岩石力学与工程学报 2007 26 (2007-S1): 2820 ISSN: 1000-6915 CN: 42-1397/O3

预处理共轭梯度法在岩土工程有限元中的应用

郑 超，张建海
(四川大学 水利水电学院， 四川 成都 610065)

收稿日期 2006-3-23 修回日期 2006-5-13 网络版发布日期 2008-1-17 接受日期 2007-7-15

摘要 在岩土工程中进行有限元分析时需要求解大型线性方程组，常用的直接法会占用较大的内存，耗费计算时间较长，计算节点规模有限。用超松弛迭代－预处理共轭梯度法(SSOR-PCG)求解大型稀疏线性方程组，并提出SSOR-PCG法的一套优化内存占用量和计算时间的实现方案。算例结果证明，此方案下的求解器在一台奔腾2.80 GHz主频、1.0 GB内存的个人电脑上，在50 min之内，可求解约30×104节点三维模型的刚度方程，其计算结果也可满足需要。

关键词 岩土工程；超松弛迭代法(SSOR)；预处理共轭梯度法(PCG)；线性方程组
分类号

SSOR-PCG METHOD USED IN SIMULATION OF GEOTECHNICAL ENGINEERING WITH FINITE ELEMENT METHOD

ZHENG Chao，ZHANG Jianhai

(College of Water Resources and Hydropower，Sichuan University，Chengdu，Sichuan 610065，China)

Abstract
The solution of a sparse and dense symmetric system of linear equations is essential to finite element simulation in geotechnical engineering. However，the traditional direct method will cost too much memory and calculation time. The paper tries to adopt the successive over relaxation(SSOR)-preconditioned conjugate gradient(PCG) method to solve linear systems and provide a new way to realize the SSOR-PCG method，which can remarkably save the memory and calculation time. In this scheme，the global stiffness is stored in a vector so that the cost of memory is the least. In the same time，the form of preconditioned matrix is changed，which makes it possible store the global stiffness and the preconditioned matrix in the same block of memory on the premise of increasing little extra calculation time. A new method to realize multiplying the global stiffness by a vector is also introduced，and it is found that the time of the iterative operation in any time is reduced greatly. Moreover，the definition of double data structure forms is presented，where the information of global stiffness is stored and this is essential to solve the special problem in rather complex geologic environment. To avoid drastic transformation of the global stiffness caused by the boundary conditions and initial information，an additional information matrix is allocated，and the global stiffness and the global load vector are also changed in accordance with a special rule. By this way，a large account of calculation is avoided on the premise of not influencing the final result. It has been proven by numerical examples that the linear equation solver based on the above improvements shows robust. The solver is able to solve the linear system of 3D structural problems with about 300 000 nodes within 50 minutes on a personal computer with Pentium 2.8 GHz CPU and 1.0 GB memory.

Key words eotechnical engineering；successive over relaxation(SSOR) method；preconditioned conjugate gradient(PCG) method；linear equations

DOI:

通讯作者