Group E

FOIA/PA NO: 2013-0332

RECORDS BEING RELEASED IN THEIR ENTIRETY

March 20, 2013

APPLICANT: NextEra Energy Seabrook, LLC

FACILITY: Seabrook Station

SUBJECT: SUMMARY OF TELEPHONE CONFERENCE CALL HELD ON MARCH 13, 2013, BETWEEN THE OFFICE OF NUCLEAR REACTOR REGULATION, OFFICE OF NUCLEAR REGULATORY RESEARCH, AND REGION I CONCERNING THE LICENSING APPROACH PERTAINING TO THE SEABROOK STATION, UNIT 1 ALKALI SILICA REACTION CONFIRMATORY ACTION LETTER

The Office of Nuclear Reactor Regulation (NRR), the Office of Nuclear Regulatory Research (RES), and Region I held a telephone conference call on March 13, 2013, to discuss the licensing approach concerning the Seabrook Station, Unit 1 (Seabrook) alkali silica reaction (ASR) confirmatory action letter (CAL).

In August 2010, Seabrook reported the presence of ASR degradation of concrete in below-grade walls of several Category 1 structures with groundwater intrusion. Seabrook is the first plant to report ASR in the U.S. nuclear industry. The NRC staff's review of this issue, to date, has determined that there are no immediate safety concerns due, in part, to existing safety margins, the localized nature of the ASR, and ongoing crack monitoring. On May 16, 2012 (Agencywide Documents Access and Management System Accession Number ML12125A172), the NRC staff issued a CAL to the plant's owner, NextEra, confirming regulatory commitments made by the company to address ASR at the plant as a result of a management meeting with NRC staff on April 23, 2012.

Enclosure 1 provides a listing of the participants and Enclosure 2 contains the licensing approach recommended by NRR.

/ra/

John G. Lamb, Senior Project Manager
Plant Licensing Branch I-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-443

Enclosures:
1. List of Participants
2. Recommended Licensing Approach

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TELEPHONE CONFERENCE CALL

SEABROOK STATION, UNIT 1

ALKALI SILICA REACTION WORKING GROUP

LIST OF PARTICIPANTS
March 13, 2013

PARTICIPANTS	AFFILIATIONS
Jim Trapp	Region I
Rich Conte	Region I
Bill Raymond	Region I
Suresh Chadhaury	Region I
Meena Khanna	NRR
Michael Marshall	NRR
Tony McMurtray	NRR
Tim Kobetz	NRR
Kamal Manoly	NRR
George Thomas	NRR
Bill Ott	RES
Rosemary Hogan	RES

Enclosure 1

TELEPHONE CONFERENCE CALL

SEABROOK STATION, UNIT 1

ALKALI SILICA REACTION WORKING GROUP

In August 2010, Seabrook Station, Unit 1 (Seabrook) reported the presence of alkali silica reaction (ASR) degradation of concrete in below-grade walls of several Category 1 structures with groundwater intrusion. Seabrook is the first plant to report ASR in the U.S. nuclear industry. The U.S. Nuclear Regulatory Commission (NRC) staff's review of this issue, to date, has determined that there are no immediate safety concerns due, in part, to existing safety margins, the localized nature of the ASR, and ongoing crack monitoring. On May 16, 2012 (Agencywide Documents Access and Management System Accession Number ML12125A172), the NRC staff issued a Confirmatory Action Letter (CAL) to the plant's owner, NextEra, confirming regulatory commitments made by the company to address ASR at Seabrook as a result of a management meeting with NRC staff on April 23, 2012.

Below is the licensing approach recommended by NRR concerning the CAL that was presented at the conference call held on March 13, 2013.

Seabrook ASR – Regulatory Process Overview and Approach

1. The licensee has performed an operability determination and is currently tracking this issue as a degraded or nonconforming condition in accordance with their corrective action program. The U.S. Nuclear Regulatory Commission (NRC) staff's review of alkali-silica reaction (ASR) issue, to date, has determined that there are no immediate safety concerns due, in part, to existing safety margins, the localized nature of the ASR, and ongoing crack monitoring. In Inspection Report, dated December 3, 2012, "The NRC determined that NextEra's methods for assessing operability of ASR-affected reinforced concrete structures were reasonable and generally comprehensive. NextEra conducted a margins analysis, using bounding ASR-affected concrete properties derived from research data, to demonstrate that Seabrook structures remained operable. The [NRC] team concluded this margins assessment provided a reasonable operability basis and noted that further testing and engineering analyses are planned by NextEra to address this reinforced concrete structures non-conforming condition. The testing and additional analyses are expected to be completed by mid-2014."

2. Seabrook submitted evaluation/analysis in accordance with the Confirmatory Action Letter (CAL) on May 25, 2012.

    2.1. Evaluation of impact of ASR on Seabrook constitutes an analysis performed at NRC request.

    2.2. 10 CFR 50.71(e) requires the Final Safety Analysis Report (FSAR) to be updated with "...all analyses of new safety issues performed by or on behalf of the applicant or licensee at Commission request."

2.3. The FSAR update must, "... assure that the information included in the report contains the latest information developed. This submittal shall contain all the changes necessary to reflect information and analyses submitted to the Commission by the ... licensee ..."

3. Therefore, NextEra is required to incorporate this information into the FSAR in accordance with 10 CFR 50.71(e)(4).

3.1. Based on the submittal dated May 25, 2012, this FSAR update must be submitted no later than November 17, 2013. Licensee is working on update and plans to submit in May 2013.

3.2. The change to the FSAR must be evaluated in accordance with 10 CFR 50.59 to determine if NRC approval is required prior to incorporation into the FSAR update.

4. The 10 CFR 50.59 evaluation of the FSAR update may trigger a request for amendment pursuant to 10 CFR 50.90. This evaluation is made by the licensee and is subject to NRC review and /or inspection.

4.1. Amendment process provides a strong regulatory framework to document NRC staff review of the licensee evaluation/analysis of ASR.

4.2. Amendment process provides a structured opportunity for public involvement.

4.3. An amendment could be structured to provide license conditions that track future milestones toward permanent resolution of the issue.

5. Licensee final disposition of the degraded/nonconforming condition will likely require additional changes to the facility as described in the FSAR after the large scale testing is completed in mid-2014. Once again, the licensee needs to perform a 10 CFR 50.59 evaluation and determine if an amendment request is needed pursuant to 10 CFR 50.90.

Chaudhary, Suresh

From: Raymond, William
Sent: Friday, April 05, 2013 12:41 PM
To: Philip, Jacob; Graves, Herman; Sircar, Madhumita; Sheikh, Abdul; Buford, Angela; Erickson, Alice; Fuhrmann, Mark; Conte, Richard; Cook, William; Trapp, James; Chaudhary, Suresh; Thomas, George; Cartwright, William
Cc: Marshall, Michael; Ott, William; Hogan, Rosemary; Nicholson, Thomas; Coe, Doug; Correia, Richard; Richards, Stuart; Thomas, Brian; Case, Michael; Gavrilas, Mirela; Dunn, Darrell; Galloway, Melanie; Tregoning, Robert; Esh, David; Alexander, George; Issa, Alfred; Frye, Timothy
Subject: RE: NIST report: Alkali-Silica Reaction Degradation of NPP Structures; A Scoping Study

Jake,
Overall, the test plan looks good based on a quick read. I need to go over it again in more detail.
I will have a few suggestions/questions for your consideration-in the area of specimen preparation (mix design, curing techniques) and levels of expansion to be studied. I will get them to you by your deadline next week.
Thanks,
Bill

From: Philip, Jacob
Sent: Friday, April 05, 2013 9:08 AM
To: Graves, Herman; Sircar, Madhumita; Sheikh, Abdul; Buford, Angela; Erickson, Alice; Fuhrmann, Mark; Conte, Richard; Cook, William; Raymond, William; Trapp, James; Chaudhary, Suresh; Thomas, George; Cartwright, William
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Subject: NIST report: Alkali-Silica Reaction Degradation of NPP Structures; A Scoping Study

I am enclosing the cited report by NIST which is a scoping study on ASR effects on concrete nuclear structures.

On January 23, 2013, NIST briefed NRC staff from the NRR and RES on the contents of this report. NRC staff provided comments to NIST on the presentation materials from the NIST briefing of January 23. and met with the NIST presenters at NIST headquarters, Gaithersburg , on February 7, 2013 to explain their comments. The enclosed report incorporates NRC staff comments.

Please provide any comments you might have on the report by April12, 2013 so that the technical plan discussed in the report can be implemented.

If you have any questions please contact me.

Thanks....Jake

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Chaudhary, Suresh

From: Raymond, William
Sent: Friday, April 12, 2013 12:28 PM
To: Philip, Jacob
Cc: Marshall, Michael; Ott, William; Hogan, Rosemary; Nicholson, Thomas; Coe, Doug; Correia, Richard; Richards, Stuart; Thomas, Brian; Case, Michael; Gavrilas, Mirela; Dunn, Darrell; Galloway, Melanie; Chaudhary, Suresh; Tregoning, Robert; Esh, David; Alexander, George; Issa, Alfred; Graves, Herman; Sircar, Madhumita; Sheikh, Abdul; Buford, Angela; Erickson, Alice; Fuhrmann, Mark; Conte, Richard; Cook, William; Trapp, James; Cartwright, William; Thomas, George; Frye, Timothy; Kowal, Mark
Subject: RE: NIST report: Alkali-Silica Reaction Degradation of NPP Structures; A Scoping Study
Attachments: NUREG_ASR_20130402 rev_FINAL.docx

Jake,
The following comments on the ASR Scoping Study are provided for your consideration. As I said earlier, the overall test plan looks really good and should further our understanding of ASR as it relates to current and future NPPs. Comments 1 & 2 are questions on making the test specimens representative on NPPs, which need not necessarily be reflected in the high level test plan, but could be addressed in lower level documents covering details of test protocols. Comments 2, 3 and 6 provide suggestions for insights to be obtained from the study that would inform structures monitoring programs and aging management of ASR issues. Comment 5 suggests a need for clarity in Section 4.2.5. The answer to question #7 can be provided in a reply to this email. I trust this helps.

Thanks for the opportunity to provide this feedback. I am available at your convenience as needed to clarify my comments/questions.
Bill

NUREG/CR-xxxx, Alkali-Silica Reaction Degradation of Nuclear Power Plan Concrete Structures: A Scoping Study
Questions 1 & 2 on mix design and reinforcement details could be addressed in a lower tier test documents.

1. Section 4 Test Plan General and Section 4.2.1 – Mix design & Reinforcement detail. The question is how will the concrete mix and test specimens be designed to be "representative of NPP designs."
    a. what parameters will be specified to create the representative mix design"
    28-day strength (4000 psi)?, aggregate type? concrete density? fine and course aggregate reactivity? alkali loading?
    what is the plan for a "number of concrete mix designs?
    b. what curing techniques will be employed? admixtures? NAOH addition? water spray?
    c. what levels of expansion will be studied? It would to have data that parallels the Seabrook study->expansions at 2% to 10%
    d. what size beams will be used? – how will scaling the results on small specimens to larger elements be handled?
    e. how many beams at each level of ASR expansion will be tested?
    f. will control specimens be included to normalize the results?

2. Section 4 Test Plan General, plus Section 3.4 (p18) and Section 4.2.1 (p23) – ASR induced stresses in the reinforcement
    a. what reinforcement parameters will be specified to make the specimens "representative" reinforcement used in NPPs?
    size (bar#)?, development length?, reinforcement ratio/density?
    b. will the test plan include beams with and without transverse reinforcement?
    c. can the study provide insights on the adverse ASR impacts of the reinforcement?
    can the installed strain gages (Section 4.2.1 #1) quantify the amount of stress placed on the rebar?

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can the study provide insight into whether the rebar remains in the elastic or plastic strain-hardening range?
can the study offer insights on the significance of this ASR induced stress relative to ACI 318 code limits and capacity of the elements?
[Note that Deschenes in the 2009 TxDOT Study reported expansions that went beyond yield for rebar steel for expansions with mild ASR damage (0.2%) and up to moderate ASR damage at 0.69% (Deschenes @ p 18, 150, 195)]

3. Section 4 Test Plan – sections 4.2.1, #3 (p23) - correlate CCI to expansion
Overview #3 will develop a protocol to determine the "extent of the ASR reaction" in an existing structure. Can the study further establish a correlation between surface cracking and core expansion that will to assure the visible inspection criteria are sufficient and conservative to assess ASR degradation in material properties and structural performance? This will inform the structures CFR 50.65 structures monitoring programs are adequate to identify the need for further evaluation, repair or mitigation. Can the study provide a correlation between crack index and expansions in terms of strain? That is, does a CCI of 1mm/m equals 1 millistrain (0.1%) for the typical reinforcement detail used at NPPs?

4. Section 4.2.3, p25: kinetic model approximation – how will uncertainties be handled such that application of the results will be conservative but reasonably accurate to make useful predictions?

5. Section 4.2.5, p26, item #2: it is unclear what property for "reinforcing bar anchorage" will be measured.

6. Section 4.3, p27: rate of corrosion of reinforcing steel – will the test plan assess the susceptibility of reinforcing steel as a function of expansion level (as measured in crack widths) and concentration of contaminants (i.e., chlorides >500ppm?)? In addition to establishing a method to detect the start of rebar corrosion starts, could the study also provide insights regarding the level of ground water chemistry that rebar corrosion becomes a concern as a function of ASR degradation (say, crack width)? Is it 1000 ppm? 10,000 ppm? 20,000 ppm?

7. Question - Test Program General - What is the time frame of the study? When will the results be available?

WJ Raymond
April 2013

From: Raymond, William
Sent: Friday, April 05, 2013 12:41 PM
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Cook, William; Raymond, William; Trapp, James; Chaudhary, Suresh; Thomas, George; Cartwright, William
Cc: Marshall, Michael; Ott, William; Hogan, Rosemary; Nicholson, Thomas; Coe, Doug; Correia, Richard; Richards, Stuart; Thomas, Brian; Case, Michael; Gavrilas, Mirela; Dunn, Darrell; Galloway, Melanie; Tregoning, Robert; Esh, David; Alexander, George; Issa, Alfred
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Please provide any comments you might have on the report by April12, 2013 so that the technical plan discussed in the report can be implemented.

If you have any questions please contact me.

Thanks....Jake

From: Miller, Ed
Sent: Tuesday, May 31, 2011 3:10 PM
To: Lehman, Bryce; Sheikh, Abdul; Conte, Richard; Modes, Michael; Raymond, William; Auluck, Rajender; Burritt, Arthur; Galloway, Melanie
Subject: Response to Chairman Questions from ASR Briefing

Here is the final version we sent to the Chairman.

From: Miller, Ed
Sent: Tuesday, May 31, 2011 3:08 PM
To: Marshall, Michael
Cc: Galloway, Melanie; Raymond, William; Bowman, Gregory
Subject:

Mike,
Here are answers to the follow-up questions from the briefing to Chairman Jaczko on the Seabrook ASR issue. Please let me know if you need any additional information.

Ed Miller
415-2481

Q1: Has ASR occurred in the DC Metro?

A1: A quick search did not identify any documentation of ASR occurring in the DC Metro,

Q2: Additional information on the Containment Enclosure Building.

A2: The Containment Enclosure Building (CEB) at Seabrook functions in a similar fashion to secondary containments at some BWRs. It serves to collect any fission products that may leak from the primary containment structure following a LOCA. The area between the two containment structures is maintained at a negative pressure (~0.25" water gauge) to ensure that any leakage into the area is 1) collected; 2) filtered (HEPA and charcoal); and 3) released from an elevated location in a controlled and monitored fashion. Millstone Units 2 and 3 have a similar structure in both function and construction. Sites that have structures with a similar function, but different construction are Waterford 3, Davis-Besse, St. Lucie 1 and 2, Kewaunee, Prairie Island 1 and 2, Sequoyah 1 and 2, and Watts Bar 1.

Q3: What experience has the international nuclear community had with ASR?

A3: ASR has been confirmed at Gentilly Units 1 and 2 in Becancour, Quebec. ASR has also been confirmed at Saint-Laurent A1 in Saint-Laurent, France. Additionally, ASR degradation has been identified in the turbine generator foundation at Ikata No. 1 in Japan. We will seek additional information of these cases to inform our understanding at Seabrook.

Q4: What is the effect of this degradation on external events response (earthquake, tornado, etc)?

A4: The Seabrook seismic Category I structures are designed to house safety related equipment and protect them from postulated environmental conditions as described in the FSAR. The structure design includes consideration of combinations of loads (normal and

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accident), and loads due to site severe and extreme environmental conditions. Since ASR develops in the presence of water, the above grade portions of structures are unaffected by ASR such that the ability of the structure to resist environmental loads (wind and tornado) would not be affected. Although ASR has impacted the below grade concrete walls, the structures remain operable for site environmental extreme events, including flooding and earthquakes. Although concrete strength and modulus were reduced compared to the initial values, the licensee's preliminary operability determination determined that the concrete strength remained above the values needed for the design basis loads. Similarly, the preliminary operability determination determined that the change in the flexure of the below grade walls was small given the margins available. The NRC staff continues to review the licensee's analytical methods to validate these conclusions.

Q5: What acceptance testing is available for detecting reactive aggregates prior to construction? What testing did Seabrook perform?

A5: ASR has been a known degradation mechanism since the late 1930's and ASTM standards have been in place since the 1950's to test for reactive aggregates prior to construction. Several of these standards were used during construction at Seabrook; however, recent experience has demonstrated that these older standards are inadequate in their ability to identify slowly reacting aggregates (i.e., the standard may identify an aggregate as non-reactive only to have it begin reacting after 10 or 20 years in service). Newer standards introduced in the late 1980's and early 90's are better able to identify slowly reacting aggregates but have their own drawbacks. Experts are continuing to work to develop a test which can reliably identify all reactive aggregates in a reasonable amount of time. Based on the OE and standards specified during construction, Seabrook probably used slowly reacting aggregates which were not identified as reactive during the initial testing. This is one of the issues the NRC and the licensee are actively investigating.

Chaudhary, Suresh

From: Raymond, William
Sent: Wednesday, August 22, 2012 12:06 PM
To: Conte, Richard
Cc: Chaudhary, Suresh; Cook, William
Subject: FW: input on rebar corrosion
Attachments: Seabrook analysis for Cl Rev2.docx

Rich,
Are we picking up on this in the Team Forum? Working Group Forum?
I have not engaged NextEra on this topic but it might be good to do so.
I am not aware of any testing they have done for chlorides inside the concrete.
Sounds like a good idea.

Bill

From: Fuhrmann, Mark
Sent: Wednesday, August 15, 2012 4:50 PM
To: Conte, Richard; Abdul @ Home; Ali, Syed; Burritt, Arthur; Cartwright, William; Chaudhary, Suresh; Cline, Leonard; Cook, William; Cruz, Holly; Cunanan, Arthur; Doutt, Clifford; Erickson, Alice; George T @ Home; Graves, Herman; Hogan, Rosemary; Jolicoeur, John; Khanna, Meena; Kobetz, Timothy; Lamb, John; Manoly, Kamal; Marshall, Michael; Merzke, Daniel; Morey, Dennis; Murphy, Martin; Ott, William; Philip, Jacob; Raymond, William; Sheikh, Abdul; Sircar, Madhumita; Thomas, George
Subject: input on rebar corrosion

Hi Richard:
Attached is a short write-up on rebar corrosion. This was requested at the meeting last week. If you have any questions or comments , please contact me.
Mark

Mark Fuhrmann, Ph.D.
Geochemist
Office of Nuclear Regulatory Research
U.S. Nuclear Regulatory Commission
Mail Stop CSB 2C-07m
11555 Rockville Pike
Rockville, MD 20852-2738

mark.fuhrmann@nrc.gov
Phone: 301-251-7472
Fax: 301-251-7410

From: Conte, Richard
Sent: Wednesday, August 15, 2012 2:51 PM
To: Abdul @ Home; Ali, Syed; Burritt, Arthur; Cartwright, William; Chaudhary, Suresh; Cline, Leonard; Conte, Richard; Cook, William; Cruz, Holly; Cunanan, Arthur; Doutt, Clifford; Erickson, Alice; Fuhrmann, Mark; George T @ Home; Graves, Herman; Hogan, Rosemary; Jolicoeur, John; Khanna, Meena; Kobetz, Timothy; Lamb, John; Manoly, Kamal; Marshall, Michael; Merzke, Daniel; Morey, Dennis; Murphy, Martin; Ott, William; Philip, Jacob; Raymond, William; Sheikh, Abdul; Sircar, Madhumita; Thomas, George
Subject: ASR Team Reminders and The UFSAR Reg Guide and Standard for Concrete (non IWL-Contianment) FW: Message from R1-3138K501

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An interesting page from the upfront section of Seabrook UFSAR section 1.8, Rev. 12 demonstrating why they need not comply with Rev. 1 of RG 1.142.

Rev 2 of RG 1.142 appears to give latest endorsement to ACI 349-1997 (not sure if it a construction/design or monitoring code – I am trying to get a copy).

Latest 349 – 2003 and reapproved 2010 seems to address ASR from a core sampling viewpoint. The large scale testing appears to be not recognized although it may not be unacceptable.

I am told that the CAL Item No. 7 on revised structures monitoring program is selectively based on ACI 349-1997, how selective was it?

We need to build consensus on about half the CAL items by September 30 (discussion with Chris Miller) – we have 4 position papers but I think we will only get to two of the four by Sept. 30.

The two remaining are on the ACI code to use and adequacy of the structures monitoring program. The draft TIA response to question 5 has some good stuff in it for the ASR issue. And, the draft RAI on AMP for ASR is also informative.

This is why the ASR working group was founded. While I like the fact that we are homing in on important issues, the challenge will be staff resource to build consensus. Right now I am estimating 30 hours week per DE rep. and 30 hours per DLR rep. each week of August and September. Marty thinks that is about right. But, how can we be more efficient?

My lead in the area is Suresh but he needs to be talking with staff in NRR and then BCs get together on how to proceed.

I plan to make this a topic for next ASR working group next week on Aug 22 at 200pm.

A reminder that we need comments by COB Aug 20 on the first two position paper sent out by Bill Cook, more core sampling and more rebar inspection.

Another reminder of a team meeting the morning of Aug. 22, Wednesday.

From: r1scan@nrc.gov [mailto:r1scan@nrc.gov]
Sent: Wednesday, August 15, 2012 4:33 PM
To: Conte, Richard
Subject: Message from R1-3138K501

Trapp, James

From: Raymond, William
Sent: Monday, August 26, 2013 3:23 PM
To: Trapp, James; Cook, William; Floyd, Niklas; Buford, Angela
Subject: RE: August 9th NRC Seabrook CAL Inspection Report

Got it, Jim. Thanks.
I gave it a quick read, and I did not see any new information / concerns.
There is a continued interest to obtain information that can only be provided by NextEra.
Let me know how I might help in any way.
Bill

From: Trapp, James
Sent: Monday, August 26, 2013 3:14 PM
To: Cook, William; Raymond, William; Floyd, Niklas; Buford, Angela
Subject: FW: August 9th NRC Seabrook CAL Inspection Report

FYI

From: Debbie Grinnell [mailto:debbie@c-10.org]
Sent: Monday, August 26, 2013 3:10 PM
To: Trapp, James
Subject: August 9th NRC Seabrook CAL Inspection Report

Hello James,

I read your latest August 9th Seabrook CAL Inspection Report. I have made notes and have questions from the report that I sent to Paul Brown today. We look forward to having a conference call with you and staff when Paul has had a chance to comment and is prepared for a call. I will contact you when we are prepared for your call.

We all appreciate your attempts to answer our questions and to engage our expert concerning the assertions and assessments NextEra has made in determining the extent of condition of ASR degradation at Seabrook. We continue to hope to have a more in-depth review of the actual data and basis for their calculations for our expert to review. We are requiring an independent assessment.

I filed a FOIA today and wanted you to know that we believe the public has a right to know four years into this new to the NRC and industry form of ASR concrete degradation exactly how this investigation is being conducted. Your process transparency when we have invested in a well respected expert since 2011 in this specialized field is both reasonable and necessary from our perspective. We have kept pace with and witnessed NextEra's investigation to-date and have deep concerns. We do appreciate your attempt to engage Paul Brown but we continue to not be provided the data he requires to make an assessment.

Both NextEra and the NRC have failed us in not conducting an adequate structural monitoring program since the plant went on-line. It was during Seabrook's construction that through wall cracks in foundations were documented in several buildings. During construction, we all had knowledge that the water proof membrane had failed before operation and that it remained an NRC unresolved item that would be of concern if the water chemistry changed and became aggressive. The documentation of aggressive water and the water infiltration of safety related buildings was well documented and known to both the industry and to your staff for two decades. There were structures NRC required to be monitored that were not by NextEra and unknown to your NRC staff at the site and in Region 1. NextEra failed to monitor and then failed to document operability. We have a loss of confidence in NextEra's ability to operate a plant safely as they can not demonstrate conformance to NRC regulations or compliance with NRC issued notices. Therefore, we insist on knowing what tests are done and what the raw data is and what is used to make calculations

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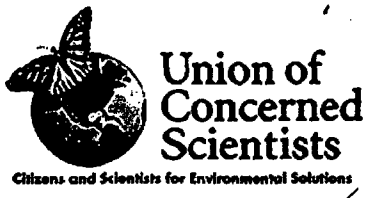
Although I could see some limited NRC progress in this investigation, there continue to exist conclusions based on false assumptions or limited testing with no data results reported. This is not acceptable.

Thank you and we will look forward to more in-depth conversation concerning Seabrook's "significant condition adverse to quality" that was not monitored nor recognized until it was extension and marked.

Debbie



September 13, 2012

William M. Dean
Regional Administrator Region 1
United States Nuclear Regulatory Commission
2100 Renaissance Blvd., Suite 100
King of Prussia, PA 19406-2713

Dear Mr. Dean,

The C-10 Research and Education Foundation and the Union of Concerned Scientists (UCS) request the Nuclear Regulatory Commission (NRC) require NextEra, the operator of Seabrook Station, to begin a complete structural integrity evaluation during its September 23, 2012 refueling outage to determine the status and extent of Alkali-Silica Reaction (ASR) degradation present in Seabrook's containment building, and any accompanying corrosion to the containment liner plate or other steel structures, including embedded concrete reinforcing steel.

In the recently released Advisory Committee on Reactor Safeguards (ACRS) transcript (ML122070401), ACRS members requested of the applicant and of the NRC staff details concerning the extent of ASR at Seabrook since it remains an open and unresolved safety item three years after its discovery by NextEra. According to NRC staff there exists no difference of opinion that ASR is occurring in Seabrook's containment enclosure building. However, the extent of ASR, its effects on structural integrity of the concrete, and the extent of corrosion of embedded steel due to intrusion of aggressive ground water remain inadequately documented and characterized.

We are not aware of a failure modes and effects analysis (FMEA) for the ASR-affected areas at Seabrook. If a FMEA showed that the ASR degradation, even if progressing to the point of structural failure, would not result in any system, structure, or component from performing its safety function during design-basis transients and accidents, then uncertainty about the extent of degradation would have minimal consequences. But without a solid extent of condition assessment and/or a FMEA, there are legitimate questions about safety levels at Seabrook today and, even if safety margins are degraded yet still acceptable, whether Seabrook will be sufficiently safe in the future.

Initially, NextEra stated that ASR was not occurring in Seabrook's concrete containment structures, but recently in a response to a Request for Additional Information (RAI) NextEra has stated it has identified areas that were exposed to six feet of groundwater that may be indicative of ASR. The ASR concrete degradation is described as extensive and with moderate-to-severe mechanical consequence within the power block buildings, yet to-date NextEra has not performed any ASTM tests to evaluate the expansive potential of the aggregate. Nor has NextEra

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systematically determined the extent to which ASR is presently affecting the properties of the concrete. Additionally, NextEra has not carried out a systematic evaluation to identify whether corrosion of embedded steel is accompanying the ASR concrete degradation

ASR concrete degradation at the Seabrook nuclear power plant was not discovered until 2009 at which point it was regarded as extensive and moderate-to-severe within most of Seabrook's safety related seismic Category 1 buildings and structures. To-date Seabrook's containment building has not been tested for ASR concrete degradation.

The NRC is obligated to determine the structural integrity of Seabrook's containment building as a priority according to NRC Regulatory Guide 1.216 and NRC NUREG-1800 Section: 3.5.2.2.1.4.

Two years into the Seabrook relicensing process, NextEra's extent of condition of ASR has still not included an investigation of Seabrook's containment building. Yet determining the extent of ASR concrete degradation on the structural capacity and the extent of an elevated risk to the reinforced concrete structures in Seabrook's containment building if a seismic event were to occur would seem to be a priority for relicensing since Seabrook was licensed under a non-ASR design basis.

UCS and the C-10 Foundation believe it is imperative for the NRC to determine the extent of ASR and corrosion degradation as soon as possible. To the extent that the affected structures are more accessible during the upcoming September 23rd refueling outage, this outage provides the opportunity for a baseline assessment of the degradation of Seabrook's containment structures.

Background

As you are aware, the NRC discovery and extent of Seabrook's ASR concrete degradation in multiple safety related buildings has resulted in an NRC stay of the safety portion of Seabrook's relicensing process secondary to this "unresolved safety item". The occurrence of ASR induced concrete degradation requires an extent of condition investigation under Seabrook's current license and under NRC NUREG-1800 Section: 3.5.2.2.1.4. as ASR concrete degradation is evidenced both below and above grade in multiple safety related buildings. Containment is the most critical building to test and systematically establish the extent of degradation accurately as it serves to shield and protect the public from radiation exposure.

According to Paul Brown, an expert retained by Union of Concerned Scientists, it is critical to establish the extent to which ASR has affected the mechanical properties of the concrete. Because of a brackish water exposure coupled with the lack of detection of this water ingress for approximately 20 years, the chloride-induced corrosion of embedded steel cannot be excluded. Such corrosion it is far more likely if ASR induced cracking is occurring. Thus, a systematic conditional assessment to establish the locations where these degradation mechanisms are active should be carried out. In addition, a systematic sampling and testing should be carried out to determine the extent to which ASR has reduced the mechanical properties of the concrete or the extent to which corrosion has reduced the tensile capacity of the embedded steel.

Professor Brown has stated that although NextEra's plan to utilize some non-standard tests may have merit, they are incomplete. In his opinion, NextEra must also systematically evaluate the concrete via petrography and physical testing of cores, and evaluate the expansive capacity of ASR based on ASTM standard tests as promulgated by ASTM Committee C-9 on Concrete and Aggregates.

According to Brown, the interior space of containment should be surveyed and photo documented, and the chemistry of the water entering this space should be tested to establish its alkali and chloride contents. In addition, the locations where standard ASME testing ultrasonic measurements were done should be mapped with respect to those locations where water invaded the dead space between the containment structures. This would assure that testing had been done at locations where the liner would be vulnerable to corrosion because it was in contact with up to 6 feet of groundwater since construction.

According to Brown, degradation due to ASR is not linear phenomenon, as there is some period during which the occurrence of ASR does not cause cracking and actually results in higher strength when compared to a control sample not experiencing ASR. But as the available local pore volumes become filled, cracking initiates. Crack formation and growth are not linear with time. In concrete restrained by reinforcement, mechanical testing of extracted concrete cores to establish compressive strengths and Young's moduli are appropriate.

To-date, Seabrook's containment has not been tested systematically or by using current ASTM standard tests for ASR or any possible accompanying steel corrosion. Doing so is essential to permit evaluation of the concerns enumerated in NRC documents related to the following adverse findings in containment:

1.) NRC construction records reveal that cracks in containment through which water was leaking had been detected and repaired, but remained an NRC open unresolved item number 50-443/84-12-01. No root cause was required by the NRC. The NRC stated "future changes in groundwater chemistry and its effects on the concrete walls and on the concrete wall's reinforcing steel bars was considered an NRC open unresolved item number 50-443/84-12-01".

2.) Seabrook has documented water chemistry characterized as aggressive for years. ASR concrete degradation has been documented both below and above grade in multiple buildings and structures.

3.) Seabrook's containment building has historically had an accumulation of up to 6 feet of water in containment around the annulus since construction in the 1980's. Whether water migrated through the concrete to the backside of the steel plate and caused corrosion remains unknown. No testing of containment has been done to rule out ASR concrete degradation or any accompanying steel corrosion. Seabrook's containment building is an NRC open item-ASME Code Section XI, Subsection IWE Program 013.0.31.0-1. The NRC has not requested a root cause investigation to determine how or from where the water infiltration of the containment building is occurring.

4.) In October 2005, during an NRC audit of the certification of visual inspection results (VT-3C) for Seabrook's concrete containment identified numerous areas of spalled concrete that was equal to or exceeded a 1-inch depth. According to evaluation criteria in ACI349.3R, Sec.5.1, spalled areas that exceed a depth of 3/8-inch and 4-inch in dimension must be evaluated. Seabrook evaluated the containment concrete in September 2010 under ACI 349.3R and reported 84 deficient areas in the containment structure.

5.) In 2009, during the NRC-required IWE inspection at Seabrook, the containment liner plate had indications of heavy corrosion. NRC staff stated the augmented examination of the containment liner plate, and specifically from the affected area and tube fuel transfer tube area, was required to verify that the effects of aging could be managed to 2050.

NextEra has determined that there are cracks in containment in the area where the walls were submerged in water, but has not ruled in or out ASR through standard testing. NextEra has chosen non-standard tests to determine the presence of ASR, to be carried out at the University of Texas, instead of using the ASME standards. Paul Brown agrees with the NRC staff that visual examination of concrete cannot rule out ASR degradation.

For these reasons C-10 Foundation and UCS request that NextEra begin a systematic conditional assessment and systematic testing during Seabrook's refueling this September 23, 2012 in order to provide base-line analyses and results, which are needed to predict the consequences of future degradation due to ASR or corrosion of embedded reinforcement.

We look forward to your prompt response to our request.

Sincerely Yours,

Sandra Gavutis

David C. Wright

Sandra Gavutis
Executive Director
C-10 Research and Education Foundation
44 Merrimac St.
Newburyport, Ma. 01950

Dr. David Wright, Co-Director
Global Security Program
Union of Concerned Scientists
Two Brattle Square, Suite 600
Cambridge, MA 02138

CC.

- Senator Jeanne Shaheen
- Senator Kelly Ayotte
- Senator John Kerry
- Senator Scott Brown
- Governor Deval Patrick
- Governor John Lynch
- Representative Edward Markey
- Representative John F. Tierney
- Representative Frank Guinta
- William Raymond, NRC Chief Resident Inspector, Seabrook Station
- Richard Conte, NRC Branch Chief, Division of Reactor Safety
- John Lamb, NRC Project Manager, Seabrook Station

Union of Concerned Scientists
Citizens and Scientists for Environmental Solutions

C-10 Research & Education Foundation · Safe Sustainable Energy

CONCRETE DEGRADATION AT THE SEABROOK NUCLEAR POWER PLANT

In 2010, NextEra Energy applied to the Nuclear Regulatory Commission (NRC) for a 20-year renewal of the operating license for the Seabrook nuclear power station in New Hampshire. Its current license was issued in 1990 and does not expire until 2030, but the license renewal being done now would extend operation until 2050. Analysis of the plant must therefore identify and understand aging issues well enough to predict its behavior for the next 40 years.

This demanding task was made more difficult by the recent discovery of the degradation of concrete in several of the reactor's safety related structures. The concrete degradation may also imply that corrosion of steel reinforcements hidden within the thick concrete walls has been occurring for years. Without understanding the scope and especially the cause of these processes, no credible basis exists for assessing the current structural status of the plant, or predicting what it will be in the future.

The NRC inspectors found that groundwater infiltration at the plant had caused widespread cracking of the concrete, due to a process called alkali-silica reaction (ASR) that had been going on for years. These findings were consistent with those of earlier inspections by NextEra personnel.[i] The NextEra inspections found groundwater infiltration at the plant, including pooling of water; evidence of moisture permeating the concrete walls; cracking and spalling (flaking of the surface) of concrete; and corroded steel supports, piping, base plates, and anchor bolts.

Alkali-silica reaction (ASR)

Alkali-silica reaction can occur when certain forms of silica in the bulk material in concrete (such as crushed rock and sand) react in the presence of water with chemicals like sodium or potassium, which are commonly found in the cement paste. This reaction produces a gel that forms in the pores of the concrete and then expands, causing stress and cracking in the concrete. As this process continues over time, those cracks can join together to form larger fissures in the cement and undermine the structural integrity of the concrete. ASR damage in concrete has been known for 70 years.

Current studies do not appear to have determined the origin of the ASR occurring at Seabrook. ASR could result from a combination of two factors, both of which involve exposure to moisture:

1. ASR may be intrinsic to the concrete if the materials in the original concrete mixture have a composition that allows them to react with each other when exposed to moisture from the environment;

2. Chemicals in the environment can change the chemistry in the concrete pores, resulting in ASR; these changes may be caused by exposure to water with a high salt content.

It is important for the NRC to understand the origin of the ASR. If it is due to the composition of the concrete mixture used in building the plant then it could be a widespread problem throughout the plant structure.

It is also important to recognize that the fine pore structure of concrete will draw water from any soil it is in contact with even if the soil is not saturated with water. This fact must be taken into account in designing mitigation measures.

In addition to causing degradation of the concrete itself, ASR can be associated with corrosion of steel reinforcement bars and other steel structures embedded in the concrete. If the water in the concrete causing the ASR contains chloride or sulfate, both of which have been detected in the groundwater around Seabrook, those chemicals can remove the usual protection the concrete environment provides embedded steel and render the steel susceptible to corrosion. Both ASR and corrosion of embedded steel can decrease the durability and strength of reinforced concrete.

Surface cracking of the concrete is just the external manifestation of ASR. By the time it is observed, ASR and possibly steel corrosion have typically been occurring for years within the concrete. Still unknown is whether ASR is occurring elsewhere in the plant but has not yet become apparent at the surface of those structures.

As a result, one cannot make assumptions about the structural state of the concrete, or the effect of aging over the next 40 years, without thorough assessment and testing to determine the extent of ASR throughout the plant and throughout the bulk of the concrete walls and floors, and the level of corrosion of steel reinforcement throughout the plant.

Unanswered Questions

Independent expert analysis, conducted by Paul Brown, Professor of Ceramic Science and Engineering at Penn State University, of the existing reports on concrete degradation at Seabrook identified the following key questions that require additional information or further study:

1. Is ASR inherent to the concrete used at Seabrook and induced merely by exposure to water regardless of its source, or is ASR induced by chemicals in the ground water? If it is inherent, how widespread is this problem throughout the concrete in the plant?

2. What, quantitatively, is the extent to which ASR is occurring, both with respect to locations throughout the plant and with respect to the position within the thickness of the concrete walls themselves?

3. What basis is there for predicting whether or not ASR has occurred or will occur at locations not yet identified?

4. Is the ASR accompanied by other deleterious reactions, especially corrosion of embedded steel and sulfate attack, and how severe and widespread are those effects throughout the plant's structure?

5. What basis is there for predicting the rate of corrosion of the steel reinforcement in the concrete that is currently exposed to infiltrating ground water, or that is likely to be exposed in the future? What effect will the corrosion have on the structure at Seabrook?

6. What, quantitatively, is the extent to which ASR has reduced mechanical properties of the concrete compared to control samples of concrete obtained from non-damaged locations? What effect will the damaged areas have on the structure?

7. What basis is there for predicting the future loss in important mechanical properties of concrete, such as compressive and splitting tensile strengths, at locations where ASR has been identified?

8. What basis is there for predicting the plant's ability to maintain structural integrity and safety-related functions in a seismic event given the extent of the ASR damage and steel corrosion in plant structures?

9. What mitigation/remediation strategies are available and what is the basis for establishing the probability of success of those strategies?

Next Steps

The above questions must be answered before the structural state of the Seabrook plant can be determined. Without that information any claims about the structural integrity of the plant are not credible.

Professor Paul Brown, the independent concrete expert who reviewed the reports on Seabrook identified the following information needed to clarify the implications of existing studies, and suggested these additional tests:

1. Documents from the plant state that core samples show ASR from "moderate" to "severe," but do not give the criteria used, or say where the ASR occurred. **Studies must determine if the ASR is localized or occurring uniformly throughout the walls. As part of this, studies should characterize the materials in the concrete that are reacting and determine if they were used throughout the concrete in the plant.**

2. Moisture migrating through the concrete walls can cause deposits of calcium carbonate and ASR gel on the inner surface of the walls. **Studies should be done to determine the composition of these deposits.** The presence of chloride suggests chloride-induced corrosion of steel embedded in the concrete. The presence of sulfates also suggests corrosion of the steel and of surface deterioration of the concrete, which means that applying waterproof layers to the walls may not be possible.

3. **Analyses should determine the extent of chloride penetration in the bulk concrete.** The presence of chloride not only allows steel corrosion, but if it was carried in as sodium chloride can establish the mechanism for ASR and give information about how exposure to water in the environment affects deterioration.

4. **More complete analyses of the ground-water chemistry should be carried out.** To determine the mechanism of ASR, it is important to determine if ASR is limited to regions where the ground water has high sodium content.

5. **Greater detail is needed about the 87 locations noted in the existing reports where spalling of the walls is significant; information about environmental conditions these areas are exposed to is especially important.** This information should include whether floors as well as walls are deteriorating. If the floors do not show degradation, tests should be conducted to understand why not.

6. Because concrete can extract moisture even from soil that is not saturated, dewatering the soil with sumps and drains may not be an effective method of reducing moisture in concrete. **The dewatering plan at Seabrook must be explained more fully to understand its purpose and possible effects.**

7. While tests have been conducted on compressive and splitting tensile strengths of concrete structures at Seabrook, **more detail is needed about the various testing procedures to understand the results and implications of those tests. For example, while existing reports claim that the modulus of elasticity in concrete at Seabrook decreased by 47%, more information is required to understand this result and its implications.**

8. **Tests should be conducted to compare compressive and splitting tensile strength of sample concrete cores to cores taken from areas where ASR is not occurring, not to "companion cylinders" that were made at the time of construction from the same concrete.**

April, 2012

[i] *NextEra Energy Seabrook- NRC License Renewal Inspection Report 05000443/2011007.* United States Nuclear Regulatory Commission. May 23, 2011. http://pbadupws.nrc.gov/docs/ML1113/ML111360432.pdf (pg 17)

Chaudhary, Suresh

From: Raymond, William
Sent: Friday, September 14, 2012 8:33 AM
To: Clifford, James; Conte, Richard; Miller, Chris; Wilson, Peter
Cc: Chaudhary, Suresh; Trapp, James; Cook, William; Burritt, Arthur; Cline, Leonard; Roberts, Darrell
Subject: Re: Seabrook's ASR open and unresolved safety item

I agree, Jim. We should get it into a process.
Bill

Sent via NRC BlackBerry

From: Clifford, James
To: Conte, Richard; Miller, Chris; Wilson, Peter
Cc: Chaudhary, Suresh; Raymond, William; Trapp, James; Cook, William; Burritt, Arthur; Cline, Leonard; Roberts, Darrell
Sent: Fri Sep 14 08:30:47 2012
Subject: RE: Seabrook's ASR open and unresolved safety item

This reads a lot like a 2.206 petition. I would suggest we get in touch with NRR/DPR and discuss with them.

Jim Clifford
Deputy Director
Division of Reactor Projects
Region I

From: Conte, Richard
Sent: Thursday, September 13, 2012 12:05 PM
To: Miller, Chris; Cook, William; Wilson, Peter; Clifford, James; Burritt, Arthur; Cline, Leonard
Cc: Chaudhary, Suresh; Raymond, William; Trapp, James
Subject: FW: Seabrook's ASR open and unresolved safety item

Will review for immediate safety impact.

From: Debbie Grinnell [mailto:debbie@c-10.org]
Sent: Thursday, September 13, 2012 11:34 AM
To: Debbie Grinnell; Conte, Richard; Lamb, John; Raymond, William; Dean, Bill
Subject: Re: Seabrook's ASR open and unresolved safety item

pdf letter attached.

Debbie

----- Original Message -----
From: Debbie Grinnell
To: Richard Conte ; Lamb, John ; William.Raymond@nrc.gov ; William Dean
Sent: Thursday, September 13, 2012 11:20 AM
Subject: Seabrook's ASR open and unresolved safety item

To: Bill Dean, Bill Raymond, Richard Conte, John Lamb

Please find attached our letter of request and our reports pertaining to Seabrook's ASR concrete degradation.

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We have still not received NRC answers to our questions submitted in person on April 23rd, 2012. We have asked repeatedly for over a year for an answer to this question. Will the NRC require NextEra to do systematic and standard testing for ASR in containment as a priority given the extensive discovery and the moderate-severe condition secondary to ASR within seismic category 1 safety related power block buildings? We have not received a reply.

We look forward to your reply as soon as possible.

Debbie

Debbie Grinnell
Research Manager
C-10 Foundation
44 Merrimac St,
Newburyport,Ma. 01950
tel.978.465.6646

Heater, Keith

From: Floyd, Niklas
Sent: Tuesday, September 17, 2013 1:17 AM
To: Heater, Keith
Subject: FOIA: Latest Questions from Feb. 27, 2013 RE: Seabrook

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From: Conte, Richard
Sent: Friday, March 15, 2013 12:56 PM
To: Debbie Grinnell
Cc: Trapp, James; Floyd, Niklas; Raymond, William; Buford, Angela; Cook, William
Subject: Latest Questions from Feb. 27, 2013 RE: Seabrook

Ms. Grinnell – I am responding to your email dated February 27, 2013, asking questions regarding Seabrook's Alkali-Silica Reaction (ASR) concrete issues. I trust the information provided below will help to answer your questions.

You asked what governing regulations and means that NRC reviewers would use to determine if NextEra has satisfied the regulations. Specifically, what specific regulatory requirements and NRC procedures will be used to determine whether the efforts undertaken by NextEra are acceptable?

While the ASR issue at Seabrook is a first-of-a-kind issue for the United States nuclear industry, the processes that the NRC has and will use to assess the resolution of the issue are existing processes that have been historically applied with effectiveness to evaluate changes to nuclear power plant licensing bases. NextEra used conservative ASR impact of performance assumptions and performed operability determinations on the ASR-affect structures; and, therefore, the NRC staff has determined that the ASR-affected buildings are operable as communicated in the December 2012 public meeting. NextEra has turned to its attention to monitoring the slow progress of ASR until the testing associated with the research and development effort is complete. NRC staff will ensure this monitoring is effective until the testing effort is complete.

In a parallel effort, NextEra has initiated a research and large-scale testing program in conjunction with the University of Texas Ferguson Structural Engineering Laboratory (FSEL) to develop the technical basis to confirm near-term effects and address long-term effects on structural performance and long-term management of the ASR issue for the affected existing safety-related structures. The testing is also intended to provide additional assurance for the operability determination when it is finalized with respect to the current licensing and design bases. NextEra will need to determine how those test results relate to the current licensing and design basis in accordance with 10 CFR 50.59. For example, if they are relying on a different methodology from the original licensing basis, then 10 CFR 50.59 requires that the change be subject to NRC staff review.

Further the results of this testing may point to substantially new information from what is known today. Should conditions warrant NRC staff review in accordance with 10 CFR 50.59 and 50.90 for a license amendment, then the NRC staff would review the change in accordance with 10 CFR, 50.90 and NUREG-0800 "Standard Review Plan (SRP)" (for example, Section 3.8.4 applies to review of affected "Other Category 1 Structures") and the corresponding Updated Final Safety Analysis Report (UFSAR) sections (3.8.1 and 3.8.4 and 3.8.5) that define the current licensing basis. NextEra's UFSAR provides information on the original plant licensing review based, in part, on ACI 318-71and others codes and standards. It must be noted that the SRP provides one approach acceptable to the NRC staff to meet the applicable regulatory requirements. However, licensees may adopt other appropriate technical approaches for the specific issue(s) being addressed in order to meet the applicable regulations in 10 CFR 50 Appendix A, General Design Criteria (e.g. for Other Category 1 Structures, GDC 1, 2, and 4 as applicable) and demonstrate that the intended functions would be accomplished, which are reviewed on a case-by-case basis.

It is expected that the information used by NextEra will be based on those measures from applicable quality assurance requirements in 10 CFR 50 Appendix B and, specifically, Criterion XI "Test Control." The licensee's processes and procedures to arrive at the final corrective action to address the ASR issue would also be evaluated against the

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applicable quality assurance requirements in 10 CFR 50 Appendix B in general, and specifically Criterion XVI "Corrective Action." On a sampling basis, NRC staff inspections have confirmed the use of such measures.

You also questioned whether there would be an advantage to conducting ASR-related concrete testing on Unit 2 structures and whether or not the NRC staff has evaluated using the concrete at Unit 2 for the research and development effort.

While conducting material testing of Unit 2 concrete is a possibility and may be informative, it was not proposed by NextEra as reflected in Confirmatory Action Letters responses. NextEra abandoned the plan to take Unit 2 concrete core samples due to adverse environmental and occupational safety and hazardous conditions. In light of this recent question, NRC staff review has determined that the use of Unit 2 concrete appears to have limited technical value as conditions in Unit 2 have not been the same as those in Unit 1 as reflected in the long term abandonment of Unit 2.

Further, the FSEL test program will fabricate and test blocks and beams at varying degrees of ASR degradation, some of which exceed those currently experienced at Seabrook. The blocks and beams will be tested to failure (anchor breakout, flexure, shear, lap splice (bond), etc.), and the results of these tests will be used to establish the effects on structural performance of ASR-affected concrete. There will also be a comparison of ASR-affected beam test results with those for control beams unaffected by ASR. Therefore, the NRC staff has determined that it would appear to be impractical to do this type of testing with sawed out large-scale specimens from existing below grade Unit 2 concrete structures.

Overall, the NRC staff will independently review the testing approach and results being taken by the licensee for the research and development effort.

From: Debbie Grinnell [mailto:debbie@c-10.org]
Sent: Tuesday, March 12, 2013 12:58 PM
To: Conte, Richard
Subject: Fw: Seabrook

FYI
----- Original Message -----
From: Debbie Grinnell
To: Richard Conte
Sent: Wednesday, February 27, 2013 3:24 PM
Subject: Seabrook

Dear Richard,
If I understand this correctly, Sections 3.8.1 on concrete containment and 3.8.5 on foundations describe the governing regulations and means that NRC reviewers should pursue to determine if licensees have satisfied the regulations.
What specific regulatory requirements and NRC procedures will be used to determine whether the efforts undertaken by NextEra are acceptable?
We are aware in phone conversations with you, that the NRC has asked NextEra why they choose not to use Unit 2 for their replica project. Unit 2 is logical as it is unused, of the same concrete composite and subjected to the same water infiltration to subsurface foundations that lie side-by side and in close proximity to Unit 1. NextEra's response was "secondary to industrial safety hazard concerns". What does that mean? Unit 2 containment was capped and has been aggressively dewatered as long as Unit 1. The dewatering hasn't worked and doesn't work It does however dilute.
What has the NRC requested to clarify the basis of NextEra's rational to not use Unit 2? What investigation of the Unit 2 structures have been made for concrete degradation and ASR specifically?
We know Unit 2 has been dewatered for as long as Unit 1 and exposed to subsurface water although not to the boric acid, heat, humidity and radionuclides from the spent fuel pool that Unit 1 has been subjected to. Operators reported to the ACRS that the containment annulus was in six feet of water since construction.
How are you going to evaluate this Texas examination and the results? What objective criteria are you going to use?
Thank you.
Debbie

Debbie Grinnell
C-10 Foundation
44 Merrimac Street
Newburyport,Ma.
978-465-6646

Heater, Keith

From: Floyd, Niklas
Sent: Tuesday, September 17, 2013 1:38 AM
To: Heater, Keith
Subject: FOIA: Seabrook ASR Conference Call
Attachments: Seabrook notes from july 11 calll.docx

From: Trapp, James
Sent: Tuesday, July 23, 2013 6:48 AM
To: Cook, William; Raymond, William; Floyd, Niklas; Buford, Angela
Subject: FW: Seabrook ASR Conference Call

FYI

From: Deborah Grinnell [mailto:grinnelldebbie2@gmail.com]
Sent: Monday, July 22, 2013 3:34 PM
To: Trapp, James; Paul Brown; Sean Meyer
Subject: Re: Seabrook ASR Conference Call

Hello James,

Thank you for arranging a conference call concerning your SAITT investigation of Seabrook's ASR with our expert, Paul Brown. We are certainly encouraged that you intend to maintain an open dialog with Paul Brown. Please find attached Paul's commentary on our conference call. We will all be very keen to know what your response to his comments will be and looking forward to the discussions that follow.

My Best,

Debbie
>
> I would like to maintain and open dialog with Dr. Brown as the
> onsite data and testing program results come in, if he is willing.
> I found his input to us was very useful.
>
> I am on vacation this week, but will be in the office all next week
> if you would like to talk.
>
> Thanks.
>
>
> -----Original Message-----
> From: Deborah Grinnell [mailto:grinnelldebbie2@gmail.com]
> Sent: Tuesday, July 16, 2013 11:52 AM
> To: Trapp, James
> Subject: Seabrook ASR Conference Call
>
> Hello James,
>
> We were all encouraged to have you and Bill provide our expert, Paul
> Brown, responses to his concerns and questions concerning Seabrook's
> extensive ASR degradation. We all appreciate that you read and

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> utilized Paul's input in your SAITT Seabrook inspection. There is
> still so much information not shared with us. We have discussed the
> call and next steps. and will respond soon. We do have one question
> before we respond. You mentioned the need for NextEra to file for a
> license amendment. Did you state that it would occur in 2016 after the
> "Replica Project" study is completed and the data results released.
> Do you suspect it will be the last and then only open CAL item to
> be resolved?
>
> Does NextEra need to complete all CAL items before they file for a
> license amendment or just complete and submit data results from the "
> Replica Project"?
>
> They have been out of design basis since the ASR discovery. I am
> not clear about when they MUST submit a license amendment. What
> does the NRC process entail?
>
> What do you view as next steps with our expert?
>
> Thanks so much.
>
>
> Debbie
>
>

Notes and Conclusions

Based on a conference call with NRC personnel on July 11, 2013

The NRC is satisfied with the analyses on replica concrete being carried out at the University of Texas. Limitations are that the aggregate originally used are not longer accessible from the quarry. Consequently, aggregate from another source have been mined from a quarry in Maine and transported to Texas. NRC personnel are not aware whether an aggregate petrographer was used to compare the aggregates from the two sources. The method of aggregate grading and sizing were not discussed. The strength characteristics of the model concrete and the original concrete were not discussed. The curing conditions of the model concrete vs. that of the original concrete were not discussed. These limitations are a consequence of the limited available public access to the experimental modes and methods. Although the experiments being carried out appear to have been well considered, it is not possible to provide an in depth assessment.

It is also commonly accepted that such accelerated testing often does not have an adequate predictive capability. Because the testing details and ongoing test results are not available for public review, it is not presently possible to provide comments in sufficient detail that might be of benefit in resolving concerns or identifying limitations that could be addressed while testing is still ongoing. It was anticipated that these results would be provided as a part of a relicensing package that was anticipated to be submitted in 2016 and would be available for public review and commentary at that time. However, it is not uncommon for such disclosures to only provide the results without the adequate background information to permit an assessment of their relevance. I encourage an ongoing discussion regarding this issue to ensure sufficient background and context is provided to permit these (future) results to be interpreted.

In the event that it cannot adequately and objectively be determined that the tests carried out on this replica concrete have meaningful predictive capabilities, the option of carrying out tests on the companion unused reactor system at the Seabrook site should be seriously considered. It could be reasonably argued that testing involving the in-place concrete of the abandoned Seabrook facility should have been carried out in preference to replica testing in the first place.

There are differing points of view with respect to the chemistry of the water intruding the Seabrook concrete. An early report indicated it to be water that contained approximately 3000 ppm of Na and Cl. However, the NRC personnel suggested this was not the case and that this elevated sodium chloride concentration was based on analyses of water from wells remote from the Seabrook concrete. It was further stated that the analyses were detecting the presence of deicing salts that had been applied to the local roads. However, deicing salt is commonly calcium chloride, not sodium chloride.

Consequently, this is an unresolved issue. The NRC has encouraged Seabrook personnel to collect and carry out chemical analyses of water that has leached through the concrete. NRC personnel recognize that the chemistry of the water can be substantially changed as it passes through concrete. In particular, chloride is removed. Because of this, even low levels of chloride in the water being collected would be a basis for concern. It should be noted that even chloride levels of 100 ppm or less can intrude 3000 psi (design strength) concrete and facilitate corrosion of embedded steel.

The NRC has not encouraged the Seabrook personnel to extract cores. I believe this is an unfortunate decision. Core extraction is inexpensive. Core extract provides a means to establish both compressive and tensile properties. The results of core testing are generally understood within the relevant engineering community. Cores provide samples for petrographic analyses. Because strength changes induced by ASR with time are not linear with time, a well designed campaign of core testing could provide far more meaningful results regarding the progression of ASR, and at a much lower cost, than would replica testing. Coring is not particularly destructive and would not meaningfully reduce the structural capacity of the reinforced concrete at the testing locations.

Testing of in-place concrete is particularly relevant with respect to assessing the adequacy of the anchorage systems in place in the operating utility buildings. In this regard, it is also of concern that testing of anchors in place within the actual Seabrook utility buildings is not being carried out and has not been mandated by the NRC.

Core testing is also highly relevant to assessing the capacity of the lap splices. In a lap spice the reinforcing steel bars are not mechanically attached to each other. Rather, by design, they are placed length-wise adjacent to one another in the anticipation that the surrounding concrete has the capacity to transfer stresses between the bars. Even though, according to the NRC personnel, the overlap is 6 feet, at least in some locations, the local occurrence of ASR will significantly degrade this capacity. IN the absence of evaluating the strength properties of the in-place concrete the extent of this degradation will remain speculative.

It was recognized by all call participants that the NRC and the operator of Seabrook are still engaged in problem definition. No meaningful analyses to establish the kinetics of the degradation of concrete properties or to establish a quantitative repair have yet been carried out and these issues were not meaningfully discussed.

Paul W. Brown, Ph.D. July 14, 2013

Heater, Keith

From: Floyd, Niklas
Sent: Tuesday, September 17, 2013 1:31 AM
To: Heater, Keith
Subject: FOIA: Dispatch of Final Document: Position Paper - "Assessment of ACI 318-71 as Design Basis for Category 1 Concrete Structures Affected by ALKALI-SILICA Reaction at Seabrook Station"

From: Green, Rodneshia
Sent: Thursday, June 13, 2013 11:50 AM
To: Khanna, Meena; Ott, William; Kobetz, Timothy; Hogan, Rosemary; McMurtray, Anthony; Schroeder, Daniel; Dentel, Glenn; Cook, William; Raymond, William; Chaudhary, Suresh; Floyd, Niklas; Lamb, John; Plasse, Richard; Sheikh, Abdul; Buford, Angela; Philip, Jacob; Graves, Herman; Fuhrmann, Mark
Cc: Marshall, Michael; Erickson, Alice
Subject: Dispatch of Final Document: Position Paper - "Assessment of ACI 318-71 as Design Basis for Category 1 Concrete Structures Affected by ALKALI-SILICA Reaction at Seabrook Station"

View ADAMS P8 Properties ML13128A521
Open ADAMS P8 Document (Memo re: Position Paper -"Assessment of ACI 318-71 as Design Basis for Category I Concrete Structures Affected by Alkali silica Reaction at Seabrook Station.")

Date: June 10, 2013

Memorandum to: James M. Trapp, Chief, Seabrook Alkali-Silica Reaction Issue Technical Team Chairman

Thru: Michael Marshall, BC/RASB/DLR

From: Alice Erickson, Structural Engineer, RASB, DLR

Subject: Position Paper – "Assessment of ACI 318-71 as Design Basis for Category 1 Concrete Structures Affected by Alkali-Silica Reaction at Seabrook Station"

RODNESHIA Y. GREEN
NRR/DLR ADMINISTRATIVE ASSISTANT
(301) 415-1183
U.S. NUCLEAR REGULATORY COMMISSION
RODNESHIA.GREEN@NRC.GOV

E71

Heater, Keith

From: Floyd, Niklas
Sent: Tuesday, September 17, 2013 12:39 AM
To: Heater, Keith
Subject: FOIA: SAITT

From: Conte, Richard
Sent: Thursday, January 03, 2013 2:08 PM
To: Ali, Syed; Buford, Angela; Cartwright, William; Chaudhary, Suresh; Cline, Leonard; Cook, William; Cruz, Holly; Erickson, Alice; Floyd, Niklas; Fuhrmann, Mark; Graves, Herman; Hogan, Rosemary; Hughey, John; Khanna, Meena; Kobetz, Timothy; Lamb, John; Manoly, Kamal; Marshall, Michael; Merzke, Daniel; Milano, Patrick; Morey, Dennis; Murphy, Martin; Ott, William; Philip, Jacob; Raymond, William; Schroeder, Daniel; Sheikh, Abdul; Sircar, Madhumita; Stuchell, Sheldon; Thomas, George; Trapp, James
Subject: FW: SAITT

Note the request to have documents publicly available similar to Davis Besse project. I knew this day would come; perhaps the best approach is to not challenge the FOIA system and agree to do something.

The position papers that the group is reviewing can easily be classified a pre-decisional now and on a FOIA request.

The working group conference calls, agenda/minutes has some sensitive information that may or may not be predecisiional. For the most part we might be able to release the first page agenda's but not the talking points. Most likely the talking points will be FOIA'd

There are also status call notes with NextEra and Weekly Status reports which can be release since they are factually based – they will need to be reviewed for SUNSI.

If we have any past drafts for the recently issued inspection reports, those can most likely will be released since the decision on the report has already been made.

The are other documents on Region I's LAN that would need to be carefully reviewed as to if they are currently predecisional vs. past predecisional. For Region I folks they are at:

G:\DRS\Seabrook Concrete

I will make this a topic for the working group on Tuesday Jan. 9. Jim please note that a reply is to be coordinated with the front office.

Whatever we will release can be uploaded to the NRC's web page now that we have one dedicated to Seabrook ASR.

From: Dean, Bill
Sent: Thursday, January 03, 2013 1:18 PM
To: Lew, David; Conte, Richard; Miller, Chris; Roberts, Darrell; Clifford, James; Wilson, Peter
Cc: Trapp, James
Subject: FW: SAITT

FYI , request from UCS for access to documents, on behalf of Debbie Grinnell. Would be interested in our reply.

Bill

E12

From: Dave Lochbaum [mailto:DLochbaum@ucsusa.org]
Sent: Thursday, January 03, 2013 12:55 PM
To: Trapp, James
Cc: Leeds, Eric; Dean, Bill; Grinnell, Debbie
Subject: SAITT

Hello Jim:

The SAITT charter (ML12270A060) indicated that you were chairing this team. If that's incorrect or no longer the case, please forward this inqury along to the chair and accept my apology for the inconvenience.

Debbie Grinnell asked me about the documents collected by the SAITT. More specifically, she asked about public access to those documents.

The Functional Responsibilities section on page 2 of the charter indicates that an action item tracking system will be established and maintained and that periodic reports will be made to the Region I Administrator and the NRR Office Director.

A search of ADAMS did not return any such records in the public arena.

UCS could seek these records under with a FOIA request. If so, we'd likely widen the request to all SAITT and ASR-related records just to make sure we didn't miss anything.

Another option, perhaps easier for NRC and us, would be for the agency to place those records in ADAMS that it feels address the issue without revealing pre-decisional, proprietary, etc. information. Following the Davis-Besse reactor vessel head degradation event, the NRC voluntarily placed documents from its Manual Chapter 0350 team (e.g., meeting minutes, action item tracking lists, etc) along with a monthly status report from Region III OPA into ADAMS.

Will the SAITT make publicly available as many records as is appropriate?

Or is our submitting a FOIA the best way for this material to be accessed by the public?

Thanks,
Dave Lochbaum
Director, Nuclear Safety Project
Union of Concerned Scientists
PO Box 15316
Chattanooga, TN 37415
(423) 468-9272 office
(423) 488-8318 cell
dlochbaum@ucsusa.org

From: Floyd, Niklas
Sent: Tuesday, September 17, 2013 1:28 AM
To: Heater, Keith
Subject: FOIA: POSITION PAPER: IN SITU MONITORING OF ALKALI-SILICA

From: Pope, Lisa
Sent: Wednesday, May 08, 2013 7:35 AM
To: Khanna, Meena; Marshall, Michael; Kobetz, Timothy; McMurtray, Anthony; Lamb, John; Plasse, Richard; Sheikh, Abdul; Erickson, Alice; Raymond, William; Hogan, Rosemary; Schroeder, Daniel; Dentel, Glenn; Chaudhary, Suresh; Floyd, Niklas; Philip, Jacob; Graves, Herman; Fuhrmann, Mark; Ott, William
Cc: Buford, Angela
Subject: POSITION PAPER: IN SITU MONITORING OF ALKALI-SILICA

Date: April 30, 2013

Letter To: James M. Trapp, BC, R-I, DRS, EB1

From: Angela R. Buford, PM, RASB, DLR

Subject: POSITION PAPER: IN SITU MONITORING OF ALKALI-SILICA REACTION (ASR) AFFECTED CONCRETE: A STUDY ON CRACK INDEXING AND DAMAGE RATING INDEX TO ASSESS THE SEVERITY OF ASR AND TO MONITOR ASR PROGRESSION

View ADAMS P8 Properties ML13108A047
Open ADAMS P8 Document (POSITION PAPER: IN-SITU MONITORING OF ALKALI-SILICA REACTION (ASR) AFFECTED CONCRETE: A STUDY ON CRACK INDEXING AND DAMAGE RATING INDEX TO ASSESS THE SEVERITY OF ASR AND TO MONITOR ASR PROGRESSION)

Lisa M. Pope
U.S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Division of License Renewal
11555 Rockville Pike, Rockville, MD 20852
Location: O-11A07 / Mail Stop: 11F1
☎ Office: 301-415-8707
✉ E-mail: lisa.pope@nrc.gov

E13

Effect of ASR on nuclear power plants

Paulo J.M. Monteiro
Rossella Pignatelli
Department of Civil and Environmental Engineering

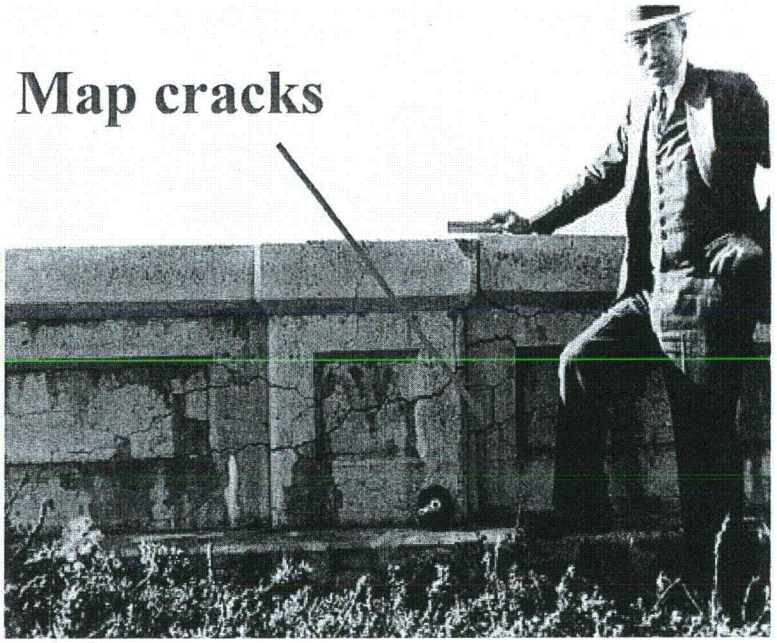
413

Introduction

This deleterious reaction is known for a long time

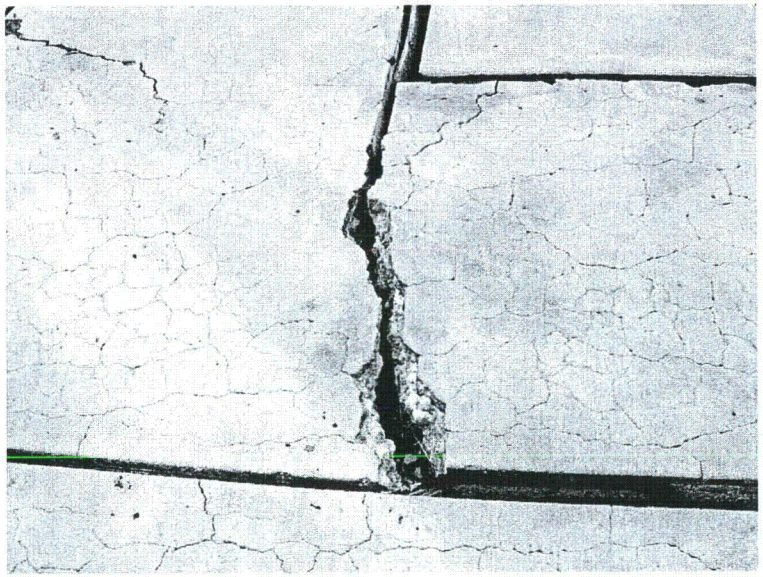
Vertical cracks

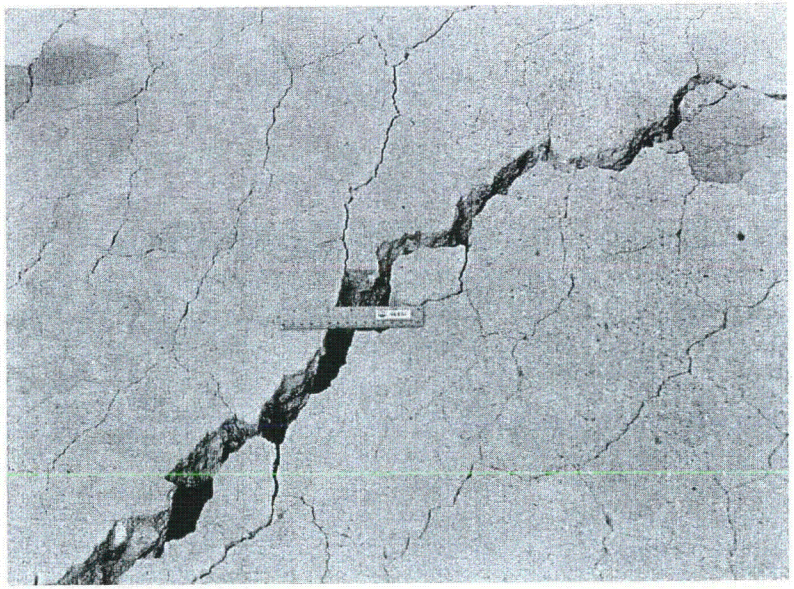
Map cracks



California, 1936

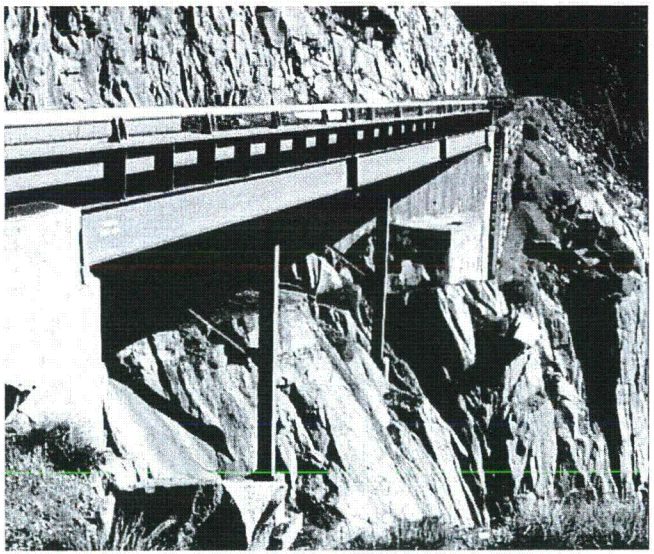
Examples of damage

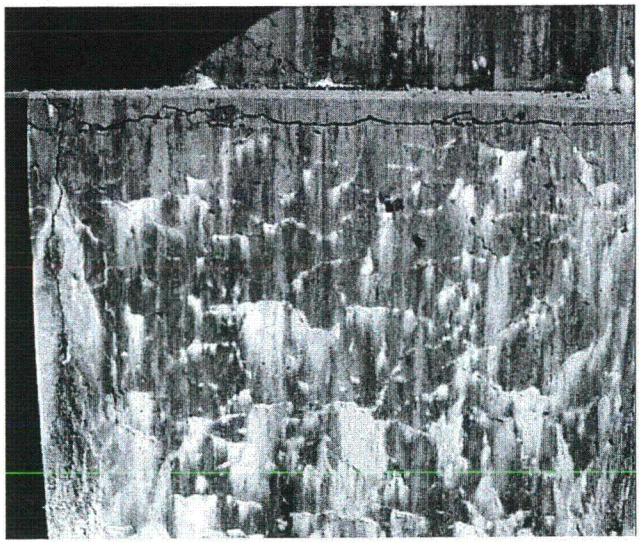




Airfield parking apron at Naval Air Station Point Mugu, California
courtesy of U.S. Navy, NFESC

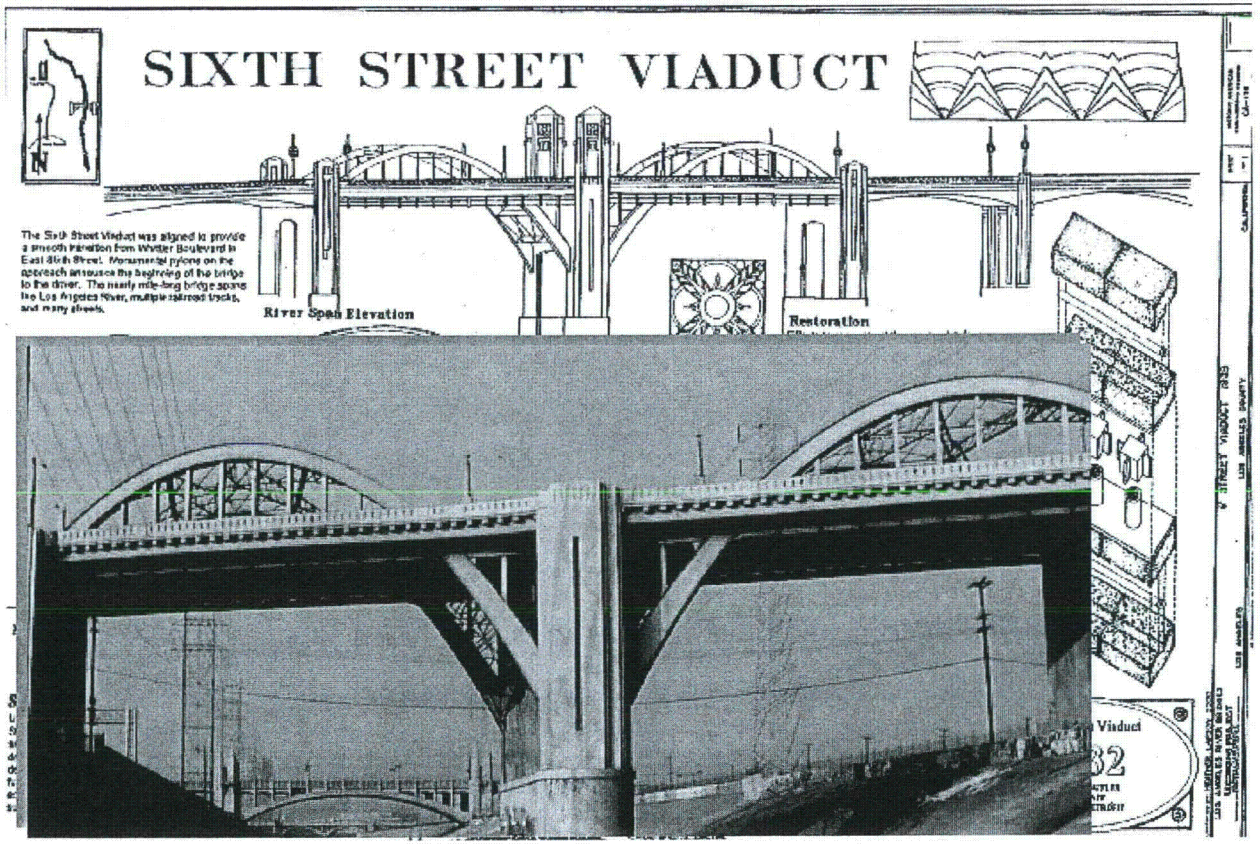
Examples of damage





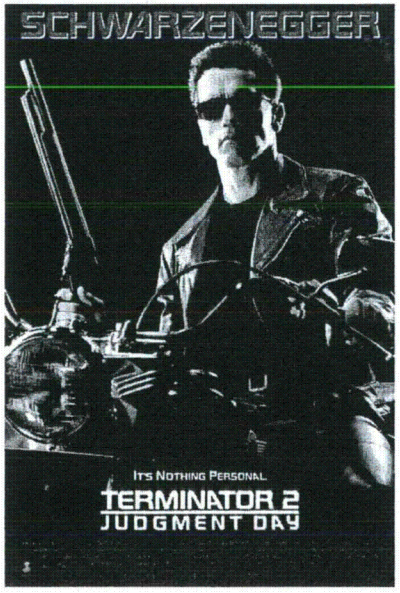
Built in 1965, this deteriorated bridge is located 9.7 miles west of Lee Vining at 9400 feet elevation on the eastern slope of the Sierra Nevada.

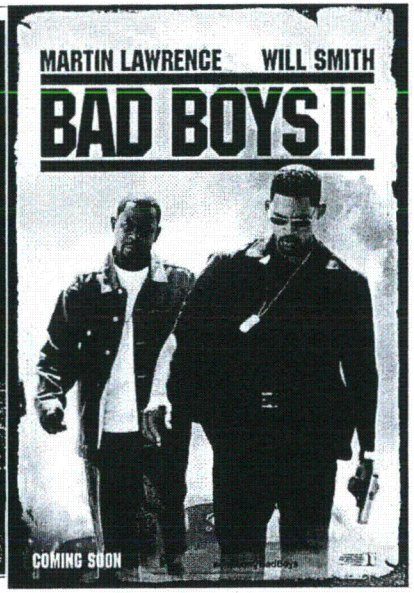
Durability (lack of): Sixth Street Viaduct



Basic Information

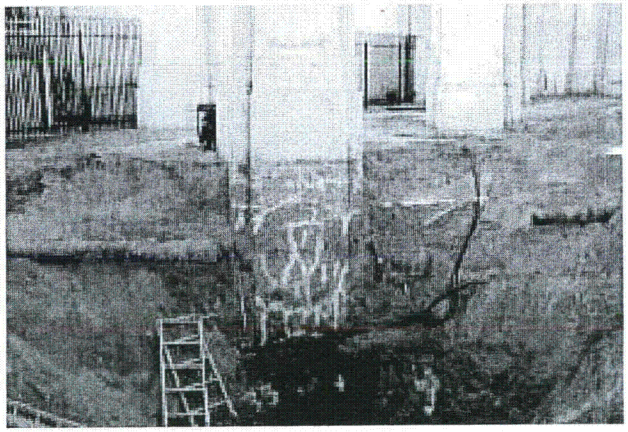
- National Historic Structure
- Daily Traffic: 11,000 Vehicles

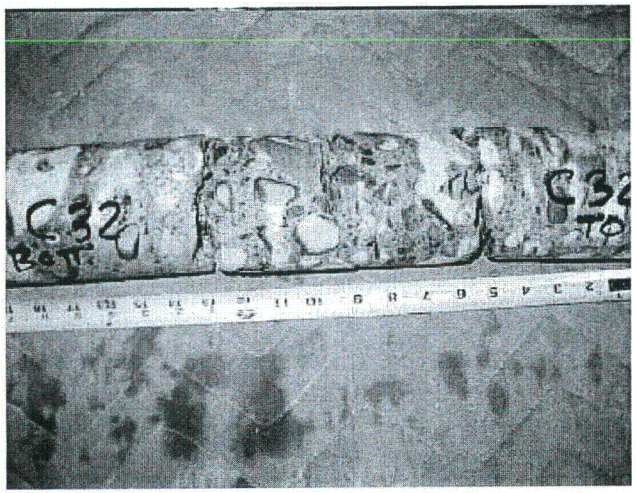




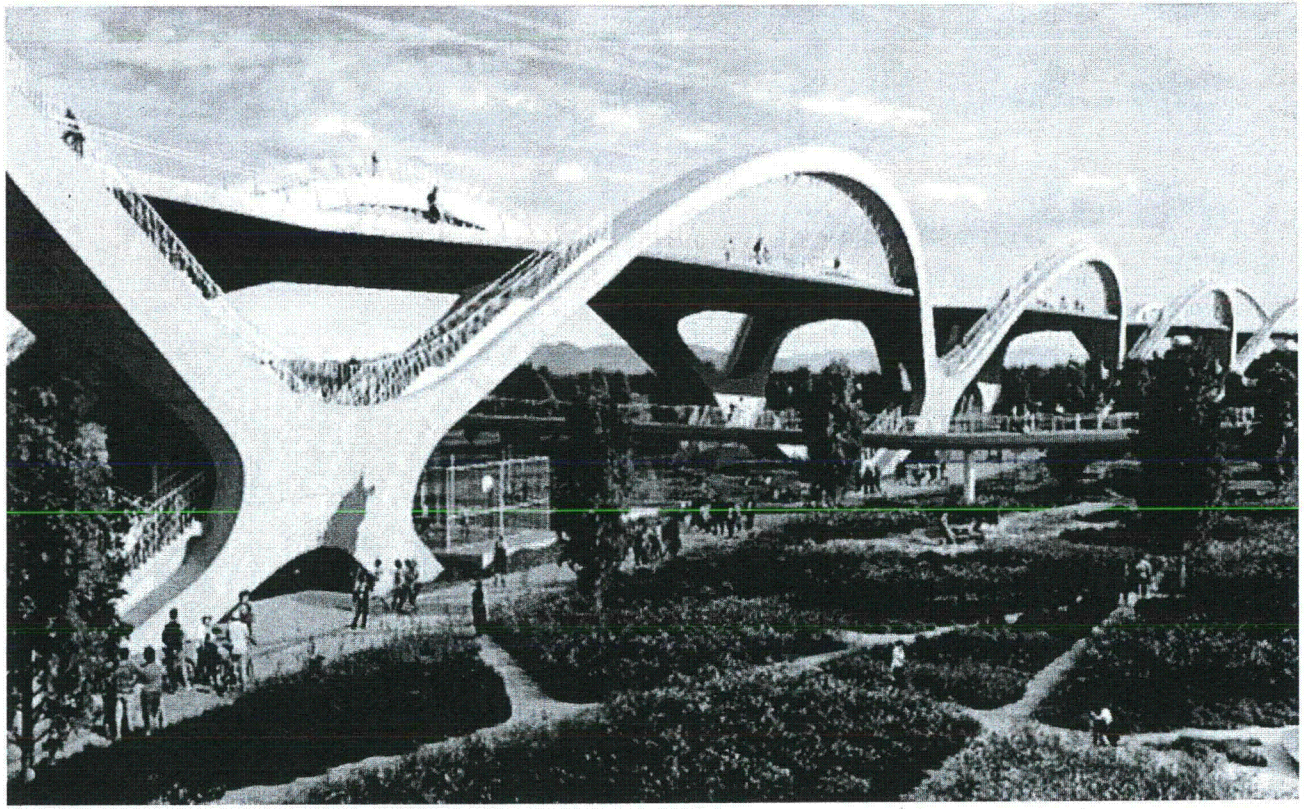
Big Durability Problem

- Every 10 Years –
- City Must Apply Epoxy
- Injection and Patching
- Replacement





Replacement



The chemistry is simple

1) The high pH in the cement paste promotes the hydrolysis of silica:

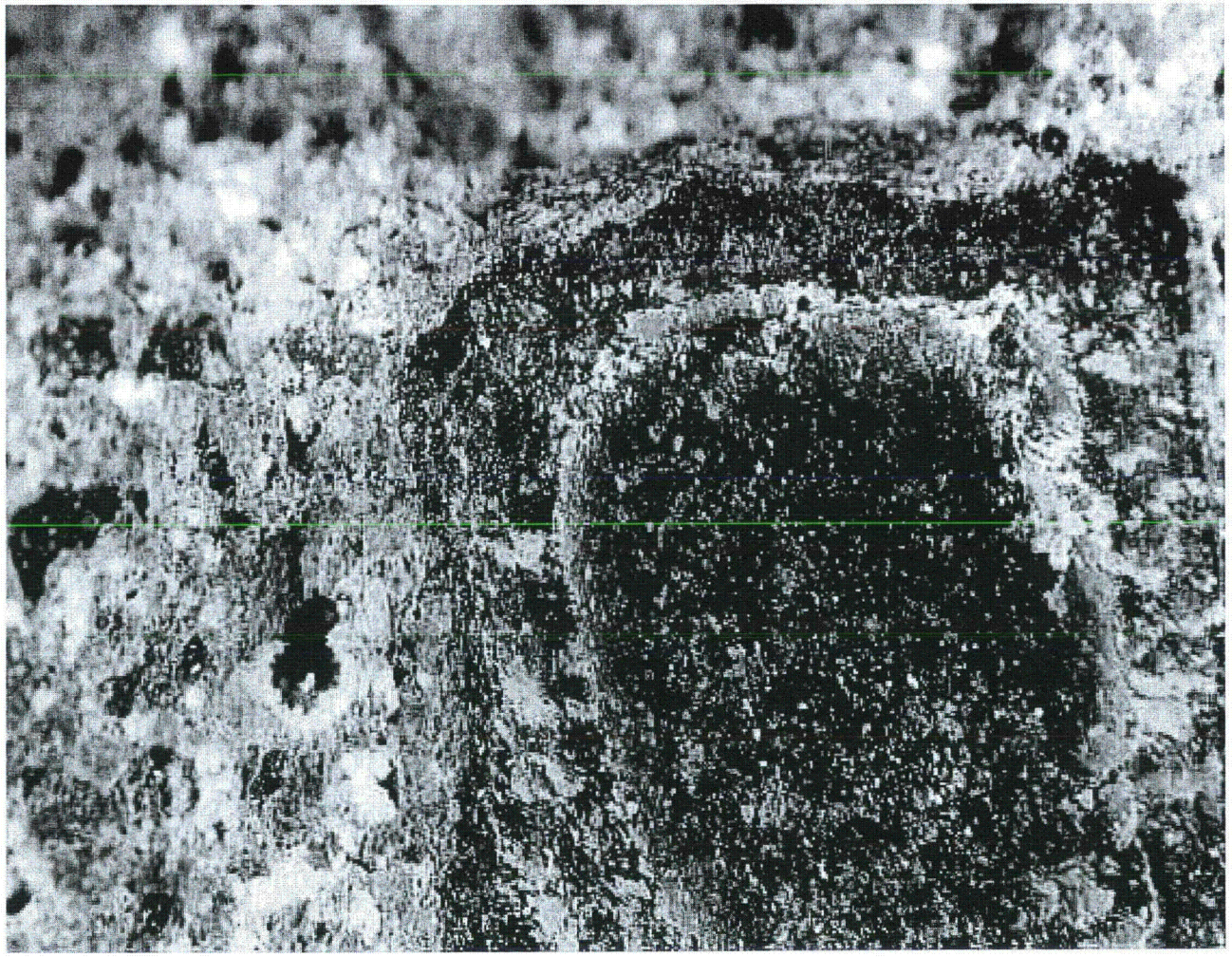
Si-O-Si + H OH → Si-OH + Si-OH

Aggregate paste

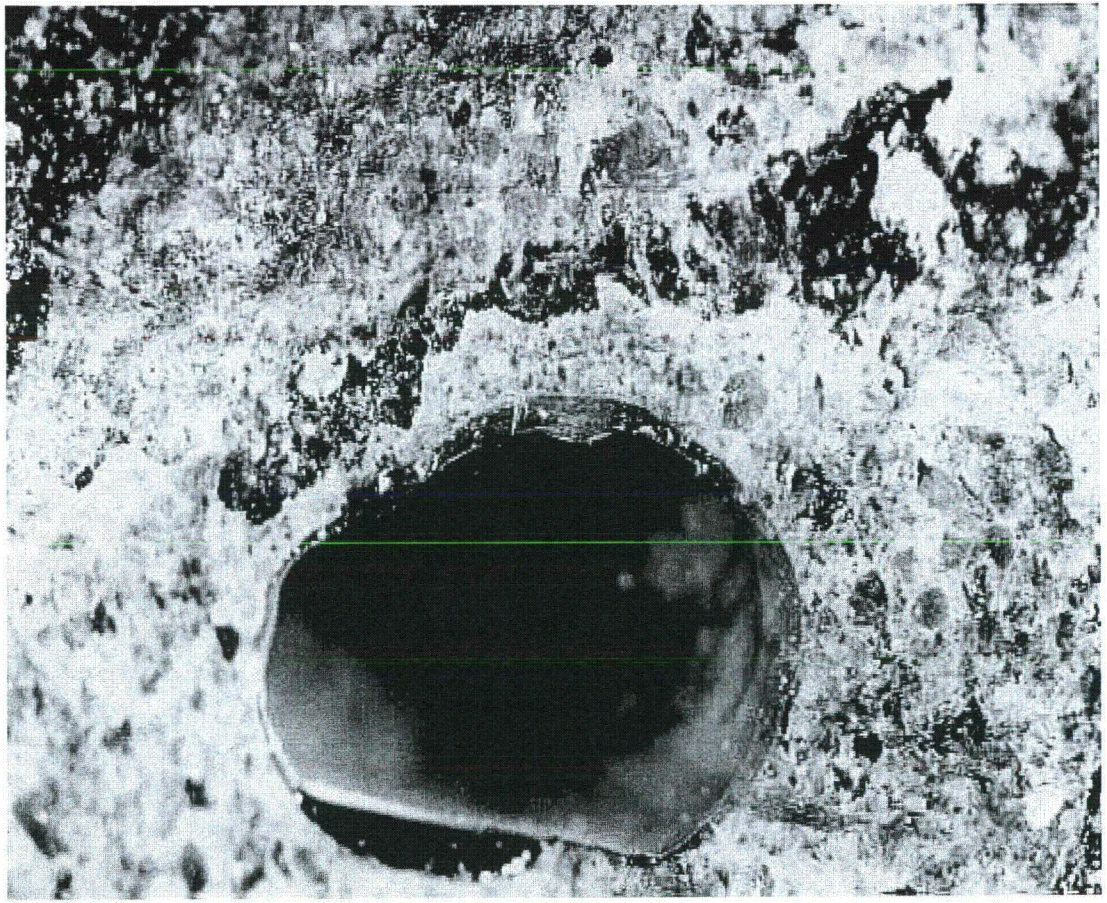
2) Si-OH react with the paste to form Si-O-

3) Si-O-, acting as a Lewis base, adsorbs Na, K, and Ca to form a gel.

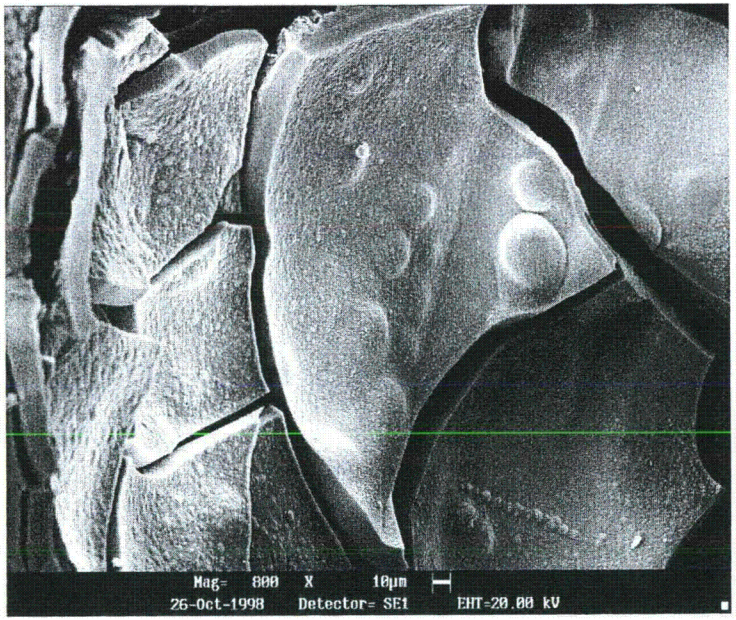
Optical

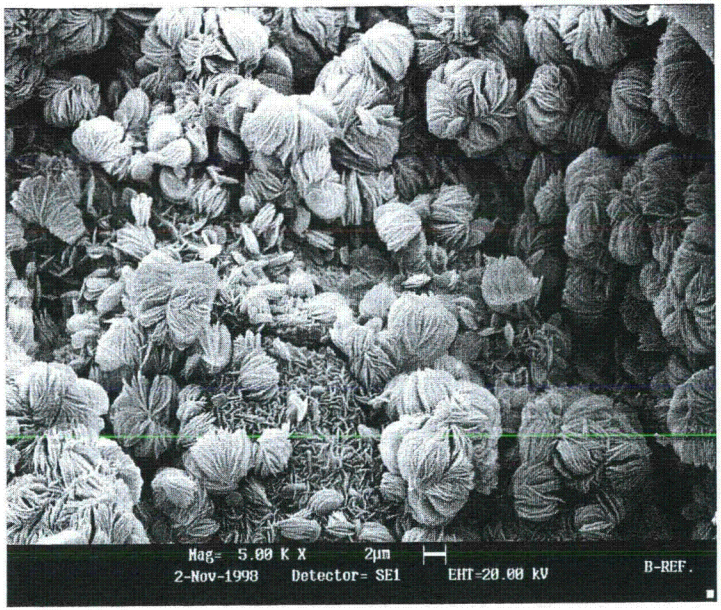


Optical

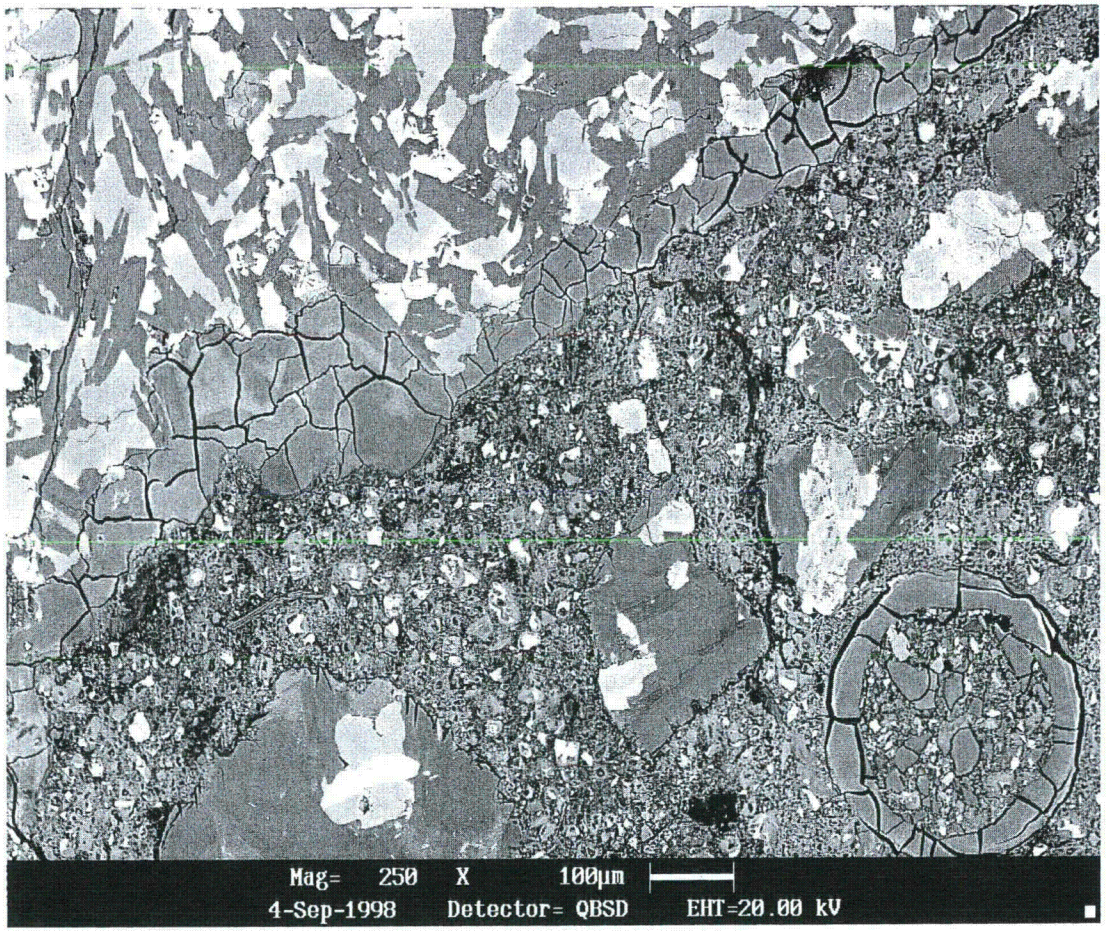


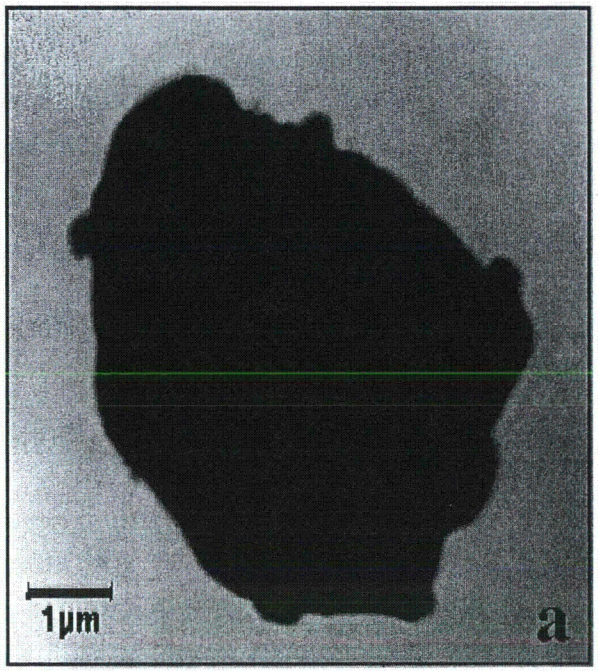
SEM


Mag= 800 X 10µm
26-Oct-1998 Detector= SE1 EHT=20.00 kV


Mag= 5.00 K X 2µm
2-Nov-1998 Detector= SE1 EHT=20.00 kV B-REF.

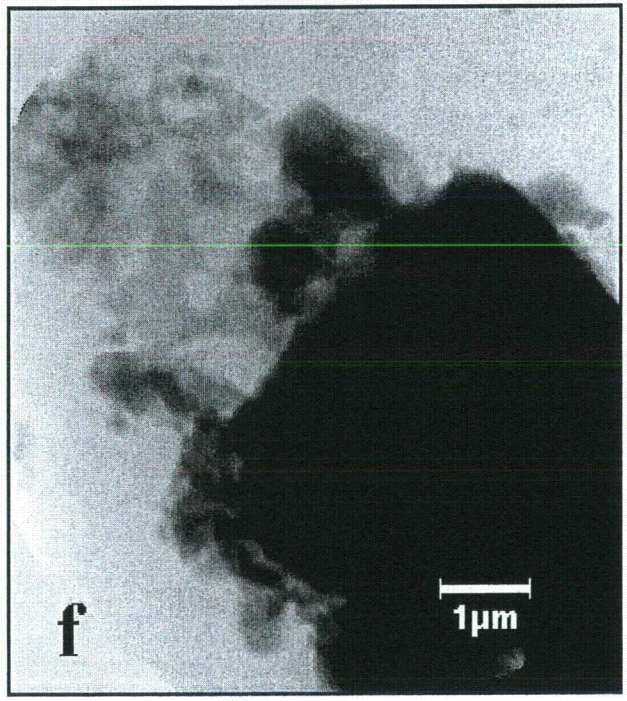
Backscattered image



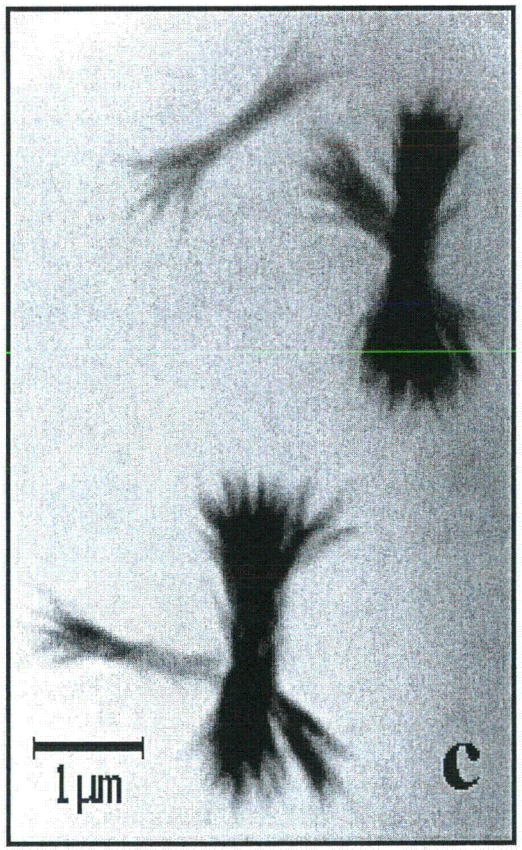


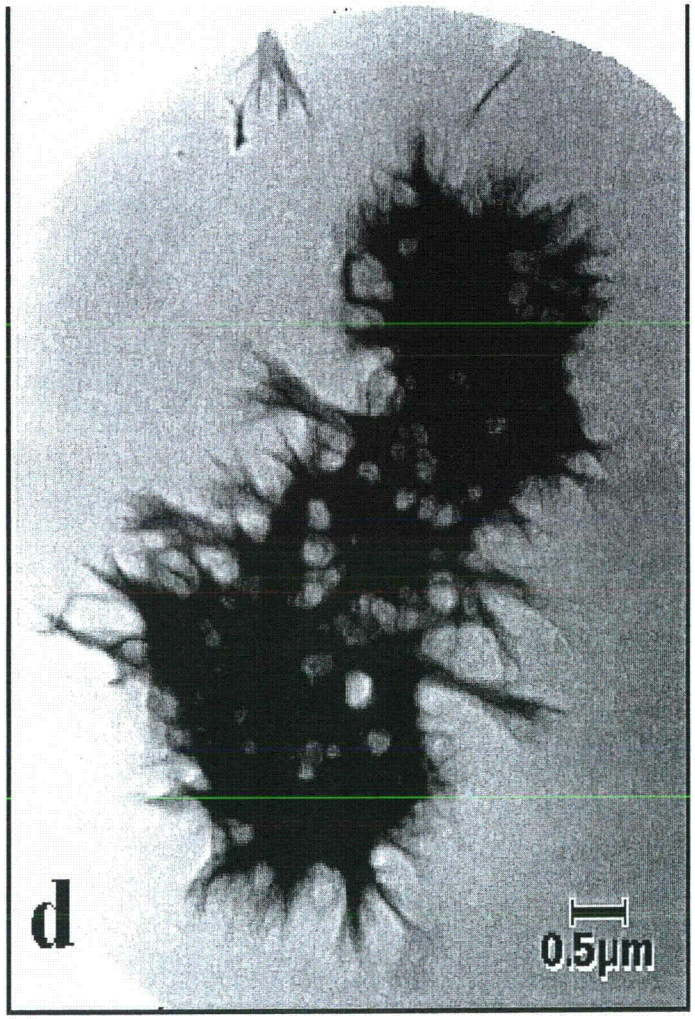
ASR Gel

Dissolution



In presence of saturated Ca(OH)2 solution





Some publications by our group

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- Monteiro, P. J. M., Kejin Wang, Garrison Sposito, Marcia C. dos Santos and W. Pacelli de Andrade, "Influence of Mineral Admixtures on the Alkali-Aggregate Reaction," *CCR Journal*, V27 N12: 1899, (1997).
- M. Prezzi, Monteiro, P. J. M., and G. Sposito, "Alkali-Silica Reaction - Part 2: The Effect of Chemical Additives," *ACI Journal*, JAN-FEB, V95 N1:3-10, (1998).
- Monteiro, P.J.M., Wang, K., Sposito, G., dos Santos, M.C., and de Andrade, W. P., A Reply to Discussion of the Paper "Influence of Mineral Admixtures on the Alkali-Aggregate Reaction", *CCR Journal*, Vol. 28, No. 8, p.1195, 1998.
- Rodrigues, F.A., Monteiro, P.J.M. and Sposito, G., "The Alkali-Aggregate Reaction: The Surface Charge Density of Silica and its Effect on the Expansive Pressure," *CCR Journal*, Vol. 29, p. 527, 1999.
- Rodrigues, F. A., P.J.M. Monteiro and G. Sposito, A Reply to Discussion of the Paper, "The alkali-aggregate reaction: the surface charge density of silica and its effect on the expansive pressure" *Cement and Concrete Research*, V30(N3):503-504, (2000)
- Monteiro, P.J.M., K. Shomglin, H.R. Wenk and Nicole P. Hasparyk, "Effect of Aggregate Deformation on the Alkali-Silica Reaction," *ACI Materials Journal*, V98 (N2): 179-183, Mar-Apr 2001.
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- Turanli, L., K. Shomglin, C.P. Ostertag and P.J.M. Monteiro, "Reduction in alkali-silica expansion due to steel microfibers," Cement and Concrete Research, V31 (N5): 825-827, May 2001.
- Rodrigues, F. A., P.J.M. Monteiro, and G. Sposito, "The alkali-silica reaction: the Effect of monovalent and bivalent cations on the surface charge of opal," Cement and Concrete Research, V31, 1549-1552, 2001.
- Kurtis, K.E., C.L. Collins and P.J.M. Monteiro, "The surface chemistry of the alkali-silica reaction: A critical evaluation and X-ray microscopy," Concrete Science and Engineering, V4, pp 1-11, March 2002.

continued

- F. A. Rodrigues, , P. J. M. Monteiro, and G. Sposito A Reply to Discussion of the Paper "The Alkali-silica Reaction: The Effect Of Monovalent And Bivalent Cations On The Surface Charge Of Opal, Cement and Concrete Research, 933-934, 2003.
- L. Turanli, F. Bektas, P.J.M. Monteiro, Use of Ground Clay Brick as a Pozzolanic Material to Reduce the Alkali-Silica Reaction" V. 33, 10, 1539-1542, 2003
- L. Turanli, F. Bektas, P.J.M. Monteiro, Use of Ground Clay Brick as a Pozzolanic Material to Reduce the Alkali-Silica Reaction" V. 33, 10, 1539-1542, 2003.
- K. Shomglin, L. Turanli, H. -R. Wenk, P. J. M. Monteiro and G. Sposito The effects of potassium and rubidium hydroxide on the alkali–silica reaction, *Cement and Concrete Research, Volume 33, Issue 11, November 2003, Pages 1825-1830*
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- C.P. Ostertag, Ck. Yi and P.J.M. Monteiro, "Effect of Confinement on the Properties and Characteristics of the Alkali-Silica Reaction Gel," ACI Materials Journal, 104 (3): 276-282 MAY-JUN 2007.
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- C. Benmore and Monteiro P.J.M., The structure of alkali silicate gel by total scattering methods, Cement and Concrete Research, Volume 40, Issue 6, 2010, Pages 892-897.
- Francieli Tiecher; Denise C. C. Dal Molin, Márcia E. B. Gomes, Nicole Pagan Hasparyk, Paulo J.M. Monteiro, INFLUENCE OF MESOSTASIS IN VOLCANIC ROCKS ON THE ALKALI-AGGREGATE REACTION, Cement & Concrete Composites, 1130–1140, 2012.

Lots of information for mass concrete

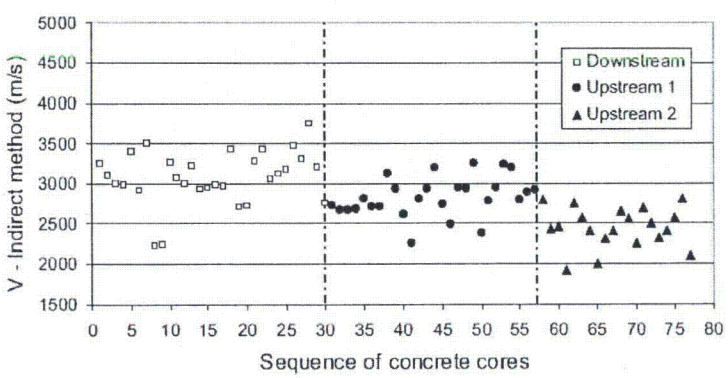
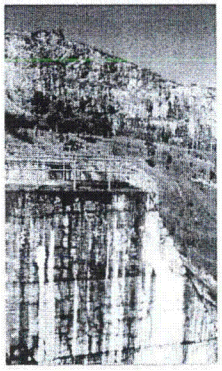


Fig. 1. Pulse velocity (V)—DS, US1, and US2 concrete classes—indirect method



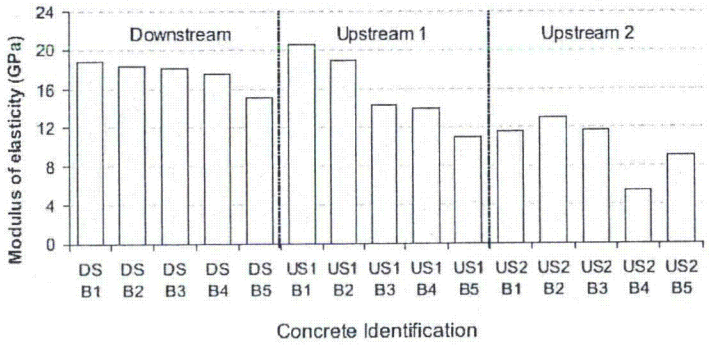
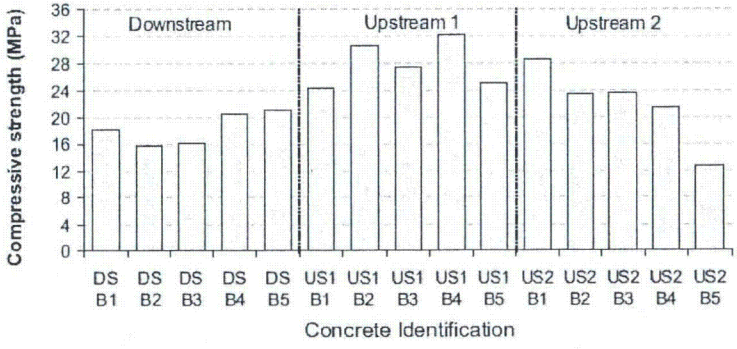


Fig. 3. Static modulus of elasticity of cores in DS, US1, and US2 classes



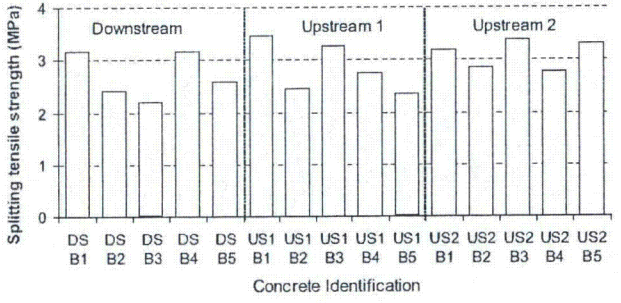


Fig. 6. Splitting tensile strength of cores in DS, US1, and US2 classes

From Hasparyk,; P. J. M. Monteiro, and Dal Molin, ASCE Materials, 2009

Effect of reinforcement

- In reinforced concrete structures, the confinement caused by the reinforcing bars can limit the effect of the ASR swelling.
- The resulting compression in the concrete is sometimes referred as "self-prestressing effect of restrained ASR expansion".
- It should be noted that the duration of this effect over time is still unknown.

Giaccio et al. (2008)

MECHANICAL BEHAVIOR OF CONCRETES DAMAGED BY ALKALI-SILICA REACTION

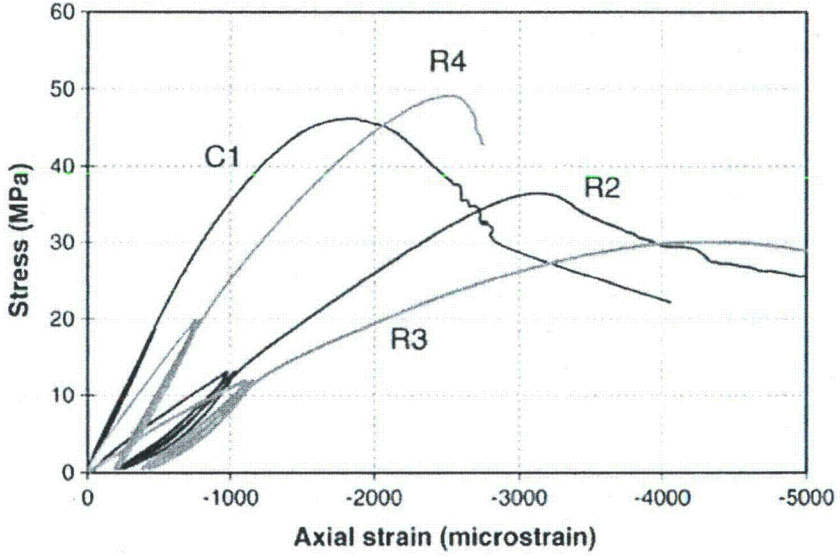
Stress-strain behavior in COMPRESSION and load-displacement response in FLEXURE

Comparison among a reference concrete (without reactive aggregates) and concretes prepared with three different types of reactive aggregates, with the same mixture proportions.

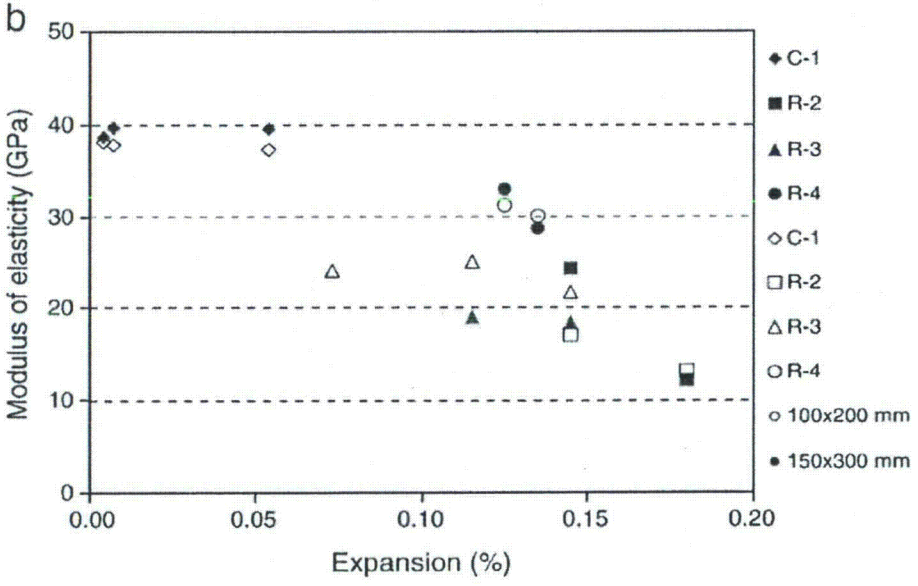
Before the mechanical tests, moist curing at 38 °C until 0.11÷0.18% linear expansions took place.

PROS

1. Comparison between different mixtures
2. Numerous information on kinetic of the reaction, swelling of concretes, decrease of compressive strength, tensile strength and Young's modulus.



STRESS-STRAIN IN COMPRESSION FOR DAMAGED (R1,R2,R3) AND CONTROL (C1) CONCRETES



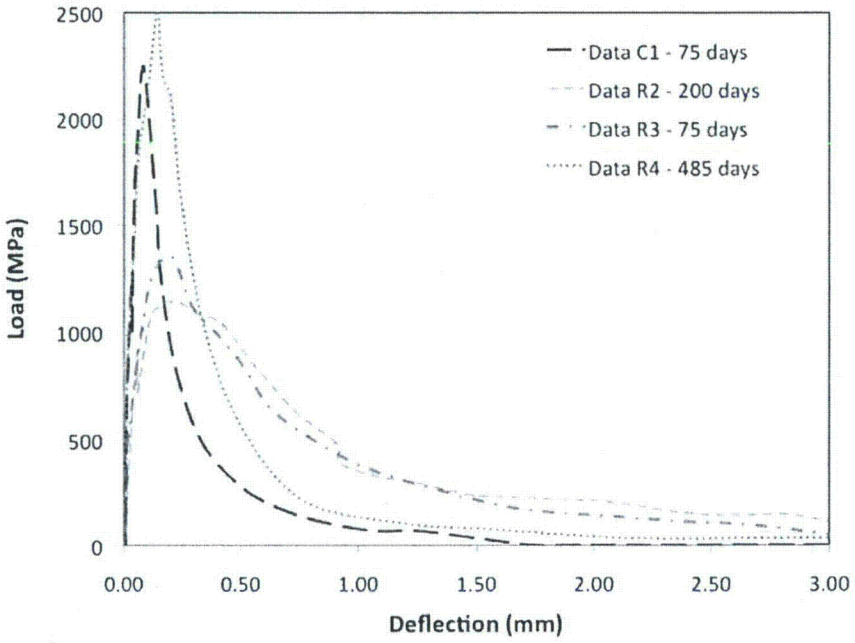
MODULUS OF ELASTICITY WITH EXPANSION

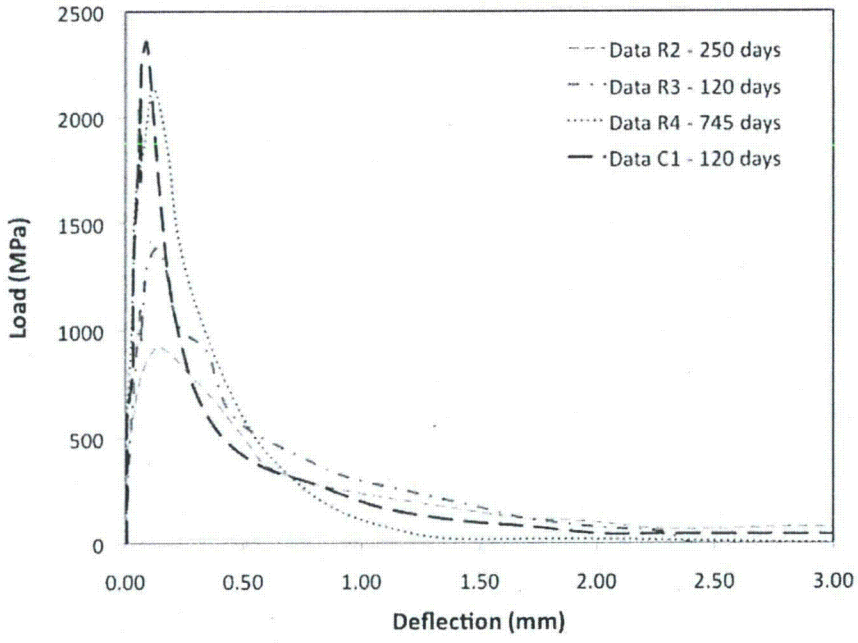
CONS

1. The proposed selection of mixtures does not allow to draw conclusions on the effect of concrete composition on the degradation of ASR
2. The initial properties of concretes without ASR are not reported, hence it is difficult to draw conclusions
3. The effect of reinforcement in the flexure response is not considered

LOAD-DEFLECTION IN THE FLEXURE TEST: AN EXAMPLE OF THE VARIABILITY OF RESULTS

Changes in the concrete mix always influence the mechanical behavior.
From these results it is difficult to separate the contribution of the ASR and the contribution of change of mixture (independent of ASR).

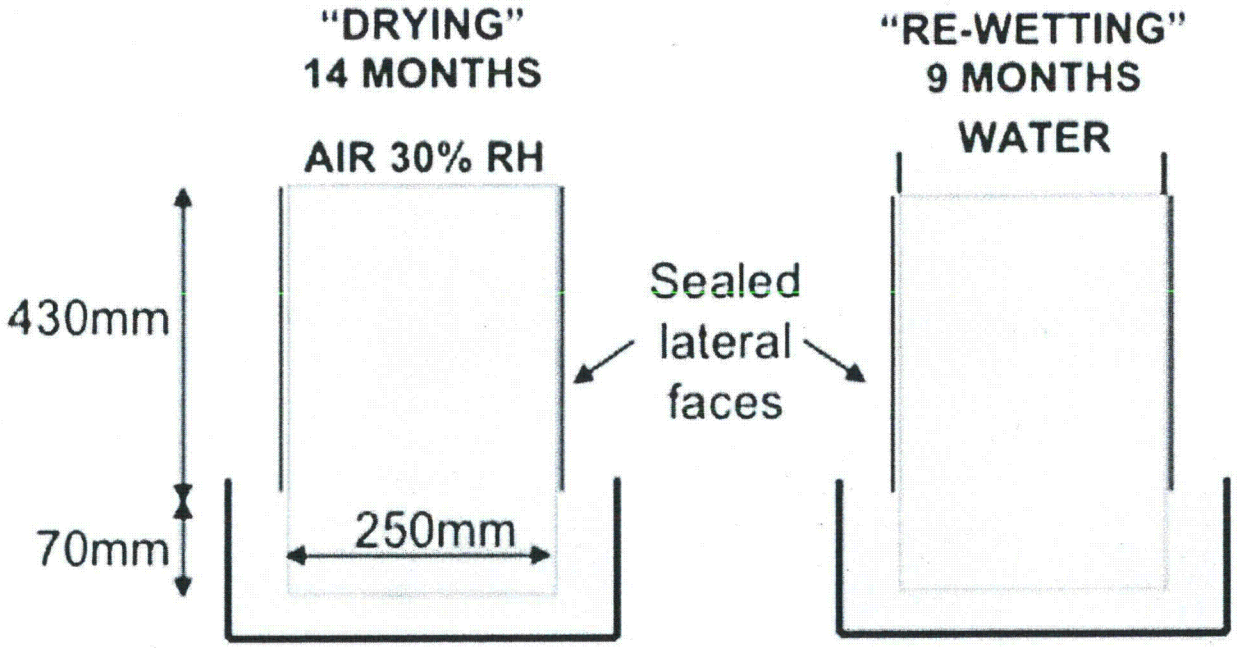




Multon and Toutlemonde (2010)

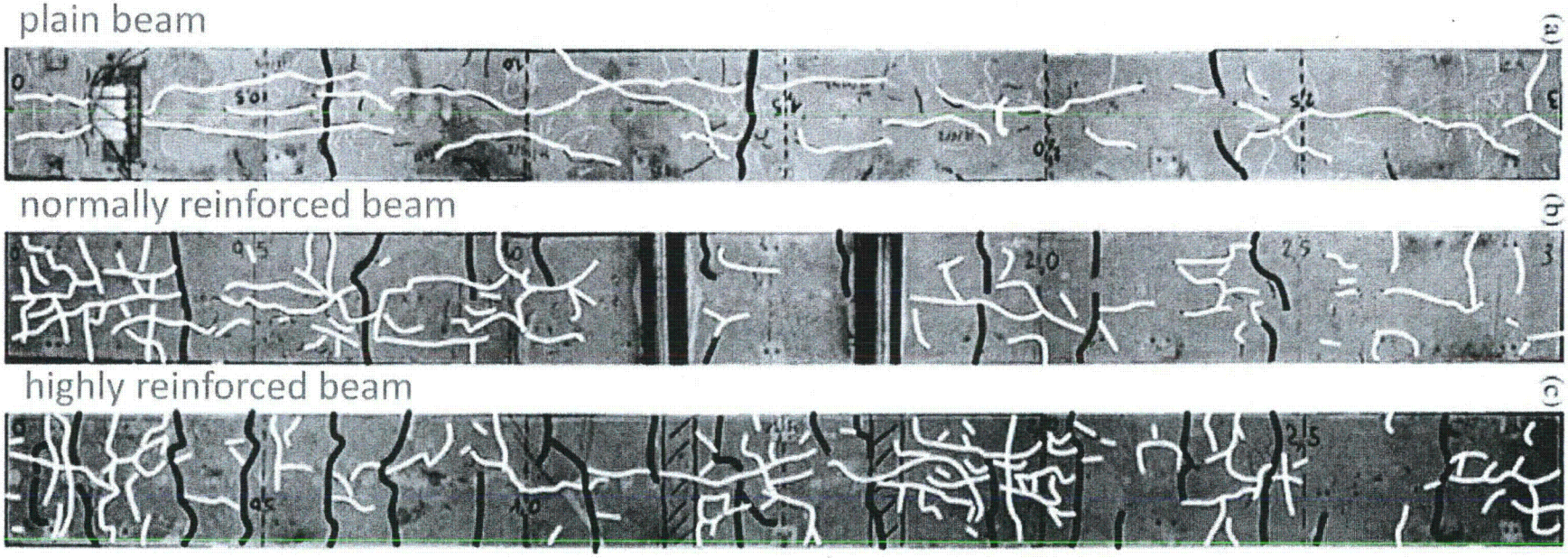
PLAIN AND REINFORCED BEAMS SUBJECT TO VARIABLE GRADIENTS OF MOISTURE

Beams affected by ASR immersed in water (lower part) from the beginning. The upper part is first dried (14 months) and then re-wetted (9 months).



PROS

Information on mass variation and kinetic of ASR, anisotropic expansions and crack patterns with and without reinforcement

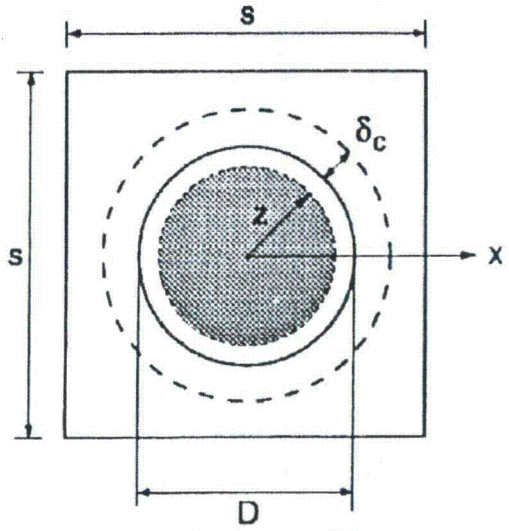


In black cracks appeared during drying (first 14 months), in white cracks appeared after late water supply

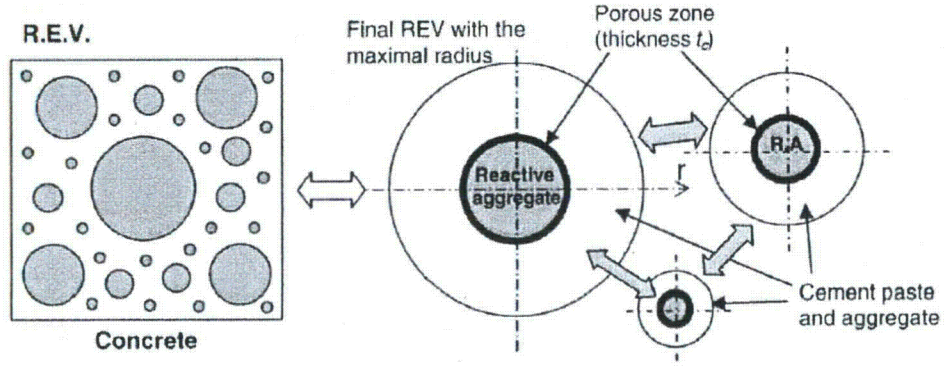
CONS

Only free-expansion tests are considered. The effect of external loads is not tested

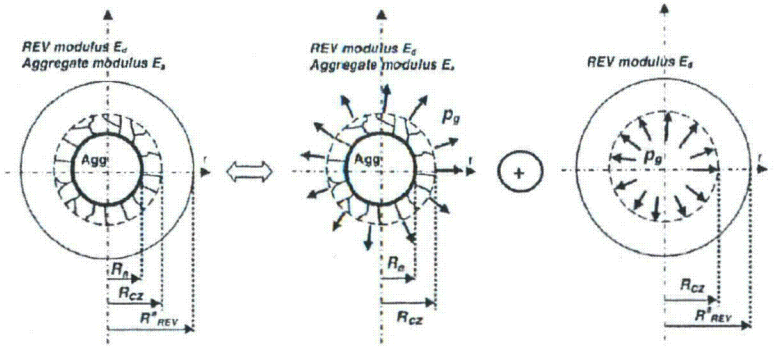
Micro-Mechanical Models



Bazant and Steffens (2000)

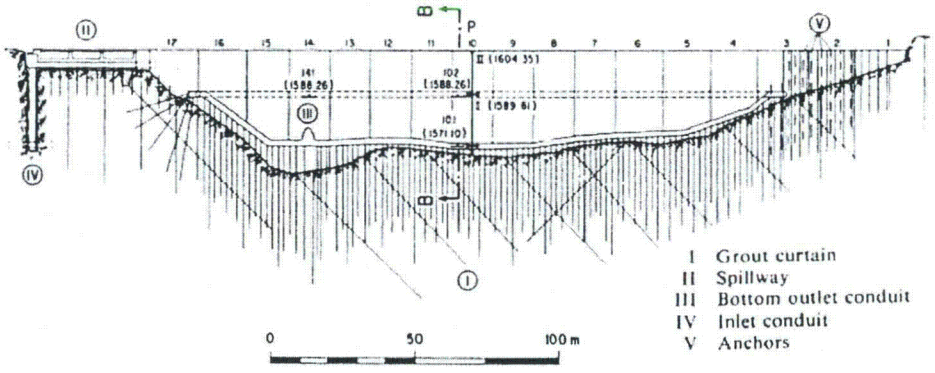


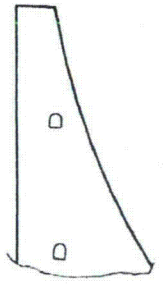
Multon et al. (2009)



Multon et al. (2009)

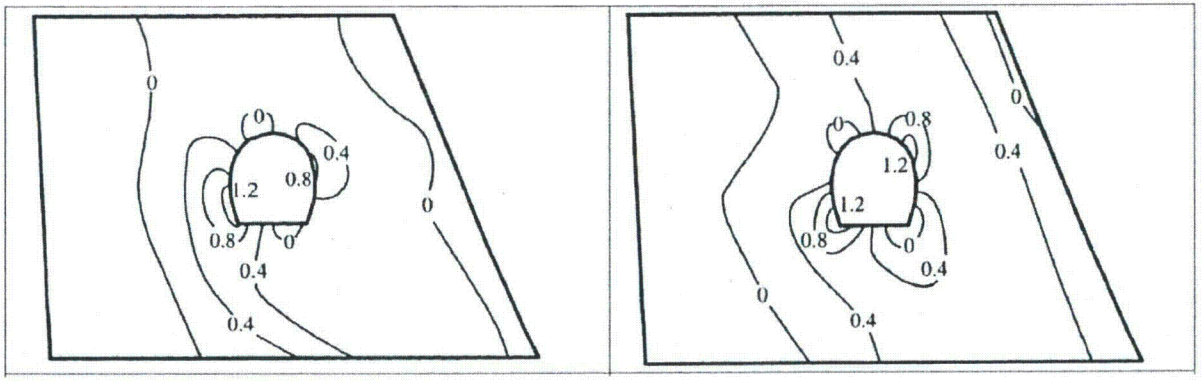
"Equivalent Thermal Expansion" Model



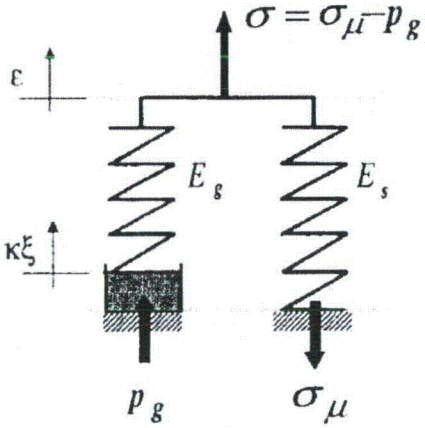


Section B - B

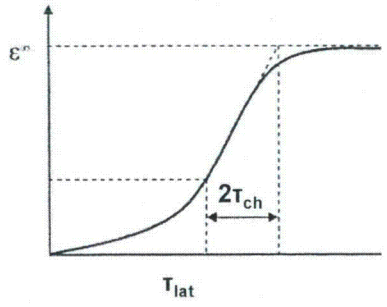
Malla and Wieland (1999)].

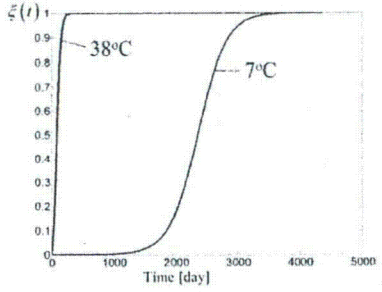


Poromechanics



$$\sigma = \sigma_\mu - p_g = E_s\varepsilon + E_g(\varepsilon - k\xi); \sigma_\mu = E_s\varepsilon; p_g = -E_g(\varepsilon - k\xi)$$

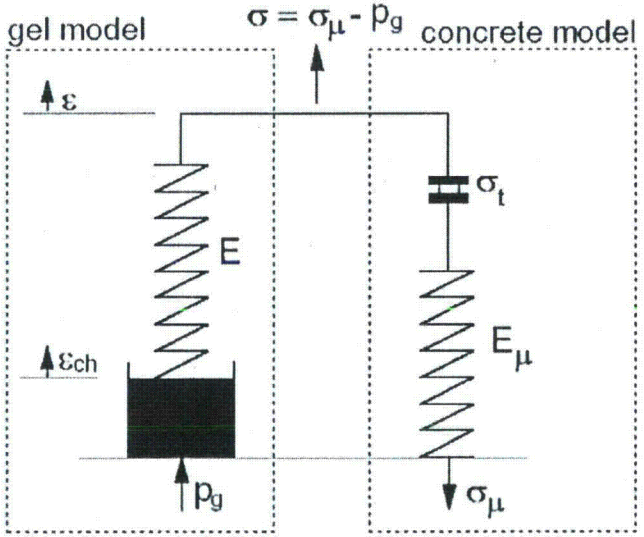




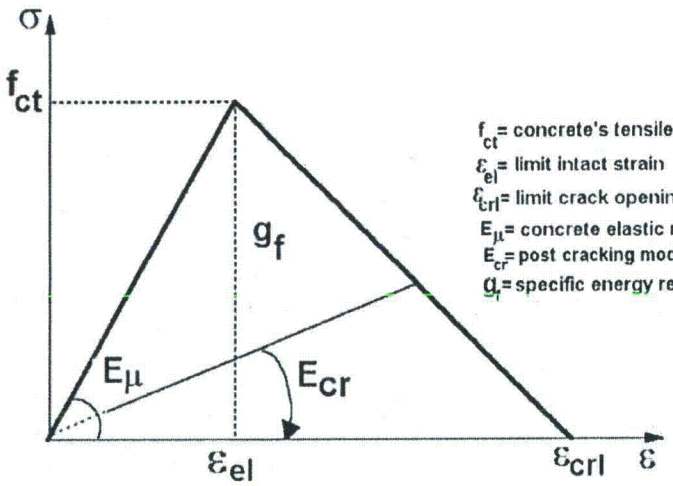
Rate

$$\xi(t,T) = \frac{1 - e^{-\frac{t}{\tau_{ch}(T)}}}{1 + e^{-\frac{(t-\tau_{lat}(T))}{\tau_{ch}(T)}}}$$

Farage and Fairbairn Model

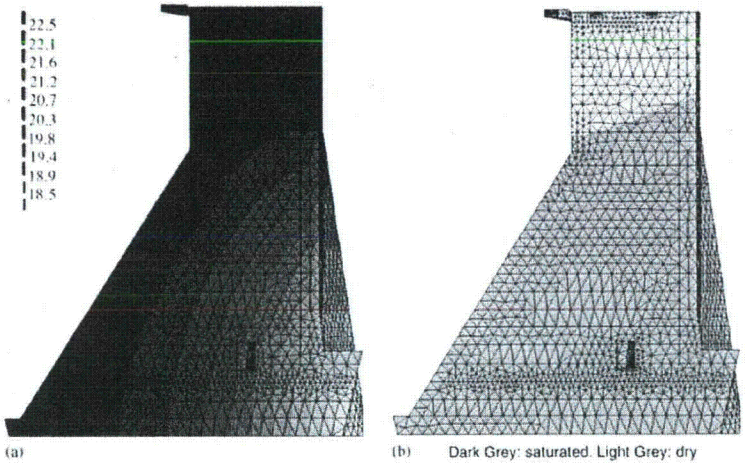


σ = total stress
σ_μ = effective stress
p_g = pore pressure
σ_t = concrete's tensile strength
E_μ = concrete's elastic modulus
E_g = gel's elastic modulus
ε_{ch} = gel expansion
ε = total strain

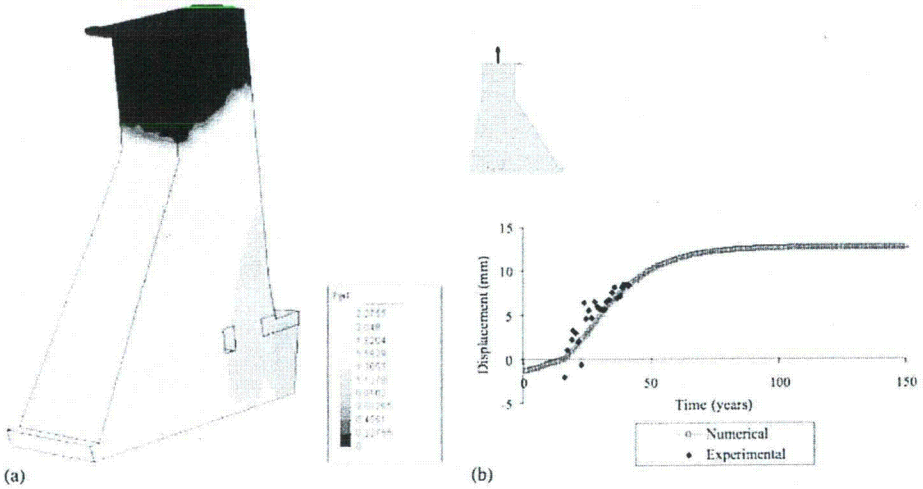


f_{ct} = concrete's tensile strength
ε_{el} = limit intact strain
ε_{crl} = limit crack opening strain
E_μ = concrete elastic modulus
E_{cr} = post cracking modulus
g_f = specific energy release rate

Applications



Steady-state temperature and moisture fields: (a) temperature; and (b) moisture



Results for the ASR simulation: (a) gel pressure for 40 years; and (b) displacements at the crest of the dam

Recommended Tests

- Potential of expansion in extracted cores from the nuclear power plant
- Measurement of deflections in the nuclear power plant
- Modeling shear and lap splice in reinforced concrete affected by ASR
- Seismic response of nuclear power plant affected by ASR
- Corrosion caused by ASR cracking

Potential of expansion in extracted cores

- ASTM C 227 Standard Test Method for Potential Alkali Reactivity of Cement-Aggregate Combinations
- ASTM C 1260 Standard Test Method for Potential Alkali Reactivity
- ASTM C 1293 Standard Test Method for Determination of Length Change of Concrete Due to Alkali-Silica Reaction

Problems

- *Unrealistic silica solubility*
- *Unrealistic internal alkali loadings*
- *Unrealistic soak solutions*

A new test

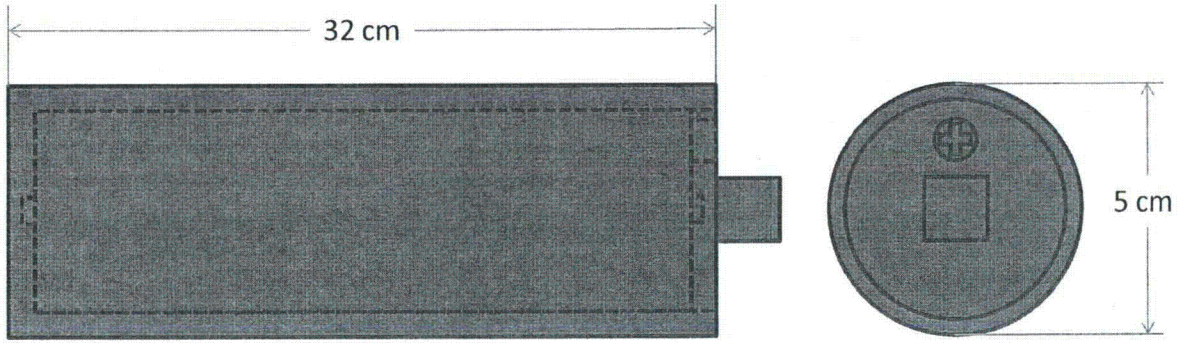


Diagram of cylinder for storing cores in simulated pore solution.

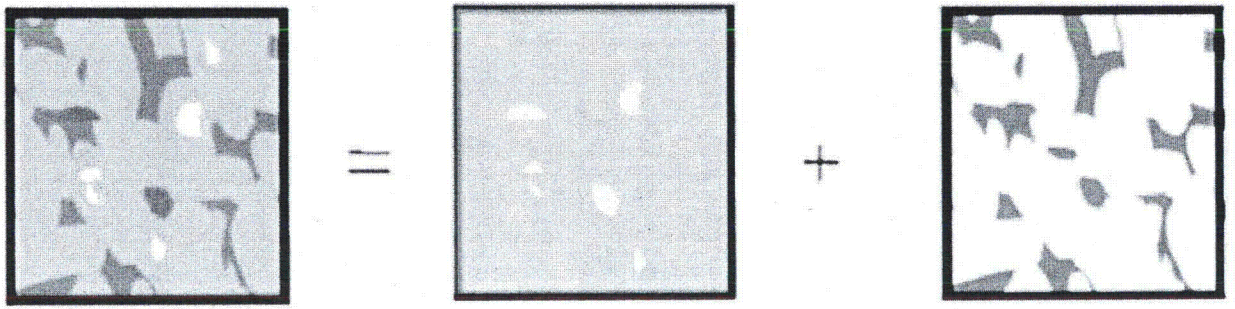
A new test

- The length of the core should be 32 cm after cutting.
- Next, the ends would need a hole drilled 1 cm deep in the center to accept a gage stud which would be epoxied in place.
- The cores would then be transferred to a specially fabricated cylinder whose radius is 2 mm greater than the core.
- After the cylinder is loaded with the core, the threaded end cap should be screwed on so that there is a 2mm gap between the end of the core and the threaded cap.
- This gap is to allow for expansion and should be maintained through the course of the experiment.
- The closed cylinder should be filled with 95% of its free volume (note free volume = volume of container – volume of cylinder with gage studs) with simulated pore solution then the plug should be closed and the enclosed specimen should be transferred to an oven maintained at 40°C.
- The specimen should be removed from the oven after 7d, 14d, 28d, 56d, and then every 4 months until expansion ceases. The pore solution should not be changed every measurement, but it should be brought up to 95% of the free volume after each measurement

Model by Comi and Pignatelli

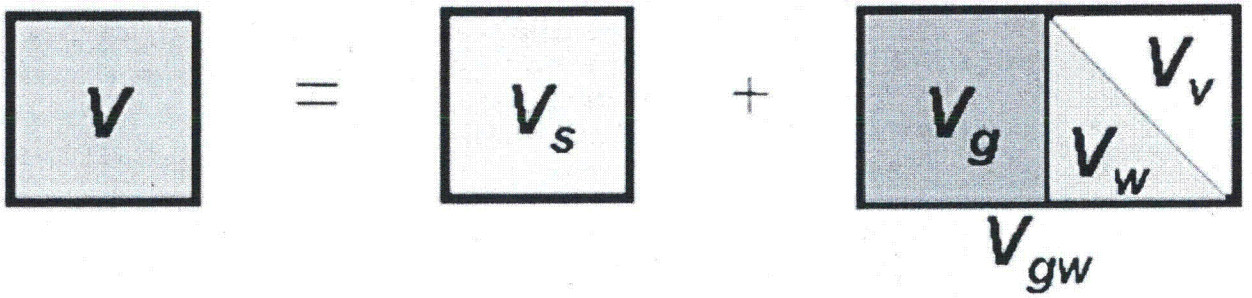
- Based on poromechanics
- Two-phase material made of a solid skeleton and a wet expanding gel
- Effects of temperature and humidity conditions on the kinetics
- Isotropic damage model
- Finite element formulation

Schematic representation

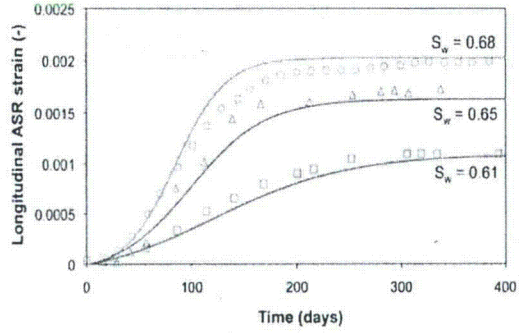


HOMOGENIZED CONCRETE SKELETON

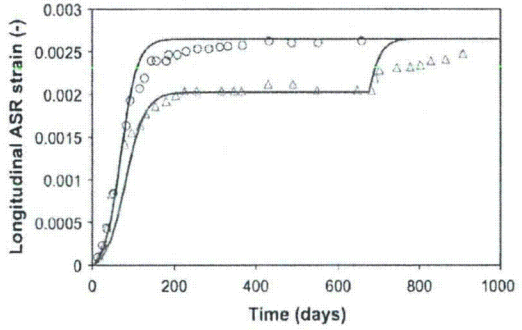
PRESSURIZED WET GEL



Calibrations

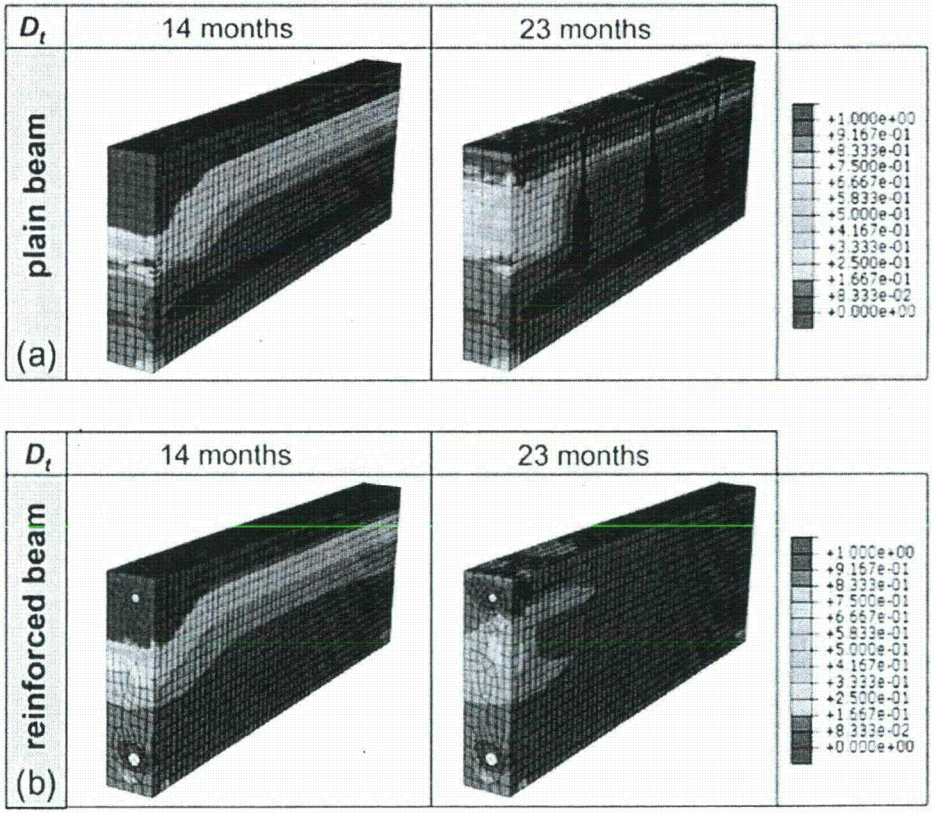


Free axial ASR expansion at T=38°C for different degree of saturation (data from Larive)



Free axial ASR expansion at T=38°C with late water supply. (data from Multon and Toutlemonde)

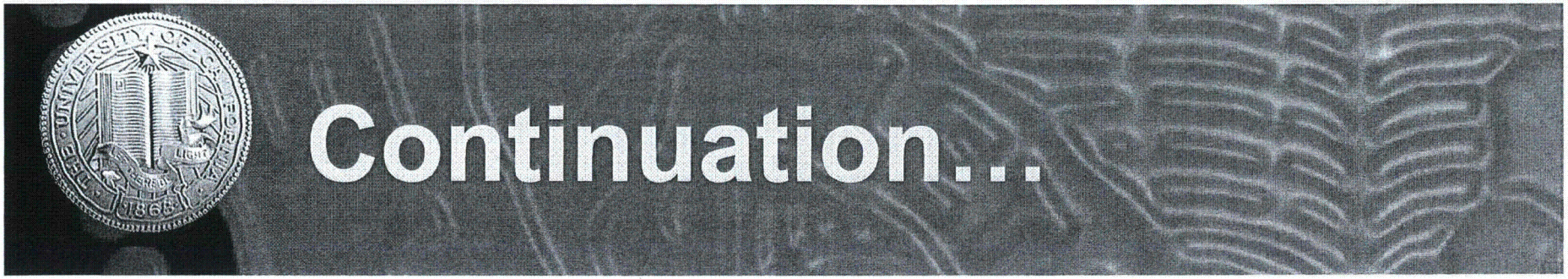
Modeling



Patterns of the damage level in (a) plain and (b) reinforced beams after 14 and 23 months

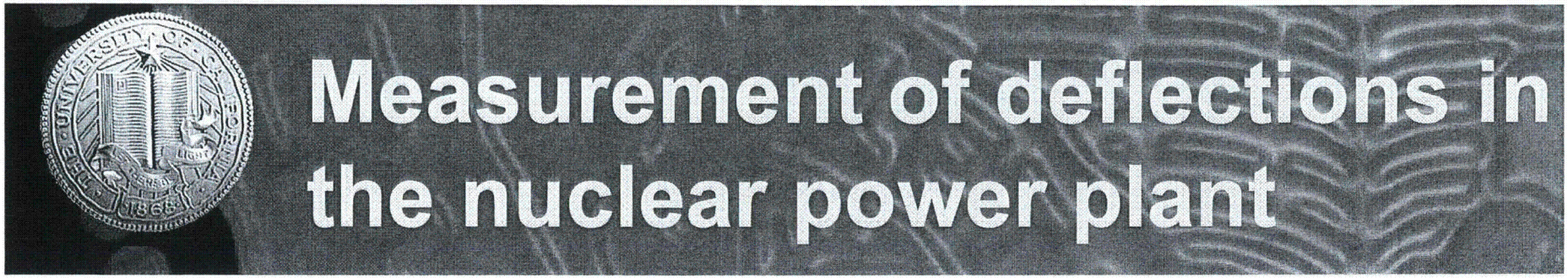
Calibration of the mechanical models

- Elastic constants (measure E and ν)
- Kinetics of the reaction, final swelling and its dependence on the humidity conditions (free-expansion tests on specimens exposed to different degree of saturation)



Continuation…

- Moisture transport
- Stress state and damage parameters **(effect of confinement)**
- Creep parameters



Displacements are critical for an inverse problem:

Find the unknown material parameters in the structure that matches the measured displacements.

Method

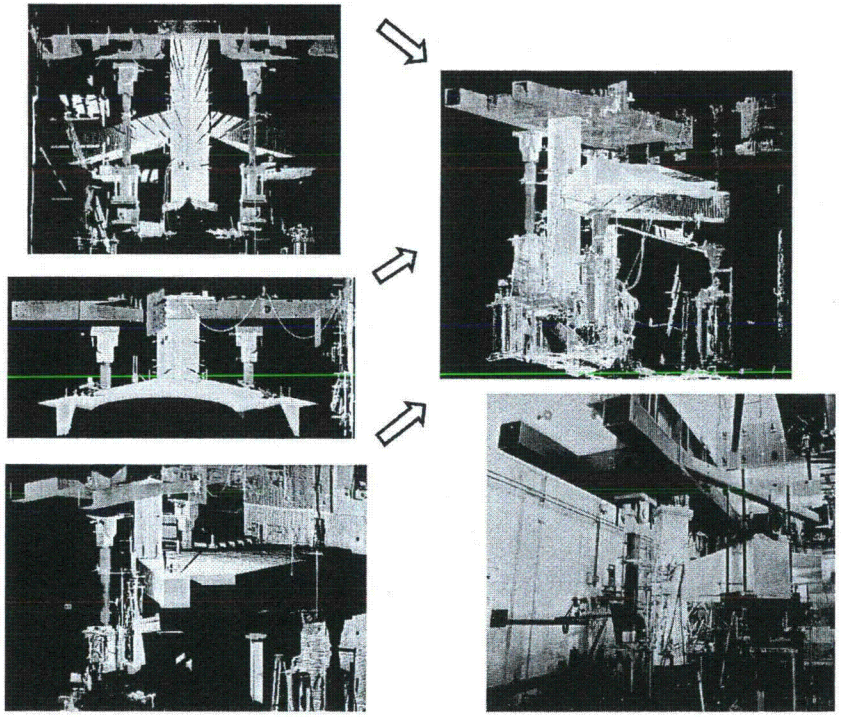
- Structural diagnosis from measurements of displacement.
- A finite element model is developed to simulate the phenomenon that causes the displacements measured.
- This model is a function of the unknown parameters of the material, which can be determined by minimization of the difference between measurements and prediction.

Successful approach in other structures

- This inverse method has been successfully applied for large dams affected by ASR.
- In Maier et al. (2004), Fedele et al. (2006) and Ardito et al. (2008) inverse analysis was used to characterize the mechanical properties of the structure to diagnose the deterioration of the structure.
- Sellier et al. (2009) this method was used to characterize the ASR parameters (in particular the asymptotic ASR swelling). Structural diagnosis by inverse analysis is usually preceded by a preliminary sensibility analysis which can quantifies the influence of the variation of unknown parameters on the measurable quantities and helps the design of structural monitoring.

Progress in other fields

- **Applications of Laser Scanning to Structures**

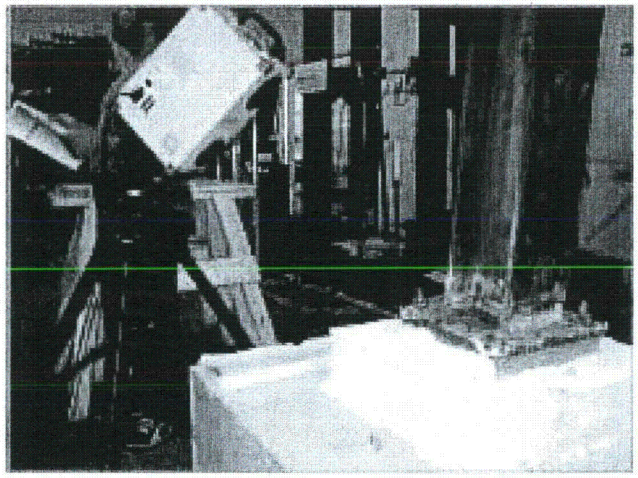


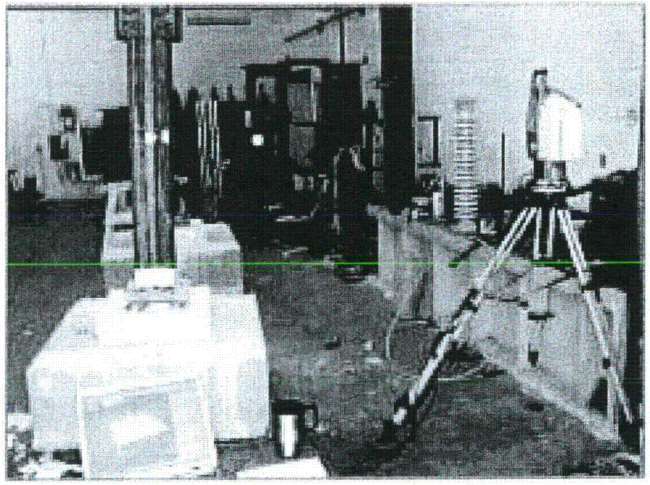
Registration (stitching) of three scanned images of a 3D RC beam-column joint with slab acquired from different locations (stations)

Courtesy from Prof. Mosalam

Laser Scanners Used in Base Plate Testing

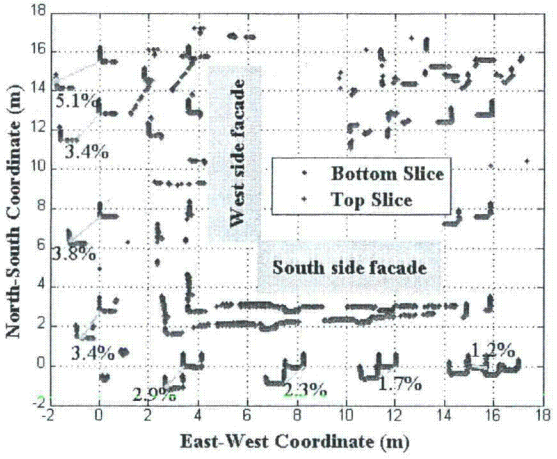
Model	Manufacturer	Range, m	Accuracy, mm	Target acquisition accuracy, mm	Achieved stitching accuracy (error)
Scan Station 2	Leica Geosystems	100	4	<1	< 4 mm
Vivid 910	Konica Minolta	1.2	0.22	NA	< 0.4 mm





- Several individual scans from all sides of a specimen were obtained
- Stitched together in application supplied by the scanner manufacturer (Cyclone and Polygon)
- 3D object of the specimen is generated

Not just in the lab



Columns drift vectors of Hotel Asscotia as they relate to point cloud registration (amplification factor = 40)

Courtesy from Prof. Mosalam

Growing field

- **http://www.dirdim.com/prod_laserscanners.htm**

Konica Minolta Range7 3D Digitizer

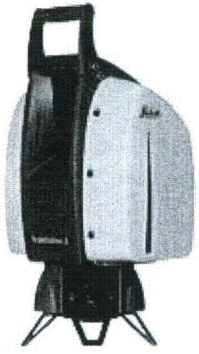
Portable, compact, point-and-shoot laser scanner for industrial applications.

Accuracy: 0.0015"

Features:

- Two interchangeable lenses
- Multi-focus mode able to obtain more accurate data
- Ideal for medium to large objects

Price (Base): $80,000



With attractive entry-level pricing, 50,000 pts/sec maximum instantaneous scan speed, and the full freedom and accuracy of a total station, Leica ScanStation 2 is a great addition to your as-built and topographic surveying tool kit. Leica ScanStation 2 features powerful laptop control and the ability to conduct full-dome scans using its oscillating mirror with front and top-window design.

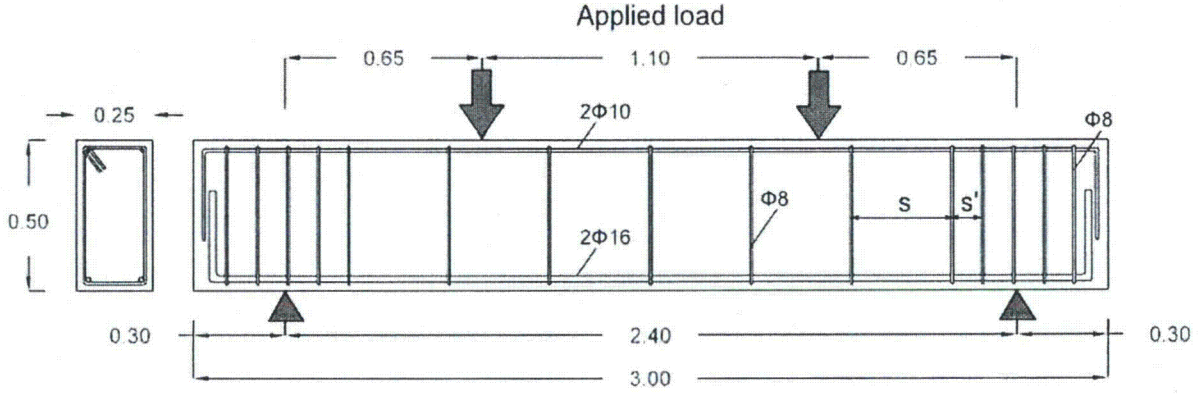
A high-resolution, internal digital camera aids with targeting and texture mapping of scan data.

Flexural test program

- The effect of ASR on the flexural performance of reinforced concrete structures can be investigated through four-points flexural tests on six non-reactive beams (NR) and twelve reactive beams with two different levels of reinforcement (L and H) and at two different level of ASR development (R1 and R2), in order to compare the influence of reinforcement on the ASR-induced strain.

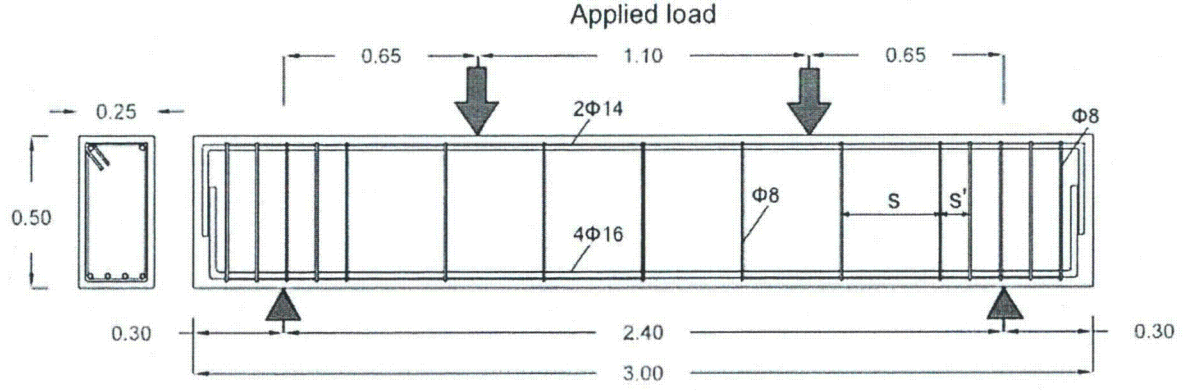
Flexural test program

F-NR-L, F-R1-L, F-R2-L: BEAMS WITH REINFORCEMENT L



The measures of the beam are in meters

F-NR-H, F-R1-H, F-R2-H: BEAMS WITH REINFORCEMENT H



The measures of the beam are in meters

Program -- flexure

Beam	Number of beams	Concrete	Upper reinforcement φ=diameter (mm)	Lower reinforcement φ=diameter (mm)	Stirrups s=0.35 m s'=0.10 m	ASR linear expansion
F-NR-L	3	Non-reactive	2φ10	2φ16	Φ8	None
F-NR-H	3	Non-reactive	2φ14	4φ16	Φ8	None
F-R1-L	3	Reactive	2φ10	2φ16	Φ8	0.0011÷0.0018
F-R2-L	3	Reactive	2φ10	2φ16	Φ8	0.0020÷0.0025
F-R1-H	3	Reactive	2φ14	4φ16	Φ8	0.0011÷0.0018
F-R2-H	3	Reactive	2φ14	4φ16	Φ8	0.0020÷0.0025