SHRP2 R21 Composite Pavement Systems – Project Overview

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MnROAD Open House

SHRP2
STRATEGIC HIGHWAY RESEARCH PROGRAM

TRANSPORTATION RESEARCH BOARD
OF THE NATIONAL ACADEMIES

R21. Composite Pavement Systems

Prime contractor: Applied Research Associates, Inc.
Sub contractors: U. Minnesota, Mn/DOT, U. California, U. Pittsburg
Key Staff: Darter, Rao, Khazanovich, Von Quintus, Harvey, Signore, Worel, Clyne, Watson, Vandenbossche, Tompkins

Duration: 48 months
Contract Start Date: September 2007

This project focuses on two applications of intentionally designed composite pavement systems:

1. Asphalt over concrete (JPC, CRC, RCC)
2. Concrete surface over concrete (wet on wet)

R21. Composite Pavement Systems (Objectives)

– Determine the behavior and identify critical material and performance parameters
– Develop and validate mechanistic-empirical performance models and design procedures consistent with the Mechanistic-Empirical Pavement Design Guide (MEPDG)
– Recommend specifications, construction techniques and quality management procedures and guidelines

European Survey of Composite Pavements

- Europe has built composite pavements for many years
- Why?
  - Excellent surface characteristics
    - High friction
    - Low tire/pavement noise
    - Low splash and spray
    - Rapid renewal (asphalt)
    - Long life (concrete)
  - Economical (**Yes, believe it or not**)
    - Lower layer: thick and low cost (e.g. recycled, low cement, etc.)
    - Upper layer: thin and high quality (e.g. hard aggregate, high cement)
  - Sustainable
    - Recycled lower PCC layer
    - Lower cost aggregates
    - Rapid renewal of top HMA layer

European Survey of Composite Pavements

- Netherlands
- Germany
- Austria

Report published as an online document

http://www.trb.org/Main/Blurbs/2008_Survey_of_European_Composite_Pavements_163693.aspx

Construction of HMA/PCC Test Sections at UCPRC for HVS Testing

Test cells constructed at University of California Pavement Research Center in Davis, CA for accelerated Heavy Vehicle Simulator (HVS) testing

- Subgrade and base constructed Fall 2008.
- JPCP constructed August 2009.
- Extensive instrumentation done at same time.
- HMA construction (and instrumentation) in October 2009.
- Currently being tested using the HVS to obtain pavement responses and measure distresses (rutting, reflection cracking).

Layout of Test Cells at UCPRC

A	HMA Mix 1 –114 mm PCC 178 mm Dowel	HMA Mix 1 – 64 mm PCC 178 mm Dowel	No HMA PCC 178 mm Dowel
B	HMA Mix 1 –114 mm PCC 178 mm No Dowel	HMA Mix 1 – 64 mm PCC 178 mm No Dowel	No HMA PCC 178 mm No Dowel
C	HMA Mix 2 –114 mm PCC 178 mm No Dowel	HMA Mix 2 – 64 mm PCC 178 mm No Dowel	No HMA PCC 178 mm No Dowel
D	HMA Mix 2 –114 mm PCC 127 mm No Dowel	HMA Mix 2 – 64 mm PCC 127 mm No Dowel	No HMA PCC 127 mm No Dowel

3.7 m

13.7 m

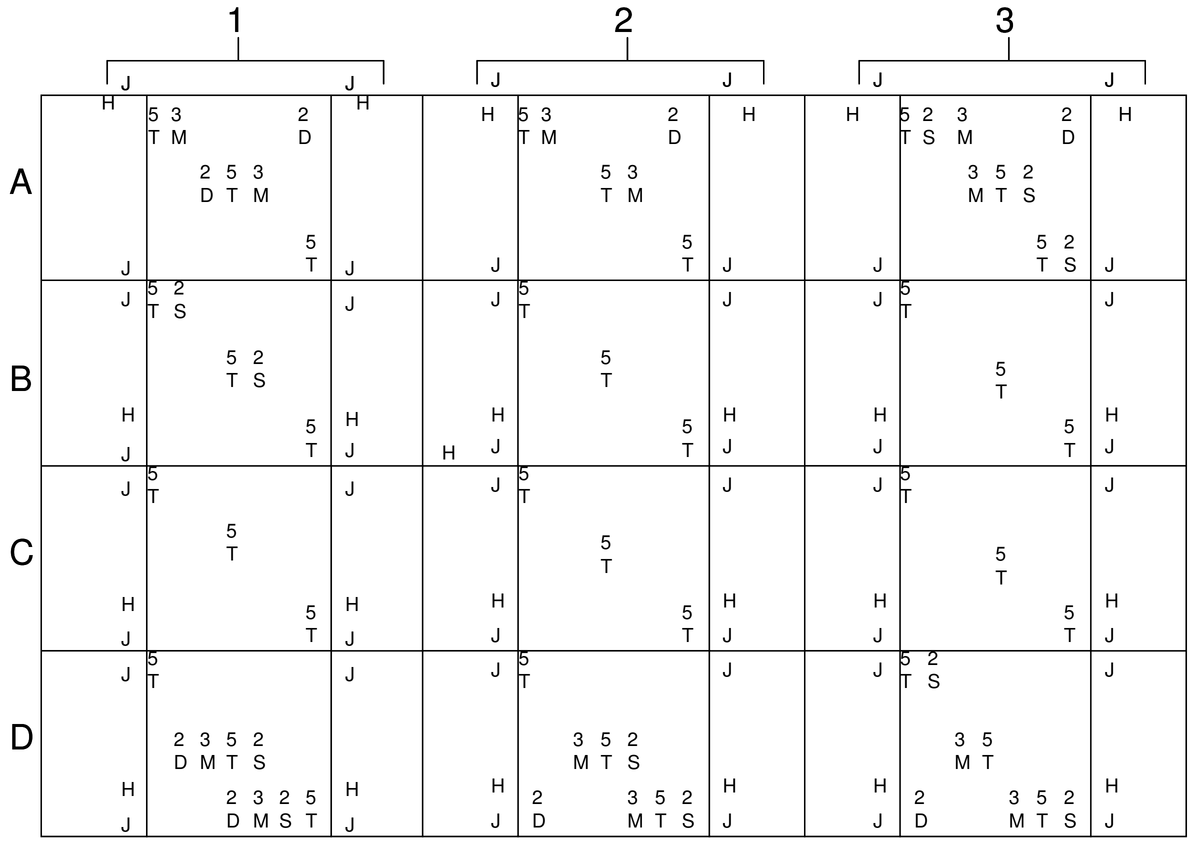
Plan View

178 mm = 7 in
127 mm = 5 in
114 mm = 4.5 ir
64 mm = 2.5 in

13.7 m = 45 ft
3.7 m = 12 ft

Section View
(construction grades)

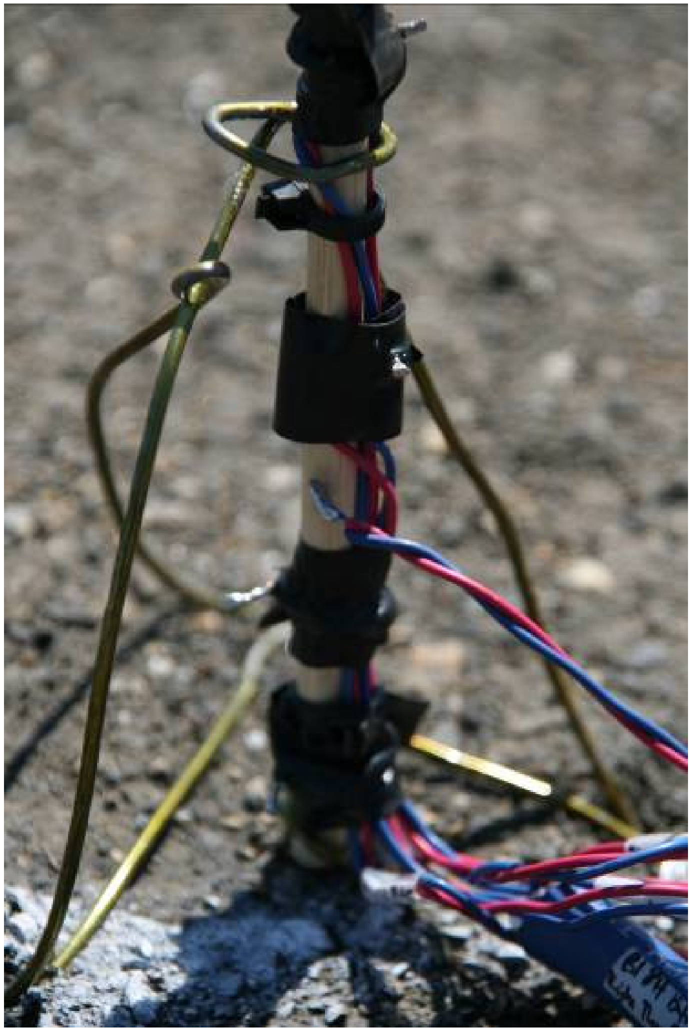
Instrumentation plan for test cells at UCPRC



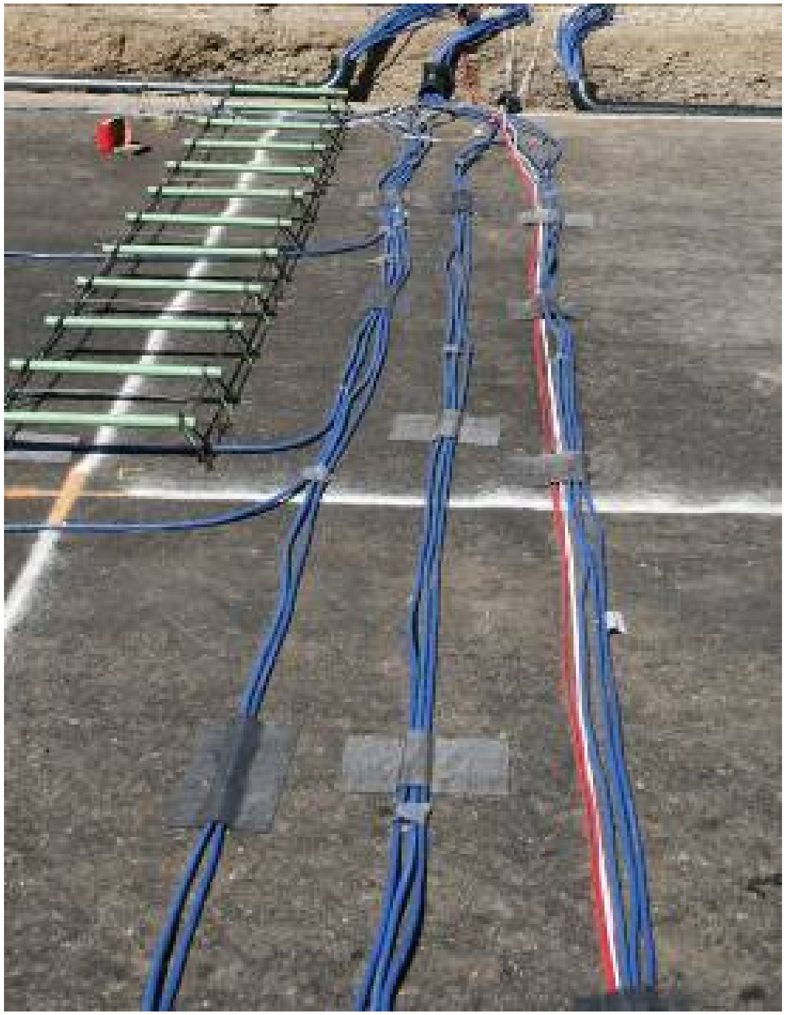
All nine slabs in each lane are 15 ft. long, center slabs of each group (1,2,3) are widened for display purposes.

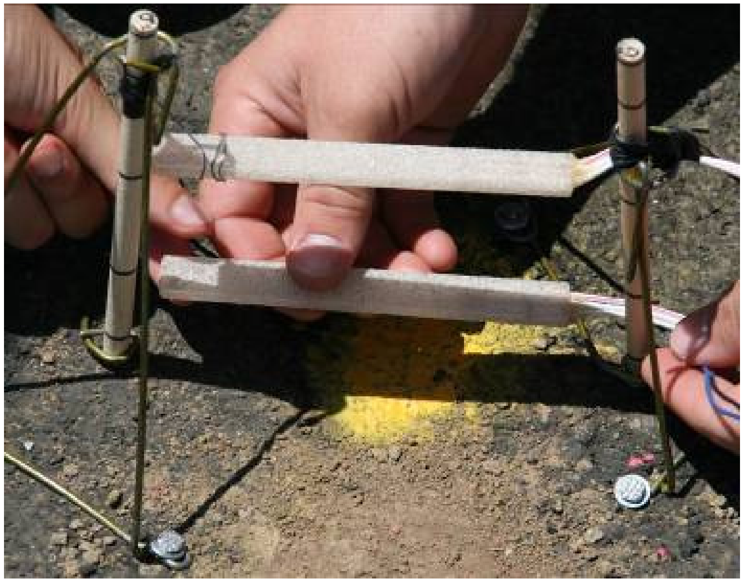
T – Thermocouple
D – Dynamic Strain Gauge
J – Vertical JDMD
M – Moisture Gauge
H – Horizontal JDMD
S – Static Strain Gauge

UCPRC Instrumentation: Thermocouples



UCPRC Instrumentation: Strain Gages and Cables





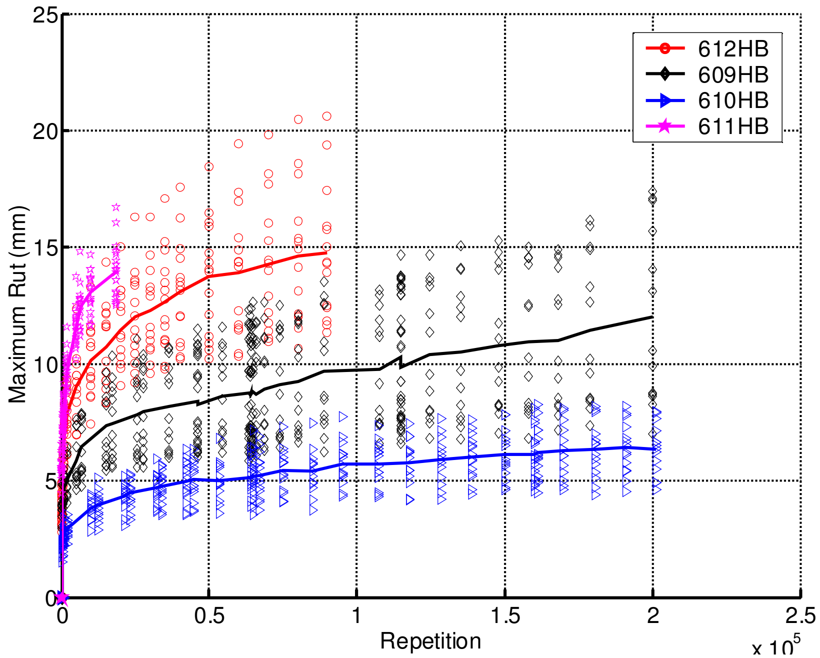
UCPRC Construction: PCC Placement

UCPRC Construction: Texturing, Curing, Saw-Cutting

UCPRC Construction: HMA Placement and Compaction

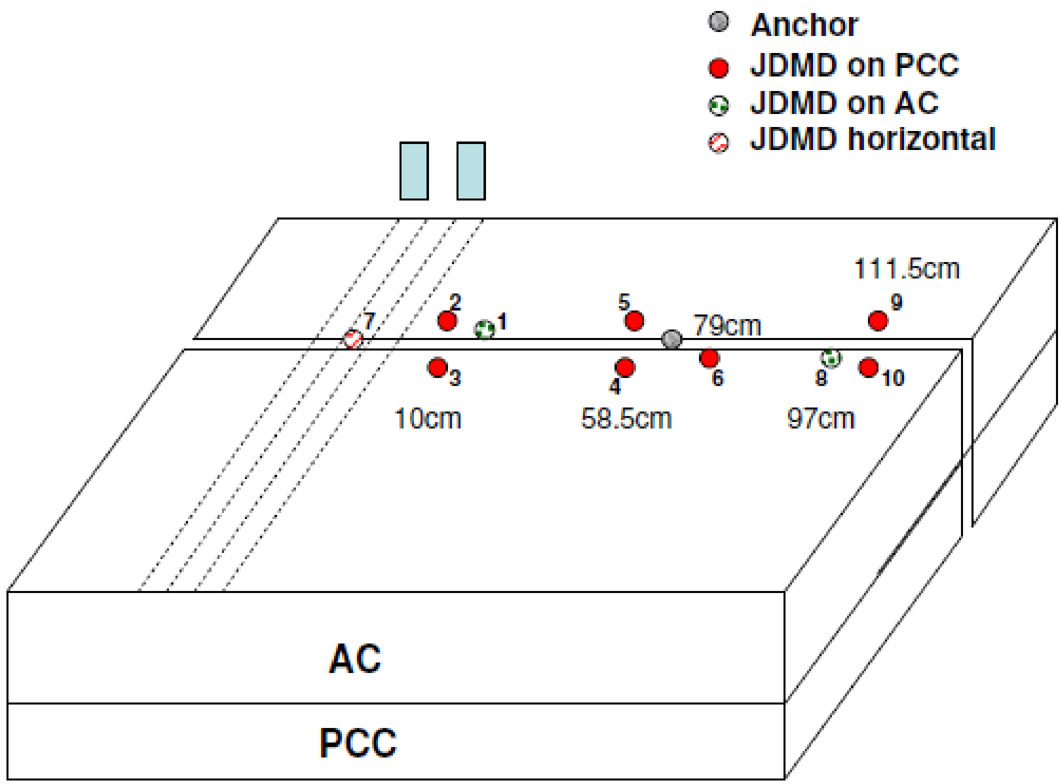
PG64-28PM (left two lanes) and Gap Graded Rubber mix RHMA-G (right two lanes)

UCPRC HVS Testing



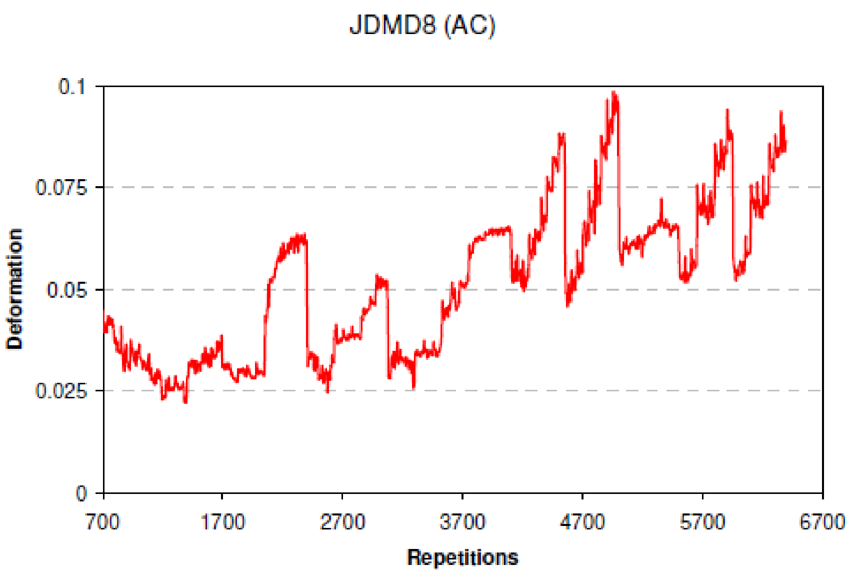
UCPRC HVS Testing – Parametric Analysis

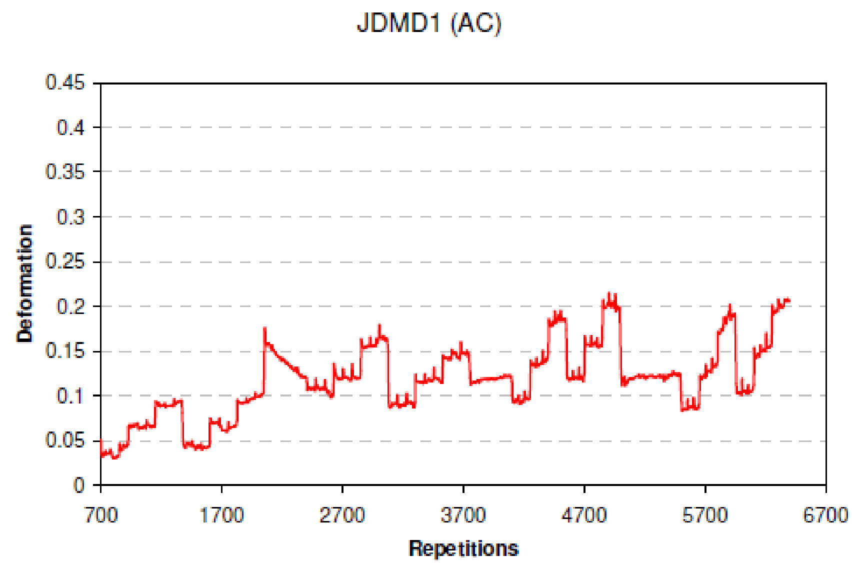
- Effect of various parameters on deflections and strains
- JDMDs (joint deflections) various positions
- Strain gages (tire center and tire edge)
- Various sections
- 50-75 load repetitions at each combination



UCPRC HVS Testing – Parametric Analysis

LOAD kN (lb)	TIRE PRES.(psi)	SPEED km/h (mph)	TEMP. C (F)
40 (9,000)	92.8	8.7 (5.4)	50 (122)
60 (13,500)	104.4	5.9 (3.7)	40 (104)
80 (18,000)		3.1 (1.9)	30 (86)
			20 (68)





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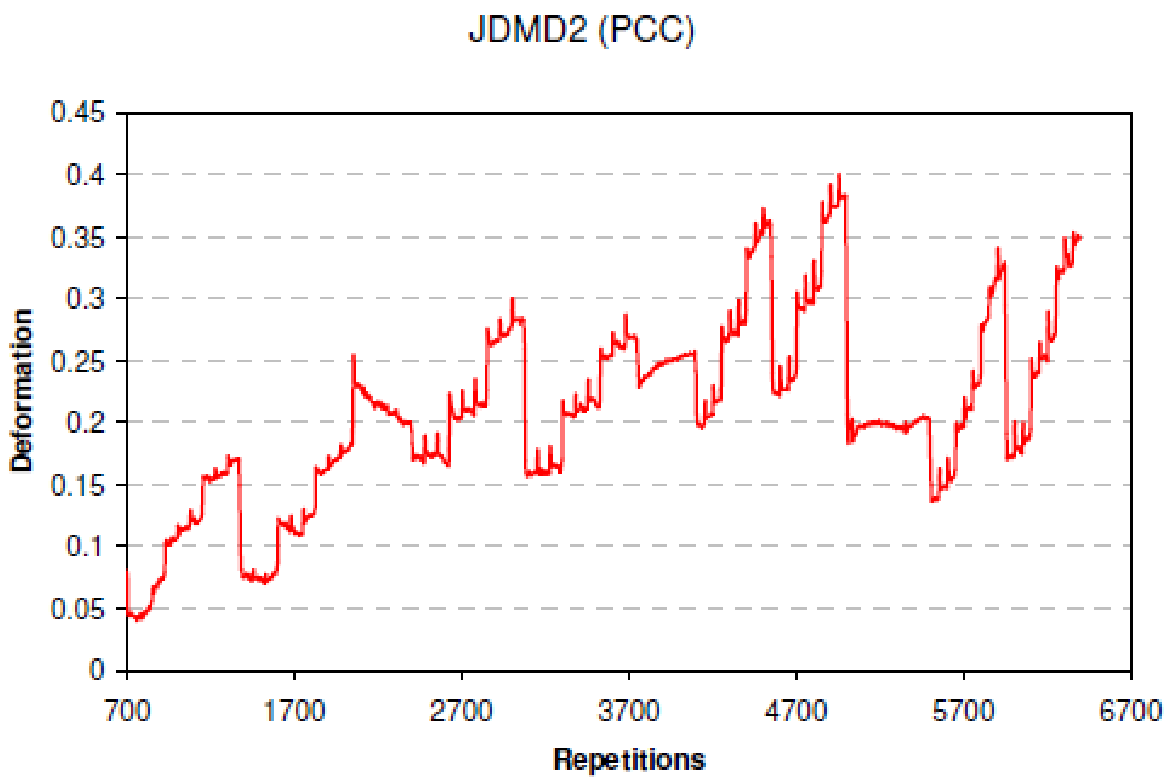

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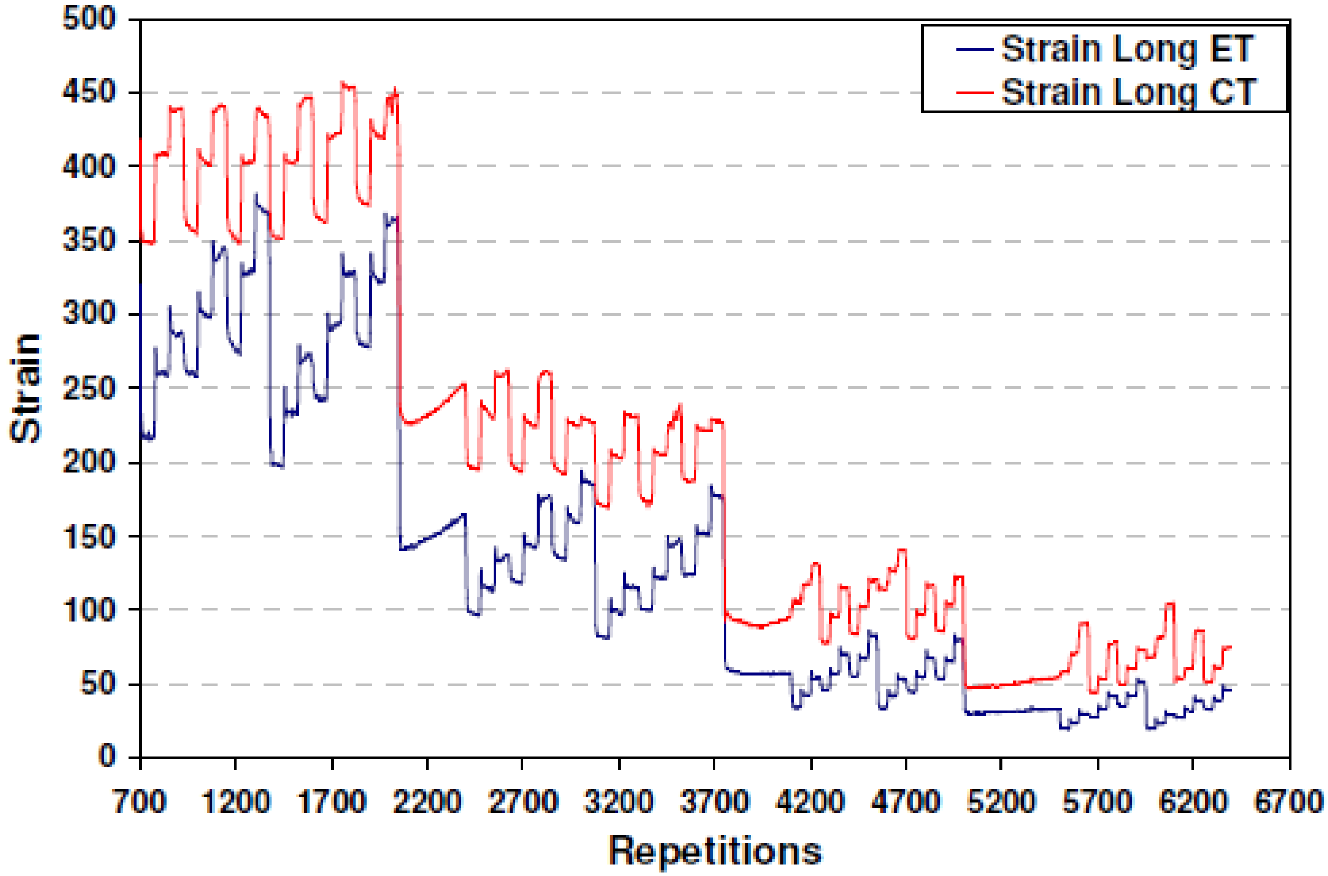
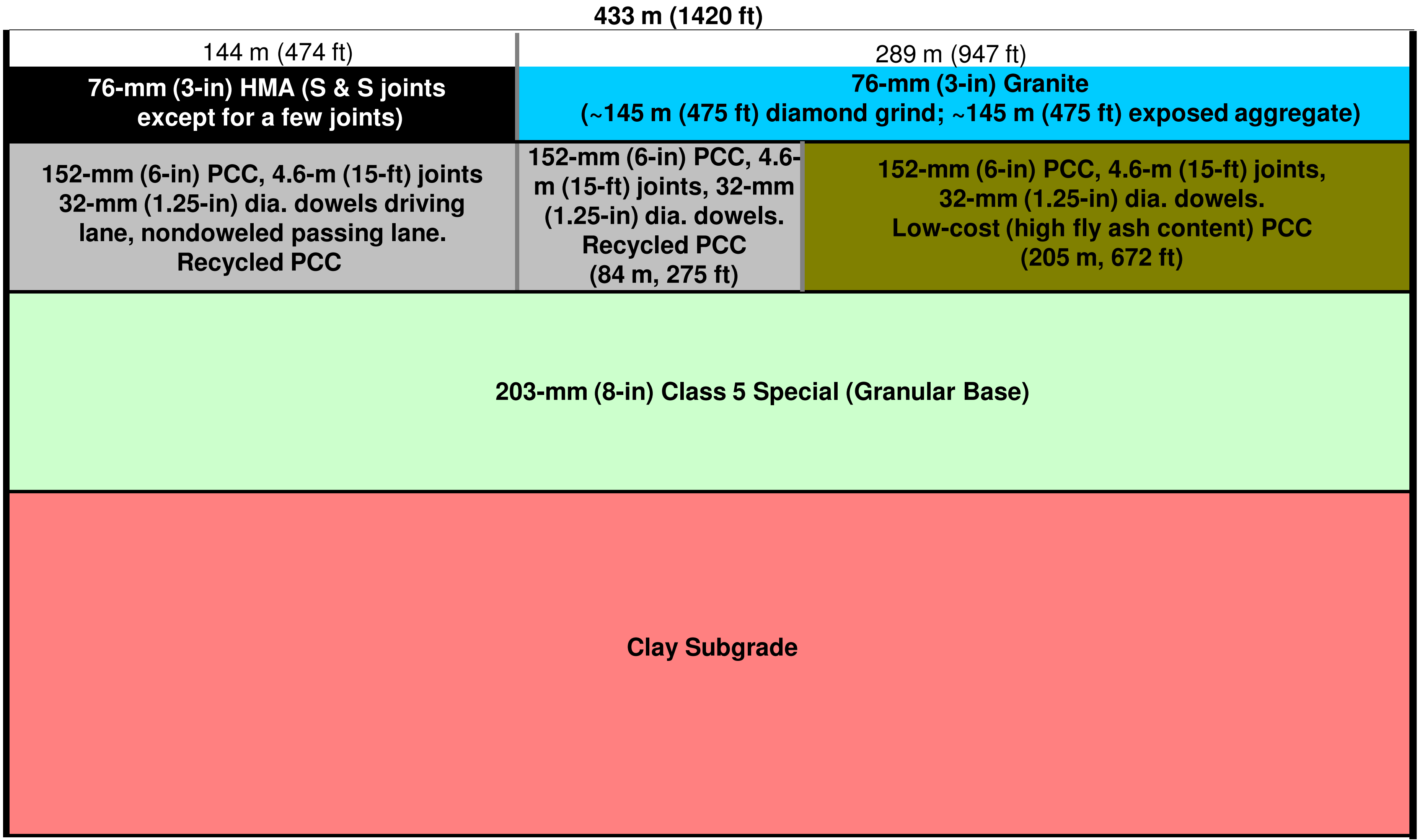


Construction of HMA/PCC and PCC/PCC Test Sections at MnROAD

Full-length two-lane test sections constructed at MnROAD in Albertville, MN on Interstate 94.

- Plans, specifications, and estimates were prepared in winter 2008/09.
- Bids let in July 2009 and lowest price (of two bids) was acceptable.
- Construction: April/May 2010.
- Currently open to freeway traffic.

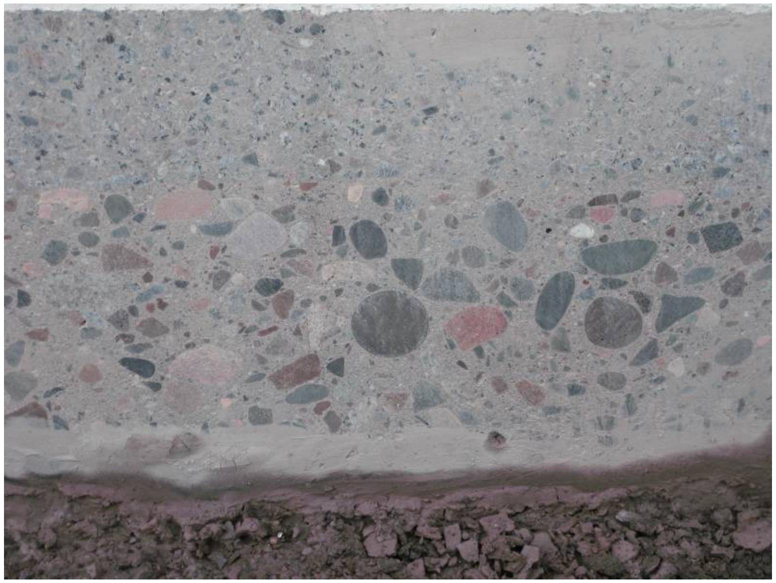
Experimental Plan for Construction at MnROAD



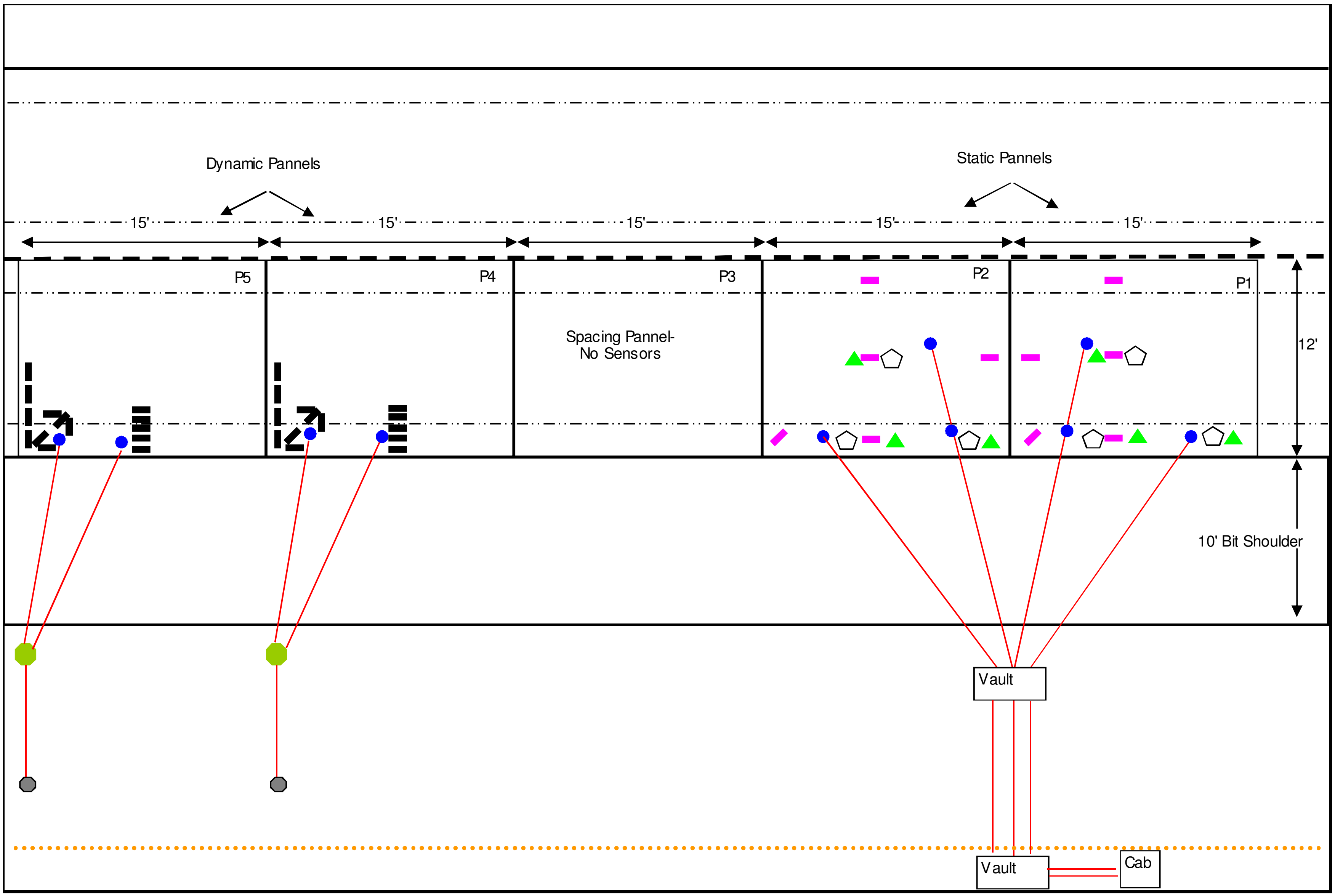
MnROAD Recycling and Salvage Operations

RCA Percent Absorption 2.93%

MnROAD Demonstration Slab



Instrumentation Plan for Construction at MnROAD



MnROAD Instrumentation: Thermocouples, Moisture Gages, Static and Dynamic Strain Gages

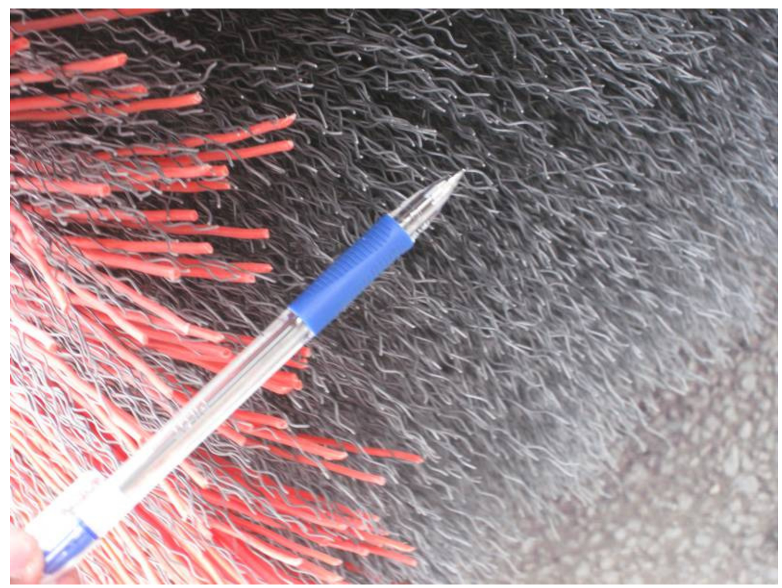
MnROAD Instrumentation: Moisture Gages, and Static and Dynamic Strain Gages



MnROAD Paving Wet-on-Wet PCC/PCC

MnROAD Construction: PCC Placement

Exposed Aggregate Concrete Texture



MnROAD HMA/PCC Design

Section		Cell 70 HMA/ PCC (145 m [475 ft])
HMA	Thickness	75 mm (3 in) placed in 2 lifts
	Binder	PG 64-34
	Mix	Superpave wearing course designated SPWEB440F with 12.5 mm (0.5 in) nominal maximum aggregate size (SP 12.5)
PCC	Thickness	150 mm (6 in)
	Mix	Low portland cement (~150 kg/m^3 [250 lb/yd^3]) 60% fly ash
	Aggregate	50% RCA, 50% Mn/DOT Class A Maximum aggregate size 32 mm (1.25 in)
Base		200 mm (8 in) Class 5 unbound
Subgrade		Clay
Joint Spacing		4.6 m (15 ft)
Dowels		32 mm (1.25 in) placed on baskets in driving lane at PCC middepth and undoweled passing lane
Joints		Saw and seal HMA over PCC joints (except last 6 joints)

MnROAD HMA/PCC Construction

MnROAD HMA/PCC Sawing and Sealing

MnROAD Test Sections

Other Field Sites

- **Data collected from many HMA/PCC & PCC/PCC sites in USA, Canada, and Europe**
- **Database set up and sections evaluated**
- **Key sections selected for further field testing and evaluation**
- **Possible construction of HMA/PCC sections at the Illinois Tollway**

What are the next steps for R21?

UCPRC and MnROAD Construction and Field Sections

- **UCPRC - Continue HVS loading and data collection until: Spring/Summer 2011**
- **MnROAD - Monitoring instrumentation and performance data collection (including ride and noise) until: Summer 2011**
- **Field Sections - Field data collection (distress surveys, materials data, IRI, etc.): Fall 2010**

What are the next steps for R21?

Modeling

- **2-layer concrete pavement modeling**
- **PCC lab modeling and materials testing**
- **Rutting model**
- **Reflection cracking model**
- **MEPDG model modifications and calibration (results from monitoring and instrumentation @ MnROAD and UCPRC; other field sections)**

Anticipated R21 products?

a. Refined and validated structural & performance models
b. Design procedures and guidelines (manual, recommended additions to AASHTO MEPDG manual)
c. Construction specifications (MnROAD, UCPRC, Europe, other)
d. Life-cycle cost procedures.
e. Composite pavement training materials to aid in implementation