

# VANKE CENTER

---FLOATING HORIZON



ARC 631 CASE STUDY

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# Overview

**Vanke Center ---Horizontal Skyscraper**, supported over a landscape garden in Shenzhen , China.

This project has been awarded with a 2010 Honor Award by AIA



# Sufficient Identification Evidence

The building appears as if it were once floating in a higher sea that has now subsided : leaving the structure propped up high on eight legs.



# The Concept

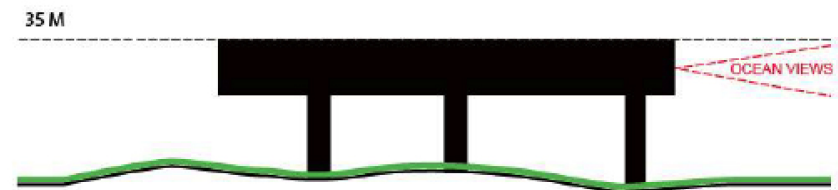
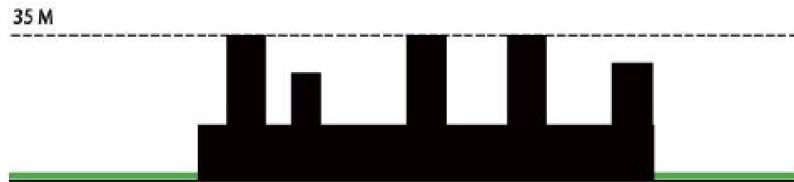
## SIZE COMPARISON



Vanke Center, Shenzhen, China

Uses the concept of a floating ground line that results in a horizontal skyscraper over a maximized landscape

The horizontal length of Vanke Center is 1250 ft as the Empire State Building height.



MAXIMIZE VIEWS AND LANDSCAPE

# Building Layout

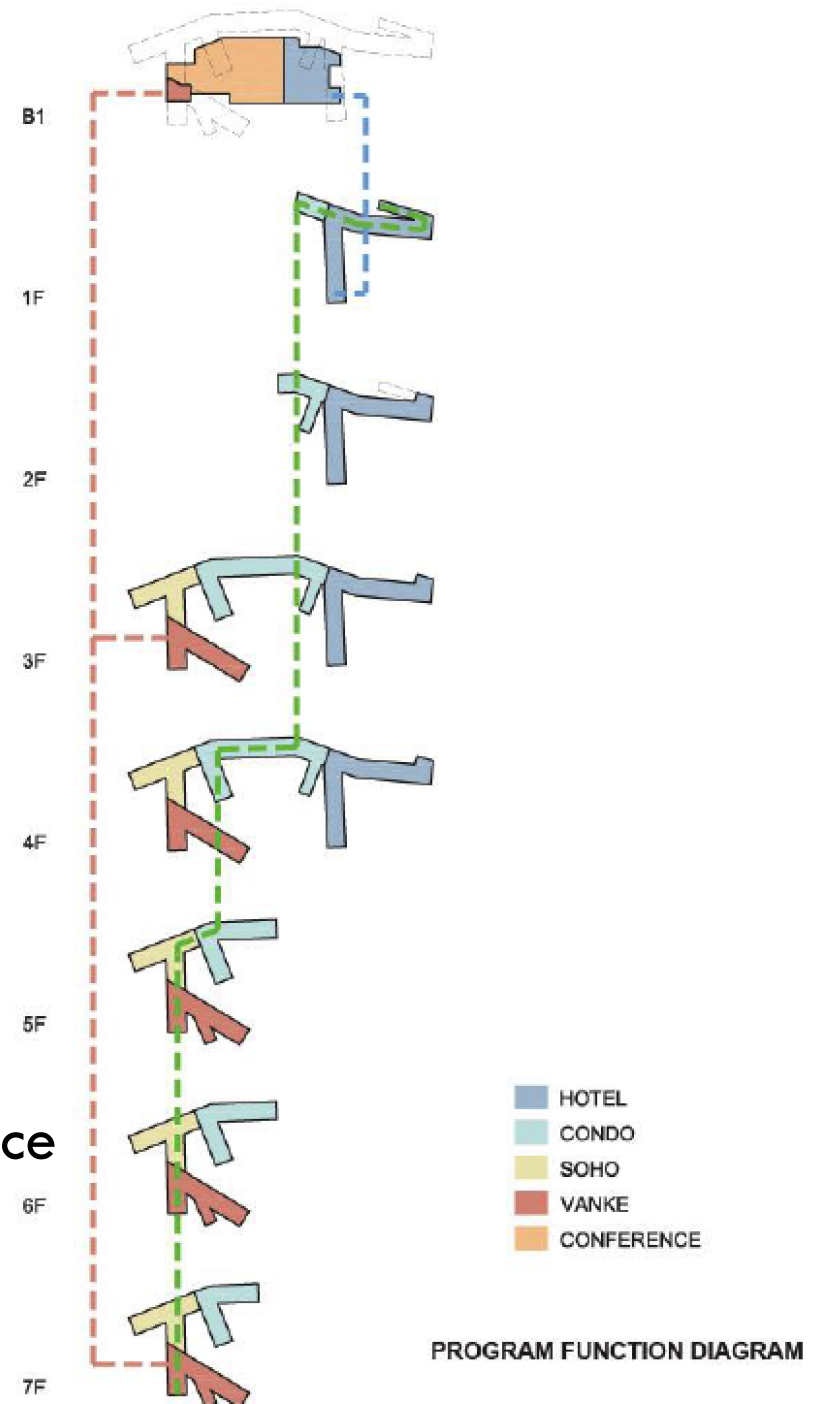
Vanke Center is consisted of three parts: office area, apartment area and hotel. Each part is connected by the stairs or elevations from the ground level.

1<sup>st</sup>, 2<sup>nd</sup> basement: parking pots

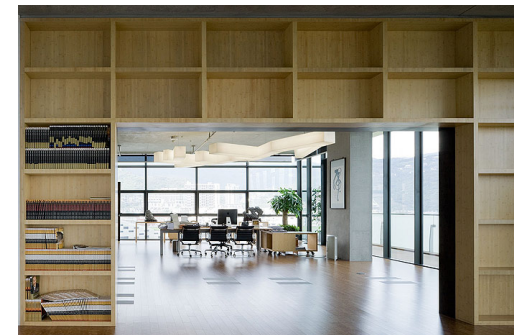
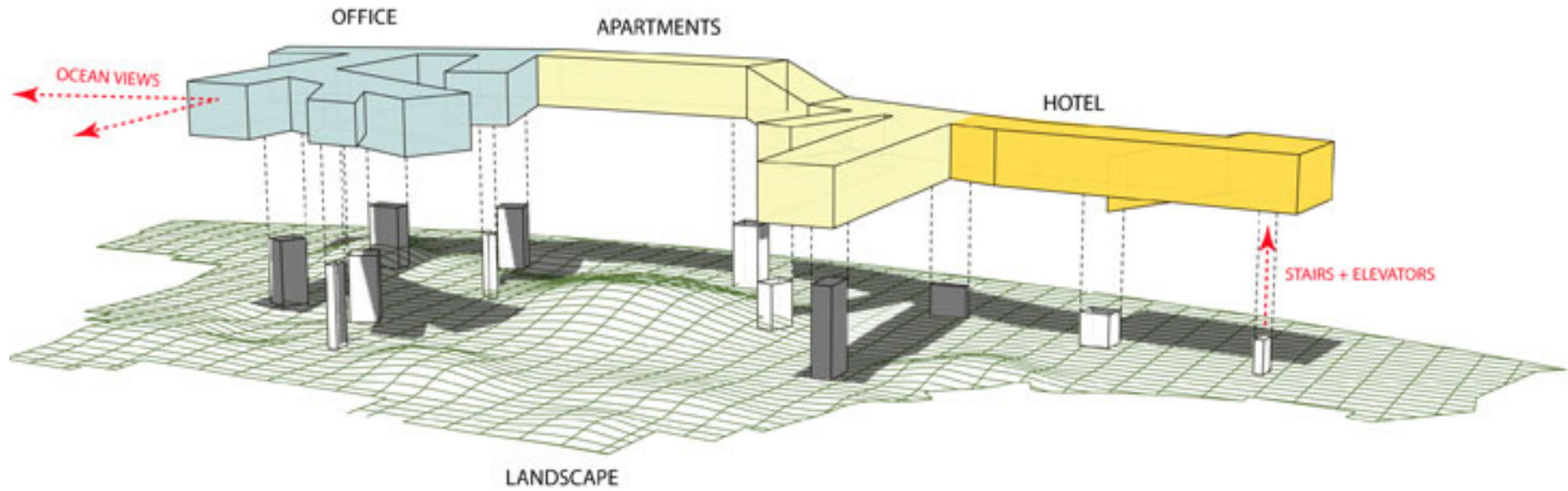
1<sup>st</sup>, 2<sup>nd</sup> F: hotel, condo

3<sup>rd</sup>, 4<sup>th</sup> F: hotel, condo, soho, conference

5<sup>th</sup>, 6<sup>th</sup>, F: soho, conference, office



# Function



# Structure Features

During the structural design process, compared steel frames, mega steel-transfer structures, cable structures, concrete frames and their available composition (*Table 1, Table 2*).

The concept of building on cable-stayed bridges was chosen from several possible structure system.



# Structure Features-Table 1

	<b>Advantage</b>	<b>Disadvantage</b>
<b>Steel Frames</b>	The design and construction of steel frames was simpler.	The required cross-sectional areas of the steel components required for the frame and transfer structures were considerable, being less economical and requiring higher costs than reinforced concrete.
<b>Concrete Frames</b>	The construction and material are cost-effective and economical.	<ol style="list-style-type: none"><li>1. The dead load of concrete is huge, so the cable will bear much more stress.</li><li>2. It is difficult to control the crack of concrete, especially on the first floor plan.</li></ol>



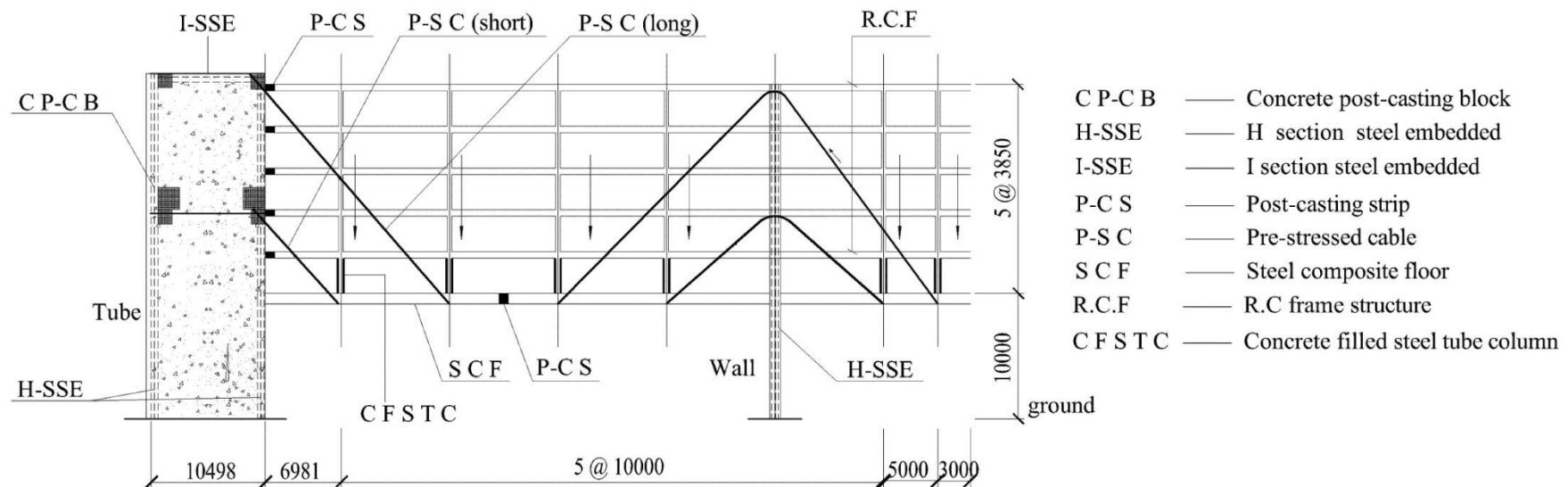
# Structure Features-Table2

	Advantage	Disadvantage
<b>Mega steel-transfer structures</b>	The transfer truss systems can provide additional lateral stiffness to the overall structure.	The span of the structure is limited and cannot exceed 50 meters.
<b>Cable structures</b>	Relative long span can be possible with the using of this type of structure.	The structural systems are not capable in resisting lateral loads.



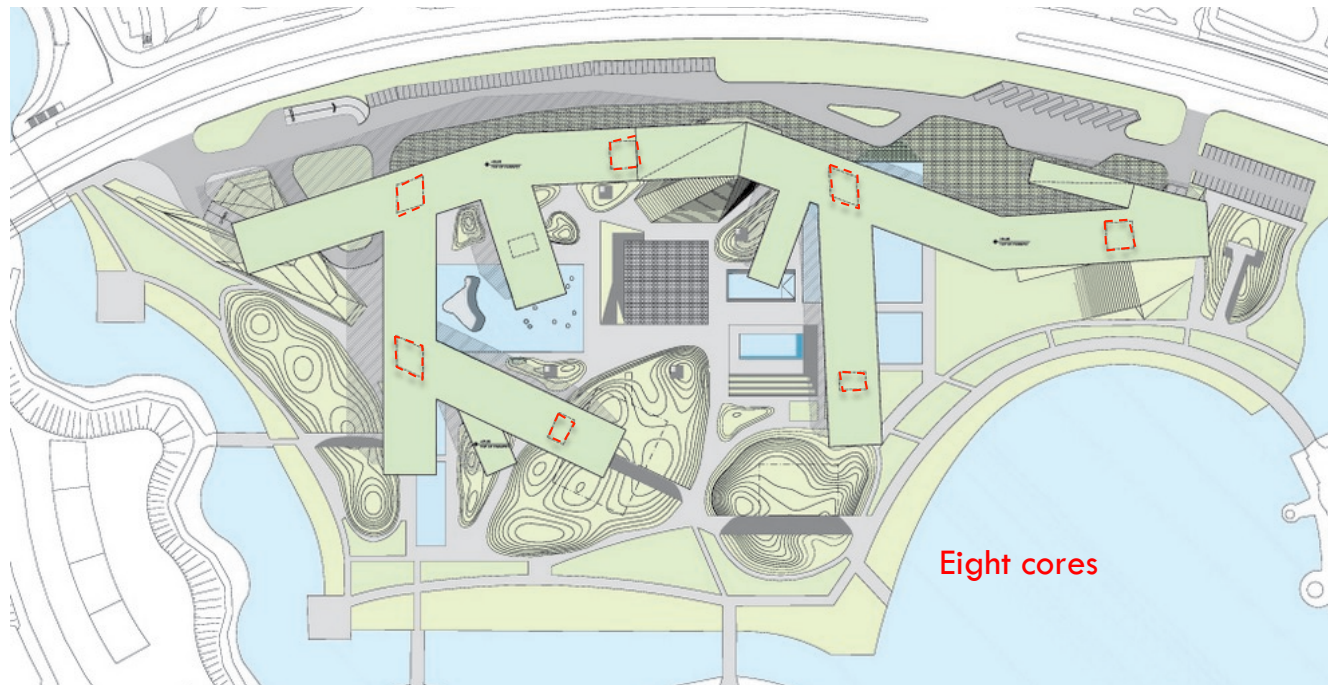
# Components

1. Steel beams on the first floor to control cracking
2. Wide RC beams on the upper floors provided a better option to coordinate structural deformations.
3. Pre-stressed cables reducing the moments at the base of the super columns.



# Main Structural System

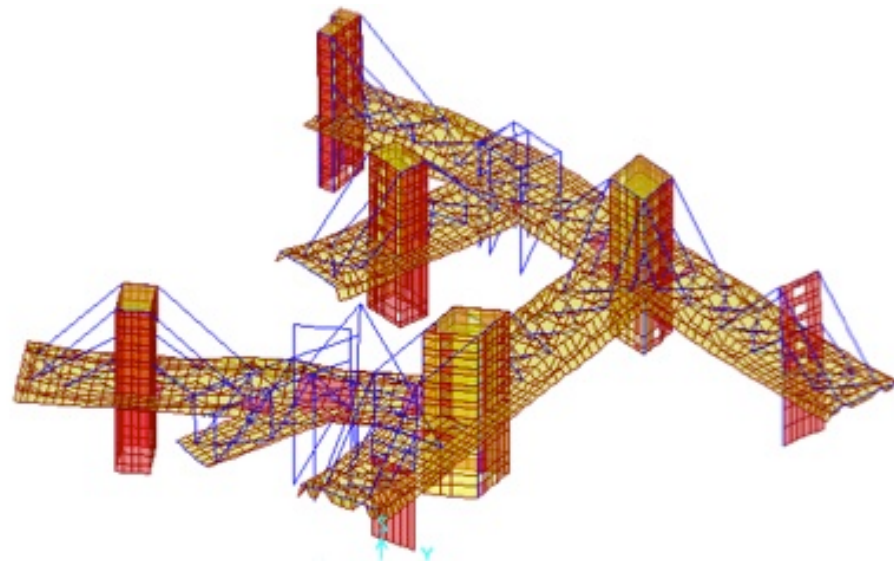
The structure spread out under the 35 meter height limit on the site, supported on eight cores using bridge- building technology and a concrete frame to maximize the area available for gardens beneath.



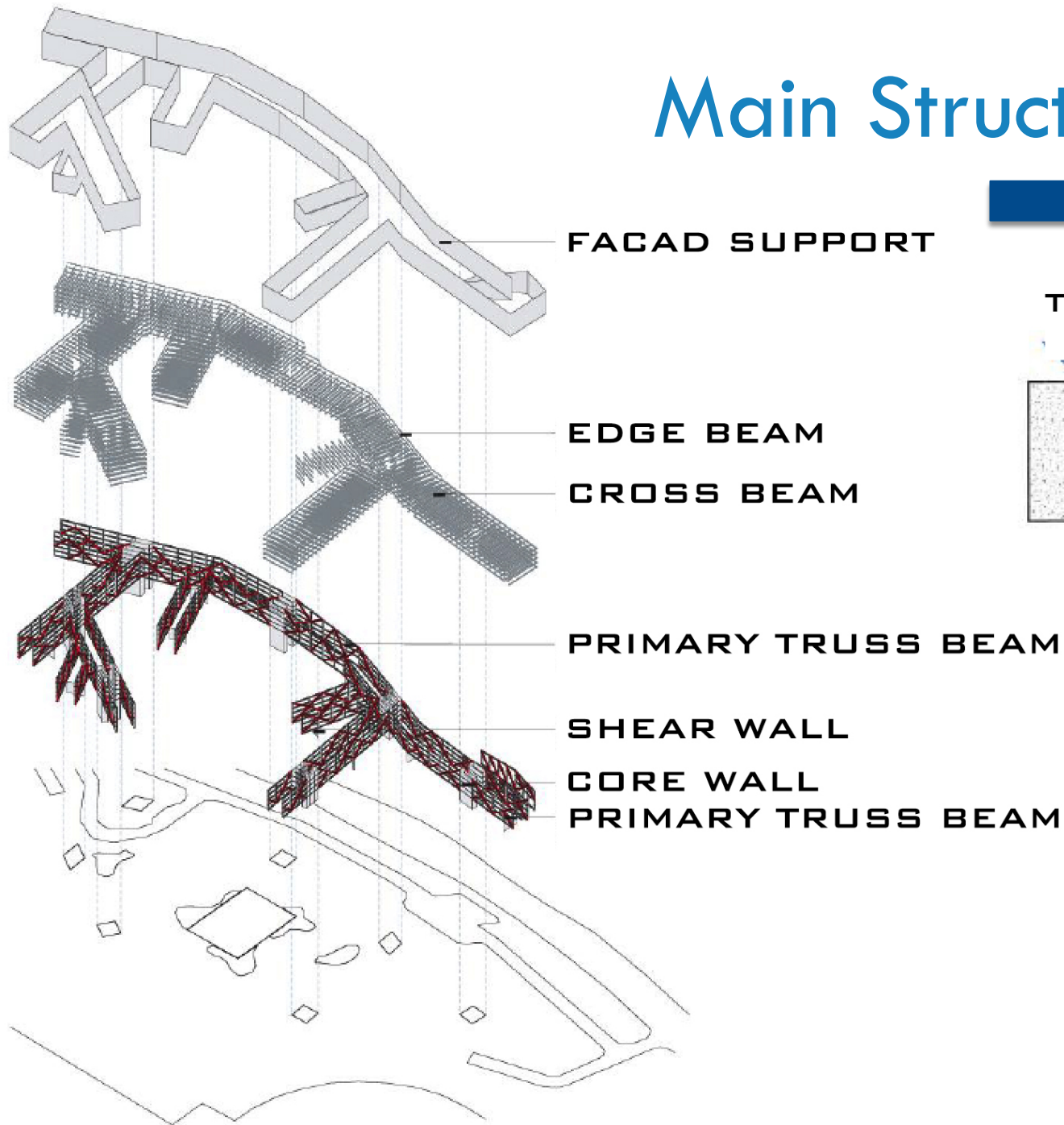
# Main Structural System

Suspended on eight cores , as far as 50 meters apart, this floating horizontal skyscraper is a sophisticated combination of cable-stay bridge technology merged with a high strength concrete frame.

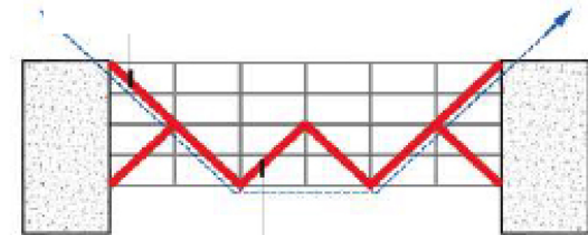
The first structure of its type , it has tension cable caring a record load of 3280 tons.



# Main Structural System



TRUSS BRACE

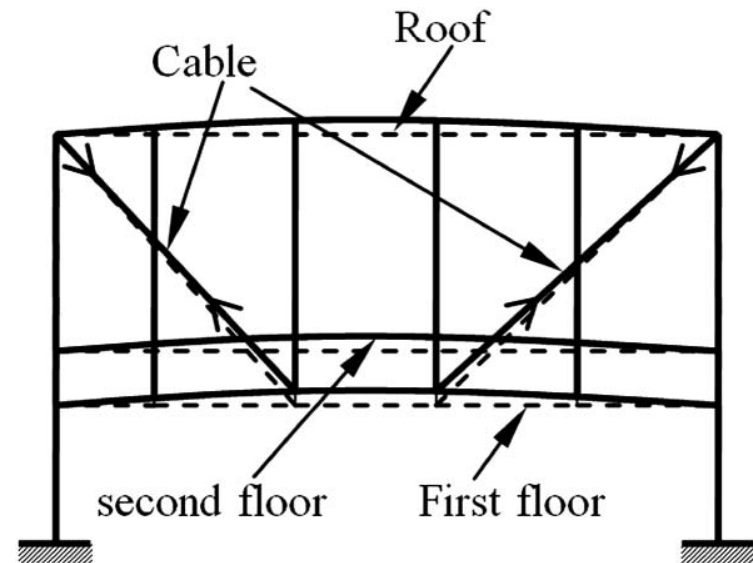
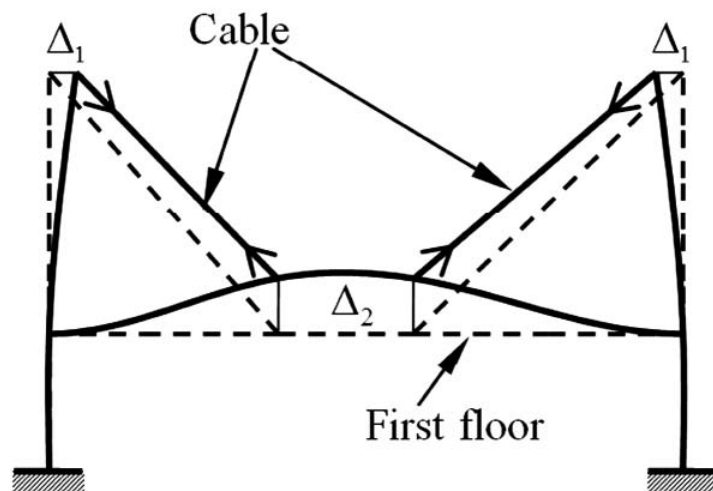


TRUSS SYSTEM

# Self-Balanced Construction

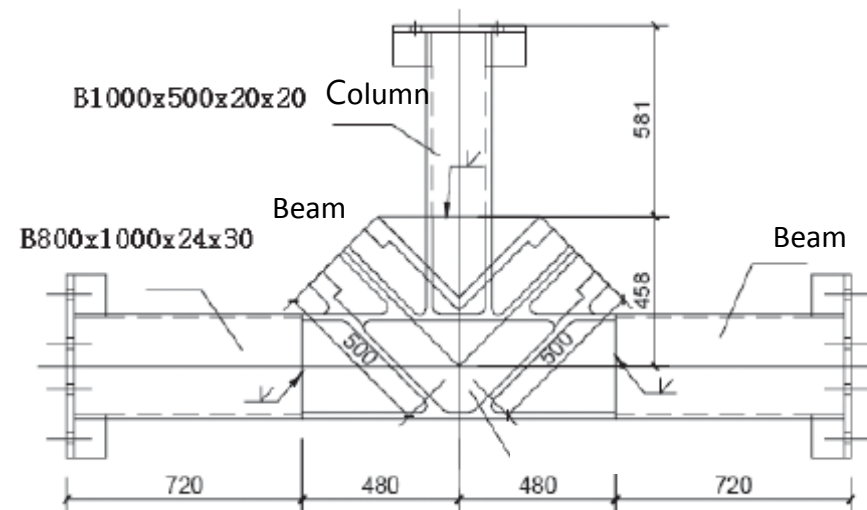
Architectural requirements mandated that deflections caused by arching following pre-stressing go cable at the mid-span and cantilever ends of the beams on the first floor needed to be restricted .

It is very different with conventional cable-stayed because the number of cables used is small but the tension forces developed in the cables are large.



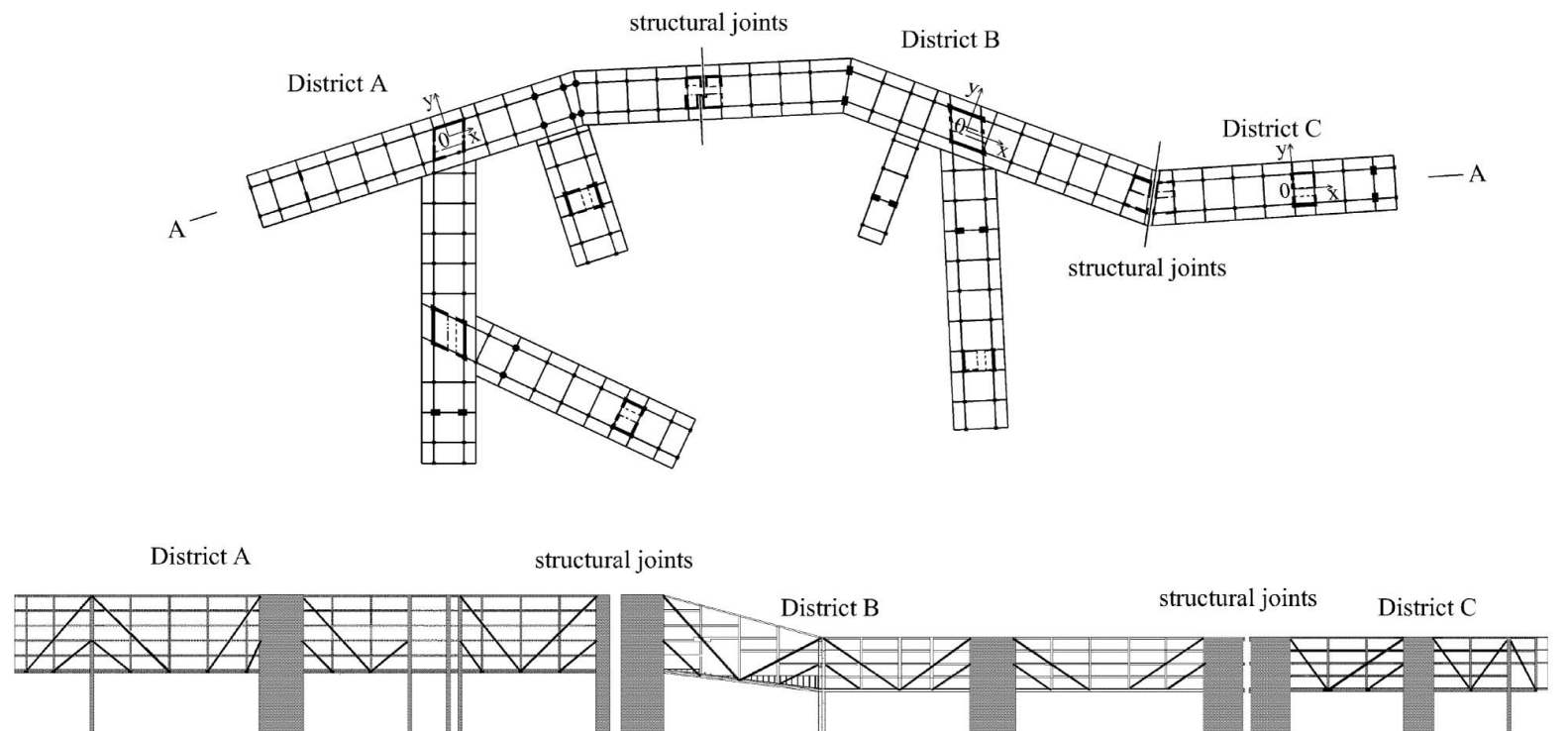
# Connection Description

Cast steel joint is a new type of structural joint developed with the application of the large-span steel truss. Top joint is fixed in core wall or wall, welding with structural steel inside; bottom joints is fixed with two-story steel beams, welding with the steel beam.



# Expansion Joint

Two structure joints were introduced between the districts, in which the positions of the tube and wall can be identified. The joint clearance was 100mm, which accounted for the lateral movement because of design level earthquake forces.

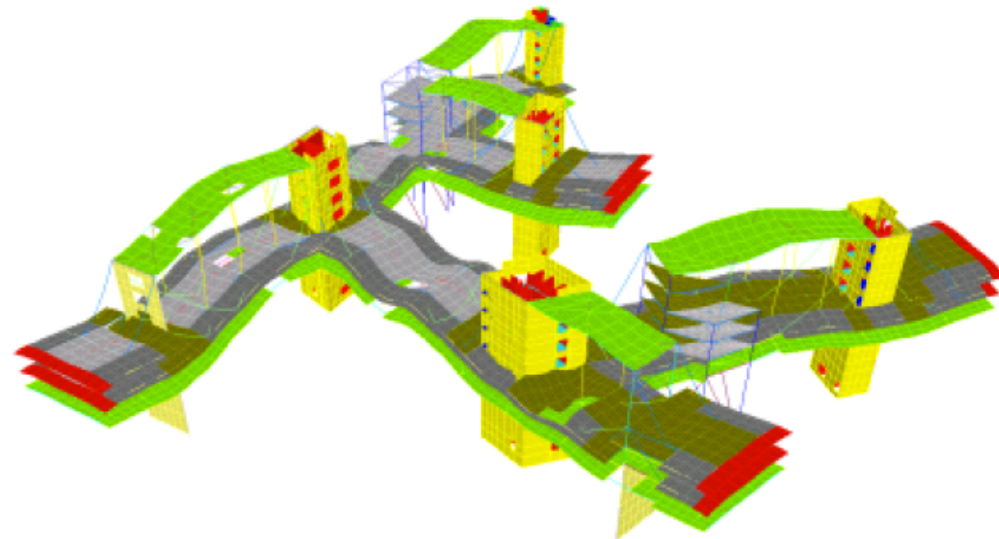




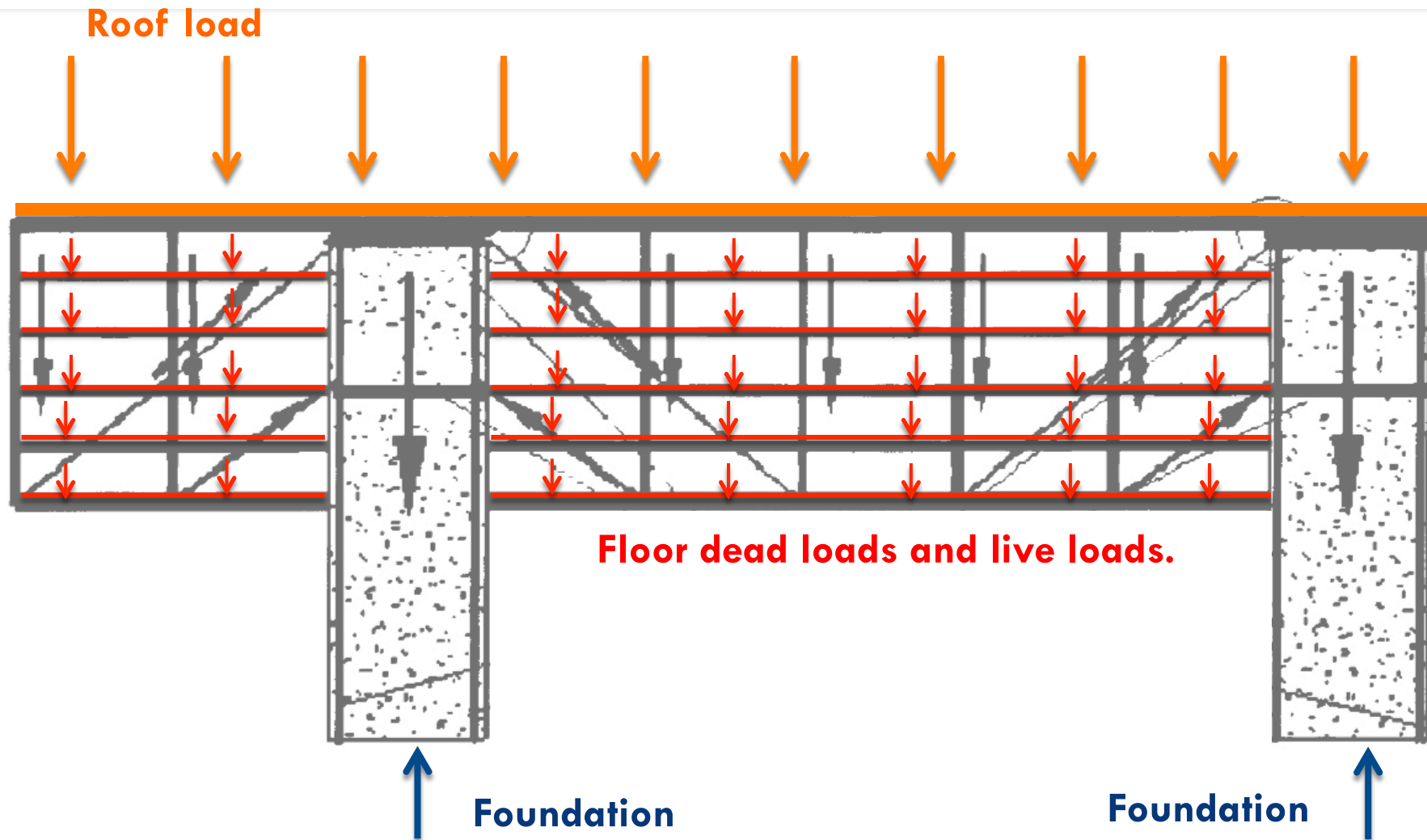
# Loading Summary

The loads carried by the slabs and tubes were introduced in two stages. First, the loads were transferred through pre-stressed cables where the loading process was fairly rapid and the loading intensity was high.

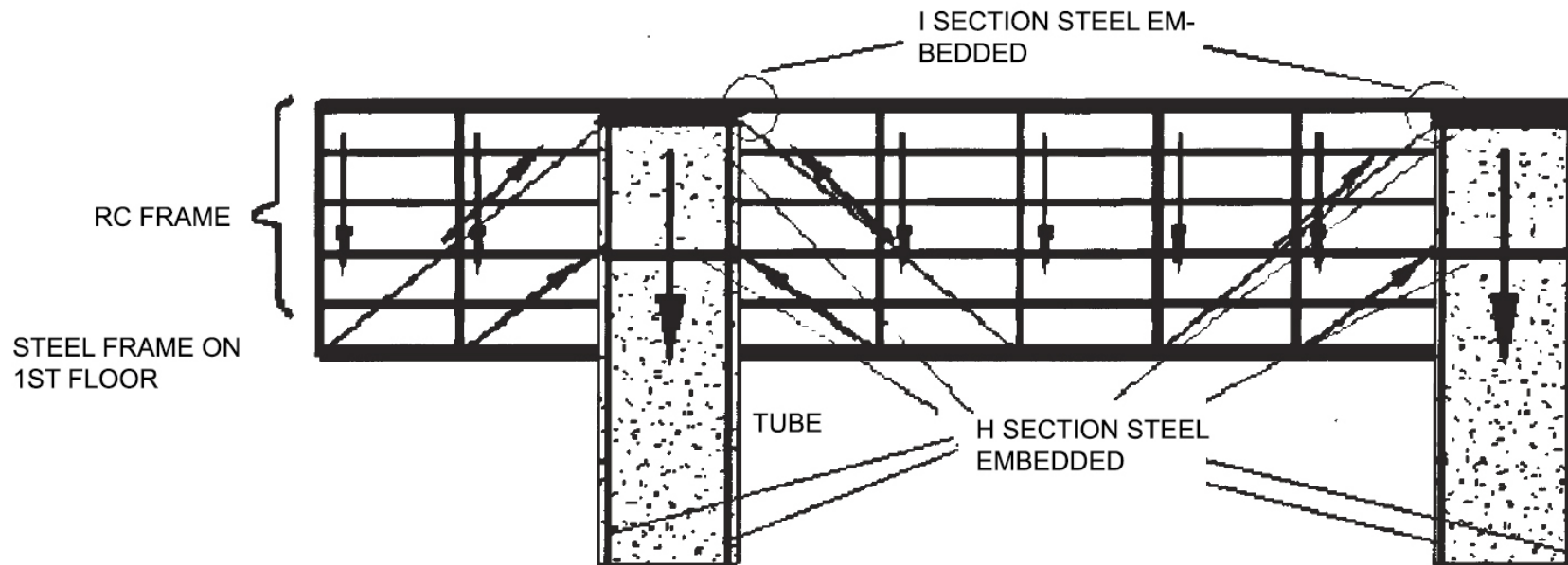
As the construction of the superstructure proceeded, the structural loads were transferred to the slab and the tube in a slow and steady manner.



# Loading Summary



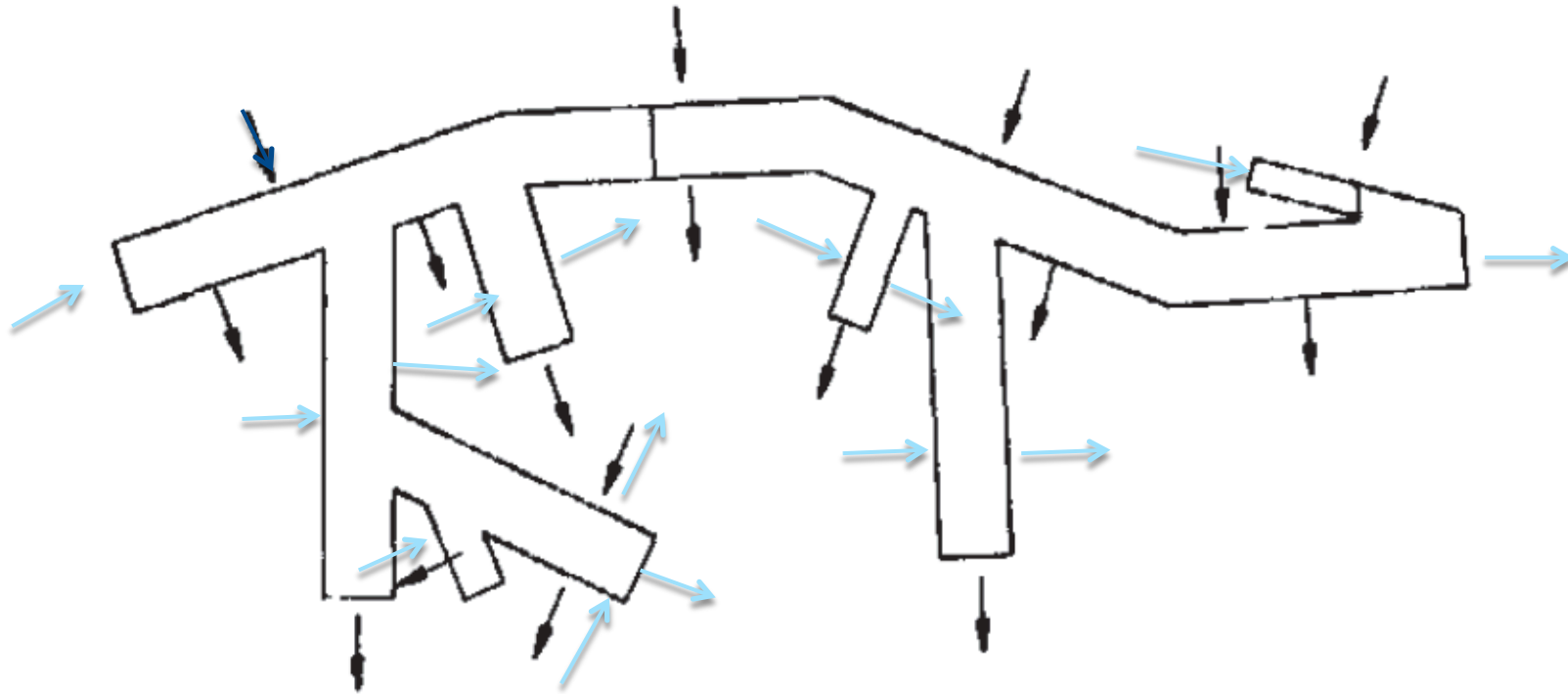
# Load Transfer Path



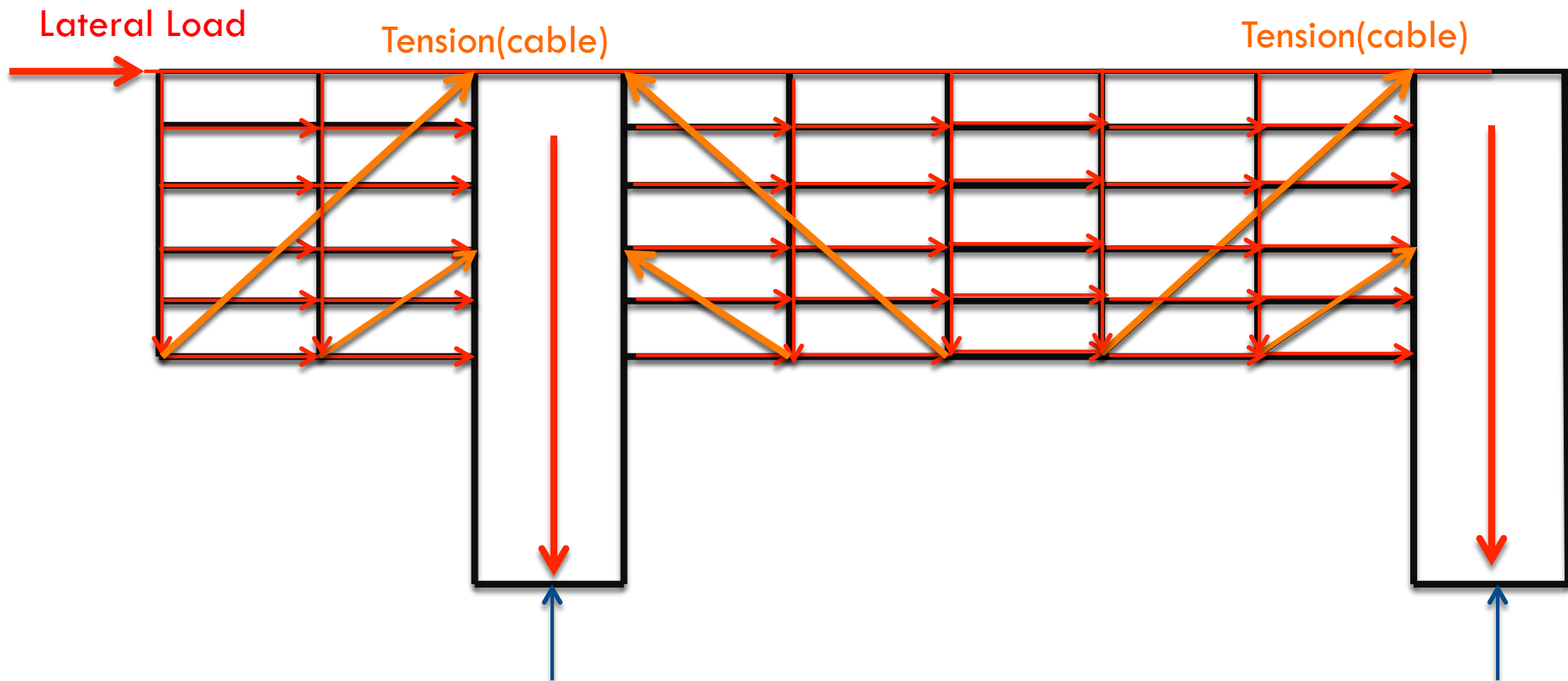
Gravity loads from the superstructure were transferred to tubes, walls, and columns by the inclined pre-stressed cables.

# Lateral Loading Behavior

Lateral load created by wind.

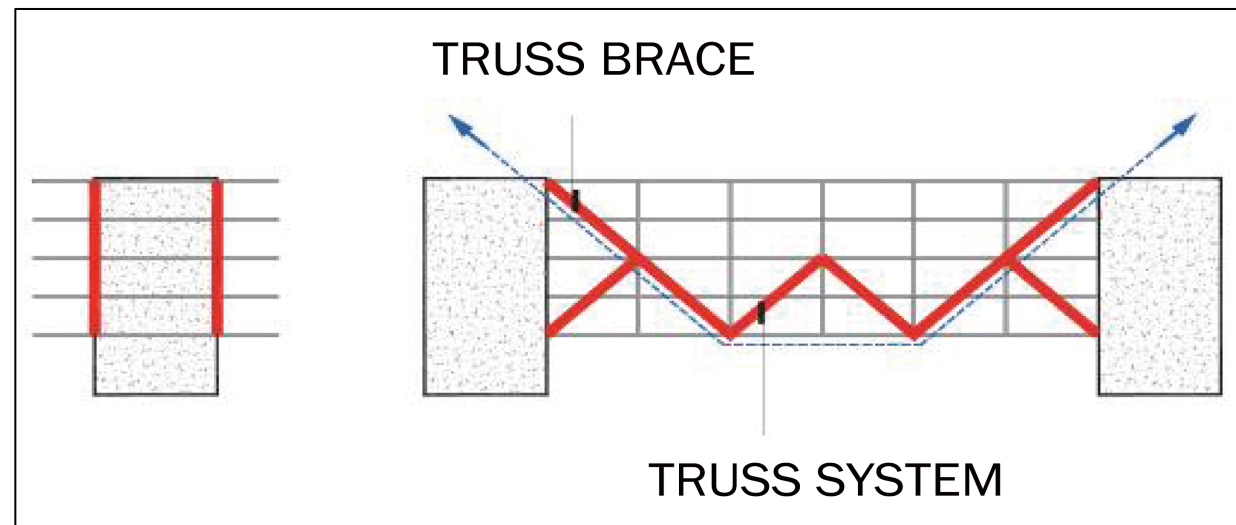


# Lateral Load



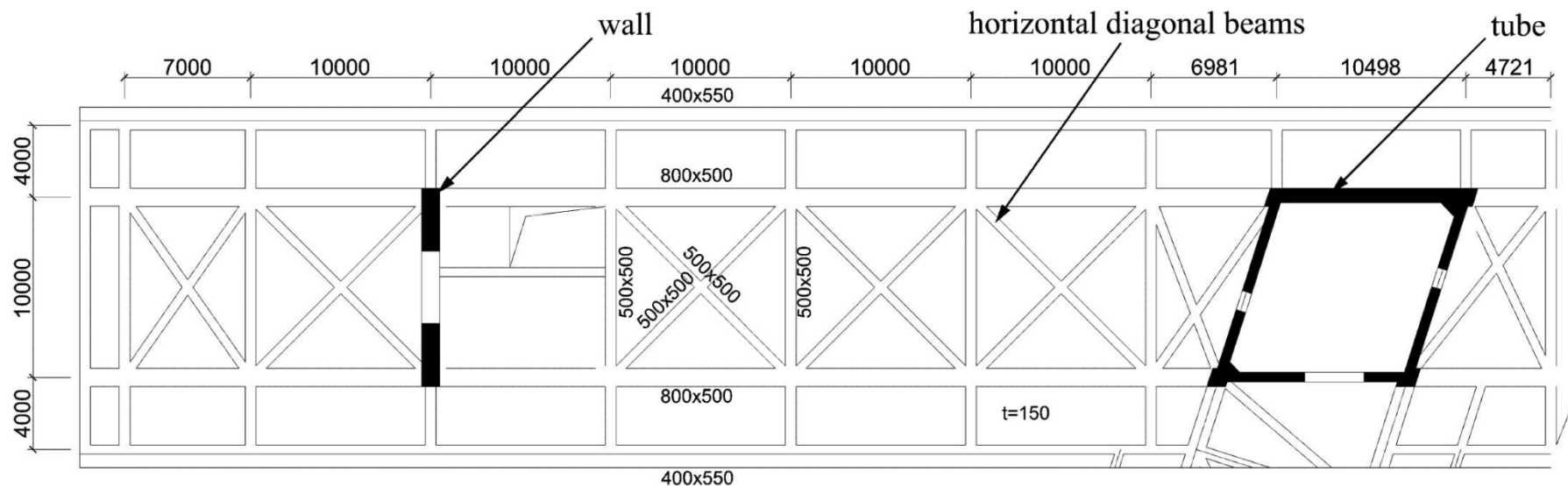
# Lateral Resisting System

The shear wall and core wall constitute the inner lateral resisting system. It can suffer the lateral load like wind force by the outside lateral resisting system. Primary truss beam and primary truss brace are the outside lateral resisting system.



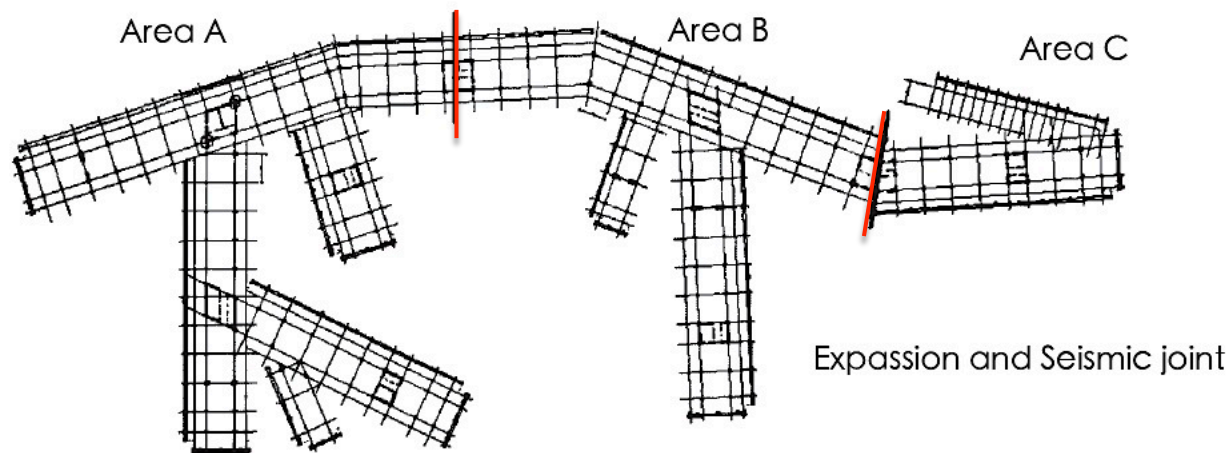
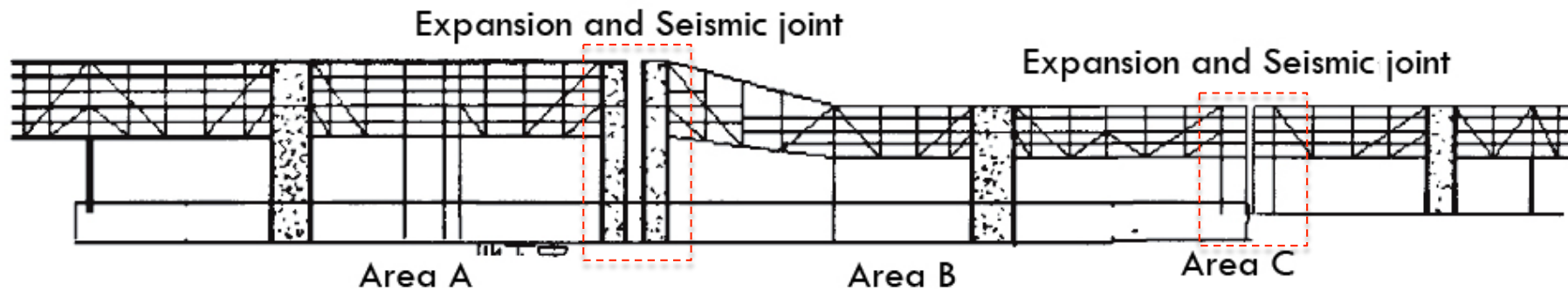
# Lateral Resisting System

**Horizontal diagonal beams** were added at the first floor and roof levels to add horizontal stiffness and increase the resistance of these floors to the horizontal component of the cable tension forces.



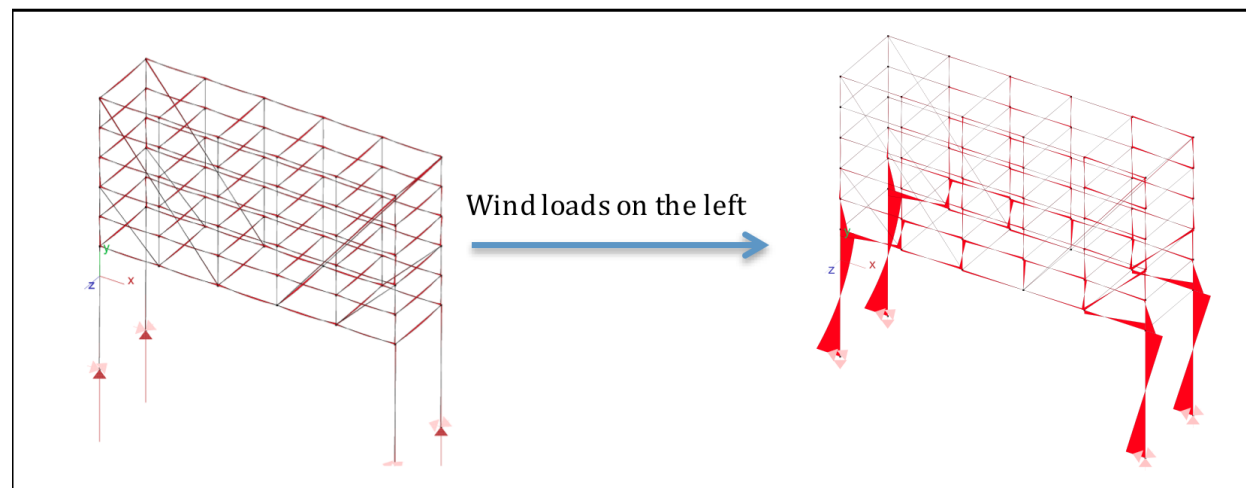
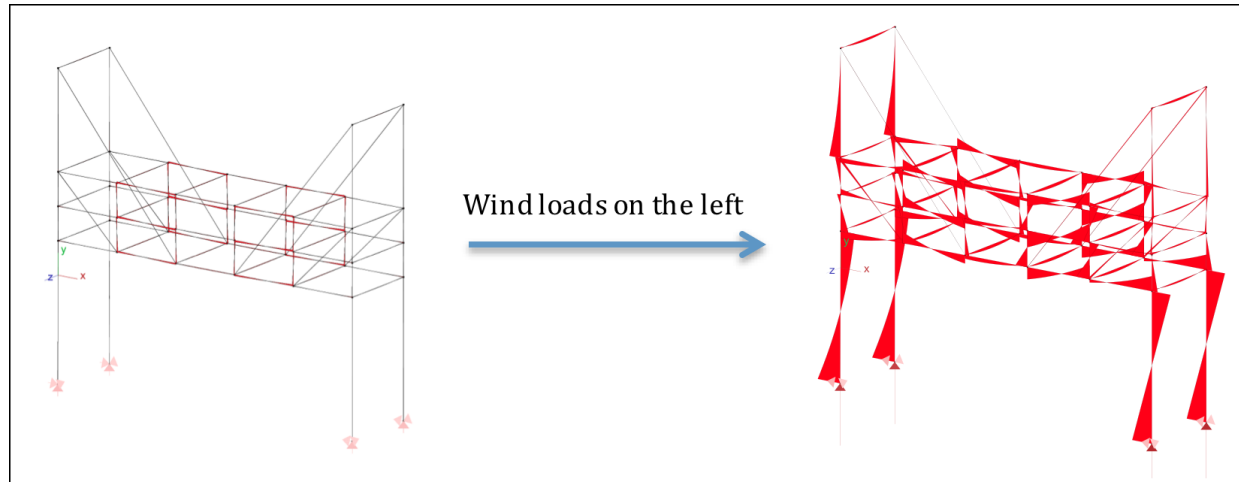
# Lateral Resisting System

## seismic joint

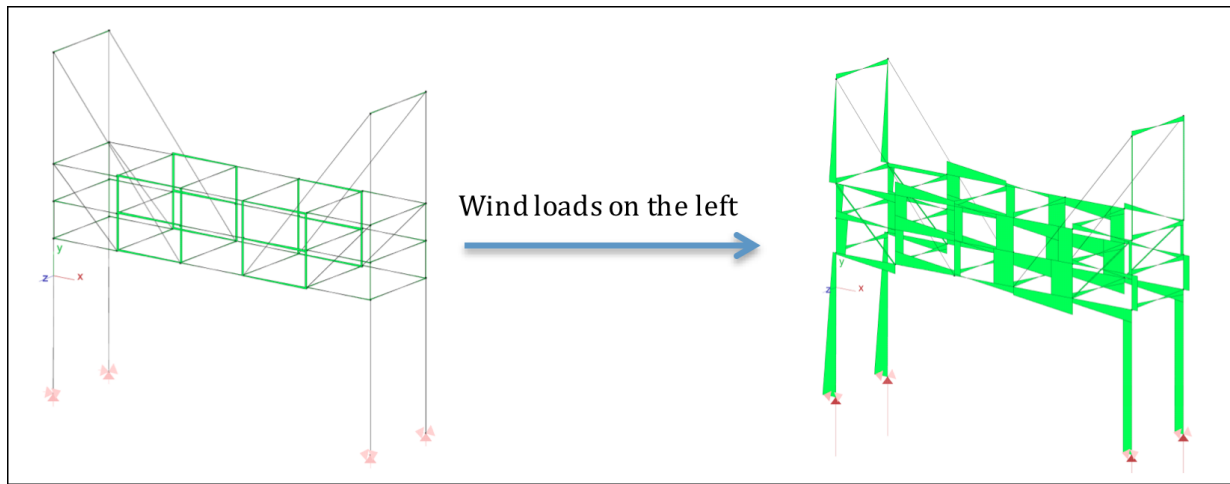




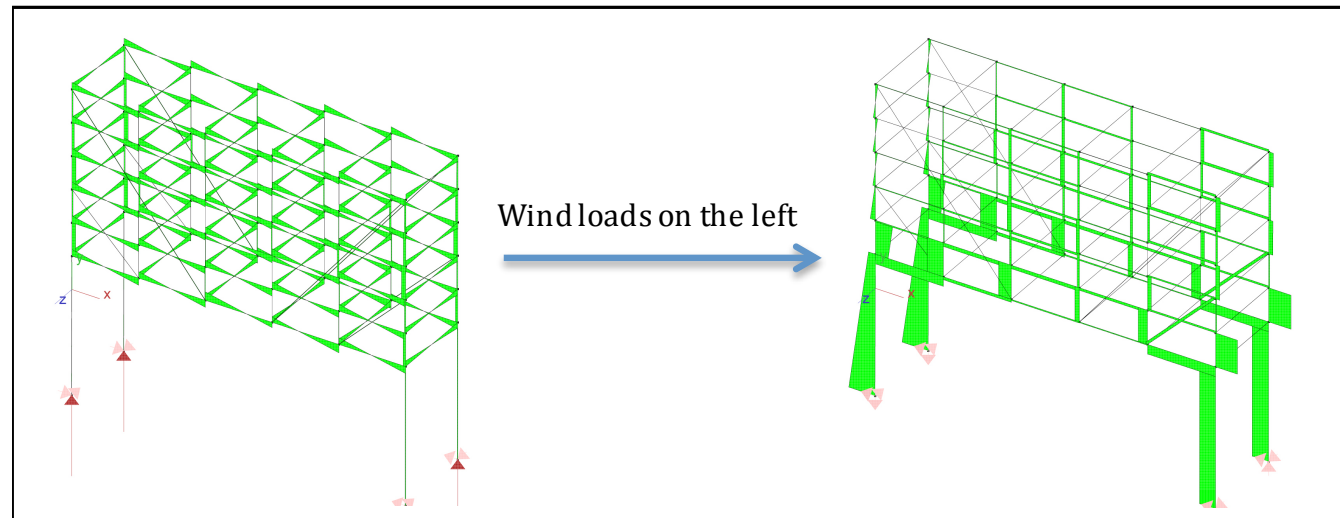
# Multiframe Analysis



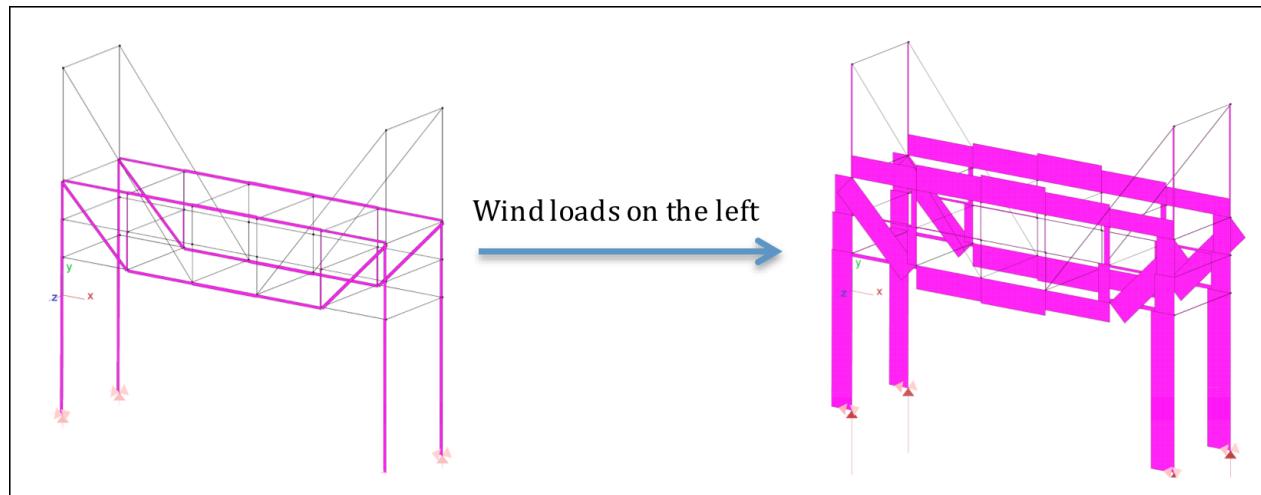
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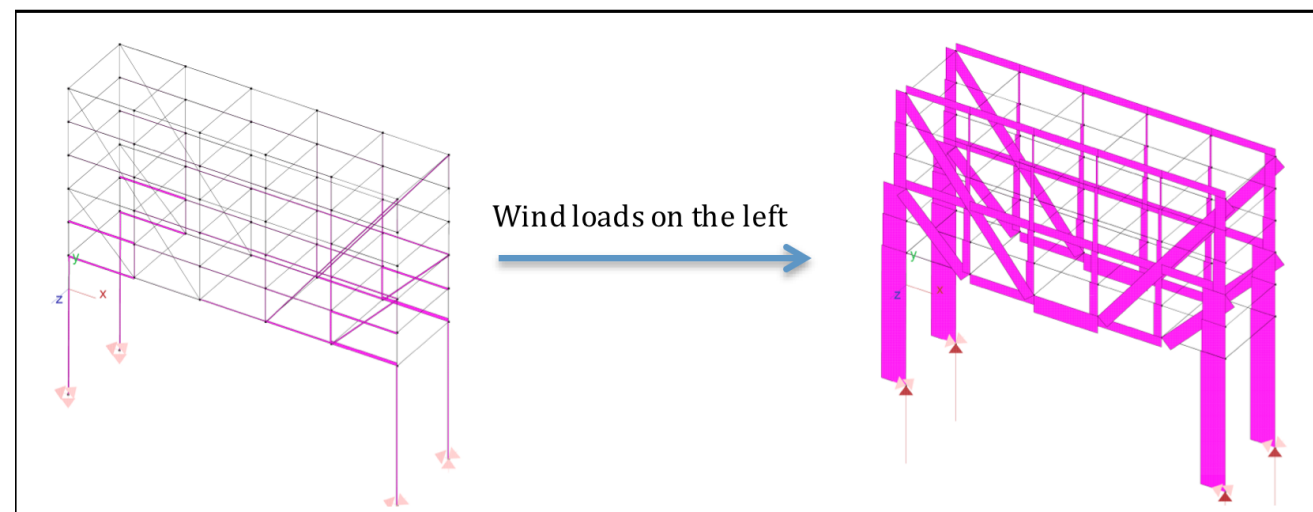
Shear diagram



# Multiframe Analysis

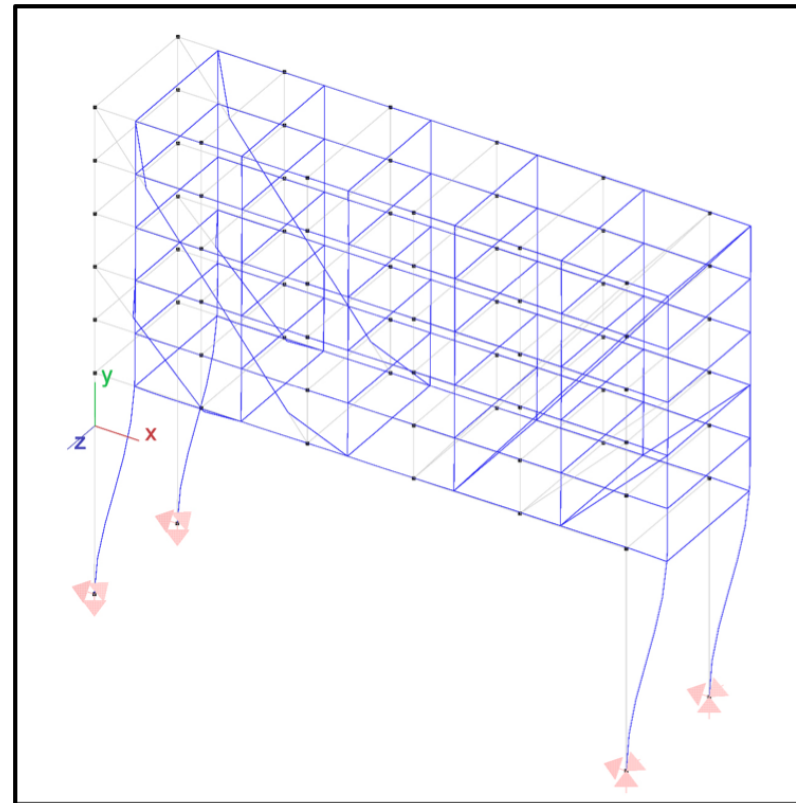
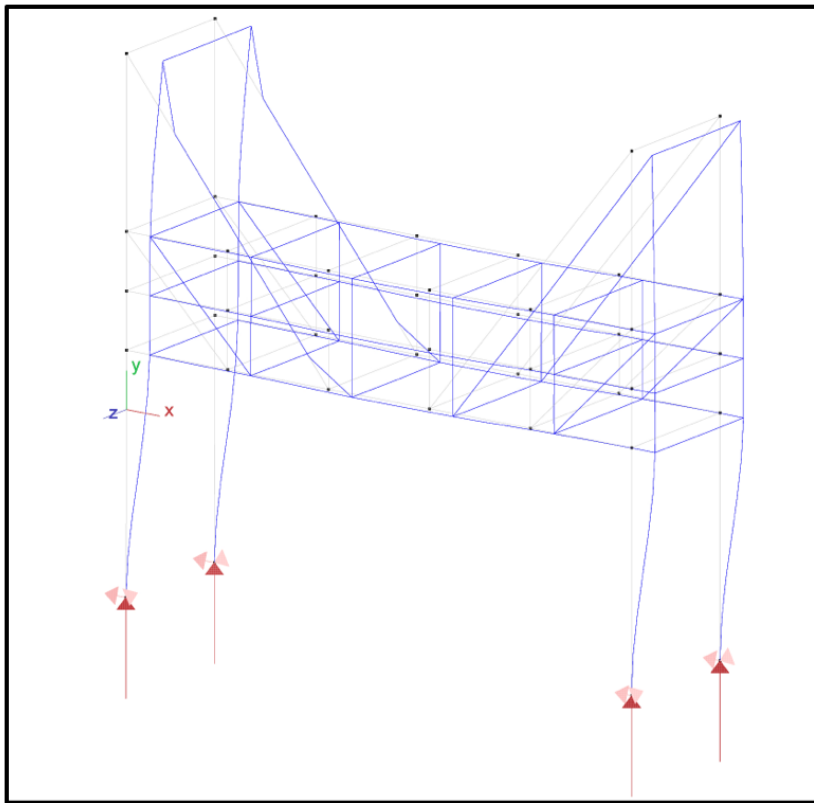


Axial diagram



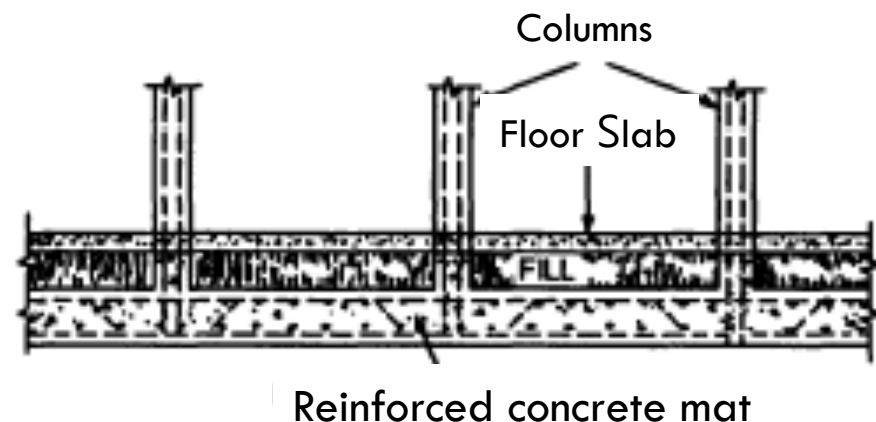
# Multiframe Analysis

## Deflection diagram



# Foundation and Soil

Shenzhen was originally a hilly area, with fertile agrarian land. However, after becoming a special economic zone in 1979, Shenzhen underwent tremendous change in landscape. The once hilly fishing village is now replaced by mostly flat ground . Vanke Center built On flat area, and it has rarely earthquake in Shenzhen. So the foundation is mat foundation for Vanke Center.



# Foundation-Mat Foundation

Mat foundation uses bearing capacity of the soil at or near the building base to transmit the load to the soil.

It used to distribute the bearing pressure over a large footprint and /or to resist significant uplift forces that can develop.

