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应力函数及其对偶理论在有限元中的应用

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摘要 借助于Cosserat连续介质模型，探讨了应力函数和位移对避免有限元C^{1} 连续性困难的互补性作用. 通过对应力函数对偶理论的深入分析，为将应力函数列式得到的余能单元转化为具有一般位移自由度的势能单元提供了严格的理论基础，在此基础上，给出应用应力函数构造有限元的一般方法.

关键词 有限元,C1连续性,Cosserat模型,应力函数,对偶理论

分类号

Application of stress functions and its dual theory to finite element

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Abstract

Cosserat's continuum is a generalized model of the classical elasticity. Many important elastic problems can be taken as its special case subjected to some geometric/mechanical constrains. In some of these problems, there exist the C$^{1 }$ continuity difficulty in finite element formulation when the elements are constructed in the displacement space. Using Cosserat's continuum, the present work discusses the reason of the appearance of the C$^{1 }$ continuity difficulty. It is noted that when geometric or/and mechanical constraint(s) is(are) enforced upon Cosserat's model there must exist C$^{1 }$ continuity requirement for either displacement field or stress function field. And the key point is that only one of these two fields has the C$^{1 }$ continuity requirement and the other is free from this difficulty. So for some problems with C$^{1 }$ continuity difficulty in displacement formulation, it is a natural approach to avoid this difficulty by using formulation in stress function space. Nevertheless, the finite element constructed in stress function space is not convenient to apply because stress functions have no explicit physical meaning and then it is difficult to appoint boundary condition for them. For this practical reason, the dual theory of stress functions is presented to provide an approach to transform an element with stress functions as degree of freedom (DOF) to the element with ordinary displacement as DOF. Based on this dual theory, a general way to construct finite element using stress functions is discussed.

Key words finite element C1 continuity Cosserat's continuum stress function dual theory

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