cross sections

Magazine for the Structural Engineers Association of New York

2015 VOLUME 20 NO. 1

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SEAoNY
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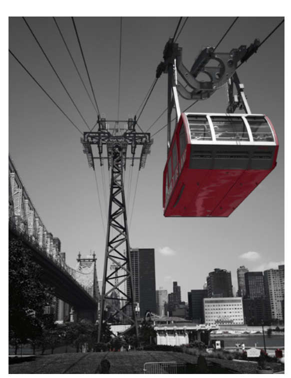
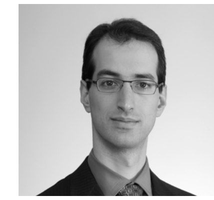


ON THE COVER

The Roosevelt Island Tram as it looks today post-renovations. This tram is descending towards the Roosevelt Island Station. The Ed Koch (Queensboro) Bridge is seen on the left and Midtown Manhattan is in the background.

PHOTO: ADAM KIRK



President's Message

Eli Gottleib, PE

As we enter 2015 Seaony is on track for another strong year. SEAoNY reinforced our relationship with the Center for Architecture and the AIA , we recently solidified a three year relationship with the CFA. This agreement gives SEAoNY a stable home allowing us to focus on our mission as well as creating opportunities for us to form joint ventures with the AIA and explore programs of common interest to our membership.

This year will be an exciting year for structural engineering in the New York area and for SEAoNY membership. New York City is seeing a boom in cutting edge projects and New York engineers are involved in major projects globally. Many of these will be on display at the multiple structures conventions that are coming to the north east and NYC over this year. We are excited to be able to collaborate and support some of these events such as CTBUH, EERI and ASCE where many of our members and projects will be highlighted.

Our many committees have created a series of great events, Structure Quest and many of our monthly events draw large crowds. We will soon be having our full Day seminar on Foundation Construction Issues and will be having roundtables and panels to engage both our membership and our counterparts in the industry to discuss how to improve and reinforce the art of structural engineering.

Looking forwards to these great events and the efforts of our membership.

Regards,
Eli

Editor's Message

Justin Den Herder, PE

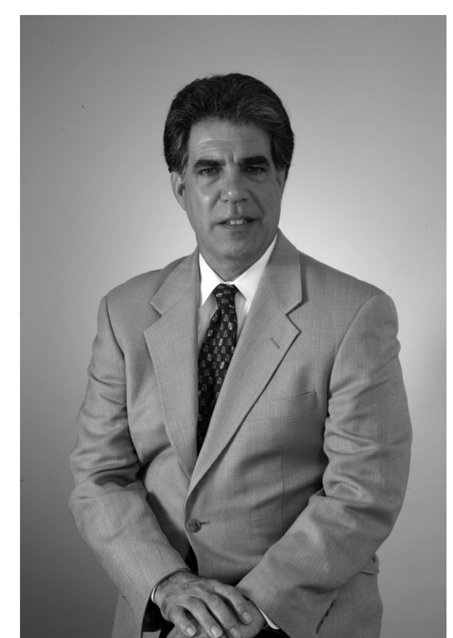
Dear Readers,

This is our first publication of the new year. Thanks to all who have contributed to the making of this issue.

We are taking strides at the Publications committee to maintain a consistent quarterly publishing schedule so that you can come to expect a new issue of Cross Sections at specific times of the year; but we need help. Given that the magazine is run on a volunteer basis, busy schedules often intervene and delay the magazine's release. What we need is a new wave of volunteers to rise up and pitch in. Volunteering for the Publications Committee does not mean that you will be relegated to the role of writing, although of course, we always encourage volunteers to write about topics that impassion them. We need help with organizational skills, experience in graphics and layout, in obtaining and tracking advertisements, editing, etc. We also need help in brainstorming new article ideas and we need to cast a wide net for them. If you have a colleague with a pertinent thesis topic or an abstract for a presentation please reach out to them and ask if they would be interested in publishing their work in Cross Sections. It can be great exposure for them and simultaneously serve to enlighten our membership.

Additionally, our meetings are fun! If nothing else, please come to just to check out the group. Our next meeting will be at a pub, Fresh Salt on March 26th at 6PM. We hope to see you there!

Regards,
Justin



IN MEMORIAM

Dan Cuoco

Daniel A. Cuoco, PE, a former President and CEO of Thornton Tomasetti, passed away on September 21st, 2014.

A respected and distinguished leader, Dan was involved in numerous building failure investigations and new building designs over a 4-decade career at TT, from where he retired in 2011. He will be widely missed by the structural engineering community, where he was an active presence.

One of Dan's many projects at TT was the Roosevelt Island Tramway, which is featured on Page 10 in this issue.

PHOTO: COURTESY OF THORNTON TOMASETTI

Six Pointers on Steel Pricing for Structural Engineers

On December 3, 2014, SEAoNY hosted an informative seminar regarding structural steel costing in NYC, presented by Robert Abramson, the President of Bramco Plus LLC.

Why should engineers understand the basics of structural steel pricing? Nobody doubts the answer is to bring an economical design to the project and the owner. In general, structural steel pricing in New York varies between $3,800 ~ $6,800 / Ton.

The seminar covered six key topics in steel pricing for "medium" complex structures:

MATERIAL
Mill Prices – Structural steel published prices are available on www.nucor.com

Material Pricing: Mill Cost Estimate

Material Cost	$0.45/lbs
Extras	$0.03
Freight/Tax	$0.04
Scrap Allowance	$0.03

= $0.55/lbs equivalent to $1,100/ton

DETAILING
Detailing Cost Estimate = $70/HR x 1.5 HR/Ton = $105/Ton
(Function of complexity & Technology)

FABRICATION
Today, modern steel facilities, with automated equipment and efficient factory layouts, are the leading source of steel fabrication, and are no longer referred as "shops."

Fabrication cost estimate average shop hour rate: $72/HR
Fabrication Rate = $72/HR x 10.5 HR/Ton
(7 Man hours per piece x 1.5 pieces/Ton)
= $760/Ton

FREIGHT
Freight Cost Estimate = $600/HR = trucking rate x 10 hours per load x 18 Tons/load
= $330/Ton

ERECTION EQUIPMENT/CRANE
Journeyman wages in New York City (union labor) = $220/HR (includes wages $47, vacation fund $18, pension & annuity $55, FICA & Fed. Medicare $15, W/C & Insurance $38, and 22% Mark-up $44)

Erection is based on site logistics, determination of crane type and cost.
Erection Cost per Hour = 28 men x $220/HR = $6160/HR
(28-man crew per crane, IW hourly rate = $220/HR)
Favco costs/operators = $1,800/HR, Other Equipment = $1,000/HR
Total = $8,960/HR

ERECTION LABOR
Erection Cost Estimate= $8,960/HR
= $71,680/Day (8 HRs)
Assuming Erection Productivity Rate = 28 pieces/day, 1 piece = 1,500 lbs, 28 x 1500 lbs = 21 Tons/day
= $71,680 / 21 Tons = ~$3400/Ton

COST TOTALS PER TON (PERCENTAGE)

Material:	$1100	(20%)
Detailing:	$105	(2%)
Fabrication:	$760	(13%)
Freight:	$330	(5%)
Erection:	$3,400	(60%)
Total:	$5,695/Ton	

Design Economy: Least weight or least cost?
Thanks to state of the art technology, material take-offs can be done electronically to a high degree of accuracy. However, structural steel fabrication and erection estimates are very specific to the complexities of each project. Material prices are flat, while labor costs always rise, with the result that cost is not proportional to lbs/sq. ft (psf). In other words, the key driver of the overall steel cost is not how many lbs/sq. ft are in the design, but rather the cost per erection piece. The key is to reduce your square foot costs.

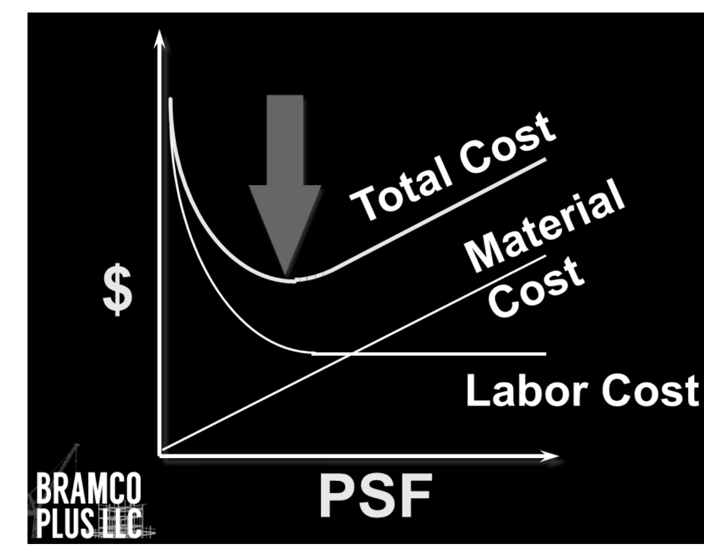


Figure 1. Cost vs. psf diagram (Bramco Plus LLC)

A project in NYC of $5,695/Ton should be better described as costing $3,800 / erection piece.

SIMON SHIM, PE
THORNTON TOMASETTI

The 5th Annual Structure Quest

SEAoNY's popular scavenger hunt brings out engineers from 5 companies and 7 colleges

STRUCTURE QUEST IS UNIQUE IN PROMOTING A REAL BOND BETWEEN STUDENTS AND PROFESSIONALS THROUGH THIS WILD MISSION EXPLORING THE CITY TOGETHER.

ABOVE
Winners on 1st Place Team: Frank Yuxing Fang (Columbia), John-James Tesoriero (Cooper), Emily George (Cooper), Carlotta Malavolti (TT), Maya Stuhlbarg (TT), Tanvir Islam (Cooper), Imer Del Cid (Columbia), and Hailey Kim (Cooper) posing as a human sculpture of a bridge. "We didn't have enough time to perfect our pose, but looking at our rushed picture we joked: 'Our bridge is under construction, it isn't ready yet!'"

ABOVE, THIS PAGE
Structure Quest Team with a Jack Arch

OPPOSITE PAGE
Structure Quest Team with Mechanical Equipment Dunnage

The SEAoNY University Outreach Committee held the 5th Annual SEAoNY "Structure Quest" on November 8th, 2014. The event was co-sponsored by The Cooper Union for the Advancement of Science and Art. Students represented schools from Columbia University, Stevens Institute of Technology, New York University (NYU), Princeton University, New York Institute of Technology (NYIT), Manhattan College, and Cooper Union. Employees from firms Murray Engineering, Robert Silman Associates (RSA), Thornton Tomasetti (TT), Leslie E. Robertson Associates (LERA), and STV joined the students in their pursuit of becoming Structure Quest winners. Students and working engineers were split into a total of 10 teams, and were then given a series of scavenger hunt questions based on significant structures in the NYC area. Unlike more conventional networking events, Structure Quest is unique in promoting a real bond between students and professionals through this wild mission exploring the city together.

This year's theme was New Structures. A majority of questions consisted of structures that were either under construction or completed in the 2014 timeframe. Students were given 4 hours to figure out what structures the questions were describing, locate them in NYC, and then visit the structures to take photos of them. Students were also tasked to find examples of common structural engineering objects such as "jack archs" and "mechanical equipment dunnage."

This year had many newcomers on both the student and professional sides. As described by two first-time participants, professionals Maya Stuhlbarg and Carlotta Malavolti from the first-place winning team, "It was nice when students asked us questions: 'Where can we find a built-up column?' 'Don't worry, every time we go in the subway we see a lot of them,' or 'what is a sidewalk bridge?' 'Look in front of you in the street, this is a sidewalk bridge!' The students enjoy answering the questions because they can interact with each other and find the right answer together."

After the groups finished their pursuit of structures, all participants gathered back at The Cooper Union to enjoy pizza and refreshments after their long expeditions. The top 3 teams were awarded coveted SEAoNY medals provided by the committee and I-beam trophies donated from Cives Steel Company. Points were based on how many structures were identified and photographed correctly. Winners were:
First Place: Thornton Tomasetti, Columbia University, Cooper Union
Second Place: Thornton Tomasetti, Cooper Union, Manhattan College, NYIT
Third Place: Robert Silman Associates, Manhattan College, NYIT

The University Outreach Committee is planning its next event, Resume/Interview workshops in the upcoming 2015 year. For anyone interested in participating in this event, or in getting involved with the University Outreach Committee, please contact us at seaonyeducation@gmail.com.

JENNIFER TSANG
THORNTON TOMASETTI

Law Abiding Citizens

A GENERAL REVIEW OF PROFESSIONAL LIABILITY LAW FOR ENGINEERS

Any discussion of the liability of engineers must begin with an understanding of the appropriate standard against which engineering services are judged. That standard is called "negligence." Negligence is defined as a breach of the standard of care exercised by a reasonably skilled member of the profession within the community in which the engineer practices at the time the work is completed. Malpractice is professional negligence. An engineer may be held liable for malpractice because of faulty plans and specifications, but his or her undertaking to prepare plans does not imply a guarantee of a perfect set of plans. The engineer will not be liable where a reasonable degree of skill was exercised under the circumstances.

The engineer's agreement is of immeasurable value in avoiding many liability situations. Many engineers use oral agreements or use a short letter agreement or no agreement at all. Many blindly use an unadapted AIA Form Agreement, when perhaps a more customized agreement is necessary. Too often, engineers allow their clients to prepare the agreement, the net result being that the owner's perception of what an engineer does infects that agreement's essential terms, in many cases much to the dismay of the engineer.

Common Sources of Professional Liability Claims

Engineers may be sued for professional malpractice based on contract or tort (negligence). The duty of care owed by an engineer may stem from the professional relationship between the engineer and the client or may be defined by the contract between the engineer and the client. When a cause of action for alleged wrongdoing arises out of a contractual relationship between the owner and the engineer, the owner may assert causes of action sounding in both theories.

Malpractice claims against engineers frequently involve negligent design. To establish negligence, a plaintiff must demonstrate a duty owed to it, breach of that duty, and that the breach was the proximate cause of the injury. The engineer is liable to the client for any damages caused by defects in the structure due to the negligent plans or design. Liability may be imposed when an engineer negligently prepares or reads design drawings. But engineers are not liable for negligent execution of the work called for by the plans – the "means and methods" of construction – or work performed that is in deviation of the plans. The builder may be held responsible when the builder's work materially deviates from the plans prepared by the engineer.

An engineer may be liable to persons other than his or her client. An engineer may be liable in negligence for personal injuries or property damage to third parties caused by negligently-designed or constructed buildings.

Section 3309 of the NYC Building Code requires the person who causes an excavation to protect from damage any adjoining structures, provided such person is afforded a license in accordance with the requirements of that Section 3309.2 If the person who causes the excavation is not afforded a license, the duty to protect the adjacent property devolves to the owner of the adjoining property. The duty under the statute applies to activities during the excavation process and to any damages suffered by the adjoining owner proximately caused by the excavator's failure to take adequate precautions to protect adjoining structures. Generally, the courts have held only owners and excavation contractors that actually perform excavation work absolutely liable, but there are cases where plaintiff-adjoining property owners are seeking to expand liability to structural engineers.

In one case, an adjoining property owner sought to hold the structural engineering firm that prepared the structural drawings and performed the controlled inspections for underpinning for the expansion of a parking garage liable under Administrative Code § 1031 (the predecessor of Section 3309). The court, however, disagreed with the plaintiff-adjoining property owner and dismissed that part of the claim against the engineer because the engineer was not the party who caused the excavation to be made.

Another emerging source of claims against structural engineers involves the an engineer's filing a TR-1 Form "Statement of Responsibility" with the Department of Buildings that makes the engineer, in the view of the DOB, responsible for categories of work such as "structural steel," "pier foundations" or "underpinning." An engineer of record with the DOB, especially one with TR-1 Forms on file, regardless of whether he or she is merely a "place holder" or is actually performing the work identified on the Form, is especially vulnerable to claims where there are excavation or underpinning failures because he or she is "signing-up" with the DOB as the party affiliated with the project that is responsible for inspecting that work. There may be very little room for interpretation.

JESSICA L. ROTHMAN, ESQ.
INGRAM YUZEK GAINEN CARROLL & BERTOLOTTI, LLP

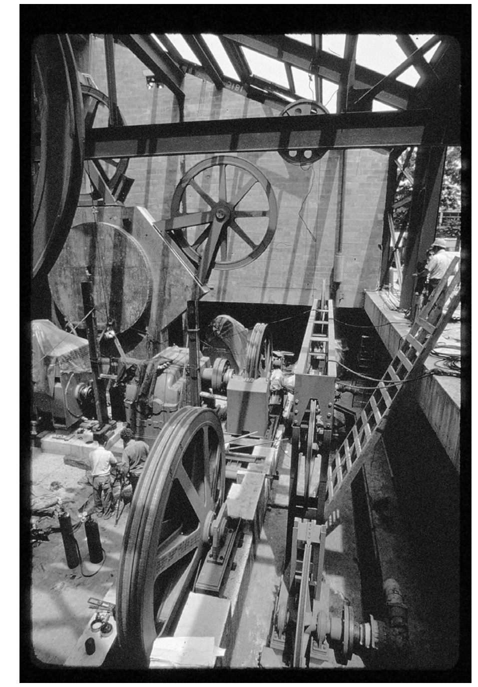
COMMUTING THROUGH THE SKY

AN ENGINEERING HISTORY OF THE ROOSEVELT ISLAND TRAMWAY

ALL PHOTOS: COURTESY OF DAN CUOCO.

ABOVE
A glimpse of the original tram car ascending from the Manhattan Station.

THIS PAGE, RIGHT
A view from behind the Manhattan Station looking east. The two steel truss towers are visible in the background.



THE TRAMWAY CURRENTLY CONSISTS OF TWO INDEPENDENTLY MOVING CABINS, EACH OF WHICH HAS A CAPACITY OF 110 PASSENGERS, AND MAKES 115 TRIPS PER DAY.

THIS PAGE, FAR LEFT
The machine room of the Roosevelt Island Tram Station.

THIS PAGE, NEAR LEFT
A view of the Roosevelt Island Tram Station with an original tram car docked inside.

Roosevelt Island is a narrow landmass, 2 miles long and 800 feet wide, situated on the East River between Manhattan and Queens. It was leased to the state of New York's Urban Development Corporation in 1969 and its master plan originally envisioned the island as a predominantly car-free zone. In earlier decades, the islanders and visitors took an elevator to the Queensboro Bridge and availed a trolley line between Queens and Manhattan that ran along the bridge. It was the only means of connection to Manhattan until it closed its operations in 1957.

The F line subway was planned to connect the island with Manhattan expeditiously, but was running behind schedule. The New York Urban Development Corporation therefore conducted some studies on the feasibility of an alternate public commute system, the new proposals being an elevator from the bridge, a ferry, and an aerial tramway service. Von Roll, the Swiss industrial group that the Corporation was consulting at the time, proposed that a tramcar with a capacity of over 100 passengers could potentially be designed, and was finally chosen as the most feasible option.

Thornton Tomasetti began structural, MEP, and site/civil design for the project in 1974. They also hired Prentice & Chan, Ohlhausen Architects for architectural design of the station buildings, while Von Roll provided the electrical equipments for the tramcars.

The structural components of the tramway included the Roosevelt Island Station building that consisted of an above-grade steel framed structure and a below-grade concrete structure surrounding the equipment room; the Manhattan Station building that consisted of reinforced concrete passenger level and basement level, a structural steel beam and column system supporting track ropes; and three trussed towers supporting the cables of the tram system.

The location of the tramway system was determined by the availability of space needed for construction of the station building in Manhattan. Once the Manhattan station site was finalized, location and height of the three trussed tower supports and the Roosevelt Island station building were planned to fit the cable profile of the track ropes that would provide the required clearance above the East River. The catenary system of the original tramway structure was anchored at the Roosevelt Island Station and a series of concrete block counterweights were suspended below ground level at the Manhattan station. As the tramcar moved along the cable profile, the counterweights moved up and down and maintained a constant force in the cables.

The three towers were quite similar to lattice type cell phone towers, but with larger and fewer structural elements. ASTM A588 weathering steel and wide flange shapes were used to design the structural elements of the towers. However, due to the long procurement time of weathering steel W shapes, truss elements were redesigned as built-up members during the construction administration phase. The cyclic nature of loading on the towers implied that these structures be designed for fatigue. The AASHTO code was used for fatigue load calculations and even though the original tramway structure was planned to have a design life of 10 years, welds and connection plates (that were quite susceptible to fatigue cracking) were designed for the endurance limit of the welding material.

Load combinations under different wind loading scenarios viz. in-operation wind loads (wind speeds less than 65 mph) and non-operational wind loads (wind speeds exceeding 65 mph) were suggested by Von Roll for structural analysis of the system. Dan Cuoco, the retired President and CEO of Thornton Tomasetti recalls that when he was working on this project, he watched a movie where an aerial tram got stuck mid-air under high wind conditions, and he decided to add appropriate load combinations to safeguard his structure.

Construction of the tramway was completed at a cost of $5 million and service started in July 1976. In spite of the eventual completion of the subway project in 1989, the popularity of the tramway system led to it being converted into a permanent facility. The tramway currently consists of two independently moving cabins, each of which has a capacity of 110 passengers, and makes 115 trips per day.

In April 2006, almost three decades after the tramway started its operations, the tramcars were involved in an incident where they were stuck over the East River due to mechanical problems. The rescue operation of the 69 passengers trapped in the cars took almost seven hours to accomplish and the tramway operations were suspended following this incident. The Roosevelt Island Operating Corporation (RIOC) commissioned Thornton Tomasetti to examine the existing condition of the electrical, mechanical and structural systems of the tramway. In a report published by TT it was concluded that the Manhattan and Roosevelt Island Station structures that were partially exposed to the elements had suffered some wear and tear and needed minor repairs. The support towers were in good condition and capable of continuing service. The mechanical and electrical systems of the tramcars were also in good condition and expected to perform reliably. However, there was a concern that the electrical system would become obsolete in the next five to ten years and finding replacement parts could become difficult. In order to extend the design life of the tramway, TT therefore recommended the replacement of the existing electrical system with a new state-of-the-art system. RIOC recruited Pomagalski to design the new electrical system and retained TT as the structural engineer.

During the upgrade of the electrical system, Pomagalski replaced the counterweights in the Manhattan station by a fixed anchorage system to improve the speed and stability of the tramcars. This necessitated some modifications of the structural system as well. Massive bollards were built in the equipment rooms at Manhattan and Roosevelt Island stations, in order to take large tensile forces in the fixed anchorage rope system. This resulted in significantly high stress build-up in the columns and shear walls of the Manhattan station building. The shear walls therefore had to be reinforced but the columns did not require any upgrades, as they already possessed very high reserve capacity. The three trussed towers supporting the tramway did not require any reinforcement. However, the head frames on top of each tower had to be replaced with wider frames that could accommodate the new configuration of the four track ropes and the two haul ropes of the new catenary system.

Upon completion of these modifications, the tramway system is now likely to have a much longer service life. It is expected to provide the islanders with an efficient service, and offer the visitors of New York City an unparalleled view of the Manhattan skyline.

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ACKNOWLEDGEMENTS:
The author would like to sincerely thank Dan Cuoco, P.E., F. ASCE for providing valuable information and images of the Aerial Tramway project as well as sharing his various personal insights.

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