


The Euclid Chemical Company



EUCLID CHEMICAL

What's Wrong with My Concrete? Fix It!


Using Concrete Petrography to Determine Cause & Extent of Concrete Deterioration

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Original Working Title:

Petrographic Report on My Cores: WTF??



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ACKNOWLEDGEMENTS

Photo credits: Euclid Chemical, WJE, DRPC Inc.

On the shoulders of giants:







Richard C. Mielenz Katherine Mather L. Brad Shotwell

Bryant Mather Bernie Erlin



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CONCRETE PETROGRAPHY & REPAIR

- Determine the cause of deterioration
- Determine the extent of deterioration
- Determine the repair method & material
- Repair!




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WHAT IS CONCRETE PETROGRAPHY?

- Applies standard geologic microscopy techniques and methods to analyze concrete and concrete raw materials
- Examinations of hardened samples and raw materials follow ASTM C 856, C 457 & others
- Investigative choices based on experience and competence of Petrographer
- Provide definitive answers in limited time




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WHAT IS CONCRETE PETROGRAPHY?

- Rapid means of analysis using geologic laboratory techniques
- Mainly troubleshooting - "After the fact" Why? How bad is it?
- There are limitations: "Can Do" and "Can Not Do"
- Constraints include adequate sample size and adequate field information



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CONCRETE PETROGRAPHERS ARE:

- Geologists
- Know how to use the equipment
- Know the prep and test procedures
- Know concrete materials, practices and impact of practices on concrete
- Know how to interpret the findings



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SOME INSTRUMENTS ARE DECIDEDLY LOW TECH...



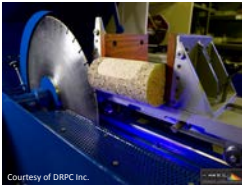
OTHERS ARE NOT...



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CONCRETE PETROGRAPHY-- TOOLS AND EQUIPMENT

Rock saw



Courtesy of DRPC Inc.

Lapidary wheel



Courtesy of DRPC Inc.



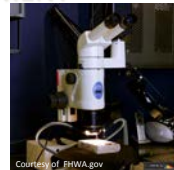
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CONCRETE PETROGRAPHY-- TOOLS AND EQUIPMENT

- Stereomicroscope – for visual examination
- With point count stage – for air void system analysis



Courtesy of FHWA.gov



Courtesy of FHWA.gov



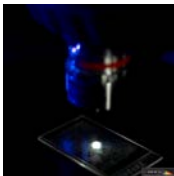
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CONCRETE PETROGRAPHY-- TOOLS AND EQUIPMENT

- Thin section machine
- Miscellaneous chemicals, reagents and standard lab procedures



Courtesy of DRPC Inc.



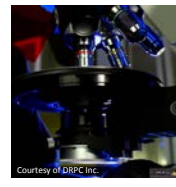
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CONCRETE PETROGRAPHY-- TOOLS AND EQUIPMENT

- Petrographic microscope (plane polarized light) and index oils



Courtesy of Iowa State



Courtesy of DRPC Inc.



Courtesy of SPI



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CONCRETE PETROGRAPHY-- TOOLS AND EQUIPMENT

- Scanning electron microscope
- Energy dispersive spectroscopy



Courtesy of DRPC Inc.



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CONCRETE PETROGRAPHY-- TOOLS AND EQUIPMENT

X- ray diffractometer

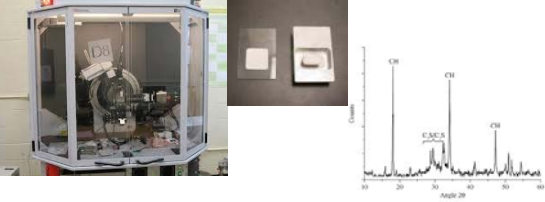



Figure 1. XRD pattern of CH hydrated for 28 days C₃S/C₂S calcium silicate hydrate (CSH) in Ca(OH)₂.




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Q: WHAT IS IMPORTANT INFORMATION TO A PETROGRAPHER REGARDING YOUR CONCRETE?


A: *EVERYTHING!*




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TEST REQUEST FORMS SHOULD INCLUDE:



- Mix design information
- Details of the problem
- Observations- just the facts
- Conditions
- Plastic properties
- Placement and finishing details
- Sample info - ID, location, ...
- Photographs if available




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LIMITING FACTORS & CONSTRAINTS

- Adequate sample size: **Is it representative?**
- **Information from the field** is **KEY** to better answers, more useful reports!!!
- Service conditions
- Other pertinent information (heaters, equipment breakdowns, sudden rainstorm...)
- Quality of the report reflects the quality of information provided





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PETROGRAPHIC REPORT CONTENT

- INTRODUCTION
- METHODS & EQUIPMENT
- OVERALL CONDITION - Top-to-Bottom
 - Finished surface
 - Air-void content
 - Cementitious matrix
 - Aggregates
- DISCUSSION
- CONCLUSION





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COMMON PROBLEMS & REQUESTS

- Low compressive strength
- Surface aesthetics - scaling, discoloration, dusting
- Cracking
- Finishing - delaminations, blistering, etc.



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WHEN A PETROGRAPHER SAYS:

“The probable cause of the reported low compressive strength was poor or inadequate curing.”

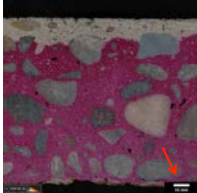


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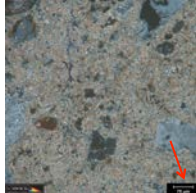
THE PETROGRAPHER SEES:

- Carbonated cement paste at & near surface
- In extreme cases, carbonation throughout

Stereomicroscope



Petrographic microscope



Courtesy of DRPC Inc.



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THE FIX

OPTIONS

- Reactive silicate sealer/densifier
- Remove weak surface to hard, sound concrete, treat with reactive densifier
- Remove weak, dusty concrete the top with overlayment or topping mix



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WHEN A PETROGRAPHER SAYS:

“The probable cause of the reported low compressive strength was an excessive air content.”

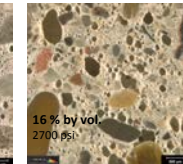
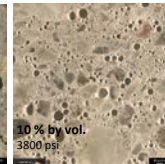
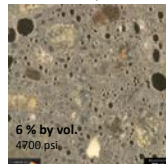


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THE PETROGRAPHER SEES:

$$1\% \text{ air} = 3 - 5\% f'_c$$

Stereomicroscope



Courtesy of DRPC Inc.




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THE FIX

- Air **cannot** be removed from hardened concrete!
- Treat with reactive silicate sealer/densifier
- Use silane sealer to minimize ingress of water

These are stopgap measures until removal & replacement can occur.




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WHEN A PETROGRAPHER SAYS:

“The probable cause of the reported low compressive strength was excessive retempering.”





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THE PETROGRAPHER SEES:

- Veneers of lower w:cm ratio paste adjacent to c. aggs.
- Clustered air voids

Stereomicroscope

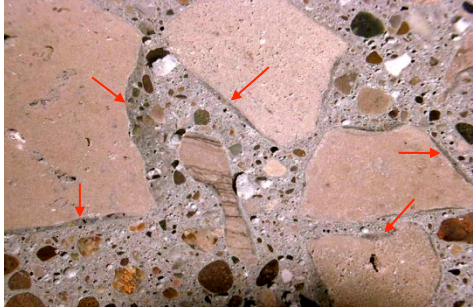
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RETEMPERING






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THE FIX

- Air **cannot** be removed from or redistributed in hardened concrete!
- Treat reactive silicate sealer/densifier
- Use silane sealer to minimize ingress of water




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WHEN A PETROGRAPHER SAYS:

“The probable cause of the reported low compressive strength was freezing of the concrete while plastic.”



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THE PETROGRAPHER SEES:
Bladed ice crystal casts on the form/finished surface, in cement paste, in aggregate sockets



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THE FIX

- Remove & replace
- Remove weak concrete then top with overlayment or topping mix
- Reactive silicate sealer/densifier
- Grind to hard, sound concrete, treat with a reactive densifier



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WHEN A PETROGRAPHER SAYS:

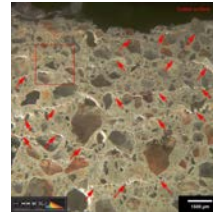
“The probable cause of the scaling was inadequate air-entrainment .”



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THE PETROGRAPHER SEES:

No or poorly distributed air.



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THE FIX

- There isn't one



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WHEN A PETROGRAPHER SAYS:

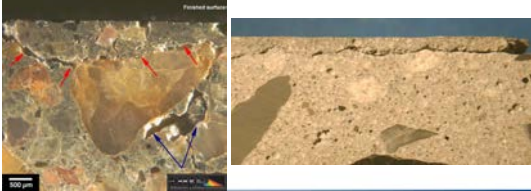
“The probable cause of the delamination was premature or over finishing .”



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THE PETROGRAPHER SEES:

- No air in the top ¼- ½ “, air entrainment in the bulk of the sample
- Incipient scaling or large voids/failure planes below finished surface
- Terminated bleedwater channels
- Bleedwater collection points

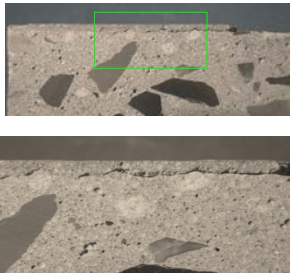


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SCALING DUE TO OVERFINISHING



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THE FIX

- Remove delamination zone, retop with microtopping, overlayment or topping mix



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MICROTOPPING

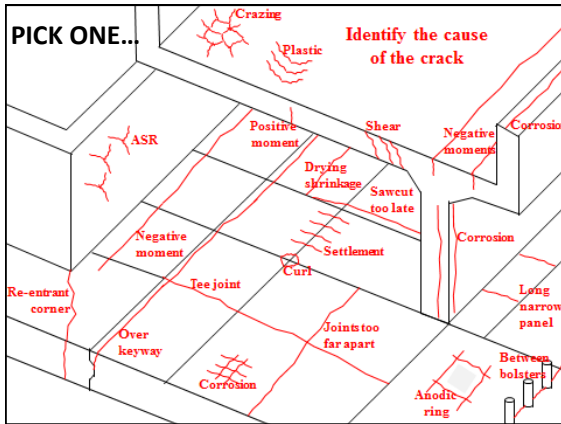


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WHEN A PETROGRAPHER SAYS:

“The probable cause of the cracking was...”

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DESCRIBING CRACKS

- Pattern vs. isolated
- Shallow vs. through
- Active vs. dormant
- Structural vs. non-structural
- Plastic vs. hardened

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PLASTIC SHRINKAGE CRACKING

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PLASTIC SHRINKAGE CRACKING

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CRAZING CRACKS

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THE FIX


- Urethane sealant
- Epoxy injection
- Ultra LV penetrating epoxy
- Crack healer/sealer (hybrid urethane, mma)

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CONCRETE PETROGRAPHY & REPAIR

QUESTIONS, COMMENTS, COMPLAINTS?

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