NATIONAL ACADEMIES *Sciences Engineering Medicine*

TRB TRANSPORTATION RESEARCH BOARD

TRB Webinar: Balanced Mix Design for Climate-Resilient Unpaved Roads

November 4, 2024

3:00 – 4:30 PM

PDH Certification Information

1.5 Professional Development Hours (PDH) – see follow-up email

You must attend the entire webinar.

Questions? Contact Andie Pitchford at TRBwebinar@nas.edu

The Transportation Research Board has met the standards and requirements of the Registered Continuing Education Program. Credit earned on completion of this program will be reported to RCEP at RCEP.net. A certificate of completion will be issued to each participant. As such, it does not include content that may be deemed or construed to be an approval or endorsement by the RCEP.

ENGINEERING RCEP REGISTERED CONTINUING EDUCATION PROGRAM

Purpose Statement

This webinar will present tools to help understand expected performances from wearing course materials on unpaved roads, how to blend different gravel sources to optimize unpaved road performance, and to select soil stabilization and dust control treatments that will produce a durable and climate resilient low-volume road driving surface.

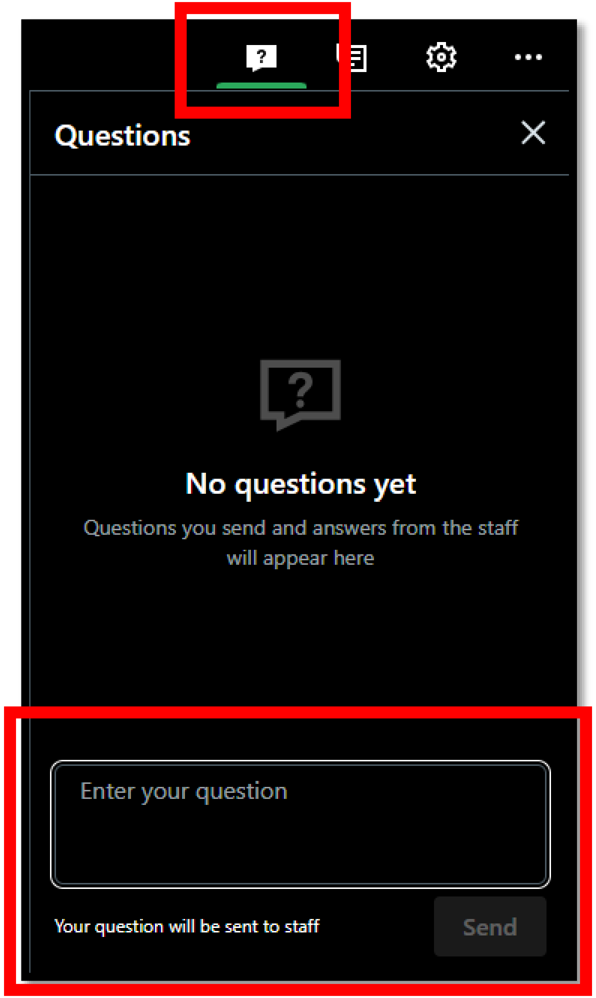
Learning Objectives

At the end of this webinar, you will be able to:

1. Select unpaved road materials and understand likely performance
2. Optimize unpaved road performance by blending two or more materials following a balanced mix design approach
3. Select the most appropriate chemical treatment for a given material and set of road conditions

Questions and Answers

- Please type your questions into your webinar control panel
- We will read your questions out loud, and answer as many as time allows



Today's Presenters

David Jones, PhD
djjones@ucdavis.edu
University of Califomia, Davis

Stephanus Louw, PhD
sjlouw@ucdavis.edu
University of Califomia, Davis

Gordon R. Keller, PE, GE
gordonrkeller@gmail.com
Genesee Geotechnical

BALANCED MIX DESIGN FOR CLIMATE-RESILIENT UNPAVED ROADS

David Jones and Stephanus Louw

University of California Pavement Research Center, Davis, California

TRB Workshop: Low Volume Roads Committee (AKD30)

November 4, 2024

UCPRC
UNIVERSITY of CALIFORNIA Davis • Berkeley | PAVEMENT RESEARCH CENTER


WARNING
GRAVEL ROADS
SURFACE CONDITIONS
CHANGE OFTEN
DRIVE CAREFULLY

Outline

- Introduction
- Understanding unpaved road materials
- Balanced mix design for unpaved roads
- Blending tool
- Chemical treatment selection tool
- Conclusions

Introduction

- Unpaved roads
  - Economically important
  - Safety, sustainability, resilience, and management issues
    - Problems exceed funding to fix them
  - Often emergency evacuation routes
  - Need to design for future climate, not past
  - Lost art of unpaved road engineering
    - "Paved road aggregate base is ok" (It's NOT!)

Introduction

- Materials are selected to optimize all-weather performance
  - Good, year-round ride quality with minimal maintenance
  - No dust when dry
  - Passable when wet
  - Resilient during intense storms
- Numerous guides and specifications available worldwide
  - Performance-related are the most useful, but not common
- Performance dependent on:
  - Particle size distribution (grading)
  - Plasticity (clay content)
  - Strength and thickness (bearing capacity)
  - Construction, shape/drainage, and maintenance
- Performance can be improved through mechanical stabilization and/or chemical treatments
  - Chemical treatments are best for "keeping good roads good"
- Primary goal: safe; cost-effective to manage & maintain

Introduction

- Considerations
  - Roads
  - Drainage
  - River crossings and approaches
  - Slopes
- Improvement and preservation options:
  - Upgrade to paved standard
  - Rehabilitate (regravel and reshape)
  - Preserve fines (dust control)
  - Stabilize or “waterproof”

Engineered Unpaved Roads

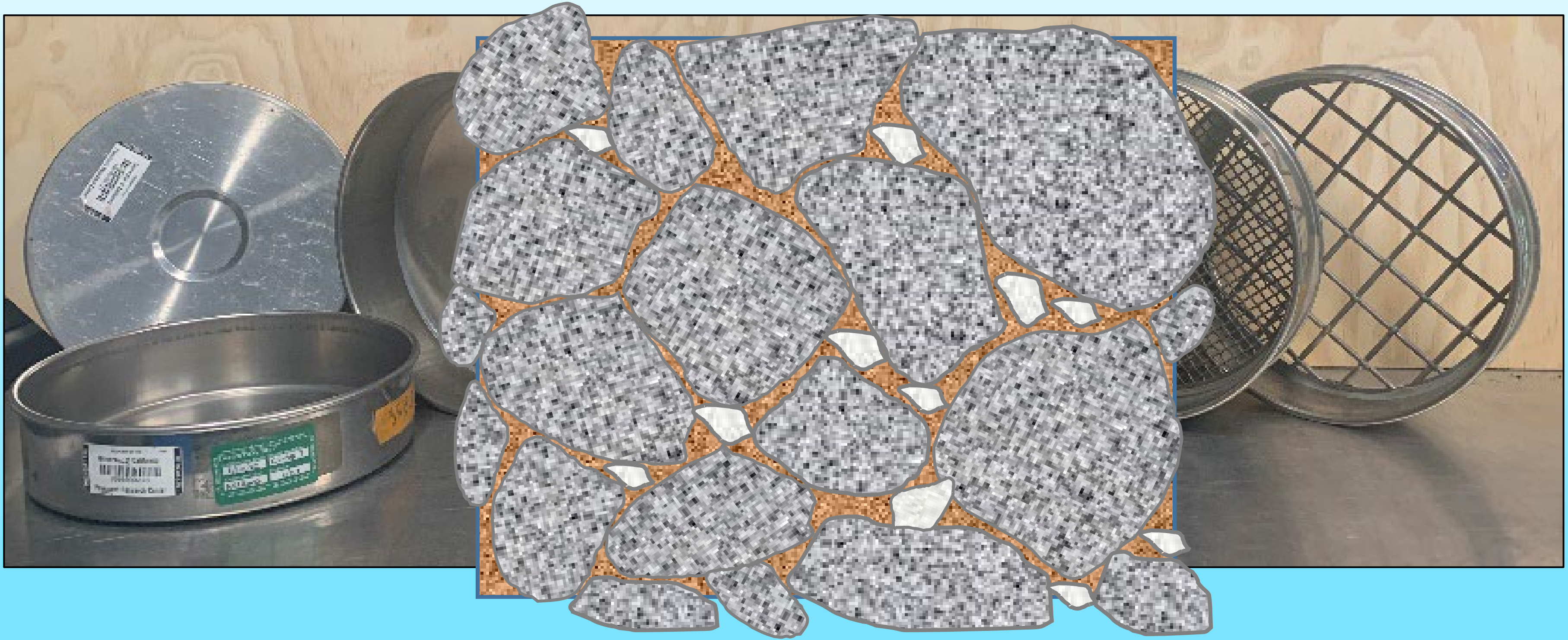
Use chemical treatments to keep a good road good

Outline

- Introduction
- Understanding unpaved road materials
- Balanced mix design for unpaved roads
- Blending tool
- Chemical treatment selection tool
- Conclusions

Understanding Materials

Materials - Grading



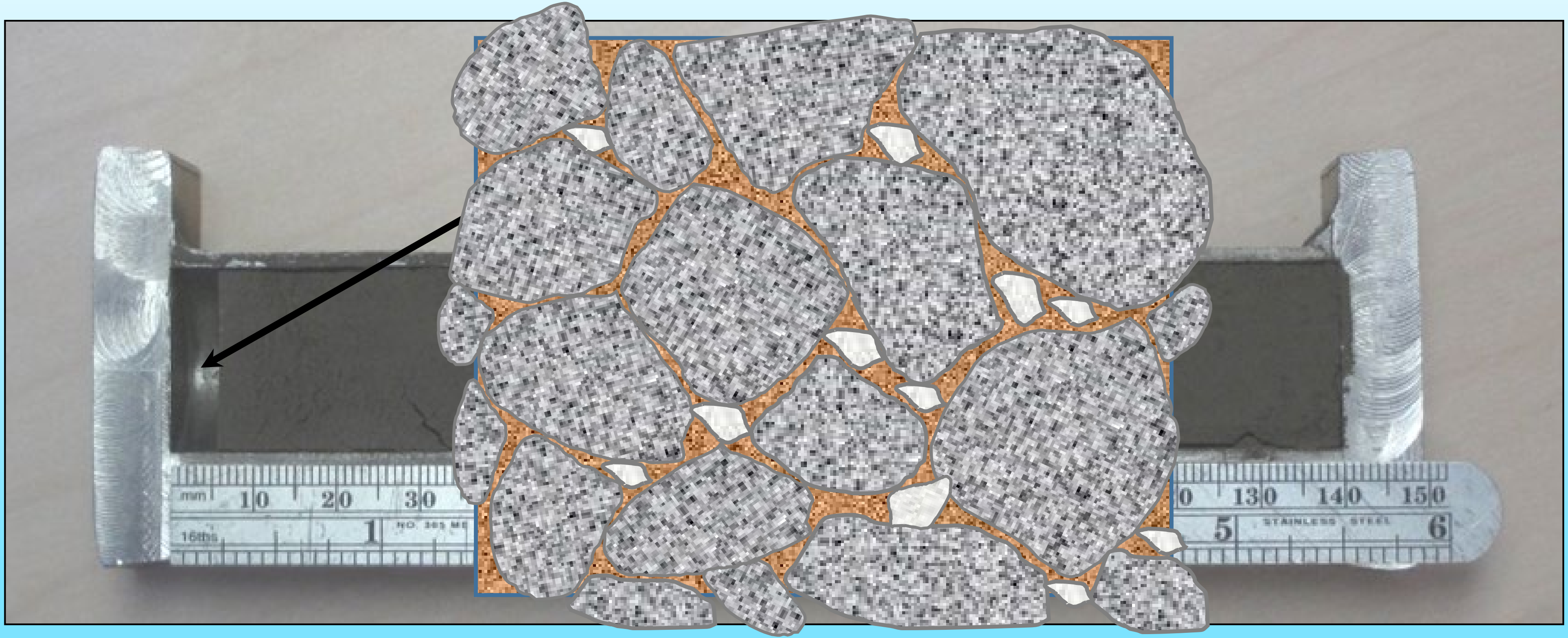
Aggregate interlock

The right ratio between coarse, intermediate, and fine particles
(26.5mm [1in.], 4.75mm [#4], and 2.36mm [#8] sieves)

Materials – Clay Content (Cohesion)

Liquid Limit - Plastic Limit = Plasticity Index

Materials – Clay Content (Shrinkage)



Some "glue" to hold everything together (weighted plasticity factor [linear shrinkage preferred])

Test Results (±$300)

ALLWEST Testing & Engineering

LABORATORY SUMMARY

PROJECT NAME:	Roadwise General	
CLIENT NAME:	Roadwise	
LOCATION:	Moscow, Idaho	
SAMPLE NUMBER:		1
LAB SAMPLE NUMBER:		A312-108
SAMPLED BY:		5/1/2012
DATE SAMPLED:		B. Bowles
MATERIAL:		Stockpile 5/8"
TEST DESCRIPTION	SPEC	RESULTS
SIEVE ANALYSIS AASHTO T27, T248 / ASTM C117, C136, C102, D1140		
1"		100
3/4"		100
1/2"		98
3/8"		84
#4		51
#8		31
#10		27
#16		20
#30		15
#40		13
#50		11
#100		9
#200		6.9
ATTERBURG LIMITS DETERMINATION AASHTO T89, T90 / ASTM D4318		Non-Plastic
FRACTURE COUNT AASHTO TP61 / ASTM D5821		100

REVIEWED BY

This report shall not be reproduced except in full without the pe

690 W. Capstone Court • Hayden, ID 83835 •

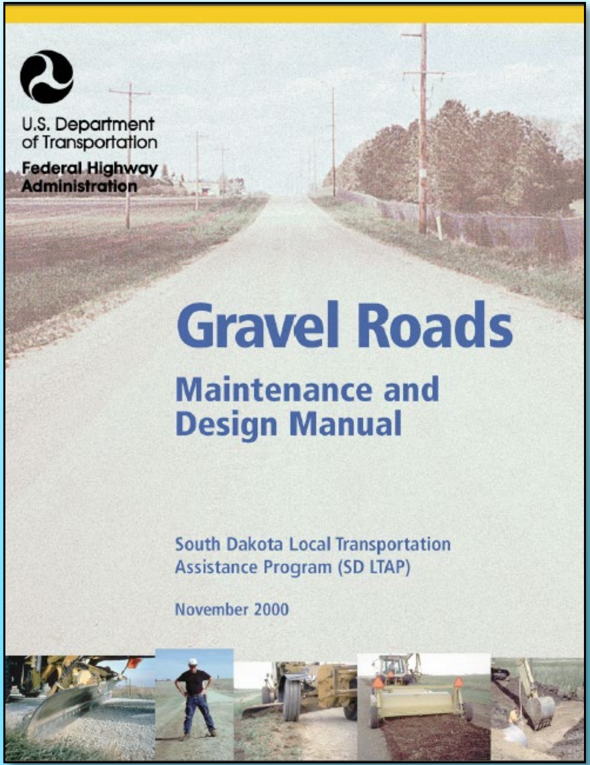
12928 E. Indiana Avenue • Spokane, WA 99216 •

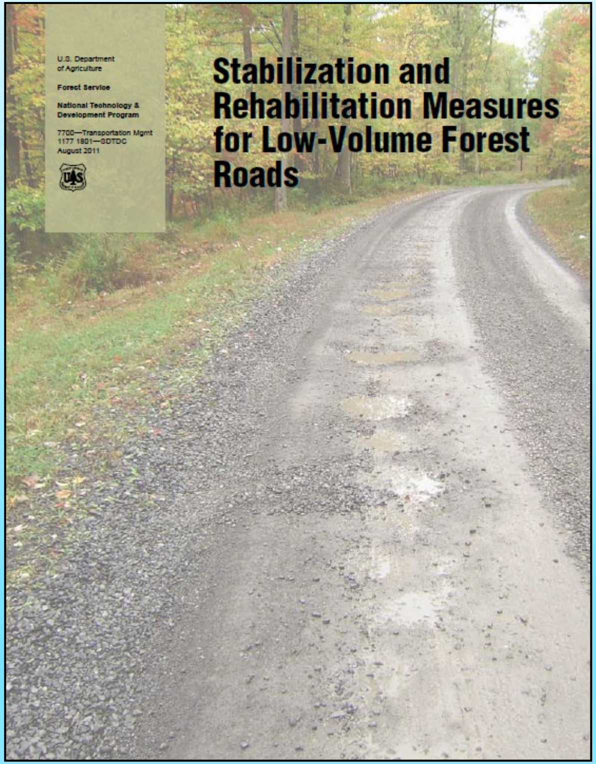
2127 2nd Avenue North • Lewiston, ID 83501 •

Revision #1- 03.20.12

SIEVE ANALYSIS				
ASTM C117, C135, C102, D1140				
26.5	1		100	100
19.0	3/4		100	94
13.2	1/2		98	80
9.50	3/8		84	80
4.75	#4		51	48
2.36	#8		31	31
2.00	#10		27	28
1.18	#16		20	21
1.00	#30		15	16
0.425	#40		13	14
0.300	#50		11	12
0.150	#100		9	10
0.075	#200		6.9	7.5
ATTERBERG LIMITS DETERMINATION			Non-Plastic	Non-Plastic
ASTM D4318				

US Guidelines & Specifications





Why Read Guidelines?

Example US Federal Specifications

Parameter			FHWA	USFS	
				Public Use	Haul
Sieve (mm [in.])	26.5	(1)	100	100	97 – 100
	19.0	(3/4)	90 – 100	97 – 100	76 – 89
	4.75	(#4)	50 – 78	51 – 63	43 – 53
	2.36	(#8)	37 – 67	28 – 39	23 – 32
	0.425	(#40)	13 – 35	19 – 27	15 – 23
	0.075	(#200)	4 – 15	10 – 16[1] or 6 - 12[1]	10 – 16[1] or 6 - 12[1]
Plasticity Index			4 – 12	2 – 9 if P0.075 is <12% <2 if P0.075 is >12%	

[1] Range for P0.075 is 6.0 to 12.0% if PI is greater than zero

US vs. MDOT Specifications

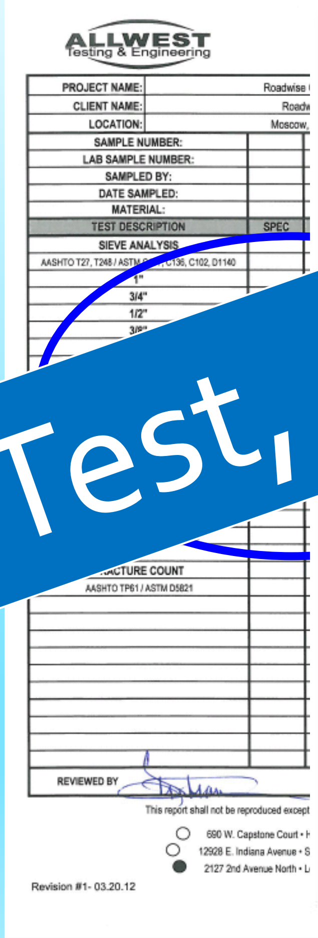
Parameter			FHWA	USFS Public Use	Michigan (Table 902-1)
Sieve (mm [in.])	26.5	(1)	100	100	100
	19.0	(3/4)	90 – 100	97 – 100	–
	9.5	(3/8)	–	–	60 – 85
	4.75	(#4)	50 – 78	51 – 63	–
	2.36	(#8)	37 – 67	28 – 39	25 – 60
	0.425	(#40)	13 – 35	19 – 27	–
	0.075	(#200)	4 – 15	10 – 16[1] or 6 - 12[1]	9 – 16
Plasticity Index			4 – 12	2 – 9 if P075 is <12% <2 if P075 is >12%	Not specified

[1] Range for P0.075 is 6.0 to 12.0% if PI is greater than zero

Outline

- Introduction
- Understanding unpaved road materials
- **Balanced mix design for unpaved roads**
- Blending tool
- Chemical treatment selection tool
- Conclusions

Test Results (±$300)



SIEVE ANALYSIS ASTM C117, C135, C102, D114				
26.5	[illegible]		100	100
19.0	[illegible]		100	94
[illegible]	[illegible]	[illegible]	98	80
[illegible]	[illegible]	[illegible]	84	80
[illegible]	#4		51	48
[illegible]	#8		31	31
[illegible]	#10		27	28
1.18	#16		20	21
1.00	#30		15	16
0.425	#40		13	14
0.300	#50		11	12
0.150	#100		9	10
0.075	#200		6.9	7.5
ATTERBERG LIMITS DETERMINATION ASTM D4318			Non-Plastic	Non-Plastic

Test, don't guess!

Balanced Mix Design for Unpaved Roads

- Replace grading envelopes with grading coefficient (G_c)
  - Ratio of coarse, intermediate, and fine
  - ((P26-P2.36) × P4.75) / 100
  - Target 15 to 35

- Replace plasticity index range with shrinkage product (S_p)
  - Weighted plasticity
  - Bar linear shrinkage (or ½PI) × P0.425
  - Target 100 to 365; preferably 100 to 240

Balanced Mix Design for Unpaved Roads

Maximum size (mm/in.) Particle size distribution factor (Weighted clay factor (Strength f	40) >15
tions and test methods! ent on construction and maintenance quality!**	

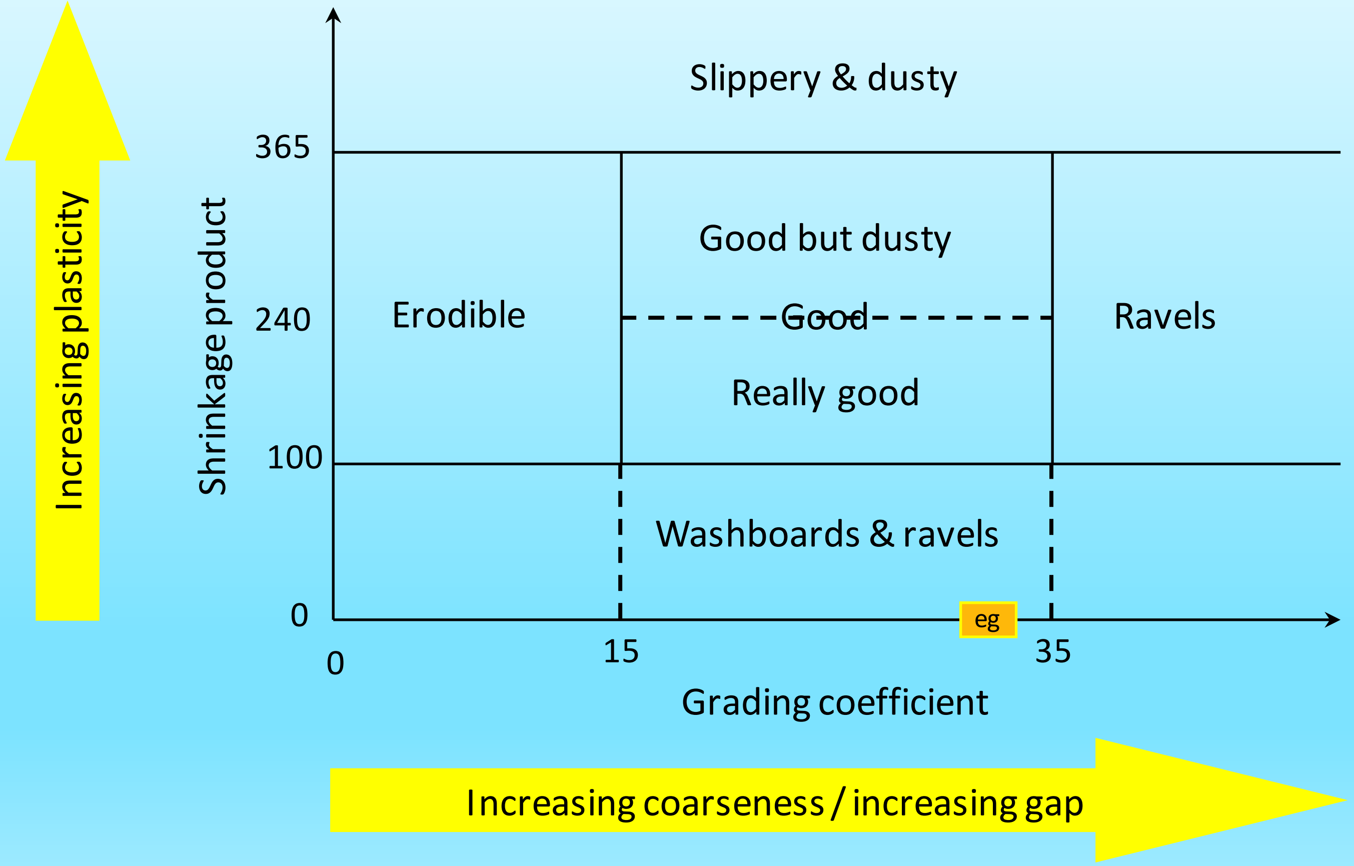
Not rocket science, just rocks and a little arithmetic!

Calibrate for Local Use

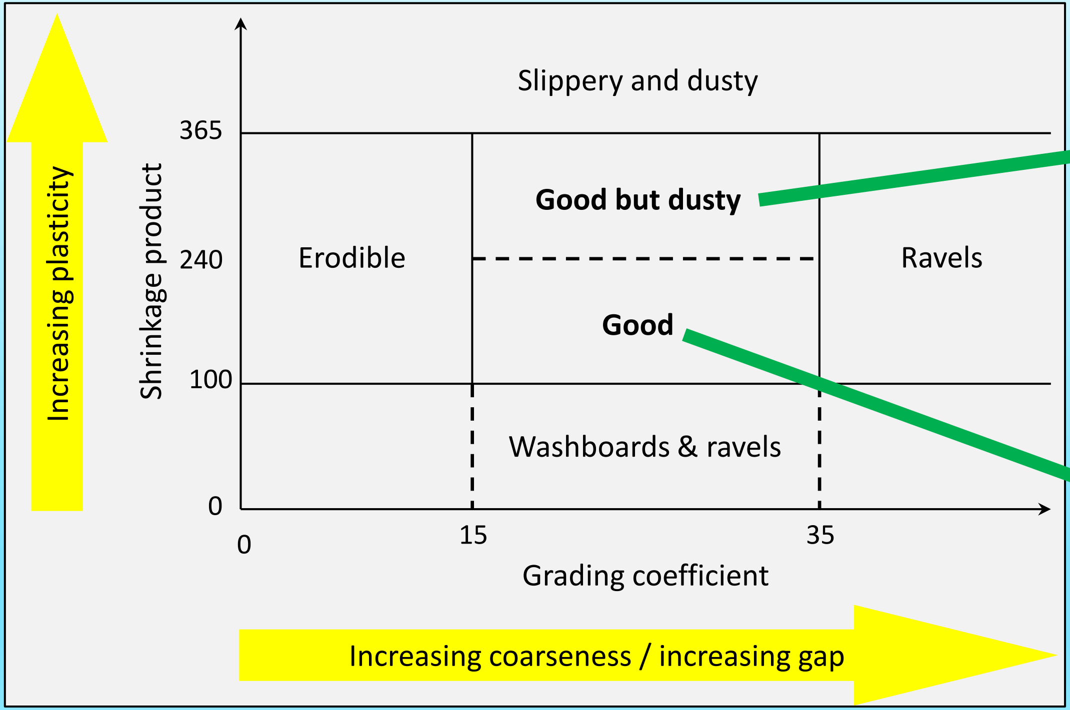
Predicting Road Performance

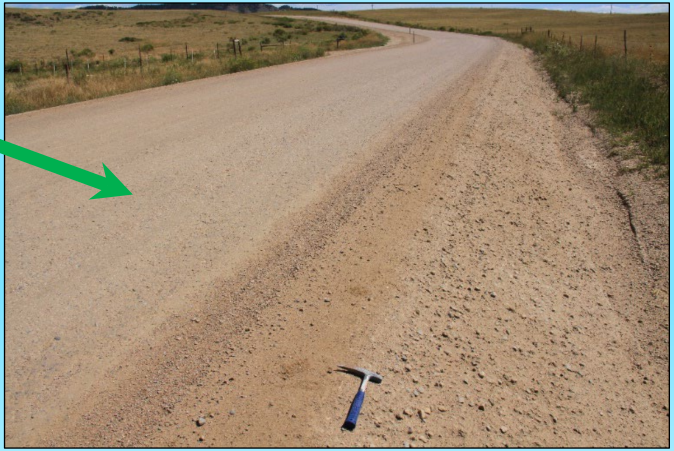
- Plot shrinkage product against grading coefficient to get expected performance
  - "Balancing" plasticity and gradation

Predicting Road Performance

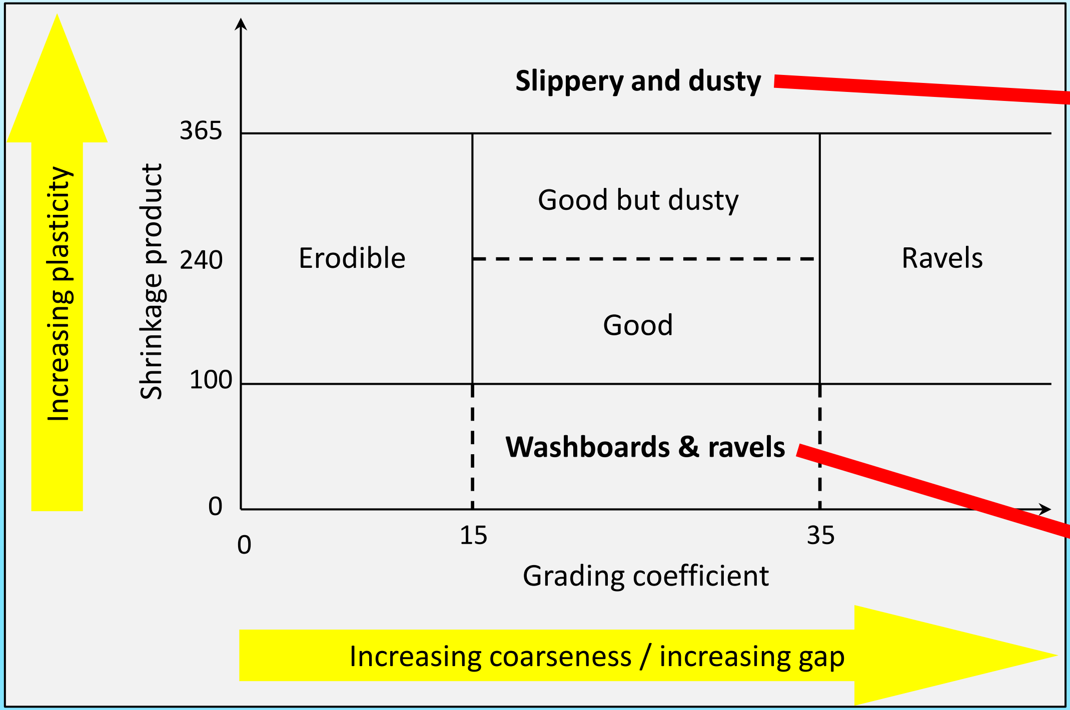


Predicting Road Performance

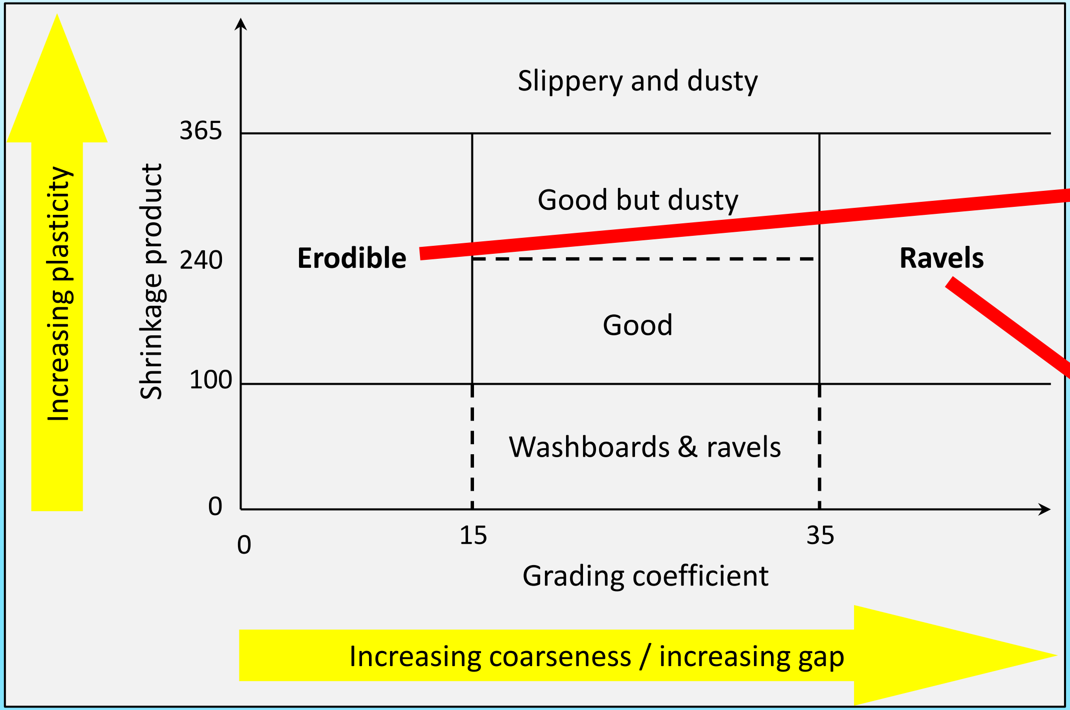




Predicting Road Performance



Predicting Road Performance



Deformation - Potholes

Deformation - Rutting

Shape + compaction + thickness!

How do US Guidelines Predict?

Parameter			FHWA	USFS	
				Public Use	Haul
Sieve (mm/US)	26.5 4.75 2.36 0.425	1 #4 #8 #40	100 50 – 78 37 – 67 13 – 35	100 51 – 63 28 – 39 19 – 27	97 – 100 43 – 53 23 – 32 15 – 23
Plasticity Index			4 – 12	2 – 9 if P0.075 is <12% <2 if P0.075 is >12%	

How do US Guidelines Predict?

Parameter			FHWA	USFS	
				Public Use	Haul
Sieve (mm/US)	26.5 4.75 2.36 0.425	1 #4 #8 #40	100 50 – 78 37 – 67 13 – 35	100 51 – 63 28 – 39 19 – 27	97 – 100 43 – 53 23 – 32 15 – 23
Plasticity Index			4 – 12	2 – 9 if P0.075 is <12% <2 if P0.075 is >12%	
Grading Coefficient: (15 – 35)		Low range Mid range High range Worst case			
Shrinkage Product: (100 – 365)		Low range Mid range High range Worst case			

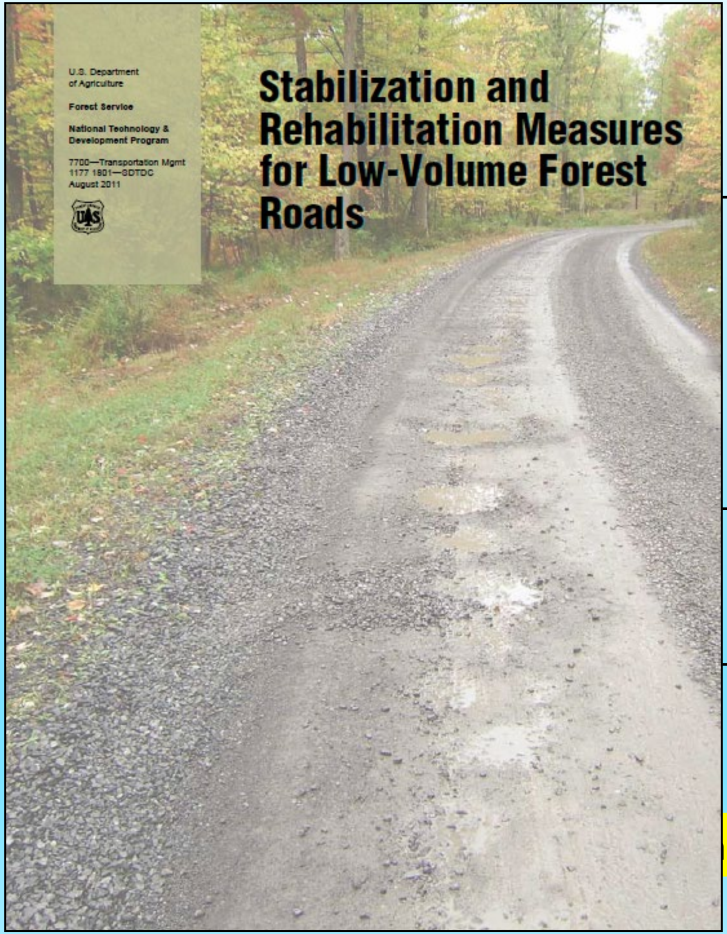
How do US Guidelines Predict?

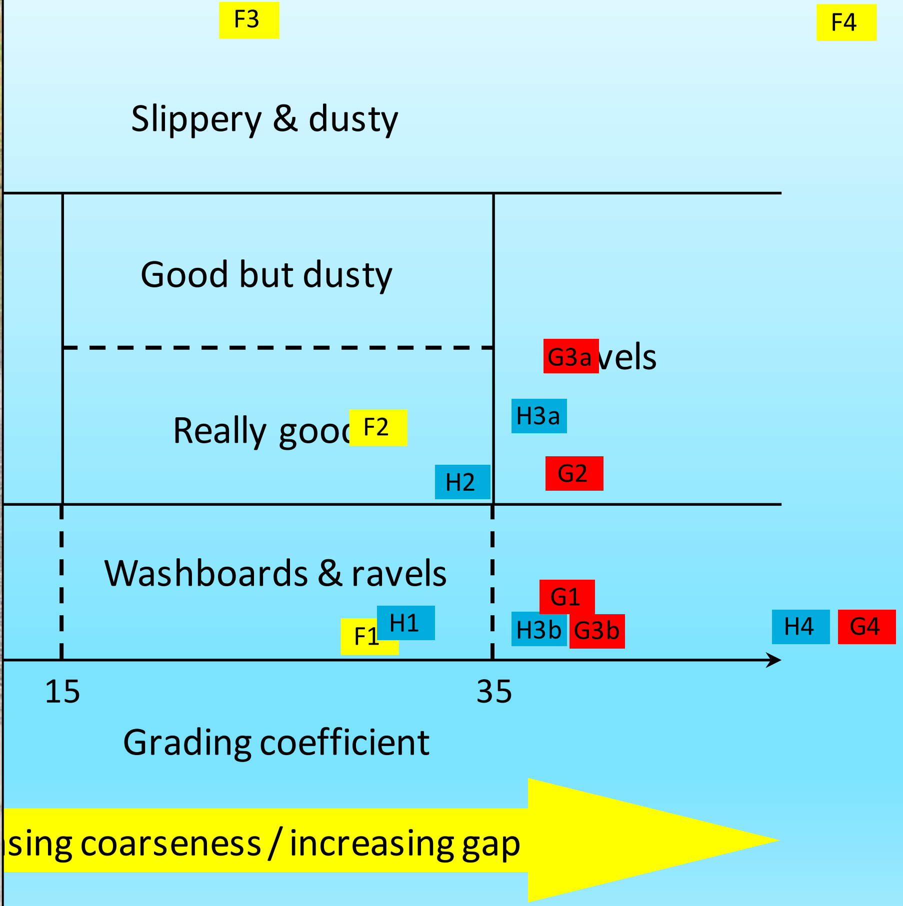
Parameter			FHWA	USFS	
				Public Use	Haul
Sieve (mm/US)	26.5 4.75 2.36 0.425	1 #4 #8 #40	100 50 – 78 37 – 67 13 – 35	100 51 – 63 28 – 39 19 – 27	97 – 100 43 – 53 23 – 32 15 – 23
Plasticity Index			4 – 12	2 – 9 if P0.075 is <12% <2 if P0.075 is >12%	
Grading Coefficient: (15 – 35)		Low range Mid range High range Worst case	32 31 26 49	37 38 38 45	32 34 36 41
Shrinkage Product: (100 – 365)		Low range Mid range High range Worst case	26 192 420 420	38 126 243/27 27	30 105 207/23 23

How do US Guidelines Predict?

Parameter			FHWA	USFS	
				Public Use	Haul
Sieve (mm/US)	26.5 4.75 2.36 0.425	1 #4 #8 #40	100 50 – 78 37 – 67 13 – 35	100 51 – 63 28 – 39 19 – 27	97 – 100 43 – 53 23 – 32 15 – 23
Plasticity Index			4 – 12	2 – 9 if P0.075 is <12% <2 if P0.075 is >12%	
Grading Coefficient: (15 – 35)		Low range Mid range High range Worst case	32 31 26 **49**	**37** **38** **38** **45**	32 34 **36** **41**
Shrinkage Product: (100 – 365)		Low range Mid range High range Worst case	**26** 192 **420** **420**	**38** 126 243/**27** **27**	30 105 207/**23** **23**

How do US Guidelines Predict?





Discussion

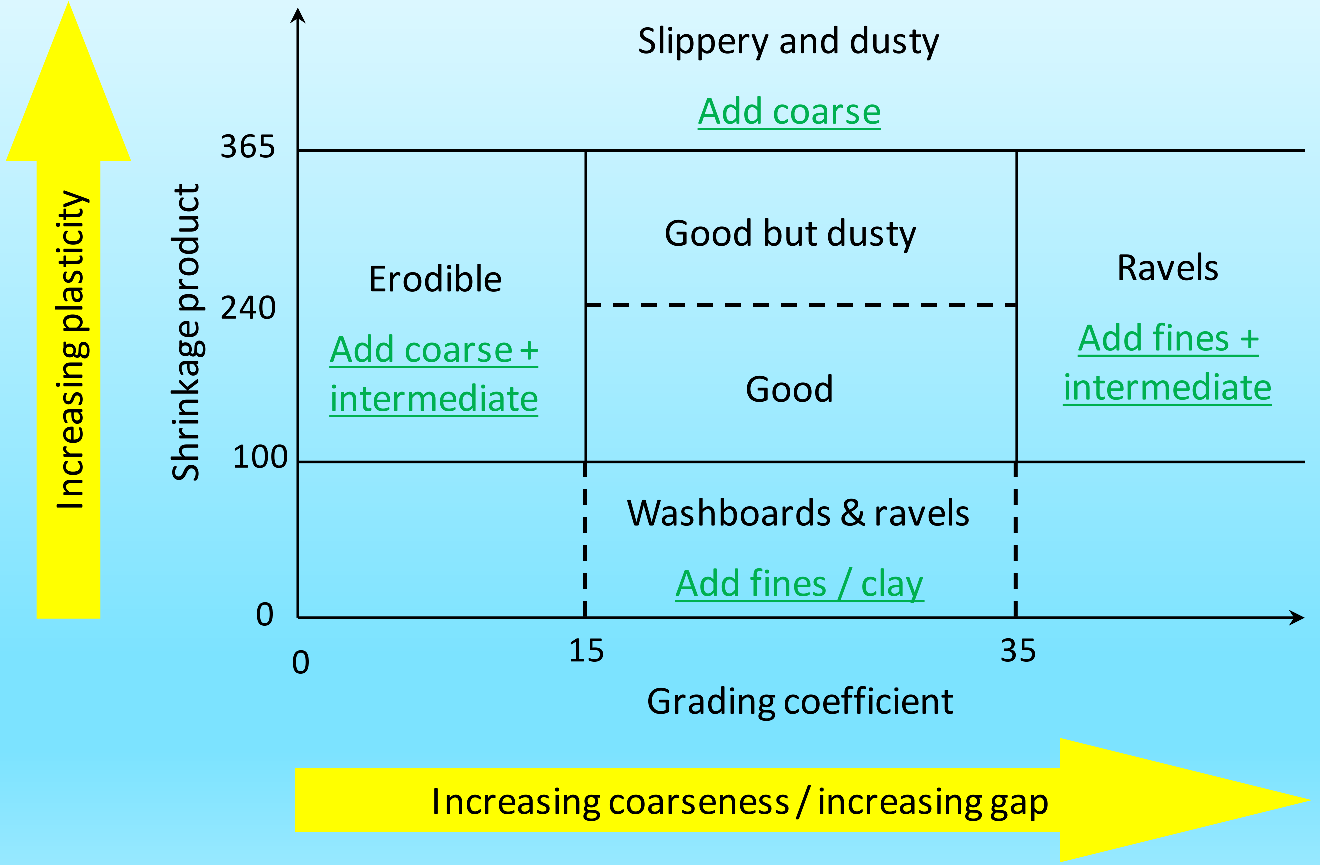
Don't always blame the contractor!

Outline

- Introduction
- Understanding unpaved road materials
- Balanced mix design for unpaved roads
- **Blending tool**
- Chemical treatment selection tool
- Conclusions

Two wrongs can make a right

Mechanical Stabilization to Improve the Balance



Web-Based Blending Tool


Unpaved Road Material Design Tool

City and County Pavement Improvement Center

Home Instructions Design About Print

Welcome to the Upaved Road Material Design Tool

Units: US SI

There are millions of kilometers of unpaved roads around the world managed by numerous authorities, land owners, and public and private organizations. Common to all of these roads are unacceptable levels of dust, poor riding quality (caused by erosion, washboarding, and/or raveling), and/or impassability in wet weather, and expensive maintenance and gravel replacement activities. Along with good construction practices, these problems can often be mitigated through better gravel selection, or by blending two or more materials to meet a performance-based specification.

With the growing interest in converting severely distressed low-volume paved roads to engineered unpaved roads, understanding expected performance in terms of the material properties after the conversion, which typically involves pulverizing the existing surface and blending it with the underlying layers, is increasingly important to ensure that the unpaved road is "better" than the paved road was. Mechanical stabilization of unpaved roads through blending of two materials is not new. However, determining appropriate blending ratios to meet performance-based specifications tends to be done on a trial and error basis until a satisfactory blend is achieved. This tool aims to eliminate the trial and error nature of material blending by providing a more accurate starting blend that can then be refined to provide optimal performance for a given application.

Ride quality affected by washboarding

Distressed low-volume paved road

An overview of performance-based specifications for unpaved road materials can be downloaded here. Use of this tool is fully described in the UCPRC guidelines entitled Guidance on the Conversion of Severely Distressed Paved Roads to Engineered Unpaved Roads and Guidance on Performance-Based Material Selection and Blending for Unpaved Roads.

Engineered unpaved road

Disclaimer

This Unpaved Road Material Design Tool has been developed to guide selection and/or blending of materials to meet a performance-based specification. Using the tool requires input of laboratory test results for the actual materials that will be used. Skipping the laboratory testing and guessing input values, or using default values from other projects, will lead to inaccurate output values. Output from the tool provides a starting point for a blend, which will need to be tested to confirm that it meets the required specification. In no event shall the University of California be liable to any party for direct, indirect, special, incidental, or consequential damages, including lost profits, arising out of the use of this system, even if the University of California has been advised of the possibility of such damage. The University of California specifically disclaims any warranties, including, but not limited to, the implied warranties of merchantability, fitness for a particular purpose and noninfringement.

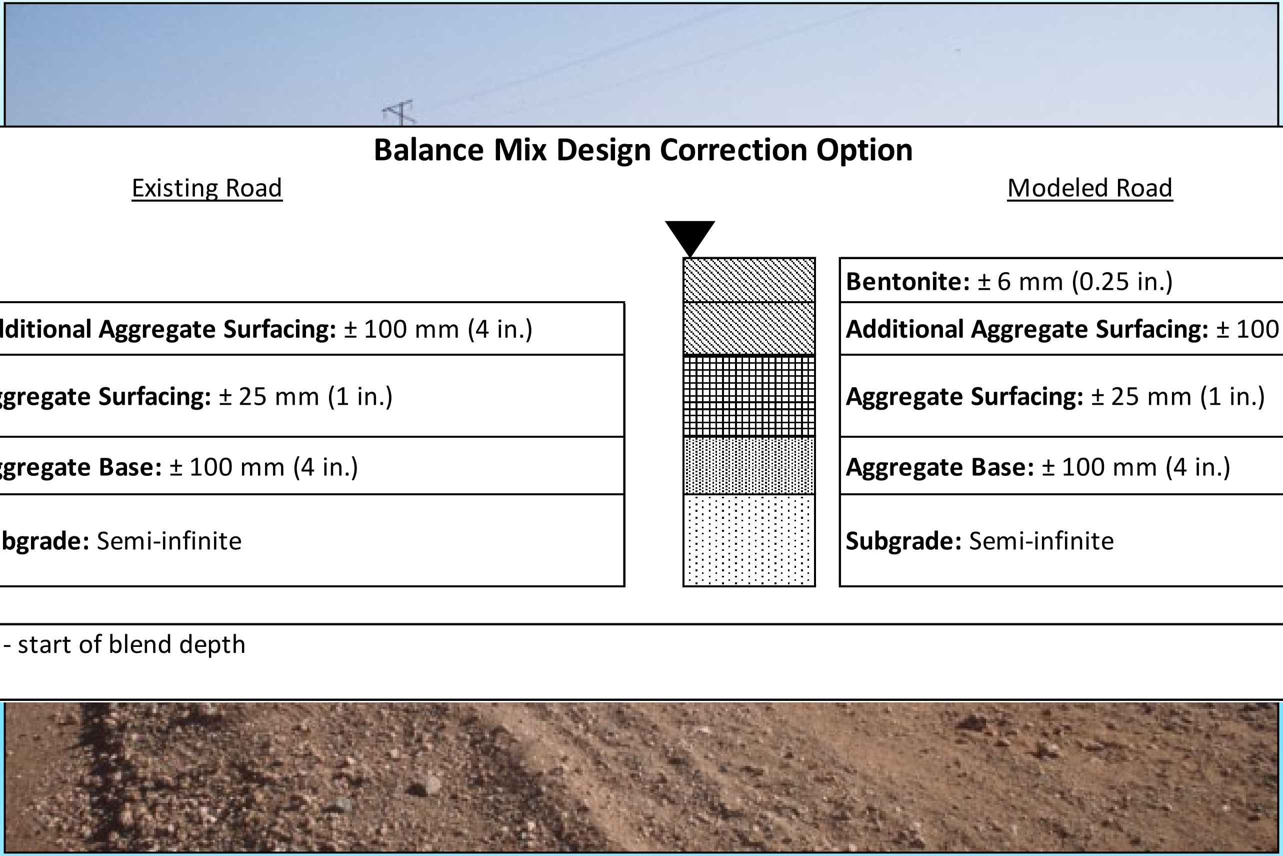
Accept

© 2019 University of California • Pavement • Research • Center

- Coded manual procedure with simple user interface
- Determines proportion that each layer contributes to a target thickness as a percentage
- Includes:
  - Three layers plus subgrade
  - Up to three materials in a blend
  - User defined materials library
  - Blend verification
- Rubbish in, rubbish out
  - Use actual test results
  - Use actual layer thicknesses

www.ucprc.ucdavis.edu/unpavedroad

Example: Balanced Mix Design Correction



Balance Mix Design Correction Option

Existing Road

Additional Aggregate Surfacing: ± 100 mm (4 in.)
Aggregate Surfacing: ± 25 mm (1 in.)
Aggregate Base: ± 100 mm (4 in.)
Subgrade: Semi-infinite

Modeled Road

Bentonite: ± 6 mm (0.25 in.)
Additional Aggregate Surfacing: ± 100 mm (4 in.)
Aggregate Surfacing: ± 25 mm (1 in.)
Aggregate Base: ± 100 mm (4 in.)
Subgrade: Semi-infinite

▼ Surface level - start of blend depth

Recommended Thickness Designs (FHWA guide)

Estimated Daily Truck Traffic	Subgrade Shear Strength (CBR)	Suggested Minimum Gravel Thickness (mm)
0 to 5	<3	175
	3 to 10	150
	>10	125
5 to 10	<3	225
	3 to 10	175
	>10	150
10 to 25	<3	300
	3 to 10	225
	>10	175
25 to 50	<3	380
	3 to 10	300
	>10	225
50 to 75	<3	455
	3 to 10	380
	>10	300

Example: Balanced Mix Design Correction

Existing road

Design thickness

Recycle depth

Supplemental aggregate

Materials library

Verification

Project ID: Balance Mix Design Correction

Existing Structure

2 Layers | 3 Layers | 4 Layers | Delete All Layers

#	Type	Thickness (Inch)	Layer Sum (Inch)	Passing 1" (%)	Passing #4 (%)	Passing #8 (%)	Passing #40 (%)	Passing #200 (%)	BLS (or PI/2)	Actions
1	Aggregate base	4.0	4.0	100	64	52	24	10	2	Edit Delete Insert
2	Aggregate base	1.0	5.0	100	64	52	24	10	6	Edit Delete Insert
3	Aggregate subbase	4.0	9.0	100	78	60	41	15	10	Edit Delete Insert
4	Subgrade	∞	9.0	100	84	78	58	44	11	Edit Delete Insert

Thickness Design: 7.0 Inch (Thickness Design Table)

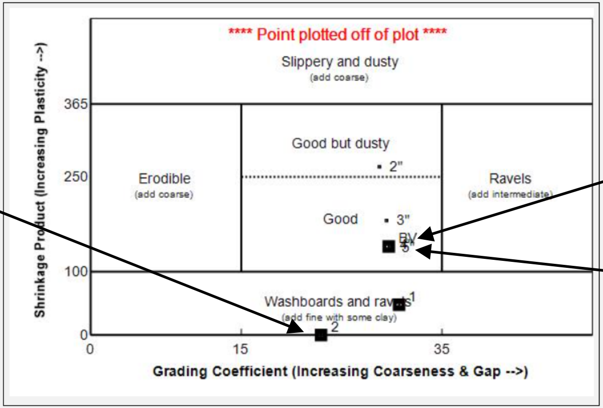
Depth of Recycling: 5.0 Inch

Predict Performance

☑ Add 0.3 Inch of Supplemental Material #: 4

☐ Add 0.0 Inch of Supplemental Material #: Select

☑ Plot Supplemental & Blend Validation Materials



Actual

Predicted

Supplemental Material Library

#	Description	Passing 1" (%)	Passing #4 (%)	Passing #8 (%)	Passing #40 (%)	Passing #200 (%)	BLS (or PI/2)	Actions
1	Aggregate Surfacing	100	64	52	24	10	2	Edit Delete Insert
2	RAP	100	28	18	6	3	0	Edit Delete Insert
3	Clay	100	87	82	62	54	18	Edit Delete Insert
4	Bentonite*	100	100	100	98	95	50	Edit Delete Insert

Add Material

Chemical Treatment Selection Tool

Blend Validation

Description	Passing 1" (%)	Passing #4 (%)	Passing #8 (%)	Passing #40 (%)	Passing #200 (%)	BLS (or PI/2)	Actions
Blend Validation	100	66	55	28	15	5	Edit Clear

Example: Balanced Mix Design Correction

Outline

- Introduction
- Understanding unpaved road materials
- Balanced mix design for unpaved roads
- Blending tool
- Chemical treatment selection tool
- Conclusions

Chemical Treatment Categories

- Fines retention/dust control
  - Water and water with surfactants
  - Water absorbing (chlorides)
  - Organic non-petroleum (plant-based)
  - Organic petroleum (crude-based)
- Stabilization/strength improvement
  - Organic petroleum
  - Synthetic polymer emulsions (acrylates, etc.)
  - Concentrated liquid stabilizers

www.ucprc.ucdavis.edu/dustcontrol

Unpaved Road Chemical Treatment Selection Tool

UCPRC | City and County Pavement Improvement Center

Home | Instructions | Treatment Selection | Results Interpretation | About

Welcome to the UCPRC's Unpaved Road Chemical Selection Tool Site

Language & Units
English Spanish
US SI

There are millions of kilometers/miles of unpaved roads around the world managed by numerous authorities, land owners, and public and private organizations. Common to all of these roads are unacceptable levels of dust, poor riding quality and/or impassability in wet weather, and expensive maintenance and gravel replacement activities. Over the last 100+ years, a range of different chemical treatments have been developed to overcome these issues. Most of these are proprietary, which can complicate selection of an appropriate treatment for a specific set of conditions. There is also no single product that will solve all problems under all conditions.

Loss of fines (as dust) on an untreated road

A procedure has therefore been developed to guide practitioners in the selection of an appropriate treatment. This procedure, based on the 1999 US Forest Service Guide (*Dust Palliative Selection and Application Guide*), and updated with new research and experience, factors traffic, climate, material properties, and road geometry into the most appropriate treatment selections for a given set of input values. The procedure is based on the philosophy of using chemical treatments to keep good roads in good condition, rather than attempting to use chemical treatments to "fix" bad roads. This unpaved road chemical treatment selection tool and information related to it is fully described in the UCPRC guideline entitled "Guidelines for the Selection, Specification, and Application of Chemical Dust Control and Stabilization Treatments on Unpaved Roads." This web-based chemical treatment selection tool can be considered as a companion to the guideline.

The photo on the left shows loss of fines on an untreated road while the photo on the right shows the results of applying a fines preservation treatment.

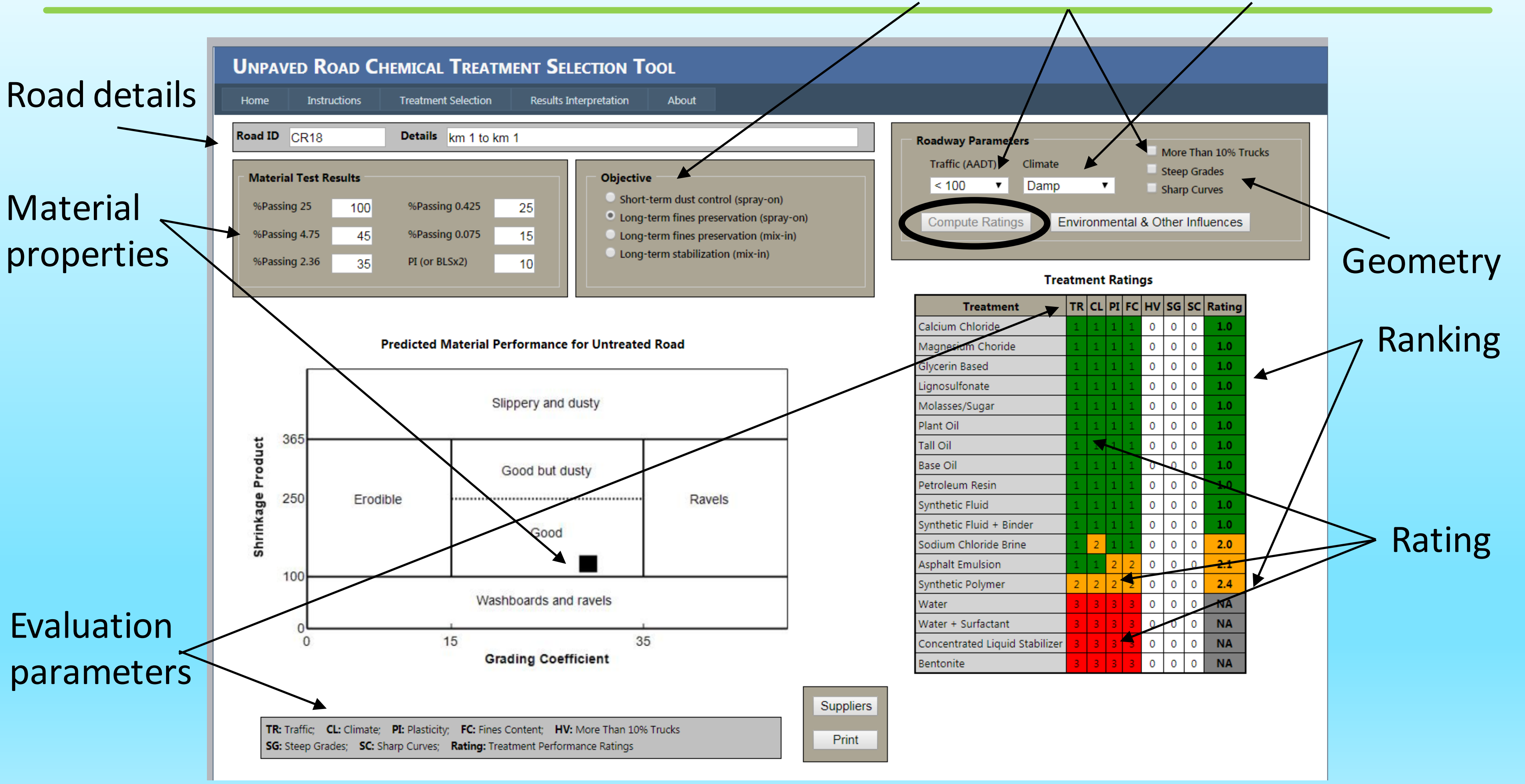
Stable fines preservation on a treated road

Disclaimer

This unpaved road chemical treatment selection procedure has been developed to guide selection of an appropriate treatment. It is based on the experience of practitioners and documented field experiment results. It is a guide only and does not replace engineering practice and judgment. Before initiating a treatment program, users should check actual performance for their particular materials and conditions with appropriate laboratory performance tests and/or short field experiments and/or seek guidance from other experienced practitioners and treatment suppliers. The University of California does not endorse the use of any specific product for dust control and stabilization of unpaved roads. In no event shall the University of California be liable to any party for direct, indirect, special, incidental, or consequential damages, including lost profits, arising out of the use of this system, even if the University of California has been advised of the possibility of such damage. The University of California specifically disclaims any warranties, including, but not limited to, the implied warranties of merchantability, fitness for a particular purpose and noninfringement.

Accept

Treatment selection for BMD



Treatment	TR	CL	PI	FC	HV	SG	SC	Rating
Calcium Chloride	1	1	1	1	0	0	0	1.0
Magnesium Choride	1	1	1	1	0	0	0	1.0
Glycerin Based	1	1	1	1	0	0	0	1.0
Lignosulfonate	1	1	1	1	0	0	0	1.0
Molasses/Sugar	1	1	1	1	0	0	0	1.0
Plant Oil	1	1	1	1	0	0	0	1.0
Tall Oil	1	1	1	1	0	0	0	1.0
Base Oil	1	1	1	1	0	0	0	1.0
Petroleum Resin	1	1	1	1	0	0	0	1.0
Synthetic Fluid	1	1	1	1	0	0	0	1.0
Synthetic Fluid + Binder	1	1	1	1	0	0	0	1.0
Sodium Chloride Brine	1	2	1	1	0	0	0	2.0
Asphalt Emulsion	1	1	2	2	0	0	0	2.1
Synthetic Polymer	2	2	2	2	0	0	0	2.4
Water	3	3	3	3	0	0	0	NA
Water + Surfactant	3	3	3	3	0	0	0	NA
Concentrated Liquid Stabilizer	3	3	3	3	0	0	0	NA
Bentonite	3	3	3	3	0	0	0	NA

Treatment selection for UBMD (Low Sp)

Unpaved Road Chemical Treatment Selection Tool

Home | Instructions | Treatment Selection | Results Interpretation | About

Road ID CR18 **Details** km 1 to km 1

Material Test Results

%Passing 25	100	%Passing 0.425	25
%Passing 4.75	45	%Passing 0.075	10
%Passing 2.36	35	PI (or BLSx2)	0

Objective

- Short-term dust control (spray-on)
- Long-term fines preservation (spray-on)
- Long-term fines preservation (mix-in)
- Long-term stabilization (mix-in)

Roadway Parameters

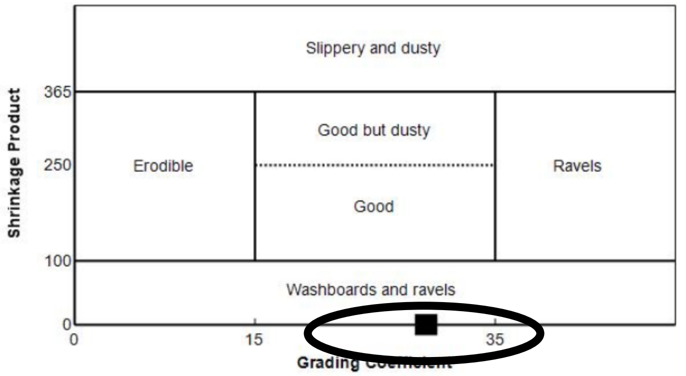
Traffic (AADT): < 100

Climate: Damp

- More Than 10% Trucks
- Steep Grades
- Sharp Curves

Compute Ratings | Environmental & Other Influences

Predicted Material Performance for Untreated Road



Treatment Ratings

Treatment	TR	CL	PI	FC	HV	SG	SC	Rating
Asphalt Emulsion	1	1	2	1	0	0	0	2.0
Calcium Chloride	1	1	2	2	0	0	0	2.1
Magnesium Choride	1	1	2	2	0	0	0	2.1
Glycerin Based	1	1	2	2	[illegible]	0	0	2.1
Lignosulfonate	1	1	2	2	0	0	0	2.1
Tall Oil	1	1	2	2	0	0	0	2.1
Base Oil	1	1	2	2	0	0	0	2.1
Petroleum Resin	1	1	2	2	0	0	0	2.1
Synthetic Fluid	1	1	2	2	0	0	0	2.1
Synthetic Fluid + Binder	1	1	2	2	0	0	0	2.1
Synthetic Polymer	2	2	2	2	0	0	0	2.4
Plant Oil	1	1	3	2	0	0	0	3.0
Sodium Chloride Brine	1	2	3	2	0	0	0	3.0
Molasses/Sugar	1	1	3	3	0	0	0	3.1
Water	3	3	3	3	[illegible]	0	0	NA
Water + Surfactant	3	3	3	3	[illegible]	0	0	NA
Concentrated Liquid Stabilizer	3	3	3	3	0	0	0	NA
Bentonite	3	[illegible]	3	3	0	0	0	NA

Change in rating order

TR: Traffic; **CL:** Climate; **PI:** Plasticity; **FC:** Fines Content; **HV:** More Than 10% Trucks
SG: Steep Grades; **SC:** Sharp Curves; **Rating:** Treatment Performance Ratings

Suppliers | Print

Treatment selection for UBMD (High Sp)

Unpaved Road Chemical Treatment Selection Tool

UCPRC | City and County Pavement Improvement Center

Home | Instructions | Treatment Selection | Results Interpretation | About

Road ID CR-18 **Details** km1 to km 10

Material Test Results

%Passing 1"	100	%Passing #40	40
%Passing #4	65	%Passing #200	30
%Passing #8	55	PI (or BLSx2	22

Objective

- Short-term dust control (spray-on)
- (selected) Long-term fines preservation (spray-on)
- Long-term fines preservation (mix-in)
- Long-term stabilization (mix-in)

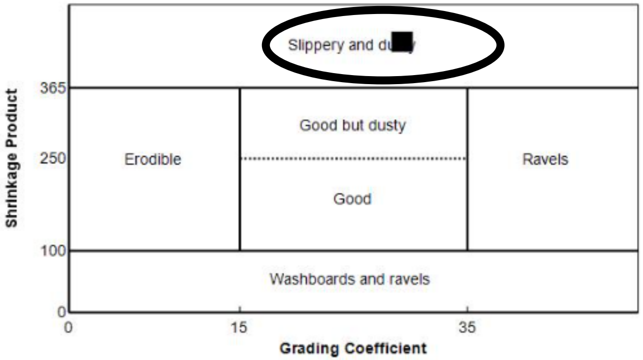
Roadway Parameters

Traffic (AADT): < 100
Climate: Damp

- More Than 10% Trucks
- Steep Grades
- Sharp Curves

Compute Ratings | Environmental & Other Influences

Predicted Material Performance for Untreated Road



Treatment Ratings

Treatment	TR	CL	PI	FC	HV	SG	SC	Rating
Lignosulfonate	1	[illegible]	3	1	0	0	0	3.0
Plant Oil	1	[illegible]	3	[illegible]	0	0	0	3.0
Tall Oil	1	1	3	1	0	0	0	3.0
Base Oil	1	1	3	1	0	0	0	3.0
Synthetic Fluid	1	1	3	1	0	0	0	3.0
Synthetic Fluid + Binder	1	1	3	1	0	0	0	3.0
Calcium Chloride	1	1	3	2	0	0	0	3.0
Magnesium Choride	1	1	3	2	0	0	0	3.0
Glycerin Based	1	1	3	2	0	0	0	3.0
Molasses/Sugar	1	1	3	2	0	0	0	3.0
Petroleum Resin	1	1	3	2	0	0	0	3.0
Sodium Chloride Brine	1	2	3	2	0	0	0	3.0
Asphalt Emulsion	1	1	3	3	0	0	0	3.1
Synthetic Polymer	2	2	3	3	0	0	0	3.2
Water	3	3	3	[illegible]	0	0	0	NA
Water + Surfactant	3	[illegible]	3	[illegible]	0	0	0	NA
Concentrated Liquid Stabilizer	3	[illegible]	3	3	0	0	0	NA
Clay Additive	3	3	3	3	0	0	0	NA

Change in rating order

TR: Traffic; **CL:** Climate; **PI:** Plasticity; **FC:** Fines Content; **HV:** More Than 10% Trucks
SG: Steep Grades; **SC:** Sharp Curves; **Rating:** Treatment Performance Ratings

Suppliers | Print

Outline

- Introduction
- Understanding unpaved road materials
- Balanced mix design for unpaved roads
- Blending tool
- Chemical treatment selection tool
- Conclusions

Conclusions

- Unpaved roads are managed with very constrained budgets, but high user expectations
- Using performance-based specifications can reduce maintenance/extend regraveling intervals
- Difficult to source good unpaved road wearing course materials from commercial sources
- Relatively easy to blend supplemental aggregates to meet that performance specification
- Adopting an "engineered" unpaved road management strategy will be most cost-effective
- It's proven technology - give it a try!

Thank-you!

djjones@ucdavis.edu sjlouw@ucdavis.edu www.ucprc.ucdavis.edu

Today’s Presenters

David Jones, PhD
djjones@ucdavis.edu
University of California, Davis

Stephanus Louw, PhD
sjlouw@ucdavis.edu
University of California, Davis

Gordon R. Keller, PE, GE
gordonrkeller@gmail.com
Genesee Geotechnical

Upcoming events for you

November 7-8, 2024

TRB's Conference on Advancing Additive Manufacturing and Construction in Transportation

May 28-29, 2024

TRB's Conference on Data and AI for Transportation Advancement

https://www.nationalacademies.org/trb/events

Register for the 2025 TRB Annual Meeting!

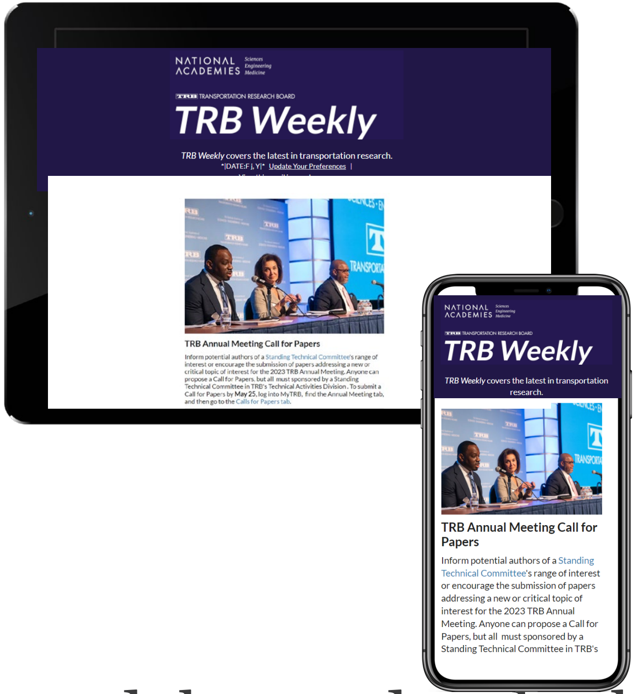
January 5 – 9, 2025
Washington, D.C.

Subscribe to *TRB Weekly*

If your agency, university, or organization perform transportation research, you and your colleagues need the *TRB Weekly* newsletter in your inboxes!

Each Tuesday, we announce the latest:

- RFPs
- TRB's many industry-focused webinars and events
- 3-5 new TRB reports each week
- Top research across the industry



Spread the word and subscribe!

https://bit.ly/ResubscribeTRBWeekly

NATIONAL ACADEMIES Sciences Engineering Medicine

TRB TRANSPORTATION RESEARCH BOARD

Discover new TRB Webinars weekly

Set your preferred topics to get the latest listed webinars and those coming up soon every Wednesday, curated especially for you!

https://mailchi.mp/nas.edu/trbwebinars

And follow #TRBwebinar on social media

@NASEMTRB

@NASEMTRB

Transportation Research Board

NATIONAL ACADEMIES Sciences Engineering Medicine

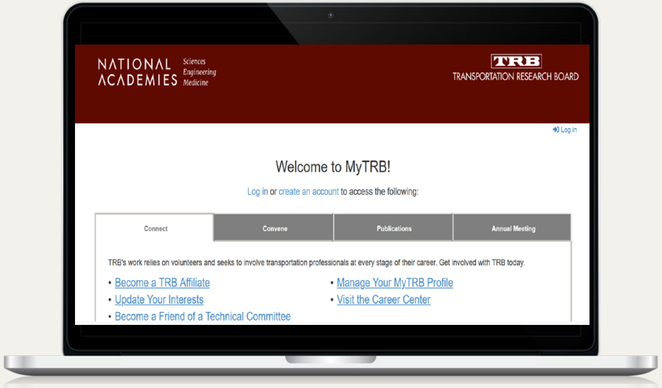
TRB TRANSPORTATION RESEARCH BOARD

Get involved

TRB mobilizes expertise, experience, and knowledge to anticipate and solve complex transportation-related challenges.

TRB's mission is accomplished through the hard work and dedication of more than **8,000 volunteers**.

https://www.nationalacademies.org/trb/get-involved



We want to hear from you

- **Take our survey**
- **Tell us how you use TRB Webinars in your work at trbwebinar@nas.edu**

NATIONAL ACADEMIES *Sciences Engineering Medicine*