening to all ideas
- Ranking is summarized and shared with team. Top 10 go to next round (develop 2-pager)
- April Meeting:
  - Additional discussion on Top 10 ideas
  - Surveymonkey (ranking/voting only State Members)
- Ranking by State Members is summarized and share with Team
- Submission of Top 5 ideas to Executive Team

General NRRA Update

- RPO:
  - March 16: *"FRC Jointless Roundabouts in Minnesota Project Update"* presented by Peter Taylor, Ph.D., P.E., Iowa State (PI) and Maria Masten, P.E., MnDOT (TL)

SurveyMonkey – Ranking of Research Ideas

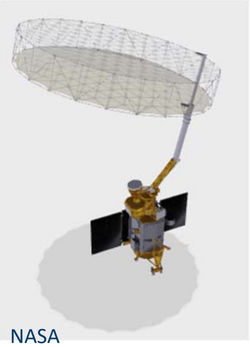
https://www.surveymonkey.com/r/YXGLW3F

Using Soil-Moisture Active Passive Satellite Data to Evaluate the Performance of Pavement Foundation Layers

- Lead Proposer: Mehran Mazari (Cal State LA)
- Objective:

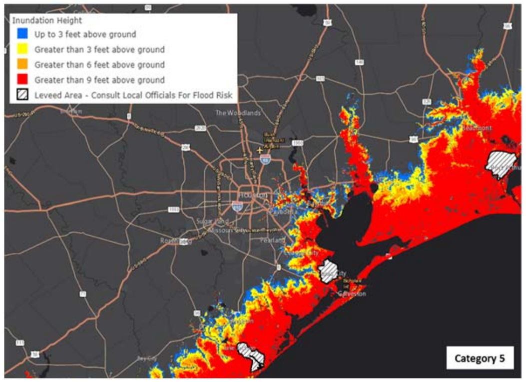
  To study the feasibility of using satellite data analysis to evaluate the moisture-induced performance of transportation infrastructure foundations and pavement layers and calibrate the results with in-situ soil moisture data.

Using Soil-Moisture Active Passive (SMAP) Satellite Data to Evaluate the Resilience of Pavement Foundation Layers



NASA

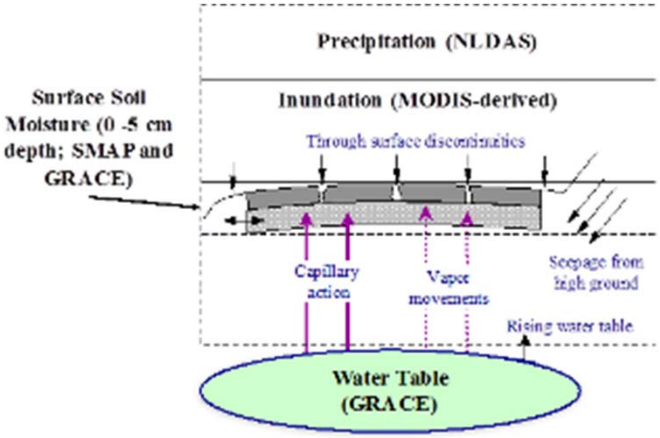
Coomer, 2017



NOAA

Opportunity:

Using NASA Remote Sensing Products to Identify Sources of Water Intrusion to Pavement

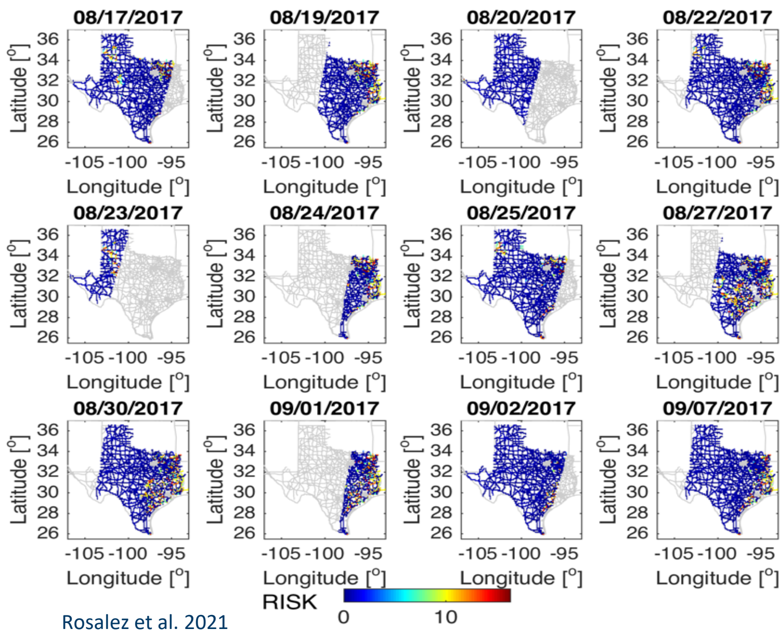


Christopher et al. (2006) and Packman et al. (2018)

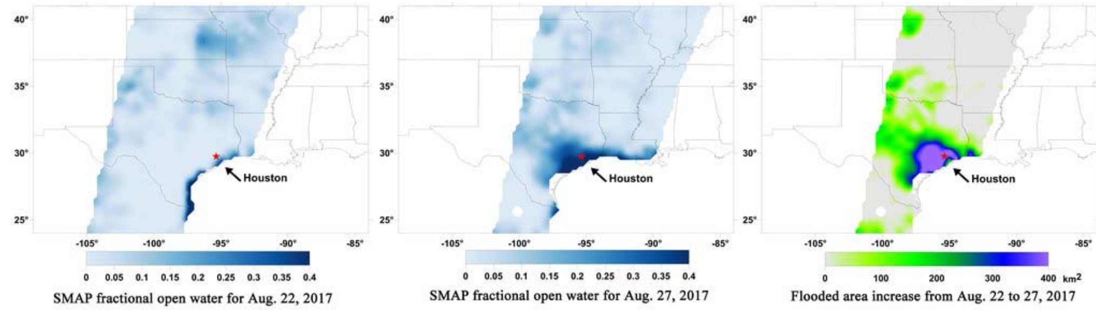
Problem:

Flooding of Transportation Infrastructure, Road Network and Pavement Structures

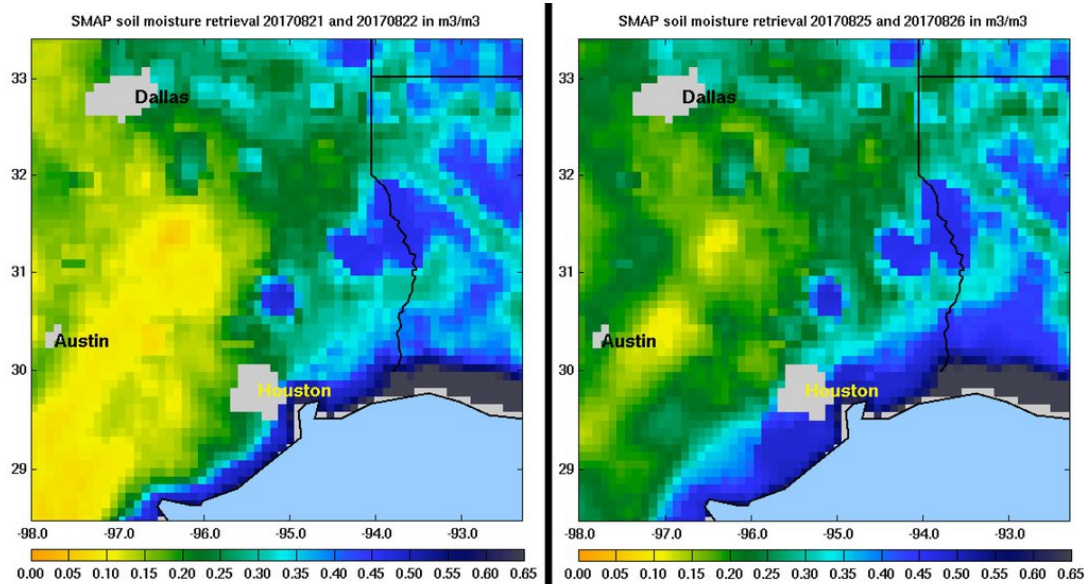
Case Study: Hurricane Harvey



Rosalez et al. 2021



NASA-JPL



NASA-JPL

Jet Propulsion Laboratory
California Institute of Technology

Optimizing Pavement Structure Considering Long-Term Performance and Fatigue Characteristics of Stabilized and Non-stabilized Pavement Foundation Materials

- Lead Proposer: Soheil Nazarian (UTEP)
- Objective:

  Optimizing pavement structure considering long-term performance and fatigue characteristics of stabilized and non-stabilized pavement foundation materials

Using TDA in a road subgrade to prevent frost heaving

- Lead Proposer: First State Tire Recycling, Inc.
- Objective:

  Demonstrate by replacing traditional aggregate with TDA that frost heaving can be prevented on roads in MN state.


Using Tire Derived Aggregate (TDA) in a road subgrade to prevent frost heaving
First State Tire Recycling, Inc.

Objectives and Tasks

- The objective of our idea is to replace traditional aggregate in a road subgrade with a sustainable TDA, by benefiting from its permeability, hydrophobic, and thermal insulation, properties, to prevent frost heaving in Minnesota roads.

- Tasks for our project are:
  - Document 3 or 4 case histories of other frost preventing road projects
  - Together with Prof. Saftner, University of Minnesota Duluth, conduct a 2–3-year demonstration project
    - Temperature variance across the road depth
    - Water movement in a road subgrade

PERMEABILITY PROPERTY

- TDA is an excellent drainage material due to high porosity and low water absorption. Its permeability is **similar to** very coarse gravel. It surpasses fine gravel **10 times**, wood chips **100 times**, coarse sand **3,000 times** and fine sand more than **30,000 times**.

Ranking	Material	Hydraulic conductivity, m/s	Reference
1	TDA ASTM 6270	0.3 - 0.51	Mwai et al. 2016
2	Clean Gravel	10^{-2} - 1.0	Cabalar & Akbulut 2016; Terzaghi & Peck 1964
3	Expanded Shale	$4x10^{-2}$ - 0.6	Bowders et al. 1997
4	Wood chips	$2.4x10^{-2}$ - $8.4x10^{-2}$ [a]	Ghane et al. 2014
5	Coarse Sand	10^{-4} - 10^{-2}	Cabalar & Akbulut 2016; Terzaghi & Peck 1964
6	Fine Sand	10^{-9} - 10^{-5}	Cabalar & Akbulut 2016; Terzaghi & Peck 1964
7	EPS geofoam	Impermeable (<10^{-9})	Akay et al. 2013

❖ [a] New and old wood chips

Conclusion: TDA is an excellent free draining material that is used as drainage layers for highways, stormwater systems, daily cover layers for landfills, and subgrade support during the spring thaw.

HYDROPHOBIC PROPERTY

- TDA is a **highly** hydrophobic material. It has a **very low** water absorption (<3%) and is comparable to EPS geofoam. Traditional aggregates as expanded shale can absorb up to 24%, wood chips 70%, and soil 80% of its volume.

Ranking	Material	Water Absorption, %	Reference
1	Gravel	<1	Fall et al. 2019
2	TDA ASTM 6270	<3	Meles et. al 2013; Humphrey 2008b
3	EPS geofoam	<5	Beju & Mandal 2017
4	Sand	22	Adebayo & Olajide 2013
5	Expanded Shale	24.2	Bundur et al. 2017
6	Wood chips	60 - 70	Kumar & Flynn 2006
7	Soil	80	Jian et al. 2012

Conclusion: TDA is a hydrophobic material which **does not** saturate **nor** loose its physical and geo-mechanic properties in contact with water.

THERMAL INSULATION: COMPARISON

TDA has a thermal insulation value that is **3 times** better than EPS block geofoam**, 7 times** better than soil, **14 times** better than granite and crushed gravel. It has a comparable thermal insulation to fine expanded shale.

Ranking	Material	Thermal conductivity, λ, W/(m*K)	R-value*, $K*m^2/W$	R-value* normalized $R_{material} / R_{soil}$	Reference
1	Expanded shale	0.11 - 0.27 [1]	3.7 - 9.1	5.8 - 15.7	Goodrich & White 1987 [1]
2	TDA ASTM 6270	0.24 [1]	4.20	6.6 - 7.1	Humphrey 2010 [1]
3	Wood chips	0.35 [1]	2.86	4.54	Skogsberg & Nordell 2001
4	EPS geofoam	0.5 - 0.8 [1,2]	1.25 - 2.0	2.0 - 3.2	ASTM C 578-95 [1] Elragi 2006 [2]
5	Sand	1.59 - 1.72 [1,2]	0.63	1	Xiao et al. 2019 [1] Humphrey 2010 [2]
6	Granite	2.77 [1]	0.36	0.57	Khan et al. 2009 [1]
7	Crushed Gravel	3.63 - 3.98 [1]	0.25 - 0.28	0.40 - 0.77	Khan et al. 2009 [1]
8	Water	0.6	1.67	2.65	Touloukian et al. 1970

*$R = L/\lambda$

Conclusion: TDA is an excellent thermal insulation material that is used as subgrade in highways, foundation and retaining walls, and utility trenches to prevent heat loss, capillary break, and frost heaving.

Robbinsdale project, MN, 2000.

Before

After TDA was placed

Determination of AASHTO Structural Layer Coefficient for bituminous stabilized Full Depth Reclamation, CIR and CCPR

- Lead Proposer: Stephen Cross (ARRA)
- Objective:

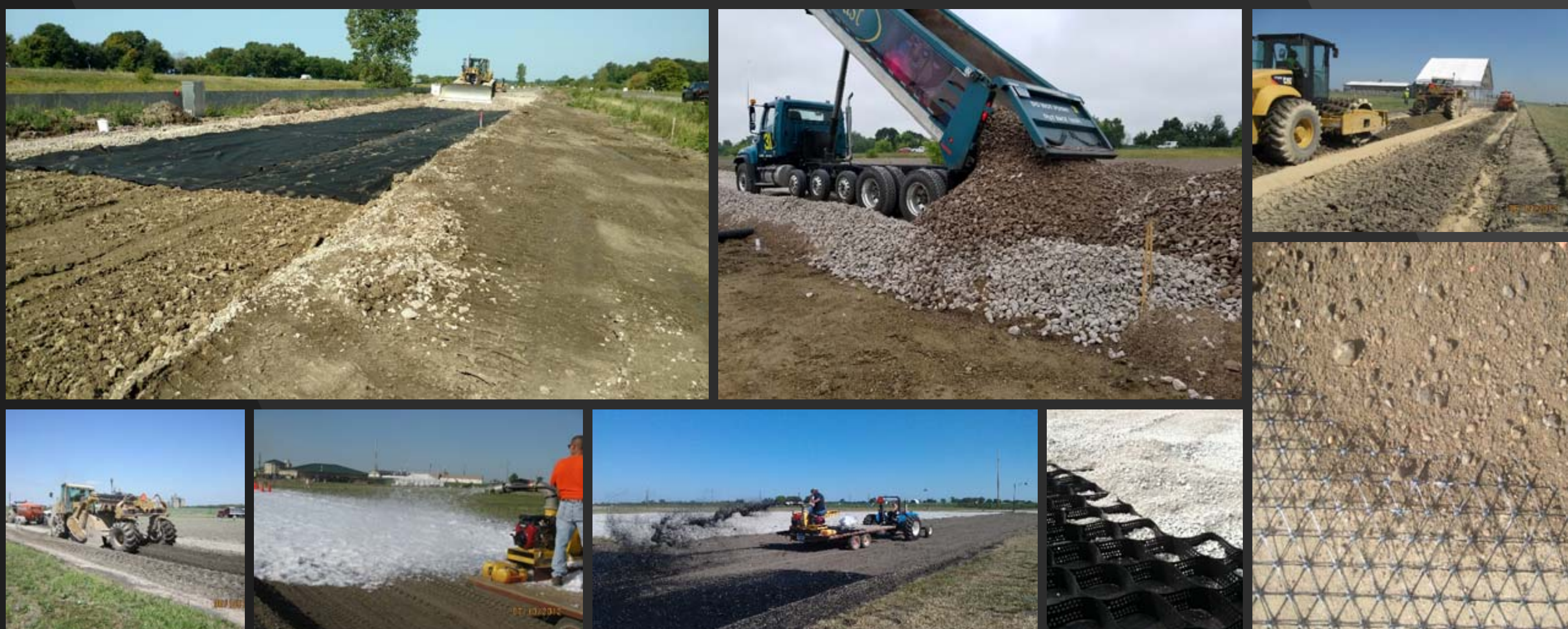
  Analyze new and existing data from the bituminous stabilized FDR, CIR and CCPR mixes on the MnROAD test track facilities to determine appropriate structural layer coefficients for use with the 1996 AASHTO Design Guide.

Strategies to Define and Measure Resiliency of MnROAD Pavement Foundation Systems to Support Need for Extended Pavement Life

- Lead Proposer: David White (Ingios)
- Objective:

  Strategies to define and measure resiliency of MnROAD pavement foundation systems to support the need for extended pavement life

Strategies to Define and Measure Resiliency of MnROAD Pavement Foundation Systems to Support Extended Pavement Life

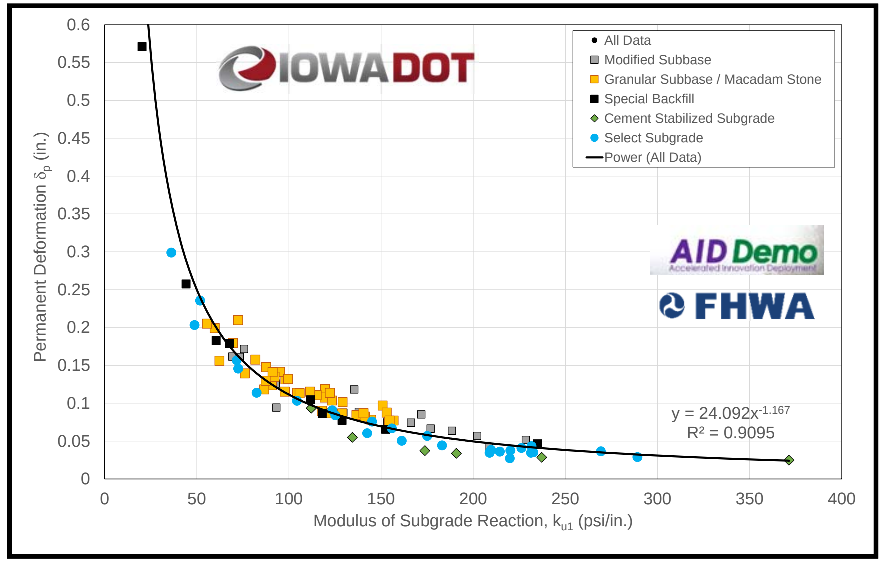


OBJECTIVES AND TASKS

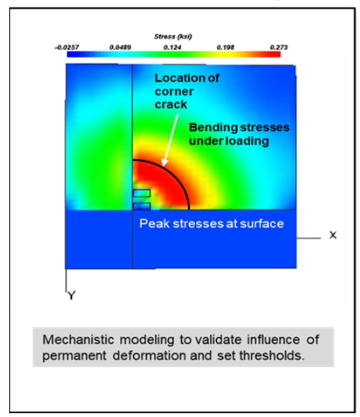
- Define resiliency: R = f(accumulated damage with time)
- Summarize literature on how to define and measure resiliency for pavement foundation systems, with a link to pavement foundation design assumptions and field performance. Recent national and international studies documented assessment of resiliency for pavements, but the influence of foundation layers lacks adequate data.
- Select pavement foundation systems in-service with different foundation stabilizations for characterization of resiliency.
- Investigate relationships between <u>Modulus, Resilient Strain, and Permanent Strain</u> within different pavement foundations, using accelerated load testing. [Note: Goal is to reduce accumulated permanent strain, not necessarily high modulus].
- Initiate a database of parameters assessing resiliency for calibration of ME pavement design models and related to performance for loading and weather events (floods, saturated subgrades, etc.).

VALUE/BENEFIT

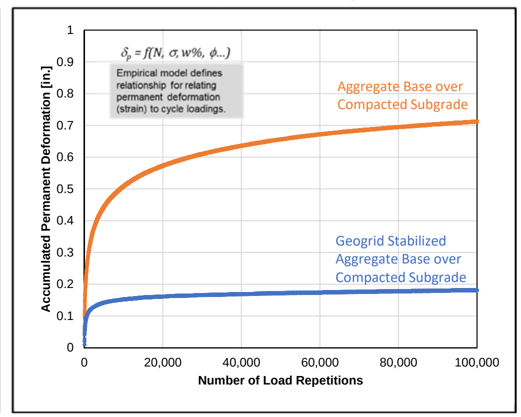
The results from this project can be used to better define resiliency for pavement foundations, obtain data that can be critical in adequately predicting the resilient behavior of pavement structures, and help agencies make informed investment decisions with respect to pavement foundations as part of building new resilient infrastructure.



Mechanistic Modeling



Empirical Modeling



Impact of cement on flexibility of CIR (1/4, ½, 1, 1.5%), both field and Lab

- Lead Proposer: Terry Beaudry and John Bormann (MnDOT)
- Objective:

  Bituminous, whether emulsions or foam asphalt add flexibility to CIR, whilst cement adds strength and lowers flexibility. What is the relationship between these two components? Additionally, what role does % crushing and type of aggregate play? Could be synthesis and/or lab project.

RAB + LSSB Materials- Phase 2

- Lead Proposer: Bora Cetin (MSU) and Raul Velasquez (MnDOT)
- Objective:

  Phase I of this study is just completed. The goal of the Phase II project is to conduct forensic analyses on 11 test sections built and tested previously for this study. These forensic analyses aim to determine changes in index, physicochemical properties, and engineering properties of base and subbase materials tested in the previous phase.

DETERMINING PAVEMENT DESIGN CRITERIA FOR RECYCLED AGGREGATE BASE (RAB) & LARGE STONE SUBBASE (LSSB) MATERIALS-PHASE II

-

BORA CETIN, DEPARTMENT OF CIVIL & ENVIRONMENTAL ENGINEERING, MICHIGAN STATE UNIVERSITY
RAUL VELASQUEZ, MINNESOTA DEPARTMENT OF TRANSPORTATION

Motivation: *First phase is completed and recommends the following:*

- More continuous data collection is required for understanding long term behavior of RAB & LSSB materials
- Forensic analyses are required to understand long term intrinsic properties of these materials.
- Comprehensive thermal and physicochemical analyses are required to better understand the freeze-thaw behavior of these materials

Overall Research Goals:

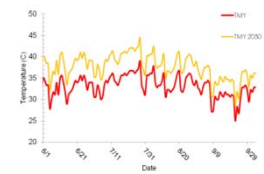
Conduct forensic analyses and more continuous field test on each test section to solve/answer the remaining challenges about the use of these materials in pavement foundation systems.

Causes

Clogging

Long term traffic load

Environmental Influences



Effects

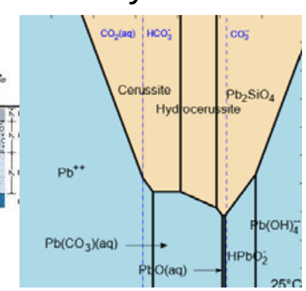
Increased maintenance cost, premature failure

Research Techniques

Forensic Analyses

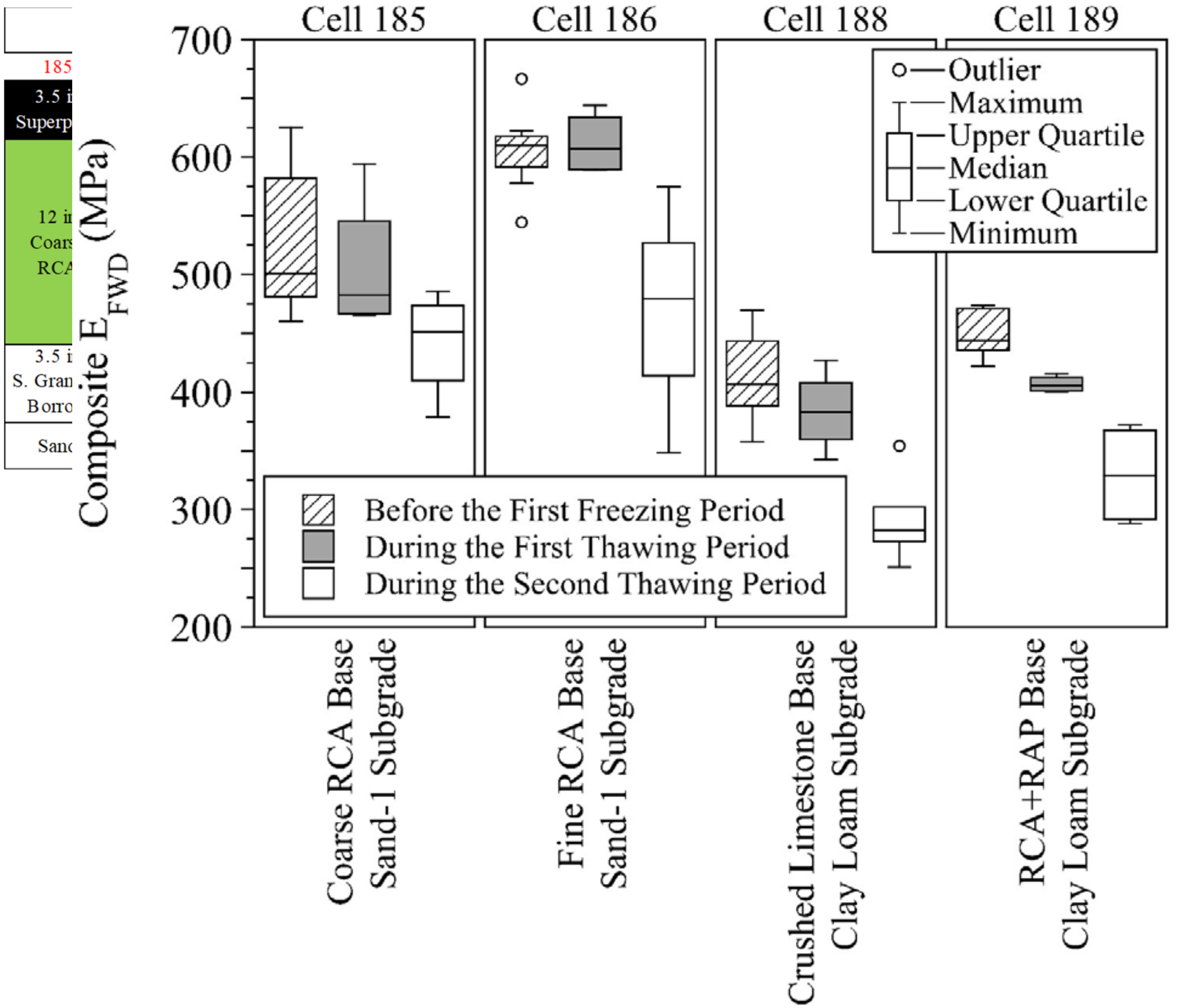
Lab/Field Testing

Geochemical Analyses



OBJECTIVES & TASKS

(1) Continue to run/analyze the FWD, IRI, rutting and other field tests



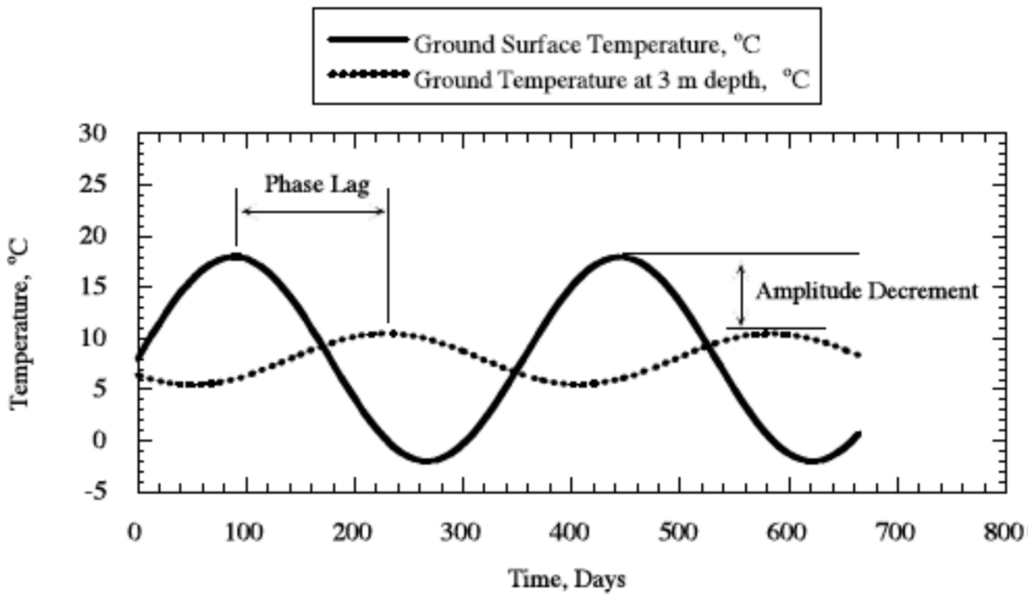
OBJECTIVES & TASKS

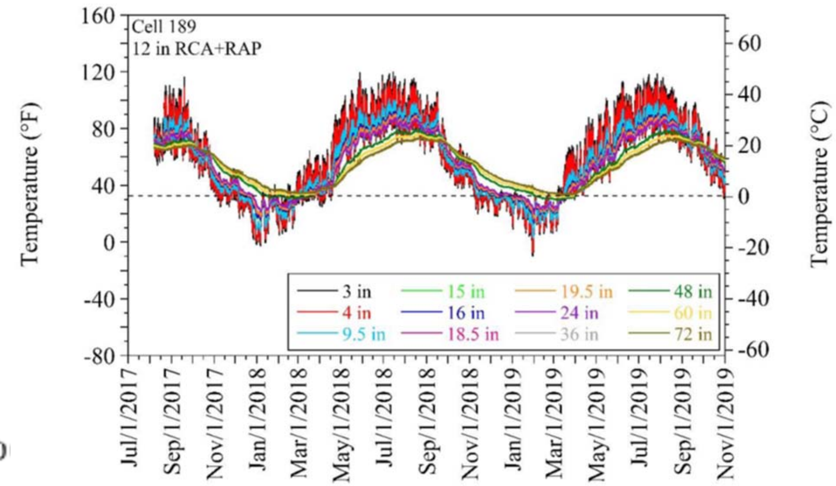
OBJECTIVES & TASKS

(3) In Depth Thermal Analyses

$$T(z,t) = \overline{T} + Ae^{-z\sqrt{\frac{\omega}{2\alpha}}}\sin\left(\omega t - z\sqrt{\frac{\omega}{2\alpha}} + C_4\right)$$

$\overline{T}$ = the average soil temperature
A = the surface amplitude of temperature
ω = the radial frequency $\left(\frac{2\pi}{p}\right)$
p = the period
α = the thermal diffusivity
C_4 = the phase constant

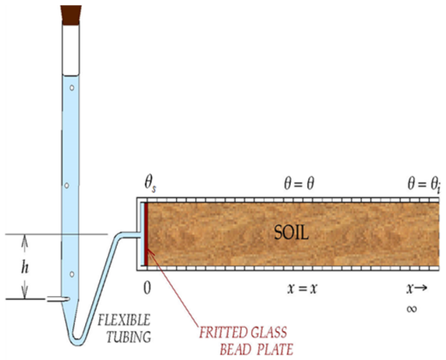




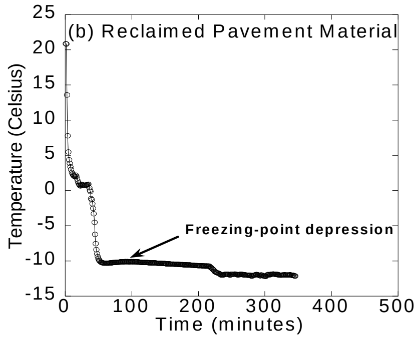
OBJECTIVES & TASKS

(3) In Depth Thermal Analyses

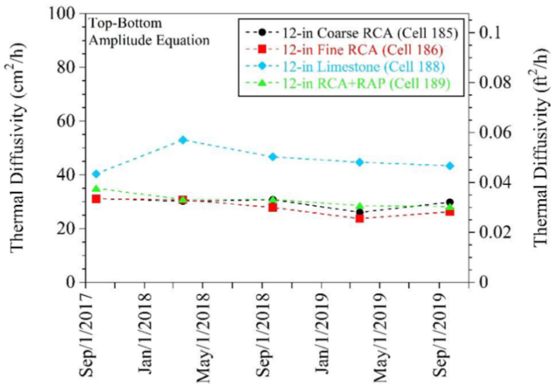
- ❑ Water diffusivity



- ❑ Freezing point depression



- ❑ Thermal conductivity
- ❑ Volumetric specific heat capacity
- ❑ Thermal diffusivity



OBJECTIVES & TASKS

(4) Conduct Forensic Analyses

Forensic Analyses

In-Situ Tests for All Layers:

- ❑ Dynamic cone penetrometer
  - ❑ Thickness check
  - ❑ Shear strength
- ❑ Ground Penetration Radar
  - ❑ Thickness

Material Sampling for Base Layers:

- ❑ Core 6 x 12 inches samples
  - ❑ Permeability
  - ❑ Resilient modulus
- ❑ Regular Shelby tube samples
  - ❑ Gradation changes
  - ❑ Tufa formation (for RCAs in particular)-geochemical analyses
  - ❑ Creep behavior (for RCAs and RAP in particular)

Sampling for LSSB Layers:

- ❑ Geo-Endoscopic Imaging
  - ❑ Thickness
  - ❑ Subgrade Migration
  - ❑ Gradation
- ❑ Geosynthetics
  - ❑ Clogging Ratio
  - ❑ Puncture/fracture damage
  - ❑ Apparent opening size measurement (AOS)

OUTCOMES/BENEFITS

- Long Term Field Evaluation of RAB and LSSB Performances
  - Freeze-thaw durability
  - Stiffness
  - Strength
  - Permeability
  - Creep/compressibility
- Guidance on the following:
  - Evaluation/prevention of tufa information
  - Evaluation/prevention of subgrade soil migration into LSSB
  - Selection of geosynthetics for the use of LSSB
  - Evaluation of changes in gradation and angularity
- Long Term Resilient Modulus and Permanent Deformation Data for Pavement ME calibration

NeoPave
(Plastic additives to CIR)

- Lead Proposer: MidState
- Objective:

  Demonstrate and test this application claims of additional strength and longer life

What if we could convert single-use waste into long-term infrastructure performance?

NEO

When Two Challenges Converge, An Opportunity Emerges

CHALLENGE 1

Reduce Plastic Waste

14%

311 million tons of plastic are produced annually worldwide.[1]

Only 14% is collected for recycling.[1]

Melting is the most common recycling process, but it degrades the plastic with each sequence. After 10 lifetimes, the material is no longer useful.

86% of plastic is lost, landfilled, or incinerated.

Chemical Recycling

Alternatively, a chemical process can use difficult-to-recycle PET from post-consumer and some post-industrial streams. In a depolymerization process, thermoplastic polymers are rebuilt on a molecular level, producing a stronger material. This ingredient is used to create NEO.

CHALLENGE 2

Rebuild Road & Highway Infrastructure

20%

20% of the 4.18 million miles of US roads are in poor condition.[2]

California has 51,000 state highway miles and 335,000 local street miles, with 6% in poor condition.[3]

Traditional road reconstruction mills off the top several inches of distressed pavement and lays new asphalt in its place.

This produces 42 truckloads per lane mile of waste asphalt, and requires 42 truckloads of new asphalt with virgin aggregate.

Cold-In-Place Recycling

Cold-in-place recycling reuses 100% of the existing roadway in-place, at ambient temperatures, eliminating the need for virgin aggregate and the environmental and structural damage from unnecessary hauling.

The Opportunity:

NEO recycles 100% of an existing roadway in-place, creating a completely new category of plastic pavement.

- Lasts 2 – 3X longer than traditional asphalt
- 5X tensile strength & greater flexibility than asphalt
- Avoid distresses like rutting and reflective cracking
- Deliver at least 50% life cycle savings to taxpayers

Upcycle plastic waste to build the safest, most sustainable pavement on the planet.

- Recycles 150,000 plastic bottles per lane mile
- 90% reduction in greenhouse gas emissions
- 6X reduction in energy requirements
- Zero use of virgin aggregate
- Zero leaching or negative impact on water, air, or soils, with no creation of microplastics

1 **EPA Plastics: Material-Specific Data** – *https://www.epa.gov/facts-and-figures-about-materials- waste-and-recycling/plastics-material-specific-data*
2 **ASCE Infrastructure Report Card** – *https://www.infrastructurereportcard.org/cat-item/roads*
3 **LAO California Tranportation System Report** – *https://lao.ca.gov/Publications/Report/3860*

Sean Weaver – Founder and President | sean@neopave.com

Evaluation to replacement of non-granular subgrade with sand vs using geosynthetics or chemical stabilization

- Lead Proposer: Terry Beaudry and John Bormann (MnDOT)
- Objective:

  Some States use a very thick subbase or sand layer under their bases, evaluate whether other methods such as using geosynthetics or chemical stabilization would be more cost effective.

Long term evaluation of wicking geotextiles for improving drainage and stiffness of road foundation

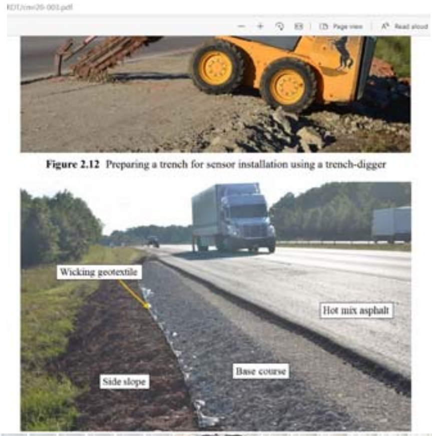
- Lead Proposer: David White (Ingios), Tom Fennessey (MoDOT), Terry Beaudry (MnDOT), and Raul Velasquez (MnDOT)
- Objective:

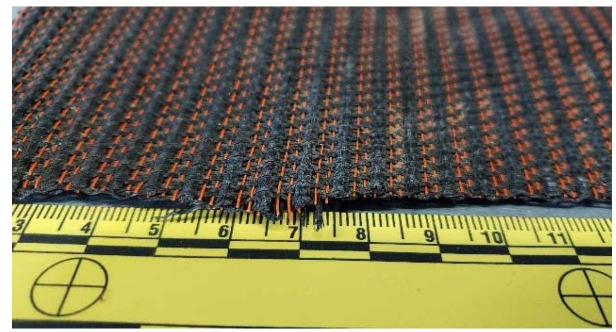
  Evaluate performance benefit (*both stiffness and drainage*) of wicking geosynthetic using accelerated load testing and MnROAD. Research studies completed are limited on this recently developed technology and what is available focuses on the drainage capabilities only and in the short-term performance.

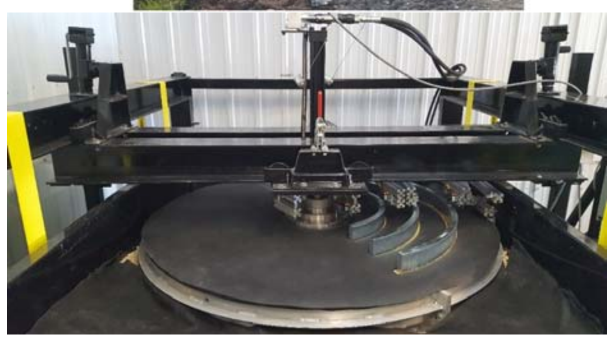
Performance evaluation of wicking geotextiles for improving drainage and stiffness of road foundation

NRRA
National Road Research Alliance

MoDOT







OBJECTIVES AND TASKS

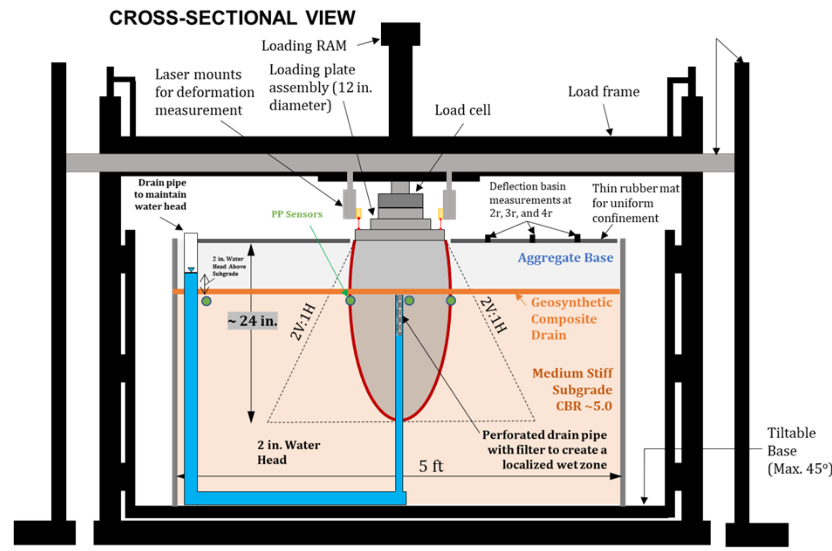
A. Review literature to summarize performance studies that incorporate wicking geosynthetics (example projects in Missouri and Alaska). Specific performance details to extract include moisture content variations over time, rutting/permanent deformation, and performance in areas with freeze/thaw and wet/dry cycles.

B. Perform set of accelerated laboratory tests with a large-scale box study to evaluate the performance benefit of geosynthetic products relative to a control section with no geosynthetic subject to controlled drainage and cyclic load testing.

C. At MnROAD perform direct field testing on new and in-serve pavement sections with wicking geosynthetics, to evaluate mechanistic pavement design input parameters (e.g., stress-dependent resilient modulus), foundation layer permanent deformation during wet seasons, and long-term moisture control in the foundation layers.

VALUE/BENEFIT

The results from this project would be used to quantify the benefit of using wicking geosynthetics in terms of long-term performance and providing an enhanced design input parameter for pavement design engineers.



Evaluation of gravel stabilizers for use on gravel shoulders and gravel roads

- Lead Proposer: Terry Beaudry and John Bormann (MnDOT)
- Objective:

  Gravel stabilizers used on gravel roads have lowered maintenance cost for gravel roads by 50%. Evaluate their use in gravel shoulders.

Approaches for Incorporating Pavement Foundation Solutions into Pavement System Life Cycle Cost Analysis (LCAA)

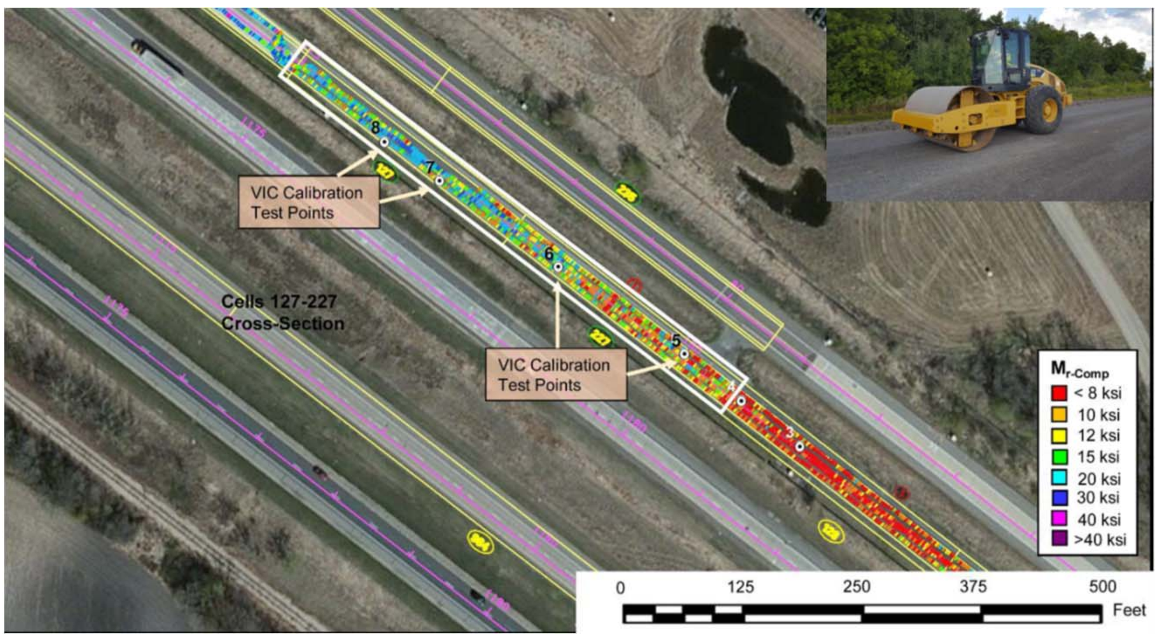
- Lead Proposer: David White (Ingios)
- Objective:

  Approaches for incorporating pavement foundation solutions into pavement system Life Cycle Cost Analysis (LCAA)

Use of IC for QA of base/subbase/subgrade construction with emphasis on assessing spatial variability of both stiffness and moisture

- Lead Proposer: Terry Beaudry and Raul Velasquez (MnDOT)
- Objective:

  Assessment of spatial variability of stiffness and moisture of foundation and its implication to performance.



*White and Vennapusa 2017

Use of Low-Density Cellular Concrete in Column-Supported Embankment Design

- Lead Proposer: Kevin Kangas (Northstar Cellular Concrete)
- Objective:

  Replace geosynthetic reinforced fill with a lightweight foamed cellular concrete fill. The LDCC would introduce less overburden on columns and surrounding soils.

Evaluation of geotextiles for use on gravel shoulders and gravel roads

- Lead Proposer: Terry Beaudry and John Bormann (MnDOT)
- Objective:

  Evaluate the use of geosynthetics for gravel shoulders.

Profile mill of FDR prior to paving HMA / PCC

- Lead Proposer: Deepak Maskey (Caltrans), Terry Beaudry and John Bormann (MnDOT)
- Objective:

  How does profile milling impact final ride of an FDR project, both for HMA or PCC pavements?

Determine difference in CIR/CCRP mix properties using 75-Blow Marshall compaction compared to 30 gyration SuperPave Gyratory Compaction

- Lead Proposer: Stephen Cross (ARRA)
- Objective:

  Evaluate the difference and variability between density, air voids wet and dry Marshall Stability and wet and dry Indirect Tensile Strength of laboratory and field produced CIR/CCPR mixtures.

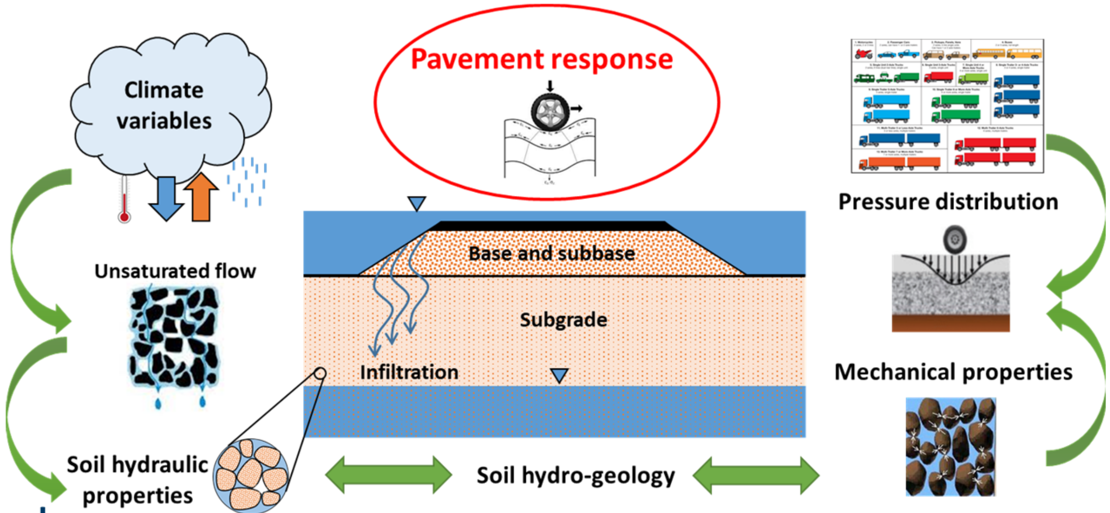
Flooded Pavements Assessment App–Phase II

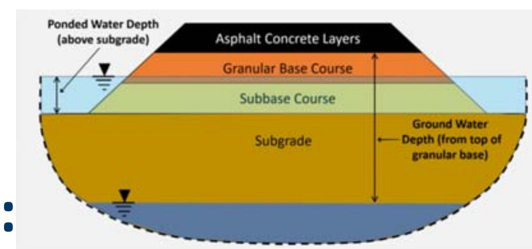
- Lead Proposer: Majid Ghayoomi and Eshan Dave (UNH)
- Objective:

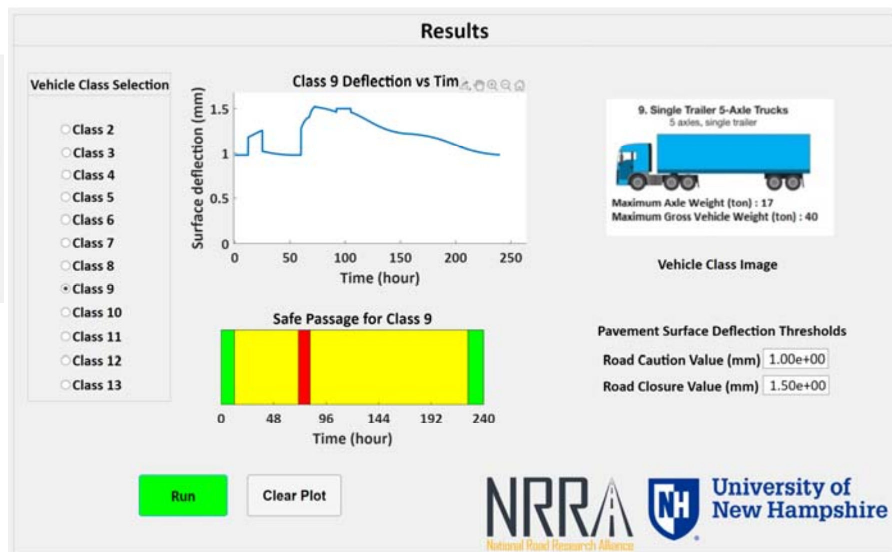
  Enhance and amplify post-flooding toolkit . Calibration and validation campaign at different scales to provide a balanced practical approach.

Flooded Pavement Assessment App
Phase II

- Post-flooding Pavement Response Assessment:
  - Mechanistic
  - Coupled and Dynamic
  - Forecasted
  - Tiered I/O (Expert) Levels



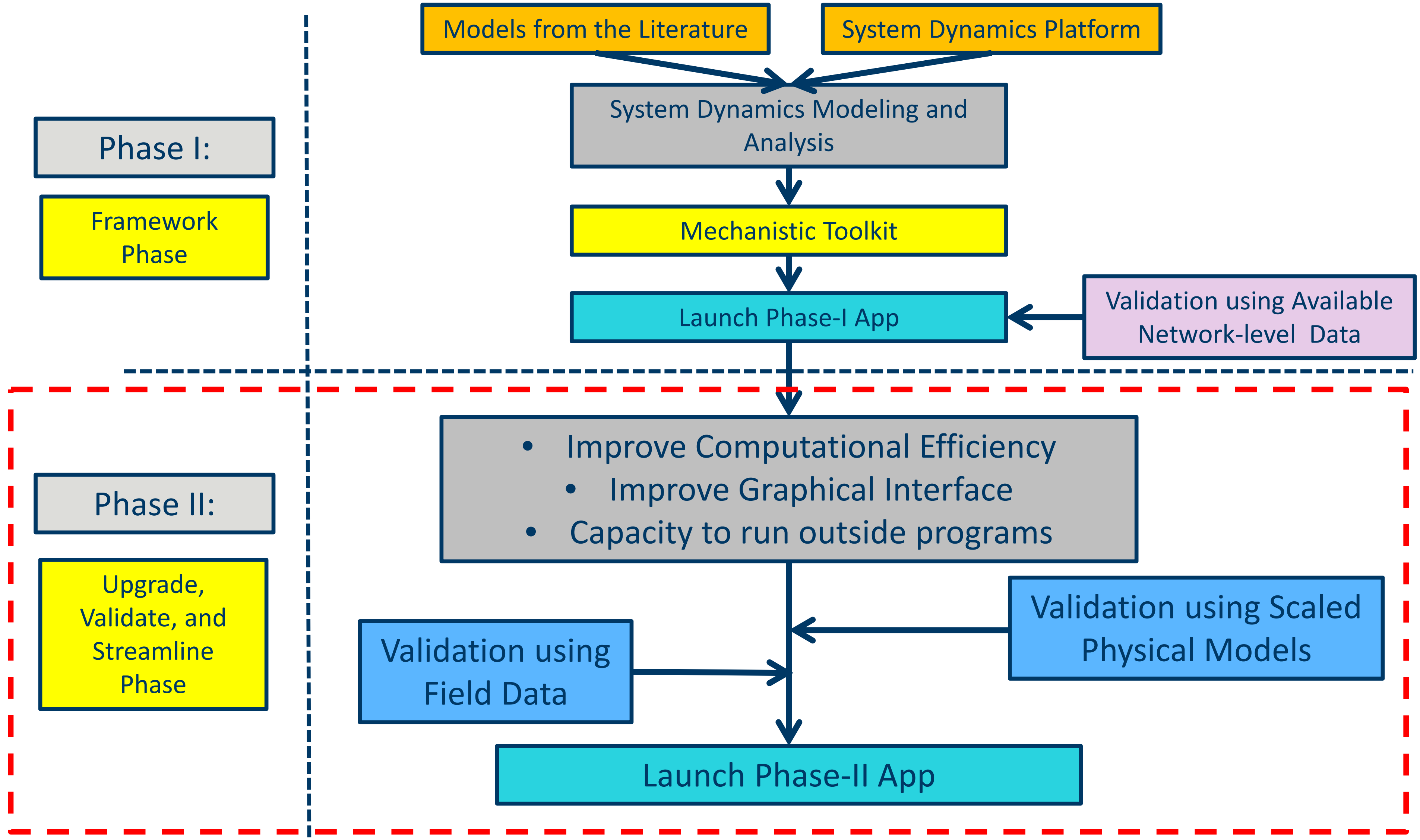




- **Phase II Goal:**

Enhance and amplify the recently developed post-flooding roadway assessment App

Flooded Pavement Assessment App Phase II



Bio-Mediated Soil Improvement Strategies for Pavement Subgrades and Slopes

- Lead Proposer: Majid Ghayoomi (UNH)
- Objective:

  Investigation of feasibility and application of bio-mediated soil stabilization techniques for non-disruptive improvement of pavement systems and slopes.

Bio-mediated Soil Improvement Strategies for Unbound Pavement Layers and Slopes

- **Biologically mediated soil stabilization**
- More sustainable alternative:

1. *Environmental Friendly: less chemical stabilizers*
2. *Energy Efficient: less effort for production and installation*
3. *Adaptable to existing systems: avoid major construction*
4. *Applicable to coarse/fine soils: Water-based treatment media*

- Recent application growth in different geo-sectors, but limited focus on transportation geotechnics, specially in **larger scale**

- It can be used both for subgrade stabilizations and roadside slopes

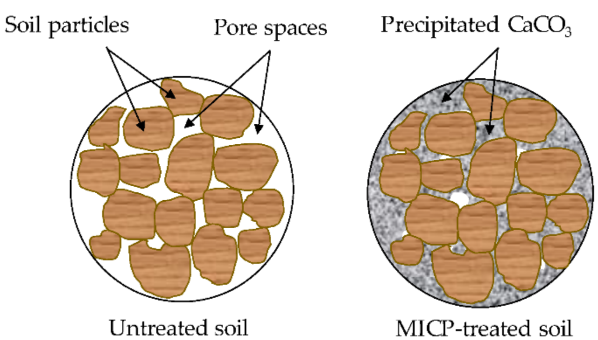
Bio-mediated Soil Improvement Strategies for Unbound Pavement Layers and Slopes

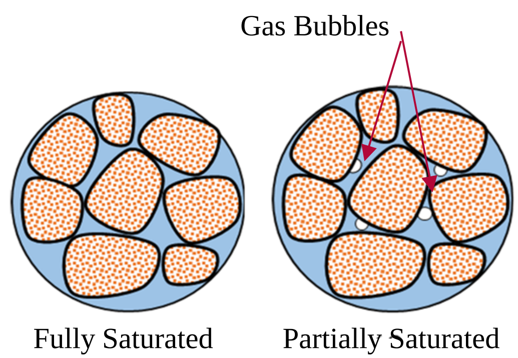
	Biomediated process	Calcite precipitation process
MICP	$CO(NH_2)2 + 2H_2O \rightarrow 2NH_4^+ + CO_3^{2-}$	$Ca^{2+} + CO_3^{2-} \rightarrow CaCO3$
MIDP	$1.25CH_2O + NO_3^- \rightarrow 0.5N_2 \uparrow + 1.25CO_2 + 0.75H_2O + OH^-$	$Ca^{2+} + CO_2 + 2OH^- \rightarrow CaCO_3 + H_2O$

Microbial induced calcite precipitation (MICP)

Microbial induced desaturation and precipitation (MIDP)

Traditional Methods





Laboratory Material Testing and Modeling

System Level Numerical Modeling

Scaled Physical Modeling

Efficiency, Ranking, and Life Cycle Assessment

Field Trials

Improving Freeze-Thaw Resistance of Pavement Foundation Systems via Engineered Water Repellency

- Lead Proposer: Bora Cetin (MSU)
- Objective:

  The overarching goal of this proposal is to evaluate the use of water repellent agents to mitigate frost heave-thaw settlement and freeze-thaw weakening of frost susceptible pavement foundation layers (subgrade soils in particular).

IMPROVING FREEZE-THAW RESISTANCE OF PAVEMENT FOUNDATION SYSTEMS VIA ENGINEERED WATER REPELLENCY

BORA CETIN, DEPARTMENT OF CIVIL & ENVIRONMENTAL ENGINEERING, MICHIGAN STATE UNIVERSITY

Motivation:

- Freeze-thaw cycles cause approximately 2 billion dollars annual maintenance costs for pavements
- These environmental cycles are more damaging in areas where soil is frost susceptible and groundwater table level is high (e.g. northern plains).
- Conventional remediation/stabilization techniques are inadequate in the long term and may pose some environmental concerns depending on geographical location.

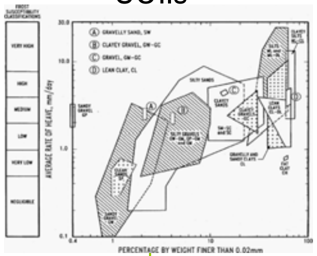
Overall Research Goals:

Evaluate the use of different types of water repellent agents to mitigate frost heave-thaw settlement and freeze-thaw weakening of frost susceptible pavement foundation geomaterials (subgrade soils in particular)

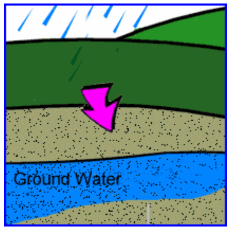
Causes

Freezing Air Temperature

Frost Susceptible Soils



Water Supply



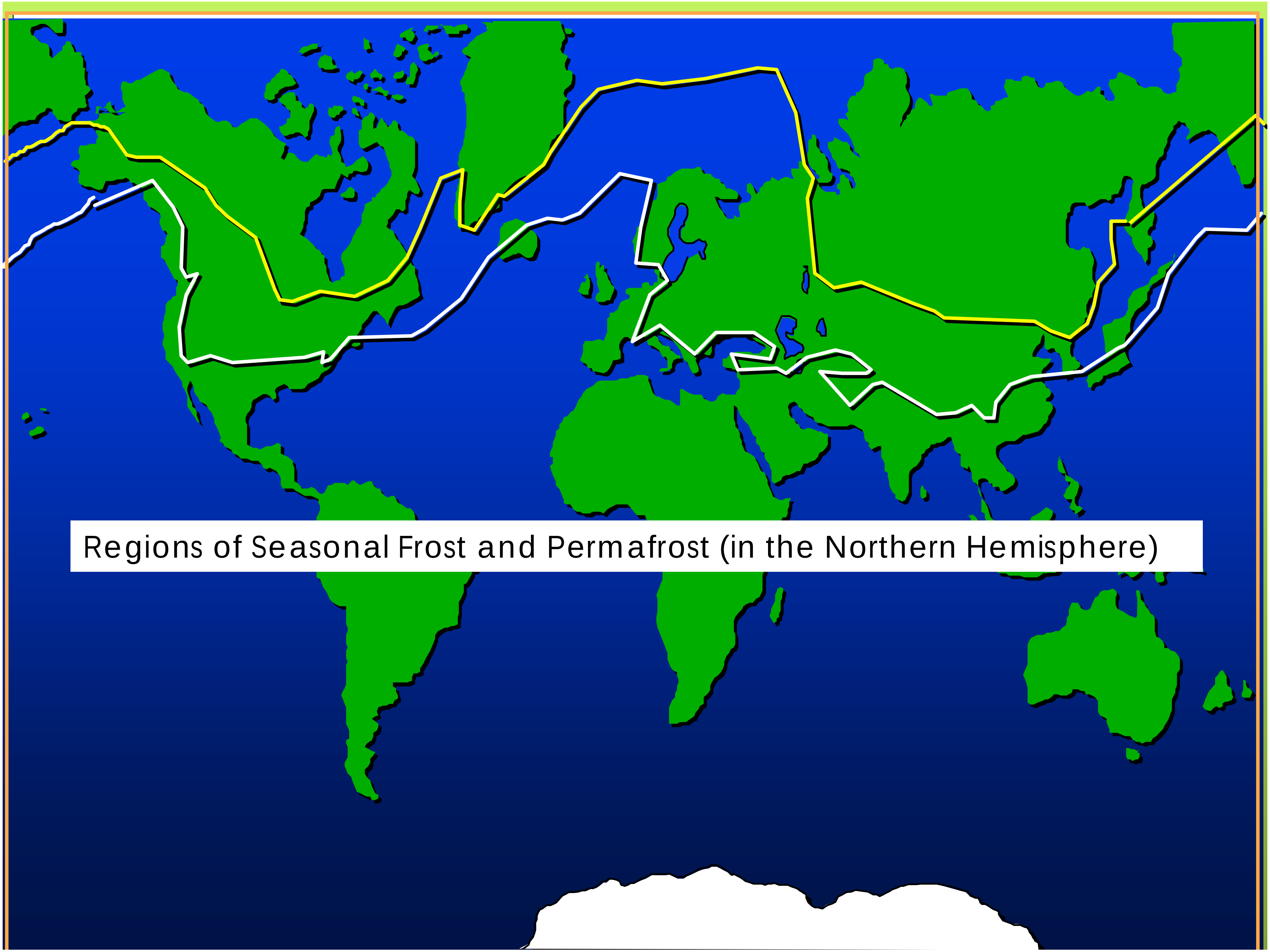
Effects

Research Techniques

Treatment Methods

Laboratory Testing

Cost Analyses


Regions of Seasonal Frost and Permafrost (in the Northern Hemisphere)

Problem Statement & Proposed Solution

Three basic requirements for frost action:

- ~~Freezing temperatures~~
- Water availability ✓
- ~~Frost-susceptible soils~~

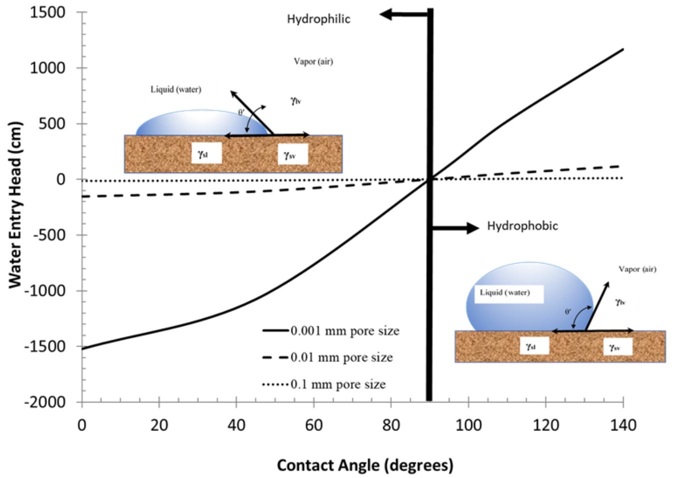
OBJECTIVES & TASKS

(1) Collect and Characterize Subgrade Soils

- ❑ Conduct index & engineering tests on soils



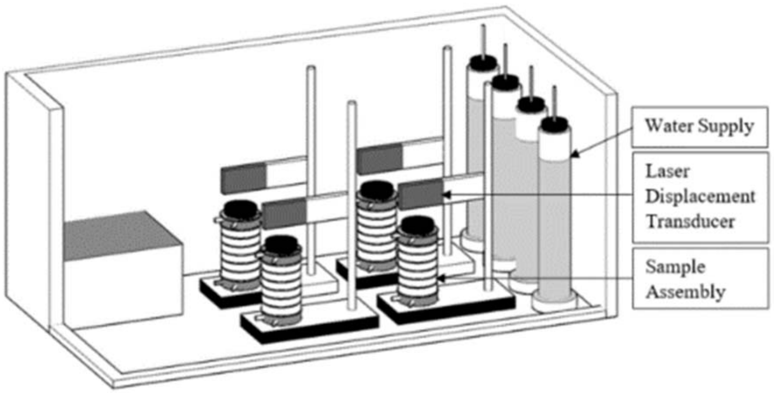

- ❑ Conduct contact angle tests on untreated/treated soils

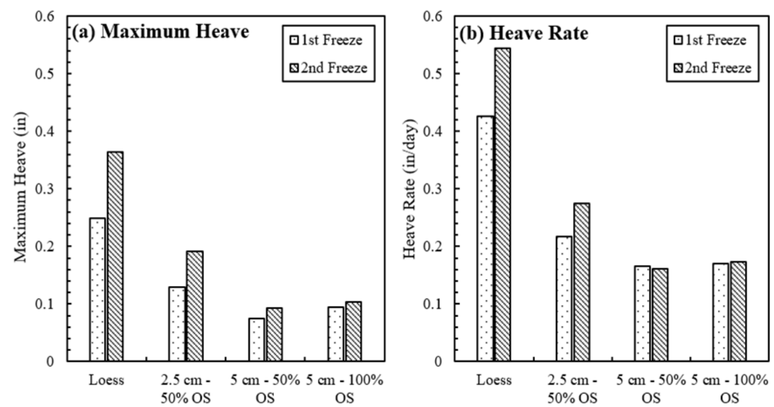


OBJECTIVES & TASKS

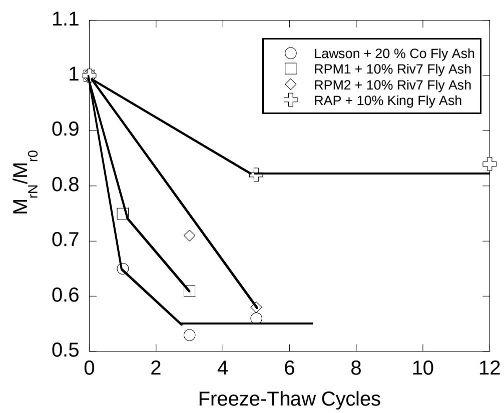
(2) Perform Laboratory Tests on Untreated/Treated Soils

- ❑ Frost Heave-Thaw Settlement Tests





- ❑ Conduct Freeze-Thaw Weakening Tests



Notes: RPM= Reclaimed Pavement Material, RAP=Recycled Asphalt Pavement, M_{rN}=Resilient modulus after N number freeze-thaw cycles, M_{r0}=Resilient modulus of original material

OBJECTIVES & TASKS

(3) Cost Analyses

Benefit category	Are the benefits quantifiable?	How will these benefits be quantified?
Construction Savings	Yes	Comparing the costs of each treated material
Operation & maintenance saving	Yes	Comparing the performances of each treated material
Improved life-cycle cost	Yes	Comparing the life-cycle cost of each treated material

OUTCOMES/BENEFITS

- Evaluation of the Performances of the Treated Specimens with Water Repellent Agents
  - Contact angle
  - Stiffness
  - Frost heave-thaw settlement

- Provide information for future field implementation:
  - List of available water repellent agents
  - Suggestions for the selection of these agents per subgrade type
  - Suggestions about the application methods and rates of these agents

The use of geotextiles or geogrids, versus emulsions or gravel stabilizers, versus no stabilization on performance of FDR

- Lead Proposer: Terry Beaudry and John Bormann (MnDOT)
- Objective:

  How do geotextiles or geogrids perform in relationship to bituminous or cement stabilized FDR?

Towards a recycled base layer with optimum drainage, stiffness, and strength

- Lead Proposer: Raul Velasquez (MnDOT).
- Objective:

  Optimization of RAP (hydrophobic)+ RCA (hydrophilic) blends for balanced performance.

*Bora et al., 2021

Agenda

1. Welcome and Introductions
    - New Members/New Attendees Introduction
2. General NRRA Update
    - Review of 2021-2022 NRRA Research and MnROAD Construction Request Timeline
3. Sharing Surveymonkey for Ideas Ranking - All Members
4. *Elevator Pitch* Presentations from Idea Champion(s)
5. *<u>Questions/Requests</u>*