8th. World Congress on Computational Mechanics (WCCM8)
5th. European Congress on Computational Methods in Applied Sciences and Engineering (ECCOMAS 2008)
June 30 – July 5, 2008
Venice, Italy

FLEXIBLE MULTIBODY DYNAMICS WITH LINEAR DEFORMATIONS: OVERVIEWEING THE BASICS

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Key Words: *Reference Conditions, Mean Axis, Principal Axis, Body Fixed Referential Mode Component Synthesis, Free Modes, Fixed Modes, Static Compensation*

ABSTRACT

The finite element method has been established as the most important computational procedure to describe deformations of structural systems. However, the limitation of the finite element method to describe large deformations accurately is also well known. The use of multibody dynamics is the most general and accurate computational methodology to describe the large relative rotations of the systems components. The use of the finite element method in the framework of multibody dynamics leads to the ability to model flexible multibody systems that not only describe the large gross motion of the system components but also their deformations. Regardless of the flexible body deformations being large or small, of the material being linear or nonlinear, elastic or plastic, a set of reference conditions is required to ensure the uniqueness of the displacement field. The use of body fixed, mean axis and principal axis conditions is presented and discussed in this work. It is shown how different reference conditions yield different bases for the space of elastic coordinates and they may lead to different numerical solutions. When the flexible body deformations are small and the material is linear elastic different choices of generalized elastic coordinates are possible, being the use of the mode component synthesis the most common approach to describe such generalized coordinates. It is shown here that the choice of the modes used in the mode superposition method is dependent on the selection of the type of reference conditions. Moreover, to minimize the number of modes used in the component mode synthesis, while ensuring a good representation of the deformation of the flexible body, a set of static compensation modes is used. It is shown how such modes are evaluated in face of the type of reference conditions used. A simple slider-crank mechanism and a complex deployable space structure are used to demonstrate the range of application of the different approaches and their computational efficiency, measured both in terms of numerical precision and computational cost.