

**The Bay Adelaide Centre: Twenty Five Years of Structural Innovation**  
**Barry Charnish<sup>1</sup>, Shelley Finnigan<sup>2</sup>**

<sup>1</sup>Entuitive Corporation, 200 University Avenue, 7th Floor, Toronto, ON M5H 3C6; PH +1 (416) 477-5829; email: barry.charnish@entuitive.com

<sup>2</sup>ArcelorMittal, 1 S Dearborn Street, 13th Floor, Chicago, IL 60603; PH +1 (312) 899-3936; email: shelley.finnigan@arcelormittal.com

**ABSTRACT**

Conceptualized in the late 1980s, the Bay Adelaide Centre is located in downtown Toronto and will eventually be home to 3.2-million square feet of commercial office space in three towers, with heights of 51, 45 and 33 storeys. Arriving at this milestone required: the use of innovative structural materials – this development features the world’s first high-rise constructed using 485 MPa (70 ksi) steel, North America’s first high-rise designed using 450 MPa (65 ksi) steel, and Toronto’s first high-rise constructed using 85 MPa (12 ksi) concrete in the core; teamwork – as with any multi-phase development, a number of development, design and construction professionals have touched this project; and patience – the project has been in design and construction for more than 25 years.

Breaking new ground in the world of structural design takes more than shovels and hard hats. From this presentation, attendees hoping to bring structural innovations to their projects will learn what questions structural engineers should ask material producers; what questions they will have to answer for the owner, fellow designers and the construction team; and what other tools they should equip themselves with in order to enter smoothly into new territory. They will also get an idea of the efficiency that high-strength structural materials can bring to projects of varying sizes, as well as an understanding of the add-on effects of these savings – from logistics and fabrication, to cost.

Conceptualized in the late 1980s, the Bay Adelaide Centre is located in downtown Toronto and will eventually be home to 3.2-million square feet of commercial office space in three towers, with heights of 51, 45 and 33 storeys. Arriving at this milestone required: the use of innovative structural materials – this development features the world’s first high-rise constructed using 485 MPa (70 ksi) steel, North America’s first high-rise designed using 450 MPa (65 ksi) steel, and Toronto’s first high-rise constructed using 85 MPa (12 ksi) concrete in the core; teamwork – as with any multi-phase development, a number of development, design and construction professionals have touched this project; and patience – the project has been in design and construction for more than 25 years.



*Image courtesy Brookfield Properties*

Figure 1: Bay Adelaide Centre, view from north

## 1987-1991: Design Inception and Groundbreaking

In 1987, Markborough Properties and TrizecHahn – with services from Webb Zerafa Menkes Housden Architects, Yolles Partnership Inc. (structural engineers), and TMP / MBII Services– embarked on the development of Bay Adelaide Center, a mid-block office complex located between Bay and Yonge Streets and Adelaide and Richmond Streets in downtown Toronto. The project was designed to feature a 275-metre-tall (902-foot-tall) tower on its south end (South Tower) that consisted of 57 office floors and four penthouse mechanical and electrical plant floors; a 12-story tower that would be 148 metres (486 feet) tall on its north end (North Tower); and a public street– Temperance Street– that would be located between the two towers.



*Image courtesy WZMH Architects*  
Figure 2: Bay Adelaide Centre, South Tower  
(original design)

The South Tower was intended to be 61 storeys in height, with 57 storeys above-grade and four storeys below-grade. Intended programming included commercial office space, trading floors, a vaulted four-storey roof-top mechanical and electrical plant area, and below-grade parking and retail space. Intended programming for the 12-storey North Tower included above-grade office space and five below-grade levels of parking and retail space. The one floor of below-grade retail was intended to be a part of the Toronto underground PATH system which includes 30 kilometres (19 miles) of pedestrian access below the buildings and streets of the city's downtown core. Architectural critics expected the towers to become "instant landmarks". The product of an international design competition, Bay Adelaide Centre's South Tower (see Figure 2) featured brown granite, a glass exterior and a signature pointed roof. The building was dubbed as a welcome relief from other new buildings in the downtown core, which were called "boxes of boredom" in editorials.

Groundbreaking for the Bay Adelaide Centre took place during the spring of 1988 and later that year, a large pit was excavated on the south side of Temperance Street. By January 1991, construction crews had placed the concrete substructure, which included a three/four-storey split parking garage, the structural foundation for the tower, and the first six levels of the building's central elevator core.

Construction in downtown Toronto had been booming since the early 1980s, but by the beginning of the 1990s, things had started to cool. Vacancy rates in the commercial market had increased to 18%, making it difficult for developers to secure anchor tenants. As a result, the developers of Bay Adelaide Centre were persuaded to place the project on hiatus. Work was expected to resume in 1994 as the rental market was expected to improve, but in 1993, the \$1-billion project was stopped for good.

This left the partially completed structure, which came to be known as “The Stump” (see Figure 3), as a glaring “monument to the over-expansion of the 1980s” –words used by the same architectural critics who had fondly referred to the Bay Adelaide Centre as a welcome relief within the Toronto skyline just a few years earlier.



*Image courtesy WZMH Architects*  
Figure 3: “The Stump”

### **2006-Present: Bay Adelaide Centre’s Second Life**

During the next several years, the Markborough Properties share of the building was sold to CANAPEN Investments. TrizecHahn and CANAPEN attempted to revive the project – including once in 1999 and again in 2001 – but a poor economic climate and geo-political concerns kept the project from gaining traction. Late in 2001, the firms sold their interests in the site to Brookfield Properties, the current owner and developer of the project. The sale expanded Brookfield Properties’ footprint in downtown Toronto and allowed them to combine the site with two properties they owned along Bay Street. With this additional land, Brookfield Properties asked the design team to reconfigure the Bay Adelaide Centre master plan. As such, the south block was arranged to support two towers (West Tower and East Tower) rather than the previous single tower (South Tower), while the north block was left with one tower that was intended to be vertically expanded from the original 12 floors to 33 floors. Having three buildings, rather than two, enabled Brookfield Properties to proceed more easily with the project from a real estate financing perspective. Marginal decreases in overall height (the buildings now stood at 51, 45 and 33 storeys) permitted the projects to start with a lower threshold of pre-leased tenant space.

As a result of these events, construction kicked off again in 2006, and in 2009, the 51-storey West Tower became Bay Adelaide Centre’s first completed tower. In 2012, the design of the 45-storey East Tower was restarted and its completion is anticipated in late 2015. The development’s 33-storey North Tower is proceeding through the municipal approval process and waiting for a tenant to trigger the final design and construction. The hope is for the entire three-tower development to be finished by 2020.

### **Incorporating Innovative Structural Materials**

Working on the design of an office complex for more than 25 years represents a unique challenge. The passage of time leads to the creation of multiple designs, implementation of multiple building codes, and exploration of multiple design and material standards. More importantly, the passing of time provides opportunities to incorporate new innovative materials and designs into the project. The Bay Adelaide Centre’s design, which started in 1987 and continues today, exposed the structural team to such an experience. As an aside, the original leadership of the structural design team developed and implemented the original design with one firm, Yolles

Partnership Inc., and moved on to fulfill the re-design and implementation with the new firm, Entuitive Corporation.

The 1987 version of the South Tower was designed with a height of 275 metres (902 feet) and plan dimensions of 68.8 metres (225 feet 9 inches) by 49.3 metres (161 feet 10 inches). The structural system was proposed as a composite structural steel gravity frame with a cast-in-place reinforced concrete core. The building's reinforced concrete core was designed not only to support local gravity loads but to also provide lateral load resistance for the tower and podium. At the time, the South Tower would have been one of the tallest buildings in the world to be solely laterally-supported by shear wall resisting systems.

Throughout the development of the design, Markborough Properties and TrizecHahn were active participants as the team explored materials that could be used on the project. The developers challenged the team to not only reduce the cost of the building but to also reduce the loss in useable floor area due to the size of vertical elements, such as columns and structural walls. Rising to the challenge, the structural engineers initiated discussions with material suppliers to understand the market and what constraints existed with respect to the strength and stiffness values of basic materials (i.e. steel and concrete).

The design team also entered into discussions with the municipal authorities who were responsible for the issuance of a building permit. It was the general position of the Municipality that the incorporation of materials that were outside of the Codes and Standards had to obtain separate approvals. The approval process for the structural steel required that they obtain supplementary acknowledgement from the Canadian Institute of Steel Construction and the Canadian Standards Association. Some of this work "piggy-backed" on an approval process that was already underway in the United Kingdom and within the European community. The approval process for the concrete required support from the academic world, including the University of Toronto, Department of Civil Engineering and the Canadian Network of Excellence in High Performance Concrete. The team also consulted with English and European efforts to understand the status of the research related to higher strength concrete and issues that arose during the design.

### **High-Strength Steel: ASTM A913/A913M Grades 450 and 485 MPa (65 and 70 ksi) aka HISTAR®**

In the initial development of the structural design, the team looked at three principal options for the structural floor system: (i) conventional reinforced concrete beam and slab construction, (ii) post-tensioned concrete beam with reinforced concrete slab construction, and (iii) structural steel with composite concrete on steel deck framing. Generally, the floor framing consisted of clear span core-to-glass framing with perimeter columns of 14.5-metre (47 foot-6 inch) spans supported on columns located along the perimeter at 9-metre (29 foot-6 inch) spacing. Parametric studies were carried out for each of the schemes, with sub-schemes also being considered. Initially, the post-tensioned concrete design was selected as it required the least floor-to-floor

height for the span. The floor-to-floor height was a concern as cladding costs were significant. The original working drawings were completed to a 95% stage and sub-grade construction started on the basis of the post-tensioned concrete design. Ironically, the Client elected at this stage to switch to structural steel with composite concrete and steel deck to achieve a quicker construction completion date. The steel scheme had to be developed so as to maintain the floor-to-floor heights, which had previously received municipal approval (maximum shadowing of Toronto City Hall) and the curtain wall floor-to-floor heights, which had already been bid.

The structural engineers developed a composite truss scheme with composite concrete on steel deck (with studs). The truss was a modified warren configuration that required the mechanical system be converted from conventional rectangular ducts to a pair of round ducts as the main trunk system. The composite steel trusses were supported on the structural steel column system and concrete corbels to be constructed from the reinforced concrete shear wall core. It was on this basis that the contract documents were revised and steel bids solicited for the original tower.

The perimeter columns were considered as an extension of the high strength, reinforced concrete column developed as part of the original post-tensioned concrete scheme. To limit the intrusion of the column into the tenant space, they were limited to 350 mm (1 ft 2 in) and 1,350 mm (4 ft 4 in) in plan area. The cladding column cover was 1,500 mm (5 ft) on the perimeter. The bid documents proposed a steel box section of 350 mm by 900 mm (1 ft 2 in by 3 ft) to generally conform to the concrete scheme. The section, along with its spray fireproofing and drywall enclosure, fell within the permitted area and thus had a tolerable impact on the floor area. The column loads were estimated to be in the order of 50,000 kilonewton (11,240 kip) service load.

Though the built-up column sections met the design needs of the building, including the Owner's criteria to limit intrusion of the framing system into the tenant space, the structural engineers recognized that at more than 2,455 kilograms per meter (1,650 pounds per foot), they may not be the most economical solution. This was especially apparent given the new alternative in steel materials that had recently come onto the market: HISTAR steel. Produced by ArcelorMittal, formerly Arbed, in Luxembourg, HISTAR steel was available in not only the commonly accepted grade of 345 MPa (50 ksi), but also in yield strengths up to 450 MPa (65 ksi). Production of the material had officially kicked off in 1990, but ArcelorMittal, in conjunction with the Centre de Recherches Métallurgiques (CRM), had been performing research and development on the product for years.

HISTAR was different from other steel on the market because it was produced using a Quenching and Self-Tempering (QST) process. QST is an in-line, rapid cooling and controlled reheating method that can be applied to structural shapes (see Figure 4). It is achieved by sending the structural shape through a water bath after it has passed through the final rolling stand. The water cools the outer layers of the section, leaving the core to retain enough energy that the section can “reheat” itself from the inside out to a self-tempering temperature of 600 deg C (1100 deg F). Controlling the cooling and reheating process in such a way positively affects the material at a molecular level by allowing for the development of a fine-grain steel that has a high yield strength coupled with good toughness and weldability characteristics.



*Image Courtesy ArcelorMittal*

Figure 4: Rolled section entering QST bank (left)

Prior to implementation of the QST process for steel sections, the most efficient way to increase the material strength was by changing its chemical composition through the addition of alloying elements. Varying the chemistry in such a way could negatively affect the material’s weldability and ductility, and it was hardly a practical or economical solution, especially for heavy gage members. Thus, the introduction of QST for structural shapes was revolutionary for the world of steel production, and its availability meant it was possible for structural engineers to push the envelope even further in their design of efficient structural systems. For Bay Adelaide South, this came in the form of lighter weight, rolled sections that could support the 50,000 kilonewton (11,240 kip) service load demanded of the 350 mm by 900 mm (1 ft 2 in by 3 ft) column sections.

The newness of the material meant that it was not yet formally accepted by the Canadian Standards Association, Material Committee; or the ASTM Standard Committee. Beyond that, ArcelorMittal had been the only steel producer to invest in such a technology and therefore, if the design team used it on the project, they would have had to sole source the material. As a result, the structural engineers elected to design the project with the more common 345 MPa (50 ksi) material, including the 350 mm by 900 mm (1 ft 2 in by 3 ft) built-up sections, but they fashioned the design documents such that steel bidders were allowed to submit alternate materials and designs as part of their bid.

When steel bids were opened, two fabricators – one of them being Canron Inc. who was eventually awarded the project – with technical support from ArcelorMittal, had proposed conversion of the perimeter columns and heavier girder sections to HISTAR Grade 450 MPa (65 ksi) material. A weight savings of 25% was identified for the columns and heavy girder sections and that savings, coupled with attractive pricing and a delivery schedule compatible with the project suggested to Markborough Properties and TrizecHahn that HISTAR could be the most appropriate material

selection for the project. The developers asked the structural engineers to research the product and advise on its impact to the project. In order to preserve the project schedule – after all, steel supply, fabrication and erection were on the critical path – the team was given four weeks to perform its formal review.

The structural engineers spent the next four weeks reviewing product literature, material composition and mechanical test reports. Primary areas of concern included: steel composition at the flange and k-area for the heaviest of sections up to W360x1085 (W14x730); the yield strength of the material; the possibility of lamellar tearing problems; and confirmation that the steel did not require preheat when welding. The fabricator requested sample material from ArcelorMittal and sent it to third party testing agencies to confirm yield and tensile strengths, Charpy V-Notch values, and weldability. Representatives from the design and construction team visited the mill and met with technical and commercial staff from ArcelorMittal to gain a clearer understanding of the production process (from molten steel to rolled shape) as well as logistics of ordering steel from an overseas producer. Ultrasonic testing was carried out by third party testing agencies to complete the independent review of the material and to ensure the material would not have a heightened risk of lamellar tearing problems, delamination or piping.

With sufficient data to verify the material, the design team determined HISTAR was a feasible alternative for the project. The structural engineers put pen to paper with a redesign and found that, as anticipated, the higher strength material led to reduction of the overall building weight. At the locations of greatest demand, however, even the largest rolled wide-flange shape available still needed a little help in supporting the load. As such, the team developed an appropriate toe-plating design for these sections, and to take full advantage of the weldability of HISTAR steel without preheating, the final detailing of these toe-plated sections used wide flange HISTAR sections, split through the web into tees and welded to the flanges of the intact main member using automatic welding machines. Subsequent to the redesign, Canron Inc. officially came on board as fabricator for the project and in 1989 the first ten floors of structural steel were purchased, rolled, delivered, and fabricated. This set the stage for Bay Adelaide Center's South Tower to become the first high-rise structure in the world to incorporate HISTAR Grade 450 MPa (65 ksi) material.

It was unfortunate timing for the project, however, as construction ceased in January 1991. The fabricator stored the material for years, waiting for the project to restart, but when it finally did, the design had changed so significantly that there was no use for the South Tower's already fabricated material. As a result, it had to be sold at auction to make way for the newly designed sections of the West Tower.

In 2006, when design of the West Tower was fully underway, HISTAR steel had been an ASTM standard material for more than 13 years. The unique steel was incorporated into the standards as ASTM A913/A913M and was most readily available in Grades 345 and 450 MPa (50 and 65 ksi). The West Tower was determined to be of a similar design to the previously developed South Tower,



featuring a hybrid concrete core and a perimeter steel frame. Generally similar to the original tower, though not as tall, the building was designed using 345 MPa (50 ksi), thereby recognizing the developer's wishes to enable competition in the market. The documents were again provided in such a way that they would permit substitution of HISTAR/A913 material as an alternative. As a result, the bidders provided figures summarizing the cost savings and assurances on delivery times, and because everything fell in line with the developer's wishes, the West Tower utilized HISTAR/A913 material, though its distinction as the first building to use the material in Canada no longer applied.

In 2012, the Bay Adelaide Centre East Tower was announced as the second phase of the project. Upon completion of construction, the building will be a 45-storey tower with a podium out to Yonge Street. Similar to the West Tower, the building consists of a hybrid concrete core and steel frame. As a result of the lead structural engineer's experience with ASTM A913 material, the project was designed from the beginning using 450 MPa (65 ksi) material. And, again, during the bidding process the team was asked to work with ArcelorMittal to consider the use of a new ASTM A913 grade. Now available up to 485 MPa (70 ksi), using this alternative led to a savings of more than nine percent for the overall weight of structural steel in the building. This benefit coupled with the rigorous review of ASTM A913 material that had been done in the late 1980s, made it easy for the structural engineer to endorse the material as an alternative for the project. Fortunate for this phase of the project, construction proceeded on schedule and the Bay Adelaide Centre East Tower lays claim to being the first high-rise building in the world designed and constructed with ASTM A913/A913M Grade 485 MPa (70 ksi) material.

### **High-Strength Concrete: 85 MPa (12 ksi)**

The Owners saw that the size and thicknesses of the vertical concrete sections had a significant effect on the useable floor area of the tenant space for columns and on the rentable floor area for the concrete walls surrounding the elevator and service core. Though there was an appreciation that the vertical elements were necessary for the vertical and lateral support of the building, they considered the need to minimize the impact on the floor space as a major driver for considering alternate materials.

The key considerations affecting the development of higher concrete strength included: the availability of competent large aggregate; the availability of cement replacements to manage the heats of hydration; and a knowledge base to consider the improvement in Young's modulus, which because the concrete core had become the main lateral force resisting system of the building, was a key factor in determining the drift that would occur under wind load. It was anticipated that improvement of Young's modulus would also benefit the strength of the concrete. The pursuit of the higher Young's modulus was particularly important as a factor in reducing the wall dimensions within the core. Concrete strength was primarily important as it is generally indicative of the higher Young's modulus, though the nature of the coarse aggregate was an important contributing factor.

In order to determine the feasibility of using high-strength concrete, the structural engineers developed a program that explored a number of the most crucial properties in the material and determined a process for establishing the highest, most economically reasonable strength. The team started its exploration by discussing directly with material producers and engaging three local suppliers. The concrete manufacturers were asked to prepare a performance-based specification for the supply of high-strength concrete and provide price ranges and proof of their willingness to undertake a testing program with their product.

The testing program required the concrete suppliers to produce and store in their own yards a three-metre (ten-foot) cube of instrumented concrete (cast according to their mix design). From this cube, the supplier was to take 24 test cylinders, which were used to verify mix strength and Young's modulus. In addition, the cubes were monitored with thermocouples representing a half section along the side and the diagonal of the concrete. These thermocouples were continuously monitored for 10 days from time of pour to collect data on the heat of hydration. Other studies considered the early and long-term strength gain, workability of the concrete, and shrinkage characteristics.

The cubes were drilled at one-, three-, seven-, 28, 56 and 90-day increments to establish the in-situ strength gain and to compare it to the laboratory test cylinders. The strength gain was particularly important as the contractor was planning to construct the building core using a "jump form" system, thereby requiring the concrete to achieve a certain minimum in order for the "jump form" to be safely raised and construction to proceed according to schedule. They also felt that the progress of the strength gains had to be monitored at seven and 28 days so that if there were an issue with the concrete or a problem was overt, it could be recognized early enough so that the progress of the job would not be hampered. The construction plan was to achieve a three-day cycle in the concrete core progress when the typical floor was being built.

In addition to the field testing, the design team conducted a literature search and consulted with the Canadian Network of Excellence in Reinforced Concrete, which was supported by various universities, governments, and private sector firms to ensure the material fell in line with industry standards. The structural engineers also required that the sources of the product to be identified and availabilities catalogued for use on the project, since the mix required considerable quantities of crushed limestone as the coarse aggregate and silica fume concrete.

The pursuant suppliers agreed to the requested program and it was subsequently confirmed that pricing was in-line with the initial thoughts of the Construction Manager and the Client's pro forma. The conclusion of these efforts was the specification of 85 MPa (12 ksi) concrete for parts of the building.

As excavation at the site was proceeding, the construction logistics of the material, including time from the plant, the maximum wait time for placing, and the selection of the concrete pump system and the like were tested and modified as required.

### **Additional Innovations at Bay Adelaide Centre**

With final design of the West Tower occurring after the tragic events of September 2001, Brookfield Properties, who are also owners of high-rise buildings in downtown Manhattan, asked that a number of measures be incorporated into the design to preserve integrity of the building should it ever face a security risk. These characteristics included alternate load path design, wider exit stairs among others to support the tenants in the building. Bay Adelaide Centre, West Tower was one of the first Canadian buildings to include such precautions.

### **“The Stump”: Overcoming Challenges at the Site**

Although it relieved the pressure of moving the project forward, the reconfiguration of the master plan uncovered one problem with the use of high-strength concrete. “The Stump” which was constructed during the first 14 years of the project, was now sitting in an area slated to become a civic plaza, “Arnell Plaza”, located on the south block between the West and East Towers. For the project to move forward with its new layout, the seven-story 33.7-metre (110-foot 7-inch) structure needed to be demolished down to the first basement level. This core had been constructed with the 85 MPa (12 ksi) concrete and had been exposed, unheated, and unprotected in the urban environment for more than 15 years. The original concrete mix used fly ash and silica fume concrete and one useful, yet challenging characteristic of the material was that it exhibited great long-term strength gain.

“The Stump” was located in the middle of the financial district of Toronto, and even during the slower economic times of the 1990’s, this area was a hub of pedestrian and vehicular traffic. Demolition of the stump would prove challenging and require specialized blasting techniques to assist in breaking down the concrete. The first trial included drilling in controlled size charges and detonating them. These proved to be ineffective as well as a safety risk. The demolition contractor had secured the project on a lump sum basis so it was also their ingenuity that was at risk. Eventually, the demolition contractor decided to use a high-reach machine with a hoe ram to effectively “jack-hammer” the concrete down. The process occurred over a period of six months with jack-hammering only permitted between 7h00 in the morning to 7h00 at night.

## **CONCLUSION**

Timing seems to be everything on major construction projects with fast-track design, sequential bidding, accelerated strength-gain concrete, and three day floor cycles. It is unusual when the design and construction of a project spans a period of over 25 years, particularly when innovation has been spurred by developments in research, industry competitiveness, and vastly improved sustainable in construction, including using less material. How one responds to this time duration, with enthusiasm for change and improvement, speaks volumes about the teams that have been selected to work on this project.

A project of such an extended duration also stretches the emotional side. The structural engineers experienced the full gamut from the joy of winning a project, the first ground breaking, various value engineering efforts, the intensity of preparing tender documents, negotiating the various bid packages along with their logistic issues and the drama of the start and stop and subsequent restart of the project. Consider that at the outset of the project, Ronald Reagan and Brian Mulroney were the respective leaders of the United States and Canada, there was no publicly accessible internet and computers were much less powerful than the phones we now carry on our pockets. One can only imagine the changes that would have occurred to a person's family and career over this time span. The technical, business and emotional intensity of the Bay Adelaide Centre project is certainly much greater than that of any "normal" project. One can only guess as to what changes innovation will bring by the time the North Tower is complete. The only certainty is that change is constant and that, as design professionals, one must always be ready to embrace technical and technological change to facilitate shaping a better built environment.

The design team welcomes the challenges and the opportunities presented by the Bay Adelaide Centre project and are grateful to the Owners for their continued faith in the design team to reach out for this innovation with responsible design and due diligence on the developed research.

## **REFERENCES**

Bateman, Chris (2014). "The story of the Bay-Adelaide Centre stump." *blogTO*.  
[www.blogto.com/city/2014/04/the\\_story\\_of\\_the\\_bay-adelaide\\_centre\\_stump/](http://www.blogto.com/city/2014/04/the_story_of_the_bay-adelaide_centre_stump/)  
(Apr. 12, 2014).

Crane, David (1993). Reporter.

Hume, Christopher (1989). *The Toronto Star*, Nov. 7, B1.

### **Key Players (Original Design):**

#### **OWNERS:**

Markborough Properties / TrizecHahn Equities Limited

#### **DEVELOPER:**

TrizecHahn Equities Limited

#### **ARCHITECT:**

Webb Zerafa Menkes Housden Architects

#### **STRUCTURAL ENGINEER:**

Barry Charnish while at Yolles Partnership Inc.

#### **CONTRACTOR:**

PCL Constructors Eastern

#### **MATERIAL SUPPLIERS:**

Canron Steel, Lafarge Concrete and PCL Construction for formwork

### **Key Players (Current Design):**

#### **OWNERS:**

Brookfield Properties

#### **DEVELOPER:**

Brookfield Properties

#### **ARCHITECT:**

West Tower - WZMH Architects and East Tower - KPMB Architects /  
Adamson Associates Architects

#### **STRUCTURAL ENGINEERING CONSULTANT:**

Barry Charnish at Entuitive Corporation (all towers)

#### **BUILDING ENVELOPE CONSULTANT:**

Entuitive (East Tower)

#### **CONTRACTOR:**

West Tower – Ellis Don Construction Corp

East Tower – Brookfield Multiple Construction Corporation

North Tower – To be determined

#### **MATERIAL SUPPLIERS:**

West Tower – Walters Steel, ArcelorMittal, CBM Concrete and Structform  
for formwork

East Tower – Walters Steel, ArcelorMittal, Dufferin Concrete and LCJV for  
formwork