30 St. Mary Axe

The Gherkin, The Swiss Re

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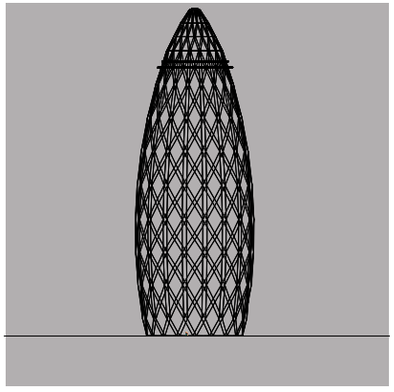


Scope

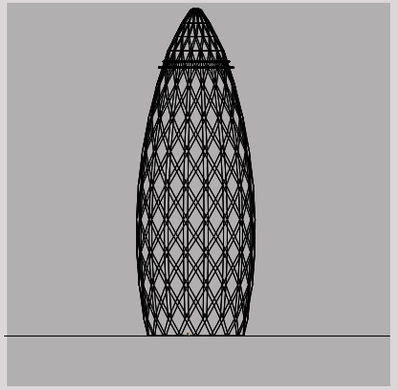
About

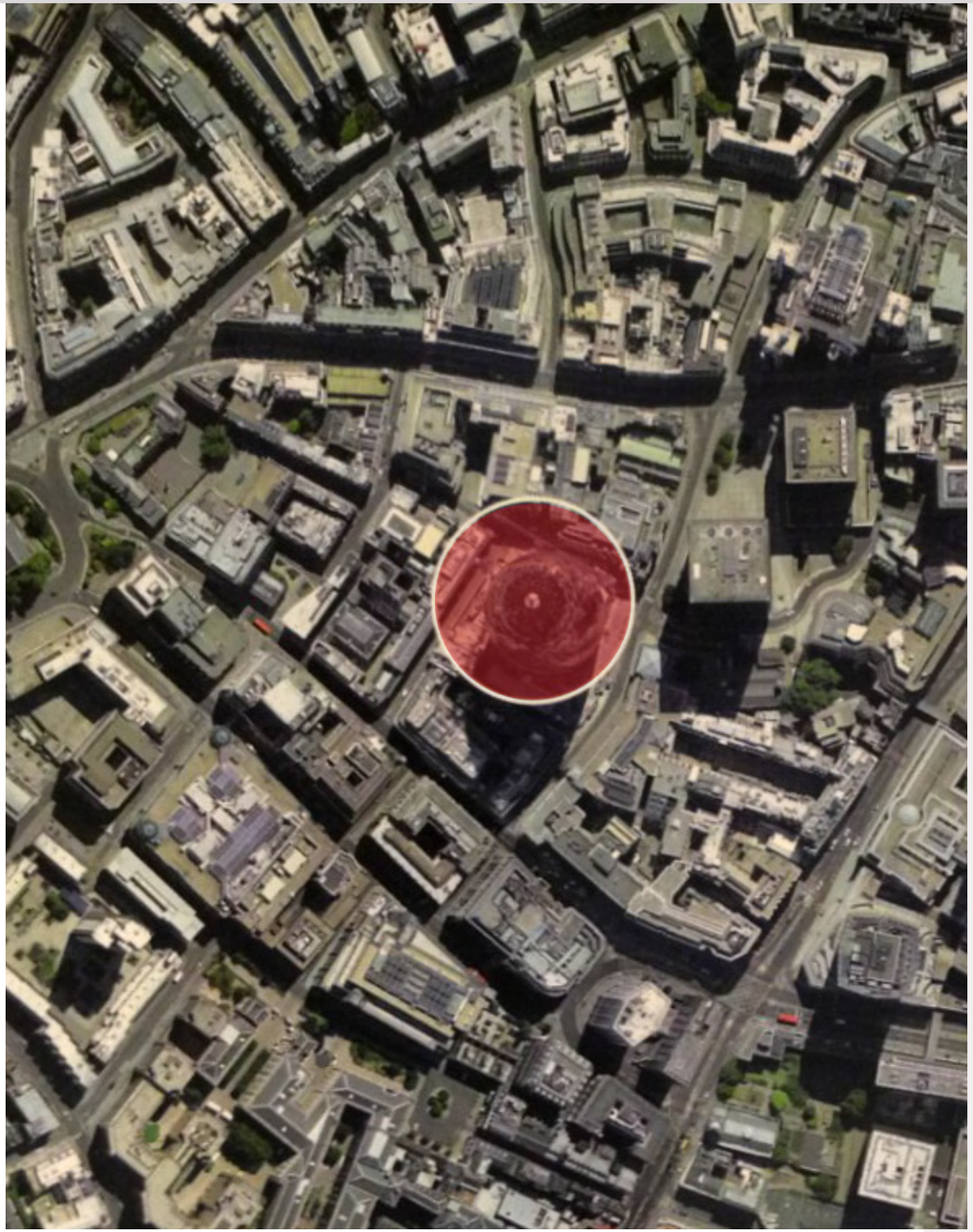
- History
- Site Conditions
- weather, foundation conditions
- Stuctural Loads
  -gravity, wind, seismic
- Structural Connection
  -column, beam, and diagrid con
  nections

30 St. Mary Axe

About

Type	**Office**
Location	**London, United Kingdom**
Construction	**2001- 2004**
Opening	**28 April 2004**
Cost	**£138,000,000.00**
Height	**180 metres (591 ft)**
Floor count	**41**
Floor area	**47,950 sq m (516,100 sq ft)**
Architect	**Foster and Partners**
Structural Engineer	**Arup**
Main Contractor	**Skanska**



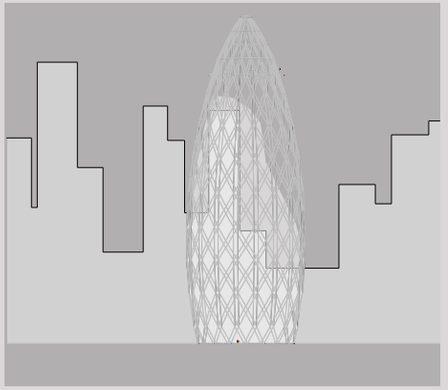


Site

Construction

Restrictions of small site (1.4 acres):

- Concrete pours, limitations of time
- Traffic, limited accessibility



Company History

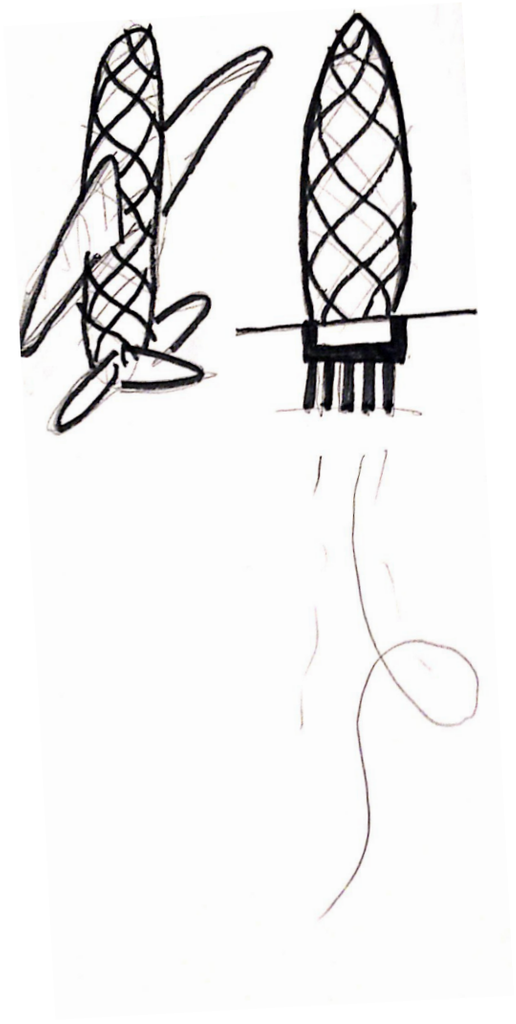
Swiss Reinsurance

- The Swiss Reinsurance Company began in 1863
- Primary headquarters in Zurich
- Reinsures other insurance companies to reduce risk and absorb losses.

Site History

Baltic Exchange

- The Baltic Exchange previously resided in the location of the Swiss Re for 250 years.
- A terrorist bomb destroyed the old exchange building and in 1995 they moved to 38 St Mary Axe.
- Negotiations with city's authorities to raze the Baltic Exchange



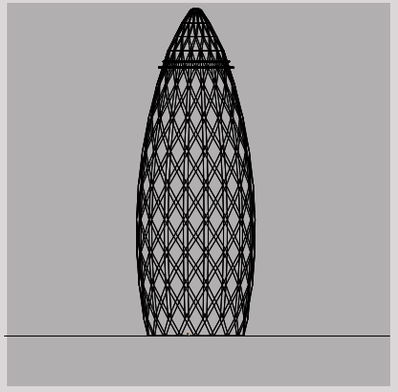
Norman Foster

Inspiration

Norman was inspired by the design of aircrafts and the way that streamlined bodies interacted with wind.

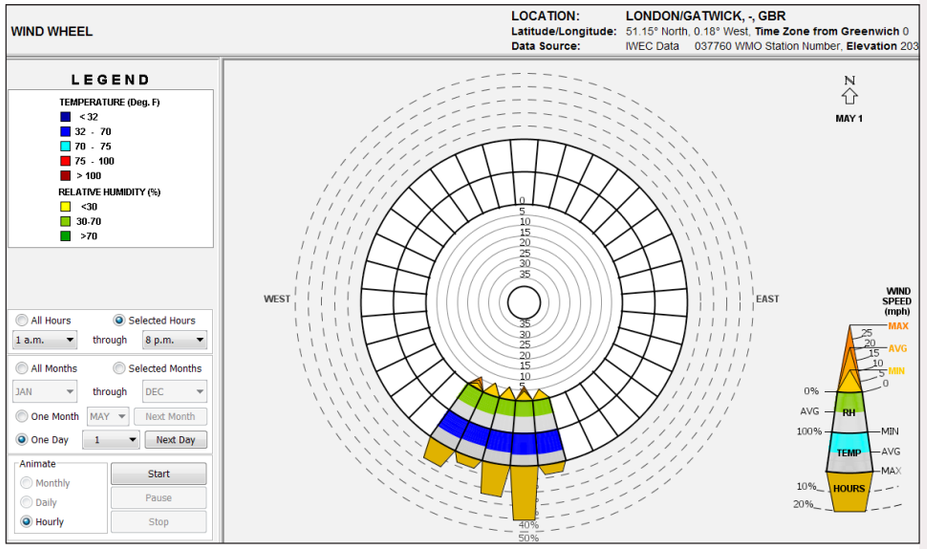
What makes this building unique?

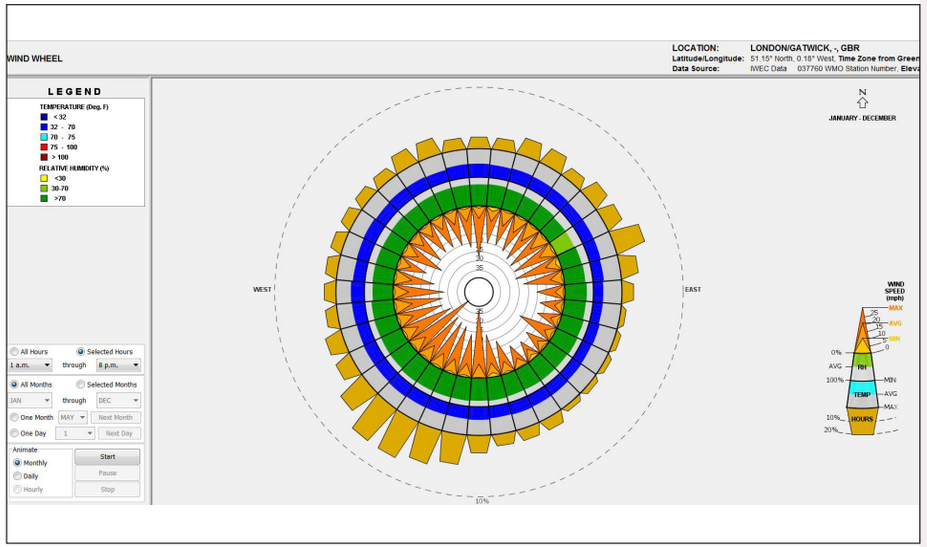
- Diagrid Structure, double helix
- Air Ventilation System with double skin shell
- Rotation of floors to incorporate vertical lightwells



Wind Site

Wind Calculations pertaining to building & site

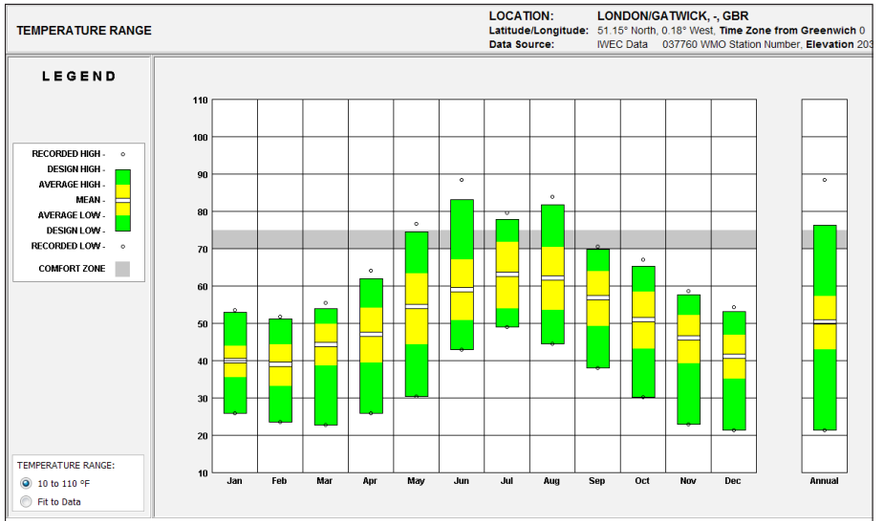


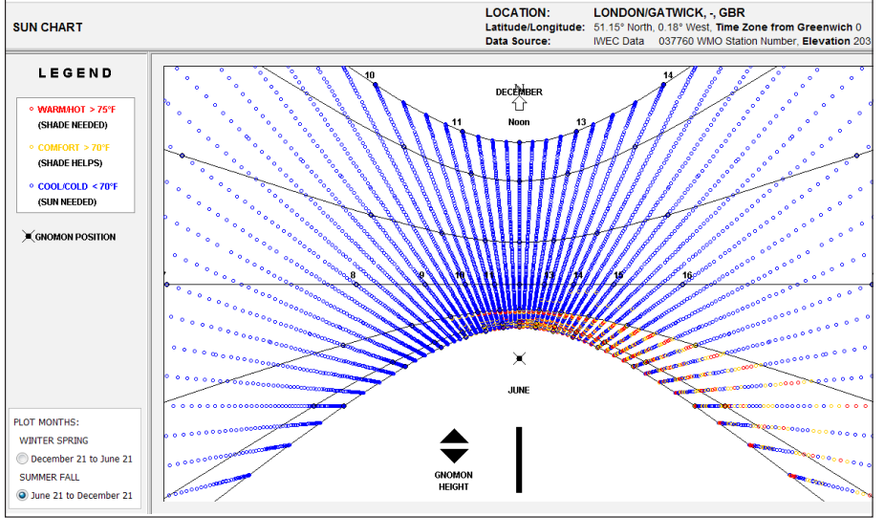


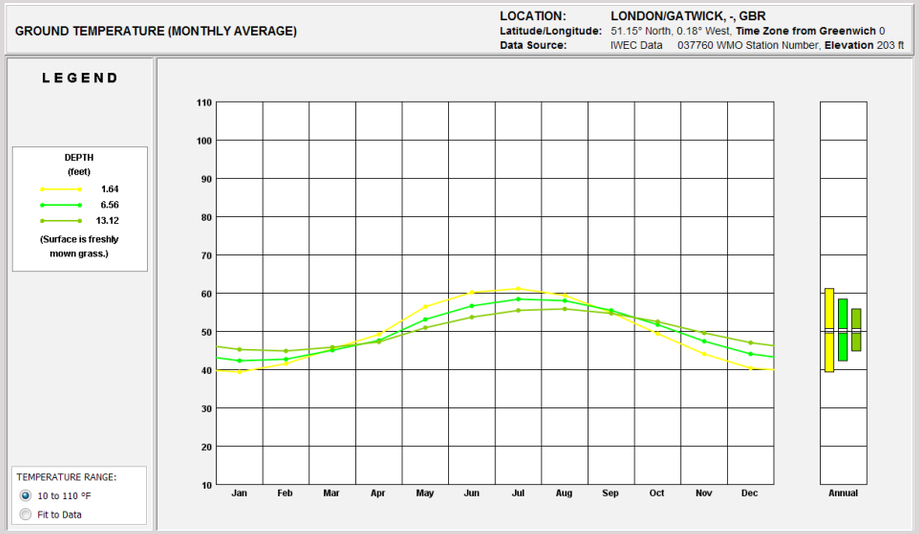
- Wind Pressure: Answer (1.12 psf)
- (.5)C x D x V^2
- V= London wind speed (6.7 m/s = 21.9 f/s) note: used in multiframe as wind load
- D= Air Density (1.25 kg/m^3 (at 44 degrees today))
- C= Drag coefficient of streamlined form (0.04)
-
- **qZ = 0.0026KZKZtKdV2l (lb/ft2)**

- Kz = velocity pressure exposure coefficient
- Kzt = topographic factor (1.0 since it is on flat land)
- V= wind speed (21.9 f/s or 6.7 m/s)
- I = Importance factor (1.0)
- C = mean pressure coefficient aka drag (0.04)
- G = gust effect factor

Site Temperature







Temperature Range:

- 22 degrees in December -
  94 degrees in June

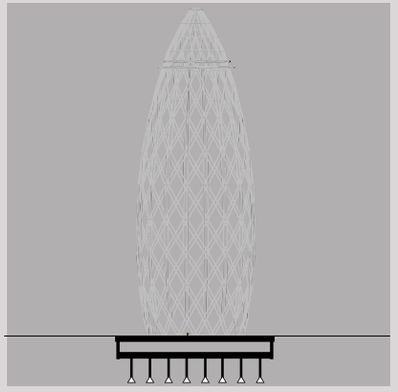
The change in temperature effects the expansion and contraction of the steel members.

Foundation

Concrete Piles

- 333 Piles
- 2.5 feet (750 mm) in diameter
- 98 feet (25 m) deep

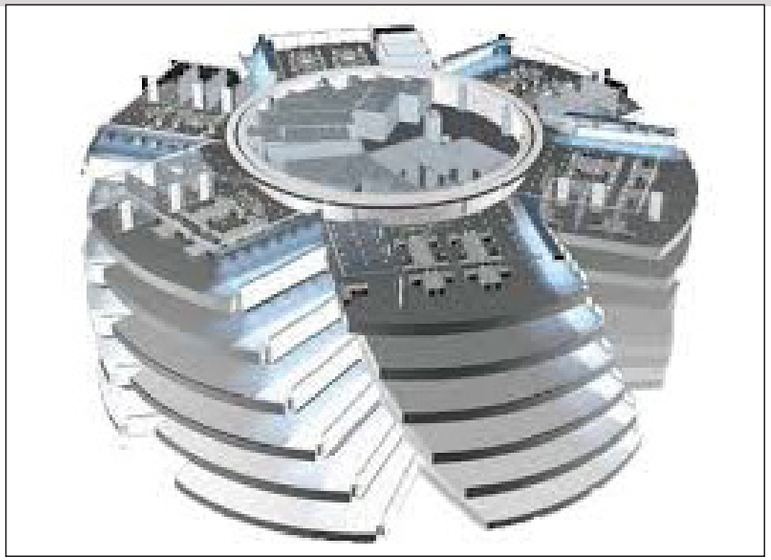
Because of site restrictions and in order to create a monolithic foundation, all piles and pile caps were poured in one day.

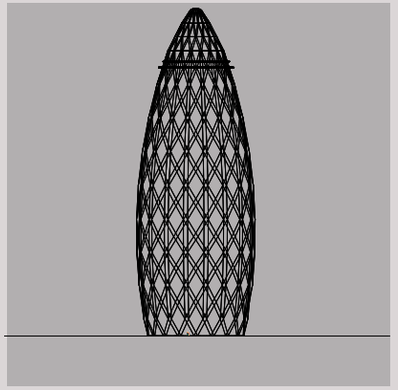


General Structure

Design Concept

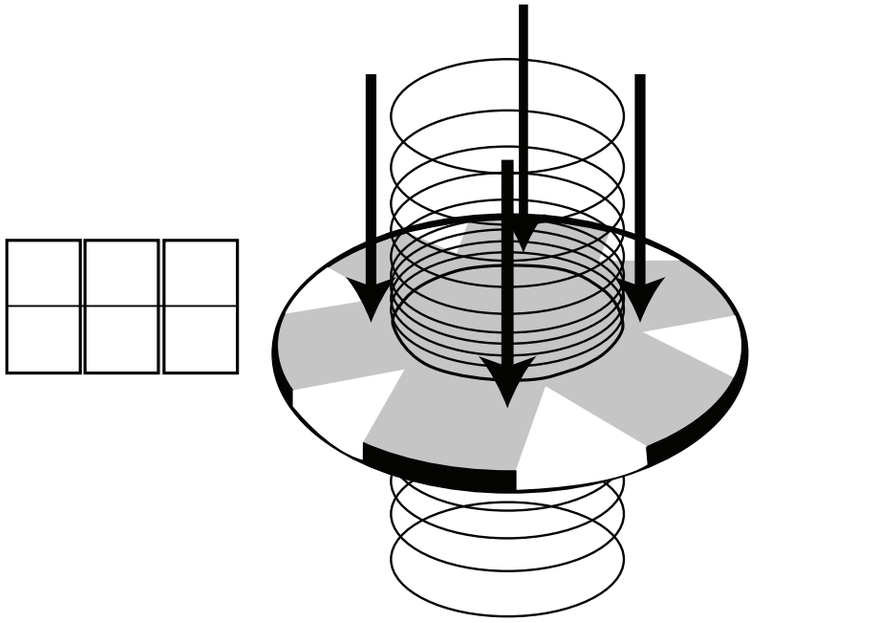
- diagrid exterior structure
- diagrid nodes at connections
- gerkin shape
- 5 degree rotation of floor plates
- wedge shaped light wells

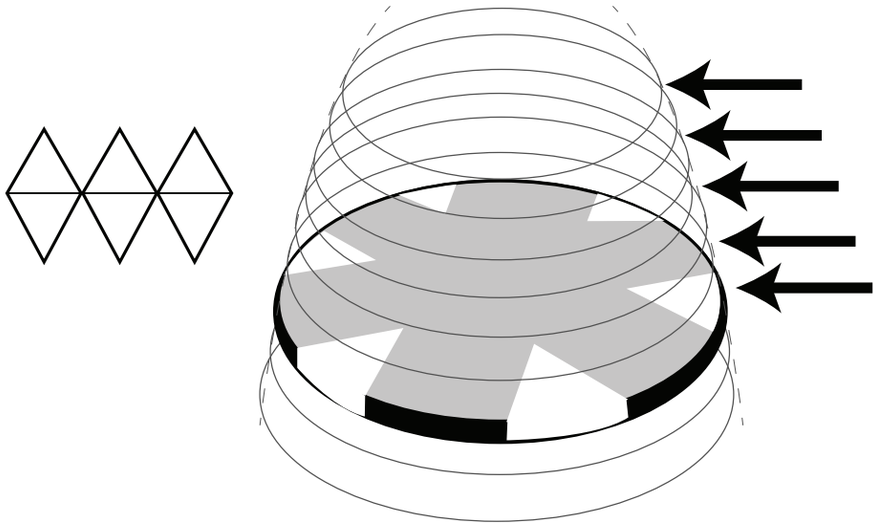




General Structure

Primary Structures

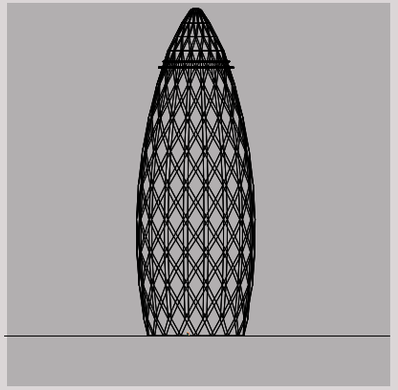




There are two primary sructures.

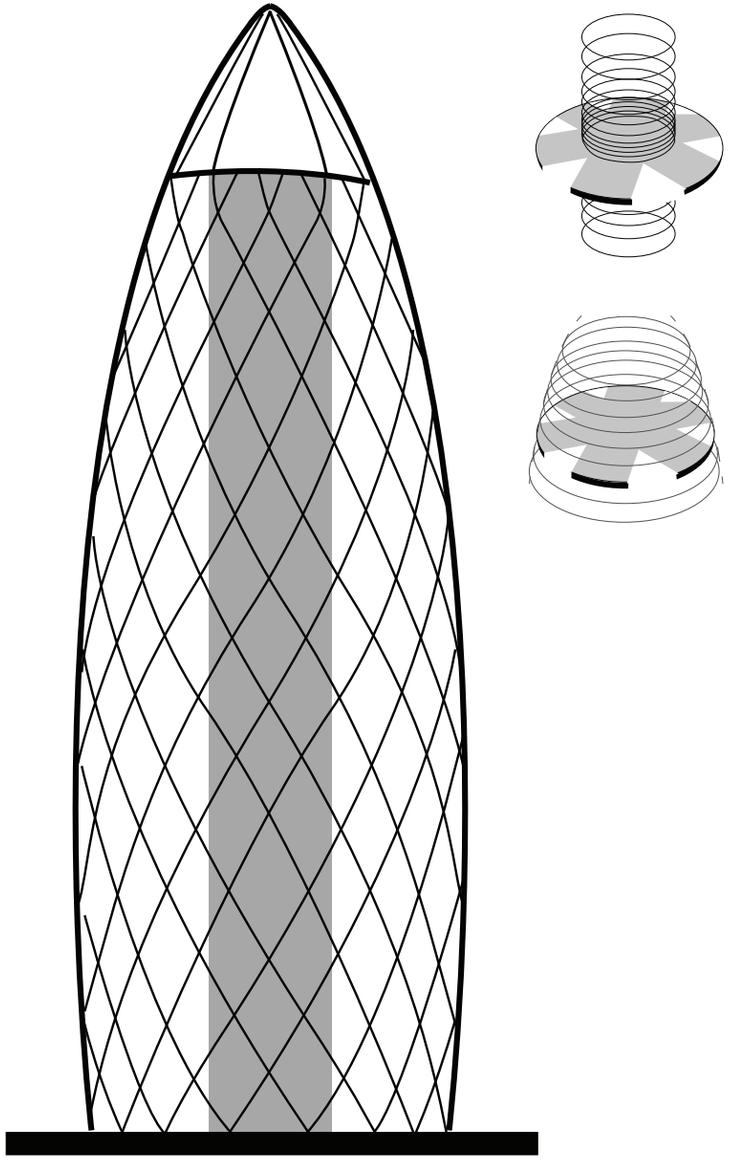
The Diagrid is the main structure (resisting horizontal and gravity loads)

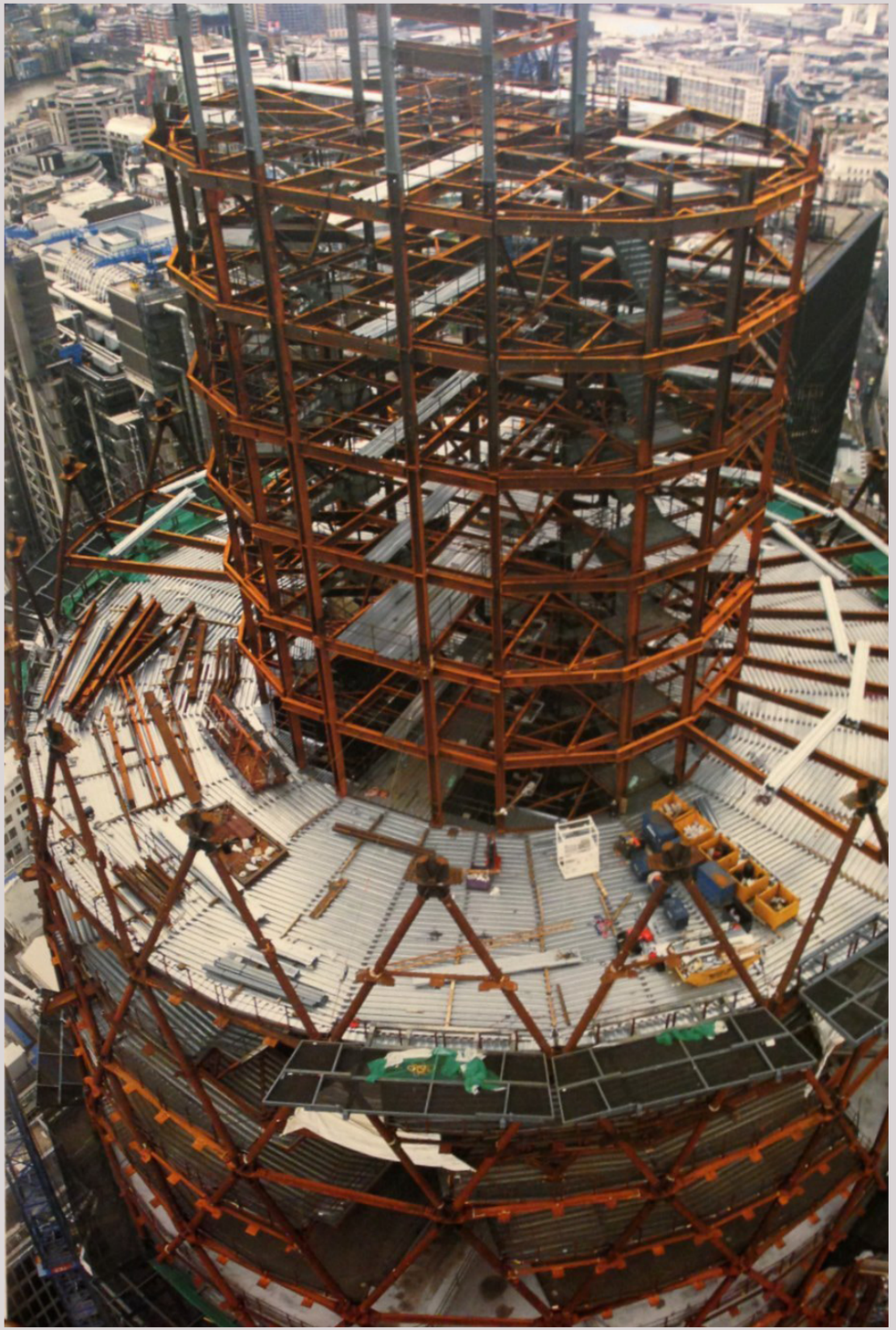
The Core (resisting gravity loads)



Structural Systems

Diagrid + Core





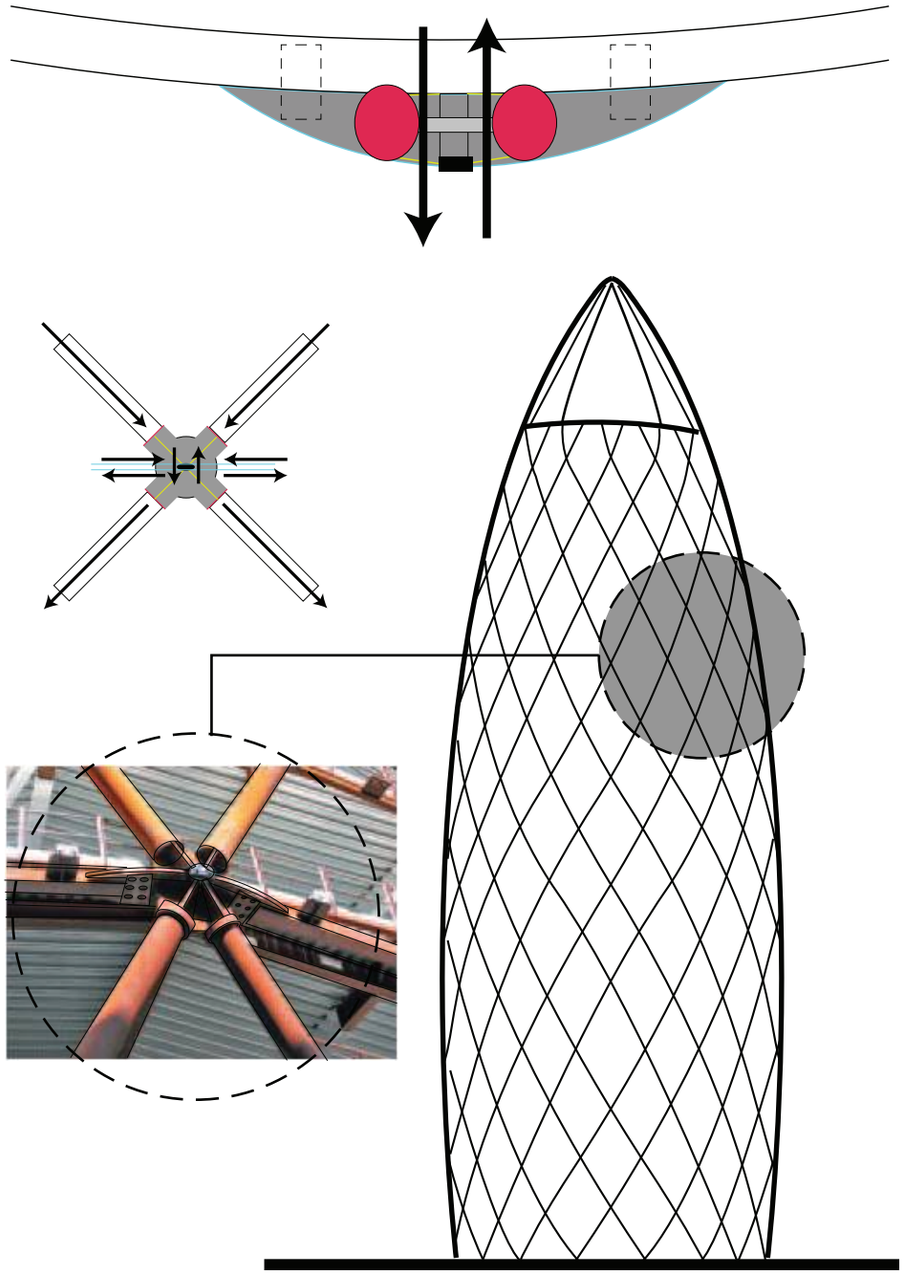
Diagrid

A-frame

- Aluminum coated tube steel
- series of two-stories-high, end to end arrangement.
- one full diamond is four-stories tall.

Connections

Diagrid



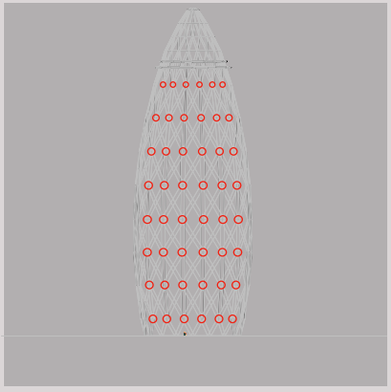
There is a special connector that transfers loads, both vertically and horizontally at the "nodes" which are rigid monolithic and welded together.

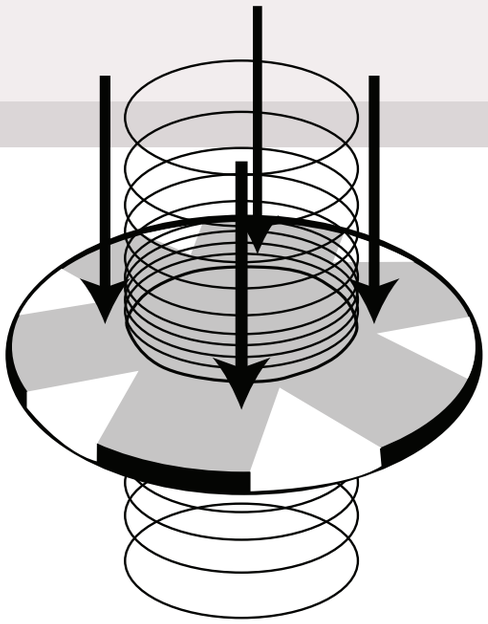
Core

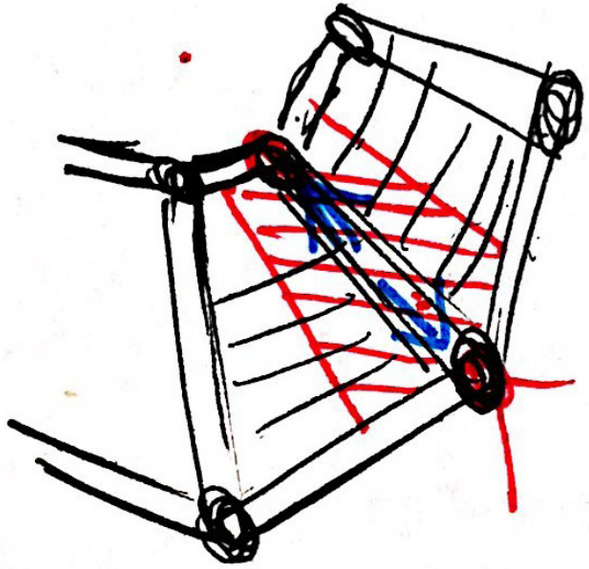
Rigid connections of steel beams and columns

Diagrid

Rigid node connections at inter secting members







Gravity Load

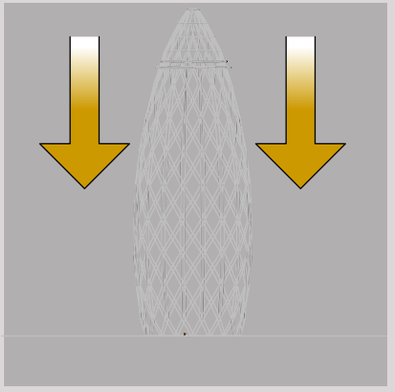
Interior Core

The core takes a portion of the vertical gravity loads and is a secondary structure to the diagrid.

The core acts as a tie back to the hoop structure preventing splay.

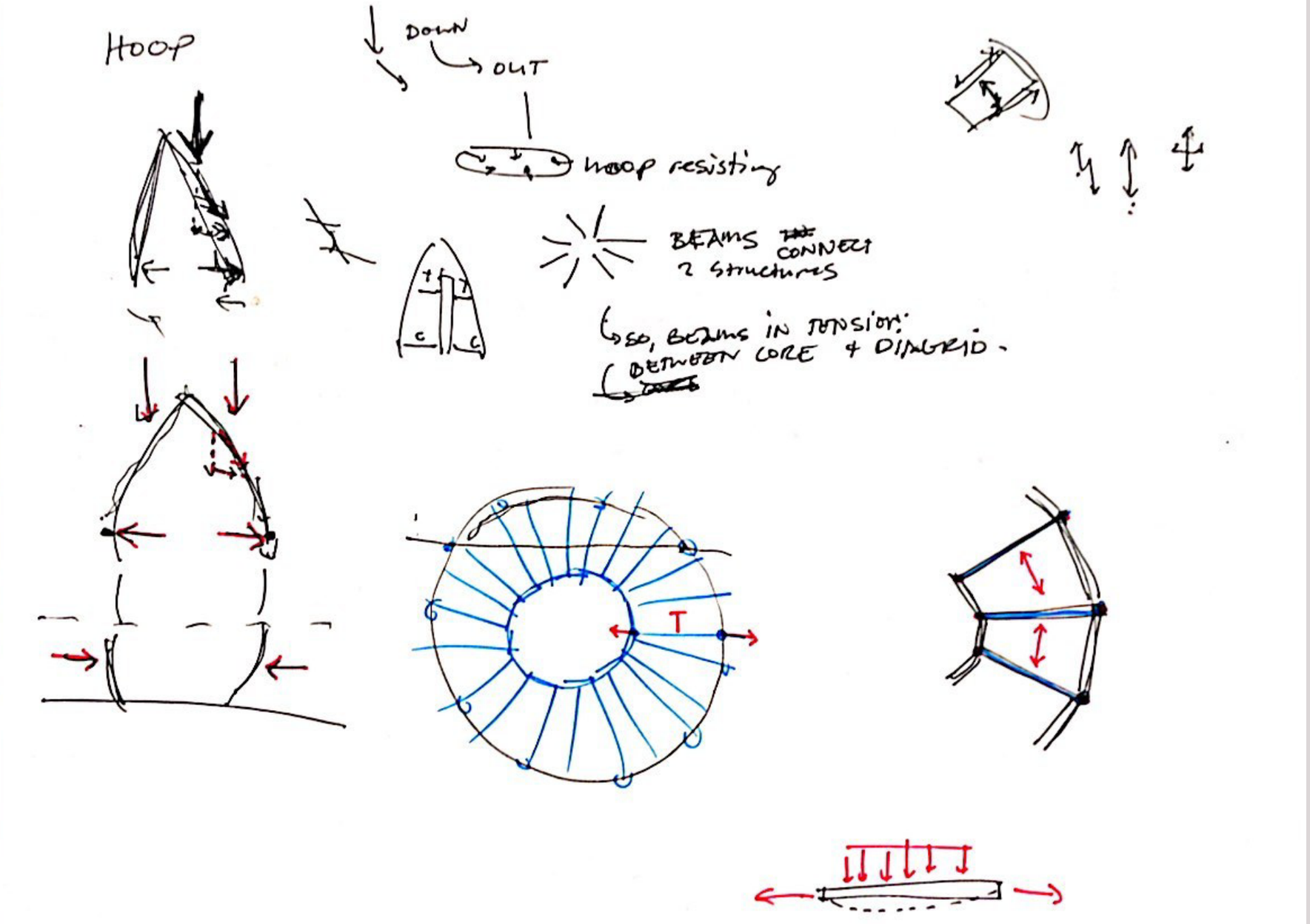
The structure system of the core is rigid using moment frames.

- Provides rigidity
- Resists torsion
- Increases stiffness



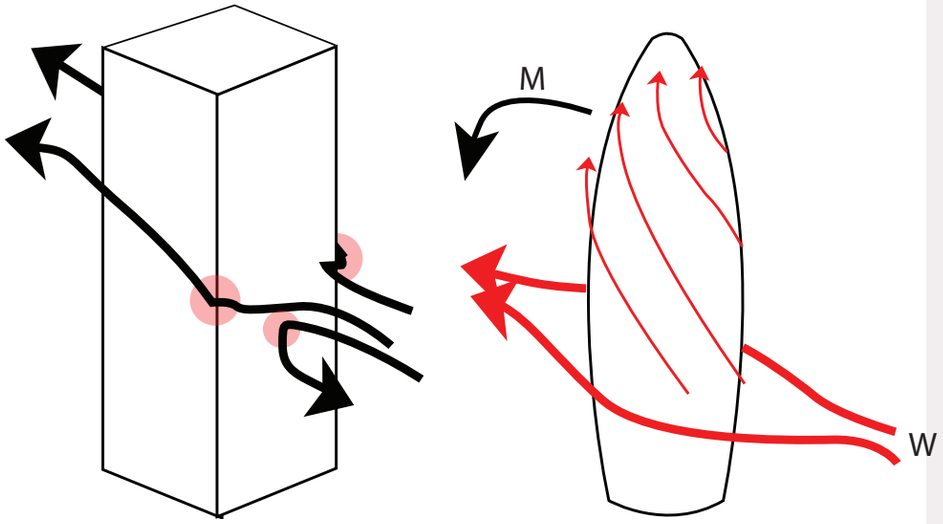
Structural Analysis

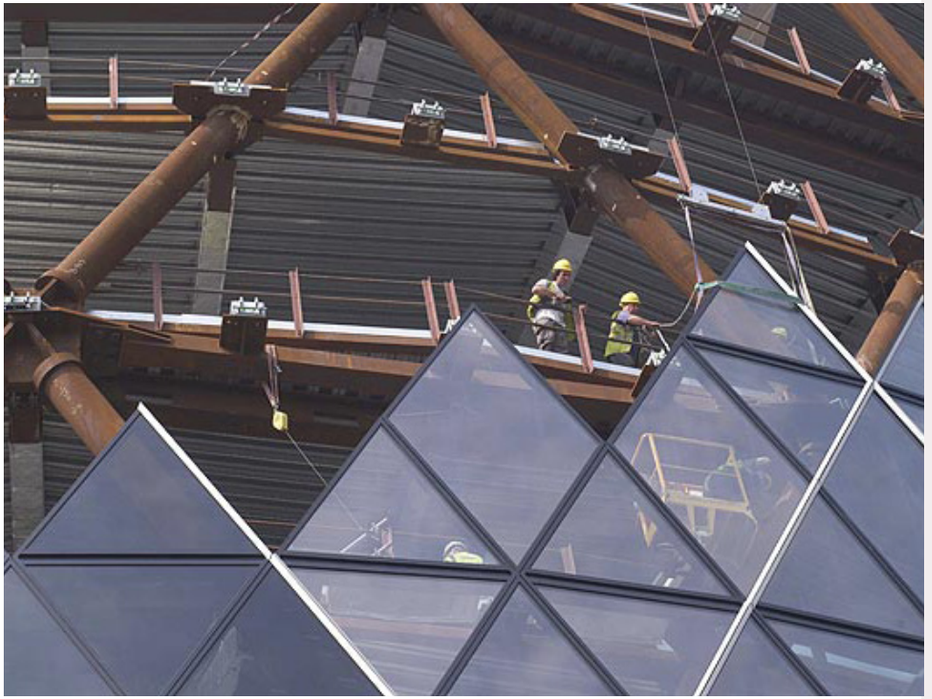
Sketches of Our Understandings



Shape

Wind Load

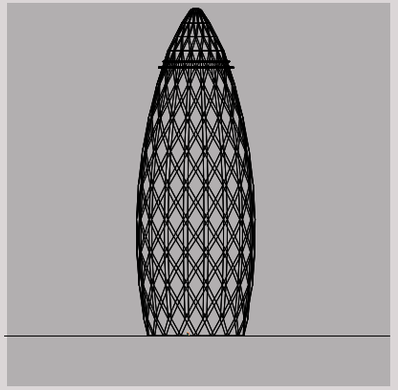




The overall cylindrical shape allows for the wind to move around the building.

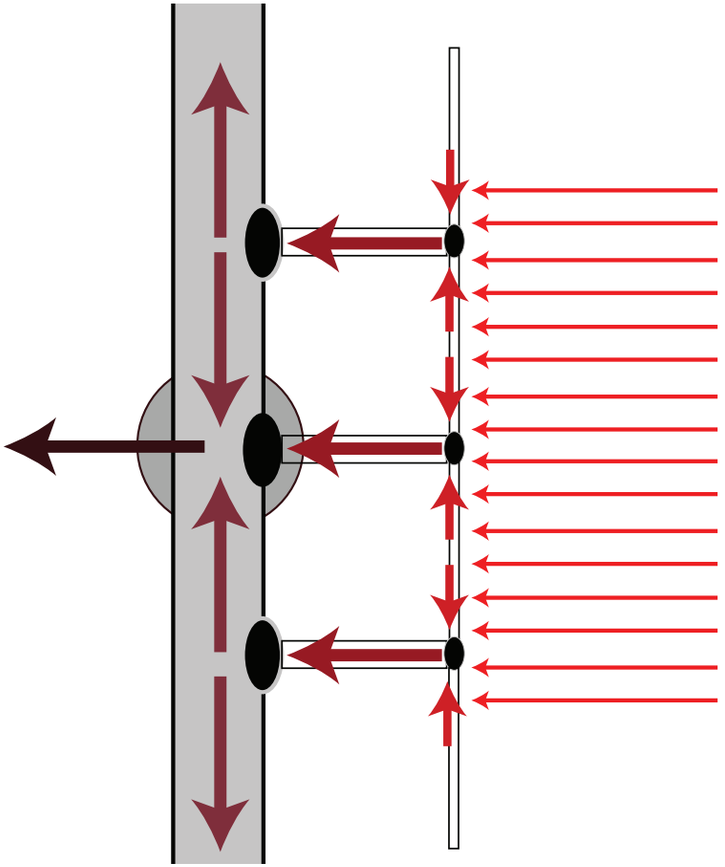
How does this shape effect the horizontal wind loads?

- Decreased Buffetting
- Reduced Vibrations
- Diminished Fluttering



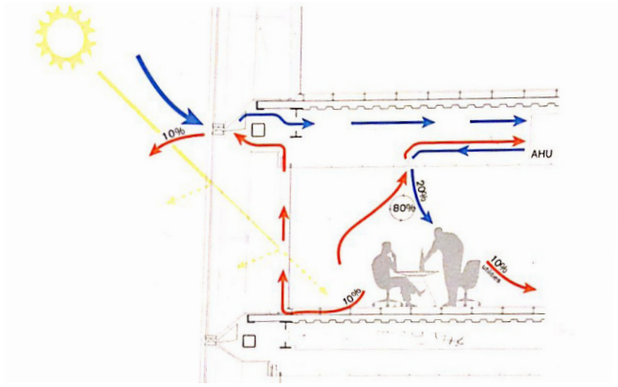
Air

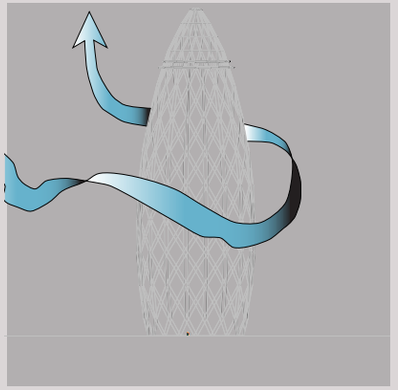
Lateral Loading



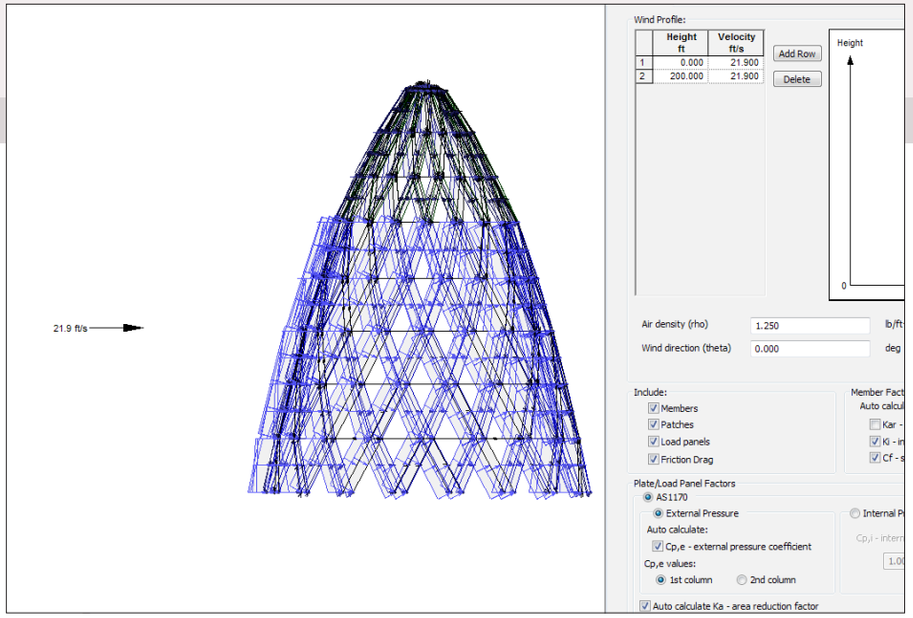
These loads are all absorbed through the glass facade and eventually transfered to the diagrid.

The pressurized air from the wind passes into the building through a natural ventilation system, which is incorporated through a double skin.

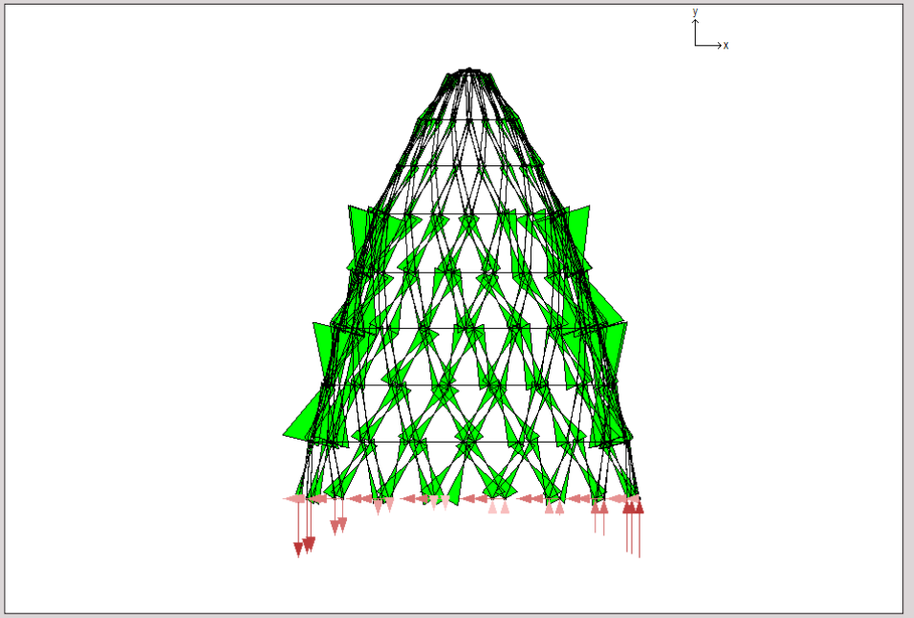




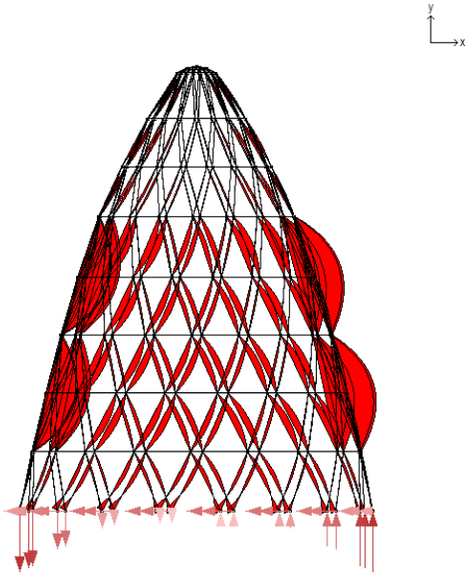
Lateral Loads



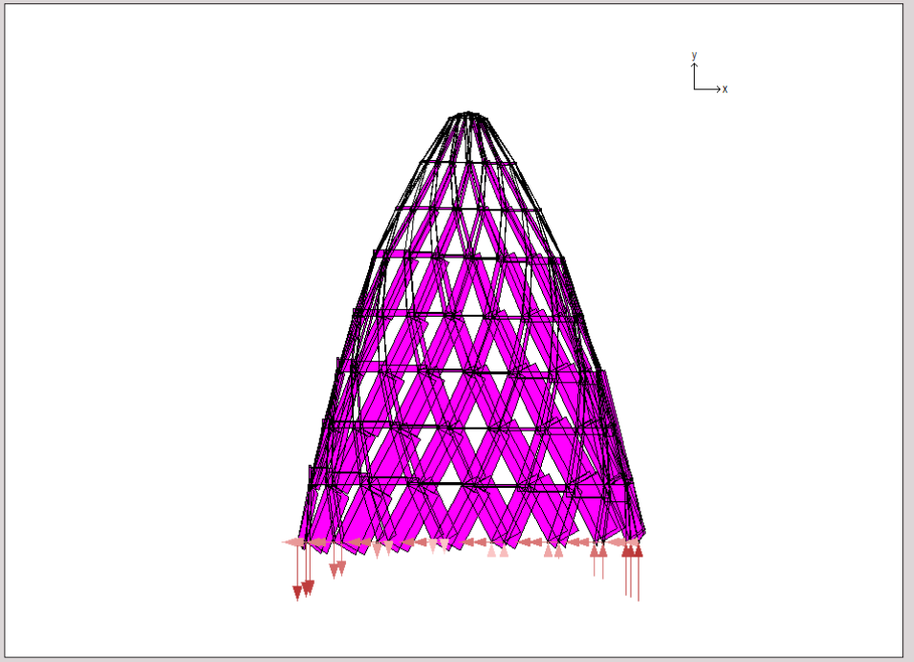
Wind Case Loading Before Analysis



Shear

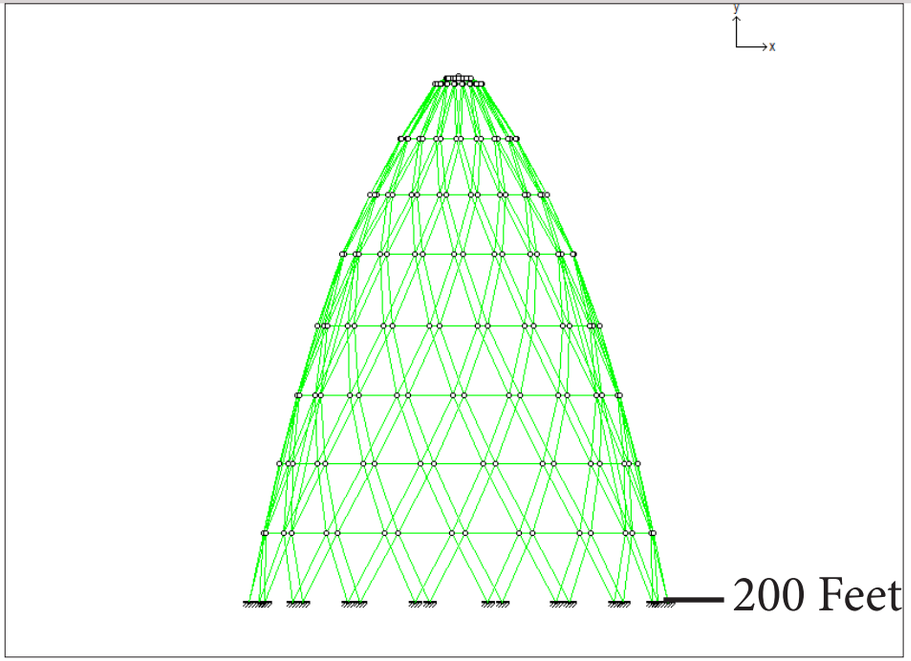


Moment

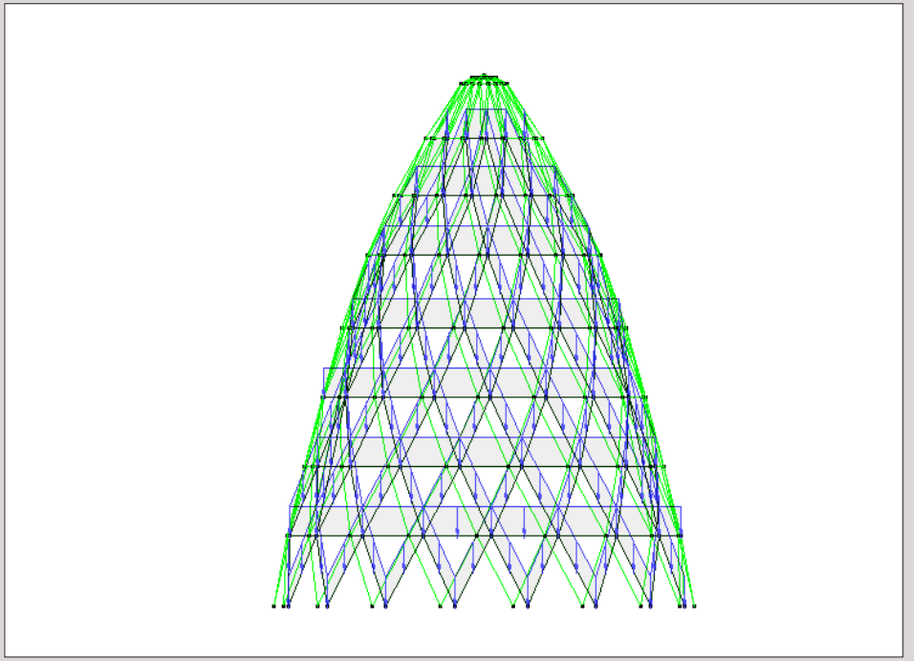


P - Axial Loading

Vertical Loads

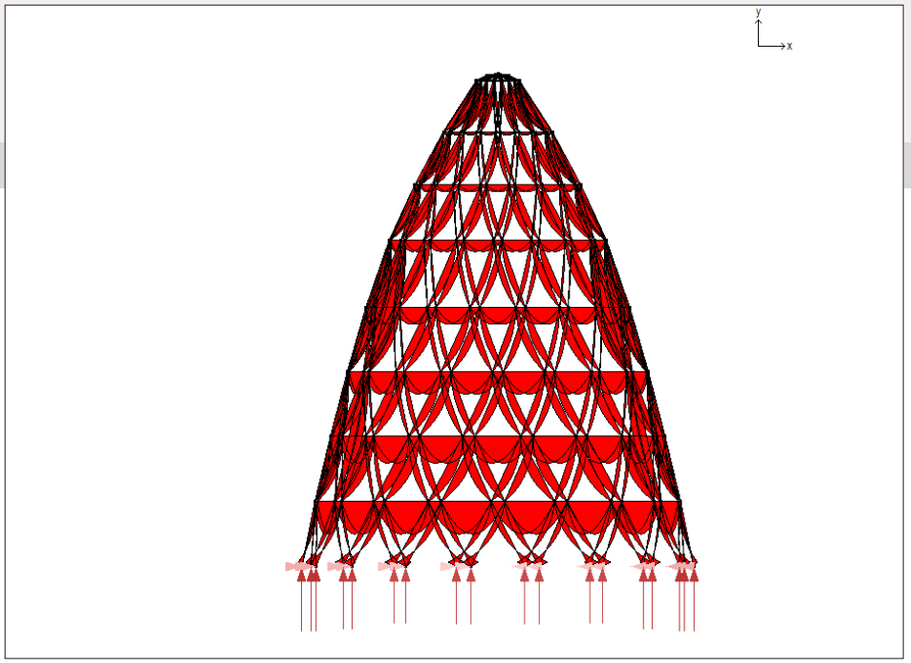


Frame Analysis, Rigid Nodes & Fixed Ends



Applied Lateral Approximate Loads

This analysis encompasses the upper portion of the building.



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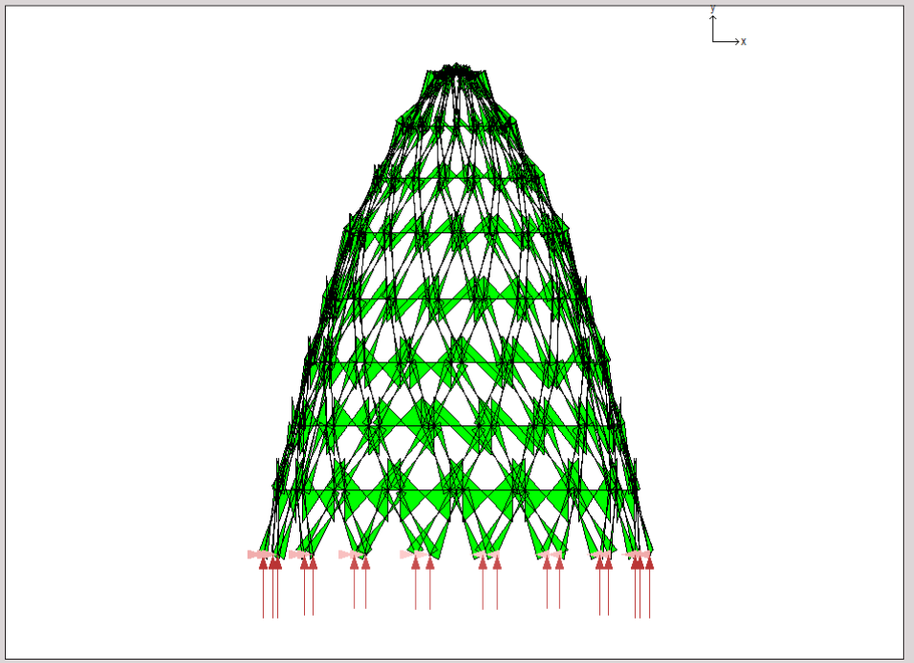

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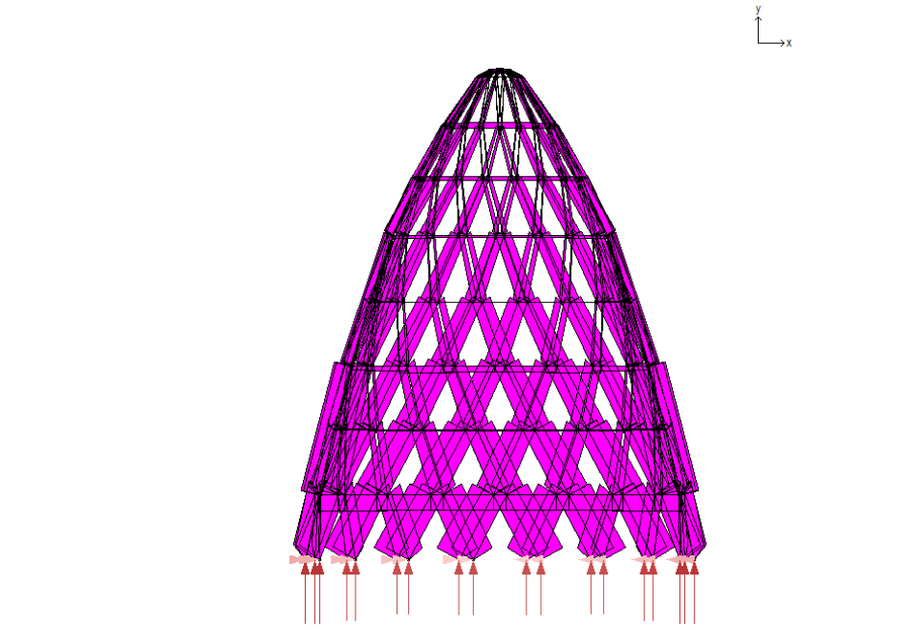
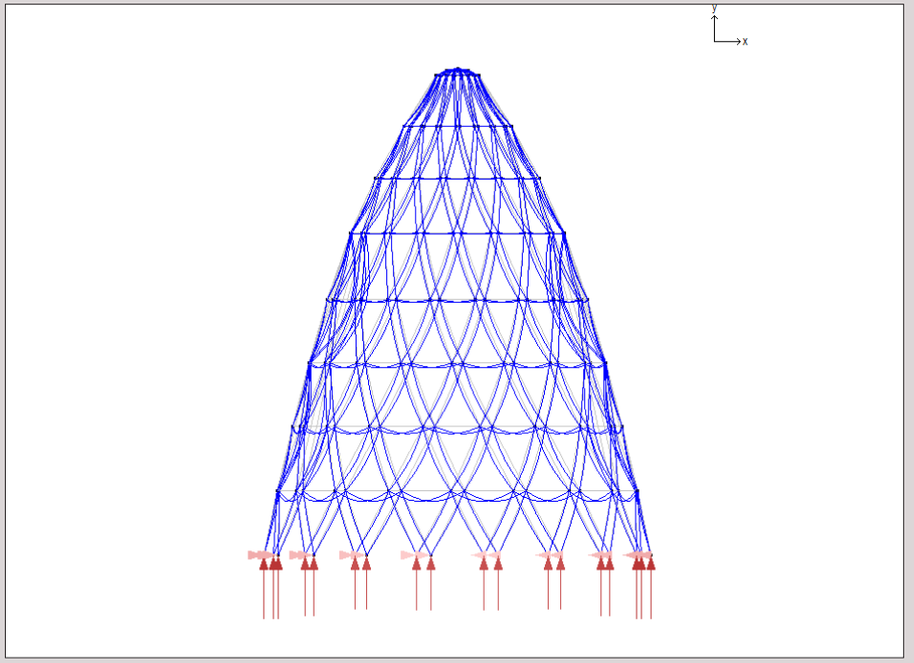


P - Axial Loading



Deflection

Conclusion

Structural Design

This building is an icon.

The Diagrid Provides:

- a unique structural solution to an innovative form
- an aerodynamic form, reducing effects of wind
- a response to external and internal loading

Sources

References

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