



An Intertek Company

*"Providing the conduit between
research and the market"*



New York Wind Turbine

Blade Test Facility:

An Opportunity for Turbine Manufacturers and Research



Prof. Pier Marzocca
Mechanical and Aeronautical Engineering Department

Prof. Kerop Janoyan
Civil and Environmental Engineering Department

Daniel Valyou
Facility Manager, CECET BTF

Sponsored by:



Partners:



AWS Truepower™
Where science delivers performance.

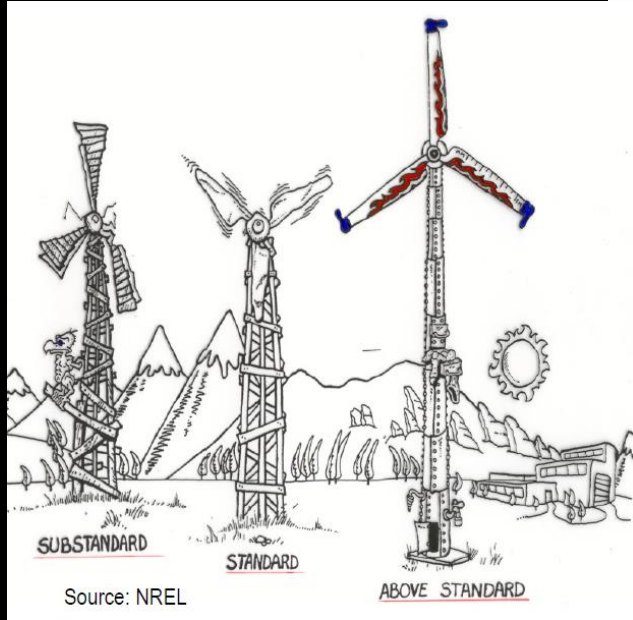


SYRACUSE COE
center of excellence



PROGRAM GOALS

Problems



Solutions



Facility Capabilities



- Structures and Materials Testing Laboratory

- ❑ Full-scale/scaled wind turbine blade testing up to 15 meters
- ❑ New rotor blade designs with cost effective testing capabilities
- ❑ Material selection, evaluation of the structural lay-out
- ❑ New testing methodologies in support of NREL and SANDIA

- Blade Test Facility



Testing Services

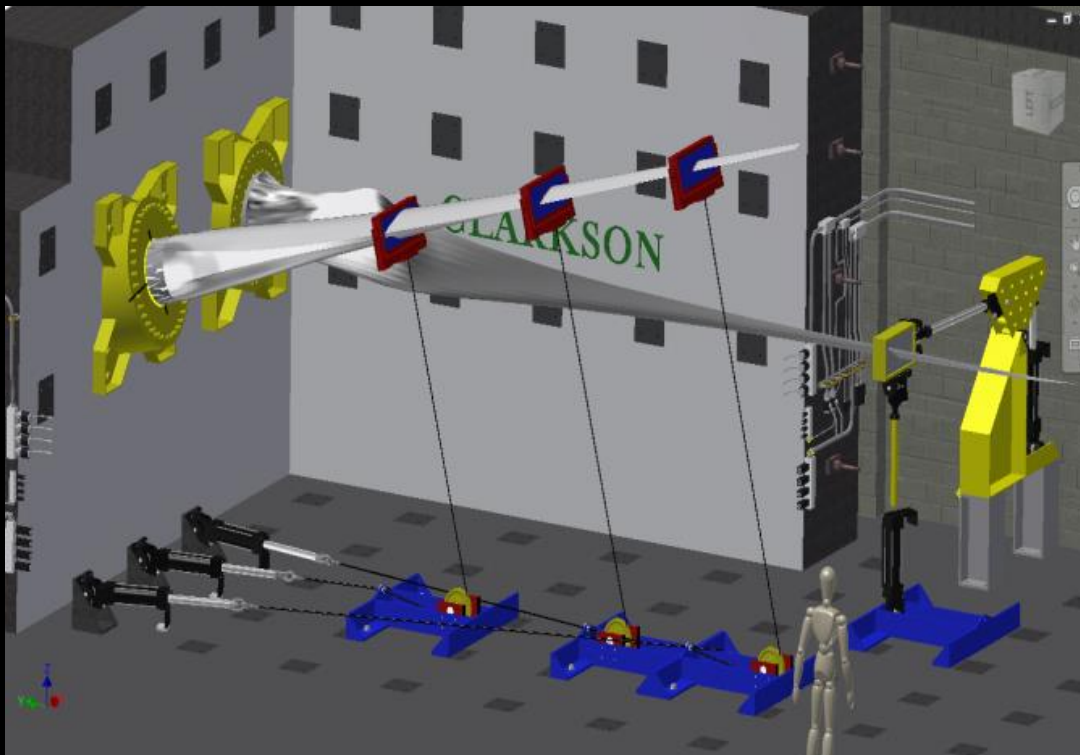
Services for Wind Turbine Blade Testing:

- ☐ Certification testing services
 - ☐ IEC 61400-2
 - ☐ IEC 61400-23
 - ☐ AWEA 9.1
 - ☐ MCS 006
 - ☐ RUK 2014 (formerly BWEA 2008)
- ☐ Rotor blade design validation
- ☐ Manufacturing quality verification
- ☐ Validation of design improvements
- ☐ Rotor blade – hub integration
- ☐ Structural integrity under load

Additional wind structures services:

- ☐ Testing nacelles and towers
- ☐ Testing advanced blade sensing and actuators
- ☐ Testing of material/structural coupons (*)
- ☐ NDT methods developed for rotor blades (*)
- ☐ Testing advanced pitch and stall control algorithms (*)

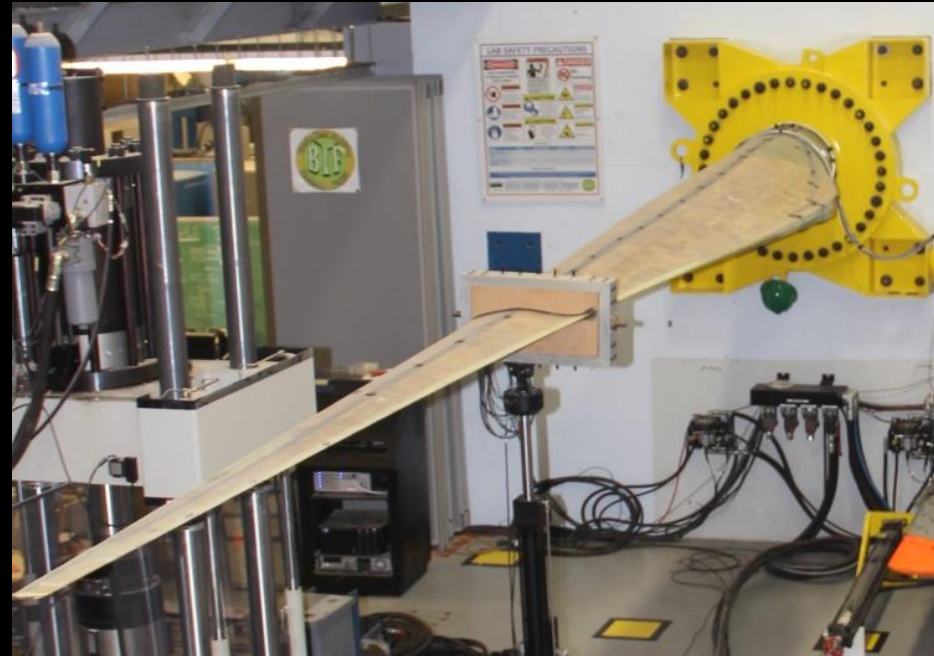
- Conducted via Center for Advanced Materials Processing



Blade Structural Testing



Static Test



Fatigue Test



Blade Testing: Testing

Blade Testing (static, fatigue, and modal)

Safety Features

- Load Abort system
- Load Limiting Manifold
- Redundant interlocks
- Separate hydraulics per station



BSDS Modal Testing



Blade Testing: Static Test pull (8X)



Blade Testing: Fatigue Testing



Blade Testing: Results

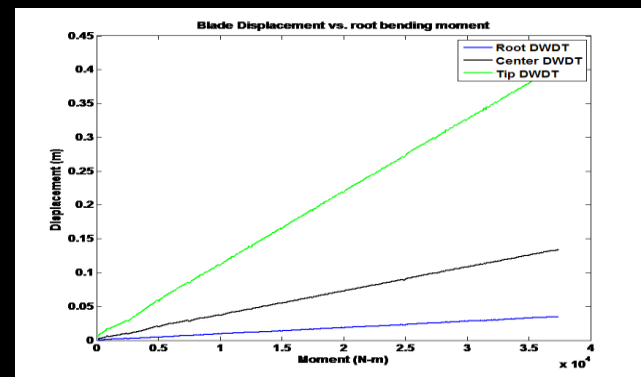
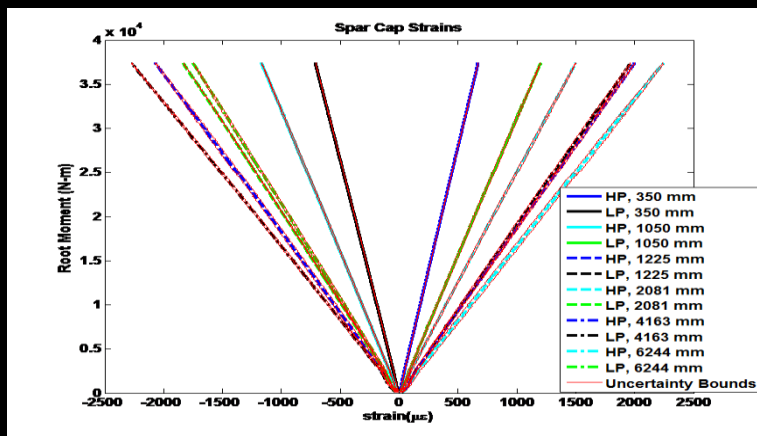
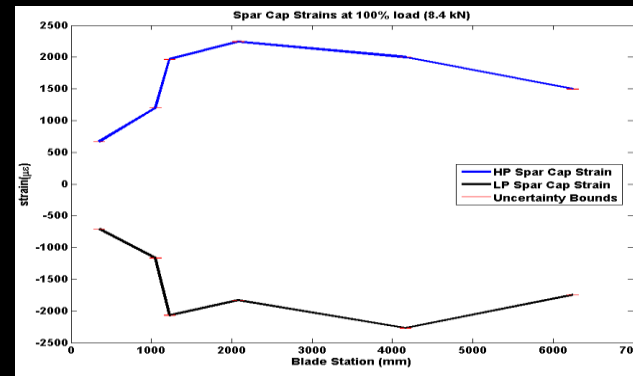
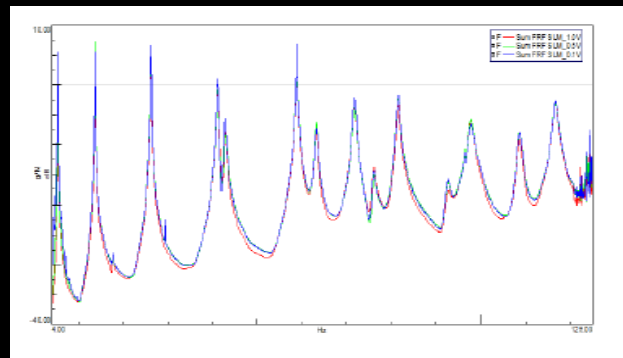
Test results

Test data

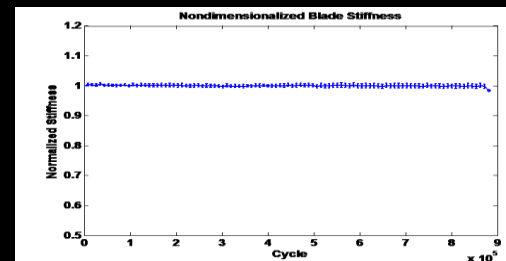
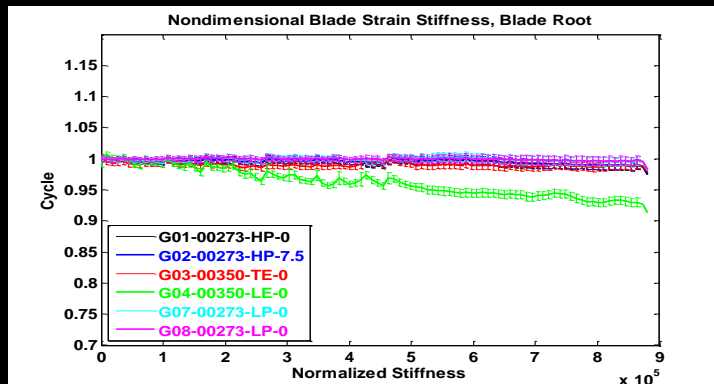
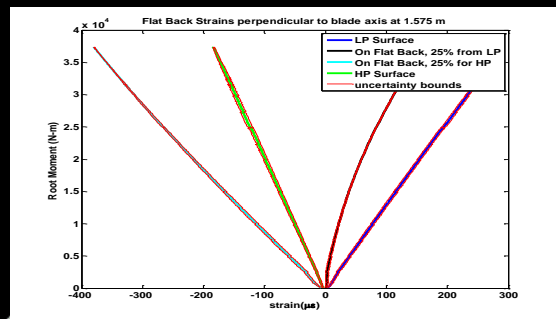
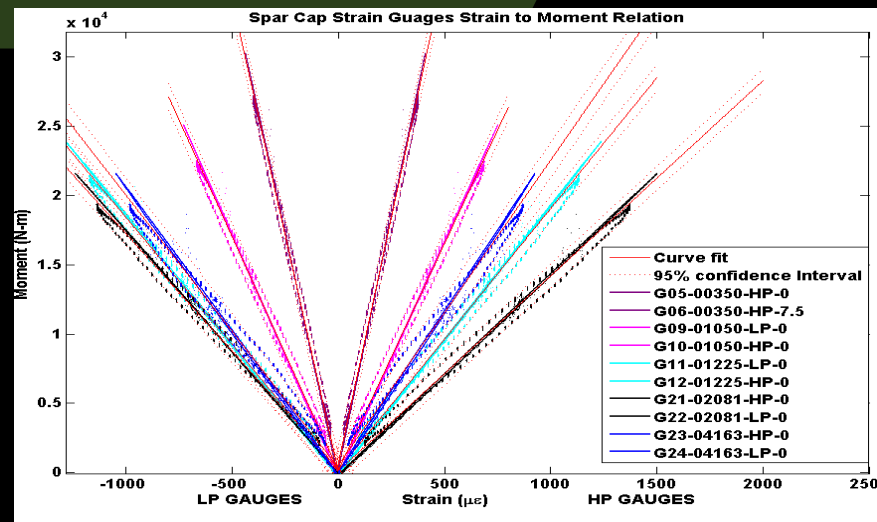
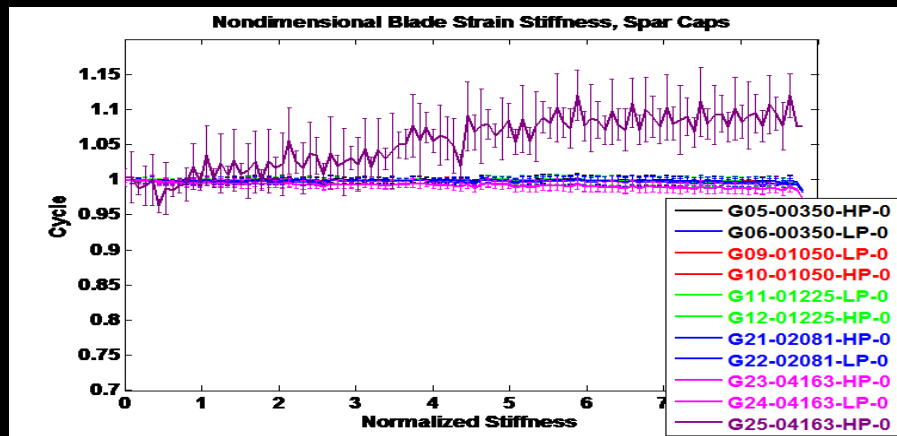
Data analysis

Reporting

Failure criteria



Blade Testing: Results



Clarkson University Wind Tunnel



Clarkson University Subsonic Tunnel # 1

80 m/s subsonic tunnel outfitted for aerodynamic testing with a 6 component force balance, several position control systems, particle image velocimetry (PIV), laser doppler velocimetry (LDV) and flow visualization. Suitable for aerodynamic testing, scale and small wind turbine testing.



Clarkson University Subsonic Tunnel # 2

12 m/s subsonic tunnel with high inlet air quality, established through 228 sq. ft. of HEPA filter. Suitable for aerosols testing and environmental / low speed wind testing.



Clarkson University Wind Tunnel

Visualization systems (PIV, PDPA, high speed camera)

Particle Image Velocimetry (PIV): Used for non-intrusive laser optical measurements. Measurement data include velocity, concentration, temperature, combustion species and particle size.

Phase Doppler Particle Analyzer/Laser Doppler Velocimetry (PDPA/LDV): Pre-configured three-component (3D) PDPA/LDV system is used to get all three components of velocity simultaneously.



High Speed Camera: 5,000-100,000 frames per second used to capture images of rapidly moving objects or interfaces.



Clarkson University Wind Tunnel – Wind Turbine Testing



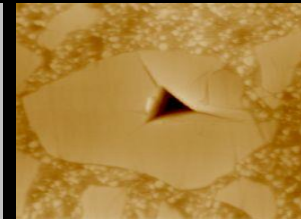
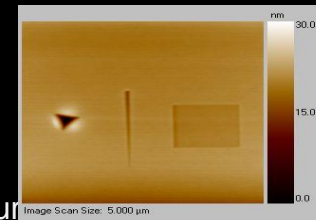
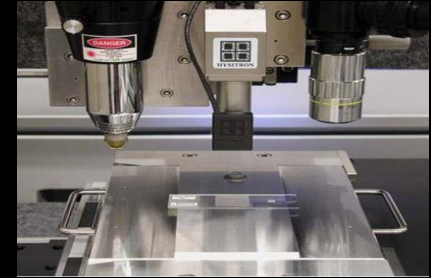
Workforce and Training Development Courses

- ❑ The BTF supports industry participation & continuing education through Distance Learning and Workforce Development Program.



Additional Testing Capabilities

- **Micro- and nano-scale testing capabilities**
 - Nanoindentation
 - Protective Coatings
 - Nanomechanical testing of thin films for integrated Circuits
 - Thin films for composites, disks, and passivation layers
 - Scanning Tunneling Electron Microscopy
 - Atomic Force Microscopy
 - Used to study NanoMechanics
 - Nondestructive measurement of specimens down to molecular size
 - Capable of viscoelastic characterization
 - Hardness and Microhardness
 - Rockwell, Knoop, and Vickers hardness
 - Leco Microhardness Tester
 - Dynamic Mechanical Analyzer
 - Characterize Polymer and composites viscoelastic properties
 - Thin film / single fiber tensile testing
 - Thermo Mechanical Analyzer
 - Characterize material dimensional responses to time, temperature or force
 - Measures coefficient of thermal expansion, heat distortion temperature, stress/strain ramps, creep, stress relaxation
 - Suitable for dynamic thermomechanical analysis and modulated thermomechanical analysis



Additional Testing Capabilities

Macro-scale mechanical testing capabilities

- Hardness
- Wear resistance facility
- Creep related facility and Environmental chamber
- Fouling and corrosion accelerated testing facilities
- Wabash Hydraulic Heated Platen Press
 - Composite Molding
 - Ceramic Molding
- High temperature Mechanical Testing System
- Spin Coater for thin film processing
- Multi-gravity research welding system
- Oven and Laboratory hoods
- Advanced Welding and Welding Metallurgy facility
- Mechatronics Lab and prototyping shop
- Research Machine Shop
- Vibration and Control Systems Testing facility



Additional Testing Capabilities

Creep Related Facility and Environmental Chambers

- Electromechanical load frames
- Bending creep test machine
- Coefficient of thermal expansion testing of long gage-length specimens
- Load frame temperature chambers



Additional Testing Capabilities

Research Machine Shop Fabrication Capabilities

- Standard and CNC milling machines
- Standard and CNC lathes
- Rapid Prototyping
 - Stereolithography
 - 3D Printing (Makerbot)

Stereolithography

http://www.clarkson.edu/rapidprototype/docs/Stereolithography_Pres.ppt
Clarkson is using a Viper Si2 ® SLA system with epoxy resin



CONTACT US

CECET BLADE TEST FACILITY, bladetest@clarkson.edu

Prof. Pier Marzocca, CECET Representative and Co-Director, pmarzocc@clarkson.edu

Prof. Kerop Janoyan, BTF Co-Director, kjanoyan@clarkson.edu

Daniel Valyou, Facility Manager/ Test Engineer, valyoudn@clarkson.edu

Rick Lewandowski, CECET Executive Director, Richard.lewandowski@intertek.com

Current staff includes 5 core faculty, a dedicated facility manager, three graduate students, two undergraduate students, and three external consultants.