cross sections

Magazine for the Structural Engineers Association of New York

2021 VOLUME 26 NO. 3

STRUCTURAL ENGINEERS ASSOCIATION NEW YORK

YEAR END REVIEW

cross sections

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MESSAGES

PRESIDENT'S MESSAGE

EUGENE KIM, P.E.

Can you believe 2021 is almost over? It continues to be an interesting time for us as we all adjust to the "new normal." While the calendar year end is fast approaching, the SEAoNY year is just starting and we plan to provide all our usual content and more. Expect to see content from our two new committees, Resilience and Sustainable Design, as well the now more active Small Practice Engineering Committee (SPEC). Keeping safety in mind, most events will remain virtual. Our current plan is to hopefully start offering more in-person events in the Spring. These events will follow CDC/NYC guidelines for in-person events. I am looking forward eventually seeing people in person at SEAoNY events.

This past September was the 20th anniversary of 9/11. I hope everyone took a moment to reflect on all that has happened since that significant day. Many of our members were actively involved in the search, rescue, and recovery efforts as well as the investigations that followed. Thank you to all who were involved. It is important to remember that the lessons learned from those efforts were instrumental to the code changes that have followed and the formation of the Structural Engineering Emergency Response (SEER) program, which has been deployed numerous times around the world since 9/11.

Depending on how much social media you interact with day to day, you may or may not have run into NCSEA's latest initiative to promote structural engineering. We as structural engineers have historically not been great at branding. Whenever a new building or structure is in the news, it is typically the architect or contractor that is celebrated. It is unfortunately when there is a failure that the structural engineer is mentioned. The work we do is important and the only way people outside our field will know is if we promote it.

So go check out weseeaboveandbeyond.com and help promote structural engineers. Help share and engage online.

Lastly, I ask that you consider volunteering some of your time to SEAoNY. Take a look through our long list of different committees (check out our revamped website, SEAoNY.org). All of our committees are on the lookout for more people to provide their input and help out. Structural Engineers at all levels of experience are welcome and encouraged to participate. It is a great way to connect, interact and learn from others in our profession.

Thank you all.
Eugene Kim, P.E.

EDITOR'S MESSAGE

DANIEL KI, PE, SE

Hello Friends,

Please find inside SEAoNY's committee updates if you were unable to attend the Annual Meeting. SEAoNY has a rich history and is a vital part of the structural engineering community, and as I've learned through the 9/11 piece by Dave Peraza (p. 8), is at times vital to NYC as a whole. Also included is an interview I conducted with SEAoNY's Honorary Member, Tom Scarangello. The opportunities to peek into the mind of an established engineer is few and far between, so I hope you enjoy it as much as I did.

And because it's not stated enough, I'd like to thank the Publications Committee members, the writers, and to our regular contributors. The Cross Sections would not have been as fun (nor would it have survived) had it not been for your involvement -- for that, I am truly grateful.

Hope to see y'all around! (Like, in person...)

Dan Ki, P.E., S.E.

COMMITTEE UPDATES

REMEMBER TO FOLLOW SEAONY ON:

SE LICENSURE COMMITTEE

The SE Licensure Committee's purpose is to raise the standard for the engineering professionals responsible for designing our most critical structures, thereby enhancing public safety and building performance.

In previous years, the SE Licensure Committee developed suggested licensing requirements and building thresholds to require an SE of Record. We are currently developing similar suggested bridge thresholds. Now, the Committee is marketing the SE License. Marketing is necessary within our industry, to the legislature, and to the general public. In the summer of 2020, a survey showed that only two-thirds of SEAoNY members supported SE Licensure. Three-quarters of those against it believed that the PE was sufficient.

In response, we wrote an article, published in the December 2020 issue of Cross Sections, concerning the value and details of the proposal. The Committee held a Townhall in January of 2021 in which 105 SEAoNY members discussed SE Licensure. A summary of the Townhall was published in the April 2021 issue of Cross Sections. Over the next year, we are doubling efforts to market SE Licensure within the industry, preparing sample legislation, and making contacts at the State licensing and legislative levels.

CHAIR: Brian A. Falconer, PE, SE, SECB
E-MAIL: bfalconer@severud.com

RESILIENCE COMMITTEE

The SEAoNY Resilience Committee provides a multidisciplinary platform to collaborate recommendations and innovations to enhance resilience in the built environment. The Committee is made up of structural engineers, civil and geotechnical engineers, planners, and other resilience specialists. Members represent public agencies, engineering consulting firms, academic institutions, and non-governmental organizations.

The Resilience Committee's goal is to educate the structural engineering community on resilience approaches to planning, design, and construction through collective experiences in the multi-hazard urban environment. We are planning on coordinating future events in collaboration with other AEC industry partner organizations, including the AIANY Design for Risk and Reconstruction (DfRR) committee and the Committee of the Environment (COTE).

We also work closely with our parent committee, the NCSEA Resilience Committee, to ensure that education extends beyond the New York structural engineering community.

Committee meetings feature updates on the national efforts, local initiatives, and include a topical presentation with discussion. SEAoNY is the administrative host for the combined national LinkedIn forum – join our conversation on the NCSEA Resilience Committee page! (https://www.linkedin.com/groups/9029533)

Future topics will consider hazards that affect the entire United States, from wildfires to earthquakes, hurricanes, and flooding.

Keep an eye out for our events at the end of 2021 and into 2022 and feel free to reach out to the committee co-chairs if you have any specific topic requests for future events.

CHAIR: A. Christopher Cerino, PE, SECB, FSEI
E-MAIL: anthony.cerino@stvinc.com

CODES AND STANDARDS COMMITTEE

The mission of the Codes & Standards Committee is to promote a greater understanding of current codes and provide technical expertise to various jurisdictions in order to develop and improve future codes.

As part of our mission, the Committee may develop guidelines of common practice that will serve the structural engineering community and provides a communication line between SEAoNY and the New York City Department of Buildings (DOB). The Committee proactively provides opinions and recommendations to the DOB and other professional organizations regarding the Building Code, responds to requests from the DOB, and keeps SEAoNY members informed of relevant code changes.

Last year the committee worked on researching historic materials for use in development of existing building code provisions, summarizing a standard of practice for townhouse renovations and repairs, and providing recommendations to the DOB on DOB NOW and roof live load provisions. Additionally, a task group was formed with the Younger Members group to review historic New York City building codes and building typology to assist in preparation of reference information for the upcoming Existing Building Code (EBC). Site visits were conducted to review nogging wall construction, shoring installation, and building demolition.

In the upcoming year we plan to continue preparing the reference information for the EBC and prepare code change proposals for submission to NCSEA to be considered in the IBC 2024 code cycle. We also intend to expand the historic code references available in the online SEAoNY reference library. Meetings are conducted via Zoom. For more information or to be added to the meeting invites and distribution list, please contact Andrea Shear at ashear@wje.com.


Andrea Shear


Andrea Shear

CO-CHAIRS: Brad Kiefer, PE | Karl Rubenacker, PE, SE, CWI, F.SEI | Andrea Shear, PE | Erik Madsen, PE
E-MAIL: ashear@wje.com

SEER COMMITTEE

The four main initiatives of the SEER Committee are training, roster management, assistance coordination, and advocacy for second responders to natural and manmade disasters.

The Committee has maintained an online presence by providing webinars and training opportunities. "Lessons Learned as a Second Responder," by Amy MacDonald introduced us to some of the great experiences encountered when helping others around the world impacted by disaster.

For a consecutive year SEER has offered a two-day webinar version of Cal OES SAP training based on ATC 20 and ATC 45. 60 professionals, some from the DOB, participated this year, increasing our second responder roster. Our second responder material library continues to grow and should be ready to become available for the rest of SEAoNY members next year.

Additionally, in the coming months our committee will continue to offer training opportunities as well as a series of webinars related to being a first and second responder.

CHAIR: Alberto Marquez, PE
E-MAIL: am@hatfieldgrp.com

SUSTAINABLE DESIGN COMMITTEE

Climate change is an increasingly urgent issue. The construction industry has a major impact on our climate which is becoming more apparent each year. As designers, engineers, and builders, we must address sustainability in our projects.

Buildings generate 40% of annual global greenhouse gases. 11% of those annual greenhouse gas emissions are due to the embodied carbon of buildings. Embodied carbon is the sum of the CO2 emissions resulting from the manufacture, transportation, and installation of all construction materials for a building over its life cycle. Just as building operating systems are becoming more efficient, we must look for ways to reduce embodied carbon in structures. With awareness and intentionality in the design process, we can reduce, and ultimately eliminate, embodied carbon in structures.

Mission:
The Sustainable Design Committee aligns with the SE2050 program to target the reduction of embodied carbon and ultimately achieve net zero. We empower structural engineering firms to commit to SE2050. Our goal is to give structural engineers the resources and tools to incorporate sustainable practices into their projects. We facilitate commitment to the program by outlining and simplifying the process.

Additionally, we are committed to guiding and providing necessary information to the community about embodied carbon and relevant updates in the AEC industry. We aim to increase the number of New York firms officially committed to SE2050 and add the structural engineering community's voice into legislative changes that are guiding the industry towards a sustainable future.

Monthly Meetings:
Join us virtually on the 3rd Wednesday of each month until we can resume in-person meetings. Email SEAoNYSDC@gmail.com for the link to join!

Upcoming Events:
Webinar, November 17, 6:00-7:30 PM
How to Measure Embodied Carbon and Perform LCA in Your Structural Design

The SDC committee will gather a panel of structural professionals to showcase several Life Cycle Assessment (LCAs) and embodied carbon calculators. Attendees will learn the several tools available and how to easily implement them into their projects at their firms.

CO-CHAIRS: Leah Peker, PE | Candice Ogando, PE
E-MAIL: seaonysdc@gmail.com

WEBSITE COMMITTEE

Thank you to the Website Committee for the completion of the www.seaony.org website refresh (David Bueno, Jacinda Collins, Joya Nuruddin, and Maya Stahlberg).

We hope that you enjoy the new look and navigation of the website. And we hope that you have been able to connect with SEAoNY through our many social media channels (LinkedIn, Twitter, and Facebook).

CHAIR: Jacinda Collins, PE
E-MAIL: collins@aisc.org

SMALL PRACTICES ENGINEERING COMMITTEE

SEAoNY membership is represented by more smaller firms than you may think! One in five SEAoNY members works at a structural engineering firm with fewer than 30 employees; one in ten work at a firm with fewer than 10 employees. The Small Practice Engineering Committee (SPEC) strives to support and nurture these firms.

In the absence of a larger office full of seasoned structural consultants, SPEC provides a community of small business owners and employees within SEAoNY to share resources, best practices, references, lessons learned, and much more! SPEC's goal is to meet or hold quarterly events. The events typically cover technical and non-technical subjects relevant to small practice structural consulting firms or DOB-related opportunities or updates.

SPEC has doubled our email list from the previous year and has held successful events such as our "Growing a Structural Firm" event, which included a panel of small business owners and associates in larger firms responsible for growing their firms. If you're part of a small consulting firm or interested in learning more about small practice consulting firms, we encourage you to join our mailing list and attend some SPEC events!

CHAIR: David Bueno, PE
E-MAIL: david@bbe.nyc

DON'T FORGET...

YOU CAN FOLLOW SEAONY ON:

9/11 REMEMBERED BY AN ENGINEER

WRITTEN FOR THE 20TH ANNIVERSARY OF THE COLLAPSE OF THE WORLD TRADE CENTER

BY DAVID PERAZA, PE

This narrative summarizes the key role that structural engineers played in the rescue and recovery following the attacks on the World Trade Center, and includes a few personal recollections by one of the engineers who led the work.

Figure 1: My view that morning.

An inch of freshly fallen powder blanketed the ground. Sounds were eerily muffled, and the smell was acrid. The scene was apocalyptic.

I had seen many building collapses, so I thought I knew what to expect. This would be the same, just bigger. But that's not what I saw.

Where were the concrete slabs? There should have been 110 of them per tower, pancaked on each other, or stacks folded into ridges and valleys. But there were none. There should have been two towering piles of debris, rising 10 or 20 stories above ground level. But the debris barely rose above ground level. It was only later that the realization came upon me: the concrete slabs had been reduced to powder.

THE BEGINNING - 9/11 MORNING

I was in the Thornton Tomasetti[1] Manhattan office early on the morning of September 11 for a marketing meeting. After hearing news of the planes' impacts, we went up to the roof of our building, where we had a clear view of the towers about 3 miles away. Plumes of smoke rose from the tops of the two towers, as if they were chimneys, and we could see large holes in the sides of the towers near their tops. We couldn't hear anything. An architect in our group asked whether it was possible that the buildings could collapse. The rest of us, who were mostly structural engineers, mulled it over; the consensus was that worst case, the portion of each of the towers above the gaping holes might topple, like a tree toppling above where it has been notched by an axe. No one said that the towers might collapse entirely.

A plume of smoke became much larger, engulfing one of the towers. Minutes passed. As the smoke gradually cleared, we strained to see the tower. Finally, we realized that there was no tower behind the smoke. It was gone. The second tower vanished silently in a similar manner.

It was too much to absorb, and after a couple hours of watching the news with colleagues, I decided to go home. There was nothing I could do and my wife, like everyone else watching this on TV, was anguished. As I was walking out, Dan Cuoco, the President of Thornton-Tomasetti, looked up from a phone call and motioned for me to wait. I called my wife and told her I would be late.

9/11 AFTERNOON

A few hours later, I was in a police van heading toward the site with Richard Tomasetti, Mike Burton, Ken Holden of the New York City Department of Design and Construction (DCC), and the heads of several major contracting firms. I had a camera with half a roll of film, a notebook, and a respirator. The respirator had been handed to me by a colleague as I walked out the door of my office. I had

[1]At the time, the firm's name was in transition. It was variously known as LZA, LZA Technology, and Thornton-Tomasetti. It is now known as Thornton Tomasetti, which I will use for simplicity for the remainder of this narrative.

Figure 2: The "Fence." The remaining structural facade of Tower 2.

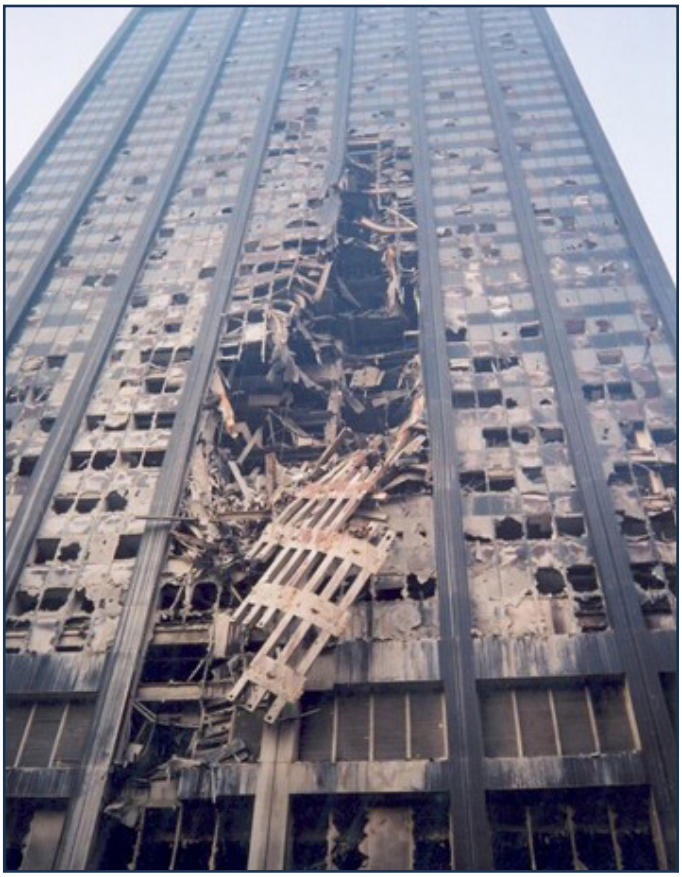

Figure 3: The Bankers Trust Building

We were approached by a firefighter, who knew we were structural engineers. He asked if it was safe for his team to go on the roof of the Bankers Trust Building (also known as the Deutsche Bank Building), located at 130 Liberty Street, so that they could tap the rooftop water tank. We looked up at the 39-story building that loomed over us. Spears of steel had penetrated the façade, and as they had fallen, they had ripped out floors, columns, and girders in a vertical gash. We were not familiar with the building's structural system, nor with the full extent of the damage. We hesitated to give any advice. But the request was urgent, and the answer could not wait. We said, "Yes, but stay in the back."

I was also approached that afternoon by a young policeman who was visibly distressed. He had colleagues who perished in the collapse. He asked me to take his photograph and send it to him. I did so, but unfortunately, I lost his contact information and was never able to send him the photograph.

As it grew dark, our reconnaissance drew to an end. Mike Burton said to come back in the morning with 30 engineers. I left the site about 9 PM, and headed to my home on Long Island. I was filthy, covered with powder. My wife made me leave my clothes on the porch. After a shower and a few hours of sleep, I headed back to the city.

9/12

During the night, Dan Cuoco had contacted staff and instructed them to meet at our office early. After I briefed them, our group of 30 engineers walked three miles to the site, since the subways were not running in that area.

We met Dan Eschenasy , Chief Structural Engineer of DDC, in the courtyard of an elementary school in the area—P.S. 89—which had been evacuated of students. There, our structural engineers were merged into multidisciplinary teams. There were seven teams, each composed of four engineers, Department of Buildings (DoB) inspectors, DDC personnel, and Police and Fire Department escorts. These teams would perform emergency structural assessments of the buildings immediately surrounding the collapsed structures to determine whether there was an immediate threat of additional building collapses.

We issued our first daily report at the end of the day. It was a bullet list of seven items, written with a felt-tip pen on graph paper, identifying the most compromised buildings.

RUMORS OF ONE LIBERTY PLAZA COLLAPSING

The rapid dissemination of accurate information is difficult in a chaotic and rapidly changing situation.

One Liberty Plaza is a 54-story commercial building across the street from the former World Trade Center Plaza.

The building had many broken windows, but no structural damage. On September 12, Tom Scarangello, John Abruzzo, and I closely observed the façade, entered the building, and inspected several floors. We found no structural problems, which we reported to DDC and DoB. But concerns persisted.

Despite our assessment, throughout September 12 and 13, many continued to believe the building was collapsing because when viewed from a certain angle, an optical illusion made it appear that the façade was bulging. On several occasions, evacuation alarms were sounded, resulting in injuries to personnel as they rushed away. These work stoppages also delayed rescue and recovery operations.

Figure 4: Unknown police officer who asked that I take his photograph.

In order to put the issue to rest, the next day we assigned an entire team of engineers to perform a top to bottom inspection of One Liberty Plaza. Since there was no electricity, the team started by climbing the stairs to the top of this 54-story building. On the way down they systematically inspected each floor. As expected, the team found no evidence of structural damage. Nevertheless, upon reaching the lobby, the leader of the team assigned to inspect One Liberty Plaza, Gary Mancini, received a call from his distraught wife who told him that she heard on the radio that the building had collapsed. He reassured her that the building he was standing in had not collapsed!

We immediately and directly informed news outlets that the One Liberty Plaza was not in danger of collapse. But it was still several days before that information was widely disseminated and accepted by personnel on site.

SLURRY WALL

While these inspections were being conducted on September 12, George Tamaro of Mueser Rutledge Consulting Engineers (MRCE), Richard Tomasetti, and I had another mission. We visited command posts on the site, explaining to each Fire Department Chief that maintaining the stability of the site's perimeter slurry wall was of paramount importance. If it were to fail, the Hudson River would rush in, flooding the site, the subway system, and the PATH rail system. For that reason, contractors should not remove any debris along the slurry wall, since that debris might be inadvertently bracing the slurry wall. George Tamaro was in a unique position to effectively communicate this information, since he was one of the engineers involved with the design and construction of the slurry wall in the 1960s.

The slurry wall was a 3-foot thick reinforced concrete wall that formed the perimeter of what was known as the "bathtub." The bathtub was the six-story deep basement, 11 acres in plan, that occupied the western half of the World Trade Center superblock. Within it were the two 110-story towers, a low-rise plaza building, and the Vista Hotel. The function of the slurry wall was to keep the Hudson River out of the basement levels—the reverse of a bathtub. The slurry wall was constantly subjected to huge hydrostatic pressures pushing toward the interior of the bathtub. During construction these pressures were resisted by anchoring the slurry wall to the surrounding earth with tiebacks.

But after construction was completed, those tiebacks were abandoned. Now, the stability of the slurry wall depended on bracing from the slabs of the subgrade levels, many of which had been destroyed. In those areas, we were concerned that the slurry wall was partially leaning on random debris along the wall, and that removal of that debris would unintentionally trigger failure of the slurry wall.

WE QUICKLY ORGANIZE

Dan Cuoco led the project for Thornton Tomasetti, and selected me as his co-leader.

We immediately engaged two consultant firms: Leslie E. Robertson Associates (LERA) and MRCE. LERA, as the original structural engineer for the twin towers and surrounding buildings, was indispensable for its first-hand knowledge of the buildings. And MRCE, as the original designer of the perimeter slurry wall, was invaluable for

Figure 5: Inspection of surrounding buildings on September 12.

assessing the subgrade conditions and designing a new tieback system to stabilize the perimeter slurry wall.

Within two days, DDC asked us to staff the project on a 24/7 basis. This would require about 30 engineers on site around the clock, which was more than any one firm could maintain for an extended period. We therefore enlisted the assistance of the Structural Engineers Association of New York (SEAoNY). SEAoNY was a fledgling organization, but its leadership was passionate about wanting to help. The president at the time was Ed DePaola of Severud Associates. SEAoNY mustered engineers and coordinated their assignments daily for several months. Most of the coordination was performed by Vicky Arbitrio of Gilsanz Murray Steficek.

We quickly developed a framework for staffing the project. It included four Contractor-Assistance Teams, a Standby Team, and a Crane Team, all of which reported to a Control Team.

SEAoNY coordinated the staffing of the four Contractor-Assistance Teams. Each of these teams was assigned to one of the four prime contractors, and their responsibility was to provide whatever engineering support was needed by the contractor. Each team typically consisted of four engineers, at least one of whom was a Professional Engineer in New York State. Over time, as work was completed, staffing was reduced, and the SEAoNY teams were no longer needed as of early January 2002.

The Standby Team, staffed by Thornton Tomasetti, was deployed on an as-needed basis to handle special projects as they arose, so that the Contractor-Assistance Teams could focus on their work. The Crane Team, also staffed by Thornton Tomasetti with assistance from crane consultants, was responsible for determining how to safely support the many needed cranes.

RISK, REWARD AND AN 800-TON CRANE

In an emergency situation where the potential rewards are high, it may be appropriate for an engineer to tolerate higher risks than usual.

Firefighters had identified a stairway in Tower 1 with possible survivors. It was within the bathtub and about 200 feet from the perimeter slurry wall. We were told that a massive crane was on the way to help reach the area, and that we needed to determine a safe location to place it.

This was not a trivial problem. We needed to get the crane as close to the slurry wall as possible, so that it could reach the search area. But placing the crane's weight on the soil immediately behind the slurry wall could collapse the slurry wall. We needed a solution fast, but what could we do? And then I had an idea. Instead of placing the weight of the crane on the soil next to the wall, what about


Figure 6: One Liberty Plaza, which was rumored to have collapsed.

placing most of its weight on the wall? We would need a platform, the front of which would sit on the slurry wall and the back of which would sit far from the wall. The platform could also act as a tieback for the top of the slurry wall. My colleagues agreed it was a good concept.

Good concept, but now we had to figure out how to make the platform. It had to be strong enough to support the weight of the crane and since time was of the essence, it had to be made using materials that were readily available. We had noticed that there were dozens of undamaged steel box columns scattered in the debris, that had been part of the Tower 1 core. Perhaps we could use them. After some rough calculations, we determined that these would be more than adequate. We issued our first design sketches for the project, which were dated September 20, 2001.

We could not see the slurry wall from top to bottom, so we had to make some assumptions about its condition. We believed the assumptions to be conservative, but there was no way to be absolutely certain without performing detailed investigations that would have taken weeks. For that reason, there was a higher level of risk associated with this scheme than would be tolerable in a more conventional situation. But the potential reward of saving lives was high, making the risk warranted.

The contractors harvested the needed steel box columns from the debris, and successfully assembled them into a platform that was ready before the crane arrived. Unfortunately, there were no survivors in the stairwell.

DAMAGE ASSESSMENTS OF ADJACENT BUILDINGS

SEAoNY undertook a systematic inspection and assessment of buildings in the neighborhood. This project was spearheaded by Guy Nordenson of Guy Nordenson and Associates. The main purpose was to identify which buildings had sustained structural damage, and to evaluate those with major structural damage.

The methodology for these assessments was based on what was commonly used after an earthquake. The first phase was a rapid assessment of 371 buildings, which was conducted on September 17 and 18. Based on this triage, 31 buildings were identified as needing detailed assessments, and these were performed on September 21. Engineering evaluations were performed in October for eight of the buildings with major structural damage.

Eighteen engineering firms participated in this project as subconsultants to Thornton Tomasetti. All of the results and underlying reports were published by SEAoNY in a bound, glossy book.

PHYSICAL AND EMOTIONAL DEMANDS

Each day was extremely demanding—physically, mentally, and sometimes emotionally. The hours on site were long, travel to the site was complicated, and of course I had other professional responsibilities to which I had to attend.

It was physically demanding. The large site required miles of walking every day. And there was a considerable amount of walking needed just to reach the site, since subways were not running to the area. The damaged high-rise buildings had no electricity, so if we needed to inspect damage on the 30th floor, we had to walk up 30 flights. I lost about ten pounds during the project. In general, the engineers were very diligent about wearing respirators, so long term health effects from the dust on our group appear to have been minimal, if any. Twenty years later, I personally have not suffered any respiratory issues.

Mentally, each day presented a potpourri of engineering problems: some challenging, some urgent, some bizarre. My mind was totally occupied with solving these problems, so while on duty I had no time for reflection about the tragic loss.

Emotions were more likely to come into play when I was off duty. For example, for months there were dozens of people flanking the exits from the site, waving "thank you" signs and applauding workers who were leaving the site as if they were heroes. I didn't feel like a hero, but every time I went past these people I teared up. Other times I felt like an alien, like when I was walking home from the train station after a shift, dusty with a hard hat and other gear, past the manicured lawns of my suburban neighbors while kids played in the street. It was a different world than the one I had just come from.

The work disrupted my family life, especially during the first month when I was leading the 12-hour night shift. My wife basically became a single mom. My daughter, who was seven at the time, probably adapted the best. But she had questions: Why was Dad sleeping during the day? Where was Dad at bedtime? But to top it off, she chose this time to pop an important question to her Mom … "Is there really a Santa Claus?" I'm sort of glad I wasn't home to handle that delicate question. When I was home, I tried to set aside a few hours for her whenever I could. Taking her for horseback riding lessons was one of our 9/11 activities.

THE MIDDLE

So what was our mission? In a nutshell, to try to prevent anyone else from being killed. It was an extremely dangerous site. The hazards ranged from small to enormous. Shards of glass could readily fall and severely injure or kill someone, or a high-rise building could collapse. Some of the hazards were clearly visible, like the spears of steel dangling from the side of a building. Some were concealed, especially in the partially collapsed basements, where fires continued to smolder.

We attacked all of the hazards simultaneously. Some were

easy, like providing overhead protection or netting next to buildings with loose glass. Others were very technical and specialized, like designing a new tieback system to stabilize the slurry wall. We developed demolition plans, and designed temporary repairs and bracing to stabilize buildings. We determined where it was safe to place heavy equipment, such as excavators. And the cranes! At one point there were at least 16 cranes on site working simultaneously. We had to find a way to safely support each one, and design whatever structural platform or ramp they needed.


Figure 7: An elementary school classroom became our field office.

The City had commandeered two classrooms at P.S. 89 to use as our headquarters. These classrooms were nearly ideal for our purposes. They had blackboards and whiteboards, chalk and markers, easels ... everything needed by visual thinkers. I say nearly ideal, because our headquarters did have one drawback—it was in an elementary school. As such, the furniture was sized for the elementary school students. It was comical to see how the adult engineers, some rather generously sized, accommodated themselves in these little desks and chairs.

We used one of the classrooms for the twice daily briefings. The main purpose of these briefings was to provide continuity between shifts. At each shift change, the outgoing teams would brief the incoming teams regarding what they had done, and what remained to be done.

We memorialized every instruction we gave to the contractors with a sketch. When the information was simple and the need was immediate, we issued hand-drawn sketches on letter-sized paper. When the information was complex, such as the tieback installation, the sketches consisted of full-size drawings. Over 500 sketches were issued during the course of the project. Although email was in widespread use, DDC preferred to distribute these as hard copies, and we had to provide 16 copies of each sketch.

A CLOSE CALL WITH THE SLURRY WALL

We were several weeks into the project, and we were gaining confidence in the stability of the slurry wall. Installation of tiebacks was proceeding nicely, gradually easing our fears of the catastrophe that would unfold if the slurry wall were to fail.

Suddenly, on October 7, that confidence was erased. A fissure had appeared along Liberty Street parallel with the slurry wall. We knew what that meant—the slurry wall had moved. All hands on deck! The engineers immediately developed a multi-pronged attack and the contractors began executing it. They poured tons of sand into the bathtub next to the slurry wall to help prop it up, installed dewatering well points in the street to reduce the hydrostatic pressure, and installed tiebacks. Surveyors monitored the wall continuously for movement.

As the contractors worked feverishly, the slurry wall continued to move. Finally, two weeks later, our efforts paid off when the movement finally stopped, after having moved more than 9 inches. Our hearts resumed beating.

EMERGENCY AT THE BANKERS TRUST BUILDING

The Bankers Trust Building had been severely damaged during the collapse. Collapsing steel from Tower 2 had penetrated its facade and raked a wide gash that extended from the 22nd floor down to the 8th floor, destroying the steel frame and floors.

The destroyed frame was a key part of the building's structural system for resisting wind loads. Additionally, it was hurricane season. In light of the possibility of a hurricane strike, the original structural engineer for the building issued a letter to the City expressing concern for the stability of the building. The City's Office of Emergency Management (OEM) immediately began drafting a plan for evacuating the area within the "fall radius" of this 39-story building. DDC asked us to evaluate the threat, so we immediately commenced a sophisticated structural analysis, with engineers working around the clock. The three-dimensional, non-linear analysis took into account the compromised structure and the ductile nature of the steel frame.

Twenty-four hours later, I presented the results of our analyses to City agencies. Our analyses showed that the building had sufficient resistance to survive hurricane level winds without collapse. This alleviated the immediate concern, and OEM discontinued developing emergency plans.

Figure 8: The appearance of a fissure in the street signaled movement of the slurry wall and triggered an immediate response to stabilize it.

A TENT FOR WINTER

As winter drew near, concerns were raised about how it would impact safety and productivity. Even a light snowfall would make the site even more treacherous than usual, and the critical tieback installation would come to a screeching halt.

We solicited ideas for how to keep the site open through the winter, and several engineering firms submitted concepts. Most were not viable, because they involved installing a tent over the entire site, which would have hampered crane operations. The most creative was submitted by FTL Happold and McLaren Engineering Group. It consisted of movable modules with tensioned fabric skin, supported at ground level around the perimeter and overhanging the slurry wall. This would have protected the tieback installation operation as it progressed around the perimeter.

For a number of reasons, including time restraints, none of these was selected. But Mother Nature smiled upon us, and gave us an extremely mild winter.

THE END

Work continued through the winter and the following spring, gradually becoming safer and requiring fewer engineers, but still proceeding around the clock.

Finally, on May 30, 2002, eight months and nineteen days after the attacks, the recovery efforts officially ended with a brief and somber ceremony.

We were proud to hear that the project was completed ahead of schedule and below budget, compared to Federal Emergency Management Agency estimates. But we were proudest that in spite of the treacherous conditions, there was no loss of life or serious injury during the entire recovery process. It was truly remarkable. The success was due in large part to the service of over 400 engineers from 39 engineering firms, who worked selflessly and tirelessly on the project at considerable personal risk to themselves.

Figure 9: A truck hauls away the final piece of debris from the site.

It was tremendously gratifying for me to work on this project, and I threw myself wholly into it. Nearly every American felt the loss deeply, and wanted to help in some manner, but for various reasons could not. As a structural engineer, I had skills that were urgently in demand, and I happened to be in the right place at the right time. I am glad that I was able to help, and I think that most if not all of the engineers who worked on the project probably feel the same way.

BEYOND THE BIO

INTERVIEW WITH SEAONY HONOARY MEMBER TOM SCARANGELLO

QUESTIONS BY DAN KI

ENGINEERING QUESTIONS

At what point in your life did you decide to pursue structural engineering? Why?

In high school, my uncle who was an engineer, saw that I was good at puzzles and math and encouraged me to pursue a career in engineering. Given he was one of my only relatives with a college education, I took his advice.

Who would you consider to be your mentor within the industry?

You don't make it to 42 years without lots of mentors who guided and helped you along the way, but I would have to say Charlie Thornton and Richard Tomasetti. Both were incredibly generous with their knowledge and guidance, and both gave me unique insights and lessons that continue to serve me well to this day.

What is most important to you with respect to design?

Constant innovation and improvement. While most of my design career is in the tall building and stadium design world, it never becomes stale because every project -- no matter whatever similarities it had to the last one – is unique. I always strive to drive a new idea, technology or innovative solution into a project. That allows me to always grow as a designer, to serve my clients the best I can and keeps the work from ever becoming boring or repetitive.

What moment or project do you consider to be the most impactful during your career?

Given the recent 20th anniversary of the 9/11 attacks I would say my work and the work of all my engineering colleagues at Ground Zero. Probably for the first time in my career, I truly understood the power of our knowledge and industry to make a huge contribution to our society. It also illustrated the camaraderie and selflessness that makes me proud to be an engineer and part of the AEC industry.

What advice would you give to an entry level engineer? What about a mid-level engineer?

For all engineers my advice is: Share what you know. But maybe more importantly: Know what you don't know, and don't be afraid of letting others know it. What we do is the ultimate collaborative effort and if you don't share your knowledge and experience and allow others to fill in your gaps by being open and honest about what you don't know, you will limit not only your growth, but your value to your colleagues and your clients.

RELEVANT QUESTIONS

What does an ideal workday look like for you?

That ideal day has changed a lot over the years as my work life and home life did, but from where I sit today, I would say a workday filled with diverse conversations and problem solving with my colleagues and clients and then capped off with a bike ride – preferably late in the day when the sun is setting or on my Peloton, and then dinner and a martini with my wife or with friends and family…and of course, a Yankee win.

Has Covid-19 changed the way you view our industry? If yes, how so?

Not really. It reinforced my views of how resilient and collaborative we are. Whether it was how quickly and efficiently we all pivoted to our homes and then back to our new hybrid world, or how we shared information and support among even fierce competitors through the pandemic to make sure we all did our best to see our industry thrive. What makes this industry so great is never more evident than in a crisis.

What are your feelings about remote work?

I am glad it's now a real option. It makes some of those crazy business trips I used to take seem absurd given our discovery during the pandemic of how well we can communicate when remote. That said, recent weeks and months have shown that 3D is so much better than 2D, and not just for the camaraderie.

Whether it's learning, sharing or innovating, none of that can be done at the highest level in a 2D Outlook calendar-scheduled way. Those casual collisions and serendipitous solutions only happen in person. When it comes to business development, that is, and always will be, a contact sport.

You've been in the industry for over 40 years. What do you miss most about structural engineering from, say, 20 or 30 years ago?

My ability to feel confident about having another 20, 30 or 40 years ahead of me!

But seriously, I have never really been sentimental when it comes to "the old days". I think we are heading into the golden age of engineering, where our ability to be leaders and at the forefront of major societal issues will be higher than it's ever been.

So while I can certainly wax poetic about the "good old days" with my generation, I am much more jealous of the young people starting out at the beginning of this new era for our profession and industry.

If you could change one thing that is considered a norm in our industry, what would it be?

Given the recent 20th anniversary of the 9/11 attacks, I would say my work and the work of all my engineering colleagues at Ground Zero.

MISCELLANEOUS QUESTIONS

How do you start your day? Do you have a morning routine?

Coffee, bagel and news...

How often do you work weekends?

It would easier to answer how often I don't... that said, I love what I do, so weekend work is mainly the reading and organizing that allows the weeks to be as fun and productive as possible. But that's why I also like to bike. It's hard to work while riding a bike... not that I haven't tried.

What's on your desk right now?

A laptop, iPad and iPhone for the digital multitasking side of my brain and a pile of manila project folders for the analog side of the brain.

How many unread emails are in your inbox?

None! And none of those red dots on any of my apps either.... did I say I had a compulsive side?

How many cups of coffee do you go through in a day?

Two early and done on a good day in the office, continuously and intravenously when I am traveling.

What structural element would best describe your personality and why?

An eccentric braced frame. Strong enough for the job, flexible enough to be efficient and accommodating and ductile enough to roll with the punches...I also try to keep my accelerations at a tolerable threshold for my colleagues and partners.

The year is 2100. What does structural engineering look like?

We are always "at the table" and of course... finally flying private.... but of course, by then won't everyone?

If you could have a billboard in the middle of Times Square, what would it say?

Did you thank an engineer today?

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