DASSAULT SYSTEMES

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CATIA SYSTEMS ENGINEERING FLEXIBLE BODIES LIBRARY

MODELING AND SIMULATION OF FLEXIBLE STRUCTURES WITH CATIA OR DYMOLA

MODELING AND SIMULATION OF FLEXIBLE MECHANICAL SYSTEMS

The Modelica based Flexible Bodies Library (FBL) enables the efficient mathematical modeling of flexible bodies such as components of multi-body and arbitrary physical systems. FBL facilitates and accelerates the analysis of large motions of flexible beams, annular plates and of flexible bodies.

MODELING FLEXIBLE BODIES

The Flexible Bodies Library is used to model large motions of beams and of flexible bodies exported from finite element programs.

The library provides a specific Modelica® beam model for Rayleigh beams used to model specific flexible bodies. The beam model supports the definition of the geometrical and physical properties of a straight, homogenous and isotropic beam. It takes bending in two planes, lengthening and torsional defections into account. The deformations are discretisized by Eigenmodes that may be selected according to the actual needs.

The library also provides a «ModalBody» object that is used to model general flexible bodies. The geometrical and physical properties of the ModalBody are defined by a Standard Input Data (SID) file that is generated by an external Finite Element Analysis (FEA) program such as Abaqus. For ModalBody models in real-time environments, the SID-data may be converted into a Modelica package so that external file access is avoided.

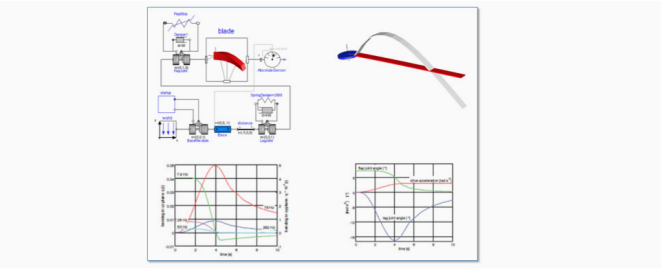
KEY FEATURES

- Supports bending in two planes, torsion and lengthening deformation
- Accounts for geometric stiffening and buckling effects
- Beam model based on analytical solution of the spatial Eigenvalue problem of Euler-Bernoulli equation
- Supports input of all necessary geometrical and physical properties of a straight and homogenous beam
- General and specific types of cross sections definition
- Animation to visualize deformation
- Compatible with other Modelica libraries

EXAMPLE USE CASE – A HELICOPTER ROTOR

The modeling and analysis of the displacement of a helicopter rotor blade, where the model consists of a rheonom driven, cylindrical rotor base (colored blue in the graphic below), two joints and one blade. The six meter long rotor blade can be modeled as a flexible beam with seven bending modes in its xz-plane and two bending modes in its xy-plane so that a frequency range up to 270 Hz can be analyzed.

The rotor base rotates around its cylinder axis that coincides with the global z-axis, while the lag joint allows for a rotation around the local z-axis at the outer radius of the rotor base. The flap joint defines an angular motion around the local y-axis at the circumference of the rotor base.



Simulation of a helicopter rotor blade system and the resultant blade deflection

LIBRARY CONTENTS

Flexible Beams

The model describes the mechanical behavior of a flexible beam that undergoes large reference motion. Models of beams are based on description of specific beam cross-sections, including geometric stiffening.

Annular Plates

The model describes the mechanical behavior of a flexible annular plate that undergoes large reference motion, in particular around its rotation axis. The model is based on a analytical description of a homogeneous Kirchhoff plate that only considers first order bending deformation.

Thermo-elastic Plate

Model of an annular plate with distributed thermal, thermo elastic and elastic properties. The model describes the 3-dimensional temperature and the 2-dimensional displacement field of an annular plate and as well considers the influence of the thermal expansion on the bending deformations.

Modal Body

Model used to represent bodies with an arbitrary geometric shape based on model description and including geometric stiffening.

BENEFITS

- Easy modeling and simulation of mechanical systems that comprise a mixture of rigid elements and flexible beam structures
- High quality simulation performance
- Significantly reduced costs due to seamless simulation of scenarios that are expensive and difficult to physically test

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