Improve Material Inputs into Mechanistic Design Properties for Reclaimed HMA & Recycled Concrete Aggregate (RCA) Roadways

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NRRA Members (Agency Partners)

- MnDOT
- Caltrans
- MDOT
- Illinois DOT
- LRRB
- MoDOT
- WiscDOT
- Iowa DOT
- Illinois Tollway

NRRA Members (Industry Partners)

- Aggregate and Ready Mix (Association of MN)
- APA
- Braun Intertec
- CPAM
- Diamond Surface Inc
- Flint Hills Resources
- IGGA
- MIDSTATE (Reclamation and Trucking)
- MN Asphalt Pavement Association
- Minnesota State University
- NCP Tech Center
- Road Scanners
- University of Minnesota-Duluth
- University of New Hampshire
- MATHY
- 3M
- Paviasystems
- Michigan Tech
- University of Minnesota
- NCAT
- GSE Environmental
- HELIX
- Ingios
- WSB
- Cargill
- PITT Swanson Engineering
- INFRASENSE
- Collaborative Aggregates LLC
- American Engineering Testing, Inc.
- CTIS
- ARRA
- 1st
- O-BASF
- North Dakota State University
- All States Materials Group

Pavement ME

- Requires several inputs
  - Hourly climate data, materials, location, pavement structure, traffic
- Calculates pavement performance parameters
  - Asphalt – IRI, Rutting, and Longitudinal, Thermal, and Alligator Cracking
  - Concrete – IRI, Transverse Cracking, Joint Faulting

Figures from:
http://www.aashtoware.org/Pages/default.aspx
http://www.pavementinteractive.org/article/Rutting/
http://brc-amps.wikidot.com/brc-road-condition-assessment-manu
http://blackdiamondpaving.com/terms-you-should-know/

MEPDG Analysis Process

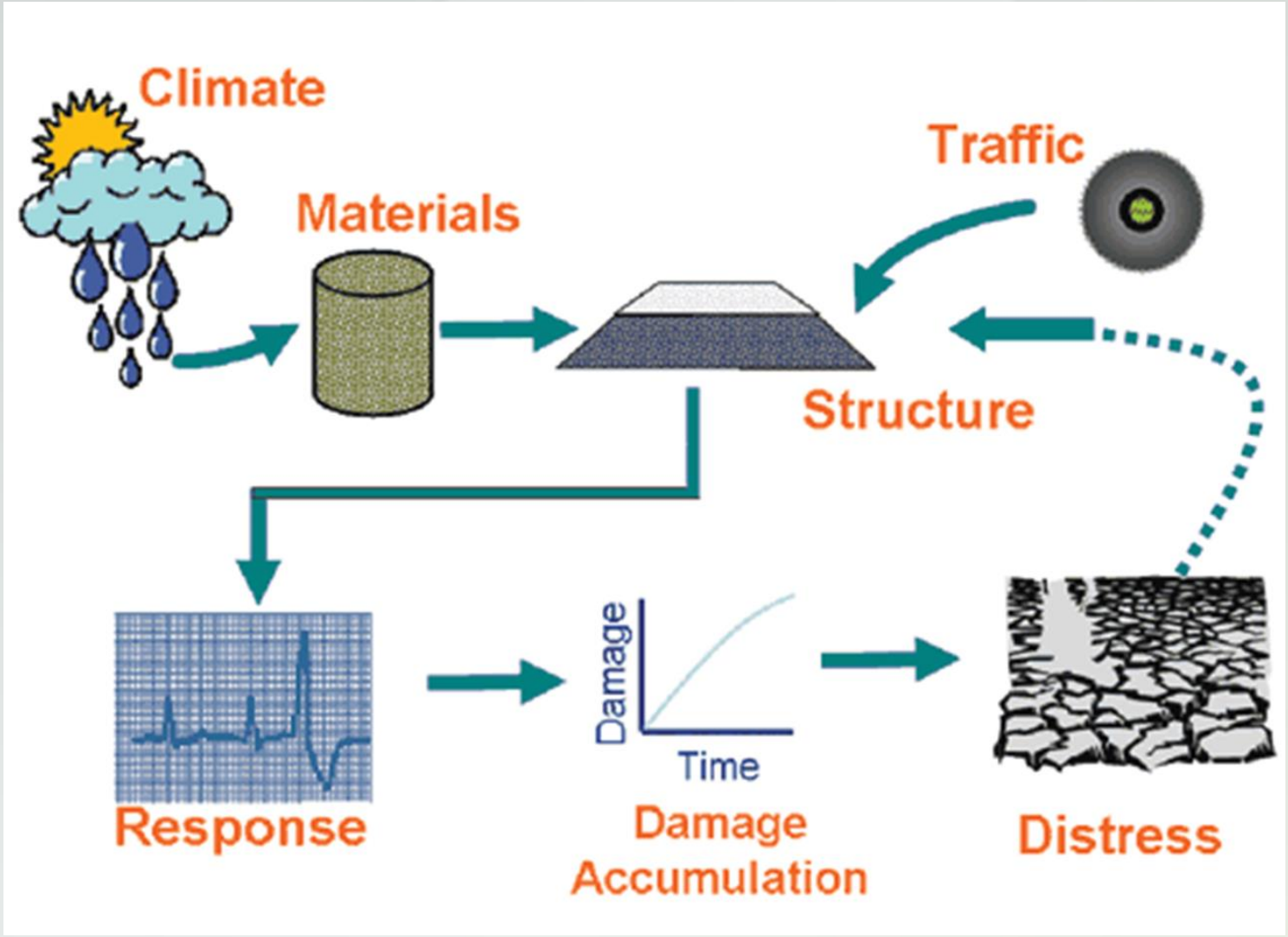
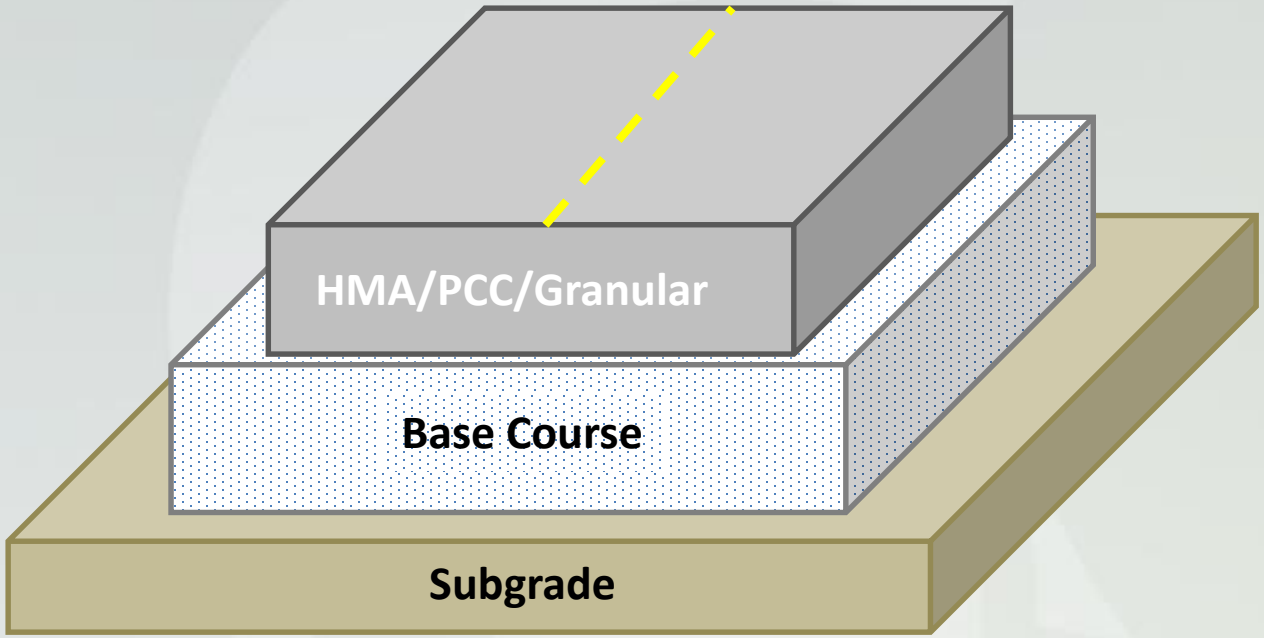


Figure from http://www.fhwa.dot.gov/pavement/concrete/cptu603.cfm

MATERIALS INPUT



MATERIALS INPUT

Range of Materials

Unbound Materials

Fine-Grained Soils

Recycled Concrete Aggregate

Reclaimed Pavement Material

Stabilized Soils

Macadam

MATERIALS INPUT FOR PAVEMET ME

Strength/Stiffness Parameters:

- Resilient Modulus (M_R)
- California Bearing Ratio (CBR)
- Unconfined Compressive Strength (UCS)

Index Parameters:

- Gradation Characteristics
- Absorption Content
- Binder Content
- Density
- Angularity
- Void Ratio

OBJECTIVES

1st Goal – Collection of Material Input Data

- M_R, CBR, UCS of RAP & RCA
- Index properties
  - Gradation
  - Density
  - Angularity
  - Absorption

2nd Goal – Sensitivity Analyses on Pavement Performance

Overview of Research Plan

- **Task 1** – Initial Memorandum on Expected Research Benefits and Potential Implementation Steps
- **Task 2** – Data Collection
- **Task 3** – Sensitivity Analyses
- **Task 4** – Final Report

Task 1 - Initial Memorandum on Expected Research Benefits and Potential Implementation Steps

Benefit category	How?
Construction Savings	***Proper Pavement Thickness Design***
Operation & maintenance saving	***Better Pavement Performance Prediction***
Improved life-cycle cost	***Proper Use of Recycled Material Use***

IMPLEMENTATION

1. Final Report
   - Material Database
     - M_R, CBR, UCS
     - Gradation characteristics
     - Construction guidance
   - Executive summary

TASK 2 – DATA COLLECTION

List of data that will be collected:

- Index Properties
  - Gradation characteristics
  - Atterberg limits
  - Absorption
  - Binder content
  - Density
  - Void ratio
- Strength/Stiffness Properties
  - CBR
  - UCS
  - M_R
- Construction Specifications

Task 3 – Sensitivity Analyses

Normalized Sensitivity Index (NSI)

$$NSI = \frac{\left(\frac{\Delta Y}{DL}\right)}{\left(\frac{\Delta X}{X}\right)}$$

ΔY = the change in pavement performance due to change in design input

DL = the design limit for the pavement performance

ΔX = the change in the design input from the baseline X

X = the base line design input

Task 3 – Sensitivity Analyses

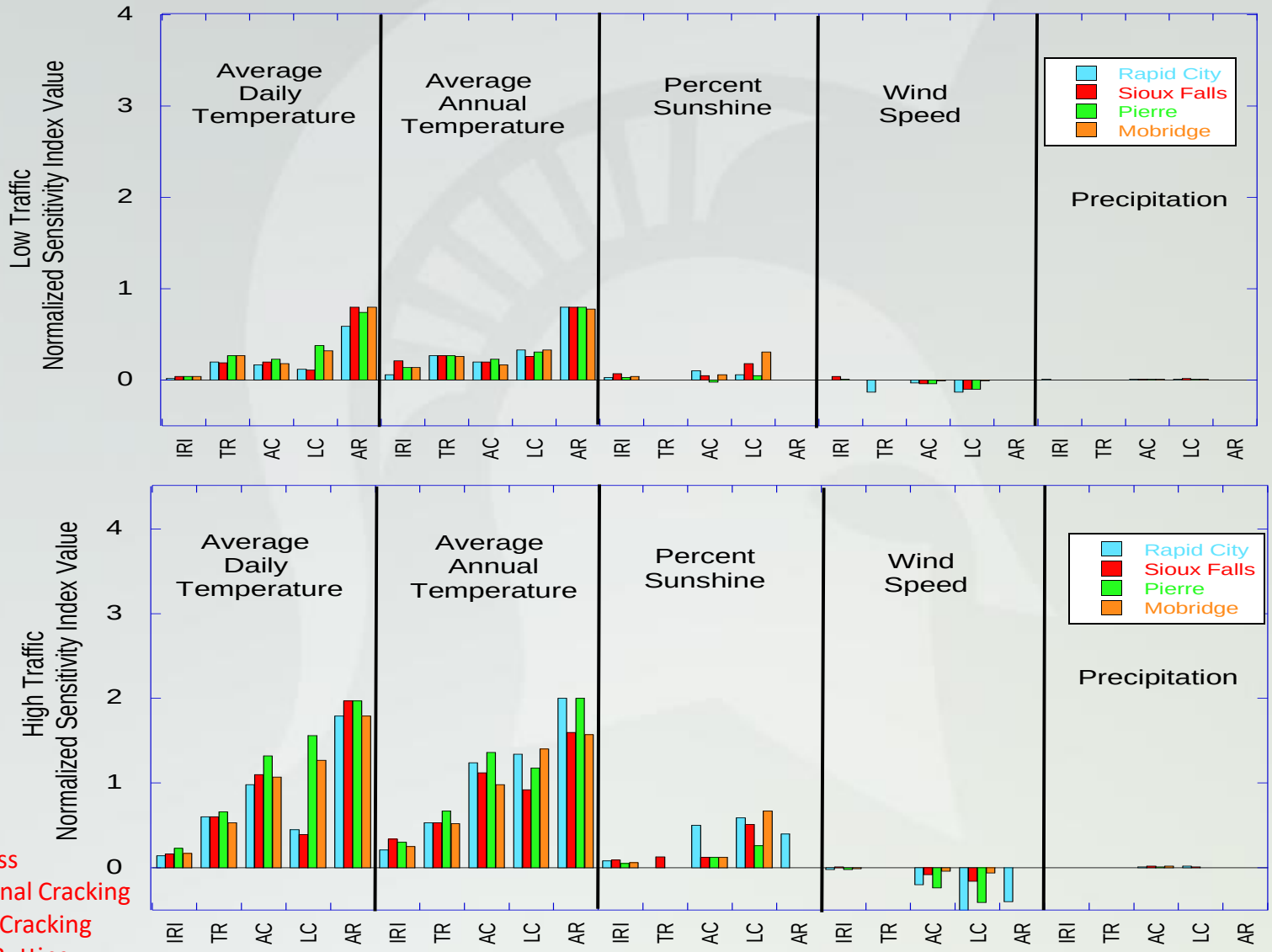
MATERIAL INPUT	TREATMENTS
M_R of RCA & RAP	25% of the average M_R over the entire M_R database is added/subtracted from each M_R value.
CBR and/or UCS	25% of the average CBR/UCS over the entire CBR/UCS database is added/subtracted from each CBR/UCS value.

Task 3 – Sensitivity Analyses
Pavement Distresses Analyzed

Pavement Type	Pavement Distress
AC	IRI (in./mile)
	Thermal Cracking (ft/mile)
	AC Rutting (in.)
	Total Rutting (in.)
	Alligator Cracking (%)
	Longitudinal Cracking (ft/mile)
JPCP	Transverse Cracking (% slabs)
	Joint Faulting (in.)
	IRI (in./mile)

Task 3 – Sensitivity Analyses

Pavement Distresses Analyzed



IRI = Roughness
LC = Longitudinal Cracking
AC = Alligator Cracking
AR = Asphalt Rutting
TR = Total Rutting

TASK 4

Draft/Final Report

SCHEDULE

Task No.	Months									
	1	2	3	4	5	6	7	8	9	10
1										
2										
3										
4										

PRODUCTS & DELIVERABLES

- Quarterly progress reports as required
- Draft final report
- Final report
- Technology transfer brief
- A copy of the executive final presentation

AGENCY ASSISTANCE

- Access to related data from agencies database (e.g. research reports and pavement design guidelines)