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WELL-CONDITIONED BOUNDARY INTEGRAL EQUATIONS FOR TWO-DIMENSIONAL SOUND-HARD SCATTERING PROBLEMS IN DOMAINS WITH CORNERS

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ABSTRACT. We present several well-posed, well-conditioned direct and indirect integral equation formulations for the solution of two-dimensional acoustic scattering problems with Neumann boundary conditions in domains with corners. We focus mainly on Direct Regularized Combined Field Integral Equation (DCFIE-R) formulations whose name reflects that (1) they consist of combinations of direct boundary integral equations of the second-kind and first-kind integral equations which are preconditioned on the left by coercive boundary single-layer operators, and (2) their unknowns are physical quantities, i.e., the total field on the boundary of the scatterer. The DCFIE-R equations are shown to be uniquely solvable in appropriate function spaces under certain assumptions on the coupling parameter. Using Calderón's identities and the fact that the unknowns are bounded in the neighborhood of the corners, the integral operators that enter the DCFIE-R formulations are recast in a form that involves integral operators that are expressed by convergent integrals only. The polynomially-graded mesh quadrature introduced by Kress [**30**] enables the high-order resolution of the weak singularities of the kernels of the integral operators and the singularities in the derivatives of the unknowns in the vicinity of the corners. This approach is shown to lead to an efficient, high-order Nyström method capable of producing solutions of sound-hard scattering problems in domains with corners which require small numbers of Krylov subspace iterations throughout the frequency spectrum. We present a variety of numerical results that support our claims.

1. Introduction. Numerical methods for the solution of acoustic two-dimensional homogeneous scattering problems which are based

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