Comcast Center

Philadelphia, PA

Cynthia Milinichik

Structural

About Me

- **Simpson Gumpertz & Heger Inc.**
  - **Starting July 2007**
- **Work Experience**
  - **Borton Lawson**
  - **Structural Repair Group, LLC.**
  - **Lutron Electronics Co., Inc.**
- **Structural Engineers Association**
  - **2006 President**

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- **Focal Point of Subway System**
  - **Concourse Level Dining Court**
  - **½ Acre Public Plaza**
- **Tallest Skyscraper between NYC and Chicago**
- **3 Story Stacked Atrium**
  - **Winter Garden**
  - **Borofsky Sculptures**

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- Cost: $540M
- Area: 1.2M SF
- Height: 1001’-6”
- Floors: 57
- Occupancy:
  - Office
  - Retail
  - Restaurant
- Construction

  Jan 2005 - Sept 2007

- **Project Team**
  - Liberty Property Trust: Owner
  - L. F. Driscoll Co: Construction Manager
  - Design Architect: Robert A. M. Stern
  - Architect of Record: Kendall Heaton Associates
  - Structural Engineer: Thornton Tomasetti
  - MEP Designer: Paul H. Yeomans
  - Landscape Design: Olin Partnership
  - Civil Engineers: Pennoni Associates
  - Acoustics Consultant: Cerami & Associates, Inc.
  - Security Consultant: HMA Consulting, Inc
  - Lighting Designer: Quentin Thomas Associates, Inc.
  - TLCD Engineer: Motioneering

Presentation Topics

- **Existing Structural System**
- **Alternative Lateral Force Resisting System**
- **Construction Issues**
- **Renewable Energy Source**
- **Summary & Conclusions**
- **Acknowledgements**

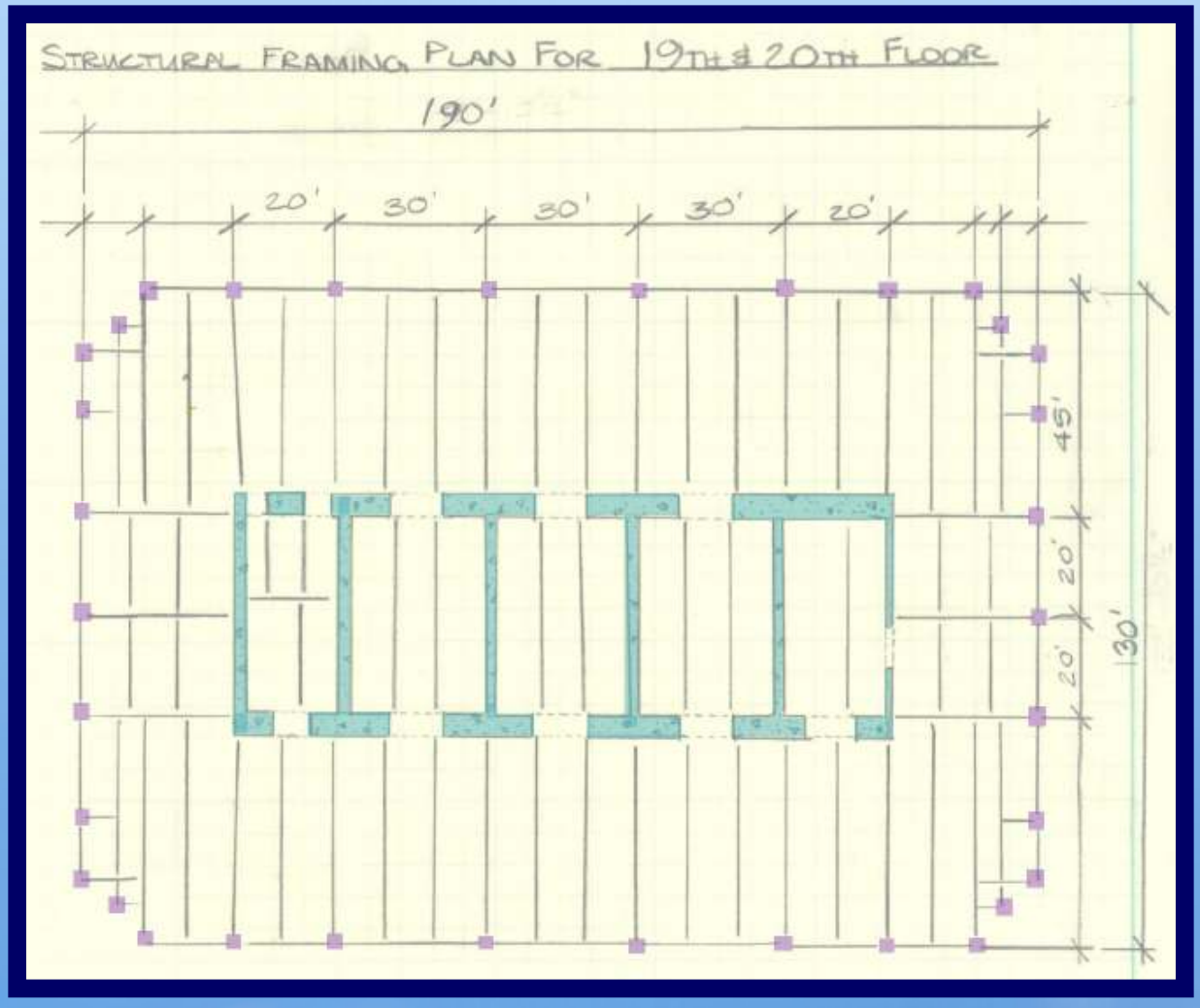
Existing Gravity System

- Composite Metal Deck Floor
  - 3" Concrete on 3" Metal Deck

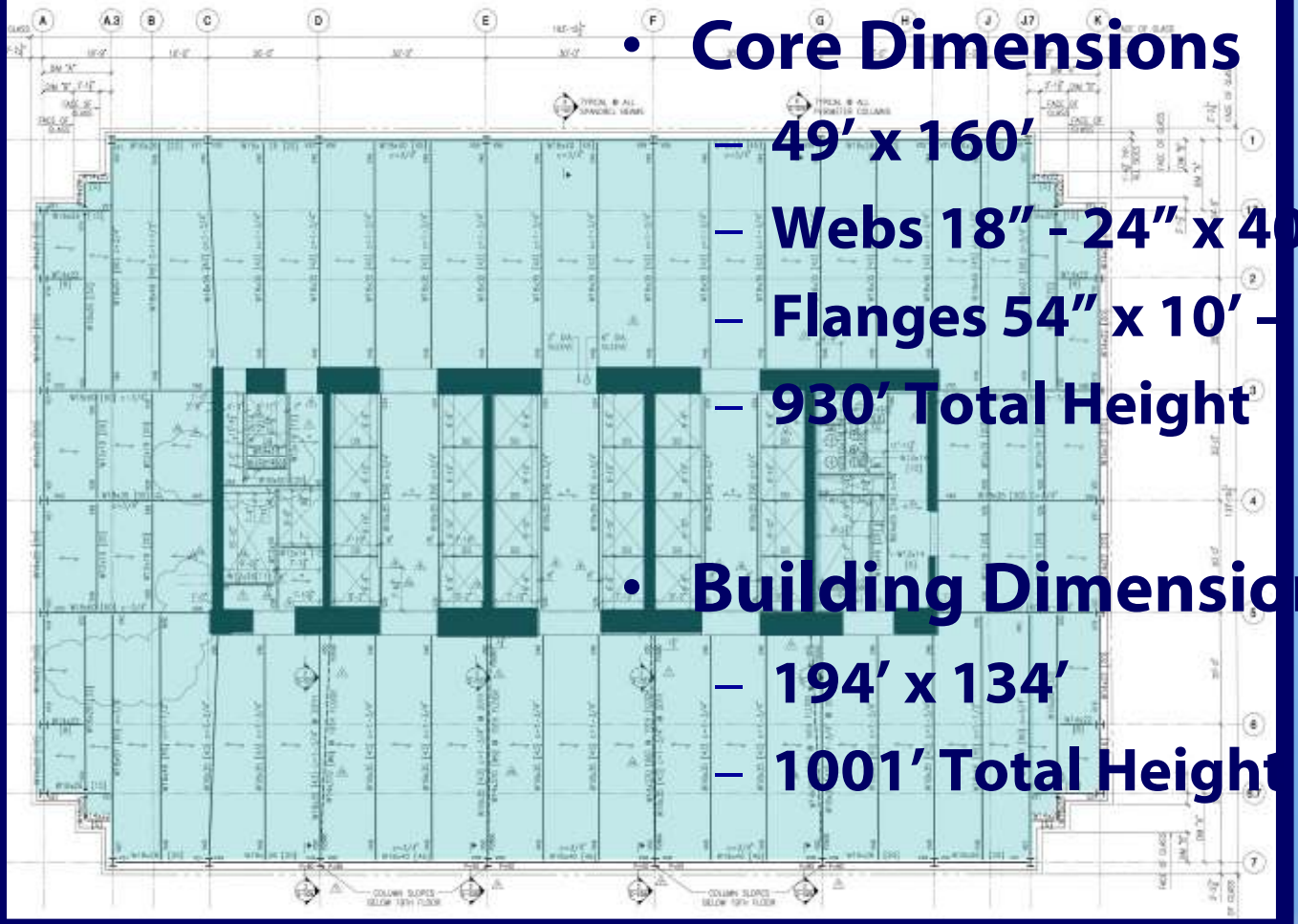
Existing Gravity System

- 10’ Thick Mat Slab → Concrete Core
- 8’ Ø Caissons → Perimeter Columns

Existing Gravity System



Existing Lateral System: Shear Walls

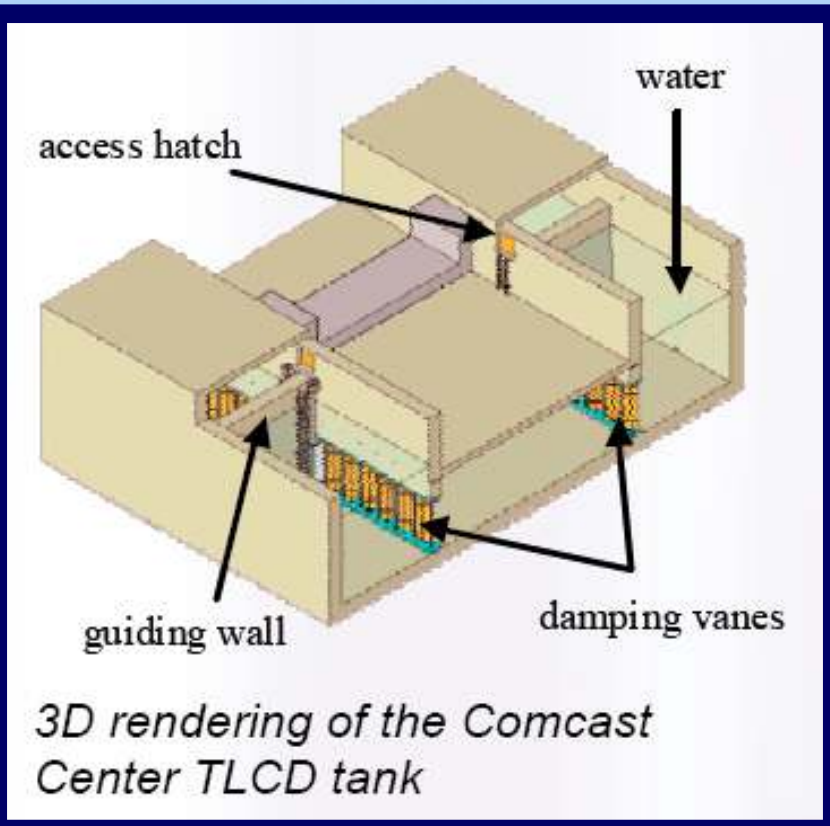


- **Core Dimensions**
  - **49′ x 160′**
  - **Webs 18″ - 24″ x 40′**
  - **Flanges 54″ x 10′ – 20′**
  - **930′ Total Height**
- **Building Dimensions**
  - **194′ x 134′**
  - **1001′ Total Height**

Existing Lateral System: Shear Walls

Existing Lateral System: Shear Walls

Existing Lateral System: TLCD

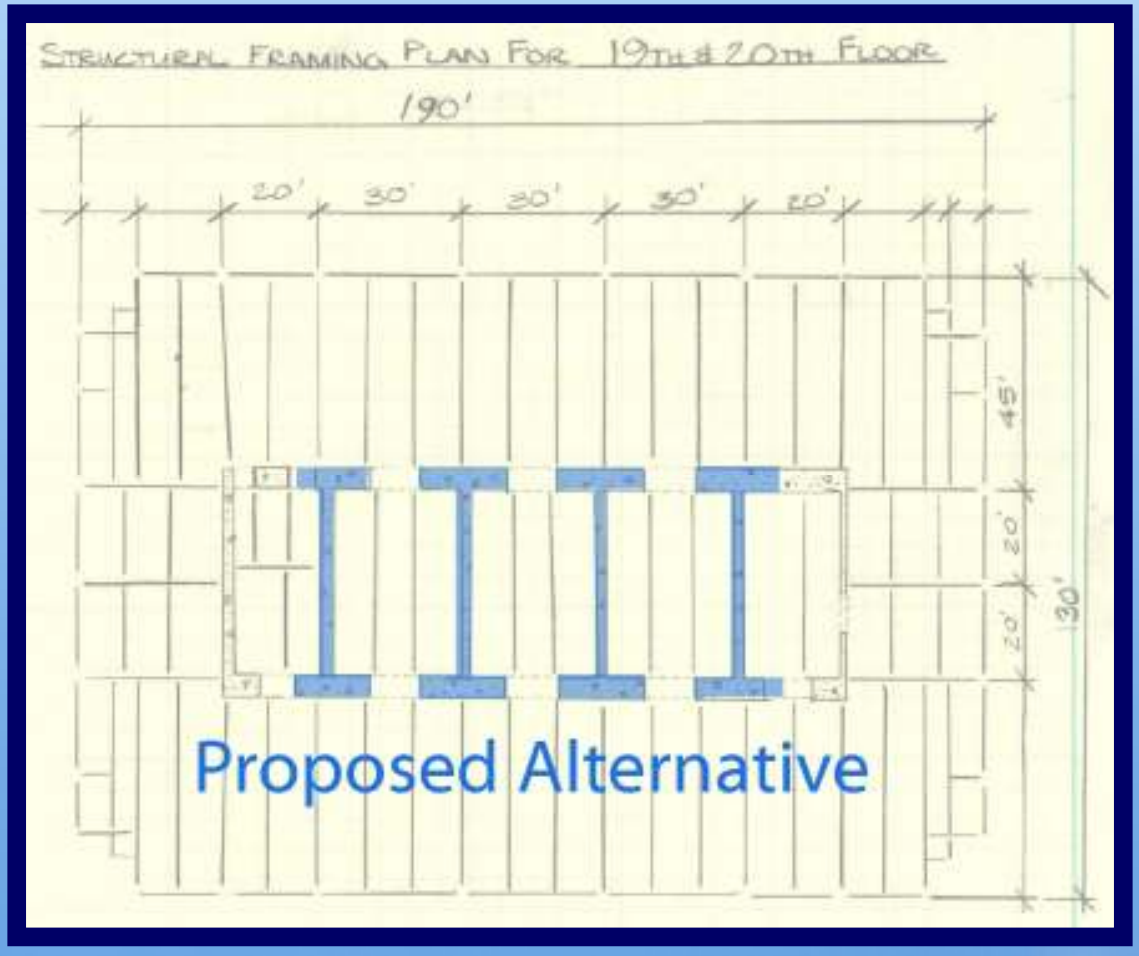


3D rendering of the Comcast Center TLCD tank

- Tuned Liquid Column Damper
- Largest in World

- Uni-Axial, typically Bi-Axial
- $905,000

Proposed 4 Web Concrete Core

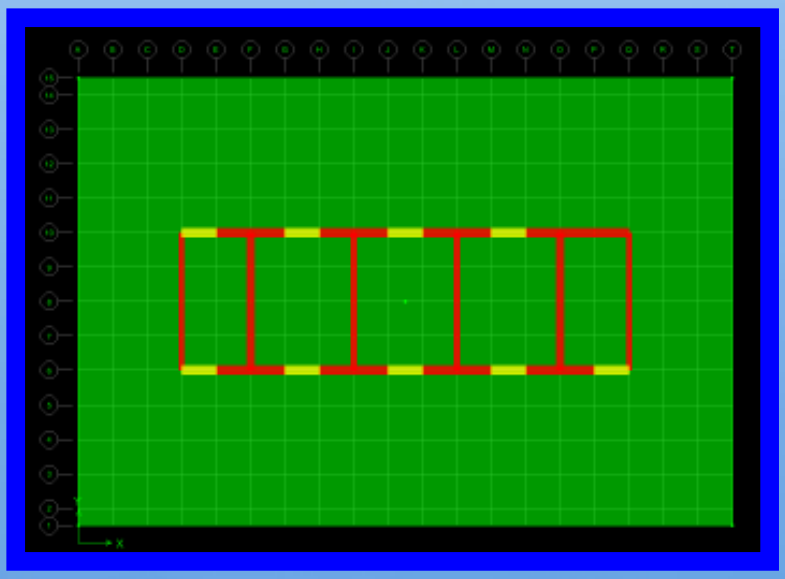


The Concept

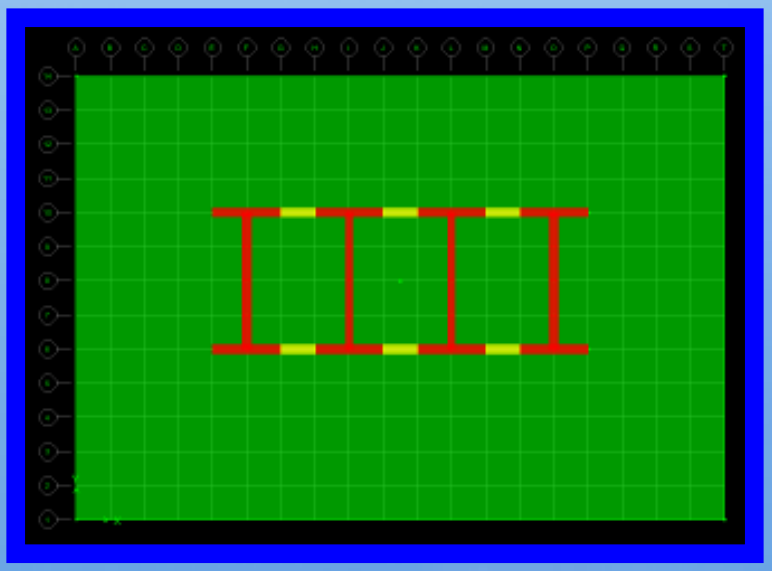
- If T(4web) within 10 % of T(6web) than TLCD can compensate for additional damping

The Approach

- 6 Web Model of Existing Core

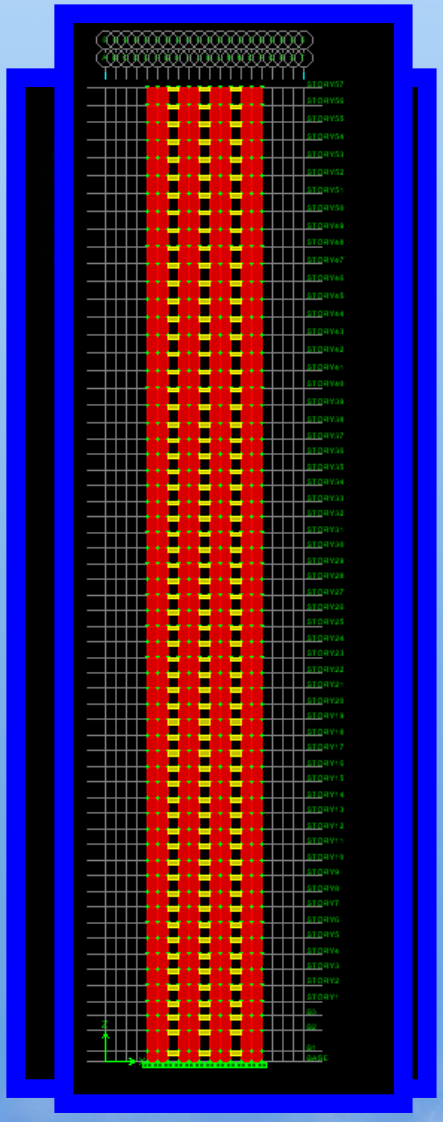


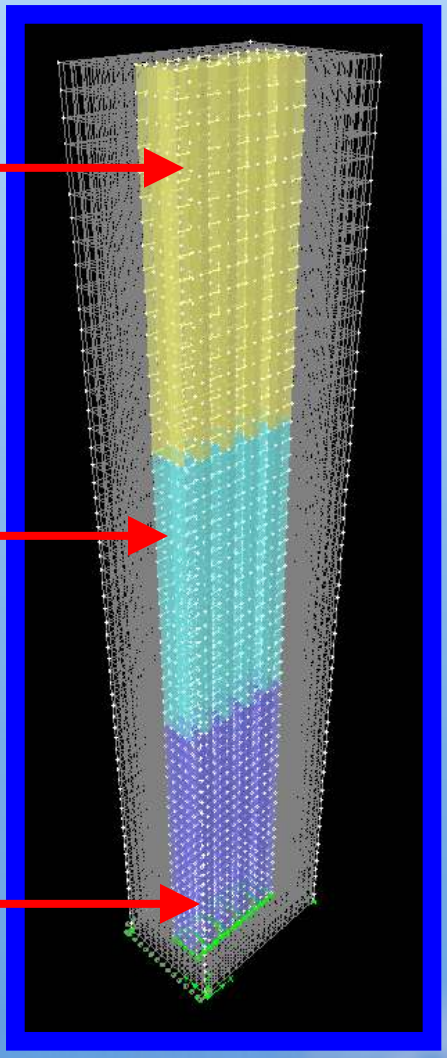
- 4 Web Model of Proposed Core



- Dynamic Analysis

Etabs Model





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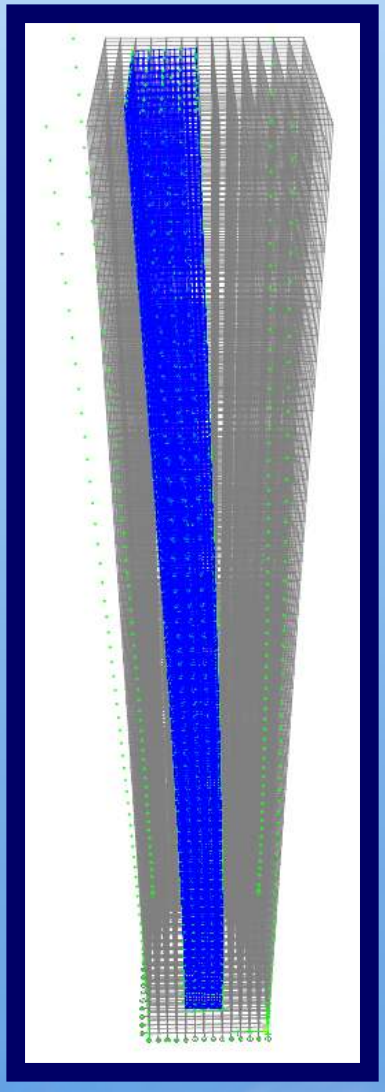
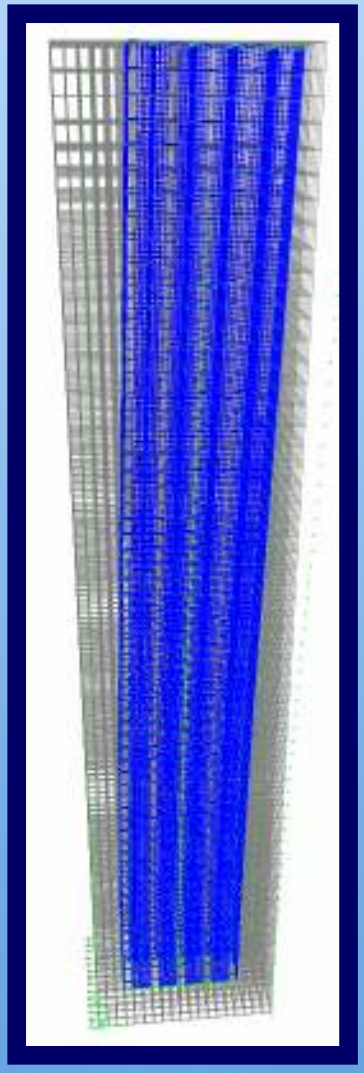
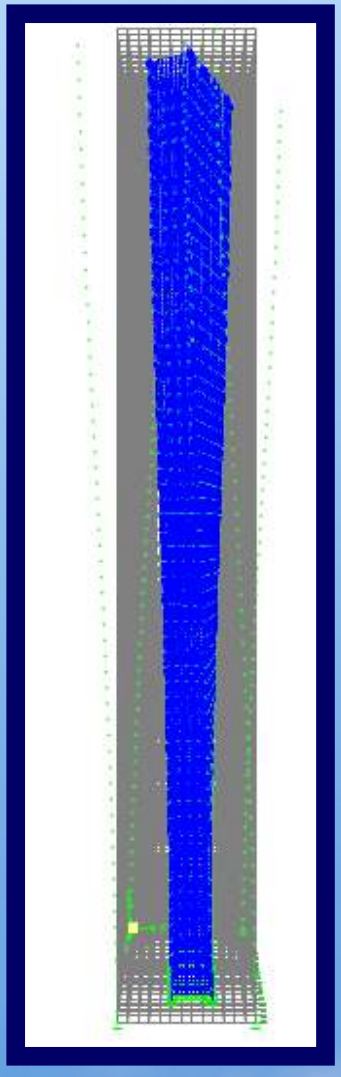
- Mode 1



- Mode 2



- Mode 3



- Natural Period of Vibration

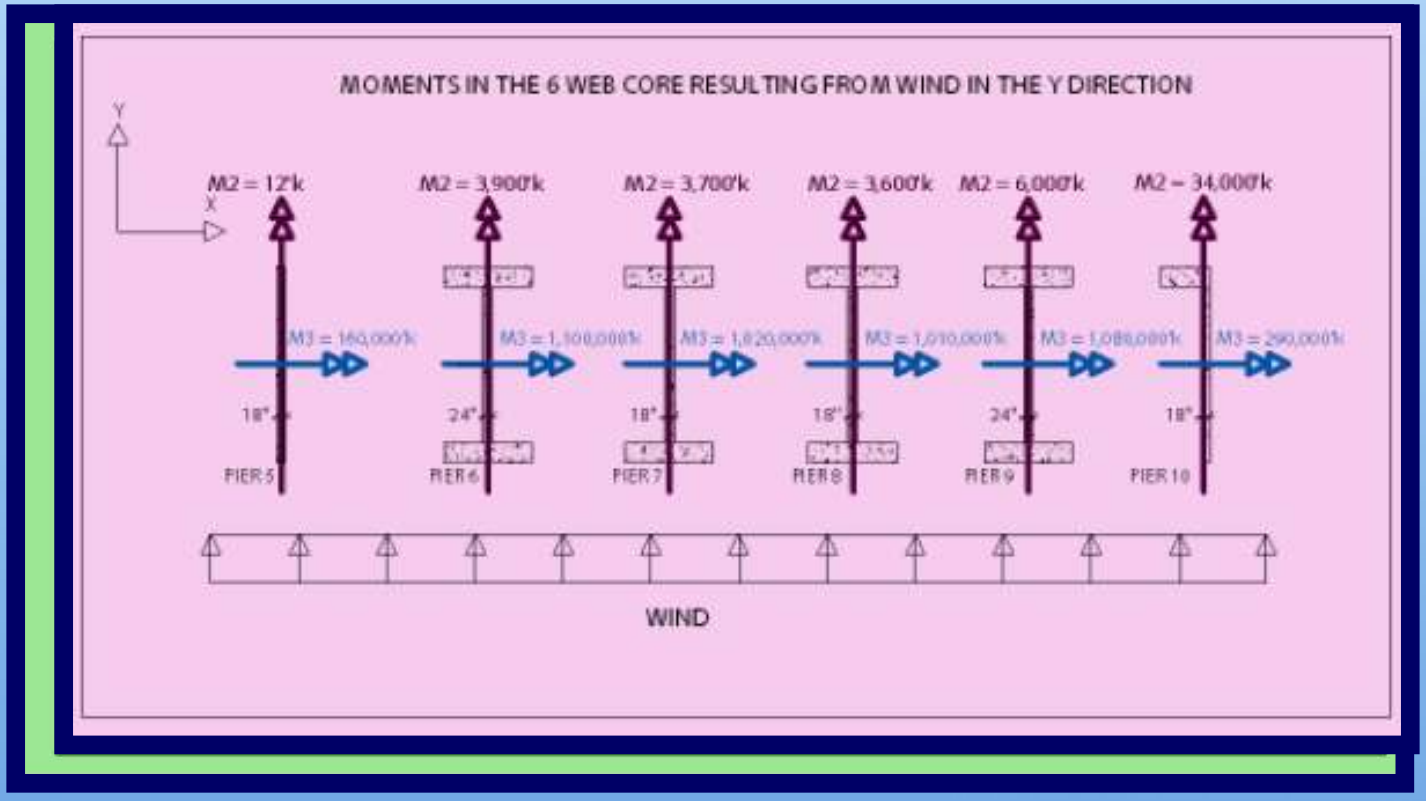
Natural Period of Vibration (sec.)

Mode #	T (6 Web)	T (4 Web)	% Difference
1	8.58	8.88	3.50 %
2	4.55	5.31	16.70 %
3	3.71	3.97	7.01 %

- Mode 1 Period < 10% Existing

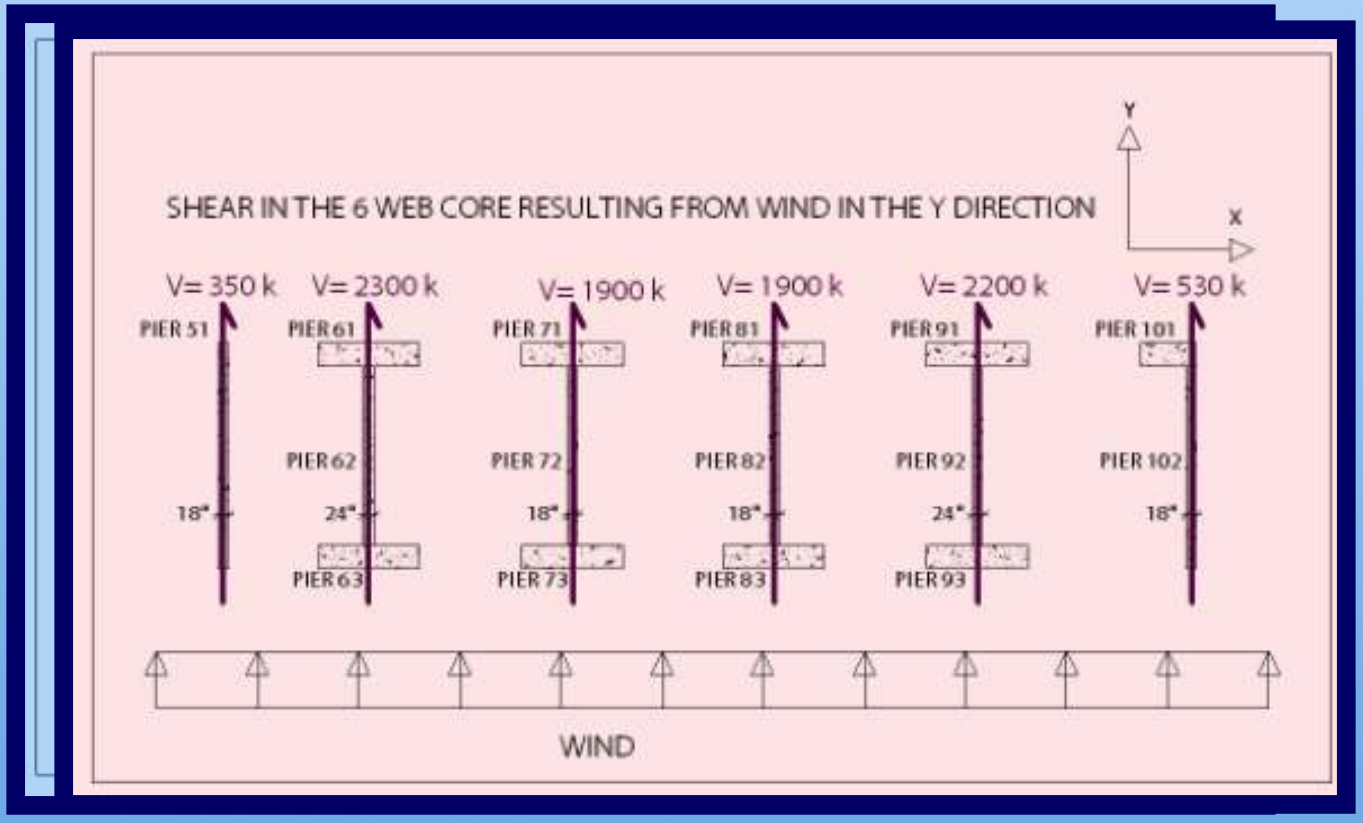
∴ OK

- Check Strength
  - Moments



- PCA Columns to check Flexural Reinforcing
  - Min Steel Required ∴ Strength does not control Design

- Check Strength
  - Shear



∴ Strength does not control Design

- Check Drift

Total Building Drift under Service Loads (in)

Load Case	Δ_6 Web	Δ_4 Web	% difference
Wind Y	32.1	37.7	17.3 %
Wind X	3.9	9.1	31.3 %

Maximum Story Drift under Service Loads

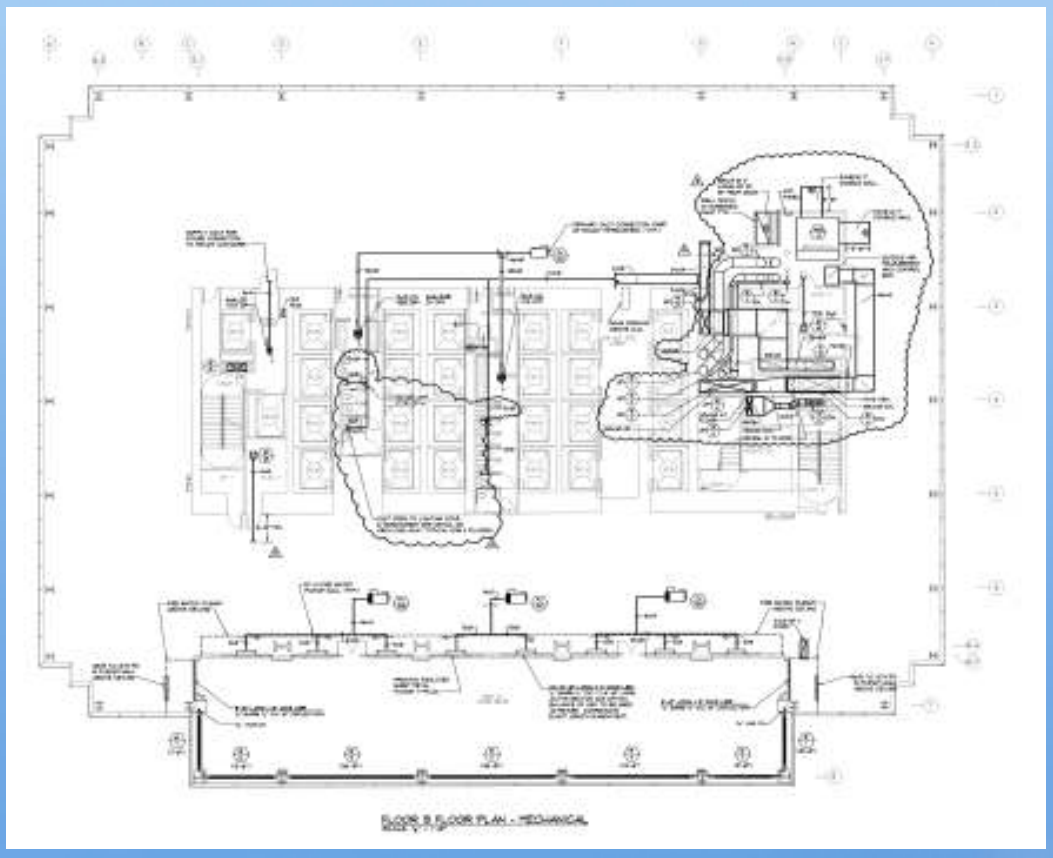
Load	Δ_6 Web (in)	Story #	Δ_4 Web (in)	Story #
Wind Y	0.84	STORY 57	0.97	STORY 55
Wind X	0.13	STORY 42	0.22	STORY 43

Advantages

- More Design Freedom, Flexibility of Space
  - Mechanical Room
- 45 SF Increased Net Rentable Space
  - **$1.2M / Year**
- Less Materials
  - Concrete
  - Formwork
  - **Save $950,000**
- Extra Parking Spaces

Advantages

- Mechanical Room



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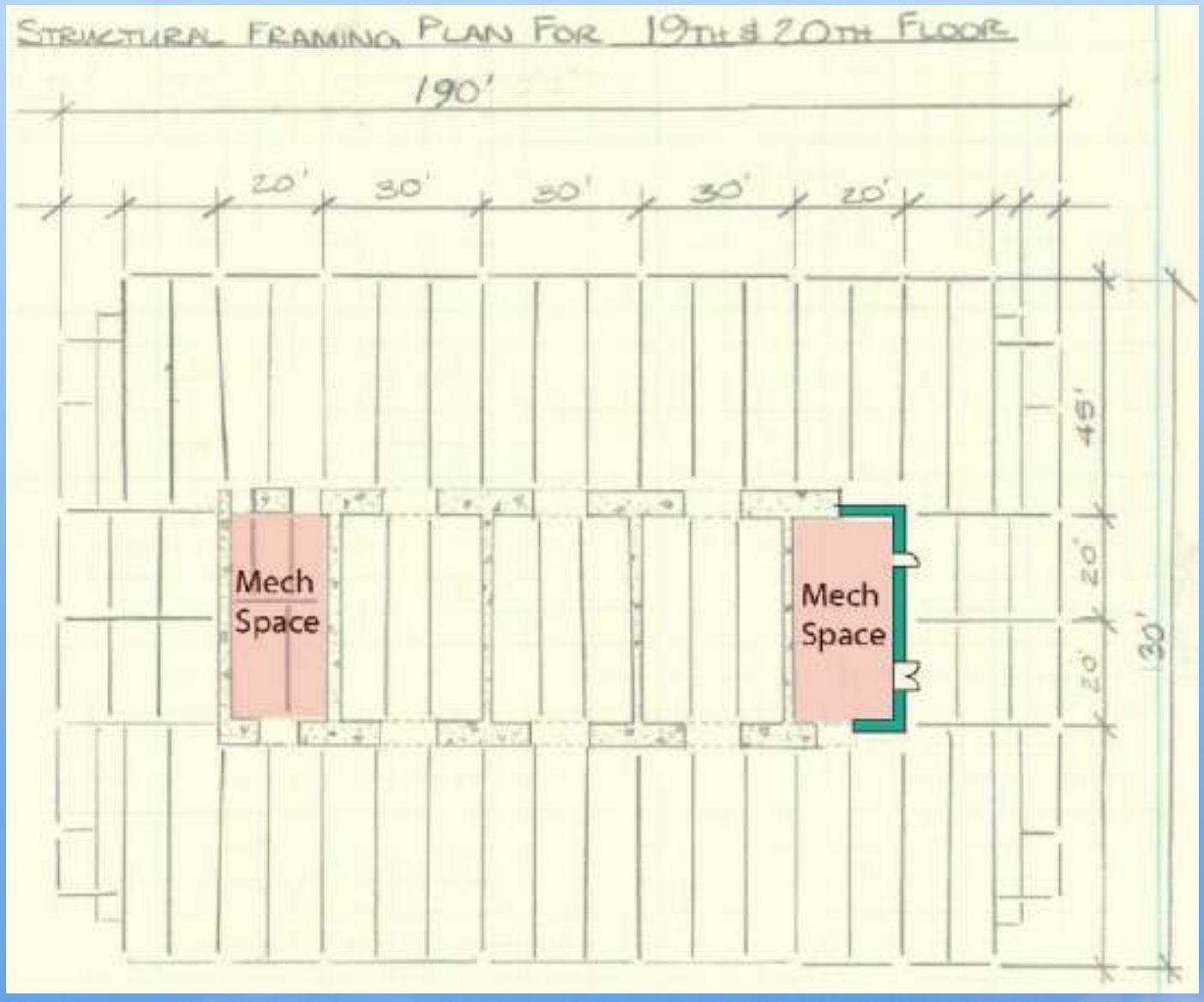

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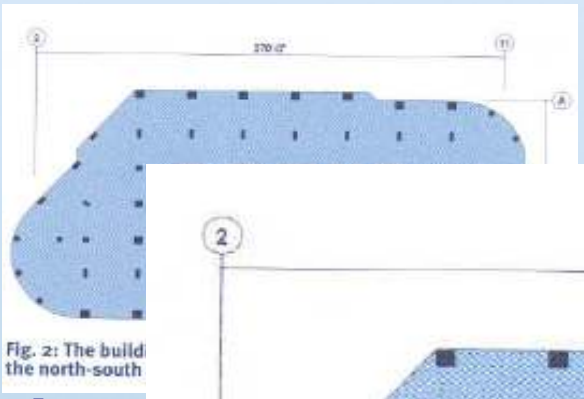
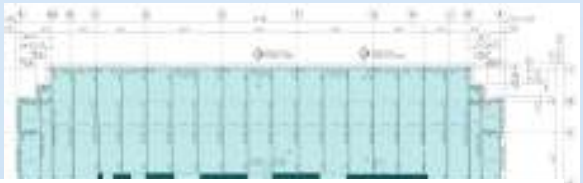
Trump Tower vs. Comcast Center





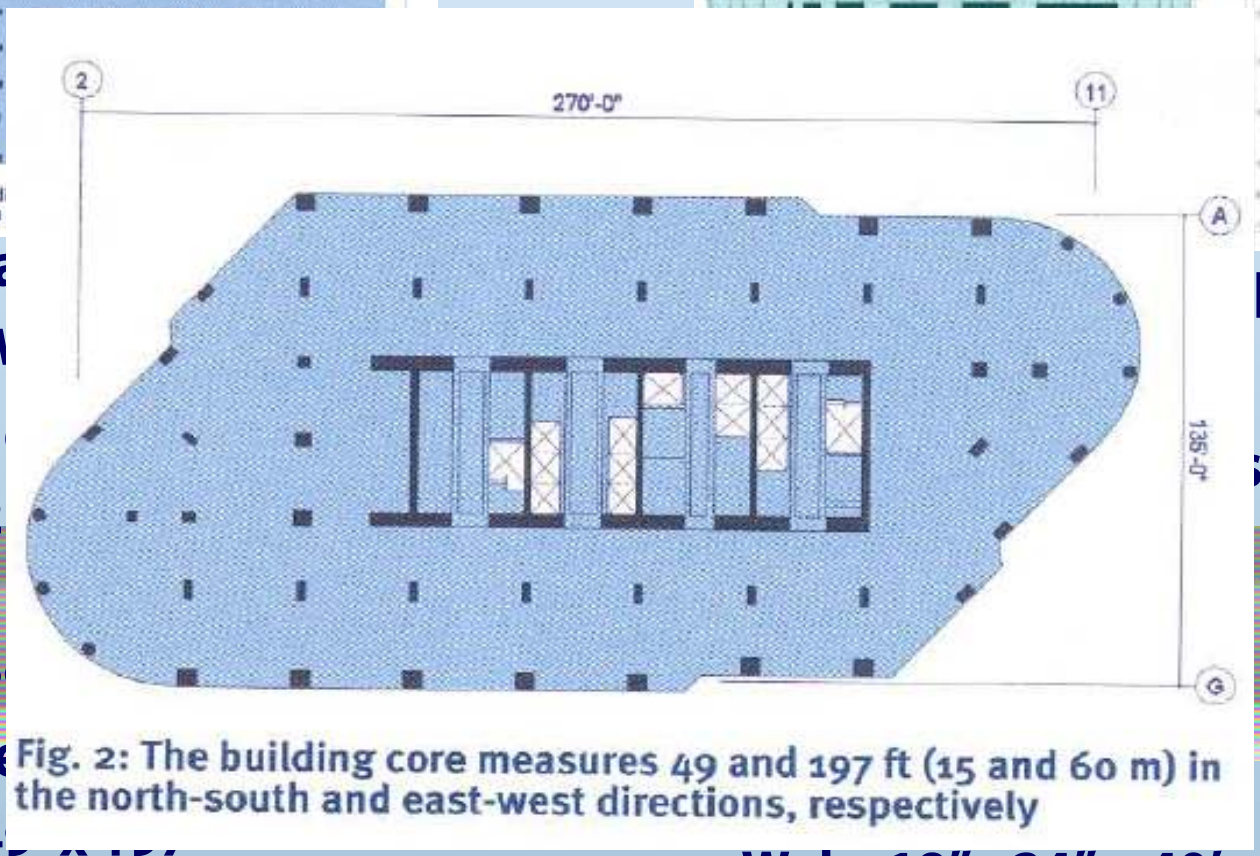


Fig. 2: The building core measures 49 and 197 ft (15 and 60 m) in the north-south and east-west directions, respectively

- **Loca** **hia**
  - **W**
- **Buil**
  - **2**
  - **1**
  - **S**
- **Core**
  - **4[illegible]**
  - **Webs 18" x 41'**
  - **Flanges 48" x 9' – 22'**
  - **Webs 18" - 24" x 40'**
  - **Flanges 54" x 10' – 20'**

Trump Tower vs. Comcast Center

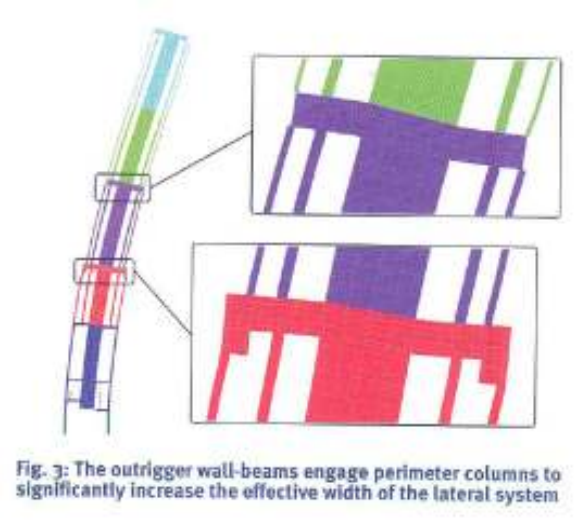
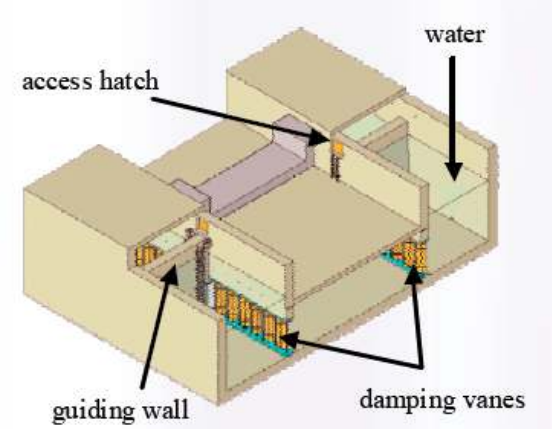


Fig. 3: The outrigger wall-beams engage perimeter columns to significantly increase the effective width of the lateral system



3D rendering of the Comcast Center TLCD tank

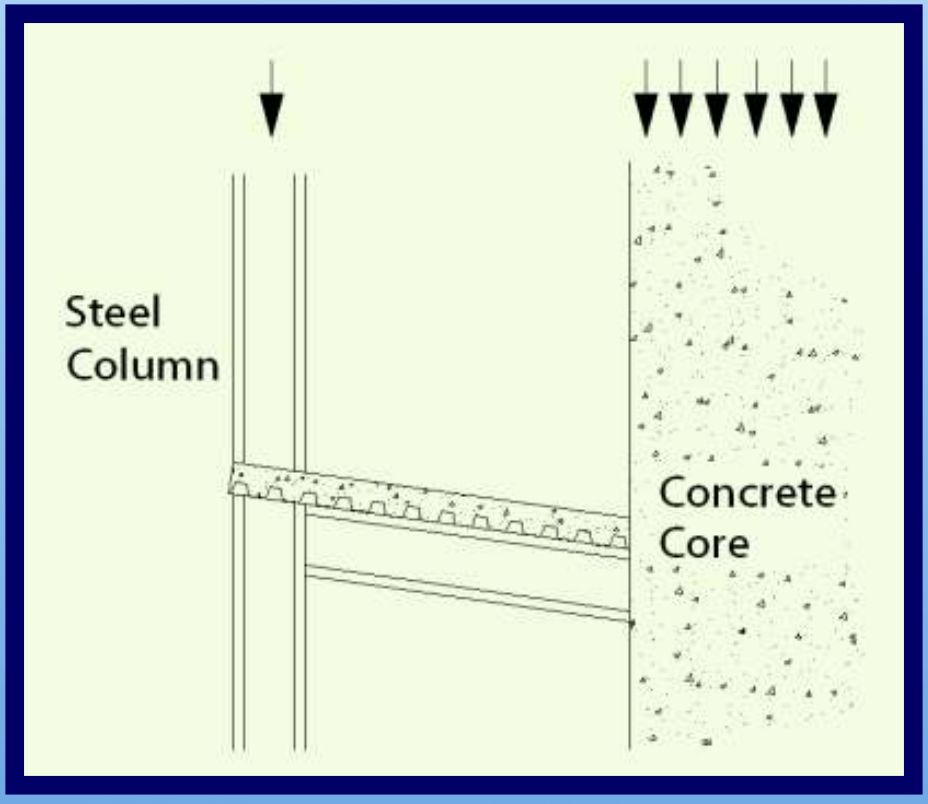
- **Concrete**
  - **12 ksi up to level 51**
- **Additional Lateral**
  - **Outriggers**
    - **Architectural Belts**
    - **3 Setbacks**

- **Concrete**
  - **10 ksi up to level 20**
  - **8 ksi up to level 40**
- **Additional Lateral**
  - **Tuned Liquid Column Damper**
    - **Architectural Crown**

Trump Tower vs. Comcast Center

- **Horizontality**
  - **Tie in with other surrounding**
- **Verticality**

Construction Management Issues: Creep



Construction Management Issues: TLCD

- **Cast-in-Place: $905,000**
- **Precast**

- Construction Management Issues
  - Pumping Concrete

CYNTHIA MILINICHIK
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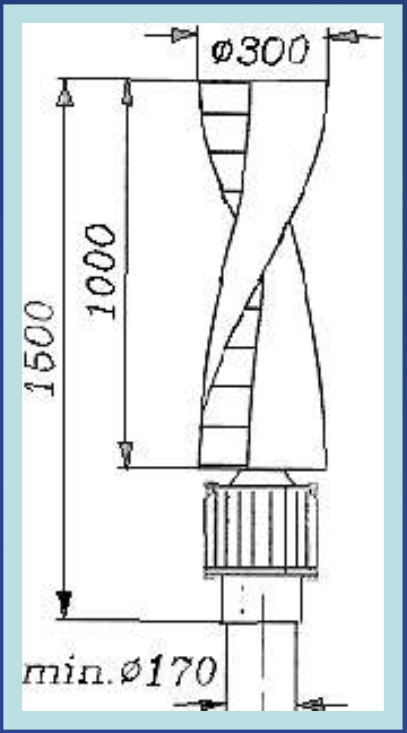
•Sustainability Breadth

- **Bahrain World Trade Center**
  - 3 Propeller Turbines
  - **95 feet diameter**
  - **11% of the Buildings Total Energy Usage**

- Sustainability Breadth



•Sustainability Breadth

Turbine Summary

# of Turbines	Cost	Energy kW	% of Total Building Energy
1	$ 15,000	2.8	0.02
4	$ 60,000	11.2	0.10
14	$ 210,000	39.2	0.34
20	$ 300,000	56.0	0.48
24	$ 360,000	67.2	0.57
30	$ 450,000	84.0	0.72
38	$ 570,000	106.4	0.91

•Mean Wind Speed for Philadelphia @ 1000': 83mph

Summary & Conclusion

- 4 Web System Benefits outweigh Existing 6 Web System
- Tolerances, Existing Conditions, Applicability should be considered in Design Phase to avoid CM issues and save $$$
- Incorporating Wind Turbines into Comcast Center will help develop Wind Energy Technology

Acknowledgements:

Project Team:

Jim Verzella, Vice President, L. F. Driscoll
Joe Klodarska, Project Manager, L. F. Driscoll
Stephan Eisenreich, Project Engineer, Thornton Tomasetti
Ray Hahn, CEO, Persohn/Hahn Associates

Faculty:

Dr. Andres Lepage, Advisor
Professor M. Kevin Parfitt
Professor Robert Holland
Dr. David Riley
AE Department Faculty and Staff

Photographer/Historian

R. Bradley Maule, Philly Skyline

Questions?