

March 2019 Vol. 5 Issue 12

civil + structural ENGINEER

CELEBRATING THE DESIGNERS OF THE WORLD AROUND US

MASS TIMBER CODE CHANGES

ICC proposals create three
new types of construction

Strategic plan to manage office costs
Design solutions for low-slope roofs
Proper GPR surveying techniques
3D printing opportunities



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CONTENTS

THE COVER

Building code changes in the U.S. mark significant progress for the mass timber industry — story on page 28. *Photo: Structurlam Mass Timber Corp.*

ON THE RISE

9 Awards, promotions, and new hires

MANAGEMENT FILES

14 U.S. office market overview

16 Know your IP

19 AECOM Global Infrastructure Report

CHANNELS

SOFTWARE + TECH

20 3D printing presents multi-industry opportunities

PROJECT DELIVERY

23 EPC model design challenges

STRUCTURES + BUILDINGS

26 Acoustics and Mass Timber (advertorial)

28 Three new types of construction

30 Low-slope roofs

WATER + STORMWATER

34 Design-Build for Water/Wastewater

ENVIRONMENT + SUSTAINABILITY

36 Global environmental consulting market surges

37 Harsh conditions & limited resources (advertorial)

TRANSPORTATION

40 Design-Build for Transportation & Aviation

41 Protection from rising seas (advertorial)

UAV + SURVEYING

42 Proper GPR surveying techniques

46 Stream cleaning

CONTINUING EDUCATION

47 Toward safety, efficiency, and sustainability

47 Developing leaders

DEPARTMENTS

4 Civil + Structural Engineer Online

7 Headlines

12 Events

48 Specify

49 Reader Index

50 Benchmarks

COLUMNS

06 **From the Publisher: Perspective from Experience**

By Mark Zweig

08 **Engineering Our Future: Importance of learning and change**

By Chad Clinehens, P.E.

10 **Engineering Front Line: Hope in liquified land**

By H. Kit Miyamoto, Ph.D., S.E.



Civil + Structural Engineer provides news and articles online to supplement content in this print issue. Visit www.csengineermag.com daily for the latest news and check out the following articles posted online with the March 2019 issue:

BREAKING DOWN BORDERS

Students from Auburn University on an Engineers Without Borders project use geospatial technology to help third-world communities access water. (<http://tinyurl.com/mar19online-1>).



A Trimble R2 GNSS receiver and Trimble CenterPoint RTX satellite-delivered correction services allowed the Engineers Without Borders team to collect 4-cm accurate elevation data in remote locations.

REVITALIZING A LANDMARK

In early December, Ford began renovation of 105-year-old Michigan Central Station in the historic Corktown neighborhood of Detroit. Abandoned in 1988, Michigan Central Station has sustained decades of damage from rain and freeze-thaw effect, which expanded cracks and holes in the masonry. The structure soaked up tons of water over the years and steps must be taken to dry out the building, assess the damage, and plan for repairs and restoration. (<http://tinyurl.com/mar19online-2>).



During a 10-day Winter Festival in January, Ford used advanced 3D projection-mapping technology with the 18-story Michigan Central Station as a canvas to re-create its glory days, its revitalization, and its future as the centerpiece of a new 1.2-million-square-foot Corktown campus.

PROJECT PROFITABILITY: SUCCESSFUL NEGOTIATING SKILLS FOR PROJECT MANAGERS

Howard Birnberg, Association for Project Managers, offers eight ideas to keep in mind (<http://tinyurl.com/projectprofit-mar19>).

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Image: Sam Morris/Las Vegas News Bureau



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PERSPECTIVE FROM EXPERIENCE

EMPATHY IS AN ESSENTIAL QUALITY TO
ACHIEVE TRUE SATISFACTION FROM
YOUR WORK AND HOME LIFE.

AT NEARLY 61, I have gone from being the young guy in the room to the old guy. It all happened so fast that it seems like a dream. And even though in my head I “feel” 25, the aches and pains in my body tell me otherwise. But not every aspect of getting older is negative.

One thing age provides is experience. And that experience should provide perspective that a younger person won’t have. Perspective is valuable!

Now that I have it, I can see how ego is a double-edged sword. It may drive you to achieve but do so for all the wrong reasons. And that drive can become self-destructive later in life because the ego keeps you from being able to empathize with others — an essential quality to achieve true satisfaction from your work and home life.

When I think about the very best civil and structural engineers I have known in my life, they were all people who deeply cared about other people. They achieved great goals through others because they could put themselves in the other guy’s shoes. That ability changes virtually everything you say and do. They gave the people they worked with the credit versus hogging it for themselves. They could think long term and do the right thing for the future versus what made them look best today. And by not trying to look like heroes, they actually acted like heroes and became heroes.

What is motivating you? Are you pursuing your work with the “right” goals in mind, or doing so thinking only about the potential glory you’ll receive? If the latter, odds are you will run off-course. Why wait until you are my age to figure that out? By then it may be too late to redeem yourself and achieve the truly great things that are possible when your energy level is highest and mind is sharpest.

We have another great issue of Civil + Structural Engineer magazine here for you in March. Bob Drake and our other editors and contributors have worked hard to put themselves in your shoes and deliver the best product for you that we can. Enjoy reading and pass it on to someone else you think will benefit from these pages!

MARK C. ZWEIG
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Here's some recent headlines you might have missed about civil and structural engineering firms:

- Savanta, Inc. joins GEI Consultants, Inc. (<https://tinyurl.com/mar19-headlines1>)
- KAI Design & Build announces restructuring, new leadership roles (<https://tinyurl.com/mar19-headlines2>)
- International award showcases Gannett Fleming's urban mobility leadership (<https://tinyurl.com/mar19-headlines3>)
- Anthem Structural Engineers opens second office in Steamboat Springs (<https://tinyurl.com/mar19-headlines4>)
- SEPTA board awards contract for KOP Rail Preliminary Design to HNTB (<https://tinyurl.com/mar19-headlines5>)
- Modjeski and Masters to rehab two vertical-lift bridges over Erie Canal (<https://tinyurl.com/mar19-headlines6>)
- Jacobs named engineering design manager for California WaterFix (<https://tinyurl.com/mar19-headlines7>)
- AECOM launches second annual global infrastructure report (<https://tinyurl.com/mar19-headlines8>)
- AMT transitions to 100 percent employee owned (<https://tinyurl.com/mar19-headlines9>)
- DBF introduces UAV services (<https://tinyurl.com/mar19-headlines10>)

And in research news relevant to civil and structural engineering:

- Missouri S&T poised to help address state's bridge repair needs (<https://tinyurl.com/mar19-headlines11>)
- Australian researchers recycle biosolids to make sustainable bricks (<https://tinyurl.com/mar19-headlines12>)
- Researchers propose new method to better assess building safety after an earthquake (<https://tinyurl.com/mar19-headlines13>)
- Smart transformation triggers robust cycle of economic growth in cities (<https://tinyurl.com/mar19-headlines14>)

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IMPORTANCE OF LEARNING AND CHANGE

REMAIN TUNED TO CLIENTS' CHANGING
NEEDS, THE RESOURCES AVAILABLE, AND
NEW WAYS TO APPROACH CHALLENGES.

CHANGE IS A CONSTANT IN LIFE. It's also a constant in our industry, but we struggle with it more so than many other professions. This is especially true when rapid change or significant change is needed. Part of it stems from our need for conclusive data, which can take time to compile. Our engineering education trains our brains to be highly analytical, with the ability to process many scenarios to arrive at the one best answer, almost always mathematically driven. In your career and in business, decisions are rarely able to have the same level of data, analysis, and conclusion. This reinforces the importance of constant learning in all aspects of your career. You must be highly tuned to your client's changing needs, the resources available, and new ways to approach challenges.

For the last six years, my engineering career expanded, bringing me to Zweig Group and research, publishing, and advisory services to the AEC industry. One of our products, Civil + Structural Engineer magazine, has existed in an industry that has experienced profound change. Like any other industry, the magazine world has felt the impacts of digital technology. For a few years now, the reduction in print publications and increasing online readership has been extensively surveyed and reported by market researchers. Print media is in rapid decline. Faster internet speeds, interactive content, and broader distribution are some of the numerous reasons why contemporary magazine publishers are continually making a move toward digital publishing.

I'm very proud of this magazine. It's the best-looking magazine I've seen in my engineering career. However, in an effort to focus our company resources to continue providing our clients the best resources available, we are discontinuing the print version of Civil + Structural Engineer magazine with this, the final March issue. Civil + Structural Engineer magazine will continue to exist in digital format online as a digital resource. In fact, the website has developed into one of the fastest-growing online resources for the AEC space, outpacing many large industry media outlets.

The cseengineermag.com website contains the electronic version of Civil + Structural Engineer magazine plus thousands of additional online resources. Because our website now offers 100,000-plus impressions per month, it is clearly the optimal resource for engineers. The benefits of this move are numerous, and include:

- Increased investment — our in-house team will shift to provide an enhanced online product dedicating additional resources to upping our online game.
- Broader focus — additional investments online allow for diversification of content, giving you more access to career-building resources.
- Focus on sustainability — the digital move saves nearly a million sheets of paper a month, saving 840 trees a year.

As an engineer, you can set yourself apart by leading change in your firm. When your clients and the market are telling you something, listen and react. Arm yourself with as much data as you can, and be thoughtful and strategic, making timely decisions as the conditions demand. We have listened to you and the market, and our decision to focus our people and resources toward the online resource should benefit every reader of the magazine and user of the website. We are confident that our future as the hub of content for the engineering profession and the AEC industry as a whole is taking a leap forward. Go to cseengineermag.com to continue reading the magazine monthly and to get even more free resources to build your career and business. Together we will elevate the industry.

CHAD CLINEHENS, P.E., is Zweig Group's president and CEO. Contact him at cclinehens@zweiggroup.com.

AWARDS, PROMOTIONS, AND NEW HIRES

ON THE RISE

Freese and Nichols, Inc. bolstered its energy services by adding Oil & Gas Group Manager and Practice Leader **Dan McKenzie, P.E.** McKenzie has almost four decades of experience in gas processing, treating, gathering, compression design, construction, operation, and optimization. Freese and Nichols, Inc. hired three planners in its Urban Planning + Design Group in Texas and Oklahoma: **Chance Sparks**, **Dawn Warrick**, and **Eleana Tuley**. Sparks has more than 15 years of planning and management experience and has worked for the Cities of Buda, San Marcos and Bulverde in Central Texas. Warrick is a project manager in Tulsa and has more than 23 years of municipal planning experience, including seven years as the City of Tulsa's planning director. Tuley is based in Freese and Nichols' Dallas office and has more than six years of experience in both the public and private sectors. The firm also hired **John Fishburne, P.E.**, a former top engineer for the City of Charlotte, to expand water/wastewater services in North Carolina. He has almost 20 years of experience through both the city and his own firm in managing a variety of pipeline rehabilitation and replacement projects.

Mehrafarid Ghoreishi, Ph.D., P.E., joined Cardno as a senior structures engineer in the company's Clearwater, Fla., office. He has more than 20 years of experience in structural and bridge engineering and transportation planning.

Neel-Schaffer, Inc. promoted **Sonny Smoak, P.E.**, to a senior vice president role, and **Steve Cockerham, P.E.**; **Richard Sullivan, P.E.**; and **Stan Wright, P.E.**, are now vice presidents with the firm. Smoak, with almost 20 years of experience, manages transportation and environmental projects and works in business development for the firm throughout the South Texas area. Cockerham has 25 years of experience, including 20 years as a project manager for civil, environmental, and water resources projects. Sullivan, with more than 20 years of experience, serves as Tennessee operations manager, overseeing the Nashville, Murfreesboro, and Memphis offices. Wright has more than 20 years of experience in the design, management, and marketing of transportation and roadway projects.

OHM Advisors added three new shareholders: **Lambrina Tercala P.E.**, **ENV SP**; **George Tsakoff, P.E.**; and **Matt Wendling, P.E.** Tercala started her career with OHM Advisors in 2014 as a wastewater design engineer in the firm's environmental water resources group. With more than 20 years of experi-

ence, Tsakoff provides leadership for several major municipal partners in southeast Michigan. Wendling has more than 22 years' experience, including feasibility studies, alternatives analysis, structural design, roadway design, non-motorized network design, and wetland mitigation oversight.

Baxter & Woodman, Inc. appointed **Rebecca Travis** to the position of Florida Division manager, overseeing business development efforts of the West Palm Beach, Fort Lauderdale, and Key West offices. Throughout her 35-year career, Travis has served in both managerial and technical roles related to municipal stormwater, roadway, and utility projects.

Roderic A. Sechrist, P.E., joined GPI as transportation operations and asset management specialist for its New York State offices, which include Buffalo, Rochester, Albany, Manhattan, and Long Island. He joined GPI after a 32-year career with New York State Department of Transportation, from which he retired in 2016.

Albert Meyer, Jr., and **Lea Cosenza** were named associates at The Harman Group, a firm specializing in structural engineering and parking planning and design. Meyer has 26 years of structural design experience across a variety of project types, including hospitality, gaming, and residential. Cosenza specializes in structural engineering for new buildings, expansions, overbuilds, and historic renovations.

Waldrop Engineering hired **James Ink, P.E.**, as director of operations for the firm's downtown Fort Myers, Fla., office. His more than 35 years of consulting experience includes waterfront-related development, including marinas, resort-hospitality, residential design, and jurisdictional permitting and compliance. Waldrop also hired **Fred Drovdlc, AICP**, as principal planner/senior project manager in the firm's Bonita Springs, Fla., office. He has 20 years of experience in planning and development consulting, with specialization in zoning entitlements, land use and comprehensive community planning, master site design, and public outreach.

Stantec expanded its water practice in North Carolina, hiring **Stephanie Holloman** as water/wastewater practice leader in Raleigh where she will mentor and manage a team of design professionals and technicians. She has extensive experience in the municipal water/wastewater infrastructure field, ranging from collection and conveyance to potable water treatment and wastewater reclamation.



Chance Sparks



Dawn Warrick



Eleana Tuley



Mehrafarid Ghoreishi,
Ph.D., P.E.



Sonny Smoak, P.E.



Steve Cockerham,
P.E.



Richard Sullivan, P.E.



Stan Wright, P.E.



Lambrina Tercala, P.E.



George Tsakoff, P.E.



Matt Wendling, P.E.



Rebecca Travis



Roderic A. Sechrist,
P.E.



Albert Meyer, Jr.



Lea Cosenza



James Ink, P.E.



Fred Drovdlc, AICP



Stephanie Holloman



HOPE IN LIQUIFIED LAND

DISASTER TRIGGERS RESOLVE TO BUILD SAFER, MORE RESILIENT COMMUNITIES.

H. Kit Miyamoto, Ph.D., S.E.
in Jakarta, Indonesia

I AM STANDING ON LIQUIFIED LAND that swallowed more than 1,000 houses and killed more than 500 people; more than 500 people are still missing. Presumably they are buried under this soil. An old man next to me said that houses moved more than half a kilometer. I see twisted, half-buried cars and broken houses awkwardly tilted and frozen, still in the soil. An imam's prayer is blasting from a nearby mosque. It sounds beautiful, but eerie. Dusk is near under thick gray clouds. The surrounding mountains are getting darker.

On Sept. 28, 2018, a magnitude 7.5 earthquake triggered a massive soil liquefaction flow in the Indonesian province of Central Sulawesi. An earthquake fault ruptured directly underneath the provincial capital of Palu at 6:02 p.m. People had started cooking dinner, then the earthquake hit. Suddenly, the earth beneath them liquefied and started moving at high velocity. It was essentially a horizontal landslide swallowing houses, cars, and people.

Visiting Japanese researchers theorized that “there could have been a void redistribution due to a layer of water-film between the liquefaction-prone soil and low-permeable cap layer, which acted as a lubricant for liquefaction flow.” It was a very rare form of liquefaction. I have never seen anything like this in my years of working on earthquake disasters.

Our team is a part of a mission for a multinational reconstruction bank to provide technical assistance in the disaster-affected area of Central Sulawesi. It is a remote area of Indonesian islands, just below the equator with incredibly beautiful jungles in a mountainous region. However, the population density is high; Indonesia is the largest Muslim country in the world with 264 million people. Towns are rustic, like something you may find in the Caribbean. People are friendly and smile quickly. Food is mostly fresh-caught fish and chicken grilled in exotic, colorful spices. Being a Muslim country, you don't find many beers here, but you get used to drinking fresh-squeezed juices during meals. Most of the buildings you find here are constructed with reinforced concrete and brick infill as happens, it seems, in much of the world. It is fascinating to see the similarity of construction worldwide.



Ground floor columns on this modern, multi-story classroom building are ruptured, bent, and twisted.

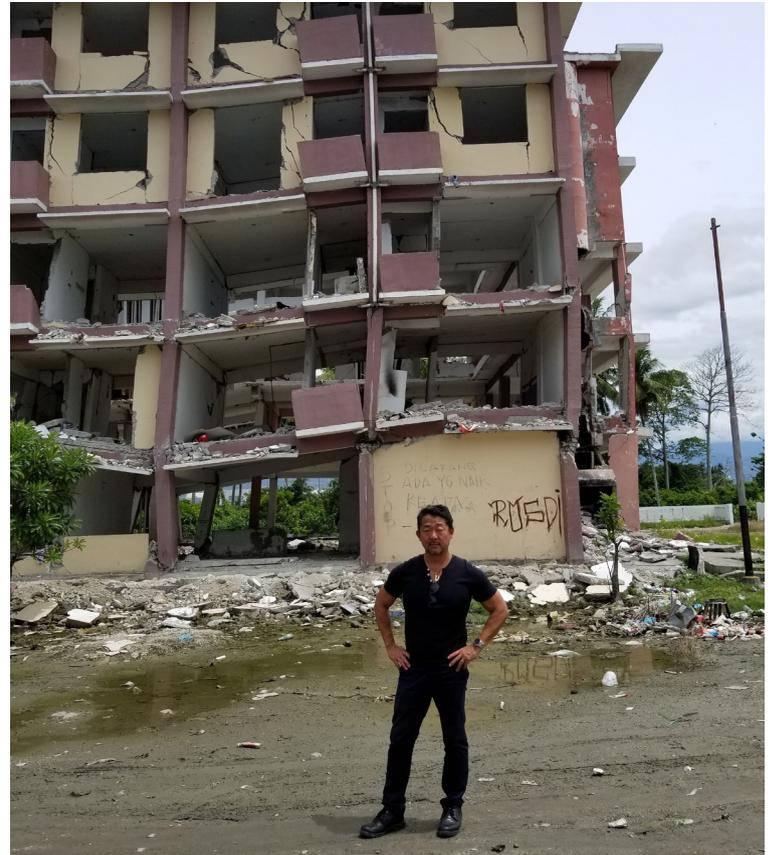
The next day, we drive up from the seaside town of Palu to the university site. It is a large campus with a student and staff population of 40,000. More than 200 buildings sit on the hillside campus. As we drive through the campus, we see a modern, multi-story classroom building with its ground floor columns ruptured, bent, and twisted. The second level is now essentially touching the ground. Everything between is squashed.

A civil engineering professor from the university is with us. Looking at me through his thick glasses he said, “This building is only a year old. You notice this plain rebar used for tie reinforcement. These are the killers. Without deformed bar, without proper 135-degree hooks at the ends, these ties are essentially useless and concrete columns and vertical rebar explodes. Sadly, we lost one student here. But we could have lost hundreds more if this earthquake was a couple hours earlier.”

His eyes are soft, but I see deep sadness. He continued, “Indonesian code is based on international code, but construction quality is not catching up. We will rebuild this school, but not the same way — better and safer. We will also need to strengthen all remaining buildings.”

We lost more than 2,200 people in this earthquake, but this may become a trigger point to build safer and more resilient communities.

H. KIT MIYAMOTO, PH.D., S.E., is the CEO and a structural engineer for Miyamoto International (<http://miyamotointernational.com>), a California seismic safety commissioner, and president of the technical nonprofit Miyamoto Global Disaster Relief. He specializes in high-performance earthquake engineering and disaster mitigation, response, and reconstruction.



Most of the buildings in the Indonesian province of Central Sulawesi are constructed with reinforced concrete and brick infill.

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www.eventsquid.com/event.cfm?id=5286

APRIL 2019

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APRIL 3-5 — ST. LOUIS

Educational and networking event for the structural steel industry, bringing together structural engineers, structural steel fabricators, erectors, detailers, and architects.

www.aisc.org/nascc

14TH NATIONAL LIGHT RAIL & STREETCAR CONFERENCE

APRIL 7-9 — JERSEY CITY, N.J.

Sessions showcase the positive results experienced in metropolitan areas that have embraced light rail and streetcar and explore new ways to plan, design, construct, maintain, and operate light rail and streetcar systems.

www.apta.com/mc/lightrail

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APRIL 8-10 — CINCINNATI

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www.dbtranspo.com

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APRIL 10-12 — CINCINNATI

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www.dbwater.com

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APRIL 10-12 — SCOTTSDALE, ARIZ.

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www.eventsquid.com/event.cfm?id=5196

THE PRINCIPALS ACADEMY

APRIL 24-25 — DALLAS

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STRUCTURES CONGRESS 2019

APRIL 24-27 — ORLANDO, FLA.

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www.structurescongress.org

AUVSI XPONENTIAL

APRIL 29-MAY 2 — CHICAGO

Join 8,500 technologists, regulators, and users across commercial and defense sectors for a comprehensive trade show for unmanned and autonomous systems.

www.xponential.org/xponential2019

AEC BUILDTECH

APRIL 30-MAY 2 — ROSEMONT, ILL.

Inaugural event intended for architects, engineers, and contractors to learn about new building technologies and processes and how to apply them. Offers continuing education credits.

www.aecbuildtech.com

MAY 2019

WEF STORMWATER AND GREEN INFRASTRUCTURE SYMPOSIUM

MAY 8-10 — FORT LAUDERDALE, FLA.

Inaugural symposium crafted to deepen the technical knowledge of professionals involved with stormwater management and provide forums to discuss leading issues.

<https://wef.org/events/conferences/upcoming-conferences/stormwater-and-green-infrastructure-symposium-2019>

SWAN 2019 CONFERENCE

MAY 15-16 — MIAMI

The annual flagship event of the Smart Water Networks Forum (SWAN), a global hub for the smart water and wastewater sectors, brings together global utilities, solution providers, researchers, consultants, and academics to further accelerate the smart water industry.

www.swan-2019.com

P3CONNECT

MAY 15-16 — DENVER

National Conference for Public-Private Partnerships offers this event for public-sector officials and private-sector innovators focused on advancing public-private partnerships (P3s) nationwide.

<https://thep3connect.org>

INTRODUCTION TO STRUCTURAL DESIGN OF WOOD BUILDINGS PER THE 2018 NDS

MAY 21-22 — BLACKSBURG, VA

Course is designed for individuals who never had the opportunity to learn wood design basics in a university-level course, but are involved in the design, construction, and inspection of wood buildings.

www.cpe.vt.edu/sdwnds/index.html

NOMINATION PERIOD OPEN FOR THE 2019 RISING STARS AWARDS!

- Nominees must be 40 years of age or younger and working in the United States as a civil or structural engineer. Self-nominations are acceptable.
- Nominees should have a record of demonstrated exceptional ability and professional accomplishments related to civil or structural engineering in one or more of the following capacities: project design; management; leadership; teaching; research; and/or public service.
- All nominations must be made online at <https://zweiggroup.myshopify.com/products/2019-rising-stars-nomination>.
- Full list of rules can be found online at <https://csengineermag.com/article/rising-stars-in-civil-structural-engineering-2/>



2019
Rising Stars
Civil + Structural Engineer

NOMINATION PERIOD CLOSSES AT MIDNIGHT (ET) ON MARCH 12, 2019

U.S. OFFICE MARKET OVERVIEW

AEC FIRMS SHOULD DEVELOP AND EXECUTE A STRATEGIC PLAN TO HELP MANAGE REAL ESTATE AND OCCUPANCY COSTS.

By Mike Ebbitt

THE U.S. OFFICE MARKET is poised for moderate growth in 2019. Office-using employment is expected to grow by 1.5 percent or by more than 300,000 jobs — a modest deceleration from 2018 primarily due to a very tight labor market. Sunbelt and tech markets are expected to register the largest percentage gains in employment, led by San Francisco, Orlando, Houston, Austin, and Tampa, each at 2.7 percent or more. San Francisco, Dallas/Ft. Worth, Houston, New York, and Chicago are projected to add the largest number of jobs in 2019 — between 15,000 and 25,000 each.

Office-using employment growth, although at a slower rate due to labor market constraints, will drive further office market expansion in 2019. New office product will help meet strong tenant demand for modern, efficient, highly amenitized space to attract and retain employees in an increasingly competitive labor market. Occupiers will continue to seek flexible space offerings and lease structures that keep them adaptable to changes in the economy and their organizational needs.

Successful strategies

With shorter business cycles and technological advancements and markets becoming more unpredictable than ever, office occupiers will continue the shift to more flexible real estate strategies. Work environments and lease structures must be adaptable to support highly dynamic organizational objectives. Following are some growing trends.

The historically low levels of unemployment create some challenges for companies. Tenants are reevaluating their real estate as a result. The most successful companies are using their office space as an asset to attract top talent rather than merely an expense.

Another trend is the drive toward efficiency. For a growing number of office tenants signing new leases, workplace strategies are being used to optimize space needs. Nationally, the average range is 150 to 225 rentable square feet (RSF) per person.

Additionally, there has been a shift in the location of private offices. Companies are moving away from offices located at the exterior in lieu of designating their offices in the interior of the space. The main benefit is the addition of more natural light to the space.

\$26 / RSF



\$37 / RSF



\$74 / RSF

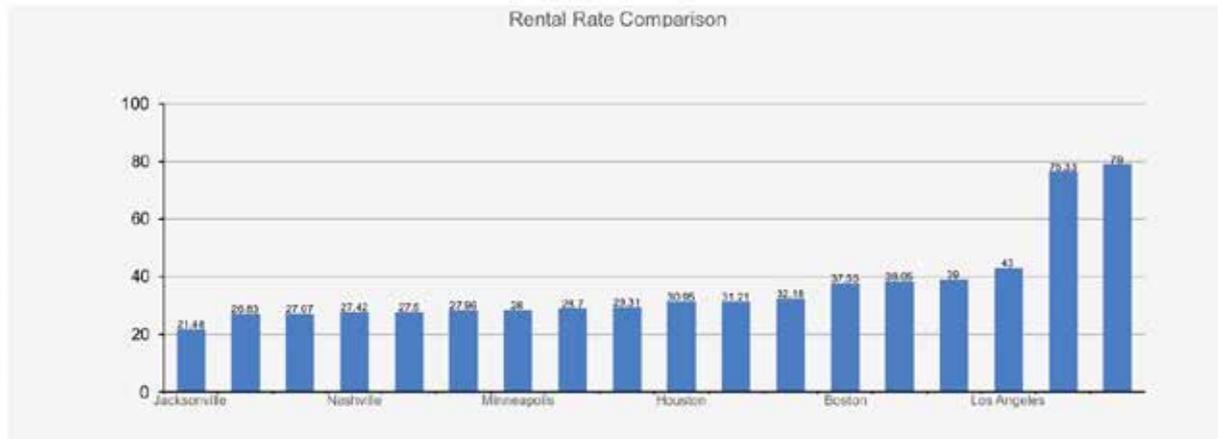


\$120 / RSF



Office build out pricing guide — dollars per rentable square foot (RSF).

City	Rental Rate
Jacksonville	\$21.48
Philadelphia	\$26.83
Phoenix	\$27.07
Nashville	\$27.42
Atlanta	\$27.50
Dallas	\$27.96
Minneapolis	\$28
Charlotte	\$28.70
Denver	\$29.31
Houston	\$30.95
Portland	\$31.21
Chicago	\$32.18
Boston	\$37.55
Austin	\$38.05
Miami	\$39
Los Angeles	\$43
New York City	\$76.33
San Francisco	\$79



Tip: The first step toward effective space management is to gather and analyze demand forecast data at the business unit level. Ideally, this should include the current state of seat occupancy and vacancy as well as business unit growth projections.

Use of forecast data is essential for making proactive real estate decisions. However, effectively planning for future requirements also requires buy-in and coordination between a company's leadership, human resources, finance, and real estate teams with the goal of minimizing the gap between space supply and demand to directly support business success. Working across business units in this way, executives can factor in long-term organizational needs, goals, and planned projects to create fact-based strategies for future real estate needs.

When done correctly, rather than merely reacting, an organization can proactively respond to changing business needs and priorities. The most common cost savings opportunities include reducing seat vacancy, trimming square footage, increasing space efficiency, and tightening seat density.

Renew or relocate guide

Markets fluctuate, employees multiply, new technologies emerge. One thing is certain: You need to make room for the future even if you can't predict it. Whether that means a moderate renovation or full-tilt relocation, the following tips will help you start the discussion. If and when you decide to move, you will know exactly what to expect.

Size matters. The size of your company will determine both the time the move will take and the type of lease terms you're likely to receive. Consider the following relocation guidelines:

- 1-5 employees — 30- to 90-day process; less than one year or month-to-month lease
- 15-35 employees — 3- to 6-month process; five-year lease or less
- 75+ employees — 6- to 12-month process; five- to 10-year lease

Whether it takes 12 weeks or 12 months, your move can be split into three phases — planning, selection, and buildout.

Phase 1: Plan Your strategy

Your move strategy is about more than picking a new building. A real estate decision can affect every facet of your business, including productivity, revenue, wellbeing, sustainability, and future success. Questions to consider include:

- What are your company's broader business objectives?
- Which real estate decision will support those goals?
- How fast is your growth rate? Do you need flexible terms?
- What is your exit plan when the lease ends?
- Who is your workforce and what is their work style?

Know thyself, as the ancient Greek aphorism goes. Understanding and acknowledging where your business is today — in terms of employees' demographics, their needs and wants, operational processes, and leadership style — is the baseline for understanding what kind of space will best serve your business. Identify inefficiencies in your current workspace, decide how the new space should function, and present the plan to stakeholders.

- How can operations improve?
- What style of building suits you?
- Enclosed office or small cube?
- How many square feet per employee?

Use an executive questionnaire. Get insight from leadership on the scope of the project and the function of the space. Questions may include:

- Rate the quality of your existing floorplan. How do you define quality?
- What do you want to prioritize most? Customer image? Cost? Recruiting new talent?
- How important are informal meeting areas?

Time is your biggest asset. Procrastinating in Phase 1 is perhaps the biggest mistake you can make when considering a move. It's never too early to start thinking about your occupancy plans. Kick off initial discussions no fewer than six to nine months before your lease expires.

Renewals without negotiations are dangerous. Your landlord hopes to not have to recapitalize your premises for another tenant. Revise your

approach even if you plan to renew your lease. It is not a renewal, but rather “Building Option One” to compare with all the other buildings you will evaluate. In essence, your building provides you with two opportunities — the one your renewal option declares and the one you successfully negotiate using the open market as your backdrop of comparables.

The fact is, you are considering leasing space in your landlord’s building again, not simply renewing. As a result, all business points should be on the table for discussion. Gain negotiating leverage by touring the market and understanding your options. Your landlord will work hard not to lose you.

Phase 2: Selection

Negotiate your lease. It is crucial that you understand all of the costs and risks associated with each property along with the terms to which you’re agreeing. Insist on a future protection clause in case your needs change. Perform proper physical due diligence so you’re not surprised by building issues later.

Many tenants overlook one of the biggest liabilities in a new lease — the base building systems and condition of the premises, i.e. the physical condition and safety of the building. Poor infrastructure is an obvious red flag but building enhancements can be just as concerning. When a landlord makes a significant improvement to their building (such as adding a new roof or replacing the HVAC), those associated costs are often billed back to tenants over the duration of the lease. A proper inspection and lease protection can prevent a large liability from a capital improvement project.

Phase 3: Build out

Begin coordinating your move during construction, up to 24 weeks before your move-in date:

- Plan: Define roles, resources, budget, timing, change messaging, and vendors.
- Communicate: Prepare employee welcome materials and move instructions.
- Transfer: Finalize security, mail, and technology moves.
- Organize: Label day-one tasks, directions, workstations, keys, and layout
- Confirm: Check inventory, end of lease terms, final invoices, and do a walk-through of your old space

Disruptive trend to watch in 2019

More and more companies are closing the door on the popular “open office” design trend. A recent study shows that the open office may do more harm than good. The Journal of Environmental Psychology jumped into the fray, releasing a study of 40,000+ workers and more than 300 companies. The study concluded the following:

- Closed offices outperformed open offices for productivity.
- Proxemics issues (how people feel when close) create uncomfortable workers (and therefore less productivity).
- Noise and visual disruption create distraction and focus issues.

If your company wants to give its employees space to collaborate and socialize without falling victim to these issues, new and emerging design trends may have the answer. Some offices incorporate the best of both worlds with flexible design plans.

Flexible plans offer private spaces for those who need a little solitude to get the job done — individual offices or small conference areas for groups to gather away from the crowd. But their main work areas still reflect an open design. People can sit among their peers in an open space for a few hours before moving to a private office to make phone calls or zone in on the details of a creative project.

Final thoughts

The integration of these strategies, location factors, and space considerations requires comprehensive due diligence and a measured approach. The information provided should help serve as a reference. While it can’t replace the personalized insight gained from working one-on-one with a tenant advisor, it can offer a starting point for the considerations and steps that should be taken to ensure your facility is an asset, not just office space.

MIKE EBBITT, director of the office tenant representation team at Lee & Associates (www.lee-associates.com) based in Dallas-Fort Worth, oversees the building and growth of the specialty group. His team assists tenants with occupancy needs in office properties throughout the region and across the nation. Lee provides end-to-end occupier representation services, including relocation, expansion, consolidation, sublease, acquisition, or disposition. Contact Ebbitt at mebbitt@lee-associates.com or 972-934-4004.

KNOW YOUR IP

BASIC INTELLECTUAL PROPERTY RULES CAN HELP CIVIL AND STRUCTURAL ENGINEERS UNDERSTAND HOW IT AFFECTS THE AEC INDUSTRY.

By Stephen L. Keefe, P.E., Esq.

INTELLECTUAL PROPERTY (IP) IMPACTS EVERY INDUSTRY, including civil and structural engineering. For example, a Florida general contractor re-

cently slapped a competitor with a patent suit alleging infringement of its concrete slip forming technologies. The case apparently settled in mid-2018 in the U.S. District Court for the Southern District of Florida, showing that the accused infringers may have taken the case seriously enough to nix the lawsuit in its early stages.

As this patent blowup shows, civil engineers and contractors have no more immunity against IP enforcement than any other industry. It also shows how civil engineering enterprises can effectively turn their IP on misbehaving rivals. Further, IP claims pose yet another risk for in-



dustry players to consider and allocate, typically via IP indemnification clauses in their contracts.

Some basic IP rules follow below to help civil and structural engineering professionals understand how IP affects their industry. IP comes in four primary categories — patent, copyright, trademark, and trade secret. Each IP type has unique costs, benefits, and disadvantages.

Patent

Patents usually cost more money and take more effort to obtain than the other IP categories. Civil and structural engineers, unlike practitioners of more abstract arts such as software and financial methods, have little trouble with patent eligibility for their inventions at the patent office. The crux of patent protection is the right to exclude others from using a patented invention. It typically takes at least two years after filing a patent application to obtain an issued patent — with patent costs totaling several thousand dollars in government fees and attorney costs to cut through the bureaucratic and legal obstacles — to create a robust patent that would-be infringers would hesitate to challenge. Receiving a patent is no sure thing, with the U.S. Patent and Trademark Office (USPTO) ultimately refusing to allow many applications it receives.

A patent owner has a right to bring a lawsuit, normally in federal court, to stop another party from making, using, selling, offering to sell, or importing his or her patented technology. Patent claims signed off on by the USPTO define intellectual property analogously to how a deed defines physical property such as land. In other words, a patent provides a property right. That right typically stays in force for 20 years from application filing.

Patent litigation can sometimes involve enormous damages and consequences for infringers. The high-stakes nature of patent lawsuits tends to make bringing and defending them quite expensive and burdensome, with extensive discovery and depositions of high-ranking corporate officers. Just the threat of litigation by a patent owner can create a strong deterrent to prevent competitors from copying the patentee's proprietary technology.

The global patent system takes territorial form, with civil and structural engineering inventors having to file and obtain a separate patent in each nation in which the innovator seeks protection. Each national patent system comes with its own costs and nuances, with the U.S., Europe, and China forming the usual first tier of filing for civil engineering. Civil and structural engineers also file in relatively high numbers in Japan, Korea, Canada, and Australia.

Global filing, of course, changes based on business goals, with smaller nations taking priority over larger markets depending on the technology and associated business strategy. Because filing patents in multiple nations easily generates costs in the tens of thousands of U.S. dollars, patentees usually reserve such wide global filing for their best technologies. Each nation that issues a patent will then charge recurring annuities to maintain that patent.

Civil and structural engineering professionals should remember above all what probably amounts to the golden rule of patenting: Avoid publicly disclosing your invention until you file a patent application on that invention. Following this rule of thumb will go a long way in keeping the inventor out of difficult situations as a patent owner.

Per Article I, Section 8, clause 8 of the U.S. Constitution, patent ownership vests in individual inventors. In the absence of a contract, multiple inventors jointly own their inventions. The freedom to contract then kicks in, with inventors having the option to enter into agreements to license, assign, sell, or otherwise use their patent as they would any piece of property.

Business associations in the U.S. such as corporations typically require their employees to assign all patents to the company as a condition of employment. As many small businesses learn the hard way, a future obligation to assign buried in an employment agreement typically does not equal a legal assignment, meaning that companies should have inventors execute an assignment with each and every patent application.

Copyright

The U.S. Constitution created copyright law in the same clause as it made patents a part of American jurisprudence. Contrary to relatively expensive patents that require USPTO issuance, copyrights cost much less and come into existence as soon as an author fixes a creative work in tangible form. For example, once an author writes down or draws an original work of authorship, he or she creates a copyrighted work. Although successfully suing for copyright damages typically requires registration with the Copyright Office, the work at least theoretically becomes protected once the words or drawings hit the page.

Copyright law protects primarily expression, which amounts to this IP form's chief limitation. As an example, imagine that a civil or structural engineer publishes a groundbreaking article on a new technique or a thoroughly researched solution to a longstanding problem in the field. Although patent law may protect the technological innovation itself, copyright law protects merely the way that article's words express the solution or innovation. So, copyright basically just protects the wording of the article expressing the idea from unauthorized copying and reproduction by an infringer. Unlike patent law, copyright will generally not stop a copyist from using the underlying innovation itself.

Although the author's copyright lawyer may zealously argue in favor of substantial similarity to the copyrighted work to underpin a finding of infringement in court, it typically does not take much rewording and revision by another party to alter expression enough to evade a copyright. This reality may explain why patents, which protect the technical breakthrough itself, cost significantly more money and trouble to obtain than copyrights. A copyright, though, will still stop the many egregious copy-and-paste infringers who infest the civil engineering industry in the internet age.

While copyright protection of literary and graphic works tends to provide straightforward enough protection, copyright law does have some wrinkles for civil and structural engineers. Copyright law protects architectural works but throws some curve balls in which only certain types of structural plans and as-built structures gain legal protection.

Copyright law covers buildings inhabitable by humans such as houses, office towers, hotels, theaters, and other structures meant for human occupation. Copyright leaves other civil engineering works out in the cold, typically denying protection for structures such as bridges and

dams. Copyright also encompasses computer code, so copyright may extend to CAD file code for original works of authorship as well.

Copyright protection typically endures for 70 years from the death of the author. For more straightforward copyright cases, civil and structural engineering authors may use a simple, internet-based website maintained by the U.S. Copyright Office to register their works for about \$50. The author may later use the resulting registration, which the Copyright Office typically issues within a few months for original works of authorship, to sue for copyright infringement. Suing for copyright infringement, usually in federal district court, involves significant nuance and procedural hurdles probably best left to a copyright attorney retained by the author to handle the suit.

Trademark

While copyright centers on expression and patent provides a right to exclude, trademark law focuses on the source of goods and services. Trademark guards against actors who would create market confusion regarding a wide variety of marks and brands, including logos, names, sounds, colors, and trade dress. Owners may use their trademarks as a shield against parties that attempt to unfairly use another's market identity or good will for gain.

For example, if a new retailer tried to use a logo resembling a bullseye, a certain Minneapolis-based retail giant might bring suit to enforce its trademark. The trademark owner may use the law to keep consumers from mistakenly shopping at that new store based on the false assumption that the competitor falls under the established brand.

Trademark laws vary by state in the U.S. more than copyright law does, and vastly more than patent law, which federal courts almost exclusively shape. Like patents, trademarks involve many nuances that could and do fill books. The U.S. Patent and Trademark Office issues trademarks based on review by government examiners, with acquisition costs typically amounting to less than patents.

Unlike patents, trademark rights may come into legal existence without an issued mark and for an unlimited term. Related rights such as false advertising claims and a right of publicity also exist in the trademark arena. Like patent and copyright law, trademark law varies on a nation-by-nation basis, though international treaties such as the Madrid System exist to streamline international filing.

Trade Secret

Trade secret forms the last primary class of intellectual property, with secrecy underpinning this type of protection. Although American trade secret law varies based on state common law, Congress recently provided a key cause of action in 2016 at the federal level with the Defend Trade Secrets Act. Trade secret basically stands as a polar opposite to patent law. While patent law gives owners a 20-year term to exclude others from using their inventions in exchange for describing their innovation in a patent, trade secret law gives its holders a cause of action against theft of trade secrets without time limit, provided the owners follow requirements under state law to maintain the right.

Coca-Cola's formula probably stands as the most famous example of

this IP type in the U.S. But trade secret comes with an Achilles heel: Once stolen and exposed to the world, the trade secret is destroyed. The law typically leaves the owner with just a trade secret theft claim against the perpetrator, and the owner can no longer stop the world from using the eviscerated secret.

Conclusion

Armed with at least the very basics of IP, civil and structural engineering professionals can recognize the various benefits, drawbacks, costs, and risks associated with these important legal rights in their industry. Civil engineering innovators can also plan how to optimally employ the various pillars of IP in their respective enterprises, whether as a shield, or if necessary, as a sword.

This article is for general information purposes and is not intended to be and should not be taken as legal advice.

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PUBLIC NEEDS AND AMBITIONS

AECOM LAUNCHES ITS SECOND ANNUAL GLOBAL INFRASTRUCTURE REPORT.

AECOM RELEASED ITS SECOND ANNUAL GLOBAL INFRASTRUCTURE REPORT, *The Future of Infrastructure: Voice of the People*, which captures data and opinions from 10,000 residents across 10 major global cities — Chicago, Hong Kong, London, Los Angeles, Mumbai, New York, Riyadh, Singapore, Sydney, and Toronto. The report is grouped into four themes to gather insight into the public's infrastructure needs and ambitions for the industry: satisfaction, engagement, innovation, and resilience.

“Residents of cities around the world want greater say in infrastructure planning, and they are growing impatient with delays in the delivery of modern infrastructure systems that can improve mobility, connectivity, and quality of life,” said AECOM Chairman and CEO Michael S. Burke. “Their views should be a call to action for wider government engagement, and new public and private partnerships that can advance ideas, funding, and advocacy, and speed the projects that lead to growth and urban well-being.”

The survey's results showed that while every city has its own distinct identity, people around the world share similar views and experiences with their infrastructure. While city dwellers have a positive outlook for the future, they are also restless for action to improve their infrastructure immediately. They are stressed when using public transportation and want their cities to be greener, safer, and better connected. Most importantly, they want to have a voice in how infrastructure systems are planned, paid for, developed, and operated.

Following are five key insights from this year's report:

There is a clear public engagement gap. Most of the cities underperform when it comes to engaging with their citizens on infrastructure, with an aggregate global average of 3.3 out of 10. It is highest in Mumbai (5.9) and lowest in Sydney, Chicago, and Hong Kong (2.7 each).

Respondents said they want a more focused interaction, which could go a long way toward improving perceptions of city governments' performance on infrastructure and securing support for future projects.

Residents want to help — and some are willing to pay. Almost half (46 percent) of respondents overall are willing to share personal data — the lifeblood of smart cities — to help city agencies improve infrastructure and services. In several cities (37 percent of respondents globally), residents indicated a willingness to pay higher taxes to fund infrastructure improvements. Both commitments underscore citizens' desire to play their part in delivering better infrastructure.

Boosting resilience against cyberattacks is a pressing concern. More respondents have confidence in their city's ability to protect infrastructure against natural disasters and terrorist attacks than those who do not. However, less than one-third (32 percent) have confidence in their city's defenses against cyberattacks. Citizens need increased reassurance from city authorities about the capabilities of their infrastructure to withstand such events.

Wanted: More private-sector involvement. A clear majority of city residents overall (63 percent) believe the private sector should be more involved in the development of infrastructure. This effort could help contribute to the financing, development, and management of better infrastructure.

Upgrading public transportation and enhancing environmental sustainability are top improvement priorities. Upgrading public transportation — particularly roads and underground rail — is the top infrastructure priority for those surveyed. Improving environmental sustainability — through solar power, recycling, and wastewater reuse initiatives, for example — is a close second and tops five cities' to-do lists.

Download *The Future of Infrastructure: Voice of the People* report or review city-specific results at <https://infrastructure.aecom.com>.

Information provided by AECOM (www.aecom.com).



Envisioned in 2038 at Changsha International Culture and Arts Centre, 3D printers are deployed in a Construction Lab to manufacture replacement building components. *Image: Newtecnic*

3D PRINTING PRESENTS MULTI-INDUSTRY OPPORTUNITIES

NEWTECNIC REVEALS SOME EXCITING OPTIONS THAT HAVE GENERATED NEW BUSINESS IDEAS AND OPPORTUNITIES.

By Andrew Watts, FICE, FIED, FIET, FRSA, RIBA

3D PRINTERS are used extensively in automotive, aerospace, and consumer goods industry applications to validate form. During the last three decades, considerable business and technical experience has been built up in enterprises that use this technology. On this foundation, and now that prices are falling, many more machines are being put into service.

Not only have 3D printers become less expensive, their capabilities have evolved. Machines that can print titanium, aluminum, silver, and now carbon fiber, are revolutionizing many businesses, including for example, jewelry making, by enabling production of shapes and designs that could not be made by conventional techniques. The opportunity to show people what a design will look like — even make a plastic example first — allows people to acquire often-unique pieces with no risk of disappointment or surprise at the outcome.

The same idea is current in the life sciences industry where dentists will soon be able to produce perfect crowns on demand from in-house machines while other types of medical implants could be made to measure. There are opportunities throughout these developments for new types of services that will evolve to help companies make the most of the technology. Manufacturing is entering a renaissance where start-ups can produce brilliantly designed, high-quality products without the need for a factory.

Onsite manufacture

Newtecnic's design engineering partnerships with U.S. university engineering departments are aimed at developing new building products and assembly methods that see them accurately and efficiently manufactured and installed on some of the world's most iconic buildings.

Rather than design components and have them made in remote factories to be delivered and then assembled onsite, Newtecnic facilitates the use of Construction Labs where local skilled craftspeople, using locally sourced materials, deploy very advanced production machinery in temporary factories. These small but efficient manufacturing cells that incorporate 3D printing are dedicated to producing mass-customized components. And as robots become more advanced, they will interact with Construction Labs, generating, moving, and installing both new and replacement building parts.

Work station

Aspects of The King Abdullah Financial District (KAJD) Metro Hub in Riyadh, Saudi Arabia, have been design engineered by Newtecnic in the U.S. Inspection, monitoring, and precise measurement of concealed areas behind panels, and within the completed building's fabric, can be executed by small flying LiDAR- and camera-equipped drones and robots. High-resolution building and system performance data collected this way can be shared with, and coupled to, onsite Construction Labs equipped with 3D printers that fabricate components that perfectly fit the as-built structure. Other projects around the world that the company is engineering are planned to deploy Construction Labs from the earliest stages of construction. In this way, mid-20th century methods and devices of mass-production are being replaced by new automated, very flexible, highly controllable and adaptable sets of tools efficiently operated at a local level.

Light bulb moment

In the past, to have an idea for a product was one thing, but to have

it made was quite another. 3D printers have changed that, so now a single product can be made, small batches are easy to produce, and individual customization has become practical. If demand increases, more machines can be simply added to meet it.

Existing manufacturing can easily adapt to accommodate 3D printing and many successfully deploy it extensively. New types of companies are also emerging that exploit the reduced cost base of 3D printing set-ups. These offer innovation through flexibility that is hard to match in a more traditional manufacturing environment.

There are opportunities too in the spares industry. Companies that are obliged to provide spare parts for many years — such as in the automotive, aerospace, and increasingly the construction industry — face storage and logistics costs with “dead” stock. With 3D printing, it is simple to maintain “digital spares” that are printed to order. That means that any amount of digital spare parts can be held in stock indefinitely. This effectively extends products’ lives with all the reputational and environmental benefit that brings.

Fast and faster

Aerospace, F1, consumer product, life science, and construction companies are increasing their 3D printer deployment to help them innovate faster. And in areas of economic under development where manufacturing industry has not taken a foothold, 3D design and printing offer great business innovation potential. Creating products locally means that new agile businesses can start with low investment, minimal

infrastructure, and potentially high returns. The ability to manufacture to demand is very appealing in poor areas of the world that view 3D printing as a way to leapfrog the industrial world’s production and development cycles. Innovative manufacturers are benefiting from this development by siting machines across the world to take advantage of operating conditions and energy costs.

The construction industry sees 3D printing as a way to avoid lengthy spare parts procurement supply chains by making parts and equipment onsite. Newtecnic is currently working in partnerships with American commercial and university engineering departments to develop, test and validate these methods.

Robot builders in space

Many people believe that our future includes colonizing other planets. Development of technologies for mining asteroids is already underway and in 20 years mining and living in space may be a reality. Robotized 3D printing in space would be a viable alternative to sending product supplies from Earth. It is predicted that the first permanent off-Earth dwellings will be built by robots using 3D printing techniques developed for the materials and conditions that are found on other planets. This long-term business opportunity has already spawned several development companies with Richard Branson and Google’s Larry Page as investors.

Currently my company’s technology is instrumental in the design, construction, and simplification of complex buildings. Engineering



It's the year 2038 and inside the Newtecnic Construction Lab additive manufacture is used to make replacement façade panels for the King Abdullah Financial District Metro Hub in Riyadh, Saudi Arabia. Each component fits perfectly because it is developed from data collected using LiDAR scans from the as-built structure. *Image: Newtecnic*

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for habitation on other planets is a daunting prospect but one that can be resolved by innovatively evolving current design engineering and manufacturing practices.

Fab gear

Started as an outreach project from MIT's Center for Bits and Atoms (CBA), Fab Labs (www.fablabs.io) aim at developing programmable molecular assemblers able to make almost anything. Projects in Fab Labs include solar and wind-powered turbines; computers and equipment for agriculture and health care; housing; and printing complete working machines — including 3D printers. Not surprisingly, there are many business opportunities and new enterprise scenarios being developed around Fab Labs and their intensive use of 3D design technology.

Another idea is for people to use designers' basic forms to customize their own products. This means that people without design skills can partner with designers to create new products. As 3D printing prices fall, this market, driven by "collective intelligence," will inevitably grow. Scanning an item with your phone and making a part is also not far away. This means, for example, people could scan, make, repair, and replace parts rather than discard products because one component is faulty. The financial argument is strong because there is immediate return through money saved. Roadside breakdown repairers could even manufacture parts on the way to a vehicle that has communicated directly with a 3D printer on-board the recovery vehicle.

Deploying modular and "cassette" building façade design methodology means buildings can easily be modified to take advantage of new technologies as they arise. In coming years, high-performance concrete and steel components will have evolved to become stronger, lighter, and more durable. New building materials will also be developed and faster 3D printers working onsite or offsite will make optimized components to be fitted by new types of robots. Many building owners and operators will, by these means, simply adapt, refresh, and renew buildings throughout their lives to suit contemporary needs.

In the coming years, 3D printing is set to grow exponentially and, as it does so, new construction industry opportunities will abound. Correctly positioning a business to capitalize on that prospect presents many exciting ways for enterprises to flourish in this inspiringly innovative technological era.

ANDREW WATTS, FICE, FIED, FIET, FRSA, RIBA, is CEO of Newtecnic (www.newtecnic.com), an engineering design house that undertakes the engineering design of building structures, façades, and MEP installations in partnership with leading international developers, architects, and contractors. In partnership with the Engineering Departments of Cambridge University, Newtecnic's R&D team analyzes, develops, tests, validates, and specifies new building technologies and methods. Newtecnic has offices in the U.S., UK, and Saudi Arabia.

EPC MODEL DESIGN CHALLENGES

ACCESS TO HISTORICAL GEOTECHNICAL DATA REDUCES ALIGNMENT RISK FOR TRANSMISSION LINES.

By Vic Donald, P.E.

TRANSMISSION LINES — those beautiful catenaries traversing our country — deliver the energy we need to live, work, and play. Strange thing about transmission lines: They push and pull and sway and require a lot from the ground that allow them to suspend elegantly above our heads. These large compressive, uplift, and lateral loads must be resisted, ultimately, by the ground they touch.

The ground is where variability comes into play. If it weren't for the ground that they must touch every quarter mile or so, structural design of these essential systems would be straightforward. No other structural foundation system is subject to such variability. A transmission line foundation may require deep piles at one structure location and rock removal at the next.

Variability in ground support conditions has a great impact on the cost of transmission lines. Choosing between alignment options for a new transmission line should take this into consideration. Thus, subsurface exploration is necessary to understand and develop even a conceptual foundation design. Such exploration is expensive and time-consuming. It requires land access and often entails land disturbance. Unfortunately, designers often make alignment decisions with little or no subsurface information.

Therein lies the risk. Mitigating this risk is necessary, and conservatism is usually the best approach to the risk of the unknown. As alignment decisions are made, designers frequently use simplified assumptions about subsurface conditions. At the preliminary stage, designers must plan for the worst and hope for the best. This approach has served us well for decades. We finalize our alignment, proceed with a traditional geotechnical exploration, design the foundations, and revise our cost estimates to reflect the actual needs.

But the rules have changed. To keep pace with required demand and to remove power transmission development barriers, the Federal Energy Regulatory Commission (FERC) issued Order No. 1000 in July 2011. This precipitated the use of an Engineer, Procure, and Construction (EPC) model. With this model, complete proposals incorporating all engineering, financing, and construction costs are submitted prior to project award. Now the EPC offer moves forward with a complete and final offer of design and construction costs, without the benefit of necessary subsurface investigations used to understand foundation design needs.

The risk of these high-variability subsurface conditions, without the ability to confirm prior to proposing, creates a major challenge in this highly competitive scenario. Requisite conservatism incorporated into foundation designs by all bidders results in excessive foundation expenses.



PROJECT DELIVERY

Variability in ground support conditions has a great impact on the cost of transmission lines.

A better understanding of subsurface geotechnical risk prior to submitting a proposal is essential. Fortunately, we have been here before. Literally, we have been here before; we have explored the hills and valleys the new transmission line will traverse. We can take advantage of a century's worth of exploration data to reduce this risk, provisions for conservative assumptions, and excessive foundation costs. In the end, the consumer pays less.

Connecting data for utilities

Historical geotechnical data, typically in the form of soil borings, are valuable, lasting assets for predicting subsurface conditions with an accuracy not possible in the past. This vast data lies hidden in paper reports. No digital source of locating geospatial information exists. Even if the reports can be discovered, the information is on paper only. Digital statistical evaluations and new project location condition predictions are difficult to perform.

Consider this example: In 1970, when geotechnical investigations were performed for a planned highway bridge in close proximity to a future transmission line alignment, our predecessors had little appreciation for the value of geotechnical data for future projects. Because of our inability to find prior exploration locations and old reports, the 1970 data becomes invisible during the 2019 transmission line design. Imagine the value of this data; why didn't we think about this back in 1970?

When paper becomes data

For the last 10-plus years, geotechnical engineers have been collecting location information of soil borings, allowing easy access through GIS systems. In addition, we use consistent, standardized database systems that detail data points associated with each boring location. This has become a vital, digital component of predictive analytics. Consider the value of knowing the Standard Penetration Resistance, undrained shear strength, or plasticity index of a given X, Y, and Z point below the ground surface, stitched together with millions of points of companion site data. This data analytics process provides an enormous potential to apply machine learning concepts and drill a "virtual boring" at new project sites.

Terracon has preserved historical exploration data dating back to the firm's inception more than 50 years ago. With the conduct of more



Historical geotechnical data, typically in the form of soil borings, are valuable, lasting assets for predicting subsurface conditions.

than 150,000 geotechnical projects during the last 10 years, we have amassed a large amount of subsurface information spanning the entire country that has been georeferenced and digitized to provide a basis for predictive analytics. This data is available to perform statistical evaluations, predict average conditions, variability, etc.

We are also rediscovering our historical data. We utilized and georeferenced every report during the last 50-plus years in our GIS system. Our combination of historical information with newer digital data allows us to make well-informed predictions of subsurface conditions at any project site.

It's more than data

The geotechnical engineering profession relies heavily on collected data to define subsurface conditions, as well as the professional experience of local engineers who have designed foundations for roads,

bridges, transmission lines, and other structures. Experienced geotechnical engineers, armed with vast and ever-increasing datasets offered in public domain and historical exploration reports, can render a valuable opinion of subsurface conditions, variability in those conditions, and a confidence level in the predictions. Certainly, those 100-mile-long transmission lines — designed and priced before subsurface exploration — will benefit tremendously from the opinion formed with our vast historical database.

Using an online portal called Stage1 GeoReport, Terracon has developed a means to deliver data quickly from the public domain, historical exploration data, and the opinion of local geotechnical engineers. The Stage1 GeoReport provides a prediction of geotechnical conditions and a confidence estimate related to the prediction. The confidence estimate is derived from the geotechnical engineer's review of data density and consistency in the vicinity of the project site. With sufficient confidence, the geotechnical engineer can even predict estimated foundation parameters using LPILE computer software, moment foundation analysis and design (MFAD), as well as other industry standards. These foundation parameters are invaluable while estimating foundation costs, often the largest unknown cost and risk to a transmission project. For larger projects, the Stage1 GeoReport helps identify alternative corridors with lower geotechnical risks or foundation costs.

Reduced — not eliminated — risk

Even with today's methods and tools, not all risk can be eliminated. The good news is that we can develop predictions of subsurface conditions, access vast public domain resources and historical databases, and use engineering experience to eliminate inherent risks in the development of final pricing. We will never have the benefit of geotechnical data at each transmission line structure, so an EPC procurement process will always have to address this risk until foundations have been constructed. Mother Nature doesn't comply with ANSI standards, and we tend to discover that every time we reach into the earth to construct the next great catenary support.

However, bringing this information and expert opinion to the design provides a major step forward in development of realistic designs for more precise (and less conservative) pricing models. This approach certainly reduces risk and informs the design team earlier than ever before.

We *have* been here before. Let's take advantage of the fact that we probably already know what the soil boring is going to tell you.

VIC DONALD, P.E., is Terracon's (www.terracon.com) national director of geotechnical services. He has more than 35 years of experience in geotechnical and geo-environmental engineering, working with clients and geotechnical engineers across the country.



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Acoustics and Mass Timber: Room-to-Room Noise Control

Richard McLain, PE, SE

The growing availability and code acceptance of mass timber—i.e., large solid wood panel products such as cross-laminated timber (CLT) and nail-laminated timber (NLT)—for floor, wall and roof construction has given designers a low-carbon alternative to steel, concrete, and masonry for many applications. However, the use of mass timber in multi-family and commercial buildings presents unique acoustic challenges.

While laboratory measurements of the impact and airborne sound isolation of traditional building assemblies such as light wood-frame, steel and concrete are widely available, fewer resources exist that quantify the acoustic performance of mass timber assemblies. Additionally, one of the most desired aspects of mass timber construction is the ability to leave a building's structure exposed as finish, which creates the need for asymmetric assemblies. With careful design and detailing, mass timber buildings can meet the acoustic performance expectations of most building types.

Basics of Acoustics and Code Requirements

Section 1206 of the 2018 International Building Code (IBC) lists requirements for acoustical performance of walls, partitions and floor/ceiling assemblies in multi-family buildings. These assemblies, which separate one dwelling unit from another or from public areas, must have a sound transmission class (STC) rating of 50 and an impact insulation class (IIC) rating of 50. (These ratings can be reduced to 45 when field tested.) Note that these code requirements only apply to multi-family construction. Although guidelines related to acoustical performance in occupancies such as offices, schools and hospitals do exist, they are not requirements under the IBC.

STC measures how effectively a wall or floor/ceiling assembly isolates airborne sound and reduces the level that passes from one side to the other. Examples of airborne sound include conversation and music. IIC measures how effectively a floor/ceiling assembly blocks impact sound from passing through a floor/ceiling and only applies to those assemblies. Examples of impact sound include foot falls and a book dropping on the floor.

Unique Mass Timber Acoustics Considerations

Bare mass timber floor/ceiling or wall assemblies are seldom used, in large part due to inadequate acoustical performance. For example, a 5-ply CLT floor with a thickness of 6.875" has an STC rating of 41 and an IIC rating of 25. As such, components are typically added to mass timber assemblies to improve their acoustics. See Table 1 for acoustical properties of bare mass timber panels.

Mass Timber Panel	Thickness	STC Rating	IIC Rating
3-ply CLT wall	3.00"	33	N/A
5-ply CLT wall	6.875"	36	N/A
5-ply CLT floor	5.1875"	09	22
5-ply CLT floor	6.875"	41	25
7-ply CLT floor	9.65"	44	30
2x4 NLT wall	3-1/2" bare NLT 4-1/4" with 3/4" plywood	24 bare NLT 29 with 3/4" plywood	N/A
2x6 NLT wall	5-1/2" bare NLT 6-1/4" with 3/4" plywood	22 bare NLT 31 with 3/4" plywood	N/A
2x6 NLT floor + 1/2" plywood	6" with 1/2" plywood	34	33

Source: Inventory of Acoustically-Tested Mass Timber Assemblies, WoodWorks

Table 1: Examples of acoustically-tested mass timber panels

In floor/ceiling applications, owners and design teams often want to expose the ceiling side of mass timber panels for aesthetic reasons, which means that any acoustical components must be installed on top of the assembly. This is one of the main acoustical design distinctions between light wood-frame floor/ceiling assemblies and mass timber floor/ceiling assemblies. In light-frame construction, acoustical components are typically included above, within and below the



T3 Minneapolis
Architect: MGA | Michael Green Architecture, DLR Group, Structural Engineer: Magnusson Klemencic Associates, Design Assist + Build: StructureCraft, Photo: Corey Gafner courtesy Perkins + Will

assembly—e.g., underlayment and/or concrete topping above the framing, batt insulation within the depth of the framing, and resilient channels and gypsum ceiling board underneath.

There are three main ways to improve an assembly's acoustical performance:

1. Add mass
2. Add noise barriers
3. Add decouplers

One of the characteristics of mass timber is that it has a high strength-to-weight ratio; therefore, when compared to other panel and slab-type construction materials, it weighs significantly less. This reduces building mass, which is beneficial in terms of lower seismic forces, smaller foundation requirements, and soil improvement measures such as pilings or piers. However, with acoustics, more mass typically means better noise control. For comparison, a typical 6"-thick concrete slab weighs approximately 80 pounds per square foot (psf) and has an STC rating of 53 while a ~7"-thick CLT panel weighs about 18 psf and has an STC of 41. Due to the lack of mass inherent



Concrete floor topping
Photo: Maxxon Corporation

in the mass timber panel, a common way to improve acoustical performance is to add a poured concrete or gypsum-based topping layer, usually in the range of 1-3" thick.

Decouplers are products that decouple, or break direct connections between, finishes on one side of an assembly and the other. This reduces the amount of noise that can directly travel through finish to structure to finish. Common examples in light wood-frame construction include resilient channels and air spaces. In mass timber floor/ceiling systems, the most common decoupling products are underlays and mats placed between the mass timber panel and concrete or gypsum-based topping. The type and thickness of material varies by product line and manufacturer, but the purpose is the same: to break the direct connection between structure/ceiling finish (the mass timber panel) and the top side finish (concrete topping and/or finish floor).

Although it is common to add noise barriers within light wood-frame assemblies (e.g., batt insulation in a floor cavity), this method is much less common in mass timber assemblies. That said, several acoustically-tested mass timber floor assemblies include wood sleepers on top of the panels and noise barriers such as sand or batt insulation between the sleepers. See Figure 1.

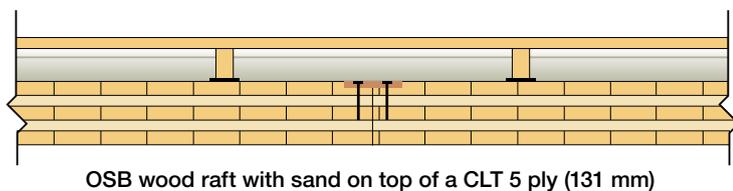


Figure 1: CLT floor assembly with wood sleepers and sand topping
Source: Regupol

Mass Timber Assembly Options – Floors

Using the design principles discussed above, a common mass timber floor/ceiling assembly includes the following (from top to bottom):

- Finish flooring (if applicable)
- Concrete/gypsum-based topping (usually 1-3" thick)
- Acoustical mat/underlayment
- Mass timber panel

Using a common 5-ply CLT floor panel, STC ratings in the range of 50-59 have been achieved for this common assembly build-up. IIC ratings are greatly influenced by the presence and type of finish flooring. For this build-up with no finish floor (i.e., concrete topping is the exposed floor surface), IIC ratings in the range of 35-60 have been achieved. When finish flooring is added, including luxury vinyl tile, engineered wood flooring, ceramic tile and carpet and pad underlayment, IIC ratings of 60+ have been achieved. Acoustical tests have been completed on variations of this assembly, with the primary variables being the specific acoustical mat product, thickness, and type of poured topping. Tests have also been completed on a number of alternatives, including options that don't involve a poured topping layer. To help designers compare options, WoodWorks has compiled a web-based Inventory of Acoustically-Tested Mass Timber Assemblies, which includes their STC and ICC ratings, plus links to the associated test reports. The inventory is updated as new tests are completed, and can be found at <http://bit.ly/mass-timber-assemblies>.

Where higher acoustical ratings for floor/ceiling assemblies in mass timber structures are required, installing ceiling gypsum board, either directly attached to the underside of the mass timber panel or hung from resilient channels or similar resilient clip systems, is a viable approach. Although this does conceal the mass timber panel from view, covering all or some of the panels may already be necessary to conceal MEP services and/or the covering material may be part of the floor assembly's fire resistance. Tested floor/ceiling assemblies with applied ceiling and resilient channel/clip systems are included in the inventory noted above.

Typical Mass Timber Floor Assembly Section View

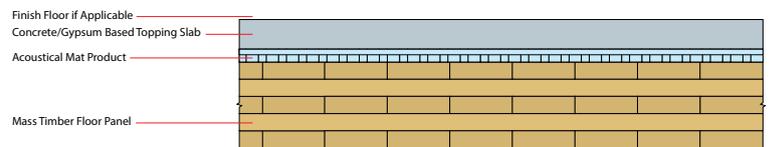


Figure 2: Mass timber panel

Improving Performance by Minimizing Flanking

Even when the assemblies in a building are carefully designed and installed for high acoustical performance, consideration of flanking paths—in areas such as assembly intersections, beam-to-column/wall connections, and MEP penetrations—is necessary for a building to meet overall acoustical performance objectives.

One way to minimize flanking paths at these connections and interfaces is to use resilient connection isolation and sealant strips. These products are capable of resisting structural loads in compression between structural members and connections while providing isolation and breaking hard, direct connections between members. In the context of the three methods for improving acoustical performance noted above, these strips act as decouplers. With airtight connections, interfaces and penetrations, there is a much greater chance that the acoustic performance of a mass timber building will meet expectations.

In multi-family mass timber buildings, where numerous interior partitions exist, there are several detailing and panel layout techniques for minimizing flanking. As noted, a poured topping is common on mass timber floor panels. Breaking the topping at unit separation walls, as illustrated in Figure 3, can help minimize the ability of sound to travel through the topping from one unit to the next. Where further noise control is required, an additional step is to break the mass timber floor panels at each unit wall (if these walls are also bearing locations). While this can be an effective means of enhancing acoustical performance, such a panel layout can create inefficiencies in the manufacturing and erection processes. As such, this approach should be discussed with the manufacturer and installer to evaluate the cost-benefit trade-offs.

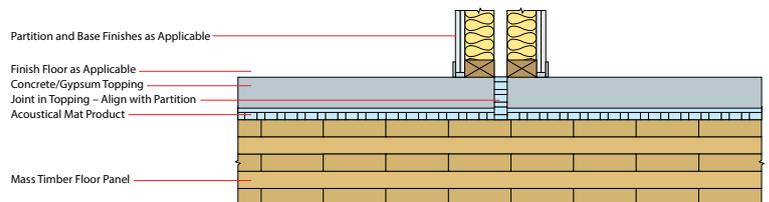


Figure 3: Flanking control detail at floodwall interface

Conclusion

Designing a building for noise control has a tremendous impact on the overall satisfaction of tenants. Laboratory and field tests have already shown that mass timber assemblies can provide satisfactory sound insulation—and this is contributing to the use of mass timber for more projects. A greater number of buildings will generate more knowledge and lead to more field testing, and the result will be an expanding inventory of cost-efficient assemblies and details that perform well acoustically.

Mass timber buildings are unique in that designers often try to maximize the visibility of structural members. This creates the need for unique solutions to address noise control. With appropriate attention to detail in the design and construction of assemblies, as well as consideration of flanking paths and sound isolation in connections and penetrations, mass timber buildings can deliver acoustic high performance.

To download a copy of the complete paper, including references, visit the WoodWorks website at: www.woodworks.org/publications-media/solution-papers/.

THREE NEW TYPES OF CONSTRUCTION

BUILDING CODE CHANGES IN THE U.S. MARK SIGNIFICANT PROGRESS FOR THE MASS TIMBER INDUSTRY.

By Hardy Wentzel

HISTORICALLY, THE U.S. CONSTRUCTION INDUSTRY has been slower to embrace mass timber buildings compared with its Canadian and European counterparts — primarily due to the nation’s more complex code restrictions. But during the last few months, several events have indicated a long-awaited transformation of the industry toward a future that is more welcoming of alternative construction materials that simultaneously better the industry, and the wellbeing of the environment.

On Dec. 19, 2018, it was announced that all 14 mass timber code change proposals put forward at an International Code Council (ICC) public comment hearing in Richmond, Va., are expected to be approved. If approved, the proposals will be added to the 2021 International Building Code (IBC), which is slated for release in late 2020 — along with the full set of 2021 I-codes.

Together, the 14 proposals will create the following three new types of construction, all of which have had their fire and safety performances verified:

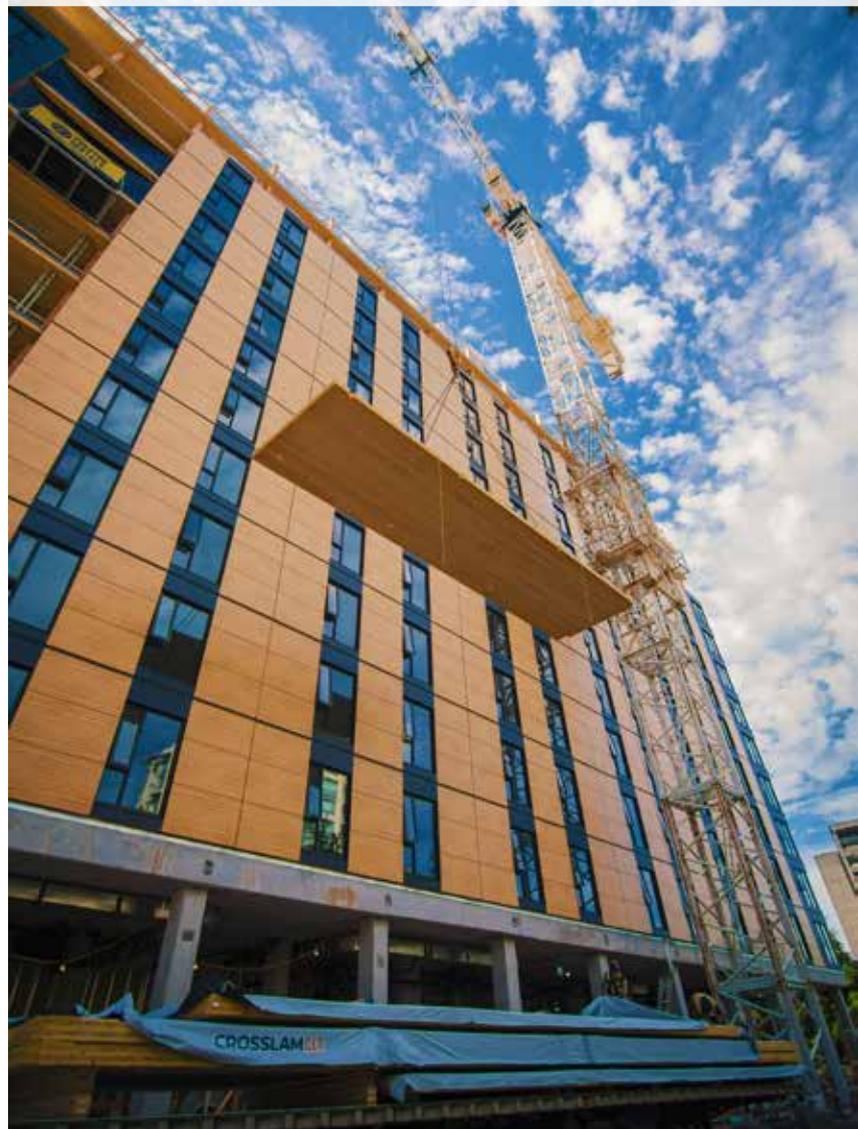
- Type IV A: Up to 18 stories high (270 feet tall) — mass timber is fully protected with noncombustible materials.
- Type IV B: Up to 12 stories high (180 feet tall) — allowable amount of exposed mass timber elements is limited.
- Type IV C: Up to 9 stories high (85 feet tall) — mass timber is allowed to be unprotected.

The code development cycle will continue throughout 2019, as well as any considerations for additional structural requirements for tall mass timber buildings.

The public hearing in Virginia follows in the state of Oregon’s footsteps. As of August 2018, Oregon became the first state to permit construction of mass timber buildings exceeding six stories. The new Oregon building codes also classify mass timber according to the three categories mentioned above.

Meanwhile in the state of Washington, proposal changes to the ICC Tall Wood Buildings Code were unanimously passed on Nov. 30. The state’s approved code changes permit construction of mass timber buildings of up to 18 stories, will be added to the IBC, and will go into effect in the second quarter of 2019. With that said, local jurisdictions are not mandated to adopt the changes and can opt out if they prefer.

Mass timber has a proven track record as a safe, fast, and sustainable construction solution with positive implications for development. In



University of British Columbia’s Brock Commons, residence to 404 students on UBC’s Vancouver campus, is one of the tallest contemporary mass timber hybrid structures of its kind.

fact, its origins date back many centuries, and mass timber has outperformed endurance and longevity tests in the face of fire, weather, and seismic activity.

As a strong proponent of mass timber wood structures, I believe in the material’s potential to become the industry benchmark against which other construction materials are measured. Over the years, Structurlam has developed an extensive portfolio that showcases exactly how mass timber is changing the way we build. Two prime examples of the power of mass timber include Carbon 12 and University of British Columbia’s (UBC) Brock Commons - Tall Wood House.

Carbon 12

Carbon 12 (www.structurlam.com/portfolio/project/carbon12) is exemplary of an environmentally advanced and technologically sophisticated residential project in the United States. A beautiful glass and timber showpiece located in Portland, Ore., the state-of-the-art



Carbon 12, an eight-story glass and timber residential project in Portland, Ore., serves as a model and precedent for timber construction across the nation.

eight-story wood structure serves as a model and precedent for timber construction across the nation.

The wood fiber used in construction of Carbon 12 was carefully sourced from the forests of British Columbia and fabricated at Structurlam's southern British Columbia manufacturing facilities. By nature of the material, mass timber wood encompasses environmentally friendly qualities — namely carbon sequestering, which describes the process of offsetting carbon dioxide in the atmosphere through extraction and long-term storage in the material itself. Mass timber is also lighter in weight compared with other construction materials, such as concrete, and much faster and safer to assemble than any other structural system. In fact, the structure above ground was completed in eight weeks, despite construction taking place during Portland's wettest winter on record.

Carbon 12 is comprised of 234 prefabricated Structurlam GlulamPlus beams, 336 GlulamPlus columns, and 242 CrossLam CLT panels. As a structural entity, the residential building also incorporates many sustainable and contextually responsive features, including an underground mechanical parking system, rooftop solar panels, and advanced earthquake monitoring and alert systems.

UBC Brock Commons

UBC Brock Commons (www.structurlam.com/portfolio/project/ubc-brock-commons), another innovative tall wood project in Structur-

lam's portfolio, is an 18-story landmark and residence to 404 students on UBC's Vancouver campus, and also happens to be one of the tallest contemporary mass timber hybrid structures of its kind.

Further to the ease of assembling mass timber structures, the Brock Commons building reached structural completion in record time — 66 days, or roughly four months ahead of schedule. In preparation for the build, the structure's mass timber components were prefabricated locally at Structurlam's southern British Columbia manufacturing facilities. Having pre-cut the materials into the quantities and configurations in which they were needed to be installed meant that the construction process could be expedited significantly. The Brock Commons project demonstrates the potential of mass timber as a reliable and durable construction material and the innovative design potential for the material.

The recent ICC announcements are encouraging, as are the exciting industry developments that are expected to follow in 2019. The building code changes observed in Oregon and Washington mark continued progress for the United States' mass timber industry and promising implications to come in the future.

HARDY WENTZEL is CEO, Structurlam Mass Timber Corp. (www.structurlam.com).

LOW-SLOPE ROOFS

DESIGN SOLUTIONS FOR BUILDING CODE-PERMITTED LOW-SLOPE APPLICATIONS THAT CAUSE PONDING WATER.

By Scott D. Coffman, P.E., SECB, and Thomas G. Williamson, P.E.

CHAPTER 15 IN THE 2015/2018 INTERNATIONAL BUILDING CODE (IBC) contains installation guidelines that permit a design slope of 1/4 in 12 for certain types of roof covers. Specifically, the code text typically reads, "...roofs shall have a design slope of not less than one-fourth unit vertical in 12 units horizontal (2 percent slope) for drainage." The stated and intended purpose of the code-specified 1/4 in 12 slope is to provide drainage; however, ponding water is often observed in these low-slope roofs. The standing water is a primary source of roof cover discoloration and deterioration that may result in framing member damage and contribute to premature failure of the structural system.

Additionally, building code deflection ratios fail to consider the short-term deflection that exacerbates the potential for ponding water. Therefore, the 1/4 in 12 code-permitted slope requires further investigation by the building design professional. The focus of this article is wood framing members; however, the principles presented are applicable to framing members of any material.

IBC and ASCE

The reason water ponds on a low-slope roof is a possible misinterpretation of the 1/4 in 12 minimum slope by the building code. Significant insight may be found in ASCE 7 Section 8.4 as referenced in IBC Section 1611.2. ASCE 7-10 (2015 IBC) attributes ponding water to the deflection of relative flat roofs and identifies a susceptible bay for ponding as a "roof slope" less than 1/4 in 12. ASCE 7-10 further clarifies, "Roof surfaces with a slope of at least 1/4 inch per foot (1.19°) towards points of free drainage need not be considered a susceptible bay."

ASCE 7-10 recognizes that relative flat roofs deflect when subjected to load. A structural member designed and installed to a 1/4 in 12 "design slope" deflects under the initial short-term dead load to create a roof surface (slope) less than 1/4 in 12. The 1/4 in 12 design slope is reduced more from live load and long-term dead load (creep) to exacerbate water retention. Therefore, a roof designed and installed to a 1/4 in 12 slope deflects downward and needs to be analyzed as a susceptible bay, according to ASCE 7-10.

ASCE 7-16 (2018 IBC) omits the ASCE 7-10 sentence that attributes ponding water to the deflection of flat roofs. However, ASCE 7-16 continues to identify a susceptible bay to include:

- "bays with a roof slope less than 1/4 inch per foot (1.19°) when the secondary members are perpendicular to the free drainage edge;" and
- "bays with a roof slope less than 1 inch per foot (4.76°) when the secondary members are parallel to the free drainage edge."

Secondary members are defined as structural members not having direct connection to the columns (e.g., joists, purlins, or rafters). Com-

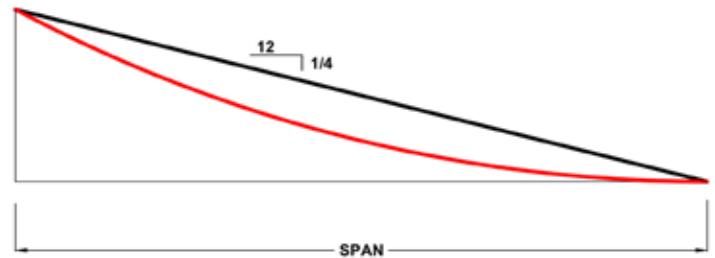


Figure 1: Wood members installed to a design slope of 1/4 in 12 often deflect from the initial dead load to create a "flat" area toward the low end.

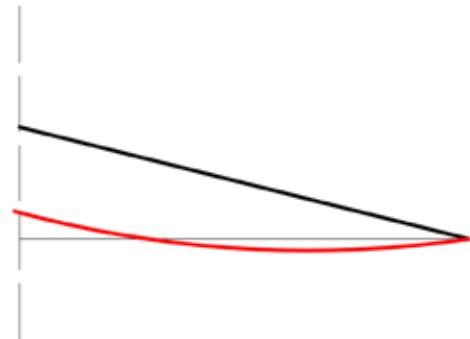


Figure 2: As the code-permitted L/120 or L/180 ratios are approached, the deflection curve extends below a horizontal datum to create a "bowl."

mentary for ASCE 7-16 Section 8.4 alludes to ponding from secondary member deflection and states the 1/4 in 12 limit is based on a maximum deflection-to-span ratio of L/240. The authors interpret the words "maximum deflection" to be total load that includes short-term and long-term deflection from dead load in addition to live-load deflection.

Therefore, framing members designed to a 1/4 in 12 slope should be analyzed for the total load at a minimum deflection ratio of L/240. This deflection criterion is more stringent than required by the IBC deflection table. However, footnotes to the IBC deflection table caution that the published deflections do not ensure against ponding. ASCE 7-10 and ASCE 7-16 recognize that structural members deflect and sufficient member stiffness is necessary to promote free drainage of a 1/4 in 12 design slope. Additionally, ASCE 7-16 requires a minimum 1 in 12 roof slope to promote free drainage for secondary members parallel to a free drainage edge. The 1 in 12 is significantly more than the commonly specified 1/4 in 12 and reflects the need of an increased slope to promote free drainage.

Analysis

There is a significant difference between "design slope" found in IBC Chapter 15 and "roof slope" used in ASCE 7. A specified design slope is absent of member deflection whereas the roof slope reflects the actual in-service deflection. The authors investigated the deflected shape of a member using the properties of a circle. The maximum midspan deflection was set to published code deflection ratios. This method is reasonable for wood since member design approaches published deflection ratios for economy.

Field observations and investigations by the authors have found wood

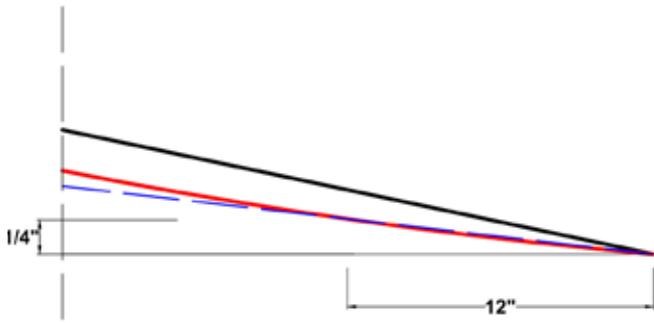


Figure 3: Increasing the code minimum 1/4 in 12 design slope to compensate for member total load deflection promotes free drainage and helps mitigate the potential for ponding by deflecting below a 1/4 in 12 surface.

members installed to a design slope of 1/4 in 12 often deflect from the initial dead load to create a “flat” area toward the low end (Figure 1). The relative “flat” region retards and/or prevents free drainage. As the code-permitted L/120 or L/180 ratios are approached, the deflection curve extends below a horizontal datum to create a “bowl” (Figure 2). (The same deflection principles apply to any material.) The bowl becomes more prominent for structural members that support roof-top units and/or for long-term deflection (creep). The authors found the bowl is eliminated for members designed to the ASCE 7-16 maximum deflection-to-span ratio of L/240. However, the deflection curve remains relatively flat (less than 1/4 in 12) for a distance of approximately L/6 to inhibit free drainage.

Additionally, deflection tables published by the IBC are limited to live load and a long-term deflection (creep) component. The omission of a short-term dead load deflection component combined with IBC published L/180 or L/120 ratios permit calculated deflection numbers to exceed the L/240 maximum found in the ASCE 7 commentary.

According to the AITC Timber Construction Manual (TCM), actual measurements of ponded water found the deflection curve to be more parabolic. The deflection at any point may be found from the equation:

$$\Delta_x = \Delta_{\max} \frac{\sin \pi x}{L}$$

From this equation, the deflection curve does not extend below a level datum to create a bowl for the L/180 and stiffer ratio. However, the deflection curve remains relatively flat (less than 1/4 in 12) for a distance of approximately L/4, and this can inhibit free drainage. Therefore, water-retention/ponding can be expected for the commonly specified 1/4 in 12 design slope.

Solution 1: Increase design slope

Increasing the code minimum 1/4 in 12 design slope to compensate for member total load deflection will promote free drainage and help mitigate the potential for ponding by deflecting below a 1/4 in 12 surface (Figure 3). This approach is consistent with the 1 in 12 roof slope requirement found in ASCE 7-16. Table 1 summarizes the minimum design slope necessary to achieve a minimum 1/4 in 12 residual surface for common deflection ratios. The deflection ratios are for Total Load,

which include short-term and long-term dead load in addition to the live load.

A precedence exists to increasing the minimum design slope to a value greater than 1/4 in 12 for drainage. The U.S. Department of Defense (DOD) published the Unified Facilities Criteria (UFC) for planning, design, and construction criteria for all DOD projects. The 2017 UFC Roofing section was updated to coordinate with the latest editions of the National Roofing Contractor’s Association Roofing Manual and Metal Building Manufacturers Association Roofing manual to meet the latest DOD requirements.

UFC Section 2-3 pertains to low-slope roofing requirements and addresses minimum slope for positive drainage. Specifically, “The minimum slope for construction of new buildings is 1/2:12 to achieve positive drainage.” The UFC requirement is consistent with the authors’ belief that the 1/4 in 12 design slope found in the building code should be increased to provide free drainage of a roof surface. The 1/2 in 12 design slope is also consistent with the authors’ findings for L/180 and stiffer deflection ratios.

Solution 2: Camber

The AITC TCM and National Design Standard for Metal Plate Connected Wood Truss Construction (TPI) recognize camber as a means to ensure adequate drainage. The building designer specifies the amount of camber to be fabricated into a structural component (e.g., glued laminated timber members and wood trusses) by introducing curvature, circular or parabolic, opposite to the anticipated deflection. For low-slope applications, the camber must be sufficient to mitigate the likelihood of a structural framing component to deflect below the 1/4 in 12 plane. Additionally, the camber is to promote free drainage. Minimum camber recommendations found in the AITC TCM for glued laminated timber beams in roof applications is 1.5 times the dead load deflection. The TPI commentary for Section 7.6.2 also recognizes a camber amount equal to 1.5 times the dead load due to deflection. Other proprietary wood truss products publish camber criteria as a function of dead load and live load. Extreme care is necessary when camber is specified, and an experienced wood design professional and/or fabricator should be consulted. In the absence of specific camber criteria, a minimum amount equal to 1.5 times the dead load deflection is recommended for roofs when a camber solution is desired.

T.L. Ratio	Slope in 12
L/120	0.75
L/180	0.625
L/240	0.5
L/360	0.5
L/480	0.375

Table 1: Design slope for residual 1/4 in 12 surface



Standing water is a primary source of roof cover discoloration and deterioration that may result in framing member damage and contribute to premature failure of the structural system on low-slope roofs.

Solution 3: Ponding design for a 1/4 in 12 design slope

The most effective method to prevent ponding is to provide adequate slope to achieve positive drainage. However, design constraints may exist that limit the design slope to 1/4 in 12 as permitted by the building code. When the 1/4 in 12 design slope is specified, a building designer should use an acceptable design method to ensure wood framing members have adequate strength and stiffness to mitigate potential ponding. For members without camber, an acceptable method is to increase calculated deflections and design stresses by a magnification factor for the wood member. The magnification factor, C_p , is:

$$C_p = \frac{1}{1 - W'L^3/\pi^4EI}$$

Where:

W' = total load of 1 inch of water on the roof area supported by the member (pounds). One inch of water weighs approximately 5.2 pounds per square foot.

L = member span (inches)

E = modular of elasticity of the member (pounds per square inch)

I = moment of inertia of member (in⁴)

The calculated design stresses are increased by C_p and compared to the

published allowable stresses. Likewise, the calculated deflection is increased by C_p and compared to the total load deflection ratio. The wood component is acceptable for anticipated ponding loads if the design stresses and deflection values increased by C_p are less than allowable values. An abbreviated example for bending moment and deflection is shown for a sawn lumber member:

$$\begin{aligned} C_p &= 1.082 \\ F_b &= 750 \text{ psi} \\ L/240 &= 0.83 \end{aligned}$$

$$\begin{aligned} f_b &= 659 \text{ psi} \times 1.082 \\ &= 713 \text{ psi} < 750 \text{ psi (OK)} \end{aligned}$$

$$\begin{aligned} \Delta_{TL} &= 0.58 \text{ inches} \times 1.082 \\ &= 0.63 < 0.83 \text{ inches (OK)} \end{aligned}$$

The total load deflection ratio is limited to $L/240$ to be consistent with ASCE 7.

The magnification factor may also be applied to a wide range of proprietary engineered wood products such as structural composite lumber

(SCL) and prefabricated wood I-joists. The design shear and moment values are increased by the magnification factor and compared to the manufacturer's published allowable values. The calculated total load deflection is also increased by the magnification factor and compared to a total load deflection ratio of L/240 or stiffer.

Modulus of elasticity (E) adjustment

The values of "E" published in the National Design Specification for Wood Construction (NDS) are average values. All wood strength properties, including the modulus of elasticity, are variable expressed by the coefficient of variation, COV_E . The variations of the modulus of elasticity (E) for wood approaches a statistical normal distribution. Therefore, when a designer desires to estimate a lower value for "E" at some percentile of the total population, such as the fifth percentile, it may be calculated by the following equation:

$$E_{0.05} = E - 1.645 E COV_E$$

Where:

$E_{0.05}$ = estimated "E" at lower fifth percentile (psi)

E = published modular of elasticity of the member (psi)

1.646 = statistical constant to determine values at the fifth percentile

$COV_E = 0.25$ for visual grade lumber; 0.15 for machine evaluated lumber (MEL); 0.11 for machine stress-rated (MSR), and 0.10 for glued laminated timber (NDS Appendix F)

For example, the NDS published "E" value for No. 2 Grade southern yellow pine lumber is 1,400,000 psi. Therefore, the $E_{0.05}$ is:

$$\begin{aligned} E_{0.05} &= 1,400,000 - (1.645 \times 1,400,000 \times 0.25) \\ &= 824,250 \text{ psi} \end{aligned}$$

This variation of "E" should be considered by a building designer when specifying a design slope of 1/4 in 12 because members with a lower "E" will deflect more. The $E_{0.05}$ is appropriate to calculate the magnification factor, C_p , and deflection of wood truss members with a 1/4 in 12 design slope. The $E_{0.05}$ is the average of the top chord and bottom chord lumber in wood truss design.

Recommendations

The intent of the IBC and ASCE 7 is to provide adequate slope for drainage and to mitigate ponding. The authors recommend that design professionals consider the following design slopes to be specified for nearly flat, low-slope applications:

- Roofs — 1/2 in 12 and a total load deflection of L/180 and stiffer.
- Exterior balcony — 3/8 in 12 and a total load deflection of L/480 and stiffer.

When design constraints necessitate a 1/4 in 12 design slope be used, the framing members should be cambered or investigated for ponding. A building designer should reference wood industry standards or contact the product fabricator when specifying camber to prevent ponding. As previously noted, only products such as glued laminated timber and metal plate connected wood trusses can be cambered. The minimum recommended camber for roofs is an amount equal to 1.5 times the dead load deflection.

Design stresses and deflection should be increased by a magnification factor for wood members that are not cambered, such as sawn lumber and timbers. The increased design stresses are to be less than the published values and the increased deflection value is compared to the L/240 ratio consistent with ASCE 7. A similar approach may be used for proprietary products such as SCL and prefabricated wood I-joists by increasing the design moments and shears by the magnification factor and comparing them to allowable values published by the manufacturer.

The designer should increase the stiffness of wood trusses designed without camber for a 1/4 in 12 slope. The $E_{0.05}$ is determined for the truss chord material and used in the deflection analysis. The calculated deflection is compared to L/240 or stiffer ratio.

Conclusion

Building designers routinely stipulate a 1/4 in 12 design slope for roofs and exterior balconies. This practice, on the surface, appears to satisfy the IBC requirement for drainage and eliminate special analysis for ponding. However, ASCE 7 indicates a 1/4 in 12 roof surface is necessary for free drainage and to mitigate ponding. The need to consider member deflection is the subtle difference between "design slope" and "roof slope." A member designed to a 1/4 in 12 design slope deflects when subjected to load that creates a surface less than 1/4 in 12. This is considered to be a primary reason roof and balcony surfaces fail to drain and ponding is often observed.

The most effective method to minimize the effects of ponding is to increase the recommended minimum design slope to 1/2 in 12 for roof applications and 3/8 in 12 slope for floor applications. The total load deflection limit is L/180 and L/480 for the roof and floor, respectively. The increased slope for drainage mitigates ponding and helps prolong the lifespan of the roof cover. When a 1/4 in 12 design slope is a design constraint, using camber or increased member stiffness and stresses should be considered using acceptable wood industry methods. Additionally, the total load deflection ratio of L/240 or stiffer should be used for secondary wood members installed to a 1/4 in 12 design slope to meet ASCE 7 criteria.

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DESIGN-BUILD FOR WATER/ WASTEWATER

ANNUAL CONFERENCE AND EXHIBITION HIGHLIGHTS
INDUSTRY SECTOR TECHNOLOGY AND TRENDS.

THE 2019 DESIGN-BUILD FOR WATER/WASTEWATER CONFERENCE, April 10-12 in Cincinnati, brings professionals together for three days of education, networking events, and the latest industry trends about design-build project delivery in the water/wastewater sector. The annual Design-Build Institute of America event is co-located with and follows the Design-Build for Transportation & Aviation Conference, April 8-10.

In addition to an exhibition with more than 100 product and service providers for the industry, the conference features five education tracks, providing opportunities for attendees to earn continuing education units (CEUs). Practitioners can earn as many as 12 CEUs and owners are eligible to earn as many as 14.5 CEUs by attending the full conference.

Following are the scheduled presentations in each track.

General session/Keynote track

When Design-Build Goes Wrong: Designer Liability Risk Management — In a combined gathering with attendees to the Design-Build for Transportation & Aviation Conference, this session will take a close look at the business and teaming aspects of design-build, including not just the good, but the “bad” and even the “ugly” that can occur when best practices fall by the wayside; and the win-win that occurs when good/fair contracting and procurement practices are coupled with good teaming.

Leading Through Organizational Change — Jon Sanchez, Team Performance Institute, will talk to attendees in this opening keynote about overcoming adversity and leading through organizational change.

Workforce Development: How to Get and Retain the Best People — This session will explore practical ways to attract and retain the best people and provide practical ideas to implement immediately. Also discussed will be more long-term solutions to create a pipeline of workers, both craft and management, to sustain a workforce during the next few decades.

How Digital is Transforming the Future of Water — Key questions addressed in this closing general session presentation include:

- How is digital water defined?
- Which technologies will make the most impact?
- How are digital solutions addressing infrastructure challenges?
- Which business models are proving most effective?



- What is the impact on utility strategies, engineering companies, and vendors?
- What do we see as the key digital trends during the next five to 10 years and where is the opportunity?

Progressive Design-Build track

Progressive Design-Build (PDB) Best Practices — No information available at press time.

PDB Delivers Innovation Resulting in Consistent Energy from Cogeneration to Power a Wastewater Treatment Plant (WWTP) — Jacobs is the design-builder for the new \$95 million cogeneration facility at the San José-Santa Clara Regional Wastewater Facility. The facility will provide reliable onsite heat and 14 MW of power, replacing aging cogeneration equipment. PDB delivery has resulted in a treatment process that meets difficult budget and schedule goals with the lowest life cycle cost.

Applying a PDB Approach for the Nation’s Largest WWTP — When the largest single-site facility in the country, Detroit’s Great Lakes Water Authority, discovered that its outfall wasn’t providing adequate disinfection, the utility implemented a PDB approach to meet strict budget and schedule demands.

Expedited Delivery from Preparation through Operation: Louisville MSD’s First Use of PDB — Louisville MSD began design of the Southwestern Parkway CSO Basin using conventional design-bid-build. However, local politics altered the basin’s location, resulting in significant delays for the Federal Consent Decree project. MSD elected to switch to PDB to ensure its objectives were achieved.

Boynton Beach’s Collaborative East Plant Ion Exchange and Upgrades Design-Build Project — Faced with anticipated redevelopment and a limited water supply source, the city implemented a state-of-the-art MIEX pretreatment system and increased the water treatment plant’s (WTP’s) capacity to 24 million gallons per day (mgd). To meet the

requirements of the local water management district and to collaboratively identify value in the project, the city utilized PDB.

Making the Design-Build Decision: Theory & Practice track
Understanding Design-Build Variations — No information available at press time.

A Decade of Design-Build Experiences at HRSD — The Hampton Roads Sanitation District (HRSD) has effectively used the Design-Build delivery method since 2008 to meet the needs of its growing Capital Improvement Program. HRSD has successfully completed six projects and begun procurement for two additional efforts.

PDB as a Tool to Maximize Collaborative Delivery — This presentation will provide detailed analysis of the process and outcomes of the PDB delivery of a greenfield WTP. The discussion will cover delivery method selection, design-builder procurement, and characteristics of the contract and delivery method that led to successful execution of the project.

The Value of Utilizing PDB to Expand a Major WWTP — Fulton County's Big Creek Water Reclamation Facility (WRF) is reaching capacity and the equipment is near the end of its useful life. The county needs to expand and upgrade the WRF from 24 mgd to 38 mgd and achieve more stringent effluent limits. The county wanted to expand cost-effectively, maintain operational compliance during construction, provide input into the design, and consider multiple options and innovative solutions. PDB was the ideal procurement method to meet these objectives.

Partnering with Houston to Deliver the Nation's Largest Progressive Design-Build WTP Project — The city of Houston, with four regional water authorities, is expanding its Northeast Water Purification Plant (NEWPP), increasing its ability to support steady residential and commercial growth while reducing dependency on groundwater. Building on lessons learned from major design-build projects, the Houston Waterworks Team is delivering this \$1.4 billion, 320-mgd project, the largest PDB project of its kind in North America.

Best Practices and Lessons Learned track

DBIA Best Practices Enhance Communication to Effectively Balance Risks During Procurement — When Denver Water solicited its Aeration Basin Quality Improvements design-build project, several RFP requirements placed significant risks on prospective design-builders. Risks included schedule performance, treatment performance, and "full design-gate" review requirements. Through early collaboration in the form of a proprietary meeting, these challenges were deliberated to arrive at mutually acceptable solutions.

Does Collaborative Delivery Cost More and How to Avoid the Off-Ramp — This presentation will address conditions surrounding successful projects. Conversely, it will address why owners may "off ramp" a delivery team and choose to discontinue its use of PDB or construction manager at risk (CMAR) because they believed it cost more.

Martinez IV WWTP and Collection System Design-Build Project Execution and Lessons Learned — The presentation highlights the benefits of using integrated delivery and when challenges presented, how the team addresses them. The project not only included delivering a 250,000-gallons-per-day WWTP and 15,600 linear feet of collection lines with a lift station, but also the sewer shed planning, collaboration with another utility, and having the plant Envision rated.

Case Study for Delivering a 70-mgd Water Supply Pump Station for Indianapolis — The owner, contractor and engineer present a case study describing the lessons learned from implementing critical best practices such as qualification-based selection, collaborative team development, open book pricing, project risk mitigation, disciplined design phase gates, incremental cost development, diversity subcontracting inclusion, BIM and 4D scheduling, and project celebrations.

Market Update for the Demand by Owners to Use Design Build — This session reports on the data from the Water Design-Build Council's ongoing research that documents growth in the use of design-build delivery methods in the public sector and why they are occurring. It will also add further specifics on the use of each of the recognized delivery methods in the water sector.

Trends and Innovation in Design-Build track

New Arizona Surface Water Plant Delivered Through Innovative Partnerships and Collaboration — The City of Goodyear, Ariz., identified the need for a new surface water treatment facility and negotiated a landmark water transportation agreement with the Salt River Project (SRP) to wheel their Central Arizona Project water allocation through SRP's canals.

Geotechnical Risk — Information not available at press time.

Joint Venture with a Purpose: Combining Human Capital to Benefit the Owner — Design-build delivery requires a team that possesses a varying and expansive set of skills to ensure success. One means of incorporating many differing viewpoints is to engage a culturally similar partner in a joint venture, with each partner bringing skill-sets that complement the other.

P3s in the Small Water Market and USDA Funding Opportunities — Panelists will share insights into implementing the P3 process in the water sector. Through the lens of experience, each panelist will discuss how they can work with USDA to implement P3s combined with USDA Funding.

Choosing and Selecting an Owner's Consultants — Information not available at press time.

More information about the conference schedule, exhibition, venue, and registration for the 2019 Design-Build for Water/Wastewater Conference is available at www.dbwater.com.

Information provided by the Design-Build Institute of America (<https://dbia.org>).

GLOBAL ENVIRONMENTAL CONSULTING MARKET SURGES

SECTOR MARKS BEST PERFORMANCE THIS DECADE, BOOSTED BY ACCELERATION IN ASIA-PACIFIC AND NORTH AMERICA.

THE GLOBAL MARKET FOR ENVIRONMENTAL CONSULTING SERVICES jumped 6.2 percent in value during 2017 to reach \$34.1 billion, according to the latest research report published by Environment Analyst. This is almost double the growth in 2016 and by far its best performance in all the years Environment Analyst has tracked and reported on the global market movements annually since the start of the decade (see Figure 1). Signs are that 2018 will see a similar order increase.

Growth among the top players has been aided by recovering mining and commodities markets (although the oil price trend has yet to inspire a sustained recovery in that important area for environmental consultants) as well as strong demand in climate resilience and storm recovery work in the key North American market. Also contributing to the result was a return to more buoyant conditions in Asia-Pacific spurred by several factors including China’s tightening environmental standards and enforcement.

However, it is also notable that among the cohort of the leading international environmental consulting players analyzed in depth in the study (the Global 22), growth is being spearheaded by those in the lower half of the rankings rather than those in the top tier.

This year’s findings once again suggest that the mid-size multidisciplinary firms and smaller environmental/sustainability specialists are more often than not outperforming their larger fully integrated technical and professional service provider rivals, for whom environmental consulting activities typically represent 5 to 10 percent (or even less) of overall group revenues.

Although the picture as a whole is now undoubtedly improving, the peer group has been through an extended period of low growth and consolidation during the last five years, with many of these firms actively participating in mergers and acquisitions to boost growth — some on a truly transformational basis. The Global 22’s dominance of what is still a fragmented market is evident from their combined performance in 2017, which saw aggregated environmental consulting revenues increase by 6.4 percent year-on-year to account for 43.6 percent share of the total global sector.

Yet despite the continued consolidation, only three players — AECOM, Tetra Tech, and Jacobs — hold an individual market share in excess of 5 percent. Former number-two CH2M has disappeared from the top three and wider rankings thanks to its takeover and rapid integration during the last year by Jacobs, a move that enabled the latter to rise up



Figure 1: Global EC revenue and revenue growth, 2010-2022e. Source: Environment Analyst

the table from its previous position of 16th to grasp the number three spot. Meanwhile, Arcadis, and ERM complete the top five.

Mega-merger activity also saw the entry lower down the table of SNC-Lavalin to the Global 22, thanks to its acquisition of Atkins in 2017, which sees their combined global environmental consulting operations now ranked 19th.

The report provides critical insight and analysis on the key strategic priorities among the top-flight players as many have sought to rebalance their organic growth versus merger and acquisition activities of late and prioritize their most profitable activities in response to the changing market dynamics and disruptors. It looks at how firms are addressing market cyclicality, the impact of the trend toward larger contracts, and the resourcing challenges as the upturn gains momentum in different sectors/geographies, as well as how players are embracing the digital revolution.

Geographically, almost half of all global environmental consulting revenues in 2017 were focused on the North American region (45.6 percent), with West Europe taking just under a quarter (22.7 percent). Asia-Pacific now ranks a close third thanks to its double-digit growth (21.7 percent), while Africa & Middle East (4.4 percent), Latin America (4.0 percent), and Central & East Europe (1.5 percent) account for the remainder. The top three environmental consulting players in each region are shown in Figure 2 (page38).

Anya Hembrough, deputy editor of Environment Analyst’s Global Market Intelligence Service and co-author of the report, said, “Despite the lingering conditions in the oil & gas sector, recovery in other sectors and regions suggests that the global environmental consulting market is now undeniably back on a growth trajectory following a very difficult period post [global financial crisis] and then as the commodities super-cycle fell away. Growth in the region of 5 to 7 percent in 2017 and 2018 is welcome proof that the industry is successfully repositioning itself to a new market norm with so many different drivers and disruptors at play compared to just five years ago.

Continued on page 38



HARSH CONDITIONS & LIMITED RESOURCES Don't Slow Down Road & Pad Construction.

Energy sites are often located in remote and difficult to access sites in environments with poor soils, limited road building resources, and extreme weather conditions.

Site Challenges in Western Canada

In Western Canada's Oil Sands region, transporting construction equipment, drilling rigs, and completions apparatus – all with heavy wheel loads (typical loads exceeding 125,000 lbs) is the challenge. It can be extremely difficult to accomplish this over the soft, wet ground (thick muskeg and saturated clays) typical of this region. Add the challenge of working in the dead of winter in below zero temperatures and on frozen ground, with limited road building materials added to the mix and the scenario makes accessing the sites extremely difficult.

In the wettest months, muddy conditions can make access by heavy trucks and equipment nearly impossible. So, energy companies typically wait for frozen ground before ramping back up construction. Even in winter, access to remote oil sites create challenges including undeveloped roads, soft ground and scarce materials suitable for constructing roads.

A Road Solution Built for Extreme Conditions

The GEOWEB® 3D soil confinement system is built for these challenges. The all-weather HDPE material is fast to install, and isn't hindered by soft ground or extreme temperatures.

GEOWEB® 3D technology allows the use of low-cost, local fill—such as sand—and literally transforms it into stable, long-lasting, and low maintenance access roads and pads. The confined infill creates a stiff road surface that is resistant to movement, preventing concentrated rutting and resulting in faster cycle times.

The compact GEOWEB material is economical to transport and fast to install on site without heavy equipment or specialized crews, minimizing environmental impact and disruption of the land. Most importantly, **confinement technology reduces base construction costs by using 50% less fill.**

Resourceful Access to Energy Sources

The GEOWEB® 3D system is a low cost and efficient way for energy companies to overcome these challenges and access their oil & gas, wind and mining sites—even in some of the worst site and weather conditions.

Presto offers free project evaluations and site support.





Figure 2: Global EC market leaders by region

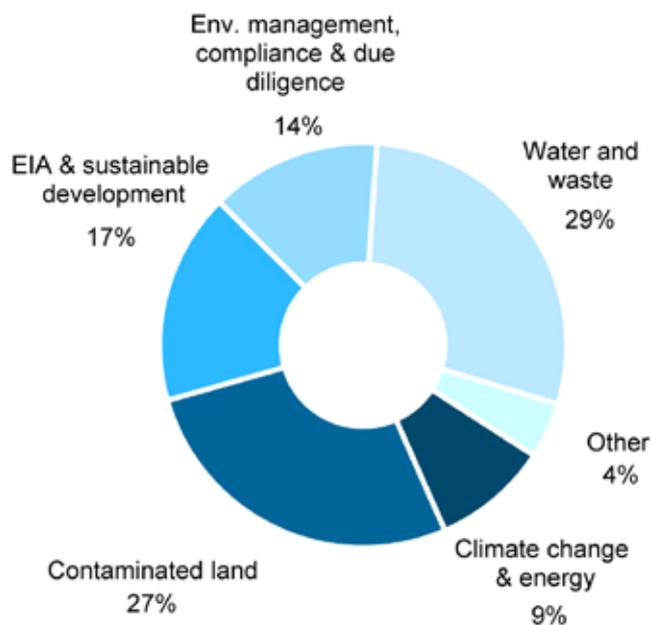


Figure 3: Global environmental consultancy market share by service area, 2017.
Source: *Environment Analyst*

“Also providing a fillip of late has been the level of disaster recovery-related work, particularly for the North American majors — although whether this will see sustained focus or if it is more of a temporary blip remains to be seen,” Hembrough said. “But what does seem more assured is the strong increase in demand coming from Asia-Pacific, particularly as China continues efforts to transform its manufacturing base and environmental credentials. As such, we also expect to see much more of some of the rising Eastern stars making their mark in the global environmental consulting space.”

Growth is forecast for 2018 and 2019, albeit at a slightly lower level given the political and economic uncertainties expected to impact key regions (notably relating to the U.S. and Brexit in the UK/Europe)

curbing confidence. But over the longer term, the compound annual growth rate from 2018 to 2022 is lifted in *Environment Analyst’s* latest global forecast model — compared with last year’s — at 4 percent. This would bring the worldwide environmental consulting revenues to \$41.5 billion by the end of this five-year period, with Asia-Pacific (driven in no small part by China) expected to account for around one-third of the c\$7.5 billion new market space created.

“The findings of the new analytical elements introduced to this latest report edition (now in its eighth year) — including environmental consulting intensity analysis by region — really serve to highlight the huge growth potential of the space as markets such as China move increasingly towards maturity in their environmental governance and service evolution,” Hembrough said.

Other key findings in the latest global environmental consulting market assessment include:

Regionally, growth in 2017 was driven by a resurgence in Asia Pacific (+12.5 percent) and, crucially, recovery in the sector’s largest and dominant North American market (+4.1 percent), boosted by the unexpected volume of disaster recovery and climate resilience work (in a year of record-breaking storm activity).

The top five players combined represent 21.7 percent of the total market while the top 10 account for 29.5 percent; in both instances, despite unprecedented merger and acquisition efforts in recent years, the combined shares have seen a downward trend, falling from highs of 24.7 percent and 33.4 percent, respectively, in 2014. The top five environmental consulting players are:

- AECOM (with a 7 percent market share),
- Tetra Tech,
- Jacobs,
- Arcadis, and
- ERM.

The top 10 is completed by

- Golder,
- RPS,
- Ramboll,
- Wood E&S, and
- WSP.

Ranked 11 to 22 are: Stantec, HDR, GHD, Sweco, Antea Group, ICF, Royal HaskoningDHV, Mott MacDonald, SNC-Lavalin Group, Cardno, SLR and WorleyParsons. Past ranked firms Atkins and CH2M have now been fully incorporated into their new owners SNC-Lavalin and Jacobs, respectively.

The Global 22 together employ approximately 82,000 environmental consulting staff (full-time employees) worldwide, servicing around 220,000 environmental consulting contracts per year, with an average contract value of \$77,000.

Based on the key performance statistics reported to — and analyzed by — Environment Analyst for the Global 22, environmental consulting services areas that saw the biggest (double-digit) increases in 2017 were: water and waste management (+22.3 percent), environmental management, compliance and due diligence (+15.2 percent), and climate change and energy (+13.1 percent). In contrast, work related to contaminated land and environmental impact assessment and sustainable development were in decline: -6.2 percent and -5.1 percent, respectively.

In terms of client sectors, the financial, professional and service sector saw the strongest growth, with total segmental market revenues up 13.4 percent in 2017. Revenues from services to the mining, extractive and process industries saw a sharp turnaround year-on-year, rising 9.1 percent globally, reversing a 4 percent contraction in 2016. There was also continued solid demand from infrastructure and development projects (+8.3 percent) and also the government sector (+6.8 percent), but revenues derived from energy and utilities were more or less static (+0.8 percent), impacted by the ongoing lower oil price

2017 was noteworthy for mega-merger activity among the top-ranked firms, effecting real change in the top-tier global environmental consulting rankings (including the pairings of Jacobs/CH2M, SNC-Lavalin/Atkins, and Wood/Amec Foster Wheeler). While 2018, by contrast, saw fewer such transformational deals, as the year drew to a close the announcement of WorleyParsons' intention to acquire the energy, chemicals, and resources unit from Jacobs, and WSP's completion of its purchase of Louis Berger will have a clear impact in the coming year. Smaller scale merger and acquisition activity has continued apace however, with the Australian market, in particular, attracting significant investment attention through 2018 among several members of the Global 22.

Information provided by Environment Analyst. The Global Environmental Consulting Strategies & Market Assessment and Global Competitor Analysis reports form part of Environment Analyst's 2018/19 Global Market Intelligence Service. More information is available at www.environment-analyst.com/global.

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Several sessions at the 2019 Design-Build for Transportation & Aviation Conference highlight the Arizona Department of Transportation's South Mountain Freeway project. *Photo: Arizona Department of Transportation*

DESIGN-BUILD FOR TRANSPORTATION & AVIATION

OWNERS, DESIGNERS, AND CONTRACTORS MEET TO DISCUSS PROJECT RISKS, BEST PRACTICES, AND EXCEPTIONAL OUTCOMES.

THE DESIGN-BUILD FOR TRANSPORTATION & AVIATION CONFERENCE 2019, April 8-10 in Cincinnati, is billed as the only U.S. event targeted to the rapidly growing design-build transportation industry. This year, the conference includes a newly added Aviation track. The annual Design-Build Institute of America event is co-located with and precedes the Design-Build for Water/Wastewater Conference, April 10-12 (see page 34).

In an opening general session/keynote, *The Future of Mobility*, transportation futurist, researcher, and generations expert John W. Martin from the Institute for Tomorrow, discusses how connected vehicles, autonomous vehicles, a growing distributed workforce, and America's newest workers may change where and how Americans live and travel in the future. Will our society's move to a network of "15-minute livable communities" permanently shift what we design and build?

In a second general session/keynote, *Alternative Technical Concept (ATC) — How to Make the Most Out of the Process*, a panel of state transportation department representatives from Washington, Virginia, and Ohio discuss the use of the ATC and provide best practices in evaluation of an ATC, including the roles and responsibilities of the evaluation team, and the importance of confidentiality.

A final conference keynote, *Workforce Development: How to Get and Retain the Best People*, explores practical ways to attract and retain the best people and provides practical ideas to implement immediately. Brent Darnell, Brent Darnell International, will also discuss more long-term solutions to create a pipeline of workers, both craft and management, to sustain a workforce during the next few decades.

Education tracks

The conference features four, concurrent education tracks with pre-

sentations over a day and a half. A Legal and Risk Management track features the following topics:

- Legal Update & Case Laws
- Managing Utility Risk for Design-Build Transportation Projects
- Risk Analysis and Allocation for Design-Build Contracts
- Geotechnical Risk in Design-Build

Presentations in the Progressive Design-Build Best Practices track include the following:

- Progressive Design-Build - Best Practices
- Progressive Design Build for Expansion at the Atlanta Airport's APM
- Use of Progressive Design Build to Deliver CSX - Virginia Avenue Tunnel
- Implementing LEAN Construction into Progressive Design Build

The following presentations are part of the P3 track:

- ADOT Quality Assurance Program: From South Mountain Freeway to a Programmatic Approach
- P3 Case Studies — What would you do differently? — An Owner's Tale
- Goethals Bridge Replacement Project - Procurement through Commissioning
- Arizona DOT's journey on their first \$1.77 billion P3 Design-Build-Maintain Transportation project

The Achieving Exceptional Outcomes track includes the following sessions:

- Crosstown Parkway Extension — How Design-Build made a 30-year project a reality
- Procurement and Award of a Design-Build Project Pre NEPA Process
- Joint-Venture Partnerships Deliver Nine Miles of Roadway in 20 Months
- Owners/Reps: Selecting and Using Owner Consultants

More information about each of the sessions and speakers, as well as the conference schedule, exhibition, venue, and registration for the 2019 Design-Build for Transportation & Aviation Conference is available at www.dbtranspo.com.

Information provided by the Design-Build Institute of America (<https://dbia.org>).

For the Pointe-au-Chien Tribe in Louisiana, Oysters and a Marine Mattress System Protect Sacred Burial Grounds from Rising Seas

Some cities are building expensive seawalls and water pumps to fight the increased flooding and land loss brought on by climate change. For the Native American Pointe-au-Chien Tribe in southern Louisiana, oyster reefs are helping to reduce the rate of shoreline erosion that threatens their sacred burial grounds. A recent study found that a key to building these reefs may just lie with Tensor's Triton Marine Mattress System. In a partnership with a researcher from Nicholls State University, the tribe hopes to install the Triton Mattresses in the parish's coastal canals to foster the creation of protective oyster reefs.



As climate change and subsidence begin to endanger America's coastal communities, city and state governments are struggling to stand their ground as it literally sinks below them. Larger cities such as Miami and Atlantic City are constructing seawalls and water pumps to fight back against the rising waters, but community members from Terrebonne Parish in southern Louisiana are relying on a different strategy: oysters. Terrebonne Parish lies along the Gulf of Mexico, and of its total area of 2,082 square miles, 41 per cent (850 square miles) of that is water. Rising seas are eating away the shoreline at an alarming rate, including the location of sacred burial sites for the Native American Pointe-au-Chien Tribe that calls the parish home. But the tribe is choosing to fight back, enlisting the help of Dr. Earl Melancon—a professor from Nicholls State University who studies coastal restoration—to facilitate the growth of oyster reefs along sections of the coast.

Melancon was previously involved in a seven-year-long study of shore protection methods along with the Coastal Protection and Restoration Authority of Louisiana (CPRA). Spanning from 2008 to 2015, Melancon and the CPRA measured the effectiveness of three different methods of shore protection. Tensor's Triton® Marine Mattress System was compared against a permeable matrix of interlocking concrete armor units and an artificial reef design made from steel and recycled oyster shells. Of the three methods tested, the Marine Mattresses created a much friendlier oyster habitat and thereby a larger oyster population. They also proved more effective than the other two alternatives at curbing shoreline loss, both in terms of cost per linear foot and meters of shoreline loss per year.

A polymeric marine mattress or "gabion mat" is a cage structure composed of strong yet flexible Tensor® Geogrid filled with aggregate. The mattresses are placed perpendicular to the shoreline and contour to it in a way that creates a gradual transition which dampens wave energy before it hits the shore. "The sloping gave opportunity for oysters to colonize more readily, and that allowed for the creation of more reef structure," Melancon said in an interview with Tensor. He further explained that the formation of reefs cushions the impact of waves on the shore, which in turn reduces overall shoreline loss.

The Pointe-au-Chien Tribe has been working to gain recognition from the U.S. federal government, which would help to better equip them in preparing for the massive amounts of land loss due to climate change. Until then, Tensor's Triton System will prove to be a powerful tool for protecting their sacred burial grounds from encroaching waters as the tribe partners with Dr. Earl Melancon and other scientists from around the country to build up oyster reefs in the waters of Terrebonne Parish.

About Tensor International

Headquartered in Atlanta, Tensor International is a full-service provider of specialty products and engineering services that offer innovative and cost-effective alternatives to traditional construction methods. Tensor solutions are based on advanced soil stabilization and reinforcement technologies and incorporate unique, engineered applications for commercial, industrial, municipal, residential and transportation infrastructure site development. The company specializes in solutions for common site development challenges, including grade changes requiring retaining walls and poor soil conditions affecting the cost of roadways, parking lots and building structures. Patented, polymeric Tensor® Geogrids and Tensor's Geopier® foundation reinforcement piers are the primary components of the company's systems, offering reliable strength and durability. Contracted services include site evaluation, conceptual engineering, design, value engineering and installation advice. For more information, visit <http://www.tensarcorp.com>.



Ground-penetrating radar (GPR) is one of the most accurate non-destructive testing methods available.

PROPER GPR SURVEYING TECHNIQUES

TIPS AND BEST PRACTICES FOR GETTING THE MOST FROM INVESTIGATIONS.

By Brian Jones

GROUND-PENETRATING RADAR (GPR) is one of the most accurate non-destructive testing methods available. To get the most from GPR surveying, it is essential to understand how GPR tools work and follow best practices when conducting surveys.

The key areas to be aware of include:

- target characteristics,
- survey design,
- correct antenna selection,
- best practices for setting up the system, and
- practical tips to guarantee success in the field.

Know your target characteristics

Before taking a single step in the field, investigators must determine the characteristics of the target they are looking for and the surrounding material they are imaging through. GPR travels at different velocities, depending on the material it is traveling through. For example, radar travels fastest through air — at about the speed of light — and slowest when traveling through water, about one-ninth the speed of light. Radar velocity for all other materials varies somewhere between that of air and water.

The value assigned to the GPR velocity through a material is called its dielectric. For example, air has a dielectric of 1 and water has a dielectric of 81, so all other materials have a value somewhere between 1 and 81. The dielectric value is used to calculate the radar velocity.

GPR equipment is looking for differences in the dielectric of the material, so surveying may be more difficult when two materials have electrical properties that are too similar (see Table 1). Users must assess whether there is enough difference between the target they are looking for and the target's host material.

For example, when scanning concrete, operators may be looking for electrical and telecom conduits. These can be tougher to locate than metallic reinforcing steel due to the slight variation in dielectric between the concrete and these targets (especially if housed in PVC pipe). A tip for overcoming this issue is turning the antenna 90 degrees from its normal orientation. Collecting data in this way may pick up different information, better allowing the operator to see plastic conduits, and give a better sense of concrete thickness.

The same technique can work in utility locating and other layer mapping applications. In other words, if a GPR surveyor cannot see the pipe they think should be there, try turning the antenna 90 degrees. Or, scan in one direction, turn around, and come back in the other direction.

Electrical conductivity of the surrounding material affects how deep surveyors can see. Since GPR emits electromagnetic energy, it is subject to attenuation (natural absorption) as it moves through a material. If the energy is moving through a resistive (low conductivity) material such as very dry sand, ice, or dry concrete, the signal can penetrate a great deal of material. If a material is conductive (clay soil, wet concrete), GPR energy gets absorbed before it has had the chance to go very far into the material.

GPR is best for inspecting materials with low electrical conductivity such as concrete, sand, wood, and asphalt. On the other hand, if the project involves locating a sewer line or an underground storage tank that is 8 to 10 feet below ground in wet, clay-filled soil, GPR might not be the appropriate tool for the job.

Choosing the best survey design

After determining the target's electrical characteristics, as well as the

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- Only 3 videos may be submitted per applicant.
- The final winner will be decided by the attendees of AUVSI Xponential in Chicago, Illinois, April 29th - May 2th, 2019.
- Your video will be used in Civil + Structural Engineer marketing with attribution.



Boundary	Dielectric Contrast	Reflection Strength
Sand-Soil	Medium	Medium
Soil-Damp Sand	Low	Weak
Clay-Air	High, phase reversal	Strong
Dry Sand-Granite	None	No Reflection
Soil-Metal	High	Strong
Soil-Water	High	Strong
Soil-Empty PVC	Low to Medium phase reversal	Weak

Table 1: The strength of a reflection is proportional to the dielectric contrast between the target and the host materials. The greater the contrast, the brighter the reflection.

size, type, and orientation of utility lines, post-tension cables, and objects of limited dimensions, including tanks and graves, investigators can design the survey.

If very high confidence is necessary, the survey design should be based on a bi-directional grid, with spacing between the lines equal to the smallest dimension of the targets. Where this is not possible due to obstructions, time, or budget constraints, the survey design should include a large overview grid, which would be followed by one or more smaller focused grids.

If looking for cylindrical objects such as an old oil tank or buried drums, investigators should choose a bi-directional grid; these targets may look flat when scanned in one direction, so they can be easily missed or mistaken for a soil layer. Using a bi-directional grid would identify a cylindrical target if the surveyor sees a flat layer in one direction and a hyperbola/arch in the other direction.

For planar objects, including mapping the depth to bedrock, water table, or soil layers, the grid spacing would be determined mainly by the size of the area and allotted time, but one might also consider if there are any odd geologic features that need to be captured. These are typically larger features, and the undulating surface is a layer that can be seen by scanning in just one direction.

The survey design can use either 2D or 3D scanning. With 2D scanning, individual profiles are collected and the data is often interpreted live on the screen. If the targets are utility lines or cables, and they are in a known direction, it may make sense to do 2D transects and mark them on the ground as they are seen in the data. 2D surveys are much quicker and easier, especially if surveying for one or two lines. They are also more effective if the survey is meant to locate geologic features, such as bedrock or soil layers. Integration with GPS positioning is also quite common with 2D surveys.

With 3D scans, operators place a grid on the ground and collect information on parallel and perpendicular lines. Then, software in the field or office takes the individual profiles and models them together to get a top down, birds-eye view, analogous to an MRI picture of the ground. A bi-directional 3D survey is effective where the targets extend in unknown directions. A 3D grid is also a better idea if one requires a high level of confidence in a target's location, or where a good visual image is needed for a report. 3D surveys are also recommended if there are any potential dangers on the site that should be avoided.

Another issue that affects survey design is the operator's confidence in the target dimensions and how well the target boundaries are defined. If looking for the edges of a tank or trying to locate where a water table transitions, set the survey boundary properly to capture what is required at the survey site. Target dimensions and confidence level control the survey grid spacing used.

For example, if the target is linear, like utility lines, and the surveyor knows what direction the features are running, the surveyor should cross linear targets perpendicular to their orientation because they can be seen better. If this information is unknown, use a bidirectional grid.

To obtain this information, consult as-built plans and look for site features that provide clues. For example, there may be similar manholes on both sides of the site, showing that a pipe runs from point A to B. Or, there may be water valve covers at regular spacing along the road, indicating the pipe orientation.

Selecting the correct antenna

Selecting the right antenna frequency for a GPR job depends on the size and depth of the target (see Table 2). A lower-frequency antenna provides deeper penetration, but the tradeoff is that the targets must be larger to be imaged.

When looking only 1 to 2 feet beneath the surface — for example, when imaging in concrete and looking for very small reinforcing and conduits — use a higher-frequency GPR antenna, which offers greater detail. For deeper targets, the primary and secondary choices are lower-frequency antennas. These allow users to see deeper, but one trades off the ability to resolve smaller features or targets.

When scanning utilities, mid-range antennas provide sufficient resolution to find 4- to 5-inch pipes. For going deeper — for example mapping geological features 40 to 50 feet deep — low-frequency antennas will work because premium resolution is not required.

Best practices for system set up

Operators should take great care in setting up their system for optimal performance on each job. There are a varying number of available settings, depending on the GPR equipment model. The factory setup recall can be a great starting point. However, users may have to make adjustments to ensure they meet two of the most crucial parameters — selecting the proper depth and collecting the ideal number of scans per unit.

The proper number of scans varies depending on the size of the target and the soil or material one is working in. A smaller scan spacing (more scans per unit) slows down the survey, so it is best to collect as many scans as possible while maintaining an acceptable survey speed. However, some projects may require devoting the extra time needed for very small scan spacing.

More scans are required for smaller targets. For example, if the target is only 1 inch, take several scans per inch to guarantee getting a hit on the target. By contrast, if conducting geologic mapping looking for

Center Frequency	Depth of Penetration	Typical Applications
2600 MHz*	0-12 in. (0.4 m)	Concrete Evaluation
2000 MHz Palm	0-12 in. (0.4 m)	Concrete Evaluation
1600 MHz*	0-18 in. (0.5 m)	Concrete Evaluation
900 MHz	0-3 ft. (0-1 m)	Concrete Evaluation, Void Detection
400 MHz*	0-12 ft. (0-4 m)	Utility, Engineering, Environmental Void Detection
270 MHz*	0-18 ft. (0-6 m)	Utility, Engineering, Geotechnical
200 MHz	0-30 ft. (0-9 m)	Geotechnical, Engineering, Environmental
International		
100 MHz	5-50 ft. (2-15 m)	Geotechnical, Engineering, Mining
15-80 MHz	0-150 ft. (0-50 m)	Geotechnical
Air-Launched		
2.0 GHz*	0-2.5 ft. (0-.75 m)	Pavement Thickness, Road Condition Assessment
1.0 GHz	0-3 ft. (0-1 m)	Highway and Bridge Deck Evaluations

*Smart antenna functionality

Table 2: Range of available antenna frequencies, depth of penetration, and applications for which each is most suited.

soil layers or the top of bedrock, one scan per foot or one scan per six inches would achieve the data density necessary to get the layer information required.

There is no such thing as too much site information. Apart from equipment and settings, proper GPR surveying relies on information about the site. Gather everything available. Collect site plans and as-built drawings. Talk to site maintenance staff and those who know local geology. Get any available nearby boring logs and geophysical information. Consult websites that contain databases of water wells that have been catalogued. These resources can assist with the expected location of buried targets and the depth at which the wells hit the water table or rock. This information provides valuable data points to use when setting up the system and conducting a GPR survey.

For geologic and cemetery mapping, consult records in the local library or other online resources. Pulling town records takes time, but it can be well worth it to ensure an accurate survey. Two great resources are the U.S. Department of Agriculture, Natural Resources Conservation Service's Ground-Penetrating Radar Soil Suitability Maps, which are available for every state, and the Web Soil Survey, which provides online maps and data for more than 95 percent of the nation's counties.

Tips and tricks to guarantee success

So, after carefully considering your target's characteristics, designing a study to maximize the likelihood of locating the targets and features you are investigating, selecting the right antenna for the depth you are surveying, and setting the equipment properly, there are a few more tips to keep in mind:

Equipment — Bring the proper equipment to the site, including paint, flags, stakes, and cones. For 3D scanning, make sure you have tape measures to create a grid. Don't forget to bring a basic tool kit (tape, wrenches, and screwdrivers) to fix equipment onsite.

Visual site survey — When arriving at a site, begin by doing a general visual site survey. Draw a site sketch and take photographs; look for service features such as manholes and valve covers.

Look for ports — For environmental surveys, look around building perimeters for spill pipes, vent pipes, standpipes, or burial evidence. There is a port out there somewhere. Look for voids or depressions in the ground.

Calibrate to known targets — Do some preliminary depth estimates on known targets. Pop a manhole cover, drain, or catch basin. Drill a test hole down to the top of a piece of rebar in concrete. Then measure down to get a point of reference. Scan right past that measured target and calibrate your equipment so the depth information for targets mapped onsite is more accurate.

Ensure proper power supply — Make sure batteries are charged. If you are going to be out in the field for 12 hours, bring enough batteries. Batteries for most GPR equipment last only three to five hours, so bring extras for all-day scanning. If working indoors, bring an AC adapter to plug into the wall.

Test in several areas — Make sure there is not a lot of change in signal or the soil or concrete does not drastically change across the site.

Document everything! — Good notes are extremely crucial, even for projects that involve only painting or marking. Take notes on system settings and prepare a site sketch. No one will remember exactly what they did in the field without written notes. It is especially crucial to have good notes and site photos if someone is collecting data and handing it off for analysis. These notes and post-survey photos can also prove useful if a project ends up in litigation.

Take good care of your GPR equipment — Treat it like the sophisticated electronics that it is and you should get years of use out of it.

From basic utility locating and marking to concrete scanning for road and bridge repairs to historical and archaeological investigations, GPR has an important role to play. But the usefulness of the data depends on careful consideration of target characteristics, proper survey design and antenna selection, and carefully setting up the system for optimal data retrieval.

BRIAN JONES is senior account manager at Geocomp Corp. (www.geocomp.com).

STREAM CLEANING

DRONE SURVEY TECHNOLOGY HELPS MAP NORTHERN NEW JERSEY RIVER OBSTRUCTIONS AND LOWER FLOOD INSURANCE PREMIUMS.

SURVEYORS ARE HARNESSING THE POWER of drone technology by focusing on at-risk riparian areas of northern New Jersey. In fact, images captured by unmanned aerial vehicles (UAV) have become part of the documentation for a Federal Emergency Management Agency (FEMA) program that saves Pompton Lakes residents hundreds of thousands of dollars per year on flood insurance premiums.

Land-use consultancy Dresdner Robin, of Jersey City, N.J., recently worked with the Borough of Pompton Lakes, N.J., utilizing image-capture flights to gather overlapping photographs of three rivers in the borough. The firm has since been involved in various mapping projects.

Dresdner Robin Survey Director Greg Gloor volunteered on a project to assess Pompton Lakes' flood-prone waterways. Gloor flew 11 individual flights over the rivers — 215 feet above the water level. The UAV moved at 10 mph, using a 15-millimeter, fixed-zoom lens, capturing 60-foot sections of the terrain. Images were snapped every two seconds (1,042 total) and were later analyzed to locate obstructions in the river channel. The photos aided a stream-cleaning project that is part of the borough's flood mitigation program.

Community Rating System

The UAV-collected data was also submitted as part of Pompton Lakes' application to FEMA's Community Rating System (CRS) program. Waterway assessment is a key component of the CRS program, and active participation saves the borough's residents more than \$300,000 on flood insurance premiums. Outside of cost benefits, the UAV program also saved the borough's volunteers hundreds of hours of "firsthand" analysis time, according to Pompton Lakes Councilman Erik DeLine.

He noted that the drones "produced stunningly clear imagery, which enabled us to fully understand and prioritize which hazards needed to be cleared, providing an invaluable service to our residents."

On the project, Gloor said, "Assisting a borough that houses three rivers — which can pose a threat to homes and other structures — is rewarding. Historically, the flood threat can be quite active here, but this emerging technology helps mitigate it."

The image-capture project offers a feasible way to spot obstructions, and the visuals help facilitate FEMA's CRS program, spurring immediate financial benefits, Gloor said

Ramapo River

Gloor's work has helped expand similar waterway assessments in the state, including the Ramapo River in Oakland, N.J. There, both video and still photography — which includes the adjacent tributaries — is used to assess river conditions for restorative work with the state.



Aerial images are analyzed to locate obstructions in the river channel as part of a stream-cleaning project to help mitigate floods. *Photo: Dresdner Robin*

As flooding continues to plague areas of northern New Jersey, especially following a particularly wet 2018, surveyors anticipate the need for survey and data acquisition of river corridors to rise.

"These river channels present unique challenges for access and safety," Gloor said. "Dresdner Robin has been utilizing the capabilities of UAV to provide critical data on river conditions to flood-prone communities in North Jersey."

Unlike traditional surveying or photogrammetric surveying performed with a pole-mounted camera, UAV surveys can be performed without interfering with traffic flow or placing surveyors close to dangerous conditions near rivers and roadways.

The use of a UAV increases data-gathering opportunities — most notably in locations previously difficult or dangerous to access. Dresdner Robin uses a professional-grade UAV that can ascend rapidly and reach speeds up to 50 mph. However, most survey applications utilize slower speeds to enhance photo quality.

Dresdner Robin's UAV is equipped with a 20-megapixel camera with a mount that allows for independent positioning and rotation. The altitude of the flight is determined by the dimensions of the area to be surveyed and the angle of the camera lens, which can be changed, depending on the project.

Information provided by Dresdner Robin (www.dresdnerrobin.com).

TOWARD SAFETY, EFFICIENCY, AND SUSTAINABILITY

NYU TANDON SCHOOL OF ENGINEERING ESTABLISHES INSTITUTE OF DESIGN AND CONSTRUCTION INNOVATIONS HUB

COMMITTED TO MAXIMIZING SAFETY, EFFICIENCY, AND SUSTAINABILITY within the construction sector, the New York University Tandon School of Engineering created the Institute of Design and Construction (IDC) Innovations Hub. The IDC Innovations Hub is chaired by Michael Horodniceanu, Ph.D., P.E., an internationally prominent transportation and construction executive, who is a professor within the Department of Urban and Civil Engineering.

An industry-supported, membership-based entity, the newly endowed center will promote innovation in construction, engineering design, and management. Member firms will leverage the Innovation Hub's resources to improve efficiency, control costs, and help identify innovative solutions that emphasize sustainability, fiscal responsibility, and safety.

The Innovations Hub will apply faculty research capabilities and hands-on industry experience to help construction leaders overcome vexing issues that often trigger cost overruns and schedule delays. Assisted by a team of PhD and Masters-level students, the center will:

- help industry executives devise creative solutions to sensitive project design and construction issues;
- provide access to consultancy services from experienced and independent experts for specific projects;
- sponsor in-depth informational seminars on topics ranging from organizational and leadership issues to best practices in the selection of materials and machinery;
- support a range of training programs provided by academics and industry leaders;
- promote networking opportunities among a wide spectrum of organizations spanning the construction sector, such as local, state, and federal government agencies; utilities, hospitals, airlines, manufacturers, and developers; architecture, engineering, and construction service providers; and labor organizations; and
- serve as a national clearinghouse for sharing information on consulting and construction opportunities.

Information provided by the New York University Tandon School of Engineering (<https://engineering.nyu.edu>).

DEVELOPING LEADERS

ARTBA FOUNDATION SEEKS NOMINATIONS FOR LEADER DEVELOPMENT PROGRAM

THE AMERICAN ROAD & TRANSPORTATION BUILDERS ASSOCIATION TRANSPORTATION DEVELOPMENT FOUNDATION (ARTBA-TDF) is accepting nominations for its 2019 Industry Leader Development Program (ILDLP), a first-of-its-kind "101" introduction to federal and state advocacy for transportation infrastructure market development and protection. It will be held May 13-15 in Washington, D.C.

The ILDP and its associated Industry Leader Development Council (ILDC) has almost 700 graduates from more than 200 industry firms, state contractor chapters, and public agencies during the last 23 years. The immersive program provides an understanding of industry economics, how transportation work in the U.S. is funded and financed, how actions by the federal government impact the industry, and how to become politically engaged to help shape transportation policy. ILDP fellows will also visit with their members of Congress to discuss the

need for congressional action on a permanent Highway Trust Fund solution and new infrastructure investment package.

The ILDP is held in conjunction with ARTBA's annual Federal Issues Program and the Transportation Construction Coalition Washington Fly-In.

Admission to the ILDP is a competitive process. Nominees should be between 30 and 50 years old and have at least three years of experience in the transportation design and construction industry, have made a significant contribution to the work of his or her firm, and shown evidence of strong leadership potential for the industry. To be considered for admission, candidates must be nominated by a sponsor and submit a completed application form. A letter of nomination and recommendation written by a principal of the firm, a senior executive within the governmental agency, or a senior-level faculty member at the university that employs the applicant must accompany each application. Applications must be received at ARTBA's offices in Washington, D.C., by Monday, April 1.

Access the nomination form at www.artba.org/foundation/industry-development-program/ildp-2019-nominate-now.



01. BALCONY CONNECTION SYSTEM

J&P Building Systems Ltd.'s BALCON unit is an adjustable assembly for joining metal balconies to concrete structures. According to the company, simple installation and design is the theme behind BALCON. It is strong, so fewer connections are required to make structural connections. It is a rigid fixing point, with no rotation, allowing the designer to focus on the supporting steel structure. Design of the BALCON system enables concrete and architectural metal trades to work in harmony, reducing the risk of site remedial work while maintaining high thermal insulation performance at the connections. At the connection points, FABREEKA_TIM shims positioned between components provide thermal insulation, minimizing leakage through the connections.

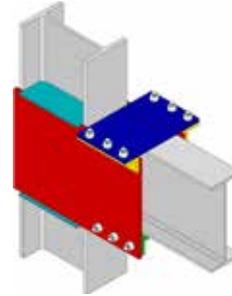
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02. SEISMIC BYPASS FRAMING CONNECTOR

Simpson Strong-Tie introduced the SCS seismic bypass framing connector, the first hybrid seismic clip engineered for either slide-clip or fixed-clip applications in high-seismic areas, and the first product of its kind to undergo full-scale cyclic research testing to determine load capacities in real-world conditions, the company said. To determine the in-plane performance of the SCS clips, Simpson Strong-Tie conducted full-scale cyclic testing on the uniaxial shake table at its Tye Gilb Research Laboratory. The results were used to develop a representative component test to determine various combinations of stud/clip in-plane capacities. The testing allowed the company to re-engineer the bypass clip to significantly increase the in-plane capacity.

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03. FIELD-BOLTED CONNECTIONS

SidePlate Systems released field-bolted connections for all applications. Its new SidePlate and SidePlate PLUS connections can be applied to any lateral steel design. The SidePlate connection is optimized for projects outside seismic regions. The joint has no field-welding, which speeds up any construction project by eliminating weather delays and minimizing the need for specialized field welding. In addition, added stiffness in the field-bolted joint design typically allows for an overall lighter steel package, reducing project costs and enhancing erection speeds. The SidePlate PLUS connection is perfect for areas with special seismic requirements. The PLUS design is also field-bolted and is AISC 358 approved.

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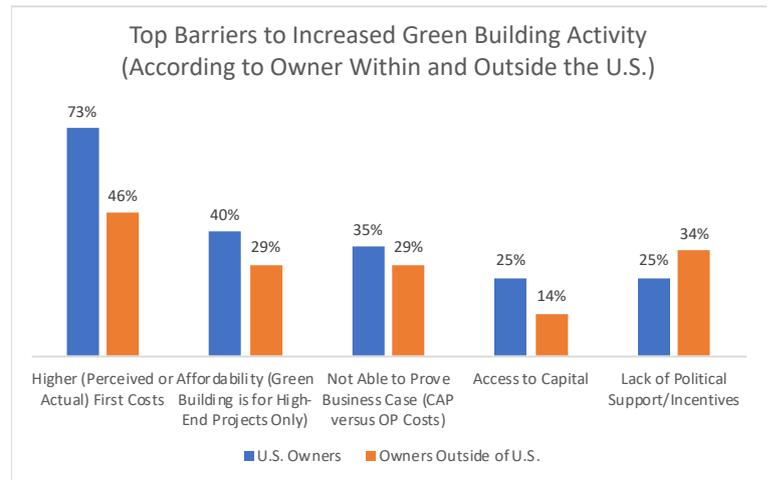
By Donna Laquidara-Carr, Ph.D., LEED AP

BY PROVIDING THE BUDGET AND SETTING THE PRIORITIES ON A PROJECT, owners exert significant influence on whether and how green a building project can be. Dodge Data & Analytics' latest green study, published in the World Green Building Trends 2018 SmartMarket Report, provides a rare glimpse of what influences U.S. owners to build green and how their responses differ from owners in other countries and from engineers in the U.S. Understanding owners' green priorities can allow engineers to better work with owners and other design team members to improve the sustainable performance of their projects.

The biggest differentiating factor between U.S. owners and the other owners who participated in the study is their attention to the cost of building green. This is revealed at several points throughout the study, but particularly in their estimation of the top barriers facing the growth of green building. Almost three quarters (73 percent) of U.S. owners consider higher (perceived or actual) first costs to be one of the top three barriers. While attention to cost may seem like a natural response from project owners, in fact, the U.S. owners stand out in this regard, since less than half (46 percent) of owners outside the U.S. consider this a top barrier.

The second highest percentage of U.S. owners (40 percent) select affordability (the perception that green building is for high-end projects only) as one of their top barriers to building green. However, only 29 percent of owners outside of the U.S. share that perspective. Instead, owners outside the U.S. are more likely to select the lack of political support or incentives (34 percent) as one of the biggest barriers, a concern shared by only 25 percent of U.S. owners.

All of this demonstrates the importance of allaying concerns about high cost with U.S. owners to increase investment in high-performing, sustainable building projects. One strategy that is often employed to overcome trepidation about the cost of building green is to show the benefits during the operational phases. The Green Building Trends study has consistently shown that owners expect savings during the operational phases that range from 7 percent to 8 percent in one year to 9 percent to 11 percent in five years. Unfortunately, though, a relatively high percentage of U.S. owners (35 percent, compared with 29 percent outside the U.S.) also regard inability to prove the business case for green due to the split between capital and operating expenses to be one of the top barriers. This undercuts the aforementioned strategy as a means of helping allay



owners' cost concerns, and it shows that project teams need to actively consider how to work with owners to invest in sustainable buildings in other ways by paying attention to the triggers that drive their investment in green.

To that end, one key finding in the study is that U.S. owners and engineers have very different perceptions about the top triggers that will increase involvement in green building. Nearly half (42 percent) of owners consider lower operating costs a top barrier, but only 28 percent of engineers agree, the same percentage as global owners. Owners also prioritize healthier buildings as a key trigger far more frequently than do engineers, with 37 percent of owners selecting it as a top trigger compared with 23 percent of engineers. Engineers are also less likely to perceive green building the right thing to do as a trigger than owners, with the 18 percent of engineers selecting this factor nine points below the 27 percent of owners that do.

Engineers seeking to engage owners more effectively in green projects need to recognize the importance, not just of lower operating costs, but also of demonstrating potential positive impacts on the health of building occupants and on the sense of social and corporate responsibility that will encourage U.S. owners to invest more in green.

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