Modeling, Simulation and Validation of a Concrete Pumps Boom System Considering Elastic Deflection and Hydraulic Equipment

Sophie Zorn, Ines Gubsch

Faculty of Mechanical Science and Engineering
Technische Universität Dresden
01602 Dresden, Germany
sophie.zorn@tu-dresden.de
ines.gubsch@tu-dresden.de

Abstract
In order to achieve lower energy consumption for robotic devices, lightweight structures became very popular. They need less actuation power, move faster and have a smaller overall mass. The major disadvantage of lightweight structures, however, is their vulnerability to vibrations. For the simulation of long and slender parts, the dynamic behaviour has to be considered. This can be done by integrating flexible bodies in a multibody system model.
One explicit example for such a long and slender construction is the boom of a concrete pump. Its task is to pump the wet concrete provided by a concrete mixer to a defined position on the construction site. Boom length between 20 and 100 meters exist and they are built of up to 6 segments which are connected by revolute joints. Each segment is actuated by a hydraulic cylinder acting between the previous segment and a linkage converting the linear drive into a rotation around the hinge point. The conveyer pipe necessary to deliver the concrete is attached to the side of the boom and due to the material flow inside, additional movement is induced to the boom system.

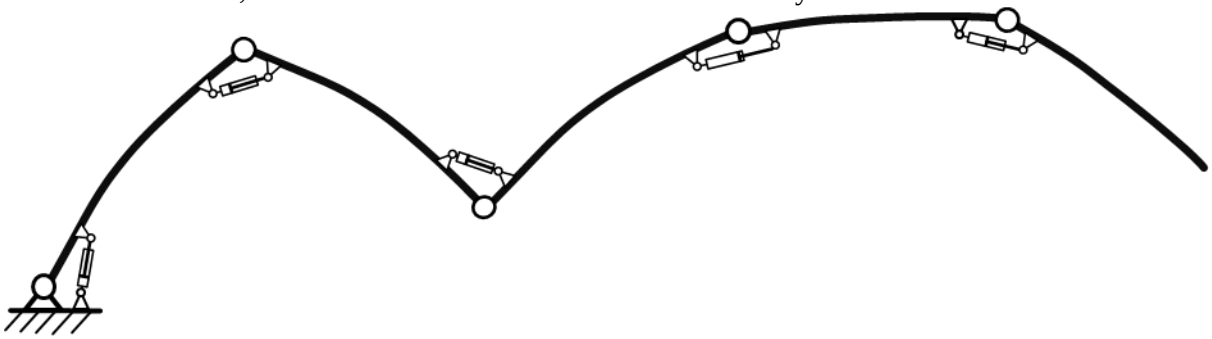

Figure 1: Mechanical structure of boom (neglecting linkages between segments)

In order to analyse the dynamic behavior of the system described above it has been implemented in the *Modelica*-based *Dymola* environment. A boom with 5 segments, shown schematically in Figure 1, is modeled and each segment is integrated as a flexible body. In order to use the FlexibleBodies Library, the bodies are described by a Standard-Input-Data-File (SID): a finite element analysis and model-order-reduction are necessary in advance [1]. The resulting model is three-dimensional so that lateral vibrations are also represented. The hydraulic cylinders are included as well, since they induce quite large dynamics to the booms vertical movement. The cylinders are integrated using the Hydraulics Library by *Modelon*.

The modeling and simulation of the boom system will be presented and its validity shown. The overall system has been verified by experiments on a real concrete pump. The eigenfrequencies and vibration amplitudes as well as the hydraulic pressures are compared and very good compliances at different boom positions shown.

References

[1] R. Schwertassek, O. Wallrapp. Dynamik flexibler Mehrkörpersysteme. Vieweg Verlagsgesellschaft, 1999.