

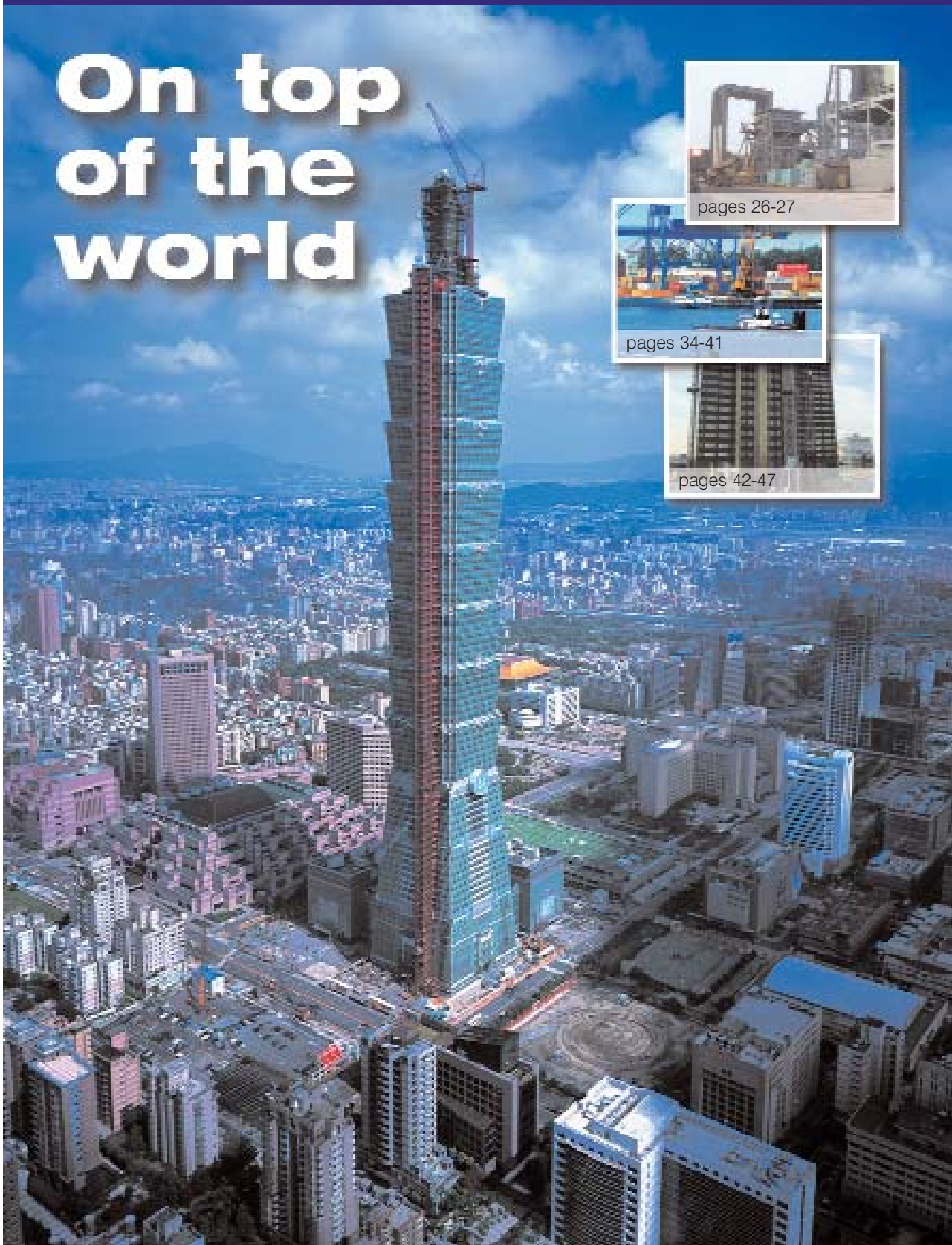
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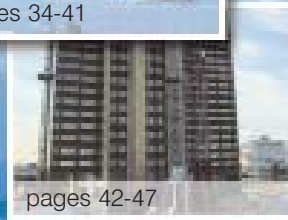
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ON TOP OF THE WORLD



TAIPEI 101

An outstanding landmark is enough to transform any city, take the Empire State Building in New York City, the Eiffel Tower in Paris, or the Jinmao Mansion, Shanghai. The world's tallest building does the job even better.

In the 21st century, Taiwan's capital needs a more expansive status to match its progressive performance. TAIPEI 101 is an

engineering feat expected to bring the city into the spotlight on the world stage. Located in the finest district Taipei has to offer, this is the largest engineering project in the history of the Taiwan construction business.

It is a major Bank of Taiwan project that represents the first joint effort between the Taipei City Government and the private sector. It will be managed by the Taipei

Financial Centre Corporation (TFC), which has a 70-year lease on the building.

Backed by 11 businesses, the TFC is the land developer responsible for the planning, implementation, operation and management of the project.

The shareholders are 14 renowned domestic businesses, including the Taiwan Stock Exchange and China Development Industrial Bank Inc.

The main contractor, Turner International, compiled project specifications at the start of the project. Firstly, "to develop an efficient 277,000-square metre site in the Hsin Yi Area of East Taipei, Taiwan for commercial and retail tenancy."

Secondly, "to design a signature structure engineered to the highest standards appropriate to local seismic, geological and climactic conditions." Thirdly, "to use green and smart energy conservation, systems management and control technology."

And lastly, was the need "to offer international class facilities and space usage flexibility, and provide a quality complex requiring minimum maintenance and disturbance free occupancy to tenants."

TAIPEI 101 will become the quintessential landmark of Taipei city and the Taipei Manhattan district. Eastern architecture will meet western technology within this symbolic building.

The design process meant a thorough investigation of all shapes, all proportions and all possible heights. The chosen solution is a world ranking structure, with its pinnacle at 508 metres, and the top of the roof structure at 488 metres high.

To compare to other tall buildings, the next best thing is the World Financial Centre in Shanghai, China at 460 metres high, followed closely by the 450-metre Petronas Tower, Kuala Lumpur, Malaysia.

Eastern image

TAIPEI 101 follows the Chinese pagoda form, transcending the uni-body concept. Resembling the flexible yet persistent bamboo plant that rises into the sky, the building is a reflection of traditional Chinese building philosophy.

The architect, CYL decided to base the structure on the Chinese number eight, a numeral long considered lucky in Chinese culture. Eight-floor structural units are connected one by one, on top of each other to form the whole. This kind of rhythmic aesthetic is brand new to skyscrapers.

FACT BOX

TAIPEI 101 has a 30,277 square metre site area and 373,831 square metre floor area.

It stands at 508 metres high with 101 floors, 61 elevators and 50 escalators.

There are 550 piles and the excavated volume was 542,000 square metres.

The building is put together using 107,000 tonnes of steel, and 102,500 square metres of curtain walling.

Its 680 tonne mass damper and 400 tonne pinnacle demanded the highest jacking operation ever.

Its chiller load is 13,600 RT, power peaks at 30,000 KVA and it has an emergency power supply of 14,000 KVA..

The mega-column structural system is built from 60 x 80 millimetre high quality steel and there are 2,500 kilometres of six-millimetre fillet equivalent welding on site.

The lift capacity is achieved by specially designed tower cranes, with a one-kilometre long, eight-tonne tower crane cable.

The ornate interior and exterior detailing also draws in many elements from Chinese art history - inspired by traditional sculpture and artistic forms.

The overall design consists of a super high-rise tower and a low-rise podium. The shopping mall or social plaza is enveloped within the podium. This is a 41-metre high grand space constructed with a super spinal truss and illuminated with in-directed sky lighting.

Inclining four degrees inwards, the structure increases in size as it gets higher. This facade is both flamboyant and functional - driving concepts behind it are less sun, more view.

And when you consider the sheer height, exposure and opportunity for viewing the Taipei vistas, you realise how important this really is.

High tech materials and innovative illumination create a see-through effect with transparency and clarity that facilitates the harmony between the building and its natural environment.

Tall and green

Energy conservation was one of the specifications set out in the beginning. With a sophisticated building like TAIPEI 101, to install anything other than the most advanced technologies would have been incongruous.

TAIPEI 101 uses energy efficient materials to minimise long term energy consumption. The transparent and non-reflective curtain walls are made of double e-glass which is energy efficient and heat reflective.



Facing and above: the Taipei finance tower is designed to resemble a growing bamboo shoot or an inverted pagoda. Inclining four degrees inwards, the structure increases in size as it gets higher.

FACTFILE

Its height of 508 metres will rank TAIPEI 101 as the world's tallest building.

Number two is the 460-metre World Financial Centre, Shanghai, China.

At number three is the 450-metre Petronas Tower, Kuala Lumpur, Malaysia

Fourth in world ranking is Sears Tower in Chicago, United States. The Tower stands 443 metres high.

Next is the Jin Mao Building, Shanghai's second building in the list. This is 421 metres high.

Other green elements include ice-storage systems to balance power consumption and reduce cooling equipment loads; a dual power system; and a gray water recycling facility for irrigation, landscaping and sanitation use.

To guarantee reliable power supply, TAIPEI 101 will have a redundant power distribution network. There will be dual incoming electrical feeders from separate substations and an on-site back-up power generation system to maintain tenant operational requirements.

A city microcosm

With a forward-looking philosophy that marries technology and culture, TAIPEI 101 is a building that can accommodate more than 10,000 individuals as well as business, financial and industrial operations.

By providing a brand new living, consumption and entertainment space. Like a self-sufficient organism, the enormous building will be the epitome of city life.

The observatory at the top symbolises the window to the future, accessible via the world's fastest express elevator. It enables observation of the entire city of Taipei - from the highest point of the city, no less.

A double deck system means that there is less core area, and the transfer lobby is divided into a high, middle and low zone. The fastest lift car on the market, operating at 16.8 metres per second, will reach the 89th floor in just 39 seconds.

Why do it? Everyone wants to visit the world's biggest, smallest, tallest, fastest, record holders. Before it, Japan's Yokohama Landmark Towers has held the title as the world's fastest passenger lifts with a velocity of 12.5 metres per second.

The TFC observation lift will be equipped with onboard digital speedometers that will be continually displayed. Despite its high speed, it is designed to run quietly with the least possible perception of movement, a pleasant route to the view from the top.

Standing firm

There have been concerns over the safety aspect with Taiwan located in one of the world's most earthquake-prone belts. In March 2002, an earthquake measuring five on the Richter scale hit Taipei.

In fact, two cranes on the top of the skeletal TAIPEI 101 building crashed down into the street, killing five people and injuring 23 others. "The quake did not cause any damage to the structure," says Dugald MacKay, project executive for the Taipei branch of Turner International. "Before resuming steel erection, the cranes' masts were strengthened and stiffened," he explains.

Typhoons are also frequent visitors, with winds reaching 180 kilometres per hour. Therefore, Evergreen Consulting Engineering, Inc. and Sino Geotechnology, Inc. were called in to study the natural constraints of the site.

To guard the 508-metre tower against wind damage, a 50-year drift ratio, a 100-year stress ratio and half-year human comfort ratio have been calculated. Seismic protection must ensure that the building remains 'elastic' for a period of 950 years, and evades collapse for 2,500 years.

In light of the geotechnical study, 40-60 meters of soft soil were laid on top of the rock formation. Then, 500 piles with a total length of over 26.7 kilometres were drilled 20-30 metres down into bedrock.

There is an 11-storey mega structure system, supported by eight 'super main' columns. As every eighth floor constitutes an autonomous space, wind effects on the surface seen in high rise buildings are eliminated. All columns are in-filled with high strength concrete, pumped to a height of 448 metres in the tower.

advert



Above: view of the top - giving some perspective of the soaring mass of the world's tallest building

The design of the foundation guarantees pedestrian safety and comfort. In total, 24,000 square metres of concrete is placed in the mass foundation for the tower.

The structural system developed has outrigger trusses and a braced core. Special measures to resist wind and seismic forces include: high strength and high ductility steel plates; high strength and high performance concrete with a 10,000 psi; high ductility beam-column connection with reduced beam sections; a tuned-mass damper in the tower; and a smaller tuned-mass damper at the pinnacle.

The visible wind damper on the 88th floor comprises of a 680 tonne steel ball, eight

high strength steel cables, eight viscous dampers/shock absorbers, and eight snubber dampers.

Fire protection is precisely designed - safety areas and routes have been effectively fitted into the building's architectural elements. There are on-floor escape corridors, intermediate refuge areas every eight floors, and pressurisation of adjacent floor areas to block smoke infiltration.

A world first

The project is groundbreaking in many important ways, even in terms of the techniques and equipment required to bring it to life. Custom designed Cab was used in structuring the platforms to guarantee they would suit the building profile. The world's tallest temporary structure was also used.

Not only committed to the highest building standards regarding construction hardware, TAIPEI 101 pursues world-class software for operation and management.

What the building aims to create is more than just a milestone in the history of architecture; it also aims to show the utmost performance that combines technology, art, economic prowess, and humanity.

DEVELOPMENT TIMESCALE

July 1997 – land development contract secured	July 2003 – topping out ceremony of the tower
January 1998 – groundbreaking ceremony	October 2003 – mall suboperational
October 1999 – start of work on the main structure	September 2004 – office tower inauguration
June 2001 – upper beams of the mall area raised	

What TAIPEI 101 fulfils is more than just becoming world number one; it is also an outstanding symbol that 23 million people in Taiwan will take pride in. It will successfully show the world the achievements that Taiwan has made over the past 50 years.

But as proof that the ego-driven tall-building trend is alive and well, TAIPEI 101's reign as a super skyscraper will not last long. It is but one of several skyscrapers on their way. Freedom Tower, New York, will stand 1,776 feet high when finished in 2006. Shanghai World Financial Centre will also be taller than TAIPEI 101 when completed in 2007.

Structurally sound

Thornton-Tomasetti Engineers has been deeply involved with the structural system. Dennis Poon, managing principal, and Leonard Joseph, senior vice-president, said: "We contributed structural system concepts, criteria and preliminary designs, performed peer reviews of the construction documents, and consulted on specific issues during design and construction.

"Our involvement reflected the experiences we gained in developing the structure of the Petronas Towers in Kuala Lumpur, previously the world's tallest buildings, as well as other high-rise towers.

"We considered it an honour to have

STRUCTURAL SYSTEM

The structural system includes many elements that contribute to its status: A braced core and multiple outrigger system with concrete-filled box columns assures building stability, minimises wind sway and improves occupant comfort.

A dual system of internal bracing and both perimeter and internal ductile moment frames provide a highly redundant earthquake-resisting system. Belt trusses on multiple floors direct gravity and

overturning loads to the megacolumns on each face. Floor plane bracing transfers perimeter lateral forces past building setbacks.

A tuned mass damper on the observatory deck minimises human perception of building movements; other, smaller dampers control wind sway of the spire. Long span steel floor framing eases space planning and future tenant modifications.


collaborated with the owner, the architect, the local structural engineer, other consultants and the construction team, to provide TAIPEI 101 with a state-of-the-art structural system befitting its premier status. We are sure the project is destined to become an internationally recognised landmark in keeping with the state-of-the-art structural system supporting it."

Engineering a masterpiece


Valentine Lehr of Lehr Associates gives an insight into the engineering at TAIPEI 101: "When involved with the design process for

Project Team

Developer – Taipei Financial Centre
 Project manager - Turner International
 Architect - CYL & Partners
 Structural Design - Evergreen Consulting Engineering, Inc



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innovative new buildings, a peer engineer fulfills two functions. First, it reviews, with a critical independent eye, the work of the design and production engineering team. Secondly it is expected to be a source of ideas and the group that provokes inquiry into innovative approaches.

"As the mechanical, electrical, and life safety/fire protection peer engineer for TAIPEI 101, Lehr Associates enjoyed an exciting and simulating role in development of the building services engineering design for the colossal structure," Lehr continued.

"The challenge for this landmark project was not only to construct a taller building but also to advance the state-of-the-art systems that would ensure the comfort and safety of all its inhabitants. Additionally, the unique climatic and infrastructure conditions in Taipei proved both problems and inspiration for innovative approaches.

"While this challenge was met in all of the engineering systems for the tower, the air conditioning and ventilating systems offered the greatest opportunity for exploration and innovation. The combined team's extensive design and review process resulted in a mid-tower plant location facilitating piping distribution and equipment selection. The thermal storage system provides impressive utility savings, and the load

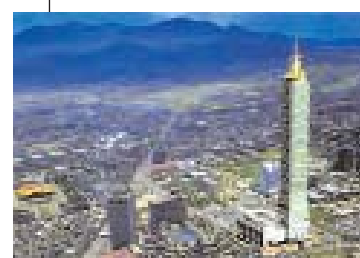
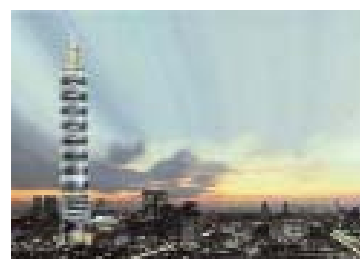
temperature air distribution systems compliment the limited space available in the extremely efficient, tight floor footprint.

Lehr remarked: "In this age of security concern, the design offers exemplary protection from chemical and biological threats. Considerable care was taken in the life safety planning for the building, offering levels of overall occupant protection well in advance of other current high-rise designs.

"TAIPEI 101 also includes a base construction with extensive commercial and public spaces. This building element offered substantial potential for thermal storage, and the system is the backbone of an energy savings programme of note.

The high occupancy density for the commercial shopping area also necessitated extensive review of smoke control and life safety systems. The resulting design is a model of current technology for assuring safe egress of the shopping complex in the event of disaster.

Concluding, he said: Lehr Associates is proud to have contributed to TAIPEI 101 and to have worked on the development of systems offering high levels of occupant comfort, exemplary safety, and operational efficiency and economy."



Above: the tower will make its presence felt in Taipei, both night and day

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