OPTIMAT BLADES: results and perspectives

A.M. van Wingerde[1], R.P.L. Nijssen[2], D.R.V. van Delft[3], L.G.J. Janssen[4],Th. P. Philippidis[5], P. Brøndsted[6], A.G. Dutton[7], C.W. Kensche[8], T.K. Jacobsen[9], D. J. Lekou[10], D. van Hemelrijck[11]

[1,2,3] Knowledge Centre WMC, Kluisgat 5, 1771 MV Wieringerwerf, The Netherlands. Tel: +31-15-2783729, Fax: +31-15-2782308, E-mail: A.M.vanWingerde@wmc.tudelft.nl / D.R.V.vanDelft@wmc.tudelft.nl R.P.L.Nijssen@wmc.tudelft.nl
[4] Energy research Centre of the Netherlands, Postbus 1, 1755 ZG Petten, The Netherlands, Tel: +31-224-564664, Fax: +31-224-568214, E-mail: l.janssen@ecn.nl
[5] University of Patras, Engineering and Aeronautics, P.O. Box 1401, Patras 265 00, Greece, Tel: +30-2610-997235, Fax: +30-2610-997235, E-mail: philippidis@mech.upatras.gr
[6] RISØ National Laboratory, DK 4000 Roskilde, Denmark, Tel: +45-4677-5704, Fax: +45-4677-5758, E-mail: povl.brondsted@risoe.dk
[7] Rutherford Appleton Laboratory, Chilton, Didcot, Oxfordshire OX11 0QX, United Kingdom, Tel: +44-1235-445823, Fax: +44-1235-445863, E-mail: A.G.Dutton@rl.ac.uk
[8] Deutsches Zentrum für Luft- und Raumfahrt e.V., Pfaffenwaldring 38-40, D-70569 Stuttgart, Germany, Tel: +49-711-6862463, Fax: +49-711-6862227, E-mail: Christoph.Kensche@dlr.de
[9] LM Glasfiber A/S, Rolles Møllevej 1, Lunderkov, DK-6640, Denmark, Tel: +45 7984 0473, Fax: +45-755-86202, E-mail: tkj@lm.dk
[10] CRES, Wind Energy Dept., 19th km Marathonos Ave., 19009 Pikermi, Greece, Tel. +30 210 6603300, Fax. +30 210 6603301, email: pvioni@cres.gr
[11] Vrije Universiteit Brussel (VUB) Dept. of Mechanics of Materials and Constructions, Pleinlaan 2, 1050 Brussels, Belgium, dvhemelr@vub.ac.be

Abstract
In a major European research project, OPTIMAT BLADES, a large number of material tests have been conducted. For the first time, a material for wind turbines has been characterised in full detail in a single consistent project. The extensive investigation of the material has revealed new and sometimes unexpected material and testing aspects. New tests methods have been established for fatigue and residual strength testing as well as for biaxial loading.

OBJECTIVES
In order to be able to build larger wind turbines in an economical way, it is necessary to fully utilize the material properties. Very large blades may even become practically impossible without further knowledge of the material behaviour since the dominating loads on the material are caused by the blade mass itself. Therefore, a consistent approach to material testing and use in design recommendations is required, covering all major aspects, as well as interactions.

DESCRIPTION
This paper outlines the project OPTIMAT BLADES, a € 4.4 mln. research project, which was started in January 2002.

The project aims to provide a consistent and integral approach to the design of rotor blades. It offers a basis for updated design recommendations, necessary for a full utilisation of the material as required for large rotor sizes.
In order to achieve this, a number of over 2500 tests have been carried out by research institutes from 7 countries.
The aspects investigated are:
- The static strength.
- The fatigue behaviour, both under constant and variable amplitude, as well as block tests and residual strength).
- The behaviour under bi-axial stress states.

- Behaviour under extreme (climatic) conditions.
- Behaviour of thick and repaired laminates.

Furthermore, a number of interactions between these aspects have been investigated as well.

RESULTS AND CONCLUSIONS

For the first time, a material for wind turbines has been characterised in full detail in a single consistent project. The results, easily accessible from a database, are not just relevant for the material selected, but are expected to have a strong impact on material testing procedures and application in design recommendations for wind turbines.

Another aspect uncovered by the investigation are plate-to-plate variations and lab-to-lab variations, which can only be properly assessed in large research projects.