Modelling and Simulation of the Coupled Rigid-flexible Multibody Systems in MWorks

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Aiming to the design challenge of modern mechatronic products, this paper presents a method to simulate the coupled rigid-flexible system in MWorks. The FlexibleBody model is designed to support the coupled rigid-flexible system, and a library of boom system of concrete pump truck is constructed base on the model. The simulations for both of rigid and coupled rigid-flexible boom system are carried out, and the comparison between their results is performed to testify the FlexibleBody model.

Firstly, the component mode synthesis technique[1] is introduced and the Craig-Bampton method[2] is adopted to build the flexible-body model. The general flexible-body model named FlexibleBody is developed based on the standard MultiBody library in Modelica, which describes the small and linear deformation behavior of a flexible-body that undergoes large and non-linear global motion. In the model, the modal neutral file is introduced as a standard interface to describe the constraint modes.

Secondly, the model is used to construct a library of boom system of concrete pump truck and the simulations covering the expanding and folding process are carried out based on both the rigid multibody and the coupled rigid-flexible system models. The results show that in each boom the value of mode coordinate q[1], corresponding to the 7^{th} mode, is the biggest. It indicates that the 7^{th} mode contributes most energy to the flexible-body. And the values of other modal coordinates are smaller and smaller, with less energy contribution. The variation tendency is complied with the modal superposition theorem and energy criterion. The force and the hydraulic flow change gently in the rigid boom system, but change dramatically in the coupled rigid-flexible boom system, due to the elastic deformation of flexible booms. Compared with the rigid system, the coupled rigid-flexible boom model has higher accuracy, and is more close to the actual system.

The method in this paper provides an effective approach to build unified model and simulate flexible-body in multi-domain engineering systems.

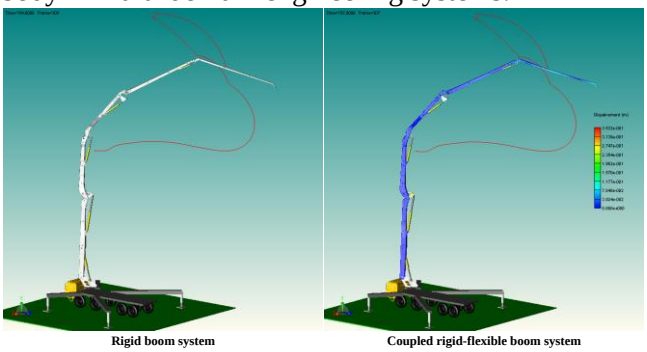

Figure 1: Comparation between rigid system and coupled rigid-flexible boom system

References

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