Prada Aoyama Tokyo,
Herzog & de Meuron

Architectural Technology II
Structures in Architecture
Columbia University GSAPP
Zak Kostura, Spring 2020

Alexis Zheng, Jean Kim, Johane Clermont,
Lucia Song, Yerin Won

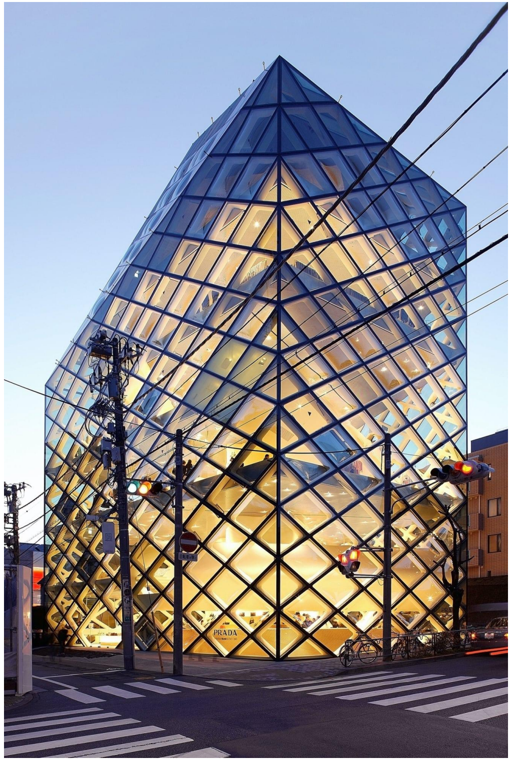
Contents

1. Principles & Precedents

Prada Tokyo,
Herzog & de Meuron

1. Principles & Precedents

1.1 Prada Aoyama Tokyo: An Introduction



The Prada Aoyama Tokyo Epicenter Building

Location: Aoyama District, Tokyo, Japan
Building Use: Prada Flagship Store
Client: Prada
Completion: 2003
Architect: Herzog & de Meuron
Structural Engineers: Takenaka Corporation, Tokyo, Japan & WGG Schnetzer Puskas, Basel, Switzerland

1. Principles & Precedents
1.1 Prada Aoyama Tokyo: An Introduction

Prada Tokyo,
Herzog & de Meuron

1. Principles & Precedents

1.1 Prada Aoyama Tokyo: An Introduction

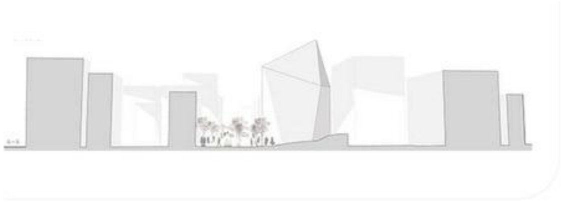
Site Strategy

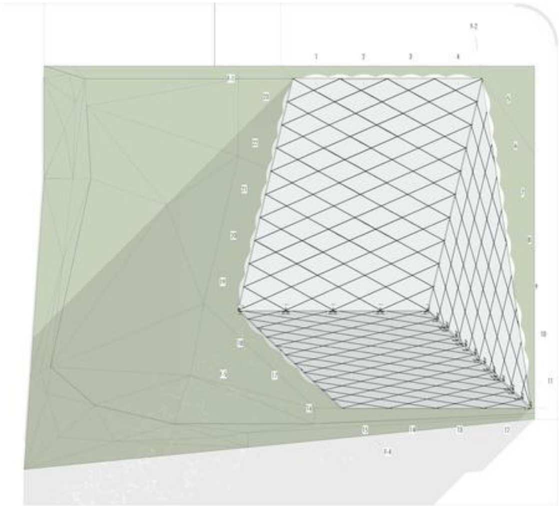
In order to create a public plaza, Herzog & de Meuron chose to create a vertical volume that contained the maximum permitted gross floor area; as a result of this decision to build up and create a 6-story shop, the building is highly visible, and almost a landmark at the corner of the site.

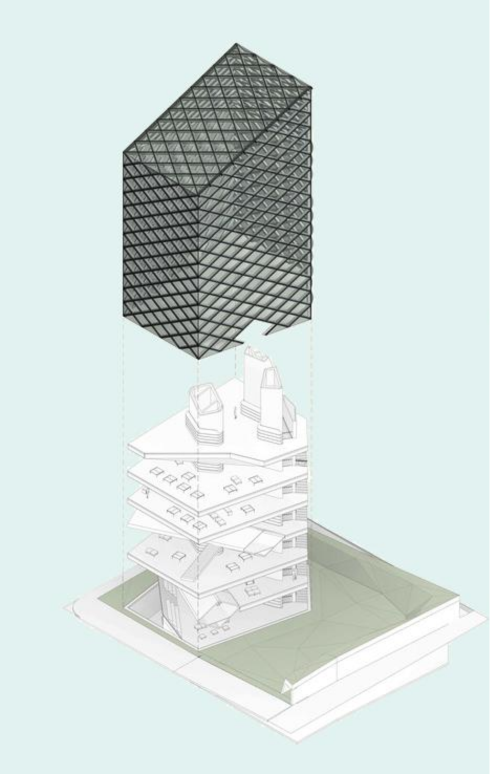
Prada Tokyo,
Herzog & de Meuron

1. Principles & Precedents

1.1 Prada Aoyama Tokyo: An Introduction







Prada Tokyo,
Herzog & de Meuron

1. Principles & Precedents

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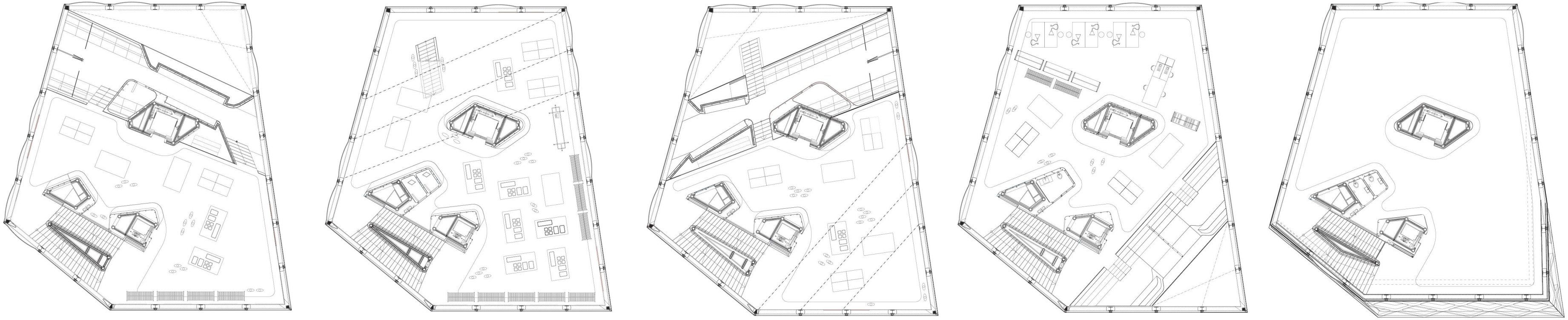

Prada Tokyo,
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Past Work with Similar Design Strategy

Basel School of Business (HSW) 2017, and Konzerthaus Munchen Munich (Music Concert Hall), 2016-2017. These two buildings also incorporates the idea of making ground floor as a public space into the design

1. Principles & Precedents

1.2 Elemental Form: Diagrid

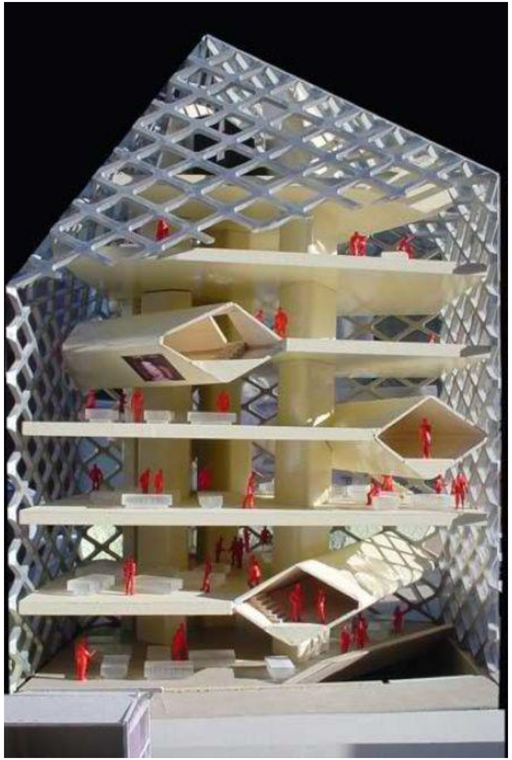
Dissecting the Grid

The Prada Aoyama Epicenter by Herzog & de Meuron is likely not classified as a pure space frame structure. It is a diagrid of sorts, with rhombus-shaped members forming the frame. The building is also supported by interior vertical shafts and horizontal rhomboid tubes.One advantage of such structural system is column-free interior.

Prada Tokyo,
Herzog & de Meuron

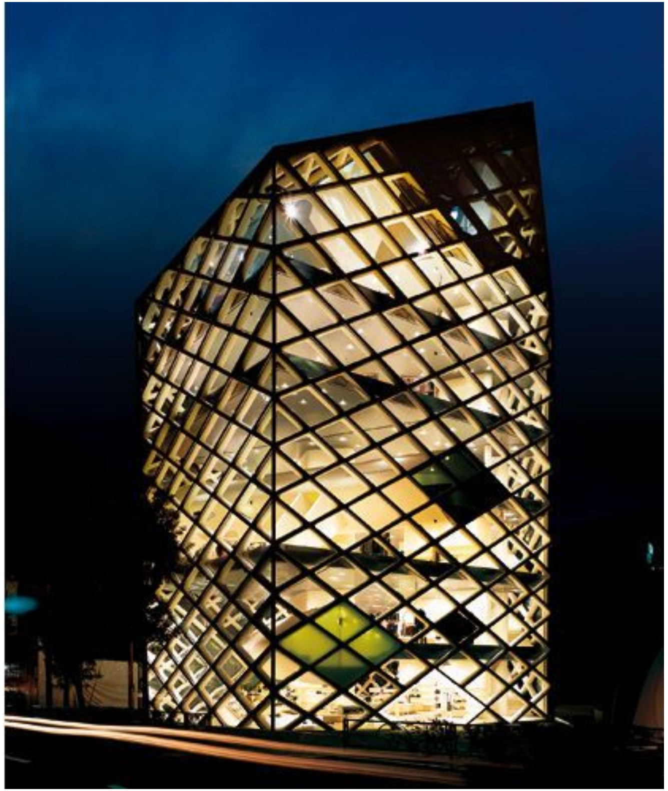
1. Principles & Precedents

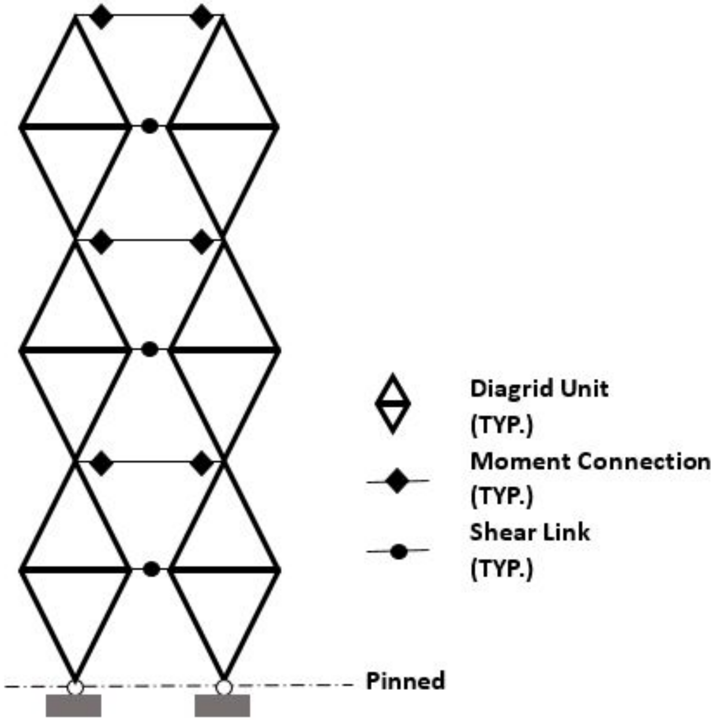
1.2 Elemental Form: Diagrid



Prada Tokyo,
Herzog & de Meuron

1. Principles & Precedents
1.2 Elemental Form: Diagrid





Prada Tokyo,
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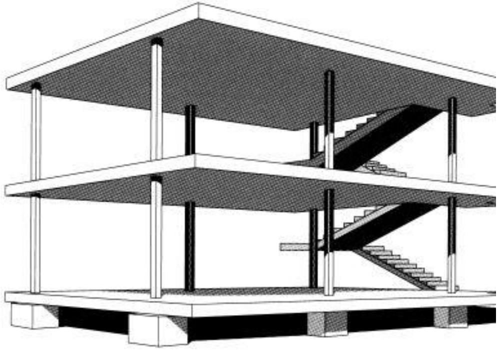
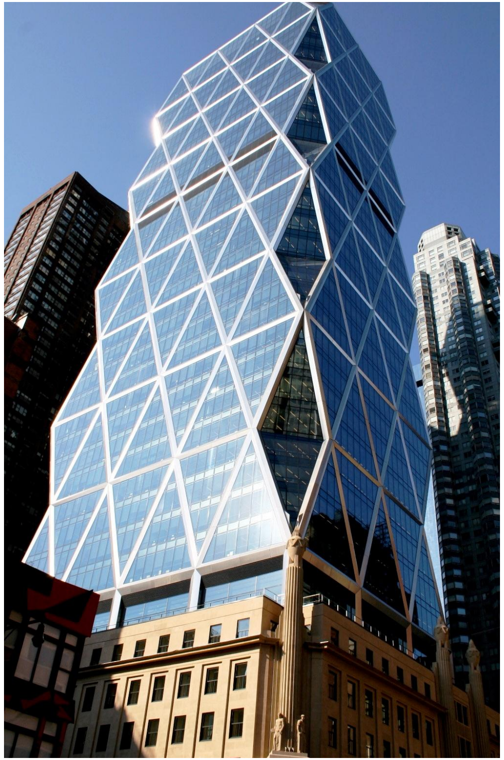
1. Principles & Precedents

1.2 Elemental Form: Diagrid

Left - Maison Domino,
Le Corbusier
Middle - Swiss Re Building,
London
Right - Hearst Tower, NYC

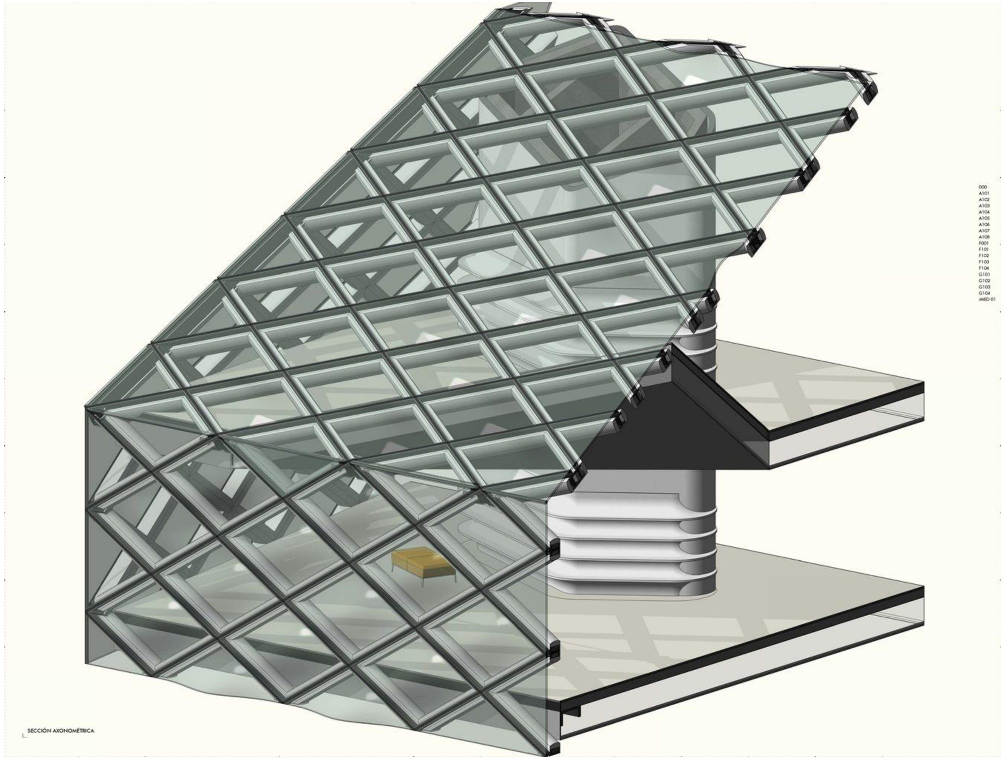




Prada Tokyo,
Herzog & de Meuron

1. Principles & Precedents

1.3 Materials



Structure and Material

To make the building is conceived as a porous spatial structure, every single visible part of the building operates as structure, space, and facade at the same time.

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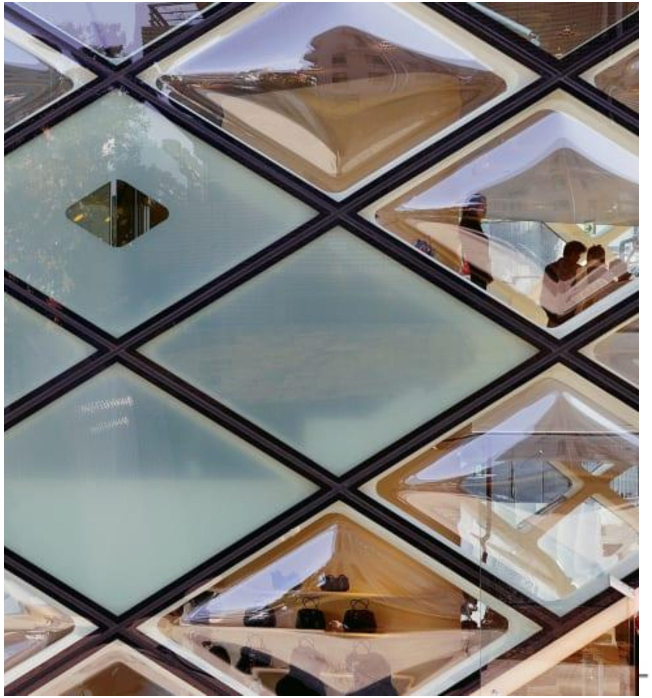
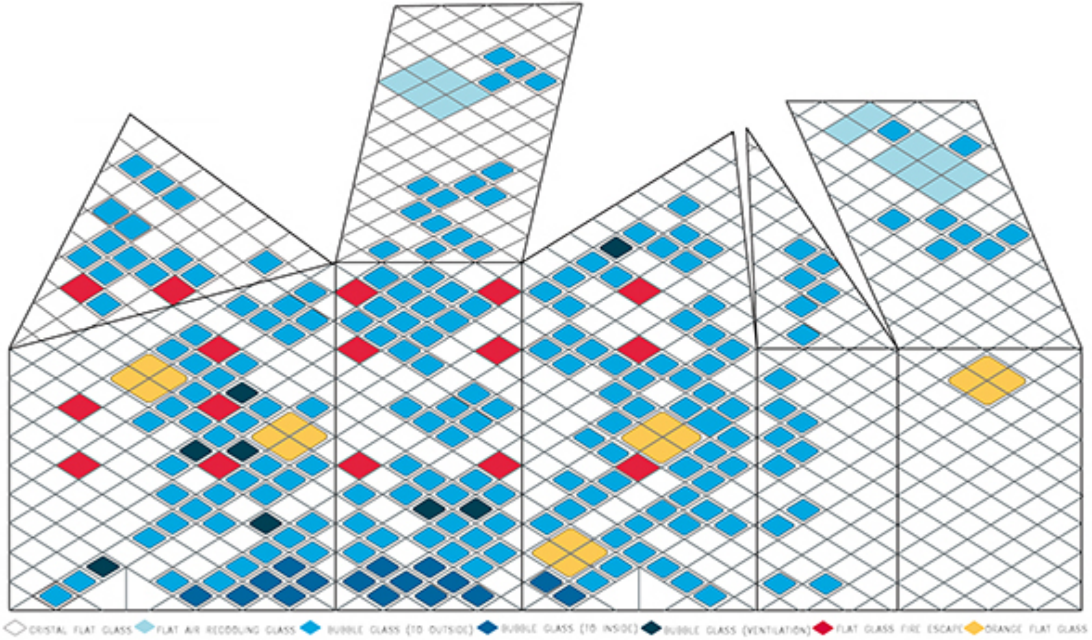
Herzog & de Meuron

1. Principles & Precedents

1.3 Materials

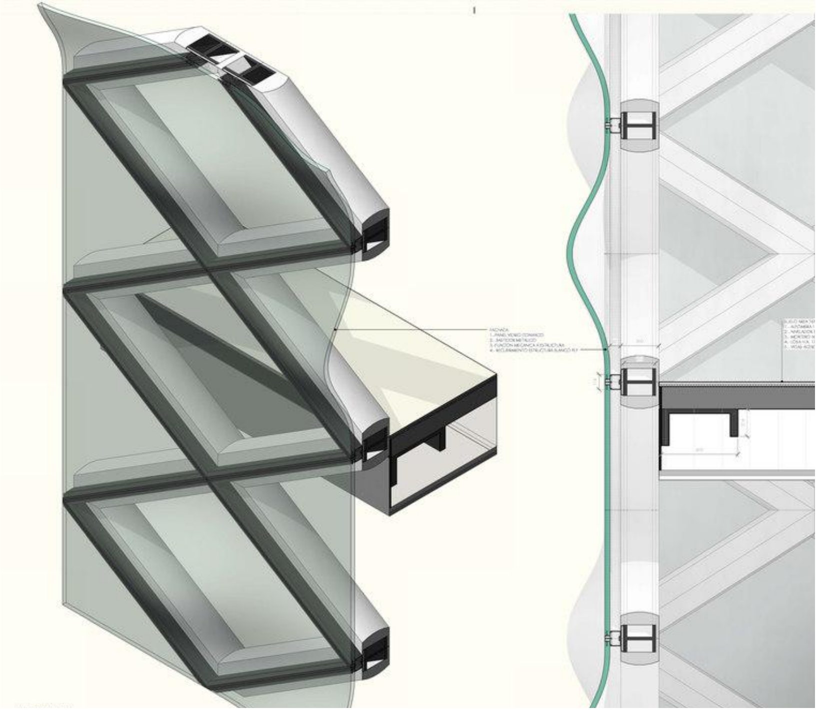




Facade Material

Prada Tokyo,
Herzog & de Meuron

1. Principles & Precedents
1.3 Materials



Facade Material

Prada Tokyo,
Herzog & de Meuron

1. Principles & Precedents
1.3 Materials

Material Selection

Steel is used mainly in this building in order to form and combine the shape of all the main structural elements, such as lattice envelope, horizontal tubes, and vertical cores. Every joint also is made of cast steel to support the form.

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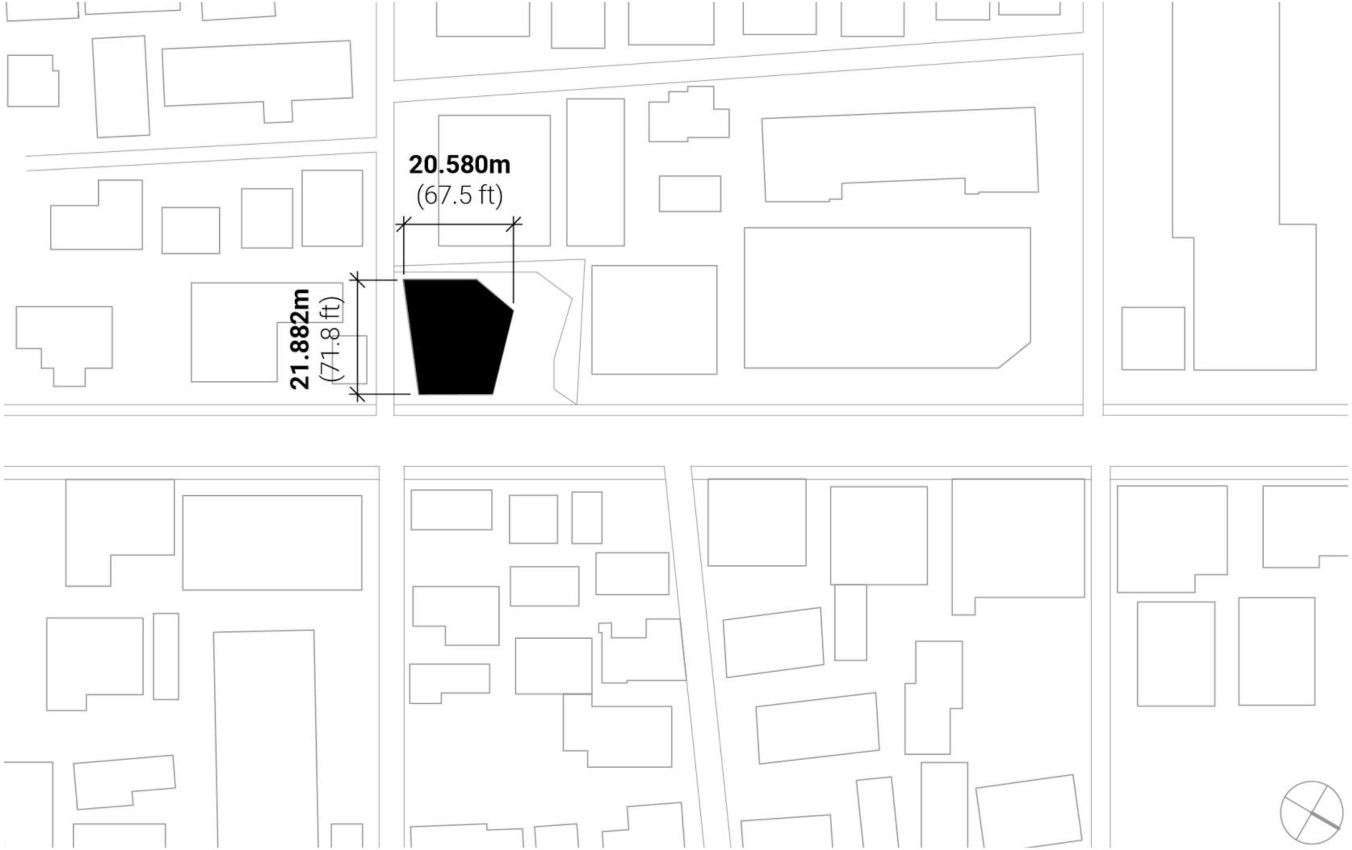
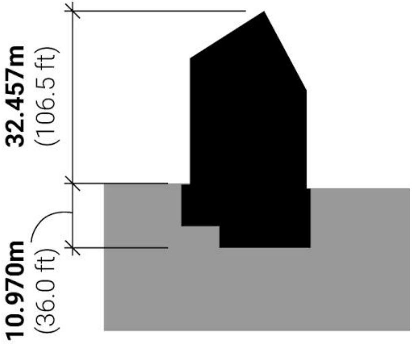
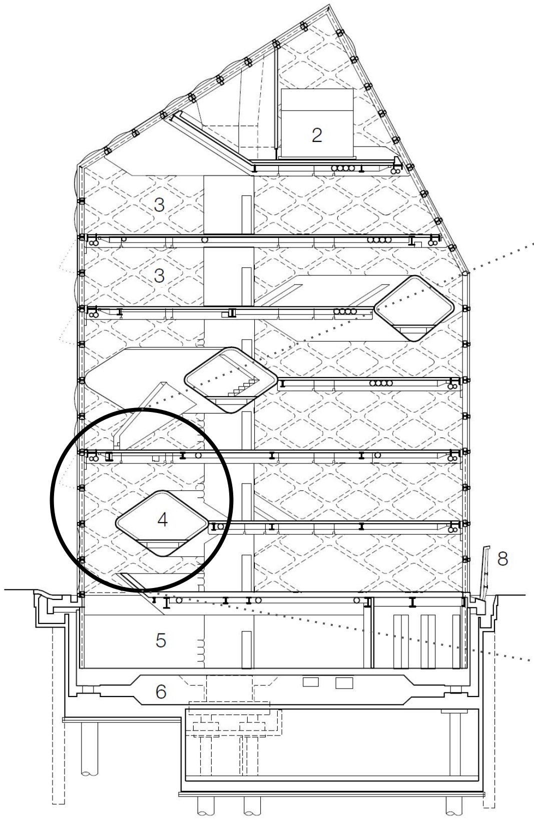
1. Principles & Precedents
1.4 Proportions

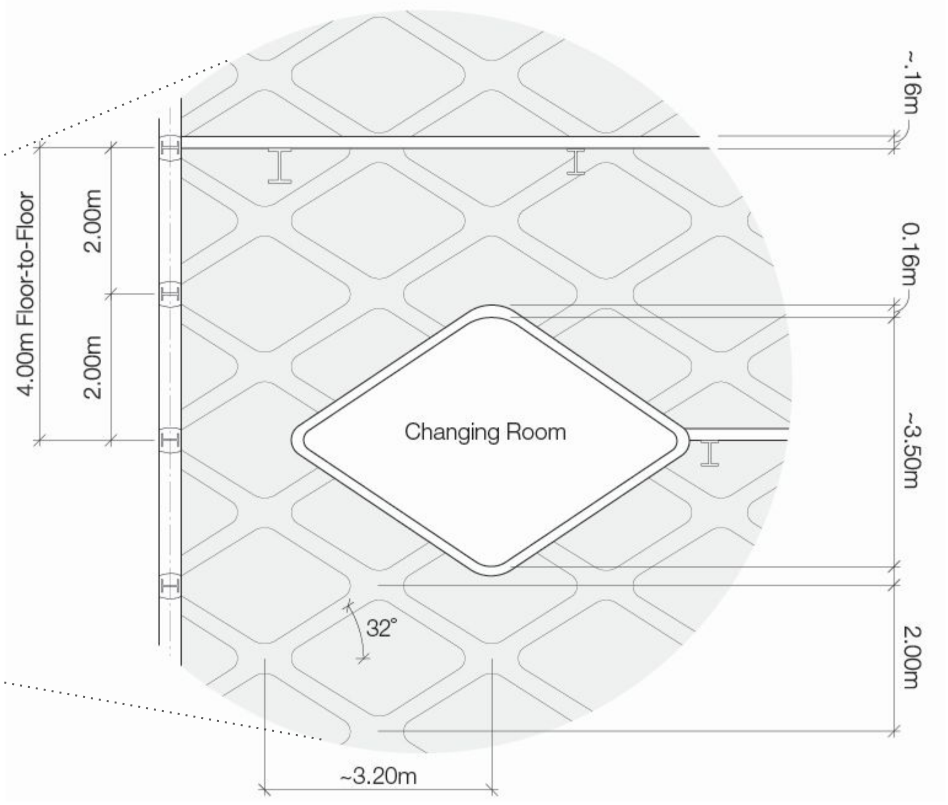




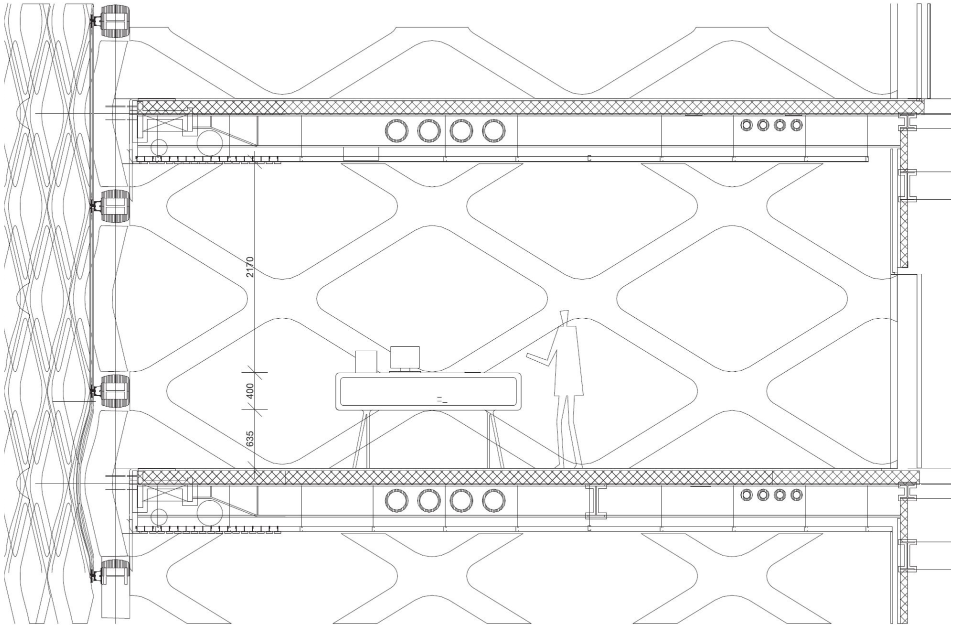
Prada Tokyo,
Herzog & de Meuron

1.4 Proportions





Prada Tokyo,
Herzog & de Meuron



Buckling & Tension

Floors are connected to the lattice intersections, and these joints are where the vertical loads are transferred. The rhombus lattice members between each floor therefore act as anti-buckling support for the members that are directly carrying vertical floor loads. These periphery girders at each floor slab act as tension members because they prevent vertical deformation of the lattice.

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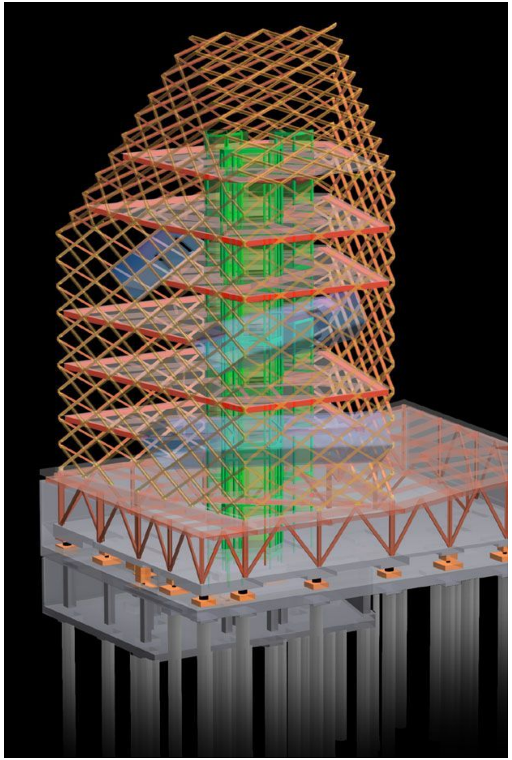
Herzog & de Meuron



Imposed Loads: Seismic & Wind

The horizontal portions of these loads are mainly supported by the exterior rhombus lattice grid frame, as the vertical shaft does not have enough horizontal rigidity. On the other hand, the lattice is more horizontal than it is vertical, and therefore experiences greater vertical deformation than columns when it comes to vertical loading

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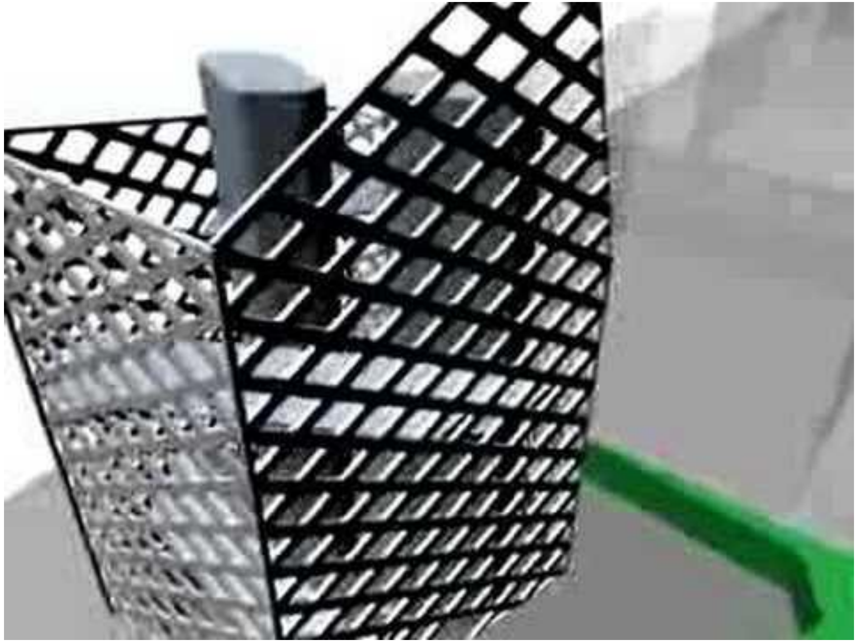
Herzog & de Meuron



Type of Structure and Additional Demand

The Prada building has a diagrid frame structure.The facade is a honeycomb structural walls comprising a diamond shape grid filled with hundreds of glass panels. The concrete slabs allows more elasticity to the union of metal and glass in case of an earthquake.

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Herzog & de Meuron

The Impact of Building Services from the Form

Because of the steel frame and glass facade, the building is the most visible at night to attract commercial attention. The frame defines the shape of the openings on the wall. The structural cores and tubes morph seamlessly into elevators, stairs, fitting rooms and display shelves, which gives a sense of continuous shopping space.

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2. Analysis

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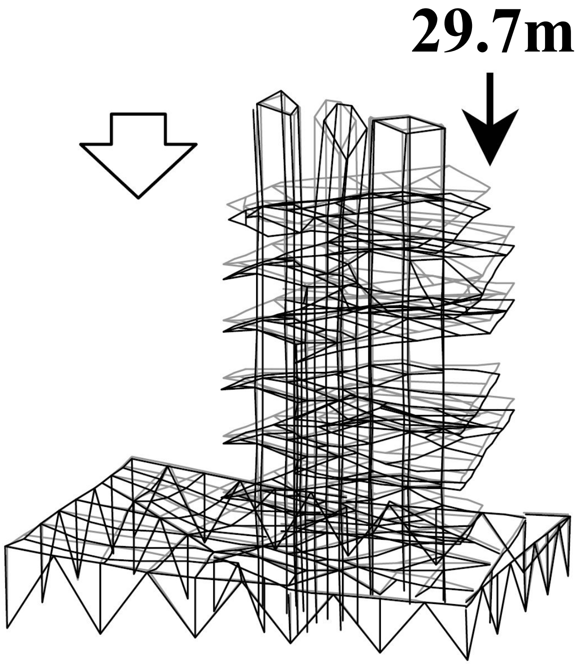
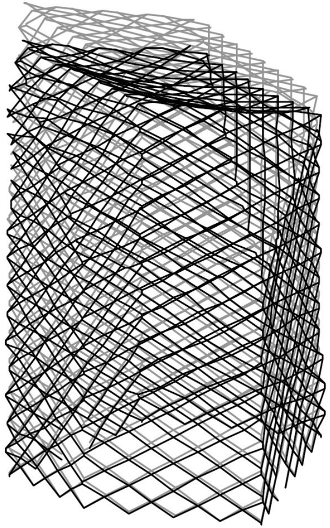
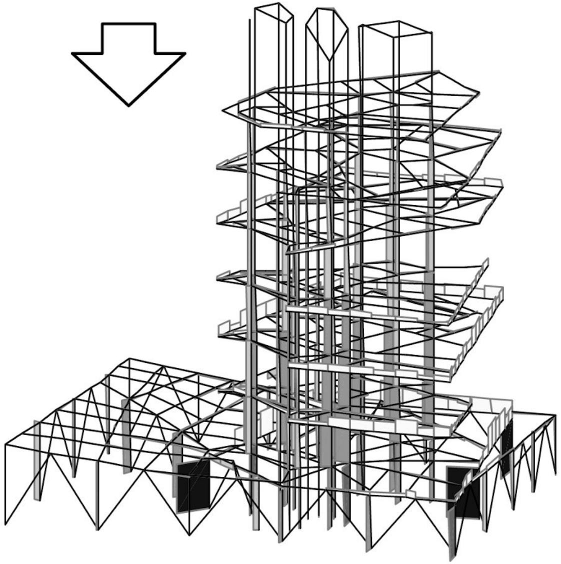
2. Analysis
2.1 Forces / Dead & Live Loads

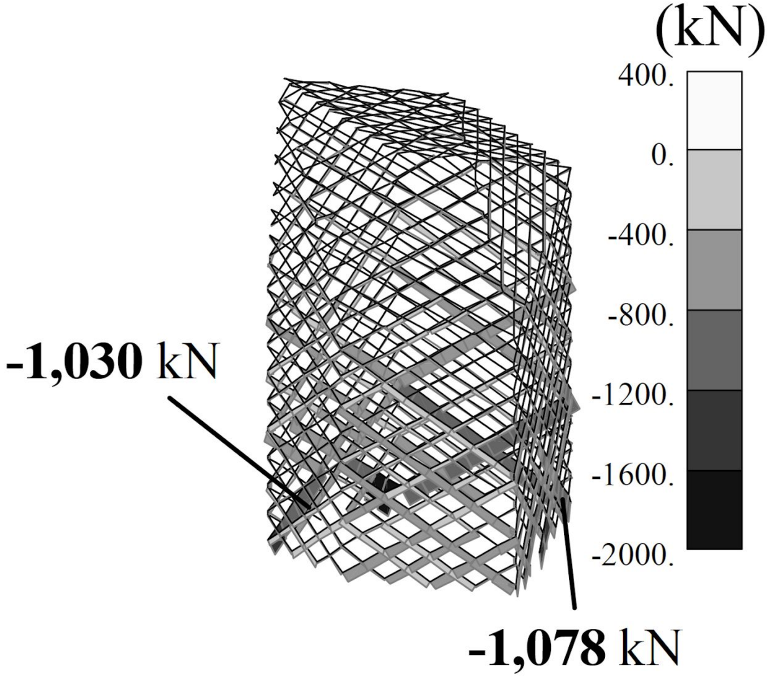




Prada Tokyo,
Herzog & de Meuron

2. Analysis
2.1 Forces / Dead & Live Loads





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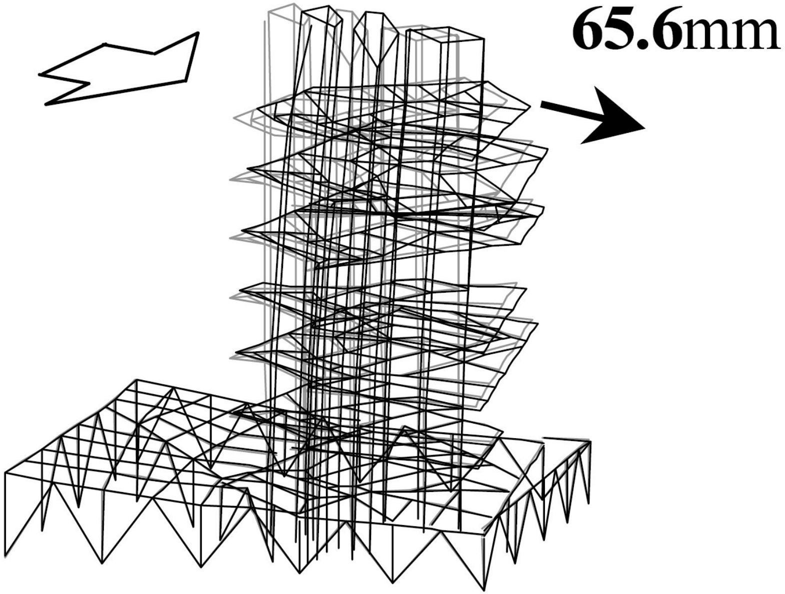
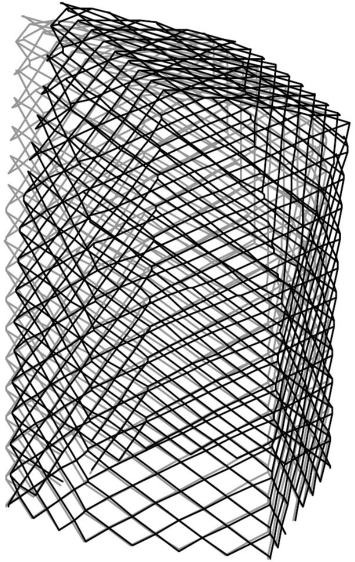
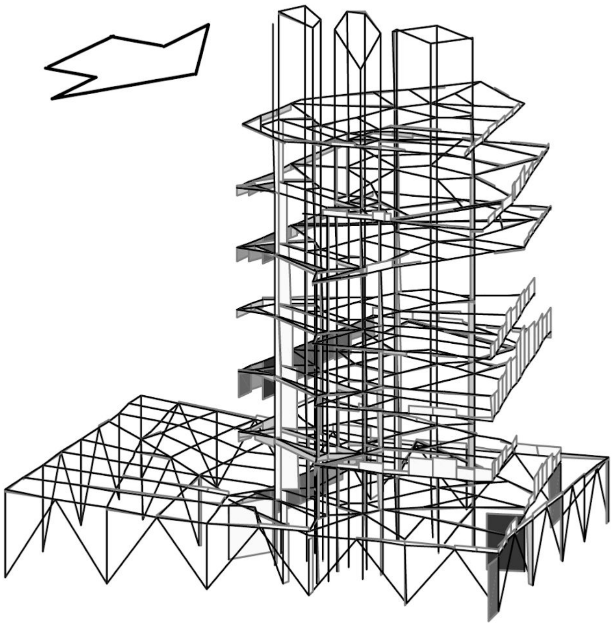
Herzog & de Meuron

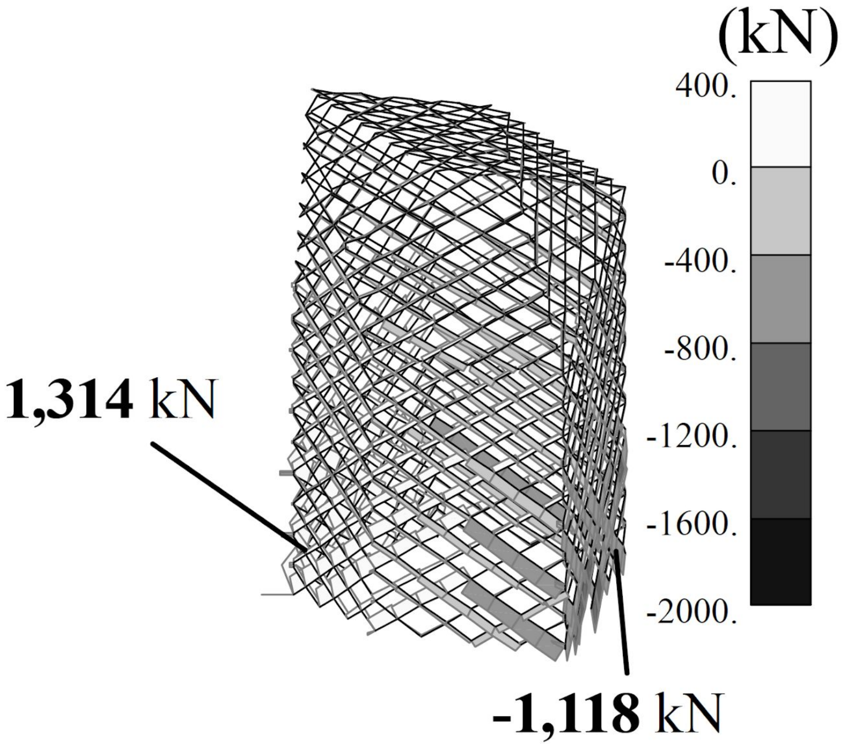
2. Analysis
2.1 Forces / Seismic



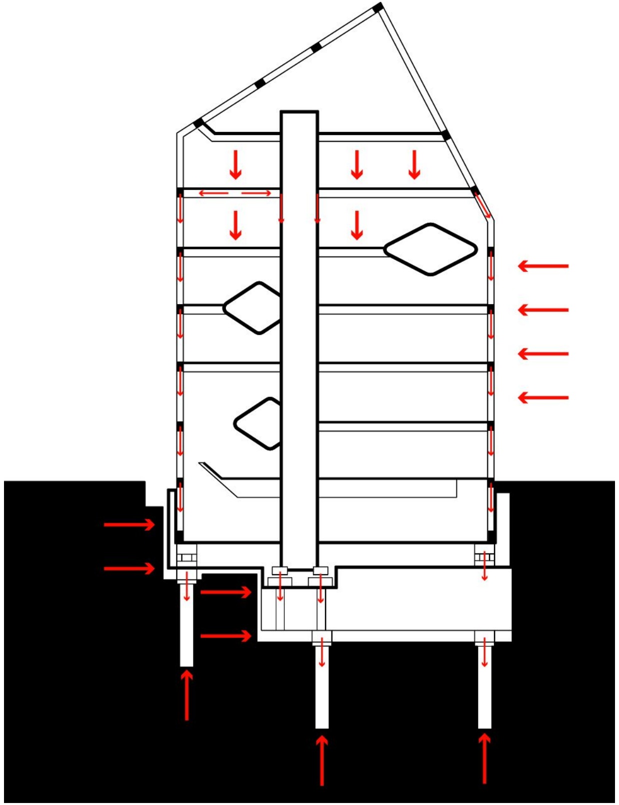


Prada Tokyo,
Herzog & de Meuron




(kN)
400.
0.
-400.
-800.
-1200.
-1600.
-2000.
1,314 kN
-1,118 kN

2. Analysis
2.1 Forces



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Horizontal Rhomboid Steel Tubes

The rhombus-shaped horizontal steel tubes span from one diagrid frame to the other, and form the changing rooms and additional display space for the store.

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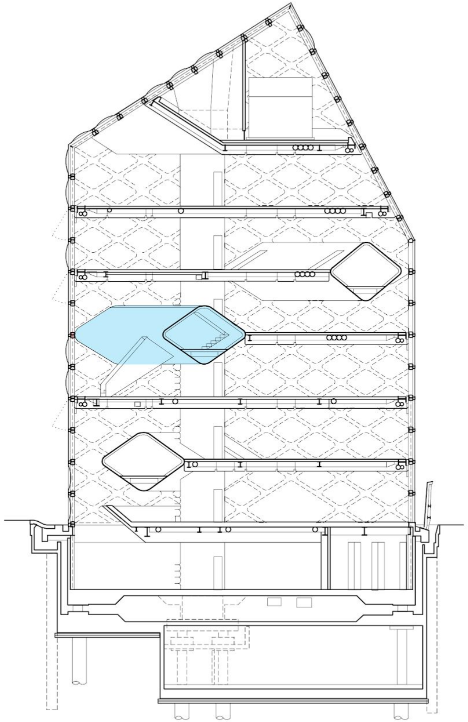
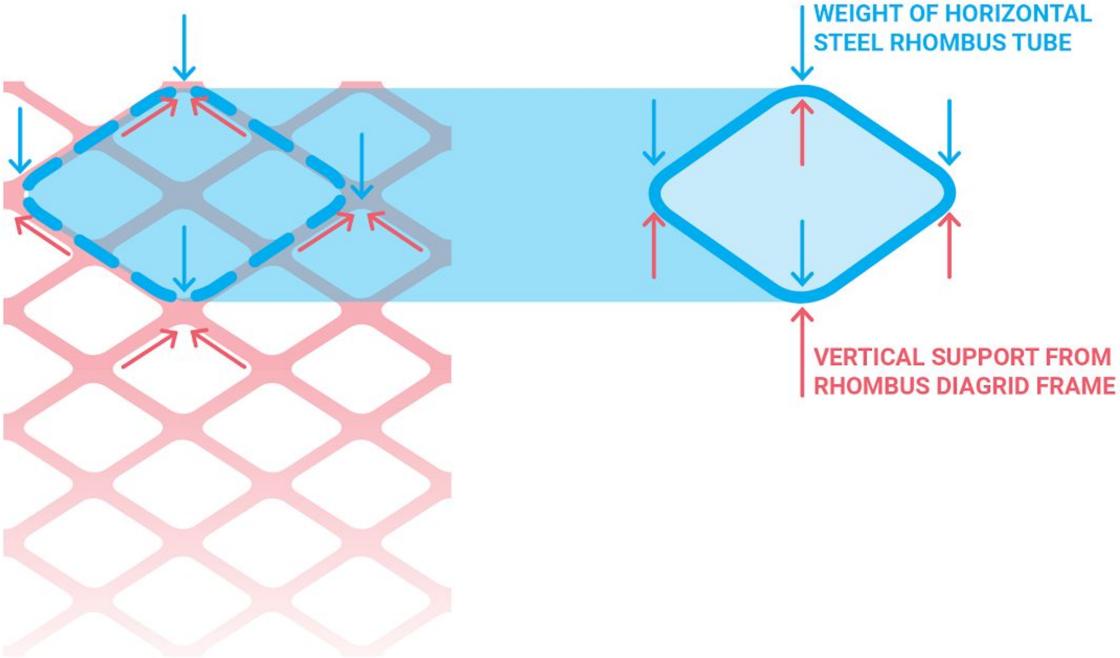
2. Analysis

2.2 Calculations



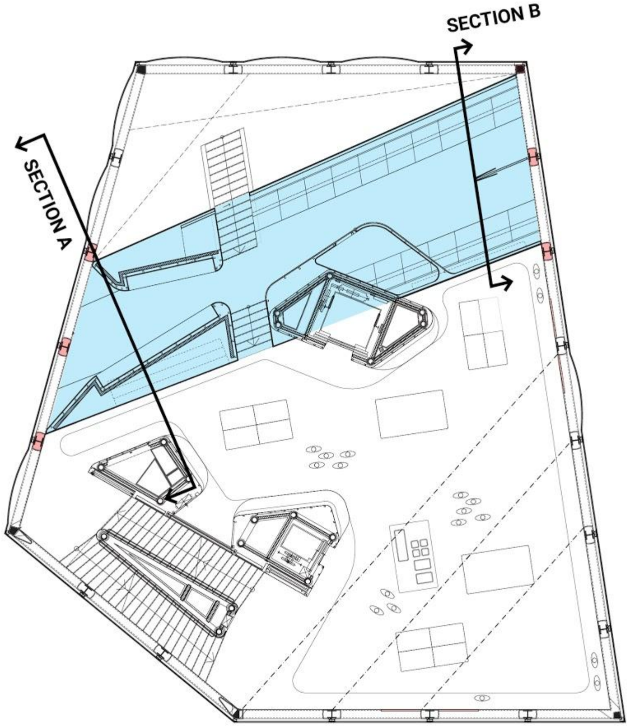


Prada Tokyo,
Herzog & de Meuron

2. Analysis
2.2 Calculations

Horizontal Rhomboid Steel Tubes

Each wall of the steel tube is made of 6mm of sheet steel with reinforcing ribs, along with 25mm of calcium silicate fire-resistant cladding on the inside and outside. We used this to estimate the weight of the structure.



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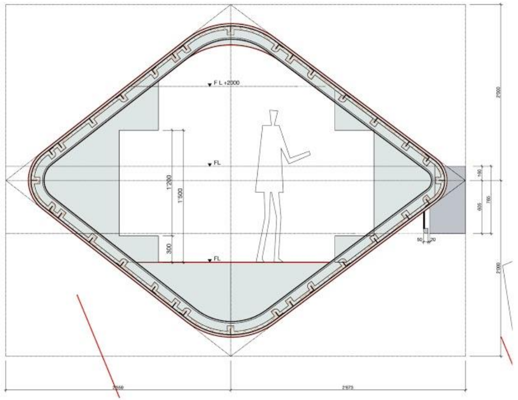
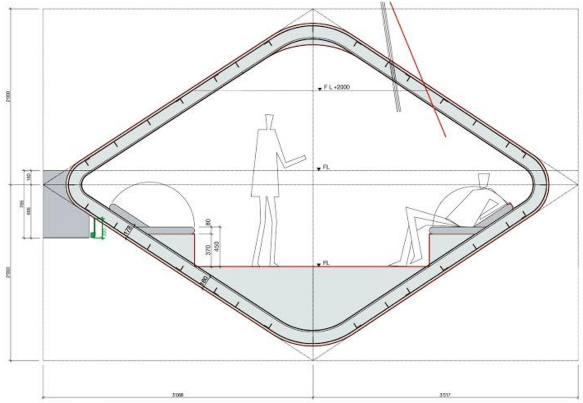
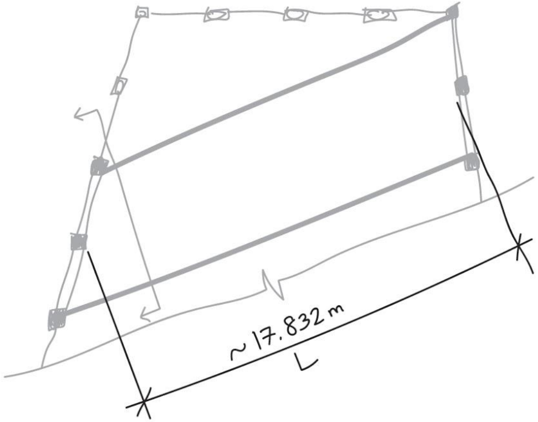
SECTION A

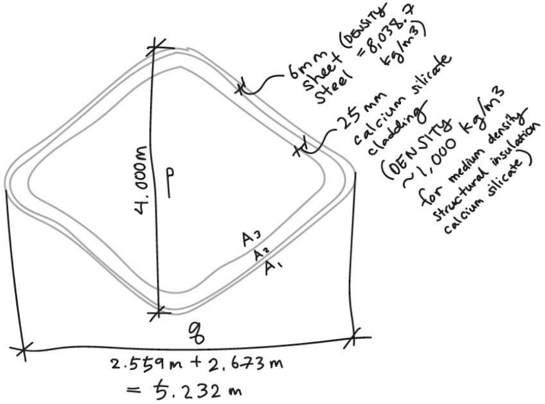




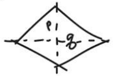
SECTION B

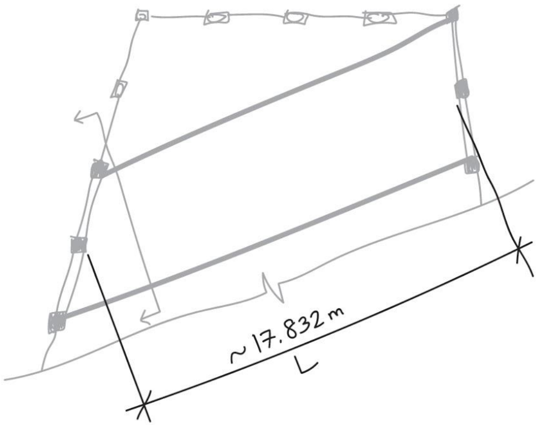
2. Analysis
2.2 Calculations

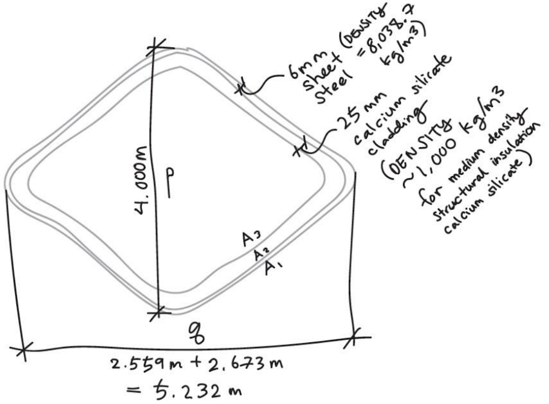




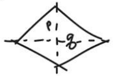
A of rhombus $= \frac{pq}{2}$







$$A \text{ of rhombus} = \frac{pq}{2}$$



$$\begin{aligned} A_s \text{ of sheet steel (cross sectional)} &= A_1 - A_2 \\ &= \left(\frac{4.000\,m \times 5.232\,m}{2}\right) - \left(\frac{3.988\,m \times 5.220\,m}{2}\right) \\ &= 10.464\,m^2 - 10.409\,m^2 \\ &\simeq 0.05\,m^2 \end{aligned}$$

$$\begin{aligned} V_s \text{ of sheet steel} &= A_s \times L = (0.05\,m^2)(17.832\,m) \\ &= 0.89\,m^3 \text{ of sheet steel} \end{aligned}$$

$$\begin{aligned} A_{cs} \text{ of calc. silicate (cross sectional area)} &= A_2 - A_3 \\ &= \left(\frac{3.988\,m \times 5.220\,m}{2}\right) - \left(\frac{3.938\,m \times 5.170\,m}{2}\right) \\ &= 10.41\,m^2 - 10.18\,m^2 \\ &\simeq 0.23\,m^2 \text{ of calcium silicate} \end{aligned}$$

$$\begin{aligned} V_{cs} \text{ of calc. silicate} &= A_{cs} \times L = 0.23\,m^2 \times 17.832\,m \\ &= 4.10\,m^3 \text{ of calcium silicate} \end{aligned}$$

2. Analysis
2.2 Calculations

MASS!

$$m_s = V_s \times D_s$$
$$= 0.89\ m^3 \times 8{,}038.7\ kg/m^3$$
$$\simeq 7{,}154.4\ kg$$

$$m_{cs} = V_{cs} \times D_{cs}$$
$$= 4.10\ m^3 \times 1{,}000\ kg/m^3$$
$$= 4{,}100\ kg$$

$$m \approx m_s + m_{cs}$$
$$= 11{,}254\ kg$$

2. Analysis

2.2 Calculations

MASS:

$m_s = V_s \times D_s$

$= 0.89\ m^3 \times 8{,}038.7\ kg/m^3$

$\simeq 7{,}154.4\ kg$

$m_{cs} = V_{cs} \times D_{cs}$

$= 4.10\ m^3 \times 1{,}000\ kg/m^3$

$= 4{,}100\ kg$

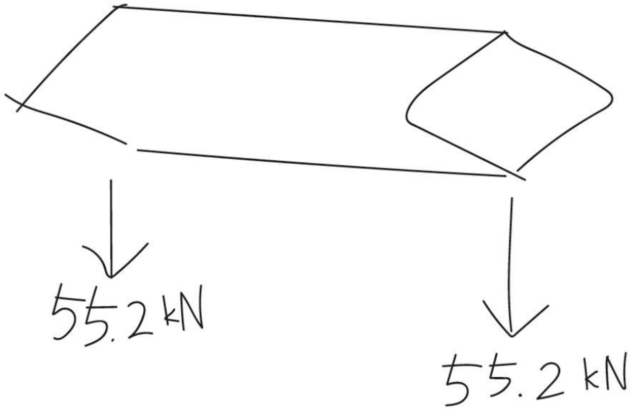
$m = m_s + m_{cs}$

$= 11{,}254\ kg$

WEIGHT: $F = ma$, $a = g = 9.81\ m/s^2$

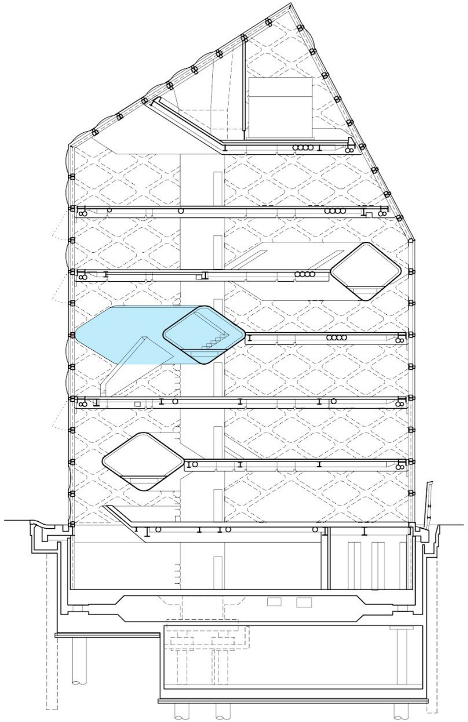
$F = (11{,}254\ kg)(9.81\ m/s^2) = 110{,}401.74\ N$

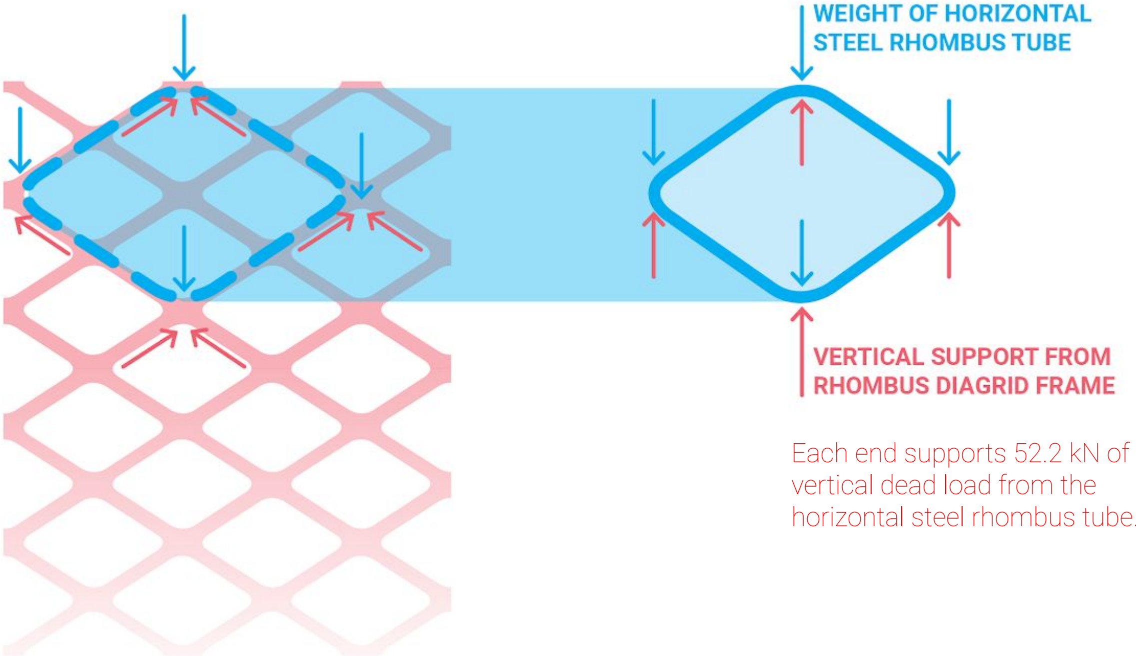
$\simeq \boxed{110.4\ kN}$



2. Analysis

2.2 Calculations





Each end supports 52.2 kN of vertical dead load from the horizontal steel rhombus tube.

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3. Construction

Prada Tokyo,
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3. Construction

3.1 Construction Process








3. Construction
3.1 Construction Process

Prada Tokyo,
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3.1 Construction Process

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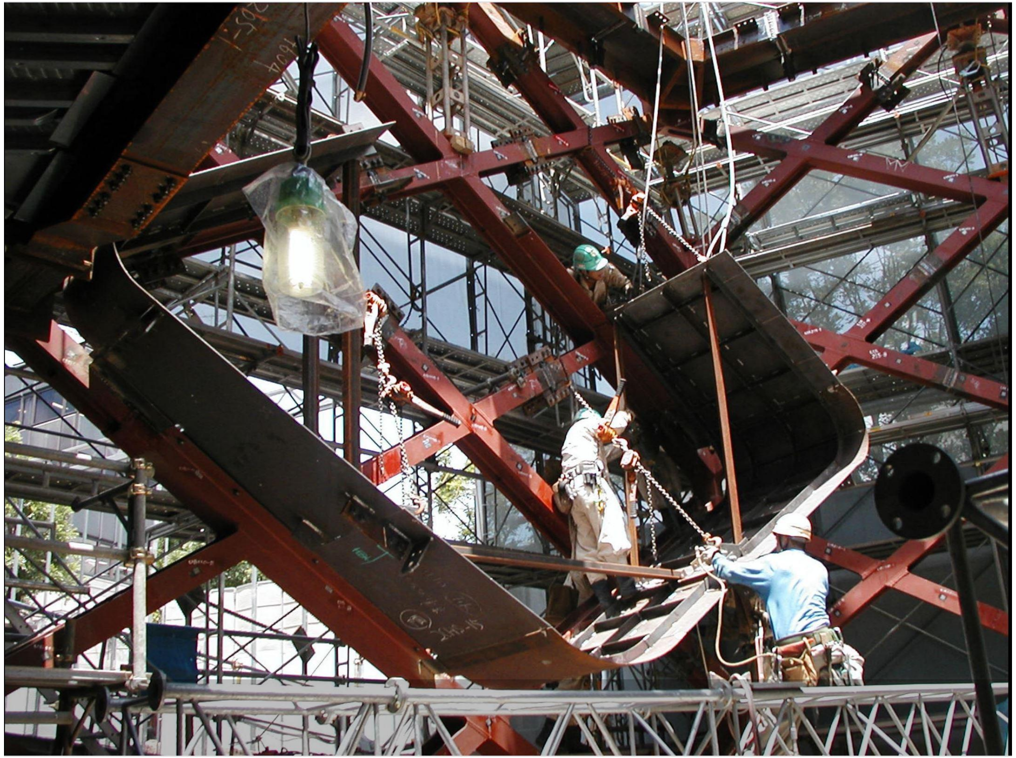
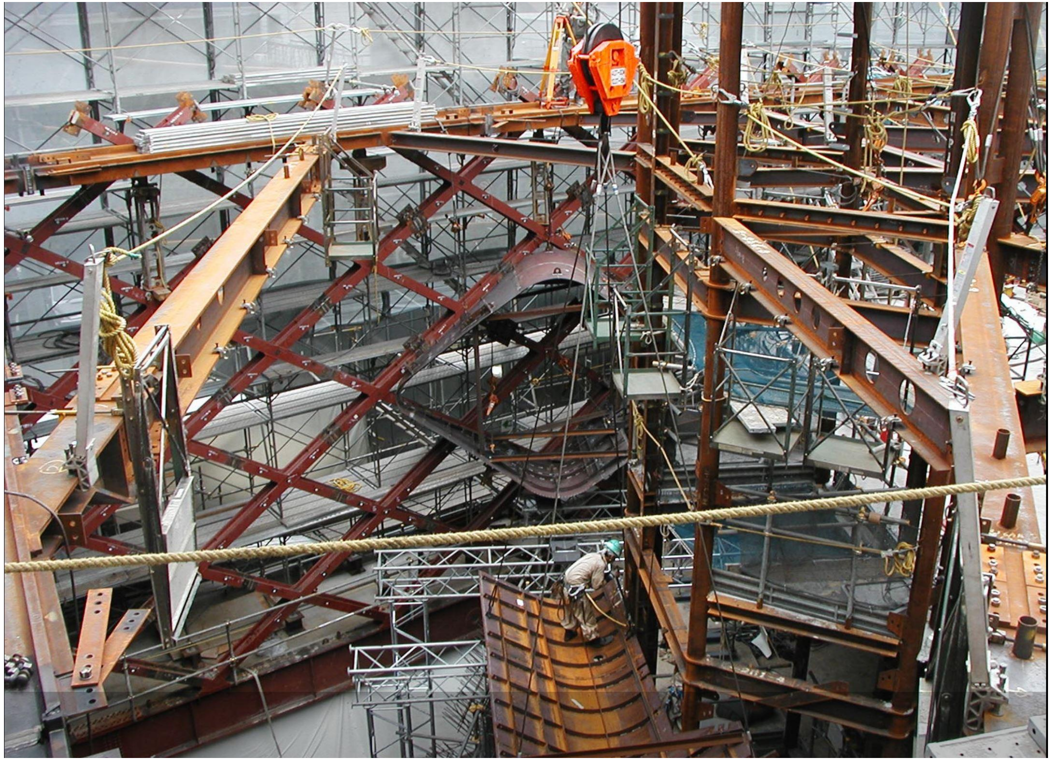


Prada Tokyo,
Herzog & de Meuron

3. Construction
3.1 Construction Process



Prada Tokyo,
Herzog & de Meuron

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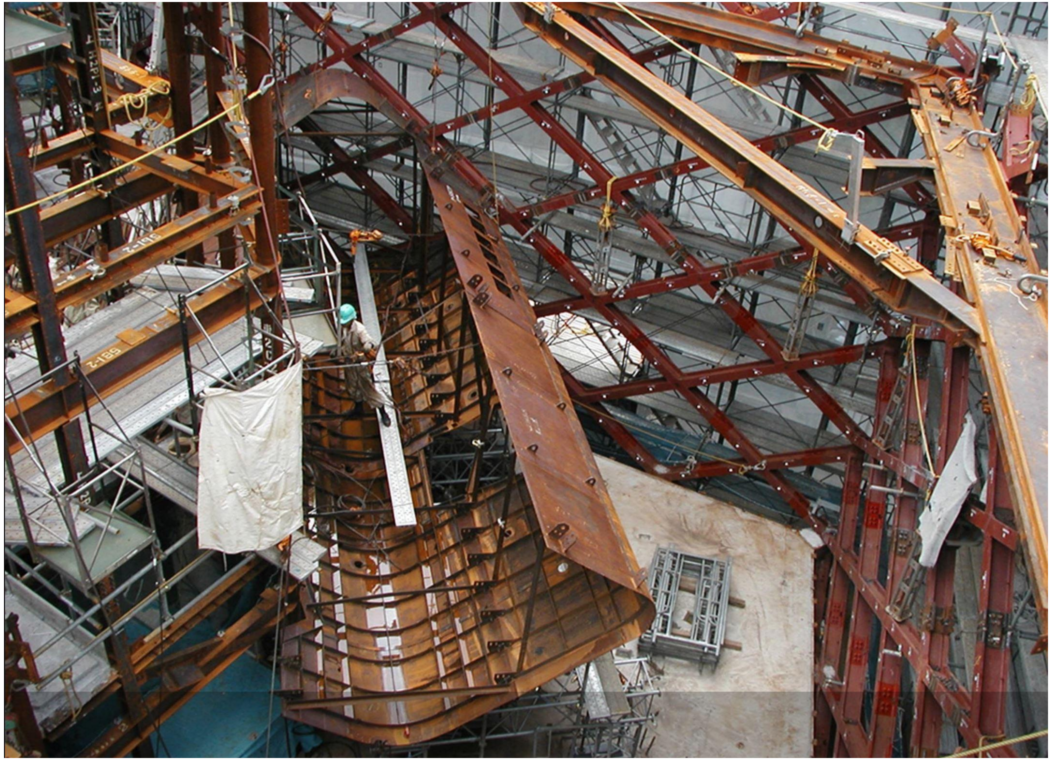

Prada Tokyo,
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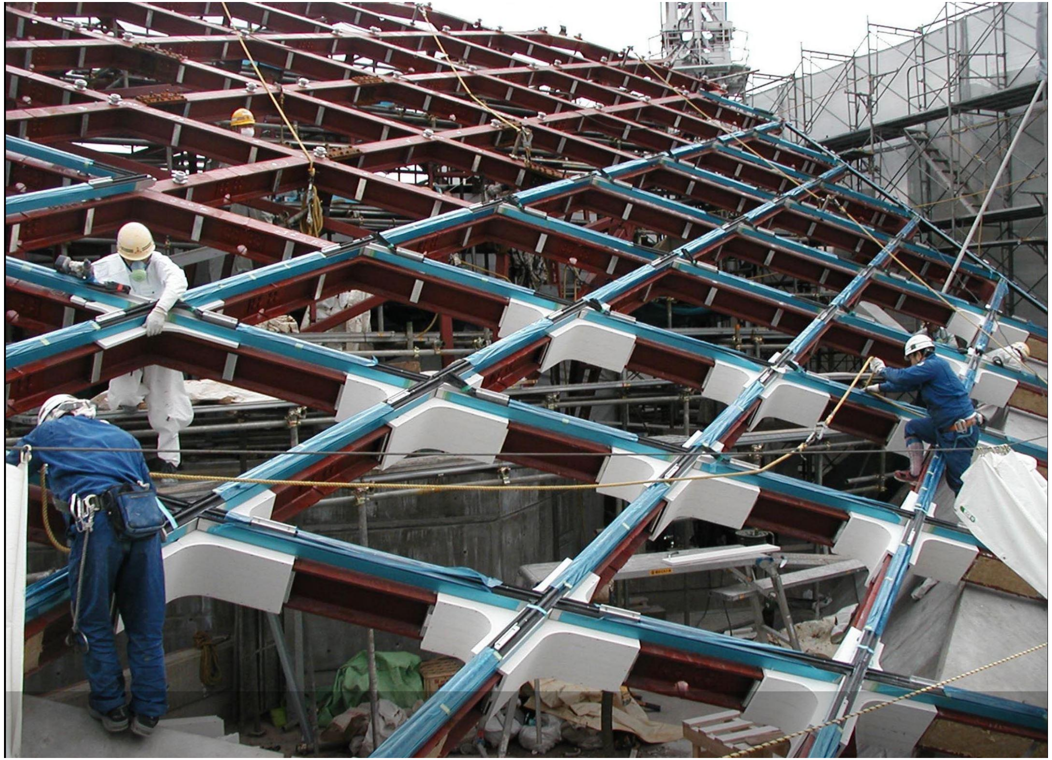

Prada Tokyo,
Herzog & de Meuron

3. Construction

3.1 Construction Process

4. References
4.1 References List

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