From the Edge to the Hyperscale Data Center:

A Case Study on Structural Considerations
Factor this into your thinking today...

Nothing is getting lighter in a Data Center.
STRUCTURAL CONSIDERATIONS IN DATA CENTERS

> OUTLINE

- TRENDS IN THE DATA CENTER INDUSTRY (and how they impact the structure)
- TRADE-OFF STRUCTURAL DECISIONS
- FUTURE-PROOFING RECOMMENDATIONS
Presentation today is based on . . .

1. Bennett & Pless structural experience in existing Mission Critical Facilities throughout the U.S. over the past 30 years.
Presentation today is based on . . .

2. Interviews with 6 Vice-President’s of Data Center Design and Construction

- Hyperscalers
- Colo
- Enterprise
- Telecom/Edge
3. Exposure to current structural design thinking for new facilities in broad markets

- Hyperscalers
- Colo
- Enterprise
- Telecom/Edge
STRUCTURAL CONSIDERATIONS IN DATA CENTERS
> INDUSTRY TRENDS

TRENDS IN THE DATA CENTER INDUSTRY
(and how they impact the structure)
Industry Trends

1. Moore’s Law
2. Land Cost
3. MEP Changes
Moore’s Law
Moore’s Law is alive and well!
Silicon is half the weight of Steel.
IBM S/390 Parallel Enterprise Server*

Physical configuration  1 frame
Weight: 540 kg (1040 lbs.)
Footprint: 1.0 M² (10.4 ft²)
Service clearance: 2.5 M² (27.4 ft²)

Load = 28psf

* Taken from IBM S/390 Reference Manual, Retired 12/29/98
Now

Load Today = 250psf

Load: 10x in 20 Years

Hyperscale Data Center - 2018
Loads will be heavier, unless...
1. Moore is wrong
2. We don’t use Silicon
Location
Location
Location
Location
## Cost of Land

<table>
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<th>Year</th>
<th>Major Urban Area</th>
<th>$ Per Acre</th>
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<tbody>
<tr>
<td>1998</td>
<td>$100,000</td>
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<tr>
<td>2018</td>
<td>$1,200,000</td>
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</table>

* Average cost for 1 acre of land - Ashburn, Dallas and Atlanta

Source - citilab.com and Federal Reserve Richmond

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Land: 10x in 20 Years
**STRUCTURAL CONSIDERATIONS IN DATA CENTERS**

> INDUSTRY TRENDS

↑ Land Cost = ↑ Bldg Height:

- Framing Cost = +/- 2x more
Structural Considerations in Data Centers

Industry Trends

\[ \uparrow \text{Land Cost} = \uparrow \text{Bldg Height:} \]

- Framing Cost = +/- 2x more
- MEP on Roof = Big Load
**STRUCTURAL CONSIDERATIONS IN DATA CENTERS**

> INDUSTRY TRENDS

↑ Land Cost = ↑ Bldg Height:
- Framing Cost = +/- 2x more
- MEP on Roof = Big Load
- Tough to Expand
MEP = Make Engineering Problems!
MEP Equipment is Changing

- **Batteries** and their use are a changing…and they are heavy - distributed power, storage, lithium ion

**Flooded Wet Cell**  
**Lithium Ion**
MEP Equipment is Changing

- Approach to **cooling** is changing... water weighs more than air
  - shift to water-cooled, roof mounted

Air Cooled → Water Cooled
MEP Equipment is Changing

- Increased size of **gensets**…not just weight, but wind/seismic - especially when they are on the roof

200kW Genset  
2MW Genset
MEP Equipment is Changing

- **Codes** are changing...tend to have structural implications
  - future modifications may require upgrade
STRUCTURAL CONSIDERATIONS IN DATA CENTERS
> TRADE-OFF STRUCTURAL DECISIONS

TRADE-OFF STRUCTURAL DECISIONS
Structural Trade-Offs

1. Steel vs. Concrete
2. MEP on Roof or Grade
3. Cost vs. Schedule
Steel vs. Concrete
STRUCTURAL CONSIDERATIONS IN DATA CENTERS
> TRADE-OFF STRUCTURAL DECISIONS

STEEL PROS
- Lower cost for 2+ stories
- Easier to strengthen in future
- Easier to expand up in future
- Release material order early

CONCRETE PROS
- Faster construction typically
- Longer spans – no columns
- Better QC in shop
- Can reinforce – carbon fiber
Locate MEP On…

roof?

grade?
CONS ON ROOF
- Risk of roof leaks
- Adds cost to building framing
- Future expansion up difficult
- Maintenance/upgrade tougher

CONS ON GRADE
- Requires lots of land
- Expensive if on piles
- Foundation for screen adds cost
- Longer/more $ piping runs
STRUCTURAL CONSIDERATIONS IN DATA CENTERS
> TRADE-OFF STRUCTURAL DECISIONS

Cost vs. Schedule

or
**Cost vs. Schedule vs. Quality**

- Let SE know your priority
- Change one, the other two change
- Cost/Schedule can limit flexibility
STRUCTURAL RECOMMENDATIONS FOR FUTURE-PROOFING
Future-Proofing Recommendations

1. Loading Considerations
2. Geotechnical Considerations
3. Future Flexibility
Loading Considerations

Mexico City, 1985
Loading Considerations

- Design to an 85% “Unity Factor”

6. \(1.2D + E_v + E_h + L + 0.2S\)
7. \(0.9D - E_v + E_h\)

STANDARD ASCE/SEI 7-16
Loading Considerations

- Design to an 85% “Unity Factor”
- Use Increased Importance Factor

Consider:

<table>
<thead>
<tr>
<th>Tier</th>
<th>Snow Importance Factor, ( I_s )</th>
<th>Ice Importance Factor—Thickness, ( I_t )</th>
<th>Ice Importance Factor—Wind, ( I_w )</th>
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Buildings and other structures designated as essential facilities
Loading Considerations

- Design to an 85% “Unity Factor”
- Use Increased Importance Factor
- Increase Floor Live Load by x%
Loading Considerations

- Design to an 85% “Unity Factor”
- Use Increased Importance Factor
- Increase Floor Live Load by x%
- Design columns & foundations for increased load
Geotechnical Considerations

Seismic

Unique Soils

Deep Foundations
Geotechnical Considerations

- Involve Structural Engineer in due diligence
- The Geotech recommendations are not the sole solution
- Creativity with deep foundations in equipment yard
Future Flexibility

Facebook Data Center Los Lunas, NM
Other Considerations for Future Flexibility

- Plan for physical expansion (horizontal / vertical)
Other Considerations for Future Flexibility

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- Make structural design loads visible
Other Considerations for Future Flexibility

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- Design all rooms as data halls
Other Considerations for Future Flexibility

- Plan for physical expansion (horizontal / vertical)
- Make structural design loads visible
- Design all rooms as data halls
- Raised floor considerations
 Loads will continue to get heavier in the future

 Unlike IT/MEP, the structure is permanent

 So factor structural future-proofing into your thinking today

 Because the TCO for doing so is low
QUESTIONS?