Rotor Blade Materials

✓ Rotor blades are usually made using a matrix of fiber glass that is impregnated with a material such as polyester (GFRP = Glass fiber reinforced polyester)
✓ The polyester is hardened after it has impregnated the fiber glass
✓ Epoxy may be used instead of polyester
✓ Likewise the basic matrix may be made entirely or partially from carbon fiber, which is lighter, but more expensive material
✓ Wood-epoxy laminates were also used for some rotor blades

http://web.mit.edu/windenergy/windweek/Presentations/Nolte_Blades.pdf
Rotor Blade Cross-section

GFRP = Glass fiber reinforced polyester

New Blade Design

Mixed glass fiber/carbon fiber with cross-bolt joining at the rotor hub

Winding Machine

Automated Manufacturing

1. Winding with D-spar
2. Placing the cones for the rear box
3. Winding the complete blade
The Purpose of Testing Rotor Blades

- The purpose of rotor blade testing is to verify that the blades are safe, i.e., that the layers of the rotor blade do not separate (delamination).
- Also, the test verifies that the fibers do not break under repeated stress.

Nacelle on the Road

Tower Transportation

Tower Transportation
Concrete Tower Construction

Turbine Supply Chain

- Supply chain of importance due to global production of turbine components
- Product (wind turbine) assembled in the field
  - Mix of mechanical, electrical, and civil engineering activities
  - Different assembly equipment (e.g., cranes) and different assemblies (e.g., high power electricity, mechanical assembly)
  - Energy cost to manufacture and transport components and assemblies is an issue
Turbine Supply Chain

Characteristics

- Overlapping supply chain with the number of sinks equal to the number of wind turbines at a park
- Transportation distance (time) a significant component of the network
- Modeling such a network is challenging due to new network architecture (intertwined networks)

Examples of supply chain modeling methodologies

- Network flow models
- Petri nets
- Neural networks
- Data-driven models (data mining)

Important to consider in modeling supply chains:

- Evolving network architecture
- Risks
- Costs

Supplier options

- Single supply source
  - Ease of quality control
  - High risk of delivery disruption
  - Low control relative to the cost of components, and assemblies

- Multiple supply sources
  - More involved quality control
  - Lower risk of delivery disruption
  - Management of cost and quality is needed
Turbine Supply Chain

- Many to many relationships prevail
- A supplier may work with many primes, and a prime may be supplied with components, assemblies, and services offered by many suppliers

Reference

http://books.google.com/books?id=Z4bhObb6f1AC&pg=PPP1.M1