PAVEMENT REPLACEMENT BY SUSTAINABLE METHODS THAT SAVES TIME, MONEY AND THE ENVIRONMENT

Presented by:

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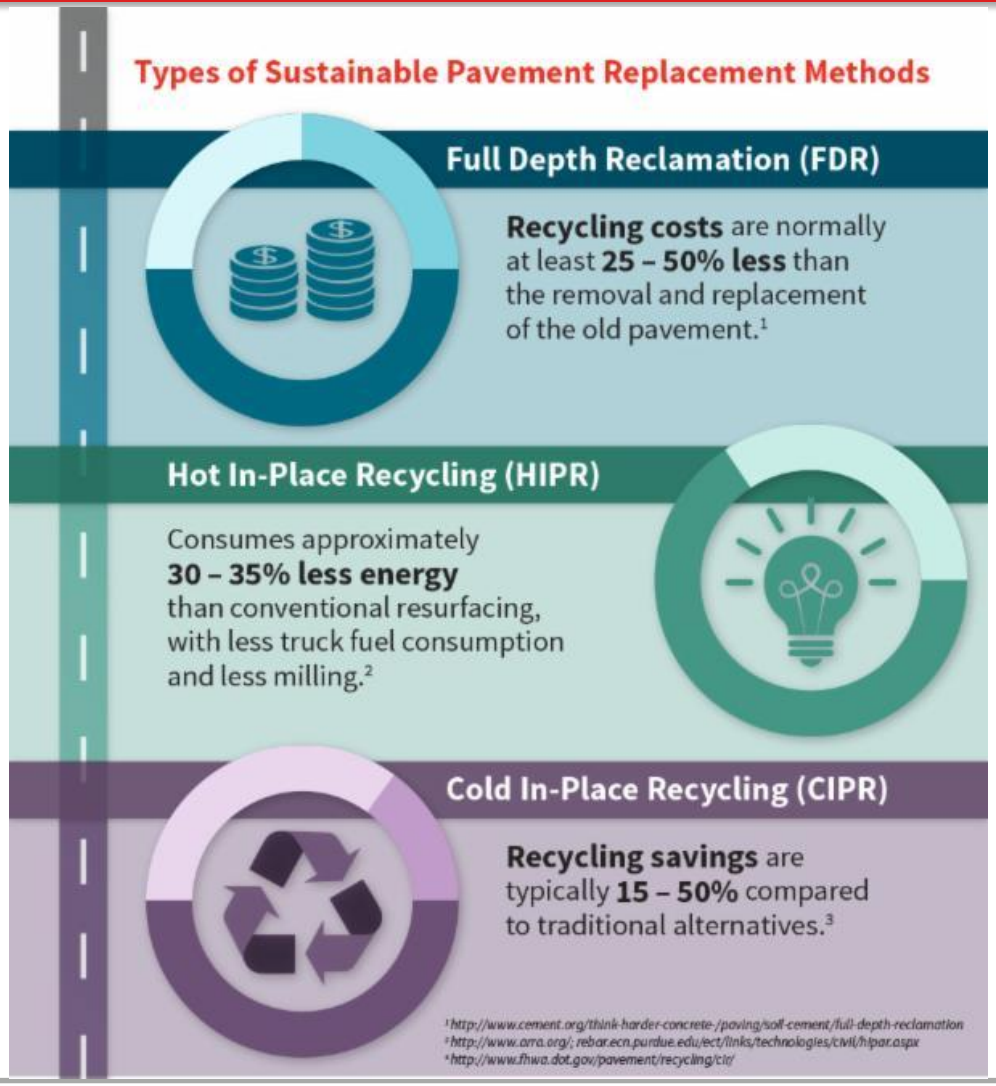
Agenda


Types of Sustainable Pavement Replacement Methods
Full Depth Reclamation (FDR)
Recycling costs are normally at least 25 – 50% less than the removal and replacement of the old pavement.[1]
Hot In-Place Recycling (HIPR)
Consumes approximately 30 – 35% less energy than conventional resurfacing, with less truck fuel consumption and less milling.[2]
Cold In-Place Recycling (CIPR)
Recycling savings are typically 15 – 50% compared to traditional alternatives.[3]
[1] http://www.cement.org/think-harder-concrete-/paving/soil-cement/full-depth-reclamation
[2] http://www.arra.org/; rebar.ecn.purdue.edu/ect/links/technologies/civil/hipar.aspx
[3] http://www.fhwa.dot.gov/pavement/recycling/cir/

Benefit 1

SAVE TIME

Eliminates Hauling

Faster Process

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Benefit 2

SAVE MONEY

Less New Material

Less Time

Reduce Initial & Life Cycle Costs

Less Hauling

Benefit 3

SAVE THE ENVIRONMENT

Reduce Use of Natural Resources (Recycling)

Less Plant Processing

Less Trucking for Import

Reduce Greenhouse Gas Emissions

Safer Environment

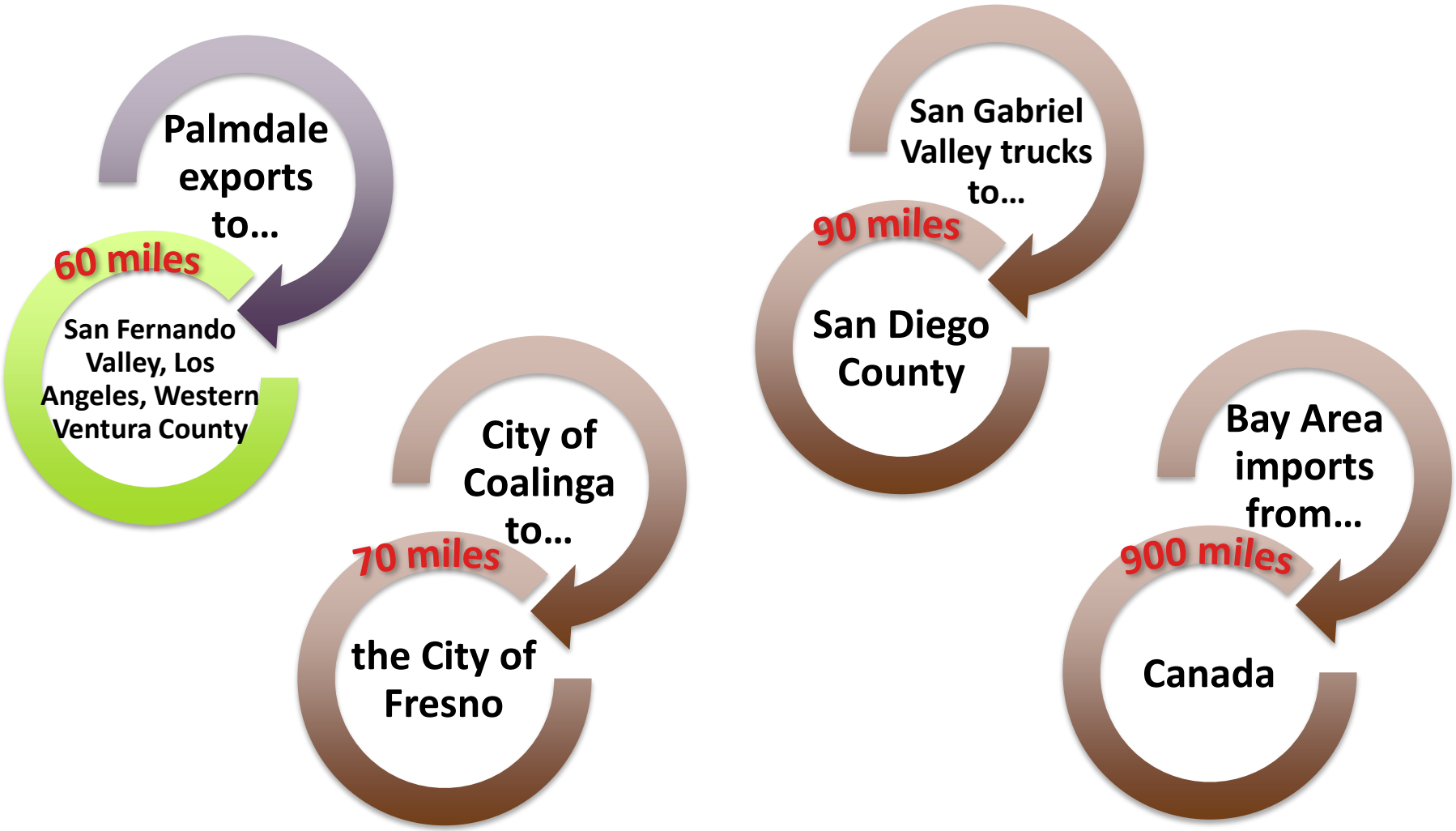
Landfill

- 130M tons annual construction waste
- Less dumping into landfill
- Less hauling off of waste

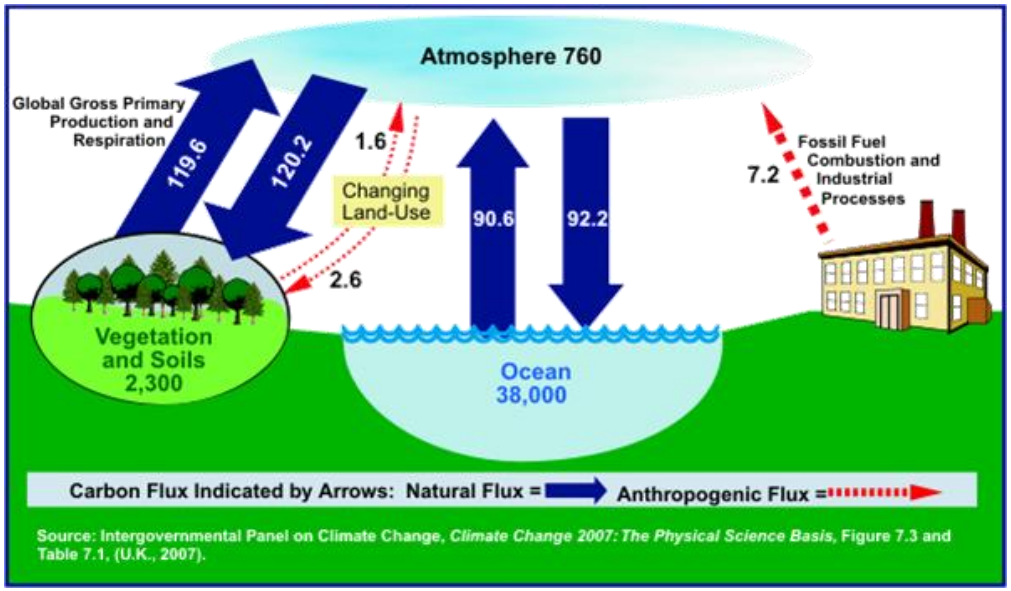
Aggregate Shortage

- **Permitted Aggregate Supply – 4.3 billion tons**
- **50-year Aggregate Demand – 13.5 billion tons**
- **CA has a 16-year supply at current rates of consumption**
- **Permitting!**

What Is Wrong With This Picture?



Safer Environment



Greenhouse Gases (Global Warming – 4.1 billion metric tons)

- Less aggregate import, use of natural resources, fuel for processing and transportation
- Less heat, fume at the Plant and on the Site

Why Then

1. **30 Years Proven Record**
2. **Energy Crises in Mid 1970**
3. **Gasoline Price Up 400%**

Why Now

1. **Financial Crises starting 2007-9**
2. **2008-13 Global Recession**
3. **Transportation**
   - Lack of funding sources (toll, carbon price, gas tax, fee-for-services charge)
   - ACEC D+ Rating
4. **$ 87B annual shortage to preserve $ 1.75T assets**

http://apwa.net/Resources/Reporter/Articles/2013/7/Transportation-challenges-demand-a-fundabmental-cultural-shift

Thinking Out of the Box

- **FDR – Full Depth Reclamation**
- **HIPR – Hot In-Place Recycling**
- **CIPR – Cold In-Place Recycling**

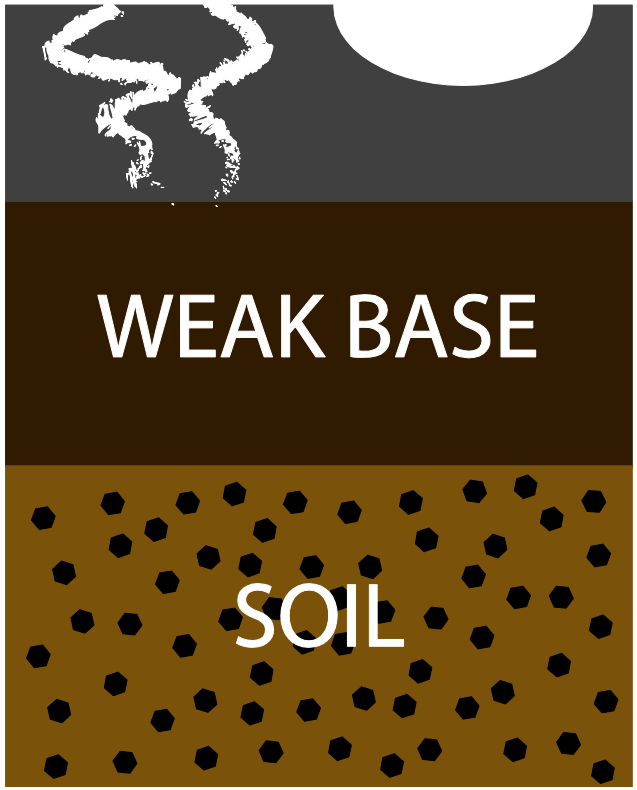
FULL DEPTH RECLAMATION (FDR)

Recycling Existing Asphalt

What is FDR (Full Depth Reclamation)?

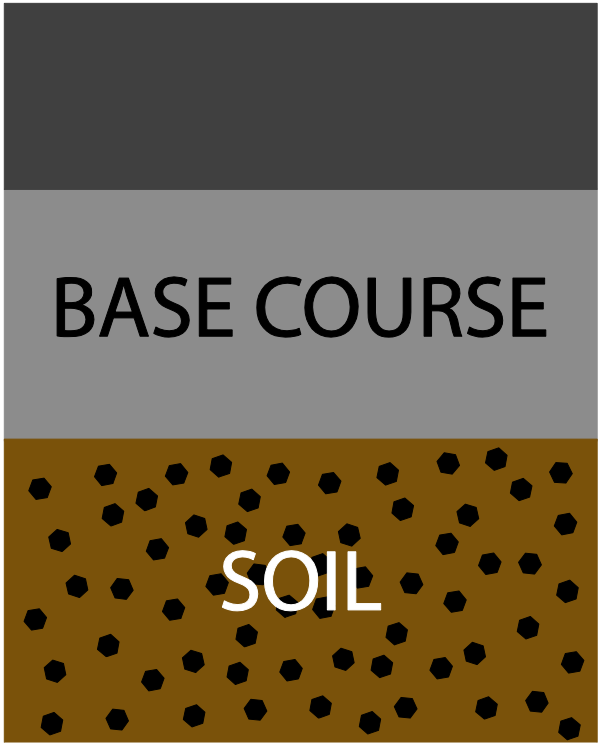
Pavement rehabilitation technique in which the full asphaltic pavement section and a predetermined portion of the underlying materials are uniformly crushed, pulverized or blended.

What is FDR?



Before:
Aging & Distressed

What is FDR?



Typical
Remove & Replace

What is FDR?

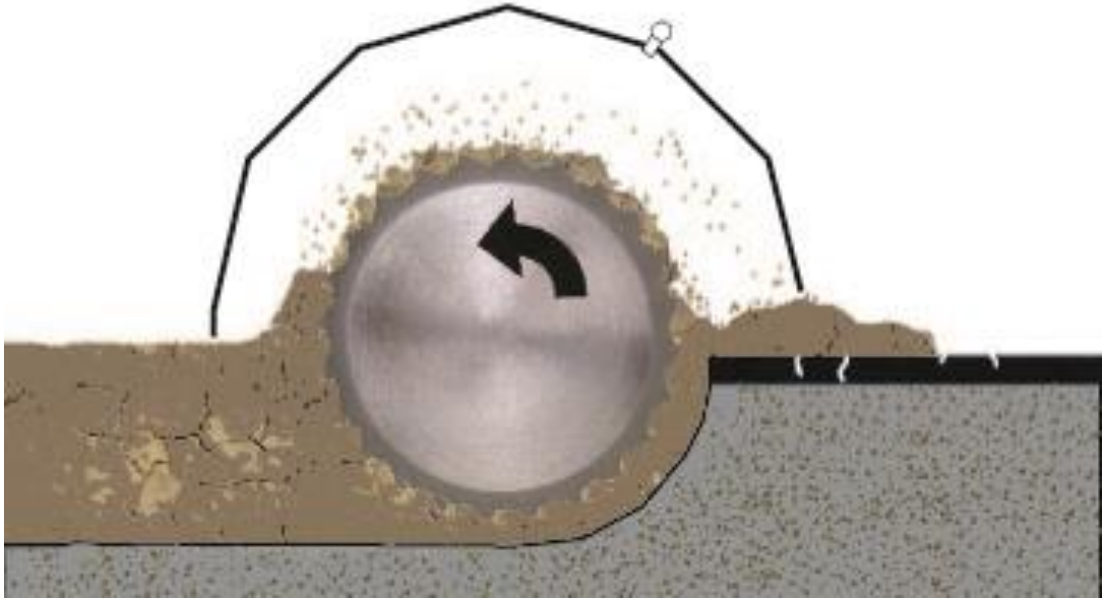
Reclaimed & Stabilized

***FDR: Structurally superior with 30% to 50% savings**

Additive Application

- 3%-7% by dry weight
- Overdone cement content
  - brittle
  - base crack reflects
  - over-shrink
- Clay
  - micro-cracking
- Slurry vs. Dry Spread (dust)
- CDF Non-FDR

Process



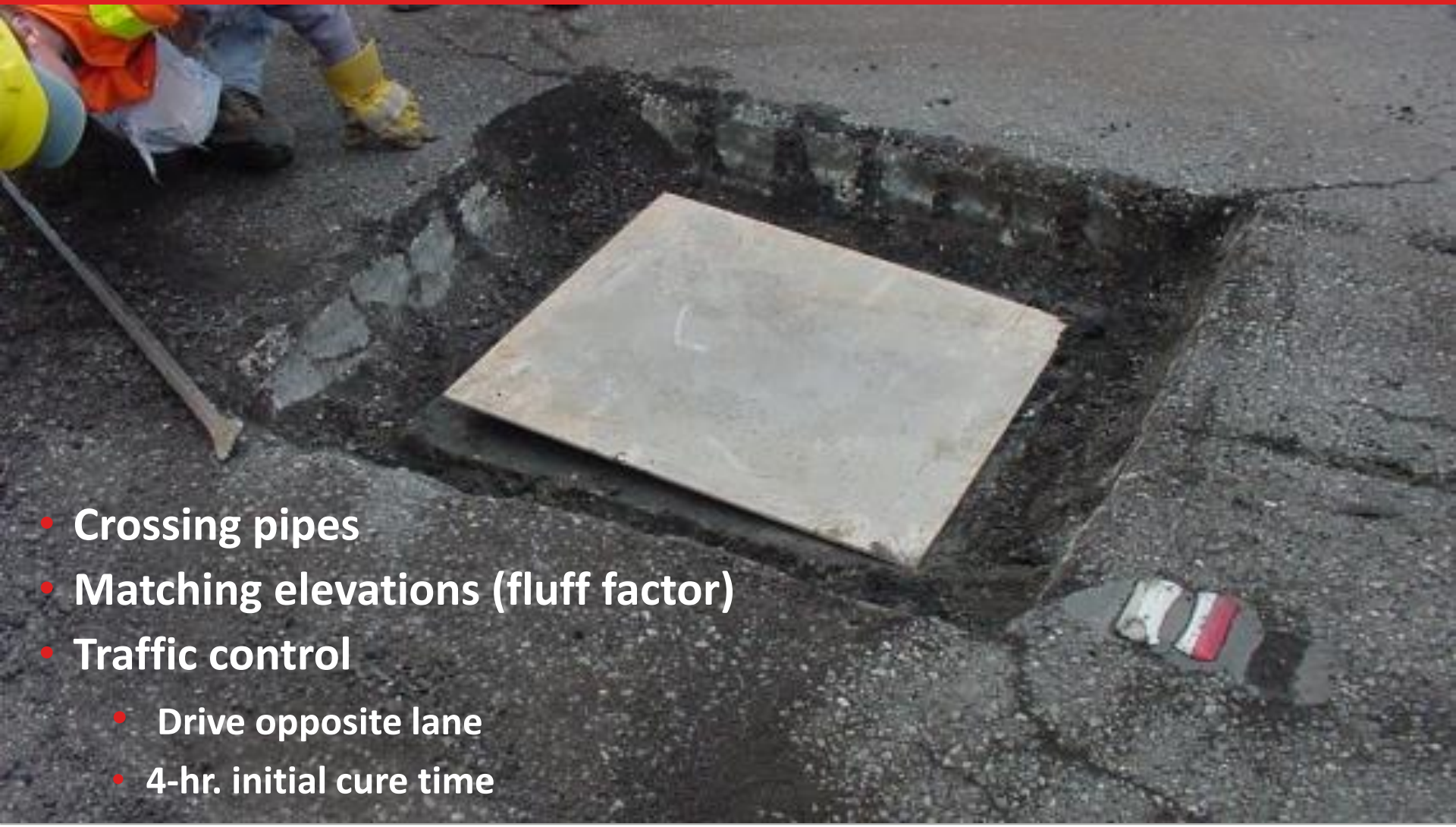
- **Crush & pulverize asphalt/sub-base, base soils, depending on FDR depth**
- **Add water and additive (Cement/Lime, Fly Ash)**

Process

- Shape, Grade, Compact
- Cure
  - Drive after 4-hr
  - 3-5 days moisture cure
  - 39˚F
  - Misty OK. No running water.

Process (Video)

Construction Considerations



- Crossing pipes
- Matching elevations (fluff factor)
- Traffic control
  - Drive opposite lane
  - 4-hr. initial cure time

PCA Study of 79 FDR Over 3-Yr

- **Pavement Condition Index**
  - **88-97 (100 max.)**
  - **60% severe cold**
  - **260-2000 psi**
  - **No structural failure**

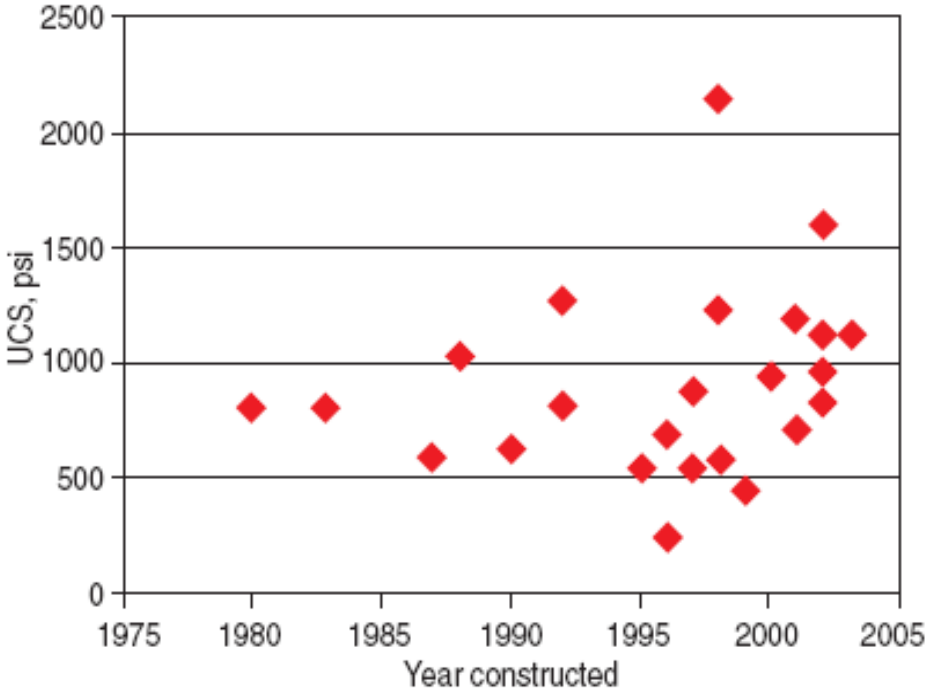


Figure 4. Unconfined compressive strength measurements.

When is FDR Appropriate?

- **Pavement distress – shallow subgrade problem**
- **Requires over 15-20% full-depth patching**
- **If you design a new curb/gutter/widening pavement - *Do it!***
  - **Ease of traffic control**
  - **Uniform base**
  - **Min. diff. settlement**

Weak Subgrade

- Deformation
  - shallow and deep ruts (shifting)
- Cracking (Load)
  - alligator
  - wheel path
- Cracking (Non-Load)
  - block (shrinkage)
  - transverse (thermal)
  - reflection
- Maintenance Patching
  - spray
  - skin
  - pothole
  - deep hot mix
- Ride Quality & Roughness
  - general unevenness
  - depressions (settlement)
  - high spots (heaving)

FDR Pros

- **Conserves**
  - **min. import**
  - **thinner section**
- **Reduce construction time – days vs. weeks**

30-50% Cost Savings

Lynnwood Project Cost Savings

Item No.	Item Description	Approx. Quantity	Unit Price	Amount Dollars Cents	FDR Cost adjustment	Explanation
A12	Removal of Pavement	7674 SY	$ 6.00	$ 46,032.00	($46,032)	No Removal
A19	Sawcutting	10721 LF	$ 1.50	$ 16,081.50	($12,000)	Min saw cutting at side streets only
A20	Roadway Excav. Incl. Haul	4840 CY	$ 7.00	$ 33,880.00	($33,880)	No road excavation
A21	Unsuitable Foundation Excav. Incl. Haul	968 CY	$ 21.00	$ 20,328.00	($20,328)	Not applicable
A51	CSBC	4930 T	$ 18.00	$ 88,740.00	($63,540)	11/2 inch 3/8 minus for final grading
A53	Planing Bituminous Pavement	6707 SY	$ 2.00	$ 13,414.00	($13,414)	Not applicable
A54	HMA Cl. 1/2" PG 58-22	6308 T	$ 78.00	$ 492,024.00	($180,000)	based on 4-inch HMA all over
A55	Temporary Pavement	755 T	$ 139.00	$ 104,945.00	($104,945)	Not applicable
A83	Flaggers and Spotters	5400 HRS	$ 48.00	$ 259,200.00	($45,000)	Saving based on 1 wk. vs. 4 wks., $ 15K/wk.
FDR	$ .50/ft^3 of volume + $ .80 /yd^2 of surface, $ 117/ton cement, quote from Plats Plus				$110,000	one foot depth, 6% cement, assume 10% mark up for plats plus
Design	Fee for HWA				$25,000	
	Total saving				($384,139)	

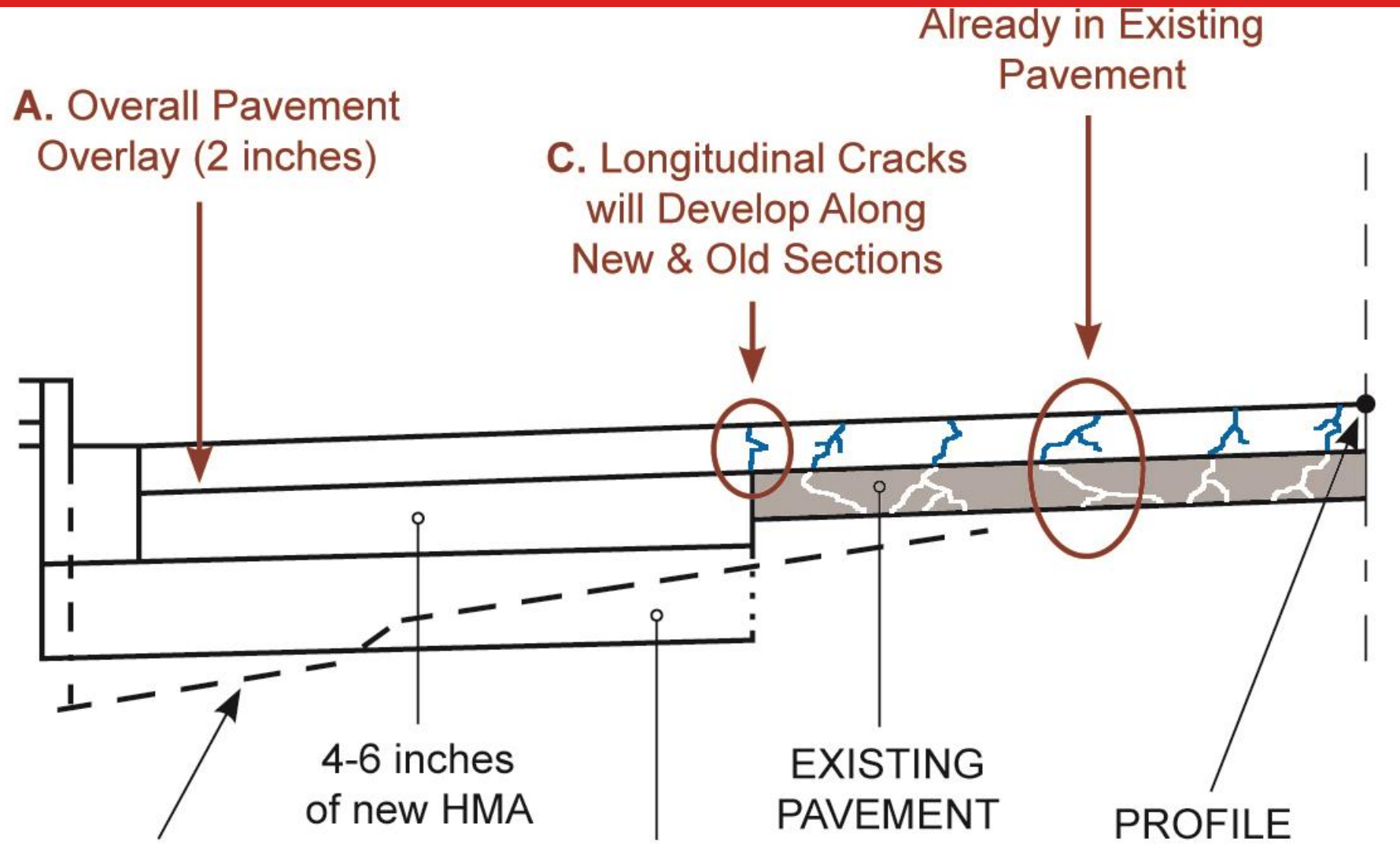
FDR Pros

- **Sustainable**
  - **Less heat, fuel, air pollution**
  - **No aggregate import – less natural resource/processing/transportation**
  - **Less dumping waste into landfill**
- **Minimized Traffic Control**

FDR Pros

- **Reflective cracking eliminated**
- **Long-term cost savings – reduced future maintenance cost**

Focus

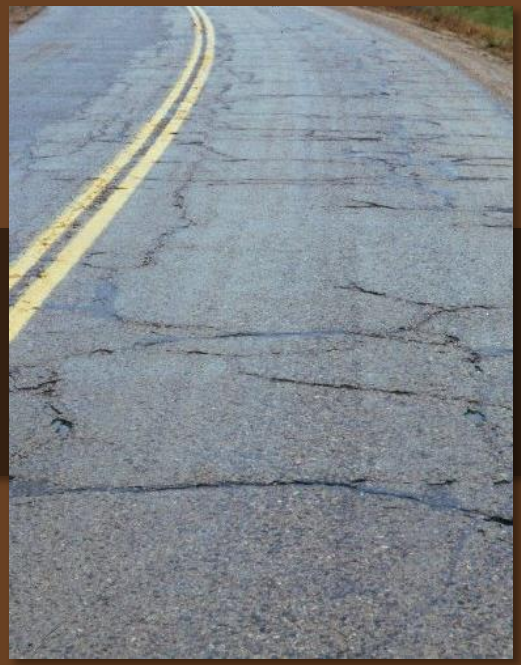

A. Overall Pavement Overlay (2 inches)
C. Longitudinal Cracks will Develop Along New & Old Sections
Already in Existing Pavement
4-6 inches of new HMA
EXISTING PAVEMENT
PROFILE

FDR Pros

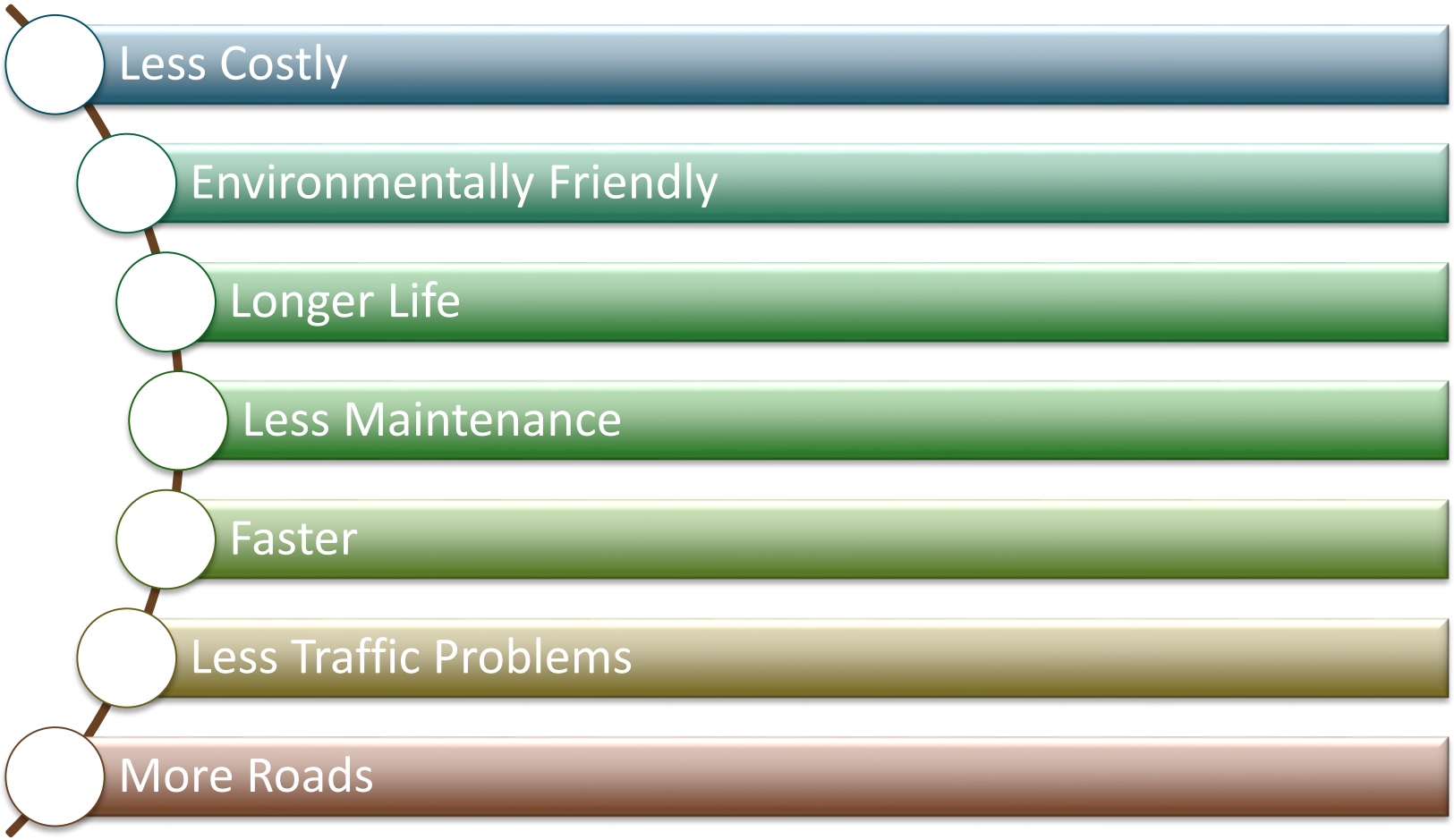
- Highly resistant to severe cold
- Method of freezing and thawing test of compacted soils-cement mixture (ASTM D560, AASHTOT136)
- Would the soil soften due to freezing and thawing resulting in volume changes and gradual break down of bonds of cementation?
- Heaving/loosing shear

FDR Cons

- Excess cement, reflecting cracks
- No new curbs and gutters (foot-long strip)
- Poor/soft subgrade
- Hot and dry weather
- Cracks not addressed
  - longitudinal, slippage, corrugation, raveling/flushing, slippiness (surface defects)



FDR Summary

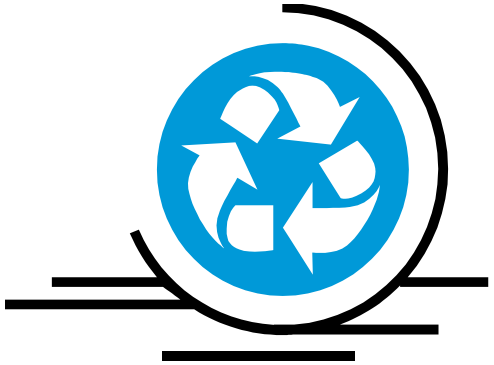

Less Costly
Environmentally Friendly
Longer Life
Less Maintenance
Faster
Less Traffic Problems
More Roads

HOT-IN-PLACE RECYCLING

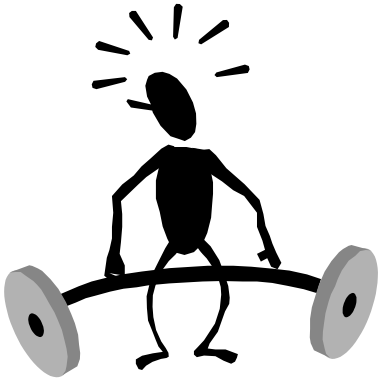
Reusing Top Surface

Asphalt is Unique

Asphalt can be reused in its original location and on the same day without taking to a remote site for processing.



Asphalt Weakness



- The oil is 95% carbon & 5% lighter fractions that are subject to:
  - oxidization
  - leaching
  - evaporation
- Once depleted, the material becomes brittle and cracks under load

HIPR vs. CIPR

- **HIPR involves from 40mm to 60mm of the asphalt surface. Cracks are limited to top 2-inch.**
- **CIPR is for material that is too deteriorated for HIPR, up to 100mm of the existing surface.**

What is HIPR?

- **Heating, scarifying, milling, restoring, and replacement of the top portion of the bituminous surface**

When is HIPR Appropriate?

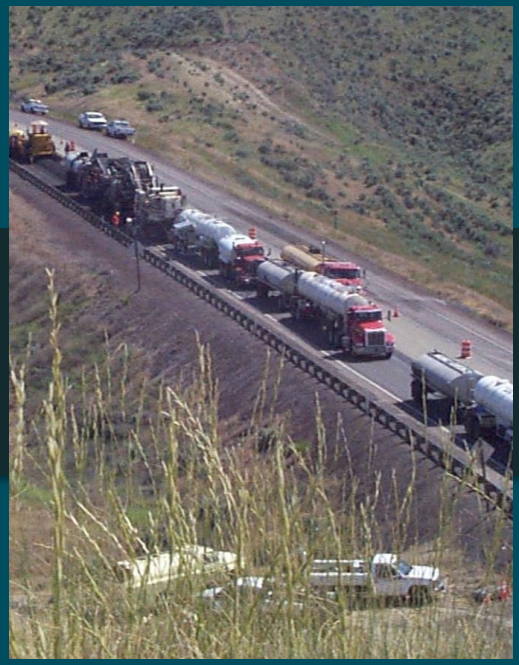
- **Any hot mix asphalt pavement with a stable base and adequate drainage**
- **Pavement should not exhibit extensive cracking**

HIPR Applications

- **Removes functional pavement distress not related to base or subgrade problems**
- **Improvement of the profile and cross slope**
- **Increases structure when necessary**
- **CIR - cost savings for projects requiring full depth repairs**
- **Use may increase if current funding continues**

HIPR Limitations

- Mat thickness of less than 3 inches
- Low oil content – less than 4%
- Fabric
- Aggregates – larger than ¾ inch



WSDOT HIPR History

Jim Weston PE, Pavement Implementation Engineer, WASDOT

- 1995 HIR project
  - South Central region (Yakima) overlaid with OGFC
- HIR was considered in the past, but “things never worked out”
  - Existing fabric
  - High asphalt binder content
  - Traffic impacts

WSDOT HIPR History

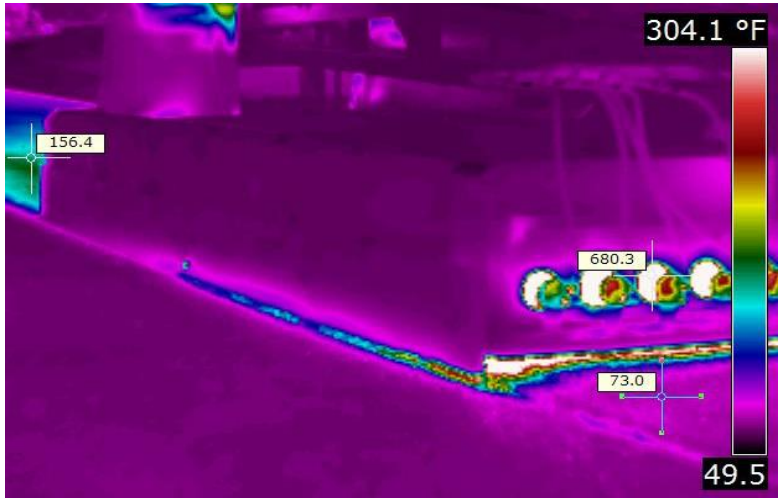
2009 – SR 542, 31 lane miles ADT 5,400 to 12,500

- 0.40’ to 0.60’ HMA over 0.50’ PCCP or 0.60’ to 1.25’ Crushed Stone Base
- HIR recycled 1.75 to 2 inches of distressed surface
- Conventional compaction equipment/roller pattern
- Constructed in 25 working days
  - Average 10 hour shift
  - 1.3 lane miles per shift

WSDOT Challenges with HIPR

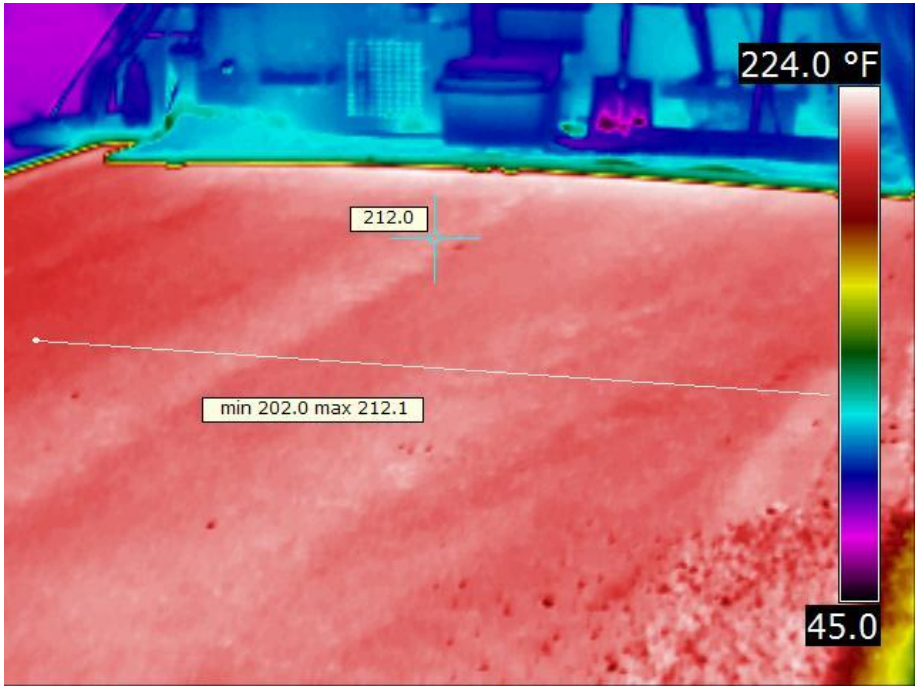
- Mix calibration was always a “discussion”
- Inspectors/decision makers uncomfortable with a process where they have little control
- Contractor experience

Contractor’s Experience (Equipment)

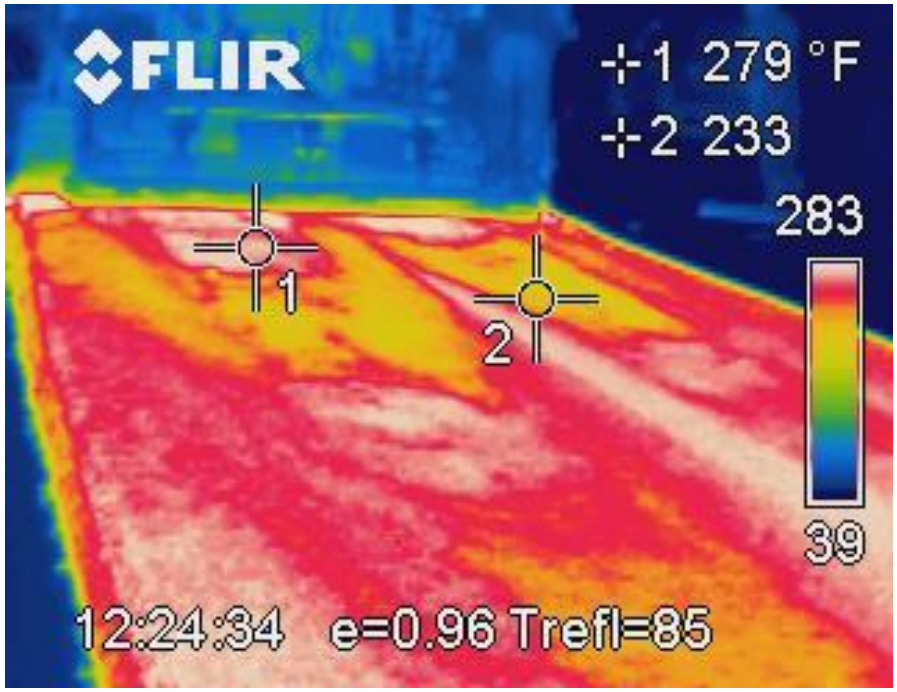


Contractor's Experience (Equipment)

Hot In-Place

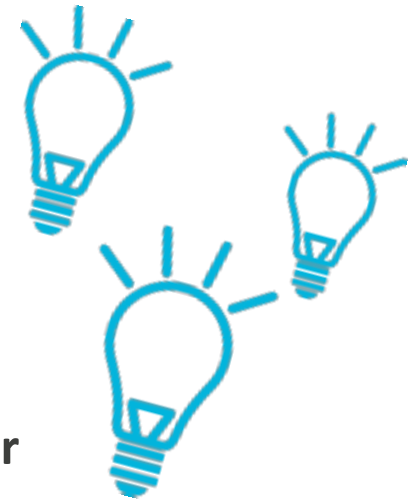


End Dumped HMA



220-230°F -- typical compaction temperature

HIPR Lessons Learned



- Less construction noise
- No abrupt lane edge during construction
- Reduced traffic disruptions
- Limited by geometrics – turn lanes
- Night joints need to be sealed
- Total HIR cost $180,000 lane/mile vs. $250,000 lane/mile for traditional HMA mill and fill
- The SR 542 project shows there is potential for HIR in Washington State
- Life-cycle break-even cost is 12 years (based on typical 16 year HMA life in Western Washington)
- Use of Chip Seal or HMA overlay on future WSDOT projects

Top 10 Ways to Make HIPR Successful

10 :: Upfront communication has to take place

9 :: Review project prior to starting…cores, field review, patching locations

8 :: Mix design process…very important

7 :: Placing fog seal at construction joints is beneficial

6 :: Cover HIR with HMA or Chip Seal…experience indicates this could provide added life

5 :: Paving crew should pay attention…proper control of heater units is crucial

4 :: HIR is art and science…requires experienced contractor

3 :: This is not HMA…do not treat it like it is

2 :: Ask questions!

1 :: Work as a team…every job is very important for producing a quality final product!

Lessons Learned

Field Adjustments

- Adjust asphalt contents for variability in roadway
- Adjustment recommendation by Contractor's staff
- Monitor and document adjustments
- If raveling or rutting occurs…Contractor is responsible for corrective action

Lessons Learned

Recommendations

- All agencies would benefit from CIR/HIR in their pavement preservation
- Start slowly and keep raising the bar
- Get the contractors involved at an early stage
- Require the contractors to accept responsibility for their work
- Continue improving the process

Conclusions

In-situ recycling is safe, efficient, environmentally friendly – meets the needs of present-day users without compromising those of future generations.

Conclusions

In-situ recycling technologies address the main criteria for sustainable pavement:

1. **Optimizing the use of natural resources**
2. **Reducing energy consumption vs. HMA**
3. **Reducing greenhouse gas emissions and pollution**
4. **Improving health, safety and risk prevention**
5. **Ensures a high level of user comfort and safety**

Conclusions

Less expensive than HMA option

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Conclusions

Quality:

provides 15 to 20 years life expectancy

Harris & Associates

Questions?

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