

A Novel Tool for FEM Analysis of Offshore Wind Turbines With Innovative Visualization Techniques

Paul E. Thomassen, Per Ivar Bruheim, Loup Suja

Dept. of Civil Engineering, NTNU

Lars Frøyd

Dept. of Energy and Process Engineering, NTNU

Trondheim, Norway

ABSTRACT

Specialized software analysis tools are needed for safe and economic design of offshore wind turbines. Many tools are today in active development both in the academic and commercial world. However, in the offshore wind turbine business both professionals and students often struggle with the multidisciplinary complexity of offshore wind turbines.

ASHES is a novel analysis and design tool for horizontal axis offshore wind turbines using an integrated model of an offshore wind turbine. ASHES seeks to distinguish itself in the joint focus on computational accuracy and efficiency, innovative visualization, and effective and convenient user interaction. Thus, serving as a tool to provide a better understanding of the offshore wind turbine.

The current prototype includes functionality for time domain simulation, eigenvalue analysis, and establishing rotor/blade characteristics. The prototype is currently being benchmarked in several projects. The preliminary results are promising.

The main research contribution of this paper is an investigation of improved visualization of model and results as well as improved graphical user interface for aeroelastic software.

KEY WORDS: offshore wind turbines, aeroelastic software, visualization

INTRODUCTION

The interest in developing offshore wind energy has been increasing sharply over the last few years, especially in countries around the North Sea. A number of reasons point in the direction of offshore wind becoming an important part of the future energy mix, e.g. it's a renewable resource, a relatively mature industry and technology for onshore production (compared to other "new renewables"), significant energy potential, available

areas, domestic energy production, secure (although intermittent) energy delivery, very low CO₂ emissions, and modest environmental problems (compared to e.g. nuclear energy). However, the cost of offshore wind energy is still considered to be relatively high compared to the cost of energy from traditional power plants fired by coal, natural gas, or nuclear energy. This paper presents what in the view of the authors can be a contribution to reducing the cost of offshore wind energy: a specialized software tool for analysis and design of offshore wind turbines.

Specialized software analysis tools are needed for safe and economic design of offshore wind turbines and are today commonplace. Many tools are in active development both in the academic and commercial world. Typically, the existing programs utilize a combination of modal analysis, multi-body dynamics and the finite element method.

ASHES is a novel analysis and design tool for horizontal axis offshore wind turbines. In the growing abundance of wind turbine analysis software, ASHES seeks to distinguish itself on three areas:

1. Innovative visualization and graphical user interface techniques in order to assist the study and understanding of the wind turbine.
2. Computational efficiency.
3. Integrating design and code verification in a single tool.

THE ASHES PROTOTYPE

The core functionality of the ASHES prototype is a time domain analysis of the integrated wind turbine. Being crucially important in wind turbine design, eigenvalue analysis is also included. Finally, the establishing of rotor/blade characteristics have been implemented in the prototype.