2021 Grid of the Future Symposium

The Impact of Extreme Events on Electrical Substation Infrastructure in Coastal Areas

October 18, 2021

Presented By:

Connor Bowen

Burns & McDonnell Lineup

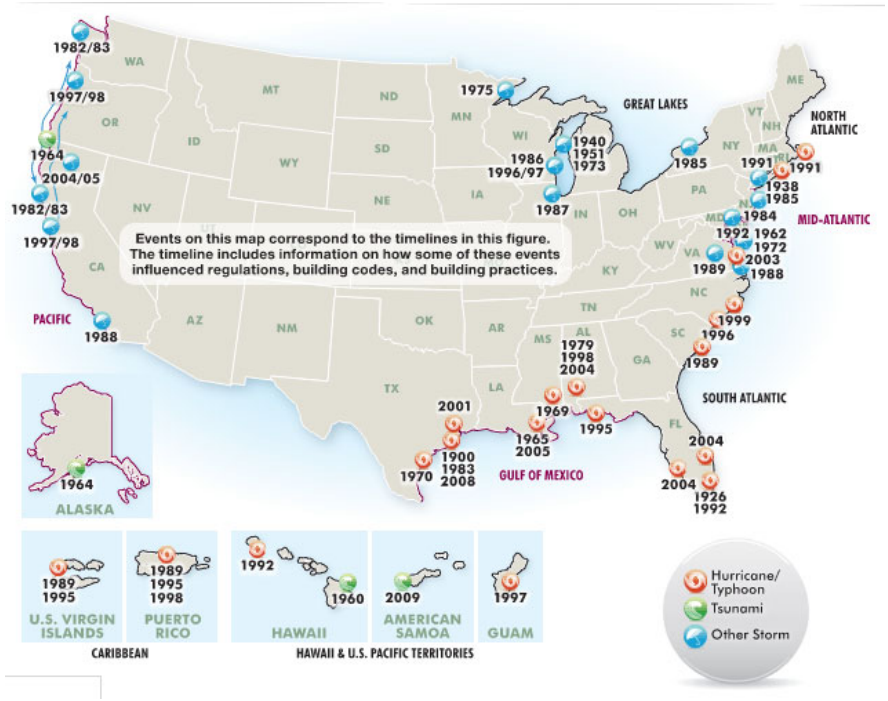
Improving Grid Infrastructure Sustainability by BIM and Optioneering Design Approach
10/18/2021 – 4:15 PM
Lyndsay Covert

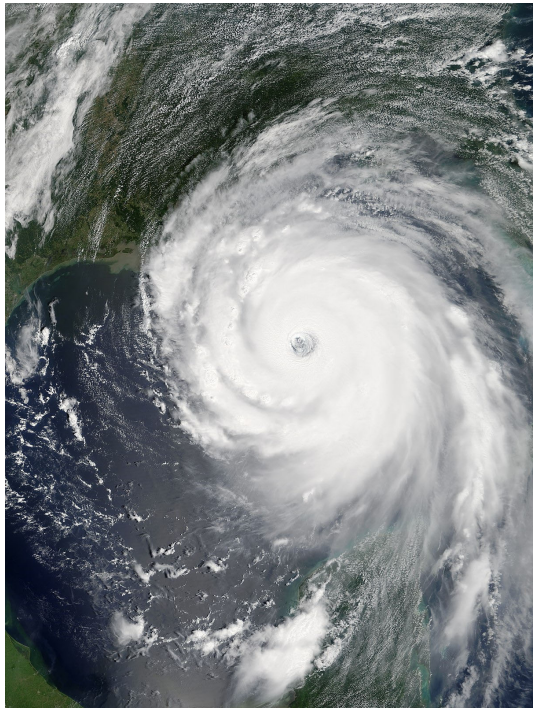
Impact of Extreme Events on Electrical Substation Infrastructure in Coastal Areas
10/19/2021 – 9:45 AM
Connor Bowen

Embracing Carbon Abatement in Concrete for the Construction of Electrical Utility Networks
10/19/2021 – 9:45 AM
Alex Pagnotta

Frequency & Historical Data

- Event Data
- Literatures
- Tsunamis
- Hurricanes
- Case Study
- Takeaways
- Q&A





Hurricane	Date	1-Minute Sustained Wind Speed (mph)
Katrina	August 2005	175
Laura	August 2020	150
Ida	August 2021	150

Design Guides & Standards

- ASCE 113 – Substation Structure Design Guide
- ASCE 7 – Minimum Design Loads for Buildings and Other Structures
- ASCE 24 – Flood Resistant Design and Construction

ASCE
AMERICAN SOCIETY OF CIVIL ENGINEERS

Tsunami Load Development

- Hydrostatic
- Hydrodynamic
- Debris Impact

Hurricane Load Development

- Wind Loadings
  - ASCE 7-16 Figure 26.5-1
  - Saffir-Simpson Hurricane Scale

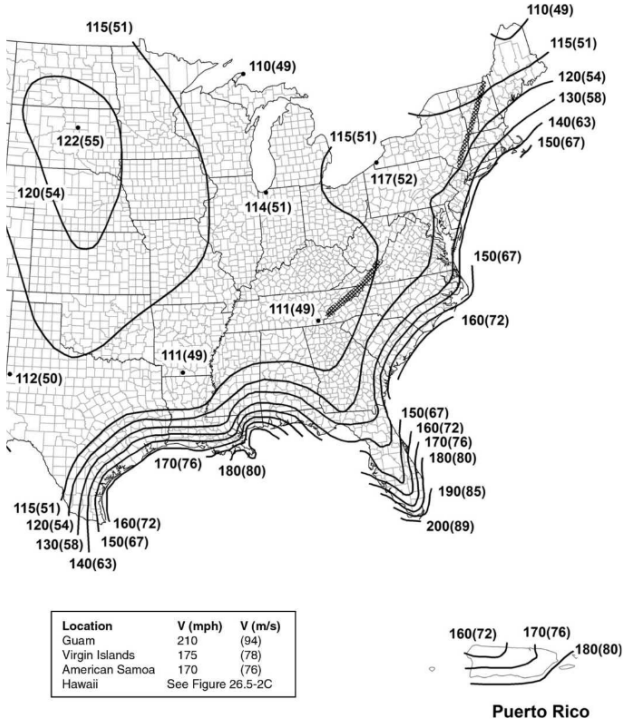
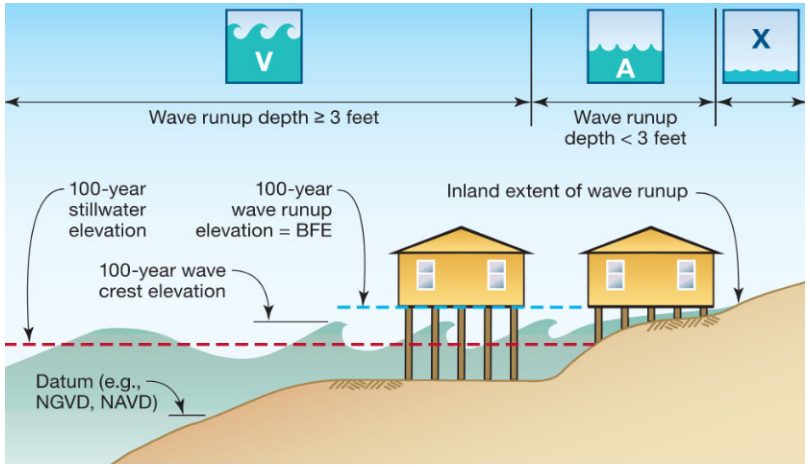


FIGURE 26.5-1C (*Continued*). Basic Wind Speeds for Risk Category III Buildings and Other Structures

Strength	Sustained Wind Speed (mph)*	Gust Wind Speed (mph)**	Pressure (millibar)
Category 1	74-95	89-116	>980
Category 2	96-110	117-134	965-979
Category 3	111-130	135-159	945-964
Category 4	131-155	160-189	920-944
Category 5	>155	>189	<920

Hurricane Load Development (Cont'd)

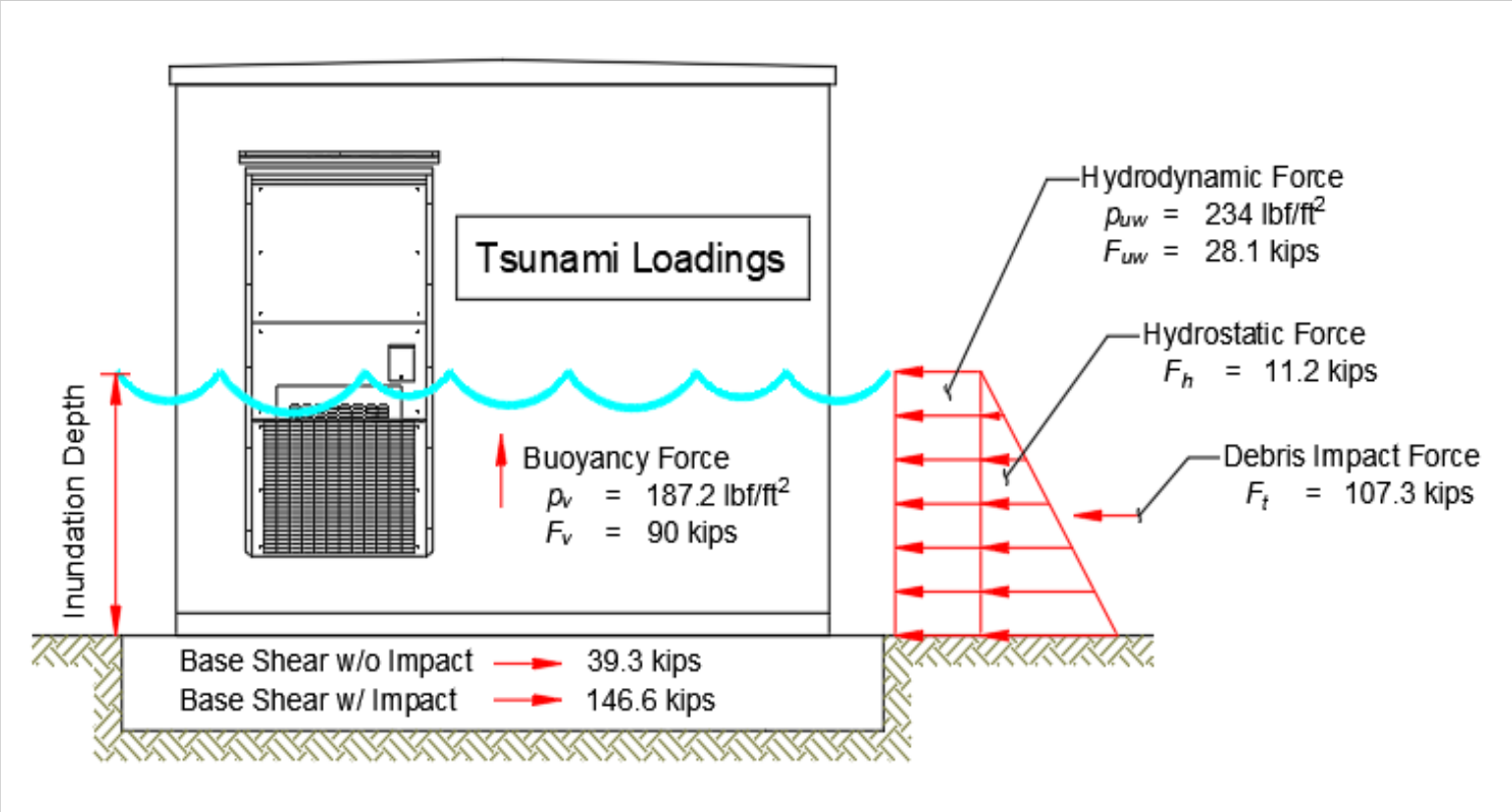
- Flood Loadings
  - Hydrostatic
  - Hydrodynamic
  - Flood Wave Loads
  - Flood Impact Loads



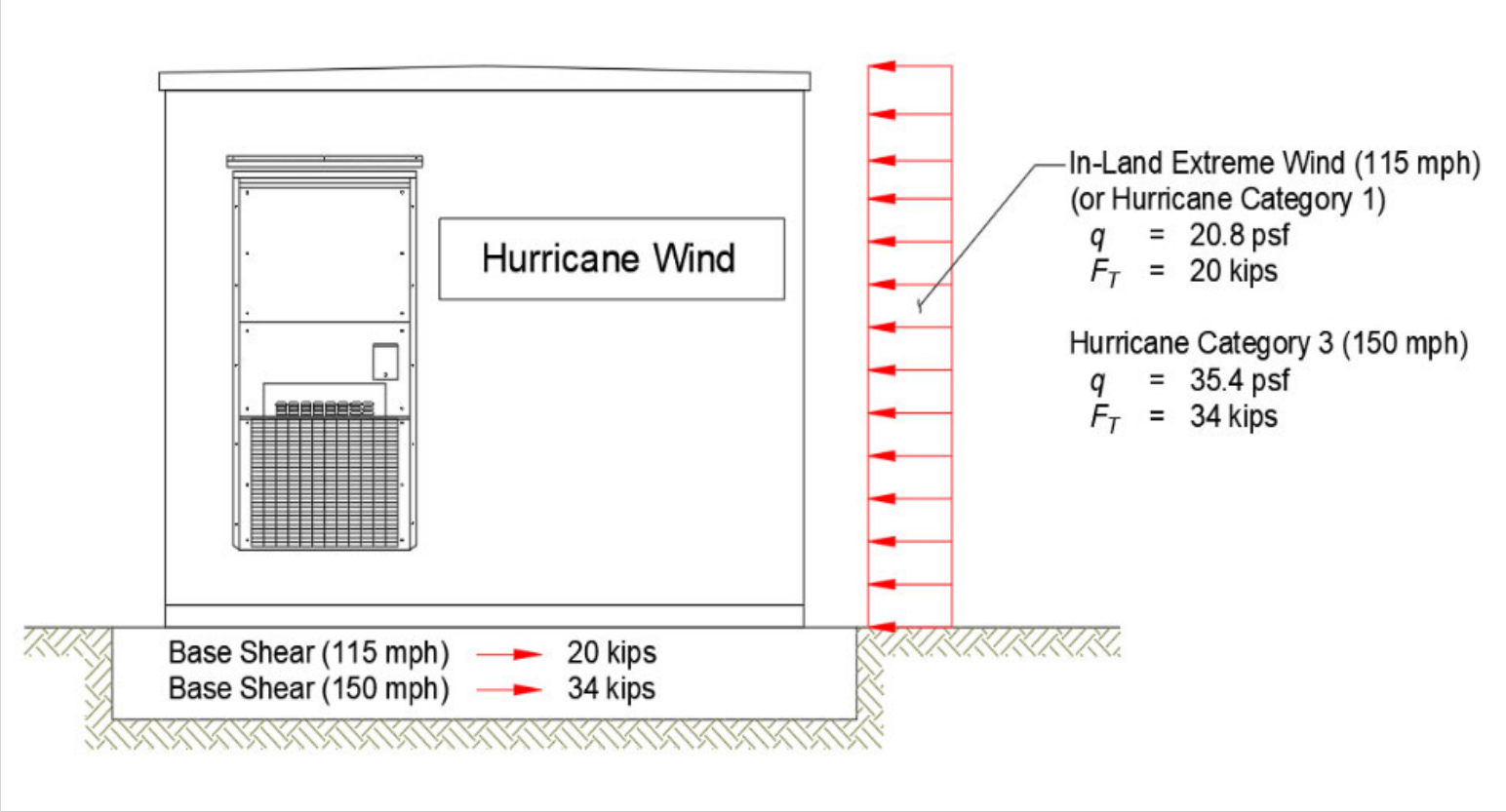
Case Study (Analysis Overview)

- Compare loadings from hurricane and tsunami to inland extreme wind
  - Risk Category
  - Inland extreme wind speed
  - Building Dimensions
  - Only Shear Considered
  - Simplified wind force calculation

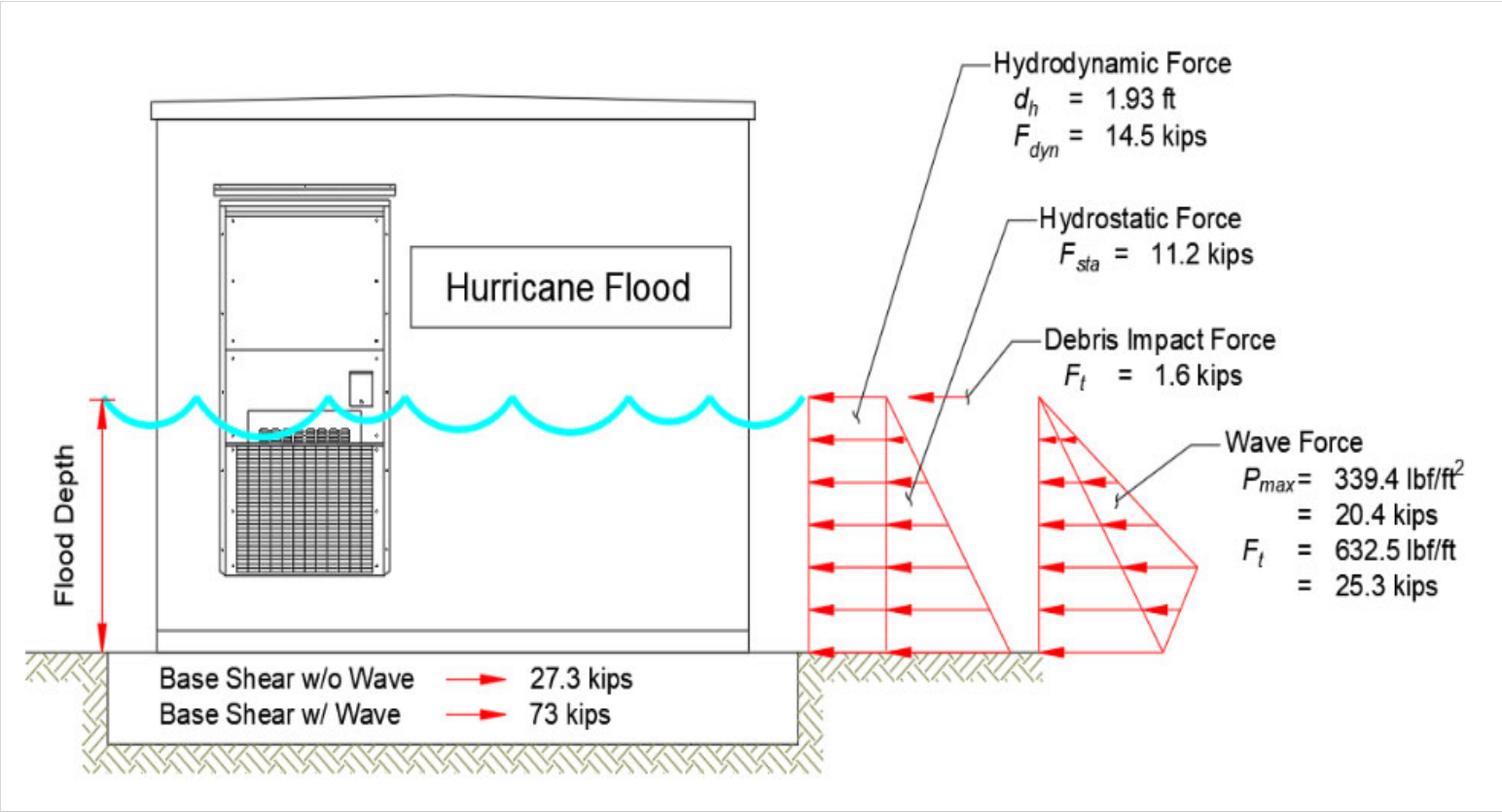
Case Study (Tsunami Loadings)



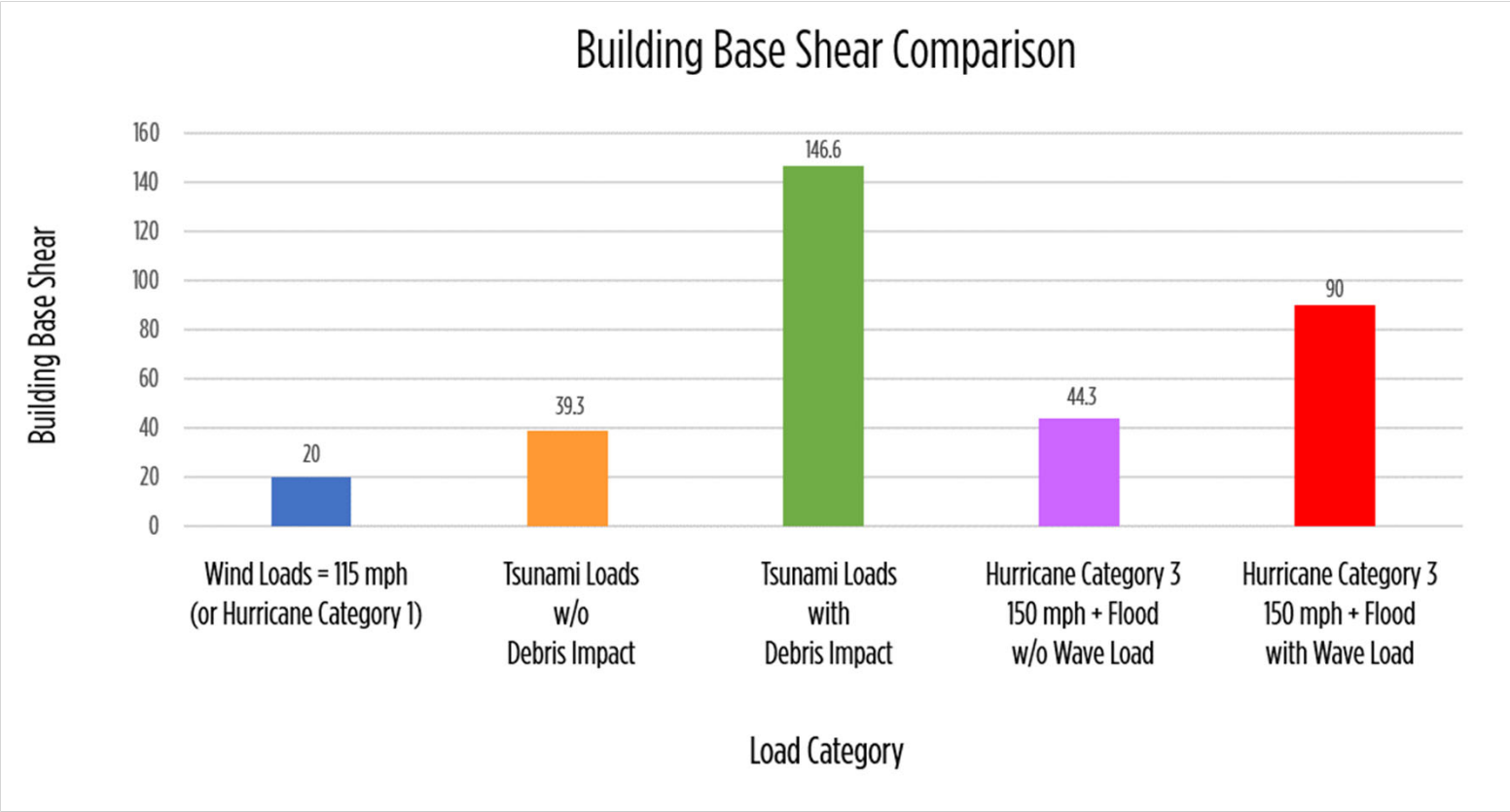
Case Study (Hurricane Wind Loadings)



Case Study (Hurricane Flood Loadings)



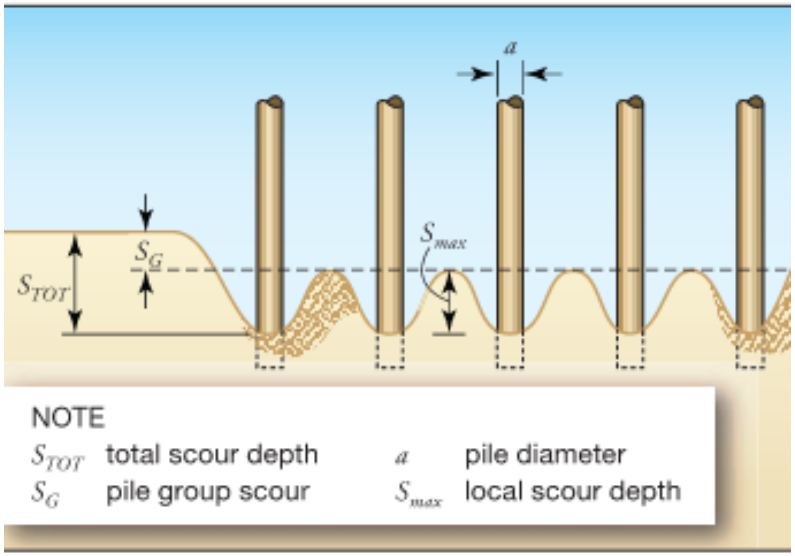
Case Study (Load Comparison)



Recommendations

- Substation Design Considerations
  - Control Buildings – ASTM E1996 Missile Loads
  - Foundations - Erosion and Scour

Missile	Missile Weight	Impact Speed	Momentum
ASTM E 1996–D	9 pound 2x4 lumber	50 feet per second (34 mph)	14 lb_f-s*
ASTM E 1996–E	9 pound 2x4 lumber	80 feet per second (55 mph)	22 lb_f-s*
FEMA 361 (Shelter Missile)	15 pound 2x4 lumber	147 feet per second (100 mph)	68 lb_f-s*



Q&A

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