

Full-Depth Reclamation (Recycling)

CNCA



Graniterock®

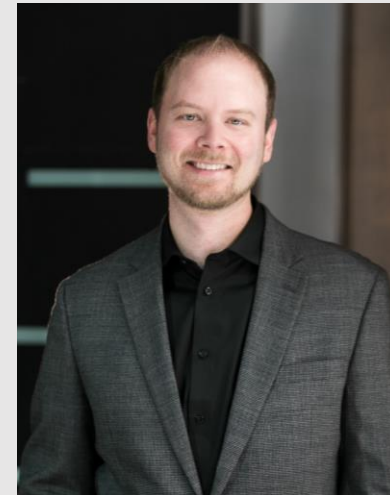
Tyler Bodnar, PE
Director of Geotechnical Markets
tyler.bodnar@cncement.org

Graniterock Tech Talk
March 11, 2021

California Nevada Cement Association

WHO WE ARE

- A non-profit trade association
- Funded by the seven producers and distributors of Portland cement in CA & NV
- Advocates for infrastructure funding
- In partnership with agencies/owners, consultants, and contractors to provide:
 - Research
 - Educational opportunities
 - Design assistance
 - Technical expertise
 - Construction feasibility



Nevada Cement Company



National Cement Company of California, Inc.

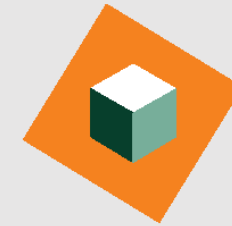


PAN PACIFIC
CEMENT

Pavement & Materials Partnering Committee

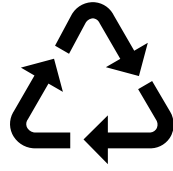


Caltrans®



Graniterock®

Same Old Thinking



Same Old Results



[Pension Reform](#) [Drug Policy](#) [Education](#) [Transpo](#)

[About](#) [Experts](#) [Topics](#) [Publications](#)

23rd Annual Highway Report – Percent Urban Interstate Mileage in Poor Condition



Rank	Name	Percent
------	------	---------

1	Vermont	0.17
2	New Hampshire	0.48
3	North Dakota	0.62
4	Arizona	0.63
5	Illinois	0.88
6	Florida	1.05
7	North Carolina	1.66
8	Montana	1.71
9	Tennessee	1.76
10	New Mexico	1.83
11	Nevada	1.91
12	Delaware	1.91
13	Utah	2.11
14	South Dakota	2.13
15	Idaho	2.32
16	South Carolina	2.41
17	West Virginia	2.65
18	Georgia	2.77
19	Missouri	2.83
20	Kentucky	2.93
21	Virginia	3.2
22	Kansas	3.26
23	Nebraska	3.39
24	Maine	3.42
25	Iowa	3.43
26	Connecticut	3.56
27	Ohio	3.65
28	Alaska	3.83
29	Colorado	3.91
30	Oregon	4.16
31	Mississippi	4.2
32	Rhode Island	4.81
33	Pennsylvania	5.06
34	Texas	5.15
35	Massachusetts	5.18
36	Wyoming	5.37
37	Washington	6.15
38	Alabama	6.3
39	Minnesota	6.54
40	Wisconsin	6.7
41	Maryland	7.44
42	Oklahoma	7.55
43	Indiana	7.6
44	Arkansas	7.96
45	Michigan	8
46	California	8.72
47	New Jersey	9.79
48	New York	11.21
49	Louisiana	13.66
50	Hawaii	25.13
Weighted Average		5.02

45	Michigan	8
46	California	8.72
47	New Jersey	9.79



Available Specifications

- Section 30-2 Pulverization (2018 Standard Specifications)
- Section 30-3 Full Depth Reclamation - Foamed Asphalt (2018 Standard Specifications)
- Section 30-4 Full Depth Reclamation - Cement (2018 Standard Specifications)
 - ○ RSS-30-4_2018 Full Depth Reclamation - Cement
 - SSP-30-4_2018 Full Depth Reclamation - Cement
- NSSP-30-5_2018 Partial Depth Recycling (Updates coming soon)
 - ○ Partial Depth Recycling - Emulsified Asphalt
 - ○ Partial Depth Recycling - Foamed Asphalt

In-Place Recycling Training Presentation and Resources

- Introduction to In-Place Recycling Training Webinar Presentation ←
- [Highway Design Manual: Chapter 630 Flexible Pavement](#)
- Caltrans PavEM Portal Website
- Caltrans In-Place Recycling Manual (coming soon)
- [DES Website](#)
- [Office of Asphalt Pavement](#)
- [Wirtgen Cold Recycling Technology Manual \(external link\)](#)
- Basic Asphalt Recycling Manual (BARM) (upon request)
- [Road Resource Website \(external link\)](#)
- Portland Cement Association Manual (upon request)



Call Us – We're Here to Help!





The Basics of FDR

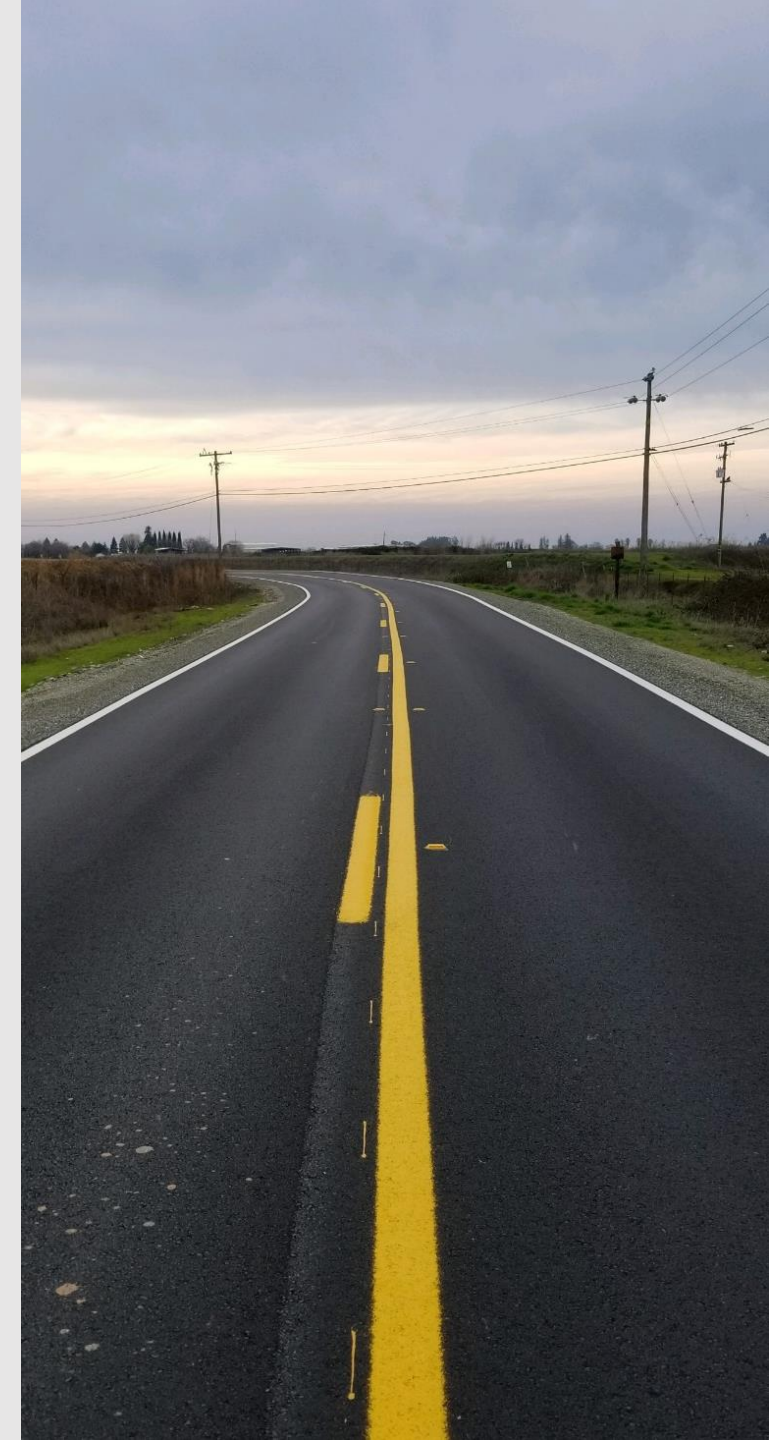
What is FDR?

In it's simplest form:

Full-depth reclamation is a road rehabilitation method that involves recycling existing asphalt pavement and its underlying layer(s), blending them with a stabilizing agent, and creating a new stronger, more homogenous base layer.

Benefits of FDR

- Cost-effectiveness
- Contractor Evolution
- Higher structural carrying capacity
- Increased durability
- *Opportunity to improve roadway geometry*
- Shorter construction time and less staging impacts
- Early opening to traffic
- Reflection cracking mitigation
- Reduced carbon footprint - Sustainability



Sustainability – Truck Trip Reduction



40:1
Replacement

Less Fuel.
Less Damage



Quantifying In-Place Recycling Impacts

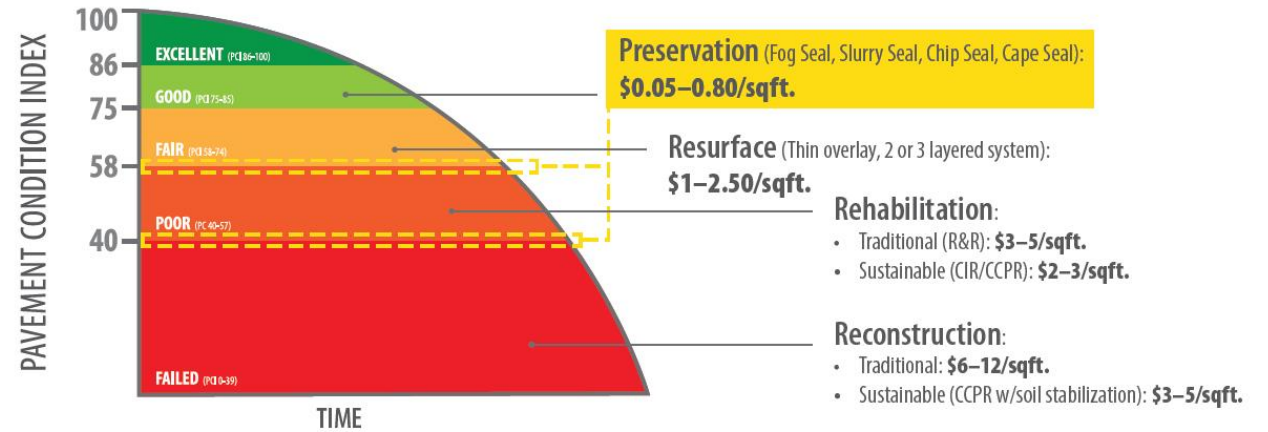


Los Angeles County's

SUSTAINABLE ROADS

National Pavement Condition Index (PCI)

National Best Management Practice=PCI 82



\$60M
Cost savings



84%
Reduction in
GHG emissions



80%
Reduction in
energy consumption

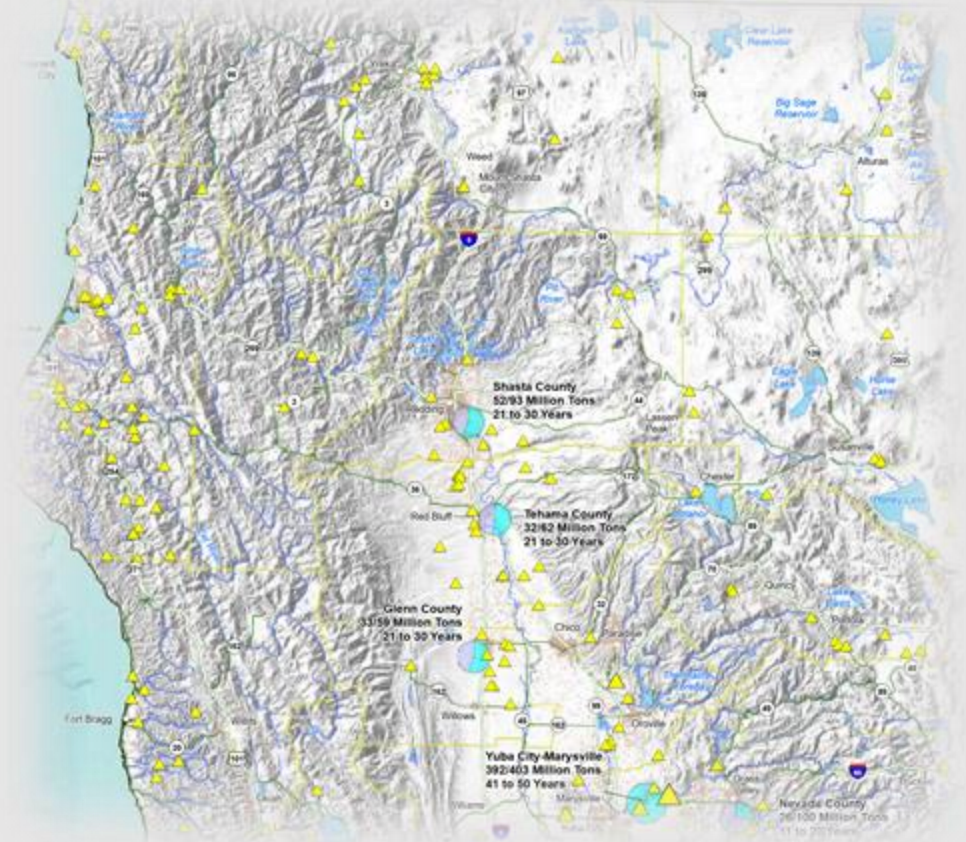


473,000CY
in landfill reduction

FDR – Recycling Making Too Much Sense



CALIFORNIA GEOLOGICAL SURVEY
AGGREGATE SUSTAINABILITY IN CALIFORNIA
Fifty-Year Aggregate Demand Compared to Permitted Aggregate Reserves



Versatility of Cement as Stabilizing Agent

Material Type - Including RAP	Well Graded Gravel	Poorly Graded Gravel	Silty Gravel	Clayey Gravel	Well Graded Sand	Poorly Graded Sand	Silty Sand	Clayey Sand	Silt, Silt with Sand	Lean Clay	Organic Silt/Organic Lean Clay	Elastic Silt	Fat Clay, Fat Clay with Sand
USCS ²	GW	GP	GM	GC	SW	SP	SM	SC	ML	CL	OL	MH	CH
AASHTO ³	A-1-a	A-1-a	A-1-b	A-1-b A-2-6	A-1-b	A-3 or A-1-b	A-2-4 or A-2-5	A-2-6 or A-2-7	A-4 or A-5	A-6	A-4	A-5 or A-7-5	A-7-6
Emulsified Asphalt SE > 30 or PI < 6 and P ₂₀₀ < 20%	X	X	X	X	X	X	X						
Foamed Asphalt PI < 10 and P ₂₀₀ 5 to 20%	X		X	X	X		X						
Cement, CKD or Self-Cementing Class C Fly Ash PI < 20 SO ₄ < 3000 ppm	X	X	X	X	X	X	X	X	X	X			
Lime/LKD PI > 20 and P ₂₀₀ > 25% SO ₄ < 3000 ppm								X		X		X	X

When FDR Should be Considered?

- Flexural distresses in wheel lanes
- PCI below 55 (Poor Condition)
- Excessive digout repairs needed (>15-20%)
- Need to increase structural design of road
- *Need to correct pavement cross slope/superelevation/drainage issues*



Project Selection - Visual Assessment



Site Investigation & Mix Design





Agency:

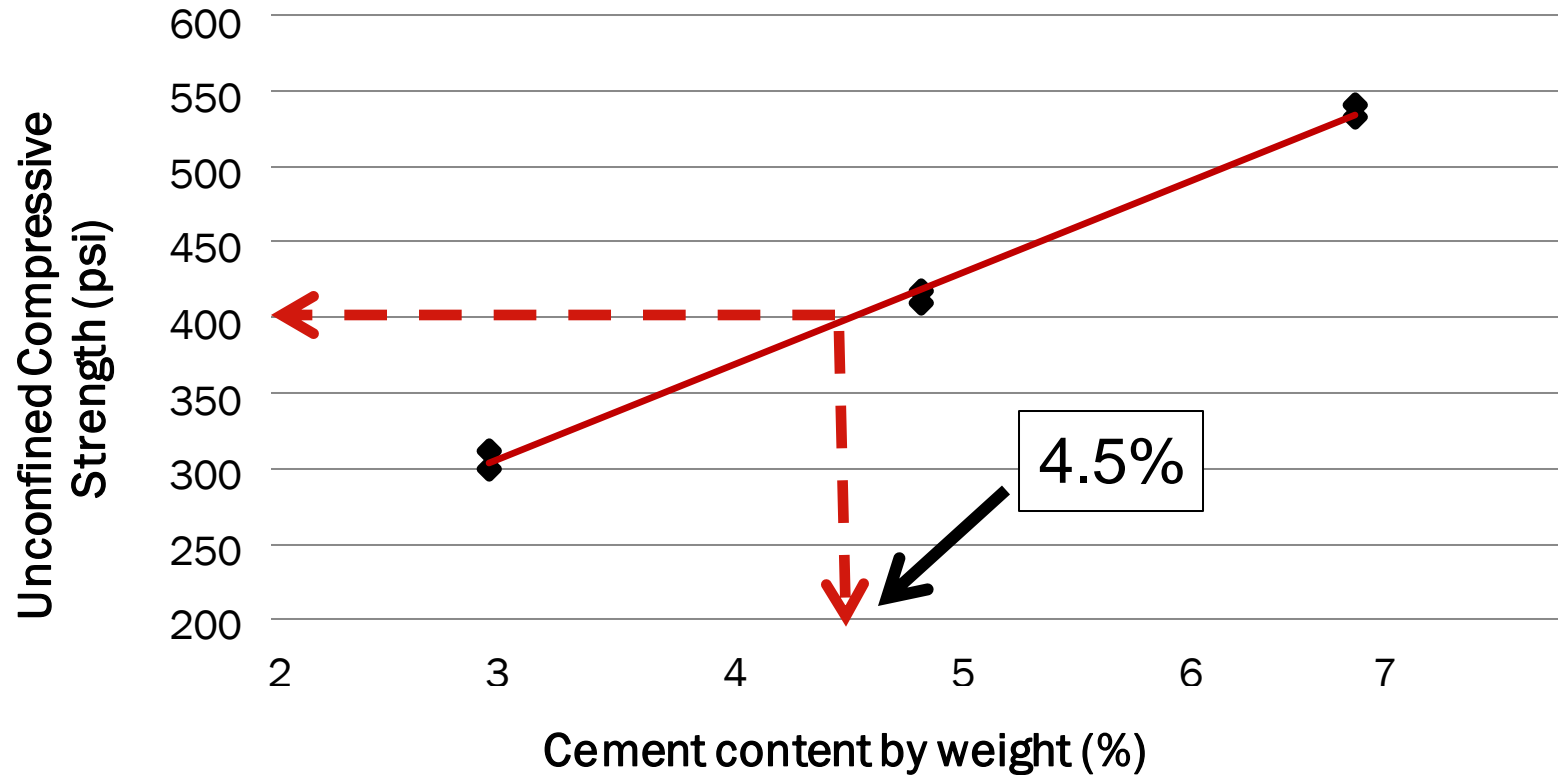
- Investigate existing pavement structure
- Determine TI, R-Value
- Design new pavement structure (HMA over FDR)
- Bid Documents should specify:
 1. SY of FDR area
 2. Depth of FDR treatment
 3. Target Unconfined Compressive Strength (UCS)
 4. Tons of cement (based on estimated quantity)

Contractor:

- Run mix design of representative field materials
- Determine actual cement content to achieve design UCS

Determine Cement Content

*Target UCS: 400 psi



*PCA recommends 7-day target UCS of 300-400 psi

*CT allows a UCS range of 300-600 psi

*Greenbook requires minimum 400 psi

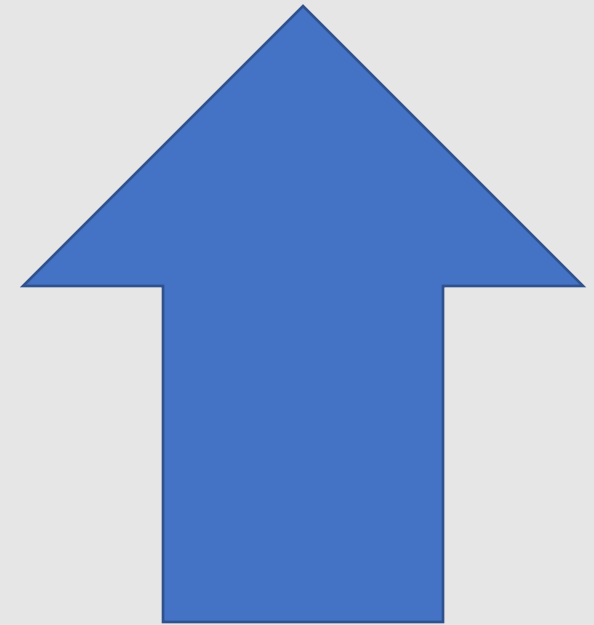
*Remember, thicker is better...too much strength can be detrimental

Looking for Strength or Performance?

Worst Cement Industry Representative Ever:



Cement Content
Strength



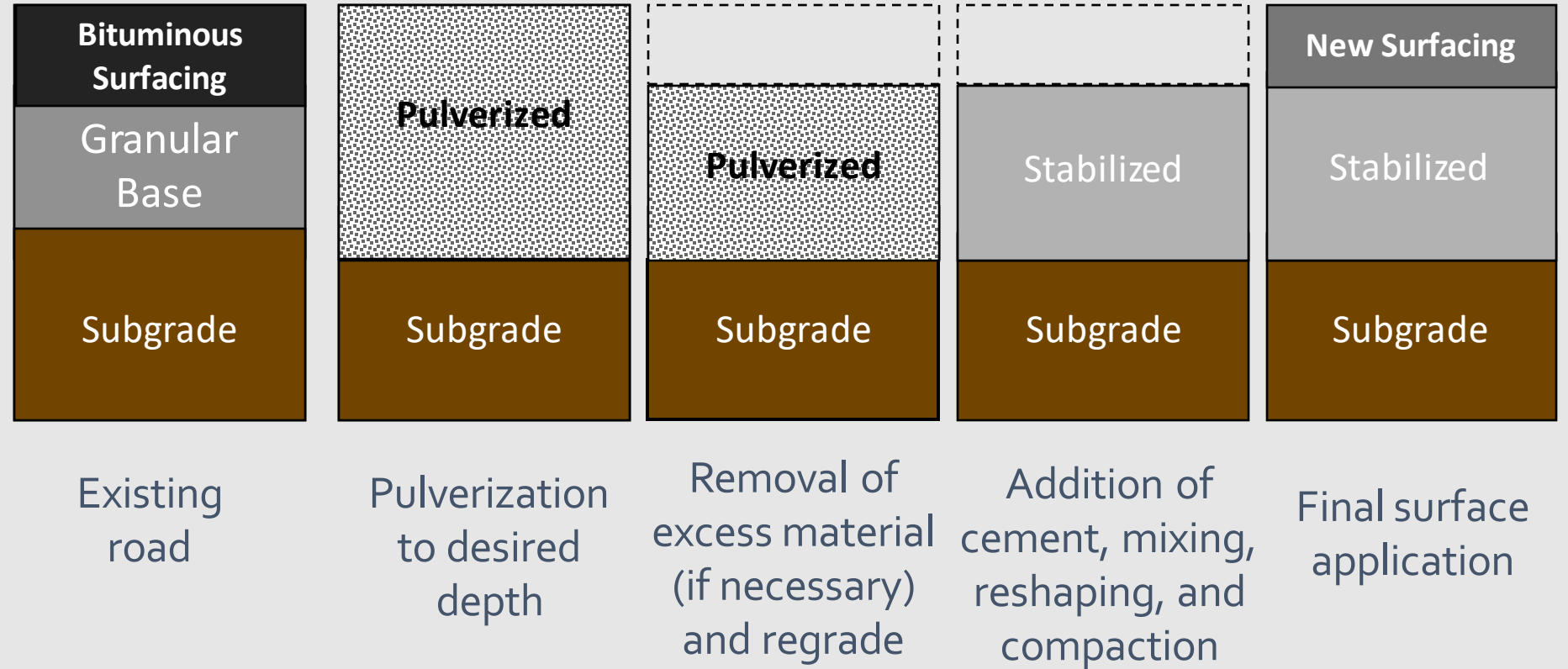
Durability
Performance



Construction

FDR Construction Process - Simplified

- ✓ Pulverize
- ✓ Shape
- ✓ Add Cement
- ✓ Mix-In-Place
- ✓ Make Grade
- ✓ Compact
- ✓ Surface



A large, heavy-duty asphalt pulverizer machine is shown at night, illuminated by its own headlights. The machine is positioned on a road surface, and its large, treaded tires and complex mechanical components are visible. In the background, another similar machine is visible, also illuminated by its headlights. The scene is dark, with the primary light sources being the machine's headlights, creating a dramatic, high-contrast environment. The overall atmosphere is industrial and focused on the task of road maintenance or construction.

ASPHALT PULVERIZATION

Curing is Crucial

- CT requires asphaltic emulsion cure: SS_{1h} or CSS_{1h}
- MUST be properly cured to allow for cement hydration and strength gain
- Other agencies allow moist curing alternative
- Curing doesn't take the weekend off!



Microcracking

- 48 to 56 hours after placement
- 12 ton vibratory roller
- Low speed (2 - 3 mph)
- High amplitude
- 2 or 3 passes
- Network of fine cracks
- Stiffness reduction 40 -60%
- Continue curing



Traffic & Surfacing

- Constructed under traffic:
Single-lane pilot car traffic control
- Compacted FDR base can be opened immediately to low-speed traffic and construction equipment



Traffic Control: Arterial Roadways



Traffic Control: Residential Roads



Quality Control



QC - What is Important?

- Gradation (sizing)
- Cement spread
- Moisture content
- Mixing adequacy
- Density
- Thickness



Characteristics vs. Acceptance

FDR—Cement Requirements for Acceptance

Quality characteristic	Test method	Value
Cement application rate (lb/sq yd)	Calibrated tray or equal	Mix design rate \pm 5%
Relative compaction (min, %, wet density)	California Test 231	95
Thickness (ft) ^a	Core measurements	\pm 0.05 of the thickness shown

^aTake 4- or 6-inch diameter cores from random locations the Engineer selects. The Engineer may require 3 locations per lot; coring more than 3 locations per lot is change order work. At time of coring, submit cores to the Engineer for measurement.



FDR—Cement Quality Characteristic Requirements

Quality characteristic	Test method	Requirement
Gradation (% passing)		
Sieve Size		
3 inch	California Test 202	100
2 inch		95–100
1-1/2 inch		85–100
Moisture content (%)	California Test 226	Mix design \pm 2 percent
Unconfined compressive strength (psi)	ASTM D1633 ^a	Specified in section 30-4.01D(2)
Laboratory maximum wet density (lb/cu ft)	California Test 216	Use for relative compaction calculation
Relative compaction (min, %) (wet density) ^b	California Test 231	95

What are your Resources?

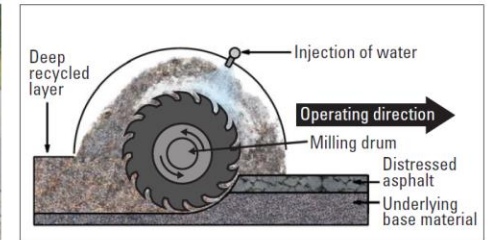
- Local technical assistance, CNCA
 - ✓ Site evaluation, design optimization, costing
- State/National Publications
 - ✓ The “Greenbook” Sec. 301-3.4(2018)
 - ✓ PCA Guide to Full-Depth Reclamation (2019)
 - ✓ Caltrans Standard Specifications (2018)
 - ✓ ARRA Basic Asphalt Recycling Manual (2015)
 - ✓ CT Division of Maintenance FDR-C Guide (2013)

MARCH 2017

Guide to

FULL-DEPTH RECLAMATION (FDR)

with Cement



National Concrete Pavement
Technology Center



PCA
America's Cement Manufacturers™

IOWA STATE UNIVERSITY
Institute for Transportation

STOP to consider FDR



Questions ?

Tyler A. Bodnar, P.E.
Director of Geotechnical Markets



CALIFORNIA
NEVADA
CEMENT
ASSOCIATION

(530) 521-0378
tyler.bodnar@cncement.org

cncement.org