WJE ENGINEERS ARCHITECTS MATERIALS SCIENTISTS

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Via Email: MBlock@catholicmutual.org

July 1, 2013

Ms. Melissa Block
Claims Risk Manager
Catholic Mutual Group
419 NE Madison Avenue
Peoria, Illinois 61603

Re: Holy Family Church
Lincoln, Illinois
Investigation of Masonry Distress in Bell Tower
WJE No. 2013.3125

Dear Ms. Block:

As you requested, Wiss, Janney, Elstner Associates, Inc. (WJE) has completed an investigation into the masonry distress that manifested recently in the bell tower of Holy Family Church at 316 S. Logan Street in Lincoln, Illinois. This report summarizes our investigation and provides some general remedial recommendations.

## Background

Holy Family Church in Lincoln, Illinois is a predominately timber and masonry structure that was constructed circa 1903. The building measures approximately 125 feet by 50 feet in plan, with the long dimension oriented in the east-west direction. The gable roof is covered with asphalt shingles. There is an approximately four-story bell tower located at the southwest corner of the building. Figures 1 through 4 present overall views of the four elevations of the church.

The parish recently began an exterior renovation project for the church building. The contractor for this project, which primarily consists of masonry tuck pointing and repairs, is Otto Baum Construction, Inc. (OBC) of Fairbury, Illinois. We understand that the current phase of the renovation project includes tuck pointing the exterior of the bell tower from the base of the bell platform upward. OBC reported that they also intended to shorten and reconstruct where necessary the individual brick piers of the decorative battlement, or castellated parapet, that rings the roof of the bell tower.

Grinding of the mortar joints on the bell tower reportedly began on June 11, 2013 (grinding out a depth of the old mortar is the first step in the tuck pointing repair process). On Friday, June 14, 2013, while OBC was grinding joints on the north elevation, a portion of the exterior wythe of brick masonry in their work area collapsed. OBC had been performing work from an aerial lift, and OBC reported that most of the debris from the collapsed portion of the wall landed in the work platform, but a small amount fell to the lower roof below. OBC indicated that they did not detect any significant damage to the roofing from the falling debris. OBC reported that their workers were unhurt in the incident, and OBC immediately began temporary stabilization efforts on the north elevation. By Friday evening, OBC had reportedly removed

areas of remaining loose masonry and installed wire mesh and plastic tarps over the damaged area on the north elevation (see Figure 5).

Catholic Mutual Group (CMG) requested that WJE visit the site to review the collapsed area, comment on the likely cause of the collapse, and make general remedial recommendations.

## Field Investigation

Mr. Jonathan Lewis of WJE visited the site on June 18, 2013 and met with Melissa Block of the Catholic Mutual Group and Father Laible of Holy Family Parish. OBC provided a manlift operated by their superintendent to enable close-up inspections of the bell tower. WJE's observations during the field investigation are summarized in the following paragraphs.

### *North Elevation of Bell Tower*

1. Prior to the visit, OBC had removed most of the face brick and stone units from the small decorative arches upward (see Figure 6). All but the two westernmost piers of the battlement had also been removed. OBC had stored the decorative limestone water table pieces on the ground near the southwest corner of the church (see Figure 7). The two remaining battlement piers moved slightly when given a firm thrust by hand. The joints in these elements had not been ground out since OBC intended to reconstruct and shorten them.
2. A portion of the outer wythe of masonry backup near the northeast corner of the bell tower had also been removed (see Figure 8). Masonry backup at the area of the collapse contained deteriorated and missing mortar, and many of the bricks could be moved by hand (see Figure 9). Due to potential instability, WJE could not confirm the total thickness of the brick backup at this location, but there appeared to be at least four or five wythes. At some locations, the coursing in the backup brick was somewhat irregular and haphazard.
3. From the decorative arches up to the water table, in the zone where each course of face brick gradually steps outward with height, OBC reported that there were no metal ties or brick headers that connected the face brick to the masonry backup. From observations at other elevations where isolated bricks had been removed, the masonry backup slightly overlaps the back of the face brick in this zone, but the degree of restraint provided to the face brick appeared minimal. Directly above the water table, there was a diagonally oriented header course (see Figure 10). OBC indicated that the face brick had been cut to fit around these header bricks, thus masking their presence from the exterior. No other header courses between the face brick and backup were identified in the vicinity of the collapsed area.
4. Copper flashing had been somewhat dismantled and modified by OBC in order to remove and stabilize loose masonry, but the copper gutters and their connection to the downspout were still intact. Figure 11 shows typical copper gutters and flashing.
5. OBC had ground out joints from the base of the colonnades at the bell tower all the way up to the water table directly beneath the battlement. WJE and OBC spot-checked the masonry, finding that many bricks would displace slightly when tapped with a hammer. Mortar joints appeared to be original and were severely weathered or completely deteriorated. Many joints were wet. OBC had also ground out joints in the face brick on the large arch (see Figure 12).

6. After completion of WJE's observations, OBC reinstalled wire mesh and tarps around the collapsed area as a precautionary measure (see Figure 13).

### *West Elevation of Bell Tower*

1. OBC had ground out joints on the west elevation above the base of the colonnades prior to the site visit. Some bricks, especially those in the stepped-out portion of the masonry directly beneath the water table, were found to be slightly loose and had been removed (see Figures 14 and 15). Face brick below the small decorative arches appeared to be in slightly better condition.
2. OBC and WJE reviewed the battlement on the west elevation. All piers except the southernmost pier (adjacent to the steeple) moved slightly when given a firm thrust by hand. Some previous repairs were evident due to the presence of lighter colored brick. Figure 16 shows an overall view of the west elevation battlement.
3. Copper flashing was in fair to poor condition. Sealant at the edges of the flashing had weathered and failed at many locations (see Figure 17).

### *Steeple*

1. The small cross at the top of the steeple consists of a copper sheathing over a framework of 4x4 timbers (see Figures 18 through 20). Church parishioners had reported that the cross moves slightly in the wind. WJE found that the copper sheathing was somewhat loose and could be moved by hand. However, the copper sheathing was not in danger of dislodging, and the movement did not appear to be problematic. The movement was apparently related to the flexibility of the connection between the cross sheathing and the copper enclosure surrounding the base of the steeple.
2. There was a small gap between the copper sheathing and the battlement at the base of the steeple. The copper flashing was not tied into the backside of the battlement at this location (see Figure 21).
3. The battlement piers did not exhibit any detectable movement when thrust by hand. Figure 22 is an overall view of the battlement surrounding the steeple.
4. Joints in the face brick below the battlement had been ground out, except on the east face of the steeple above the lower roof. WJE and OBC spot-checked the masonry, finding that many bricks would displace slightly when tapped with a hammer. Mortar joints appeared to be original and were severely weathered or completely deteriorated. Many joints were wet. At several locations, OBC had removed loose face brick, exposing the masonry backup. The mortar in the backup appeared deteriorated and unsound (see Figure 23).

### *South Elevation of Bell Tower*

1. OBC had ground out joints on the south elevation above the base of the colonnades prior to the site visit. Some bricks, especially those in the stepped-out portion of the masonry directly beneath the water table, were found to be slightly loose (see Figure 24). Mortar was severely weathered or completely deteriorated. Face brick below the small decorative arches appeared to be in slightly better condition. Observations of the masonry backup on the south elevation were not possible.
2. The piers comprising the south elevation battlement were all in poor condition and moved noticeably when thrust by hand (see Figure 25). OBC had removed loose portions of brick masonry prior to WJE's site visit.

3. Copper flashing was in fair to poor condition, similar to the west elevation (see Figure 26).

### *East Elevation of Bell Tower*

1. Similar to other elevations, OBC had ground out joints on the east elevation above the base of the colonnades. Some bricks were found to be loose when tapped with a hammer. A few replacement bricks were noted near the northeast corner (see Figure 27) and a large portion of the east elevation above the water table appeared to have been previously tuck pointed. Bed joints in the stepped-out portion were somewhat wavy (see Figure 28), likely indicative of movement of the brick units during or after grinding.
2. OBC indicated that a few of the face brick in the large arch dislodged during grinding of the joints. WJE noted that some of the brick still in place had displaced downward slightly and were noticeably loose (see Figure 29).
3. The piers of the east battlement were all in poor condition and moved noticeably when thrust by hand (see Figure 30).
4. Copper flashing was in fair to poor condition, similar to the west and south elevations.

### *Bell Tower Roof*

The bell tower hip roof consists of clay tiles and an ornamental orb at the peak. The roof drains into the perimeter gutter system located behind the battlement. Figure 31 is an overall view of the bell tower roof.

### *West Elevation above Entry*

Although not in the OBC scope of work, WJE and OBC used the aerial lift to review and sound selected portions of the west facade above the main entrance to the church (see Figure 32). Brick and stone components were generally found to be stable, with only minor cosmetic cracking and failed mortar joints.

### *Church Exterior Walls*

WJE also made cursory observations of the main exterior walls of the church away from the bell tower. OBC had recently finished tuck pointing the buttresses on the south elevation (see Figure 33). Typical forms of masonry distress such as weathered, cracked, or missing mortar joints, and some localized cracked brick were common throughout the facade.

## Discussion and Recommendations

Advanced deterioration of the mortar joints in the face brick and brick backup, coupled with further weakening caused by the grinding of the exterior joints, led to the partial collapse of the brick masonry facade on the north elevation of the bell tower. Our observations revealed little or no reliable anchorage for the stepped out portion of the face brick, which was not unexpected since normal grinding and pointing operations rarely cause a collapse of the masonry. The backup brick may have nominally overlapped the face brick, but deterioration of the mortar in the collar joint and between the individual bricks of the backup masonry effectively rendered the face brick laterally unsupported. Further, the coursing in portions of the backup brick was irregular and haphazard, indicative of poor workmanship. Considering all of these factors, it is not surprising that the face brick dislodged during the recent repair efforts.

Similar deterioration exists on the remaining three elevations of the bell tower, and as such, these areas may also pose significant risk of localized collapse, especially now that the mortar joints have been removed. Out of an abundance of caution, WJE continues to recommend that the immediate areas beneath the bell tower (including the southern portion of the main entrance, sidewalk areas along the west wall south of the main entrance, and sidewalk areas along the south wall) be cordoned off until stabilization repairs are implemented. OBC installed yellow flagging around this area on June 18, 2013 and it is our understanding that this area is still closed off. Father Laible thought it was acceptable to use only the northern portion of the main entrance until stabilization repairs can be completed. WJE feels that this is an appropriate precaution.

Design of specific measures to repair the area of face brick that collapsed on the north elevation, as well as design of possible replacement or anchorage-in-place of the similar face brick areas on the other three elevations, requires further investigation. WJE recommends that the parish or OBC retain the services of a qualified engineer or architect to proceed with this further investigation and repair design work. The design professional should further review the extent of the deterioration, develop additional stabilization measures as required, determine appropriate extents of removal, evaluate the condition of the masonry backup (from inside the bell tower as well), and provide detailed recommendations for structurally sound repairs.

Thank you for the opportunity to assist you with this investigation. If you have any questions, please do not hesitate to call.

Sincerely,

**WISS, JANNEY, ELSTNER ASSOCIATES, INC.**

Jonathan E. Lewis, S.E.
Project Manager

Arne P. Johnson, P.E., S.E.
Principal

## FIGURES

*Figure 1. Overall view, west elevation.*

*Figure 2. Overall view, south elevation.*

*Figure 3. Overall view, east elevation.*

*Figure 4. Overall view, north elevation.*


*Figure 5. Tarps on north elevation of bell tower (photo by Catholic Mutual Group).*

*Figure 6. Overall view of collapsed portion of bell tower, north elevation.*

*Figure 7. Limestone pieces from north elevation of bell tower stored on ground, south side of church.*

*Figure 8. Backup brick masonry removed at northeast corner of bell tower.*

*Figure 9. Backup brick masonry loose and easily removed by hand (arrow).*

*Figure 10. Note no evidence of metal ties in backup brick. Course of diagonal header bricks shown by arrow.*

*Figure 11. Copper gutter and flashing on north elevation.*

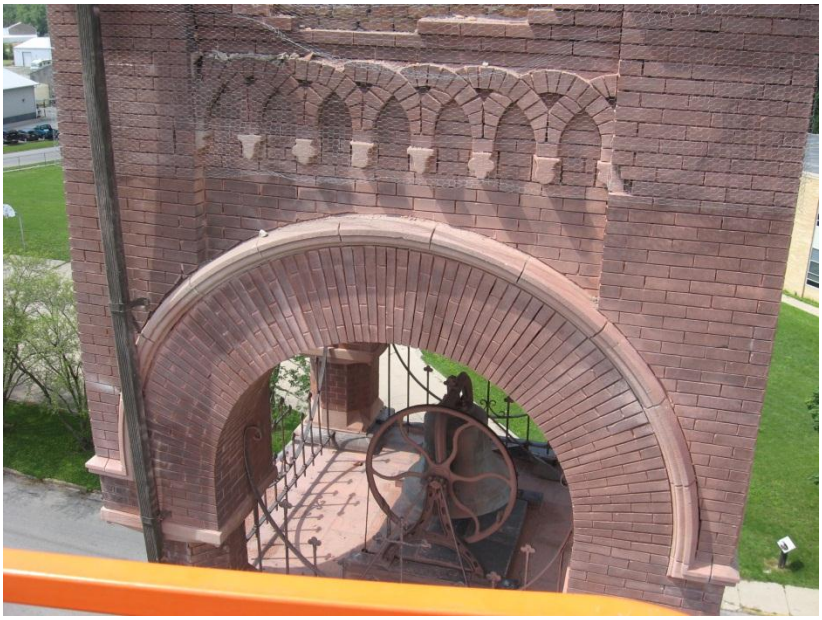

*Figure 12. Ground out joints on large arch, north elevation.*

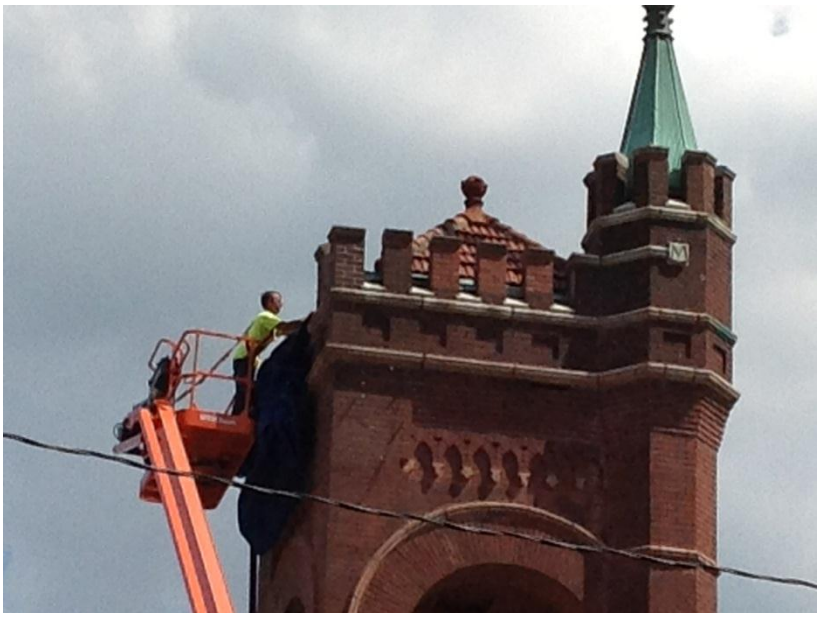

*Figure 13. OBC reinstalling tarps at end of WJE/OBC investigation.*

*Figure 14. Overall view of west elevation of bell tower. Joints in stepped out portion of brick masonry (arrow) were ground out. Note missing bricks under limestone water table.*

*Figure 15. Close up view of stepped out portion of masonry showing profile and removed brick.*

*Figure 16. Battlement on west elevation. Note lighter colored bricks indicative of previous repairs.*

*Figure 17. Copper flashing on backside of west elevation battlement.*

*Figure 18. Overall view of steeple, looking over bell tower roof.*

*Figure 19. Base of cross at steeple. Overlap of copper sheeting allows some movement at this location.*

*Figure 20. Base of steeple.*

*Figure 21. Copper flashing at backside of battlement pier adjacent to the steeple. Note flashing is not adhered to pier.*

*Figure 22. Battlement around the base of the steeple.*

*Figure 23. Removed face brick on turret below steeple. Backup brick also was loose and unsound at these locations.*

*Figure 24. Stepped out portion of face brick on south elevation. Note deflection at loose brick (arrow).*

*Figure 25. South elevation battlement. Note some loose pieces of masonry had been removed (arrows).*

*Figure 26. Copper flashing behind battlement, south elevation of bell tower.*

*Figure 27. Partially rebuilt portion of facade above water table on east elevation of bell tower.*

*Figure 28. Waviness in bed joints at stepped out portion of face brick on east elevation.*

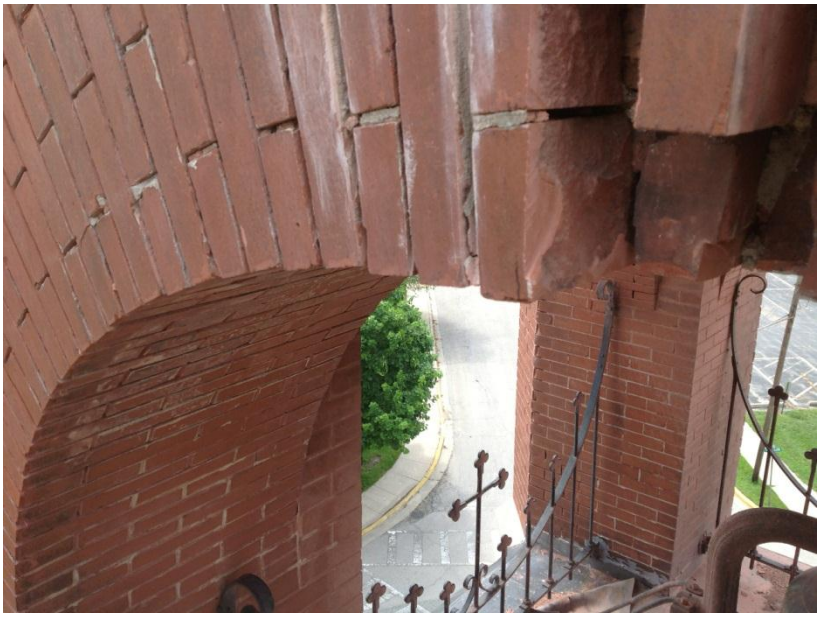

*Figure 29. Dislodged bricks in the large arch, east elevation of bell tower.*

*Figure 30. Piers of the east elevation battlement.*

*Figure 31. Overall view of bell tower roof.*

*Figure 32. OBC sounding representative portions of west elevation facade above church entry.*

*Figure 33. Recently tuck pointed buttresses on south elevation.*