CTBUH Journal

International Journal on Tall Buildings and Urban Habitat

Tall buildings: design, construction, and operation | 2015 Issue I

Case Study: Bosco Verticale, Milan

When Buildings Attack: Mitigating "Death Rays"

Frankfurt and Rotterdam: Skylines Comparison

Sustaining a Historic High-Rise Structure

A Year in Review: 2014 Sets All-Time Records

Talking Tall: Kees Christiaanse

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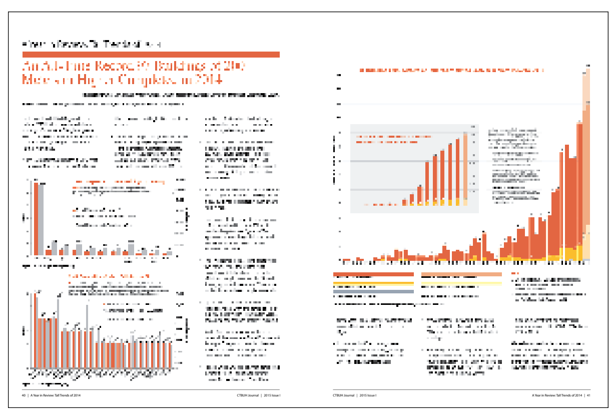

"Increasingly complex geometries in buildings, in concert with a more elaborate palette of exterior materials, have exacerbated the effect of reflected light from glazed buildings."

Vicente Montes-Amoros, page 20

Global News

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Americas

The last few months of 2014 saw intense skyscraper activity on both the east and west coasts of North America and some major fireworks out of the US Midwest.

For decades, **Miami** has been the gateway for Latin American investors looking to grab a foothold in the city's established high-rise condominium market. But recently, more mixed-use projects have come to the fore. In November, it was announced that the **Worldcenter,** a multi-building project downtown, would include a 60-story condo tower embedded in a three-level shopping mall that would span three city blocks. A 285-meter office/hotel/residential tower called the **World Trade Center of the Americas** – which would be the city's tallest building if constructed – has been proposed for the popular Biscayne Boulevard strip. Meanwhile, the billion-dollar complex at **Brickell City Center** topped off the first of six towers, a 40-story hotel, in December – and significantly, the money is coming from Asia rather than Latin America. The project is being developed by Swire Properties of Hong Kong.

Up the coast, **New York** continues to be an isle of surprises and superlatives. Construction began on the 70-story **15 Hudson Yards,** the first of a group of residential towers in the US$20 billion megaproject being built over rail yards that will transform the city's post-industrial West Side. Just across the street, the substantial **Manhattan West** project announced the completion of its innovative platform over the tracks at the throat of Penn Station, upon which a public space between two skyscrapers will be constructed. In addition to the formal opening of **One World Trade Center** with the arrival of anchor tenant Conde Nast, another Manhattan megasite got some good news, as **3 World Trade** Center resumed construction upon securing sufficient leases and a mortgage to support the issuance of US$1.6 billion in bonds. In Midtown, the planned **One Vanderbilt** tower got a height boost from 441 to 461 meters, which would put a new spin on the superslim skyline now rising in the area.

World Trade Center of America, Miami. © Arquitectonica

15 Hudson Yards, New York. © Related

Chicago, America's skyscraper city on the "third coast" of Lake Michigan, had more than enough spectacle to compensate for the final demise of the **Chicago Spire** project when its developer missed a critical deadline for preventing the property from reverting to a creditor. In November, daredevil **Nik Wallenda** brought a worldwide TV audience to the Chicago skyline when he tightrope-walked between the Marina City and Leo Burnett buildings across the Chicago River at a 15-degree angle, only to immediately cross between the two Marina City towers blindfolded. In December, as if in response to the crushed ambitions for the Chicago Spire, a hugely ambitious three-tiered mixed-use skyscraper was proposed almost directly across the river by China's Wanda Group. The **Wanda Vista,** designed by Studio Gang, could rise up to 350 meters, placing it in the top ranks of the city's famous skyline.

Brickell City Center, Miami. © Brickell City Center

Nik Wallenda walked across the Chicago River. Source: ABC7

Wanda Vista, Chicago. © Studio Gang Architects

Torre Costanera, Santiago. © Pablo Blanco

THEY SAID

"In China and in other parts of Asia, western architects continue to perform their one-off magic, while at the same time repeating many of the urban design catastrophes of the previous century, at significantly larger scales."

Steven Bingler, architect and Martin Pedersen, architectural journalist in "How to Rebuild Architecture," New York Times, December 15, 2014.

In **San Francisco,** developer Forest City revealed plans for one of the largest projects ever to be proposed in the city, covering 1.5 hectares and offering 130,000 square meters of space. To achieve this, a special-use district will be required to raise the towers beyond the area's 49-meter height limit.

South America welcomed its first supertall (300-meter-plus) building in the form of **Santiago,** Chile's **Torre Costanera,** which finished late last year. But it may not hold the title of South America's tallest for long. Argentinian president Cristina Fernandez de Kirchner announced the awarding of a contract to build the **Polo Audiovisual of Buenos Aires,** which would become the continent's tallest at 335 meters. Construction on this project began in November and is due to complete by 2019.

Polo Audiovisual of Buenos Aires. Source: Agency DyN

Asia and Oceania

A record 74 buildings of 200 meters or higher completed in 2014 – 76% of a global total of 97 – were in Asia (see 2014 Year in Review, page 40). In keeping with this, in the latter quarter of the year, the majority of tall building news came from Asia, and within the continent, China took the lead, though there was plenty of activity elsewhere to keep skyscraper-watchers satisfied.

Construction began on **Chengdu's Greenland Tower,** designed by Adrian Smith + Gordon Gill and set to rise 468 meters with a mix of office, hotel, and shopping uses. Greenland also made the news in **Yinchuan,** where the major developer selected John Portman & Associates to design the **Yinchuan Greenland**

Greenland Tower Chengdu, Chengdu.
© Adrian Smith + Gordon Gill Architecture

Yinchuan Greenland Center.
© John Portman & Associates.

A New Urban Forest Rises in Milan

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In 2011 she obtained her PhD in building technology at the Università degli Studi di Ferrara, with an experimental thesis entitled *An Artificial Soil: the Role of Water in Green Roof Design,* which was named as the "best PhD thesis in building technology" of that year. The research analyzes the runoff regulation of green roofs through rain chamber tests and evaluates the benefits derived by application of vegetated and draining built surfaces in the urban environment.

From 2011, Giacomello has been a professor of building technology and a temporary research fellow at Iuav.

Recently, she completed a year-long monitoring research project on Bosco Verticale, funded by the 2013 CTBUH International Research Seed Funding program sponsored by Arup.

Her main research interest concerns technologies that combine plants and construction.

The Bosco Verticale "vertical forest" in Milan, Italy, takes the definition of "green skyscraper" to a new level, deploying more than 13,000 plants across 90+ species, including full-sized trees, on all façades of both its towers. The project was cited as a case study in the CTBUH 2014 Technical Guide ***Green Walls in High-Rise Buildings.*** In 2013, the CTBUH International Research Seed Funding Program, sponsored by Arup, awarded a grant of US$20,000 to a team led by the author of this paper, Dr. Elena Giacomello, which spent a year studying the Bosco Verticale, examining all aspects of its design and construction, especially the extensive plantings that give it its name. The full report will be published in the forthcoming CTBUH research report: ***Bosco Verticale: Evaluating the Promise of Vertical Greenery.*** This case study introduces the project and its many innovations.

Introduction

The Bosco Verticale in Milan supports one of the most intensive living green façades ever realized. The combination of its sophisticated plant selection, the deployment of greenery in all orientations, the structural design to accommodate the plants, and the maintenance, safety and irrigation systems, represents one of the most innovative tall building projects in recent memory.

The Bosco Verticale consists of two residential towers, 26 and 18 floors high respectively, characterized by the presence of dense vegetation along their outer envelopes (see Figure 2). There are about 13,000 plant specimens, including about 700 trees up to six meters high, on both towers.

All the plants take root in containers located on the external side of deep cantilevered terraces, which are accessible from each apartment.

Acting as an extension of the exterior envelope of the towers, the plants represent a filter between the interiors of the towers and the urban environment. From inside, the plantings offer inhabitants a special experience of their terraces, which are pleasantly shaded by luxuriant tree crowns, and a "green-filtered view" to the city, in addition to an enhanced feeling of privacy (see Figure 1).

From outside, the plants realize an urban vertical reforestation, providing several environmental and microclimate benefits particular to trees' physiology: dust

Figure 1. Planters are located on each balcony.

absorption, pollution reduction, BVOC (Biogenic Volatile Organic Compounds) production, carbon sequestering, air temperature mitigation, and air humidity all increase or improve as an effect of evapotranspiration.

As result, the envelope of Bosco Verticale is an active interface to the environment, with a special architectural quality. The dynamism of plant life, in fact, is also expressed in the combination of forms and colors that derives from the carefully selected distribution of different species and specimens, which change over the seasons and the years. The greenery of the plantings is underscored by the grey color of the exterior walls, making the plants the protagonists of an architectural story of great visual, environmental, and ultimately, societal impact.

Site Conditions

The Bosco Verticale is part of the new Porta Nuova area, an extended urban transformation of a neglected area of Milan. This 34-hectare area is completely new; before the construction of 20 towers in the last decade, it was one of the last unbuilt sites in the city. Before the Porta Nuova project began, the area was partially occupied by an amusement park; much of the remainder was abandoned, vestigial land.

In 2004, the urbanization project was approved and the available surface was arranged for a radical urban transformation, comprising an investment of more than €2 billion (US$2.51 billion) to create a mixed-business and residential district.

The new Porta Nuova project is divided into three neighborhoods: Isola, where the Bosco Verticale is located, Porta Garibaldi, and Varesine, taking advantage of its proximity to the city center.

In addition to lying about 2,200 meters from the main cathedral, excellent accessibility is provided by two nearby railway stations, two

Figure 2. Bosco Verticale, Milan. © Kristen Bucher

"The greenery of the plantings is emphasized and underscored by the grey color of the exterior walls, making the plants the protagonists of an architectural story of great visual, environmental, and ultimately, societal impact."

When Buildings Attack Their Neighbors: Strategies for Protecting Against "Death Rays"

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Some recent high-profile skyscraper designs that employ extensive exterior glass paneling have generated solar reflectivity, causing negative outcomes, such as melting plastic car parts and creating hazardous glare to neighboring buildings and nearby traffic. Solar reflectivity can also raise surface temperatures on adjacent properties and kill vegetation.

Building energy modeling can be invalidated if light reflected from neighboring buildings is not taken into account. Today, Computational Fluid Dynamics (CFD) can be used to offer an accurate and advanced study that predicts not only the location of reflected light, but also the intensity of these reflections and the related temperature increase originated by the reflected light. In this way, CFD can help designers limit solar reflectivity effects from their buildings.

> "In Singapore, solar reflectance of construction materials is limited to not more than 20%, and authorities have considered lowering that threshold to 15%."

Introduction

The undesirable designation of "death-ray building" has a basis in history. Archimedes used an array of mirrors to set adversaries' warships on fire during the Siege of Syracuse (214–212 BC). This piece of weaponry has been known as "the Death Ray" ever since. Today's death rays emit from tall glazed buildings earning them the nickname "fryscrapers."

Basic optics laws tell us that when a light ray travels in a medium and encounters a glass surface, for example, part of the incident ray is reflected and the rest is transmitted to the other side of the glass. Depending on glass characteristics, the light transmitted exhibits different ranges of phenomena such as heat-gain. Reflections produced by glass and other smooth and polished surfaces is called *specular reflection*. The reflection from rough surfaces is called *diffuse reflection*.

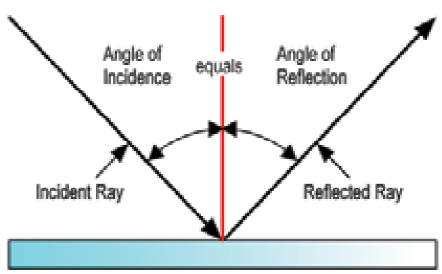

Figure 1. Reflection law. Source: Tippens, P. 2005. Physics. New York: McGraw-Hill Science/Engineering/Math.

The scope of this paper includes the portion of the incident ray that is "bounced" back to the medium and will be referred to as "reflection" from this point. Although reflectivity issues are not exclusive to glass, this paper focuses on glass due to its predominant use in contemporary architecture.

The reflected light's directional behavior is described by the reflection laws (see Figure 1):

- The incident angle is equal to the reflected angle.
- The incident ray, the reflected ray and the line perpendicular to the surface (the normal) are located on the same plane.

With advances in technology and enough computational power, these theories and principles that were developed over three centuries ago, and which constitute the basis of optics, can now be taken to a new level in the world of 3D applications.

The Demand for Skyscrapers That Sparkle

The built environment has seen an increased demand for skyscrapers that maximize views through extensive exterior glass paneling. The solar reflectivity phenomenon has generated attention lately due to the increase in heat that buildings can produce, which has resulted in significant property damage and distracting glare.

We must remember that "light" is not only that which is visible, but that it comes in the form of thermal load. Light is comprised of different components: ultraviolet (UV) radiation, visible light, and infrared. Light reflected off buildings carries all three components at different scales, based on material properties.

With the use of reflective glass, spectrally selective coatings, and advanced glazing in general, it is imperative to study solar reflectivity at a level that covers both visual and temperature increase effects in order to evaluate results on a project's surrounding environment.

Increasingly complex geometries in buildings, in concert with a more elaborate palette of exterior materials, have exacerbated the effect of reflected light from some glazed buildings. Unfortunately, many designers have limited their study of solar reflectivity by using rudimentary analytical tools that, while providing an accurate prediction of the path of reflected light, do not predict the intensity of this reflection. Such tools are limited to single ray-tracing computations and can typically be found in commercially available design software as one of many built-in functions. On the other hand, using CFD, one can accurately predict the location of reflected light, the intensity of these reflections and the theoretical temperature increase caused by light reflected off buildings.

Figure 2. London's 20 Fernchurch Street's façade reflects sun rays onto a nearby street. © Simon Price

Glare in the airspace can be also be predicted using this technique in order to comply with the civil aviation regulations for buildings and structures at or near airports. For example, the US Federal Aviation Administration (FAA) regulations require that no visual obstructions be allowed at the air traffic control tower or along aircraft's gliding slopes. Solar reflectivity is considered an obstruction of safe operations at airports. CFD can measure glare in the airspace, which is something that other tools lack today.

Legislation

The last decade has seen an increased number of adverse solar reflectivity cases, in which buildings have "attacked" their neighbors, and their owners have been taken to court. However, many of the plaintiffs have found that the solar reflectivity nuisance has little or no enforcement precedents. Not only are building codes silent on requirements for, or limits on, reflectivity; there is also no industry metric available for defining acceptable performance.

Most city building codes briefly and lightly address solar reflectivity in the same sentence as other types of nuisance such as noise, shadows, and bright paint colors. However, there are two building codes internationally that deal with this matter more categorically. In Singapore, solar reflectance of construction materials is limited to not more than 20%, and authorities have considered lowering that threshold to 15%. In Sydney, Australia, two requirements must be fulfilled; reflectivity of construction materials is limited to not more than 20% and a solar reflectivity study/analysis must be performed.

Driven by recent local events, the City of Dallas made an attempt to regulate this phenomenon. In the proposed legislation, new construction and major retrofits had the option of addressing solar reflectivity on a prescriptive or an analytical path. To qualify under the prescriptive path, building height and reflectance of construction materials were limited. The analytical path would have applied if the previous factors were not fulfilled and/or if the proposed design had convex surfaces, which concentrate light. Unfortunately, this proposal did not survive beyond the public comment phase.

Due to the lack of legislation or industry standards, this problem has not been successfully tackled in court. The cases of buildings that have produced severe damage or disputes regarding solar reflectivity have been addressed by the project's design team or developers. This was the result of a recent case in London, in which the 20 Fenchurch building's concave shape cast concentrated beams of light into neighboring streets (see Figure 2), which were strong enough to melt plastic mirrors and gaskets on cars.

Solar Reflectivity Considerations

Solar reflectivity is a common phenomenon, caused by the interaction between the reflective materials on the façades and the structures around it (Shih & Huang 2000). It can produce discomfort, and can even be a threat to motor traffic when the light is returned in the form of glare.

There are two glare types and two subtypes:

- **Discomfort glare** is caused by two subtypes:
  - **Direct glare** is a phenomenon originated from light sources that cast luminance directly into the eye's visual cone.
  - **Reflective glare** occurs when light rays bounce off a surface and luminance is perceived from the angle of incidence of the reflection.
- **Disability glare** is a luminosity level change significant enough to reduce visibility of the observer.

Most of the cases dealing with the solar reflectivity of buildings are related to discomfort glare rather than disability glare (Shih & Huang 2001).

Below are some of the factors that contribute to solar reflectivity's negative effects on the urban environment:

Frankfurt and Rotterdam: Skylines as Embodiment of a Global City

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In contrast to US cities, which allowed construction of skyscrapers in central urban areas, the post-World War II development of western Europe generally involved new construction in peripheral zones, while urban centers were mostly preserved or reconstructed to resemble their state before the war. As exceptions to the rule, Frankfurt and Rotterdam were rare European cities that adopted high-rise buildings as main driving forces for the redevelopment of their central zones. These decisions set the conditions for the establishment of the powerful metropolitan images – communicated through skylines – that these cities promote today.

Introduction

A global city is not merely a site of economic transactions, but rather a place of global imaginings (Short 2004). The idea of a "global city" itself is a crucial factor in the contemporary construction of the urban imagination, representing "… an authorized image of city success" (Robinson 2006). This idea shapes images of cities, both through creation of new symbolic meanings, and through spatial change powered by intense competition to attract new investors, citizens, and tourists.

The common image of a "global city ideal" is often expressed through the skyline, as well as through the never-ending challenge of constructing "the world's tallest building," a powerful means of waging intercity competition. Skyscrapers doubtlessly carry many symbolic meanings, as they represent economic power and status. They are also easily perceptible in the Information Age, as a form of advertising supported through different media. The predominant features of skyscrapers, such as visibility, presence, and local/global domination, as well as strict rules and requirements set forth by investors and the real-estate market, have often required the construction of such landmarks in dedicated districts, in order to make both the buildings and their districts economically feasible. Frankfurt and Rotterdam both have multiple instances of such districts.

> "Despite its status and great importance to its metropolitan image, the skyline in Frankfurt has always carried some negative connotations, although its mocking moniker Mainhattan gradually became widely accepted and turned into an asset for urban branding and tourism."

"Mainhattan": World's Smallest Metropolis

The image of Frankfurt as a city is to a large degree synonymous with the silhouette of its skyscrapers (see Figure 1). Rapid transformation from "a city with *some* high-rises" into "the city *of* high-rises" classified Frankfurt as a rarity among European cities, in that it supported a concentration of high-rises in its central zones. However, the implementation of a modern skyline in Frankfurt during the last 50 years has not been seamless. It has involved initial public rejection, as well as constant reviews, alterations, and partial realizations of broad planning concepts.

The prime high-rise cluster in Frankfurt today is located within the *Bankenviertel* (banking district), named after its predominant function. Many banks, insurance companies, and other financial institutions raised their headquarters in the zone located next to the historic center, gradually creating an unofficial urban district with loosely defined boundaries that are still expanding. On the

Figure 1. View of Frankfurt's financial district. © Norbert Naegel.

Figure 2. *Fingerplan* (1968) with *Bankenviertel* (framed in black) and zones for densification (shaded areas). Source: Müller-Raemisch, 1996: 212

one hand, these structures are the modern successors to the fortifications that used to gird the same area in medieval times. On the other hand, its spatial structure, with high-rises organized around a central green area, bears a strong resemblance to the skyscrapers surrounding Central Park in New York, if at a far smaller scale.

Becoming the City of High-Rises

The historical conditions of the development of Frankfurt's skyline were arranged after the city was passed over as the site of the postwar federal capital. Its new economic strategy was based on its long tradition in trade, banking, and industry, with the intention of becoming at least the economic capital of the country, if not of Europe. For this reason, the city

Figure 3. *Bankenplan/Clusterplan* used by the City Planning Office until 1984. Source: Müller-Raemisch, 1996.

municipality created a positive climate for development in order to attract investors, which is now recognized as one of the main preconditions for the commencement of the early skyline. The first generation of high-rise buildings, reaching up to 70 meters, began to emerge during the 1950s, taking modest-sized, contemporary American and classical pre-war German Modern buildings as their role models (Alexander & Kittel 2006).

Construction of the Zürich Haus in 1962 marked the beginning of the second generation of skyscrapers, characterized by a sharp increase in height and the abundant use of international styles in various forms, shapes, and contexts. To deal with evolving construction dynamics, the city planning authority proposed the *Fingerplan* in 1968 (see Figure 2), which directed expansion along the radially distributed main streets outside of the old city core. At the same time, the first proposals to organize high-rises into a recognizable urban form appeared, with the introduction of the *Bankenplan/Clusterplan* in 1970, which more closely defined a high-rise area organized around the central green core of Taunusanlage and Gallusanlage parks (see Figure 3). The most vigorous high-rise boom occurred during the 1970s, when the "taboo" of 97 meters – the height of the Frankfurt Cathedral – was finally exceeded (Alexander & Kittel 2006). The most prominent buildings to follow the *Bankenplan/Clusterplan* include the Euroturm (1977), Silberturm (1978), and the Citibank Tower (1984).

Along with the rise of the Postmodern style in architecture, the third generation of Frankfurt high-rise was born. The double towers of Deutsche Bank (1984) were the first constructed in this period, followed by Trianon (1993) and Japan Center (1996). Skyscrapers generally became slimmer and taller, as represented by the construction of Commerzbank tower by Foster + Partners in 1997, which is still the tallest building in the city and in Germany (see Figure 4).

Development of the booming skyline was regulated by the High-Rise Development Plan of 1999, which took into consideration the experiences of some other important global cities, such as Paris and London, as well as of Berlin, Munich, Vienna, and Boston, and presented an urban design vision for the implementation of high-rise buildings into the

Figure 4. Commerzbank Tower, Frankfurt. © Marshall Gerometta

Sustaining a Historic High-Rise Structure

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One of the tallest seismic retrofits in North America was undertaken in the heart of San Francisco. The Pacific Telephone & Telegraph Company headquarters was an achievement of architecture of its day when completed in 1925, and it remains an emblem of the Art Deco movement. The building's current owner decided to embark on the challenging endeavor of reviving the historic structure. This meant preserving the historic fabric, creating an open, flexible workspace, and infusing state-of-the-art technology and sustainability into all its aspects, including a voluntary full seismic structural upgrade.

Introduction

Situated in the heart of downtown San Francisco, the Pacific Telephone & Telegraph (PT&T) Company headquarters opened in 1925, reaching 132.7 meters and becoming the tallest building in the city upon completion (see Figure 1). The building, now known as 140 New Montgomery (140NM), still stands as an icon of design and a reminiscence of the power of the latest technology of the time.

The building's current owner since 2008, Wilson Meany, a real estate developer, decided to embark on a challenging endeavor of reviving the historic structure. While it will continue to host offices, the building will now introduce state-of-the-art technology in all aspects, including a voluntary structural system upgrade, while maintaining the architect's original intent. In addition to preserving the building's historic features, the project team wanted to create a healthy, sustainable space for its tenants and targeted LEED Gold for the project.

This paper outlines the design goals of this upgrade: from the preservation of the historic fabric to the creation of open flexible office space, all while providing a safe and sustainable structure in San Francisco's unforgiving seismic environment. It also discusses the strengthening scheme evaluated and challenges faced during the design. It presents details on the analysis method of the seismic retrofit, which utilized a performance-based design. This method presents the engineer with the capability to look past conservative building codes and determine in a more precise way the capacity of the existing building system. Moreover, this approach allows the engineer to better understand how the new and existing systems behave together during a seismic event, and therefore provides a smart, more sustainable, and less obstructive solution while maintaining the historic fabric of the building.

Lastly, the paper discusses the environmental benefits of retrofitting versus rebuilding, and how the sustainability objectives of the project shaped the design.

The Historic Building

140NM consists of a 26-story base, with a four-story tower above Level 27 and two basement levels, designed by Timothy Pflueger and Frank Miller. When completed, 140NM became the tallest building in the city, until its height was matched by the neighboring Russ Building two years later.

The building provided space for PT&T's 2,000 employees. The PT&T building was known nationally and internationally in the business and design communities, and was visited by VIPs such as Winston Churchill, who in 1929 made one of the first Transatlantic phone calls from the building.

The building is classified by the City of San Francisco as a Category I Historic Building and is eligible to register for the National Register of Historic Places. Some of its historic features include 2.4 hectares of terracotta façade constructed by the Gladding McBean Company, and eight terracotta eagles perched atop the tower

Figure 1. 140 New Montgomery, San Francisco. © Nathaniel Lindsey

“Some of the building’s historic features include 2.4 hectares of terracotta façade constructed by the Gladding McBean Company, and eight terracotta eagles perched atop the tower. The entrance houses an ornate and dramatic lobby with detailed bronze doors, marble walls, and a hand- painted plaster ceiling by Mark Goodman.”

(see Figures 2 and 3). The entrance houses an ornate and dramatic lobby with detailed bronze doors, marble walls, and a hand-painted plaster ceiling by Mark Goodman (see Figure 4). The entrance also leads to a marble staircase.

Since completion, the building has remained relatively untouched, with a façade renovation in the 1980s and parapet bracing installed just prior to the 1989 Loma Prieta earthquake. Comparing the building then to now, one can quickly notice that the historic fabric of the structure has stayed intact throughout the decades.

After housing one company for over 80 years, the building was sold in 2008 to a real estate developer. It was the refined character of the historic building that would set the tone for the project and the vision of its new and proud owner.

Project Vision and Goals

An article in ***San Francisco Newsweek*** from 1925 described 140NM as “the new building generation, a monument to western progress, and foresight.” Eight decades later, a new developer was determined to continue this vision and honor its original inception as a modern communication hub and a center of innovation. 140NM was going to continue housing the technology of tomorrow by attracting creative entrepreneurs and companies in the tech sector, by providing them with state-of-the-art technology infrastructure and flexible workspace within a historic high-rise. To achieve that vision, the developer engaged a design team in 2011 that would spend the next few years following the guiding principles that would restore and reinvigorate this iconic structure.

Some of the major work undertaken in this renovation includes the historic lobby rehabilitation, elevator modernization (to support destination control), and entirely new mechanical, electrical, and plumbing systems designed with tenant controllability.

Figure 2. Terracotta façade along New Montgomery Street. © Stephen Schafer

Figure 3. Eight terracotta eagles perched atop the 140 NM. © Nathaniel Lindsey

Figure 4. Historic Lobby Entrance. © Stephen Schafer

An All-Time Record 97 Buildings of 200 Meters or Higher Completed in 2014

Report by Daniel Safarik and Antony Wood, *CTBUH;* Research by Marty Carver and Marshall Gerometta, *CTBUH*

Note: Please refer to "Tall Buildings in Numbers – 2014: A Tall Building Review" in conjunction with this paper, pages 48–49

The Council on Tall Buildings and Urban Habitat (CTBUH) has determined that 97 buildings of 200 meters' height or greater were completed around the world in 2014 – a new record (see Figure 3, opposite). Further highlights:

- The 97 buildings completed in 2014 beat every previous year on record, including the previous record high of 81 completions in 2011.
- A total of 11 supertalls (buildings of 300 meters or higher) completed in 2014 – the highest annual total on record. Since 2010, 46 supertalls have been completed, representing 54% of the supertalls that currently exist (85). The number of 200-meter-plus buildings in existence has hit 935, a 352% increase from 2000, when only 266 existed.
- This was the "tallest year ever" by another measure: The sum of heights of all 200-meter-plus buildings completed across the globe in 2014 was 23,333 meters – setting another all-time record and breaking 2011's previous record of 19,852 meters.
- Asia's dominance of the tall building industry increased yet again in 2014. Seventy-four of the 97 buildings completed in 2014, or 76%, were in Asia.
- Once again, for the seventh year in a row, China completed the most 200-meter-plus buildings (58, see Figure 1). This represents 60% of the global 2014 total, and a 61% increase over its previous record of 36 in 2013.
- The Philippines took second place with five completions, the United Arab Emirates and Qatar share position three with four completions, and the United States, Japan, Indonesia, and Canada tie for fourth, with three completions each.
- Japan marked its first entry into the supertall stakes with the completion of the 300-meter Abeno Harukas in Osaka, becoming the country's tallest building.
- South America also welcomed its first supertall, the 300-meter Torre Costanera of Santiago, Chile, which was also the only building of 200 meters or greater to complete on the continent in 2014.
- Tianjin, China, was the city that completed the most 200 m+ buildings, with six. Chongqing, Wuhan, and Wuxi,

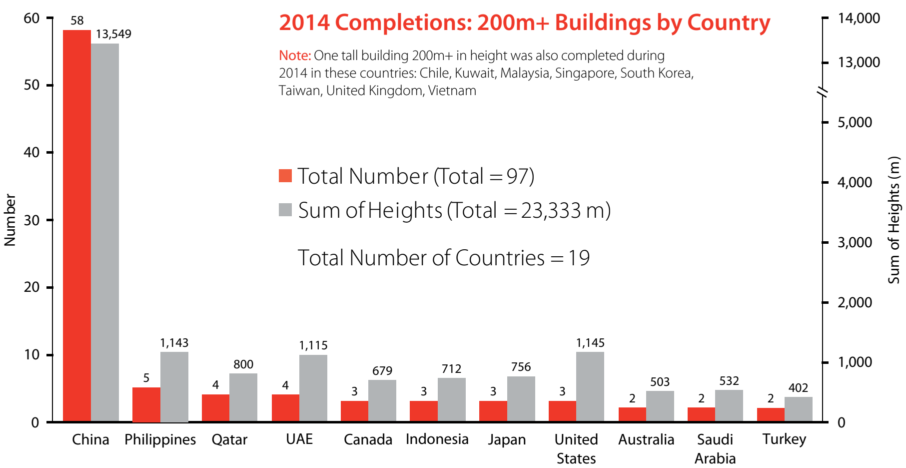


Figure 1. 2014 completions by country.

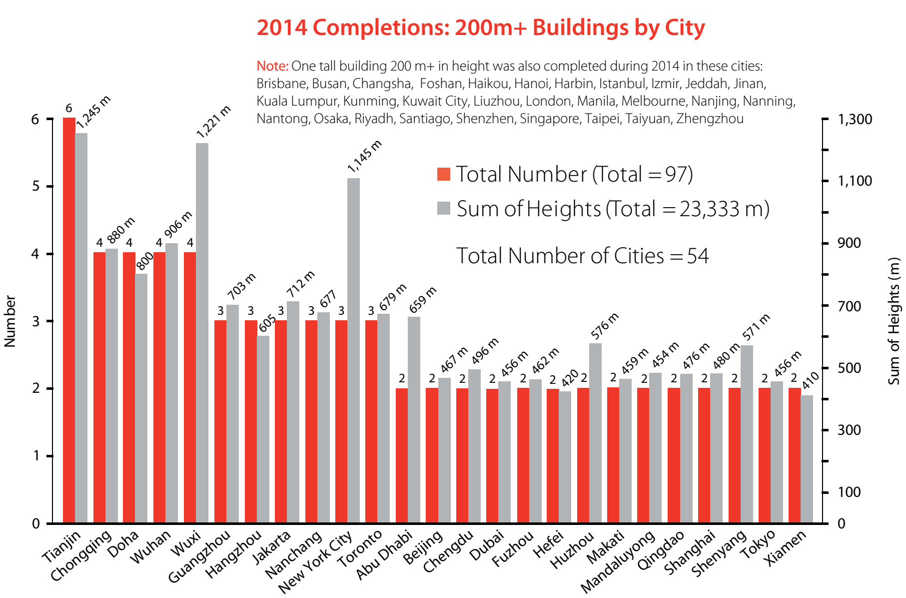


Figure 2. 2014 completions by city.

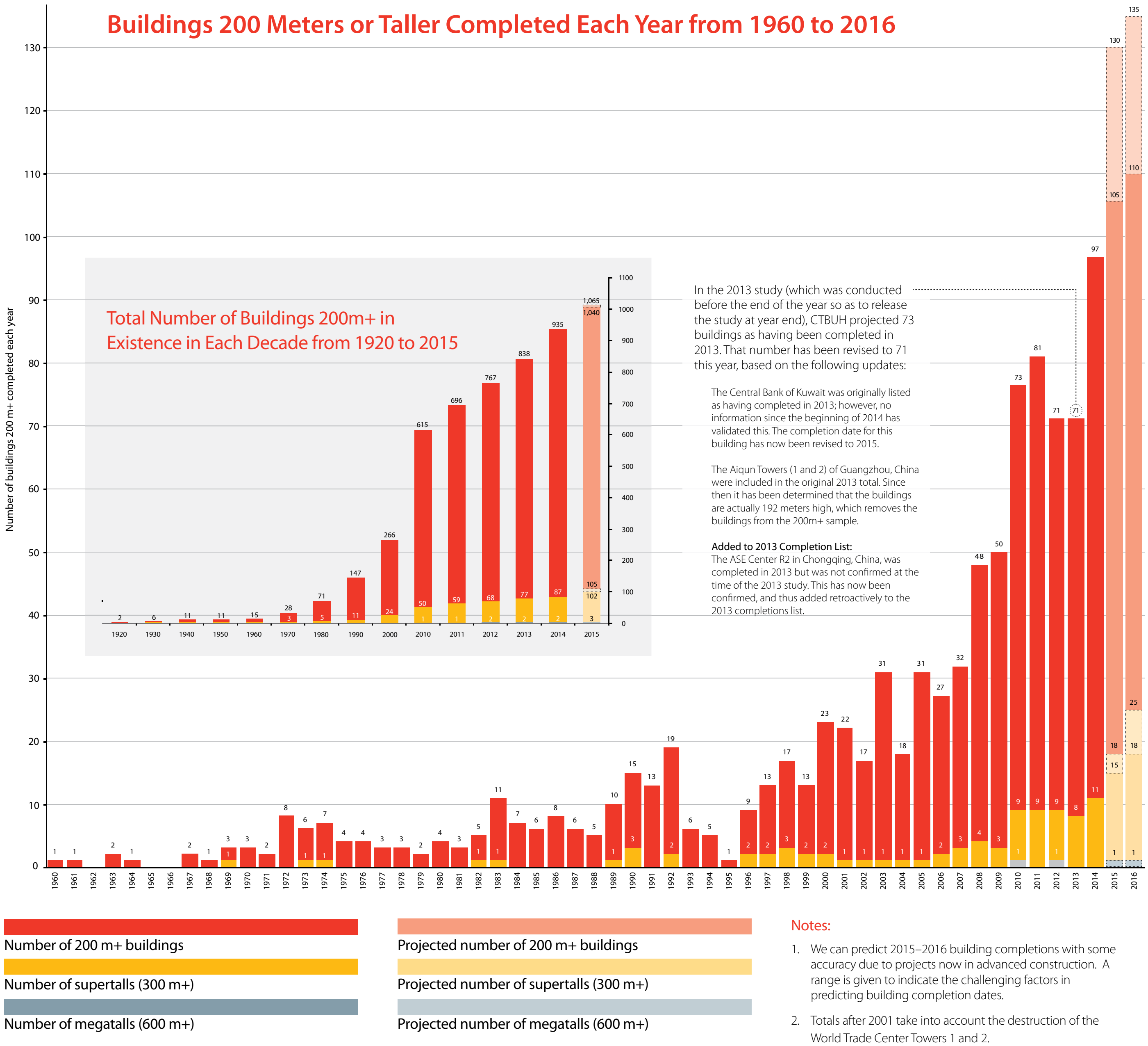


Figure 3. The amount of 200 m+ buildings completed each year from 1960 to 2016.

China, along with Doha, Qatar, all tied for second place with four completions each (see Figure 2).

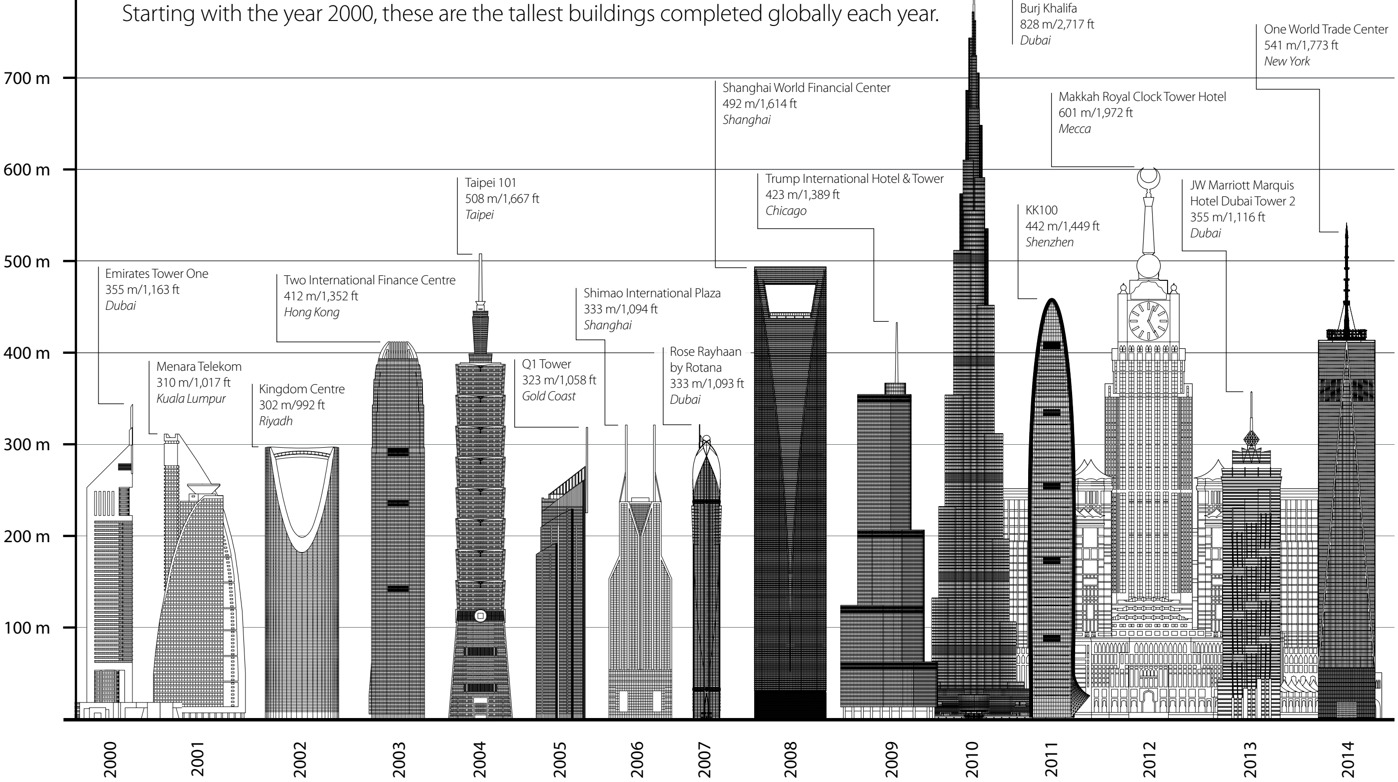
- In 2014, 47 all-office buildings were completed (48% of the total), the largest total ever, versus 31 (38% of the total) in 2011, the previous record high.
- At 541 meters, One World Trade Center was the tallest building to complete in 2014 and is now the world's third-tallest building.
- A majority of 2014 completions used composite construction as the primary structural system – 52 out of 97 (54%), as compared to 24 out of 71 (34%) in 2013. The number of buildings whose predominant structural material is concrete dropped to 38% in 2014, from 61% in 2013.
- All-steel continued its decline as a primary structural material, comprising only 5% of 2014's 200-meter-plus completions and 13% of the world's 100 tallest buildings, though it showed a slight uptick from 3% in 2013.

The Global Tall Building Picture: Impact of 2014

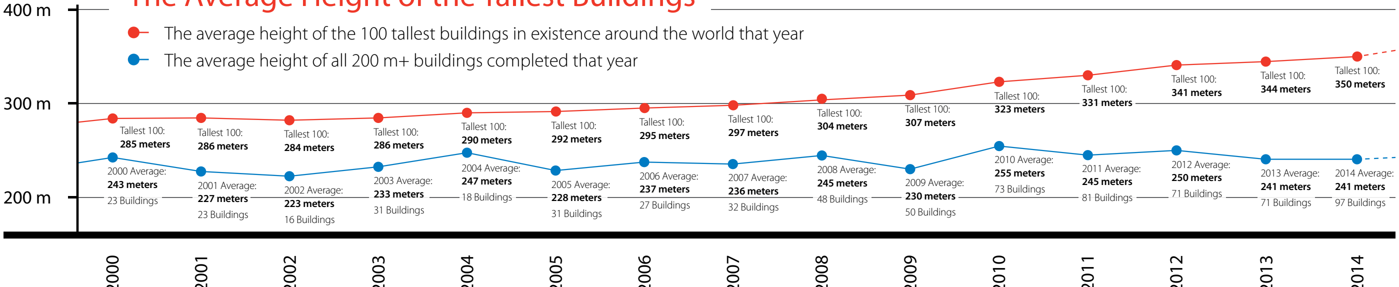
In 2014, a total of 97 buildings of 200 meters or higher were completed, more than in any previous year, and a 20% increase from the previous record of 81, set in 2011. Not surprisingly, 60% of these 2014 buildings were in China. Perhaps more counterintuitively, 2014 saw an apparent reversal in the decline of all-office buildings, and a significant drop in all-concrete buildings, while the United States claimed its first tallest worldwide completion since 2009. For more analysis of 2014 completions, see "A Year in Review: Tall Trends of 2014," pages 40–47.

World's Tallest Building Completed Each Year

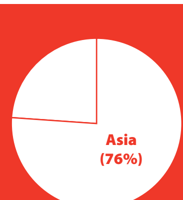
Starting with the year 2000, these are the tallest buildings completed globally each year.



The Average Height of the Tallest Buildings

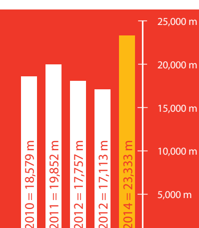


Amidst much fanfare, One World Trade Center, New York City, at 541 m height, was the tallest building completed in 2014, also becoming the third-tallest building in the world



2014 marks the second year in a row that at least 75% of all 200 m+ building completions were located in Asia

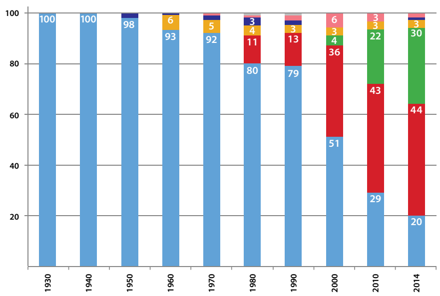
76% in 2014
75% in 2013



The sum of all the 200 m+ buildings completed in 2014 was 23,333 meters, the tallest year in history

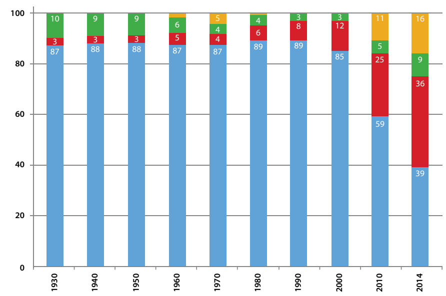
World's Tallest 100: Analysis

As the graphs below show, we continue to see major shifts towards Asia, mixed-use function, and composite structures.



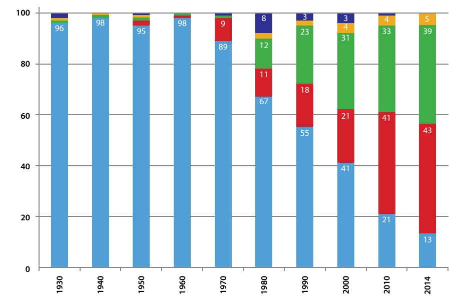
100 tallest buildings by location

North America | Asia | Middle East | Europe | South America | Australia | Central America | Africa



100 tallest buildings by function

Office | Mixed-use | Hotel | Residential

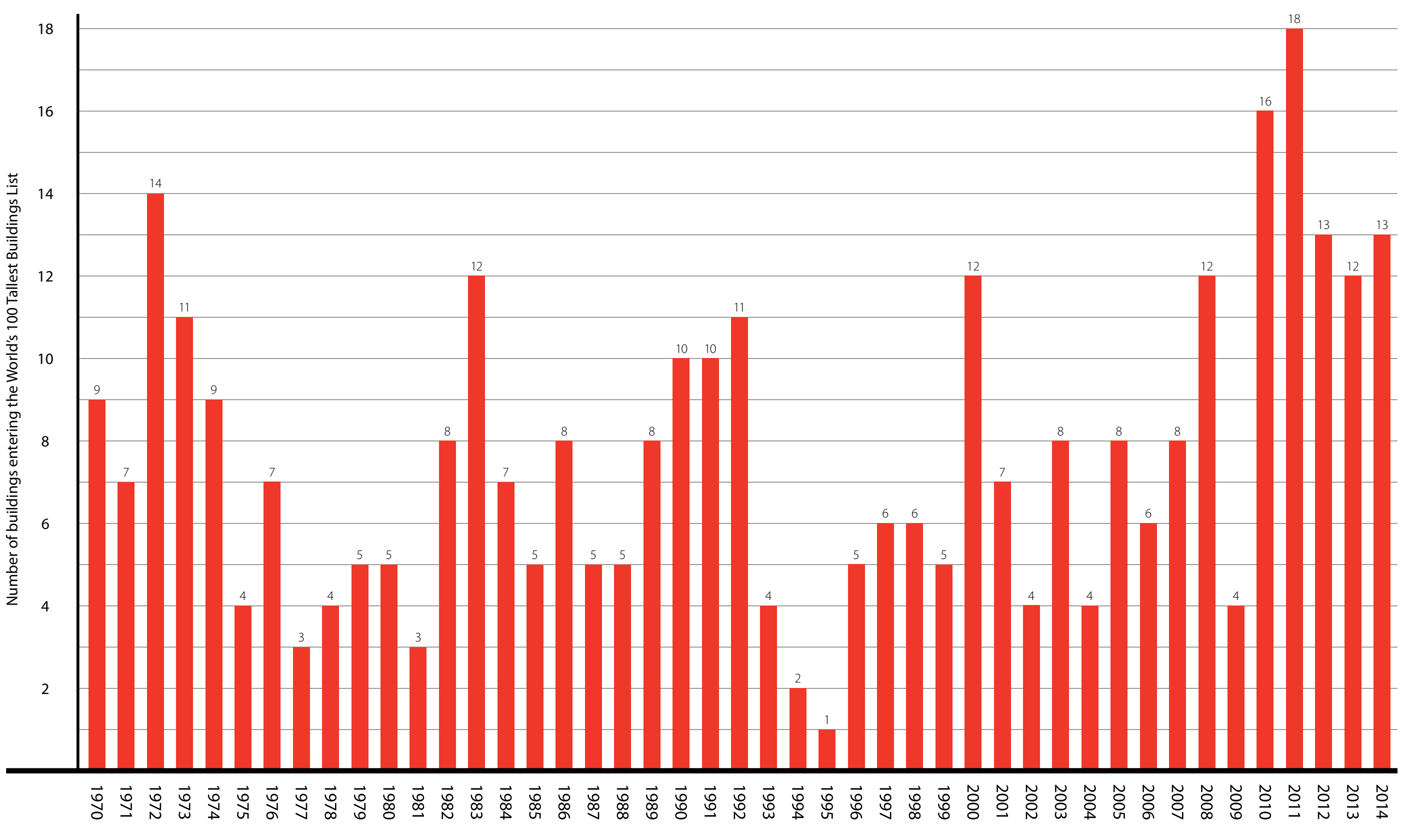


100 tallest buildings by material

Steel | Concrete | Composite | Mixed | Unknown

Number of Buildings Entering the World's 100 Tallest by Year

Though 2014 was the most active year ever for completions of 200-meter-plus buildings, with 97 buildings, only 13 entries made it into the 100 Tallest in the world. The year 2011 saw the greatest number of buildings entering the 100 tallest list, at 18.



25

25 cities completed at least two 200 m+ tall buildings in 2014, the highest of all time, showing the increasing global demand for tall buildings. 2007 had the second-highest total, with 17 cities

South America's first supertall, Torre Costanera, Chile, 300 m, entered the World's 100 Tallest Buildings list at position 84; It is the only South American building on the list

Similarly, Japan's first supertall, Abeno Harukas, Osaka, 300 m, entered the World's 100 Tallest Buildings list at position 85; The only other Japanese building on the list is Landmark Tower, Yokohama, 296 m

Taming Tall Buildings' "Autistic" Tendencies

Kees Christiaanse

Interviewee

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Kees Christiaanse
Kees Christiaanse studied architecture and urban planning at TU Delft. From 1980 until 1989, he worked for the Office for Metropolitan Architecture (OMA) in Rotterdam, becoming a partner in 1983. In 1989, Christiaanse founded his own office, Kees Christiaanse Architects & Planners in Rotterdam, known as KCAP since 2002. From 1996 until 2003 he taught architecture and urban planning at TU Berlin, Germany. Since 2003, he has been a professor at the ETH in Zurich, Switzerland. In 2009, Christiaanse was curator of the International Architecture Biennale Rotterdam (IABR) with the title *Open City: Designing Coexistence.* Since 2010, Christiaanse has been program leader of the Future Cities Laboratory (FCL) in Singapore.

The CTBUH is actively expanding the "Urban Habitat" portion of its mission, which calls for tall buildings to be optimally integrated into human-scaled urban environments. Reflecting this mission, CTBUH Editor Daniel Safarik recently spoke to Kees Christiaanse, principal of KCAP Architects & Planners. The firm has offices in Rotterdam, Zurich, and Shanghai, and has extensive experience in urban master plans throughout Europe and Asia, as well as having designed numerous individual tall buildings in those contexts. These include the districts of HafenCity, Hamburg and Wijnhaven Island, Rotterdam, where KCAP's Red Apple, a 2009 CTBUH Award-nominated tall building, is located.

I'm very interested in the concept that your firm has developed called "flexible urbanism." That has a very appealing sound to it. Can you define it in your own words?

If you work in the city and you work within a larger context, you will soon learn that everything that you draw that you think is fixed will be changed over time. These days, when there are such enormous and rapid transformations in economies and urban contexts, it's no use to work on designs that are inflexible and fixed. It's necessary to work in a more strategic way, to work in a way of control and *laissez-faire,* in which you define certain things that you assume are robust, and leave other things open. This makes you more like a director and less of a sculptor. I think this is a vital difference between an architect and an urban designer. The architect always ends up creating his own confined product within the brief and the site that he's got and according to his own fine taste, but the urban designer has to coordinate between everybody's bad tastes and make something out of it. So it's a radically different way of working if you want to do it right. You also have to very clearly study impacts of urban design in order to get feedback and identify if your designs will have an impact or not.

> "[As an urban designer] you have to have a very hard head, because you are constantly punched in the nose."

Tall buildings are often accused of being contextless, immutable, and hostile to the street. You've designed several very interesting tall buildings that fit within their environments and many more urban plans that incorporate others' tall building designs. What do you think is essential in order to facilitate "flexible urbanism" in that context?

What is very important is the relation between plot size and the urban ensemble of tall buildings. In many cases, tall building ensembles are footprint developments that have a very autistic relationship with public space. For instance, they only have one entrance over a whole block. They are often blind in the sense that they have basements or parking garages on their façades. That's not a good condition to develop urban quality. There is a direct relationship between plot size typology – on the one hand – and urban vibrancy. Let's say we always try to work in high-rise conditions to give them smaller footprints, so they have to arrange themselves in relation to other plots. This creates an emerging friction where they settle themselves and are given much more grounding in the urban fabric.

Connected to that is the idea of a podium. Many modernist towers still stand as shafts on the ground without any public space or courtyards. You see that most urban vibrancy develops in conditions with clear fronts and backs, and clearly indefinite spaces that can be colonized by uses. This is something that a lot of those buildings don't have.

Then of course, you have the traditional American problem, where there are building regulations that allow enormous floor plates. These aren't allowed in Europe, because there are daylight rules that limit large cores. This initially looks very economical, but in the end it is very inflexible, because it means that these building can be used in no other way than as large offices. If you take into account that the life cycle of buildings is increasingly short, then these enormous floor plates are not very sustainable in terms of flexibility.

You also see that gradually people are looking for either smaller footprints or modulated plans, where there is much more exposure to the outside. It's also very important to take into account where the cores are, in order to have a semblance of flexibility.

As a master planner, do you feel that you are able to get the appropriate level of flexibility out of local codes when you are working with authorities in different countries?

In many cases not. Unfortunately, the urban designer is someone who has a lot of power, but also is completely powerless. This unstable condition is often reflected in an urban design, which means that certain aspects you cannot control, such as if a mayor comes and says, "I'm going to do this, and despite your design I'm going to change it." You have to have a very hard head, because you are constantly punched in the nose. You have to give up principles, not because you are compromising, but because there is no choice. People just go over you. This is a basic aspect of urban planning which you shouldn't conceive as something personal, but as a consequence of urban development being the result of so many people, influences, and forces of power. The direction that it goes sometimes is not predictable. If you do not like this kind of unpredictability, then you are in the wrong business.

We have a lot of problems with mayors in cities that have romantic, and short-sighted legislation-oriented ideas of how the city should be. This is very damaging sometimes, but it's all in the game. I would say that out of 10 projects, one project is OK as it is realized.

What do you think were some of the most successful projects that integrated the verticality of tall buildings with a humanistic, flexible urban design as you intended?

I think our HafenCity Hamburg project (see Figure 1) is really the most successful, but this is due to the politics that were very enlightened. The management of the HafenCity Corporation consisted of extremely well educated and insightful people.

Figure 1. HafenCity, Hamburg. © Reinhard Kraasch. Source: Wikipedia

Some have criticized that certain buildings in that development, like the Elbphilharmonie, were expensive and too slow to finish.

It's just one building, which is not part of the HafenCity budget. Apparently it eats up part of the cultural budget of the city, which is quite damaging, although in 10 years nobody will talk about it anymore. Another stagnating project in HafenCity is the middle section, The Überseequartier, which, contrary to the other projects, was tendered as one big project at 300,000 square meters. This has caused problems. The Dutch investment banks pulled back after the economic crisis because they weren't allowed to go into real estate anymore.

The German developer was too small to do it by himself, and had never done such a big project, and almost went bankrupt on it. In the end there was no commitment after a little bit less than two-thirds was constructed. After it was completed, the main shopping street was still unfinished, so the shops within the development got into difficulties, because there was no circulation. It's a snowball effect.

The main part of HafenCity was developed block by block. Sometimes there were two or three building sites that were organized as competitions for design-build teams. When somebody won, they only got the land and property from the moment they handed in the building permit request, that is, when they paid the fees to the city. This meant that they would certainly build the project, because the fees are significant. That led to an incremental kind of development, in which every project that started was secured because the building permit was handed in. That's also why it is both a large-scale and small-scale project.

Are there standalone projects that you also think were successful?

The second project of ours that I think is very successful is this tower project in Rotterdam, the Red Apple (see Figure 2). This is a single building within an urban design that we

Figure 2. Red Apple, Rotterdam. © KCAP

About the Council

The Council on Tall Buildings and Urban Habitat, based at the Illinois Institute of Technology in Chicago and with a China office at Tongji University in Shanghai, is an international not-for-profit organization supported by architecture, engineering, planning, development, and construction professionals. Founded in 1969, the Council's mission is to disseminate multi-disciplinary information on tall buildings and sustainable urban environments, to maximize the international interaction of professionals involved in creating the built environment, and to make the latest knowledge available to professionals in a useful form.

The CTBUH disseminates its findings, and facilitates business exchange, through: the publication of books, monographs, proceedings, and reports; the organization of world congresses, international, regional, and specialty conferences and workshops; the maintaining of an extensive website and tall building databases of built, under construction, and proposed buildings; the distribution of a monthly international tall building e-newsletter; the maintaining of an international resource center; the bestowing of annual awards for design and construction excellence and individual lifetime achievement; the management of special task forces/working groups; the hosting of technical forums; and the publication of the CTBUH Journal, a professional journal containing refereed papers written by researchers, scholars, and practicing professionals.

The Council is the arbiter of the criteria upon which tall building height is measured, and thus the title of "The World's Tallest Building" determined. CTBUH is the world's leading body dedicated to the field of tall buildings and urban habitat and the recognized international source for information in these fields.

Council on Tall Buildings and Urban Habitat

Council on Tall Buildings and Urban Habitat

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ISSN: 1946 - 1186