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Research On Beam Deformation Based On Absolute Node Coordinate Method

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Abstract: *This paper takes the flexible multi-body system with absolute node coordinates as the research background, relaxes the assumption of the traditional beam theory. After the beam is loaded, the cross-section will be deformed. Based on the absolute node coordinate method, the beam element displacement model analyzes the beam section deformation. Using Fortran software programming calculations, the displacement of the selected point of the beam section is obtained, the figure is simulated, and the deformation of the beam section is analyzed.*

Keywords — Absolute nodal coordinates, section deformation, shared undetermined coefficient method, five-point displacement analysis, displacement model

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I. INTRODUCTION

Because the deformation of the flexible body will have a great influence on the dynamic behavior of the system, the modeling of the flexible multi-body system will be put on the agenda. In the development of flexible multibody dynamics, the floating reference frame method [1], the incremental finite element method [2], the large rotation vector method [3] and so on have appeared successively. However, these methods describe the deformation and movement of a rigid body through a reference frame fixed on the flexible body. Therefore, there are highly nonlinear terms in the motion equations of these methods. Until 1996, Shabana proposed the absolute nodal coordinate method to greatly reduce the nonlinearity of the motion equation. Shabana's absolute nodal coordinate method for multibody systems is more accurate than the floating coordinate method proposed by previous scholars. The degree of simplicity is more advantageous.

II. MODELING OF BEAM ELEMENTS BASED ON ABSOLUTE NODE COORDINATES.

Displacement mode is an approximate expression of the displacement of any point within a unit by the displacement of a unit node. It has been found that there are differences in the analysis of beam cross-sections using high-order interpolation displacement modes and low-order interpolation displacement modes[4]. The use of high-order interpolation displacement modes can more clearly capture changes in beam cross-sections, including the tensile values of beam sections. The change[5,6]. Using the method of shared undetermined coefficients, the y2 and x terms are introduced in the form of shared undetermined coefficients to create a longitudinal high-order interpolated displacement model[7]. The y2 interpolated displacement model can more clearly capture the cross-section deformation.

The beam element proposed by Omar and Shabana is shown in Fig. 1. Each node has 6 position coordinates defined in the global coordinate system.

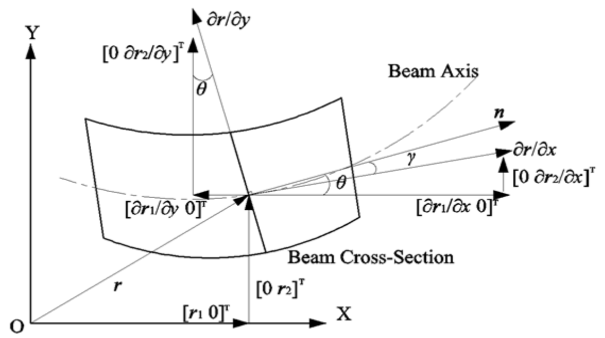

Fig. 1

The function of the position of any point in this cell is:

$$\boldsymbol{r}=\begin{pmatrix}r_1\\r_2\end{pmatrix}=\begin{pmatrix}X\\Y\end{pmatrix}=\begin{pmatrix}a_0+a_1x+a_2y+a_3xy+a_4x^2+a_5x^3\\b_0+b_1x+b_2y+b_3xy+b_4x^2+b_5x^3\end{pmatrix}=\boldsymbol{Se}$$

The longitudinal interpolation of the displacement mode is the first order, and the section after the beam deformation is a plane. In order to study the deformation of beam cross-section, y2 is introduced into the displacement mode using the undetermined coefficient introduction method to create a longitudinal high-order interpolation displacement model[8].

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