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基于平面偶应力-Reissner/Mindlin板比拟的偶应力有限元

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摘要 偶应力理论的有限元列式面临本质性的C1连续性困难. 平面偶应力理论和Reissner/Mindlin板弯曲理论之间的比拟关系表明这两个理论系统的有限元的同一性，而R/M板有限元并不存在C1连续性困难. 因此，研究将R/M板单元转化为具有一般位移自由度的平面偶应力单元的一般方法. 根据这一方法，将典型的8节点Serendipity型R/M板单元Q8S转化为一个4节点12 自由度的四边形平面偶应力单元，数值结果表明该单元具有良好的精度和收敛性

关键词 比拟,偶应力,Reissner/Mindlin板弯曲,C1连续性,有限元

分类号

Finite Element Of Elasticity With Couple-Stress Using The Analogy Between Plane Couple-Stress And Reissner/Mindlin Plate Bending

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Abstract

In order to include the effect of microstructure, the theory of elasticity with couple stress considers couple stress which does not appear in the classical elasticity theory. However, there exists a crucial C^{1} continuity difficulty in the finite element formulation of elasticity with couple stress. The analogy between plane elasticity with couple stress and Reissner/Mindlin plate bending provides an important way to avoid the C^{1} continuity difficulty. According to the analogy, the C^{1} continuity difficulty can be avoided naturally by the formulation in the space of stress functions, and the formulation can be analogous to the one of certain Reissner/Mindlin plate bending element in the space of transversal deflection and rotation. The unsettled problem is how to transform the finite element with stress functions as degree of freedom (DOF) into the one with usual planar displacement and rotation as DOF. Using the analogy, the present work provides an effective and rigorous method to deal with this problem. The final finite element has two important characteristics. Firstly, the formulation in space of stress functions avoids C^{1} continuity difficulty. Secondly, the discrete unknown DOF are usual displacement and rotation. As an application of the present method, a finite element of plane couple stress with 12 DOF is transformed from the eight nodes serendipity Reissner/Mindlin plate bending element. Numerical results of typical problems show that the present element has satisfactory precision and convergence.

Key words analogy couple-stress Reissner/Mindlin plate bending C1 continuity finite element

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