

Overview of FDR-FA Research in California

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Summary

- Introduction
- Research focus areas
- Key findings
- Research implementation
- Conclusions

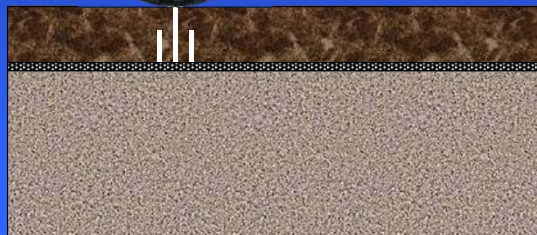


Introduction

- FDR-FA introduced to California in 2000
- Pilot study in 2001
- International research focus
- USA research focus
- California research focus
 - + Thick AC "evolved roads"
 - + Closure limitations
 - + Mix & structural design
 - + Construction factors



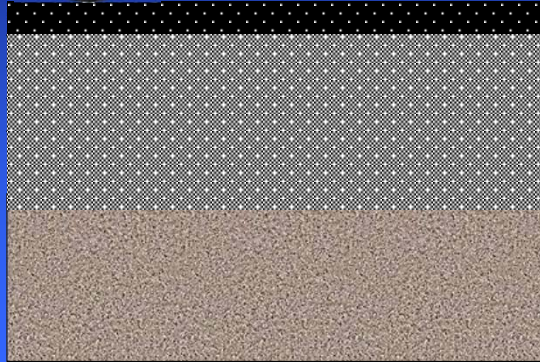
Introduction



- Asphalt concrete (50mm)
- "Oil"
- Subgrade/Base (Old gravel road)



Introduction



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UCPRC Research Focus

- Recycling/sustainability strategic initiative
- FDR and FDR-FA study
 - + Literature review
 - + Mechanistic sensitivity analysis
 - + Pilot project assessment
 - + Laboratory study
 - + Guidelines
- Next phases
 - + FDR with cement
 - + FDR with emulsion + active filler
 - + PDR (CIR) with emulsion
 - High air voids
 - Weak base / reflection crack concerns



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Literature Review (2004)

➤ Key findings

- + Very little work on FDR-FA of thick AC pavements
- + No guidelines suited to CA conditions & practice



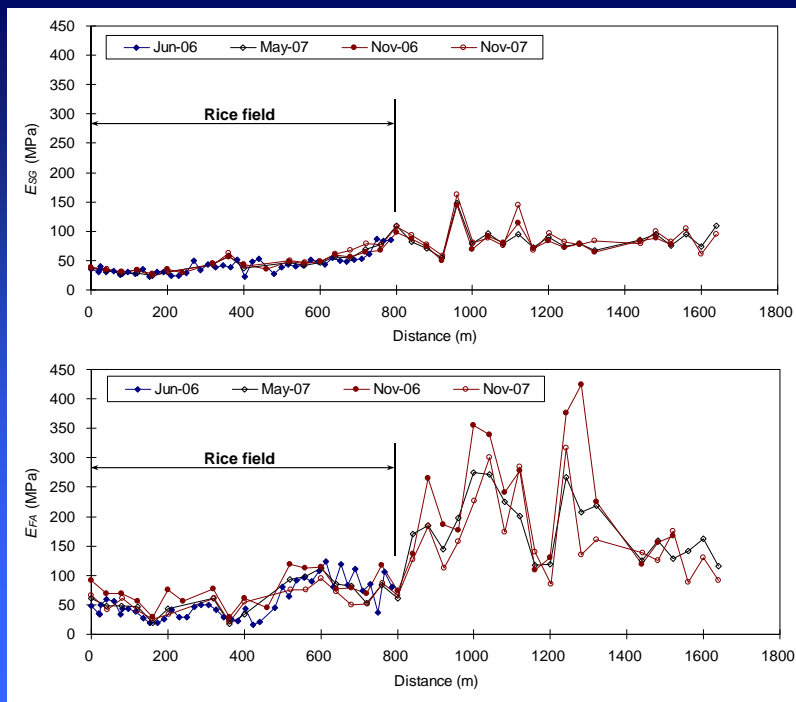
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Pilot Project Assessment

- > Key findings on Project Selection + Drain



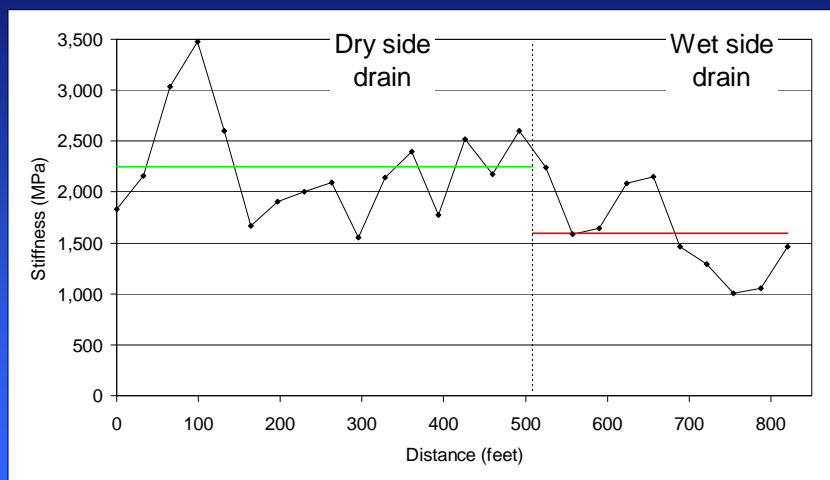
Pilot Project Assessment

Dry

Wet



Pilot Project Assessment



Pilot Project Assessment

> Key findings on construction

- + Pre-pulv
- + Equipme
- + Training



Pilot Project Assessment

> Key findings on construction

- + Pre-
- + Equ
- + Tra
- + Tem



Pilot Project Assessment

> Key findings on construction

- + Pre-pulv
- + Equipme
- + Training
- + Temper
- + Compact



Pilot Project Assessment

> Key findings on construction

- + Pre
- + Equ
- + Tro
- + Ter
- + Con
- + Con



Pilot Project Assessment

➤ Key findings on construction

- + Pre-pu
- + Equipm
- + Traini
- + Tempe
- + Compo
- + Compo
- + Qualit



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Laboratory Study

➤ Experimental design

- + Full factorial to prepare partial factorial
- + Four phases
 - 1: Specimen preparation, test methods
 - 2: Binder and RAP properties, test components
 - 3: Binder and RAP properties
 - 4: Fillers, curing, aggregate temperature

➤ Scale

- + >3,500 specimens, 8 tons of RAP, ~100 buckets of asphalt binder



Laboratory Study

➤ Key findings on binders

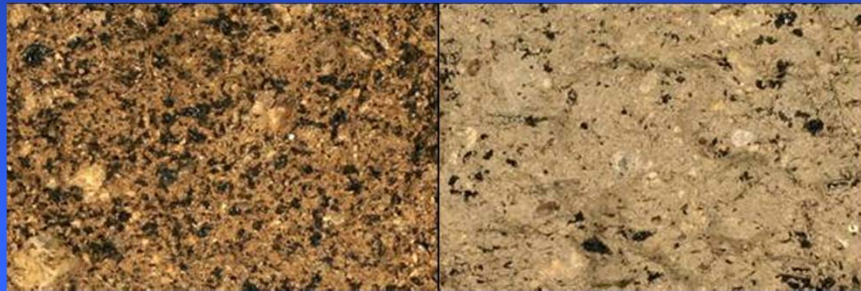
- + Highly variable in California
- + Anti-foamants
- + Softer binders have best foam characteristics
- + Foamability requirements linked to pavement temperature



Laboratory Study

➤ Key findings on aggregate

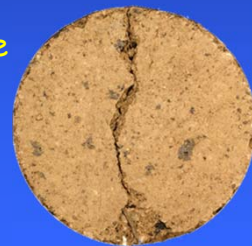
- + Lab aggregate temperature $>20^{\circ}\text{C}$
- + Fines content (P0.075mm) 5-12%



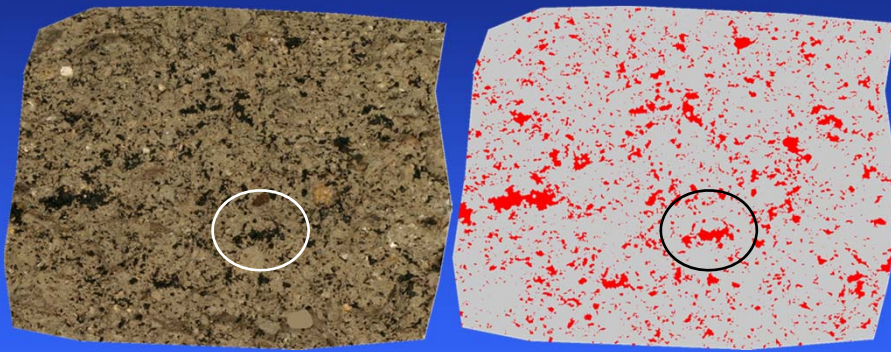
Laboratory Study

➤ Key findings on lab test methods

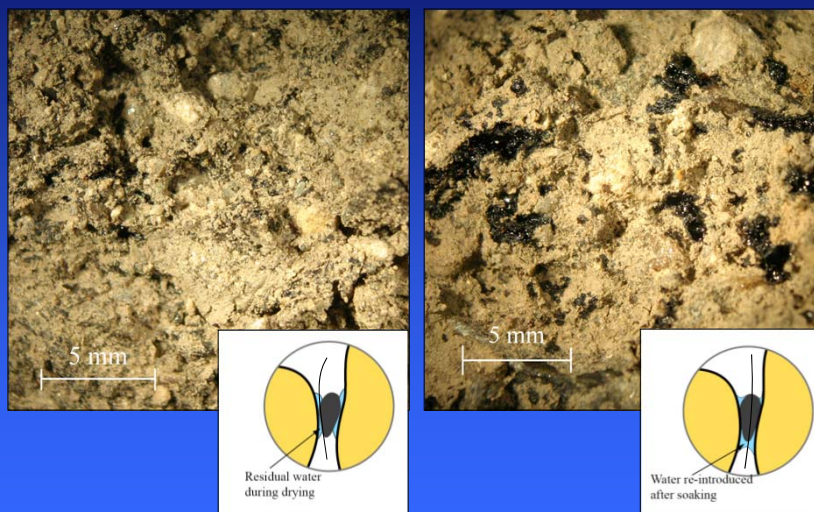
- + Focused on addressing field observations
- + Focused on same-day opening to traffic
- + Restricted by testing ability in districts
 - Monitor & record temperatures throughout
 - FA and then FA plus active filler
 - Compare fracture energy/shrinkage
 - Soaked and unsoaked tests
 - Soaked test for mix design
 - ITS test ok
 - Fracture face analysis



Fracture face analysis (1)



Fracture face analysis (2)



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Research Implementation

- **Final report documenting entire study**
- **Guideline for California**
 - + Project investigation
 - + Mix design
 - + Structural design
 - + Construction
- **FDR and FDR-FA chapters in specification document**
- **Tech transfer on projects**
 - + Implementation decision at District and county level



Guidelines

> Project selection

- + Each project should be designed
- + FWD, Cores, DCP, possibly GPR
- + Material sampling

> Mix design

- + Two phase
- + Active filler mandatory
- + Fines content
 - 5-12% recommended (excl active filler)
 - >15%: monitor soaked strengths closely
- + ITS test, monitor fracture face



Guidelines

> Construction

- + Just-in-time training
- + "Walk behind" technician
- + Temperatures
 - Air: > 10° C
 - Surface, filler (and mid depth): >15° C
- + Mixing moisture content
 - In recycler, not after
 - No additional water until after pad-foot
- + Compactor weight
- + 1 pad-foot roller per recycling train
- + Distance control behind train
- + Surfacing assessment



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Conclusion

- **FDR-FA is an appropriate technology for California (state, county and city)**
- **Use continues to grow while specifications are refined**
- **Long-term performance acceptable**
- **Good design, construction and training is essential**



Thank you!

