MIDDLE EAST TECHNICAL UNIVERSITY
DEPARTMENT OF ARCHITECTURE / BUILDING SCIENCE PROGRAM

BS 536
STUDIES ON TALL BUILDINGS: DESIGN CONSIDERATIONS
Spring 2015-2016

Case Study: **Goldin Finance 117**
by
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Submitted to: Assoc.Prof.Dr. Mehmet Halis Günel
Assist.Prof.Dr. Bekir Özer Ay

Project Facts

Case Study: **Goldin Finance 117** by Gözde Bulut
Submitted to: Günel, Ay – Spring 2016

OFFICIAL NAME: Goldin Finance 117 [1]
OTHER NAMES: Walking Stick [1]
LOCATION: Tianjin, CHINA [1]
USAGE: Hotel/Office [1]
ARCHITECT: P & T Group [1]
ASSOCIATE ARCHITECT: ECADI [1]
STRUCTURAL ENGINEERS: Arup [1]
OWNER/DEVELOPER: Goldin Properties Holding Ltd. [1]
ARCHITECTURAL HEIGHT: 596.5 m [1]
ASPECT RATIO: 9.5
STORIES: 128 occupied floors [1]
TOTAL FLOOR AREA: 370,000 m² [1]
STRUCTURAL SYSTEM: Braced Tube (According to Günel & Ilgın)
Mega-brace Frame (According to Arup)
STRUCTURAL MATERIAL: Composite [1]
STATUS: Architecturally Topped Out (On Hold)[1]
CONSTRUCTION STARTED: 2009 [1]
COMPLETION: 2017 (estimated)
ENERGY LABEL: LEED Platinum [1]

Figure 1: www.skyscrapercenter.com/
[1] Retrieved from: www.skyscrapercenter.com/building/goldin-finance-117/73

Project Facts

The projected 20 tallest buildings in 2020 [2]

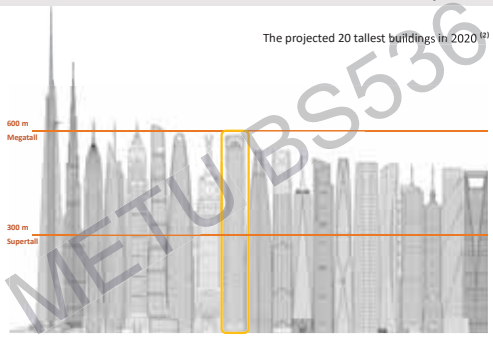


Figure 2[2]: CTBUH (2011). *'The Tallest 20 in 2020: Entering the Era of the Megatall'*

Project Facts

The design of the tower:

- a **bejeweled walking stick**, with a long slender form capped by a diamond-shaped atrium[1]
- a **rotating observation deck** and a fine dining establishment [1]
- **grade A office** accommodations and a double-decker lift [1]
- a **6-star hotel**
- **Sky lobbies** at various heights along the tower, providing views of the surrounding districts. [1]
- **9.5 aspect ratio**, exceeding the limit of 7.0 imposed by Chinese seismic code [1]

Figure 3 : www.skyscrapercenter.com/building/goldin-finance-117/73
[1] Retrieved from: www.skyscrapercenter.com/building/goldin-finance-117/73

Design Process

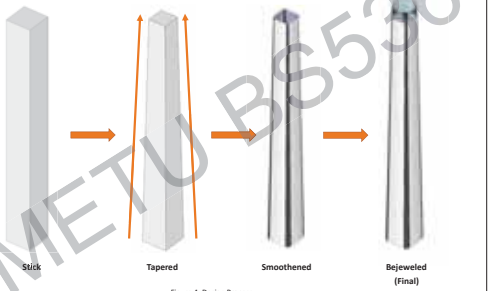


Figure 4: Design Process
Drawn by **Gözde BULUT**

Design Process

Figure 5: www.skyscrapercenter.com/building/goldin-finance-117/73

Figure 6: Functions
Drawn by **Gözde Bulut**

Figure 7: www.skyscrapercenter.com/building/goldin-finance-117/73

Design Process

Plans - Section

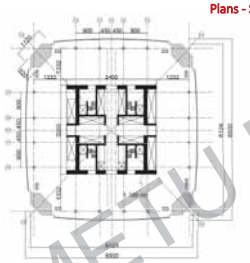


Figure 8: Ground Floor Plan
Drawn by: **Gözde BULUT** [3]

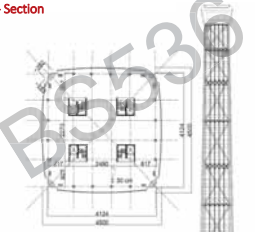


Figure 9: 122th Floor Plan (estimated)
Drawn by **Gözde BULUT** [3]

Figure 10: Section (estimated)
Drawn by **Gözde BULUT** [3]

[3] ARUP (2012).*'The Structural Design of Tianjin Goldin Finance 117 Tower'*

Structural System

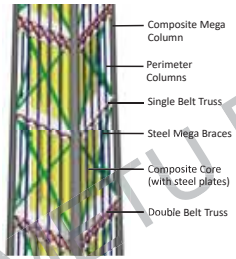


Figure 11: Structural Axonometry
Drawn by **Gözde BULUT** [3]

Figure 12:
http://www.skyscrapercity.com/showthread.php?t=558031&page=82

[3] ARUP (2012).*'The Structural Design of Tianjin Goldin Finance 117 Tower'*

Structural System

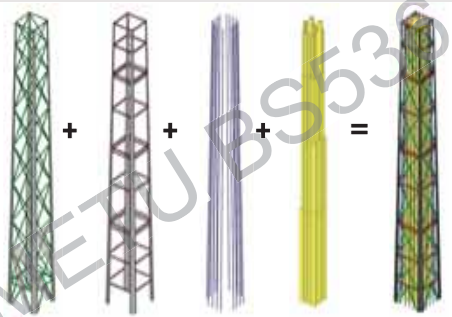


Figure 13: Structural System Drawn by **Gözde BULUT**

Structural System

Belt Trusses

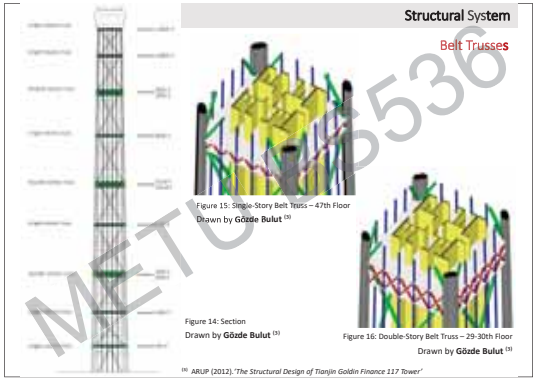


Figure 14: Section
Drawn by **Gözde Bulut** [3]

Figure 15: Single-Story Belt Truss – 47th Floor
Drawn by **Gözde Bulut** [3]

Figure 16: Double-Story Belt Truss – 29-30th Floor
Drawn by **Gözde Bulut** [3]

[3] ARUP (2012).*'The Structural Design of Tianjin Goldin Finance 117 Tower'*

Structural System

Mega Braces & Belt Trusses

Figure 17: https://www.youtube.com/watch?v=Qc2ou5b0avc

Structural System

Core

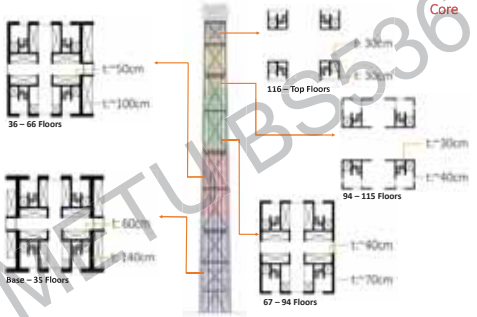


Figure 18: Composite Steel Plate Wall plan arrangement Drawn by **Gözde Bulut** [3]
[3] ARUP (2012).*'The Structural Design of Tianjin Goldin Finance 117 Tower'*

Structural System

Core

Figure 19: Core Axonometry
Drawn by **Gözde Bulut**

Structural System

Core – Steel Plates

Figure 20: Ground Floor Composite Steel Plate Wall plan arrangement
Drawn by **Gözde Bulut** [3]

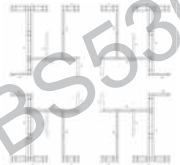


Figure 21: Ground Floor Composite Steel Plate Wall and Cast-in Steel Post arrangement[4]

- The core adopts steel-reinforced concrete shear walls with embedded steel sections. At the low zone, alongside steel sections, steel plates are added to form composite steel plate walls to prevent shear failure of the concrete walls in case of a severe earthquake.
- Steel plate arrangements within the wall panels vary from two 35 mm thick steel plates at the bottom to a single 25 mm steel plate at about Level 32. [3]

[3] ARUP (2012).*'The Structural Design of Tianjin Goldin Finance 117 Tower'*

Structural System

Mega Column

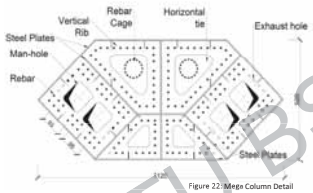


Figure 22: Mega Column Detail
Drawn by **Gözde BULUT** [3]

- an external steel plate enclosure with internal inter-connected plates, filled with concrete [3]

Cross sectional area [4]:
- about 45 m² at the bottom
- about 5.4 m² in area at the top

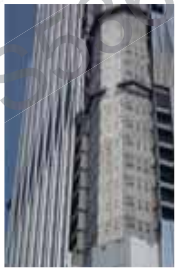


Figure 23:
www.facebook.com/megaprojectsandskyscrapers

[3] ARUP (2012).*'The Structural Design of Tianjin Goldin Finance 117 Tower'*
[4] Bao, L. (2015). *' The New Structural Design Process of Supertall Buildings in China'*

Structural System

Floor Slabs

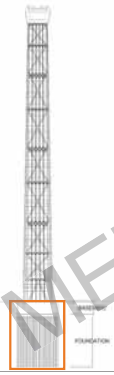
Figure 24: http://media.snimka.bg/s1/3825/033894710-big.jpg?r=0

- Outside the core of the tower, a **composite floor system** is adopted with simply supported beams spanning from 6~13m from top to bottom of the tower at 3m typical spacing. [3]
- The office slab floor is 120 mm thick and the hotel floor is 130 mm thick. [3]

[3] ARUP (2012).*'The Structural Design of Tianjin Goldin Finance 117 Tower'*

Structural System

Foundation



- 4-story **26 m** deep basement
- **6.5 m** thick raft
- 941 cast in situ **bored piles** (steel pipe, concrete barrette, bored pile were studied; bored pile was selected because of safety, economy and construction feasibility.)
- piles are **1 m in diameter** and founded at **100 m** below ground [5]

Figure 25: Section [3] [5]
Drawn by **Gözde BULUT**

[3] ARUP (2012).*'The Structural Design of Tianjin Goldin Finance 117 Tower'*
[5] Liu, P. (2012).*'The Solution to a Slender Geometry'*

Structural System

Detail

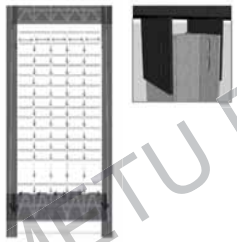


Figure 26: Perimeter frame and slotted joint at the top [6]

- Each sub-frame zone is about 15 stories, in which a beam-column frame passes the gravity load to the belt truss below, which in turn transfer it to the mega columns. [3]
- To prevent the potential progressive collapse **when the lower part of the sub-column is damaged** (in an extreme scenario, for example under blast or external collision), **an alternative load path for the upper portion is provided by connecting the columns with the belt truss above via a long slotted joint** which was triggered like a "fuse" when the lower column fails. [3]

[6] ARUP (2012).*'The Structural Design of Tianjin Goldin Finance 117 Tower'*

Sky Lobbies

Figure 27: Diamond-shaped Atrium

Figure 28: Observation Deck

Figure 29: Sky Lounge

Figure 27-28-29: *http://www.goldinppt.com/our-business/goldin-metropolitan/media-gallery/*

Construction Photos

Figure 30: *www.skyscrapercenter.com/building/goldin-finance-117/73*

Figure 31: *www.skyscrapercenter.com/building/goldin-finance-117/73*

References

1. Retrieved from: *www.skyscrapercenter.com/building/goldin-finance-117/73*
2. CTBUH (2011). *'The Tallest 20 in 2020: Entering the Era of the Megatall'*
3. ARUP (2012).*'The Structural Design of Tianjin Goldin Finance 117 Tower'*
4. Bao, L. (2015). *' The New Structural Design Process of Supertall Buildings in China'*
5. Liu, P. (2012).*'The Solution to a Slender Geometry'*
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