Lagoon Balustrade Preliminary Assessment

In the left rear of the photograph above, cordoned off with yellow caution tape, is the West Staircase of the Sunken Lagoon.

A shifting of the blocks outlined in red, to the left, has caused a pronounced list in the balustrade, shown at right. This list has reached a degree where it was determined a hazard to public safety, and the staircase closed to traffic.

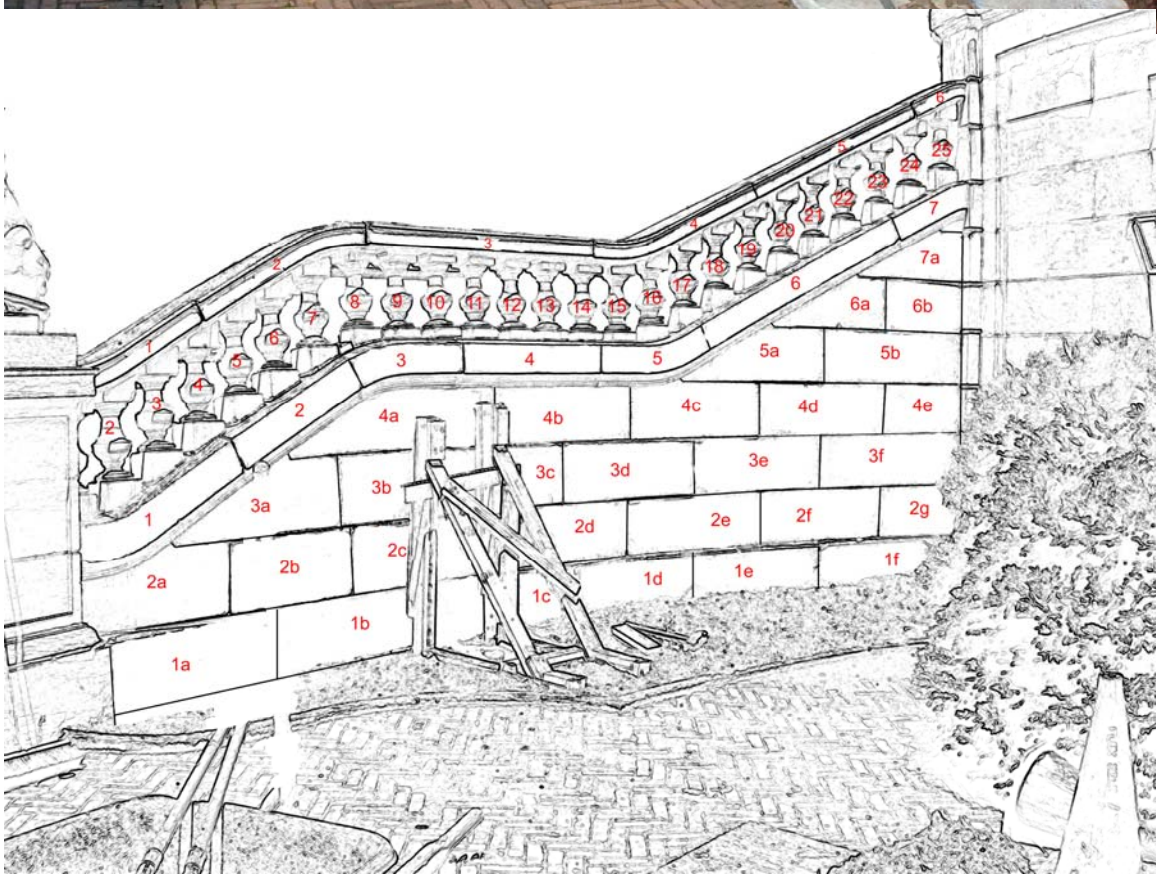
The width of the caulk joint between the risers and the lower rail of the balustrade is further evidence of this movement.

The displacement of the upper rail is clearly illustrated in the photo, at left.

Repairs in this case will likely require disassembly of the balustrade, and the inside retaining wall, before reaching a point where the cause of damage becomes evident, can be alleviated, and reassembly accomplished. It is possible that some below grade work will also be necessary.

Repair Process
West Balustrade
Sunken Garden
Summer 2003

The first steps in the repair process entail the marking of each piece in the installation and mapping of it's placement. The most severely buckled section of wall has been shored to protect against the danger of collapse as the upper sections are dismantled.



In order to separate individual stones from surrounding material, the mortar joints were cut with a four inch diamond blade in a hand held grinder, and hammer/chisel work. Wooden wedges were then driven into the spaces available, breaking the mortar bond, without damaging the visible edges. Elements were then lashed in rope slings, lifted by crane, and deposited on pallets. Fearing that the balusters might come loose and fall while lifting pieces of the top railing it was determined that they should be lashed together. Since the wall is curved, regular lumber could not easily be made to conform. Bundles of flexible bamboo were bent to shape and lashed together, inside and out. Once the top stones were removed, the lashings were undone, from the bottom up, and the

balusters removed one at a time. Several balusters evidenced cracks between the base and the central bulbous form. Only one could not be excised intact. This one had to be drilled and pinned before reinstallation.

As we progressed in the process of disassembling the structure we discovered several distinct varieties of mortar that were used in the original construction, and others applied subsequently in various repairs performed since. The original mortars can be identified by the gray-white sand used as aggregate, in all forms. Modifications were apparently utilized depending on the demands made of the particular element. The upper reaches of railing, including top rail, balusters, and coping, were assembled using a very hard, almost crystalline mix. Compressive strength is very high, and bond is extremely

tenacious. In the railing, from the landing down, medium bond strength and much lesser compressive strength prevails. A similar mix was used to pad out the top surface of the wall blocks, providing a regular surface that once set, would support the copingstones. In the joints of the face of the wall, a much softer mix was used to bed the stones. Many of the bed joints were reduced to sand, encouraging the belief that this was straight lime putty mortar that has had the lime leached out, over time. There was no mortar in the head joints aside from pointing material.

There is a considerable void between the masonry core and the marble façade. This void was filled with what appears to be soil that might have washed in through the opened joints between the treads and the wall cap. Confusing the issue is the presence of brick rubble in this fill. Did these bits flake off the face of the masonry mass as the sediments were deposited? Or, did the masons, hoping to provide additional support for the coping, fill with this organically rich material that by its nature holds moisture and would present difficulties generated by freeze/thaw action? As completed, the reconstruction was accomplished with the void unfilled and weeps at the base for drainage and aeration.

The top surfaces of the masonry core and the footing constructs were slathered in a heavy bituminous coating. This material is essentially intact and was left as is. The side of the riser mass was uncoated, presumably encouraging transmission of moisture, from the core, to the void, to the atmosphere. This surface was left untreated.

Nearly every stone has a depression carved to accept insertion of wire ties that should bind the façade to the core. All but one had been filled with mortar without use of the intended tie. The one installed tie was found at the junction where the vertical edge of stone 4D intersects the mid-point of stone 3E. It is from this point towards the bottom of the staircase where the major displacements had taken place. One other tie was found inserted into the masonry core, but it had never been set, in the marble. These ties were of galvanized steel and the one installed had corroded to the point that it broke off during the process of cleaning fill from the void between the core and façade. Stainless ties were fabricated for installation during re-construction.

In the photo at right the never utilized tie is seen, in the background, bent up out of place. In the foreground is a new stainless tie, set and ready for the next stone

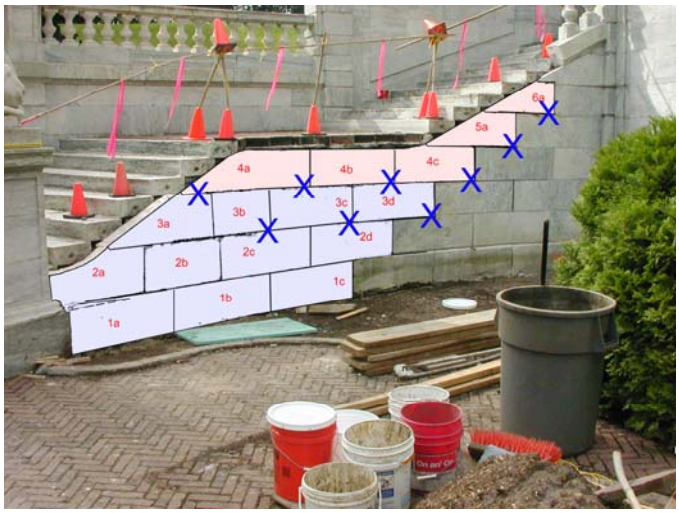
Circled, in the photo, at left, the one installed original wall tie.

Fortunately, displacement of the wall did not extend beyond those stones locked in place by elements of the main façade. With stones removed, as shown to the right, all sediments and debris removed from the cavity between core and façade, we moved on to preparation for reinstallation.

Before resetting each stone had to be cleansed of old mortars still adhering to the bond surfaces, and, as much as possible, mortars bonded to the face. As noted earlier, the bedding mortars had deteriorated to the point where a stiff brush was sufficient to provide an acceptable result, in most cases. The material left from previous repointing efforts presented the major difficulty. Soiling and biological growth was removed through an application of GranQuartz 515C Periodic Intensive Cleaner.

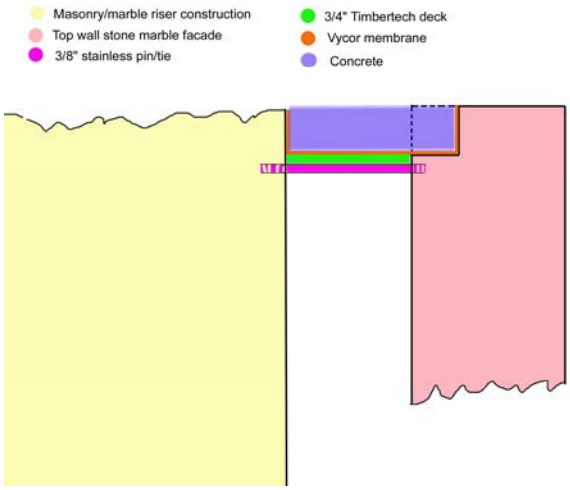
Removal, of sound bedding mortar and pointing mortars, from bedding surfaces, was effected primarily with hammer and chisel.

Repointing mortars on the face of the blocks had to be carved away so as not to destroy the grooved finish detail. In the interest of facilitating reconstruction and to avoid over-tooling the edges, the bulk of this work was put off until the structure was reassembled, but prior to final pointing. A common Dremel, with a heatless ceramic wheel, shaped on a diamond dressing tool, was used in this operation.



Two days with a full crew and the façade blocks were set. Those shaded blue on the first, and the red on the second. Stones were bedded in a Butterjoint Hydraulic Lime Putty Mortar, premixed by US Heritage Group, in Chicago, and the joints cut back to allow uniform pointing, at a later date. Head joints were left clean as in the original construction. One stainless anchor was set at each "X".

At this point we make our only major departure from the original design. As stated earlier, when dismantling the structure we discovered a cavity filled with soil and masonry debris. The copingstones are considerably wider than the façade blocks and in most places had less than a 50% bearing on the lower construction. It is very possible that the original masons purposely added this fill hoping to support the coping while the mortars set. If so the concept worked, initially. However, such a fill would hold moisture and in a freeze would exert an expansive force sufficient to displace the façade blocks. A slight movement would open the joints between the façade and the risers. In a thaw, the fill would soften and settle into the additional space left by the movement during freeze/expansion. Later rains would wash additional sediments into the open joints caused by the initial movement, beginning a cycle that could very likely have caused the eventual condition of near collapse. The fact that almost none of the intended anchors were installed certainly contributed to this progression. In order to cope with the situation, the following innovation was incorporated into the structure.



Hoping to keep the cavity open, facilitating drainage and aeration, it was decided to span the void between the top façade stone and the riser core structure with a concrete deck. Distributing the burden of the upper structures evenly amongst the separate lower constructs, provided a sound base for the copingstones without creating stresses that would encourage lateral movement.
At left find the final detail for the concept.

The photos below show projected and actual implementation.

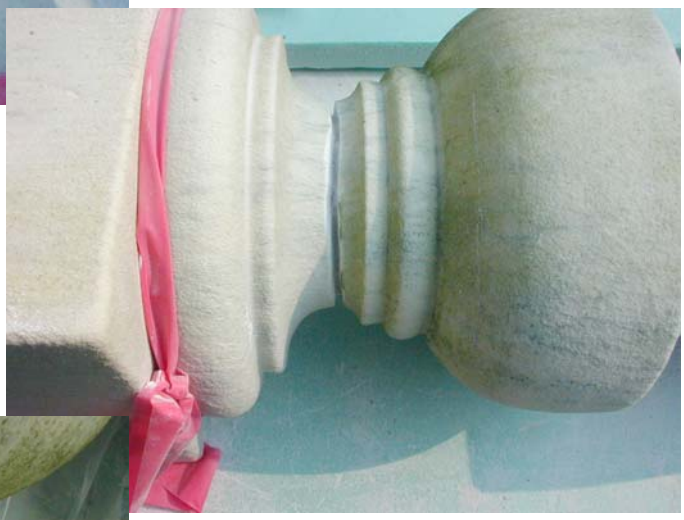
With setting of the copingstones the base structure was complete and we moved on to preparation of the balusters and rail. As can be seen at right, the material used to set the balusters was of an extremely tenacious bond. So much so that in dismantling, often the marble gave before the mortar. Before reassembly, the bonding surface of the stones had to be cleansed

In order to protect the vulnerable edges of the stone the old mortar was cut back using a four-inch diamond blade in a hand held grinder. Scoring of the mortar into a grid pattern allowed use of hammer and chisel to clear the bulk of the offensive material.

A light application of an abrasive wheel in a hand held five-inch sander produced a clean, keyed surface, ready for installation. A masonry drill was used in clearing the holes meant to accept stainless anchors that were used in pinning the balusters to the coping. These helped maintain position of the balusters while setting, as well as providing some reinforcement to the final set.

As mentioned earlier, one baluster was broken during removal. Repair entailed drilling and pinning the two segments. The stainless pins were set with Hilti epoxy.

With pinning complete, the epoxy was left to cure over night.



Next day, fully cured, it was possible to rout the excess and prep for filler.

The filler, a cement/lime putty mix, with crushed marble aggregate, was allowed to cure over night.

The following morning a carbide file was used to cut the final profile. A stiff nylon bristle brush was used to remove residual filler and the piece was ready to set.

The photo at right shows the condition of the #1 baluster as we approached the job. Broken sometime in the past, the shards are unavailable, and replacements must be fabricated.

As documented in the previous operation, the stones are marked and drilled to accept stainless pins, that are anchored in Hilti epoxy, and left to cure overnight.

Next, we rout a channel of sufficient depth and breadth to hold filler, and pack with cement/lime putty/marble aggregate. Since this filler will be carved with the stone, a plastic cover is placed over the filled section, and the site kept shaded and moistened through the day, hoping to encourage a maximal cure.

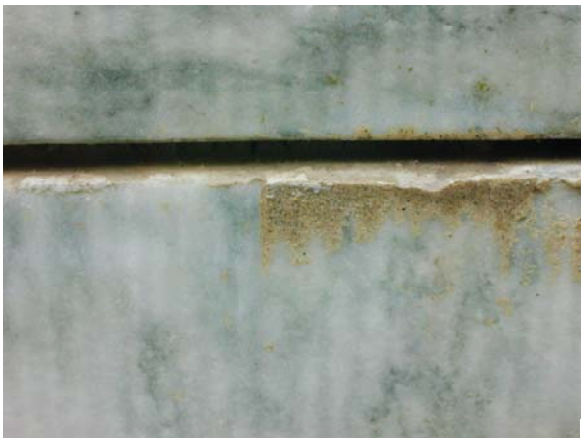
At the end of the day the excess is shaved to produce a rough profile, and the piece is covered and left to cure over the weekend.

Making use of various diamond burrs and bits mounted in a Foredom Flexshaft, hand held files, and a five-inch circular sander, we carve the grafted material to produce the appropriate profile.

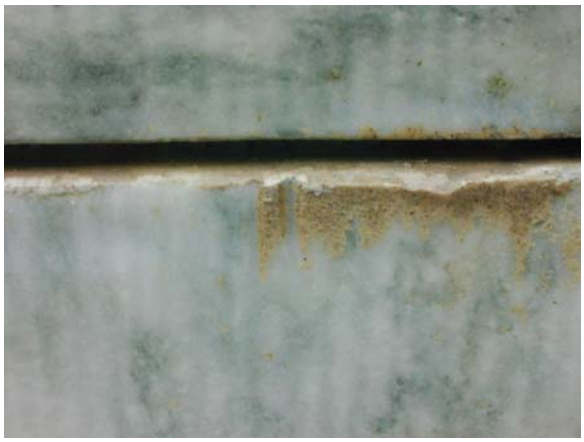
Some slight touch-up to the filled area, and the piece is ready to be set, once again producing a bond joint between the rail section and the pedestal/terminus.

With setting of the balusters and rail sections, assembly is complete. Now began one of the most tedious, time-consuming tasks of the project.

As mentioned earlier, previous repointing attempts had left a residue of hard Portland mortar, following the joints, and smeared across the face of the blocks. Because of the grooved texture applied as a finish to the stone neither hammer/chisel, nor grinder/sanders could be used to remove the material. As noted, a Dremel with shaped, heatless, ceramic wheels was used to carve away these unsightly deposits.



1) As one moves across the stone…



2) …first carve the valley …

3) …then go back and clear the crest…

4) …and again…

5) …and again…

6) …and again…

…and so, this…

…becomes this…

…and this…

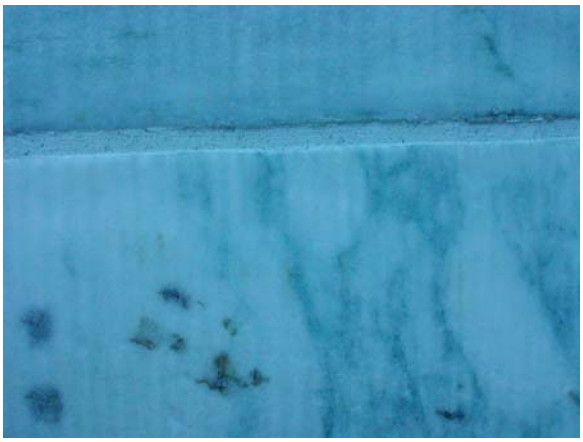
Seven days were spent in this way, until all but those areas to be covered by plantings were clean. The carved areas were then lightly sand blasted to create a texture that would blend with the weathered fields adjacent.

…just so…

Pointing proceeds in the shade of a canopy slung from the scaffold and the structure itself. Protection from direct sun and constant misting are essential to allow the mortar a sufficient period of hydration for proper cure.

Initially, the pointing mortar is packed proud of the stone facing.

After an initial curing period, that material protruding beyond the face of the blocks is tooled flush with the face.



A light brushing then gives the final finished joint, slightly recessed from the face of the stone.

The last stone in place, the final joint packed and finished, the structure is complete, with only the landscaping to provide the finishing touch.