

The image features a tall, white, cylindrical skyscraper with a distinctive twisted design, known as the Turning Torso. The building is set against a clear blue sky. In the foreground, there are green trees and a grassy area. To the right, a modern glass-walled building is partially visible. The overall scene is a clear, bright day.

TURNING TORSO

ARCH631 Structural Case Study

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OUTLINE

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Architect: Santiago Calatrava

Location: Malmo, Sweden

Design: 1999-2001

Construction: 2001-2005

Type: Residential Tower

Structure: Core and Slabs
(concrete)

Exoskeleton: Steel

Height: 623ft.

Levels: 56

Façade Area: 215,278ft.²

Net Floor Area: 227,710ft.²



BACKGROUND

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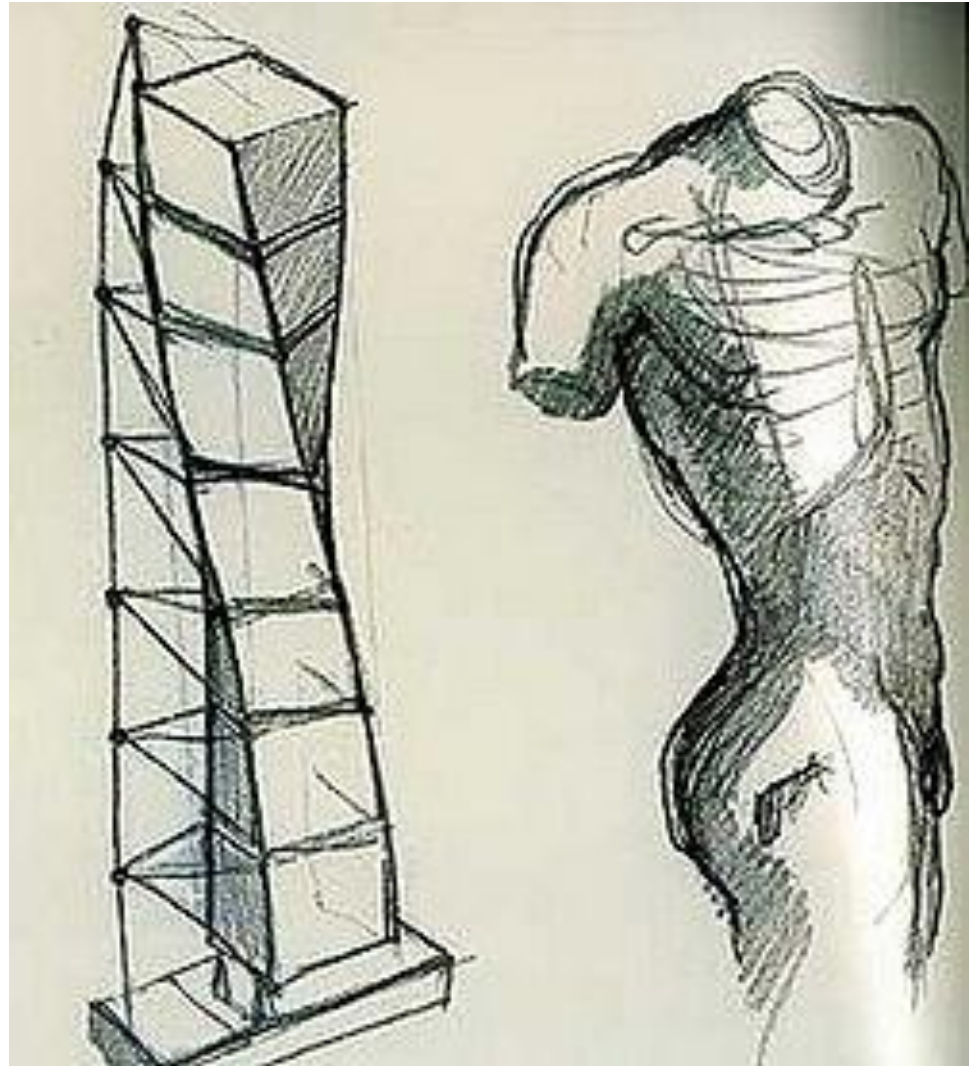
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Based on the sculpture,
“Twisting Torso” exploring
the human body in motion,
twisting as far as it can
naturally being pushed while
staying directly upright

Form is made up of 9 cubes,
each individual cube
containing five stories



CONCEPT

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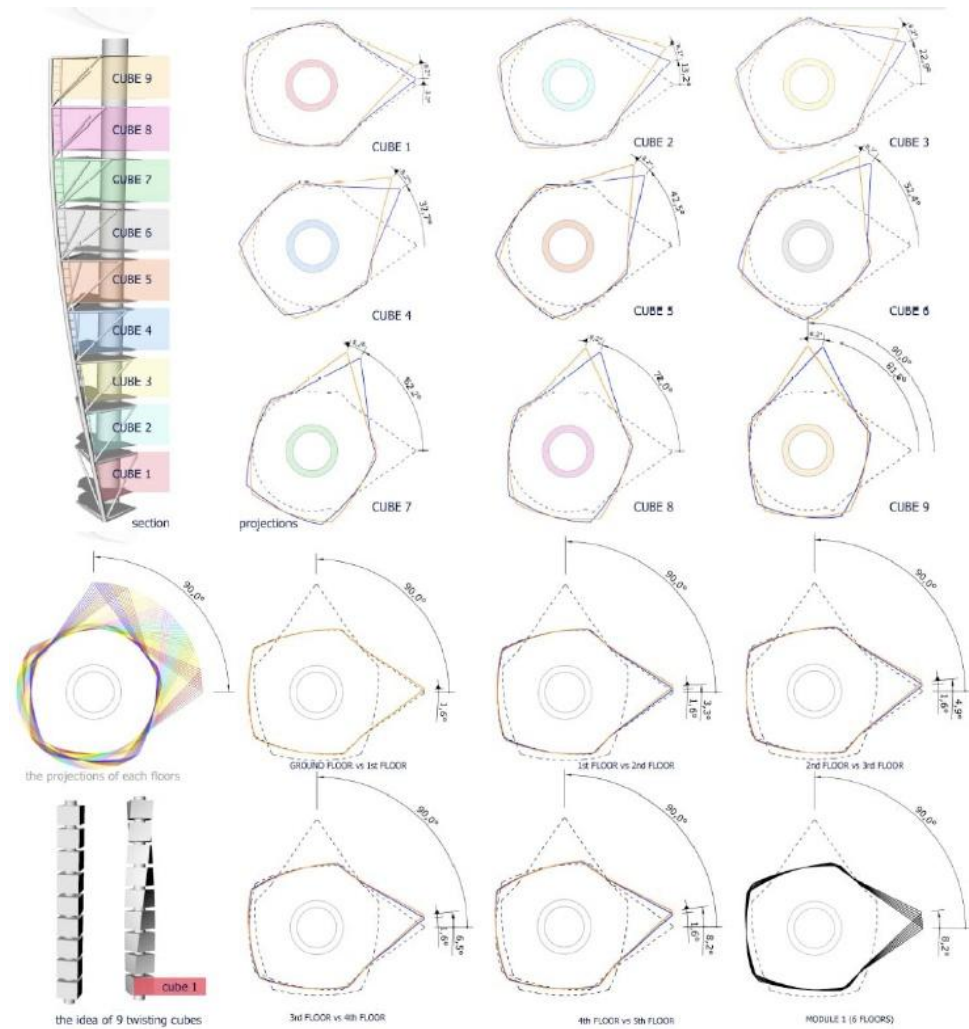
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Twists 90 degrees from the ground level to the top floor



CONCEPT

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Each floor consists of a square section around the core and a triangular part supported by an external steel structure

The central core is supported by a foundation slab

The corner of each floor is a concrete column supported by a pile foundation



STRUCTURE

The structural slab is fitted around the core

The forms for the structural slab are triangular shapes, together forming a floor

The forms were rotated 1.6 degrees for each floor in order to create the characteristic twist of the building



SLAB

The core is the main load-bearing structure

Large concrete pipe, with an inner diameter of 35ft.

The walls are 8ft. thick at the bottom, gradually shifting to 1ft. thick at the top

The elevator shafts and staircases are located inside the core

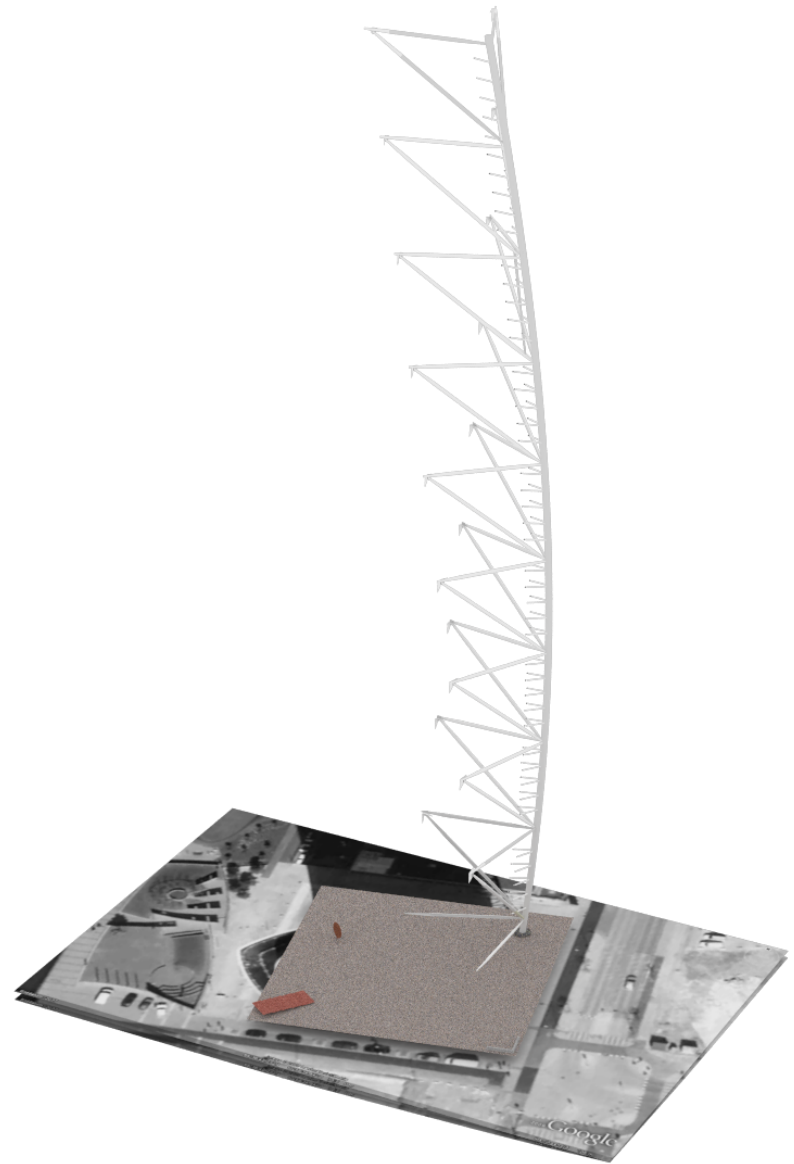


CORE

The steel support is located on the exterior of the building, which is linked together by the spine, acting as the loading backbone from the winds

The steel support transfers shear forces to the supporting concrete core.

Each steel section of the spine has to fit precisely in the one below it



SPINE

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The system consists of a spine column at the corner of each floor plus horizontal and diagonal elements that reach to each side of the glazed spine

Stabilizers also connect the floor slabs with the framework



SPINE

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The tower rests on piles driven into a foundation of solid limestone bedrock at 49ft. below ground level

Avoids unacceptable bending or swaying



FOUNDATION

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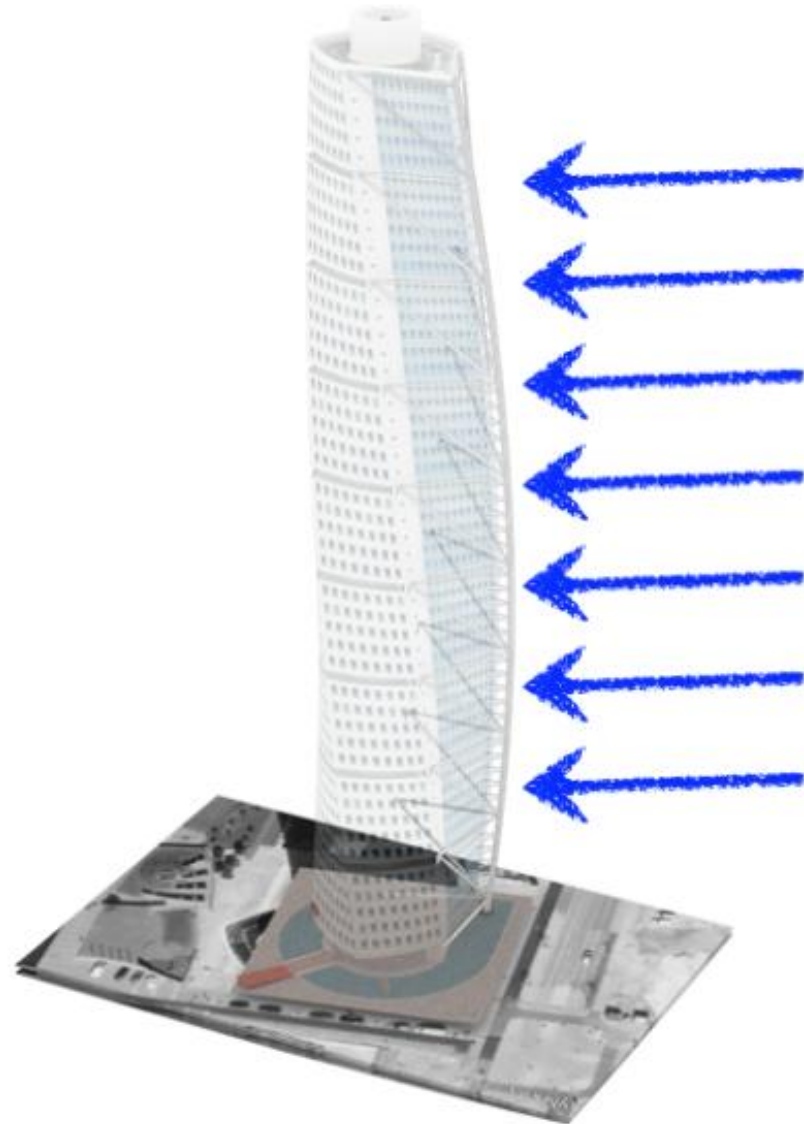
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Steel Spine

Cantilever Floor Slab

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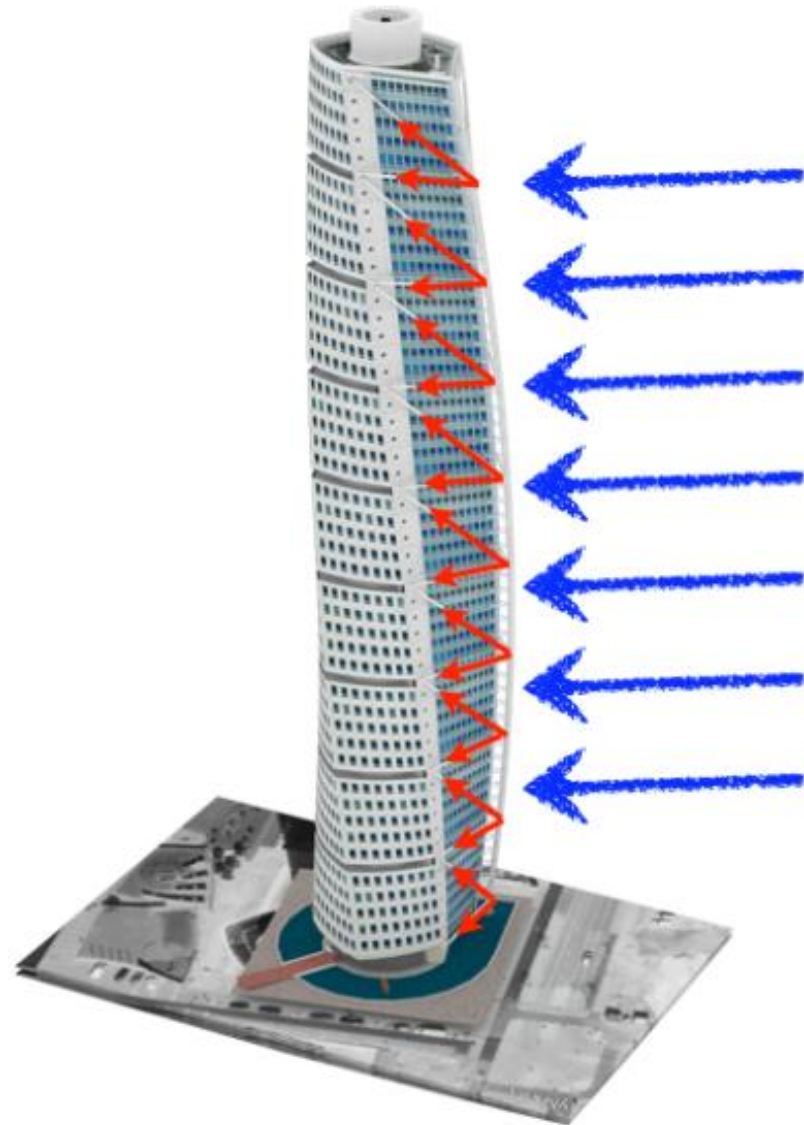
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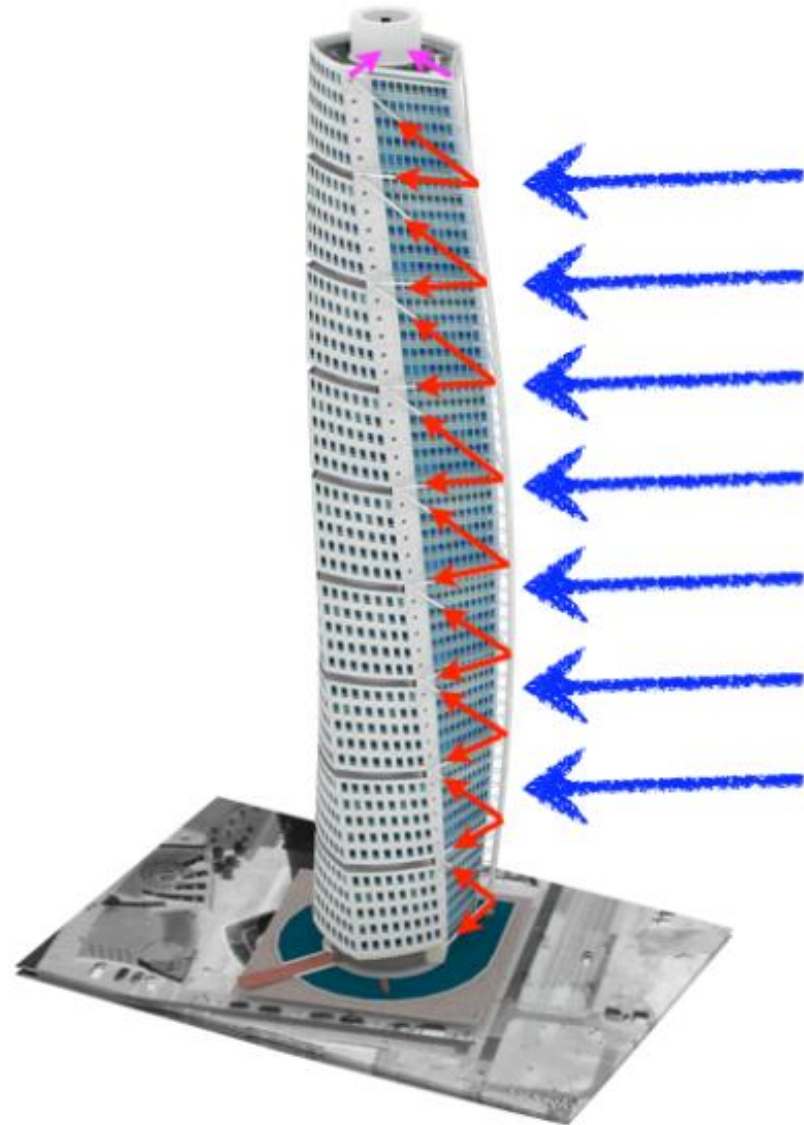
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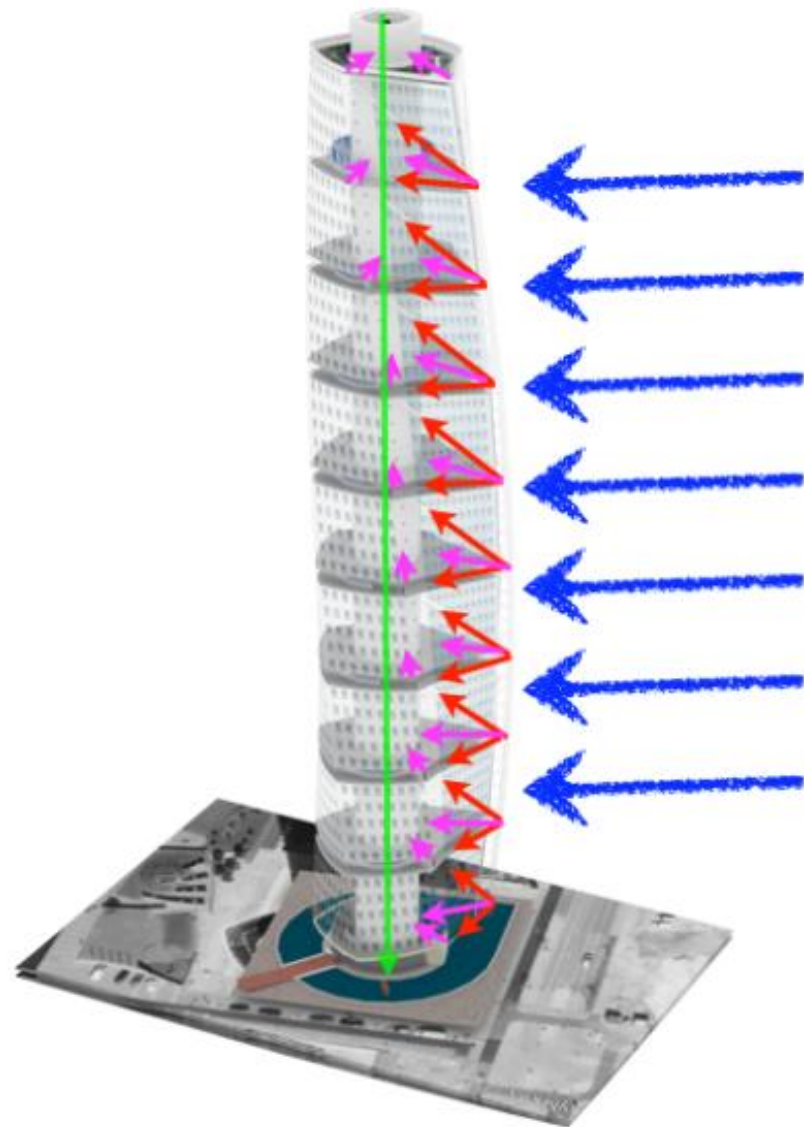
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The twisted form can be very effective, alleviating the effects of vortex-shedding induced by lateral wind loads and minimizing the wind loads from prevailing direction



WIND LOADS

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When analyzing the structure under wind loads, Calatrava found that the Turning Torso could move up to 3ft. at the top during the most severe storm

Giant pins attached to the ground were then implemented, decreasing the movement to less than a foot during the most severe storm, which is nearly unnoticeable

WIND LOADS

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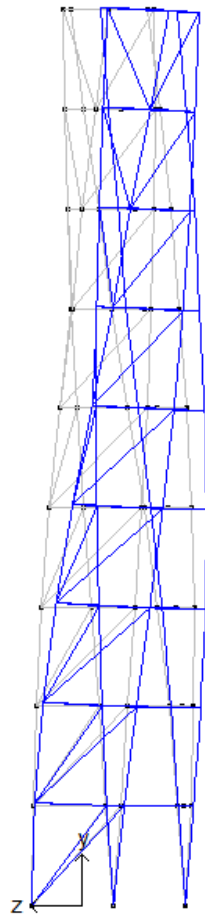
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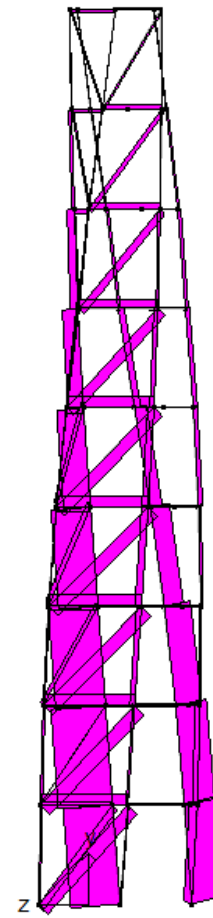
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Deflection



Axial

MULTIFRAME

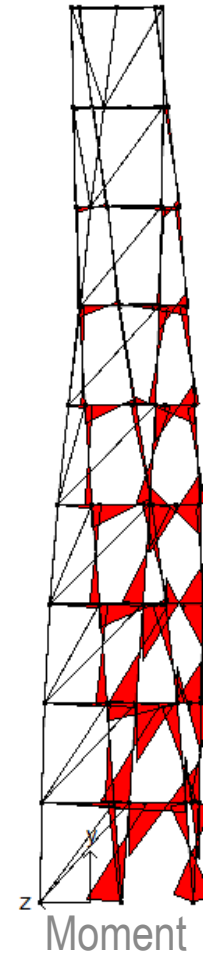
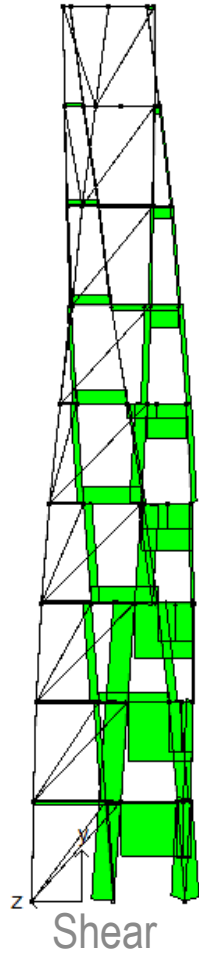
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The building was constructed using an Automatic Climbing Structure

This four story workhouse climbs up the building as each floor is completed



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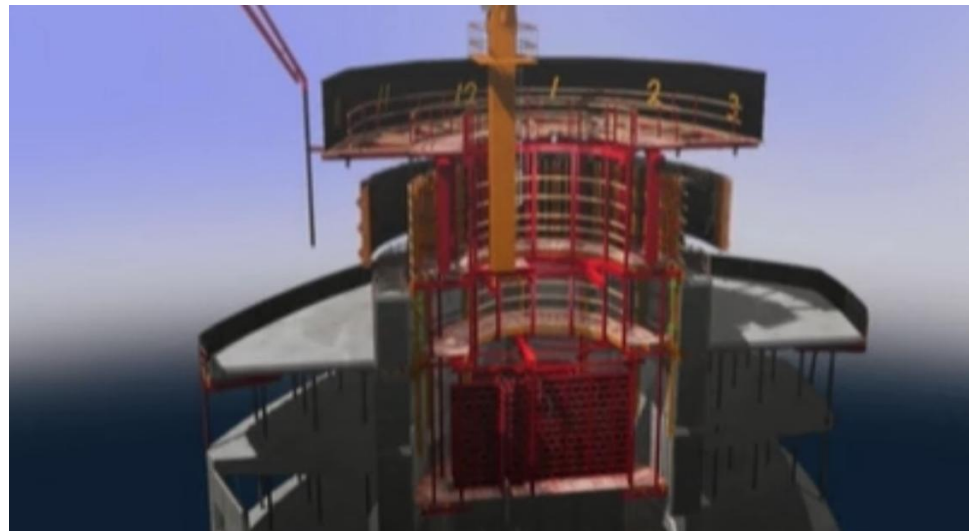
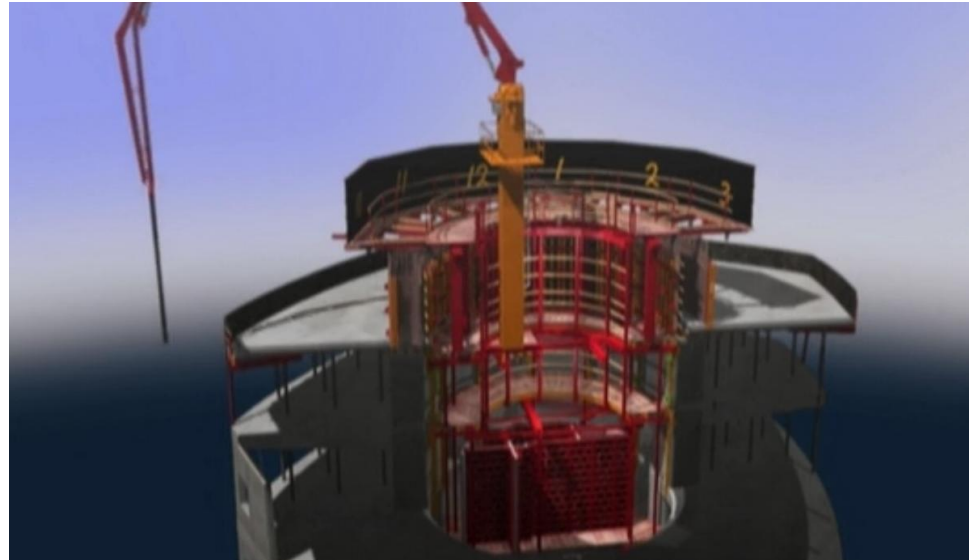
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First, it shapes the concrete core, then a large ground pump draws the concrete to fill the forms

After the concrete is poured, the ACS climbs



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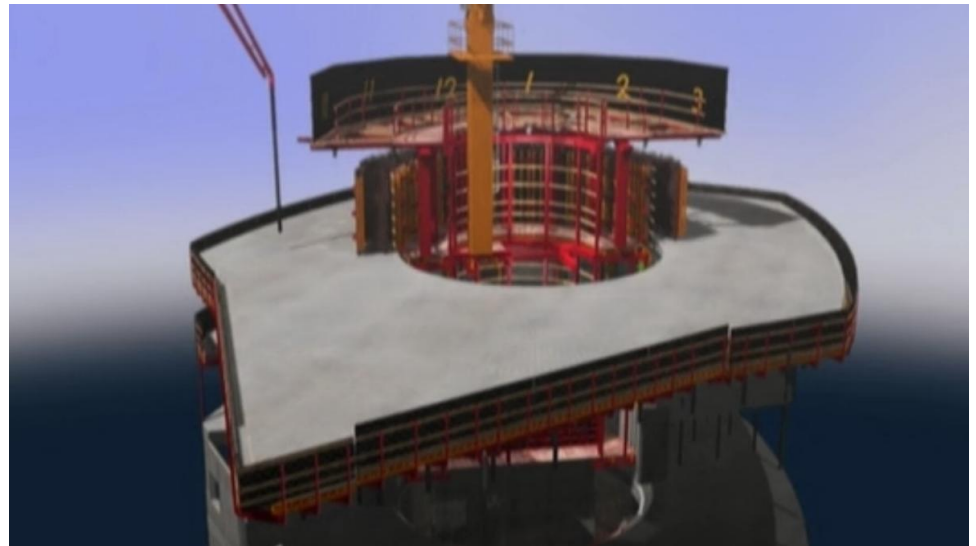
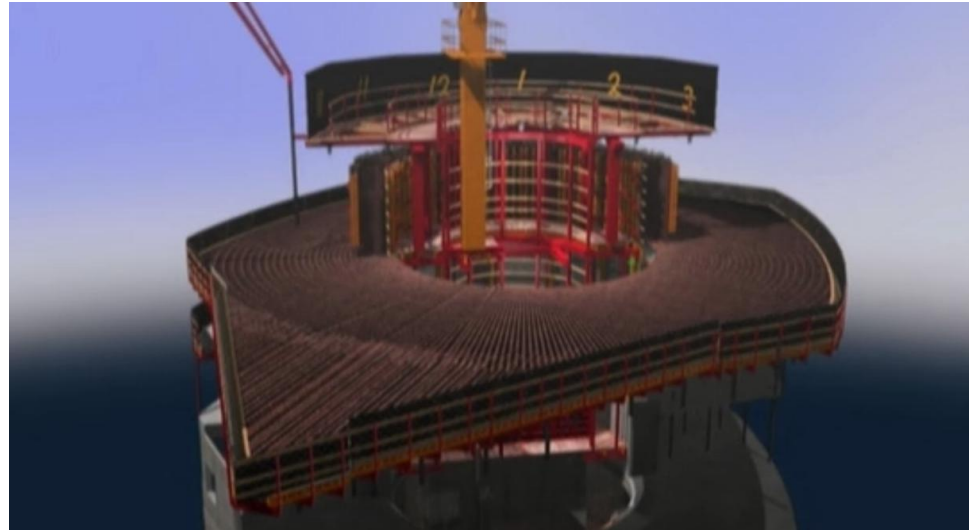
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Next, table form sections are lifted up with a crane, and provide a place to set rebar

Concrete is again pumped up to form the floor slabs

Before the table slabs are moved to the next floor, they are removed and inspected on the ground



CONSTRUCTION

Double curved glass and aluminum façade

2,800 curved panels and 2,250 flat windows in the façade

In order to follow the twist of the building, the windows are leaning between 0 and 7 degrees either inwards on the western façade or outwards on the eastern façade



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THANK YOU.