Raffle City Chengdu

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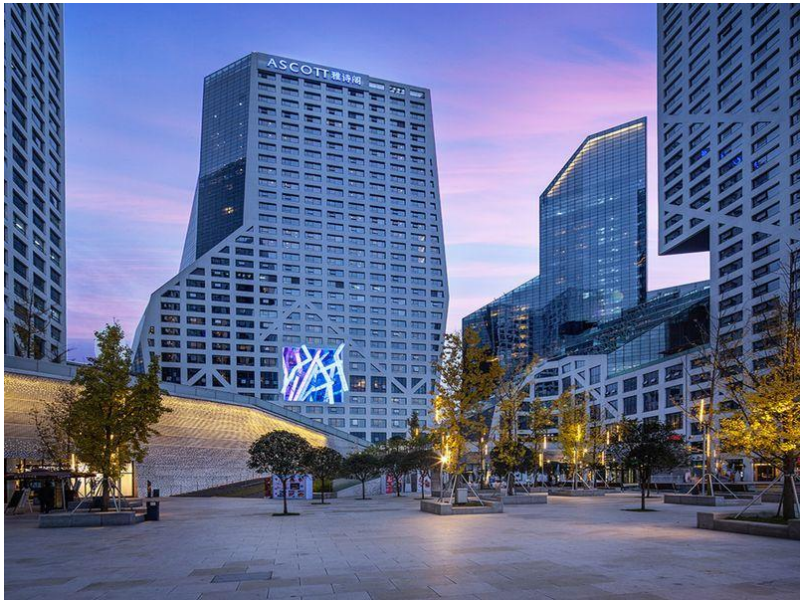
ARCH 631 FALL 2015 APPLIED ARCH STRUCTURE/ CASE STUDY/

Professor Anne Nichols/ 12-03-2015

General Background

- Location: Chengdu, China
- Time Completed: Nov. 2012
  •Function: a metropolitan public space with mixed use
- Floors: 29
- Floor Area: 308,278m^2
- Building Height: 119.05m
- Architect: Steven Holl
- Structural Engineer: China Academy of Building Research



Architect-Steven Holl

Linked Hybrid, Beijing

A New York based American architect.

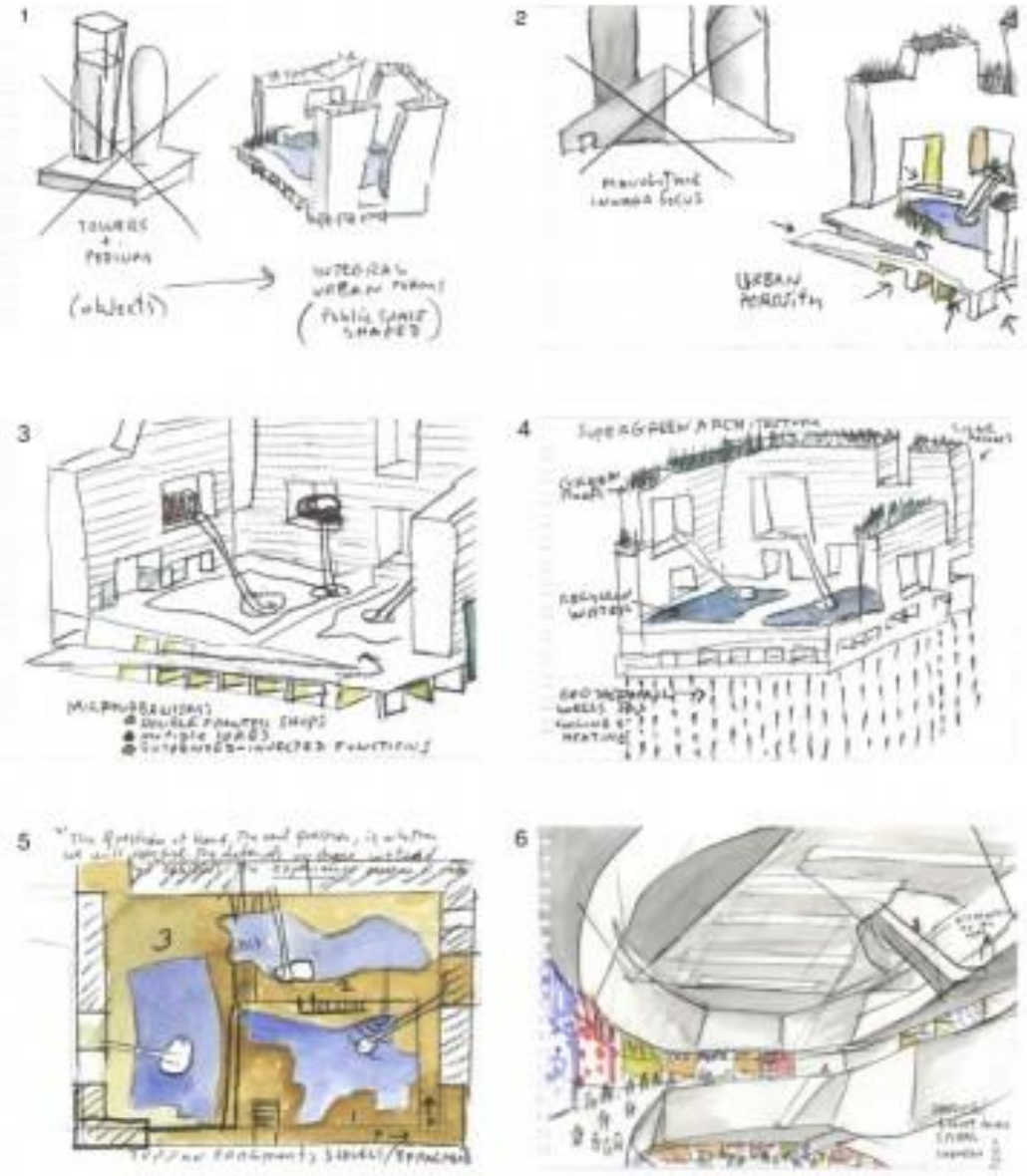
He graduated from the University of Washington and pursued architecture studies in Rome in 1970.

In 1976, he attended graduate school at the Architectural Association School of Architecture in London and afterward established his offices in New York City.

Design Concept

The large public space is inspired by a poem, Du Fu (713- 770), who wrote, ‘From the northeast storm- tossed to the southwest, time has left stranded in Three Valleys.’

Building shape is mainly designed by the distribution of natural light.

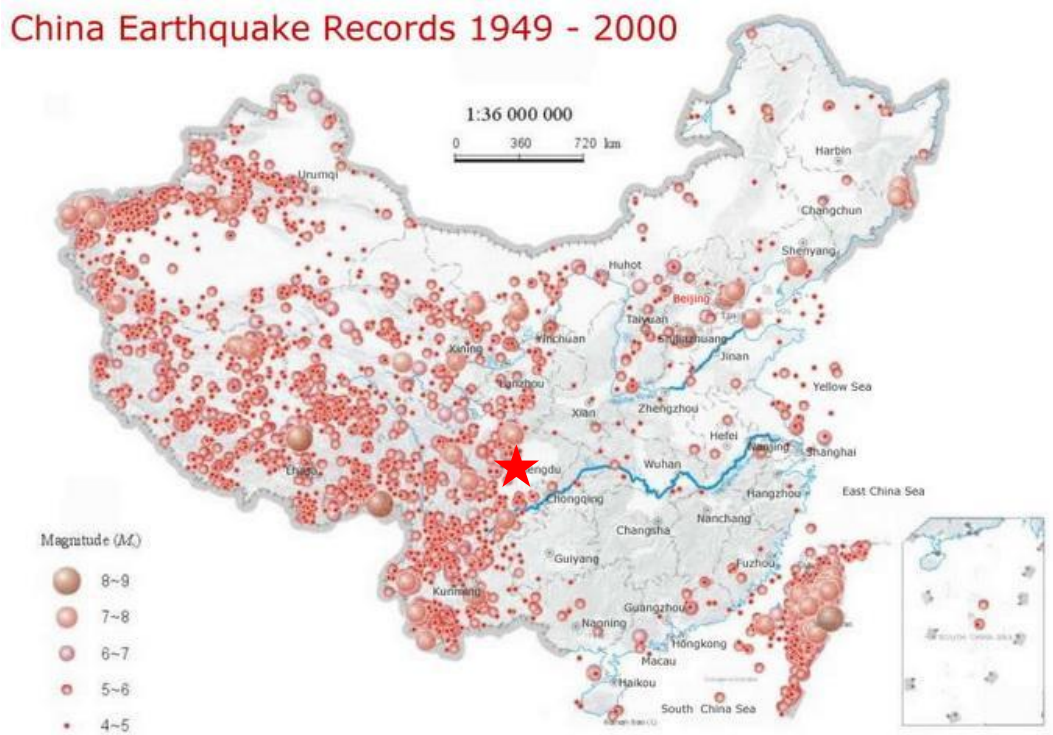


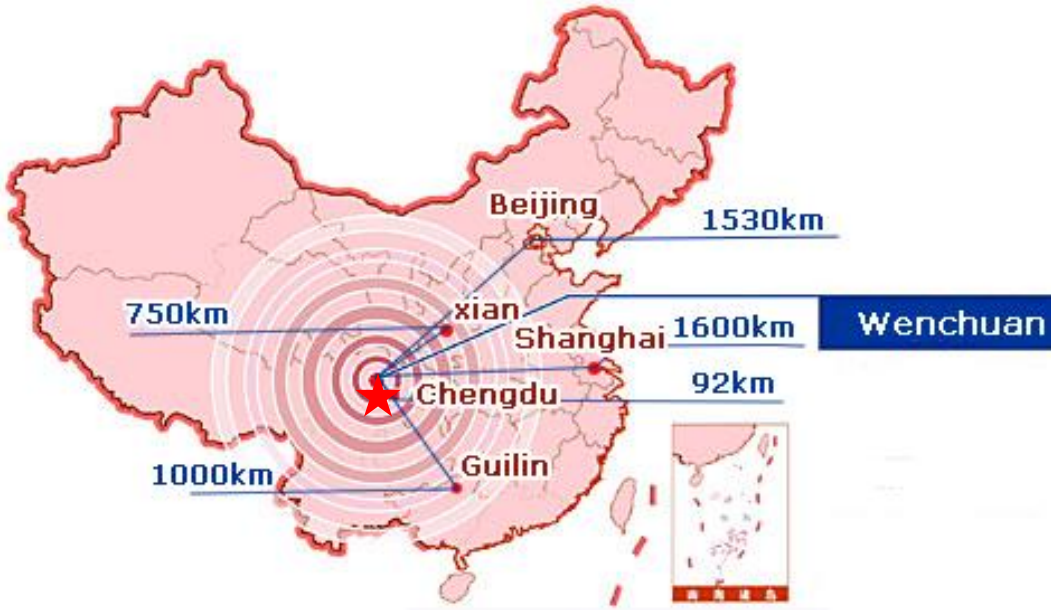
1 Integral urban functions shape public space
2 Porosity
3 Microurbanism
4 Super-green architecture
5 “Three valleys” inner gardens
6 Spatial geometry lit via pond skylights

Earthquake

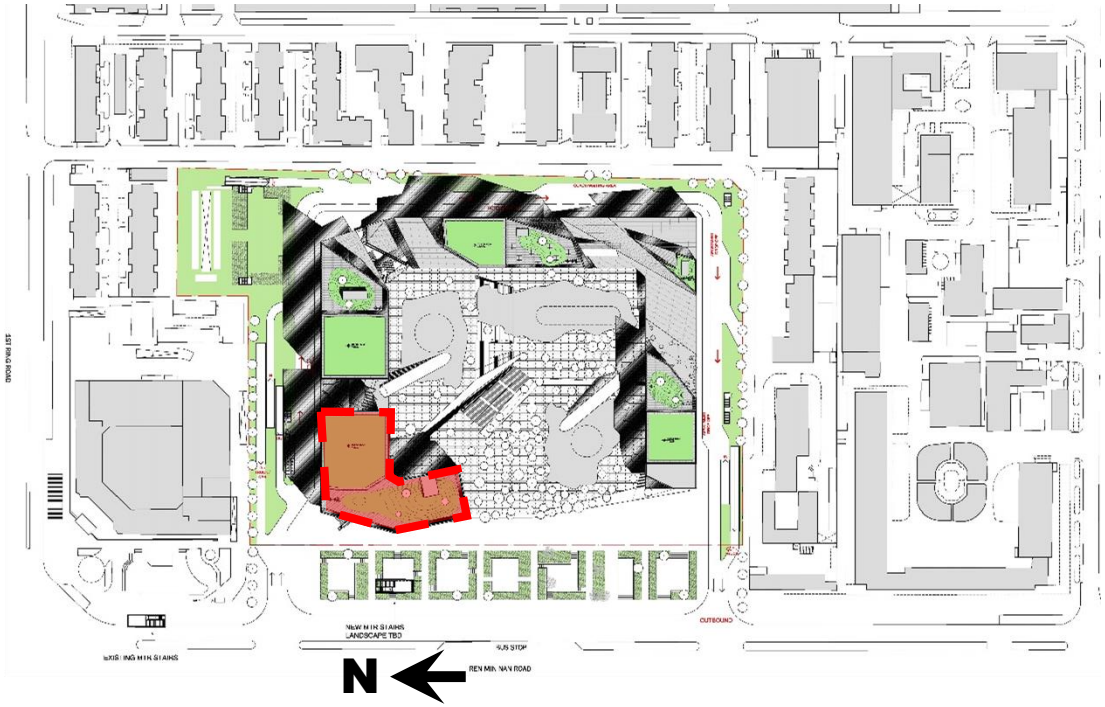
Chengdu is in a seismically active area.

On May 12th 2008, an 8.0 degree Wenchuan earthquake happened just 50 miles away from Chengdu. It caused almost 87,000 people to be dead or injured.





T1 Tower



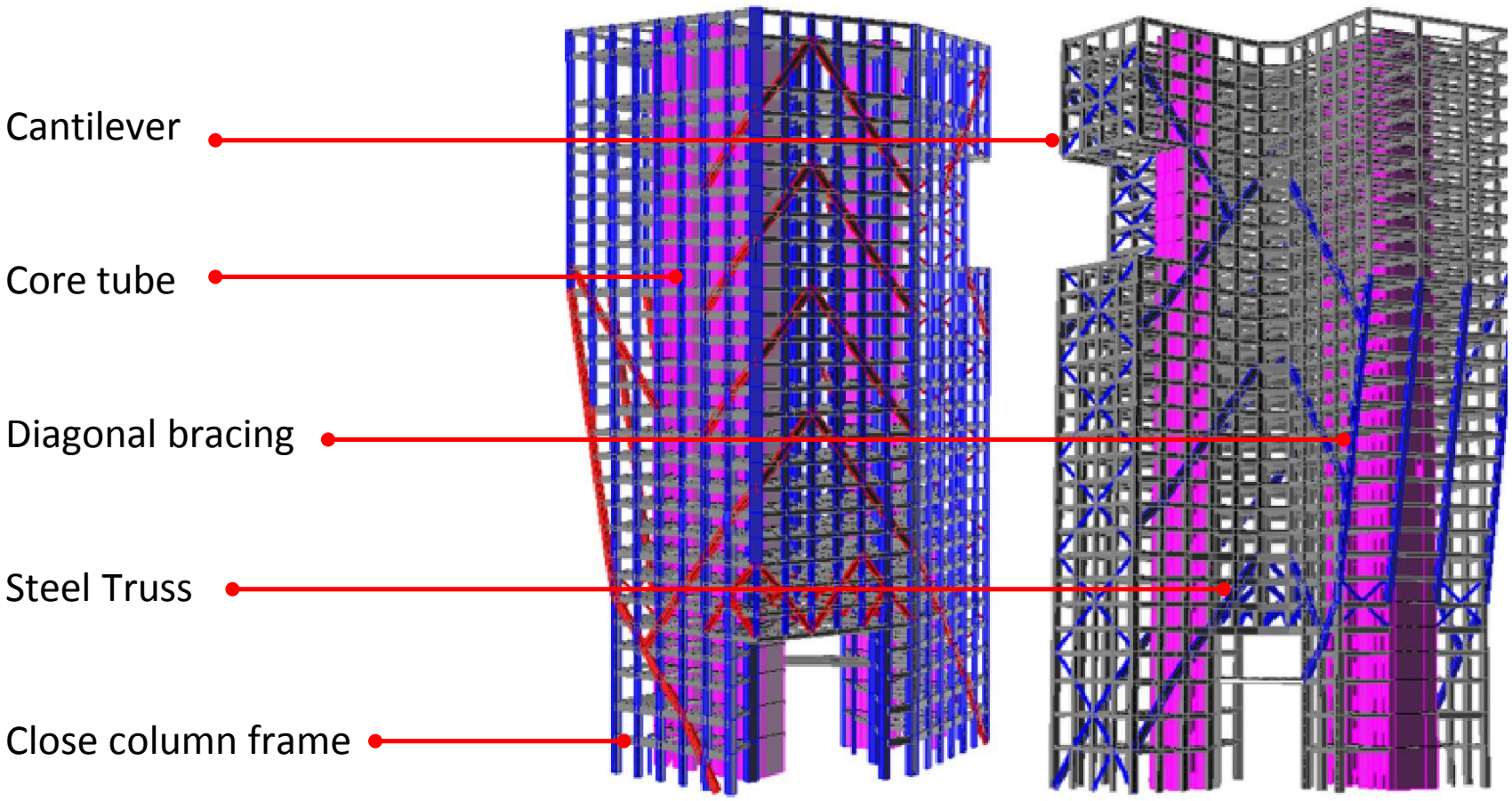
Function: Office

Form: L shape

Height: 120 Meter

Floors: 29 Floors above ground
4 Floors of basement

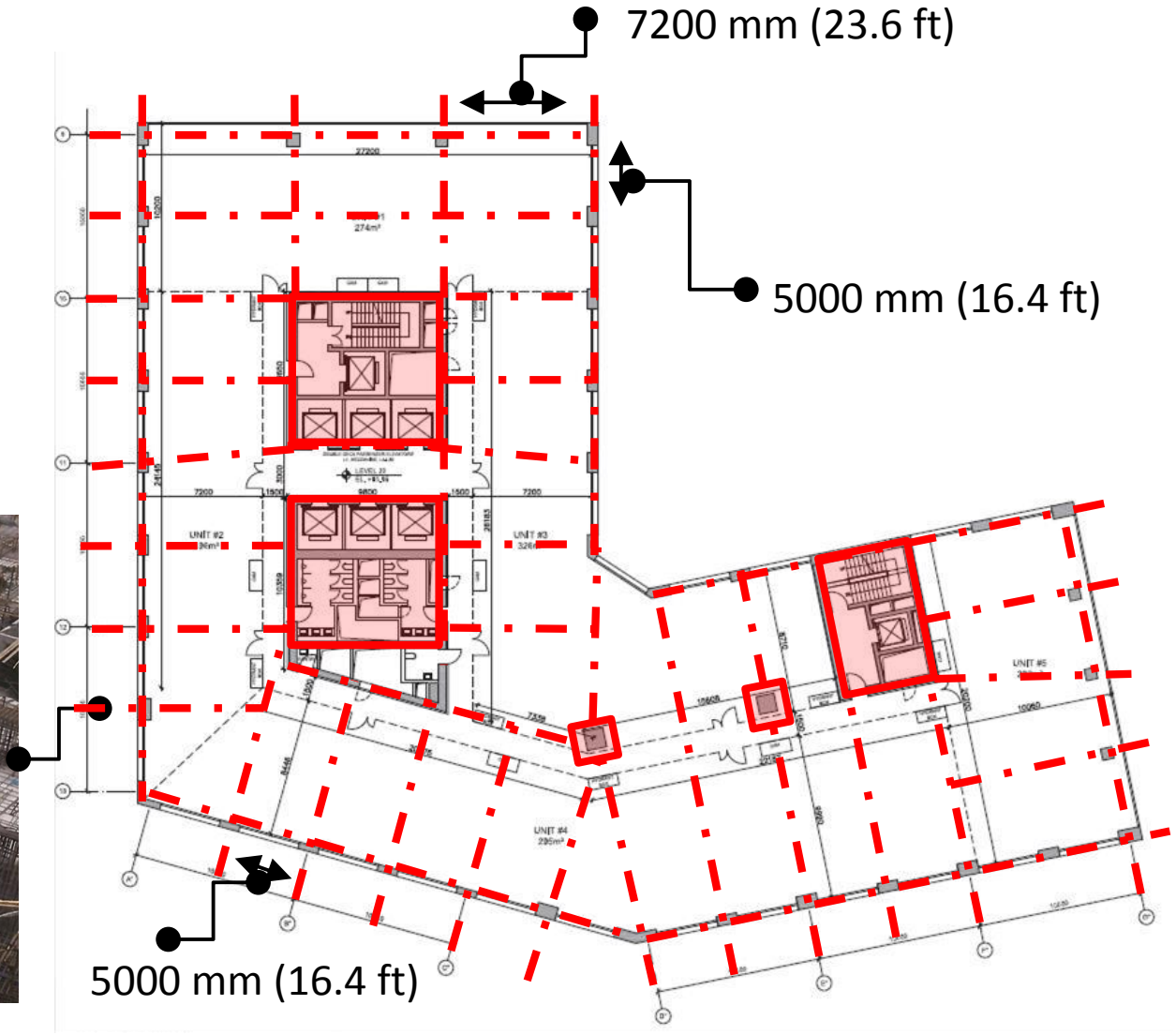
Sructure Components and Systems



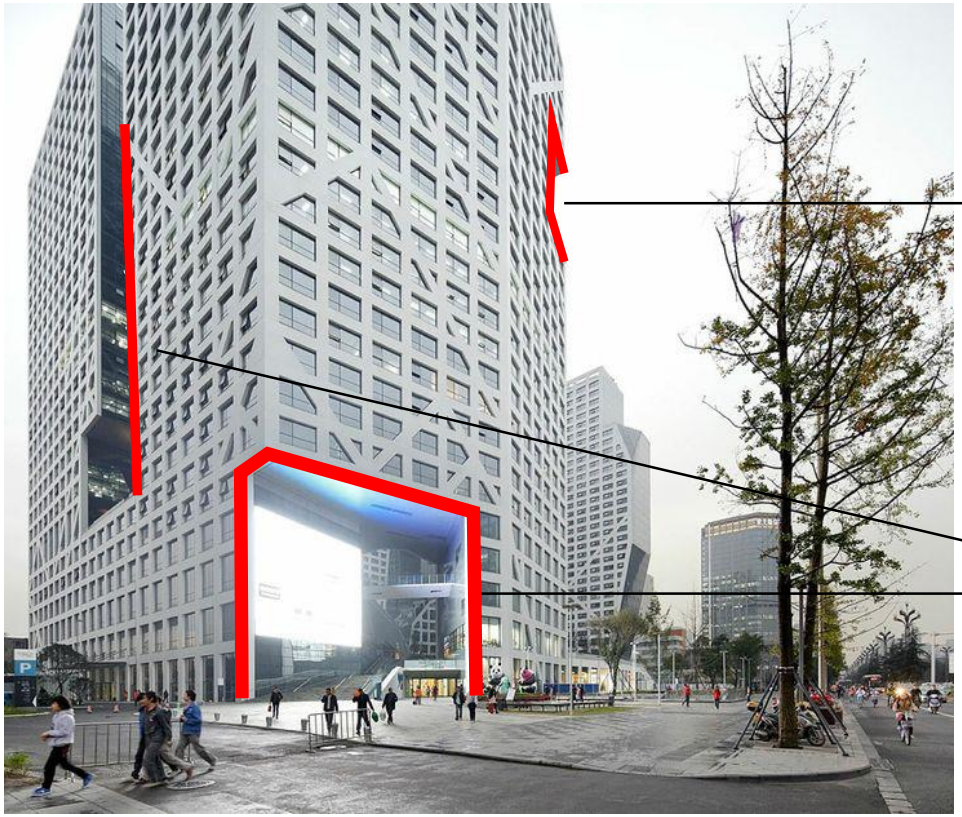
Structural System

Typical system is white C60/C40 reinforced concrete beam and slab. These tie into three concrete cores and thicker concrete columns.

Bays are typically spaced at 5000mm x 7200mm.



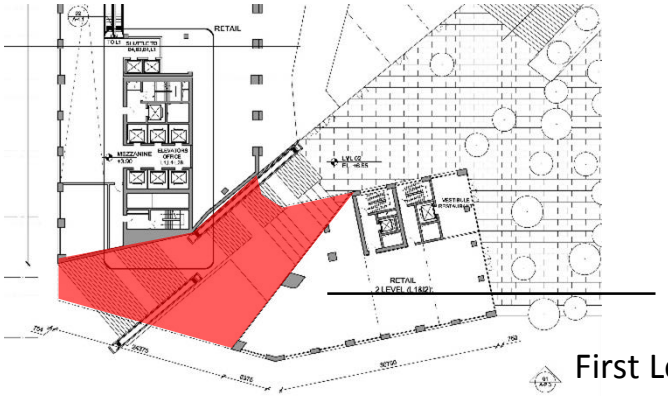
Structural Features



Northwest View

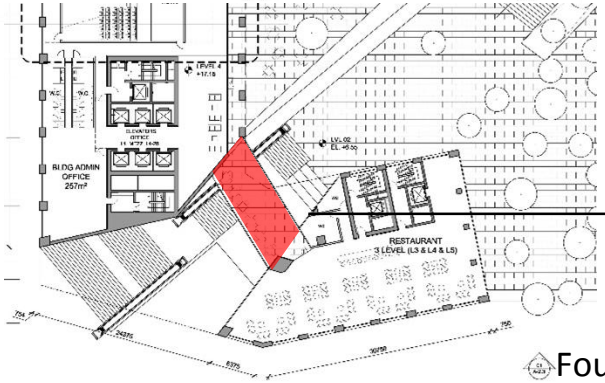
Structural Features

Span Opening



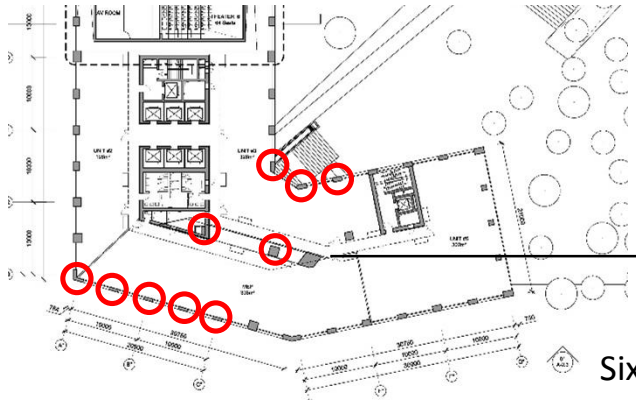
Opening Span

First Level



Bridge

Fourth Level

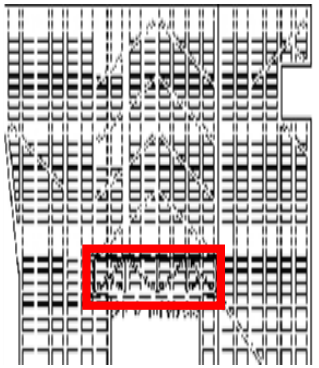


Transition Columns

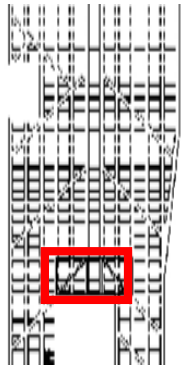
Sixth Level

The openings span 5m and 10m for the inner side and the outer side is more than 25m. It stands 5 floors high.

The sixth level is the transition level, which includes ten transition columns above the opening. The floor slab of the sixth level increases to 200mm and strengthens the structure with two full height trusses on both sides of the building.



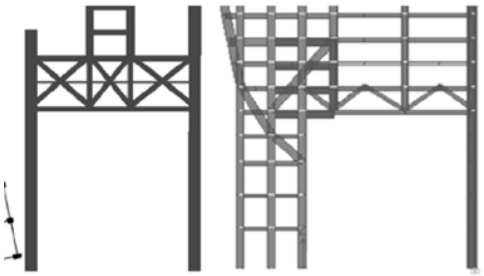
Northwest View

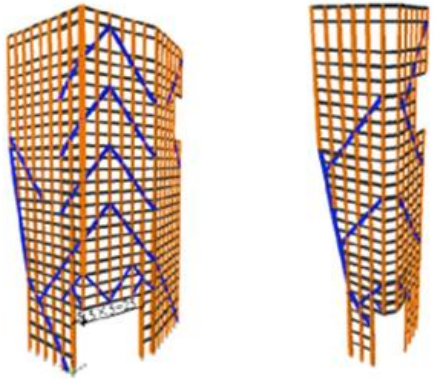


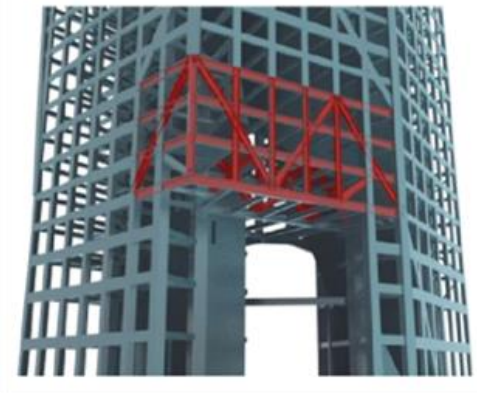
Southeast View

Structural Features

Span Opening







Double height trusses of HJ1 are placed along the north-south direction above the opening.

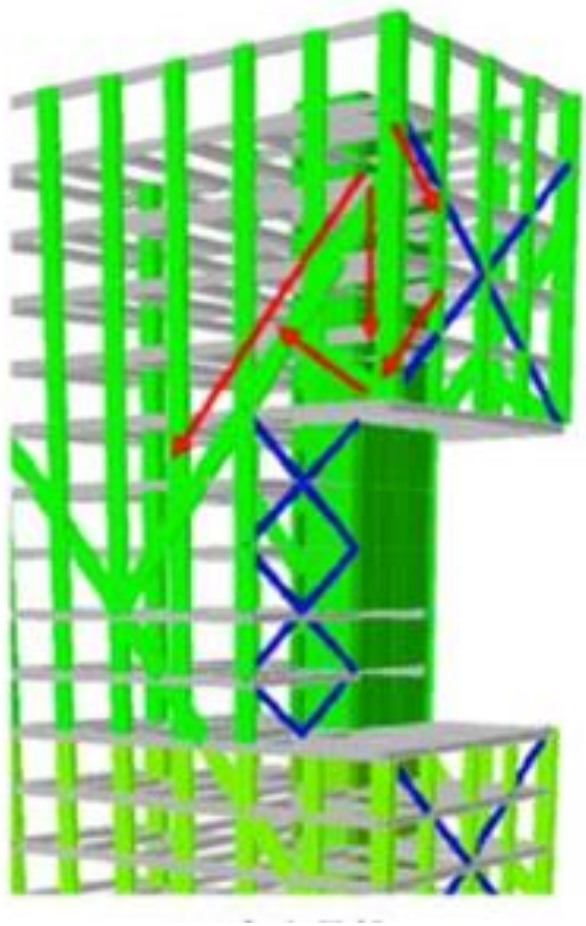
Single height trusses of HJ2 are placed along the west-east direction above the opening .

The main structure with diagonal bracing helps trusses transfer the load from the spans.

They poured concrete over the trusses after the main structure was almost finished. This was in order to prevent cracking in the early stages before greater frame action.

Structural Features

Cantilever



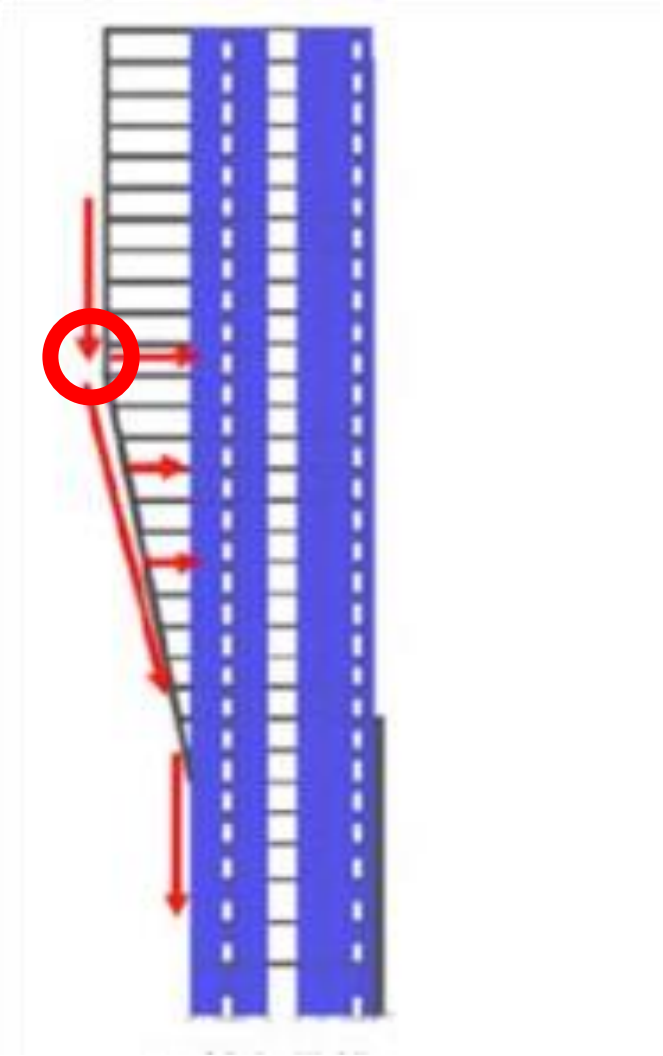
The floor slab thickness extends to 180mm both inside and outside.

Steel diagonal bracing is present on the facades. They connects with the beams and act together as trusses.

The steel diagonals and columns on the cantilever side transfer the load from the cantilever beams to the shear walls and the columns directly connect to the foundation.

Structural Features

Cantilever



This side of the cantilever extends 5 meter from the main structure.

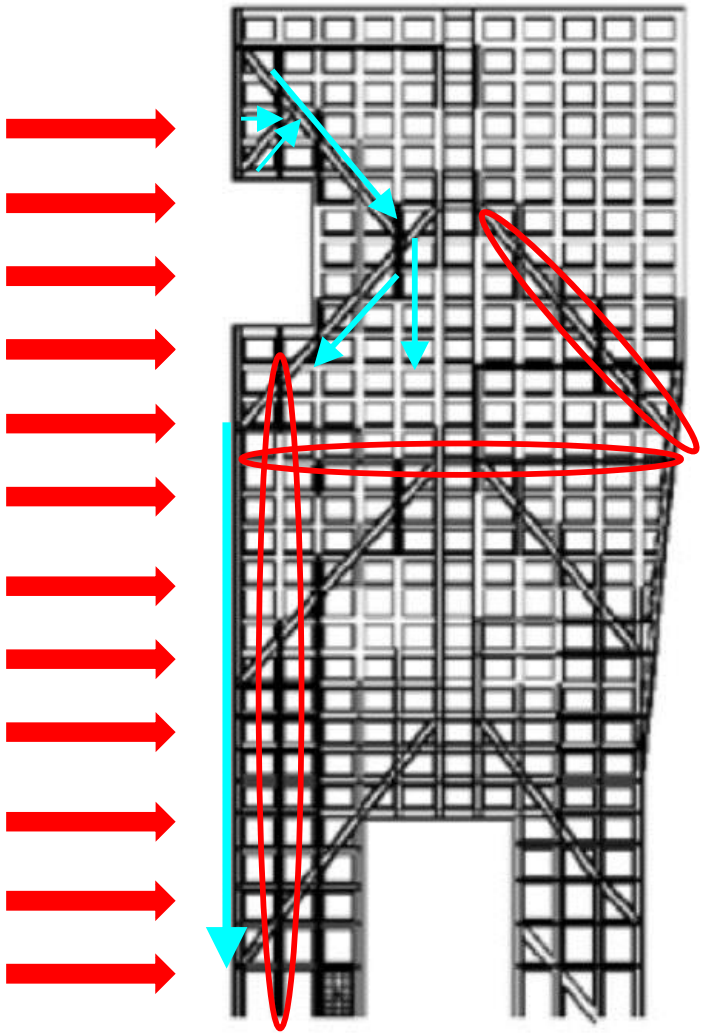
There are four diagonal columns along the east side of the facade, which support the cantilever.

The maximum tension force takes place at the beam in the red circle. This beam decreases the deflection and moment caused by the cantilever.

Lateral

The outer envelope must resist lateral loads and torsion from wind and seismic activity.

To provide the required stiffness the exterior structure contains columns, diagonal bracings and beams, which distribute the load across one another.



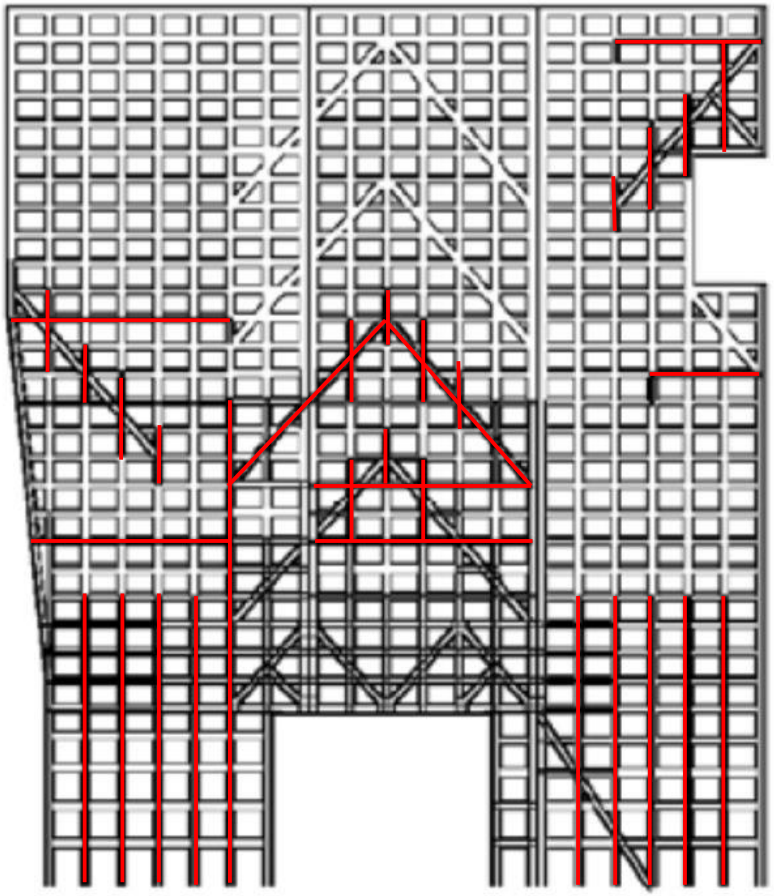
Lateral

In order to withstand seismic forces, steel was combined with reinforced concrete and was applied where structural analysis dictated.

This was done to meet Chengdu City code. Requirements consisted of

- -minimizing twisting
- -lateral deflection
- -tensile forces

for concrete buildings.



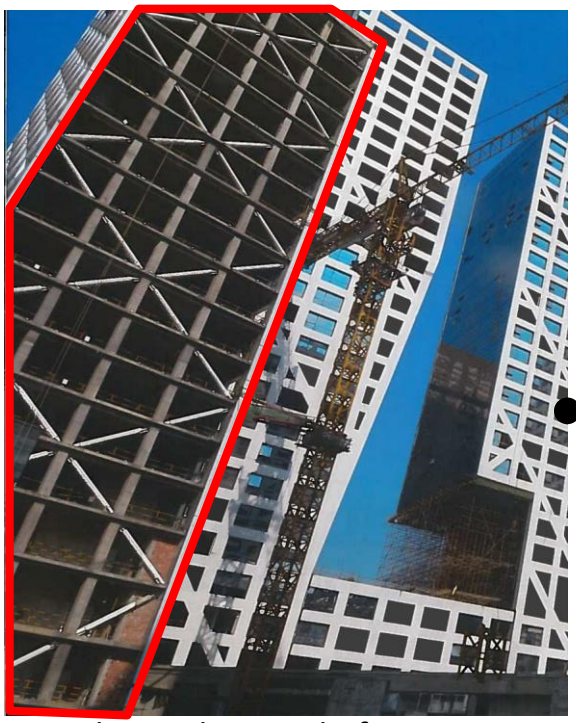
Connections

Typical connections are rigid, cast-in-place, reinforced concrete.

Bracing connections are Steel Beams bolted to plates located at “sliced” facades. On dominate facades Steel Tubes encased within concrete at diagonals.

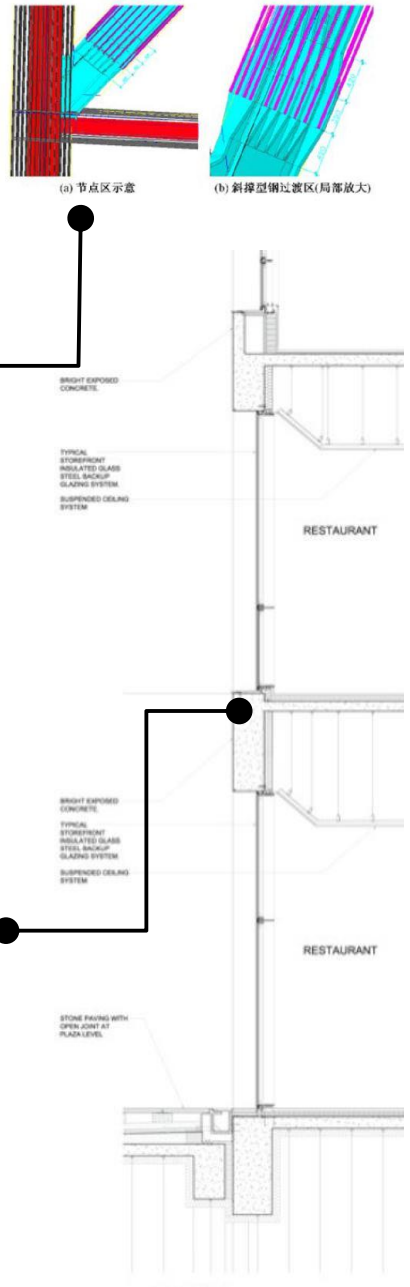
At the outer and inner facade each floor and concrete exoskeleton are poured together to create a continuous rigid connection for increased strength.

At diagonal members a steel beam is anchored into the structure and later cast within concrete forming a rigid connection.



Steel cross bracing before cast in concrete

Rebar for beam and slab construction connecting exterior and interior structure



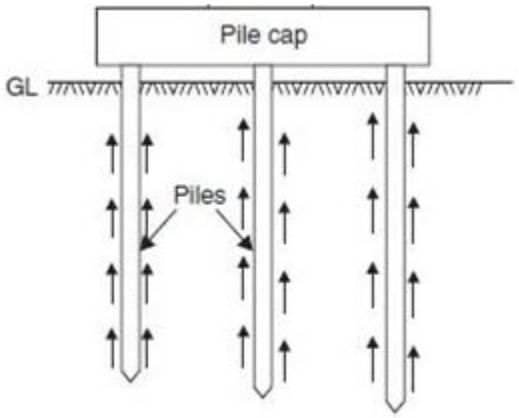
Soil and Foundation

The soil in the city of Chengdu is comprised of:

- Bury Soil (miscellaneous fill)
- Silty Clay, Silt
- Cobblestone
- Weathered Layer
- Medium to Strongly Weathered Mudstone Layer

The loose composition required concrete Friction Piles to be used. These use friction to resist the live and dead loads of the structure above.

There are also four large concrete Retaining Walls for the underground levels.

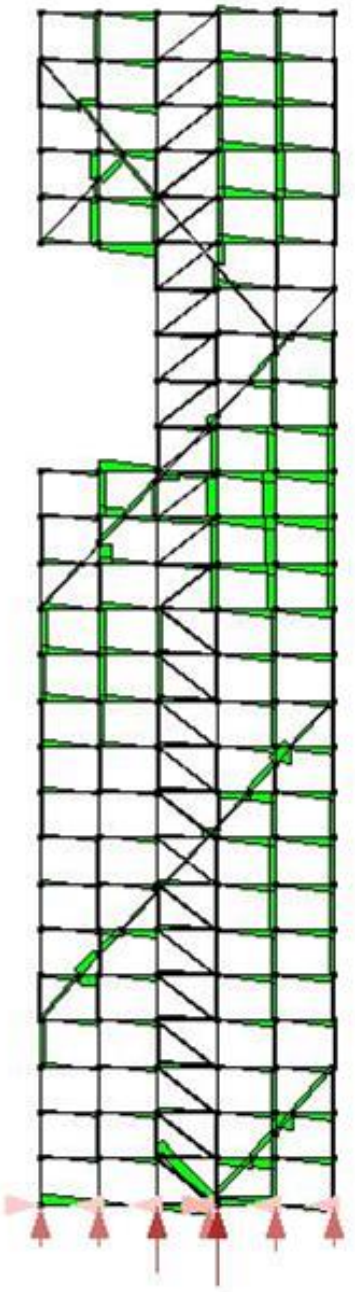


(b) Friction pile

Live Load and Dead Load Shear Diagram

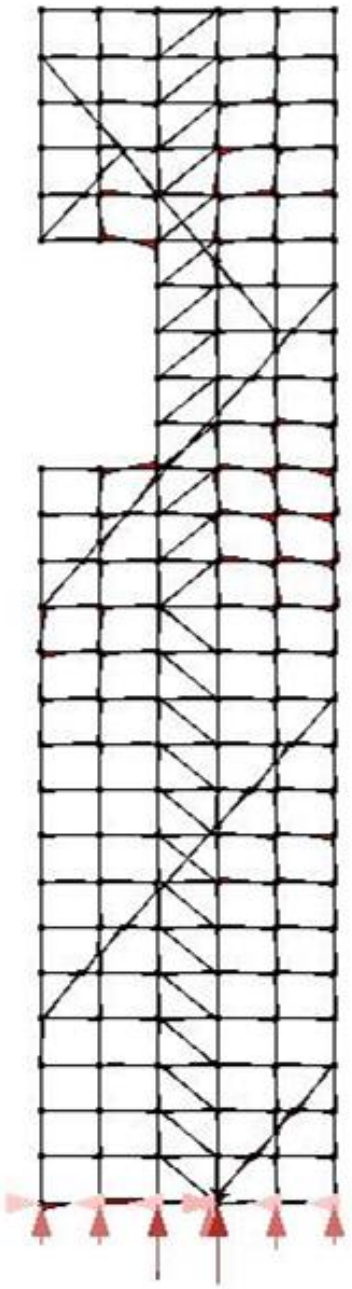
- Max shear load: 147 kN
- Min shear load: 0.259 kN

LL: (2.394 kN/m^2 x 21 m)/8 = 6.4 kN/m



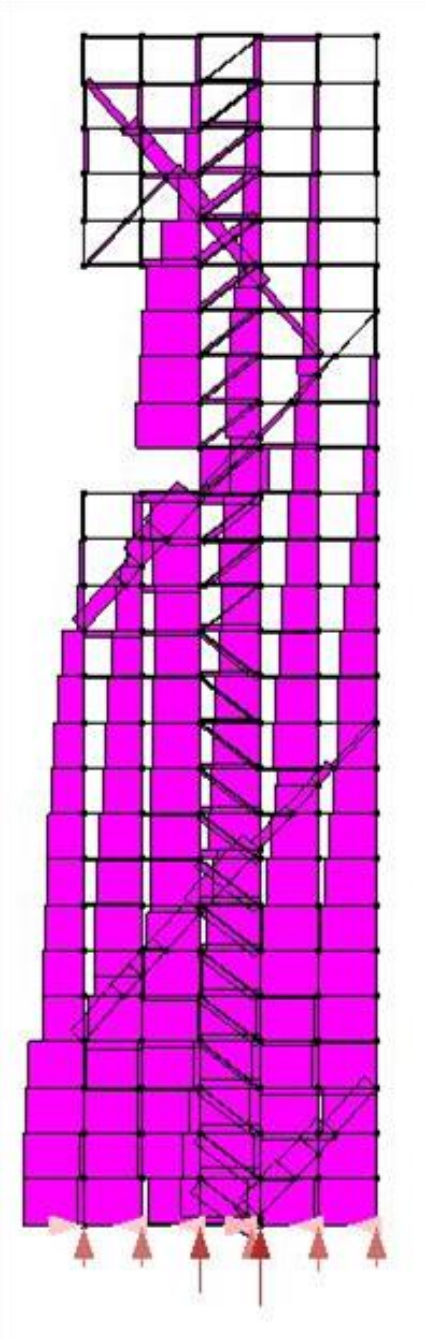
Live Load and Dead Load Moment Diagram

- Max moment: 51 kN
- Min moment: .003 kN



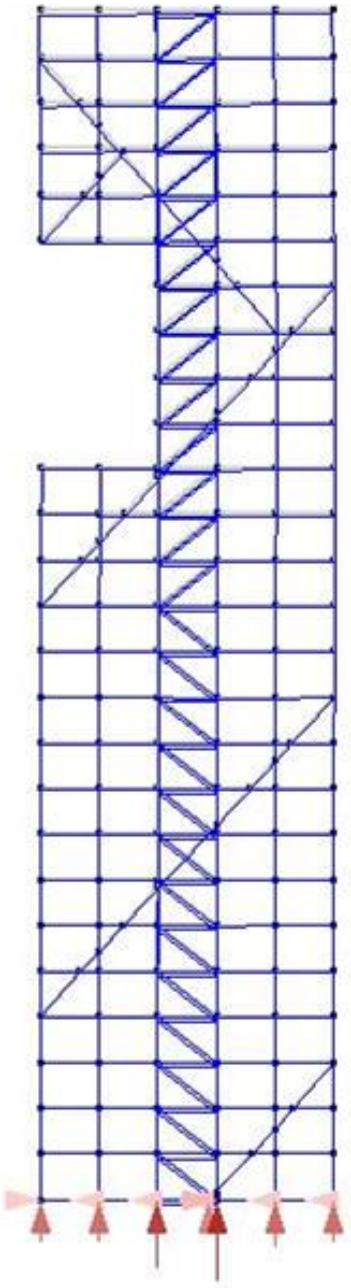
Live Load and Dead Load Axial Diagram

- Max axial load: 1274 kN
- Min axial load: .112 kN



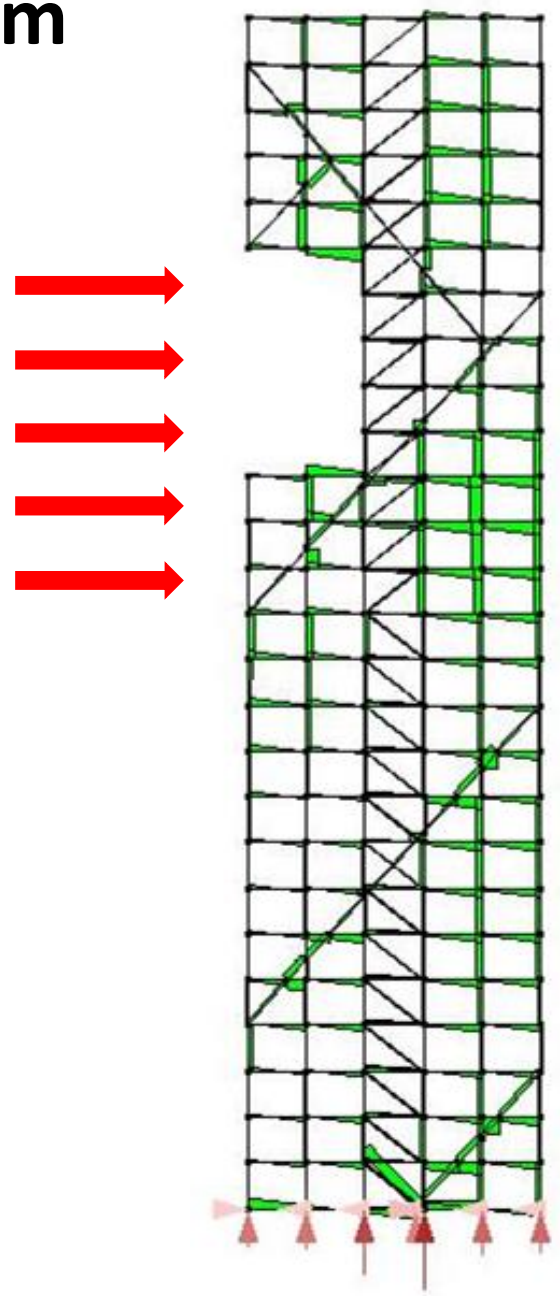
Live Load and Dead Load Deflection Diagram

- Max deflection: .46cm
- Min deflection: 0 cm



Wind Load North Shear Diagram

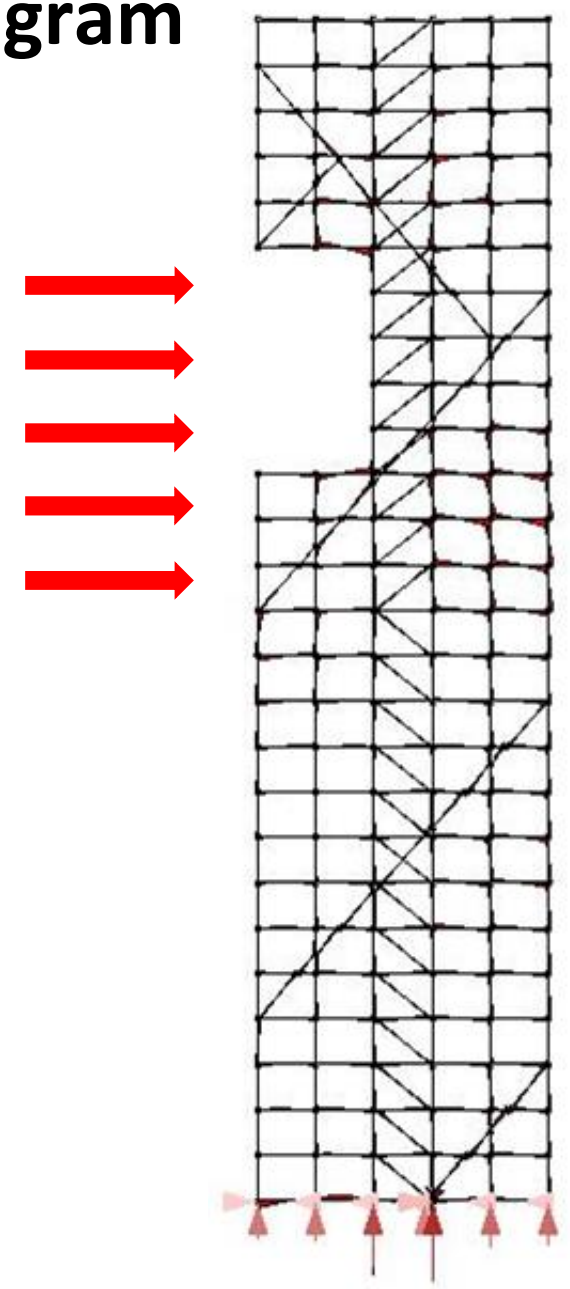
- Max shear load: 155 kN
- Min shear load: .082 kN



Wind: .35 kN/m x 1.1 = .385 kN/m

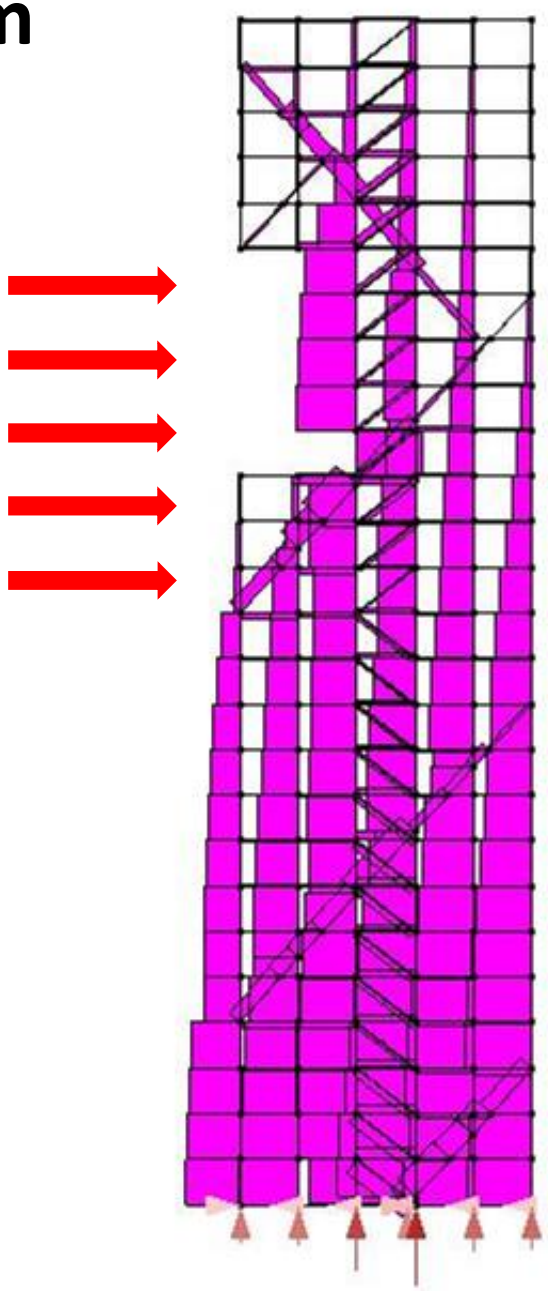
Wind Load North Moment Diagram

- Max moment: 95 kN
- Min moment: .003 kN



Wind Load North Axial Diagram

- Max axial load: 1324 kN
- Min axial load: .409 kN



Wind Load North Deflection Diagram

- Max deflection: .46 cm
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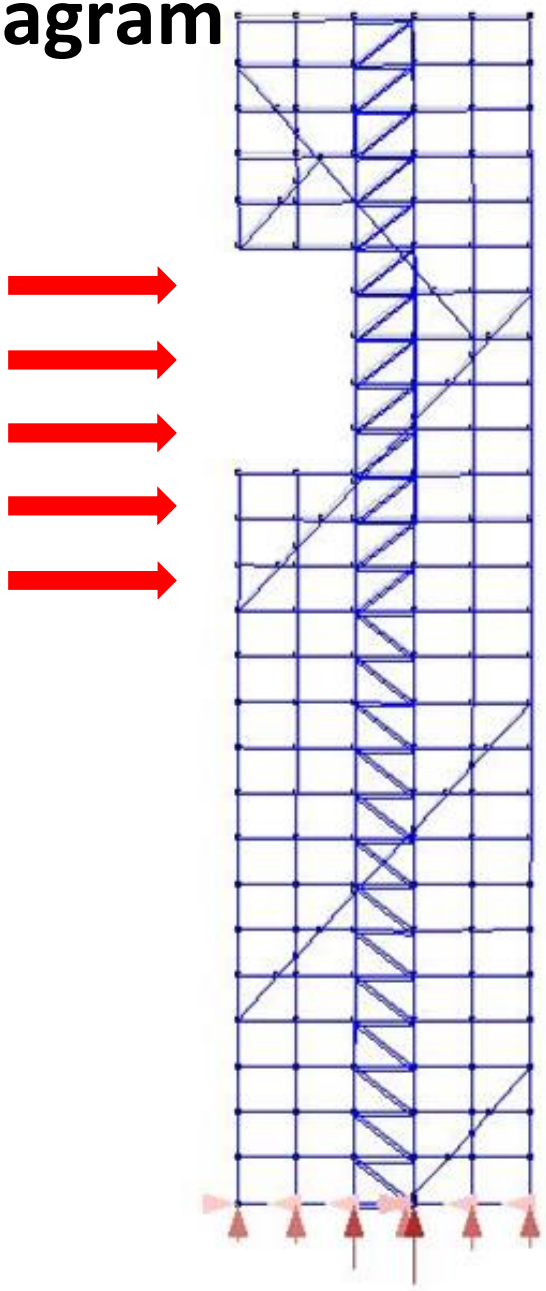

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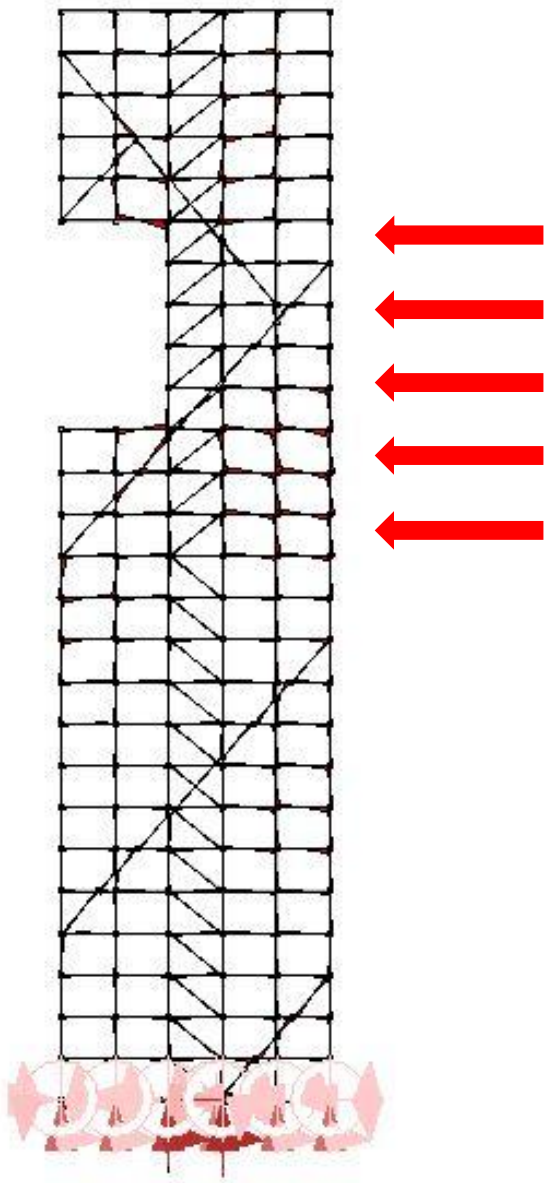
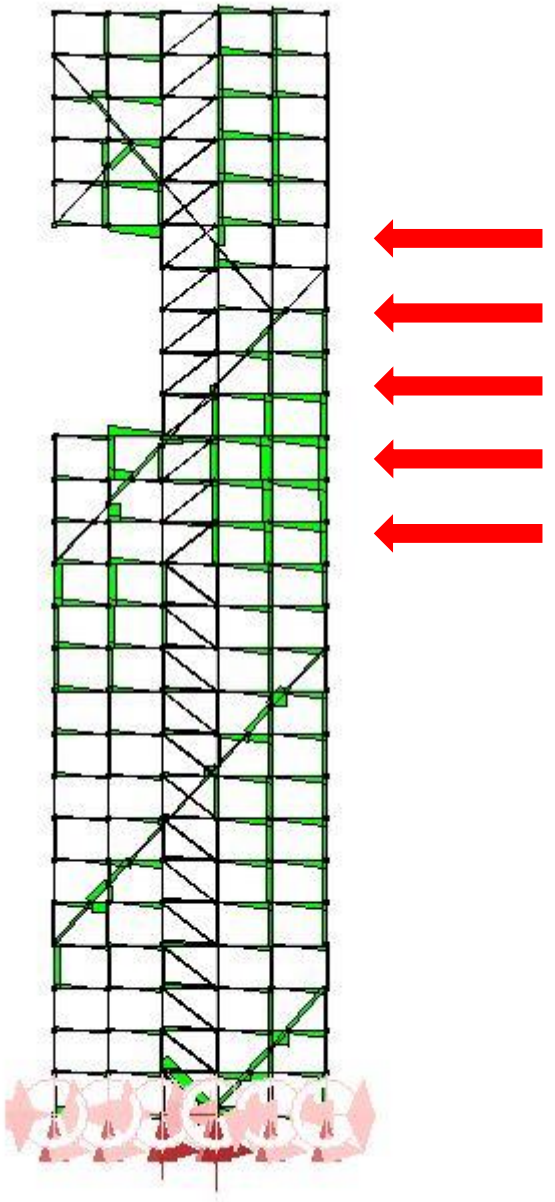


Wind Load South Shear Diagram

- Max shear load: 155 kN
- Min shear load: .082 kN

Wind: .35 kN/m x 1.1 = .385 kN/m



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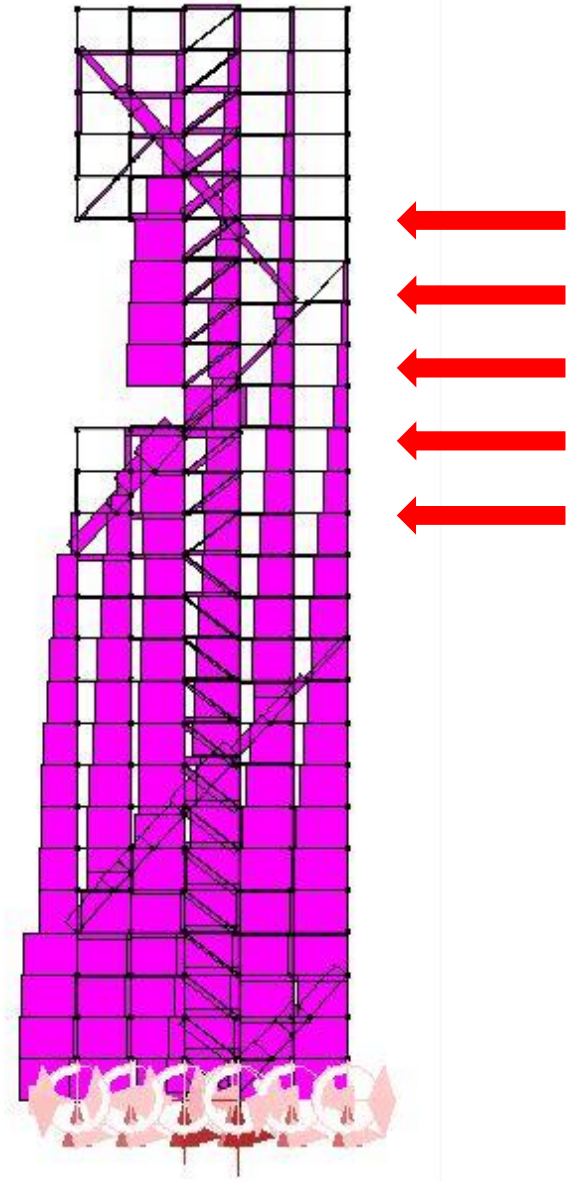

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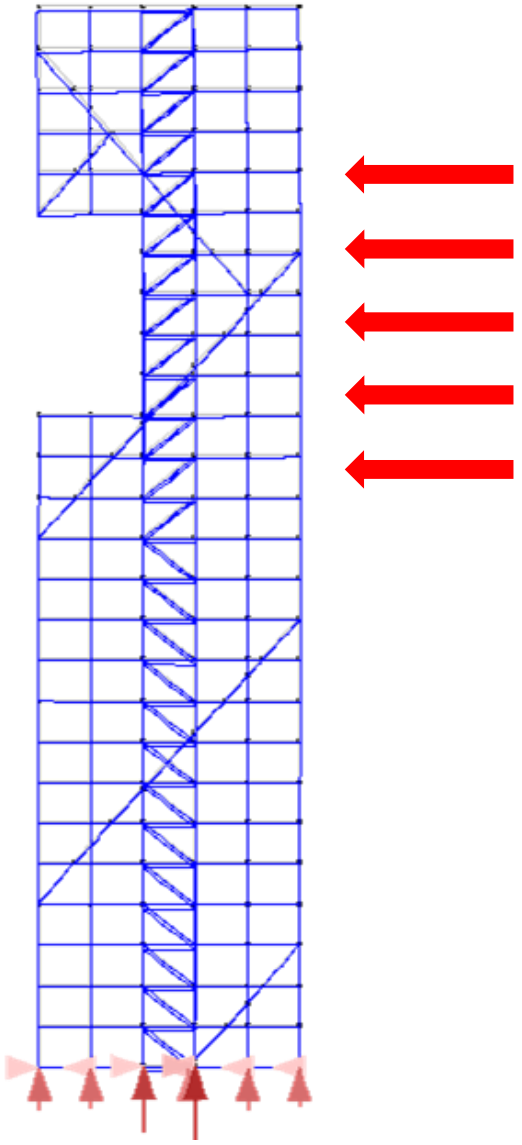

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