

Active Structure

Citicorp Center 1971-74 planning, 1974 - 1977 construction....1978 structural refit

HRH Construction (Horowitz, Ravitch, Horowitz) since 1925

Hugh Stubbins architect

William LeMessurier, structural engineer



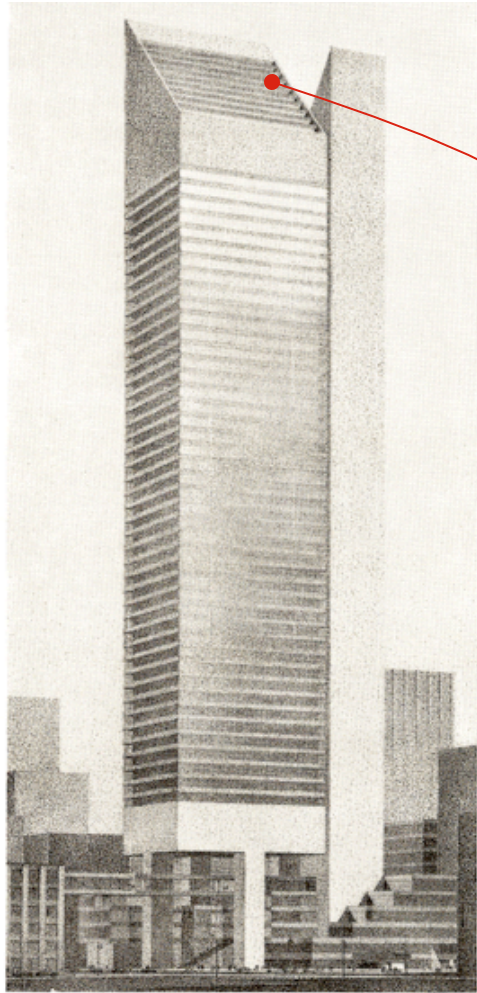
A Mission to NY

- St. Peters
Evangelical Lutheran
Church
- 1969 Statement of
purpose "We must neither fear
nor avoid our mission, but must
strive to bring a witness to this city,"
- Without funding, their
mission could not
move forward
- Sold their property to
Citicorp 1969

A sale with a few conditions

- Build us a new church
- The church must be on the corner of 54th St. and Lexington
- Wanted to own it's land in a condominium agreement with Citicorp
- No columns can pass through the church
- No connection between church and building
- Citicorp said OK

First scheme, side loaded



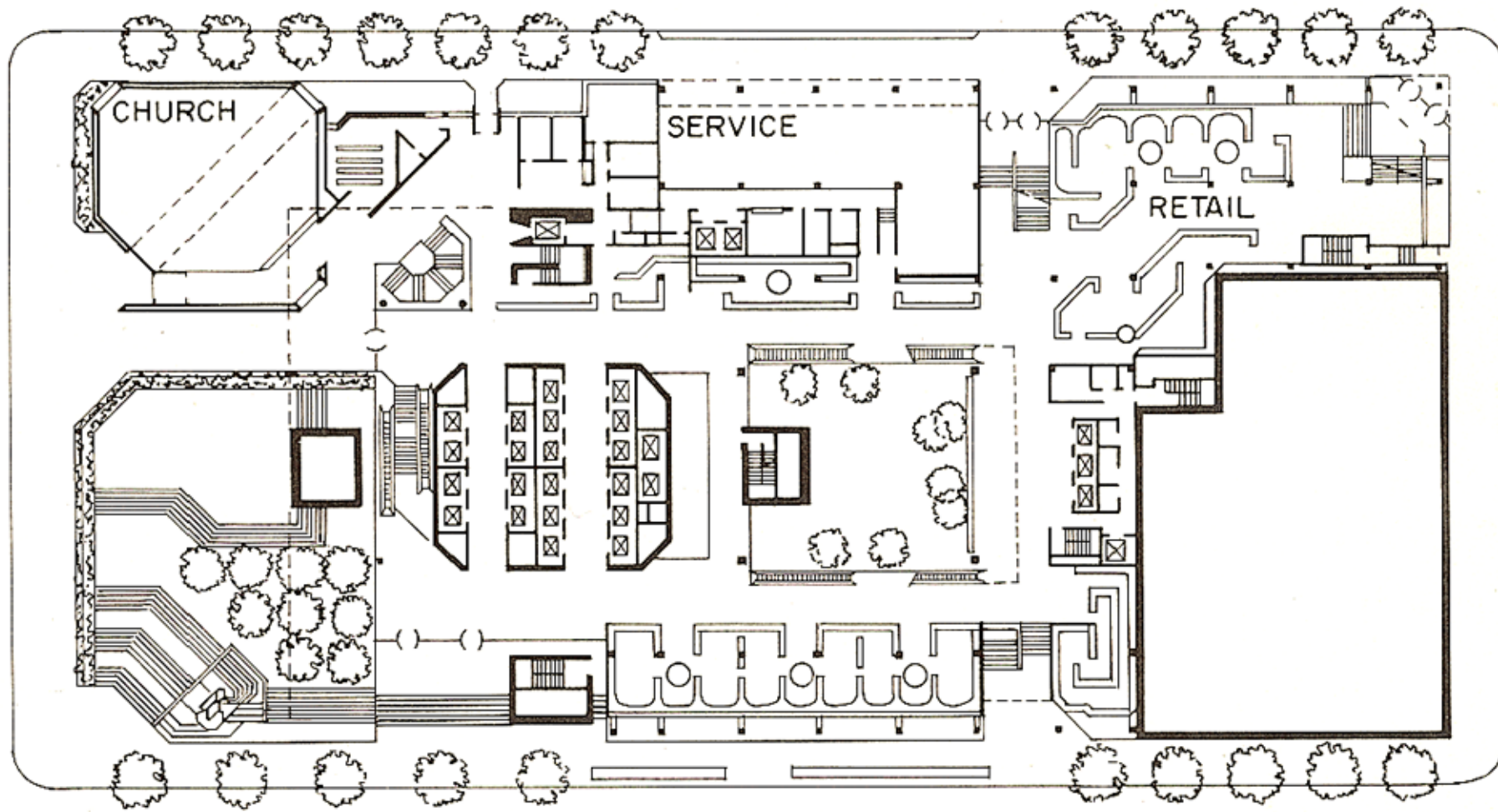
- The condition of sale meant the earliest designs assumed building above a church structure on the corner.
- Terraced residential units to help populate the neighborhood (turned down by city zoning)



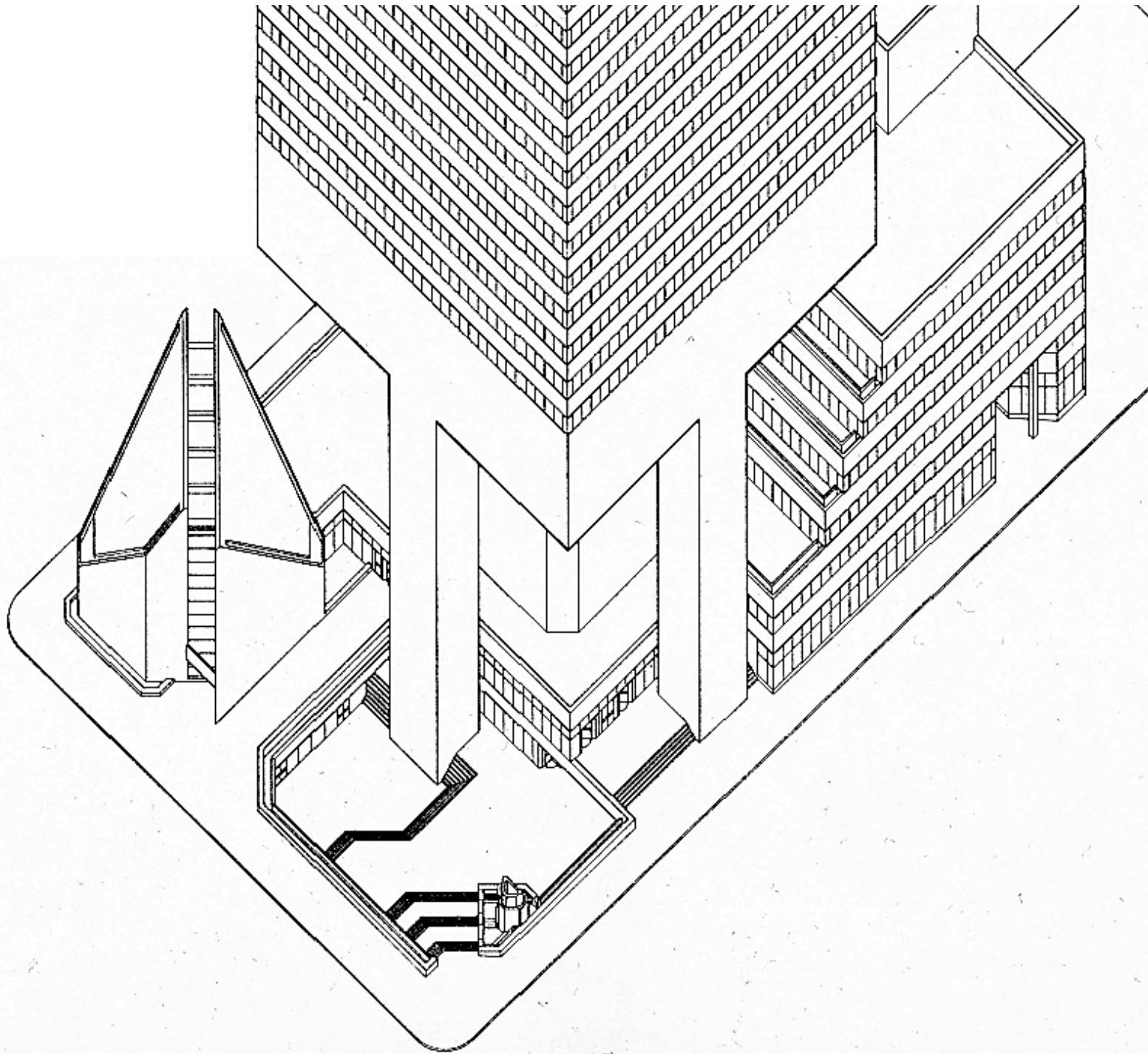
Initial scheme for site

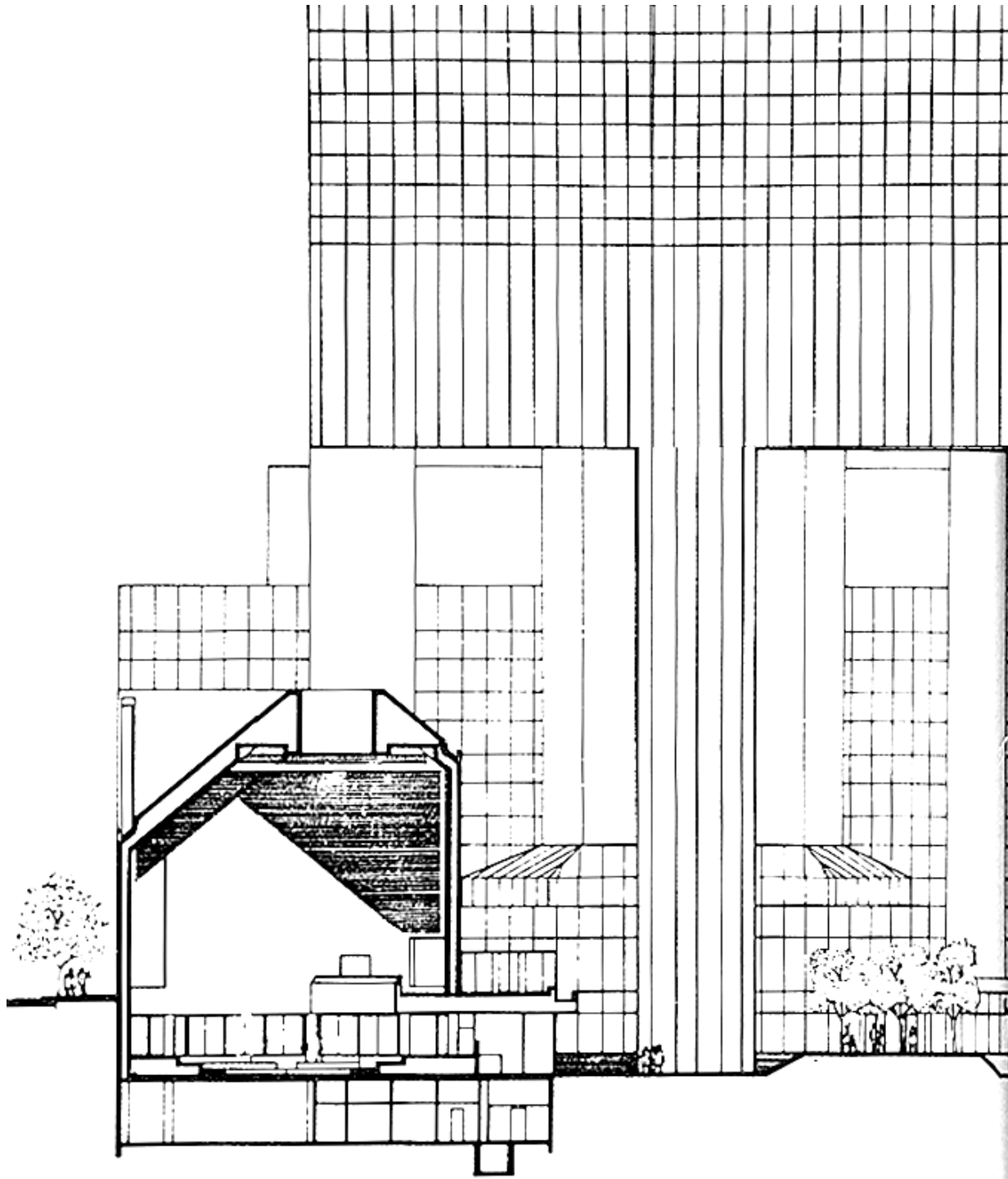


- \$195 million 1974
- 914 feet tall
- 59 floors
- 7th tallest building in the world
- Flawed by a change order



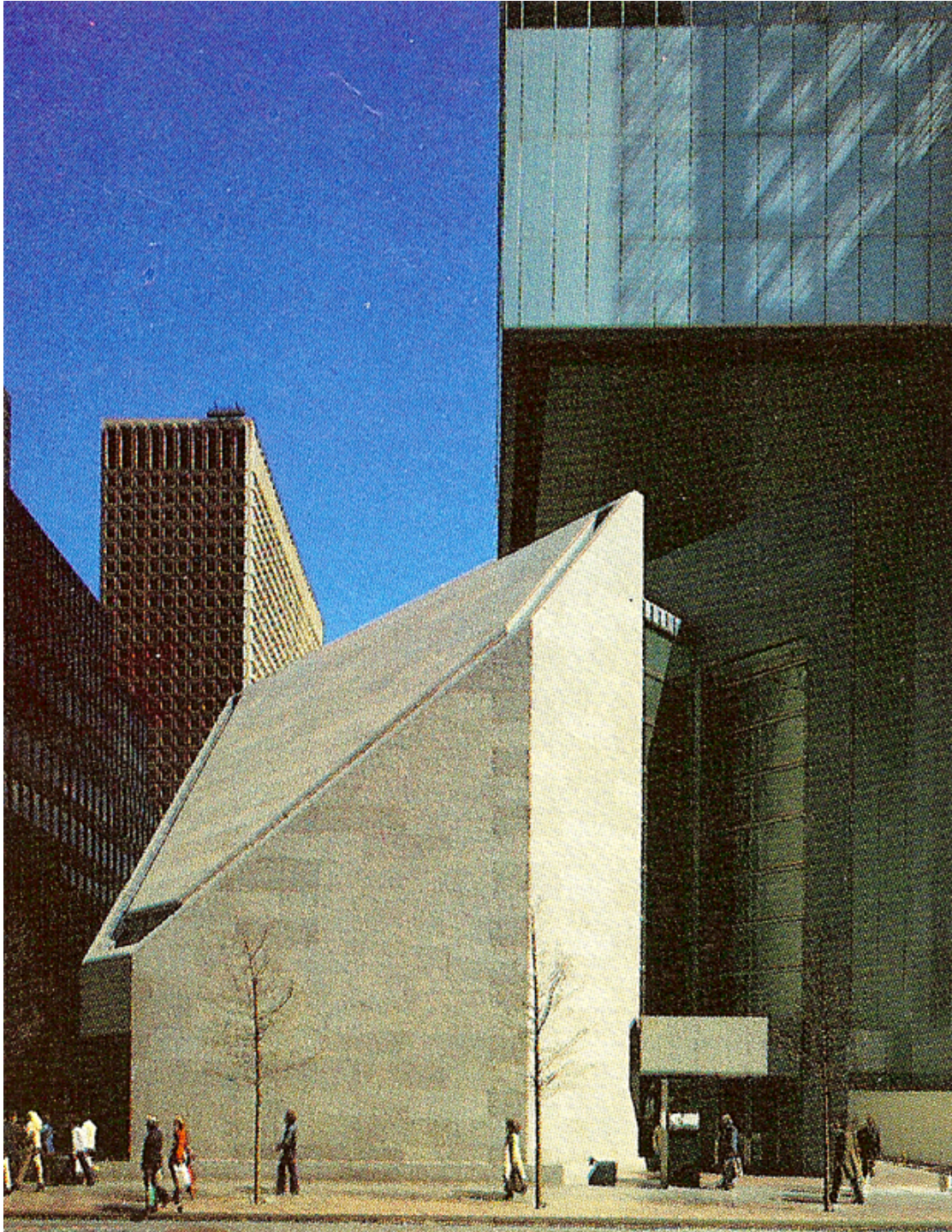
STREET LEVEL





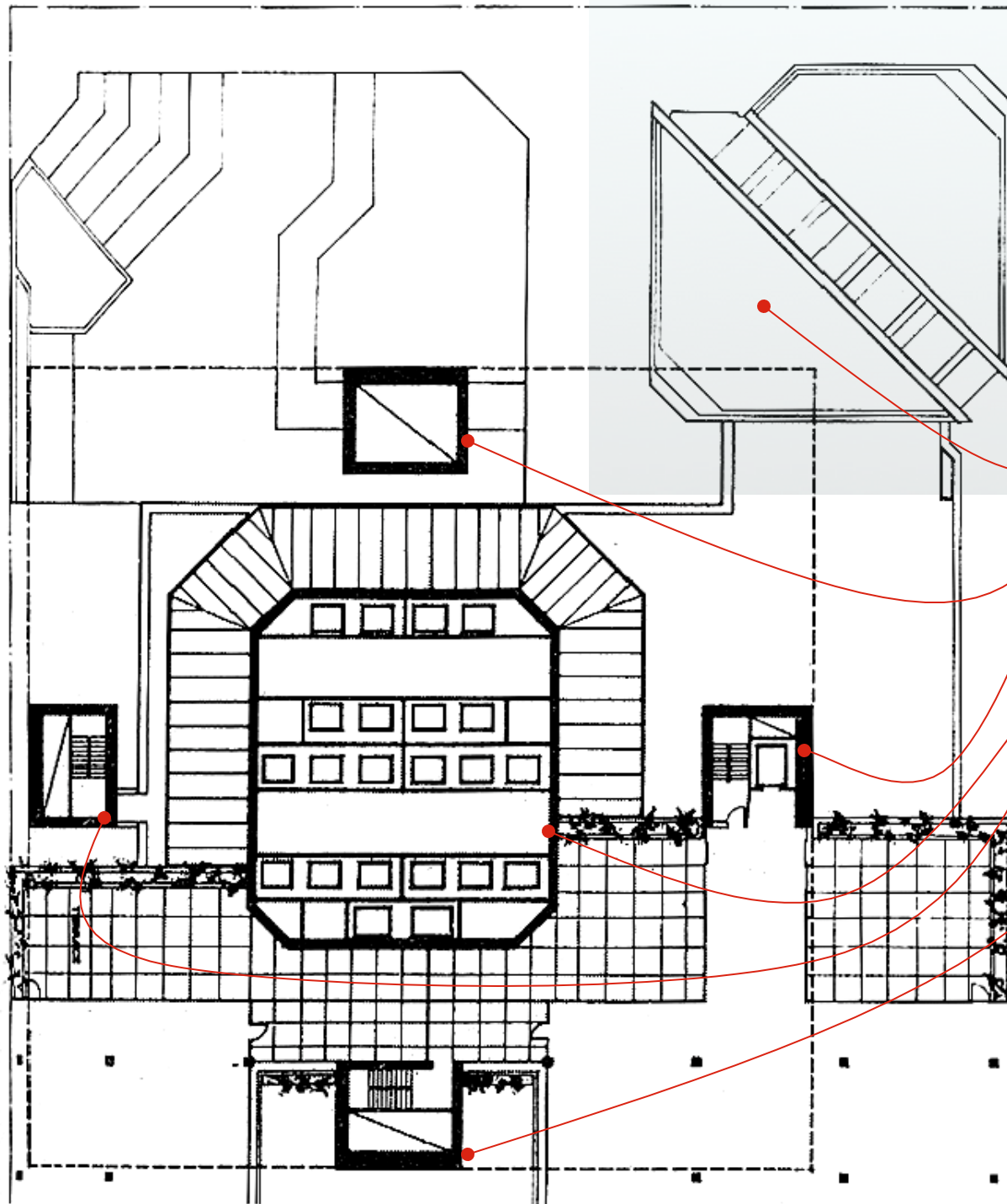
Keeping their word

- On the corner
- Structurally independent
- Below grade







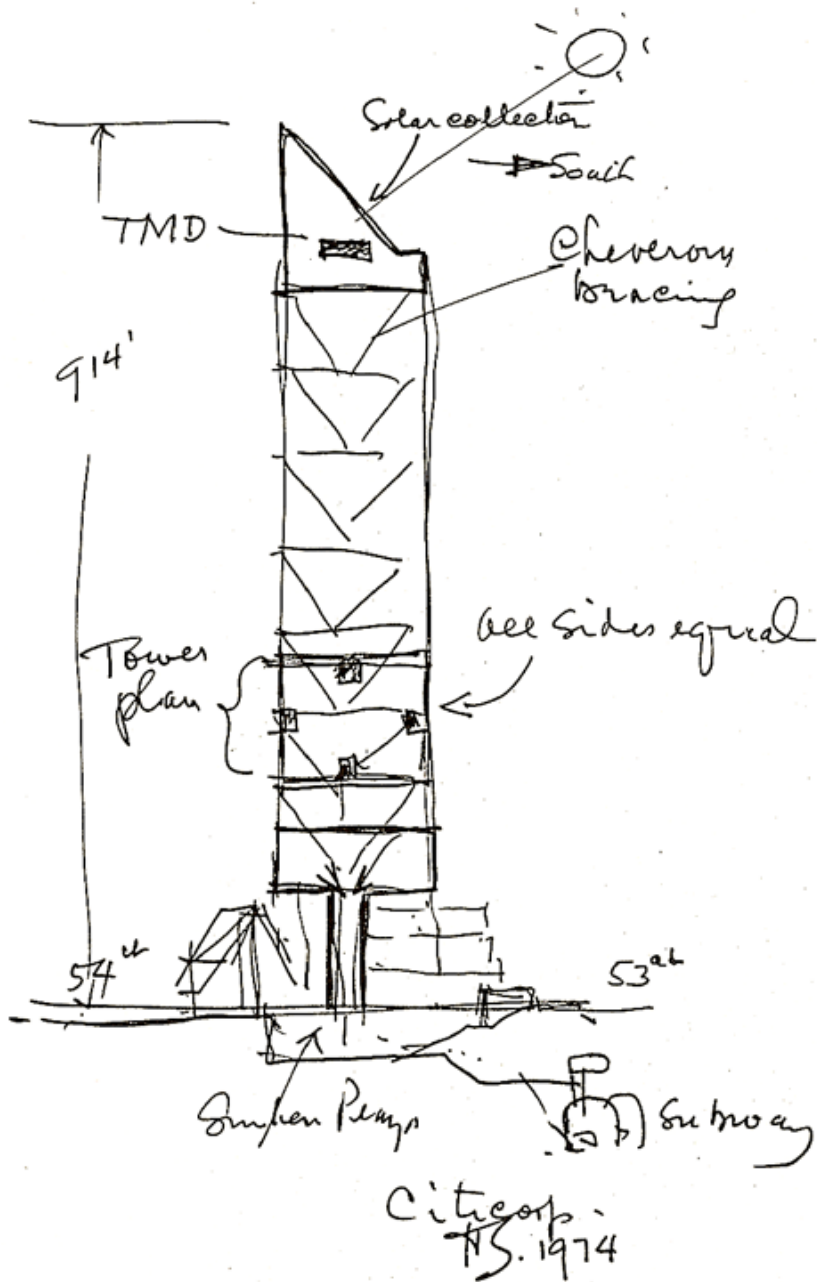


Church "lantern"

Outboard legs

Braced shear
core

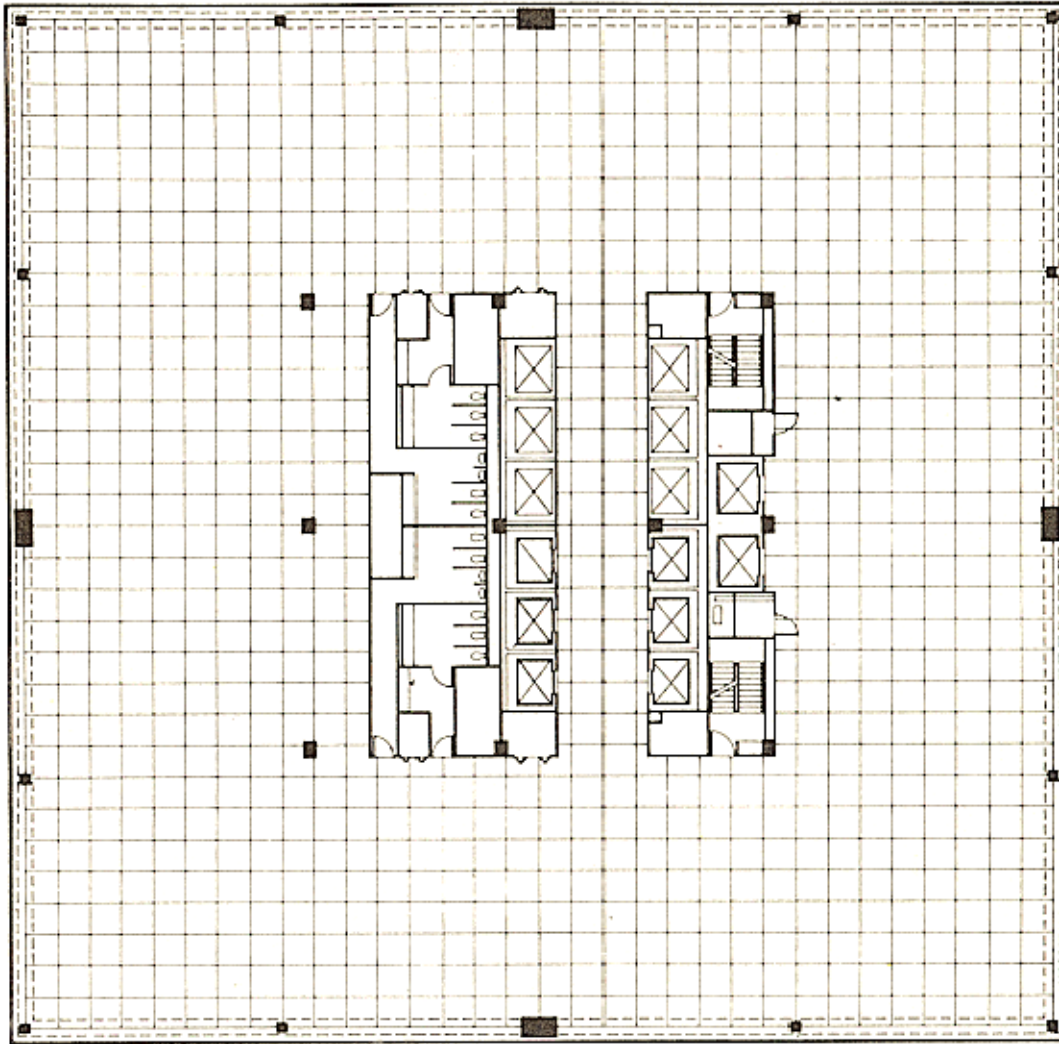
Seeing the Whole



Sketch by Hugh Stubbins

Compact core

23,104 g.s.f.
per floor

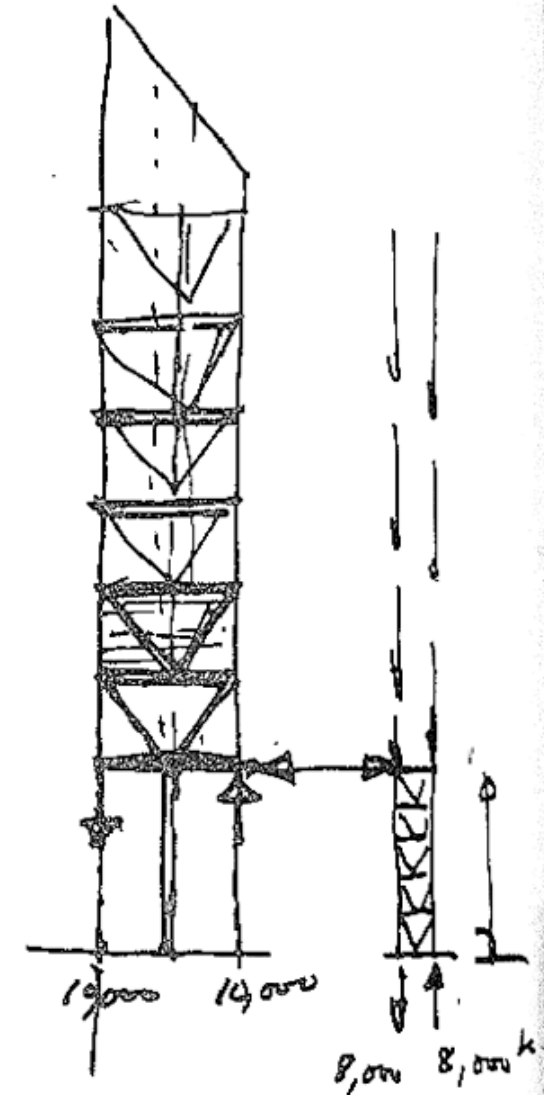
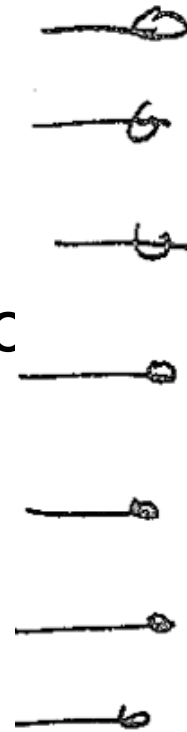
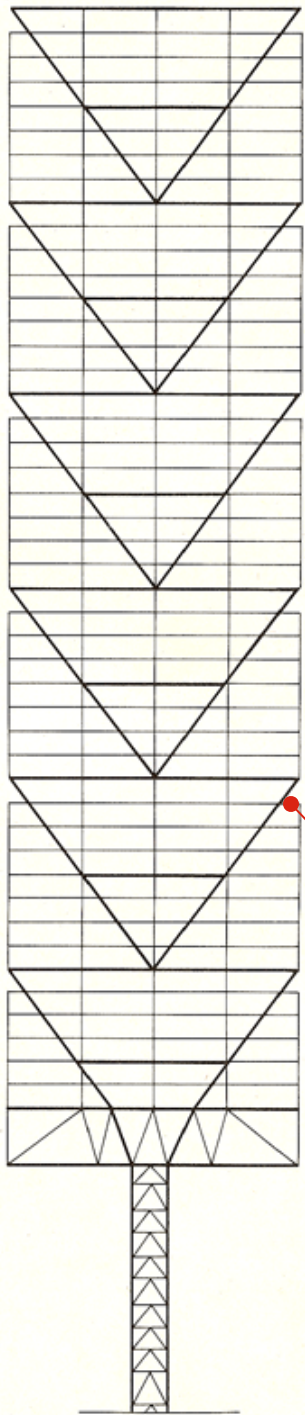


TYPICAL FLOOR
(TOWER-MID RISE)

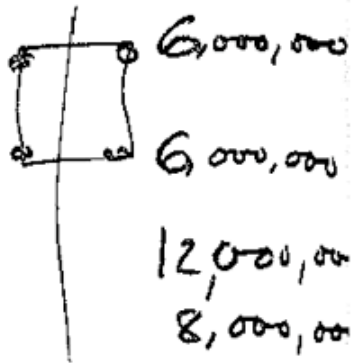
Chevron's direct forces

- Belt truss at 9th floor transfers wind to braced shear core

Missing column?

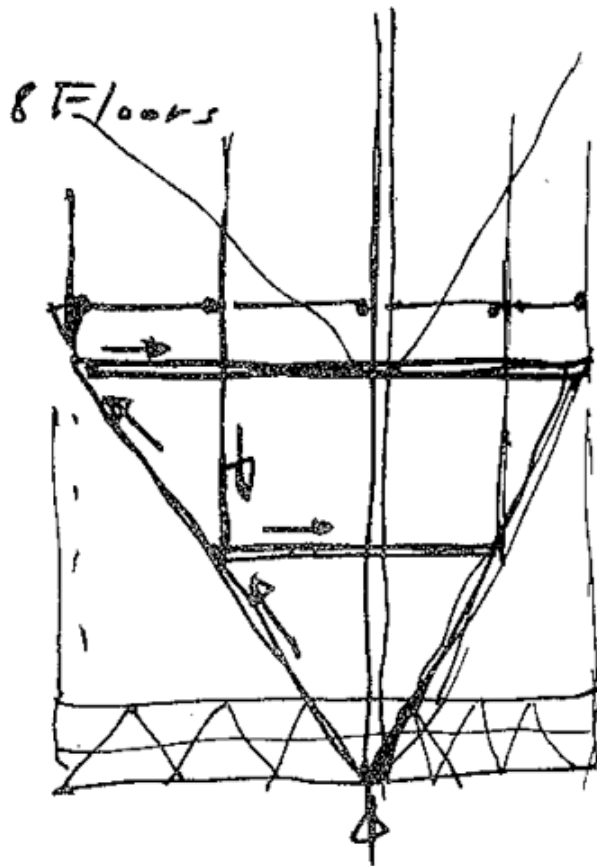


... WHICH TRANSMITS ALL WIND LOAD TO BASE OF TOWER, WHERE SHEAR IS TRANSFERRED TO THE CORE.

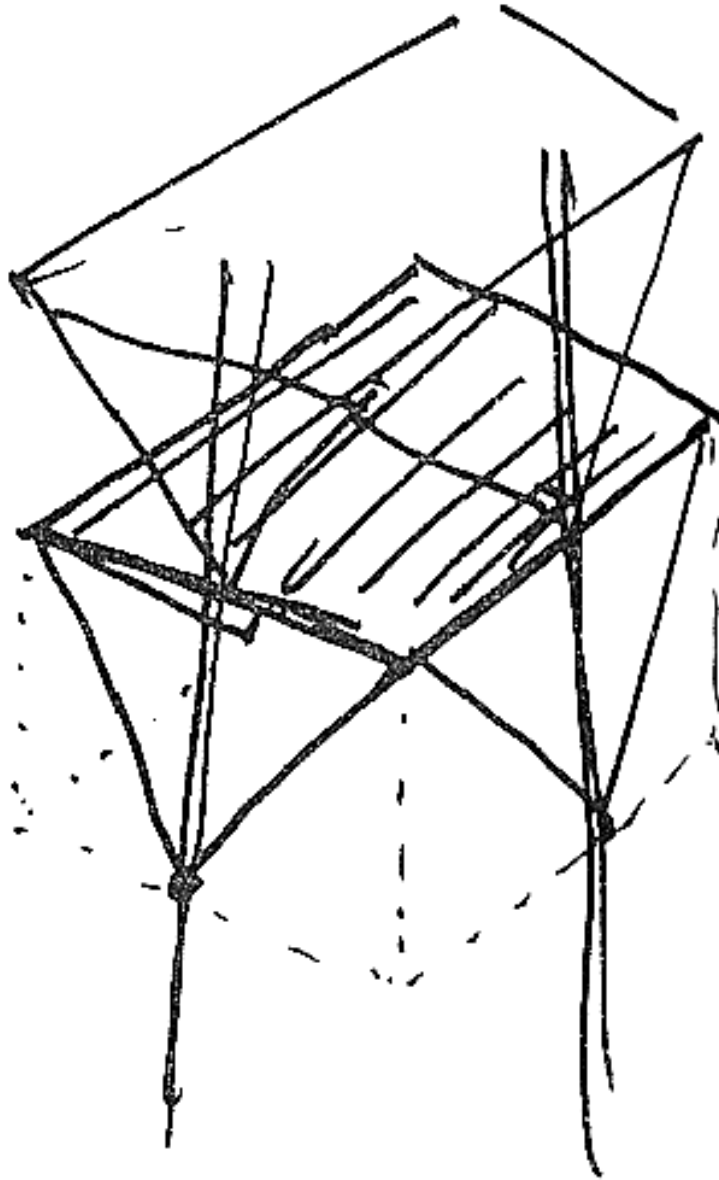


Mast and outriggers

- Chevrons channel gravity loads to central mast column
- Belt truss at base connects columns



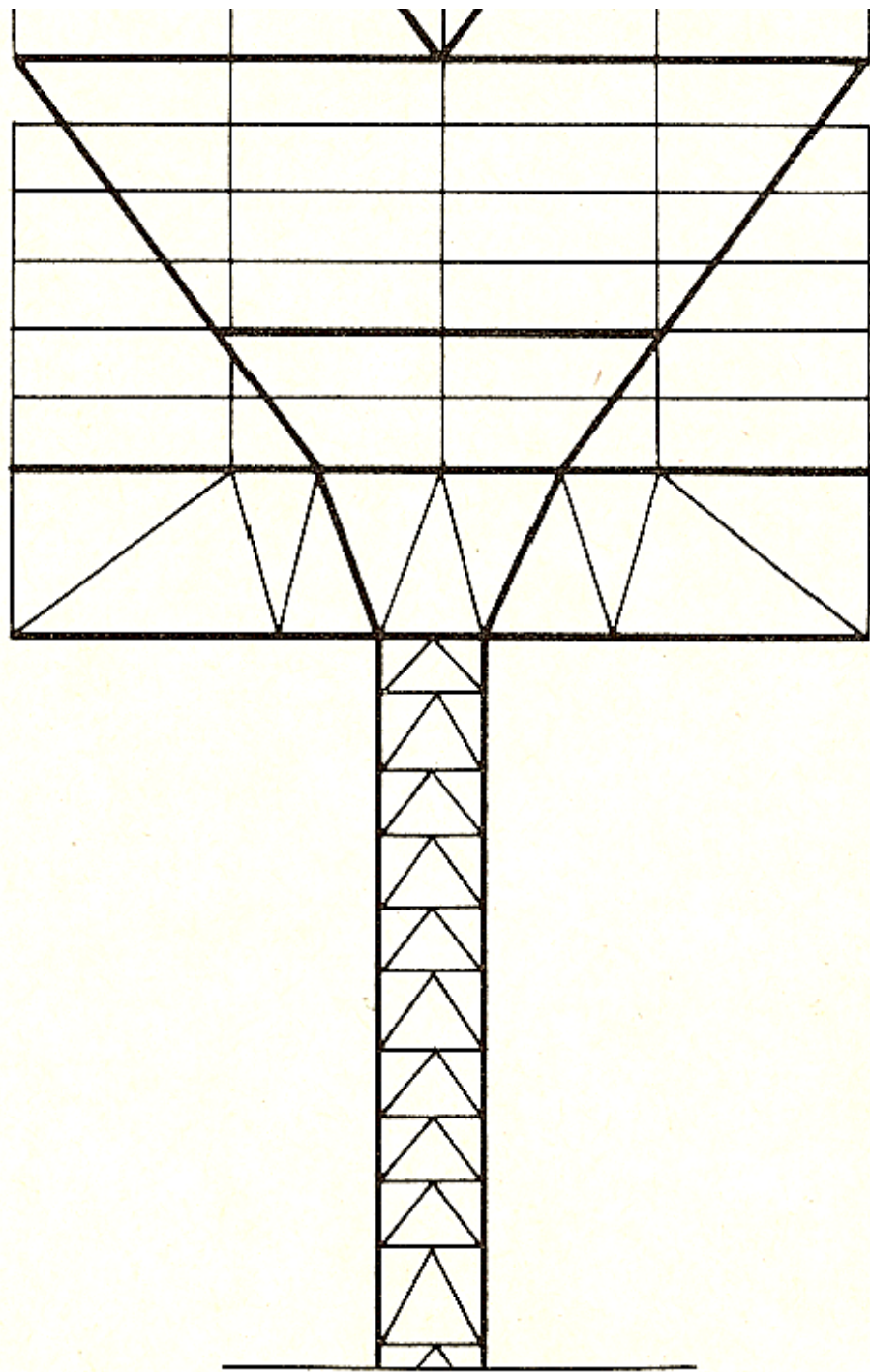
GRAVITY LOAD WORKS ITS WAY DOWN THE MAST COLUMNS

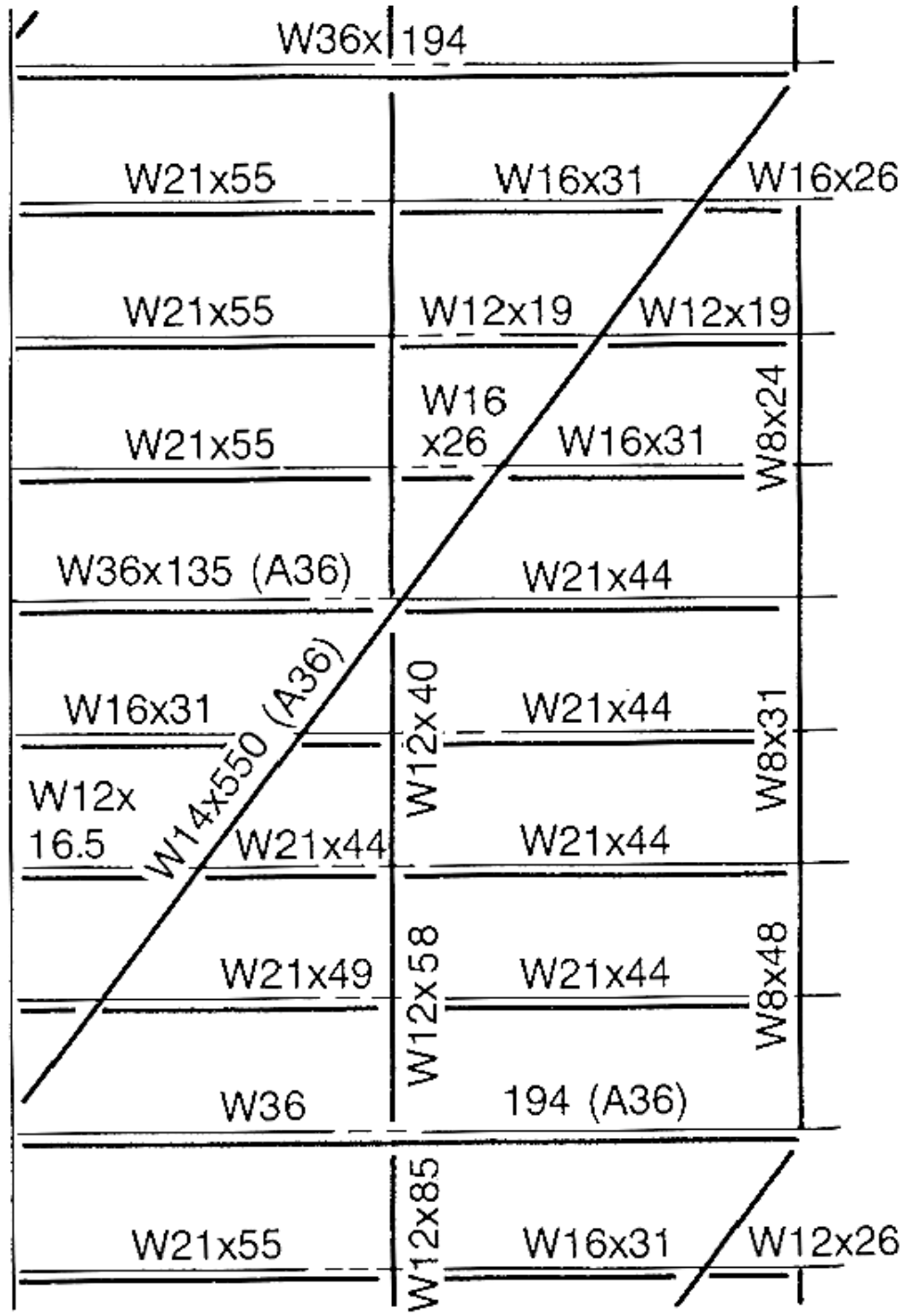
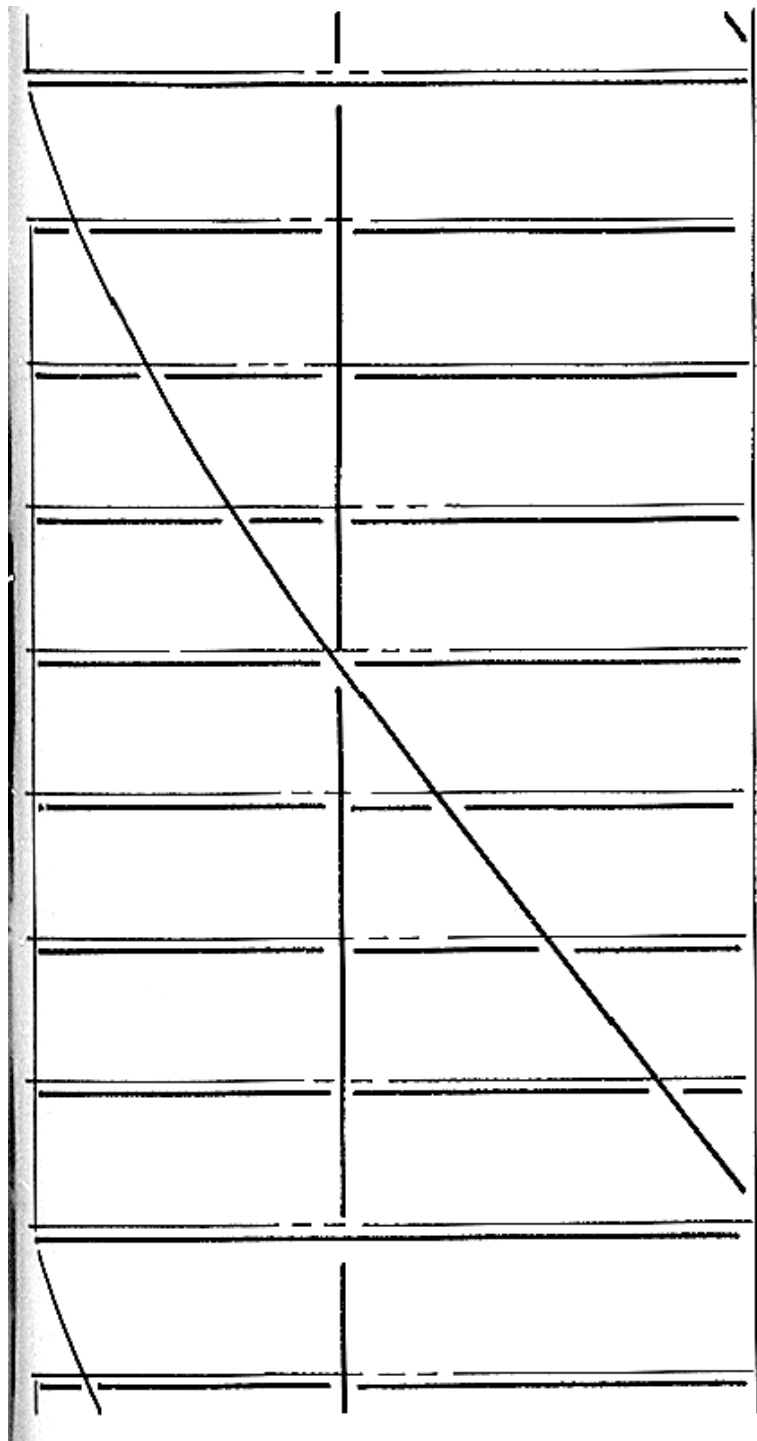


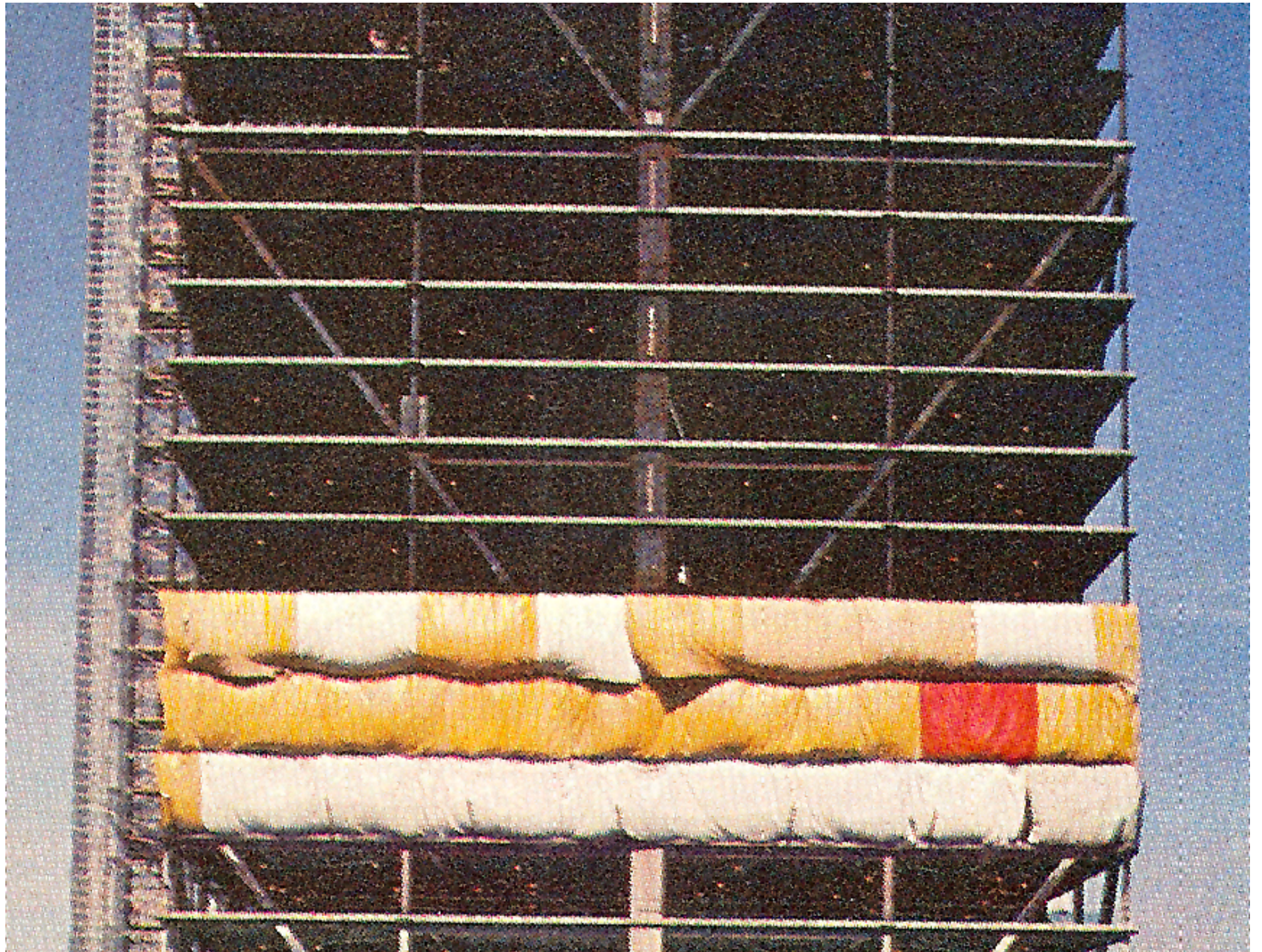
EACH EIGHT-STORY TIER IS
STRUCTURALLY INDEPENDENT.

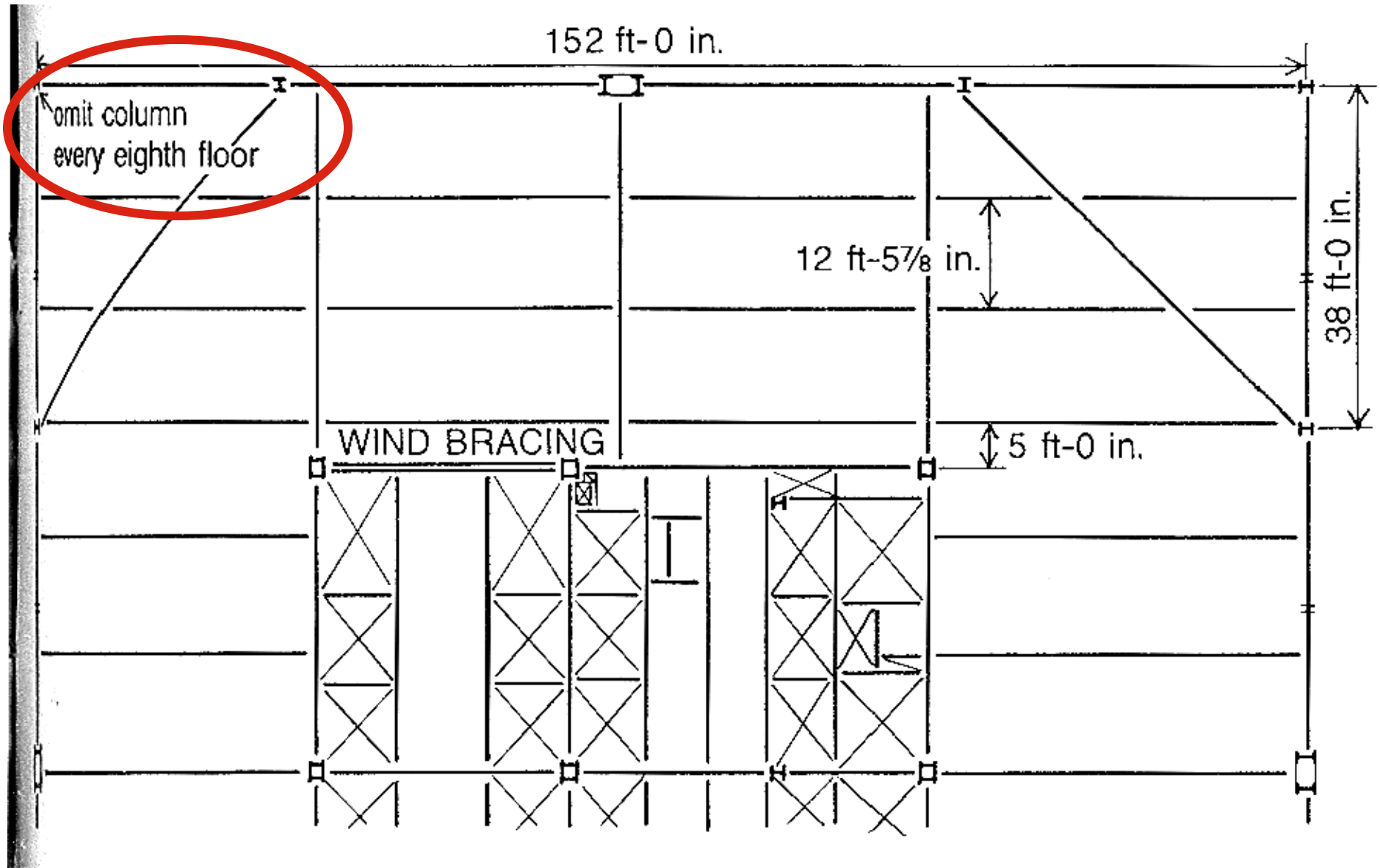
Stacked Tiers

- Every 8 floors is a structural whole, independent
- Transferring load through chevron diagonals to mast column

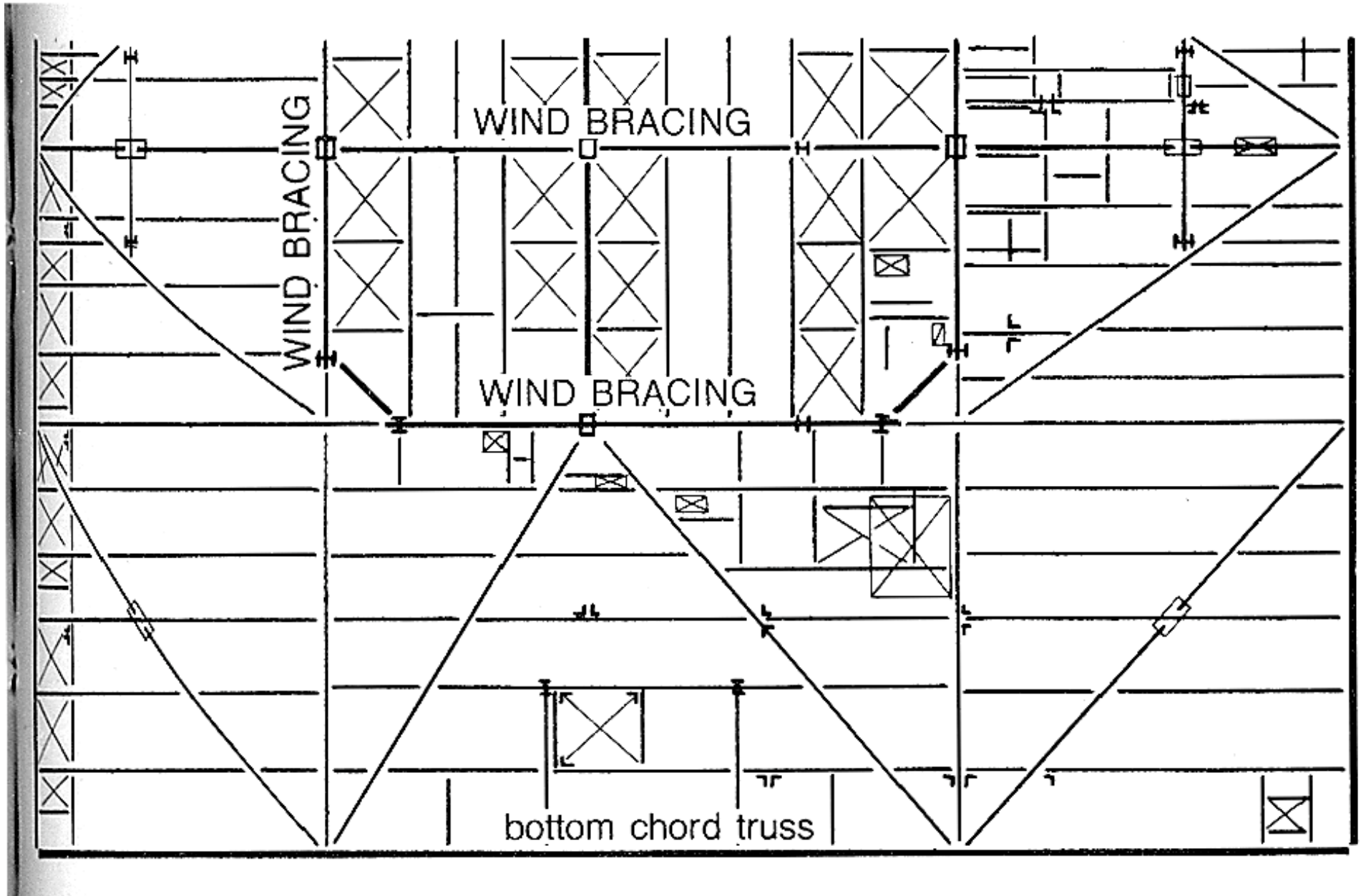




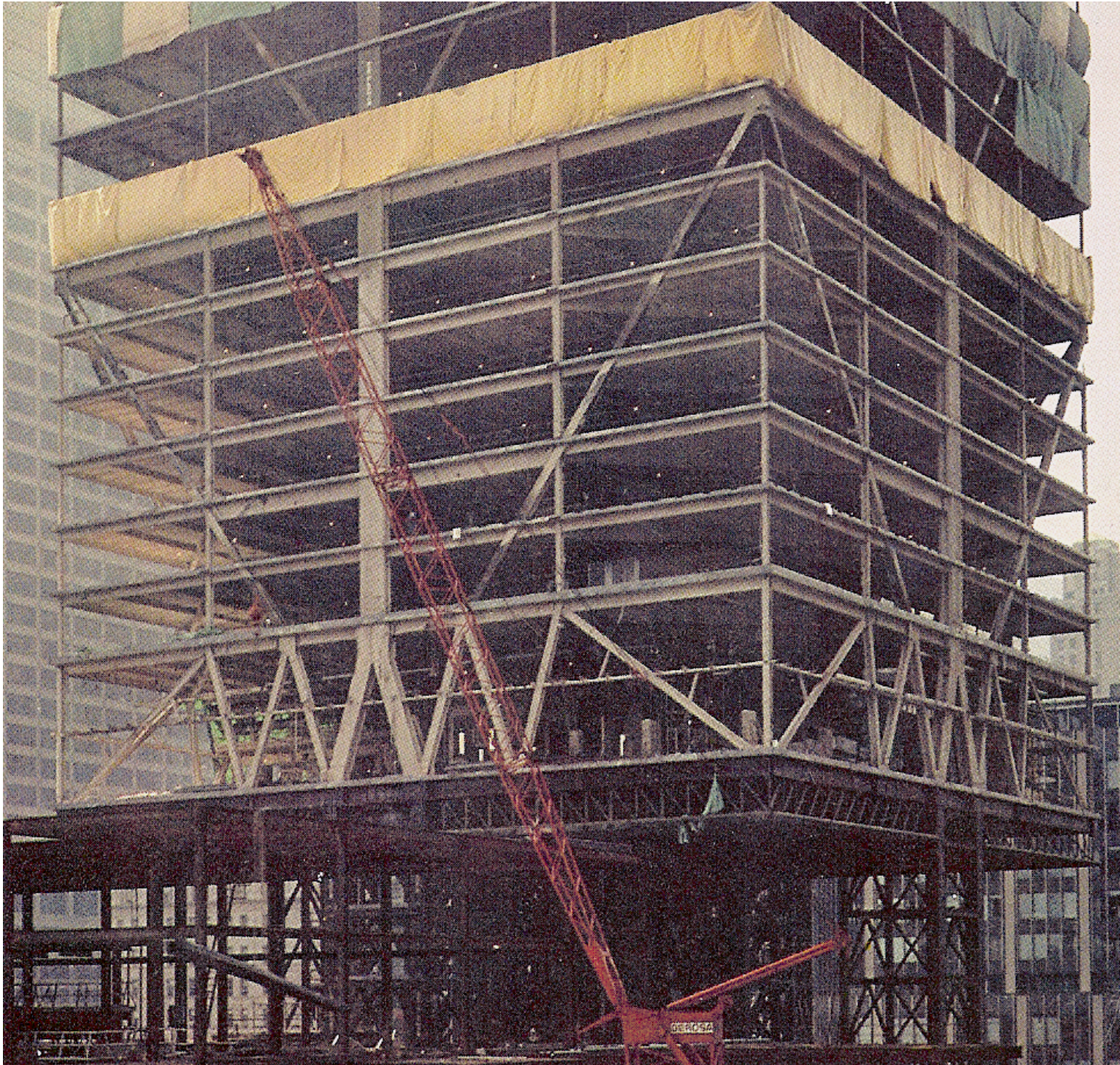


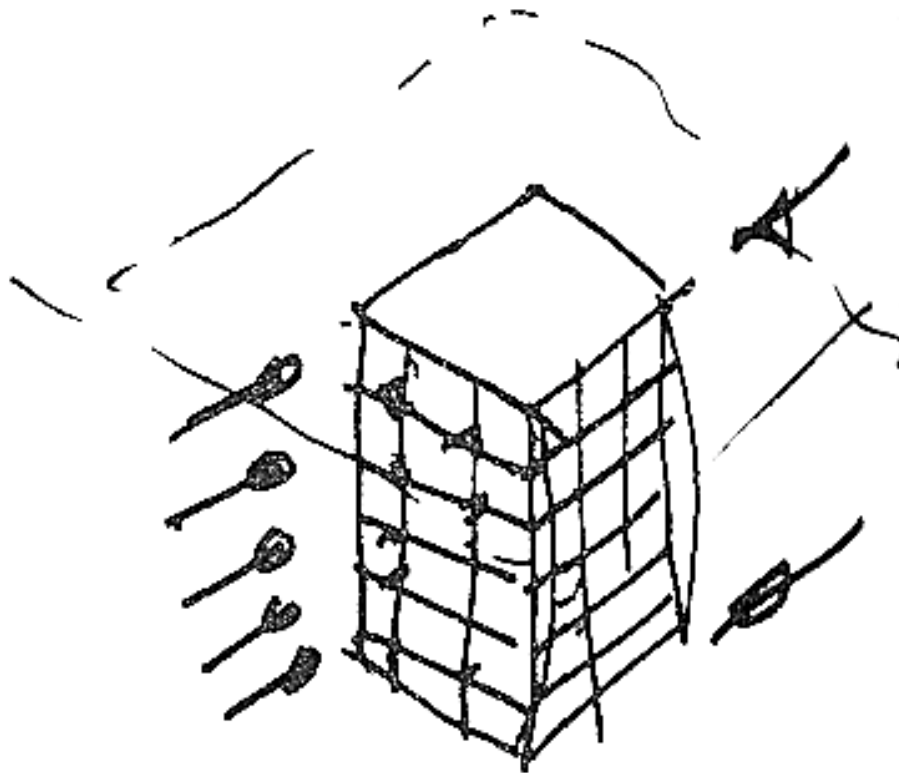


Typical floor framing (half plan)



Extra bracing in belt truss floor



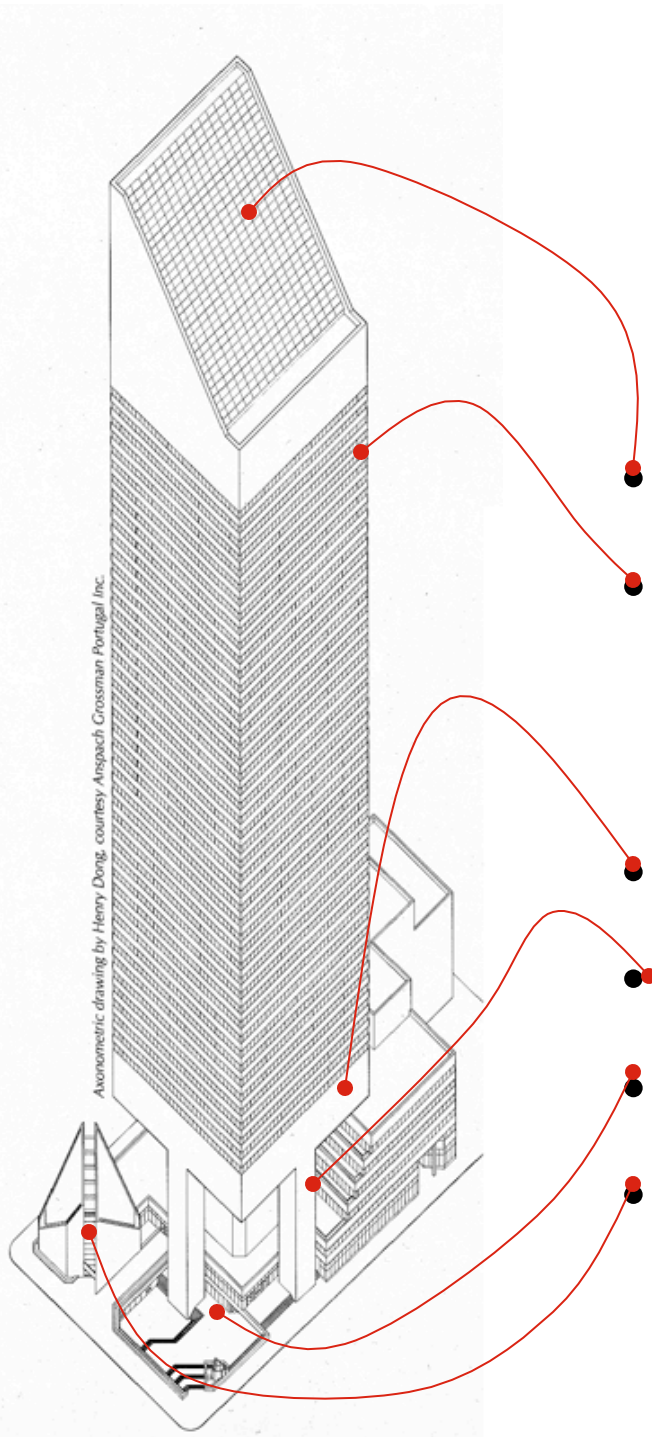


...WIND IS TAKEN BY THE CORE
FOR EIGHT FLOORS, THEN
TRANSFERRED TO THE
TRUSSED FRAME...

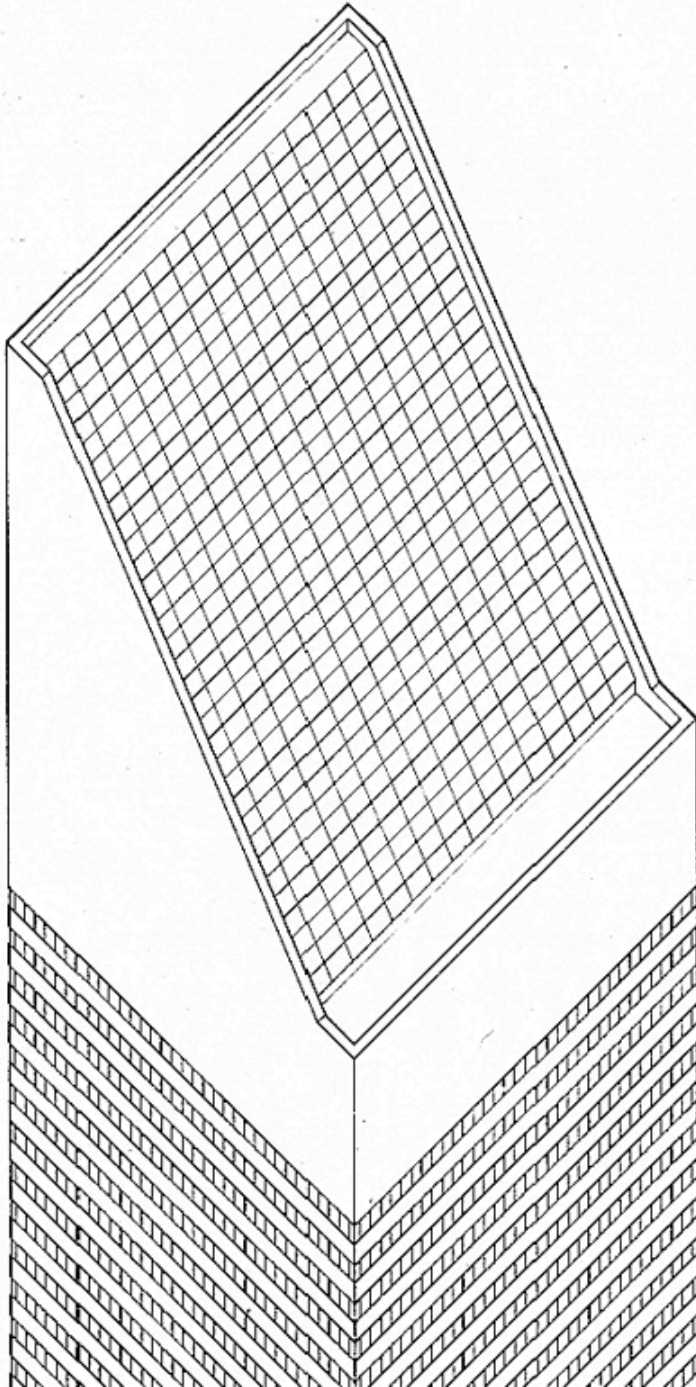
Why the missing column?

- To help core transfer wind back to the trussed shear core

Final Scheme



- Roof sloped for solar panels
- Smooth cladding, glass/ aluminum in almost same plane
- Belt truss transfer beam
- Structural stilts
- Underground shopping
- Underground church



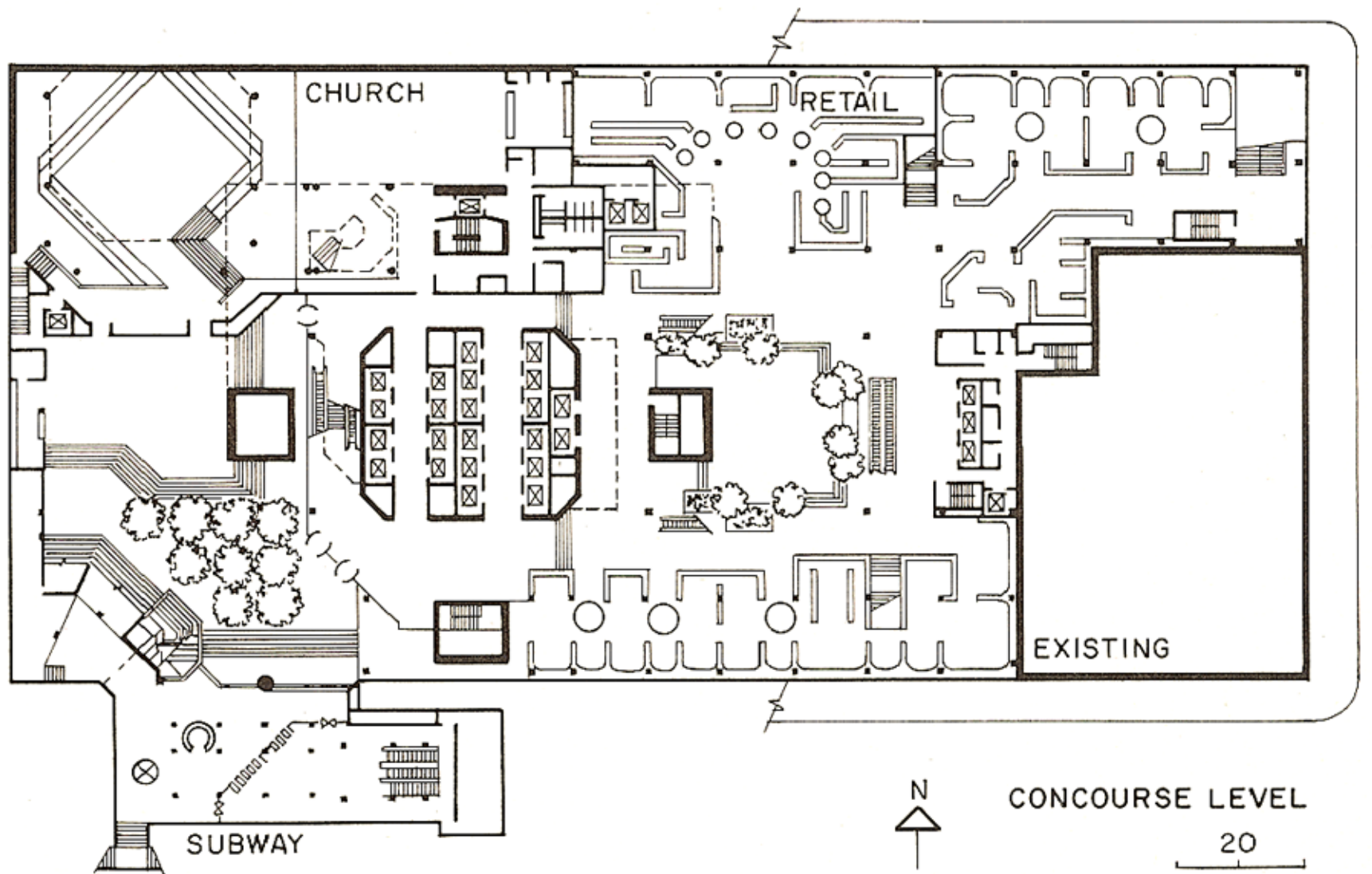
A million dollar view

- Initial desire was for terraced housing looking south over Central Park
 - Zoning overruled
- Next option: Solar Panels
 - Cost overruled
- Now home to TMD

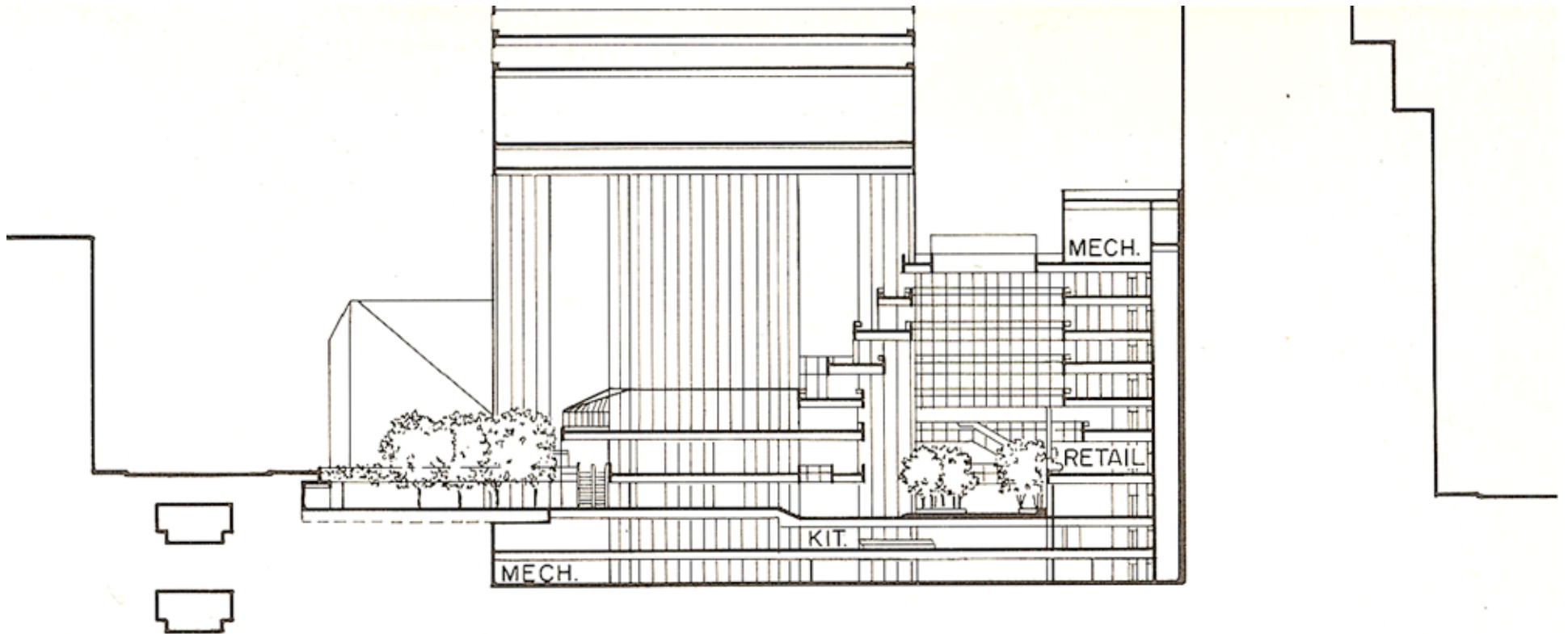


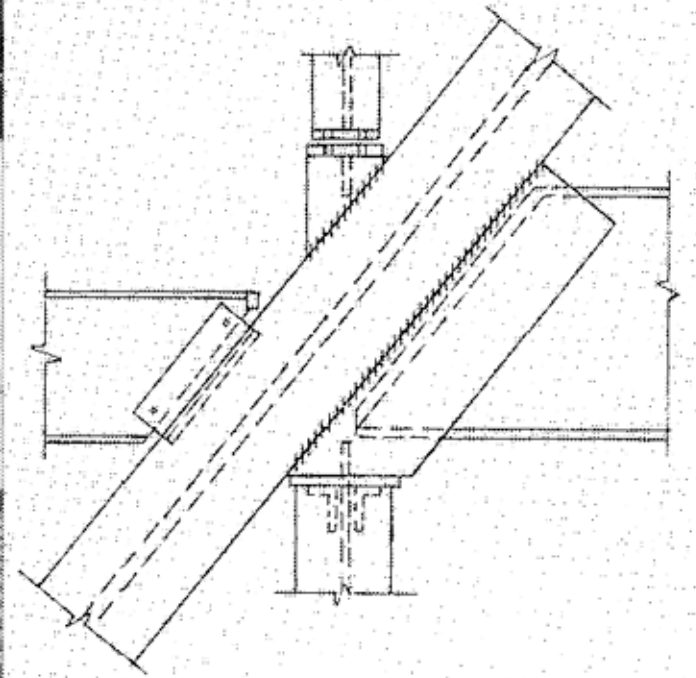
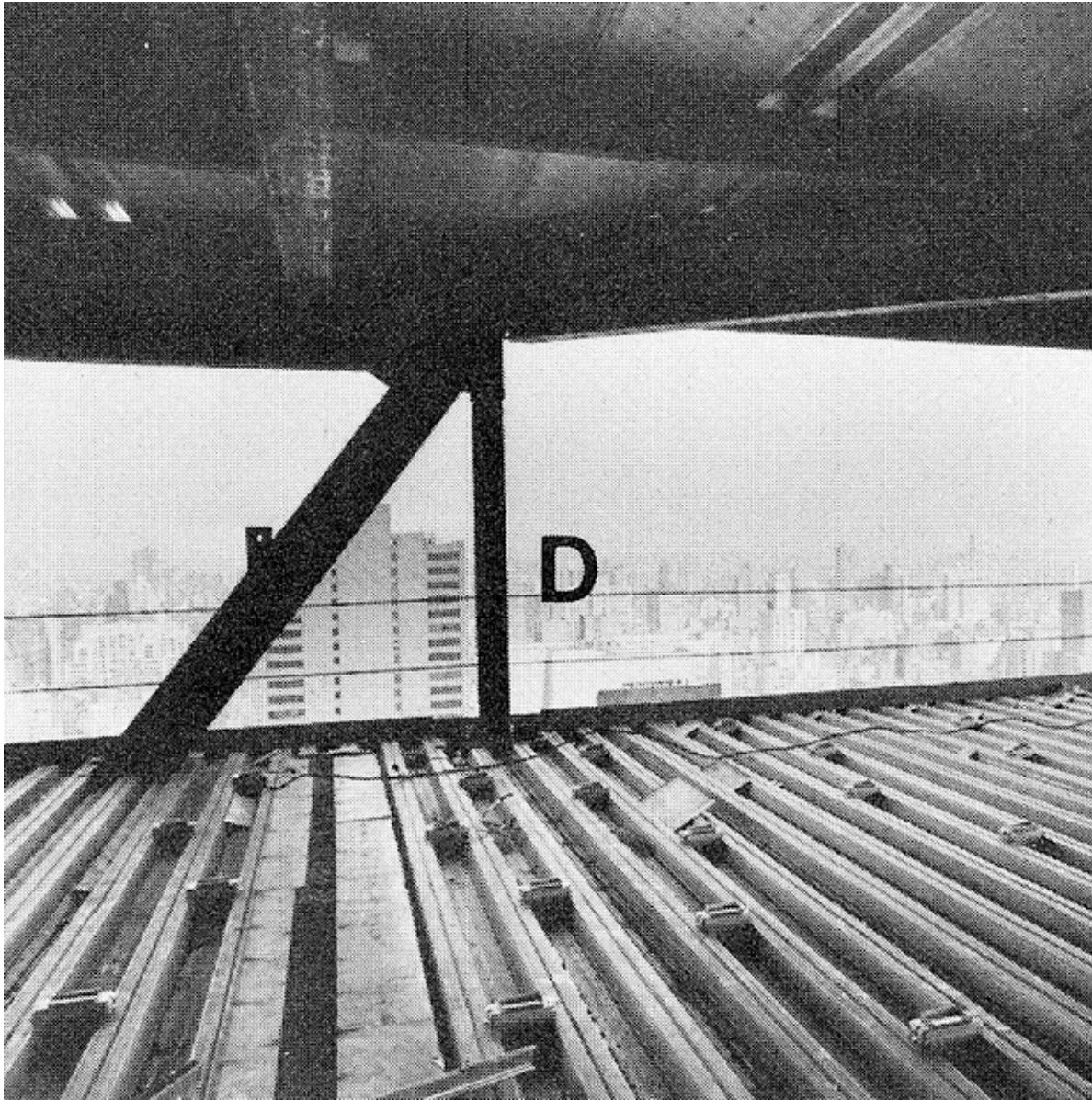
We want shops!

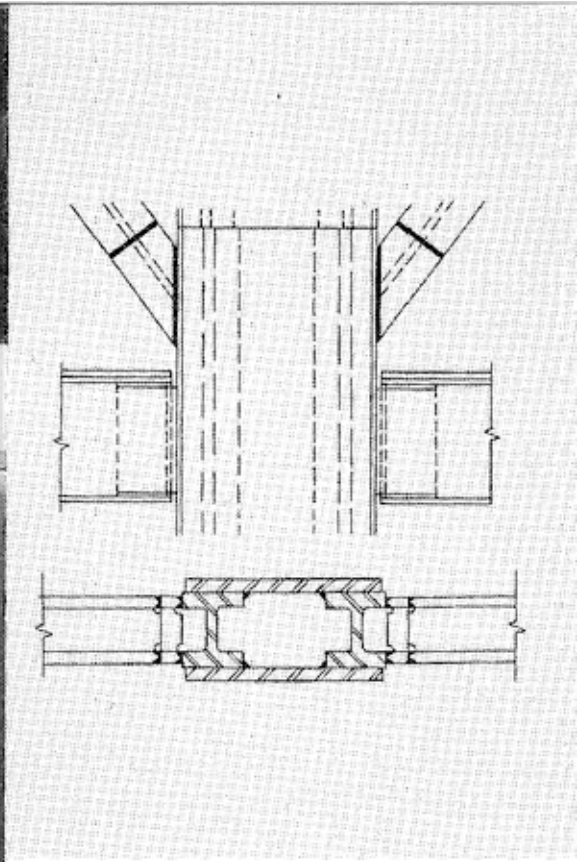
- No zoning incentives for housing,
- F.A.R. increase to 18 (from 16?) as incentive for shopping atrium

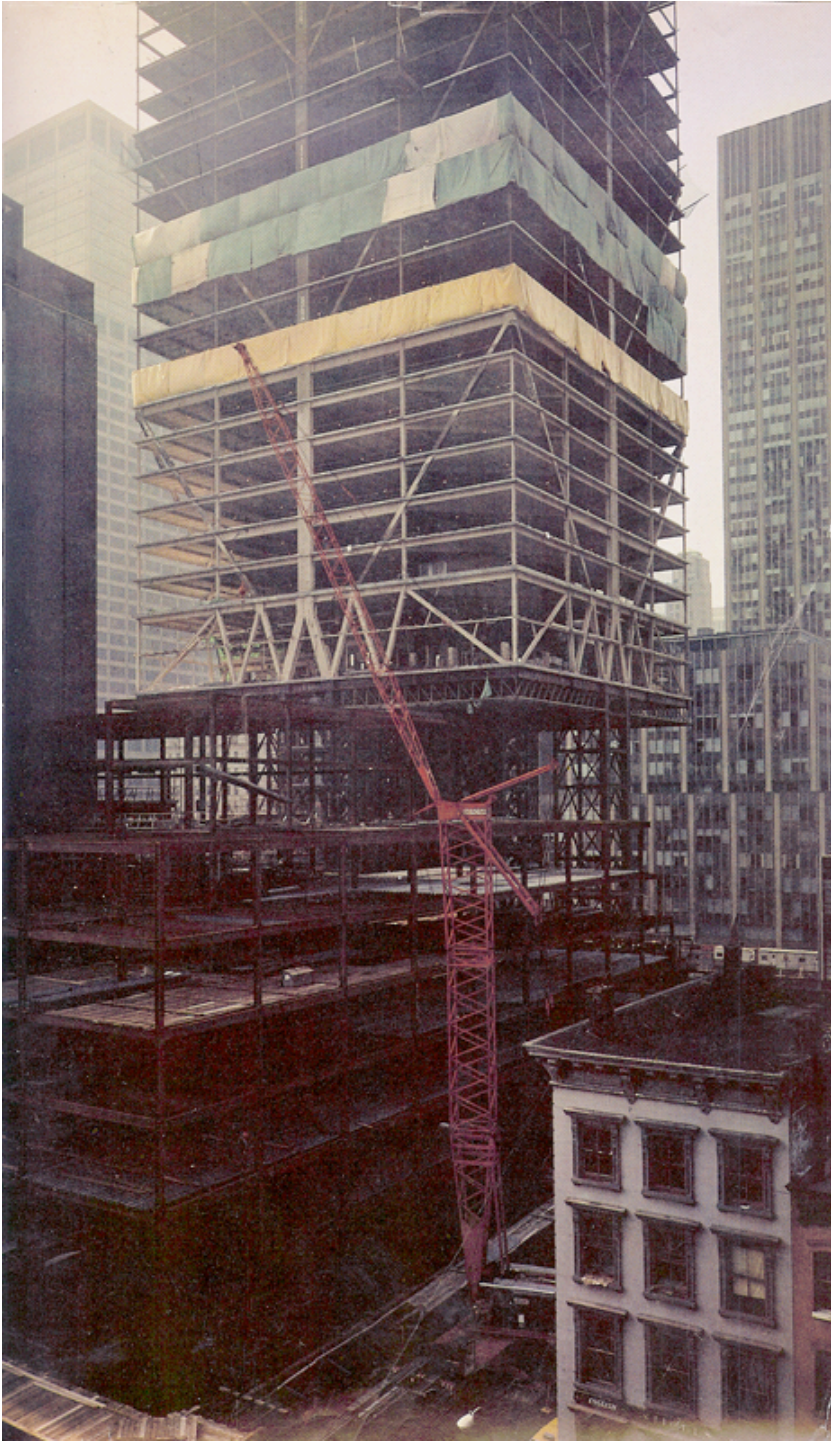


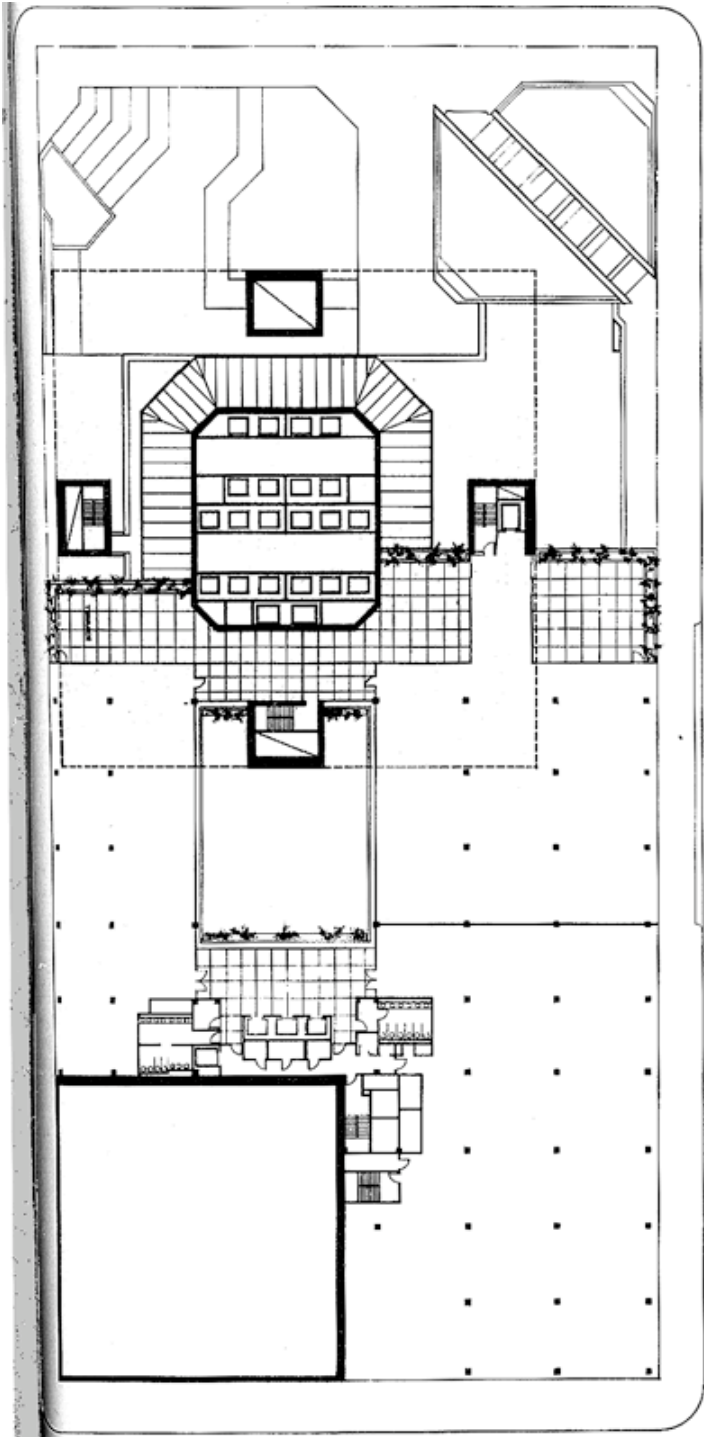
Atrium shopping

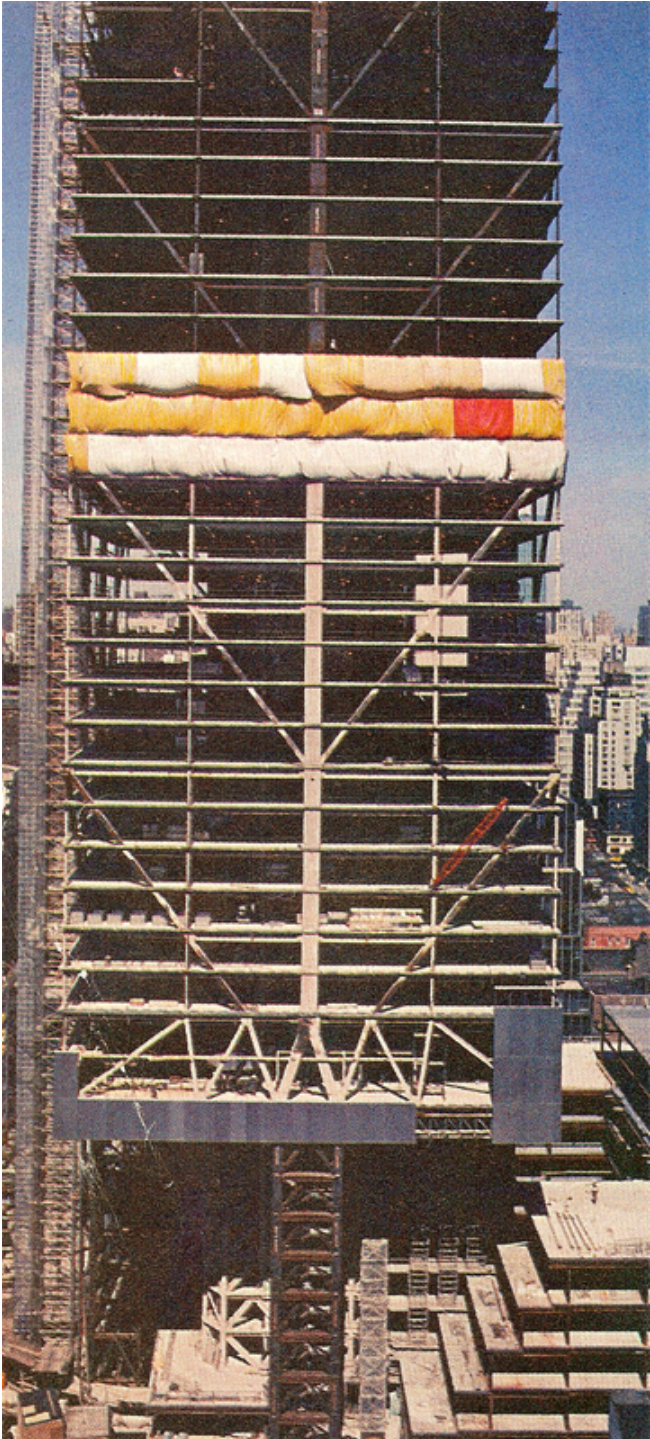


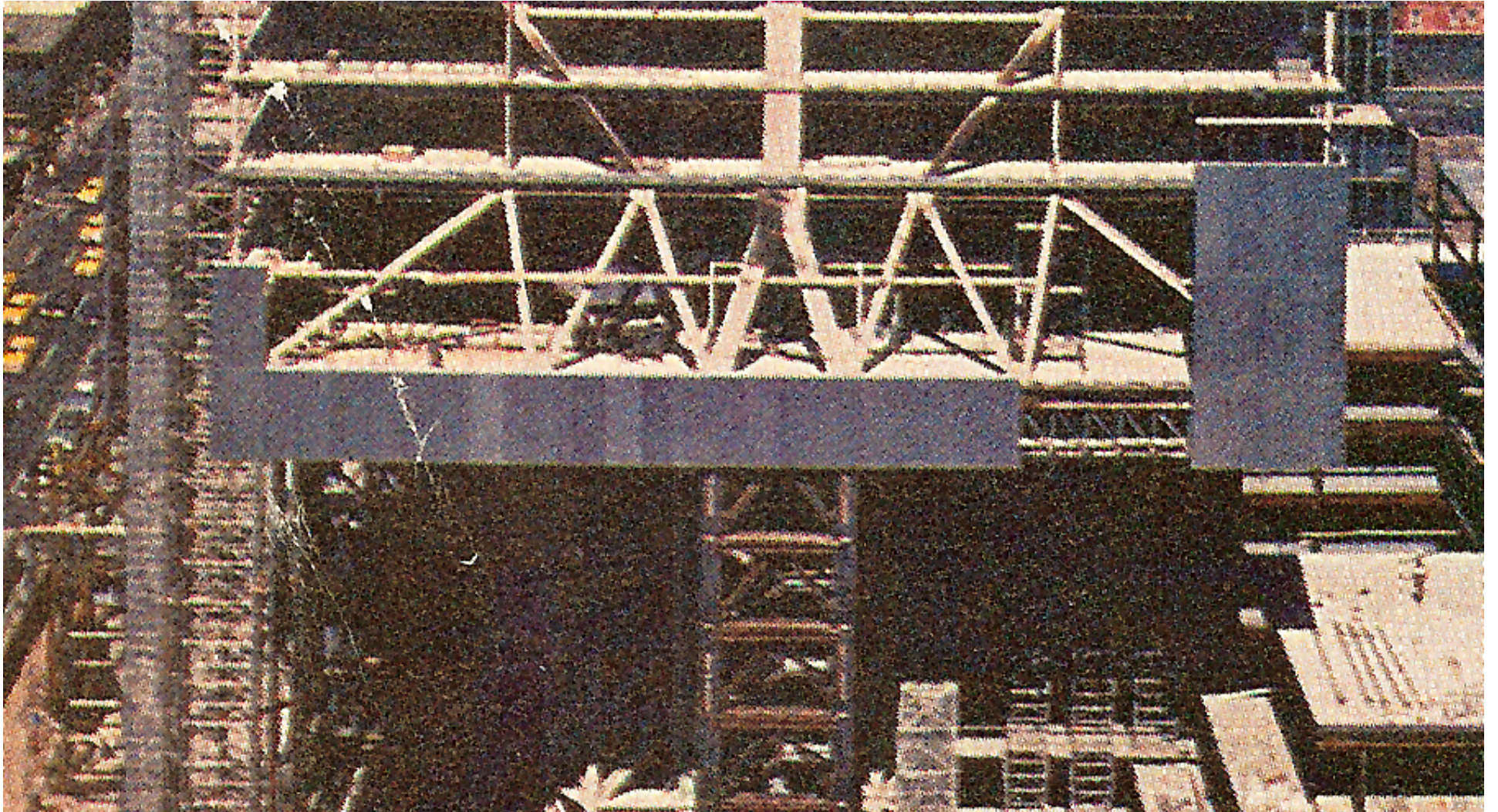


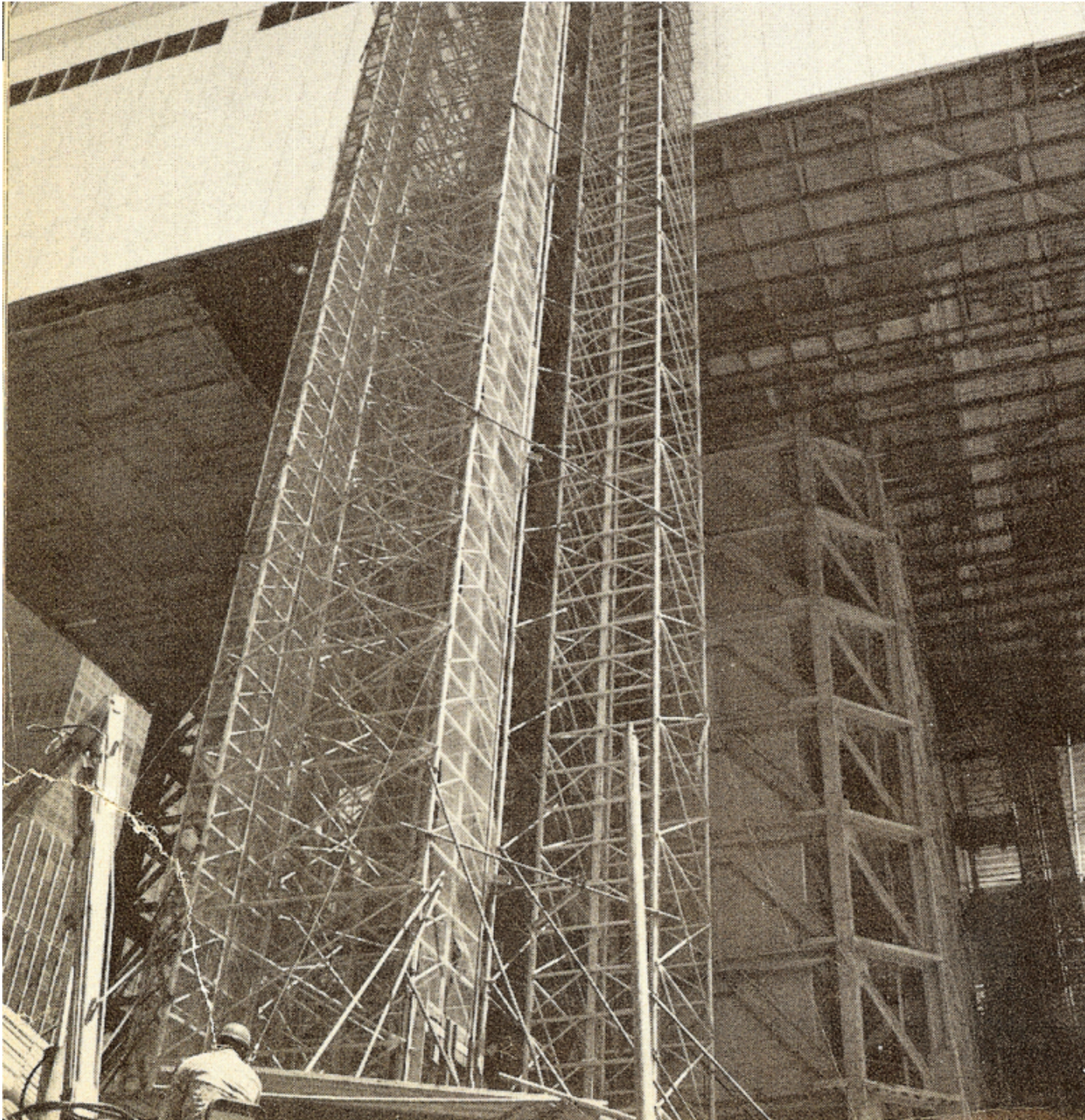




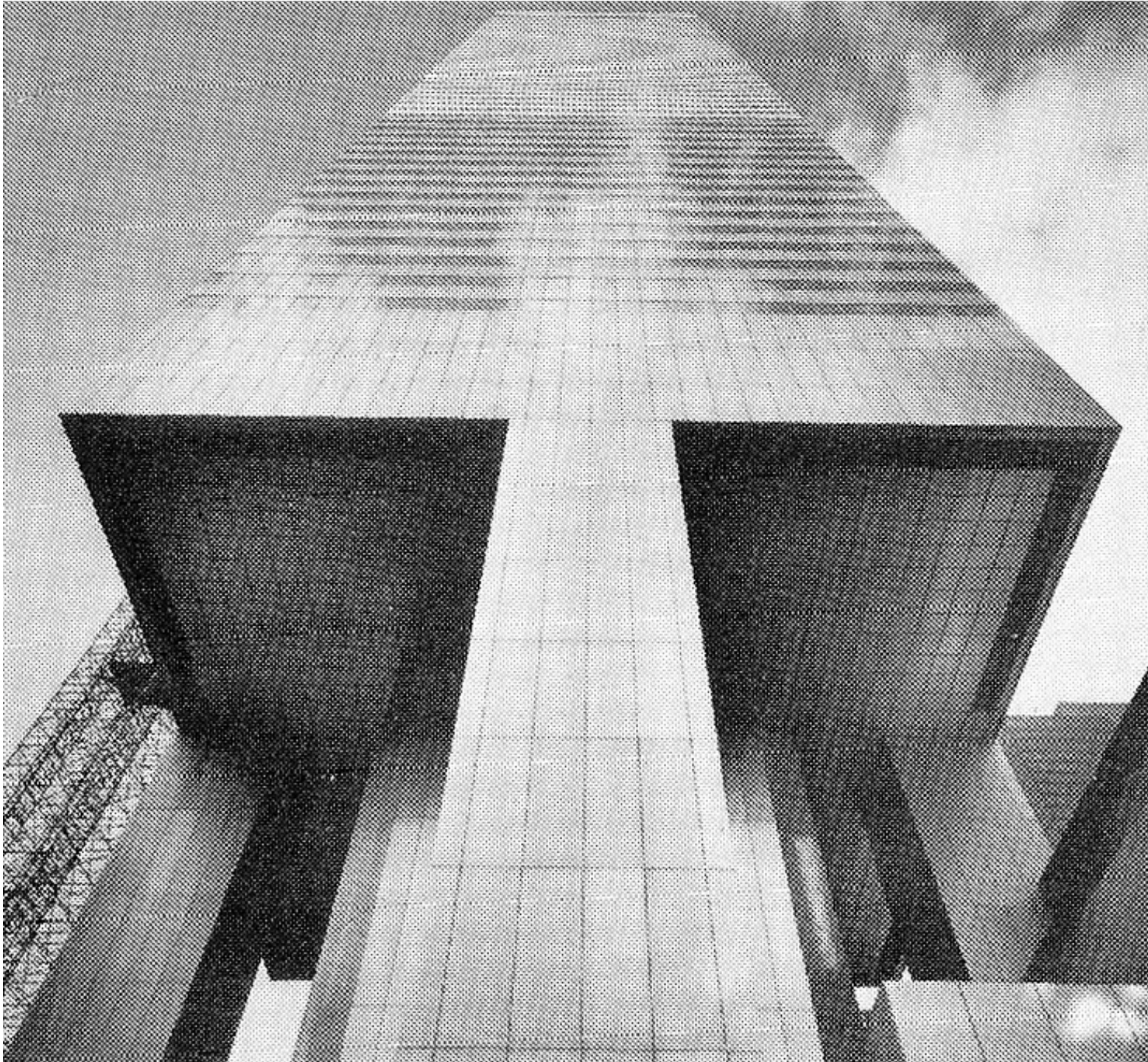






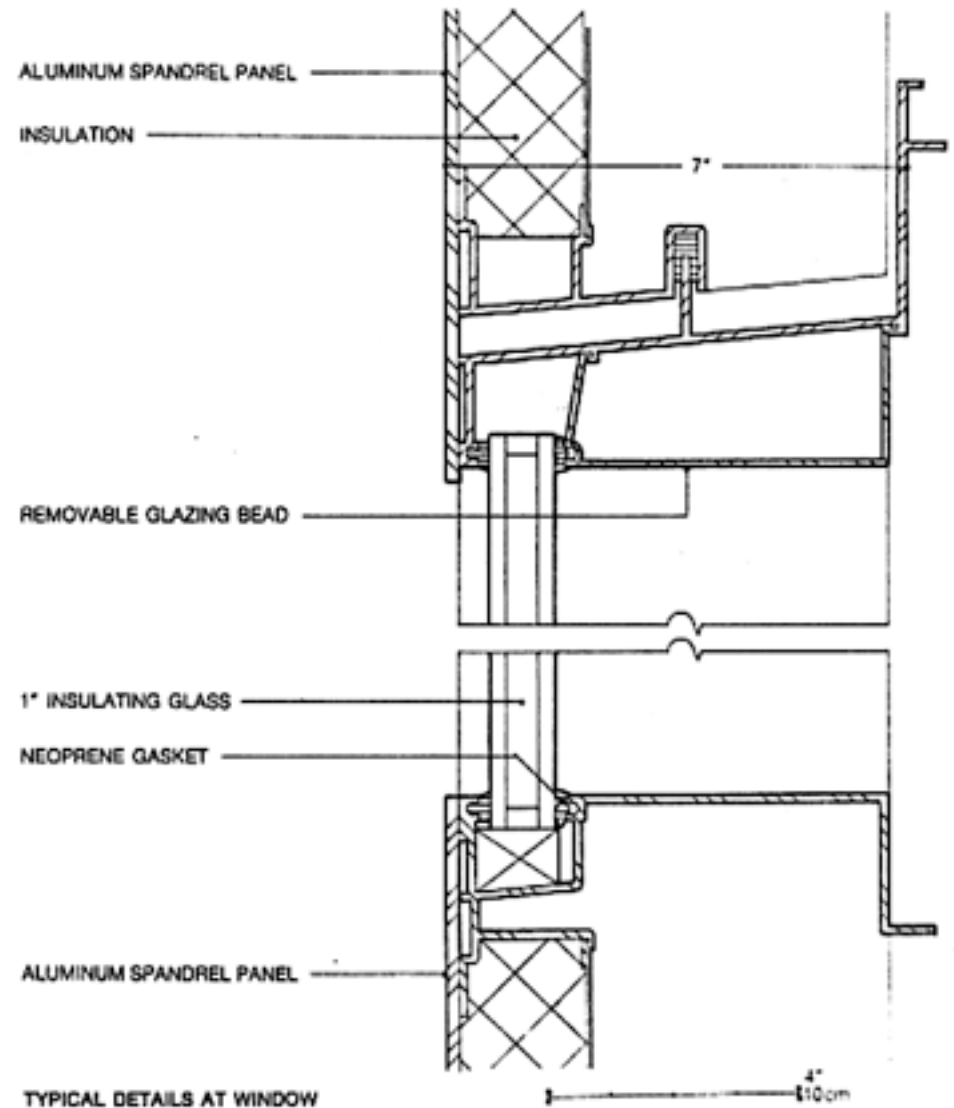






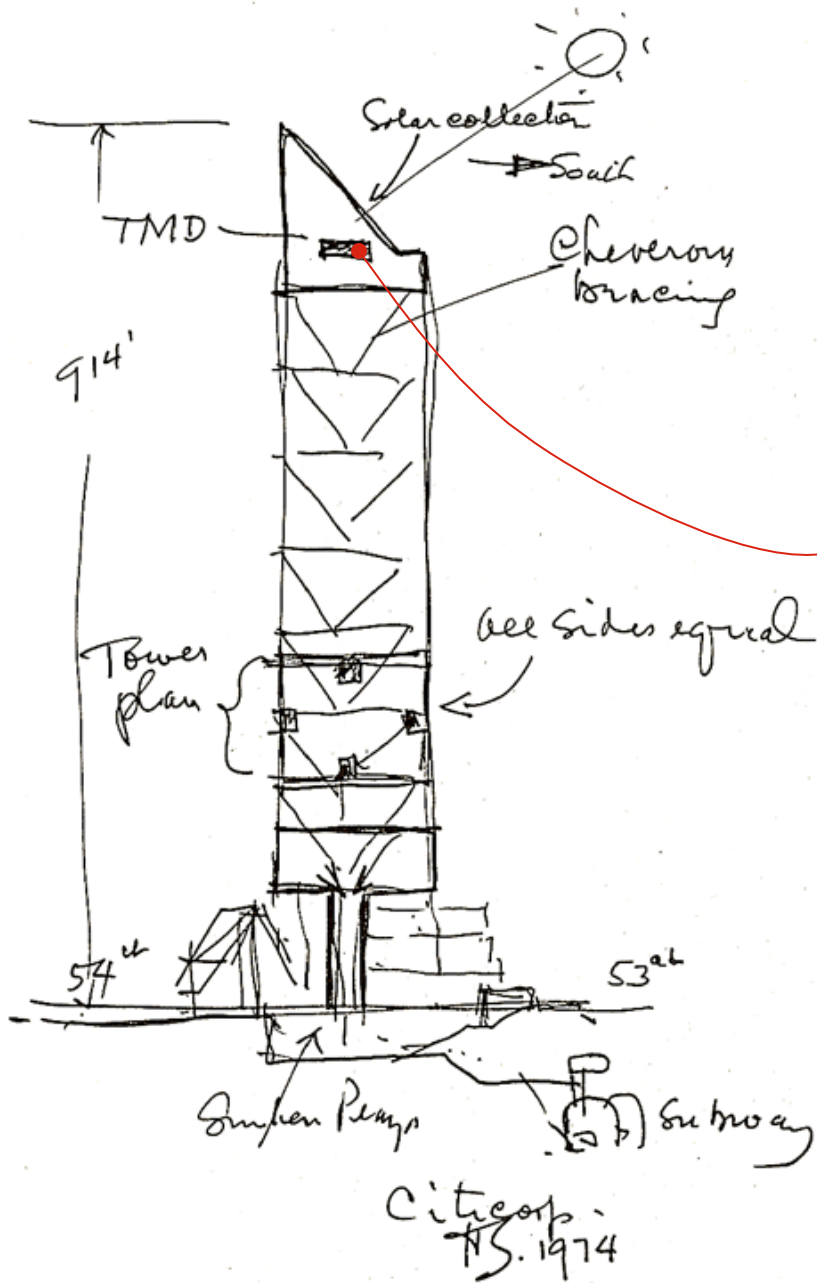
Thick skin means smooth skin

- Thick aluminum skin strong enough to act as part of window frame
- Glass is almost in the same plane as aluminum, smooth appearance
- Cladding panels insulated to reduce thermal warping during summer/winter

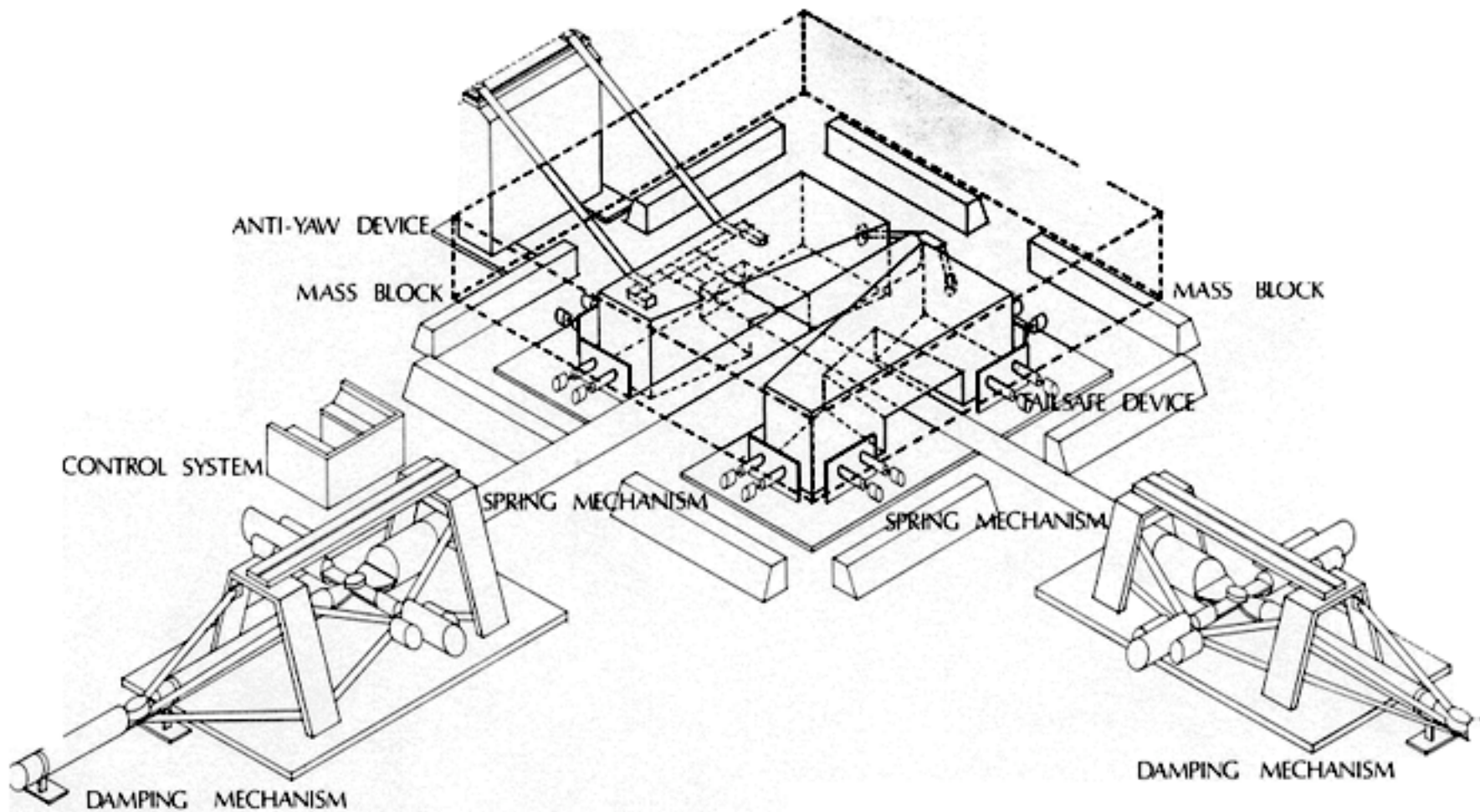


Seeing the Whole

• TMD?



Sketch by Hugh Stubbins



STRUCTURE Citicorp Center (1978), New York, N.Y. [Architects: Hugh Stubbins, in association with Emery Roth and Sons. (Hugh Stubbins and Associates)] Tuned mass damper (TMD) reduces building sway caused by winds. TMD utilizes 400-ton concrete mass which moves in opposite direction from building to reduce building sway by some 40 percent.

A 400 ton lump of smart concrete

Change order request

- Bethlehem Steel was fabricator
- Calculated loads for connections per code
- Found welded connection to be overkill for code
- Requested substitution of bolted connection
- Approved by LeMessurier's office 8-1-74
- LeMessurier gets call from student in N.J. in June 1978

Student discovers, others check

- LeMessurier's own students checked the calculations of the NJ student
- Found them to be true
- LeMessurier calls his office asks how the welded connections are performing (for use in another project)
- Finds out about the change
- Calls for wind tunnel tests of the bolted condition
- It fails

LeMessurier, stand up guy



- Tells Citicorp CEO



1978 Student discovers 70mph weakness

- 200 Bolted
corner
connections
needed to be
welded
 - Quietly
 - At night
 - On weekends
 - Not made
public Sept.
1978

“That day was awsomey low”

- July 28, LeMessurier goes to his private island
- Rechecked the numbers...same result
- Ethical dilemma
 - Don't say anything?
 - Admit and repair?
 - End life?
- Checked weather forecast, hurricane season starting
- Winds strong enough to collapse were predicted once every 16 years

31 July 1978

- Called the lawyers, said he was going to tell the client
- Lawyers wanted to meet with him to see if he was sane
- Met with Hugh Stubbins, went to client Walter Wriston, Citicorp CEO...
- ...couldn't get an appointment

“I have a real problem for you sir”

- August 2
- Finally get a meeting with executive VP John Reed
- Explained the problem
- Proposed night repairs
- Reed gets Wriston
- Wriston listens and decides to go forward with repairs, not litigation

“We’re a little busy right now”

- LeMessurier arranges for backup power for TMD
- His consultant Robertson (from WTC) calls Karl Koch Erecting to begin repairs
- Koch says they’re busy
- Robertson says “You don’t understand what we’re talking about here”

Notified Red Cross

- Surveyed neighborhood
- Developed evacuation plan
- Began work
- Done by October
- Close call with Hurricane Ella
- Repaired for 4-6 million
- No lawsuits

A code flaw too

- Wind loads only required to be calculated perpendicular to the face of the wall
- Meant only one wall was seeming to load the corner connection
- Reality was the wind hit could on the corner, 45 degrees from the face
- Would mean wind would load **TWO** walls, and fail the bolted connection