

# Restoring the FOUNDATION OF JUSTICE

By Thomas E. Forsberg, P.E.



Figure 1. Dome shrouded in a scaffolding tower.

**T**he foundation of Justice in the County of Lancaster, Pennsylvania is once again stable and poised for another century of oversight. Justitia (the Statue of Lady Justice) is re-perched on a new structural framework atop the County courthouse dome.

The 1850s-era wood-framed dome structure suffered the primary long-term effect of water intrusion: rot. A broad and vague term, “rot” defines merely a symptom, but does not convey any degree of extent. Atop the courthouse dome, the rot can only be described as severe.

## History

When the roof on a historically significant piece of your county’s architecture leaks, what do you do? Of course, you patch it. And many attempts were made to do exactly that. However, there is a point where the “patch method” no longer works; when you’re re-patching patches, it’s time for a better solution.

In 2014, the County’s Facilities Management department decided that they needed a new approach. At nearly 80 years of age, the copper roofing was, literally, wearing thin. Too many applications of incompatible materials aimed at preventing ongoing water infiltration were doing more harm than good.

Prompted by observations of water leaks and signs of damage to the wood framing,

the County retained Schradergroup Architecture, LLC, to thoroughly examine the roofing and dome structure, develop a report describing the conditions, and recommend corrective work to restore and preserve the dome.

Further, the County decided to remove and restore the Statue. The current copper version, installed in the 1920s, is the second Statue to grace the top of the courthouse dome; the original was made of wood (*Figure 2*). This work required a scaffold tower around the dome reaching nearly 140 feet above the sidewalks and streets below. Fortunately for the team, the scaffold would facilitate the examination and subsequent restoration work (*Figure 1*).

## Examination

Able to proceed with a hands-on examination of the exterior roofing surfaces, the inspection team quickly observed that the copper skin was in poor condition along with evidence of an entire system failure: pan seam overstress, material deterioration, loose and missing fasteners, leaks, and failed repairs resulting from inappropriate patching materials applied to the copper.

By its geometry and construction, the upper portion of the dome’s interior was inaccessible for visual inspection. However, based on the overwhelming evidence of leaks and deterioration in the copper roofing system,



Figure 2. Profile of original (1850s) wooden Lady Justice head.

the examination continued with invasive probes to assess the underlying structure. There was no question whether there was any structural damage, only the extent to which the damage had reached.

The evidence from several probes overwhelmingly showed that the dome structure had been compromised. Wood decking was rotted so severely that it could not retain the fasteners that held the copper roofing on the dome nor maintain its connection to the structural framework.

Removing the Statue happened concurrently with the examination and evaluation of the dome. In November 2014, the Statue was secured into a steel-framed lifting cage, hoisted from atop the dome, and transported to an off-site studio to begin its makeover. With the Statue out of the way, the upper reaches of the dome structure were exposed and accessible for examination. The final evidence required to conclude the examination was observed, and corrective work was recommended (Figure 3).

In a presentation to the County's decision-makers, the final conclusion of the team's report was summarized:

*Movement in the excessively large copper pan's overstressed seams caused tears and open joints. Further, repairs made with incompatible materials have failed, exacerbating long-term water intrusion and the ensuing structural damage: eroding roofing fasteners and rotting the wood decking and structure.*

Given the conditions of the roofing system and structural deficiencies, there was no choice but to undertake a wholesale restoration: remove all the copper, repair/replace all of the damaged structural framing, replace the wood deck, and install a new roofing system.

## Documentation

One of the greatest challenges in this type of work is to know where and when to strike a balance between probing for more evidence and data versus making assumptions and estimates about the work that will need to be done. Perhaps the most successful aspect of this project was the method by which the team worked together, examining the structure and systems, defining what was known, and making a list of unknowns with associated worst-case and worst-cost outcomes.



Figure 3. Conditions of wood rot at top of dome structure, underneath statue.

In the end, the Owner had the equivalent of a guaranteed maximum price to perform the work, even though many pieces of the scope were still unknown.

Architects and engineers usually manifest their work through the development of construction documents. After all the behind-the-scenes work is done – research, calculations, coordination, etc. – plans, elevations, sections, and details are developed and organized as an instruction manual. And by following those instructions, builders bring projects to fruition. For this project, however, developing an accurate set of construction drawings, while not entirely impossible, was both impractical and unnecessary; impractical because of the convoluted and variable nature of the existing construction, and unnecessary for the exact same reason. Therefore, the team agreed that the documentation process would take an as-built approach and be developed as a collection of photographs, field notes, and sketches to reflect the discoveries and corrective work that occurred along the way.

*continued on next page*



Figure 4. Looking between dome truss bays at the good condition of existing truss framing.



Figure 5. Conditions of wood rot at clock base.





Figure 6. Transfer posts to facilitate removal and replacement of compression ring.

Simple schematic drawings were used to label various elements such as dome bays, trusses, tension and compression rings, and outriggers. However, these documents were used for establishing consistent nomenclature, tracking the progress of work, and documenting locations of various field repairs, not for bidding purposes or to accurately define the work scope.

## Restoration

Work began on Monday, December 8, 2014 – not the best time of year to start an 8-month roofing project in the Northeastern US. While there was a broad understanding of how this project would proceed, the team anticipated a wide range of conditions and the

need for real-time, on-the-fly review and resolution. Standard details did not apply here. Moreover, to the greatest practical extent, new structural elements required for either repair or replacement work had to be made on site. With an open roof during winter months, there was no time for a typical shop drawing and fabrication process.

The main dome trusses – there are twenty-four in all – were assembled using several pieces of heavy-timber framing. Despite the poor conditions of the wood decking, the underlying structure was largely unaffected and in very good condition (Figure 4, page 35). There were still a number of repairs to be made on a localized basis, but no primary structural elements needed to be removed and replaced in entirety.

Removing the copper roofing and wood decking unveiled all of the hidden structural elements and conditions. On Day 1, the team observed cracks and rotten wood in one of the trusses. Fortunately, having both the designer and contractor standing on the scaffolding looking directly at the problems, they were able to talk through various ideas and determine a workable solution that could be implemented immediately.

There are four clocks on the main dome, one facing in each of the four cardinal compass directions. Each clock stands proud of the main dome surface and is covered on the top and sides by a dormer-like structure. These elements suffered significant damage from water infiltration, particularly the structural framing under the clocks (Figure 5, page 35) and the main dome compression ring that supports the dome trusses.

The compression ring, constructed from multiple layers of heavy timber with offset splices and thru-bolted connections, is critical to the structural integrity of the dome. Repairing it meant removing the rotted wood and rebuilding entire segments. Of primary concern was the relief and transfer of dome truss loads around the damaged portions of the ring. This required a series of transfer posts connected to the structural framing above and below the ring. These elements facilitated unfettered access to the ring for corrective work (Figure 6).

Perhaps the worst conditions occurred at the top of the dome. The compromised condition at the base of the Statue allowed years of water intrusion. The wood framing quite literally crumbled to shards as it was removed. However, enough integrity remained to allow the team to document geometry and element sizes to ensure reconstruction occurred in a like manner. Figure 7 illustrates the condition of the original wagon-wheel



Figure 7. Existing condition of wagon-wheel base framing.



Figure 8. Rebuilding the wagon-wheel base.



Figure 9. Rebuilding the cap structure which supports Lady Justice.



Figure 10. Completed restoration of the Lancaster County Courthouse Dome.

Thomas E. Forsberg, P.E., is Principal – Structural Engineering at Schradergroup Architecture, LLC, with offices in Pennsylvania, Maryland, and Delaware. Thomas can be reached at [tforsberg@sgarc.com](mailto:tforsberg@sgarc.com).

frame underneath the dome cap, and Figures 8 and 9 show its reconstruction progress and the new framework to support the Statue.

Not one leak occurred during the restoration of the Lancaster County Courthouse Dome. Working through winter months of rain, snow, sleet and wind is a testament to the quality, craftsmanship, and pride of the restoration crew. A revitalized Lady Justice is once again overseeing the Courthouse, and she has a new weather-tight connection between her base and the top of the dome. Since the connection was the worst flaw in the roofing system, considerable care was taken to ensure the integrity of the joint so that it will no longer be a source of water infiltration.

Restoring the dome was accomplished in the manner that every owner desires: ahead of schedule, under budget, and without any change orders. The process of real-time tracking of work and budget allowed the County to perform additional maintenance and repairs on portions of the structure that were not part of the original scope. In the end, this piece of the County's history is ready for another century of service (Figure 10). ■



## Project Team

**Owner:** County of Lancaster, Pennsylvania  
**Restoration Team:** Lancaster County Facilities Management Staff  
**Architect & Structural Engineer:** Schradergroup Architecture, Lancaster, PA  
**Roofing Consultant:** Tricon Building Services, Lititz, PA  
**Roofing Contractor:** Ream Roofing, York, PA  
**Supplier:** The Garland Company  
**Conservator:** Materials Conservation, Philadelphia, PA

ADVERTISEMENT—For Advertiser Information, visit [www.STRUCTUREmag.org](http://www.STRUCTUREmag.org)

Restoration Team Experience Since 1978

# Helical Wall Tie Systems for Stabilizing Veneers and Structural Repair

# SAVE THE WALL

Using **CTP STITCH-TIE** Helical Wall Ties!

Brick to Concrete Block

Multi-Wythe Brick

Brick to Concrete

Brick to Wood or Steel Stud

Crack Repair

**Pinning Solution for Re-Anchoring Existing Veneers to Various Sub-Strates**

- Austenitic stainless steel
- Self threading into a pre-drilled hole
- Significant axial core characteristics
- Tensile strength  $\geq 119$  ksi
- Replicates missing wall ties
- Stress free connections between wythes
- No exposed hardware
- Installs with ease
- Stock anchor sizes and lengths to choose for your applications

Contact our CTP Technical Services Team with your repair application needs.

**Discover Other CTP Products Like:**

- Mechanical Repair Anchors: CTP Grip-Tie
- Stone Facade Repair anchors: CTP Stone-Grip Tie
- Masonry Anchors and Accessories: CTP-16 and CTP 5801
- Stone Anchors: Various Stainless Steel Strap Anchors
- Specialty Masonry Repair Accessories: CTP MAD-2000

At our website: [www.ctpanchors.com](http://www.ctpanchors.com)

**CTP**  
CONSTRUCTION TIE PRODUCTS

7974 W. Orchard Drive  
Michigan City, Indiana 46360-9390 • USA  
Phone: (219) 878-1427  
Contact: [steve@ctpanchors.com](mailto:steve@ctpanchors.com)  
[www.ctpanchors.com](http://www.ctpanchors.com)  
*Engineered Anchoring Solutions Provider*