

CITIGROUP CENTER

New York City, New York



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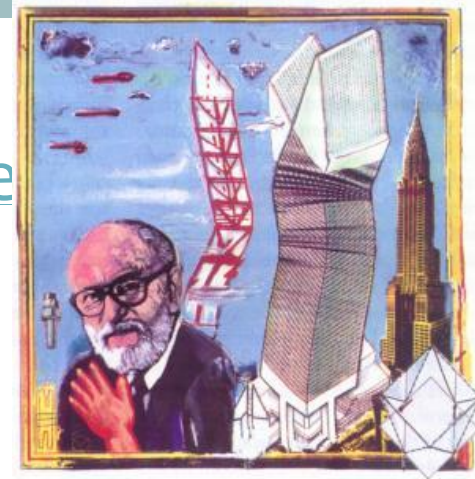
Overview

- Cost: \$195 million dollars
- Construction Date: 1974-1977
- Site: Lexington Avenue & 54th Street
- Architect: Hugh Stubbins
- Structural Engineer: William LeMessurier
- Height: 915 feet (7th tallest structure in New York City)
- Number of Floors: 59



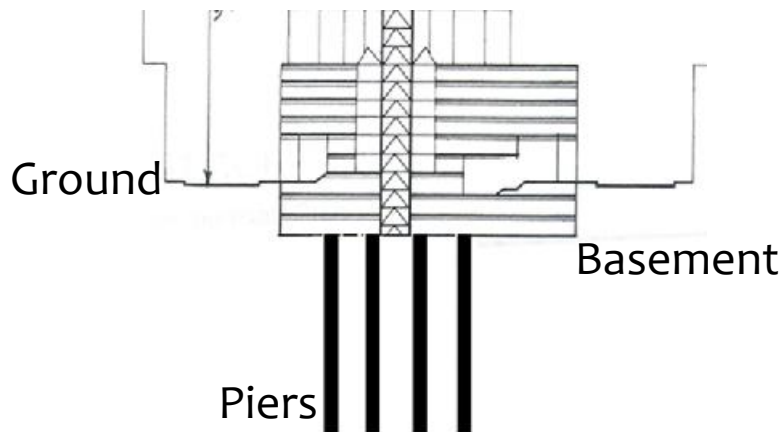
Engineering Crises of 1978

- <http://www.teachersdomain.org/resource/ci.phys.mfw.bbsskyscraper/>
- It was finally publicized in a lengthy article in *The New Yorker* in 1995.
 - Le Messurier was criticized for not providing sufficient oversight to be aware of the change to bolts rather than welded joints and for misleading the public regarding the extent of the catastrophe that could have occurred if the building had failed before the repair was completed.
- With the modifications to the bolts completed, the building is now believed to be “one of the most structurally sound skyscrapers in the world”.



Foundation

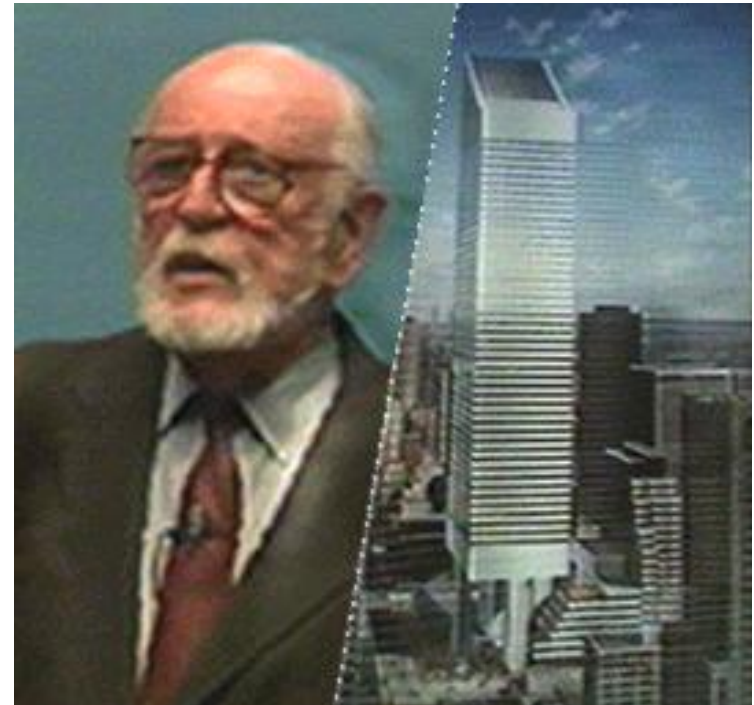
- Because the bed rock lies deep beneath the ground of Manhattan, it was necessary to drill down to hit bedrock
- Under each side they placed four ten story pillars 22 meters from the corners
- These pillars and the central core act as the foundation supporting the structure



Influence of Codes on Citigroup Building

‘Fifty-Nine Story Crisis’

- Engineer confirmed strength of bracings for perpendicular winds
- Satisfied code regulations
- BUT building would fall over in winds at 45degree angle
- Code doesn't anticipate everything



Influence of Codes on Citigroup Building

Zoning Ordinances

- Architect designed for mixed-use
 - commercial space on the main floors
 - terraced luxury apartments on the angled upper floors
- NYC zoning said no
- Citigroup Building is used for solely commercial purposes



ZONING MAP
THE NEW YORK CITY PLANNING COMMISSION

Major Zoning Classifications:
The number(s) and/or letter(s) that follows an **R**, **C** or **M** District designation indicates use, bulk and other controls as described in the text of the Zoning Resolution.

R - RESIDENTIAL DISTRICT
C - COMMERCIAL DISTRICT
M - MANUFACTURING DISTRICT

..... AREA(S) REZONED

EFFECTIVE DATE(S) OF REZONING:
** 8-25-2010, C. 100047, ZMM
* 2-11-2009, C. 070137, ZMM
11-13-2008, C. 080362, ZMO

■ SPECIAL PURPOSE DISTRICT
The letter(s) within the shaded area designates the special purpose district as described in the text of the Zoning Resolution.

① - RESTRICTIVE DECLARATION
② - CITY ENVIRONMENTAL QUALITY REVIEW DECLARATION

③ - REFERS TO BLOCKS WITH LOTS SUBJECT TO LOTS REDESIGNATION E-137
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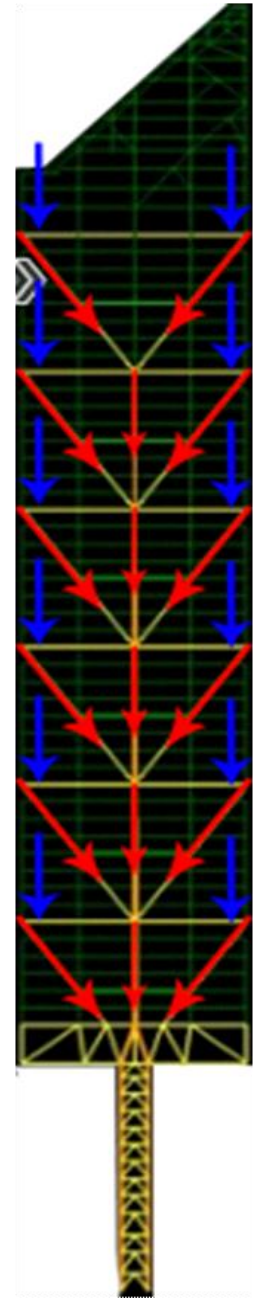
CITY MAP CHANGE(S):
▲ 8-14-2010, C. 080276, MMQ

MAD KFY

Structural System

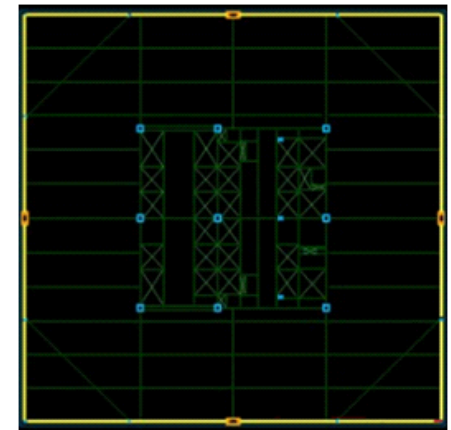
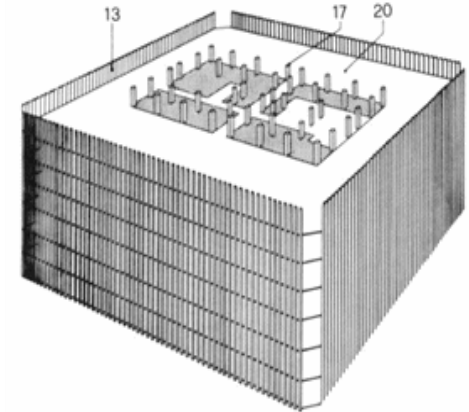
Large inverted Chevrans

- W14-550 steel members
- Series of 6 stacked at 8 stories high.
- Transfer lateral load to central mast
 - Also transfer overturning moment of building to lower 9th story trusses.
- Covered by Double glazed curtain wall
- Help form overall structure
 - Braced or Trussed tube structure

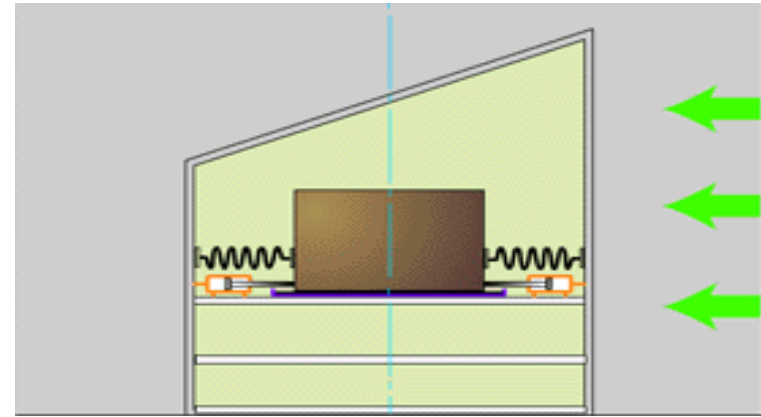


Structural System

- Braced or “Trussed” Structural system
 - Based of Fazlur Kahn's basic framed tube design.
 - Figure to right
 - Decreases amount of exterior columns
 - More lateral stability needed
 - Chevrons designed
 - Design allows for both lateral and vertical forces to be resisted without over abundance of interior support.
 - Other buildings with same system include John Hancock Tower and Bank of China.
 - Figure to right shows Citigroup adaptation.



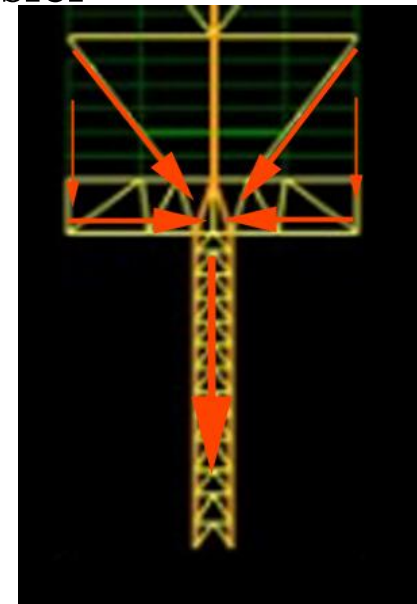
Tuned Mass Damper



- Tuned Mass Dampers
 - giant blocks composed of concrete or steel mounted in tall, slender structures, and move in opposition to the resonance frequency oscillations of the structure through the use of springs or fluids.
- The Citigroup Center utilizes a 400 ton, 225 cubic foot concrete block, floating on a film of oil, located in the mechanical space on the top floors of the building to counteract the lateral forces acting on the structure.

First Nine Floors

- The 9th floor is incredibly important in regards to structure and load transfers.
- It is where all loads accumulate and are thus carried into the ground.
- The weight of all 47 floors above, including the 400 ton tuned mass damper, must be transferred from the edges of the building down through the columns centered in each facade.
- Much of the weight of the upper floors is transferred to the columns through the use of inverted chevrons, but there remains a section of building that requires its loads be transferred to the central columns by means of a large truss acting like a transfer girder.
- This truss, which cantilevers an amazing 72 feet out from the facade columns in opposing directions, actually constitutes a 28 foot deep mezzanine level and redirects all remaining exterior forces to the central column to be carried down into the foundation.

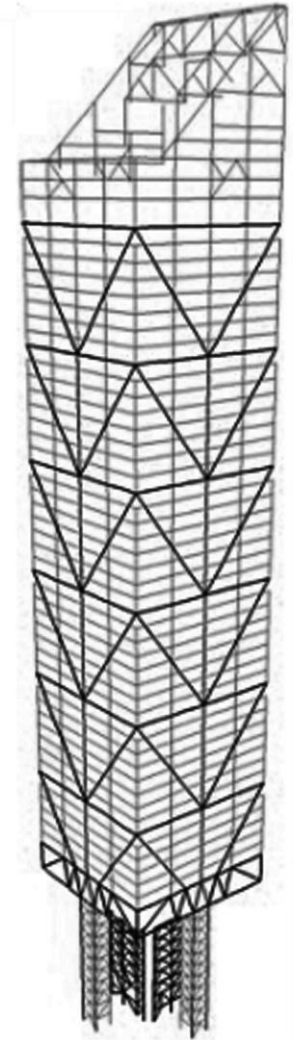


6:1 Slenderness Ratio

6 stacked trusses creating the chevron shapes above the 9th floor

Corner columns discontinuous to allow the load to be transferred down the chevron to the central columns

Moment frames at building core distribute local lateral loads to the stacked trusses



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