

IOWA STATE UNIVERSITY
Hexcrete Tower Project (DE-EE0006737)



Concept and Benefits of Hexcrete Tower

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Iowa State University

Outline

- Motivation
- Concept
- Accomplishments (Phase I and Phase II)
- Phase II tests

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Motivation

- Increase tower height
- Eliminate transportation challenges



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Benefits of Taller Towers

- Increased wind speed
- Steadier wind condition
- Higher power output (due to increased harvest time)
- Facilitates increase in turbine capacity and blade length
- Harvest energy where the demand is high (especially in the US)

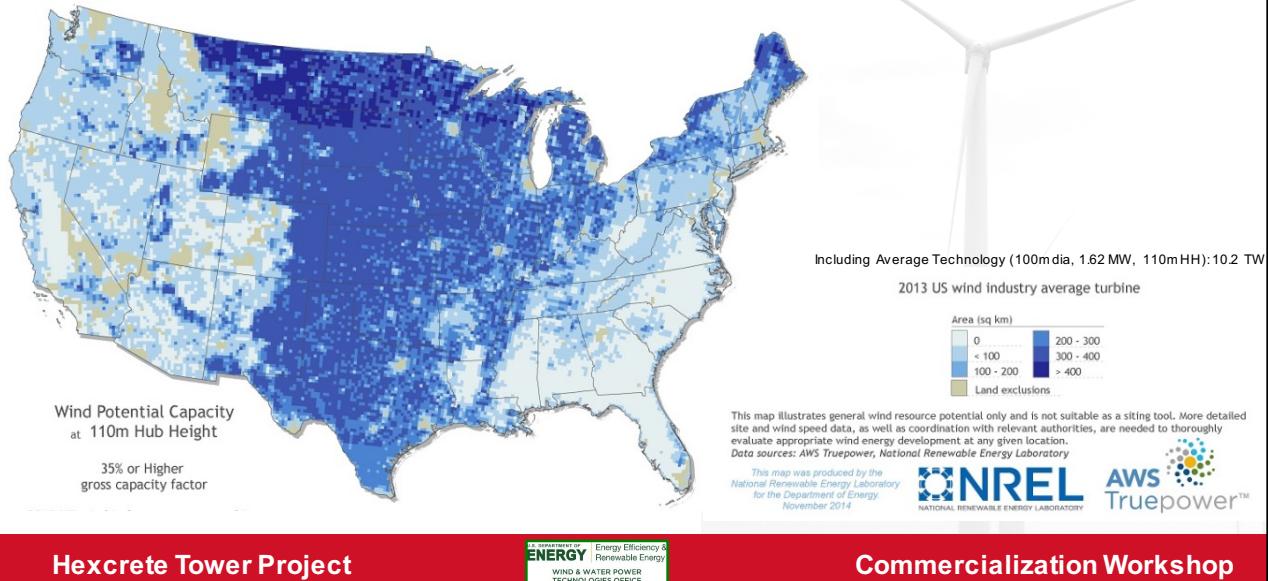


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Wind Potential at a 110 m Hub Height

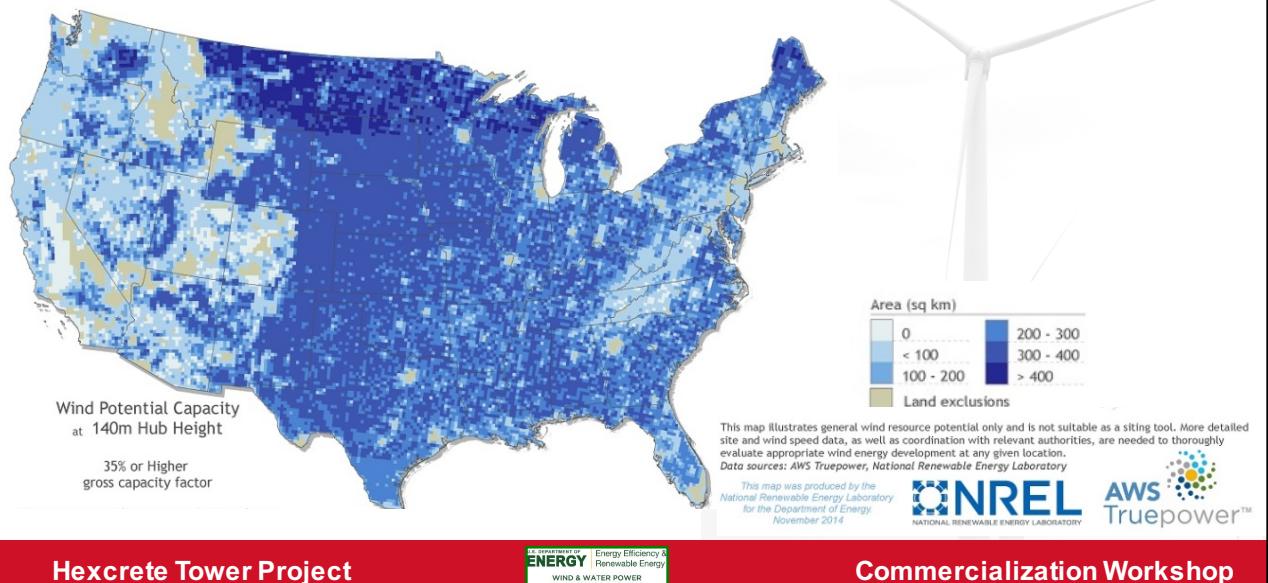


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Wind Potential at a 140 m Hub Height



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100 m Steel Tower (ISU Design)

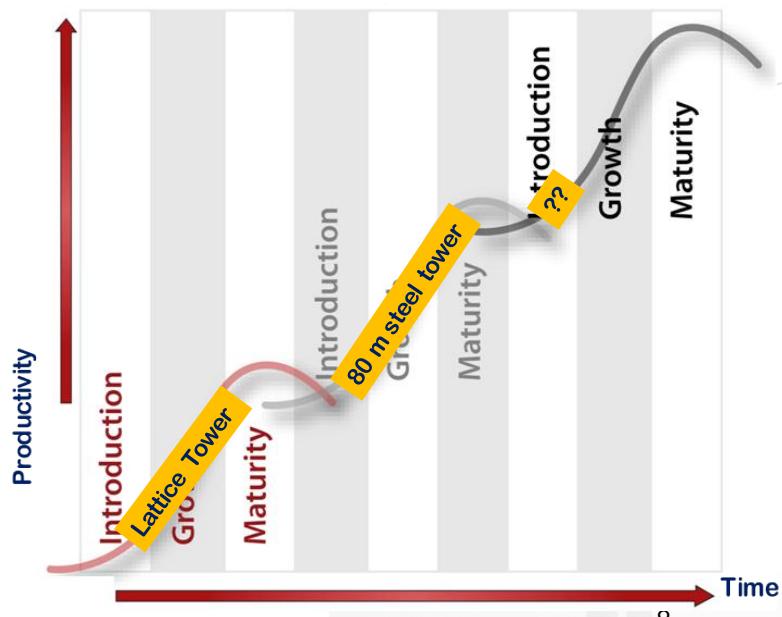
- Base Diameter: 18 ft (5.5m) – base dimension cannot be transported as a single piece
- Base Shell Thickness: 1.5 in (38.1 mm)
- Top Diameter: 10 ft
- Top Shell Thickness: 0.80 in (20.3 mm)
- Volume of steel increases by a factor of 2 – increases the lead time
- Tower design is governed by fatigue – imposes a shorter lifetime

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Tower Technology



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Utilizing Concrete....

- Curved sections – increases formwork and labor costs
- Normal concrete – increases overall dimensions and weight while limiting the rotor diameter
- Large sections – increases logistical challenges and transportation costs



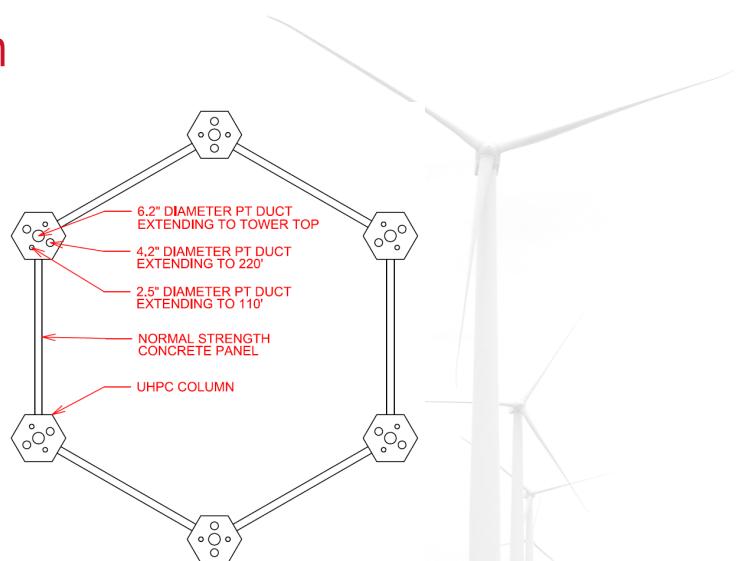
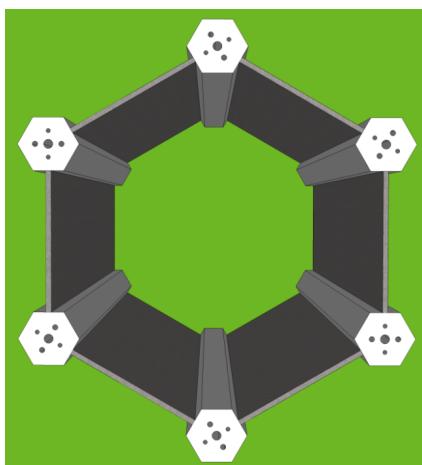
Source: www.inneo.es

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The Hexcrete Solution



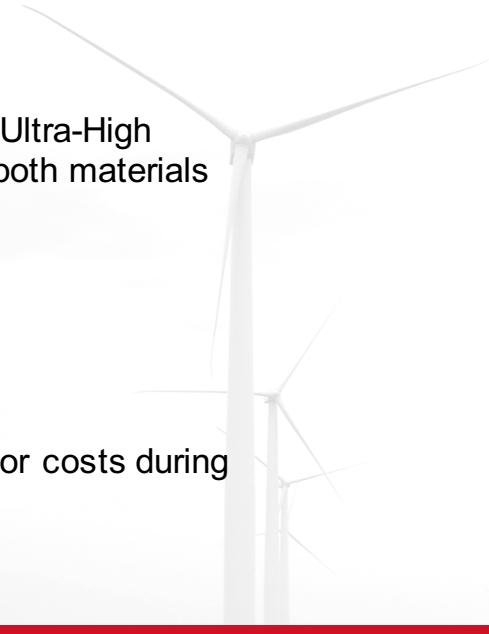
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Features of Hexcrete

- Uses High Strength Concrete (HSC) and Ultra-High Performance Concrete (UHPC) – one or both materials can be used
- Enables stage post-tensioning
- Facilitates tailorability
- Relies on easily transportable modules
- Increases tower life span
- Avoids specialized formwork and high labor costs during prefabrication



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Expected prefabrication...



- Uses existing technology



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This inaugural interactive symposium on Ultra High Performance Concrete will provide a platform:

- to share a knowledge about material development, structural design, and application examples
- to identify knowledge gaps, and
- to advance the UHPC design and applications worldwide

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uhpc2016.com

DES MOINES, IOWA

JULY 18-20, 2016

FIRST INTERNATIONAL INTERACTIVE SYMPOSIUM ON UHPC

IOWA STATE UNIVERSITY U.S. Department of Transportation Federal Highway Administration IOWA DOT LafargeHolcim BEKAERT LEHIGH WHITE CEMENT aci American Concrete Institute CSCE PCL Precast/Prestressed Concrete Institute

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A 100-m Tall Hexcrete Tower

- Uses columns and panels (no curved sections)
- Tower base diameter: 20 ft (6.2 m)
- Tower top diameter: 10 ft (3.1 m)
- Column diameter at base: 30 in. (76 cm)
- Column diameter at top: 15 in. (33.8 cm)
- Use both HSC and UHPC
- Can reduce concrete volume up to 50%

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Expected transportation...



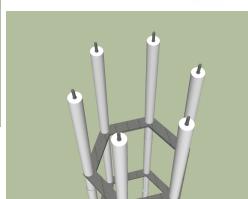
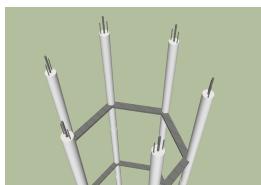
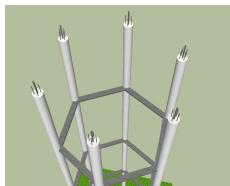
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Assembly Option 1

- Erect columns and attach panels over a preselected height and repeat

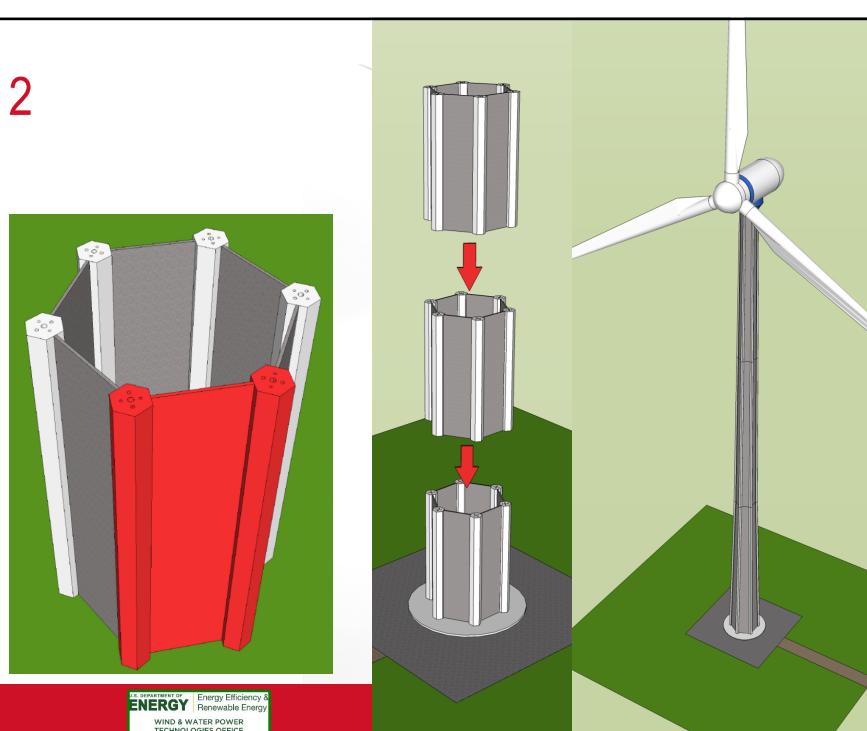


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Assembly Option 2

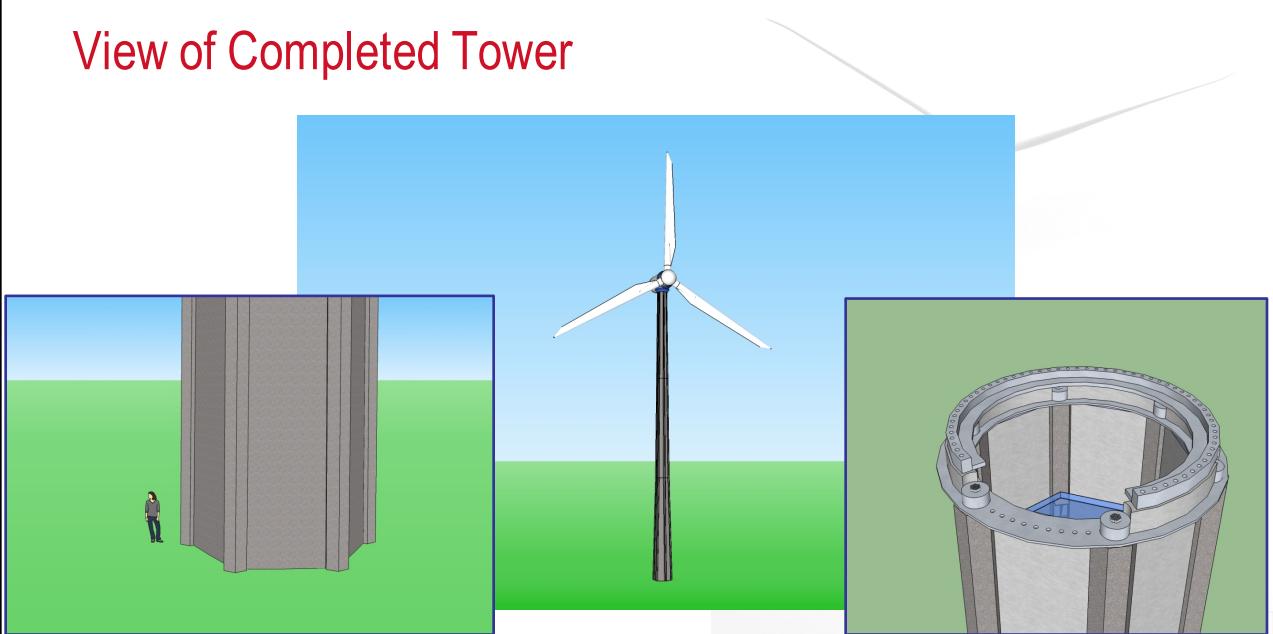
- Form cells on or off site and stack on top of each them



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View of Completed Tower



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Phase II Study - Completed

- Focus – connection design
- Testing of connections
- Develop design methods for connections

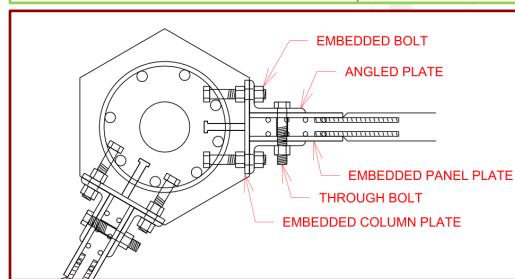
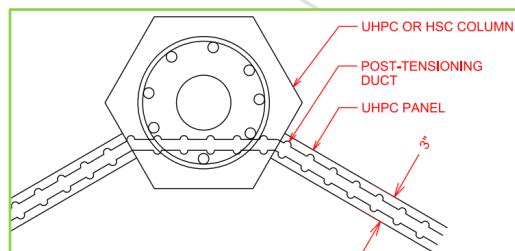
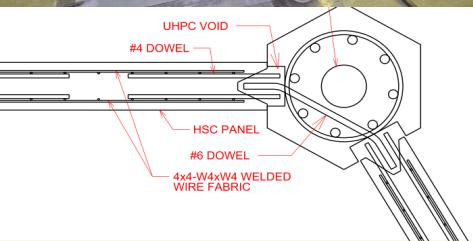


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Different Options



LAFARGE
NORTH AMERICA **CORESLAB.**
STRUCTURES
(OMAHA) INC

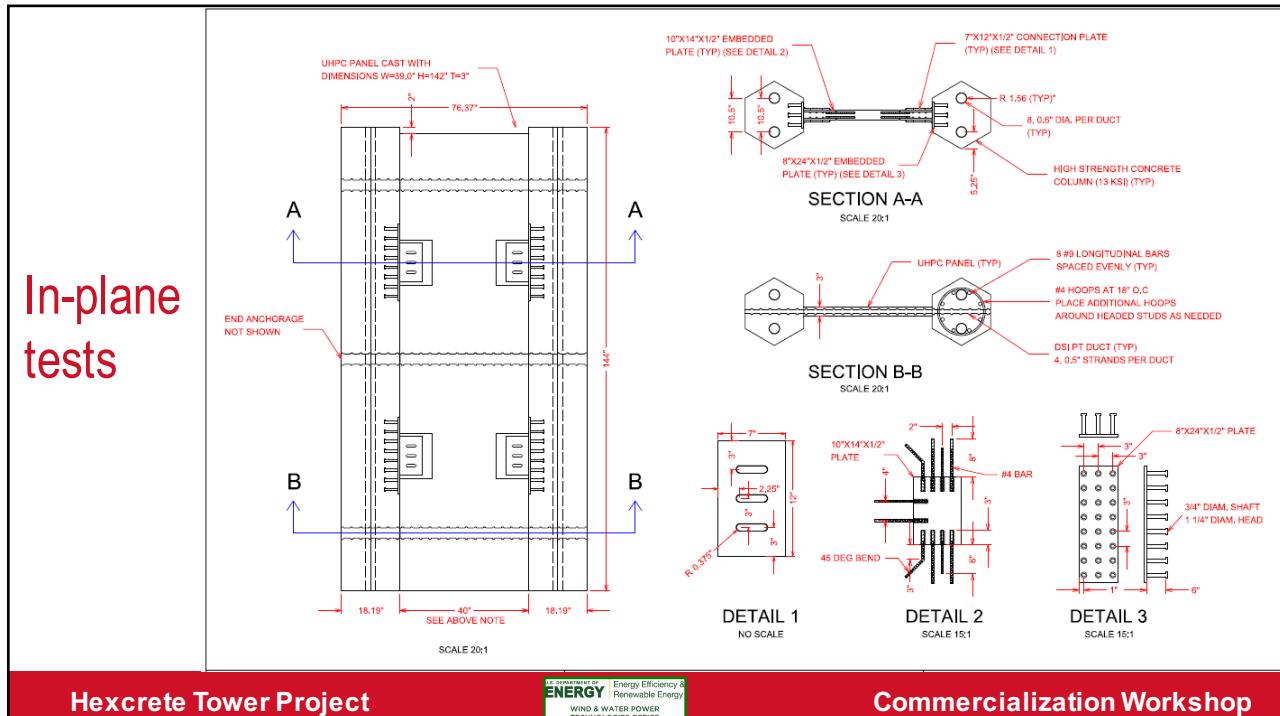


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In-plane tests



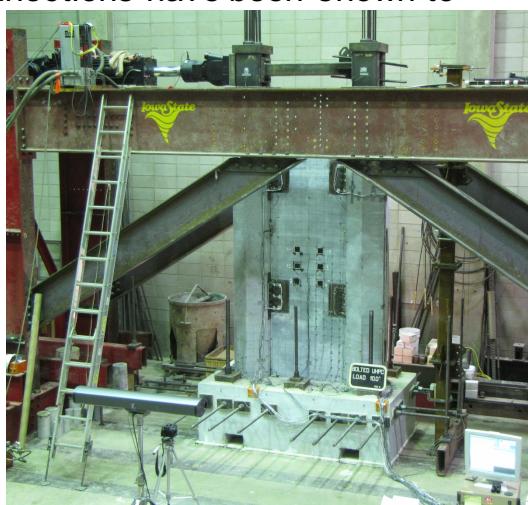
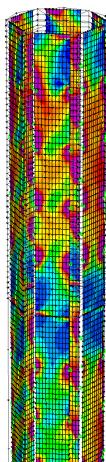
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Testing @ ISU

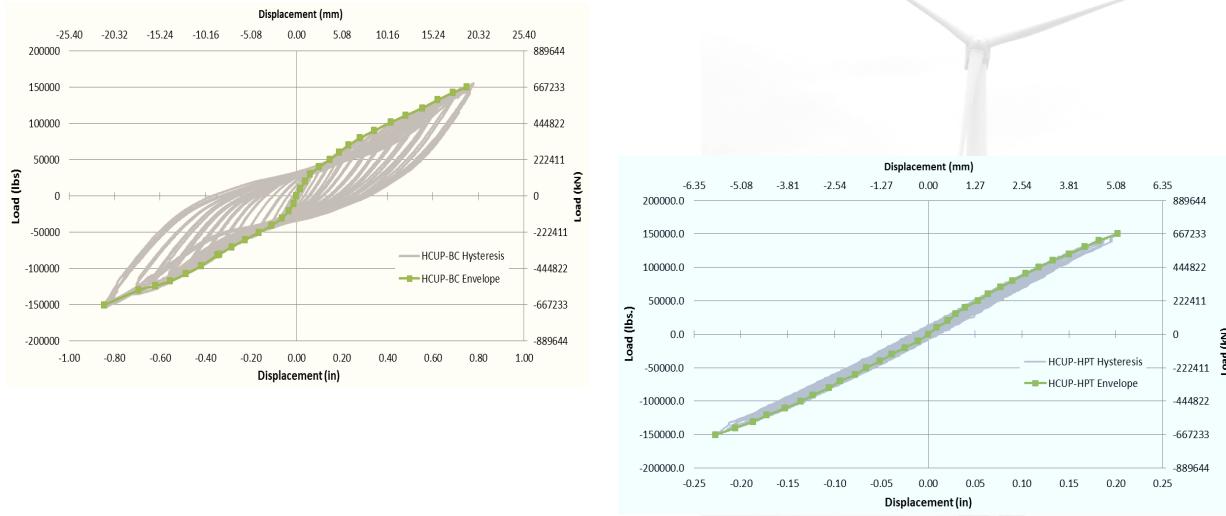
- All three connections have been shown to be viable



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Measured Responses



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Summary

- Modularized tower enables easier transport, which will significantly reduce the transportation cost.
- The new concept facilitates the overall dimensions of the towers to be kept similar to the steel towers.
- Performance of all test units were extremely satisfactory under operation and extreme load conditions
- In all cases, sufficient reserve capacity beyond the extreme load condition was quantified.
- Combination of HPC and UHPC led multiple options for the user, and three connections between the columns and panels.

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