TILED SHOWER WALLS ARE COMPARABLE TO CLAD EXTERIOR WALLS

By Lonnie Haughton; David M. Field, AIA; and Jared Orozco

Figure 1 – Removal of loose tiles at the base of this wall exposed water staining and deterioration at the thin-set mortar.

INTRODUCTION

In many ways, ceramic-tiled shower walls can be investigated and evaluated in the same manner as clad exterior walls. Both rainwater and plumbed interior water have the same potential to promote decay, deterioration, and fungal growth via unintended breaches in a wall's water-protective envelope. In all cases, the most severe levels of internal damage generally will be encountered within those wall systems that have been most exposed to water leakage at breaches and voids. Conversely, the less water that flows across such deficiencies, the greater the likelihood that any internal damage will be minor. Further, at all water-exposed walls, deficient transitions at changes in plane and changes in material tend to be the most common locations of moisture infiltration.[1]

This article demonstrates how industry standard guidelines for the investigation and evaluation of water leakage at exterior walls similarly could be used to appraise leakage behavior properties and associated internal damage within ceramic-tiled shower walls at a residential condominium complex in San Francisco.

GUIDELINES FOR WATER LEAKAGE EVALUATIONS AT EXTERIOR WALLS

ASTM Standard E2128 (*Standard Guide for Water Leakage of Building Walls*)[2] describes recommended methods for determining and evaluating causes of water leakage of exterior walls: "This guide does not address leakage through roofs, leakage below grade, or water that accumulates due to water vapor migration and condensation. It is not intended for use with structures designed to retain water, such as pools and fountains."[3]

E2128's authors report: "The evaluation of water leakage…is a cognitive process in which technically valid conclusions are reached by the application of knowledge, experience, and a rational methodology to determine the…applicability of findings to similar uninspected or untested locations on the building."[4]

Despite this standard's narrow focus on the evaluation of leakage at exterior walls, its basic sampling guidelines certainly can be used to evaluate water leakage behavior properties of comparable building envelope systems—such as roofing membranes and deck/balcony waterproofing—intended to resist rainwater intrusion. In similar fashion, as reviewed below, a cognitive evaluation of the project-wide water-resistive performance of tile-clad shower walls also can be carried out in general accordance with the evaluative strategy of ASTM E2128.

PRELIMINARY INVESTIGATION AND FINDINGS

Consider a three-building, three-story, wood-framed residential condominium complex constructed circa 2005 in a continuous manner by the same developer, general contractor, and subcontractors. During our investigation of reported cladding and waterproofing failures, homeowners at all three buildings also reported interior leakage that appeared to originate from their neighbors' bathrooms. Within the 176 dwelling units were 304 shower and tub-shower spaces with ceramic-tiled walls (*Figure 1*). These

Figure 2 – Deterioration behind the loose tiles extended to the gypsum wallboard behind the CBU panels (see Figure 3).

Figure 3 – Per TCA methods B412 and B415, the CBU panel should overlap this vertical flange in a water-shedding manner. (These TCA details also depict an asphaltic or polyolefin "membrane" behind the CBU – also overlapping the flange.)

tiles were adhered with a thinset bond coat to a cement board underlayment (CBU) installed atop gypsum wallboard *(Figure 2)*.

At all inspected locations, the installer terminated these CBU panels directly at (or as much as ¼ inch above) the vertical flanges (*Figure 3*) that project upward from the fiberglass shower pans and tub units. In contrast with these as-built conditions, industry standard methods B412 and B415, published by the Tile Council of America (TCA),[5] show the CBU panel overlapping the vertical flange in a water-shedding manner similar to that seen at exterior lap siding and shingles.

Further, the TCA details prescribe placement of a protective "membrane" (also overlapping the vertical flange) behind the CBU. This asphaltic or polyolefin sheeting provides secondary protection against incidental water leakage through the grouted ceramic-tiled wall assembly, which acts as a "face-sealed" primary barrier.

"FACE-SEALED" BARRIER WALL SYSTEMS PER ASTM E2128

Regarding the weather-resistive design and performance characteristics of exterior walls, ASTM E2128 advises: "The 'first line of defense' against water penetration is the exterior exposed surfaces of the wall system. In order for leakage to occur, water must first penetrate the outer surfaces. The ability of a wall to resist leakage may or may not be totally dependent on the 'first line of defense.'"[6]

The authors of ASTM E2128 then describe several basic types of water-resistive walls, including "face-sealed" barrier walls: "The exterior surfaces are relied upon as the only barrier. All joints and interfaces must be sealed to provide a continuous exterior barrier, and the absorption properties of the materials must also be controlled. The materials within the wall assembly must be able to sustain occasional short-term wetting as might occur between maintenance cycles of the exterior seals or from unintended incidental water infiltration. *The system can also incorporate a secondary water-resistant system* in selected areas where incidental infiltration is anticipated."[7] [Italic emphasis added.]

In our assessment, the ceramic-tiled shower walls prescribed by TCA methods B412 and B415 are intended to function in the very same manner as exterior face-sealed barriers with a secondary leakage protection layer, as described by ASTM E2128.

GATHERING INFORMATION

The authors of ASTM E2128 emphasize the importance during the early diagnostic phase of an investigation of researching the history of a project's water leakage problems: "Gathering information on the service history related to leakage problems serves several purposes. First, patterns in the observed leakage and visible damage can provide an indication of the cause(s) and where to focus an investigation. Second, and more importantly, the information provides a checklist against which failure theories and conclusions can be evaluated. A comprehensive diagnostic program should

Figure 4 – Ceramic tiles at this tub-shower unit were loose. Multiple sections of the grout were deteriorated or missing.

Figure 5 – At many shower walls at all three buildings, many of the grout joints were failing or missing.

result in an explanation for most if not all aspects of the observed leaks and damage."[8]

After our initial visual surveys and preliminary testing, we concluded that the most likely source of the water damage seen in multiple bathrooms was leakage at loose shower tiles and those that exhibited deteriorated and missing grout (*Figures 4* and *5*). Due to the tile installer's failure to install the secondary protective membrane recommended by TCA, this water leakage then migrated through the poorly grouted, non-lapped CBU-to-flange transitions into the wood-framed walls.

POORLY BONDED TILES AND FAILED GROUT JOINTS

One member (Orozco) of our investigative team had extensive past experience operating his own tile installation company before concluding that diagnosing large-scale building envelope performance failures would provide a far more challenging and rewarding career.

Upon closer evaluation of the many partially detached tiles already observed, Orozco determined the installers commonly had set these ceramic tiles into a thinset bond coat that already had "skinned over" (i.e., the bond coating already had begun to cure and no longer was sticky), contrary to controlling industry standards.

Further, Orozco reported that the many grout failures observed at all three buildings were indicative of poor quality control and inconsistent workmanship, including: 1) failures to properly "pack" the grout into the joints, 2) improperly mixed grout, and/or 3) grout packed after cement hydration had started.[9]

Figure 6 – Purposeful supplemental testing confirmed limited and localized water damage within this wall assembly.

GENERAL CONSISTENCY OF CONSTRUCTION

It has been our firm's experience that generally similar construction practices (whether of good, middling, or poor quality) often will be found throughout large-scale residential projects initiated and completed by the same developer and general contractor from beginning to end. For example, at any particular project, the windows likely will be flashed in a similar manner, deck waterproofing membranes will be terminated at the perimeter edge metal in generally the same fashion, and cladding and siding systems will tend to be consistently installed.

In short, it is our experience that good workmanship commonly will spread through a construction project. Likewise, poor and middling quality control generally proves contagious. (The phrase "general consistency of construction" was used in a prior *RCI Interface* article[10] to describe such expectations for the "portable production line"[11] processes that are typical for large-scale residential projects driven by tight financial pressures.)

The authors of ASTM E2128 use the phrase "intrinsic" at Section 4.1.4 to describe a comparable concept that reliably consistent design and workmanship can be expected, in general, at many buildings: "The methodology in this guide is intended

Figure 7 – Supplemental testing (at this purposefully selected shower) confirmed widespread water intrusion and extensive damage under loosely bonded ceramic tiles.

Figure 8 – As expected, the CBU panel was not properly lapped over the vertical flange.

to address intrinsic leakage behavior properties of a wall system, leading to conclusions that generally apply to similar locations on the building."

Upon completion of our initial assessment phase of these ceramic-tiled shower walls, two generally consistent deficiencies had been identified, per *Figure 3*: 1) poorly grouted and non-lapped CBU-to-flange transitions, and 2) the absence of the TCA-required (and architect-specified) protective sheet membrane behind the CBU panels. Further, issues of poor quality control (improperly packed grout and the practice of setting the ceramic tiles to skinned-over mortar) by the installer appeared likely to be intrinsic to the complex.

Additionally, while some of these showers (at guest bedrooms, for example) were seldom used and others most likely had been occupied at least several times a day ever since these buildings had first been occupied, the actual durations, spray patterns, or flow rates of past showering processes at the project's 304 shower and tub-shower spaces certainly could not be quantified.

Therefore, the varying nature and extent of any internal water damage within these failed tiled wall assemblies—resulting from the complex multiyear interplay between intrinsic construction defects, poor quality control, and widely inconstant historical shower usage patterns—certainly could not be readily quantified.

ESTIMATING HIDDEN DAMAGE

Even if the distribution of any particular defect is consistent within a cladding system, this does not mean the nature, extent, and/or severity of resulting internal water damage similarly will be consistent. In our experience, widely disparate levels of leakage and associated deterioration can ensue from even minute exposure variables at comparable deficiencies in a wall's primary water-resistive barrier.

This perspective is confirmed by the authors of ASTM E2128: "It is not assumed or expected that all locations with similar design, construction, and service characteristics will be currently performing in precisely the same manner. Likewise, it is not necessary to establish such in order to reach technically valid conclusions about why and how a building leaks."[12]

To better diagnose and project the range of resulting internal damage (from none to severe) occurring behind the intrinsically deficient tile cladding, supplemental surveys and destructive testing were targeted at shower enclosures that were expected (based on the presence or absence of external clues) to be "rich"[13] with comparative data.

As an example, the shower enclosure in *Figure 6* had been selected for sampling because it did not exhibit obvious external clues and evidence of hidden damage. In a manner that is fully consistent with the above-cited guidelines of ASTM E2128, the team's "cognitive" assessment process at this shower was purposeful and targeted, not the blind random sampling beloved by traditional statisticians.

Similarly, as documented at *Figure 7*, team members removed intrinsically loose tiles at a shower wall where they expected (based upon external evidence) to expose severe damage and decay due to water infiltration through the failed grout joints. As evidenced by *Figure 8*, the mislapped CBU-to-flange transition was also exacerbated by the absence of the TCA-required protective membrane layer behind the CBU.

Figure 9 – Leakage and deterioration extended to the unprotected gypsum wallboard behind the CBU.

Per *Figure 9*, it was confirmed that leakage through the mislapped (and poorly grouted) CBU-to-flange transition can "wick" upward (via capillary action) at the back side of the CBU panel, promoting deterioration and fungal growth at the unprotected gypsum wallboard.

Additional removal of loose tiles at this shower confirmed (per *Figure 10*) that the internal water damage within these walls was not limited to just their base-wall transitions to the fiberglass shower pan. Further, removal of this pan exposed a fully destroyed subfloor assembly (*Figure 11*).

Even then, it was only after exposing the dramatic damage conditions depicted in *Figures 12* and *13* (showing the underside of the same failed subfloor) and *Figure 14* (revealing severe multi-floor decay and structural impairment within this shaft enclosure) that the remarkable extent of the damage resulting from the intrinsic waterproofing deficiencies at this single ceramic-tiled shower enclosure could be fully delineated.

Figure 10 – Water infiltration at the CBU-to-flange transitions had damaged all walls at this purposefully selected shower.

THE REPAIR PLAN

Clearly, any repair plan for the shower and tub-shower enclosures had to account for project-wide (intrinsic) defects at the primary water-resistive barrier (the face-sealed ceramic tiles) and also associated internal water damage, ranging from minimal to severe (as exacerbated by occupants' shower usage variables), within these wood-framed wall assemblies.

Upon close review and further qualitative analysis, including visual (nondestructive) evaluation of 222 of the 304 ceramic-tiled enclosures, the team concluded that the necessary repairs could be projected and budgeted in accordance with a three-part plan:

Figure 11 – The subfloor system below the fiberglass shower pan was also found to be severely damaged.

Figure 12 – Viewed (looking up) from below, structural damage resulting from the CBU butt joint leakage was severe.

Figure 13 – The CBU butt joint leakage had destroyed the subfloor system and the underlying floor joists.

1. At all (100%) of the shower and tub-shower enclosures, remove and replace existing ceramic tiles, CBU panels, and fiberglass pans in compliance with tile industry standards, as specified in the original contract documents. Inspect all exposed wall, ceiling, and subfloor materials for evidence of internal water damage.
2. For budgeting purposes, assume 45% of these tiled enclosures also would require remediation of minor-to-moderate internal damage within their wall, ceiling, and/or subfloor assemblies.
3. Further, assume that at an additional 9% of the inspected shower enclosures, the internal damage would prove to be sufficiently extensive and severe (e.g., *Figure 10*) to necessitate multi-floor structural repairs within these shafts, including substantial replacement of structural framing and floor joists.

These estimated scope-of-repair percentages were qualitative and purposeful (non-random) in nature, in a manner consistent with ASTM E2128's evaluative guidelines: "The protocol in this guide is not based on conventional hypothesis testing and quantitative random sampling. The starting premise for the application of this guide is that the building is suspected or known to leak. The objective of this guide is qualitative, purposeful, and intended to address the question of why, how and *to what extent* a building leaks."[14] [Italic emphasis added.]

Additionally, at Sections 11.2 to 11.5, the authors of ASTM E2128 provide the following perceptive guidance:

- The information systematically accumulated in a leakage evaluation is analyzed as it is acquired. The information may motivate a change in approach or focus for subsequent steps in the evaluation process.
- The evaluator is expected to establish a cause-and-effect relationship between wall characteristics and observed leakage. This requires an appropriate selection of activities and a logical analysis and interpretation of the acquired information.
- The conclusions and findings from an evaluation must be rationally based on the activities and procedures undertaken and the information acquired, if they are to be considered legitimate and substantiated.
- The record should be sufficiently complete so that any interested party can duplicate the evaluation program and acquire similar information. Notes on the analysis and interpretation of the acquired information should be clear and complete enough to be understood by any other building professional skilled in leakage evaluation.

A primary goal of our team's assessment strategy had been the tying together of causes and effects. The primary leakage pathways at these shower enclosures had been identified; the range of potential consequences of such leakage had been established; and the severity, consistency, and distribution of these consequences credibly had been estimated. Our many digital photographs and related notes and records had been compiled and maintained in such a manner than any party skilled in leakage evaluation could duplicate the assessment process. In short, the investigation and evaluation had been both inductive[15] and deductive[16] in nature and had been carried out with methodological competence, intellectual rigor, and professional integrity.

DEFENSE OBJECTIONS

The consultant representing the contractor who had erected these face-sealed enclosures similarly had carried out his own qualitative assessment of the alleged deficiencies and resulting damage. This defense evaluation process did not include any additional testing or tile removals.[17] He reported that the as-built CBU-to-flange transitions and the absence of an underlying protective membrane represented the unwritten local "industry standard" for tile contractors, even at projects where the architect had specified compliance with TCA methods and details.

In response, we advised our plaintiff clients that industry standards are not simply the unwritten customary practices of a local group of contractors. Just because everyone within a trade reportedly does or does not carry out any particular activity, this is not evidence of a consensus industry standard. In short, poor-quality work cannot be defended by arguing that this level of craftsmanship is customary for a specific group of contractors who specialize in being the low bidder at large-scale multifamily residential projects.[18]

Soon thereafter, the attorneys for the tile contractor's insurance carrier raised a new objection. Because none of these analyses by either the plaintiff or defense consultants had been founded on random statistical sampling, all of them should be excluded from the litigation process. In short, at trial, the judge would be asked to issue a ruling that expert evaluation processes for construction defects claims in California should strictly adhere to the tenets of random statistical analysis.

In our experience, this defense approach—asking the judge (via a 'motion in limine'[19]) to issue a ruling that statistical sampling is the only acceptable technique for expert evaluation of alleged water-resistive performance failures at large-scale residential complexes—is increasingly common when the plaintiffs' case is strong and well documented.[20]

Further, when the trial eventually commenced, the judge also would be asked to rule that ASTM E2128's evaluative guidelines, as discussed and documented above, could be applied (at most) only to investigations at exterior walls, not the failed ceramic-tiled shower enclosures at this residential complex. In response to these various motions, we were prepared to inform the judge that:

1. For the purposes of this investigation, there is no substantive difference between shower water and rainwater. Regarding protection against unintended water intrusion, tile-clad shower walls are designed to function in a manner that is closely comparable to clad exterior walls.
2. Expert evaluations of building performance failure almost never conform to statistical sampling protocols.[21] (During the deposition phase of this litigation, all of the seasoned defense and plaintiff experts testified to having never encountered a forensic construction defects investigation controlled by a statistician.)
3. Instead, the qualitative sampling processes used by skilled forensic investigators represent a well-validated puzzle-solving strategy of inductive and deductive analysis of plausible rival hypotheses:

> In the end, the core of the scientific method for all quantitative and qualitative surveys consists of a puzzle-solving strategy or methodology for analysis (or elimination) of rival explanations or hypotheses. This strategy may start its puzzle solving with hypothesis (i.e., quantitative analysis) or it

Figure 14 – Leakage from the shower stall above had caused severe deterioration and decay at structural framing below.

may start with evidence (i.e., qualitative analysis).

The quantitative survey begins by forming a hypothesis that can be evaluated statistically upon later collection of evidence, while the qualitative survey starts the puzzle-solving process by collecting evidence from which substantive explanations will emerge. In both cases, the core of the scientific method is represented by the strategy of analysis of plausible rival hypotheses.[22]

4. Further, the defense's efforts to use a university professor with no construction experience to discredit our well-developed qualitative findings and ensuing project-wide "projections"[23] of resultant water damage was not consistent with industry standard ASTM E2128 or the testimony of their own construction experts.

Overall, we were fully confident that the judge and jury would accept the honesty, integrity, and professionalism of our qualitative analyses of all plausible rival hypotheses to explain the nature, extent, severity, and necessary repairs of the intrinsic defects and resulting damage (both documented and projected) at these tile-clad shower enclosures.

However, months later, as we still continued to prepare for trial, we suddenly were advised that all parties had agreed to settle this matter. While the settlement terms remained confidential, we noted that our clients' attorney appeared to be extremely satisfied with the results of the litigative process.

REFERENCES

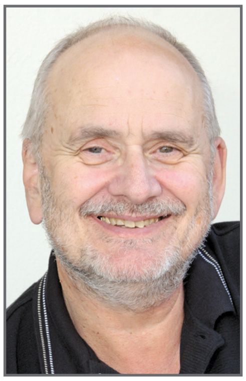
1. L. Haughton and C. Murphy. "Qualitative Sampling of the Building Envelope for Water Leakage." *Journal of ASTM International*, Vol. 4, No. 9, 2007 (www.astm.org/digital_library/journals/jai/pages/JAI100815.htm): "The transitions between the work carried out by different trades are the most common locations of water infiltration. Leakage primarily occurs at changes-in-plane and changes-in-material, such as window and door perimeters and wall transitions to decks and balconies."
2. ASTM E2128-12, *Standard Guide for Water Leakage of Building Walls*. ASTM International, West Conshohocken, PA. (www.astm.org/Standards/E2128.htm).
3. Ibid., Section 4.3.
4. Ibid., Section 5.3.
5. Reference Methods B412-03 and B415-03 prescribed and detailed in the *2003-2004 Handbook for Ceramic Tile Installation* published by the Tile Council of America (now the Tile Council of North America: www.tcnatile.com).
6. ASTM E2128-12, Annex Section A1.5.2.
7. Ibid., Annex Section A1.5.3.1.
8. Ibid., Section 8.1.
9. Orozco: All cement-based mixtures have a useful "pot life." If water is added to the mix after the grout begins curing in the bucket, the grout will be sufficiently plastic to pack but will not cure into a hard homogeneous material; rather, it will remain crumbly and weak.
10. L. Haughton. "Bayes' Rule and the Extrapolation of Testing Results." *RCI Interface*, August 2013: "For the purposes of this article, let's assume ...that 'general consistency of construction' means: Generally similar installation/construction practices (whether good, fair or poor) will be found at a minimum of 80% of large-scale residential projects at a minimum of 90% of their locations."
11. E. Allen and R. Thallon. *Fundamentals of Residential Construction, 3rd Ed.* John Wiley & Sons, NJ 2011: "Large-volume production of new houses is achieved by working on large tracts of repetitive units, and contractors achieve success in this arena by managing labor and materials on the building site as they would a housing production line in a factory."
12. ASTM E2128-12, Section 5.3.
13. Haughton and Murphy (2007): "The logic and power of purposeful sampling lie in selecting information-rich samples for step-by-step evaluation of issues of central importance to the purpose of the inquiry. For the experienced researcher, studying information-rich samples yields broad insights and in-depth understanding of the existing population rather than empirical generalizations derived from probability theory." Also reference M. Q. Patton's book, *Qualitative Research & Evaluation Methods*, Sage Publications, 2002.
14. ASTM E2128-12, Section 5.2.
15. NFPA 921-14 (*Guide for Fire and Explosion Investigations*) published by National Fire Protection Association (www.nfpa.org). Section 3.3.109: "Inductive Reasoning. The process by which a person starts

from a particular experience and proceeds to generalizations. The process by which hypotheses are developed based upon observable or known facts and the training, experience, knowledge, and expertise of the observer."

16. Ibid., Section 4.3.6: "Test the Hypothesis (Deductive Reasoning). The investigator does not have a valid or reliable conclusion unless the hypothesis can stand the test of careful and serious challenge. Testing of the hypothesis is done by the principle of deductive reasoning, in which the investigator compares the hypothesis to all known facts as well as the body of scientific knowledge associated with the phenomena relevant to the specific incident."
17. More and more, we participate in construction defects litigation where the defense simply elects not to carry out any testing to further evaluate plaintiff's findings. In most cases, this decision appears to be based upon a realization that the results of such additional testing most likely would serve to strengthen the plaintiff's claim. Further, under increasingly common "wrap" insurance policies (in which the general contractor and all of the subcontractors become named insureds under a single policy that wraps the entire construction project), there often no longer is any financial incentive for certain member(s) of the overall defense team to point a spotlight on defects caused by other team members.
18. C. Murphy and L. Haughton. "Building Codes, Industry Standards and Evaluation Reports." *RCI Interface*. January 2010: "An industry standard is a published document or detail that helps define the levels of design, materials and workmanship that currently are recognized via consensus by regional or national industry associations that represent a broad spectrum of the key players within the specific industry. These consensus standards represent the minimum efforts necessary to achieve a level of quality construction that, with reasonable and timely maintenance, will provide satisfactory performance throughout the intended service life of the system."
19. A motion in limine filed by a party to a lawsuit asks the court for an order or ruling limiting or preventing certain evidence from being presented by the other side at the trial.
20. It should be noted that this defense statistician had not actually proposed any statistical sampling design for evaluating these 304 shower and tub-shower spaces. Instead, he had been hired simply to opine that the purposeful, cognitive, and evidence-based sampling guidelines delineated by the authors of ASTM E2128 were not inherently random, and therefore our qualitative results could not be considered statistically valid.
21. C.L. Searls and T.N. Stubblefield. "Investigating Large-Scale Building Envelope Leakage: Ten Practical Tips for Litigation Projects." American Society of Civil Engineers, 2012:

"The building envelope investigation is not based upon conventional hypothesis testing and quantitative random sampling, but rather on scientifically valid principles of qualitative analysis (Haughton and Murphy, 2007; ASTM E 2128). The building is known to leak, and the purpose of the investigation is to determine why it leaks, the extent of leakage, and possible repairs. This is done through a process of observation, testing, and analysis using engineering experience."

22. Haughton and Murphy (2007). Also reference D. Campbell's foreword to R. K. Yin's book, "*Case Study Research: Design and Methods*," Sage Publications, 2003.
23. In these matters, we tend during depositions to use the term "projection" in lieu of "extrapolation" to describe the process of applying our qualitative findings to estimate the nature and extent of project-wide damage because the latter term often is interpreted by university professors (and defense attorneys) to mandate the use of randomized quantitative sampling.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Women Experience Pay Gap and Discrimination in Architecture

Multiple studies and surveys in the field of architecture show women still have a long way to go before they reach pay and opportunity parity. Sexual discrimination and harassment are also widespread.

A 2016 British poll of 1,277 women and 340 men showed a widening pay disparity, with the salary gap broadening as seniority increases. The survey, conducted by *The Architect's Journal* (*AJ*) and *The Architectural Review*, showed women are paid £55,000 less than men at the director, partner, and principal level—a figure that has risen by £42,000 since 2014.

Female architectural assistants reported salaries £1,800 less than men doing the same job; project architects, £3,000 less; associates, £2,000 less; and female directors, £12,700 less. A 2017 report of pay disparity at British architectural firms Foster + Partners and AECOM—large international firms with offices also in the U.S.—showed large gender gaps.

The American Institute of Architects' (AIA's) Diversity in the Profession of Architecture survey from 2016 reported 50% of female respondents believed women were less likely to be paid the same as men for the same role.

The British study also showed "sexual discrimination and bullying are rife," according to former *AJ* editor Laura Mark.

Another 2016 report by the AIA, "Women in Architecture," showed that of the 1,152 women surveyed worldwide, 72% said they had experienced sexual discrimination, harassment, or bullying within architecture—up from 60% in 2015, with 12% reporting it occurred to them at least monthly.

RCI has 169 members with the designation AIA or RA (registered architect), with 14 (8.3%) believed to be women. Seven percent of its members who are professional engineers are women (17 out of 243). Eight percent of RCI's 3,500 members overall are women.

— Multiple sources