

HEARST TOWER CASE STUDY



Nicole Hoffman
Mark Navarro
Kimberly Nordhoff
Stephanie Schwindel
Chris Williams

Original Building

- Architects: Joseph Urban and George P. Post & Sons
- Opened in 1928, \$2 million
- “Important monument in the architectural heritage of New York”
- The building was structurally reinforced to accommodate an office tower that was never realized
- Cast limestone façade with fluted columns and decorative statues



BUILDING HISTORY

New Tower Expansion

- Architect:
Foster + Partners
- Structural Engineer:
WSP Cantor Seinuk
- Construction Management:
Turner Construction
- New 46-story tower completed in
2006
- 856, 000 sq ft. office building
- Project cost:\$500 million
- New York City's first LEED Gold
Accredited Skyscraper



BUILDING HISTORY



ARCHITECT

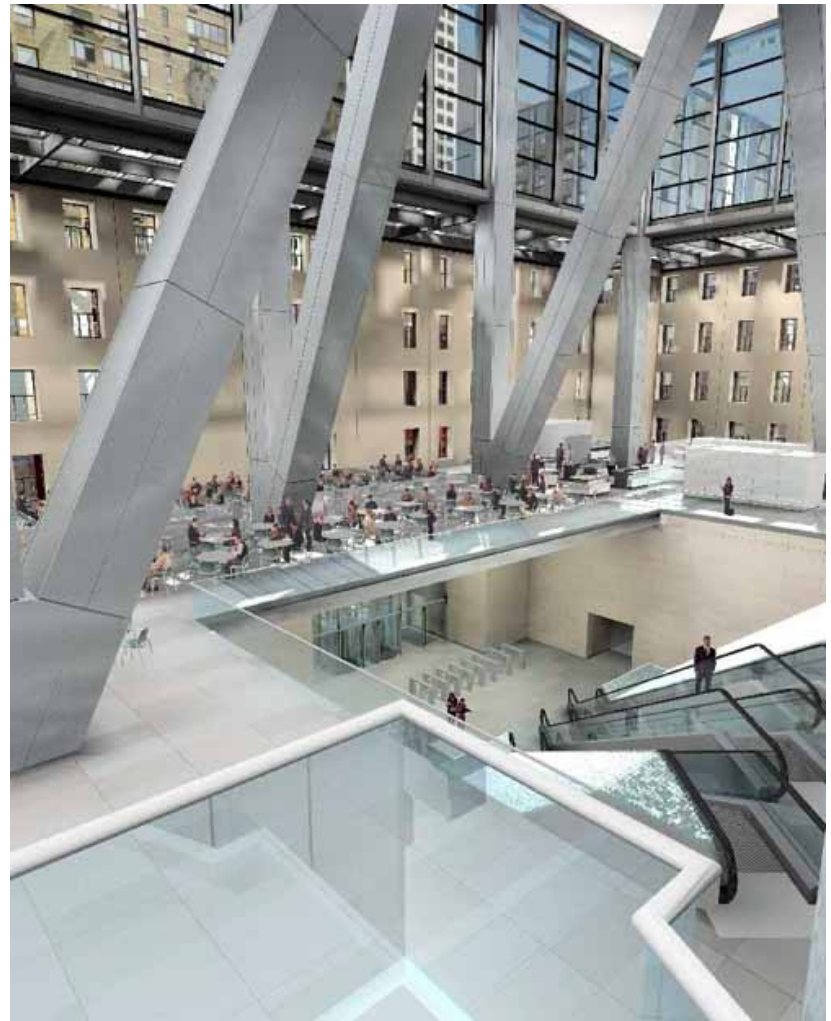
Lord Norman Foster

- Honored into knighthood in 1990
- Pritzker Prize in 1999
- Life Peerage (Lord Foster of Thames Bank)
- Began Foster + Partners in 1967.
- Received 470 awards and citations for excellence and has won more than 86 international and national competitions.

STRUCTURE

Existing Building Renovations

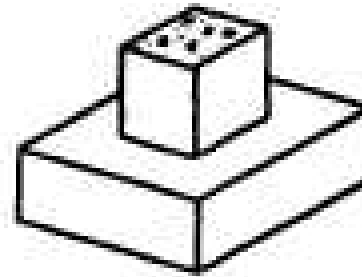
- Interior of original building was completely gutted
- Limestone façade was saved to serve as a historic reminder to the past
- Additional framing added behind limestone façade for extra lateral strength
- Made room for independent steel and glass mega structure to set inside



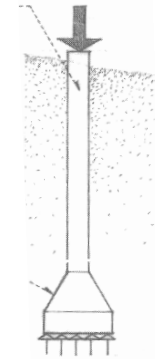
STRUCTURE

Foundation and Soil

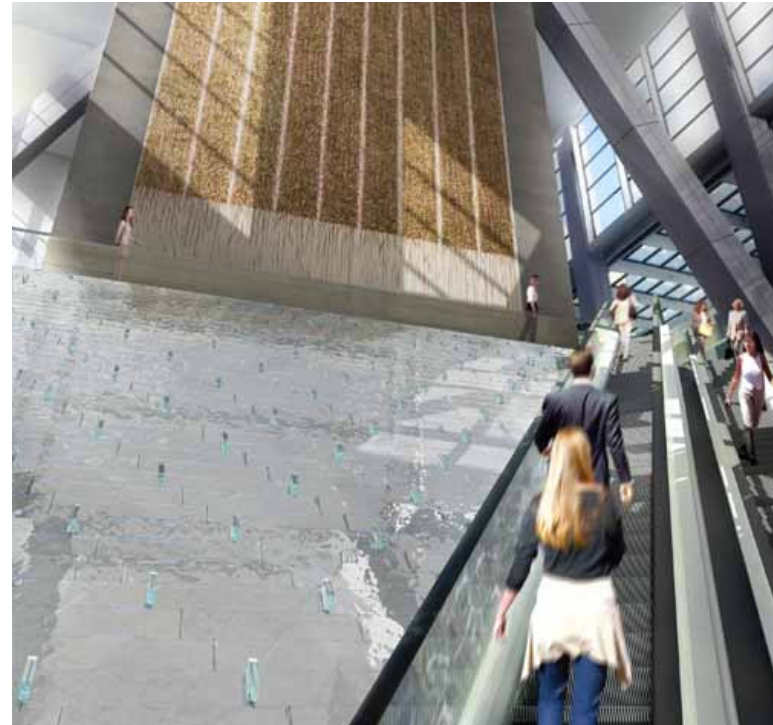
- Separate foundation system from existing building
- Large difference in elevation of the bedrock under site
 - A few feet to 30 feet
- Half of tower supported on spread footings
- Half of tower supported on caissons
- Assumptions: Take into account weight of “Ice-fall” water feature in lobby



SPREAD FOOTING



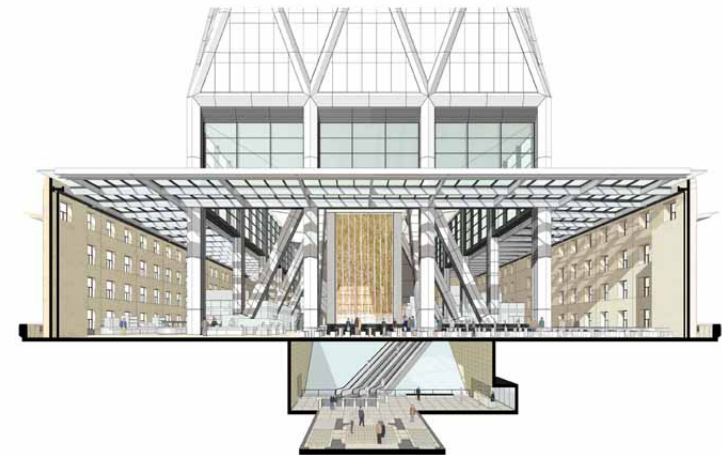
CAISSON



STRUCTURE

Mega Column and Super Diagonal System

- Located at the exterior of the new tower
- Comprised of built-up steel tube sections that are in-filled with concrete
- Extend from the foundation to the 10th floor of the tower
- Allow for open interior atrium
- Carry gravity loads of tower to ground and provide lateral stability



Lobby - Sectional Perspective

STRUCTURE

Skylight glass “skirt”

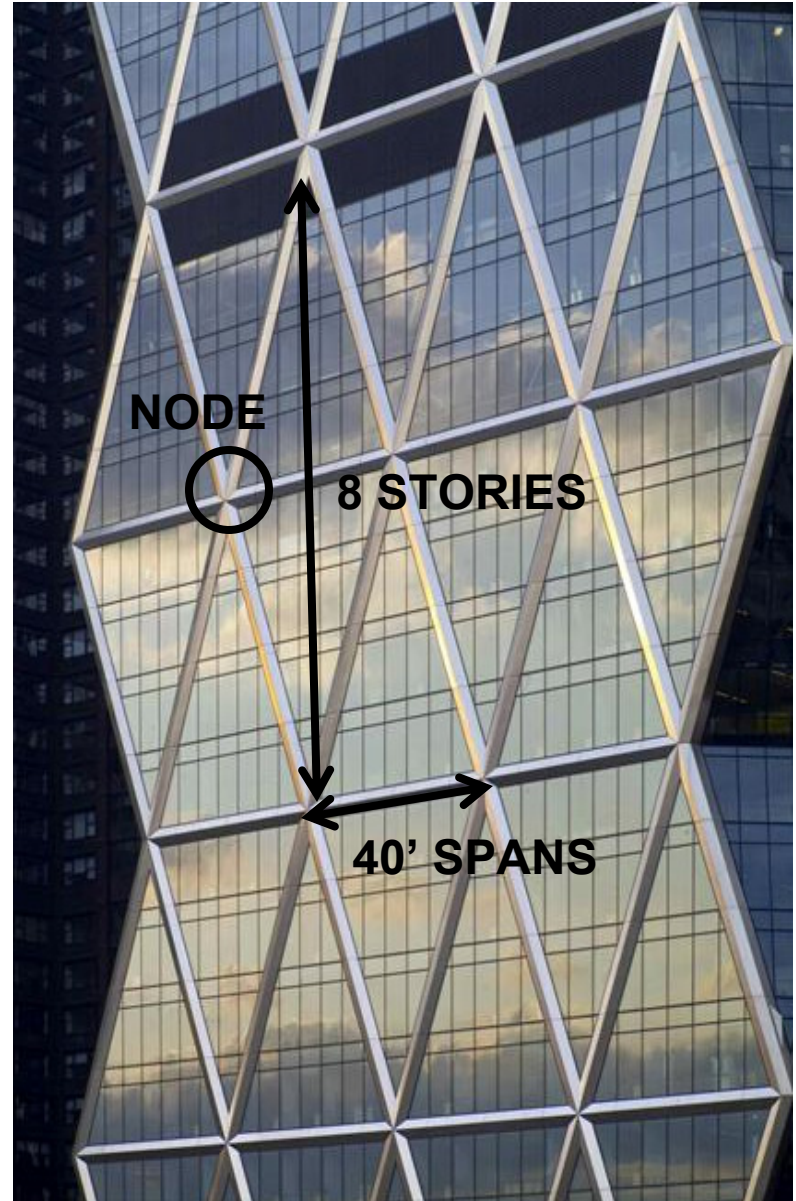
- Spans from new tower exterior columns to existing exterior masonry façade
- Solves problem of connecting existing to new
- “Floating” tower appearance



STRUCTURE

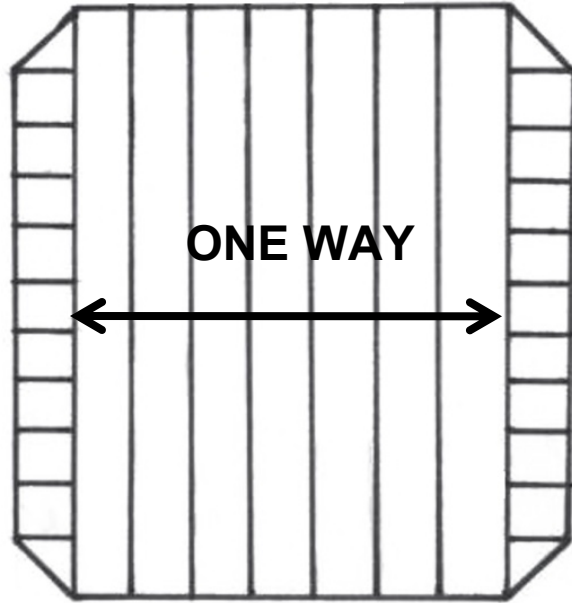
Diagrid System

- Chosen early in design process
- 40 foot spans horizontally and 8 stories vertically
- Node connections every 4 floors
- System begins on 10th floor
- “Triangulated truss interconnecting all four faces of the tower”
- Assumption: Diagrid members act as beam columns
- Consumed 20% less steel than conventional skyscrapers



STRUCTURE

Floor System



DETAIL OF FLOOR PLATE



- Comprised of steel and concrete
- Act as horizontal diaphragms
- Assumptions:
 - Behave like one way slabs
 - Shorter interstitial members are placed between floor beams on two sides of tower for lateral support



STRUCTURE

Node Connections

- Not larger than the cross dimension of the diagrid elements
- Prefabricated off-site and bolted in place
- Two types:
 - Interior: planar, transmit loads two dimensionally
 - Corner: more complicated, transmit loads three dimensionally
- Act as hubs where the member forces are redirected
- Assumption: Rigid, moment resisting connections



STRUCTURE

“Bird’s Mouth”

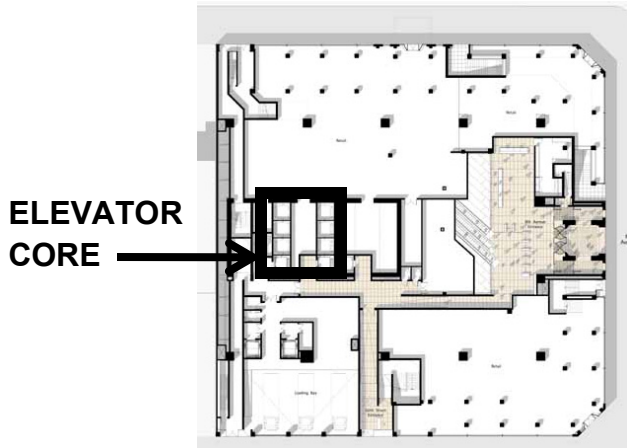
- Occurs on all four corners
- Produced because of structural arrangement created by diagrid
- Alleviates problem of having 20 foot cantilevers in corners (typically left behind by diagrid)
- Adds visual interest to building
- Allows for expansive views
- Unique feature as opposed to box-like neighbors

- Wind loads most significant, but seismic loads were also calculated according to NYC Building Code requirements
- Existing perimeter columns and beams in existing 6-story building were kept for lateral support
- Additional framing added to existing building satisfy new seismic requirements



LATERAL RESISTING SYSTEM

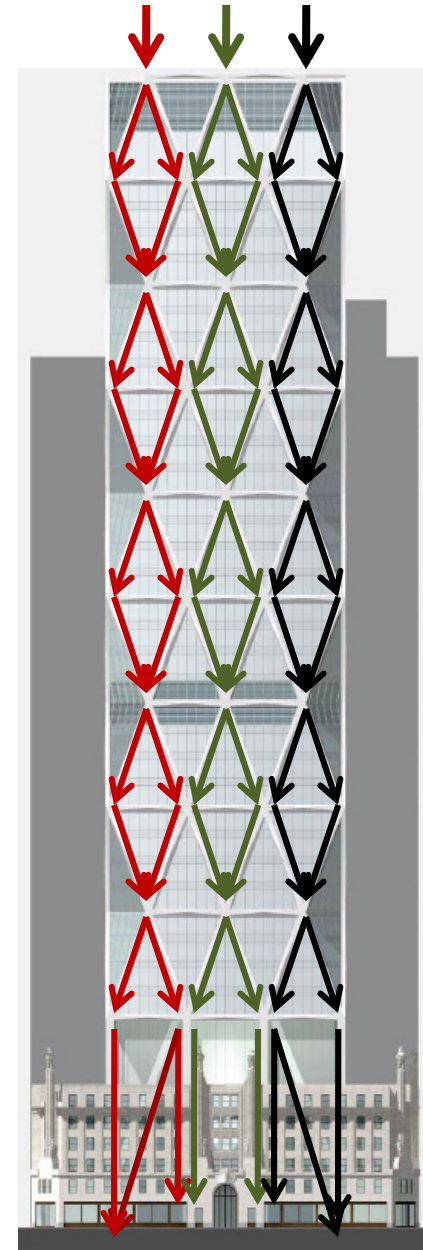
- Elevator core shifted to westward side of building, additional cross bracing required around core
- Diagrid structure is tube structure
- Floors act as diaphragms
- High redundancy

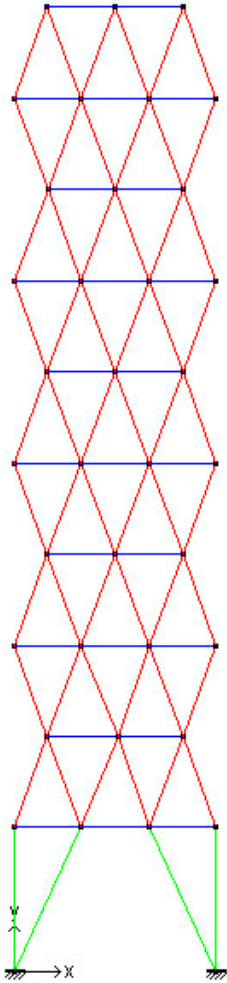


LATERAL RESISTING SYSTEM

Loads travel down diagrid members in plane on the facade of the building, down the mega columns and super diagonal members to the spread footing or caisson foundations and spread across an area of soil large enough so that the allowable bearing stress of the soil is not exceeded.

LOAD TRACING

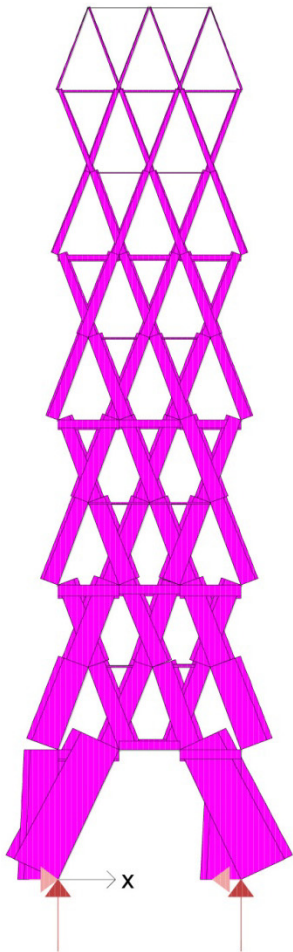




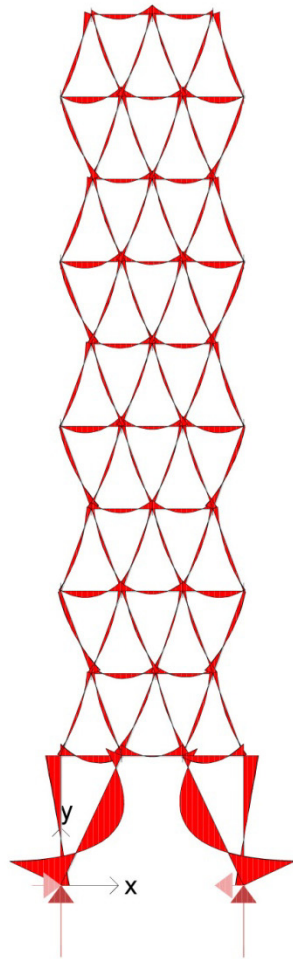
Modeling Procedure

- Building was simplified and modeled with steel wide flange members
- Connections made rigid and members at base fixed to ground
- Largest members -Super diagonals
Mega columns
- Medium size members- Diagrid members
- Smallest members- beams for floors

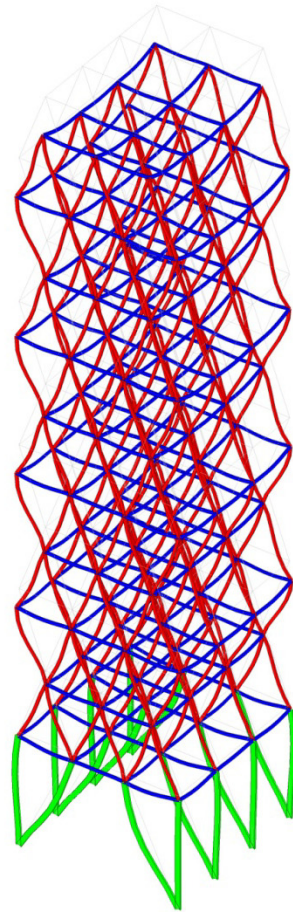
MULTIFRAME ANALYSIS



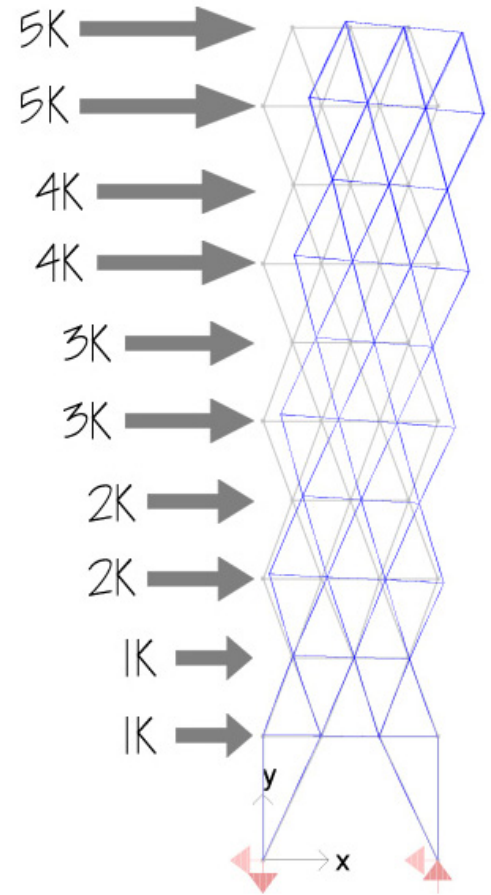
Shear Diagram



Moment Diagram



Self-weight Deflection



Wind Deflection

MULTIFRAME ANALYSIS

ISSUES WITH CONSTRUCTION

- Mega columns and super diagonals too large to be shipped in one monolithic piece
- Escalator hoisted into building through roof of existing building and covered with plywood
- Tolerance for error at connections was smaller than normal, so prefabrication offsite was required
- Needed custom made scaffolding to install windows and cladding
- A typical floor had up to 30 different window configurations



CONCLUSION & REFERENCES



- Architect: Foster + Partners
- Addition of new tower within an existing building
- Foundation System: spread footing and caissons
- Main Structure System: Diagrid, mega columns, and super diagonals
- Nodes: Rigid moment connections
- Lateral System: horizontal diaphragm and diagrid elements
- Tolerance for construction errors minimal

CONCLUSION & REFERENCES



- Ching, Francis D.K. and Cassandra Adams. Building Construction Illustrated Third Edition. New York: John Wiley & Sons, 2001.
- Foster + Partners. "Facts and Figures." 2 March 2007.
- "Hearst Magazine Building." NYC-Architecture.com. <<http://www.nycarchitecture.com/MID/MID124.htm>>.
- Milliard, Bill. "Hearst Tower, NY by Foster and Partners." BD Magazine Nov. 2006. <<http://www.bdonline.co.uk/story.asp?sectioncode=719&storycode=3077506>>.
- Nolan, David. "Hearst Tower – Reinventing the Skyscraper." Popular Mechanics April 2006. <<http://www.popularmechanics.com/technology/industry/2591931.html>>.
- Rahimian, Ahmad, and Yoram Eilon. "New York's Hearst Tower – A Restoration, an Adaptive Reuse, and a Modern Steel Tower Rolled into One." Structure Feb. 2006. <<http://ecow.engr.wisc.edu/cgi-bin/getbig/cee/340/davidcamac/readings/hearst-tower-feb-06.pdf>>.
- Schodek, Daniel L. and Martin Bechthold. Structures - Sixth Edition. New Jersey: Pearson Prentice Hall, 2008.
- Welch, Adrian and Isabelle Lomholt. "Hearst Tower New York." E-architect 2007. <http://www.earchitect.co.uk/new_york/hearst_tower_new_york.htm>
- Images taken from Foster and Partners, Structure, E-Architect, and Popular Mechanics (references listed above).

HEARST TOWER CASE STUDY



THANK YOU!

Nicole Hoffman
Mark Navarro
Kimberly Nordhoff
Stephanie Schwindel
Chris Williams