Beijing 2008 Olympic
National Indoor Stadium

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Venue: National Indoor Stadium  
Location: Beijing, China center of “Olympic Green”  
Total land surface: 80,900 sq m  
Events: Artistic Gymnastics, Trampoline, Handball, Wheelchair Basketball  
Seating: 20,000

The “green” features are the photovoltaic generators installed under the roof and behind the curtain wall which put out approximately 100 kilowatts of electricity daily. Additionally, public walking areas are constructed of water-permeable material to allow rainwater to seep into the ground for harvesting.

Design by Glöckner3 Architektur und Städtebau with Beijing Institute of Architectural Design  
Concept: Unfolding Traditional Chinese Fan  
Cost: $125 million

The steel roof trusses stretch 144 meters tall and 114 meters wide. The frame is composed of 14 steel beams weighing a total of 2,800 tons. It is a bi-directional truss string structure made of a multi-layer laminated metal composite material that is strong and lightweight while reducing noise. The roof required 9 robots to assist in construction.
Plan and Section

Plan

Section and Elevation
Cable Connection

Elevation

Section

Schematic Turning Section

Steel Pipe of Mast
8.4" v 9.4"
Roof Connection

- Roof Purlin
- Angle Brace
- Roof Brace
- Pipe
- Upper Chord Bar
Roof System

TWO-WAY STRING OF SPACE GRID STRUCTURE

- Upper Chord Bar
- Cable
- Lower Chord Bar
Cable Test

(b) Cable test--one (m)

(b) Cable test--two (m)

(b) Cable test--three (m)
Roof Load:

\[ 490 \frac{lb}{ft^2} \times (3.28 \frac{ft}{m})^2 \times \frac{KN}{224.81lb} \times 0.875m \times 8.77m = 590.21 \frac{KN}{m^2} \]

Snow Load:

\[ 0.55 \frac{KN}{m^2} \times 8.77m = 4.8235 \frac{KN}{m^2} \]

Wind Load (for top face):

\[ 0.6 \frac{KN}{m^2} \times 8.77m = 5.262 \frac{KN}{m^2} \]

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LRFD:

\[ 1.2DL + 1.65 + 0.8KV = 1.2 \left( 590.21 \frac{KN}{m^2} \right) + 1.6 \left( 5.262 \frac{KN}{m^2} \right) + 0.8 \left( 4.8235 \frac{KN}{m^2} \right) = 720.53 \frac{KN}{m^2} \]
Loads from the roof trusses are transferred to the ground through a frame consisting of 437 beams and 78 columns of steel reinforced concrete.
Construction Considerations

- Durable structural design of 100 years
- Base structure reliability of 50 years
- Seismic design category “B” which indicates almost no limitations
- Seismic intensity of 8, which means
  - People have difficulty walking during activity
  - Moderate destruction occurs, including structural destruction
  - Peak acceleration is 2.5 m/s^2
  - Peak speed is 0.25 m/s
Seismic Evaluation

- Performance Evaluation: maximum displacement angle of 1/138 occurred in the y direction in the first group under the action of natural seismic waves.
Seismic Evaluation

- Shear wall structure is main structural system for straightforward earthquake transmission and has very good stiffness and deformation.
- Concrete cylinders supporting the balcony structure have good lateral force stiffness and the ability to stand as part of the reinforced concrete frame.
Seismic Evaluation

- Steel structural system strengthens the balcony and enhances the in-plane stiffness, integrity, rigidity and stability of the reinforced concrete columns
- A steel reinforced concrete frame can maximize steel’s good ductility and concrete’s resistance to stress to improve seismic performance
Multi-structural system is good for seismic forces in large span structures

Good ductility and stiffness of the system has influence over the large-span areas, improving their overall security

Structure meets severe earthquake need in maximum story displacement

Working condition is maintained

Has reserves of strength and deformation capacity
The Beijing 2008 Olympic National Indoor Stadium is an example of a modern structural accomplishment. It meets structural design standards in terms of aesthetics, safety and reliability while creating an incredibly interesting vision and a monumentality successful functional building to be enjoyed by generations to come.