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Tall buildings: design, construction and operation | 2012 Issue I

The Hansar, Bangkok

Developing Skyscraper Districts: La Défense

Hybrid Mass Dampers for Canton Tower

Greening the Urban Habitat: Singapore

Talking Tall: A Future for Tall Building History

Debating tall: A Supertall Future in the US?

2011: A Tall Building Review

Tallest 20 in 2020

Council on Tall Buildings and Urban Habitat

This Issue

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Front cover: The Hansar, Bangkok © WOHA
Back Cover: The Hansar – utility screen © WOHA

It is with pleasure that in our first quarterly Journal of 2012, I welcome everyone to a new year! 2011 was another banner year for the Council, which included the kick-off of our research division; enhancement of the quality of our output both in print and on our website; a successful World Conference in Seoul; and continued growth of our membership (now with new organization members added for 60 consecutive months). Let me take this moment to thank all of our members for their continued support and commitment to the Council – without your extraordinary efforts to advance the tall building industry, we wouldn't exist. I would also like to thank our brilliant and dedicated CTBUH staff (who number over 20 full-time and part-time employees) based at the Illinois Institute of Technology (IIT) in Chicago – they work tireless hours to assure the CTBUH is running smoothly. On behalf of the Council, we all wish you a happy, healthy, prosperous and TALL 2012.

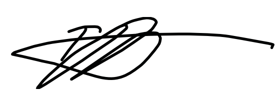
A few weeks ago I had the opportunity to visit the 9/11 Memorial in lower Manhattan. Since the majority of the former World Trade Center location is still a massive construction site, accessing the Memorial is a bit circuitous. However, once inside, the Memorial is a powerful place to pay respect to those tragically involved in that unfortunate day. The former footprints of the towers now outlined in waterfalls are a dramatic and moving experience. The Memorial also goes well beyond that and you begin to sense the powerful composition of urban space and buildings that are forming the new World Trade Center. Rooted in lower Manhattan's more organic urban grid, the master plan by Daniel Libeskind establishes a well-planned and balanced relationship between open space, tall buildings, and the people that will inhabit them. The integration of these above ground spaces and tower masses with the vast network of subways lines and the PATH train to New Jersey is also an inspiring example of the complexities of the city resolved in a human way to ultimately become one of the world's most important urban spaces. I can't think of a better example under construction in the world today that so clearly exemplifies the mission of the Council.

As I peer up the mass of Tower One on its way to 541 meters (1,776 feet) in height, I marvel at its scale and presence. I am always inspired by seeing the construction of any building. In this case seeing simultaneously the vertical services core, perimeter structure, and enclosure all progressing vertically is a text book look at the diagram of the tall building for all to understand. With thousands of people visiting the site daily, our industry is on display like no other time in history.

I glance to the east and it is fascinating to see just a few blocks away, the gothic expression of the Woolworth Building articulated in stone and ornament. Ironically, exactly 100 years ago, this building was also under construction. The building, designed by Cass Gilbert, was constructed from 1911–1913. At 57 stories and 241 meters (792 feet), the building was the world's tallest, edging out the Metropolitan Life Building before being overtaken by the Bank of Manhattan in 1930. It is a great reminder that tall buildings have a lasting impact for decades, sometimes centuries, and therefore have to be robust enough to be adapted over time. As we know, in the era of sustainability, the renovation and re-purposing of all buildings is a mandatory act that we must all become knowledgeable about and help building owners cost effectively achieve. This Journal issue has a relevant article about the Randolph Tower Apartments project (see "Talking Tall," page 50–53) that gives us an example of how to advance this part of the industry.

With the continued growth of our population, further depletion and reallocation of the world's natural resources, and the need to constantly find higher performing solutions for buildings, the tall building industry will only become more relevant and we have much to look forward to in 2012.

Onward and Upward,



Timothy Johnson, *CTBUH Chairman*

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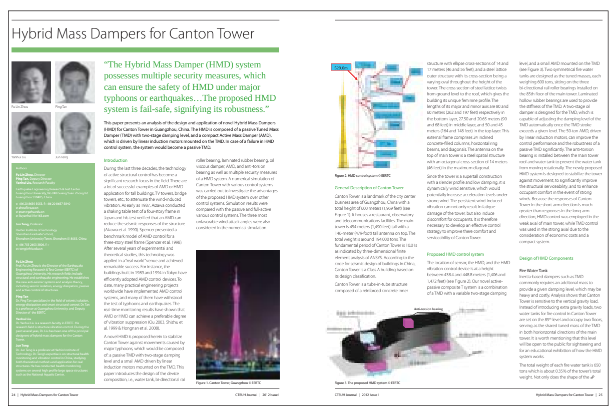
Hybrid Mass Dampers for Canton Tower

"The Hybrid Mass Damper (HMD) system possesses multiple security measures, which can ensure the safety of HMD under major typhoons or earthquakes…The proposed HMD system is fail-safe, signifying its robustness."

"The term 'supertall' (a building over 300 meters) is no longer adequate to describe the world's tallest buildings of the future: we are entering the era of the 'megatall.' This term is now officially being used by the Council to describe buildings over 600 meters in height."

Nathaniel Hollister & Antony Wood, page 44

Debating Tall: A Supertall Future in the US?

In 1990, only 11 buildings in the world could be counted as a "supertall" (defined as a building over 300 meters tall), and all but one could be found in the United States. By the end of 2011, the number of supertall buildings in the world had risen to 42, but during those two decades, only four new supertall building were completed in the United States. So the question posed in this edition of Debating Tall is: *Does the supertall building have a future in the United States?*

YES

Adrian Smith
Partner at Adrian Smith + Gordon Gill Architecture, Chicago

If cities don't continue to build and improve their conditions, they will die. Supertall towers can be a catalyst for growth and prosperity in our cities. I have also seen the pride in people's eyes when they're involved in creating, owning, building and operating such grand edifices. When we lose the spirit to reach for glory, we lose our soul.

When considering the very tall or supertall building in the United States, we have to take into account three factors. One is the cost-effectiveness of the tower, in particular the return on investment. If the construction of a supertall tower makes economic sense and planning permission is given to build it, there will be more supertall structures built in the US. A city such as New York has a very high premium for luxury condominiums in its high-density core that could justify the building of a supertall tower if the government permits it.

If the return on investment is not there for a stand-alone tower, a very tall tower could make sense as the centerpiece of a larger development. The central tower can increase the value of the adjacent land and the buildings around it, making the overall project financially feasible. This was the concept with the Burj Khalifa in Dubai, where the tower itself made little or no profit but increased the value and desirability of the land around it, which made the entire urban subdivision very profitable. Jin Mao Tower in Shanghai was a similar example. If the developer of the Chicago Spire had owned the adjacent parcels of land, the Spire might have been built on this premise.

The third reason to build a supertall is to create a local, regional or national landmark, bringing significant attention to its owner and location. The Petronas Towers in Malaysia is a great example of this approach. Petronas made little economic sense and sat two-thirds empty for several years after completion, but the worldwide attention it brought to Kuala Lumpur and to Petronas as an oil and gas company was very significant. It established Kuala Lumpur as a tourist destination and enhanced its reputation as a location for business. It also showcased the attractive lifestyle of this part of the world and bolstered its economy.

There's no reason that any one of these three development strategies couldn't work in the US. We must always strive for greatness and find the means to attain it. If not, we will become irrelevant.

One World Trade Center, New York will be the newest US supertall when completed in 2013 © CTBUH

NO

Paul Beitler
President of Beitler Real Estate Services LLC, Chicago

From our earliest recorded history, man has been obsessed with building tall structures. The Tower of Babel, the Pyramids, Eiffel Tower, Empire State Building, Willis (formerly Sears) Tower, Burj Khalifa and now the next "world's tallest building" in Jeddah, Saudi Arabia rising 3,280 feet above ground level. Even when man isn't building, that hasn't stopped him from dreaming. In 1956, the visionary architect, Frank Lloyd Wright, proposed a "mile-high" building (which bears a striking resemblance to the design proposed for the Kingdom Tower in Jeddah). If Sigmund Freud were alive today, I wonder what he would say about man's quest to build all these tall towers projecting into the sky. Could it be that man would rather aspire to build the next tallest "anything" than to not aspire at all?

The truth is supertall buildings in America offer no advantage over shorter buildings when attracting tenants or investors. Financial lenders will not take the risk to lend over a five to six year construction period. From an operational and energy standpoint, they are not sustainable. Today, their height serves as a reminder that they were built because someone could.

Looking out from the top of Willis Tower, one gets the same Lilliputian view of the ground below as a passenger flying in an airplane. That is, of course, when the clouds are not engulfing the building reducing visibilities to zero. Standing in the washroom can be such a thrill watching the water in the toilet basin slosh from side to side, as the building sways to the ever constant pressures from the wind.

I've always admired those people who can spend fifteen minutes of their day or more riding a series of elevators and/or escalators to reach their appointed office or living space atop supertall buildings. How frustrating it must be if they forget a business document or car keys and have to make the trip several times. Have you ever tried walking down an eighty-story or taller building when there is an emergency and you can't use the elevators?

Living in the age of "green" awareness, I'm sure that by building "taller" and thin versus "shorter" and wide, there is the argument that with less earth being covered, you are reducing the building's carbon footprint.

Are supertall buildings in America's future? Well, as long as building technology continues to advance; capital to build remains available; and the obsession for tall buildings persists, our attention will be drawn to whomever proposes the next "world's tallest."

Global News

Visit the daily-updated online resource for all the latest news on tall buildings, urban development and sustainable construction from around the world at: ***http://news.ctbuh.org***

Hudson Yards, New York © KPF/DBox

High Line Project, New York © Jeff Goldberg/ESTO

New York

New York has been a regular news source in these columns of late, due to the many interesting projects being developed in the "Big Apple." New York is one of the few cities in the world which is strengthening its position as an international financial center, attracting many unique developments in its wake. This includes a number of projects that are being redeveloped, refurbished, and reenacted after previous delay.

In October, handbag maker Coach Inc. was signed as the first anchor tenant of the development known as **Hudson Yards.** Located on a 10.1-hectare (26-acre) train yard near the Hudson River, Hudson Yards is a massive 1.2 million square-meter (13 million square-foot) mixed-use development by New York based developer Related Companies. The architect of the master plan is William Pedersen of KPF, who had already given delegates at the recent CTBUH Seoul Conference a peek review of what was about to come. Pedersen also designed the two office towers. A 67-story north tower slopes diagonally inland, while the 51-story south tower points diagonally toward the Hudson River. Construction of this first phase of development is scheduled to start in six months.

Located immediately south of the Hudson Yards site, New York's already famous **High Line** project, reported in the Journal 2011 Issue II, has announced a $20 million commitment from the Diller-Von Furstenberg Family. The pledge will support a fundraising effort by Friends of the High Line to transform the third and final section of the High Line at the West Side Rail Yards between West 30th and West 34th Streets and 10th and 12th Avenues. The commitment is the largest contribution to a public park in the history of New York City. To date, Friends of the High Line has raised $85 million toward its $150 million goal for the final development.

Recently, New York has also seen the revival of previously stalled projects. The New York Observer reported that the iconic **56 Leonard Street** project in the TriBeCa area, designed by Herzog & De Meuron, is back on the to-do list of project developer Hines. The design is described by the architects as 58 floors of houses stacked in the sky. The 243-meter (796-foot) tall project was announced just before the start of the global financial crisis, but had since stalled because of it.

… sprout up

> "If London can let skyscrapers sprout up around a 900-year-old church, then surely Washington can live with a few 20-story buildings in its mostly non-historical downtown."
>
> *Stephen Smith, Forbes contributor on Europe's attitude towards modern skyscrapers. From "How Europe Learned to Stop Worrying and Love the Skyscraper," www.forbes.com, October 18, 2011*

Philippines

The Philippines is one of the many Asian countries which has witnessed a strong development of tall buildings, with a number of these aimed at those seeking luxury branded condominiums. Let's have a look at these:

The **Milano Residences** in **Manila,** designed by Jason Pomeroy of Singapore-based

Case Study: The Hansar, Bangkok

Wong Mun Summ

Richard Hassell

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Wong Mun Summ & Richard Hassell
The architecture of WOHA, founded by Wong Mun Summ and Richard Hassell in 1994, is notable for its constant evolution and innovation. A profound awareness of local context and tradition is intertwined with an ongoing exploration of contemporary architectural form-making and ideas, thus creating a unique fusion of practicality and invention. WOHA conceptualizes all aspects of the architectural process, and environmental principles have always been fundamental to the work of the practice, which is guided by a commitment to responsive place-making and to the creation of an invigorating and sustainable architecture.

WOHA's built projects – throughout Southeast Asia, China, and Australia – range from apartment towers to luxury resorts, mass-transit stations, condominiums, hotels, educational institutions, and public buildings. WOHA has won an unprecedented amount of architectural awards for a Southeast Asian practice: they received the Aga Khan Award for Architecture in 2007 for One Moulmein Rise, they collected four awards in the RIBA International Awards of 2011 and 2010 for Alila Villas Uluwatu, School of the Arts, The Met and Bras Basah MRT Station, and they won the 2011 RIBA Lubetkin Prize and the 2010 International High-rise Award for The Met. As an emphatic indication of WOHA's versatility and global recognition, the practice won two titles in two consecutive years (in four separate categories) at the World Architecture Festival: WOHA are the only architects to have achieved such a distinction. Both Wong Mun Summ and Richard Hassell have lectured at universities in Singapore, Australia, Hong Kong, the USA, and the United Kingdom, and they have served on various design advisory panels in Singapore.

"The concept of a tropical tall building as a naturally ventilated, perforated, indoor-outdoor, fully shaded furry green tower is central to tropical living and a necessary alternative to the temperate models of sealed, glazed curtain wall buildings being erected across tropical regions."

High-rise, high-density living has been embraced as a positive housing solution for many millions of people living in Asia's growing urban metropolises. WOHA has designed a series of buildings for South-East Asia that expand the way high-rise, high-density living is conceived. Based in equatorial Singapore, WOHA has designed the following completed tropical skyscrapers: The Met, The Hansar, The Pano, 1 Moulmein Rise and Newton Suites. Approaching the design from lifestyle, climate and passive energy strategies, the towers are radical yet simple. This paper focuses on The Hansar, a 45-story hotel and residential development that embodies principles of sustainable and tropical living within dense urban cities.

Bangkok, Thailand

Bangkok, the capital city and main port of Thailand, is a major economic and growing financial center in Southeast Asia with a population of nearly nine million people within a city area of 1,569 square kilometers (605.7 square miles). With the highest volume of vehicular ownership in Asia, Bangkok is one of the most congested cities in the world with notorious traffic jams and high levels of vehicular exhaust emissions resulting in severe air pollution.

A rapidly modernizing community, Bangkok has one of the fastest rates in the world for erecting high-rise buildings, but its construction industry still relies intensively on manual labor and the use of locally available materials, which are far cheaper than imported alternatives. Most existing buildings in Bangkok are designed to resist lateral wind loads only. In the wake of the 9.1 magnitude Great Andaman Earthquake on December 26, 2004 and the subsequent tsunami tragedy, the first seismic design regulations were

enforced in 2007 mandating that buildings above 15 meters (49 feet) tall be designed to accommodate for seismic movement.

Bangkok is situated on a low flat plain of the Chao Phraya River which extends to the Gulf of Thailand. Geographically located 13°45′ North (latitude), and 100°28′ East (longitude) of the equator, the city's climate is hot and humid with temperatures ranging from 26 to 31°C (78 to 90°F). A normal year is defined by three main seasons, with the cool season occurring from November to February; the hot season from April to May; and the rainy season from June to October. In this environment, being high up where there is more privacy, better views, lower humidity, stronger breezes, better security, less insects, less noise and less dust make external high-rise spaces pleasant, comfortable and desirable. A typical overcast sky also means diffused lighting and many hours of sunlight that generally reaches into buildings at a height-to-depth ratio of 1:2, which needs to be countered with sufficient shading.

Introduction and Site Context

The Hansar is a "crown property" located in the heart of Bangkok adjacent to the Four Seasons Hotel, just off Sukhumvit Road, which is the city's leading commercial, retail and entertainment district. It is surrounded by major shopping areas, a large city park, high end condominiums and luxury hotels (see Figure 1). The development, conveniently located within walking distance of the Rajdamri BTS Station, encourages a practical way of dealing with Bangkok's urban sprawl and severe traffic jams by permitting higher use of the city's existing public transport infrastructure, its privately run elevated walkways and an improved pedestrian

Figure 1. The Hansar, Bangkok © WOHA

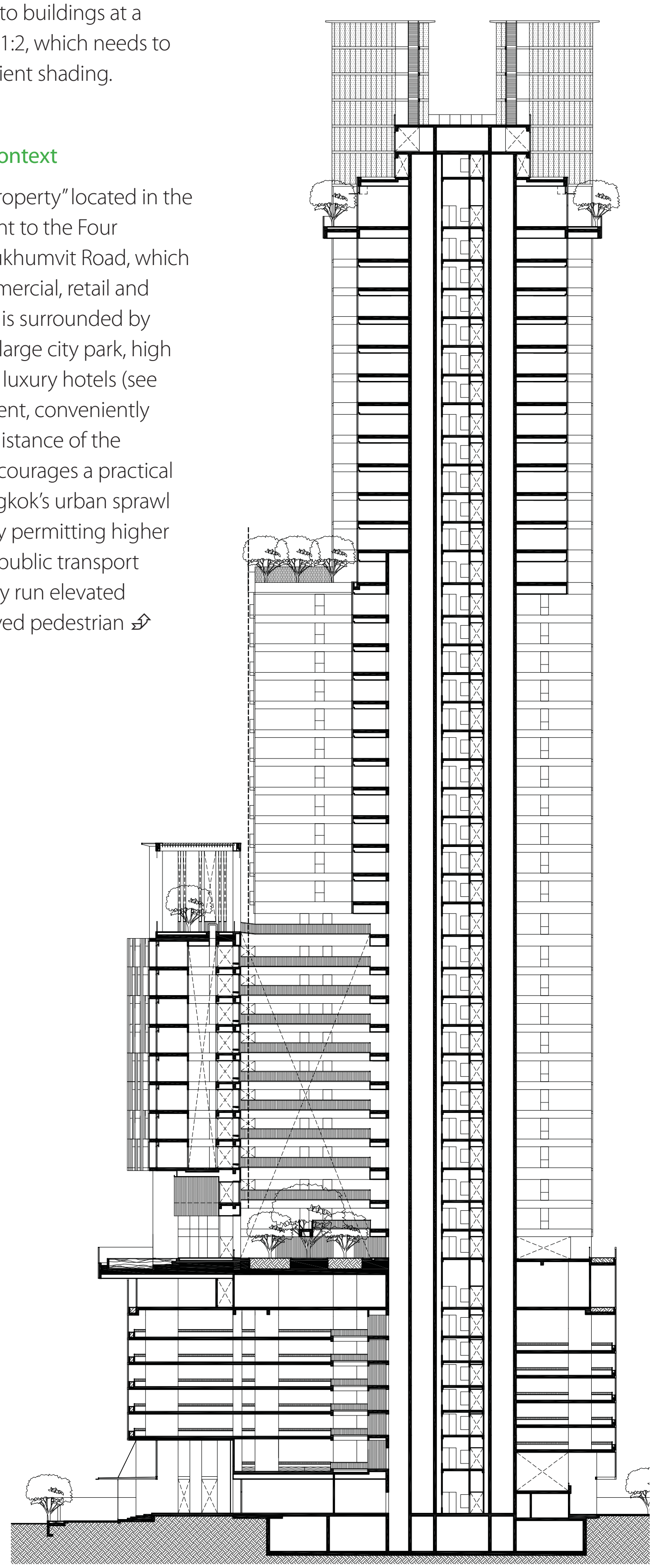

Figure 2. Typical section © WOHA

Hybrid Mass Dampers for Canton Tower

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Yanhui Liu
Dr. Yanhui Liu is a research faculty in EERTC. His research field is structure vibration control. During the past several yeas, Dr. Liu has been one of the principal designers of hybrid mass dampers for the Canton Tower.

Jun Teng
Dr. Jun Teng is a professor at Harbin Institute of Technology. Dr. Teng's expertise is on structural health monitoring and vibration control in China, studying both theoretical methods and application for real structures. He has conducted health monitoring systems on several high profile large space structures such as the National Aquatic Center.

"The Hybrid Mass Damper (HMD) system possesses multiple security measures, which can ensure the safety of HMD under major typhoons or earthquakes…The proposed HMD system is fail-safe, signifying its robustness."

This paper presents an analysis of the design and application of novel Hybrid Mass Dampers (HMD) for Canton Tower in Guangzhou, China. The HMD is composed of a passive Tuned Mass Damper (TMD) with two-stage damping level, and a compact Active Mass Damper (AMD), which is driven by linear induction motors mounted on the TMD. In case of a failure in HMD control system, the system would become a passive TMD.

Introduction

During the last three decades, the technology of active structural control has become a significant research focus in the field. There are a lot of successful examples of AMD or HMD application for tall buildings, TV towers, bridge towers, etc.; to attenuate the wind-induced vibration. As early as 1987, Aizawa conducted a shaking table test of a four-story frame in Japan and his test verified that an AMD can reduce the seismic responses of the structure (Aizawa et al. 1990). Spencer presented a benchmark model of AMD control for a three-story steel frame (Spencer et al. 1998). After several years of experimental and theoretical studies, this technology was applied in a "real world" venue and achieved remarkable success. To date, many practical engineering projects worldwide have implemented AMD control systems, and many of them have withstood the test of typhoons and earthquakes. The real-time monitoring results have shown that AMD or HMD can achieve a preferable degree of vibration suppression (Ou 2003, Shizhu et al. 1999 & Hongnan et al. 2008).

A novel HMD is proposed herein to stabilize Canton Tower against movements caused by major typhoons, which would be composed of: a passive TMD with two-stage damping level and a small AMD driven by linear induction motors mounted on the TMD. This paper introduces the design of the device composition, i.e., water tank, bi-directional rail roller bearing, laminated rubber bearing, oil viscous damper, AMD, and anti-torsion bearing as well as multiple security measures of a HMD system. A numerical simulation of Canton Tower with various control systems was carried out to investigate the advantages of the proposed HMD system over other control systems. Simulation results were compared with the passive and full-active various control systems. The three most unfavorable wind attack angles were also considered in the numerical simulation.

General Description of Canton Tower

Canton Tower is a landmark of the city center business area of Guangzhou, China with a

Figure 1. Canton Tower, Guangzhou © EERTC

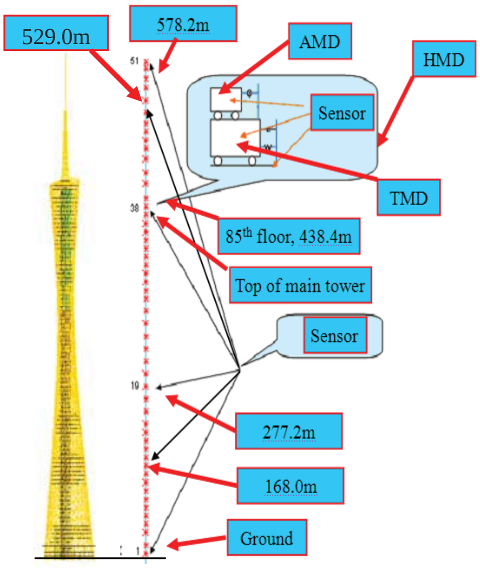

Figure 2. HMD control system © EERTC

total height of 600 meters (1,969 feet) (see Figure 1). It houses a restaurant, observatory and telecommunications facilities. The main tower is 454 meters (1,490 feet) tall with a 146-meter (479-foot) tall antenna on top. The total weight is around 194,000 tons. The fundamental period of Canton Tower is 10.01s as indicated by three-dimensional finite element analysis of ANSYS. According to the code for seismic design of buildings in China, Canton Tower is a Class A building based on its design classification.

Canton Tower is a tube-in-tube structure composed of a reinforced concrete inner structure with ellipse cross-sections of 14 and 17 meters (46 and 56 feet), and a steel lattice outer structure with its cross-section being a varying oval throughout the height of the tower. The cross section of steel lattice twists from ground level to the roof, which gives the building its unique feminine profile. The lengths of its major and minor axis are 80 and 60 meters (262 and 197 feet) respectively in the bottom layer, 27.50 and 20.65 meters (90 and 68 feet) in middle layer, and 50 and 45 meters (164 and 148 feet) in the top layer. This external frame comprises 24 inclined concrete-filled columns, horizontal ring beams, and diagonals. The antenna on the top of main tower is a steel spatial structure with an octagonal cross-section of 14 meters (46 feet) in the maximum diagonal.

Since the tower is a supertall construction with a slender profile and low damping, it is dynamically wind sensitive, which would potentially increase acceleration levels under strong wind. The persistent wind-induced vibration can not only result in fatigue damage of the tower, but also induce discomfort for occupants. It is therefore necessary to develop an effective control strategy to improve the comfort and serviceability of Canton Tower.

Proposed HMD control system

The location of sensor, the HMD, and the HMD vibration control device is at a height between 438.4 and 448.8 meters (1,406 and 1,472 feet) (see Figure 2). Our novel active-passive composite T system is a combination of a TMD with a variable two-stage damping level, and a small AMD mounted on the TMD (see Figure 3). Two symmetrical fire water tanks are designed as the tuned masses, each weighing 600 tons, sitting on the three bi-directional rail roller bearings installed on the 85th floor of the main tower. Laminated hollow rubber bearings are used to provide the stiffness of the TMD. A two-stage oil damper is designed for the TMD, which is capable of adjusting the damping level of the TMD automatically once the TMD stroke exceeds a given level. The 50-ton AMD, driven by linear induction motors, can improve the control performance and the robustness of a passive TMD significantly. The anti-torsion bearing is installed between the main tower roof and water tank to prevent the water tank from moving rotationally. The newly proposed HMD system is designed to stabilize the tower against movement; to significantly improve the structural serviceability; and to enhance occupant comfort in the event of strong winds. Because the responses of Canton Tower in the short-arm direction is much greater than responses in the long-arm direction, HMD control was employed in the weak axial of main tower, while TMD control was used in the strong axial due to the consideration of economic costs and a compact system.

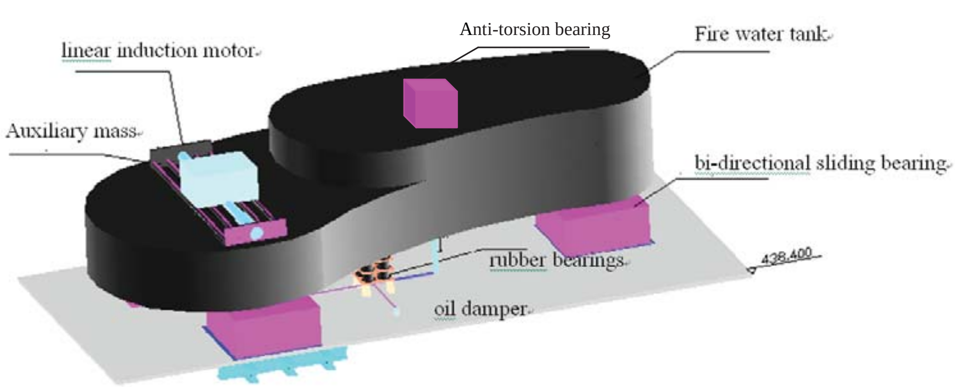

Figure 3. The proposed HMD system © EERTC

Design of HMD Components

Fire Water Tank

Inertia-based dampers such as TMD commonly requires an additonal mass to provide a given damping level, which may be heavy and costly. Analysis shows that Canton Tower is sensitive to the vertical gravity load. Instead of introducing extra gravity loads, two water tanks for fire control in Canton Tower are set on the 85th level and occupy two floors, serving as the shared tuned mass of the TMD in both horionzontal directions of the main tower. It is worth mentioning that this level will be open to the public for sightseeing and for an educational exhibition of how the HMD system works.

The total weight of each fire water tank is 650 tons which is about 0.35% of the tower's total weight. Not only does the shape of the water tanks meet the demand of space, but it also offers an appropriate mass ratio to make the TMD achieve a favorable level of performance. The top of the water tanks are not

About the Council

The Council on Tall Buildings and Urban Habitat, based at the Illinois Institute of Technology in Chicago, 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

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