

# CTBUH Journal

Tall buildings: design, construction and operation | 2008 Issue II

The Shanghai World Financial Center  
Sustainability Through Greener Concrete  
Sustainable rating systems around the world  
Building Façade or Fire Safety Façade?  
CTBUH Working Group Update: Seismic  
Tall Buildings in Numbers

# Editor's Message

The CTBUH Journal is an official periodic publication of the Council on Tall Buildings and Urban Habitat. Published and circulated to the Council's worldwide membership three times each year, the Journal aims to document and publicize groundbreaking work taking place in the many fields related to tall building and urban development. In addition to technical papers, issues of the Journal host updates and news from the Council leaders and its subcommittees, literary reviews of relevant internal and external publications, and information on upcoming events hosted and sponsored by the organization.

It is my pleasure to introduce several new features of the Journal, which will become regular installments in each subsequent issue. The CTBUH News section has been expanded in order to cover the fervent activities of the Council and its budding regional chapters. This section is now complemented with an industry news section, which offers coverage of several high-profile developments in tall buildings and urban development around the world. Extensive supplementary information is available on our website, which is continually updated to offer CTBUH members coverage of all relevant news items.

The Journal will soon boast a letters section which showcases feedback from members on subjects raised in previous issues. I welcome you to contribute to this new section by sending your thoughts and opinions to [letters@ctbuh.org](mailto:letters@ctbuh.org).

The papers in this issue of the CTBUH Journal build on the themes presented at the 2008 Dubai World Congress. A paper on the Shanghai World Financial Center by Paul Katz and Leslie Robertson has been expanded to include additional information on building systems and the intensive efforts of the design team to optimize its superstructure. Daniel O'Connor of Schirmer Engineering Consultants presents an enhanced paper on fire safety in the context of unique facade designs. A final paper by Antony Wood and Candace Say explores various sustainability metrics around the world - from LEED to BREAM to CASBEE - and attempts to reveal the advantages and disadvantages of these current guidelines. Finally, Gareth Moores, CEO of UK firm Hargreaves Building Products discusses how choice of materials can have an impact on sustainability and design when building tall.

The CTBUH welcomes both members and nonmembers to contribute to the Journal through the submission of papers for potential publication. Publication in the CTBUH Journal awards the featured author with broad exposure to a multitude of industry leaders and active professionals around the world. By sharing knowledge, findings or experience, each author fosters valuable discourse amongst Council members with common interests, and in turn opens an opportunity to gather information useful to his or her published pursuits. Above all, each author contributes to the organization's mission of elevating its members' collective awareness of the built environment.

Enjoy the issue. On behalf of the CTBUH editorial board, I hope the wealth of information in the newly enhanced Journal inspires you to contribute in the future.



Zak Kostura, Editor

Best Regards,

A handwritten signature in black ink, appearing to read 'Zak Kostura'.

Zak Kostura

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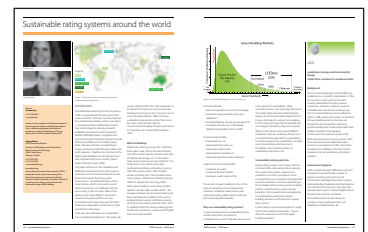
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Visit [www.ctbuh.org](http://www.ctbuh.org) for more on the global tall building industry and the Council on Tall Buildings and Urban Habitat

“Lingering discrepancies between the reward to the designer for a specific inclusion and its lasting impact on the surrounding environment is a fundamental flaw in all major sustainability rating systems.”

Candace Say and Antony Wood, page 18



## Ryugyong Hotel Back Under Construction After 16-years

The infamous 105-storey Ryugyong Hotel is back under construction in the capital of North Korea after 16 years of construction inactivity. According to foreign residents in the city, Egypt's Orascom group has recently begun work refurbishing the upper floors of the 330 meter tall hotel, adding glass panels, installing telecommunications antennas and erecting an artist's impression of what the building will look like when completed. Designed to contain 3.9 million square feet of floor space with 3000 rooms and seven revolving restaurants, construction on the project originally started in 1987, but halted in 1992 following North Korea's economic decline. Were it finished today, it would stand as the 20th tallest building in the world and the second tallest single-function hotel, behind the Rose Rotana Tower in Dubai.



## Singapore's Most Sustainable Building

Designed by Ken Yeang of T. R. Hamzah & Yeang, sister company to Llewelyn Davies Yeang, the 15-storey Fusionopolis will become Singapore's most sustainable and environmentally-friendly building. Set within a masterplan designed by Zaha Hadid, the design incorporates what Yeang calls a 'green infrastructure' – a spine of vegetation rising up through the building – the longest continual stretch of greenery in a building anywhere in the world. Daylight will be directed onto this vegetation via a light-pipe that deflects the passage of natural light deep into the building's interior. For Yeang, it is important that the whole building functions as an ecosystem – "What we should be trying to do is make a building into a living system... Balancing the organic with the inorganic in a building is crucial" he says.



## 9/11 Rebuilding Running Late According to Report

The Port Authority of New York and New Jersey, owners of the World Trade Center site, have released a 34-page report outlining how each of the public projects face significant delays and cost overruns. The report also highlighted

**"It's not like I start out going, 'Here's my shape, how do I make it?'" Gang says. "It's more like, 'How do I build it?'"**

**Whether it's a condo tower or community center, Jeanne Gang's approach to materials and construction remains bold and ingenious. From "The Art of Nesting" Portrait by Stephen Zacks, Metropolis, June 2008, p 142**

why construction is running behind; the redevelopment involves more than two dozen projects, with some five major skyscrapers; the third-largest transportation hub in the city; two new city streets; a major performing arts center; and more than 500,000 square feet of shops. Although delays have been acknowledged, the Port Authority has been eager to express that some progress has been made on the Freedom Tower as well as on the three adjacent office skyscrapers.



### Beijing's Linked Hybrid Complex

With the arrival of the Olympic Games, Beijing has seen an unprecedented boom in construction, with many new iconic skyscrapers rising across the city. The latest addition to Beijing's skyline, Steven Holl's 'Linked Hybrid' development consists of eight 21-storey towers linked at the upper levels by sloping skybridges. These are lined with public amenities such as galleries, restaurants, bars and shops. The entire complex acts as a three-dimensional urban space in which buildings on the ground, under the ground and over the ground are linked together. The project, which will house 2,500 inhabitants, has been widely praised for its sustainable design; one of the world's largest geothermal systems eliminates the need for boilers or electrical air conditioners, whilst a waste water recycling plant with large ponds to harvest rainwater, green roofs and pollution filters all contribute towards the aim of LEED Gold certification. The building is set to open in October 2008.



### Trump Tower Tampa Project Goes Belly Up

The development firm for the 52-story Trump Tower Tampa, a massive luxury condominium project along the city waterfront, has filed for Chapter 11 bankruptcy protection in Florida courts. Simdag/Robel LLC filed for protection after it failed to locate a lender to finance the \$200 million tower. Financial difficulties were exacerbated by numerous complications on site, including construction delays resulting from soil issues and community resistance to the project. Ground was broken for the luxury tower in March of 2006. One year later, the site had been all but vacated by contractors, as the developer struggled to find a lender to support the project. The developer is now facing a lawsuit as well, resulting from their failure to pay Donald Trump \$1 million for naming rights on the project. News sources cite the recent downturn in the U.S. housing market as a stumbling block for developers in Florida, who have struggled recently to find sources of funding for new projects. "No one wants to lend money in Florida right now," explained Frank Dagostino, CEO of Simdag, "Every developer is desperate right now."



### Shanghai Center to be China's Tallest

Located adjacent to China's current tallest buildings, the 421 meter Jin Mao Tower and the 492 meter Shanghai World Financial Center, the Shanghai Center will be the country's tallest building upon completion, standing at 600 meters in height. The 118-storey building, nicknamed the 'Shanghai Dragon' is designed by Gensler who were selected after an extensive competition between local and international design firms. Conceived as a "vertical city," the mixed-use design includes nine atrium-sky gardens, office space, high-end retail, residential housing and public amenities. It will incorporate the latest sustainable design and renewable energy systems, such as innovative skin technologies and seek a high level of LEED certification by the China Green Building Council. Thornton Tomasetti structural engineers, Cosentini Associates mechanical engineers and the Architectural Design and Research Institute of Tongji University, serving as the Local Design Institute, will support Gensler in the design of the building. Ground breaking is expected in December of 2008 with completion in 2014.

# Case Study: Shanghai World Financial Center

From the onset of the Shanghai World Financial Center project, its developers targeted a cutting-edge, mixed use mega-complex that would serve a multitude of tenant lifestyle demands. When a desire to change the building size surfaced after the foundation was put in place, it was up to the structural designer to come up with a new approach to the building systems in order to keep the project on track. Following a substantial and fast-paced reconfiguration of the building's structural design, the project team achieved a taller building without compromising the capability of the original foundation to support it. A discussion of the design process of the building and its cutting edge features follows.



Paul Katz



Leslie E. Robertson

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## Paul Katz, *Principal*

Paul Katz, Managing Principal with Kohn Pedersen Fox, is a leader in the planning, design, and development of office, mixed-use and high-rise buildings. In addition to the Shanghai World Financial Center, Mr. Katz presently has several projects in design or construction around the world, including the KPMG headquarters at Canary Wharf in London, the Marina Bay Business and Financial Centre in Singapore, and the International Commerce Center in Hong Kong.

## Leslie E. Robertson, *Principal*

Responsible for the structural design and construction of some of the world's tallest buildings, Leslie E. Robertson has been at the forefront of structural engineering design for more than 50 years. In addition to the Shanghai World Financial Center, Dr. Robertson is responsible for the structural design of the World Trade Center in New York, the Puerta de Europa Towers in Madrid, and the award-winning Miho Museum Bridge in Shigaraki, Japan.



Figure 1. Shanghai World Financial Center nearing completion.

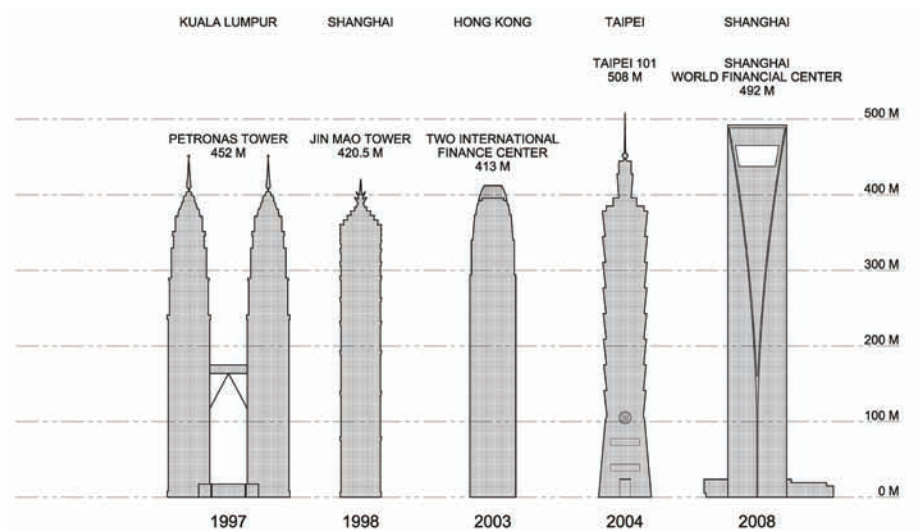


Figure 2. Shanghai World Financial Center in comparison with some of the world's current tallest buildings.

## 1. Introduction

Strategically located in the heart of Pudong's Lujiazui district, an area that has emerged as China's commercial and financial capital, the 492 meter Shanghai World Financial Center (SWFC) is destined to become a symbolic icon of Shanghai. This 21<sup>st</sup> century vertical city will symbolize Shanghai's status, China's arrival, and a new era unfolding in Asia. It will become a destination where people from around the world come together to enjoy and to share a wealth of information, knowledge, and culture, as well as a place to explore new business opportunities.

In an effort to reduce commuting time and urban sprawl, projects like SWFC increase density and conserve valuable land. People can live, work, and play within the same area. Vertical complexes can accommodate these urban lifestyles, embodying a density that greatly enhances their accessibility.

Now nearing completion, the structure was topped-out in September 2007 (see Figure 1). Anticipated to be completed in summer 2008, it will be recognized by the CTBUH as the world's tallest in two of its four categories; as the "Highest Occupied Floor" and "Top of Roof" (see Figure 2).

The tower's basic form is that of a square prism, 58 meters on a side, intersected by two sweeping arcs to form a vertically-evolving six-sided shape in plan, ultimately tapering into a

single diagonal line at the apex, 492 meters above the base.

The building will be mixed-use, with a museum and sophisticated urban retail spaces at the base, a 174-room luxurious five-star hotel at the top, and sixty-two office floors with cutting-edge specifications between. Above the hotel, at the 94<sup>th</sup> to 101<sup>st</sup> levels, there will be a visitor's center and observatory. Much of the available space on the three floors below grade is devoted to mechanized parking.

According to the developer, Mori Building Company, the anticipated tenants are world-renowned financial institutions. In order to provide these business people with entertainment and recreation opportunities after working long hours, this project will include restaurants, shops, and entertainment facilities. Currently, this area of Lujiazui does not provide these amenities. A multi-use project like SWFC will provide a more human-oriented place for people working in this city within a city'.

## 2. History

### 2.1 Early History

The original designs began in 1993, with development by Mori Building Company, and with Kohn Pedersen Fox Associates (KPF) as the Design Architect. Following the completion of conceptual structural designs by Ove Arup &

Partners, New York, all design work, but for Architecture, then moved to Tokyo to be completed locally by the Shimizu Corporation.

By 1995, the piling had been tendered and installed. Making use of reusable followers, about two hundred concrete-filled steel pipe friction piles were driven at minimum spacing to a depth of 78 meters from the ground surface. Pile cut-off was at the anticipated bottom elevation of the mat at 17.5 meters (58 feet) below street level. Steel H-piles extend from some of the piling to the ground surface, which were to be used for subsequent top-down construction, providing temporary vertical support for the below-grade concrete floors.

Whilst the construction documents package for the tower superstructure was largely complete by this time, Leslie E. Robertson Associates R.L.L.P. (LERA) was approached by Nippon Steel Corp. with the goal of providing a lower-cost, faster-to-construct structural system for adoption prior to tendering of the structural steel. Structural designs were completed by LERA in sufficient detail for tendering; however the project was subsequently placed on hold.

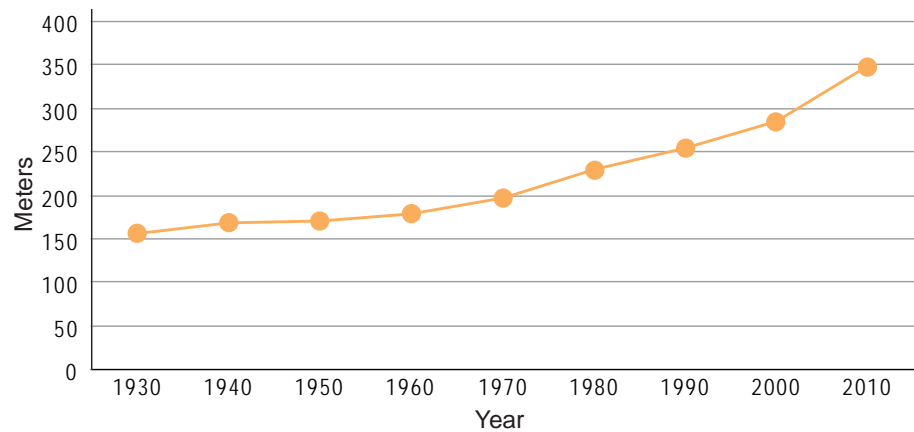
With the resurrection of the project in 1999, and with the foundation piling already in place, Mori Building Company initiated an extension to the overall height of the building from the previous 460 meters (1,509 feet) to 492 meters (1,614 feet) and an enlargement ↗

# Tall Buildings In Numbers

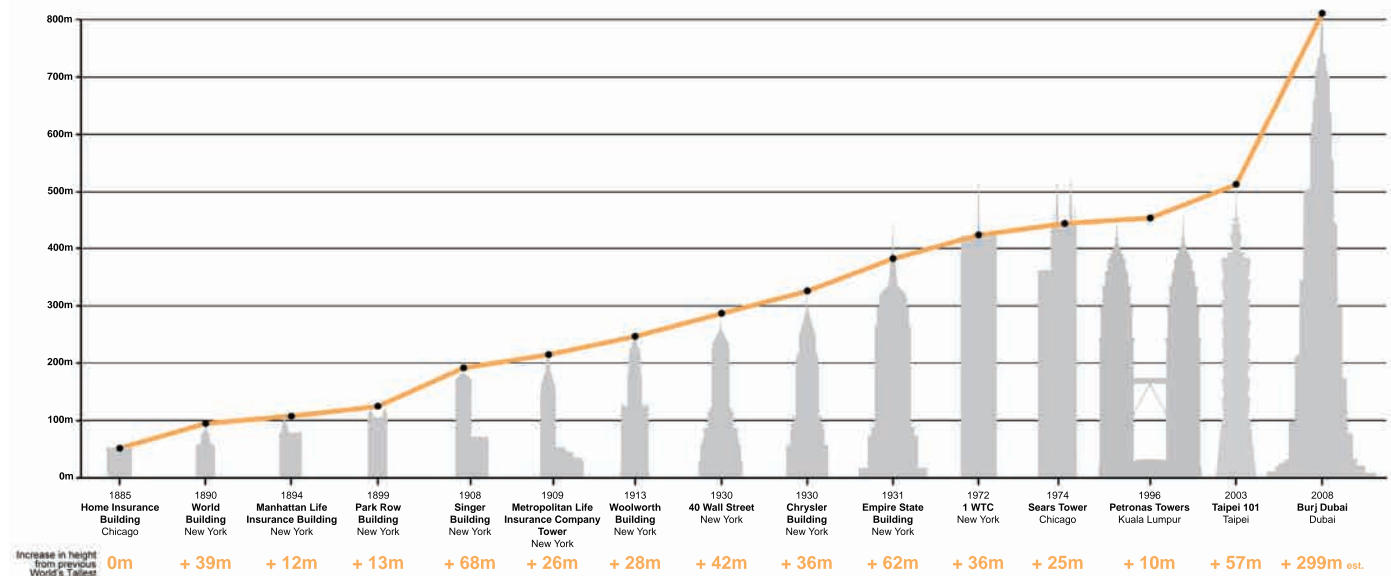
## The Tallest Buildings in the World: Past, Present & Future

Over time, the average height of the 100 tallest buildings in the world has been steadily increasing. However, by 2010, this average height will have jumped to 349 meters, up from 286 meters in 2000, an increase of 22%. This is almost double the increase from 197 meters to 229 meters that occurred between 1970 and 1980, the second largest increase in average building height across a decade.

Average Height of the 100 Tallest Buildings in the World

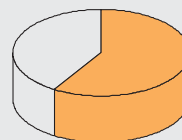


Height Incremental Changes in the Development of the World's Tallest Buildings Historically



Assuming a height of 800 meters, the **Burj Dubai** will make a **60%** leap in height increase over the previous world's tallest

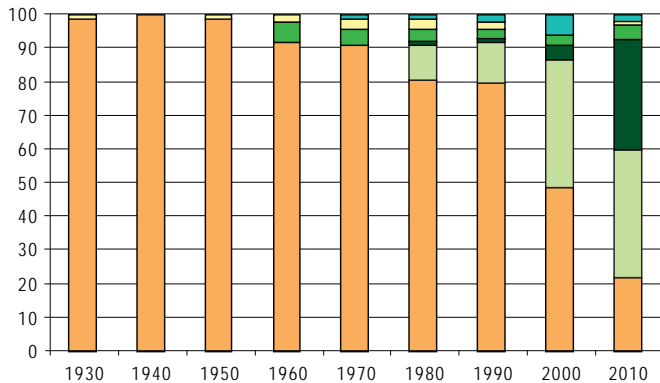
From 2006 to 2010 the combined height of the 100 tallest buildings will have increased by over **5 kilometers**, or **17%**. That's the equivalent to **10 Taipei 101's** stacked end to end



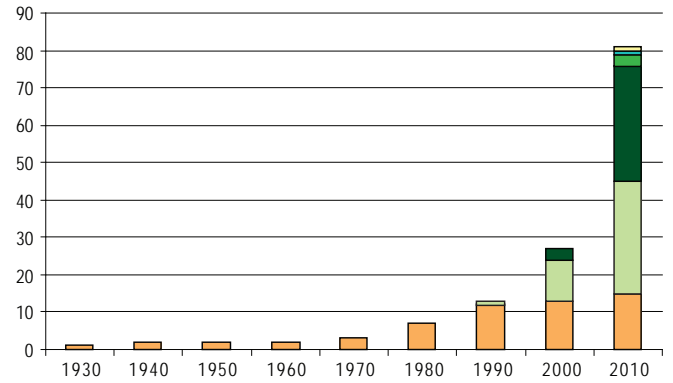
By 2010, **59** of the tallest 100 buildings in the world as documented in 2006, only **4** years beforehand, will be new



## 100 Tallest Buildings in the World by Region



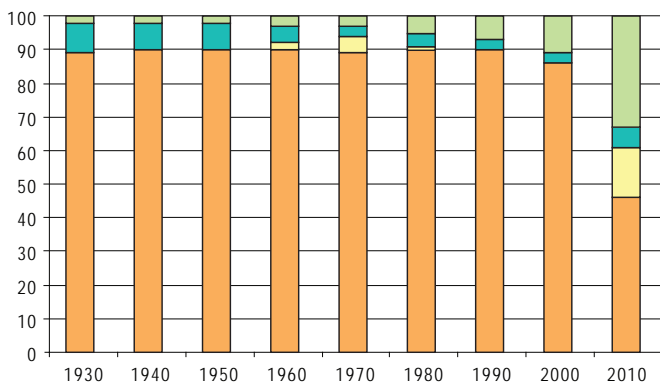
## Total Number of Supertall\* Buildings by Region



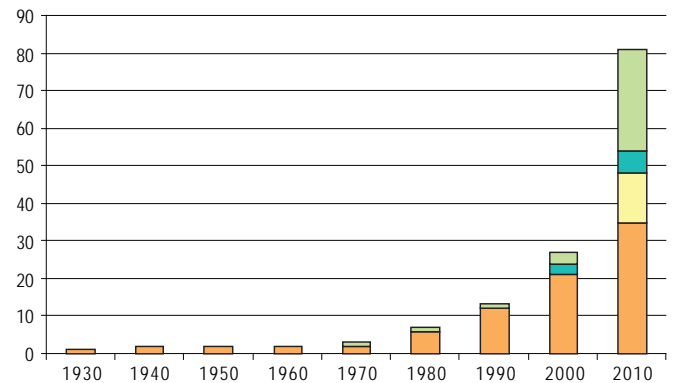
For a significant period of time, North American towers have dominated the 100 tallest buildings in the world, although this is rapidly changing due to the global boom in tall building activity, with a dramatic increase in the number of supertall\* buildings located mostly in Asia and the Middle East.



## 100 Tallest Buildings in the World by Function



## Total Number of Supertall\* Buildings by Function



The world's tallest buildings have for decades accommodated predominantly an office function. This however, is quickly changing – by 2010 less than half of the tallest 100 buildings in the world will be office towers, with the majority instead accommodating residential and mixed-use\*\* functions.



\*The CTBUH defines a building as a 'Super Tall' if it is 300 meters or greater in height.

\*\* The CTBUH defines a mixed-use tall building as containing two or more functions, where each of the functions occupy at least 15% of the tower's total floor area. Ancillary / support areas such as car parks and mechanical plant space do not constitute mixed-use functions.

For further information on CTBUH tall building height criteria, see [www.ctbuh.org/tallest.htm](http://www.ctbuh.org/tallest.htm)



In 1930, **99%** of the tallest 100 were located in North America with **51%** in New York City alone. By 2010 that will have decreased to only **22%** and **5%** respectively



By the end of 2007 there were **34** supertall\* buildings in the world. By the end of 2010, just **3** years later, this will have more than doubled to **82** supertall buildings globally



On the tallest 100 buildings lists from 1930 to 2000 the percentage of office towers was never below **86%**. By 2010 it will be down to just **46%**

# About the Council

The Council on Tall Buildings and Urban Habitat, based at the Illinois Institute of Technology in Chicago, is an international organization sponsored by architecture, engineering, planning, and construction professionals, designed to facilitate exchanges among those involved in all aspects of the planning, design, construction and operation of tall buildings.

The Council's mission is to disseminate information on healthy urban environments and tall building technology, 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.

Since its founding in 1969, the Council has been active in organizing and sponsoring professional conferences on the regional, national and international levels. Symposia, workshops, seminars, and technical sessions are held periodically on topics of unique interest to the particular community.

As one of its services to the public, the Council publishes the CTBUH Journal, a journal that includes papers submitted by researchers, scholars, suppliers, and practicing professionals in the industry. The Council also operates the "High-Rise Buildings Database" which contains important data on thousands of tall buildings throughout the world.

The Council is the recognized source for information on tall buildings worldwide, focusing on their role in the urban environment. The Council provides a forum for discussing the ideas associated with providing adequate space to live and work, involving not only technological factors, but social and cultural aspects as well.



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