JOURNAL OF INTEGRAL EQUATIONS
AND APPLICATIONS
Volume 8, Number 2, Spring 1996

THE hp-VERSION OF THE BOUNDARY ELEMENT METHOD ON POLYGONS

N. HEUER AND E.P. STEPHAN

ABSTRACT. We give a new proof for the exponential convergence of the hp-version of the boundary element method for some first kind integral equations on polygons. Crucial for our analysis are asymptotic expansions of the solutions of the integral equations in terms of singularity functions near the vertices of the polygon. The boundary integral equations under consideration are Symm's integral equation with the logarithmic kernel and the hypersingular integral equation resulting from taking the normal derivative of the double layer potential. Applications to acoustic scattering problems and crack problems in linear elasticity are given.

1. Introduction. The paper gives a further contribution to the analysis of the hp-version of the boundary element method (BEM) by presenting a more general result for Dirichlet and Neumann problems than [**1**] allowing the use of a general geometric mesh refinement on the polygonal boundary Γ. We give a new proof for the exponential convergence of the hp-version by exploiting only features of the solutions of the boundary integral equations. The key results in this approach are asymptotic expansions of the solutions of the integral equations in singularity functions reflecting the singular behavior of the solutions near corners of Γ. With the help of such expansions we show that the solutions of the integral equations belong to countably normed spaces. Therefore, these solutions can be approximated exponentially fast in the energy norm via the hp Galerkin solutions of those integral equations. This result is not restricted to integral equations which stem from boundary value problems for the Laplacian but applies to Helmholtz problems as well. Further applications are 2D crack problems in linear elasticity.

The paper is organized as follows. In Section 2 we recall the integral equations for the Dirichlet and the Neumann boundary value problem

Received by the editors on February 13, 1995, and in revised form on November 7, 1995.
AMS *Subject Classifications.* 45B05, 45E05, 45L10, 65R20.
Key words. hp-version of BEM, geometric mesh, exponential rate of convergence.

Copyright ©1996 Rocky Mountain Mathematics Consortium