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DESIGN AND CONSTRUCTION DEFECTS

CAN'T ANYBODY HERE PLAY THIS GAME?

WILLIAM R. BROZ, PE, LEED AP

WOMEN IN CONSTRUCTION:

WE CAN DO IT

HELPING THE COMMUNITY, ONE PROJECT AT A TIME

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By William R. Broz, PE, LEED AP

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After roughly 10,000 years of civilization, it's safe to say that humankind is still awaiting its first perfectly-designed and constructed building.

Construction is a complex enterprise carried out by fallible human beings. Add to that the non-repeating or "one-off" nature of most building projects, along with the increasing complexity of building systems in recent years; and the aphorism about the bumble bee comes to mind – the remarkable thing isn't that it flies well, but that it flies at all.



William R. Broz, PE, LEED AP is Associate Vice President and forensic engineering practice leader for the Construction Claims Service Line in California. He is a registered mechanical engineer and a LEED AP with over 30 years of design, construction and claims experience. He has been a principal in his own design firm and has provided expert services for a variety of project types including education, commercial, correctional, industrial, and hospitality. His specialties include forensic investigations, expert testimony, deposition and trial.

Bringing a building from concept to reality is a humbling experience. As a previous design engineer, I have contributed to the historical record of building errors. As a forensic engineer and claims consultant, I've been in a position to observe much more. Error has always been part of the construction process, as well as the source of the many lessons we have collectively learned along the way. Owners should recognize this and approach projects with an understanding that perfection is not the standard to which professionals should be held. Within certain relatively well-recognized bounds, the mere fact that mistakes have been made does not necessarily translate to negligence on the part of the architect, engineer or builder.

All that being said, I've noted certain trends over the last decade that are troubling and qualitatively different from the historically-observed design and construction errors. This article is a summary of some of the situations I have come across along with the potential causes and solutions that the industry could take to reduce the likelihood of these design and construction defects to occur. The case studies featured in this article are trends that can appear across various market sectors, geographic locations, design and construction teams, and project delivery systems.

The Standard of Care

How well does a building have to be designed or built to avoid a justified charge of negligence? The answers are different for the design professional and the builder.

The performance of the design professional is essentially judged against their peers. In every jurisdiction in which I have practiced, the standard of care is defined as:

"The level of skill and care ordinarily exercised by members of the same profession engaged in similar work, under similar circumstances and at the same time and location."

Perhaps the key word in this definition is "ordinarily." In simplistic terms, the "passing grade" for the design professional is not A, nor B, but C, average performance. Of course, contract terms can and often do call for a standard of care higher than what is called for by statute. However, without such an elevated standard, "average" is what is required.

Negligence is typically manifested as either omissions or errors. An omission is the failure to include a necessary element of the work in the construction documents (plans, specifications, architectural program, etc.). Typical examples might include the absence of a required wall section from the plans or an air handling unit from the specifications. An error is the incorrect specification or depiction of an element that is included in the construction documents. Sources of errors are many and varied. Examples include the incorrect sizing of building elements, physical interference between elements, misconfiguration of building systems so as to preclude designed performance, and so forth.

The design standard of care is typically breached in one of two ways. The first is an accumulation of errors and omissions which, taken collectively, result in change orders with a dollar value excessive with respect to the original contract price. A frequently-cited industry rule of thumb for a greenfield (i.e., new construction) project is that the value of change orders attributable to design error should be five percent or less of the contract price (this is supported by

findings of the National Research Council in a study of architect/engineer performance for federal facility design¹. The value, however, will vary by project type, circumstance and complexity. For matters in litigation, it is ultimately determined by the trier of fact (judge or jury), aided by the expert judgment of the architect's or engineer's professional peers.

The second way the standard of care can be breached is through the failure to perform one or more obligations that would be considered average performance for any design professional. For instance, assuming the designer has been retained to produce issued-for-bid construction

documents; physical coordination of building elements is a fundamental obligation that must be fulfilled. Failure to do so would generally be considered a violation of the standard of care, irrespective of the resulting level of damages.

By contrast, the general contractor's standard of care is more akin to strict liability. The project is first required to conform to all prevailing laws, ordinances, regulations, codes and standards. Second, the project must conform to all requirements of the construction documents including the material, configuration and performance requirements set forth in the plans and specifications. Failure of the contractor

to materially comply with these requirements is *prima facie* evidence of failure to conform to the standard of care. The on-site owner's representatives (typically the construction manager, and the architect and engineers of record) are there to prevent this from happening – they "defend the spec," or in other words, ensure compliance with the contract documents. Final payment is withheld until the last of the punch list items are cleared.

¹National Research Council, *Committee on Architect-Engineer Responsibilities, On the Responsibilities of Architects and Engineers and Their Clients in Federal Facilities Development*, p. 74. National Academy Press, Washington, DC, 1994.

Today's Challenges to the Design and Construction Team

As projects have become more complex, so have the teams charged with their successful completion. Today, for a major public works project under the traditional Design-Bid-Build project delivery system, the team may include all of the following:

- Project owner and its on-site representative
- Architect of record
- Design subconsultants – Primarily engineers but also includes specialty consultants such as fire protection system designers, kitchen equipment consultants, audio-visual specialists, etc.
- Construction manager
- General contractor

- Subcontractors
- Equipment and material vendors
- Commissioning agent
- Sustainable building consultant
- Inspectors of record – Governmental staff in the case of some projects or independent agents such as special inspectors, retained by the GC.

Each of these key roles must work together as a coordinated team to ensure successful project completion. Increasing specialization has brought new efficiencies to the design and construction

process. However, this development has not been without risk as roles and responsibilities must be clearly defined in order to ensure that essential work does not fall between the cracks as we will see in one of the case studies.

The financial pressures on the design and construction businesses are unprecedented as owners seeking to maximize a return on investment, have moved aggressively to minimizing costs. I, among many other observers, have noted the following:

Extreme pressure on design fees. This trend, now more than three decades old, has coincided with the effective commoditization of specialized design services. Several books have been written about this very topic (I would highly recommend *Value Redesigned* by Susan Harris and Kyle Davy, as well as *Leadership by Design* by Richard Swett). Design firms have largely gone from the owner's trusted advisor to being one of many vendors. The result: little margin for experienced practitioners to mentor early-career practitioners, and in some cases, even to successfully complete the most rudimentary design functions.

Extreme low bids. A more recent construction cost trend is the extreme low-bid environment that has become the norm on public projects nationwide, particularly in the wake of the two economic bubbles in the first decade of the 21st century. Bids today commonly range between 20 to 40 percent lower than the architect's or engineer's estimate. There are two contributory sub-trends: marginally or unqualified firms bidding on jobs they would not have in a normal economy and qualified firms that are forced to compete with them in order to stay alive. Especially in a hard dollar bid environment, owners can't predict whether they will get Dr. Jekyll (a good job with few changes and significant cost savings with respect to the budget) or Mr. Hyde (a change order quagmire). A more detailed discussion may be found in a previous ARCADIS newsletter article entitled "*Pandora's Box*" by Joseph L. Seibold, PE.



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Case Study 1: Systemic Failure An Entire Team Fails to Prevent Defective Construction

Some “lowlights” among the many examples of defective construction for a recent public project included the following issues:

- Shear wall timbers not anchored to the foundation slab (in the nation’s severe seismic environment).
- Window flashings installed in a way (and contrary to plan) that would bring water into the building instead of keep it out. In essence, the building’s overcoat was tucked into its pants.
- Required noise attenuation for air conditioning terminal devices were omitted throughout the project.
- Fire doors left with large gaps between the door and floor, invalidating the fire rating.

Two of these items are critical life-safety issues; the other two affect fundamental building performance. Unlike our other case studies below, the required construction was shown clearly in the plans. The contractor simply failed to install it that way. How could that have come to pass?

It was not for lack of eyes on the job. At any given time, some or all of the following had responsibility for ensuring that construction was in accordance with plan:

- Subtrade foreman
- General contractor’s site superintendent
- Owner’s representative (from the architect and engineers of record)
- Construction manager
- Inspector of record

All in all, no less than five sets of eyes were on every element of the project, all belonging to experienced building professionals. In fairness, concerns with potentially defective construction were logged by different people at different times, but the efforts were sporadic. While some non-compliant construction was avoided, others were installed, ultimately requiring immediate correction.

There was no ambiguity in law or contract regarding the respective responsibilities of on-site staff, so

I can only conclude that the root cause must lie elsewhere. Without the benefit of a formal investigation, my views are admittedly speculative, albeit aided by insight from my own experience in large organizations. It is likely that three factors were in play. The first I will term “perceived diffusion of responsibility,” a fancy way of saying, “I think Jack over in the CM trailer has this one.” Second, I suspect that the project protocols for handling reported defects from all parties were weak and inconsistently managed. Third, the general contractor and subcontractors were under budgetary pressure from the low-bid environment as described above. Together, these potential causes have a lot of explanatory power.

Underlying all of these possibilities is the problem of coordinating today’s larger construction staffs on evermore complex projects.

Case Study 2: A Fundamental Calculation Left Undone

A major public building began to suffer unusual problems with its sanitary drainage systems shortly after occupancy. An intensive investigation revealed the cause as being the systematic undersizing of the plumbing vent piping.

Maldesign of a building’s plumbing vents is uncommon. Design engineers sometimes refer to the vent system as the “silent servant,” reliably fostering proper drainage from plumbing fixtures and ensuring that trap seals remain intact even under upset conditions, preventing unhealthy sewer gas from entering the building. In virtually all instances, the method for sizing the vent piping is stipulated by the governing plumbing code. It is more or less a rote calculation that a competent journeyman plumbing designer is capable of doing. Again, designers are not any closer to being perfect people than anyone else and from time to time an

incorrect sizing may occur in an isolated pipe or two. More often than not, that type of error has little effect on the system’s performance since standard codes typically have a large safety factor. What we saw in the case, however, was different.

The undersizing of the vent lines in this case was so pervasive, it was clear that either the code requirements had been fundamentally misinterpreted by the engineers or, more likely in my view, the code calculation was simply not done. Minor errors I’d seen before, but this type of pervasive undersizing – never. What was the root cause? Again, given the information at hand, I can only offer an educated guess. If the issue was unfamiliarity with or misapplication of the governing code, then the solution would be a relatively straightforward one to include training and education. The engineering firm in question,

however, was well-known and highly regarded nationwide, so gross incompetence seemed unlikely. Another explanation would have been a misunderstanding of the contractual requirements for detailed design including calculations. This too seemed unlikely, as the project delivery system was Design-Bid-Build and the design contract was unambiguous about the requirement for detailed design. What was left as the most likely explanation was a lack of project controls and engineering supervision at the senior level. Given the budgetary pressures that have afflicted the industry for so long, I would expect that looking deeper under the hood of this incident would reveal a lack of attention from experienced engineers and the project manager. Such attention could have prevented this critical design omission.





Case Study 3: What We Have Here Is a Failure to Communicate

On another large public project, a series of shear walls had to be redesigned during the construction phase to accommodate openings for building systems (e.g. duct and piping) to pass through. Out of many hundreds of openings that were ultimately required, less than half were depicted in the bid set of plans. As a result, every wall had to be redesigned on the fly, resulting in critical path delay.

Again, the project was Design-Bid-Build and the design team was contracted to provide a

coordinated, detailed design. In this case, the construction documents spoke for themselves. After a certain point in the development of the design, inter-discipline coordination ceased to occur. When I have seen similar errors in past projects, the situation usually entailed a small number of coordination issues due to last-minute design changes just prior to bid. This case was fundamentally different in that it was a basic coordination task that was simply not accomplished.

The situation here is different from that in Case Study 2. In that case, a single design discipline was responsible for error. Here, the entire design team was required to work together to produce an internally coordinated and consistent set of plans, therefore, this was a systemic failure with weak project protocols. While liability rests with all design team members, primary responsibility accrues to the lead professional, in this case, the architect of record.

Some Potential Remedies

I believe there are answers to the problems described in the preceding case studies. Unfortunately, none are easy or cheap. Some involve engaging the political system, adding another layer of difficulty. My view, however, is that our profession has always been in the business of doing work ranging from the difficult to the borderline impossible.

On one level, the situations described here could have been solved with time-honored and field-proven claims prevention and construction management techniques. For Case Study 1, the defective construction could have been headed off by robust protocols for inspection, consistent reporting and stop-work authority regulations. For Case Study 2, an intensive design review process would certainly have uncovered the undersizing issue. In Case Study 3, a thorough constructability review would have had the same effect for the coordination of wall penetrations.

Clearly, these measures were not taken, suggesting a deeper problem involving different solutions. In short, it boils down to lacking the resources, whether it's financial or related to qualified staff, to get the job done right.

For the phenomenon of low bids (sometimes below cost), there is no easy answer for public sector work. Public contract law in many states requires the contracting entity to accept the lowest responsive bid, virtually guaranteeing a perpetuation of the Jekyll-Hyde scenario being played out today. Some states are making some headway in this area by

only allowing the best-value bidding model in certain instances, mostly those that involve Design-Bid-Build and CM-at-Risk contracts. On the project delivery side, alternative project delivery methods may be allowed, offering the promise of increased return. But in some cases the incentives can run toward cutting corners, potentially leaving the owner with the same problems seen today.

Construction in the private sector industry offers an alternative model. Negotiated work is not uncommon there and in many cases has been employed with great success. Some large contractors avoid the hard-dollar bid game altogether in favor of private work. Back on the public side, I would like to see experimentation extending beyond selection upon the best-value by developing a pilot program that would combine negotiated price with strong prequalification provisions (yet mindful of necessary incentives for disadvantaged business enterprises). It would be essential to then study the relative financial performance of negotiated versus hard-bid projects, controlling for project type, size and other circumstances, in order to make intelligent future decisions about public policy. The legislative obstacles to even a modest step towards a similar approach to this are likely to be severe.

On the design side, architects and engineers are typically seen by owners and contractors (not without justification) as the most risk-adverse entities in an inherently risky game. I believe that this mindset has contributed strongly to the design community's marginalization as members of the

building team (as evidenced by certain provisions of the ConsensusDocs' series of master contracts). The aforementioned commoditization of design services, I believe, is also closely related to low risk appetite. It is rare for a design professional to put its fee at risk – either to share in the potential project profit with the construction team or to take an equity stake in a project in lieu of fee. There is no “skin in the game” from architects and engineers. Project delivery systems, such as integrated project design (IPD), show potential in addressing this through the AIA or ConsensusDocs multiparty contracts where all parties proportionally share the project risks and rewards. IPD has been slow to gain acceptance, not surprisingly, due in part to risk aversion by designers and their attorneys. By whatever means it is done, for the design community to ensure its future financial health – and the corresponding ability to manage work and mentor its junior staff – some means of garnering higher margins is critical. It will necessarily involve a sea-change in the professional paradigm, from risk-averse to risk-tolerant.

Construction is the only industry group in the United States whose labor productivity has not increased in the last fifty years. Based on what I have seen over the last decade, this trend appears unlikely to reverse itself until the building and design professions take decisive action. We owe it to our clients and to the public whose health and safety we are obligated to uphold.

For more information, please contact the author, William Broz, at 213.486.9884.

HELPING THE COMMUNITY, ONE PROJECT AT A TIME

ARCADIS recognizes the importance of protecting the environment and natural resources for future generations.

As such, ARCADIS' Construction Claims Services (CCS) group regularly volunteers with local organizations to support the environment, consistent with our firm's commitment. Recently, CCS's two biggest volunteer projects have included a park restoration project in New Orleans and a trail restoration project in Scottsdale, Arizona.

The 1,300-acre City Park in New Orleans is one of the largest city parks in the U.S. Due to Hurricane Katrina in 2005, the park was completely inundated with as much as ten feet of brackish water for several weeks. The storm killed more than 2,000 mature trees, many of which were 100 to 600 years old. Gardens and historic buildings were also partially destroyed. To assist with the city's restoration, ARCADIS CCS joined in and sponsored an event that brought out more than 150 volunteers who painted, cleared debris, dug holes and planted small shrubs and trees for the historic City Park. The "crew" worked relentlessly and was able to plant hundreds of trees, shrubs and

flowers. In addition, ARCADIS' sponsorship included enough funds to support a year of water maintenance, giving time for the newly planted trees to flourish.

The McDowell Sonoran Desert and Mountains Preserve is the largest natural preserve in any U.S. city; occupying approximately twenty-five percent of the city of Scottsdale. The long term goal of the Conservancy is to expand the nature preserve so that it provides a large contiguous area, connecting wildlife habitats and offering hiking and recreational activities to regional residents. While much of the area is relatively undisturbed desert, recent population growth and accompanying off-road vehicles have damaged parts of the sensitive ecological area. ARCADIS' dedicated volunteer group spent a significant part of a hot spring day this past April, working on the reclamation of this giant preserve remediating damaged areas, transporting and planting hundreds of cacti and collecting litter over several acres. As we rode off into the sunset after our work, we reflected on the great time we had and the new friends we've made while performing an important public service.



ARCADIS CCS supports these community projects every year to help retain the beauty, diversity and ecological health of our communities. Our level of commitment is enhanced by a little bit of digging and a little sweat from our brows. We thank all of those that have volunteered with us and hope you can join us at a future volunteering event soon.



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WOMEN IN CONSTRUCTION: WE CAN DO IT

When you think of a construction site, do you immediately think of women? Somehow field boots and hard hats do not conjure up the ideal, but welcome to the future. The construction industry, long known for its ethnic diversity and inclusion, is enjoying a new minority – women in construction.

The Department of Labor reports that women comprise almost 50% of the total American workforce and 10% of the construction labor force. Within this statistic is a subtle shift from labor to management – brawn to brain. Characteristics such as effective communication, adept multi-tasking and collaborative leadership are all necessary in the changing business environment; skills typically associated with women. As the construction industry continues

to evolve through the advancement of new technologies, equipment and education, we find that the gender rift continues to narrow. Whether an architect, engineer, craftsman or construction manager is a male or female makes no difference. Instead, determination and dedication are what sets the individual ahead.

The construction claims field, likewise, is enjoying an increase in professional women. By polling the competitive set, we learned that our industry average for fact and testifying experts is 8% women. As more women complete degrees, gain knowledge day-to-day on the jobsite, and become seasoned construction professionals, we will see even more well-informed, analytical and articulate experts entering our practice.

ARCADIS proudly announces that 18% of our claims professionals are women, and are women of varied ethnicities. We credit this success to our emphasis on the importance of a diverse workforce. Diversity not only improves our ability to provide high-value services for a broad range of clients and projects, but also strengthens our communities and the society in which we live. We take great pride in introducing three of our women in construction in our construction claims service line:



Stephanie Turk, PE

Ms. Turk brings more than 25 years of industry experience and has constructed numerous bridges, soundwalls and retaining walls across Los Angeles County. As a Bridge Engineer for Caltrans and Field Engineer for contractors, her major projects included the I-105 Century Freeway, I-110/Route 91 Interchange and the I-110 HOV Viaduct. She has managed multi-discipline engineering teams through the preliminary engineering and design of various highway projects, Caltrans District 7's A&E procurement unit, selection and implementation of P3 as a management tool for the district's capital outlay program, and the consultant team performing QA/QC on Los Angeles Unified School District's \$9 billion bond program. Ms. Turk currently manages ARCADIS' on-call claims and scheduling contracts for Caltrans in Los Angeles, San Francisco and San Diego.



Amy Phillips

Ms. Phillips brings nearly 30 years of experience in development, design, construction and litigation support to ARCADIS. Ms. Phillips is responsible for the national strategic planning, marketing and business development for the Construction Claims Services team. Her public and private sector experience includes airports, multimodal transportation, convention centers, lodging, leisure, retail, entertainment, corporate, commercial and mixed-use development. This vast experience has led to multiple speaking engagements at industry and trade groups, including the American Bar Association, Urban Land Institute, American Institute of Architects, Construction SuperConference and the Society for Marketing Professional Services.



Christi Fu, PE, LEED AP

Ms. Fu has five years of experience in the construction and project management field, which has provided her with a strong background in project cost controls, risk analysis, construction contracting and claims analysis. She has been involved in commercial and high-end residential buildings through her work for a general contractor and a project management firm. Ms. Fu is a registered Professional Engineer in California and is an active member of American Society of Civil Engineers.



Women in construction have come a long way.

From administration to the trades, to management and consulting, women help plan, create and build our communities. For more information on ARCADIS' careers, please visit www.arcadis-us.com/Careers.

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Events

International Municipal Lawyers Association
Annual Conference
September 11-14, 2011 in Chicago

American Bar Association
Forum on the Construction Industry
Construction Insurance Program
September 22, 2011 in Chicago

League of California Cities, Annual Conference
September 22, 2011 in San Francisco
Topic: "Public Contracting Alternatives and
Challenges in a Fiscally Constrained Environment"
Speakers: Randy L. Breault, PE, Brisbane
Joseph L. Seibold, PE, FCMAA, ARCADIS
Paul W. Taylor, Hefner Stark & Marois, LLP

American Bar Association, Forum on the
Construction Industry, Fall Meeting
October 13-14, 2011 in Atlanta

Virginia CLE Construction Law
Construction and Public Contracts Law Seminar
November 4-5, 2011 in Charlottesville, VA



30
years
helping you prevent,
mitigate and resolve
construction disputes

ARCADIS can minimize your exposure

to the risks associated with project challenges, by implementing a dispute management strategy that includes prevention, mitigation and resolution. Together, we can prevent these inevitable setbacks from threatening the success of your project.

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