Dynamic models of the cranes applied to offshore wind farm service

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Abstract. The paper is concerned with modelling cranes installed at wind farms. The crane booms applied can be either welded box cross-sectional or lattice structures. In order to omit the necessity of involving different boom structures into the computer program, the virtual model of substitutional boom is formulated by means of the rigid finite element method. The parameters of virtual boom are chosen by application of the optimization procedure, which assures the correspondence of static deflections and natural frequencies in original and substituting booms. The received substitutional boom model is then implemented into the final general model of the crane dynamics. The process described is used by PROTEA company in the offshore crane's design. It allows us to perform complex dynamic calculations of offshore wind farm service cranes independently of their boom's type.

Introduction

The rapid climate change and the government regulations encourage the production of green energy. This provokes a growing trend of new offshore wind farm installations. Service of these wind farms often requires application of offshore cranes convenient and safe in exploitation. These are commonly cranes with relatively small lifting capacity, simply operated and highly reliable. The crane boom can be either a welded box crosssectional or lattice structure. The hoisting, luffing, and slewing mechanisms drives can differ from electric to hydraulic systems. Safety features like AOPS (Automatic Overload Protection System) are considered to be crucial in this type of application.

Result and Discussion

Nonlinear models are necessary in order to perform calculations of the dynamics of cranes used at wind farms. The authors propose a virtual model of the crane which uses the rigid finite element method (RFEM) [1] for boom discretization (despite the type of its structure). Parameters of the substitutional boom discretized by means of the method are chosen in such a way that geometrical dimensions, static deflections, and frequency of vibrations are the same as those of the original boom calculated with the use of commercial FEM software. The substitutional boom parameters are calculated using a nonlinear optimization method. The received substitutional boom model is then implemented into the overall, universal dynamics model of the crane. The process described is experimentally verified and it is used by the PROTEA in design practice [2,3].

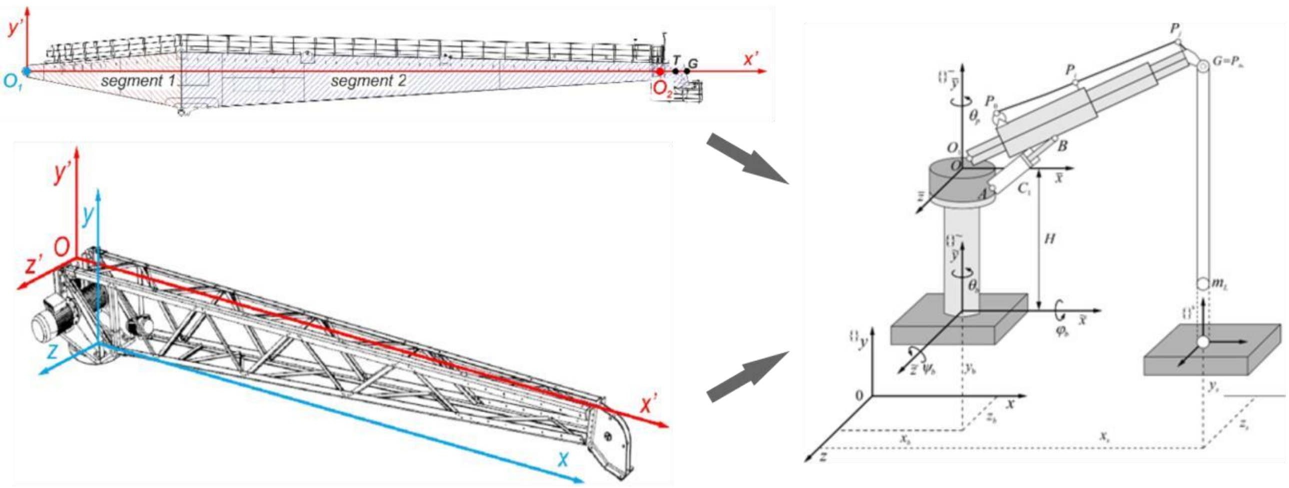

Figure 1: Box cross-sectional and lattice booms, virtual model of a crane.

References

[1] Wittbrodt E., Adamiec-Wójcik I., Wojciech S. (2006) Dynamics of flexible multibody systems: rigid finite element method, Springer, Berlin.

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[3] Adamiec-Wójcik I., Drąg Ł., Metelski M., Wojciech S. (2018) Application of the rigid finite element method to static analysis of lattice-boom cranes Int. J. of Applied Mechanics and Engineering **23/3**: 803-811.