

Monolithic

Carbon Fiber Wind Mill Blade

NCRAC 2012, Hyderabad

15th June

Nachiket Thakur

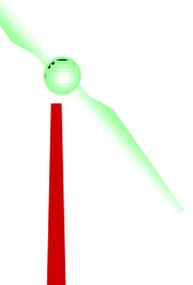
Head, Innovation Center, GM, Product Design & Development

 **Mahindra composites**

Mahindra composites



Innovative composite solutions



Summary

Salient Features

Material & Process

Development

Learning's

Team



Monolithic Carbon Fiber Wind Mill Blade



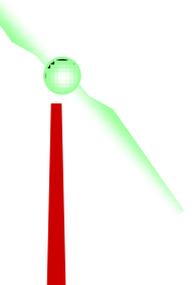
Market Scenario

674 Small Wind Turbines
521 Horizontal Axis Wind Turbines (HAWT)
152 Vertical Axis Wind Turbines (VAWT)
and **1** kite



Monolithic Carbon Fiber Wind Mill Blade





Market Scenario

- Machine sizes : 3.4 kW, 5 kW, 8kW, 10kW, 15kW, 20kW, 25kW, 30kW - Offgrid
- Blade sizes : 1.8m to 5.8 m

Reinforcement : Carbon + Glass

Matrix : Vinyl Ester + Epoxy

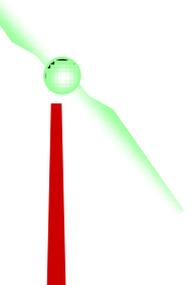
Process : HLU, Infusion, RTM

- Government Subsidies
- Wind Mill OEM's : Schneider, South West, Altem, Advanced bolting solutions,



Monolithic Carbon Fiber Wind Mill Blade





INDIA's First commercially produced single piece (Monolithic) molded blade of this size till date

The monolithic Carbon Fiber Wind Mill Blade is a unique example of detailed engineering and exquisite craftsmanship.

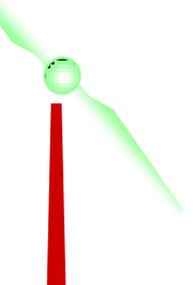
This blade is 1500 mm long having 3.4 kgs of weight used for 3.5 kW wind mill

It uses Carbon fiber as a reinforcement, structural foam as core and vinyl ester resin as matrix.

The blade is made using Vacuum Assisted Resin Transfer molding

Monolithic Carbon Fiber Wind Mill Blade



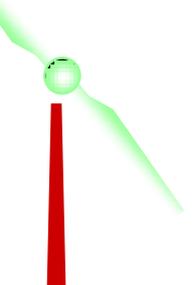


Salient Features

- a. **Single piece construction** : A specially designed & molded foam is used as an inner core, with appropriate layup to get structural strength & outer shell to get the aerofoil
- b. **Optimized Layup sequence** : A mix of unidirectional & multi-axial carbon fiber, Foam layup to get the desired strength with minimum weight for best functional performance
- c. **Critical Design optimization** : The best of the CAD & CAE tools were deployed to achieve a critical to function design optimization to get the correct combination of material & process.

Monolithic Carbon Fiber Wind Mill Blade





Salient Features

d. Process optimization : Process designed and developed to get 8 blades / day with only 2 % wastage

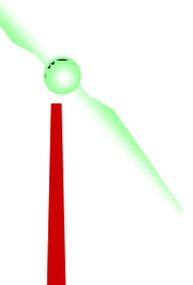
e. Indigenous Development : The entire development from design-material selection-optimization-process design-tooling development to production achieved by inhouse Mahindra Composite Team & other Development partners

f. Competitive cost : The development cost for this project was almost 80% less & the product is 40% cheaper than those available from US

g. Mold Development : Mold designed and developed using best of the materials from around the world to suit Indian molding conditions & requirements.

Monolithic Carbon Fiber Wind Mill Blade





Material

Reinforcement : Carbon Fiber UD & Combi Matt : Zoltek

Matrix : Vinyl Ester Resin : AOC

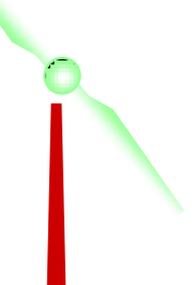
Core : PU Foam & PE Structural Foam : DIAB

Process

Vacuum Assisted Resin Transfer Molding

Monolithic Carbon Fiber Wind Mill Blade





Development Process

a. Product Design : Lay up design using UD & Multi Axial Carbon fabric, structural PE foam, Resin. Design optimization for light weight & high strength using best of the CAE tools.

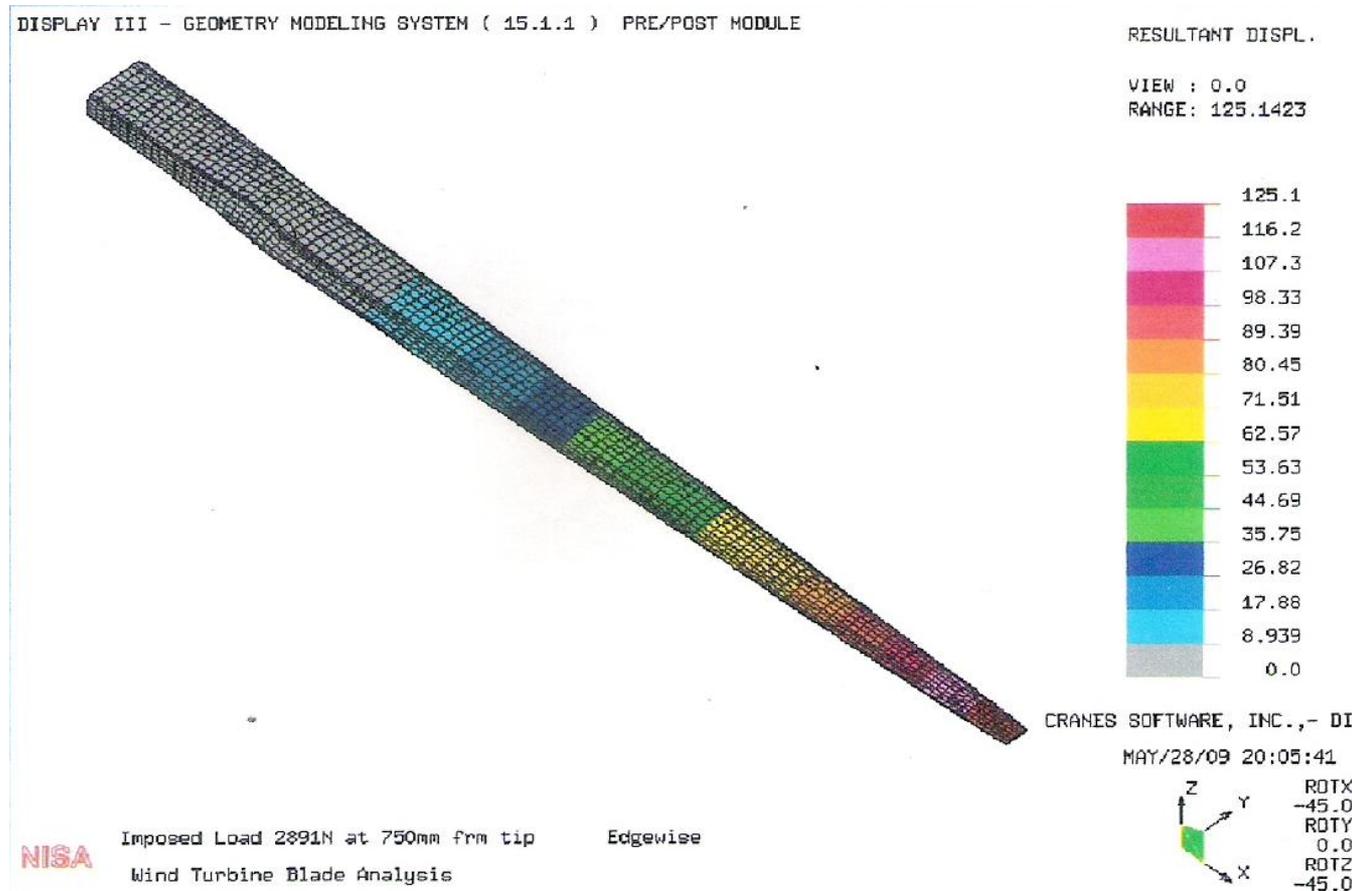
b. Process Design : To cater to the Monolithic – single piece requirement of the molded product, Vacuum assisted RTM process was customized. The correct formulation of Vinyl ester resin to suit the carbon fabric and the foam core was arrived at.

c. Tooling (Mold) Development : Appropriate molds were developed using tool grade resin to suit vacuum molding.

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Development Process : CAE

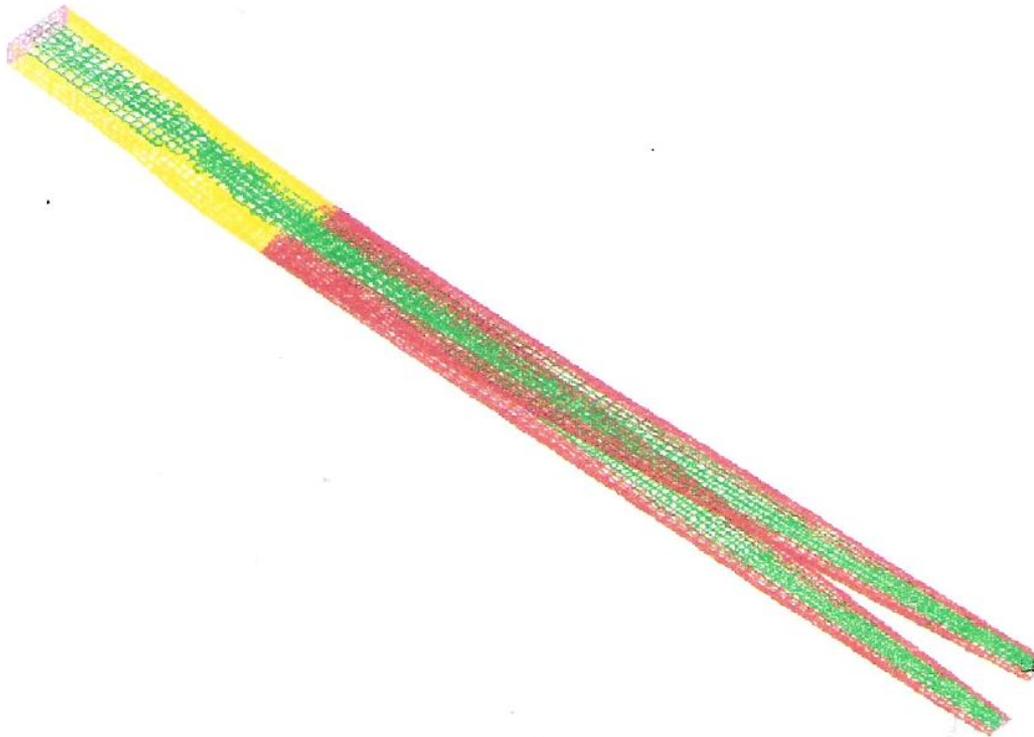


Monolithic Carbon Fiber Wind Mill Blade

Development Process : CAE

DISPLAY III - GEOMETRY MODELING SYSTEM (15.1.1) PRE/POST MODULE

DISPLACED-SHAPE
MX DEF= 1.25E+02
NODE NO.= 208
SCALE = 1.0
(MAPPED SCALING)



NISA

Imposed Load 2891N at 750mm frm tip
Wind Turbine Blade Analysis

Edgewise

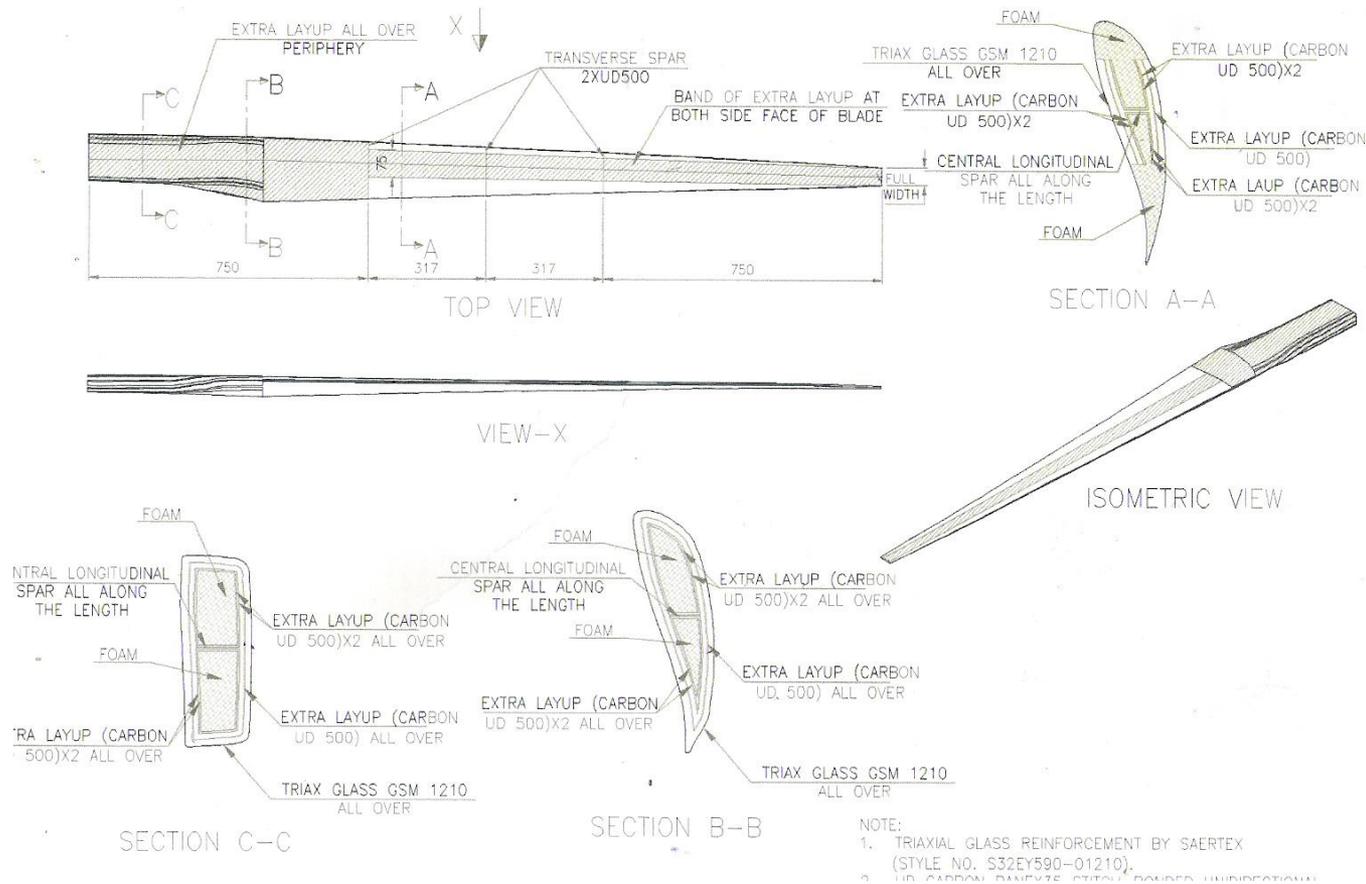
ANES SOFTWARE, INC., - DIS

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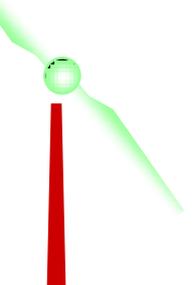
Z	RTX
Y	-45.0
X	RTY
	0.0
	RTZ
	-45.0

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Development Process : Final Design of the Blade



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Development Process

d. Part molding : To get the required weight of the component various optimization techniques were deployed. We achieved a wastage of only two percent of the raw material before starting serial production

e. Balancing : A unique 2 component balancing technique was evolved using lead pallets.

f. Production : The facility is designed for making 5 blades a day, which is a landmark

Monolithic Carbon Fiber Wind Mill Blade



Development Stages



Foam Core



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Development Stages



Pre Cut Reinforcement

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Development Stages



Mold

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Development Stages



Mold preparation



Gel coat application

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Development Stages



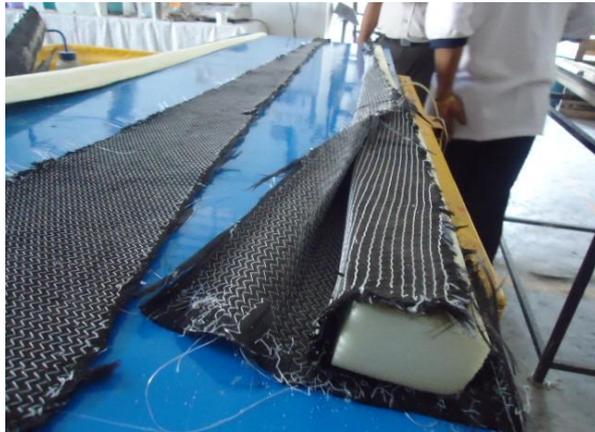
Lay-up sequence



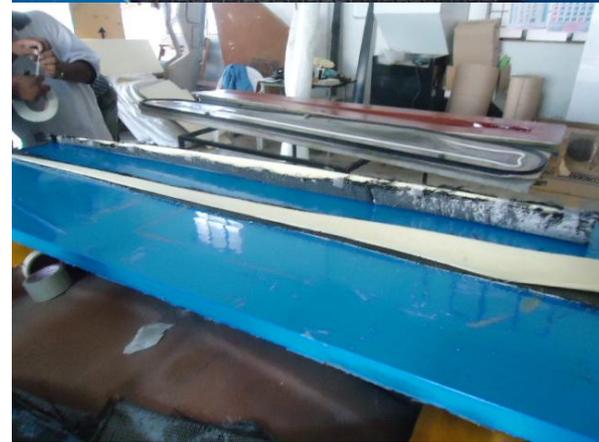
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Development Stages



Lay-up sequence



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Development Stages



Lay-up sequence



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Development Stages



Lay-up sequence



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Development Stages



**Mold Closure –
Vacuum Application**

Resin catch pot



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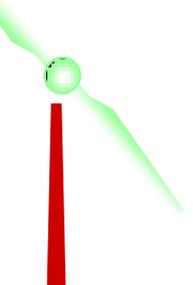
Serial Production

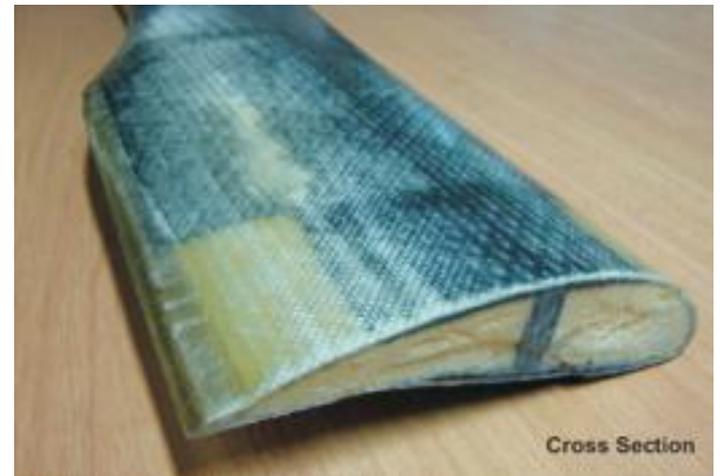


150 blades per month

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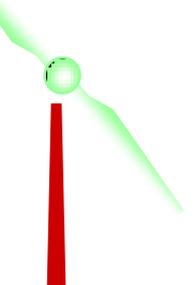

Final Blade



Cross Section

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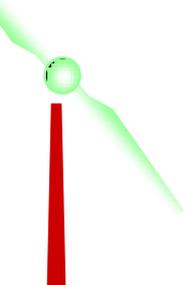
Learning

1. Appropriate material
2. Correct material specs
3. Design & Validation Tools
4. Persistence
5. Methodological approach
6. Collaborative efforts



Monolithic Carbon Fiber Wind Mill Blade





Team

1. Mahindra Composites

Pravin, Sachin, Kiran, Yogesh

2. Zoltek – Akhil Hebbar

3. Epsilon Composites Solutions : ADC Resin & Engineer

Vijay Deshpande Perera, Sanjay Rade



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ICERP 2011

International Conference and Exhibition on Reinforced Plastics
2 - 4 March, Mumbai

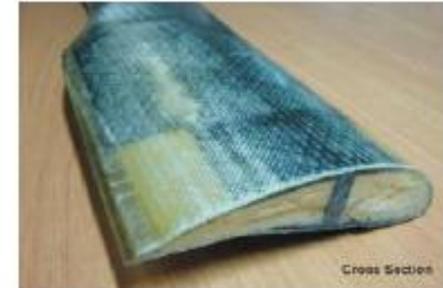
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Awards and Recognitions

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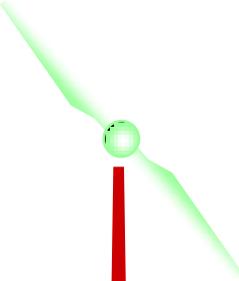


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Thank You

Thank You



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