Bringing Back Old Technologies

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Topics to be Covered

- Bituminous Surface treatments
  - Chip seals, including high float emulsions
  - Penetration Macadam
- Full Depth Reclamation (or soil stabilization)
  - Emulsion
  - Cold Foam
  - Lime
  - Cement

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Bituminous Surface Treatments

- Chips seals
- High float emulsions with graded aggregates
- Penetration Macadam

Chip Seals

- Splash and spray operation that includes:
  - Single chip seal
  - Double chip seal
  - Triple chip seal
- Binder can include
  - Asphalt emulsion
  - High float emulsion
  - Hot asphalt binder, including rubber & polymers

High float emulsions

- High-float asphalt emulsions (HFEs) have been used for many years.
- HFE’s emulsifying agent creates a gel structure in the asphalt residue. The gel structure permits a thicker asphalt coating on the aggregate particles.
- The thicker film prevents raveling and is more resistant to oxidation from exposure to the atmosphere.

High Float Emulsions (con't)

- High-float residue is resistant to flow at high temperatures while not being affected as much by low temperatures.
- Allows a softer grade of the base asphalt to be used that resists bleeding at high temperatures.
- Softer asphalt does not become as brittle at low temperatures and resists thermal cracking. HFEs are commonly used in arid environments with cold evenings.

Graded HFE Surface Treatments

- Used in Alaska, Canada, and the Midwest where good chip seal aggregates are not readily available
- Provides good service for low volume roads
- Anionic emulsions normally used
  - HFMS-2 or HFMS-2s
  - HFRS-2 or HFRS-2P

Canadian Experience

- Used since the 50's
- Generally used as chip seals on paved roads
- Aggregates tend to be on the dirty side, not the traditional chip seal aggregate
- Top size either ¾ inch or 1 inch
- Most agencies use the McLeod method for design

Alaska Experience

- Patterns its specifications after the Yukon Territory
- Used only on aggregate surfaced roads
- Has been used for several decades
- Application rates are
  - Asphalt emulsion- 0.75 g/yd 2
  - Graded aggregate-75 lbs/yd 2

Construction Considerations

- Dependant on
  - Good weather
  - Proper application rates
  - Good construction techniques
- Weather is important

Construction Process

- Application of materials
- Initial densification by rolling
- Action of time, temperature and traffic
- Brooming
- Final densification

Application of Materials

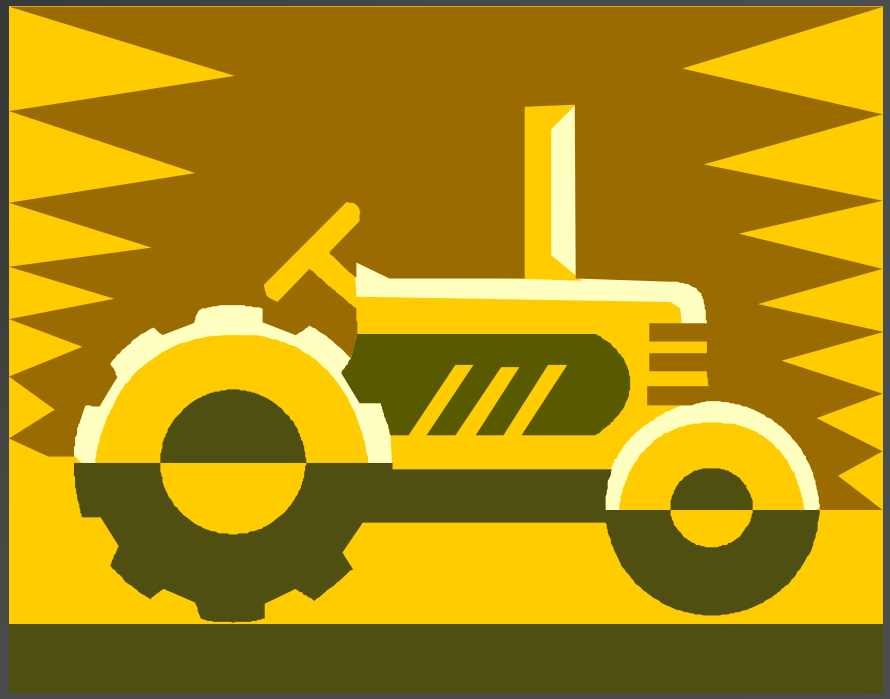
- Apply shortly after surface preparation
- Problems are usually not viable at this state
- Poor calibration of the equipment can lead to problems
  - Too little material
  - Too much material

Initial Densification

- Rubber tire rollers increase the density of the cover aggregate and press it into the emulsion
- For aggregate surfaced roads, this may involve pressing the cover rock into the underlying layer too
- The emulsion will rise to fill some of the void

Action of Time, Temperature and Traffic

- The HFE cures under traffic where the cover rock is bond to the residual asphalt
- Dirty aggregate particles may not stick completely resulting in some aggregate loss



Brooming

- Needed to remove excess or loose aggregate
- Takes place after initial curing period
- Aggregate will be lost during this process

Final Densification

- Given time and warm weather, additional densification can occur
- This may result in problems of bleeding, particularly in the wheel paths, if the application rates were not correct
- Resulting pavement is about 1 inch thick

Things Can go Wrong!

- Wrong application rates
- Wet cover aggregate and excess clay
- Placing in cold temperatures

Macadams

- Aggregate is applied first followed by the binder. Several layers can be used
- Single size chips with a binder coating produce an open graded type mix
- John McAdam founded this process in the early 1800’s

Make-up of Early Macadam Roads

- First layer consisted of 3 inch rock
- The upper layer consisted of 20 mm(less than a inch) stone
- None of the stone could be affected by frost
- Crushed stones performed best
- Early binders included water or water-bound macadam

Later Macadam Surfaces

- With the coming of motor vehicles, asphalt was used to bind the layers of aggregate
- Rocks were laid on the road, followed by an application of asphalt
- Maximum rock size was decreased
- Oregon and Washington use macadam roads in the 1900’s
- Sam Hill was one of the early pioneers

Examples of Later Macadam's

- Pennsylvania Avenue, Wash DC, 1907
- Walla Walla, CO, 1910
- Maryhill, Klickitat, CO, 1912
- 0-11 mm Macadam used in eastern OR

Examples of Use Today

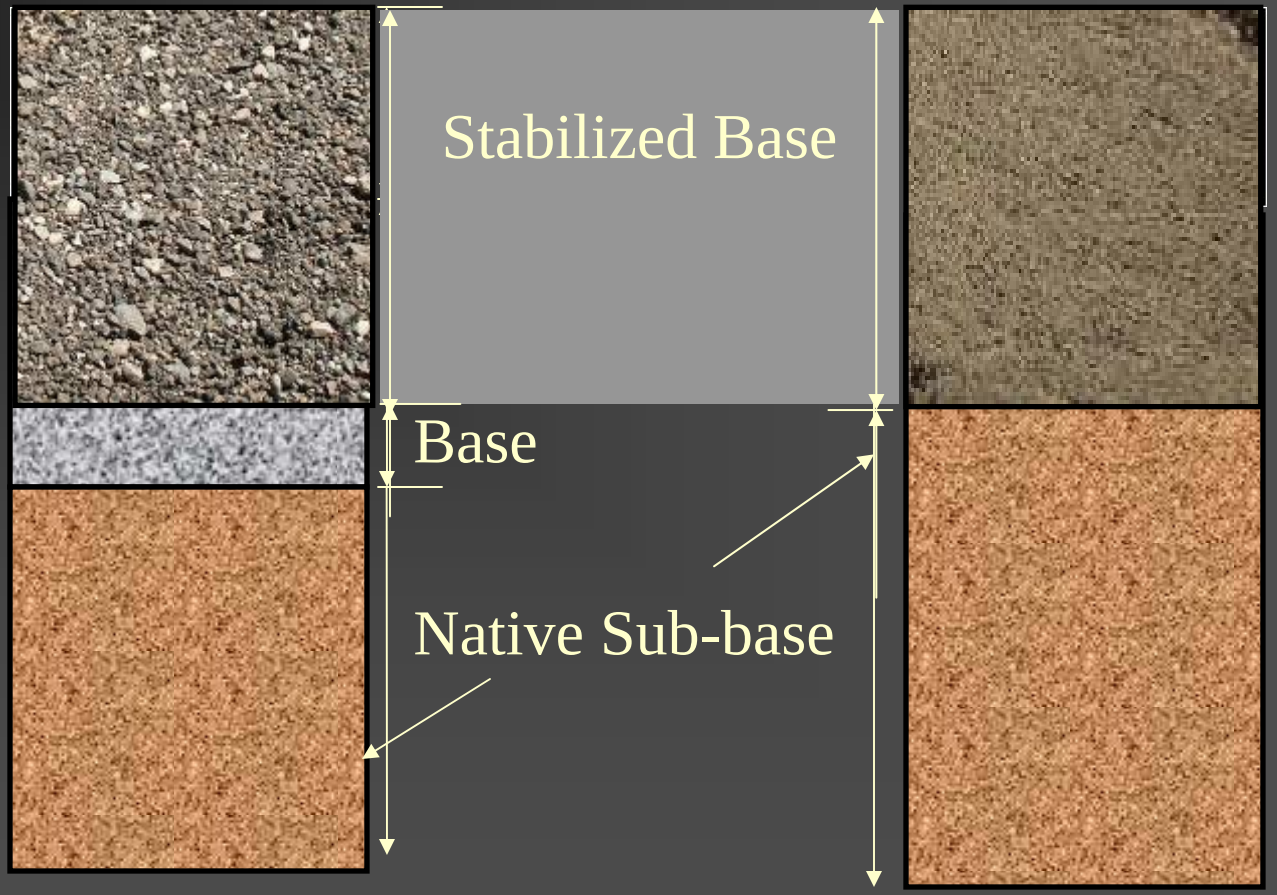
- Not widely used today in the USA
- Used elsewhere in the world because of ease of construction
- Here are some examples of it use

Full Depth Reclamation

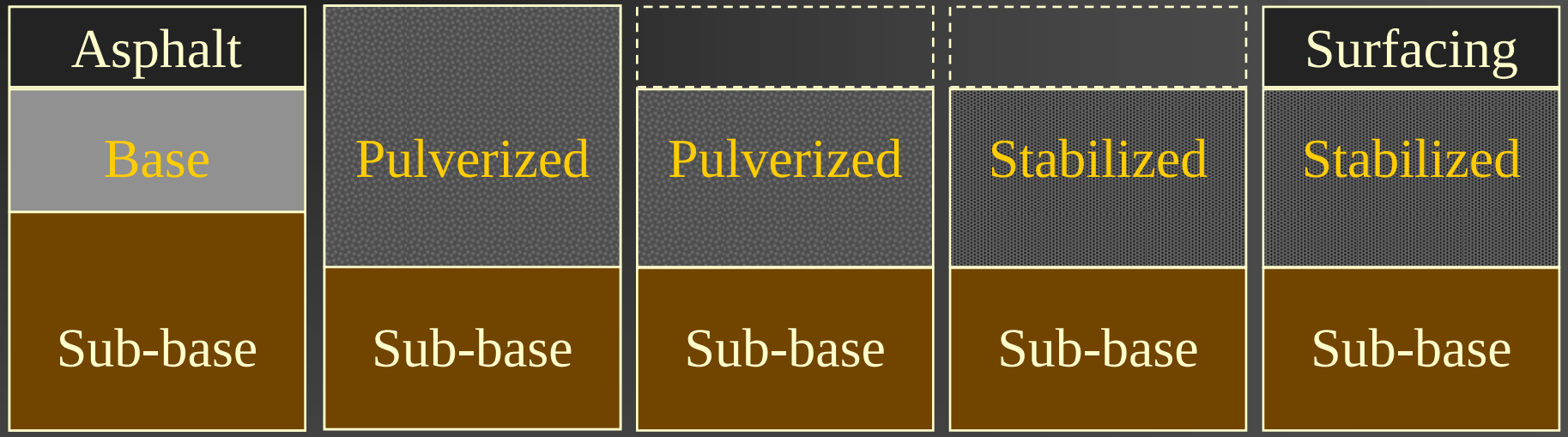
- Used for many years
- Referred to as soil stabilization in the 50’s and 60’s
- Additives included
  - Lime
  - Cement
  - Asphalt
  - Chemicals

Full Depth Reclamation (FDR)

Improves existing materials in-place to provide greater structural support and reduction of imported material.



Full Depth Reclamation (FDR) Construction Sequence



Existing road

Pulverization to design depth

Removal of excess material (if necessary) and shaping

Addition of reagents, mixing & compacting

Final surface treatment

Pulverization

AC and underlying materials are pulverized and mixed to provide a homogenous base material.

Add Additives = Stabilized Base

Chemical Stabilization

- Portland Cement
- Lime

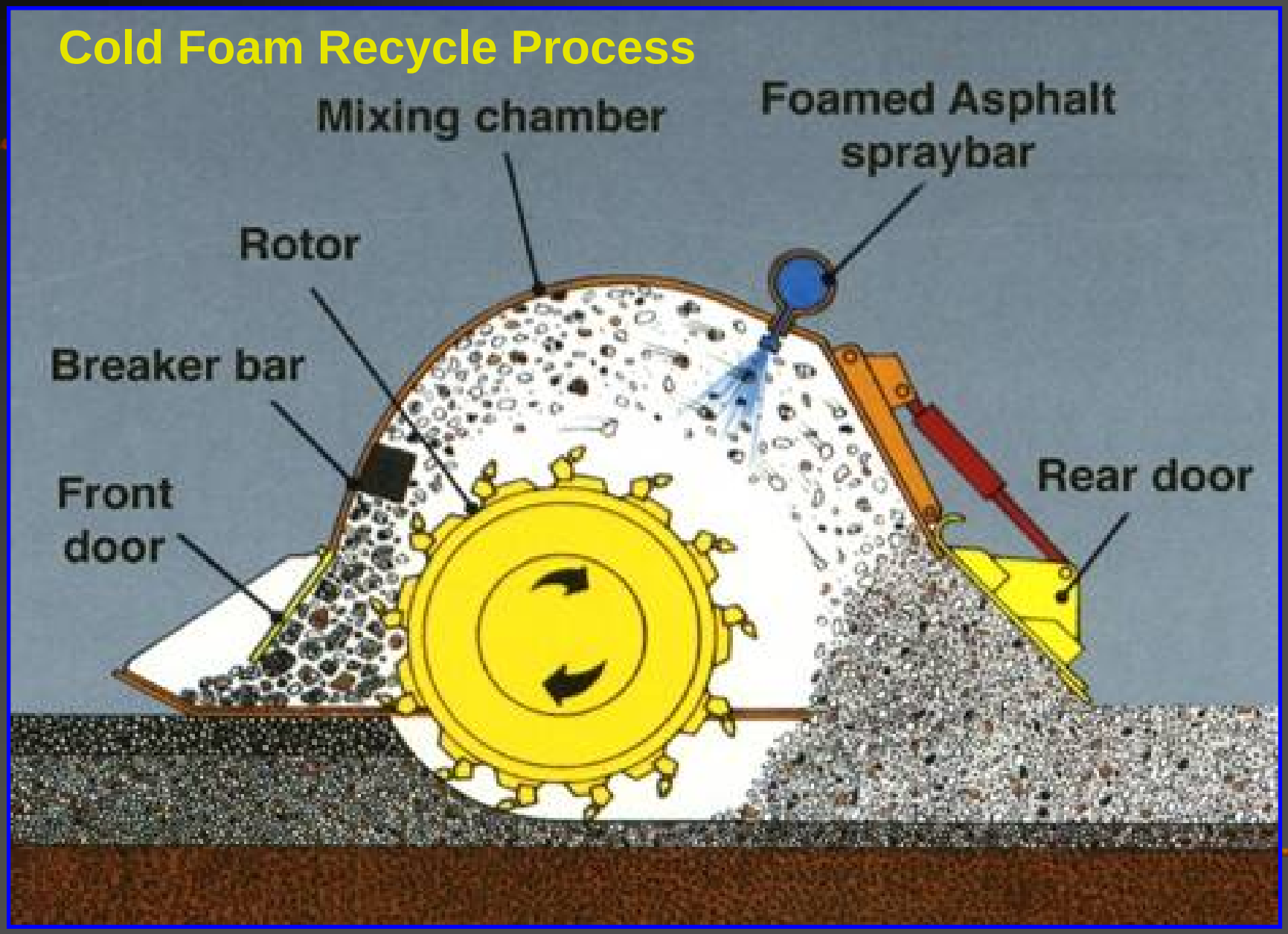
Bituminous Stabilization

- Asphalt Emulsion
- Foamed Asphalt

Bituminous Stabilization
Asphalt Emulsion or Foamed Asphalt

- Generally for stabilization of blended material with 8 to 20 % fines.
- Increases pavement support characteristics, while remaining flexible and wear resistant.
- Does not crack within itself (shrinkage cracking). Traffic can be applied Immediately.
- Can add RAP, Aggregate Base, Cement or Lime to enhance gradations or change underlying soil plasticity characteristics.

Bitumen Introduced at Mixer



Delano, CA – FDR with Asphalt Emulsion

Traffic Index - 9

Pulverizing

Swell factor needs to be considered for pulverized material.

Reclaimer adding 4% Emulsion

Compaction and Grading

Finish Rolling

- Steel
- Pneumatic

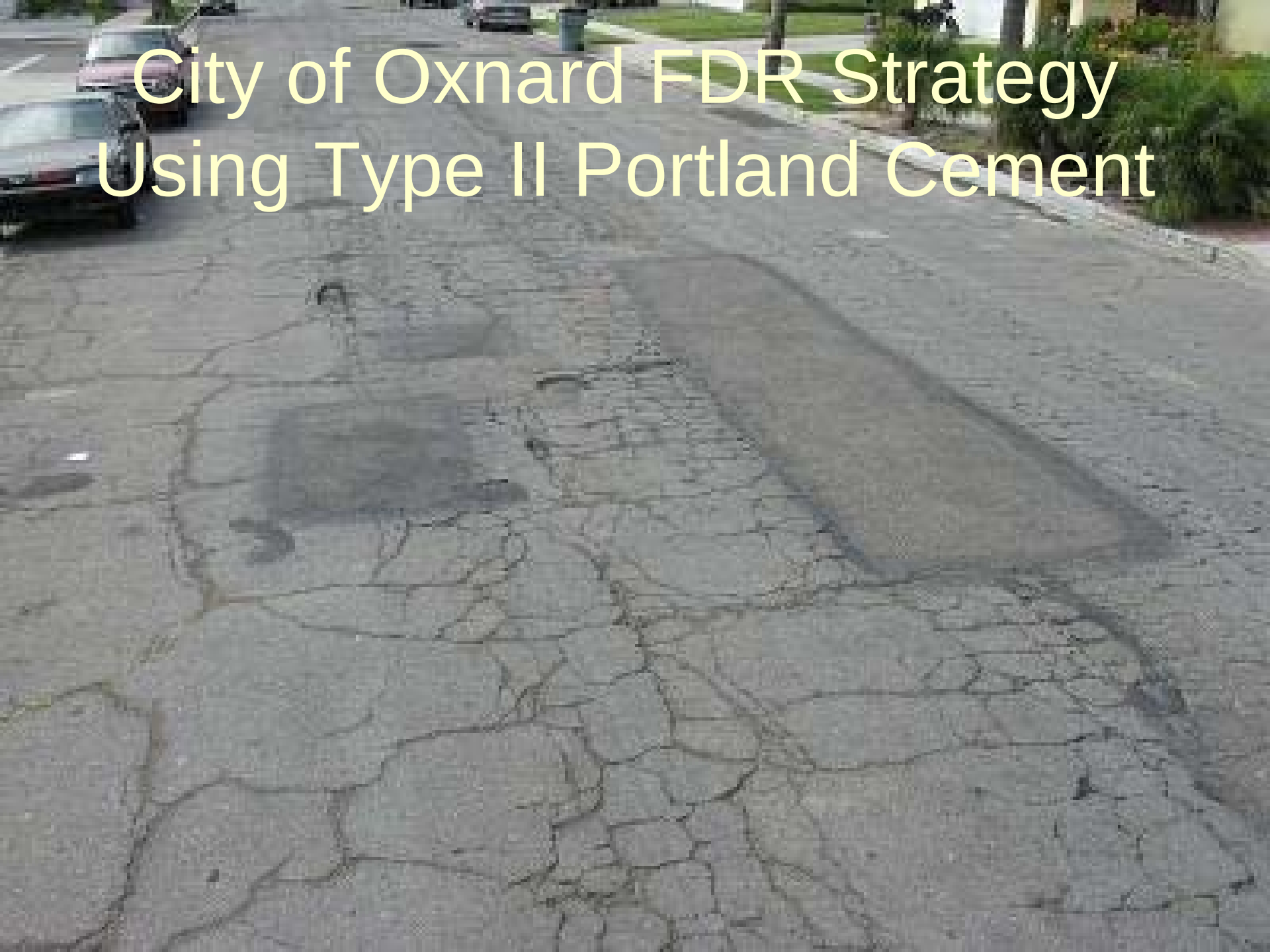
Reconstructed in 10 days

Before

After

Chemical Stabilization
Portland Cement or Quicklime (CaO)

- Cement is the most economical way to gain substantial increases in strength and wear resistance, but more rigid.
- Lime is used to increase the performance when soils have plastic and expansive properties.
- Curing period typically 3 to 5 days or more.
- Cement may require a stress relief course to prevent new reflective cracking or micro cracking.


City of Oxnard FDR Strategy
Using Type II Portland Cement

Pavement Pulverized

Pulverized asphalt concrete will generally meet grading specifications for Cl. 2 AB

Pulverization disrupts cracking pattern

Subgrade Conditions

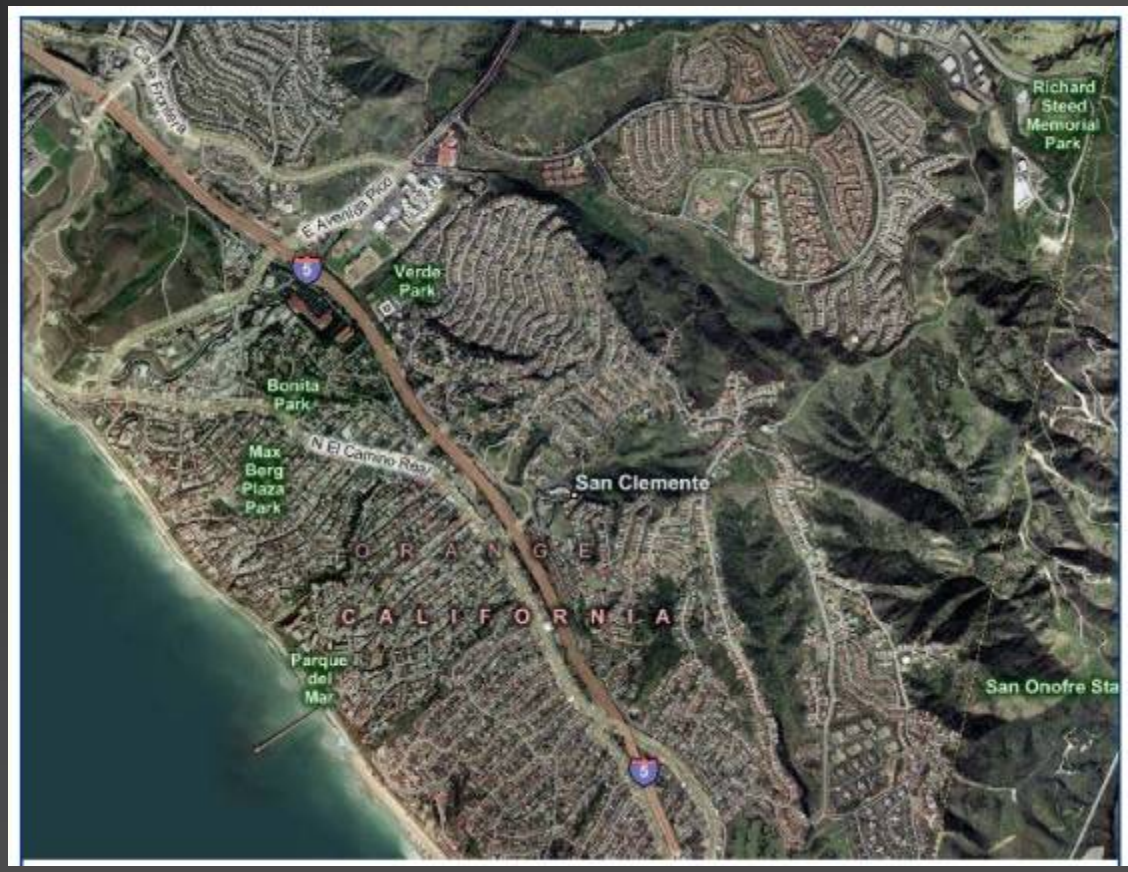
Cement Stabilized Base--

Percent of cement for stabilization is determined by laboratory testing.

Paving

FDR Strategy – Chemical Stabilization San Clemente, California

- Oceanside community of 67,000 residents
- 140 miles of streets
- 1995 Street Rehabilitation Program
- 50% of streets completed
- 30 streets using FDR with quicklime



Pavement Subgrade: Unsuitable Clay Soils

- Typical residential pavement sections: 3-4 inch AC over native clay subgrade
- Shallow utilities
- Distress:
  - Rutting
  - Potholing
  - Cracking

Spreading

Lime application rate is determined by laboratory testing.

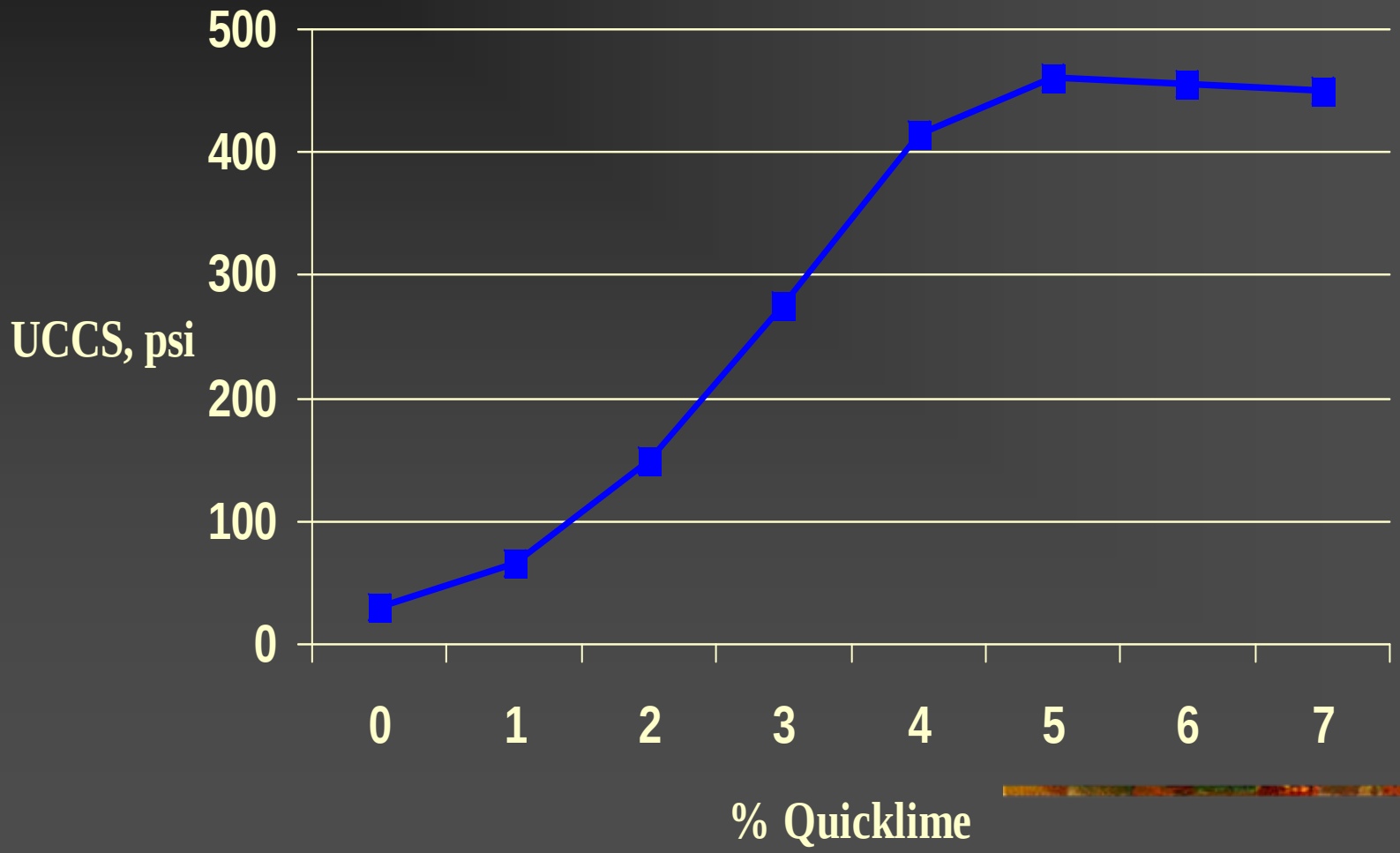
Mixing

- Quicklime, soil, and water are mixed with the stabilization machine and allowed to cure loosely or “mellow” for an overnight period.
- After the “mellowing” period, the lime treated soil is remixed and moisture-conditioned prior to compaction.

Avenida Gaviota

Avenida Vacquero

Typical Strength Increase of Lime Stabilized Soil at 7 Days



Structural Equivalency: Pavement Section Design

- **A standardized structural value is given to the stabilized subgrade:**

Caltrans Equation (Section 605 DS):

$G_f = 0.9 + (UCS/1000)$ *UCS in psi*

$G_f = 0.9 + (UCS/6.9)$ *UCCS in MPa*

Minimum Strength = 400 psi (Cal 373)
Maximum G_f = 1.2 (lime)
Typical Sections = 8" – 12"

Agencies Specifying FDR in CA

- City of Burbank
- City of Costa Mesa
- City of Delano
- City of El Centro
- City of Fontana
- City of La Habra
- City of La Quinta
- City of Los Angeles
- City of Oxnard
- City of San Clemente
- City of Santa Ana
- City of Torrance
- City of Ventura
- City of Westminster
- County of Los Angeles
- County of Orange
- County of Riverside
- County of Ventura
- Los Angeles Airports
- Port of Long Beach
- Port of San Diego
- Caltrans

Why FDR?

- Uses Value of the Existing Pavement
- Eliminates Existing Cracking Patterns
- Cost Effective: Savings of 30 to 50 %
- Reduces Carbon Footprint – Trucking 40:1
- Increases Base Effective Depth Without Excavation
  - Significant Increases in R Value and Strength
  - Caltrans Gf = 1.2 to 1.7
- Allows use of existing materials to widen and reshape existing roadway to meet current geometric design standards.

Cost Comparisons

Newland Street Westminster, CA

Item	FDR	Reconstruct
AC 0.33' (4 inch)	$1.76	$1.76
AB 1.33' (16 inch)	---	$2.24
Excavation	---	$1.48
Pulverize & 1.00' (12 inch) Cement Treatment	$0.72	---
Excess Material Removal	$0.30	---
Reinforcing Fabric	$0.13	---
Total Sq. Ft.	$2.91	$5.48

*Additional savings in recycle rebate and user costs.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Summary

- Old technologies do have a place in maintaining pavements
- Bituminous surface treatments are still widely used
- FDR is coming back fast.
- Are there other older technologies that should be considered?

Questions

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