A Report on Conditions and Monitoring at the J.K. Williams Flagpole and Monument

Monument during determination of rebar locations.

In July 2015 Frank Briscoe with Briscoe Architectural Conservation (BAC) participated in a study of conditions at the flagpole and monument immediately east of the J.K. Williams building.

Administration

Building at Texas A&M University (TAMU). The existing cast stone monument was installed in January 2015, replacing the original ca. 1934 cast stone monument designed by Hugo Villa. The original was removed in order to replace the badly corroded flagpole at the center of the monument, and because the original monument itself was in very poor condition.

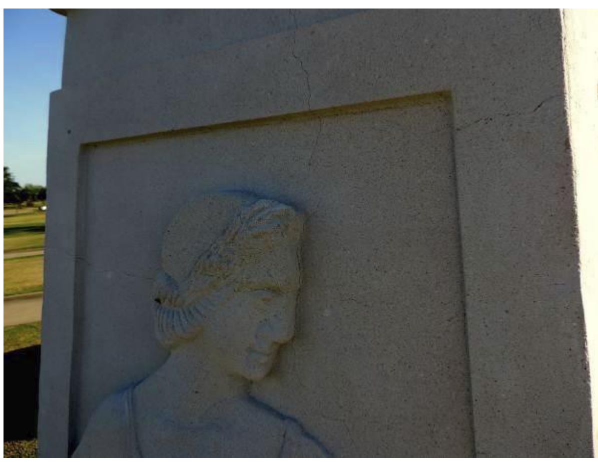
The study has two goals. The first is to determine the causes and severity of several fractures and blemishes that have been observed since the installation of the existing monument in January. The second is to assist in a determination about whether the monument can be satisfactorily repaired and retained.

A key component in making these determinations has been a careful monitoring program. FB/AC asked Robert Warden, Director of the Center for Heritage Conservation at TAMU, to conduct a three month, high-resolution photographic monitoring program at the monument. Monitoring began in mid-July and has continued through mid-October. Coincidentally, Warden's department had scanned the original monument before it was disassembled.

Summary of Findings

From the outset of the study, the team has primarily focused on four potential sources of the observed fractures: dynamic stresses from contact with the flagpole; corrosion of rebar or other intrinsic factors with the fabrication; thermal stresses; and distinct but related design issues that may have created elevated humidity levels in the flagpole mortise.

Changes in the size and number of fractures over the course of this study have been dramatic. Two roughly parallel, generally horizontal cracks that were almost imperceptible when the monitoring program began are now continuous through the perimeter. Several new vertical fractures have appeared and are now prominent. However, the star-shaped bench on which the monument rests, cast in exactly the same way, with the same materials and by the same fabricator, is in virtually perfect condition.



Increases in fractures, in size and width was noticed during September monitoring.

Rebar placement strongly coincides with fracture locations, but is unlikely to have contributed to the fracturing. According to the fabricator, rebar within 2” of the surface was coated with epoxy before installation, and is therefore unlikely to have corroded and be the cause of the fractures. Even if not coated, corrosion would take longer and manifest itself less evenly than in the pattern of fractures that exists.

Thermal stresses have possibly contributed to the fractures -- especially the early ones. The attenuated shape of the upper monument and relatively cool core around the sealed, enclosed mortise make it prone to thermal stresses. However, the material the monument is composed of, especially the size and shape of sand grains (small and round), significantly reduces the chance of extensive damage from thermal stresses.

Monument being installed in January 2015, and flying its first flags a few days later.

While the precise cause or causes of the fractures still cannot be identified with certainty, the character of the fractures and the times they appeared are consistent with specific weather events. In particular, the appearance and extension of fractures correlates with high wind and rain following the installation of the monument in January, and year-to-date high winds in August. Weather both of these dates included at least one inch of rain.

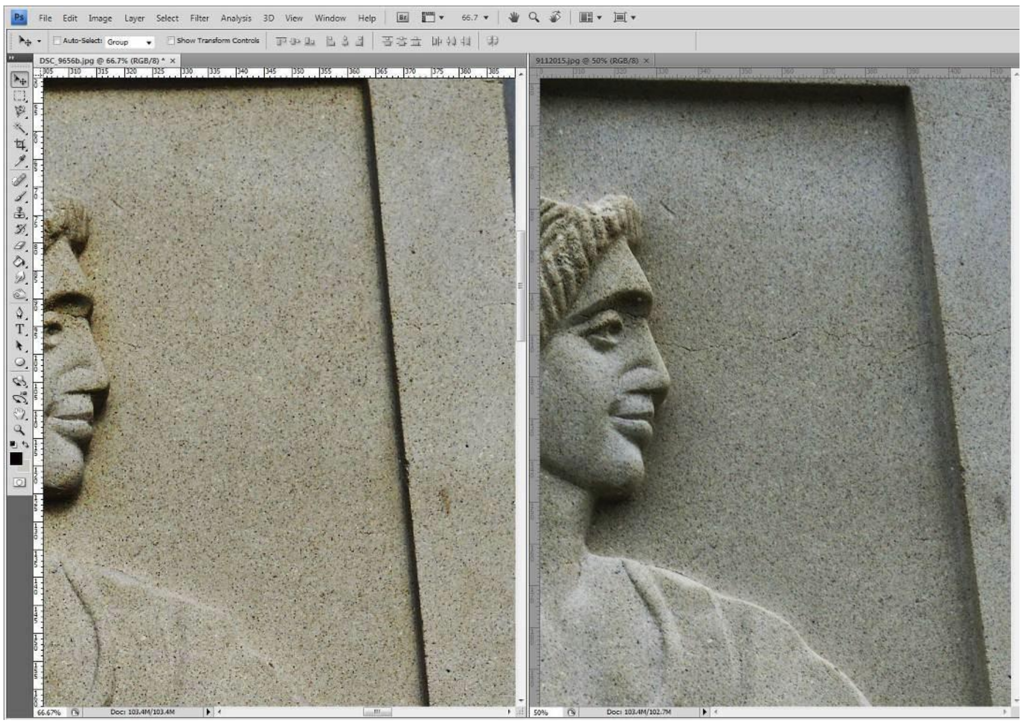
The likelihood is very high that the recent, perhaps irremediable, increase in fractures are due to a combination of high winds, wet porous flags, thick backer rod, and an offset mortise. In the opinion of the consultant, while the existing monument could be modified to reduce further damage from identified causes of fractures, the damage already done may make repairs aesthetically unsatisfactory, ineffective, and/or cost-prohibitive.

If the existing monument is to be replaced, much can still be learned from it before it is disassembled. Among the adjustments that could help assure the integrity of the next replica are: removing the backer rod, installing a venting collar, monitoring interior humidity and weather data, and continuing the photographic monitoring program.

Methodology

The conclusions reached in this study have been based on four site visits to the monument; close collaboration with Robert Warden, who conducted the LiDAR scanning and photographic monitoring program; phone conversations and one site visit with the fabricator of the monument (John Morton, owner of Stone Castle Industries); review of weather data from Easterwood Field weather station (GHCND:USW00003904); structural drawings provided by Southeast Services; reports by Terracon and McCoy Architects; and non-destructive investigation of the monument.

Methods of investigation at the monument include checking the flagpole for plumb and the star-shaped bench for level; detection of rebar locations using a metal detector; and temperature readings inside and outside the mortise after removing the steel collar at the top of the monument. Additional observations about wind loading and the flag material were made during a chance encounter with the crew that lowered the flags one day the consultant was on site.



Monitoring by Center for Heritage Conservation: July 2015 (L), and Sept 2015 (R).

Analysis

Photographic monitoring and weather data reveal a close connection between weather events and the striking difference in conditions at the monument during successive monitoring sessions. Weather data from Easterwood Field for August 27 indicate a 68mph gust from the North-NW, of more than five seconds. (Any strong burst of wind of any duration is considered significant.) This was by far the strongest five-second wind event this year. The fourth strongest five-second wind event, 44.1mph out of the East-NE, came less than a week after the monument was installed, accompanied by heavy rain.

Between July and September 2015, what had been visible, but fine, fractures erupted into conspicuous cracks belting the monument along with new strongly vertical ones. The vertical fractures continue over the upper surface and a few inches down into the mortise. In three of four cases they pass through the patches at the anchorage points from which the monument was lowered during installation.

The second and third-strongest wind events occurred shortly before the monitoring program began. Easterwood data for 1 July show at least one five-second gust of 50.1mph from the South, and for 16 June a gust of 46.1mph from the East, accompanied by 2.43” of rain. Three of the four strongest five-second wind events have been accompanied by more than an inch of rain.

The consultant was on site once when the flags (a U.S. and a Texas flag) were being lowered. As one of the two was about to touch the ground the consultant reached for it and was surprised how much force was acting on it, even in the very mild breeze. After mentioning this to one of the people lowering the flag, he was told that the force is much stronger when the flags are wet. The flags in use, at least on that day, were not nylon - as many flagpole specifications include - but very porous cotton or a cotton-synthetic blend that would be much heavier when wet.

Cast stone fabrication

The consultant visited Stone Castle Industries on 13 October 2015 to see pieces of the original monument and to gather information about rebar placement in the existing monument. Many pieces of the original are still on site there, and show what looks like a two-part construction technique. It appears that the dolomitic surface referred to in the McCoy report of 2012 was packed into the mold before a much grainier mix with +/- ò” aggregate was either poured or packed in behind it. The original pieces that were inspected contain very little reinforcement bar.

Pieces of the original cast stone monument designed by Hugo Villa, being stored by Stone Castle.

The monument was filled using a dry process. The minimum amount of water necessary was mixed into 1 part Portland cement, 1 part crushed limestone, and 3 parts sand, and packed into the mold with a pneumatic ramming tool. According to the fabricator, rebar less than 2” from the surface must be epoxy-coated, and his was.

The fabricator also mentioned that construction and installation schedules were very aggressive, resulting in the minimum allowable curing time for cast stone. Immediately after delivery, the monument was hoisted 35' in the air and lowered over the first section of flagpole. Even though it had cured to the minimum standard, it is quite possible that the rapid change from the curing booth to 22-degree weather during the installation affected the monument adversely.

Flagpole design

There is not unanimous understanding about the design of the existing flagpole and the foundation of the monument. The consultant's understanding is that a 100' pole was designed, and that this unit was abandoned in favor of an "off-the-shelf", less expensive flagpole. The existing flagpole is approximately 98' high, measured from the base of the monument, and has a diameter of 14", although it has been referred to as an 85' flagpole.

Eder Flagpole Company lists a 100' flagpole in their catalogue. Like the existing flagpole at the monument, it has a 14" diameter - although the thickness of the existing pole is not known. Specifications for the Eder flagpole indicate it will sustain upwards of 100mpg winds without a flag, and a maximum of 88mph with a flag. The largest flag they recommend using is enormous - 30' x 50'. The total square footage of the flags in general use at the monument is much smaller than that, but the porous material they are made of brings into question the relative load they put on the pole, particularly when they are wet.

With regard to the monument flagpole, the essential engineering issue is not the wind load it can handle, but how that wind load translates into deflection 9' above grade. The smallest, briefest contact between the flagpole and the monument's mortise is enough to cause unacceptable damage. This contact is immediately reflected in cracks at rebar locations, and especially on the side the wind came from.

Flagpole collar and mortise

A sheet metal collar diverts water from the mortise at the intersection of the monument and the flagpole. It is fastened together with sheet metal screws and sealed to the pole and monument with silicon. It is not welded to the pole. At the most recent inspection, the lower seal was completely separated from the top of the monument, while the seal to the flagpole was largely intact.

When the collar was removed it could be seen that the upper edge of the mortise was chipped in places, with small fragments of the monument sprinkled over the backer rod. It is possible this is from the collar scraping the top surface, as even slight breezes are enough to move the collar perceptibly. The monument is not centered on the flagpole, but about 1/2" toward the south from center. The distance from the north edge of the mortise to the pole is about 2-3/4"; from the south about 1-5/8"; and about 2" from the east and west sides.

The space between flagpole and mortise is 2-3/4" on the north side (L) and 1-5/8" on the south side (R). On the east and west it is almost even.

A thick, soft backer rod is stuffed into the mortise, circling the flagpole. When removed, it was found to be dripping wet, although it had not rained in a few days. The purpose of the backer rod seems to be to exclude moisture and perhaps debris from the mortise. In practice, it is trapping water and decreasing the amount of play the flagpole has before it begins to exert pressure against the side of the mortise. Although it is very soft, once it is compressed to about ½", it resists much further compression.

The section of the flagpole within the mortise was found to be dripping with moisture, and at least 1/2" of water could be seen at its base. The missing string of lanyard beads could also be seen at the base of the mortise. These were retrieved and found to be much too small to become wedged between the flagpole and monument, or to be an agent of the fractures.

Recommendations

Whether the existing monument is to be replaced or not, every opportunity should be taken to understand the forces at work there, so that the existing or its replacement will be in service for as long as possible. The damage to the existing monument occurred through a combination of factors; porous flags, a thick backer rod, and a mortise off center by 5/8". Two of these factors can be remedied at very little cost - removal of the backer rod, and replacement of the flags currently in use with lighter, nylon ones. It is conceivable that these actions alone will prevent any additional fractures.

This opportunity could also be taken to fabricate a ventilating collar, to reduce humidity levels in the mortise. These levels should be monitored periodically. Movement of the collar due to wind should also be monitored, and will inform the design of a replacement monument, if that is the decision taken.

If a determination is made to replace the existing monument, the following should be considered:

- review scans of the original and make any corrections to the model as necessary for accuracy;
- install vented collar;
- replace thick backer rod with screen;
- increase the diameter of the mortise to reduce chance of flagpole contact with top of monument, based on monitoring of movement of the collar;
- introduce weep holes, descending from intersection of flagpole with base, and create positive drainage from flagpole base toward weep holes so that no water will be standing in contact with flagpole.