

论文

## 二维类桁架材料结构弹塑性分析

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**摘要** 类桁架材料所构成结构的弹塑性行为的精确建模分析保证非常耗时, 为了在保证精度的前提下提高此类问题的求解效率, 本文利用类桁架材料基本构件长细比较大的特点, 将材料单胞简化为桁架模型. 考虑到微单胞空间分布的周期性, 基于数值均匀化理论提出了类桁架材料结构的宏微观两级弹塑性求解格式. 原问题转化为宏观上一个非线性弹性连续体计算问题和微观上多个小规模桁架系统的弹塑性计算问题. 两个数值算例分别考虑了简单加载, 非单调加载, 规则宏观结构和具有非完整单胞的较复杂宏观结构等问题. 与实际结构计算结果在精度和时间等方面的比较验证了求解格式的有效性. 最后还探讨了算法的适用范围.

**关键词** [类桁架材料](#) [弹塑性计算](#) [多尺度分析](#) [数值均匀化](#)

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## Elasto-plastic analysis for 2d structures with truss-like materials

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### Abstract

The elasto-plastic analysis of structures composed of truss-like materials takes much time and considerable resources in modeling and numerical calculation if all struts are taken into consideration. The main purpose of this paper is to speed up the solution of this class of problems. The unit cell is simplified as a truss model according to the large ratio of strut's length to the section size. Numerical homogenization is carried out due to the periodic arrangement of cells in space. The original problem is thereby transformed to two interrelated problems of two different scales: a nonlinear elastic continuum computation in macro-scale and several elasto-plastic analyses of small-scale truss systems in micro-scale. Monotone load, non-monotone load, regular macro-structure and irregular macro-structure with imperfect unit cells are, respectively, considered in two numerical examples. In comparison with the results of the actual structures, the proposed method is found to enjoy the same precision but to take less time. At last the applicable conditions of the proposed method are discussed.

**Key words** [truss-like material](#) [elasto-plastic computation](#) [multi-scale analysis](#) [numerical homogenization](#)

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