

SPARKS ENGINEERING, INC.

STRUCTURAL EVALUATION, DESIGN AND TESTING

February 29, 2008

Ms. Leslie Wolfenden
Save Austin's Cemeteries
PO Box 41814
Austin, TX 78704
(512) 917-1666

SUBJECT: STRUCTURAL EVALUATION
Oakwood Cemetery Chapel
Austin, Texas

Dear Ms. Wolfenden:

We have completed our structural evaluation of the Chapel at the Oakwood Cemetery in Austin, Texas. These services were requested by you and were performed in accordance with our contract for consulting services authorized January 21, 2008. Our consulting services were for preliminary structural assessment services.

PROJECT INFORMATION

The existing structure is a historic 1914 Gothic revival building located in Oakwood Cemetery, Austin, Texas. The building is a one story structure with ashlar limestone load-bearing walls and a wood framed roof. We understand that the building has several major issues including foundation movement, mortar and stone deterioration, roof damage and wood decay. You have requested our structural engineering services to evaluate the existing structure and identify major cost and feasibility issues.

We visited the site two times during January and February, 2008 to observe the condition of the building. We were accompanied in our visits by either personnel of *Save Austin's Cemeteries* (Leslie Wolfenden on January 31) or personnel of the Cemetery on February 11. During our site visit, we made observations of typical structural systems in readily accessible areas. We looked for signs of significant structural distress, such as excessive cracking, deformation, and visible deterioration. We obtained limited field measurements of typical structural systems to assist in the evaluation.

DOCUMENT REVIEW

We reviewed the following available documents related to the chapel:

- Architectural drawings (Plan, elevations and sections) provided by *Saving Austin's Cemeteries*
- Historical Photos provided by *Saving Austin's Cemeteries*

FOUNDATION

The building is located on urban land (Oakwood cemetery, Austin). The Travis County Soil Survey¹ states that the soil in the area of the Chapel consists of *silty clay* of *UtD—Urban land, Austin, and Whitewright soils* with 1 to 8 percent slopes. These soils are characterized by a moderate to high shrink-swell potential.

During our site visit, cemetery staff excavated one test pit to allow observation of the condition and depth of the foundation. The test pit was excavated on the east face of the building, to a depth of about 4-feet below grade. The foundation consists of shallow continuous concrete footings.

There are signs of past movement in the foundation, such as a diagonal crack on the north wall. Although this cracking does not present an immediate structural concern, there will likely be continued seasonal movement and recurrent cracking in the walls.



Foundation inspection pit.

The interior floors are cracked and differential settlement has created slopes. The floors do not have structural function and the damage affects only serviceability.

MASONRY WALLS AND MORTAR

We assessed the ashlar limestone load-bearing walls for signs of distress. Cracks are present throughout the building, and are more visible on the interior due to the stucco finishing. An extended detachment of the stucco was also observed on interiors. Several sections of the stucco have collapsed and a poor connection between walls and remaining stucco was observed. On the exteriors, some stones are also detached and a significant degradation was observed mainly on the window sills and copings which are made of soft stone.

¹ Natural Resource Conservation Service. websoilsurvey.nrcs.usda.gov



Degradation of window sills.

We used a laser level to survey the lateral displacement of the east and west walls. A clear deformation was observed on the west wall. The results of the survey are attached to this report.

In addition, we developed a settlement survey on the exterior using as a reference the coping stone on the buttresses on each buttress of the building. A clear relative settlement between east and west walls was observed, in some cases exceeding five inches. For detailed information, please refer to the elevation report attached.

We observed a soft structural mortar in the wall joints. There is evidence of previous joint repointing campaigns in localized parts of the building. The newer repointing mortar is much harder and is portland cement based.



Erosion of original mortar joints due to rain.

The original mortar is made of irregular-shaped fragments of beige-colored sandy mortar material, as well as unconsolidated sand. The mortar is poorly cemented, and exhibited high friability. The binder

material appeared to be relatively homogeneous and is very soft. The binder material appears to be a calcitic lime paste. See full Mortar Analysis Report attached.

ROOF

We assessed the visible sections of the wood roof and no major damage was observed. However, some decay is present on exterior sections of the roof, mainly where the wood is exposed to rain water. We also expect that some hidden decay exists which will be revealed when the roof is replaced.



Damage in exterior wooden roof due to rain water

REMEDIAL MEASURES

The main problems observed in the Chapel are related to differential settlement probably associated with shrink-swell soil phenomena, which is caused by a combination of seasonal variations, poor storm water drainage, and possibly leaking plumbing. We recommend a program to reduce soil moisture variations as well as to underpin the exterior walls of the building, which will result in a significant reduction in the likelihood of future distress. Additional structural maintenance work is also necessary and is listed below.

1. Underpin the exterior walls with drilled piers. We expect that the piers will be at least 18-inches in diameter and 12-feet deep, depending on the bearing stratum.
2. Improve storm water control and surface drainage around the building:
 - a. Lower the grade as much as possible and slope the ground away from the building,
 - b. Install below-grade storm drains to collect the downspouts. Alternatively, assure that the downspouts discharge onto hard surfaces and that the water is conveyed away from the building. Replace the existing storm drains that do not function properly.
 - c. The sloped site may require the construction of a low retaining wall to manage the drainage

- d. Avoid high-water-demand landscape and large foundation plantings. Use drought-tolerant low ground cover near the building. Implement a reasonable irrigation program²,
3. Replace deteriorated sills and similar, more durable stone³.
4. Inject larger cracks with lime-based grout.
5. Selectively install retrofit veneer anchoring to assure the face stones are properly tied to the back up masonry (assume 25% of wall area).
6. Selectively repoint with lime mortar (match existing).
7. Repair, selectively replace, treat, and paint exterior and structural wood.
8. Replacement of detached interior stucco.

OPINION OF COST

An opinion of cost⁴ is provided below for the stabilization, structural repairs, and basic strengthening for the chapel⁵:

Foundation stabilization	\$ 100,000
Storm water control	\$ 30,000
Replacement of damaged stones	\$ 15,000
Selective crack injection	\$ 8,000
Mortar repointing	\$ 12,000
Exterior wood repair	\$ 10,000
Interior replacement of damaged plaster	<u>\$ 9,000</u>
Subtotal	\$ 184,000
Geotechnical study	\$ 5,000
Design Fees	\$ 25,000
Contingency (20%)	<u>\$ 35,000</u>
Total	\$ 249,000

These costs are based on engineering judgment and experience with similar projects. The costs are approximate values based on the scope of the recommended repairs, and are in addition to the costs that may be required for interior finishes, furnishings, etc.

² Maintain a moderate level of soil moisture, especially in drought conditions, irrigate thoroughly no more than once per week.

³ Chemical consolidation is an option on some sills and copings that are not yet significantly deteriorated.

⁴ The opinion of cost is for planning purposes and is intended only to provide information on the general magnitude of costs. Unit costs are based on our engineering judgment and experience with similar projects. The opinion of cost is not a quotation or guarantee of actual costs. We have no control over the actual cost or availability of labor, equipment or materials, market conditions or a contractor's method of pricing. Further, no detailed design documents have been developed on which to base the cost of a specific project. As with any rehabilitation work, an appropriate contingency should be included in the project budget.

⁵ This would not include re-roofing, restored flooring, special finishes, furnishings, electrical, mechanical, plumbing, replacement windows, restrooms, accessibility improvements, or other tenant finish-out requirements.

CLOSING

This preliminary structural assessment was based on visual field observations of readily accessible areas. The recommendations are based on the observed conditions at the subject property at the time of the assessment. Other conditions may exist, or develop over time, which were not found during the assessment. These recommendations do not represent a final design or specification. Additional investigation may be required as part of a comprehensive program or design.

Please contact us if you have any questions regarding this report.

Sincerely,

SPARKS ENGINEERING, INC.

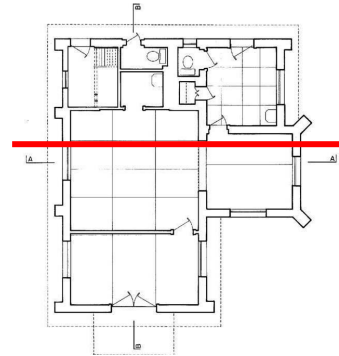
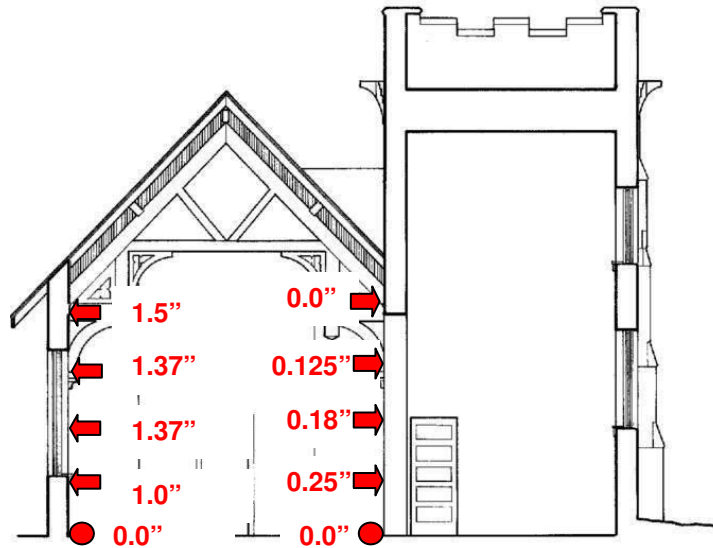
S. Patrick Sparks, P.E.
President

Juan Carlos Araiza, PhD
Senior Consultant

Attachments: Attachment A. Wall deformation survey
Attachment B. Building elevation survey
Attachment C. Mortar Analysis Report – Cates Laboratories

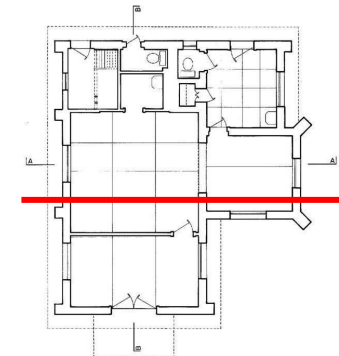
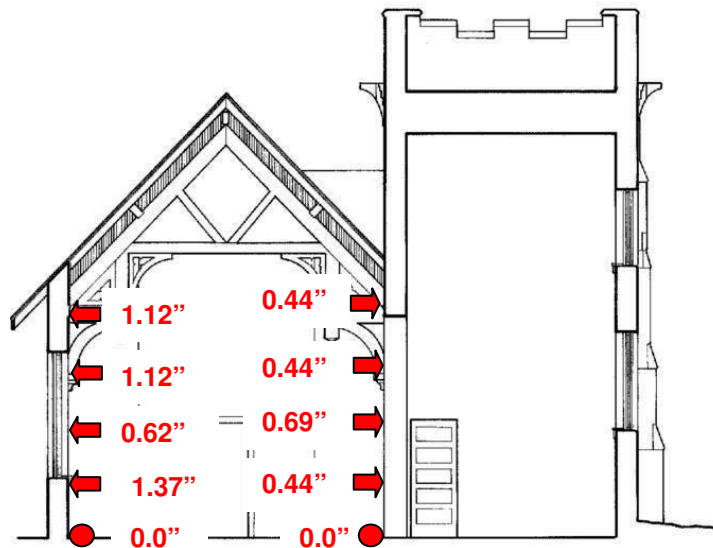
Attachment A

WALL DEFORMATION



● Reference point
 ➔ Displacement direction

Evaluated Section

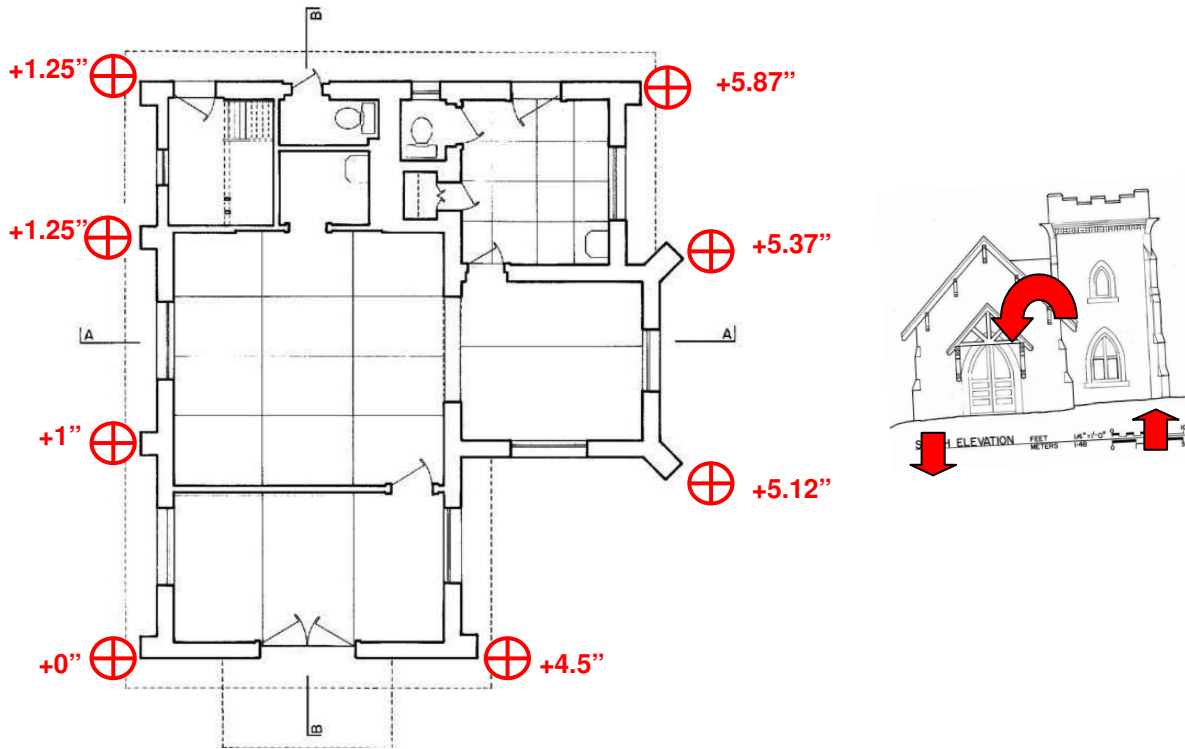


● Reference point
 ➔ Displacement direction

Evaluated Section

Attachment B

ELEVATION SURVEY



Differences in level for low coping stones in buttresses (left). Settling trend of the Chapel (right)



Coping stones in buttresses used as a horizontal Baseline for level comparison