Abstract:
Traditionally, wind turbine dynamics are analyzed using computationally efficient but geometrically coarse aeroelastic models. With ever larger offshore turbines being installed in deeper waters, the wind industry is gradually moving toward more complex foundation types such as jackets and tripods. Even the simplest models of such structures have many more degrees of freedom (DoFs) than the complete wind turbine model, leading to excessive computation times. To cope with this, we can employ reduced ‘superelement’ modeling of the support structure. However, since these structures are subjected to hydrodynamic loading at a large portion of their DoFs, traditional reduction methods fail to properly describe the response to this excitation. In this paper, we therefore propose to combine superelement modeling with the concept of modal truncation augmentation, which consists in extending the reduction basis by adding ‘residual vectors’. Furthermore, we use principal component analysis to find the predominant hydrodynamic loading on the support structure. A case study is performed on a reference wind turbine model on a jacket structure, revealing both the need for coupled dynamic analysis and the shortcomings of traditional superelement models for offshore support structures. Most importantly, this case study shows that the proposed augmented superelement approach allows to create very compact yet accurate models of the
complex support structure, thereby enabling efficient integrated simulation of offshore wind turbines. Copyright © 2013 John Wiley & Sons, Ltd.

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