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June 19, 2014
Project No. 14140

Mr. Alan West
Superintendent
Vernon Cemetery Commission
22 Cemetery Avenue
Rockville, Connecticut 06066

Ref: Lucina Memorial Chapel
Grove Hill Cemetery
Evaluation of Stone Masonry Walls

Dear Mr. West:

On May 20, 2014, Silva Engineering, LLC conducted a site inspection and performed a preliminary evaluation regarding the condition of the stone masonry walls for the referenced building. In brief, the masonry walls are exhibiting signs of water damage, particularly along the front face of the building. This damage is likely being caused by the following:

1. Deterioration of the mortar joints between the gable coping limestones, which allows water to seep into the rubble stone masonry below.
2. Improper repointing of the rubble stone masonry joints preventing the proper evaporation of moisture from the rubble stone masonry.

Building Description

Information on file with the Vernon Historical Society[1] identifies the chapel as an 11th century Romanesque style design, which was constructed in 1922 and was based on specifications by Walter B. Chambers, a New York City architect. The building has a footprint of 27 feet by 44 feet; at the front of the building is an interior 6-foot wide by 27 foot vestibule. The ridge height is 30 feet, and the bell tower is 40 feet high.

The book "Cascades and Courage - The History of the Town of Vernon and the City of Rockville Connecticut"[2], includes the following building construction description:

> *"The walls of the Chapel are built mainly from stone on land owned by Richard Glessman, laid very carefully, but not too regularly. The gable copings and buttress heads are of cut limestone, rough dressed, except where door and window jambs made smooth work necessary.*

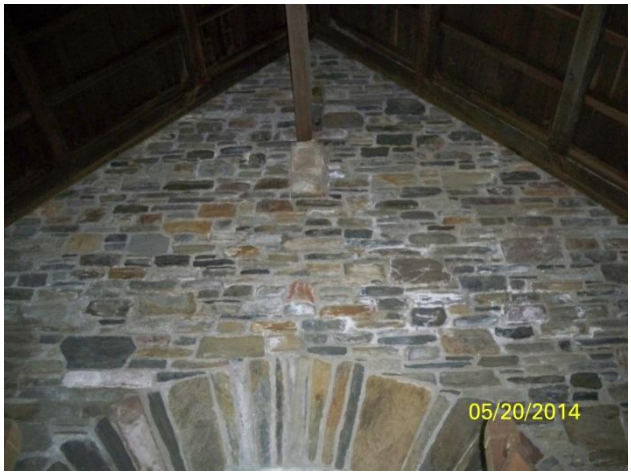
> *The chapel floor is of slate, irregularly laid. The roof is also of slate with lead flashings and gutters."*

Findings

During the inspection, distressed masonry was observed throughout the building exterior but particularly on the gable end wall at the entrance to the chapel.

Efflorescence, a "whitish haze of soluble salts into the masonry caused by excessive pulling of the soluble salts into the masonry and out through the surface"[3],' was visible on both the interior and exterior surfaces of the gable end wall rubble stones. On the exterior face, efflorescence originated just below the gable coping limestone units and extends to the level of the door archway stones. Efflorescence is more pronounced to the left of the entrance, but also extends up to the bell tower coping limestone units.

Exterior Efflorescence

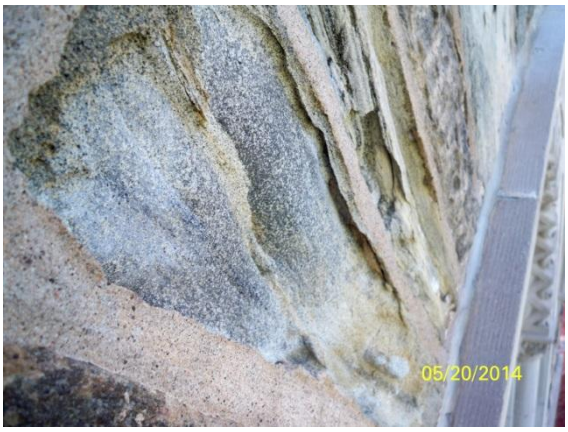


Interior Efflorescence

The dressed cut limestone around the front entrance door is also showing signs of distress, including delamination, exfoliation, weathering, and spalling.

Damaged Limestones at Doorway Arch

The exterior faces of the rubble stones also exhibit both delamination and exfoliation of the stone masonry, however the adjoining mortar joints were observed to be intact. No records of repointing the exterior stone masonry of the building have been discovered but the observed conditions indicate that repointing likely was completed at one time. Our observation of the damage to the masonry stones also indicate that it is likely that an improper mortar was used during repointing.



View of Delaminated Rubble Stone – Note that mortar joints are intact
Looking down from top of wall towards grade (left) and entrance arch (right)

The following excerpt of the National Park Service "Preservation Brief No. 2"[4] includes recommendations for selection of mortar for masonry repointing, and describes the damage that can result for the use of the wrong type of mortar.

"Mortars for repointing should be softer or more permeable than the masonry units and no harder or more impermeable than the historic mortar to prevent

damage to the masonry units. It is a common error to assume that hardness or high strength is a measure of appropriateness, particularly for lime-based historic mortars. Stresses within a wall caused by expansion, contraction, moisture migration, or settlement must be accommodated in some manner; in a masonry wall, these stresses should be relieved by the mortar rather than by the masonry units. A mortar that is stronger in compressive strength than the masonry units will not "give," thus causing stresses to be relieved through the masonry units--resulting in permanent damage to the masonry, such as cracking and spalling, that cannot be repaired easily.

While stresses can also break the bond between the mortar and the masonry units, permitting water to penetrate the resulting hairline cracks, this is easier to correct in the joint through repointing than if the break occurs in the masonry units.

Permeability, or rate of vapor transmission, is also critical. High lime mortars are more permeable than denser cement mortars. Historically, mortar acted as a bedding material—not unlike an expansion joint--rather than a "glue" for the masonry units, and moisture was able to migrate through the mortar joints rather than the masonry units. When moisture evaporates from the masonry it deposits any soluble salts either on the surface as efflorescence or below the surface as subflorescence. While salts deposited on the surface of masonry units are usually relatively harmless, salt crystallization within a masonry unit creates pressure that can cause parts of the outer surface to spall off or delaminate. If the mortar does not permit moisture or moisture vapor to migrate out of the wall and evaporate, the result will be damage to the masonry units."

Based on the observed conditions and damage, it appears the building was repointed at one time with a hard, dense mortar that is less permeable than the masonry rubble stones. As described above, the rubble stone could not "give" due to the hard mortar repair, which resulted in hairline cracks of the rubble stone face. Additionally, the hard mortar prevented moisture from wicking to the exterior through the mortar joints.

In addition to the improper repointing, the mortar joints between the gable coping limestones has deteriorated, creating an avenue for water to seep into the stone masonry below. [Additionally, it does not appear flashing was placed below the gable coping limestones.]

All of these factors appear to have been exacerbated by freeze/thaw cycles, likely resulting in the observed damage.

Recommendations

We recommend that repairs and restoration of the structure be performed in a two-phase approach. The front wall of the structure appears to have more damage than the remaining portion of the building. To prevent further damage to the rubble stone and

limestone elements, repointing of this area should be completed before the upcoming 2015 winter season.

Phase I - Immediate Stabilization

- Utilize high permeable mortar similar to that used for repairs to Fox Hill Monument i.e. high lime mortar.
- Repoint rubble stone joints at front (entrance) gable end wall.
- Repoint bell tower and chimney above roof line.
- Repoint all joints between gable end coping limestones.

We recommend that the second phase of restoration be conducted within a 1 to 4 year timeframe. The improper repointing does not affect the overall structural capacity of the building but it does cause structural and aesthetic damage to the individual rubble stones and limestones. A second phase will provide additional time for the Town to plan and budget for repairs; possible funding sources could include grants for historic structures.

Phase II - Develop Restoration Program

1. Minimum Recommendations
   - Repoint exterior joints for remainder of building.
   - Remove and reset gable end coping limestone, and repair of damaged areas exposed subsequent to removal of stone. Also determine need for installation of flashing below coping stones.
2. Additional Repairs for Consideration
   - Repair or replace damaged limestone at entrance doorway.
   - Replace damaged rubble stones, if needed.
   - Clean stone masonry surfaces to remove efflorescence stains using proper water washing techniques.
3. Determine work forces, i.e. Town Staff or independent contractor.
4. Develop documents/drawings as per extent of repairs and type of workforce to be utilized.

If you have any questions regarding this letter, please do not hesitate to contact our office.

Sincerely,

SILVA ENGINEERING, LLC

James L. Silva, P.E
Principal

c: John Ward, Town Manager; Terry McCarthy, Town Engineer

Bibliography

1. Telephone conversation with Carolyn G. Blouin of the Vernon Historical Society (June 9, 2014).
2. Brookes, George S. Ph.D. (1955), *Cascades and Courage - The History of the Town of Vernon and the City of Rockville Connecticut*, page 479, <https://archive.org/details/cascadescourageh00broo> Digitizing sponsor: LYRASIS members and Sloan Foundation, Book contributor: University of Connecticut Libraries.
3. Grimmer, Anne E. (1984), *A Glossary of Historic Masonry Deterioration Problems and Preservation Treatments*, page 11; National Park Service, US Department of the Interior.
4. Mack, Robert C., FAIA and Speweik, John P., (Oct 1998) *Preservation Brief 2: Repointing Mortar Joints in Historic Masonry Buildings,* Technical Preservation Services, National Park Service, US Department of the Interior