Case Study: Tianjin CTF Finance Centre, Tianjin

2019 Year in Review:
Another Record Year for Supertall Completions
Ban All-Glass Skyscrapers?
A Rainwater-Collecting Tall Building Façade
Impact of Tall Buildings’ Lower Public Spaces
How to Reduce Bird Strikes on High-Rises?
All-glass towers have high operational or embodied carbon lifecycle costs, contribute to climate change, and are an investment risk. They are artifacts from the 20th Century and have no place in the 21st.
Americas

City councilors in Barrie, Canada, approved the construction of a twin-tower project in the city’s downtown. The developer was granted an exception to the city’s maximum building height rules, paving the way for a pair of 32-story residential towers atop a seven-story podium.

One of Calgary’s most recognizable landmarks reopened nearly four months after an elevator plunged several stories with eight people inside. Calgary Tower officials said issues with the structure’s elevators have been addressed, and the elevators have passed inspection.

Meanwhile, in Vancouver, the Squamish First Nation plans to build a 6,000-unit residential development. Located on the reserve lands at Senâkw, the project will be Canada’s largest development on First Nations land. Elsewhere in Vancouver, a vacant 3.6-acre (1.6-hectare) site at 9905 King George Boulevard is planned to be developed. The proposal calls for four towers, including a 42-story and a 36-story condo tower, a 19-story tower with 204 purpose-built market rental units, and a 10-story office building.

The World Trade Center (WTC) brand has announced a new project in Santo Domingo, Dominican Republic. The new BlueMall Santo Domingo mixed-use complex will include two residential towers and a hotel.

Guatemala City will see two interlocking towers that share a lobby and are joined by skybridges in a project primarily dedicated to residential use. Dubbed IQ10, the towers will rise 23 stories and offer 88 residential units, with a maximum of four apartments on each level to prioritize natural light access.

The San Benito District of San Salvador will soon host a new 20-story medical tower, the Torre Humana project, which will dedicate nine of its floors to clinics.

Towers were illuminated for Catalinas Rio, a waterfront office building complex in the city’s Catalinas Norte business district. The scheme comprises retail, public green space, and two intertwined, trapezoidal towers.

On the US West Coast, new imagery and details have been released that highlight 8850 Sunset Boulevard, a 15-story mixed-use project slated for development on the Sunset Strip in Los Angeles. On the site of The Viper Room nightclub, the proposed 369,000-square-foot (34,281-square-meter) building would accommodate both a residential tower and a hotel in addition to public amenities. Plans for a 31-story tower in downtown Los Angeles, near the landmark Grand Central Market at 340 South Hill Street received initial approval from a Los Angeles City Council committee. The tower would sit directly over an entrance to the Pershing Square Metro subway station at the northeast corner of Hill and Fourth streets, where the Historic Core and Bunker Hill meet.

Designs were revealed for a planned development in the Mission Bay neighborhood in San Francisco. It will span a 28-acre (11-hectare) waterfront site that is currently used as a parking lot. Construction is slated to commence in early 2020.

Officials broke ground on what could eventually become San Jose, California’s tallest building. Located at the corner of Park Avenue and South Almaden Boulevard, and...
set to stand 300 feet (91 meters) and 19 stories, 200 Park will be finished sometime in 2023. It will be downtown’s first office tower to be built on a speculative basis in several years.

Elected officials in Salt Lake City will discuss a sales price for the Utah Theater after the city inked a deal with developers hoping to dismantle the 100-year-old Main Street venue and build a skyscraper in its place at 150–160 South Main Street. The proposed 375-foot (114-meter) tower would have retail outlets, up to 300 apartments, a mid-block walkway, and a small park.

In Chicago, developers have submitted zoning applications to the City Council, outlining plans for a pair of large office buildings at 1101 West Carroll Avenue and 400 North Aberdeen Street in the West Loop neighborhood. Plans have also been unveiled for the Tribune East Tower in the Streeterville neighborhood, which is slated to be built on a parking lot just east of the landmark Tribune Tower. If approved by the city, the mixed-use supertall could begin construction in 2022. A groundbreaking was held for Union Station Tower, also known as BMO Tower, a new 50-story office building in the West Loop neighborhood, across the street from its namesake, one of the busiest rail hubs in the country. Completion is anticipated for 2022.

Known as the “Gold Building” because of its gold-toned façade, Market Square Center in downtown Indianapolis is set to lose its distinct luster. After purchasing the 20-story office tower in 2019, local developers announced they would modernize the façade with a transparent, all-glass curtain wall, stripping the 44-year-old building of its signature feature.

Permits have been filed for a 68-story mixed-use skyscraper at 242 Hudson Street in Jersey City named Harborside 8. If approved, the 708-foot (216-meter) building would be among the tallest structures in the state of New Jersey.

In Boston, a planned South Station Tower secured initial financing. If completed, it will rise 677 feet (206 meters) above South Station, a transportation hub that is swarmed daily by thousands of rail commuters. Demolition began at the former site of the Boston Flower Exchange in the city’s South End neighborhood. The move is in anticipation of transforming the 5.6-acre (2.3-hectare) parcel at Albany and East Canton streets into a 1.6 million-square-foot (148,644-square-meter), four-building technology and life sciences campus.

As always, New York City is awash with project updates. In the Boerum Hill neighborhood, demolition was completed at 80 Flatbush Avenue at the site of an 840-foot-tall (256-meter) skyscraper. Right next door at 100 Flatbush Avenue, Alloy Development has unveiled plans to construct a sustainable mixed-use development, in which the residential portion of the tower will be 100 percent electric. Excavation and foundation work on Strata Tower at 8 West 30th Street began. Just five blocks south of the Empire State Building, it will rise 551 feet (168 meters) tall and 34 stories. The tower will yield a total of 300,000 square feet (27,870 square meters) and incorporate sheer glass walls and staggered outdoor terraces along the eastern elevation.

In Atlanta, at 1230 West Peachtree, a high-rise was approved for a site across the street from the Arts Center MARTA station. The 40-story mixed-use tower would front the planned extension of 15th Street. If realized, the development would produce 8,600 square feet (798 square meters) of ground-level retail beneath 258,000 square feet (23,968 square meters) of office space and 328 market-rate apartments. Also progressing is the 279-unit Seven 88 West Midtown, which is now under construction after securing US$105 million in financing.

Miami’s first Airbnb-branded building started rising in its downtown area. The 48-story tower, dubbed Natiivo, will have 604 units, including 412 condos and 192 hotel rooms, all of which can be rented and managed via the short-term rental company. Brickell Flatiron, a new 64-story luxury condominium tower in Downtown Miami’s Brickell Financial District, received its Temporary Certificate of Occupancy (TCO) from the City of Miami.

Asia & Oceania

Construction on Brisbane’s AU$3.6 billion (US$2.5 billion) Queen’s Wharf development is well underway. The entire complex will consist of six towers with residential, hotel, and casino/hotel uses.
Case Study: Tianjin CTF Finance Centre

Determinism, Integration, and Articulation Lead Up to a Landmark

Abstract

Completed in 2019, the Tianjin Chow Tai Fook (CTF) Finance Centre is currently the seventh-tallest building in the world, tied with the Guangzhou CTF Finance Centre at 530 meters (see Figure 1). Beginning with the circumstances of the commission, this case study describes the integrated design process, shares the creative strategies evaluated and pursued, and summarizes the innovations developed by the collaborative design team. This elegant mixed-use supertall tower is a unique form that was based on rational and thoughtful explorations of efficiency, functionality, and beauty. Reinforcing and emphatically marking Tianjin’s new TEDA mixed-use, multimodal commercial business district, the aerodynamically-shaped form, curving sloped column system, and visually powerful envelope combine to define a new generation of landmark tall buildings.

Keywords: Mixed-Use, Transit-Oriented Development, Wind Engineering, Supertall

Location and Context

Tianjin is one of China’s largest cities, connecting the national capital region to global trade networks. The Beijing-Tianjin high-speed rail line, inaugurated in 2008, links Beijing with several places in and around Tianjin, extending southeast through the city’s core to the Binhai New Area, and reducing travel time to Beijing to approximately one hour. A metro line also connects Binhai with Tianjin’s core, stitching the area more closely into the larger Beijing-Tianjin urban fabric (see Figure 2).

The Tianjin Economic Technological Development Area (TEDA) was established in 1984, and together with the adjacent Yuyiapu CBD, have addressed growing needs for office, research, and residential space in Binhai. The Central Government has set sustainable design principles that guide developments with urbane street and open space networks, less resource-intensive development, and improved quality of design and construction for urban development in the country.

Tianjin CTF seamlessly integrates residential, office, hotel, and retail programs into a mixed-use, dense, walkable urban complex with excellent transit connections. The design and engineering team’s approach—to develop a solution that elegantly integrates a diverse program—demonstrates a method that not only makes multi-program supertalls possible, but meets and exceeds the guidelines shaped by the government to build a sustainable urban future.

Design Challenge

The architecture team was asked by the owner to work on the project after another international architectural and structural design team had proposed a scheme that the owner had been unhappy with—it was costly, viewed as slow to construct, and visually underwhelming to the chairman. Aware of the challenge to satisfy the last issue of creating something that inspired, the team presented a typology of tower forms in small models and diagrams, which addressed the relevant issues of building tall mixed-used structures.

The primary challenge for the design team was to create a tower that integrated three distinct program elements, in a form that was both rational and evocative. Each of the program elements—office, residential, and hotel—have very different dimensional

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Inho Rhee received his Bachelor of Arts in Architecture with Highest Honors from the University of California, Berkeley in 1976 and his Master of Architecture with Commendation from Harvard University Graduate School of Design in 1978. After practicing in the SOM San Francisco office for 28 years, he joined the Chicago office in 2007.

Thomas Kinzl is responsible for the technical coordination and development of projects through the construction administration phase, organization of the construction documents and communication between client, contractors, and consultants. Kinzl is also responsible for the management of architectural project teams, deliverables and monitoring, and implementing current trends in building technology.

Inho Rhee collaborates and develops design concepts in conjunction with the design partner. He is responsible for the project design and for the leadership of the project team. Rhee implements and directs the design strategy of a project and is responsible for the project’s adherence to the design intent.

Ronald Johnson works under the direction of the structural engineering partner and is responsible for the design and documentation of structural engineering projects. He collaborates with the architectural design team to incorporate a structural engineering system which is compatible with the project’s planning and architecture and other required systems.
requirements for space planning and access to natural light. Key to the design work was recent research on, and experience with other tall buildings that demonstrated the effects of wind loads on structural performance. The effects of lateral forces due to wind and vortex shedding was well known to the design team.

The architects and engineers collectively studied tapering and softened forms that performed well in wind tunnel tests and optimization programs. In the end, the clear choice for development was the tapered, round-cornered, and scalloped form—a lyrical massing that seemed to easily distinguish itself from the other rectilinear, faceted, or angular articulated towers that were familiar to the experienced client (see Figure 3).

Working from the bottom up and from the core outward in a core-to-envelope approach, the sinuous topographic expression of the exterior envelope reflects the integration of disparate programs within a singular smooth object. This expression is optimized to accommodate the relationships between the different leasing spans, the varying structural core widths, and the
Façades

Development and Testing of a Tall Building Façade System to Collect Rainwater

Abstract
The key objective of this research was to devise and test a vertical rainwater harvesting system and demonstrate that the rainwater could be collected off building envelopes in sufficient quantities, and then cycled into the buildings’ water systems. While tall building envelopes have traditionally been designed to prevent water infiltration, this study proposes a building envelope system to allow for “controlled water leakage”, transforming into a channel to catch desired rainwater, as well as a barrier to unwanted water infiltration. Weather data were collected for six major cities around the globe experiencing a water crisis, and in which the tall building is the principal building type in the central districts, to determine the optimum building orientation based on normal and average amounts of rain per event. Next, buildings of varying heights were digitally modeled, simulating rain events for each city and the resulting rain volumes. Finally, water-droplet size, adherence, cohesion, filming and streaming of rainwater on building façade were studied, using rainwater performance simulation.

Keywords: Façades, Rainwater Harvesting, Tall Buildings, Sustainability

Introduction
For most of history, buildings have been constructed using the exterior wall as the main structural system. Advancements in steel and reinforced concrete allowed the structural system to be independent of the façade and recede behind the envelope. The exterior walls were then allowed to be much lighter, and thus non-load-bearing. With this advancement, buildings such as the Crystal Palace, London (1851), and the Kaufhaus Tietz, Berlin (1901), used large glass façades in lieu of masonry walls. The Bauhaus movement started to incorporate the idea of a modern curtain wall, consisting of Mullions and glass; the same idea predominates in much of contemporary high-rise design.

Curtain wall construction has always been concerned with water and moisture. The materials used in the system are heavily dependent on how well they withstand corrosion and water accumulation. Modern curtain walls use an array of sealants, gaskets and flashing to prevent such issues. Watertight construction is integral to the life of the façade system and the overall building.

Understanding Tall Building Pressures
Tall buildings experience an immense amount of pressure on their envelopes, as well as on the interiors. Known phenomena, such as the “stack effect,” give mechanical engineers headaches in their task to balance the interior pressure loads within the building. Failure to do so results in lobby doors being difficult to open, as well as infiltration and exfiltration of moisture. In addition, wind loads on buildings increase pressure on the exterior envelope, and on the building as a whole. As wind hits the façades of buildings, its velocity is abruptly exchanged for an increase in pressure, pushing on the building façade. When an obstructing building impedes the wind, it will cause increased pressure on the face of the building. However, while the wind may...
stagnate on the windward side, it will most likely increase in velocity along the sides and top of the building. In these areas, the pressure will be reduced, thereby causing a suction or pull on the building façade. The diagrams in Figure 1 depict wind patterns and their pressure in cases where wind hits the building head-on and at an angle of approximately 45 degrees. Negative and positive pressures are also represented.

Proposed Design

This research proposes a system to collect the rainwater off the vertical surface of tall buildings. The curtain-wall sections depicted in Figure 2 include mullion-less assemblies. These types of non-protruding mullions are essential to the success of the rainwater collection system. They provide a smooth, unimpeded surface that will allow the rainwater to adhere, as well as maintain a streaming film of water on their surface.

Figures 3–5 illustrate this system as used in physical simulations. The uppermost hopper is the water delivery assembly that was designed to create rain streaming on the vertical surface. A garden hose connects to the rear of the hopper to fill it. As shown in the diagram, the film flow moves downward

Figure 1. Illustration of wind effects on and around tall buildings when striking the façade at 45 degrees (top) and 90 degrees (bottom).

Figure 2. Mullion-less window assemblies, sectional view (left) and plan view (right), which serve as the base model for the experiments.

Figure 3. Elevation (left), section (middle), and axonometric (right) views, of the experimental assembly designed to siphon water accumulating on the exterior surface of the façade into a water collection system.
Tall Buildings’ Lower Public Spaces: Impact on Health and Behavior

Abstract

Tall buildings unquestionably need to improve their impact on the urban habitat. A human-focused approach to measuring the social impact of tall buildings’ ground conditions, i.e., public space and interface, has been applied in three CBDs of Asian megacities facing similar problems: Shanghai, Hong Kong and Singapore. Specifically, typical patterns and categories of lower-level public spaces among the three CBDs were abstracted via typological analyses and field studies. Evaluations of social impacts were achieved through statistical surveys, wearable devices and virtual reality environments. The study revealed the quantitative relevance between tall buildings’ lower public spaces and their social effects. The findings of this study could support more efficient place-making and promote better social benefits around tall buildings’ ground planes. The research also suggests a design code for tall buildings aimed at a more human-oriented urban habitat.

Keywords: Urban Habitat, Ground Plane, Tall Buildings, Urban Design, Urban Planning, Spatial Analysis

Introduction

Designing tall buildings as participating components of the urban habitat, rather than as objects that stand aloof from their environments, has become an important concern. Evidence shows that positive behaviors encouraged by high-quality public spaces, e.g., social interactions and physical activities, may contribute to physical, mental and social well-being (Evans 2003). As public space is crucial to people’s quality of life, there is strong justification for further studies on the most essential and urban parts of tall buildings, i.e., public spaces, podiums, and the interfaces of tall buildings with their environments, from the ground plane up to the fifth floor, referred to here as “lower public spaces.”

Nevertheless, the lack of quantitative understanding cannot support efficient architectural design or urban renewal targeted at better place-making. Aiming to fill this gap, a human-focused approach for measuring the social impact of tall buildings’ lower public spaces has been applied. The stated preference (SP) survey is suitable for complicated scenes, in which observed behavior is inadequate and is thus widely applicable to high-density built environments (Ulrich et al. 1991). Three more approaches are used to compensate for the shortcomings of the SP survey. First, virtual reality (VR) techniques are introduced to compensate for the inability of SP to illustrate the complex features of the high-density built environment in social interaction (Schofield and Cox, 2005). Second, the analytic hierarchy process (AHP) is introduced to simplify the process of an SP survey faced with numerous features (Lo et al. 2003). Besides, exploratory data analysis (EDA) was used to evaluate lower public spaces’ impacts on participants’ health. The results were used to verify the discrete choice model. The combined application of SP, AHP, VR methods, and biometric data will help to achieve a systematic and objective evaluation of perception-based and behavior-oriented studies of the built environment.
Methodology

Analytical Framework
First, three central business districts (CBDs) of Asian megacities were selected as cases: Shanghai, Hong Kong and Singapore. All three CBDs are facing similar problems because of the lack of urbanity around tall buildings at street level. Typical patterns and categories of lower-level public spaces among the cases were abstracted via typological analyses and field studies. The following evaluations on social impacts were achieved through the AHP via expert rating and SP survey. Virtual reality techniques were applied in the SP survey to create an immersive, three-dimensional environment for illustrating different combinations of spatial patterns. People’s perceptions and personal preferences were collected as representations of social performance. Data collected from interview and biometric sensors were used to verify the results of the SP surveys. After that, the discrete choice model was used to run statistical analyses.

Finally, the assessment of tall buildings’ lower public spaces was established and applied to three study areas. Finally, a total of 171 participants were invited via the Internet. Sixty-four participants were male and 107 were female. Most participants had no prior VR experience.

VR Scene Design
The simulation of real experience was crucial for spatial evaluations in the VR environment. The more a representative model resembles the real environment, the more reliable participants’ responses are (Kuliga et al. 2015). The basic scenario of this research was selected from the typical features of the three CBDs.

Tables 1 and 2 present some built environment features collected from the three CBDs. Based on those data, the basic scene included six blocks with a width of 212.8 meters. Each block had four tall buildings. The buildings’ basic volume was 40 x 40 meters, and the building spacing was 10 meters. Road facilities and signs, including street lamps, traffic signals and traffic signs, etc., were placed to increase the realism of the scene. To simulate a real pedestrian experience, public spaces’ models in each scene were placed in pairs on participants’ left and right sides. By observing a panoramic video in the VR environment, participants were asked to state their preferences between the two models (see Figure 1).

<table>
<thead>
<tr>
<th>CBD</th>
<th>Block Length (m)</th>
<th>Sidewalk Width (m)</th>
<th>Street Width (m)</th>
<th>Building Length (m)</th>
<th>Building Spacing (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lujiazui</td>
<td>160–220</td>
<td>6–13</td>
<td>4–8 Lanes</td>
<td>45–75</td>
<td></td>
</tr>
<tr>
<td>Central</td>
<td>80–100</td>
<td>2–6 Lanes</td>
<td>15–60</td>
<td>15–60</td>
<td></td>
</tr>
<tr>
<td>Marina Bay</td>
<td>150–200</td>
<td>3–18</td>
<td>4–5 Lanes</td>
<td>30–60</td>
<td>8–12</td>
</tr>
</tbody>
</table>

Table 1. Typical features of built environment in three CBDs.

<table>
<thead>
<tr>
<th>Case</th>
<th>IAPM Shanghai (Lujiazui)</th>
<th>Shanghai Center (Lujiazui)</th>
<th>K11 Shanghai (Lujiazui)</th>
<th>Pacific Place (Central)</th>
<th>C-03 (Central)</th>
<th>C-111 (Central)</th>
<th>C-67 (Central)</th>
<th>M-04 (Marina Bay)</th>
<th>M-36 (Marina Bay)</th>
<th>M-39 (Marina Bay)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Footprint (m)</td>
<td>155x65</td>
<td>90x60</td>
<td>86x53</td>
<td>220x50</td>
<td>90x75</td>
<td>60x25</td>
<td>70x30</td>
<td>132x50</td>
<td>80x80</td>
<td>72x63</td>
</tr>
</tbody>
</table>

Table 2. Typical features of tall buildings with podium public spaces.

Figure 1. Part of the experimental scene in the VR simulation. Spatial attributes were added and removed, and participants’ reactions scored and recorded.
Evaluating the Modal Response of Linked Tall Buildings

Introduction

Worldwide, the height of tall buildings is rapidly increasing to address urban densification. This has resulted in architectural, programmatic, and developer concerns about accessibility in tall urban environments. Urban planners are seeking ways to improve not only everyday accessibility, but also community connectivity and emergency egress. To address this concern, connecting tall buildings to each other through skybridges is increasingly being considered (Wood, Safarik 2019). However, such elements introduce complexity to the structural system. To minimize this complexity, the bridges are often structurally “decoupled” from one or both towers using sliding bearings. While mitigating the structural dynamic complexity, this common approach has removed the potential of structural dynamic enhancements between coupled towers.

Building Designs

The reinforced-concrete buildings considered in this study are based on the structures in Taraldsen’s study with a number of modifications. Firstly, the central core was enlarged to be more representative of a modern tall building design. Secondly, to understand how the dynamics could be affected at a more general level, the tall buildings considered here are of two different heights. Lastly, to focus the attention on the rigid link, the structural systems are linear and equipped with specific material properties.

Table 1. Structural details of Tower 1 (T1) and Tower 2 (T2) used in the research.

<table>
<thead>
<tr>
<th>Story</th>
<th>Column (cm)</th>
<th>Beam (cm)</th>
<th>Shear Wall (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tower 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40–45</td>
<td>70 x 70</td>
<td>50 x 70</td>
<td>40</td>
</tr>
<tr>
<td>32–39</td>
<td>80 x 80</td>
<td>50 x 70</td>
<td>70</td>
</tr>
<tr>
<td>22–31</td>
<td>90 x 90</td>
<td>50 x 70</td>
<td>100</td>
</tr>
<tr>
<td>15–21</td>
<td>120 x 120</td>
<td>60 x 90</td>
<td>120</td>
</tr>
<tr>
<td>7–14</td>
<td>150 x 150</td>
<td>60 x 90</td>
<td>150</td>
</tr>
<tr>
<td>1–6</td>
<td>180 x 180</td>
<td>60 x 90</td>
<td>180</td>
</tr>
<tr>
<td>Tower 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25–30</td>
<td>70 x 70</td>
<td>50 x 70</td>
<td>30</td>
</tr>
<tr>
<td>19–24</td>
<td>80 x 80</td>
<td>50 x 70</td>
<td>50</td>
</tr>
<tr>
<td>12–18</td>
<td>90 x 90</td>
<td>50 x 70</td>
<td>70</td>
</tr>
<tr>
<td>7–11</td>
<td>120 x 120</td>
<td>50 x 70</td>
<td>90</td>
</tr>
<tr>
<td>1–6</td>
<td>150 x 150</td>
<td>50 x 70</td>
<td>120</td>
</tr>
</tbody>
</table>

Abstract

Aesthetic characteristics, new materials, structural configurations, and construction technologies are pushing the boundaries of the built environment. At an urban scale, planners are increasingly considering inter-connected tall buildings with skybridges to address a growing need for accessibility between residential and commercial buildings. However, this demand is not only introducing complexities to buildings’ exterior features and height, but also to their structural dynamic behavior, especially when rigidly connected. To date, there is limited work on these inter-connected structures and the effects of their combined behavior. This paper investigates the dynamic response of two prototypical tall building patterns, connected via a skybridge, idealized as a beam having different stiffness. This study uses 3D finite element analysis models to examine the modal shapes and participating mass ratios between individual buildings and the linked building systems.

Keywords: Skybridges, Finite Element Analysis, Modal Analysis, Wind Loads, Seismic Loads

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In both structures, each story was loaded with additional weight due to the reinforced-concrete deck of each story (the 3D models consist only of the central core, the columns and the beams). These towers were modeled using SAP 2000 (CSI, 2018).

The taller of the two structures, Tower 1 (T1) is a representative office building with 45 stories and a height of 184 meters (see Figure 1). The framework of such a tower is made up by a core structure form, in which the gravity and horizontal loads are carried by a slab supported at each level by a single core and perimeter columns (rigid core plus moment-resisting frames). The cross sections of the columns change with story height, with the largest sections in the lower stories, and follow the strong column/weak beam design approach. The big central core follows the same rule, with the core thickest in the lower floors and thinnest at the top (see Table 2). Furthermore, for a realistic design, the first-story height was doubled to 8 meters, to create a tall lobby, with all other stories remaining at 4 meters’ height.

Tower 2 (T2) is a representative residential building, which has 30 stories and a height of 124 meters (see Figure 2). The framework of this tower is the same as that of Tower 1, i.e., it is made up by a rigid core plus moment-resisting frames. Therefore, T2 exhibits a similar distribution of structural elements, with some size variations and a different height from T1 (see Table 1). Here again, the first-floor height was doubled to 8 meters to create a tall lobby, with all other stories being 4 meters high (see Figure 2).

Lastly, the linkage is modeled using a beam 30 meters long, which is representative of a coupled connection between buildings on opposite sides of a street. In the first case, the link is placed between two identical Tower 2’s (see Figure 3); whereas in the second case, it connects Tower 1 to Tower 2 (see Figure 4). These patterns produce two situations that might occur when buildings are connected. The twin-tower system (TTS) describes a well-ordered scenario, in which the link can be realized in a symmetric position and the buildings have almost the same masses, heights and footprints. However, these conditions are not always a given; therefore, any change to the model increases the computation time needed to process any variations. In the second case, which is, in fact, representative of such a disorder, two completely different towers are linked together in an asymmetric configuration. This second building system, the twin-tower/asymmetric (TTA) system, is doubtless more realistic than the first one, but in order to better understand how the behavior of such structures changes, it is fundamental to compare a simple pattern to one that is more complex.
Abstract

The Council on Tall Buildings and Urban Habitat has released its annual report, CTBUH Year in Review: Tall Trends of 2019, part of the Tall Buildings in Numbers data analysis series. The report shows that 126 buildings of 200 meters’ height or greater were completed in 2019, including 26 “supertall” buildings of at least 300 meters’ height, a new record.* The total number of supertall buildings worldwide is now 170. In 2013, there were 76 buildings 300 meters or higher worldwide; in 2000, only 26. The 530-meter Tianjin CTF Finance Centre in Tianjin, China was the tallest building completed in 2019 (see Figure 1).

Note: Please refer to Tall Buildings in Numbers—The Global Tall Building Picture: Impact of 2019 in conjunction with this paper, pages 50–51.

*The study sets a minimum threshold of 200 meters’ height because of the completeness of data available on buildings of that height.

Keywords: Skyscraper Completions, Supertalls, Construction Trends, Economics, Statistics, Urbanization

Introduction

The year 2019 was remarkable for the tall building industry, as it saw 26 supertall buildings (300 meters or taller) completed, the most in any year. This is the second year in which this record was established, besting 18 supertalls in 2018. It was also the sixth year in a row that at least one 500-meter-plus building was completed (see Figure 2). Overall, 126 buildings of at least 200 meters were completed in 2019, compared to 146 in 2018, a 13.7 percent decline. This is the first year in which the overall completion figure declined since the 2010 to 2011 gap, which was attributed to the lag effect of project cancellations due to the 2008 recession. The tallest building to complete in 2019 was the Tianjin CTF Finance Centre, at 530 meters (see Figure 1). It is now tied for the third-tallest building in China with its sister tower, Guangzhou CTF Finance Centre (also 530 meters) and is the seventh-tallest in the world. This marks the fifth year in a row in which the tallest building to complete is in China.

Key Worldwide Market Snapshots

The 126 completions figure was within the range predicted by CTBUH at the end of 2018 (120 to 150), albeit near the lower end. China completed 57 of these buildings, representing 45 percent of the total. This is also a decline from 2018, when 92 buildings representing 63 percent of the total were completed in China. Asia (excluding the Middle East) overall contributed 87 of the 126 completions, for a 69 percent share; down from 110 completions for a 75.3 percent share of 2018’s total (see Figure 3).

The United States was again the second-most prolific country, with 14 completions, for 11 percent of 2019’s total. The number was equal to 2018’s total, though the percentage represented was lower. North
Notes:
1. We can predict 2020 building completions with some accuracy, due to projects now in advanced construction. A range is given to acknowledge the challenging factors in predicting completion dates.
2. Totals after 2001 take into account the destruction of the World Trade Center Towers 1 and 2.

Figure 2. Main chart: Number of 200-meter-plus buildings completed in each year from 1979 to 2019, with a 2020 projection. Inset: Total number of 200-meter-plus buildings in existence at decade’s end, from 1930 to 2019, with a 2020 projection.

America represented 20 of the completions, or 15.9 percent of the world totals, compared to 16 of 2018’s completions, or 10.8 percent (see Figure 4).

It was followed by the United Arab Emirates, with nine completions, down from 10 in 2018. The Middle East overall recorded 11 completions, down from 13 in 2018.

Malaysia and India tied at seven completions; and the Philippines had five. In 2018, Malaysia also recorded seven completions, India had zero; and the Philippines had one completion (see Figure 5).

At the city scale, Shenzhen, China was once again the world champion, besting its own record for the fourth time in a row, with 15 completions, compared to 13 in 2018.
The Global Tall Building Picture: Impact of 2019

In 2019, 126 buildings of 200 meters’ height or greater were completed. This was a 13.7 percent decrease from 146 in 2018. The total number of 200-meter-plus buildings worldwide now stands at 1,603, up from 1,477 in 2018. This is a 163 percent increase over 2010, and a 519 percent increase from 2000, when only 259 such buildings existed. Asia continued to be the most dominant region in terms of skyscraper construction, however, China’s relative influence has waned somewhat. For more analysis of 2019 completions, see “CTBUH Year in Review: Tall Trends of 2019,” page 42.

World’s Tallest Building Completed Each Year

Starting with the year 2004, these are the tallest buildings that have been completed globally each year.

The Average Height of the Tallest Buildings

Tianjin CTF Finance Centre, at 530 meters, the tallest building to complete in 2019, is tied for seventh-tallest building in the world with its sister, Guangzhou CTF Finance Center. 26 A record number of supertall (300-m+) buildings completed in 2019. Algeria and Africa got a new tallest building: The Great Mosque of Algiers (265 meters).
World’s Tallest 100: Analysis
A plurality of the world’s tallest 100 buildings are located in Asia, have a mix of uses, and employ composite structural systems.

Number of Buildings Entering the World’s 100 Tallest by Year
A total of 17 buildings entered the global 100 Tallest list in 2019, just below the 2011 record of 18.

Of the 126 200-meter-plus buildings completed in 2019, seven were 265 meters tall, the most common shared height. 377 The average height in meters of the 20 tallest buildings completed in 2019. All eight of the buildings over 200 meters completed in Chongqing were in the same complex, Raffles City.
I was interested to learn that thyssenkrupp Elevator (TKE) hired an architect to be the CEO of its MULTI effort. What do you think that experience brings to the table?

It was a mutual feeling. TKE was very keen to get an architect on board, and I was already a big fan of MULTI (see Figure 1). I was the one signing the first letter of intent (LOI) on the East Side Tower, Berlin project, on behalf of OVG Real Estate (to be the first MULTI customer). But the design changed massively, and it no longer made sense for this to be the first use case. So, we disengaged, and then I was on the other side of the table.

As we came up with the next project, we came to realize, “architects are best at talking to architects.” Even in my previous positions as a CEO of development companies, I had probably come to know 60 or 70 of the world’s top 100 architects, personally. And that gave me a little bit of a head start when I came to work for TKE. They realized that the old-school elevator salesforce, with the brochure under their arms, going to an architect, doesn’t make sense anymore. I was throwing those guys out of my office, because I didn’t want to know what the machine was; I wanted to know what it could do for my building.

So, if the normal design and construction process has 10 phases, an elevator company will usually come in roughly at phase six or seven. With my experience and connections, I can come in at phase one or two. It’s not that I am trying to avoid the tendering process. We will still have to meet the market price, but we can collaborate from the start with the architects and design in a productive way.

How have your interactions with architects been since taking on this role?

I’ll give you an example. I met with Helmut Jahn last year at the 2018 CTBUH Tall + Urban Innovation Conference. I’ve known him for, I don’t know, decades. We were sitting in his office and he jumped off his chair and said: “You know what, I have never designed a core.” I said, “What do you mean, you never designed a core?” He said: “Yeah, well, it’s boring. I mean, it’s determined by the authorities, given the size of the staircase, and by you guys when you design the elevator. So, what is left for me but flooring and lighting? Boring!”

The thinking of an architect is not to design the building around an elevator shaft, nor...
Manufacturing is outsourced?
It is completely outsourced. It’s a supply chain—which is also something this company was not used to. It was one of my preconditions when I started. Before I signed, I said, “I will not produce it! I don’t want to have any production in my portfolio. I am not measuring my quality by the number of heads I am employing. I need a flexible ‘speedboat.’ That’s the only way an individual product can survive in this market.

How would one go about finding people to produce something that hasn’t been made before?
We created a purchasing department, but we structured it in a different way. I’m not looking for companies I can squeeze. I could never have the best people for specific problems in my company unless I specialize in those issues. So, when it comes to the powertrain for example, there’s a company that does nothing but that. Why would I think that I could hire powertrain people and do better than that? They’re always working on the next version, because that’s what they do, and they need to stay on top of the market to survive. And you can say the same thing for doors, optical sensors, and all the other parts. We have wonderful brake experts here, but are they better than specialized companies in the market? I don’t know. I would like to question it.

It seems almost like you’re approaching this as an architect with a good specifier on staff—orchestrating, but not necessarily getting down to the details, just developing the confidence that the individual parts are being supplied by people at the top of their game, which requires a lot of research up-front, but it smooths the path later. Yeah, and I think the job description of successful and modern architects has changed massively. Still 50 to 60 percent of the job is being creative and designing. But the rest is networking, and knowing who does everything best. This is what people like Bjarke Ingels do in a fantastic way. His network is outstanding. And it includes the developers. He can easily get people on his side, because he’s such a personality. And being a personality is meeting people at the end of the day.

So, what was next for building the team and the product?
The next thing I did was ask for a list of all the people they wanted to fire. They said, “you’re crazy!” But I submitted that these people are capable of something, or they would not have been at the company for so many years. I said, “give me those people you think you can’t discipline; who are just crazy, who don’t respect hierarchy—I need those people!” And they did! I felt at first like I had a bunch of orphans. But after two or three months, they learned they could act freely, that I would listen to them, and would respect their expertise. Of course, you cannot lead such a team in a hierarchical way. You have to prove yourself every single day. Your business card means nothing. I’ve done this for a living for a long time, and for me it is so fun; but I realize for some it would just be a nightmare.

How has this decision gone over?
It was very much against the established corporate culture, but it is working. I put a young lady in charge of sustainability, and there was a lot of shouting that she was too young. But she was burning for this stuff. There is no point talking about sustainability after we have already designed the machine. I need her to really push the engineers and get them to take sustainability seriously. There are so many characters like that in the office now—it’s a good thing.

“‘When I took the job, I said, ‘Give me those people you think you can’t discipline; who are just crazy, who don’t respect hierarchy—I need those people.’”
About the Council

The Council on Tall Buildings and Urban Habitat (CTBUH) is the world’s leading resource for professionals focused on the inception, design, construction, and operation of tall buildings and future cities. Founded in 1969 and headquartered at Chicago’s historic Monroe Building, the CTBUH is a not-for-profit organization with an Asia Headquarters office at Tongji University, Shanghai, a Research Office at Iuav University, Venice, Italy, and an Academic Office at the Illinois Institute of Technology, Chicago. CTBUH facilitates the exchange of the latest knowledge available on tall buildings around the world through publications, research, events, working groups, web resources, and its extensive network of international representatives. The Council’s research department is spearheading the investigation of the next generation of tall buildings by aiding original research on sustainability and key development issues. The Council’s free database on tall buildings, The Skyscraper Center, is updated daily with detailed information, images, data, and news. The CTBUH also developed the international standards for measuring tall building height and is recognized as the arbiter for bestowing such designations as “The World’s Tallest Building.”