Castillo de San Marcos National Monument, St. Augustine, Florida. Taken in 1995, this view looks across the moat toward the southwest bastion, where several major cracks are visible.

Monitoring structural cracks

Campbell Scientific equipment helps to preserve and restore an historic monument

Sensors are installed across a crack in the southwest bastion.

The Castillo de San Marcos National Monument, St. Augustine, Florida, is a 17th Century historic, cultural, structural, and civil engineering landmark. The Park Superintendent, Gordie Wilson, together with the Southeast Region of the National Park Service, has commenced a long-range monitoring effort at the fort. The goal is to better understand the causes of movement—and the resulting cracks—that have plagued areas of the fort walls for two hundred years.

The fort's bastions are earthen-filled, masonry ramparts, constructed on shallow foundations. Two of the four bastions have evidenced cracks since the early 1800s. The fort's foundations ought to be structurally sound according to an extensive investigation of both the foundations and the soil bearing capacity. An emerging theory postulates that the wall construction is near its structural limit in retaining the earth fill. Rainwater infiltration may increase the internal load on the walls, causing the structure

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APPLICATION AT A GLANCE

Application type:
Geotechnical Monitoring

Project area:
Castillo de San Marcos National Monument, St. Augustine, Florida, USA

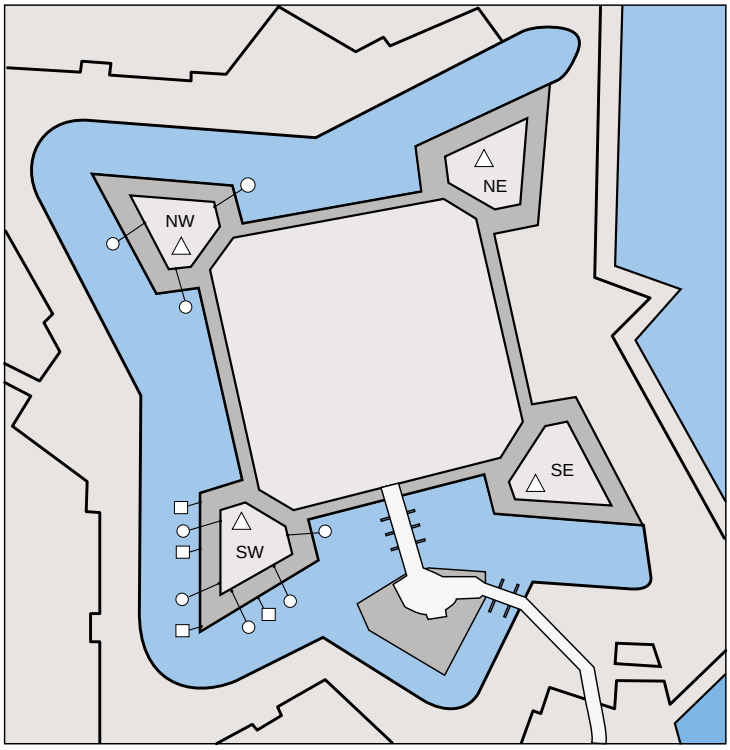
Author:
David Wright, architect
Grieves Worrall Wright & O'Hatnick

Contracting agency:
National Park Service

Datalogger(s):
Campbell Scientific CR10Xs

Communication links:
Phone line

Measured parameters:
x-y-z movement along cracks, tilt, soil moisture, meteorological conditions



Sensor emplacements are denoted by squares (tilt meters/inclinometers), circles (x-y-z crack gauges), and triangles (soil core/moisture sensors).

Campbell Scientific provided the datalogger, multiplexers, weather stations, and soil moisture probes. The equipment was integrated with crack and tilt sensors.

Sensors straddle cracks to directly measure displacement in each of three axes.

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to move. A design team was formed to investigate this theory. Headed by architects Grieves Worrall Wright & O'Hatnick, the team proposed that the park monitor:

- existing cracks in three-dimensions
- tilt of the large segments between the major cracks
- change of soil moisture with in the bastion at two levels, one near the surface and one 16 feet deep
- weather conditions at the site to assess their impact on geotechnical activity

Monitoring equipment was assembled from several vendors. Campbell Scientific provided the datalogger, multiplexers, weather stations, and soil moisture probes. The equipment was integrated with crack and tilt sensors manufactured and installed by Geokon (Lebanon, NH). AMJ Equipment (Lakeland, FL) and PSI Engineering (Jacksonville, FL) provided technical and installation assistance. To reduce the installation's aesthetic impact on the park, cables were concealed in custom conduit with the help of the park's maintenance staff.

The sensors are measured and the data are stored by the CR10X at 5 a.m. and 5 p.m. On a quarterly basis, the data stored in the CR10X is downloaded via phone modem to computers located in the offices of the engineers and architects for analysis and interpretation. The project is scheduled to collect data for five to ten years.

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