Fatigue Reliability Analysis of Wind Turbine Cast Components

The fatigue life of wind turbine cast components, such as the main shaft in a drivetrain, is generally determined by defects from the casting process. These defects may reduce the fatigue life and they are generally distributed randomly in components. The foundries, cutting facilities and test facilities can affect the verification of properties by testing. Hence, it is important to have a tool to identify which foundry, cutting and/or test facility produces components which, based on the relevant uncertainties, have the largest expected fatigue life or, alternatively, have the largest reliability to be used for decision-making if additional cost considerations are added. In this paper, a statistical approach is presented based on statistical hypothesis testing and analysis of covariance (ANCOVA) which can be applied to compare different groups (manufacturers, suppliers, test facilities, etc.) and to quantify the relevant uncertainties using available fatigue tests. Illustrative results are presented as obtained by statistical analysis of a large set of fatigue data for casted test components typically used for wind turbines. Furthermore, the SN curves (fatigue life curves based on applied stress) for fatigue assessment are estimated based on the statistical analyses and by introduction of physical, model and statistical uncertainties used for the illustration of reliability assessment.