Sengupta, Abhijit

From: Thomas, George
Sent: Tuesday, January 12, 2010 3:59 PM
To: Naus, Dan J.
Cc: Lake, Louis
Subject: FW: Petrographic Report
Attachments: MACTEC Petro Chunk.pdf

From: Miller, Craig L [mailto:Craig.Miller@pgnmail.com]
Sent: Tuesday, January 12, 2010 2:30 PM
To: Thomas, George
Subject: FW: Petrographic Report

Third and last one.

From: Miller, Craig L
Sent: Tuesday, January 12, 2010 2:23 PM
To: 'Thomas, George'
Subject: RE: Petrographic Report

George,

Attached are the various test reports from MACTEC and S&ME (excluding the first two reports that you already have). There have also been some tests that PII had performed at Photometrics and the University of Colorado. I will send you those final reports as I get them from PII.

Let me know if you have any questions.

Thanks,

Craig

From: Thomas, George [mailto:George.Thomas2@nrc.gov]
Sent: Tuesday, January 12, 2010 1:15 PM
To: Miller, Craig L
Subject: RE: Petrographic Report

Yes, Craig. I would like to also have the additional test reports that you have.
Thanks.
George

From: Miller, Craig L [mailto:Craig.Miller@pgnmail.com]
Sent: Tuesday, January 12, 2010 11:02 AM
To: Thomas, George
Subject: RE: Petrographic Report

Hi George,

We do have a couple more petrography reports, but we also have a number of additional test reports (strength, density, modulus of elasticity, etc.). Would you like all of the test reports that we currently have?

P/105

Let me know and I will send them asap.

Thanks,

Craig

From: Thomas, George [mailto:George.Thomas2@nrc.gov]
Sent: Tuesday, January 12, 2010 10:19 AM
To: Miller, Craig L
Subject: RE: Petrographic Report

Hello Craig,

You had previously provided us with a Mactec Petrography report dated 11-11-09 and a CTL Petrography Report dated 11-2-09. Could you please email me other petrographic reports that have come in since then.

Thanks.

George Thomas
Special Inspection Team - USNRC
301-415-6181

From: Miller, Craig L [mailto:Craig.Miller@pgnmail.com]
Sent: Saturday, November 21, 2009 6:20 PM
To: Thomas, George
Subject: FW: Petrographic Report

George,

Here is the reply I received regarding your question on core 2. I have not yet determined if the report will be revised to correct the misleading statements.

Thanks,

Craig

From: Wilson, David [mailto:DWILSON@mactec.com]
Sent: Thursday, November 19, 2009 11:04 AM
To: Miller, Craig L
Subject: RE: Petrographic Report

HI Craig-

I did do some limited observations on this core but I didn't see anything that would really help in our analysis. The control sample was submitted for comparison, but to compare the existing fracture to a new fracture we made some fresh fractured surfaces in our lab in sample 5 to compare fresh vs. the existing fractured surface. Do you need us to provide a report on the core #2?

Thank you
-David

From: Miller, Craig L [mailto:Craig.Miller@pgnmail.com]
Sent: Wednesday, November 18, 2009 9:27 AM
To: Wilson, David
Subject: Petrographic Report

David,

A question was raised by the NRC on the petrographic report. It mentions that core 2 (MACTEC # 21270) was a "control sample" used for limited observations. However, there is no discussion of how it was used or what was observed in the report. Can you provide any details on this core?

Thanks,

Craig

MACTEC

engineering and constructing a better tomorrow

14 pages

December 23, 2009

Mr. Craig Miller
Progress Energy

Subject: **Report of Petrographic Observations**
Crystal River Containment Wall
Steam Generator Replacement Project
Crystal River Nuclear Generating Facility, Florida
MACTEC Project 6468-09-2535

Dear Mr. Miller

MACTEC Engineering and Consulting, Inc. (MACTEC) is pleased to present this report of our petrographic observations performed on a concrete chunk that was shipped to our laboratory under chain of custody. It is our understanding the chunk is from an area of the containment wall where a fracture was discovered running parallel to the surface at a depth of approximately 8 to 9 inches. We understand the submitted chunk contains the subject fractured surface and a portion of the concrete that was cast against a tendon duct.

The purpose of our work was to perform a petrographic analysis of the sample to observe the fractured surface and the surface that was cast against the tendon duct for depth of carbonation and other similarities or differences.

PETROGRAPHIC OBSERVATIONS

A Petrographic Analysis is a visual and microscopic analysis of cementitous materials performed by a qualified petrographer. Petrographic examinations are typically performed on polished sections or thin sections. Polished sections are generally cut sections that have been lapped (ground flat and smooth) and polished and are observed using reflected polarized light microscopes at magnifications of up to 80X. Thin sections are samples mounted to glass slides and ground to specific thicknesses (generally 20, 30, or 40 microns depending on the application) and observed using transmitted polarized light microscopes at magnifications of up to 600X.

A petrographic evaluation may be performed to identify and describe a specific item of interest such as the presence or extent of distress in concrete, or to provide a general characterization and measure of

quality of the materials being evaluated. The petrographic evaluation of concrete examines the constituents of the concrete including coarse aggregates, fine aggregates, embedded items, hardened paste, and air void structure. The examination identifies cracking present in the concrete, indications of corrosion, extent of damage from external sources, aggregate reaction, chemical attack, sulfate attack, freeze thaw cracking, acid attack, and other mechanisms of deterioration. The petrographic examination can also estimate the water to cement ratio, look for indications of mineral additives and unhydrated cement particles in the paste, look for indications of bleed water and excess porosity in the concrete, look for indications of curing procedures used and methods of finishing, observe micro cracking present and other conditions within the concrete which might give information on the overall quality or the quality of any particular constituent material. Aggregate mineralogy, rock types, and mineral crystal structure can be identified when thin sections are viewed under a transmitted polarized light microscope.

TEST RESULTS AND OBSERVATIONS

PETROGRAPHIC OBSERVATIONS

The petrographic analysis was performed in general accordance with the applicable sections of ASTM C 856-04 Standard Practice for Petrographic Examination of Hardened Concrete. The results of our petrographic analysis are on the attached sheets, Summary of Petrographic Observations of Hardened Concrete. Photographs from our examination are attached. A summary of our observations and discussion are as follows.

Aggregate

The coarse aggregate generally consisted of a natural carbonate crushed rock with a maximum size of 3/4 inch. The rocks types observed included limestone and fossiliferous limestone. The particles were generally angular to sub-rounded in shape and fairly evenly distributed. The coarse aggregate appeared to comprise approximately 50% of the total aggregate quantity with the remaining fraction being fine aggregate.

The fine aggregate was observed to be a natural siliceous sand consisting mostly of quartz. The particles were generally sub-angular to sub-rounded in shape and fairly evenly distributed.

Cement Paste

The cement paste was medium light gray (Reference colors from The Geological Society of America Rock-Color Chart, 1991). The paste appeared moderately hard and not easily scratched with a hardened steel point. The concrete appeared to have been placed at a moderately low water to cement ratio,

possibly in the range of 0.4 to 0.5. Indication of placement at a high water to cement ratio such as significant bleed channels and water gain voids were not observed.

The fractured surface and the surface that was cast against the tendon duct showed surficial carbonation that may be due to exposure to the atmosphere after removal from the structure. Significant carbonation or differences in the distribution of hydrated and partially hydrated cement particles was not observed between the two surfaces.

Air Voids, Voids, and Cracks

The concrete appeared to be air entrained and had a total air content estimated to be around 2 to 3%. The voids were generally small and spherical. Some air void clustering was observed around a few coarse aggregate particles. The air voids distribution was moderately un-even and some small areas lacked air entrainment. There was limited mineral growth observed in some of the air voids. Calcium hydroxide was observed lining some air voids.

Some limited minor fractures were observed on the fractured surface and the surface cast against the duct. One lone hairline fracture was observed and shown in photograph 6.

SUMMARY

The fractured surface and the surface that was cast against the tendon duct showed surficial carbonation that may be due to exposure to the atmosphere after removal from the structure. Significant carbonation or differences in the distribution of hydrated and partially hydrated cement particles was not observed between the two surfaces.

Sincerely

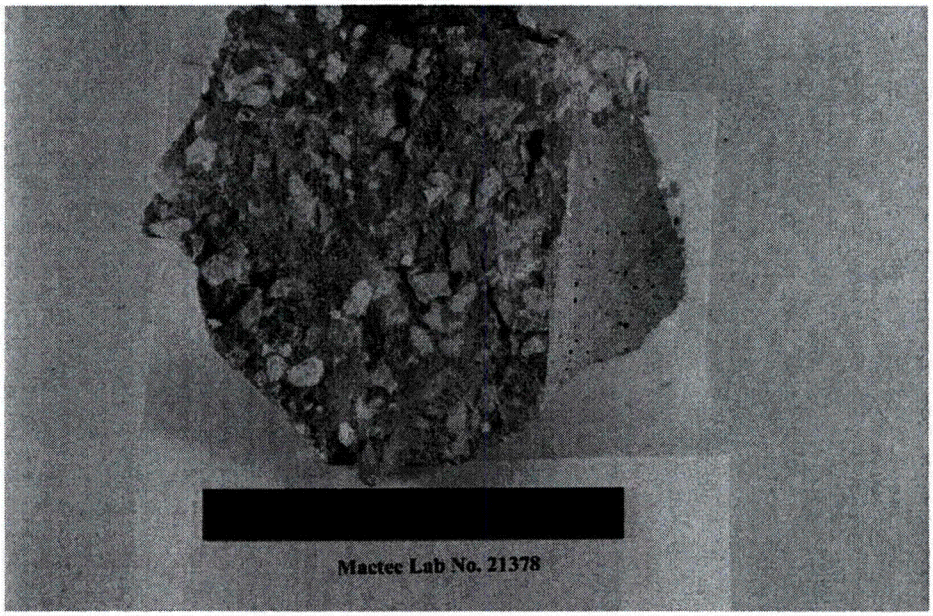
MACTEC ENGINEERING AND CONSULTING, INC.

David C. Wilson
Senior Principal Professional

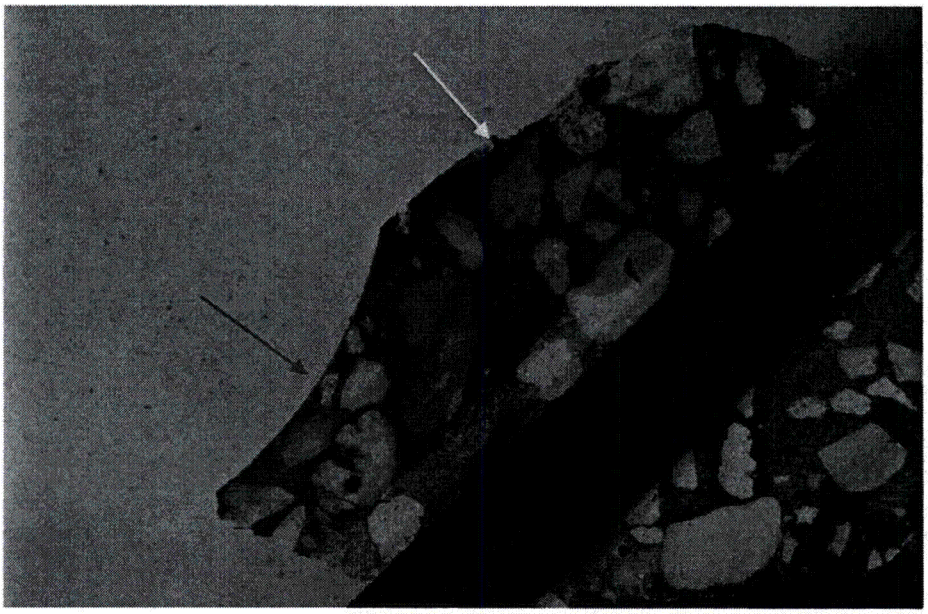
Ufuk Dilek

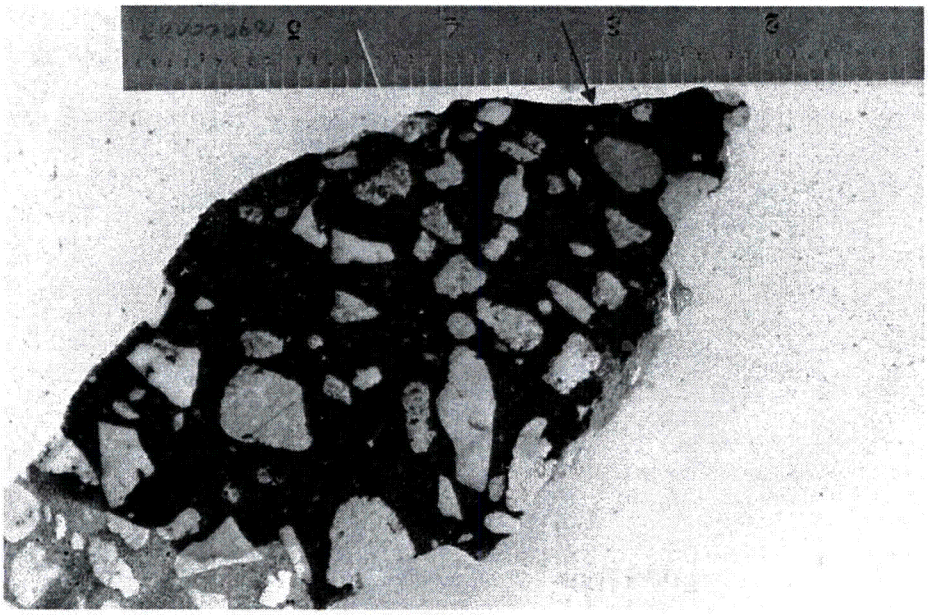
Ufuk Dilek, Ph.D., P.E.
Principal Engineer
by PCC with permission

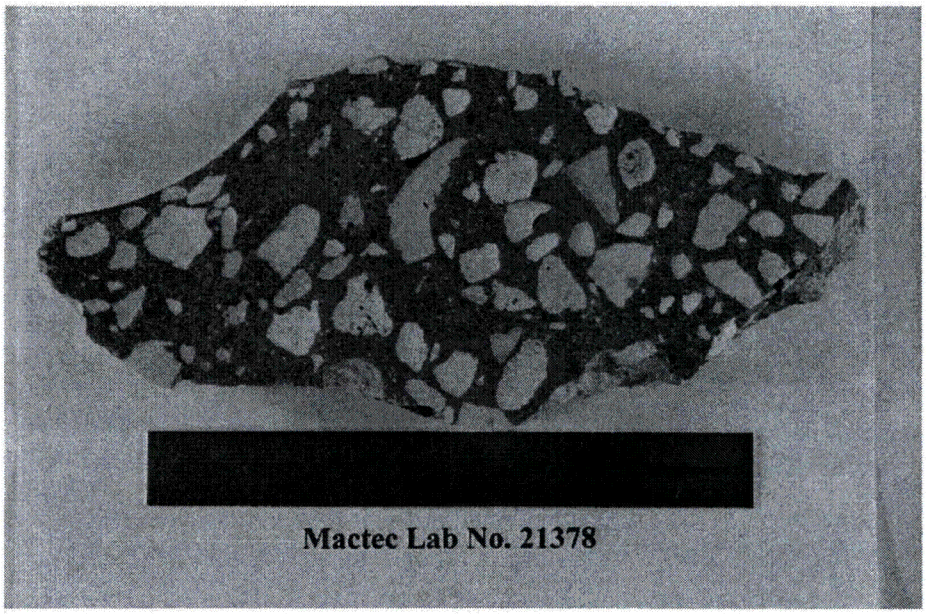
Attachments: Photographs #1 - #14
Summary of Petrographic Observations for Cores 21269A and 21271A

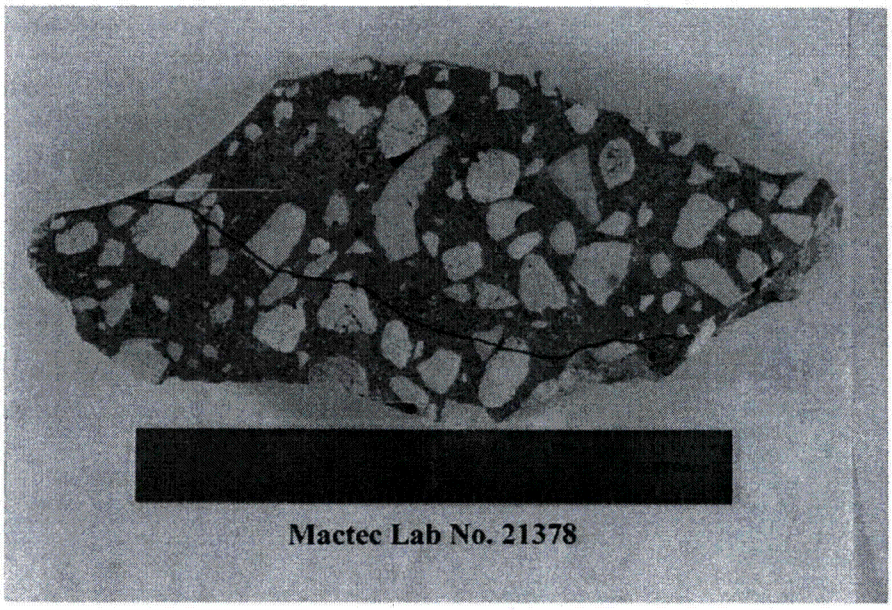
Photograph #1	**Remarks**
	Sample as received.

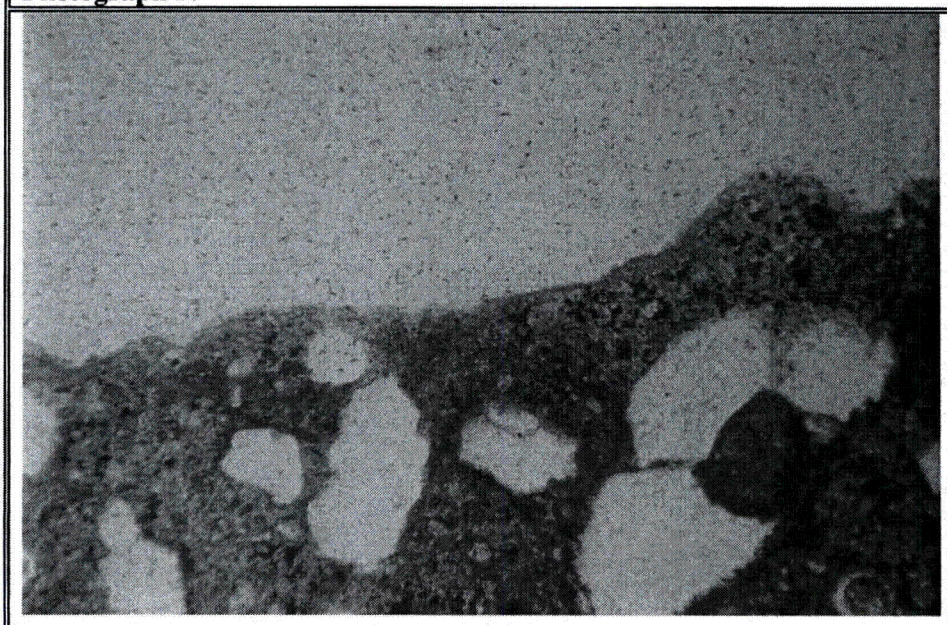
Photograph #2	**Remarks**
	Sample as received.

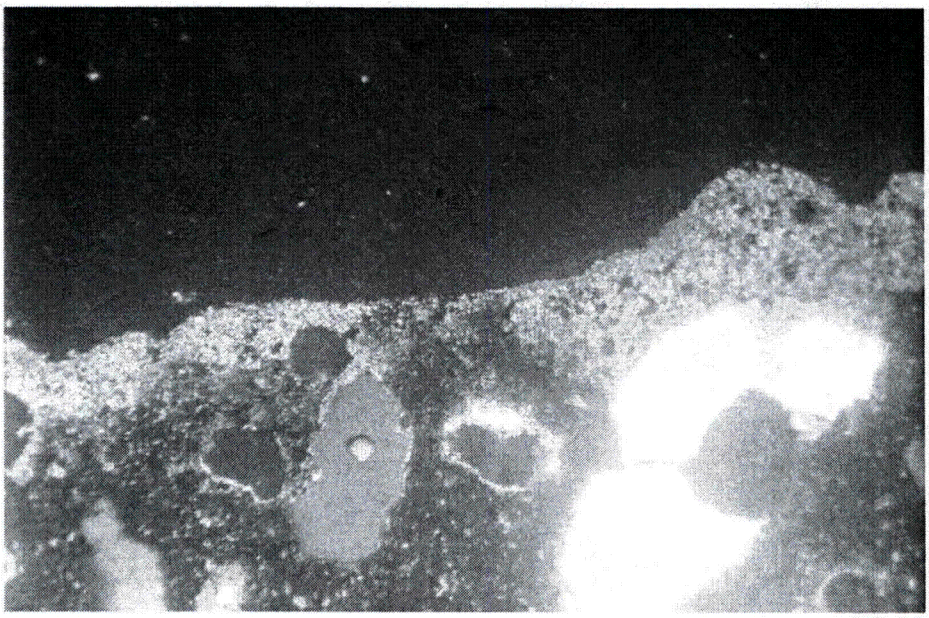
Photograph #3	**Remarks**
	A cut section of the sample after staining one area with phenolphthalein to observe for carbonation (only the pink area was treated with the phenolphthalein). Carbonated areas remain clear and non-carbonated areas turn pink. The portion of the surface cast against the tendon duct is shown by the red arrow. The fractured surface is shown by the yellow arrow.

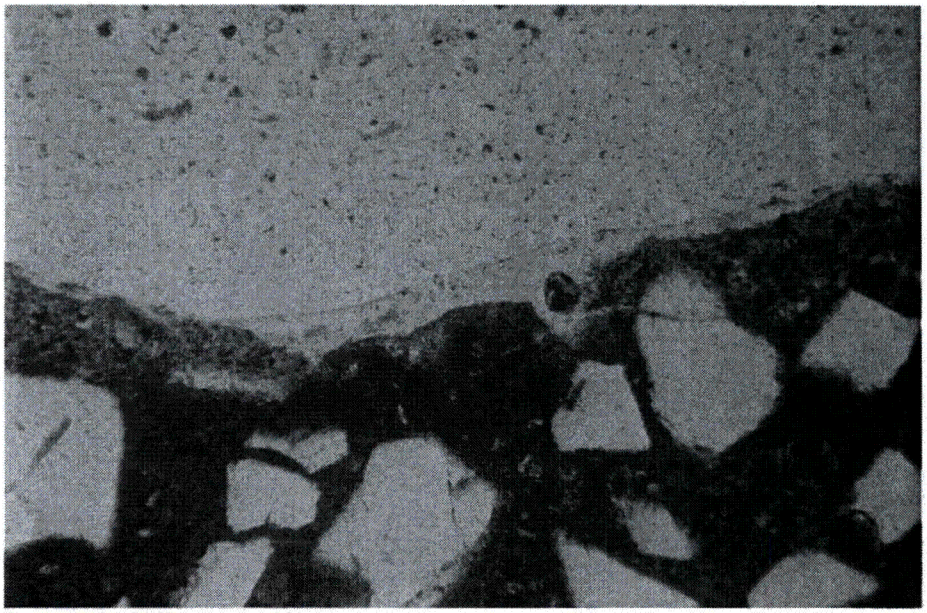
Photograph #4	**Remarks**
	A cut section of the sample after staining one area with phenolphthalein to observe for carbonation (only the pink area was treated with the phenolphthalein). Carbonated areas remain clear and non-carbonated areas turn pink. The portion of the surface cast against the tendon duct is shown by the red arrow. The fractured surface is shown by the yellow arrow.

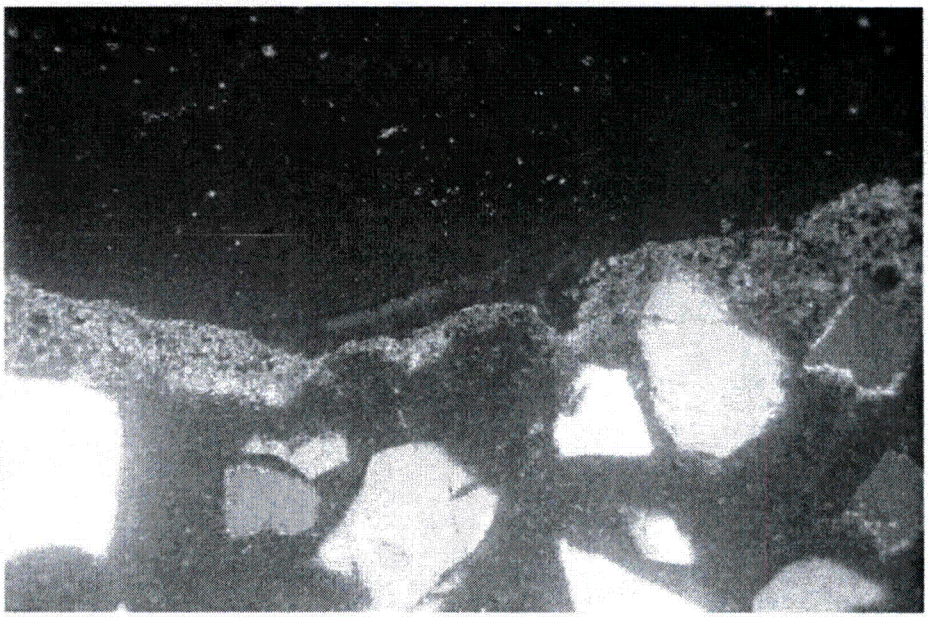
Photograph #5	**Remarks**
	The polished section prepared from the sample.

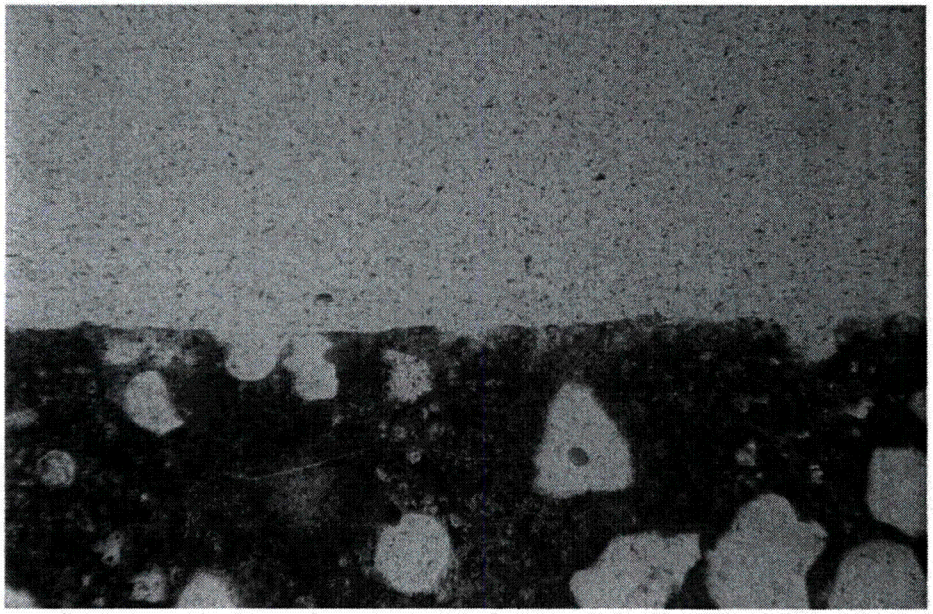
Photograph #6	**Remarks**
	The red line shows the approximate location of the hairline crack that was observed in the polished section.

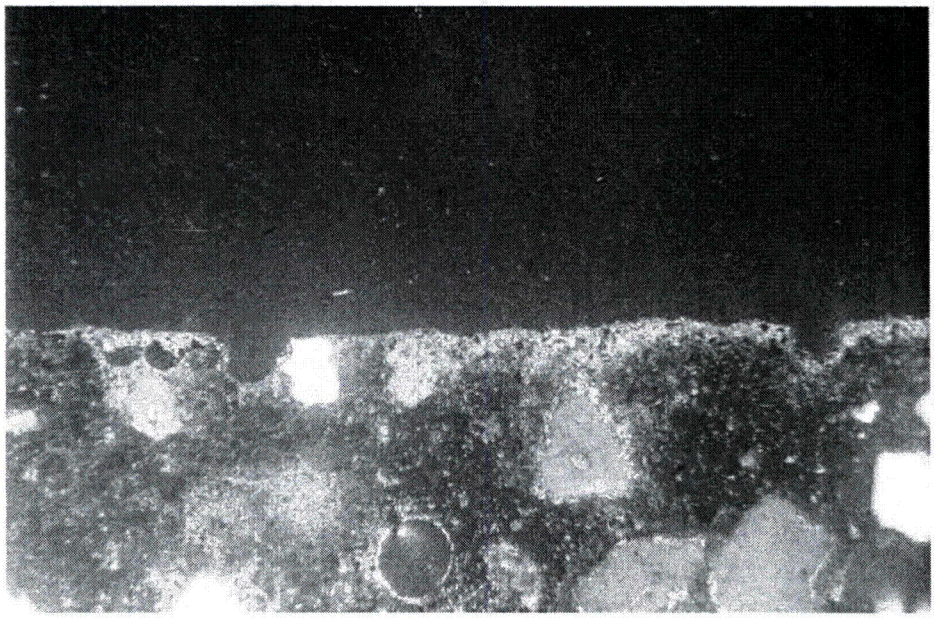
Photograph #7	**Remarks**
	Photomicrograph in plane polarized light showing the fractured surface. Width of view is approximately 0.05 inch.

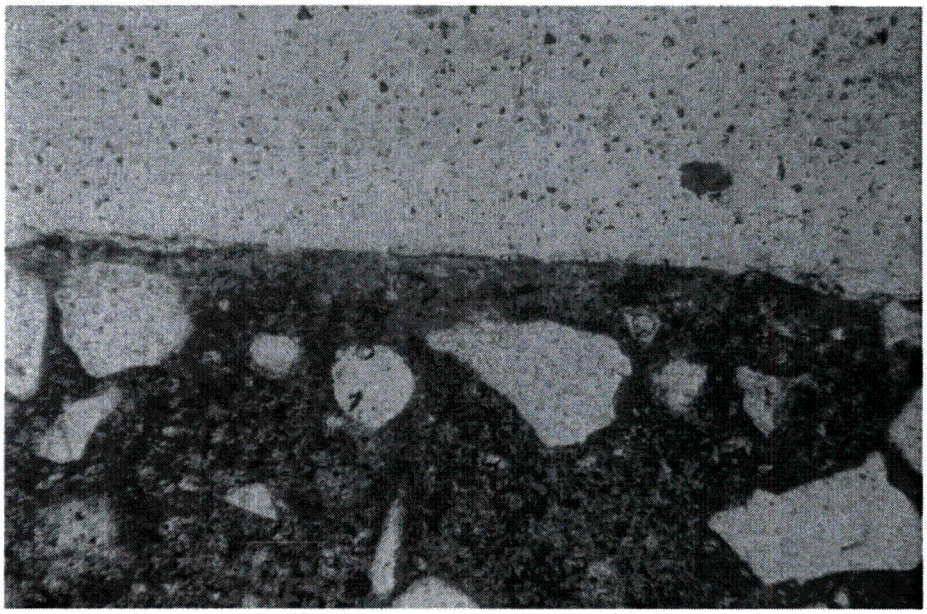
Photograph #8	**Remarks**
	Photomicrograph in plane polarized light showing the fractured surface. Width of view is approximately 0.05 inch.

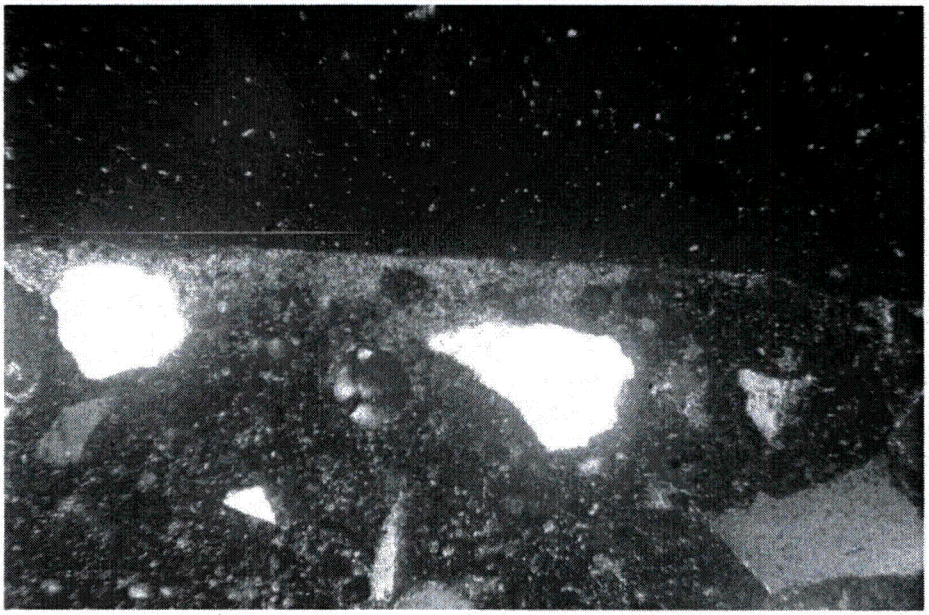
Photograph #9	**Remarks**
	Photomicrograph in plane polarized light showing the fractured surface. Width of view is approximately 0.05 inch.

Photograph #10	**Remarks**
	Photomicrograph in plane polarized light showing the fractured surface. Width of view is approximately 0.05 inch.

Photograph #11	**Remarks**
	Photomicrograph in plane polarized light showing the fractured surface. Width of view is approximately 0.05 inch.

Photograph #12	**Remarks**
	Photomicrograph in plane polarized light showing the fractured surface. Width of view is approximately 0.05 inch.

Photograph #13	**Remarks**
	Photomicrograph in plane polarized light showing the fractured surface. Width of view is approximately 0.05 inch.

Photograph #14	**Remarks**
	Photomicrograph in plane polarized light showing the fractured surface. Width of view is approximately 0.05 inch.

MACTEC

SUMMARY OF PETROGRAPHIC OBSERVATIONS OF HARDENED CONCRETE – ASTM C-856-04

PROJECT NAME	Crystal River Core Petrography Project
PROJECT NUMBER	6468-09-2535
DATE SAMPLED RECEIVED	12-2-09
SAMPLE I.D.	21378
SAMPLE SIZE AND DESCRIPTION AS RECEIVED	Chunk of Concrete identified as "small piece adjacent to sleeve". The chunk has a section that appears to have been cast against a tendon duct and reportedly has a section of the subject fractured surface adjacent to the surface cast against the duct.
OBSERVATIONS BY	David Wilson

CHARACTERISTICS	OBSERVATIONS
COARSE AGGREGATE:	
Shape	Angular to sub rounded
Grading	Approximately ¾ maximum size
Distribution	Even. Approximately 50% of the aggregates appeared to be coarse aggregates with the remaining fraction being the fine aggregate.
Texture	Fine
Composition	Carbonate
Rock Types	Limestone, fossiliferous limestone
Alteration: - Degree - Products	Not observed
Coatings	Not observed
Rims	Not observed
Internal Cracking	Generally not observed except in the vicinity of the fractured surface.
Contamination	Not observed
FINE AGGREGATE:	
Shape	Generally sub-rounded to sub-angular
Grading	#4 and smaller

Distribution	Even
Texture	Fine
Composition	Siliceous
Rock Types	Quartz
Alteration: - Degree - Products	Not Observed
Coatings	Not Observed
Rims	Not Observed
Internal Cracking	A few internal fractures were observed
Contamination	Not observed

CHARACTERISTICS	OBSERVATIONS
CONCRETE:	
Air-Entrained or Not	Appeared to have some air entrainment. Total air content based on visual observations appeared to be 2 to 3%
Air Voids: - Shape - Size - Distribution	Mostly small and spherical. Some air void clustering was observed around a few coarse aggregate particles. The air void distribution was moderately un-even, some small areas lacked air entrainment. There was some limited mineral growth observed in some of the air voids. Calcium hydroxide was observed lining some air voids.
Bleeding	Not Observed
Segregation	Not Observed
Aggregate-Paste Bond	Coarse and fine aggregates appeared to have a good bond to the cement paste with few openings. Some aggregate particles had increased calcium hydroxide in the paste surrounding the perimeter of the particle.
Fractures	One long hairline crack was observed and is shown in the attached photograph #6. Some minor fractures were observed near the portion that was cast against the duct and the portion that contained the fractured surface.
Embedded Items - Shape	Not observed

- Size - Location - Type	
Alteration: - Degree & Type - Reaction Products - Location - Identification	Not observed
Nature and Condition of Surface Treatments	Not observed
Estimated water-cement ratio (based on visual observations only)	Appeared to have a moderately low w/c ratio possibly in the range of 0.4 to 0.5
Estimated cement content (based on visual observations only)	Appeared to have a moderately high cement content
PASTE:	
Color (GSA rock color chart 1991)	Medium light gray
Hardness	Appeared moderately hard when scratched with a hardened steel point
Porosity	Did not appear very porous. It took from 10 minutes to over 20 minutes to absorb 15 micro liter drops of water.
Carbonation	The fractured surface and the portion that was cast against the duct did not show significant carbonation when stained with phenolphthalein. Some surficial carbonation was observed in thin section observations.
Residual un-hydrated Cement: - Distribution - Particle Size - Abundance - Composition	Some un-hydrated/partially hydrated cement particles were observed. There was even distribution throughout the sample.
Mineral Admixtures: - Size - Abundance - Identification	Fly-ash was not observed
Contamination: - Size - Abundance - Identification	Not observed

Equipment Used:

Cannon EOS Digital Rebel with 50mm macro lens and microscope adapters

AmScope 7X to 45X stereo zoom microscope (with and without polarized light)
Olympus BH-2 polarized light microscope

Zeiss Photomicroscope II polarized light microscope

Starrett 6 inch rule SN 109000003

Note: No M&TE used is subject to calibration requirements.