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变截面Timoshenko梁的单元刚度矩阵

Element stiffness matrix for Timoshenko beam with variable cross-section

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中文摘要:

变截面构件在工程中应用广泛，在对变截面梁进行数值计算时，需要建立变截面梁单元的刚度矩阵。该文采用势能驻值原理，考虑了轴力引起的几何非线性和剪切变形的影响，将梁截面刚度的变化率作为小量，得到了近似到二阶的单元刚度矩阵。在构造位移模式时，从梁的微分平衡方程出发，得到同样近似到二阶、分别以三次和五次多项式表示的剪切和弯曲位移模式。该文还证明了单元刚度矩阵的奇异性，给出了轴压刚度的表达式，定量论证了与某些精确解的误差，表明在一定范围内，该文的结果具有足够的精度。最后以一个计算实例说明该文的单元刚度矩阵具有较快的收敛性。

英文摘要:

The variable cross-section members have been widely used in engineering practice for many years,thus it is necessary to investigate their element stiffness matrixes.In this paper,based on the principle of potential energy,the element stiffness matrix with approximation to second order are obtained,where the change rates of both the flexural and shear stiffness are treated as infinitesimal quantities (or Infinitesimal).It is noted that the effects of geometric nonlinearity due to axial force as well as shear deformation is considered in the matrix.In addition,based on the differential equilibrium equations of the members,the flexural and shear displacements modes with approximation to second order,expressed as cubic and quintic polynomial respectively,are also obtained.Moreover,the singularity of the element stiffness matrix and the expression of axial stiffness are discussed in detail.By comparing the obtained matrix results with some exact solutions,it is indicated that the accuracy of the obtained element stiffness matrix can be guaranteed.Finally,the convergence of this method is discussed by comparing with other methods in a case study.