onBalance

Case History
#oB–00015

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The [homeowner name] pool at [homeowner address] in Phoenix Arizona was replastered in March of 2001 by Superior Pool Plastering Management Inc. (License #ROC162915, Class C-36).

During the first seven months after the replaster, the pool was chemically maintained by Bobbi Bowen Pool Service. In November of 2001, the service was switched to Poolman pool chemical and cleaning service.

In December of 2001, the homeowner began noticing surface discoloration in the form of white spots, which then took on a turquoise color. In March of 2002 a rust bleed appeared below the tile by the diving board.

After using the pool for the summer season, the homeowner contacted the plastering contractor in September of 2002. Dissatisfied with the result of their visit, in December of 2002 the homeowner requested and received a Registrar of Contractor's courtesy inspection by Inspector Bud Combs. The complaints included "spot etching" and rebar bleed. The inspector determined that the contractor needed to repair the rebar bleed, but that the spot etching was due to improper water chemistry (per the Arizona Minimum Workmanship Standards, the text of which is included in this report as Attachment A).

In February of 2003, the homeowner requested a formal inspection, which occurred in March 2003. The inspector again determined that the contractor needed to repair the rebar bleed, but that the spot etching was due to improper water chemistry.

As a result of that inspection, a request for formal hearing was made on March 20, 2003. The contractor's mandated written response to the hearing included: "The accusations brought against Superior Pool Plastering are clearly unjustified! The damage on the surface of [homeowner's name]'s pool IS a water driven phenomena. There are no signs of workmanship or material problems."

Four core samples of the pool were taken and submitted to three separate labs on March 24 (RJ Lee Group, onBalance, and Construction Technologies Laboratory). The three reports are included as Attachments B, C, and D. The finding of all three labs was that the calcium chloride exceeded the allowable standard (5% calcium chloride by weight to the cement, instead of the allowable 2%). This extreme over-acceleration of the cement, along with other improper finishing practices, including evidence of over-trowelling and water-trowelling, was found to be the cause of the surface defects.

The hearing was scheduled for July 14, 2003, Docket 03F-1399-ROC. As part of the hearing process, the homeowner subpoenaed plastering information, and received response from the plasterer, included as Attachment E. The homeowner also took pictures of the spot etchiong, rust bleed, and plaster- and sponge-blocked main drain, which are attached (F).

At the start of the hearing, at the request of the contractor, the hearing was recessed to allow a settlement discussion. Upon reconvening the hearing, it was determined that the plastering contractor would replaster the pool without admitting guilt, with the provisions that the work be done in the winter, that the calcium chloride dosage not exceed 2%, and that the contractor would provide a free upgrade to a silica-based aggregate.

After the settlement details were formalized, the homeowner and Que Hales from onBalance presented documentation on the pool to the hearing judge, who agreed to forward that material to the Arizona State Registrar to facilitate reviewof the Minimum Workmanship Standards.

From the Arizona Registrar of Contractor's *Minimum Workmanship Standards for Licensed Contractors*, January 2000 revision, page 48:

7.	**PD**	**Spot etching at or prior to substantial completion.**
	AT	**The owner should notify the contractor of any spot etching at substantial completion. Contractor should provide an acceptable plaster finish prior to substantial completion.**
	CR	**After substantial completion, contractor should not be responsible for spot etching caused by water chemistry.**

Notes:
PD = possible deficiency
AT = acceptable tolerance
CR = contractor responsibility
Definition – substantial completion = 30 days from pool being filled with water

onBalance

Swimming Pool Chemistry and Plaster Consulting

Mr. John Quatrini
President, Poolman
PO Box 35669
Phoenix AZ 85069

Re: onBalance Project oB-00015 (Kennett)

Mr. Quatrini:

You engaged onBalance to diagnose the cause(s) for discolorations on the surface of the swimming pool plaster located at 14637 N. 55th Street in Phoenix Arizona, at the residence of John and Kitty Kennett.

An onBalance partner, Que Hales, visited the pool on a number of occasions, including a preliminary inspection, the Registrar's inspection, and a visit to obtain core samples of the pool for analysis.

The following is a summary of the observations and results of the analysis.

Methods

Visual/Tactile

The pool was inspected when filled with water and when drained.

The pool exhibits a spotted discoloration pattern, and the spotted areas are highlighted with copper deposits (see Figures 1, 2, and 3). The pool also exhibits fan patterns of discoloration (Figures 4 and 5) and drip lines (Figure 6).

At both of these inspections, it was noted that the plaster surface was very smooth to the touch and to visual analysis. In the presence of the Registrar's inspector, a tactile examination of the plaster was undertaken. The homeowner, the service company manager and I were unable to determine the location of the spot discolorations by tactile means alone (i.e., by touch with closed eyes).

The distribution of the spots is relatively random, except for a concentration of affected surface under a shallow-end water return (Figure 7) and patterning on the pool walls where "fans" of spots indicate the influence of trowel passes in the spot distribution.

Optical Photography

Photographs were taken of the pool. The photographs document the spotting, the distribution of the spots, driplines, fan patterning, and the macrostructural cracking (Figure 8).

Water Analysis

Pool and tap water was sampled for analysis. Trace levels of dissolved copper were detected in the source water, which could account for some of the copper deposited on the pool surface. Old brass fittings plumbed into galvanized iron pipe is likely the source of additional copper in the pool water and on the most porous sections of the pool surface (Figure 9).

Core Analysis

Photography – The pool was core sampled, and the cores were photographed both *in situ* and in the lab (see Figures 10 – 13). During the coring, it was noted that there is a total bond failure between the pool plaster and the gunite substrate in some areas of the pool (see Figure 14).

Photomicography – The surface of a core sample was photographed at 40X magnification, with care taken to document the level of surface cement paste erosion as evidenced by the exposure of aggregate (sand) at surface (see Figures 15 and 16).

Chloride analysis – A sample of the plaster was analyzed for chloride content using ASTM Standard Method C1152 (Standard Test Method for Acid-Soluble Chloride in Mortar and Concrete) and a Hach Quantab titrater variation of ASTM Standard Method C114.19 (Standard Test Methods for Chemical Analysis of Hydraulic Cement – Chloride). The chloride content of the sample was 1036 ppm in a 10g/100ml sample, which calculates to 4.98% pure $CaCl_2$ or 5.9% calcium chloride dihydrate by weight to the cement in standard swimming pool plaster.

Observations

The presence of calcium chloride is associated with discoloration in cementitious products. Industry-accepted documentation from the Portland Cement Association, the American Concrete Institute, and other authorities indicate that even low levels of calcium chloride (<2%) will cause discoloration. Tests of the Kennett pool plaster shows levels of calcium chloride more than double the industry-accepted maximum. This serious breach of accepted industry practice also produces detrimental microstructural cracking and the formation of detrimental Freidel salts in the void spaces, which can lead to disruption of the surface's structural integrity. These latter features require scanning electron microscopy (SEM) and backscatter electron (BSE) analysis for detection and documentation. Core samples from the pool were sent to RJ Lee Group, an accredited laboratory specializing in cement failure analysis, for SEM, BSE, and independent, confirmatory chloride analysis (see attached report).

The microphotographs of the Kennett plaster were compared by onBalance with photographs of other plaster standards (at the same magnification) which had been subjected to known degrees of aggressive chemical attack (Figures 17 – 21).

Conclusion

The pool has not undergone an aggressive chemical attack. None of the accepted hallmarks of aggressive attack (such as surface cement paste dissolution and etching of the surface-exposed aggregate) are evident. This is consistent with the chemical history documentation provided onBalance and with the water analysis undertaken by onBalance. The effect under the step return is best explained by the fact that the return water flow was pointed directly onto the fresh plaster from the time the pool was freshly filled until months later. This impingement on fresh plaster will cause surface erosion.

Many factors are usually associated with spot discolorations, including excess calcium chloride, wet troweling, and overworking the surface. All of these factors may have been contributory in the problems seen in the Kennett pool. However, the tests, observations, and additional independent analysis indicate that in this case, the level of abuse of calcium chloride alone is enough to cause the plaster defects seen in this pool.

Sincerely,
Que Hales
Partner – onBalance Consulting

Figure 1 – Pool Steps

Figure 2 – Spa Wall

Figure 3 – Copper Deposits

Figure 4 – Pool Wall

Figure 5 – Pool Wall

Figure 6 – Side Wall

Figure 7 – Step under return

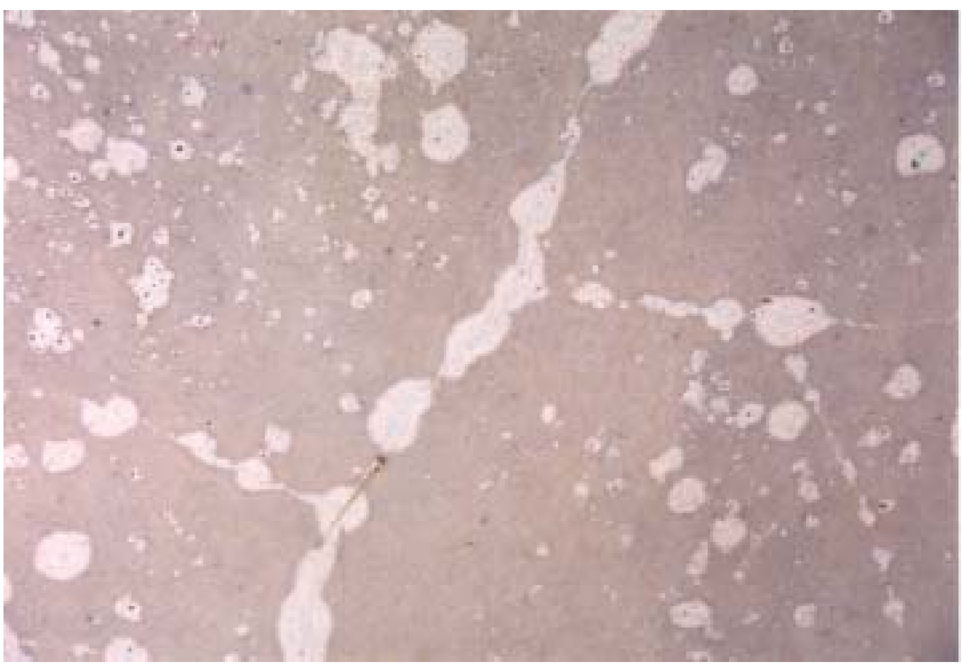

Figure 8 – Cracks

Figure 9 – Brass Fittings

Figure 10 – Core in Spa

Figure 11 – Core 1 in Lab

Figure 12 – Core 2 in Lab

Figure 13 – Core 3 in Lab

Figure 14 – Bond Failure

Figure 15 – Aggregate Exposure of Kennett Pool Surface

Figure 16 – Aggregate Exposure of Kennett Pool Surface

Figure 17 – Aggregate Exposure of Unetched Plaster (Unexposed to Water)

Figure 18 – Aggregate Exposure of Plaster Cured in Balanced (Non-aggressive Water)

Figure 19 – Aggregate Exposure of Lightly Etched Plaster

Figure 20 – Aggregate Exposure of Moderately Etched Plaster

Figure 21 – Aggregate Exposure of Heavily Etched Plaster

RJ Lee*Group*, Inc.

350 Hochberg Road
Monroeville, PA 15146
Tel: (724) 325-1776
Fax: (724) 733-1799

The Materials Characterization Specialists

July 8, 2003

OnBalance
3116 E. Pennsylvania Street
Tucson, AZ 85714

Attention: Mr. Que Hales
Re : RJ Lee Group Project Number MAH304128

Dear Mr. Hales,

A core sample was sent to RJ Lee Group to characterize the discoloration on the surface. The sample was identified as RJ Lee Group sample number 0808763.

Sample Preparation

The sample was a small core of plaster only, shown in Figure 1. Figure 2 shows the plaster core with oblique lighting. No concrete, from the pool substrate, was observed on the opposite side (not shown), indicative of plaster delamination from the shotcrete substrate.

No sample preparation was made for the stereo optical microscopy analyses. The surface in contact with pool water of the sample was simply placed in the view of the microscope.

To prepare a polished specimen, a portion of the sample was dry cut through the thickness and the cut surface polished, using a diesel solvent, approximately a millimeter into the material. The sample was dried, at approximately 50 °C, and vacuum impregnated with a low viscous epoxy resin. Further polishing was accomplished using a non-aqueous solvent (diesel) and diamond grit of increasing fineness, finally lapping the surface with diamond grit less than a micrometer in size.

Analytical Techniques

Stereo optical microscopy, scanning electron microscopy (SEM) and selective ion electrode were utilized for this investigation.

The stereo optical microscope uses reflective light imaging at magnifications between 10 and 50X. The sample is placed under an intense light source and images acquired through binocular lens.

The scanning electron microscope (SEM) produces an electron beam that is rastered across the surface of a material. When this electron beam interacts with material a number of physical processes take place. Backscattered electrons (BSE) are electrons, which after the beam interaction, are observed coming "back" nearly 180 degrees. Thus, a detector is situated around the initial electron beam and image produced from these backscattered electrons. BSE images give limited information concerning topology; more information is discerned about the chemistry. The more intense the BSE signal the higher the electron density of the area; i.e. an image with a dark contrast indicates a low electron density. Both the density of the material and the atomic number of the elements present will influence

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the electron density. Thus an unhydrated cement grain will have a "lighter" contrast than the surrounding hydrated paste; or limestone sand grains will appear "lighter" in a hydrated paste, which has higher silicon content.

The selective ion electrode works much in the same manner as pH meter, a probe is placed in solution and the current generated through a permeable membrane from the anion in solution is compared to a "standard" solution. Analysis was performed per ASTM method C 1152-97, "Standard Test Method for Acid-Soluble Chloride in Mortar and Concrete".

Photographic and Stereo Optical Results

Photographic images are shown in figures 1 and 2. Stereo optical images are presented in figures 3, 4 and 5. Figures 1 and 2 show a line of "spot etching" following the length of a crack running along one side of the core.

Evidence of re-tempering on the surface is not observed in figure 1 and 2; the paste surface is relatively smooth. Figure 2 shows the sample in oblique lighting; relief due to re-tempering is not evident. Previous studies of samples obtained by OnBalance (e.g. report date 7/13/2001) have documented that re-tempering relief (an over-trowelled surface) directly corresponded to "spot etching".

Relief is observed, in figure 2, decorating the length of the crack due to efflorescence, indicative of a calcium rich material. From our discussions, this phenomenon seems to be generally termed nodular growth in the swimming pool industry. A green discoloration is observed also decorating the crack. Figures 3, 4 and 5 show higher magnifications of the efflorescence. The stereo optical images do not show evidence of "disrupted" paste indicative of an aggressive solution (surface attack due to acidic water conditions). This surface phenomenon is exemplified in a previous study (report date 2/6/02) where eight plaster coupons were subjected to various curing regimes and acidic water conditions (by OnBalance).

SEM Results

BSE micrograph images of the cross-sectioned sample are presented in figures 6 through 17. Figure 6 shows an affected ("spot etched") region. As observed in many previous "spot etched" swimming pool plaster samples, the region consists of a calcium rich layer directly adjacent to the swimming pool water followed by a elliptical region of reduced calcium content (and higher silicon content). This highly siliceous region of increased porosity is indicative of the "spot etched" effect. These effects are documented in figures 6, 8, 9 and 11.

Figure 10,12 and 13 show depositions of ettringite, a calcium aluminosulfate hydrate compound. Ettringite depositions are observed along cracks and in highly porous regions, indicating the depositions are formed during the paste reconstruction occurring during the movement of calcium through the paste. The ettringite deposits have thus formed after the formation of the highly porous regions.

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Figures 7, 14 and 15 show cracking throughout the paste. Figure 7 shows a shrinkage crack pattern in a region away from the affected region and is typical of the general paste structure. The implication is that the crack pattern predates the affected region. Figures 14 and 15 are high magnification images taken of the cross-section along the crack shown in the stereo optical images. The images show that a calcium rich phase, indicative of calcium hydroxide decorates the crack. The morphology of this calcium hydroxide matches the structure of the crack, confirming that the calcium hydroxide formed after the crack had formed. The images also show a porous highly siliceous region decorating the crack.

Figures 16 and 17 show a high content of chloride is present in the paste. The chloride concentration is high enough that not only are Freidel salts present, but also increased chloride content is observed in calcium silicate hydrates.

Conclusions

The chloride content in the paste (observed in the SEM) indicates that calcium chloride has been added to the plaster at a concentration greater than 2 Wt.%. This addition has resulted in extensive shrinkage cracking throughout the plaster paste. This cracking also appears to predate the formation of the affected region, highly porous paste follows the crack and calcium rich material has moved from the porous regions into the crack.

Porous regions forming or following cracks have been observed in a previous study, from samples produced by Onbalance (report date 3/19/2001). In that study, plaster coupons were produced with elevated levels of calcium chloride and were similar to the porous regions decorating the major crack in this sample.

The results from ASTM method C 1152-97 indicate chloride is present at 1.04 Wt.%. Assuming a water to cement ratio of 0.3 (in the harden plaster) and a cement to aggregate ratio of 1.75, indicates a calculated calcium chloride content of 5.0 Wt.% was added to the plaster.

The results from this sample, when compared to previous studies conducted on swimming pool plasters (exhibiting "spot etched" regions), indicate that the "spot etched" regions are primarily due to elevated levels of calcium chloride added to the plaster.

Sincerely,

Boyd Clark
Senior Materials Scientist
RJ Lee Group, Inc.

RJ Lee Group Project No. MAH304128

Figure 1.

Figure 2.

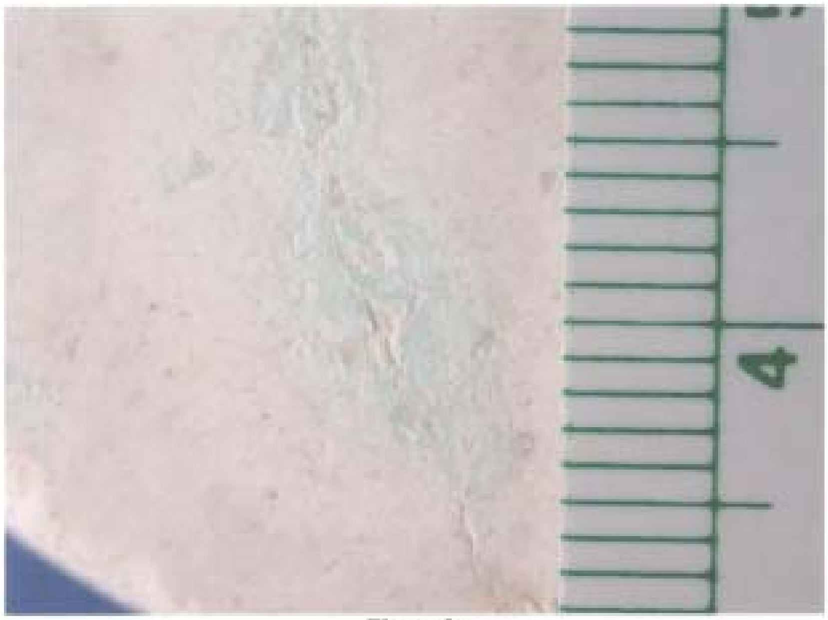

Figure 3.

Figure 4.

RJ Lee Group Project No. MAH304128

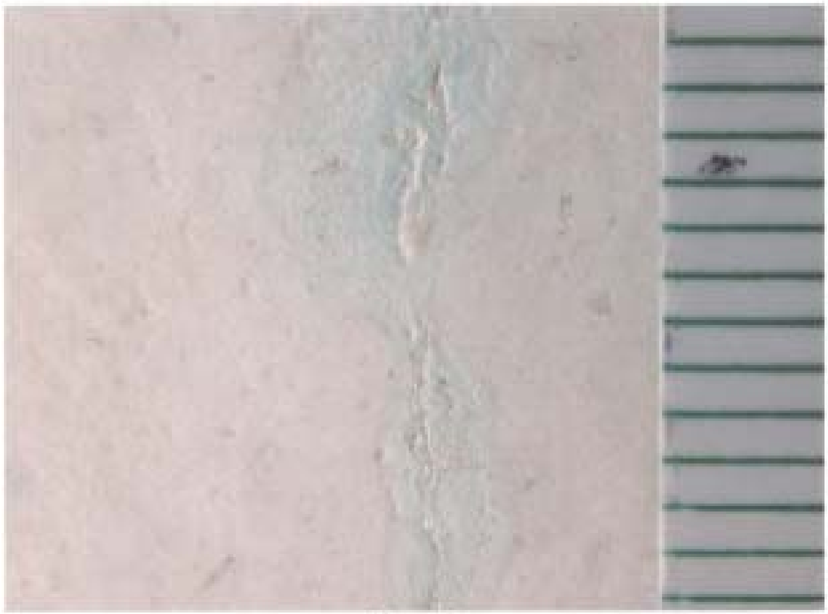

Figure 5.

RJ Lee Group Project No. MAH304128

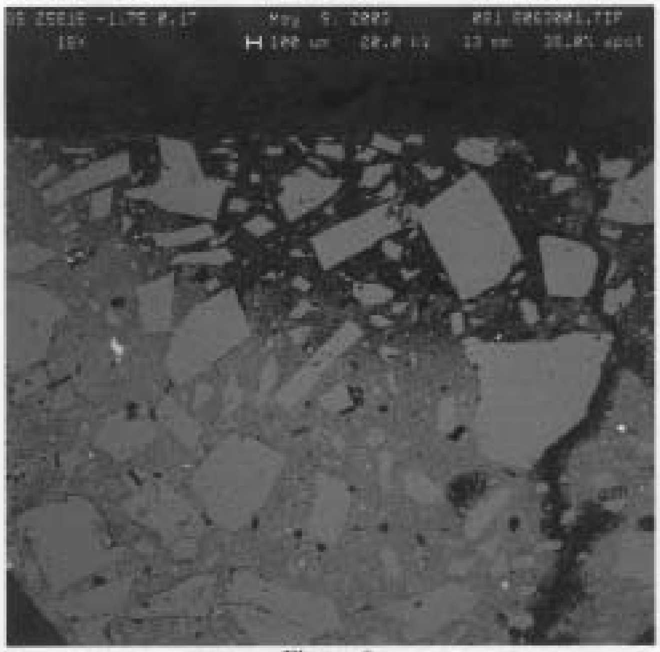

Figure 6.

RJ Lee Group Project No. MAH304128

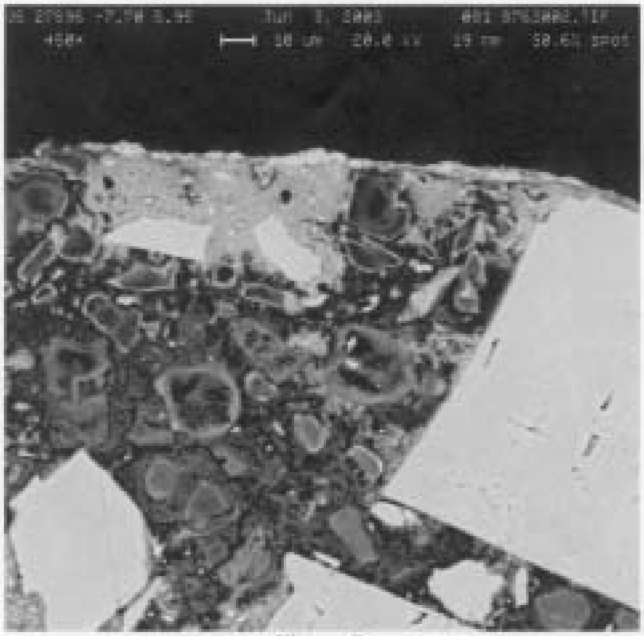

Figure 7.

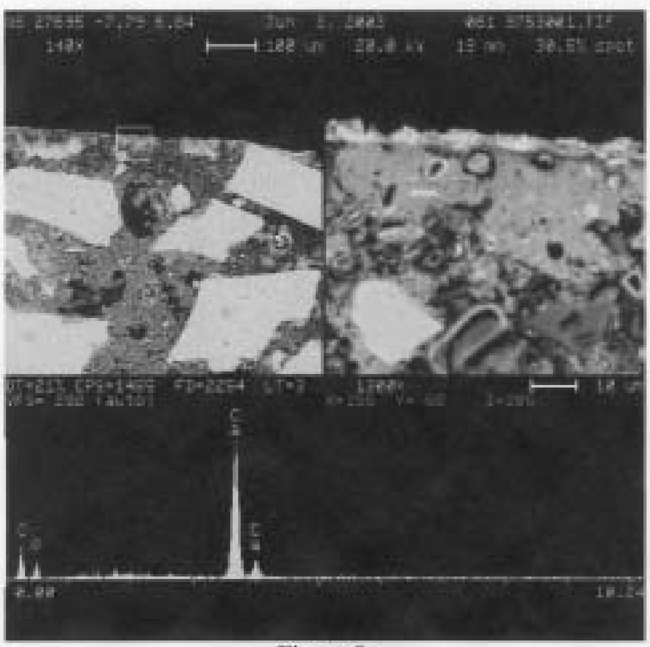

Figure 8.

RJ Lee Group Project No. MAH304128

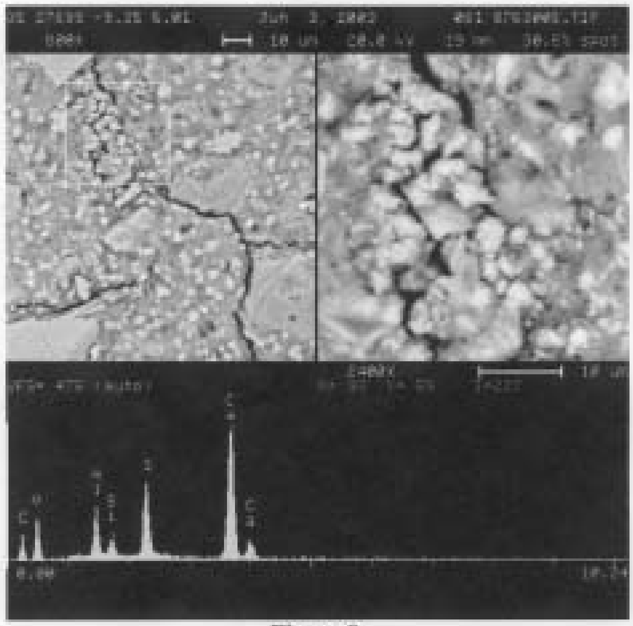

Figure 9.

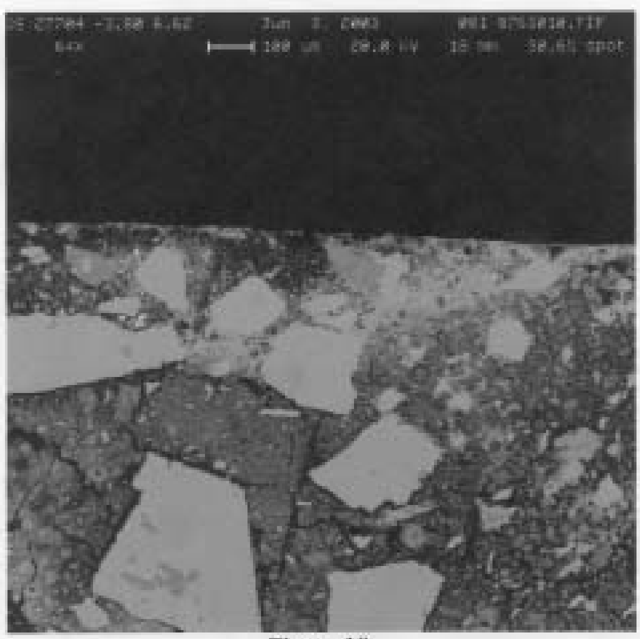

Figure 10.

RJ Lee Group Project No. MAH304128

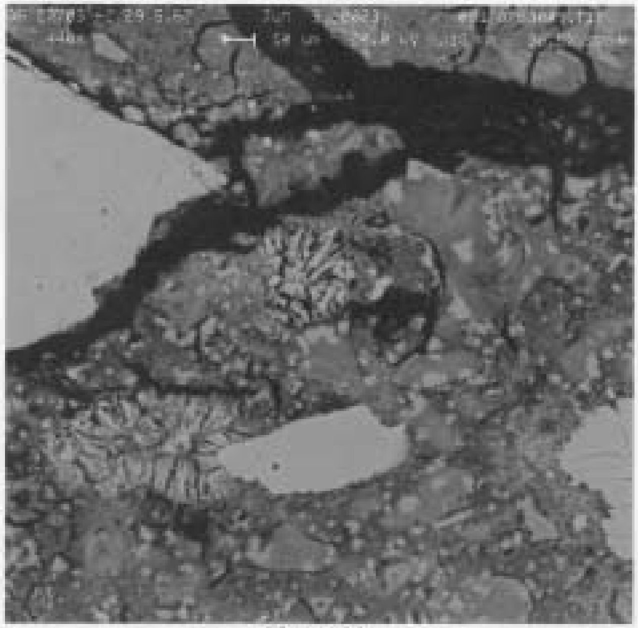

Figure 11.

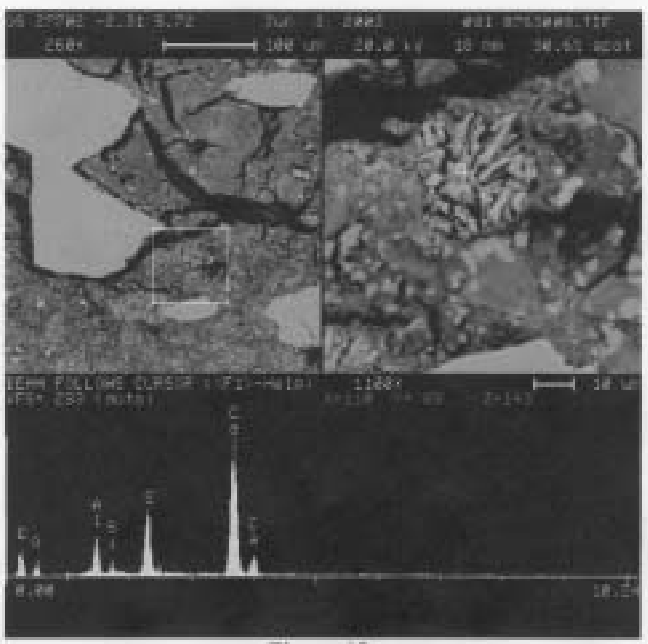

Figure 12.

RJ Lee Group Project No. MAH304128

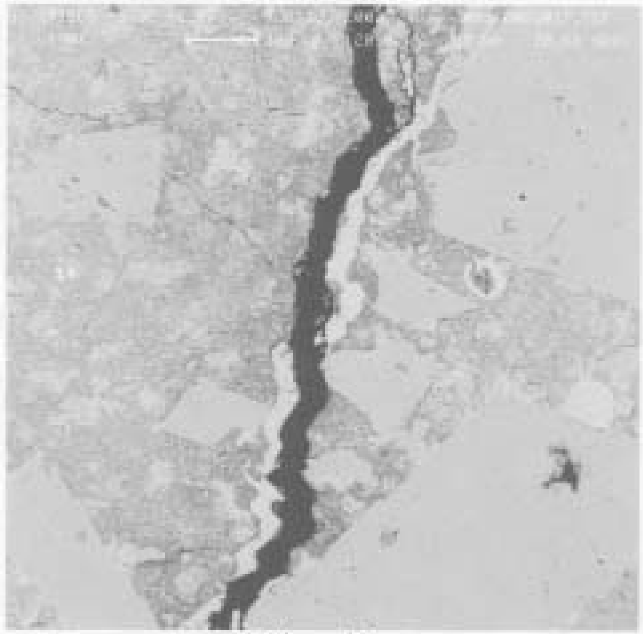

Figure 13.

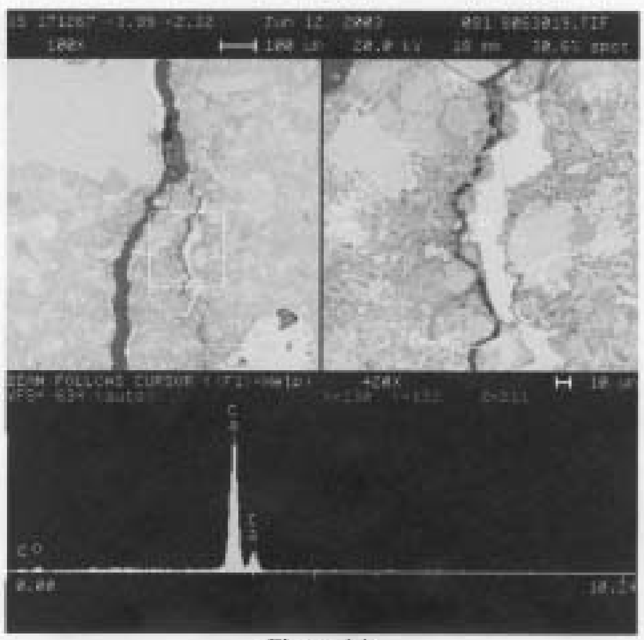

Figure 14.

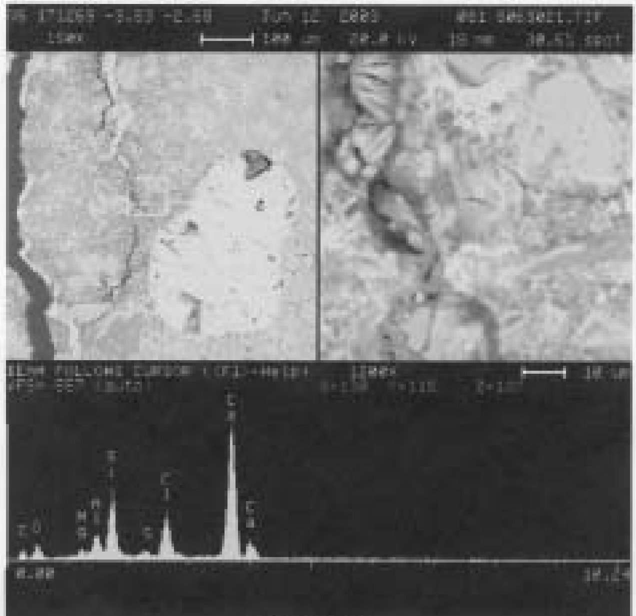

Figure 15.

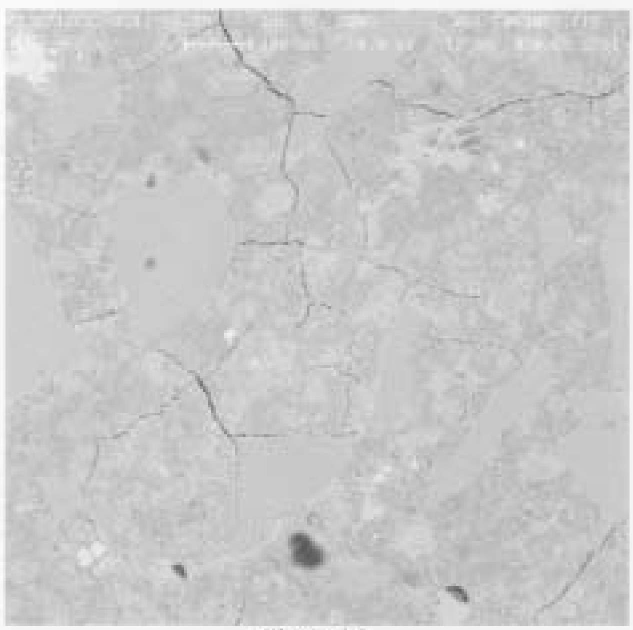

Figure 16.

RJ Lee Group Project No. MAH304128

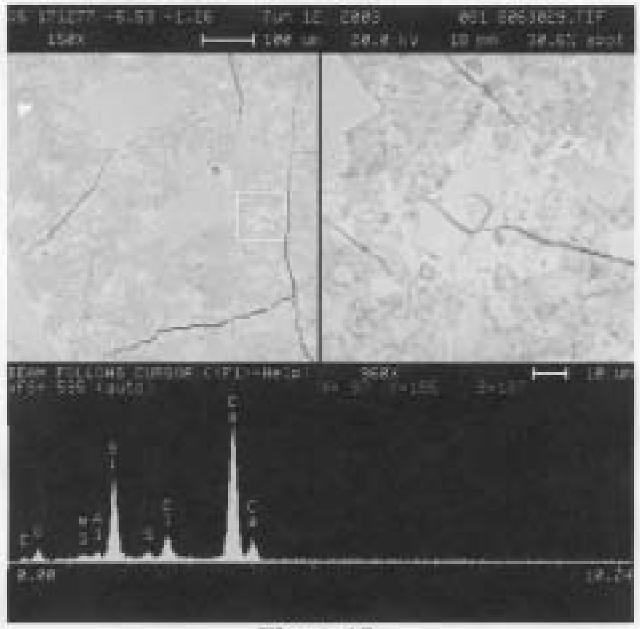

Figure 17.

CTL
Construction Technology Laboratories, Inc.

REPORT TO:

onBalance

3116 East Pennsylvania Street

Tucson, AZ 85714

EVALUATION OF SURFACE DISCOLORATION SWIMMING POOL PLASTER

by

L. J. Powers

August 14, 2003

CTL Project No. 154801

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CTL

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REPORT OF LABORATORY EVALUATION

CTL Project No.: 154801 Date: August 14, 2003

Re: Evaluation of Surface Discoloration Swimming Pool Plaster

One core sample of pool plaster with patches of shotcrete substrate attached was received in May 2003 from Mr. Que Hales of onBalance, Tucson, AZ. The surface of plaster represented by the submitted sample exhibit bright white circular, irregularly shaped, and patterned discoloration. Color photographs showing the surface condition of the plaster and a copy of reports prepared by RJ Lee Group, Inc., Monroeville, PA were also submitted.

Scope of CTL Work: Microscopical examination combining petrography and scanning electron microscopy (SEM) was requested to investigate possible causes of the observed surface discoloration. Chemical analysis of the sample for acid-soluble chloride concentration was also requested.

FINDINGS AND CONCLUSIONS

Visual examination of the plaster sample reveals that the reported bright white features surround greenish gray spots on the surface. These greenish gray spots are also observed in the field photographs. Greenish gray and bright white surface discoloration also occurs at cracks (seen in several of the submitted photographs) and the patterns tend to be symmetrical about the crack. The pattern of green and bright white discoloration is often complex when viewed at magnifications of 10 to 40X with a stereomicroscope. The following observations are summarized from the observations made with the stereomicroscope, polarized-light microscope, and the study of selected areas with the scanning electron microscope.

- The greenish gray and bright white features are confined to the troweled surface – no evidence of the discoloration is seen at the back surface of the plaster. A cross section cut through a typical green and bright white spot shows discoloration only at the plaster surface; however, the 'affected' zone of disturbed paste properties (see below) extended to a depth of 3 mm below the white and green spot sectioned. The shape of the disturbed zone is broadly lenticular (lens-like shape).

- Small bright white spots with and without greenish gray rings occur over shallowly embedded chips of marble aggregate (Figs. 1 and 2). These spots consist of soft and porous paste and are slightly depressed below the troweled surface. In the areas studied, smaller spots are found above smaller aggregates and larger spots with green rings (sometimes multiple rings) are present above larger aggregate particles. The outer surface of the marble does not exhibit evidence of dissolution or etching. The marble contains variable but small amounts of pyrite (iron sulfide) and rust stains are sometimes present around exposed pyrite crystals. It is not know whether the presence of pyrite is related to the development of the observed discoloration.

- Green to gray rings of relatively harder and denser material, slightly elevated above the troweled surface, surround the bright white spots. Alternating rings of softer bright white paste and harder greenish gray material are frequently observed. SEM-EDX element scans of the greenish gray material revealed calcium and phosphorus with traces of copper (Fig. 4). The source of phosphorus is not known. Interestingly, the calcium phosphate mineral apatite is green and chlorapatite is greenish gray.

- Thin-section microscopy shows that the normal depth of paste carbonation outside of the discolored areas is approximately 0.4 mm. At the location of a sectioned bright white spot, the paste is intensely carbonated to a depth of 3 mm. A tight layer of secondary carbonate 5 to 7 micrometers thick is present on the outer surface of the plaster. The microstructure of the paste is disturbed within the area of intense carbonation. The paste appears lacy (Fig. 3) with patches of calcium-depleted leached paste containing cement relics interspersed between threads of fine-grained calcite intermixed with other phases, including Friedel's salt (calcium chloroaluminate). Denser areas of disturbed paste, described above, appear to be secondary deposits within the area of enhanced porosity (lacy paste) that developed by leaching.

- Green to gray rings of relatively harder and denser material, slightly elevated above the troweled surface, surround the bright white spots. Alternating rings of softer bright white paste and harder greenish gray material are frequently observed. SEM-EDX element scans of the greenish gray material revealed calcium and phosphorus with traces of copper (Fig. 4). The source of phosphorus is not known. Interestingly, the calcium phosphate mineral apatite is green and chlorapatite is greenish gray.

- Calcium hydroxide is not present at the surface in carbonated areas, but is observed in amounts estimated at 2 to 3% below the carbonated paste layer and outside of the disturbed paste areas. Calcium hydroxide is often seen in voids, microcracks, and adjacent to the aggregate particles.

- Distribution of cement grains is fairly uniform throughout the thickness of the sample, based on evidence of cement that includes unhydrated cement grains, partly hydrated grains, and relics (shape of cement grain preserved). Unhydrated cement grains are not present in the broadly lenticular disturbed region that includes the bright white and greenish gray areas. Relics, typically with multiple hydration rims, are present in the disturbed regions. The effective water-cement ratio in the disturbed regions is very high relative to the moderate w/c interpreted for the undisturbed areas.

- Random microcracks are common throughout the thickness of the plaster. Most microcracks are narrow (less than 2 micrometers wide). Some microcracks are open. Deeper microcracks are sometimes filled with calcium hydroxide. Shallower microcracks are sometimes filled with calcium carbonate or fine-grained dark particulate material.

- Calcium hydroxide and secondary ettringite (calcium sulfoaluminate hydrate) are present in voids outside of the areas of carbonated and disturbed paste. Within the area of disturbed paste, Friedel's salt (calcium chloroaluminate hydrate) is present in small pores.

- The plaster contains crushed calcitic marble dispersed in white portland cement paste. Estimated paste volume is 50 to 60%. Estimated air content is less than 1%.

Chloride Analysis

Results of chemical analysis (see attached report) show that the acid-soluble chloride content of the plaster is 1.06 wt%. This amount of chloride ion is consistent with addition of a chloride compound. Information provided with the sample states that chloride is added as $CaCl_2$.

DISCUSSION

Based on the results of the analysis, white discoloration is related to the presence of localized areas of high porosity resulting from leaching of the paste at and near the surface of the plaster. The apparent high w/c locally may result from secondary hydration of cement that is often seen at surfaces of cement paste exposed to copious amounts of water. The areas of weak paste appear to be centered predominantly over aggregates and cracks. Trowelling practices that expose aggregates at the surface may provide avenues for water to enter the plaster along the boundary between the paste and the aggregate. Water may also enter the plaster at crack locations and then circulate through microcracks. The network of random microcracks observed in the plaster is attributed to shrinkage, possibly caused by high paste content and by the addition of calcium chloride (Design and Control of Concrete Mixtures Portland Cement Association 14th Edition, 2002, p 113). The subsequent formation of colored rings appears to be a secondary phenomenon caused by deposition in the porous areas and related to interaction between water and dissolved salts (such as phosphate), and trace elements (such as copper) in the water.

METHODS OF TEST

Petrographic examination was performed in accordance with ASTM C 856-02, "Standard Practice for Petrographic Examination of Hardened Concrete." The submitted sample was examined at magnifications up to 45X using a stereomicroscope. For thin section preparation, a rectangular block measuring approximately 45-mm long, and 10 to 15-mm thick was cut to provide a cross section through the thickness of the plaster. One side of the block was impregnated with low-viscosity epoxy resin. After the epoxy hardened, the prepared surface was finely ground, cleaned, dried overnight, and then attached to a glass microscope slide with epoxy resin. After the epoxy hardened, the thickness of the mounted blocks was reduced to about

20 µm by further cutting and grinding. The resulting thin section was studied at magnifications up to 400X with a polarized-light (petrographic) microscope.

A polished thin section, fracture surface, and the troweled surface of the specimen were further examined using an Hitachi S-2600N scanning electron microscope equipped for energy dispersive x-ray fluorescence (EDX) analysis to provide identification and relative concentrations of elements with atomic numbers greater than five. Portions of the sample were examined using secondary electron (SE) and backscattered electron (BSE) modes. The title bar along the bottom of each SEM micrograph includes sample identification, scale bar, and acquisition parameters.

Chemical analysis for acid-soluble chloride ion concentration was performed in accordance with ASTM C 1152. Additional information is available in the attached report.

Laura J. Powers
Principal Microscopist
Microscopy Group

LJP/ljp

154801

Attachments

Fig. 1 Stereomicroscope image showing soft spots over marble aggregates and discoloration of the troweled surface of the plaster.

Fig. 2 Stereomicroscope photograph showing soft spots and discoloration on the troweled surface of the plaster.

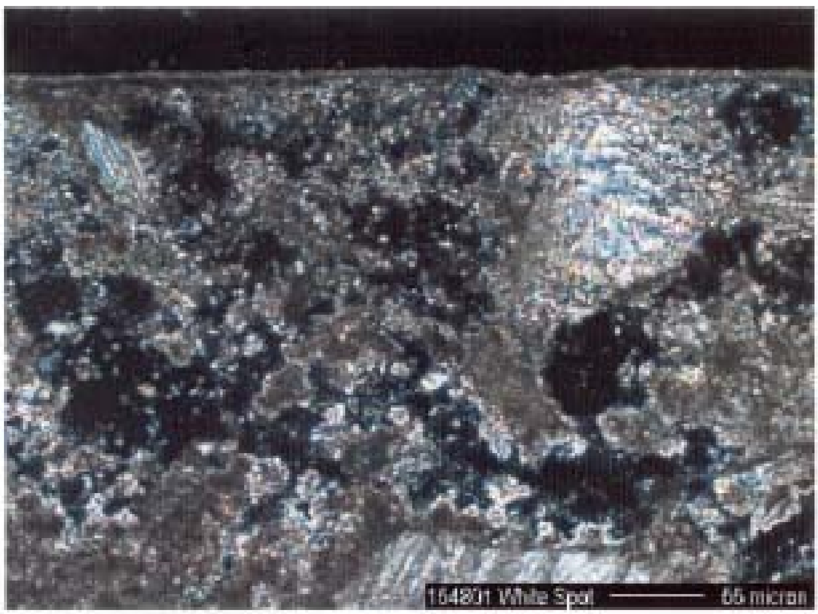

Fig. 3 Thin-section micrograph showing lacy texture of paste in the soft white spots at the troweled surface of the plaster. Dark areas are leached paste. Cross-polarized light.

CTL
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Client:	**onBalance**	CTL Project No:	**154801**
Project:	**Pool Discoloration**	CTL Project Mgr.:	**Laura Powers**
		Analyst:	**M. Bharucha**
Contact:	**Que Hales**	Approved:	
Submitter:	**Laura Powers,CTL**	Date Analyzed:	**22-Jul-03**
Date Rec'd:	**9-May-03**	Date Reported:	**22-Jul-03**

REPORT of ACID-SOLUBLE CHLORIDE

Sample Identification			Determined
			Chloride (Cl)
CTL ID	Client ID	Description	(wt% of sample)
856701	Plaster Specimen	Plaster	1.063

Notes:
1. This analysis represents specifically the samples submitted as received.
2. This report may not be reproduced except in its entirety.
3. Analysis by potentiometric titration with silver nitrate. (ASTM C1152)

Structural/Architectural Engineering, Testing and Materials Technology

Swimming Pool Finish Specialist
5120 W. Bethany Home Rd – Glendale – AZ - 85301
(602) 249-3018 Office (623) 463-0644 Fax

Superior Pool Plastering has supplied the following information to the best of our knowledge.

1. What is the standard mix ratio?
   - -400 lbs. cement
   - -600 lbs. poll grade sand. Enough water to achieve proper consistency.
   - -Calcium chloride as needed (up to 2%)

2. What was the mix in the Kennett's pool?
   - -Standard

3. What were the conditions on the day that the pool was plastered?
   - -The average temperature on March 22, 2001 was 72.5 degrees. At 8:45am the temperature was about 71.6 degrees
   - -The humidity at 8:45am was 33%
   - -The cloud coverage was mostly cloudy
   - -The time of day that the pool was plastered was approximately between 8:00am and 8:30am
4. What is the interior surface area of the pool?
   - -The interior surface area of the pool was 1010.
5. How many finishers were on the crew?
   - -There were 3 finishers on the crew
6. How many pools did that crew do that day?
   - -Martin and his crew did 2 pools that day.
7. Which was the Kennett's pool in that sequence?
   - -Kennett's pool was first in that sequence.
8. How long did it take to finish the pool?
   - -Unknown

9. Who turned on the water to fill the pool?
   - -Unknown. Under normal condition –plaster crew member
   - -When (relative to the completion of the troweling)?
   - -After the new plaster is hard enough to except water. (normally shortly after the last troweling.)
   - -By whose instruction?
   - -Superior Pool Plastering