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Pavement Macrotexture and Its Effect on Bicycle Ride Quality

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Jan 12th, 2015

UCPRC UNIVERSITY of CALIFORNIA Davis • Berkeley | PAVEMENT RESEARCH CENTER

Outline

- Project Background & Pavement Texture
- Macrotexture Measurement
- Bicycle Vibration Measurement
- Survey of Bicycle Ride Quality (Phase I)
- Remedial Treatment on SLO-1
- Additional Survey (Phase II)
- Remarks

Biking on Coastal Highway 1, California

2012, Chip Seal,
40 km ($2.1 million)

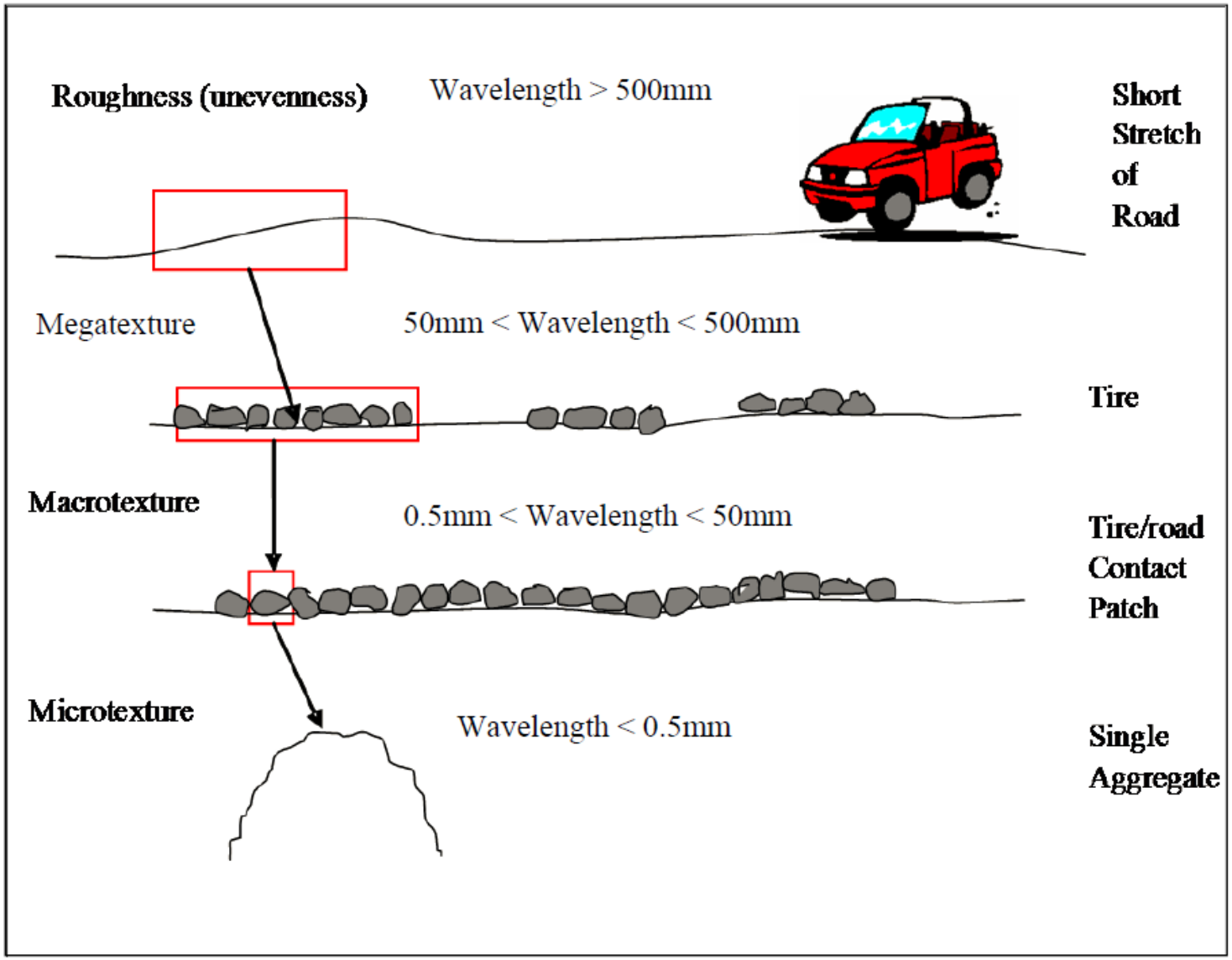
SLO-1


Help Us Fix Highway 1
CALIFORNIA
1
HOME
KEY DOCUMENTS
SUPPORTERS
KEY CONTACTS
CONTACT US

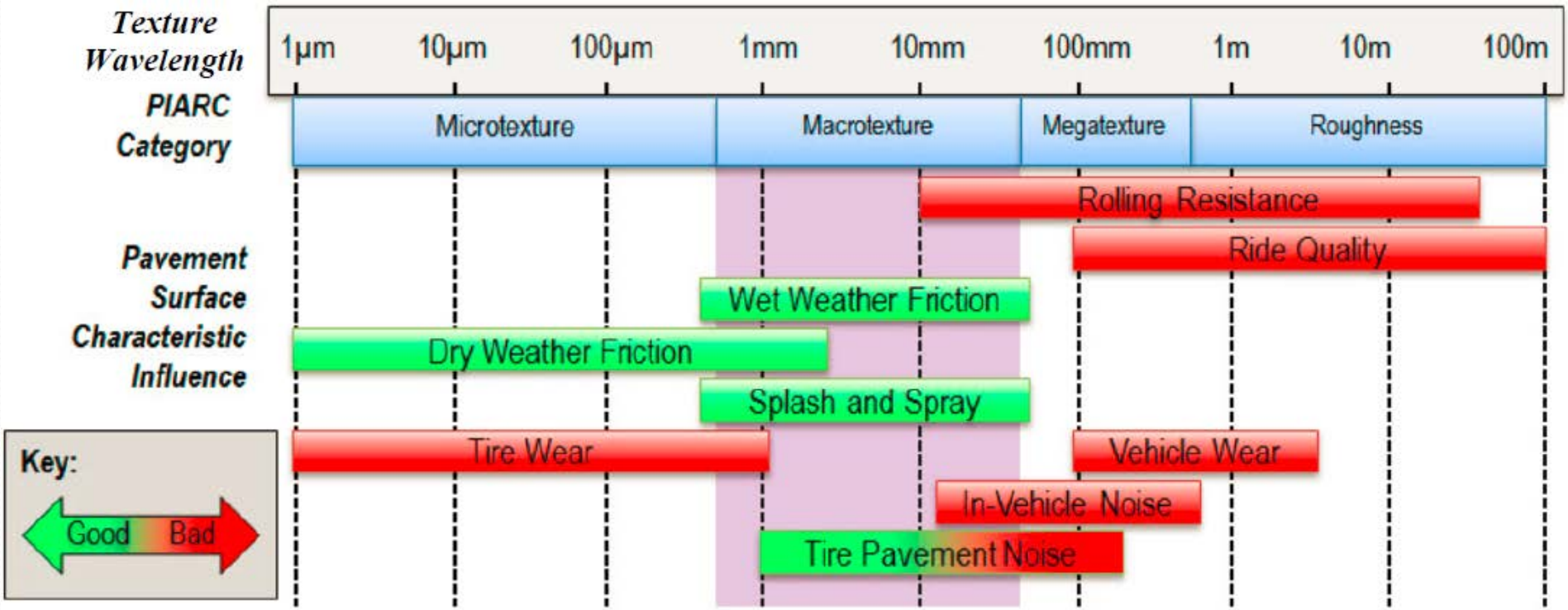

www.fixhwy1.com
1


Governor Brown
"Please Fix Highway 1"
Sign the Petition
at
w.fixhwy1.com

Pavement Surface Texture Components and Wavelengths



Influence of Pavement Surface Texture on Motorized Vehicles



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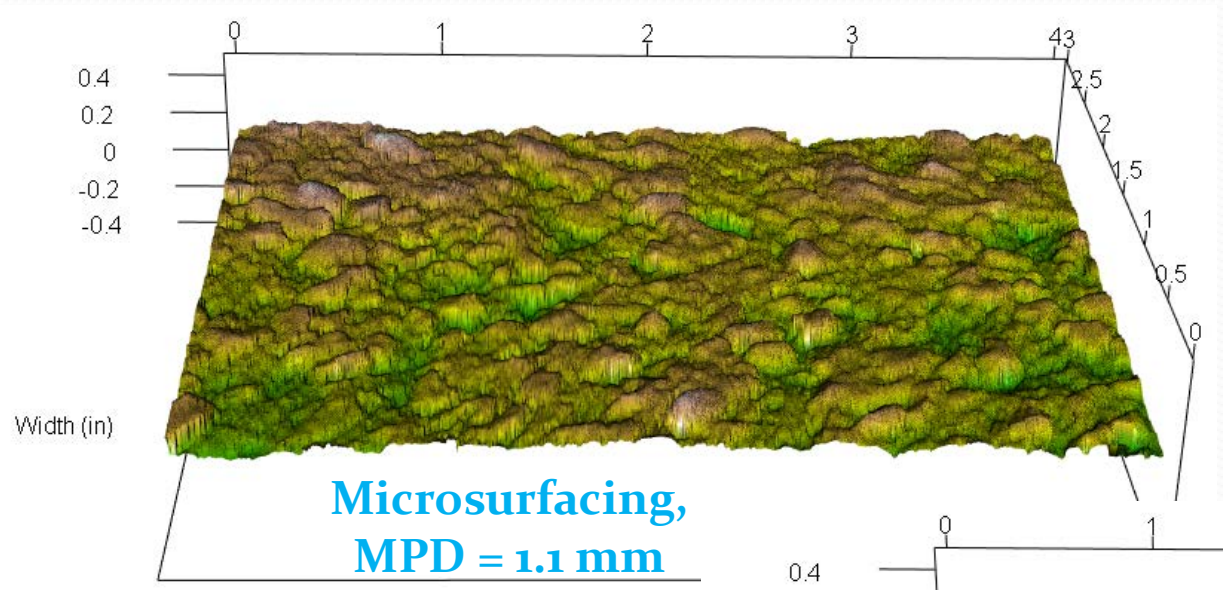
Macrotexture Measurement Method

Laser Texture Scanner (LTS)
Spot measurement
with need for traffic closure

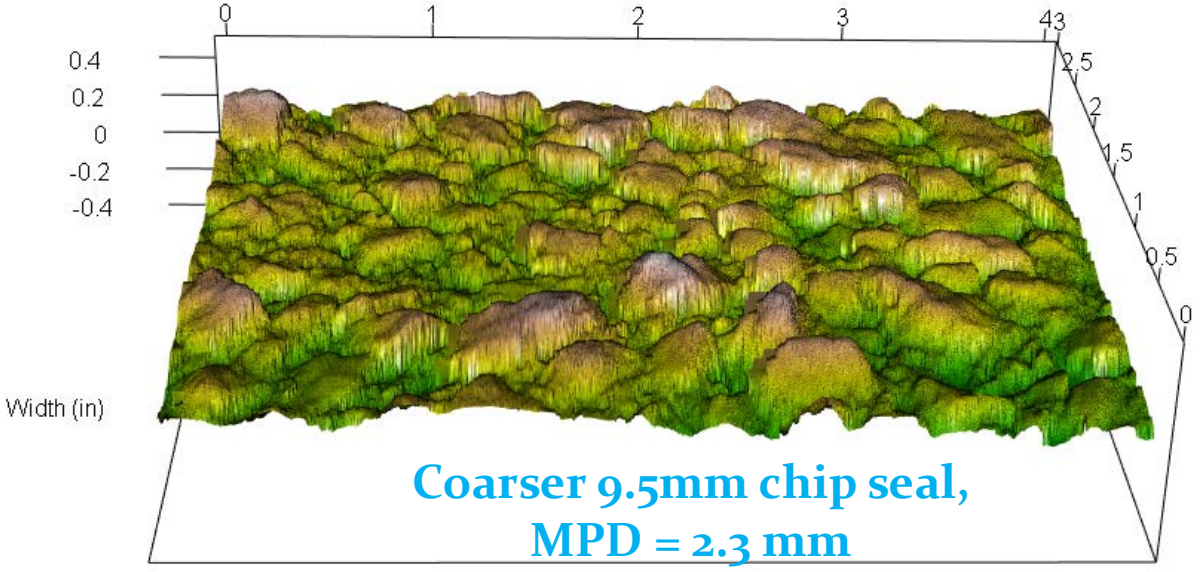
Inertial Profiler (IP)
Continuous linear measurement
without need for traffic closure

Mean Profile Depth (MPD)
Unit: mm or in

Example 3D Macrotexture Images and MPD from LTS

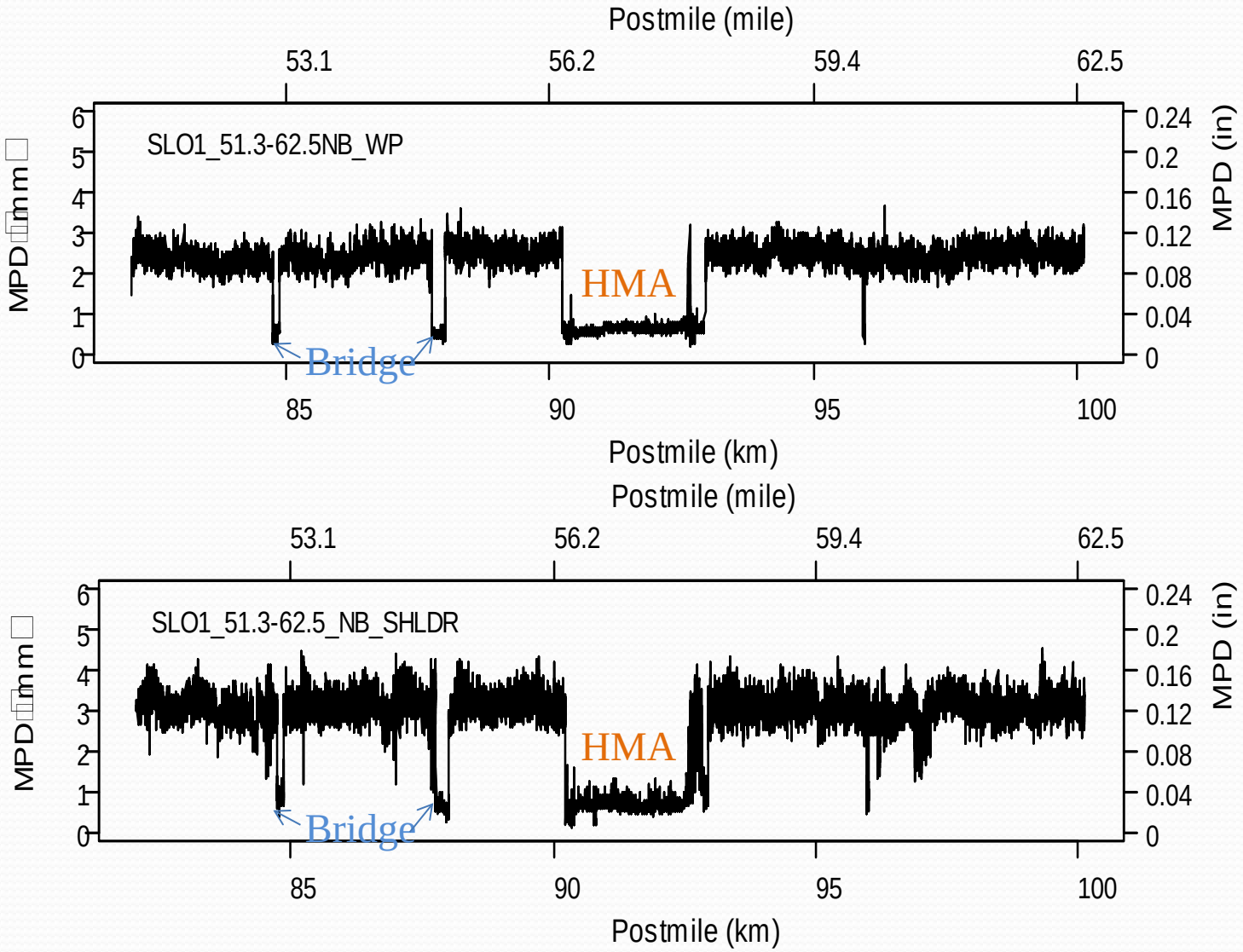


Microsurfacing, MPD = 1.1 mm

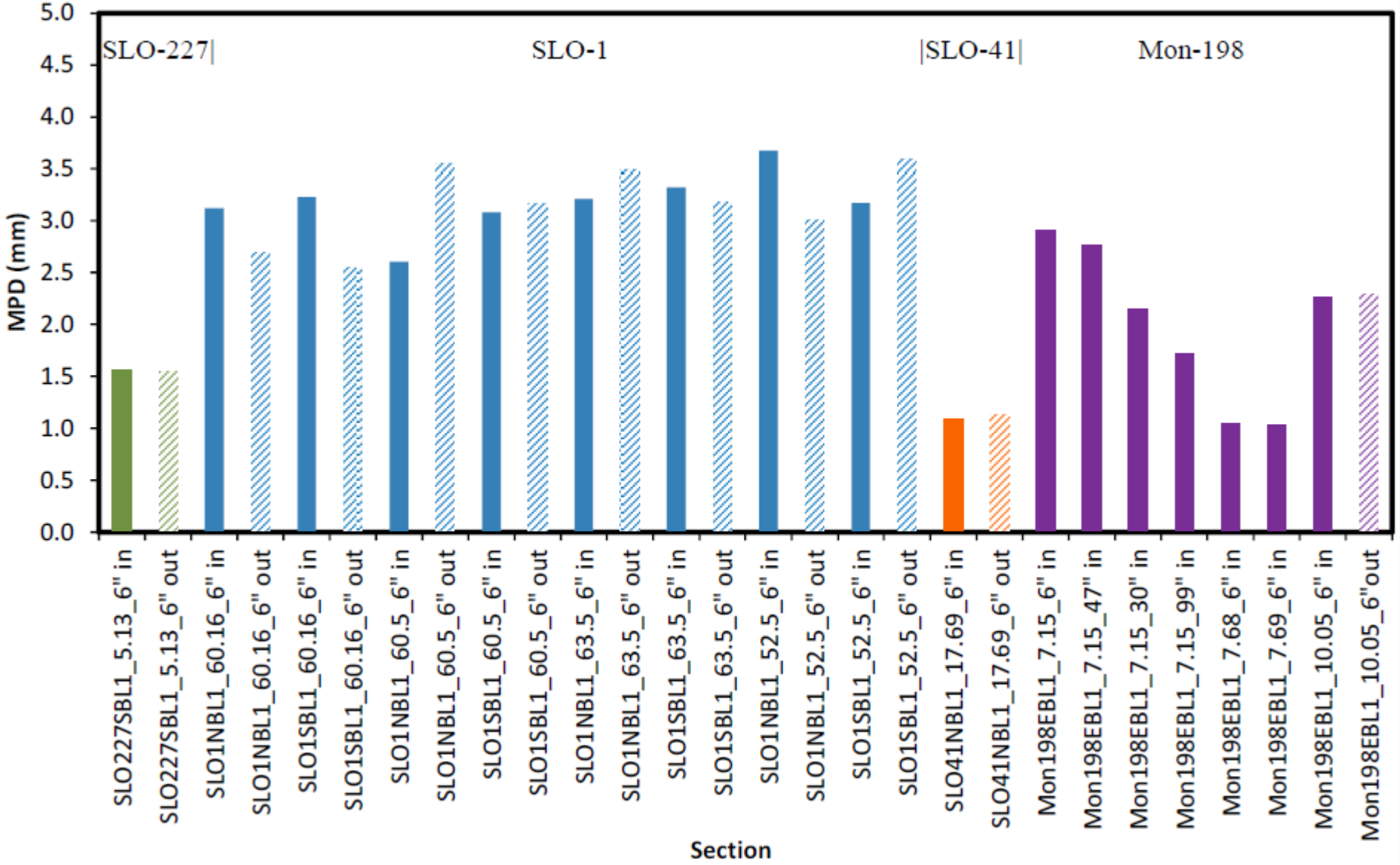


Coarser 9.5mm chip seal, MPD = 2.3 mm

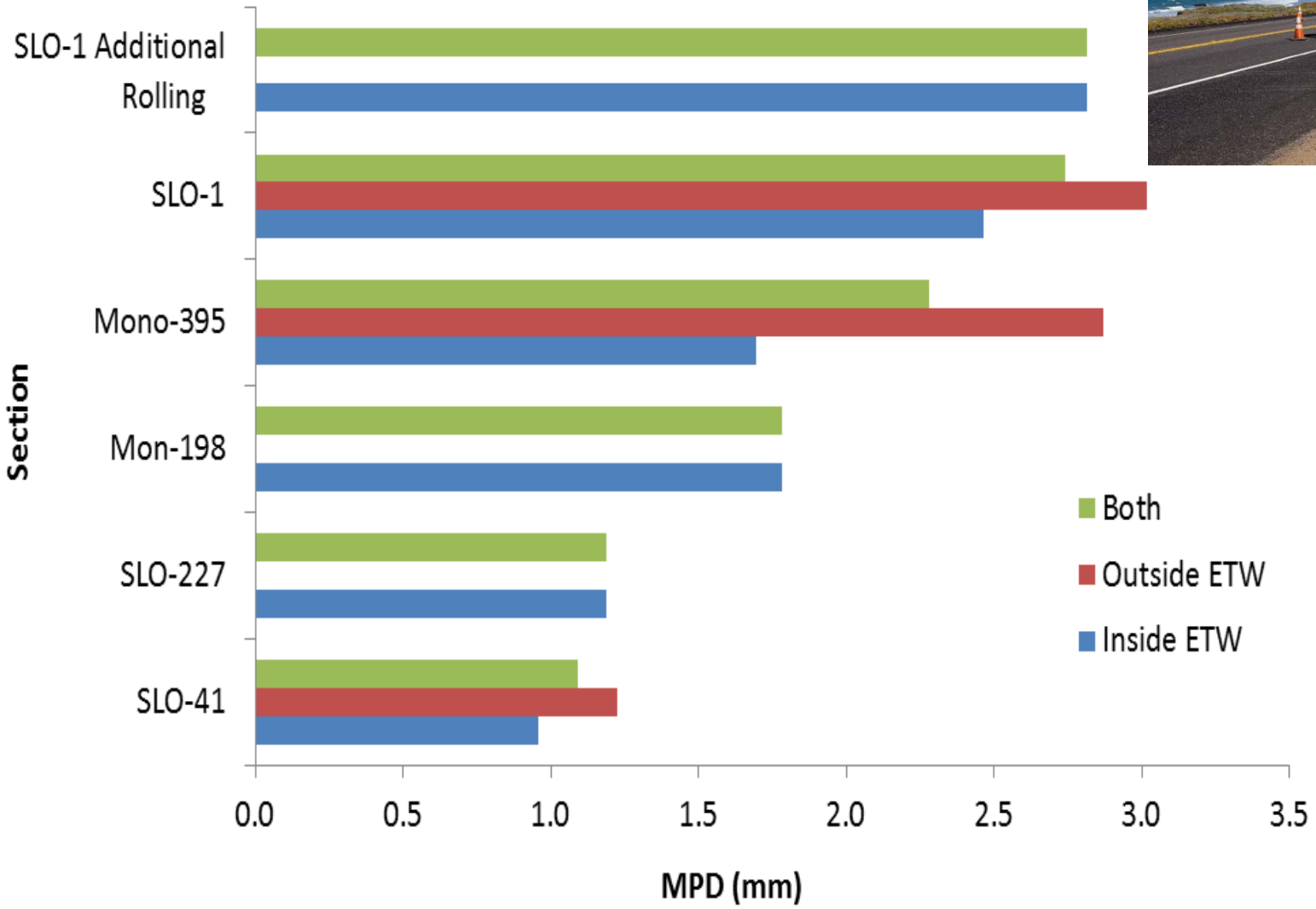
Example MPD on SLO 1 Continuous Measurement with IP



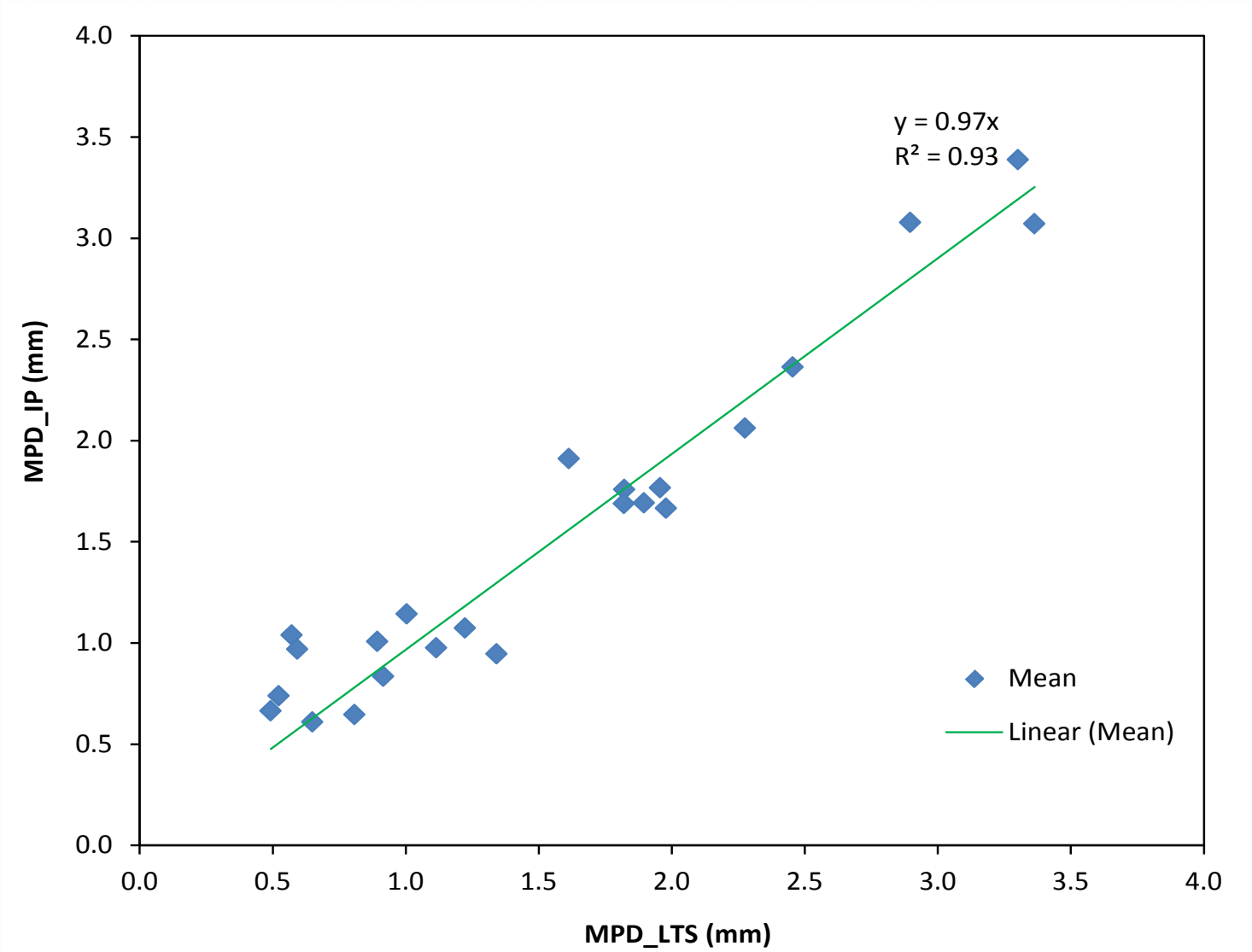
MPD from LTS for Different Roads and Sections

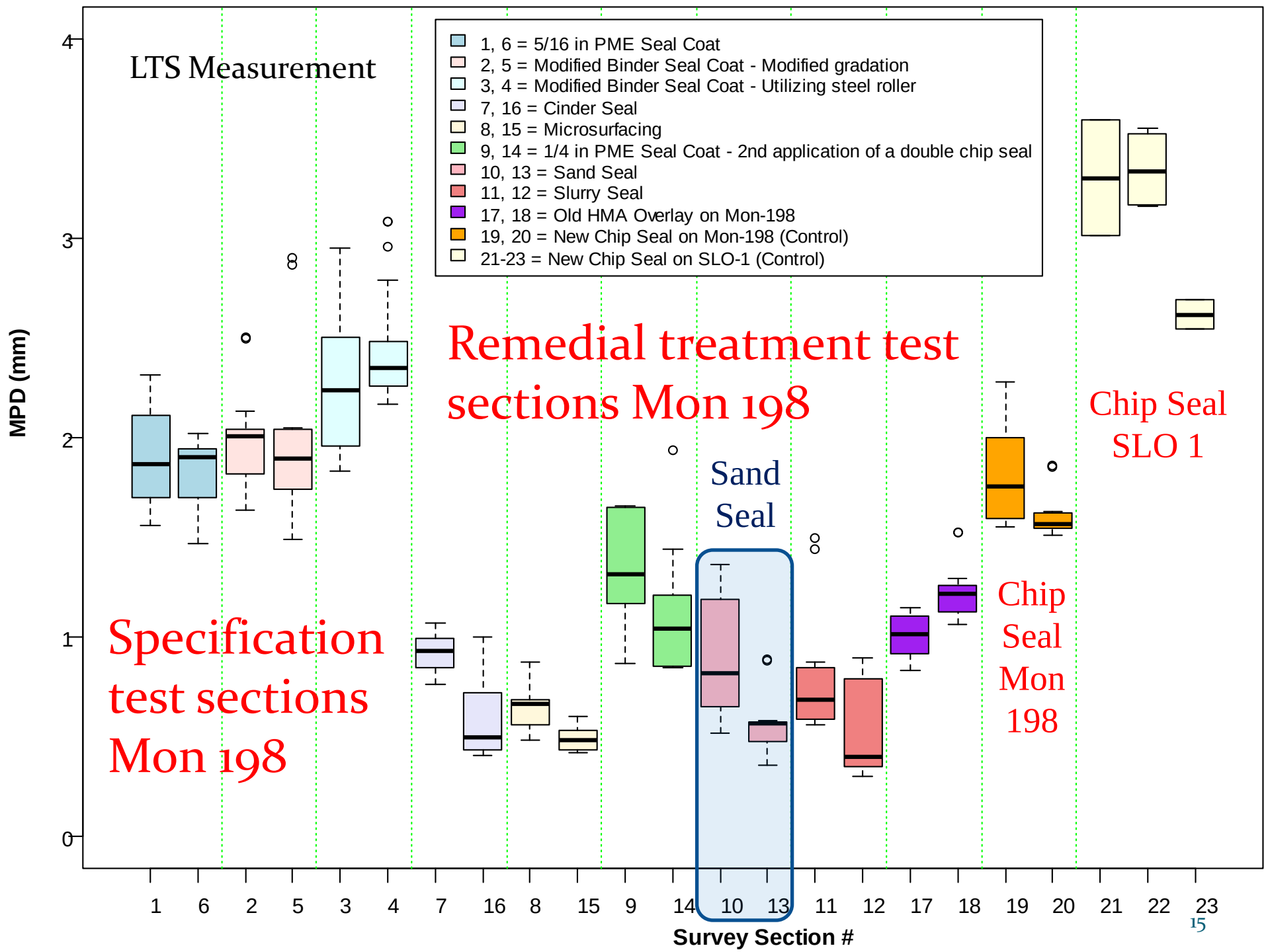


MPD Measured from IP for Different Phase I Sections



Correlation of Macrotexture Measurements with IP and LTS




LTS Measurement
1, 6 = 5/16 in PME Seal Coat
2, 5 = Modified Binder Seal Coat - Modified gradation
3, 4 = Modified Binder Seal Coat - Utilizing steel roller
7, 16 = Cinder Seal
8, 15 = Microsurfacing
9, 14 = 1/4 in PME Seal Coat - 2nd application of a double chip seal
10, 13 = Sand Seal
11, 12 = Slurry Seal
17, 18 = Old HMA Overlay on Mon-198
19, 20 = New Chip Seal on Mon-198 (Control)
21-23 = New Chip Seal on SLO-1 (Control)
Remedial treatment test sections Mon 198
Sand Seal
Chip Seal SLO 1
Chip Seal Mon 198
Specification test sections Mon 198
MPD (mm)
0
1
2
3
4
1 6 2 5 3 4 7 16 8 15 9 14 10 13 11 12 17 18 19 20 21 22 23
Survey Section #

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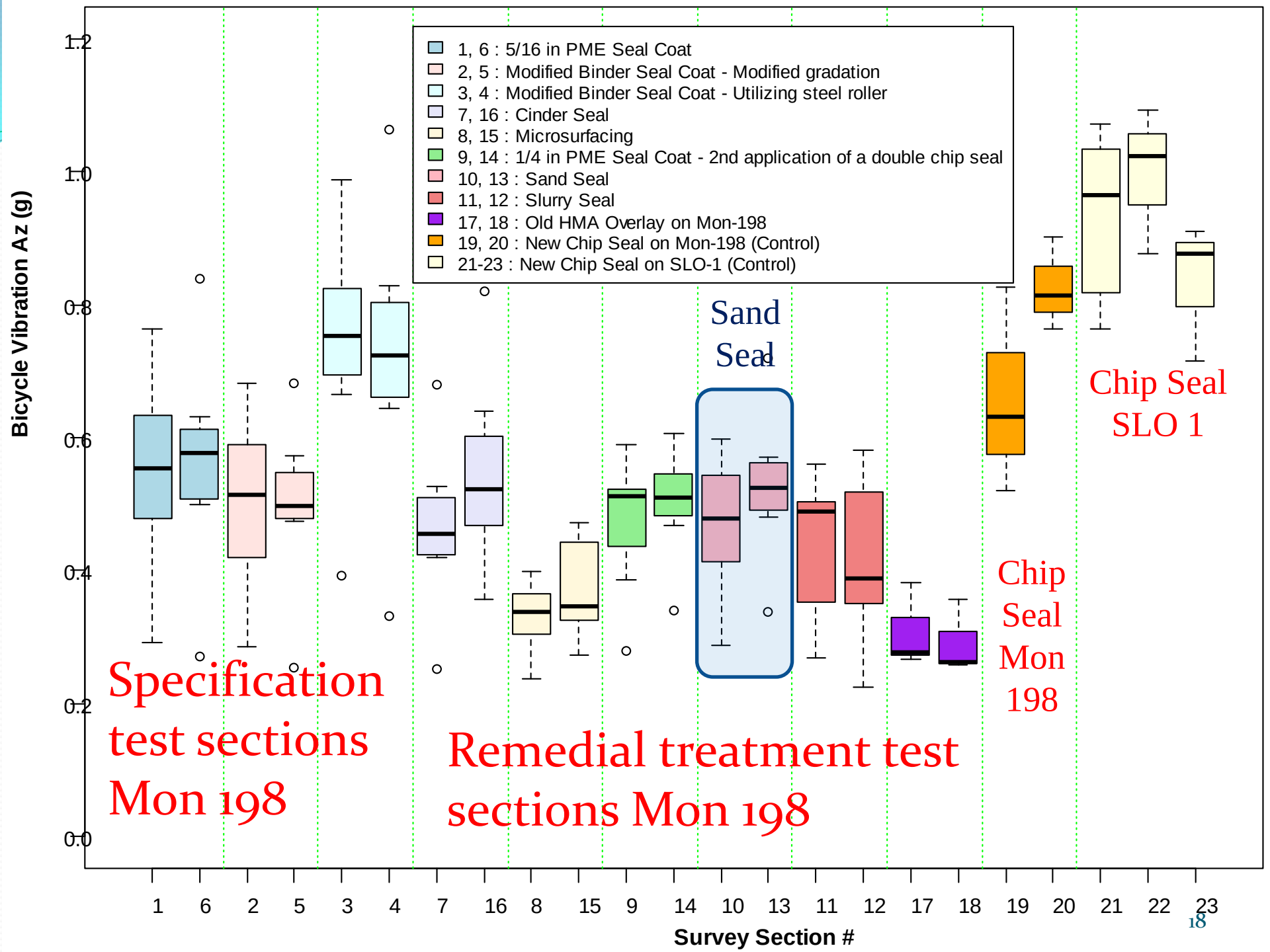
Bicycle Vibration Measurement

Accelerometers (solid red circles)

GPS unit (dotted blue circle)


1, 6 : 5/16 in PME Seal Coat
2, 5 : Modified Binder Seal Coat - Modified gradation
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10, 13 : Sand Seal
11, 12 : Slurry Seal
17, 18 : Old HMA Overlay on Mon-198
19, 20 : New Chip Seal on Mon-198 (Control)
21-23 : New Chip Seal on SLO-1 (Control)
Bicycle Vibration Az (g)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1 6 2 5 3 4 7 16 8 15 9 14 10 13 11 12 17 18 19 20 21 22 23
Survey Section #
Sand Seal
Chip Seal SLO 1
Chip Seal Mon 198
Specification test sections Mon 198
Remedial treatment test sections Mon 198

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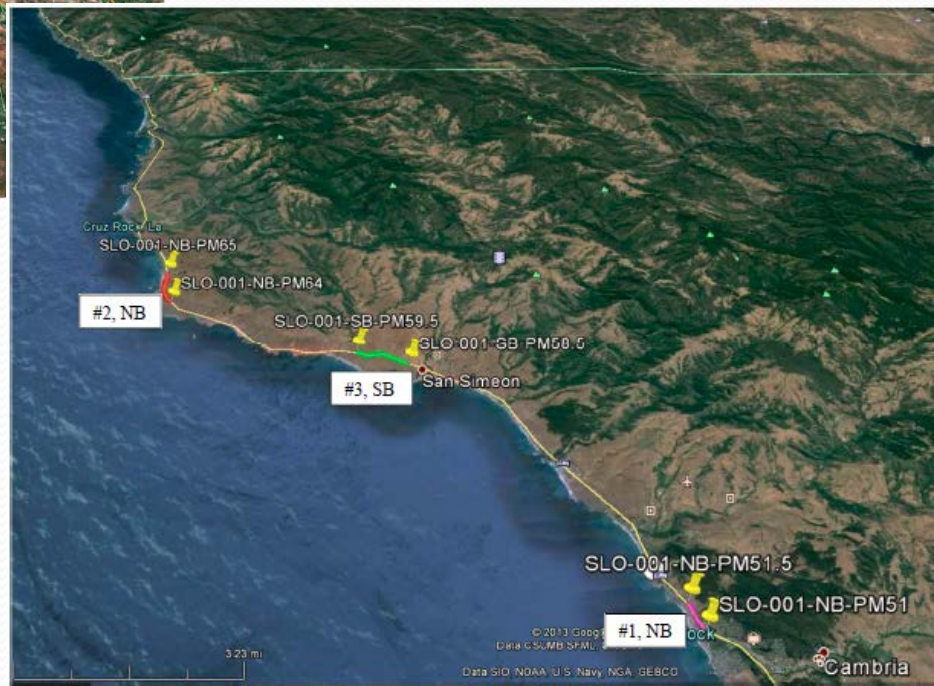
Sections in Phase I Survey

Mon-198

SLO-1



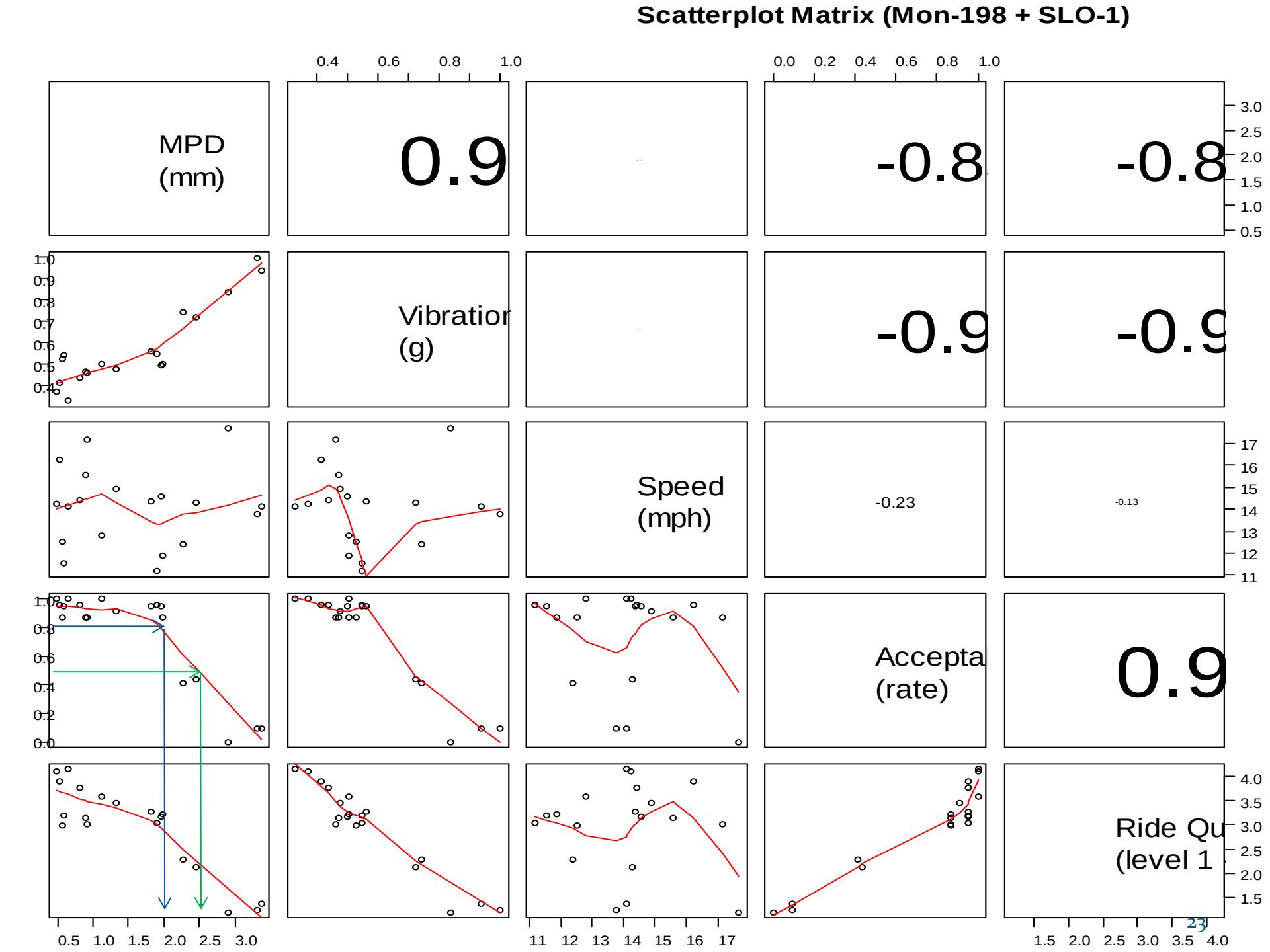
Survey Briefing (Mon-198)

Bicyclist Survey

- Acceptability (0 = Unacceptable; 1 = Acceptable): average rate of all riders or percentage of riders rating pavements as "Acceptable"
- Ride Quality: 1 to 5, with 1 = Poor and 5 = Excellent

- Other background information with potential explanatory power

Group	No. of Sections	No. of Riders
Mon-198	*16*	*24*
SLO-1	*3*	*11*


Scatterplot Matrix (Mon-198 + SLO-1)
MPD (mm)
0.9
-0.8
-0.8
Vibration (g)
-0.9
-0.9
Speed (mph)
-0.23
-0.13
Accepta (rate)
0.9
Ride Qu (level 1
0.4 0.6 0.8 1.0
0.0 0.2 0.4 0.6 0.8 1.0
0.5 1.0 1.5 2.0 2.5 3.0
11 12 13 14 15 16 17
1.5 2.0 2.5 3.0 3.5 4.0

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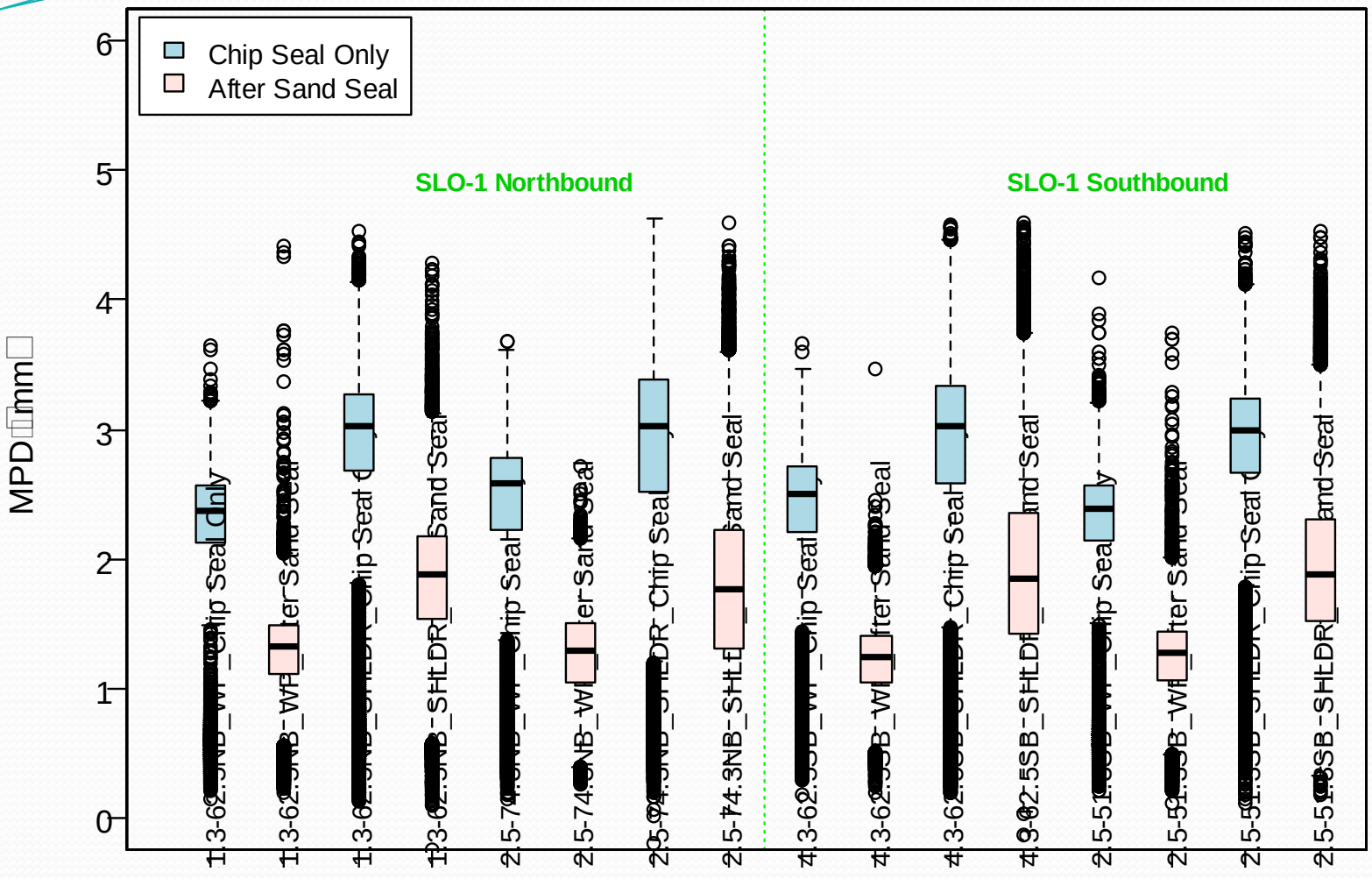
Remedial Sand Seal on SLO-1

Remedial Treatment on SLO-1



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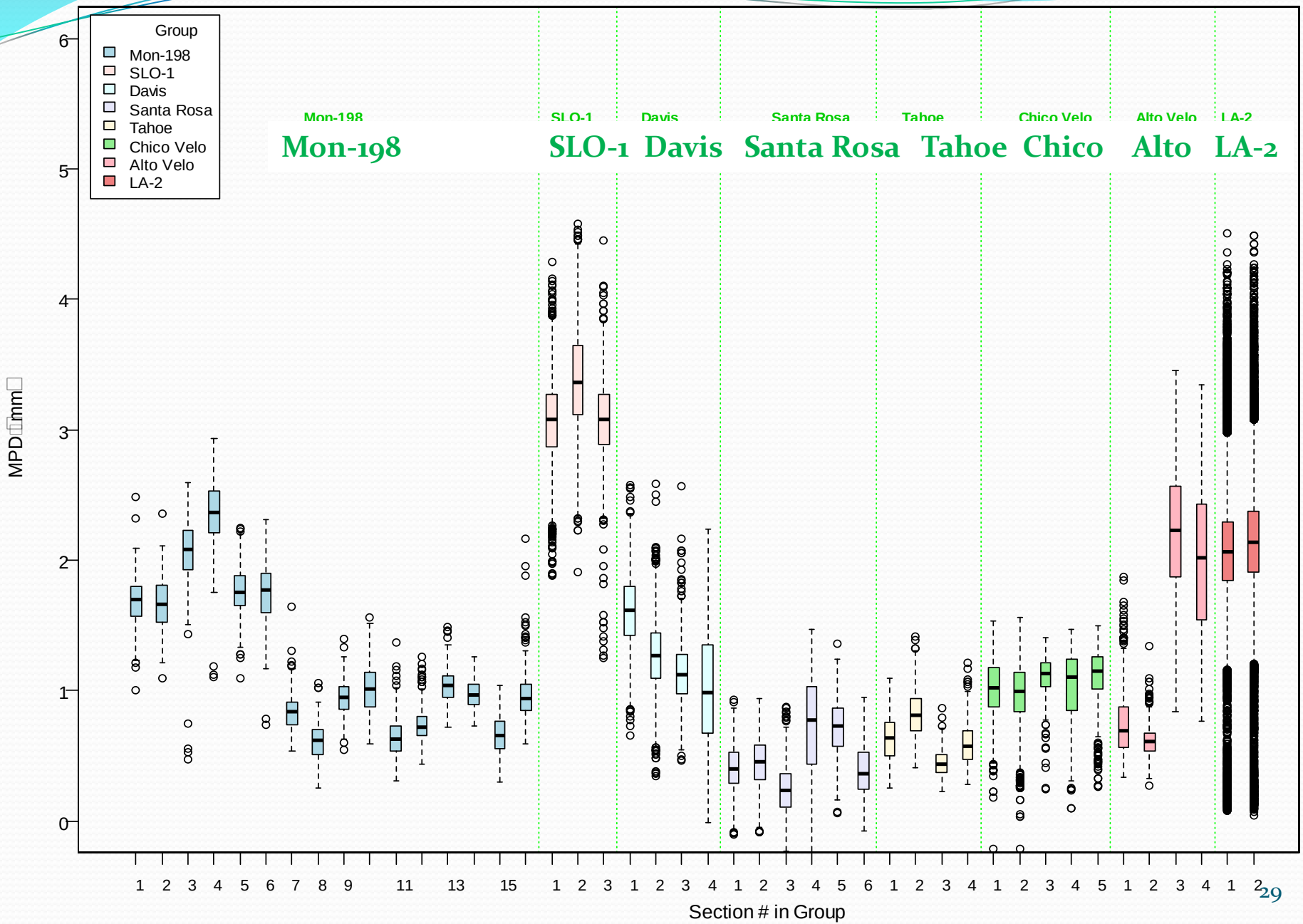
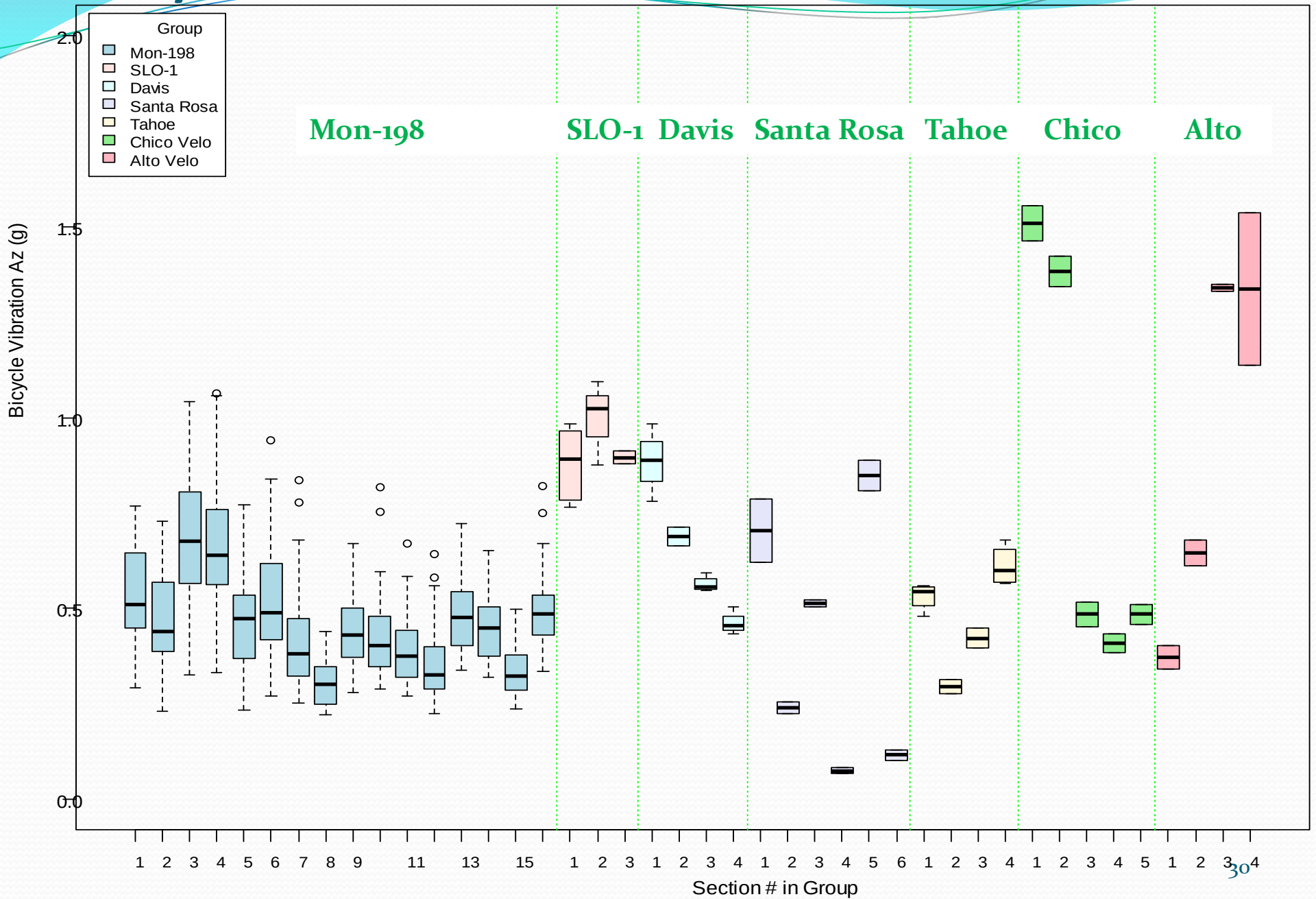
Additional Survey: Phase II

Group	No. of Sections	No. of Riders
Mon-198	*16*	*24*
SLO-1	*3*	*11*
Davis	4	6
Santa Rosa	6	26
Tahoe	4	16
Chico Velo	5	8
Alto Velo	4	16
Total	*42*	*107*

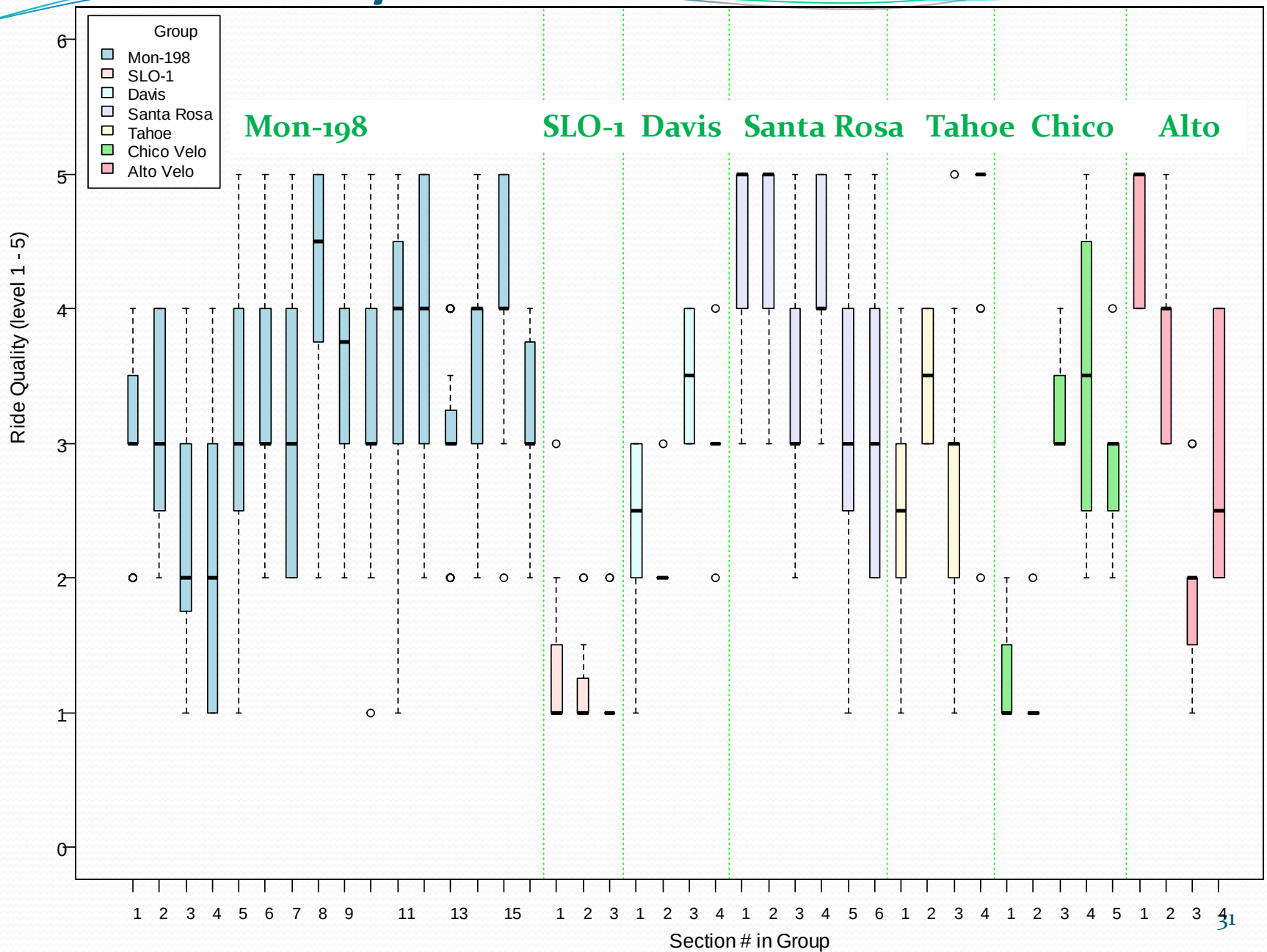
MPD


Group
Mon-198
SLO-1
Davis
Santa Rosa
Tahoe
Chico Velo
Alto Velo
LA-2
Mon-198
SLO-1
Davis
Santa Rosa
Tahoe
Chico
Alto
LA-2
MPD (mm)
Section # in Group

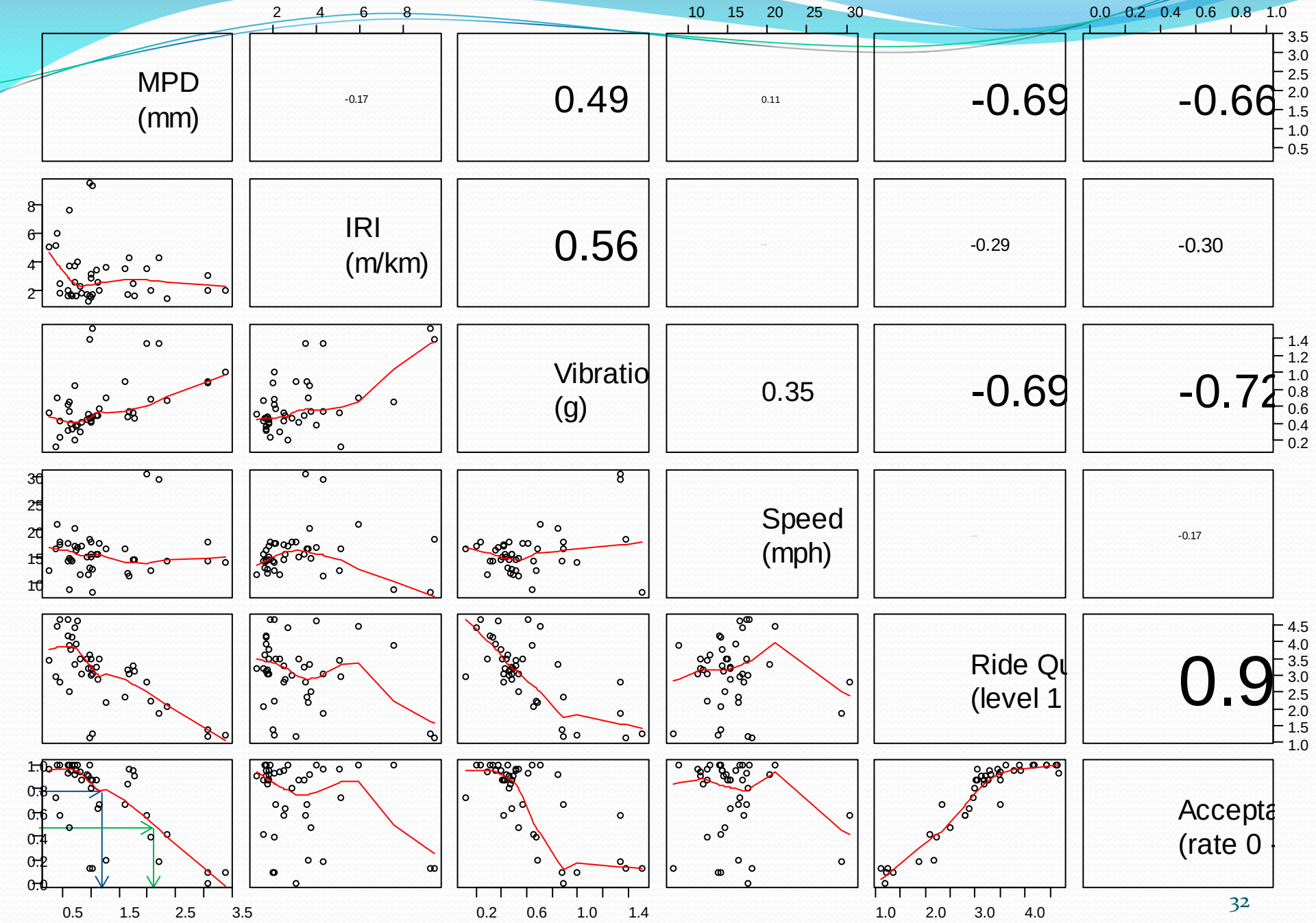
Bicycle Vibration



Ride Quality



Scatterplot Matrix (All Groups)



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Remarks

- From preliminary results, 80% of riders rate pavements with 1.3 mm MPD as acceptable; 50% for 2.1 mm.
- Additional sand seal helped reduce the macrotexture (MPD) of the chip seal on SLO-1.
- Beside MPD (macrotexture), IRI (roughness/unevenness) may also influence the bicyclist's ride quality.
  - IRI is tuned for cars not bikes
  - Missing megatexture parameter
- Need to consider the balances & tradeoffs:
  - Ride quality (smoothness) and ride safety (skid resistance)
  - Vehicle users and bicycle users (different needs)
  - Performance and cost

December 2013
Research Report: UCPRC-RR-2013-07

Surface Treatment Macrotexture and Bicycle Ride Quality

Authors:
Hui Li, John T. Harvey, Calvin Thigpen, and Rongzong Wu

Part of Partnered Pavement Research Program (PPRC) Strategic Plan Element 4.47:
Impact of Chip Seal on Bicycle Ride Quality

PREPARED FOR:

California Department of Transportation
Division of Research, Innovation, and System Information (DRISI)
Office of Roadway Research

PREPARED BY:

University of California
Pavement Research Center
UC Davis, UC Berkeley

August 2013
Technical Memorandum: UCPRC-TM-2013-07

Preliminary Results: Measurement of Macrotexture on Surface Treatments and Survey of Bicyclist Ride Quality on Mon-198 and SLO-1 Test Sections

Authors:
Hui Li, John Harvey, Rongzong Wu, Calvin Thigpen,
Stefan Louw, Zhang Chen, Jeremy Lea, David Jones, and Arash Rezaie

Part of Partnered Pavement Research Program (PPRC) Strategic Plan Element 4.47:
Impact of Chip Seal on Bicyclists

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PREPARED BY:

University of California
Pavement Research Center
UC Davis, UC Berkeley

- http://www.ucprc.ucdavis.edu/PDF/UCPRC-RR-2013-07.pdf
- http://www.ucprc.ucdavis.edu/PDF/UCPRC-TM-2013-07.pdf

Next Steps (2014-2016)

- Correlate MPD and treatment specifications
- Repeat measurements and surveys for urban treatments, different bicycle types, broader demographic of riders
- Long-term monitoring of texture and roughness change for different treatments
- Develop improved models to characterize the impact of texture and roughness and vibration on bicycle ride quality
- Develop guidelines for design of preservation treatments for bicycle routes on state highways and local streets


Questions?
Thanks to Caltrans, participating bike clubs, NCE and other volunteers
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Hui Li, hili@ucdavis.edu