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September 16, 2022

Nick Lardas
St. Nicholas Greek Orthodox Cathedral
416 South Dithridge Street
Pittsburgh, PA 15213

Sanctuary Plaster Ceiling Collapse Evaluation

St. Nicholas Greek Orthodox Cathedral, 416 S. Dithridge Street, Pittsburgh, Pennsylvania
WJE No. 2022.5007

Dear Mr. Lardas:

At your request, Wiss, Janney, Elstner Associates, Inc. (WJE) visited the St. Nicholas Greek Orthodox Cathedral located at 416 South Dithridge Street in Pittsburgh, Pennsylvania. The purpose of WJE's visit was to investigate a plaster collapse that occurred in the cathedral's sanctuary on July 24, 2022.

WJE was asked to provide an opinion regarding the cause of the collapse, an evaluation of the general condition of the plaster, and recommendations for further evaluation and/or repair. Please note that our review indicates that there are other areas of plaster that remain at risk of failure similar to the materials that fell on July 24; therefore, we recommend that the sanctuary remain closed until a more extensive survey and repair/stabilization work can be completed.

BUILDING DESCRIPTION

St. Nicholas Greek Orthodox Cathedral is a two-story limestone structure built circa 1906 in the Classical architectural style. The primary roof structure of the sanctuary consists of heavy timber trusses that span the sanctuary along with supplemental wood and steel framing members. The ceiling is coffered and consists of 3/8-inch-thick wood lath with a three-coat plaster. Plaster ornamentation is also present in the coffer bays.

In 1958, a plaster dome was constructed over the center of the sanctuary. Multiple minor renovations were completed in the late 1990s, including making openings in the plaster ceiling to accommodate lighting and mechanical ventilation systems. We understand the installation of the existing recessed lights occurred prior to the installation of the mechanical systems in 1999, but exact dates are unknown.

OBSERVATIONS

WJE visited the site on July 26 and August 18, 2022, to meet with cathedral personnel and to review the condition of the plaster ceiling. WJE performed a cursory visual assessment of the ceiling from the sanctuary floor below and from the attic space above. Plaster samples were also gathered from the material that had fallen for potential laboratory analysis. The following summarizes the pertinent observations from our visual assessment:

- An area of wood lath was exposed where plaster dislodged and fell at the south aisle (Figure 1 and Figure 2). The failure area extends between a light and mechanical opening (Figure 3 and Figure 4). Batt insulation fragments in the attic around the failure area were dry, and no evidence of moisture issues (wet materials, water stains) was observed either from below or in the attic (Figure 5).
- Plaster fragments (Figure 6 and Figure 7) were found to be dry and brittle, with fibrous materials (Figure 8). We also noted evidence of top-side soiling in some locations on the fallen plaster fragments, indicating that the plaster was not bonded to the wood lath (Figure 9).
- As is typical for a plaster assembly of this type, at original installation, the plaster was pushed through the gaps between wood lath to create mechanical engagement between the plaster and lath. The portion of the plaster that extends above and around the lath is called a key. The plaster at the keys appears to have fractured near the bottom surface of the lath (Figure 10). Some plaster was able to be removed by hand from above the lath (in the attic) at broken key locations. Such conditions were observed at the south aisle collapse area and also near light penetrations at other non-collapse locations, all with consistent fracture planes located at the underside of the lath.
- The plaster was observed to be cracked and sagged downward at two locations near penetrations in the ceiling above the north and south pew sections and aisles (Figure 11 and Figure 12). Broken keys were observed in these areas from the attic (see previous bullet point).
- Cracked plaster and peeled coating were observed adjacent to recessed lights near the dome springing (Figure 13).
- Peeled coating was observed at multiple locations on the coffered ceiling and beams (Figure 14).

DISCUSSION

Gypsum plaster from the early twentieth century was typically a three-coat system. The first coat or “scratch coat” is composed of gypsum mixed with aggregate such as sand and often also contains reinforcing fibers such as plant fibers or animal hair. The scratch coat is typically applied to wood or metal lath. The support for plaster relies on the mechanical keying of the plaster into the spaces between lath strips. When wood lath is used, the plaster is also partially supported by adhesion to the wood, although this adhesion tends to decrease over time.

The second coat or “brown coat” is applied to the scratch coat and brings the plaster to the desired profile and configuration. Typically, the brown coat also consists of gypsum mixed with sand. The third coat is the finish coat, typically composed of gypsum blended with lime, and is applied to provide a hard and smooth finish which is then coated. Cast decorative details composed of gypsum plaster are often adhered to plaster systems as ornamentation.

Common failure mechanisms for gypsum-based plasters are often moisture related. Gypsum plasters cure relatively quickly and are hard and durable; however, gypsum is generally water soluble, and, if exposed to water, the binder can expand and dissolve. Furthermore, when exposed to moisture, the supporting wood lath may swell and cause loss of integrity of the system through the expansion and contraction of the lath within the plaster.

During WJE's inspection at St. Nicholas Greek Orthodox Cathedral, no evidence of water infiltration or condensation was observed in the attic space above the plaster ceiling, neither at the area of fallen plaster, nor at other areas where plaster distress was observed. Based on these observations, we believe it is unlikely that the plaster collapse was caused by recent saturation of the plaster or lath.

Another potential failure mechanism is cracking and debonding of the plaster due to impact or vibration that damages the plaster keys. Lath movement can be due to internal pressure from humidity changes, corrosion of fasteners, or from movement of the frame to which the lath is attached. Lath movement and breakage of plaster keys can also be due to external pressure from heavy loads; from transitory loading, impact, or vibration during construction; or from maintenance personnel or others impacting the plaster.

Based on our observations, experience with previous plaster failures, and the known history of work on the building, we believe a possible cause of displacement of the plaster is movement of the lath and plaster caused by construction activities to create holes in the plaster ceiling for lighting and mechanical equipment. The construction activities resulted in breakage of the plaster keys which support the ceiling. This opinion is supported by similar plaster cracking and displacement observed next to penetration locations other than the collapsed plaster.

It is probable that plaster failure initiated at the underside of the lath near the penetrations during construction. Plaster did not dislodge initially because of adjacent load sharing. In addition, there was likely a limited amount of adhesion between the plaster and the wood lath that remained when the keys were broken, although this adhesion is not reliable in the long term. Over time, normal thermal and moisture cycles as well as mechanical vibrations likely induced stress on the displaced areas, causing the extent of fractured materials to increase. Once the fractured/damaged area was large enough, adjacent materials could no longer support the underside plaster.

RECOMMENDATIONS

In addition to the portion of the plaster ceiling that fell in July 2022, there are other areas of the ceiling with cracking and apparent displacement that are at risk of a similar failure. Based on observations from our limited survey, the apparent risk of dislodged plaster is located along the north and south coffer bays above the pews and aisles, in particular near light and mechanical penetrations. Therefore, WJE recommends inspecting the entire ceiling at arm's-length using hands and rubber mallets to "sound" the plaster. This process will allow us to identify additional areas of displacement that are not immediately obvious from a visual survey and to determine the full scope of repairs needed. Previously provided preliminary repair details (SK-01 and SK-02) are attached to this report. We anticipate providing additional direction regarding repairs once inspections have been completed.

CLOSING

Thank you for the opportunity to conduct this investigation for the St. Nicholas Greek Orthodox Cathedral. Please feel free to contact us with any questions you may have or to discuss next steps of the evaluation and repair.

Sincerely,

WISS, JANNEY, ELSTNER ASSOCIATES, INC.

Jamie M. Hudson
Project Associate

Phillip T. Elgin, PE
Associate Principal and Project Manager

Figure 1. Area of plaster collapse; viewed looking toward south wall of sanctuary.

Figure 2. Fallen plaster at the south aisle.

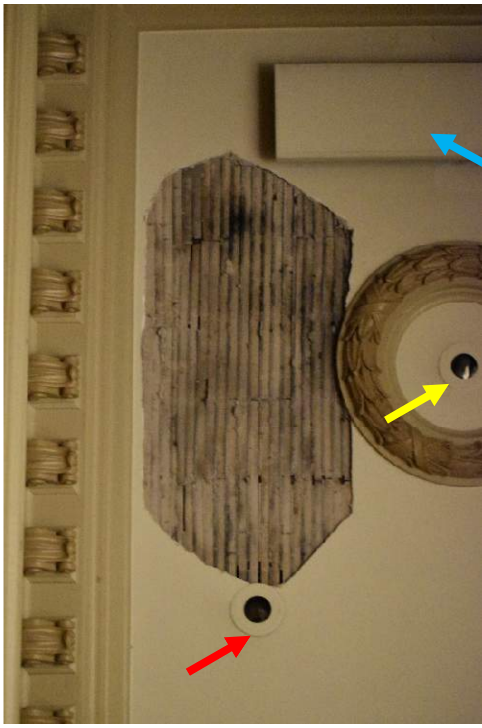
Figure 3. Area of plaster failure, looking overhead. West is oriented up.

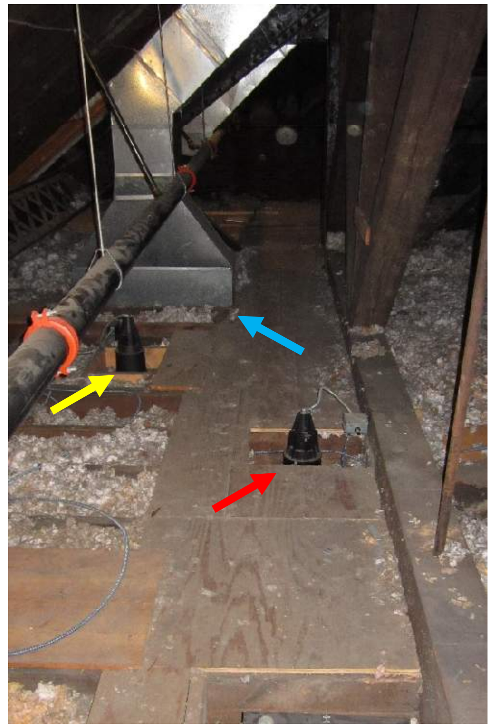
Figure 4. Area above plaster failure, in attic, looking west.


Figure 5. Light adjacent to failure area with no evidence of moisture.

Figure 6. Pieces of fallen plaster.

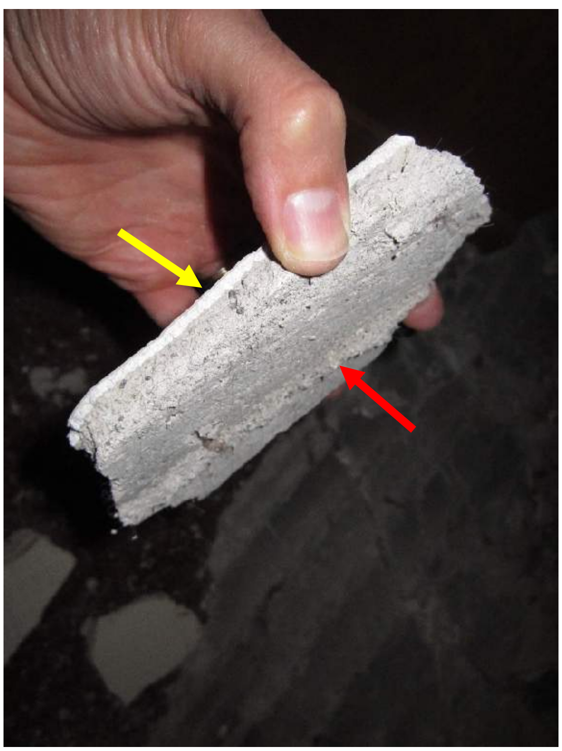

Figure 7. View of side of fallen plaster, the underside (exposed ceiling) is indicated with a yellow arrow. The fracture plane is indicated with a red arrow.

Figure 8. Fibrous material, likely plant fibers, in plaster.

Figure 9. Fallen plaster with evidence of top-side soiling (darker areas), indicating previous debonding between the plaster and the wood lath.

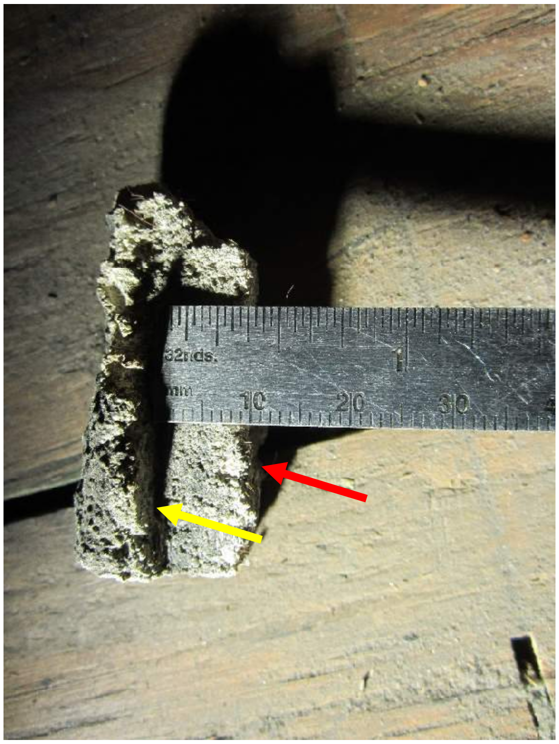

Figure 10. Fragment of broken plaster key removed from the attic side of the wood lath. The yellow arrow shows the plaster interface with the topside of the wood lath. The red arrow shows the fracture plane below the lath.

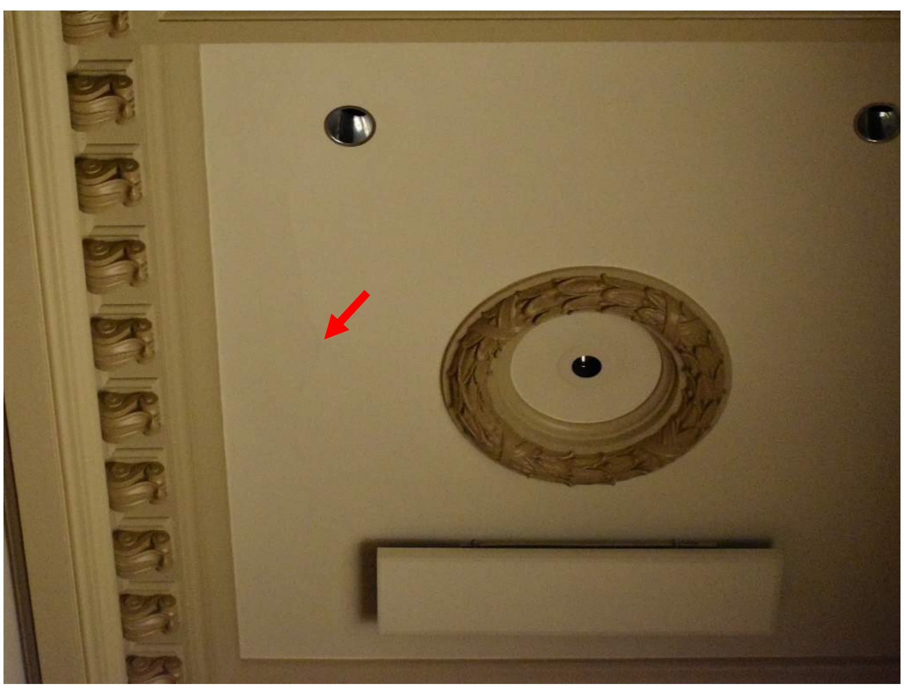

Figure 11. Cracked and bowed plaster at the south aisle.

Figure 12. Cracked and bowed plaster at the north aisle.

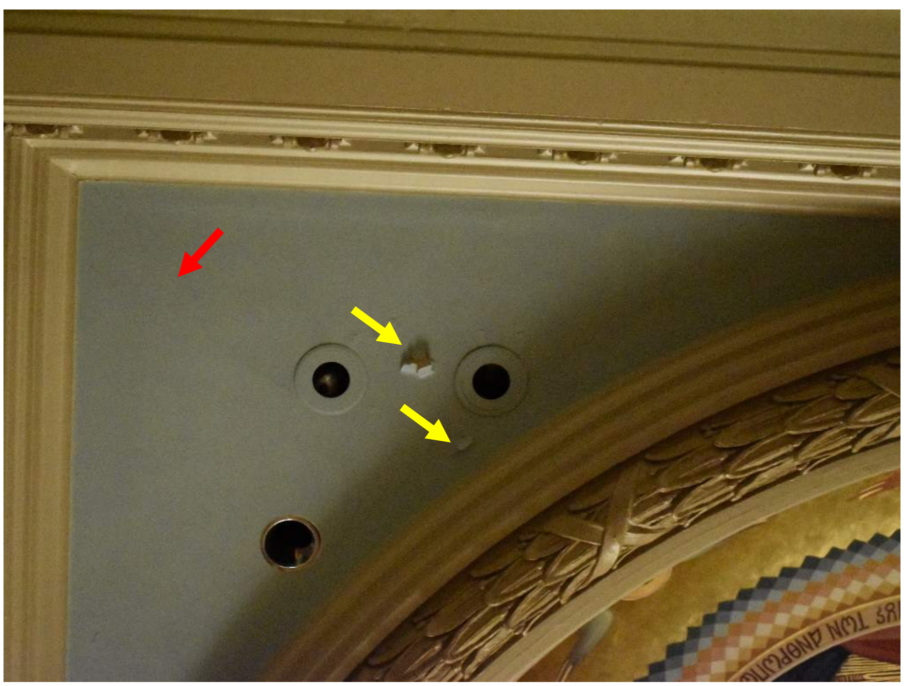

Figure 13. Cracked plaster (red arrow) and peeled coating (yellow arrows) near dome springing.

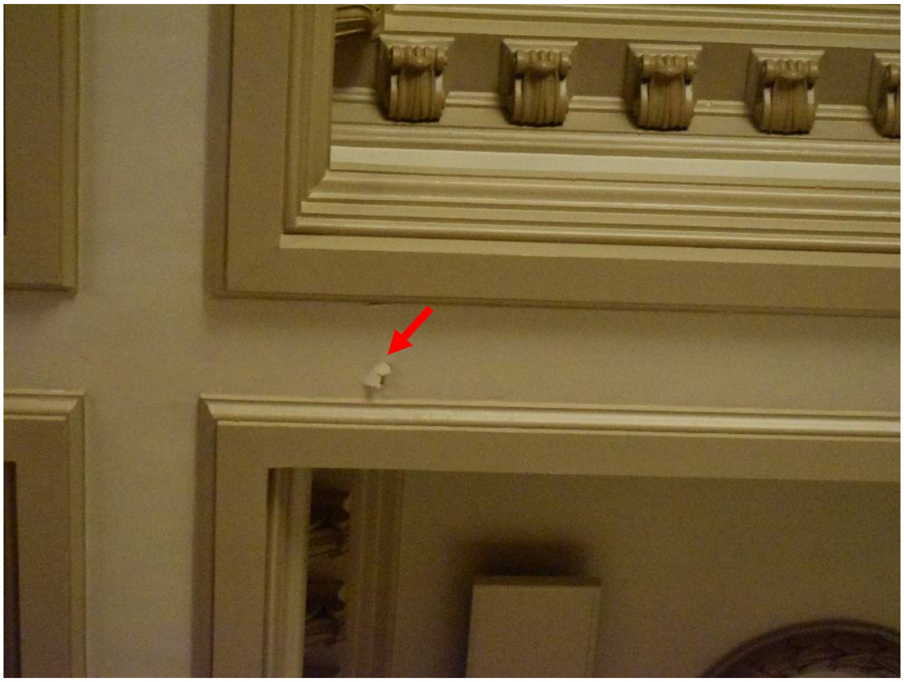

Figure 14. Peeled plaster coating at beam. Multiple similar conditions were observed on the sanctuary ceiling.