taipei 101

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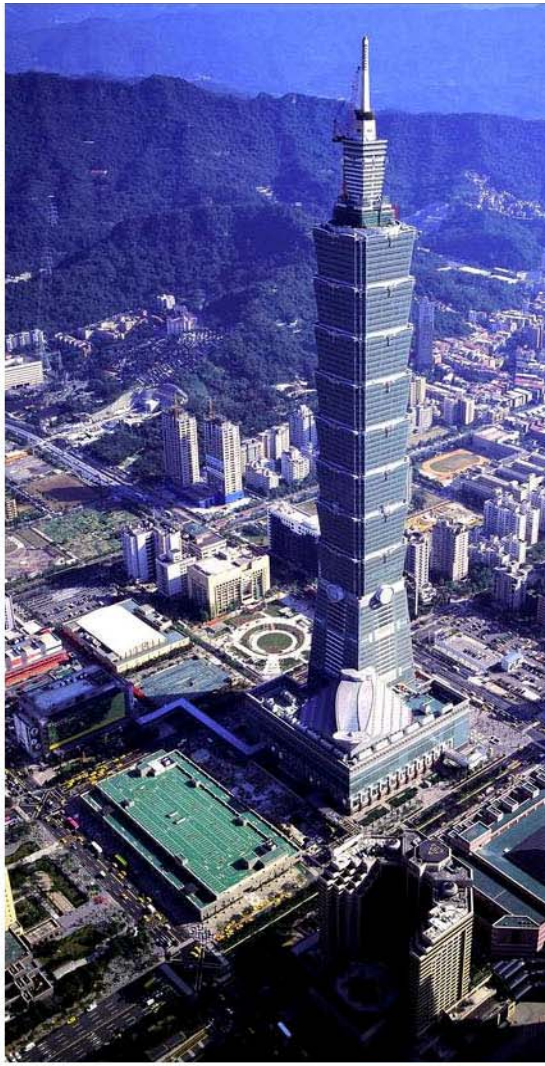

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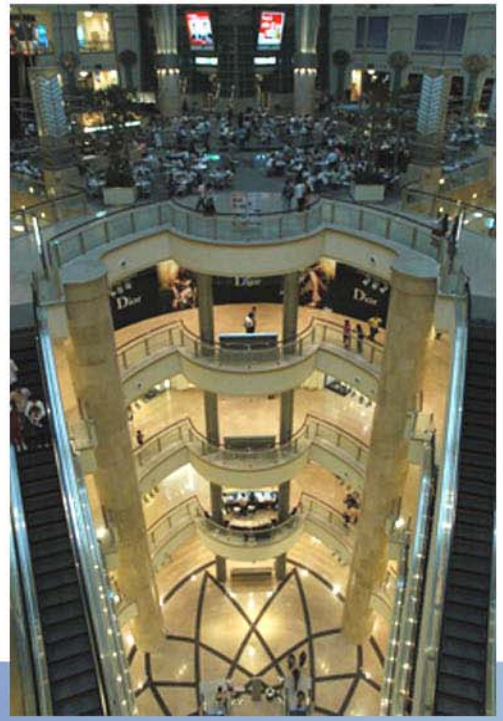
project details

client : taipei financial center corp.
architect : c y lee
structural : thornton-tomasetti engineers. new york consultants
wind tunnel testing : rowan williams davies & irwin inc
cost : $1.75 billion
building typology : mixed use
height : 508.0 m, (1667 ft)
stories : 101
area : 412,500 sq.m

construction material : steel, in-situ concrete and glass

date of commmencement : Jan 1999
date of completion : Dec 2004



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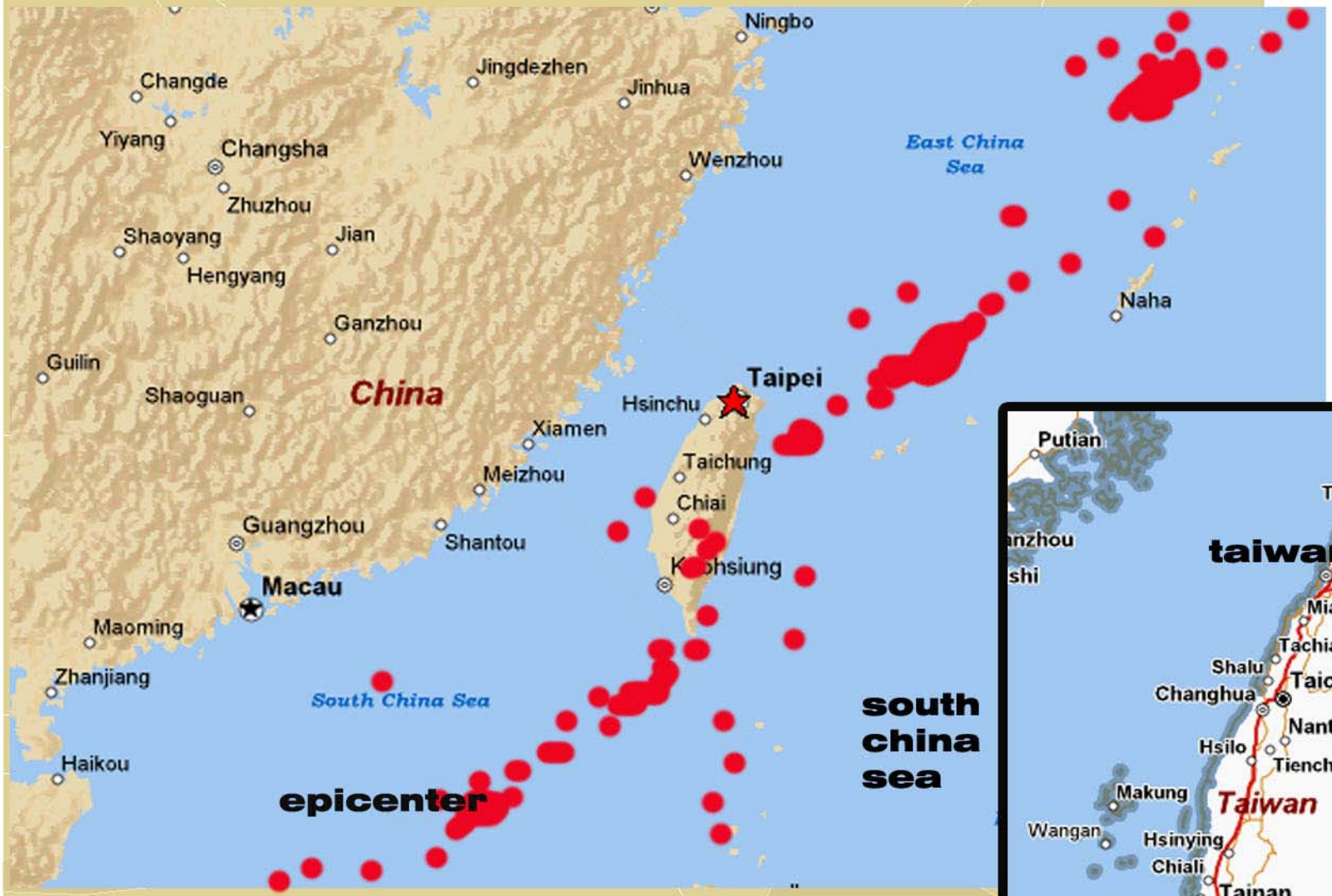

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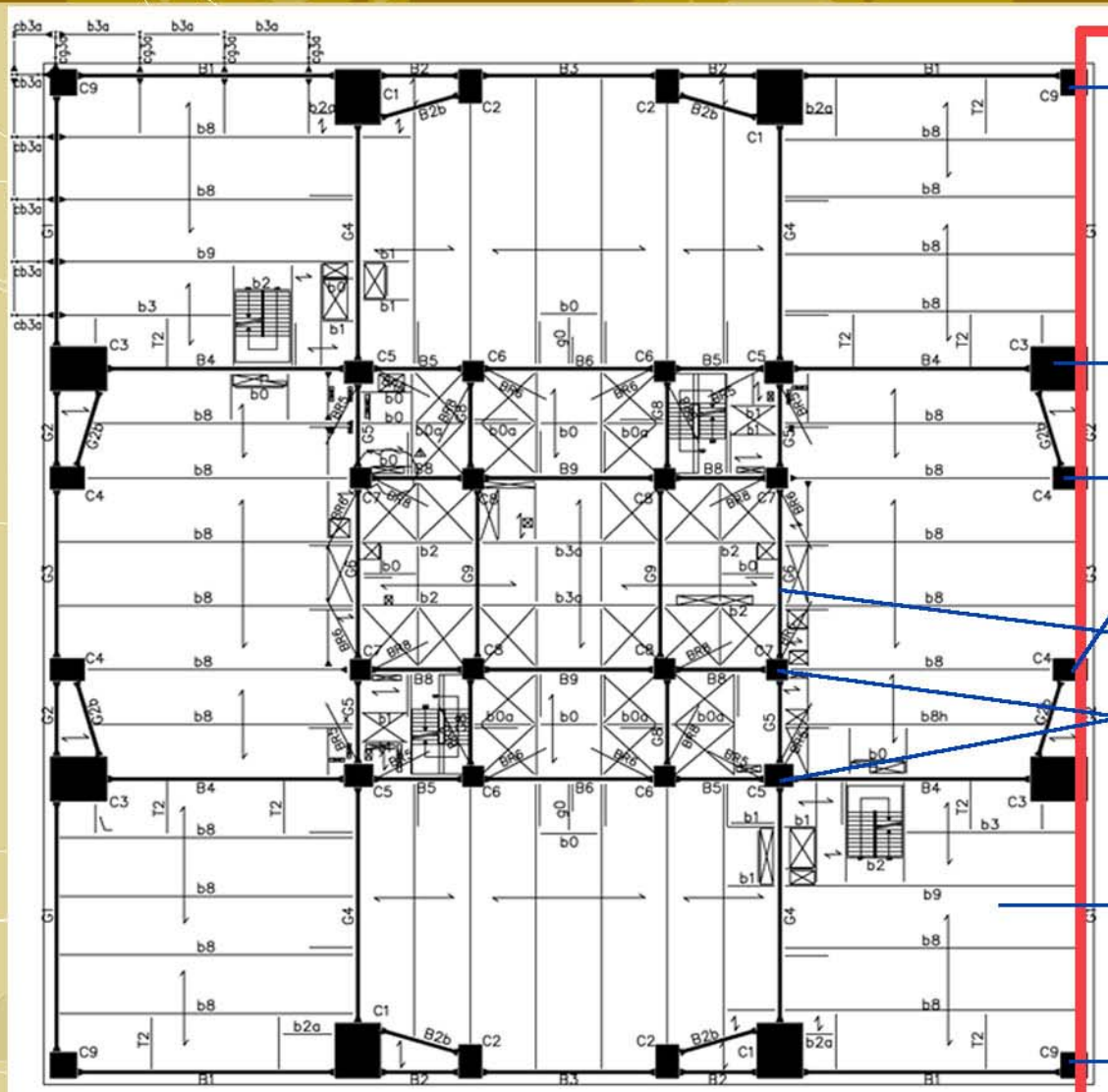
structural analysis



level 10 : tower framing plan

corner columns

super columns
filled with concrete up to 62 floor

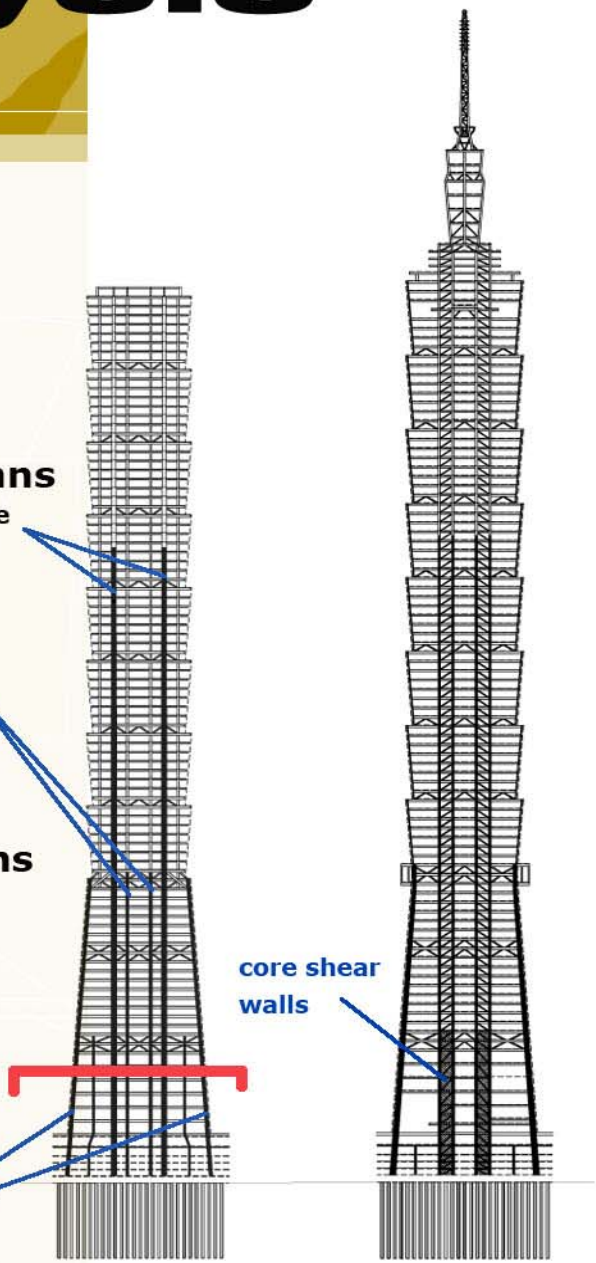
sub- super columns

core shear walls

core columns

one way slabs

corner columns



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construction phases

The massive supporting pillars are made of boxes of 80 mm thick steel-plate, filled with concrete for stiffness.

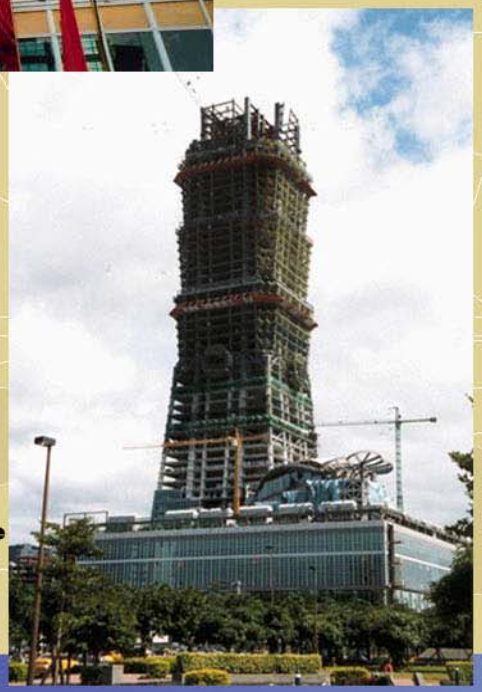
However, only steel is used above the 62nd floor. There are 16 of these giant columns to support the gravity-load.

There are many lateral braces and moment-resisting frames around the building perimeter.

Wrapped around the supercolumns is a web of a ductile steel framework designed to bend during an earthquake.

The frames support the outward slope of the building, making possible the repeating inverted pyramid shape.

There is a dedicated mechanical floor every eight floors, with massive floor-high steel outrigger trusses.



These connect the columns in the core to the supercolumns on the perimeter, effectively widening the building to help it resist overturning.

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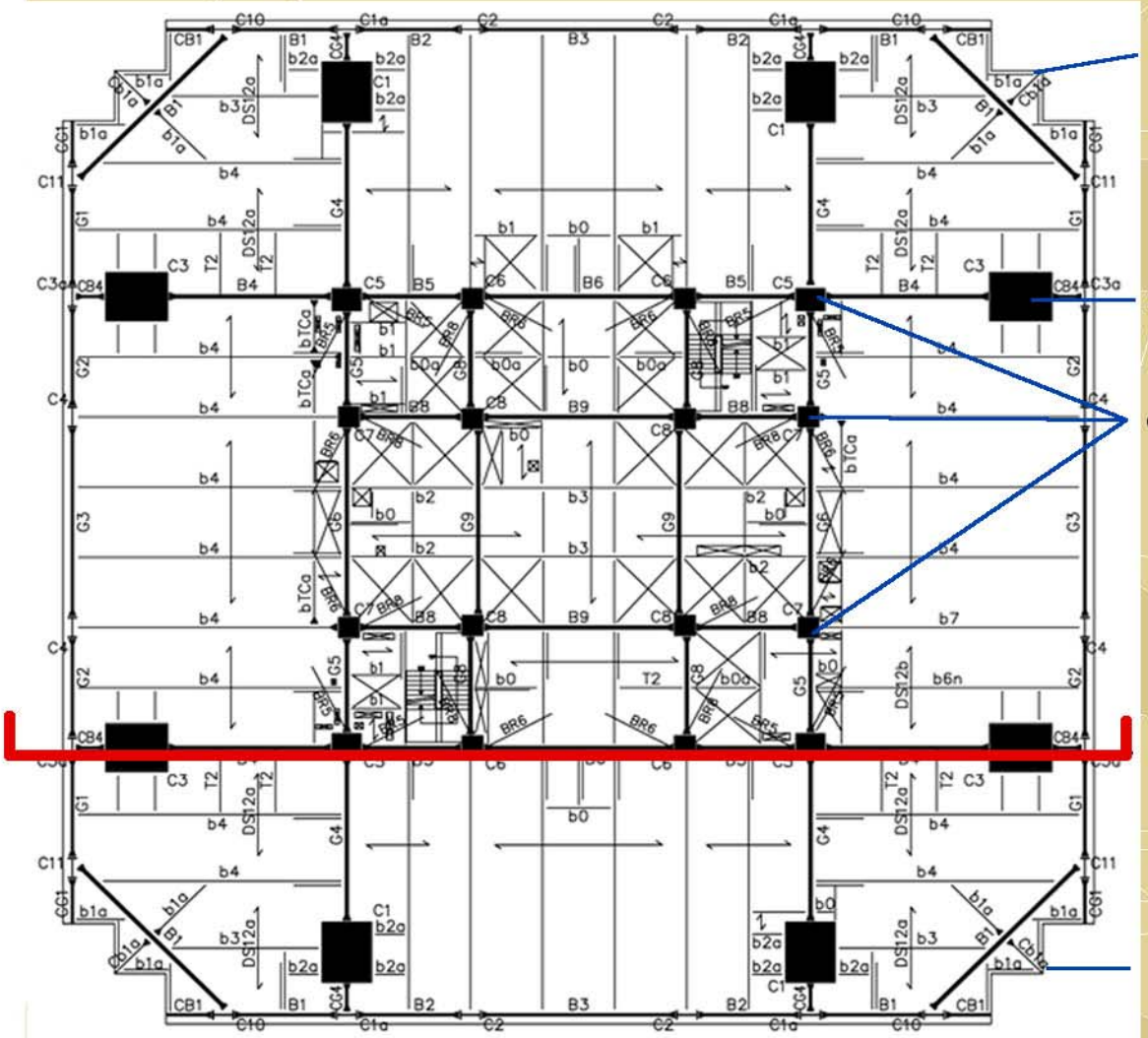
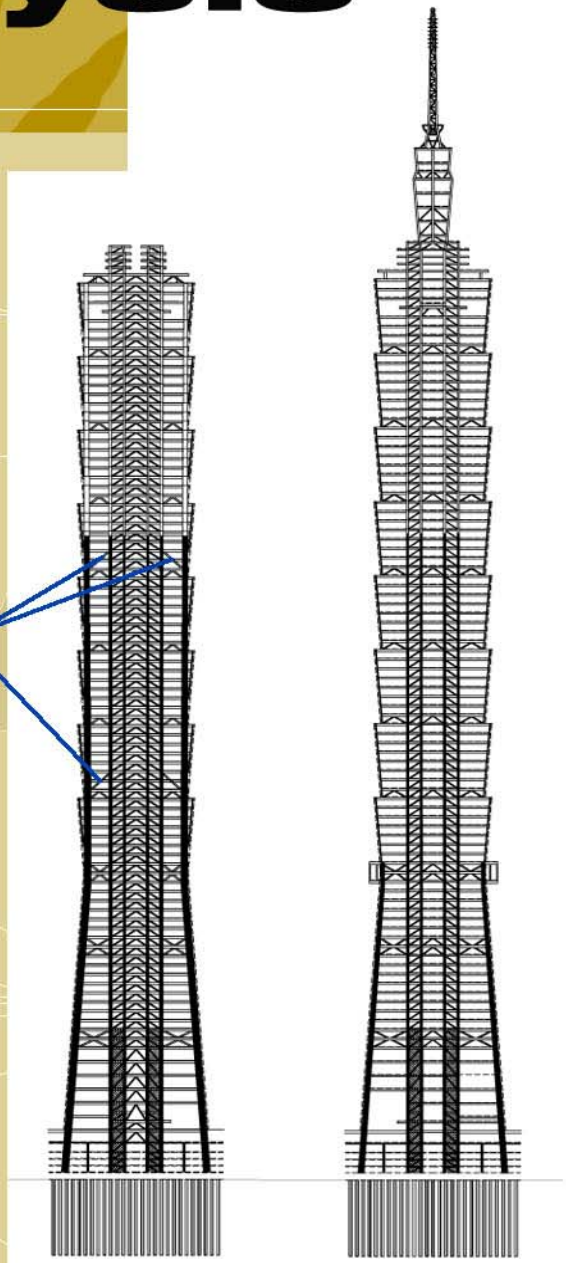
structural analysis



level 32, tower framing plan



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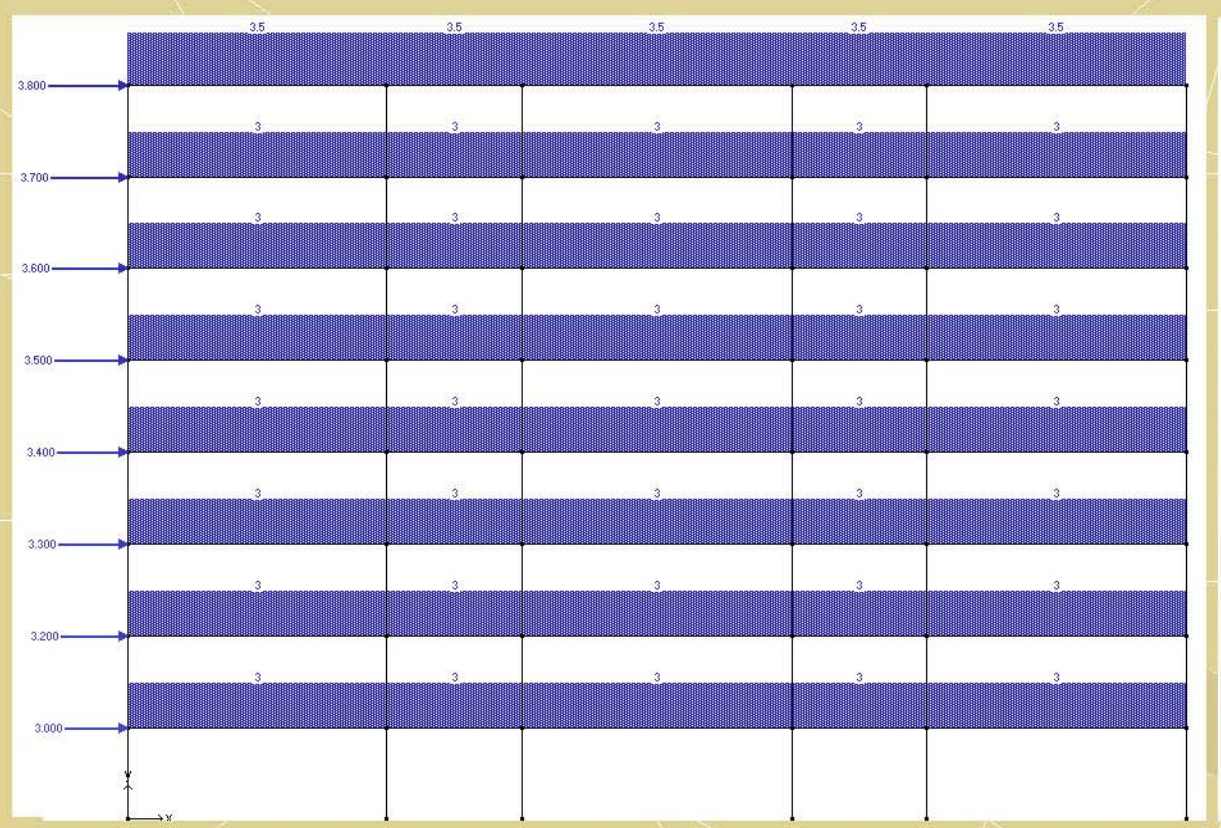
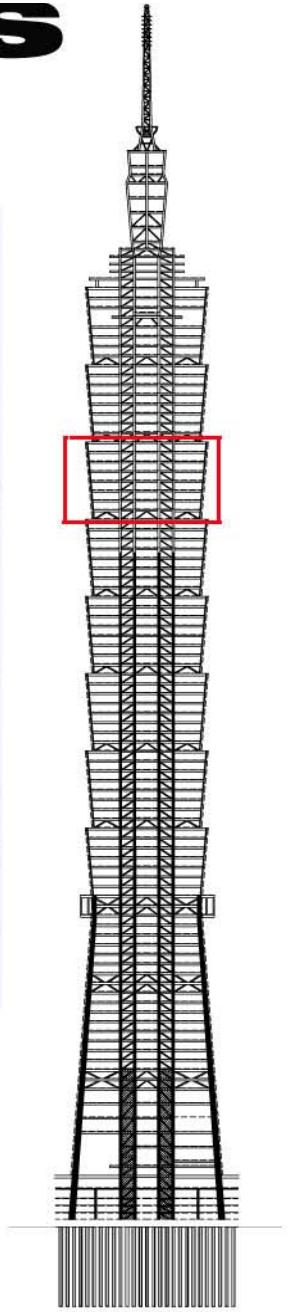
structural analysis





considering five bays of unequal lenghths. The exterior columns are super columns sized 3m x 2.4m and the internal columns are 1.5m x 1.2 m.

loading conditions for a single module:
live load on each floor = 3.0KN/m
live load on top floor = 3.5 KN/m
(considering load of the outrigger truss)
wind load = 3.0 KN/m to 3.8 KN/m

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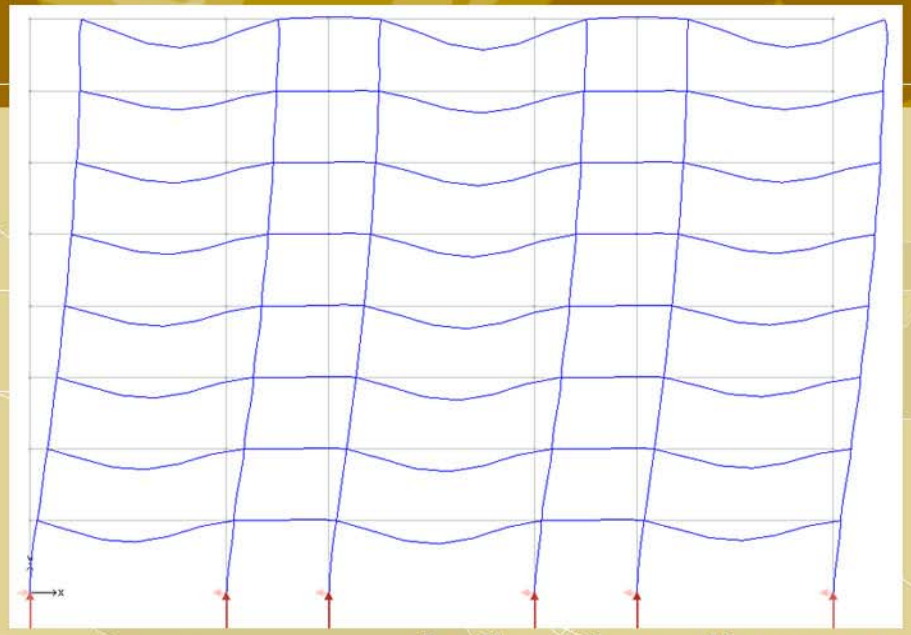
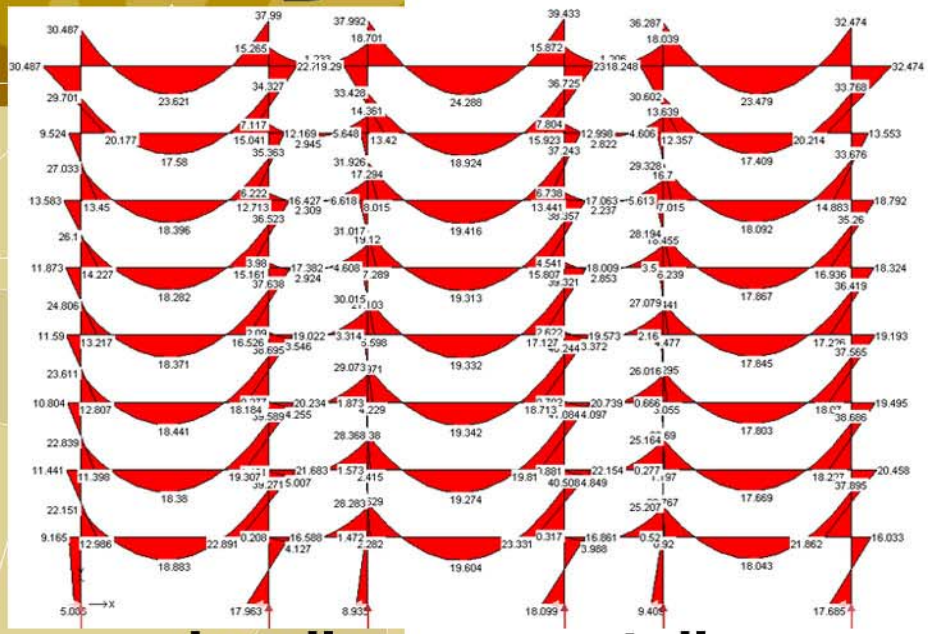
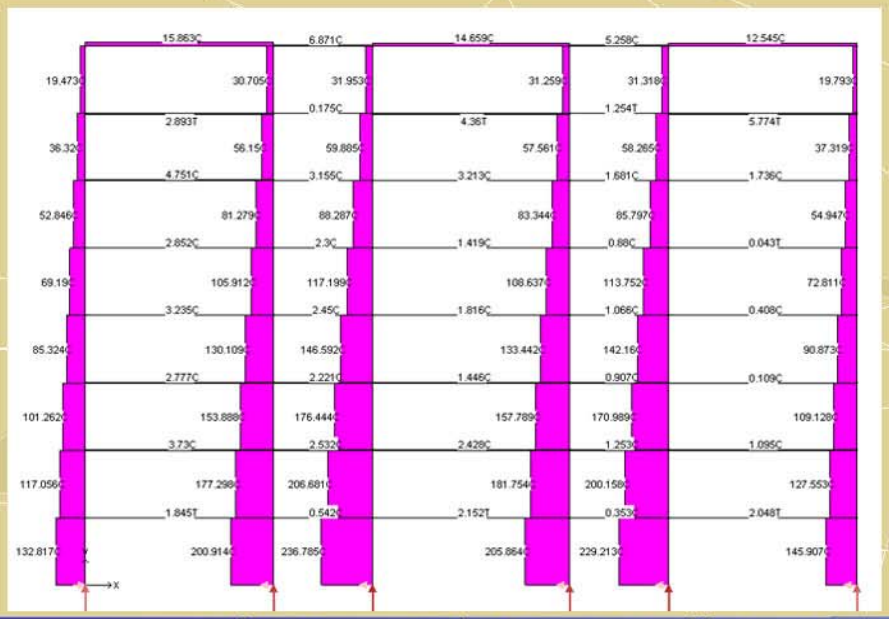
structural analysis



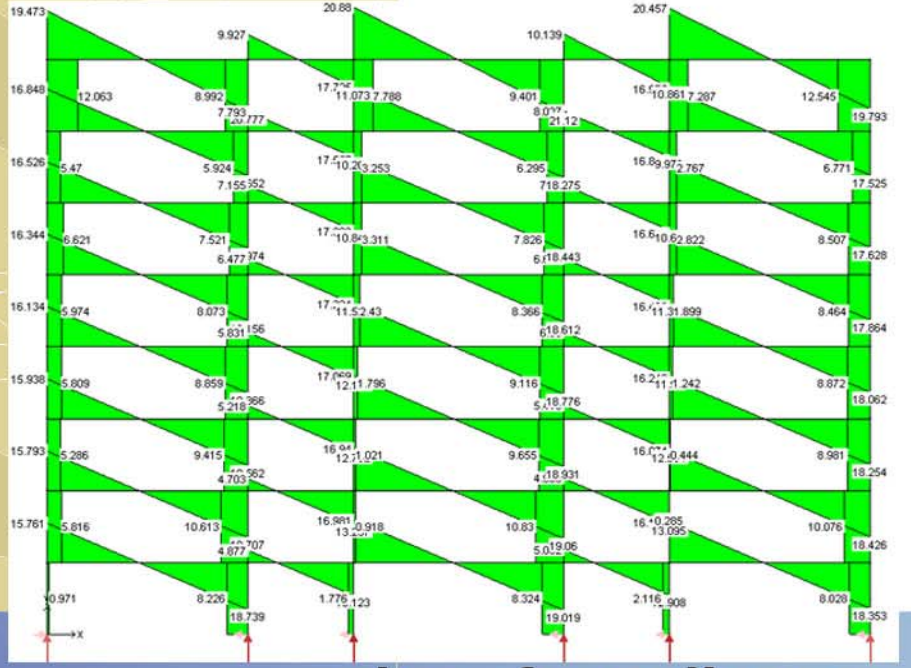
deflection diagram



bending moment diagram



shear resistance diagram



shear force diagram

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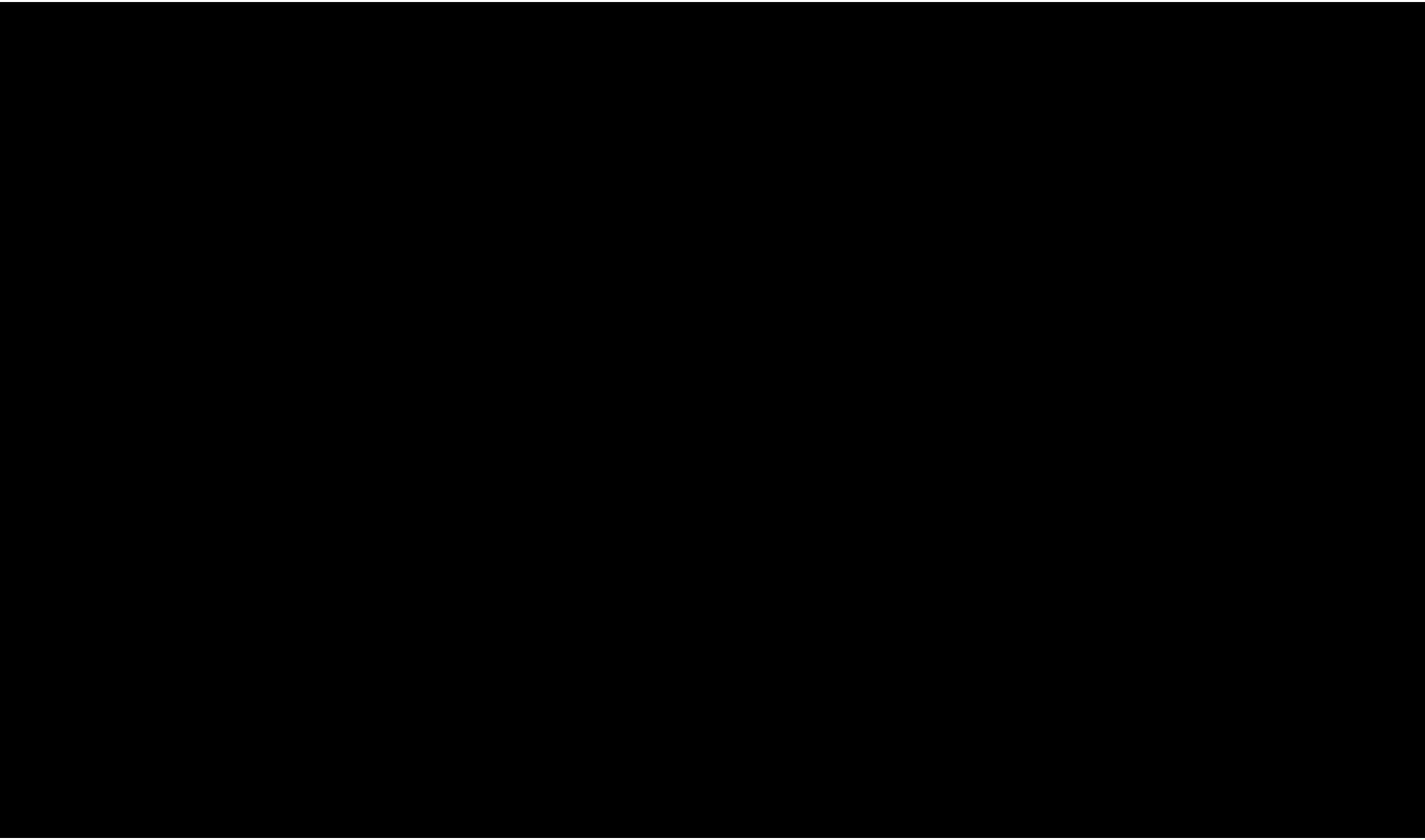
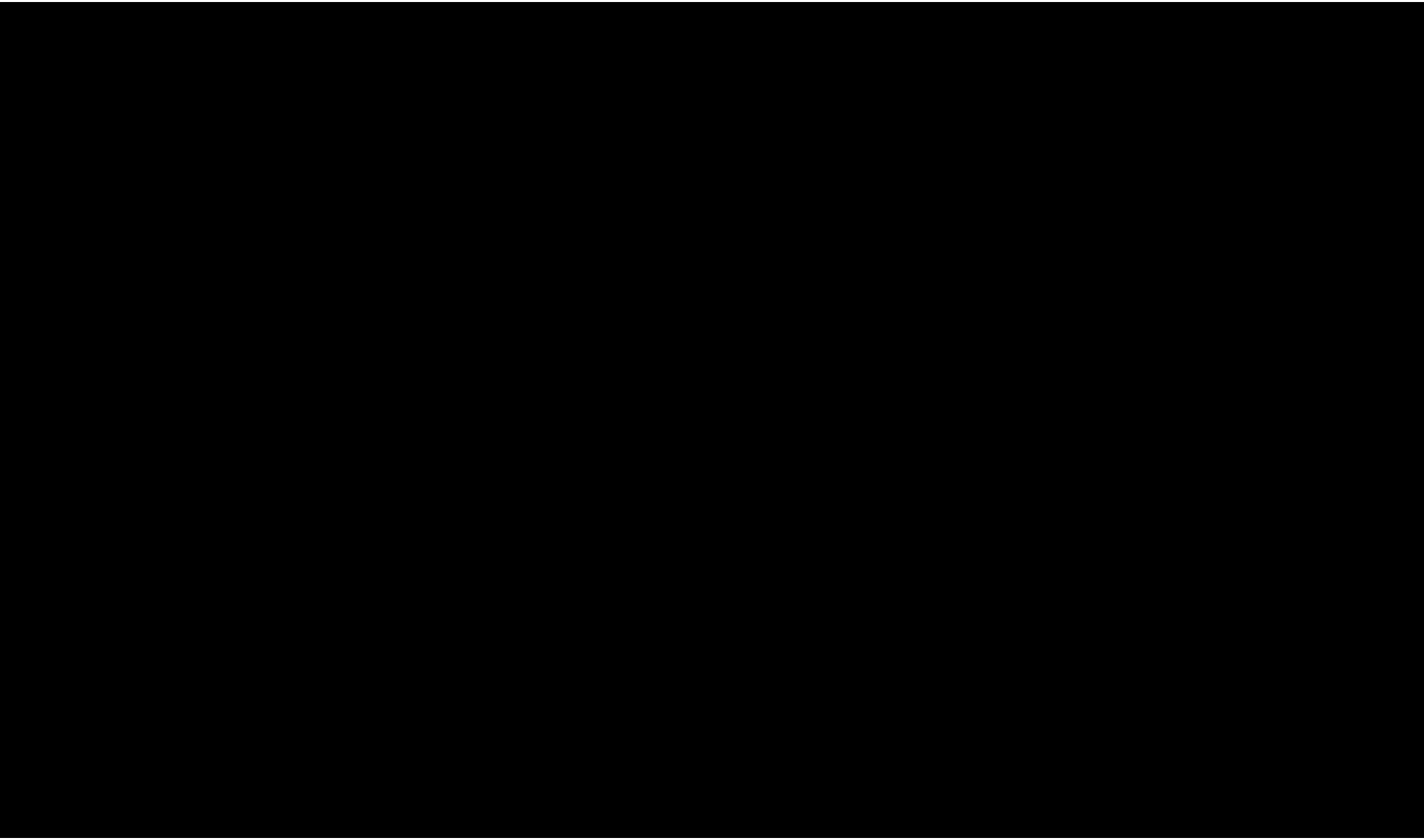




project details

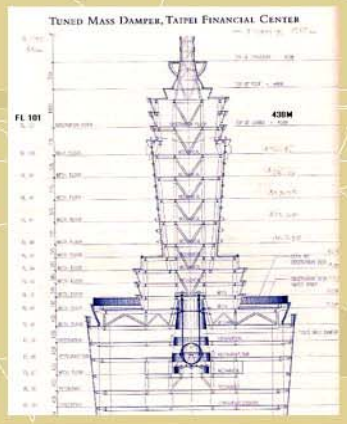
TAIPEI 101 follows the Chinese pagoda form, transcending the uni-body concept. Resembling the flexible yet persistent bamboo plant that rises into the sky, the building is a reflection of traditional Chinese building philosophy.

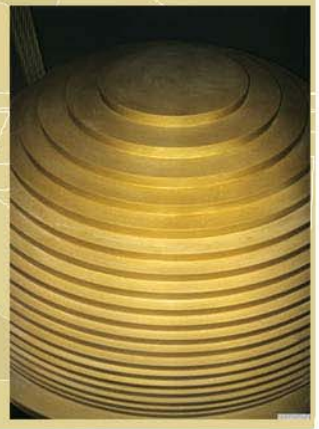
There is an 11-storey mega structure system, supported by eight 'super main' columns. As every eighth floor constitutes an autonomous space, wind effects on the surface seen seen in high rise buildings are eliminated

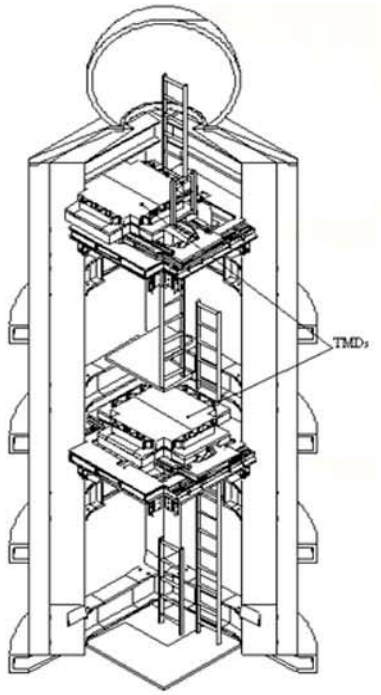
The structural system developed has outrigger trusses and a braced core.

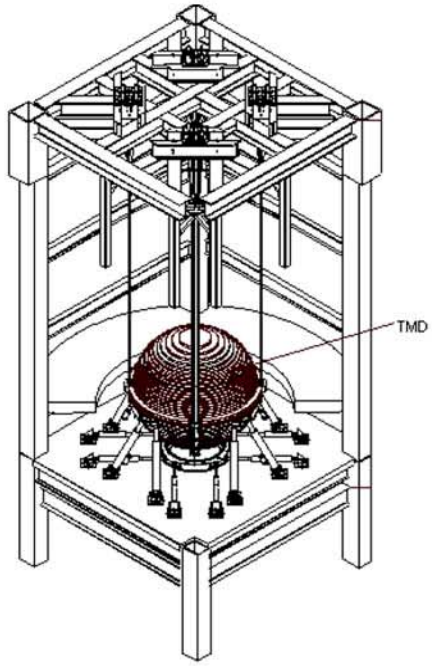
The architect, CYL decided to base the structure on the Chinese number eight, a numeral long considered lucky in Chinese culture. Eight-floor structural units are connected one by one, on top of each other to form the whole. This kind of rhythmic aesthetic is brand new to skyscrapers.

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.









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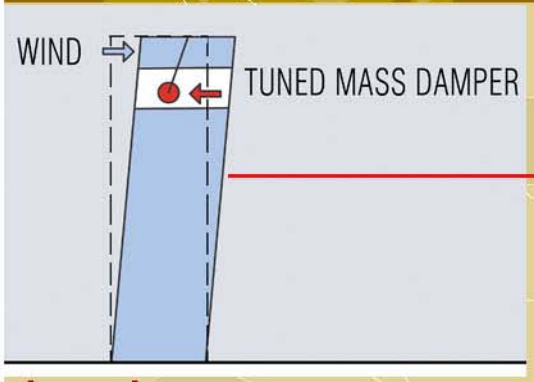
details

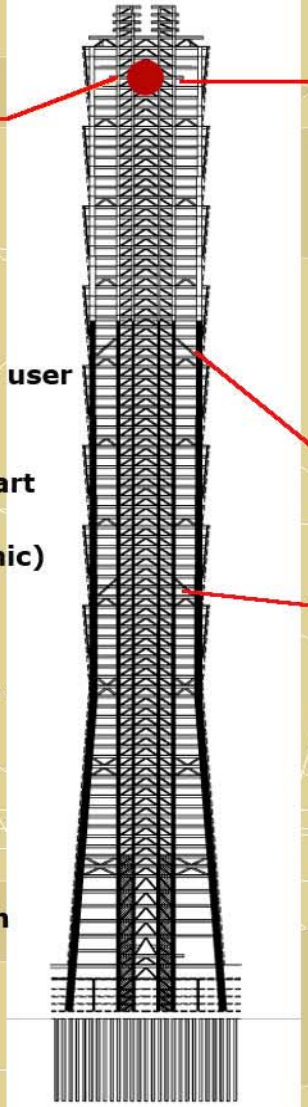


about damper :

6-meter-dia (660-tonne) steel ball will ensure user comfort in times of relative calm
– Damper visible from a mezzanine level: probably largest of its kind and first to form part of a building's architecture
– Damper will reduce tower's peak (non-seismic) vibrations by more than one third
– 60 cm dia pin projecting from the underside of the ball limits its movement to about 1 m
– During seismic or wind events, pin "nudges" surrounding ring and dissipates energy through pistons.

about outrigger trusses :

Outrigger trusses occur at 11 in locations in elevation. 6 of the trusses are one -storey high fitting in mechanical floors.
The remaining 5 locations are double-height.
In plan, on each of these floors 16 outriggers occur.



Design concept of the module :

- Stepped profile
(7° windowslopes)
– Enhance downward vision
– Reduce solar gain
– Creates external fire safety decks at the base of each eight-floor module (inside Shelters have fire fighting, smoke displacement and communications equipment)
– Fire- and smoke-resistant safety stairways and corridors also provide security

details

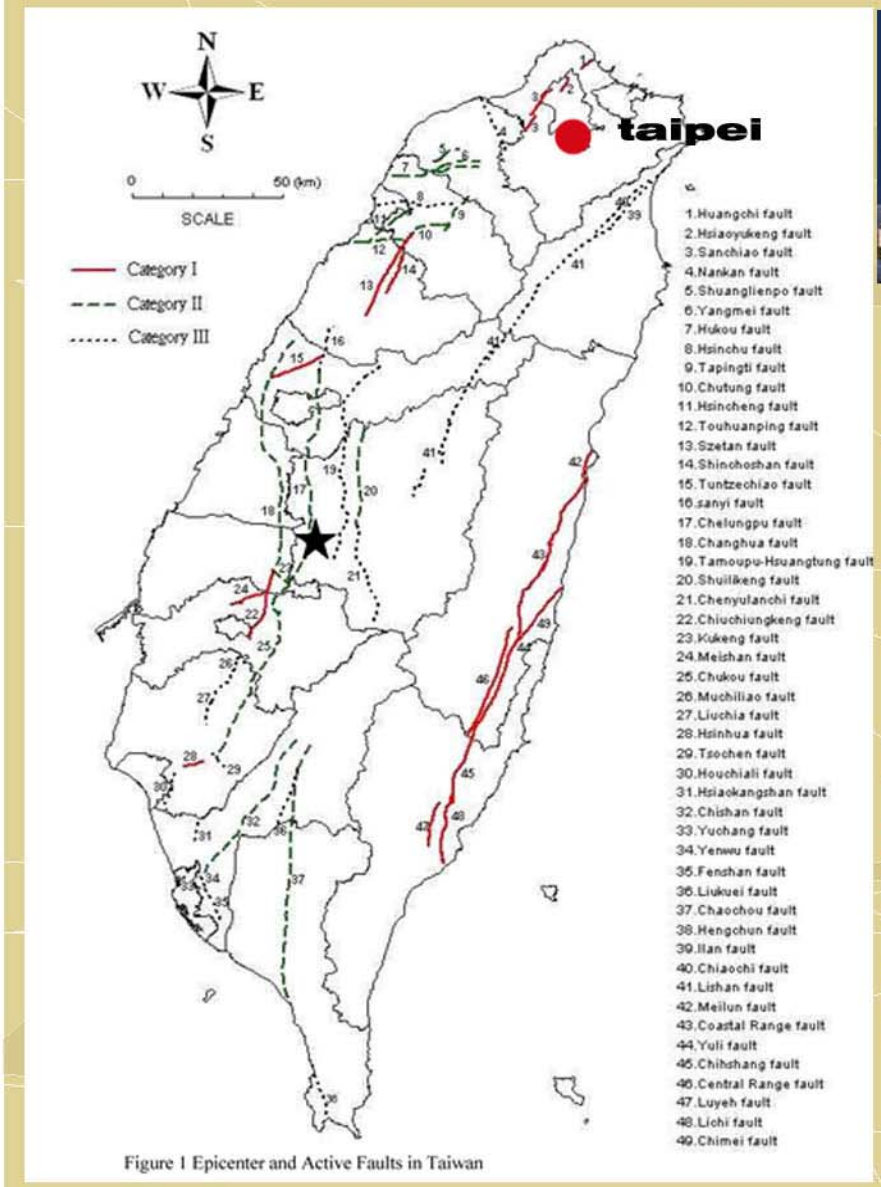


Figure 1 Epicenter and Active Faults in Taiwan

For very high winds, and for significant earthquakes, the swinging of the pendulum is restrained at the bottom of the sphere by a large steel pin 60cm(2 ft) in diameter that restricts the movement of the pendulum to one meter.

Super columns ensure the towers survival in the event of an earthquake and typhoons. For wind, stiff bracing planes and outrigger trusses limit wind swaying effect.

For additional core stiffenss, the lower floors from the basement to the 8th floor use concerete shear walls cast in between the core columns in addition to diagonal brasses.

This area has weak clayey soil and so the stiffness requirements of the structure is taken care by the super cloumns.

arch 631, fall 2005

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references

Shieh, S., Chang, C., Jong, J. "Structural Design of Composite Super- Columns for the Taipei 101 Tower", International Workshop on Steel and Concrete Composite Construction, IWSCCC, National Center for Research on Earthquake Engineering, NCREE, Taiwan, October 2003. Available from http://www.ncree.org.tw/iwsccc/PDF/03%20-%20Shieh.pdf.

Olney, G., Planting, H. Taipei 101 Tower. Union College. Available from http://www1.union.edu/~olneyg/projectfolder/project.htm

Poon, D., Joseph, L., Sheieh, S. "Reaching for the Sky." Civil Engineering Magazine (January 2004)

Fernandez, John E. "Building to Extremes." Innovation- Life Inspired: Ask the Experts. Online Posting. PBS (February 10, 2005) Available at http://www.pbs.org/wnet/innovation/experts_qa1.html

Shieh, S., Chang, C., "Structural Design of Taipei 101- An Uncommon Tall Building", North America Taiwanese Engineers' Association, NATEA, 2005. Available from http://www.natea.org/sv/events/2005/062705_Taipei101.pdf

Reitherman, R., "The Expression of Seismic Design", Consortium of Universities for Research in Earthquake Engineering, CUREE, 2005. Available from http://www.curee.org/image_gallery/calendar/essays/2005-CUREE_excerpt.pdf

Lin, D., Woo, S., "Geotechnical Analyses of Taipei International Finance Center (Taipei 101) Construction Project", Department of Soil and Water Conservation, National Chung-Hsing University, 2005. Available from http://www.icsmge2005.org/reports/Paperabstract/SouthEastAsiaGS/2c-Lin-SE-06.pdf

Haskett, T., Breukelman, B., Robinson, J., Kottelenberg, J. "Tuned Mass Dampers Under Excessive Structural Excitation". Motioneering, Inc. Guelph, Ontario, Canada, 2004. Available from http://www.motioneering.ca/User/Doc/1273.pdf

taipei 101

arch 631, fall 2005