Approximate methods for ultrasonic scattering like the Kirchhoff approximation and the geometrical theory of diffraction (GTD) can deliver fast solutions with relatively small computational resources compared to accurate numerical methods. However, these models are prone to inaccuracies in predicting scattered fields from defects that are not very large compared to wavelength. Furthermore, they do not take into account physical phenomena like multiple scattering and surface wave generation on defects. Numerical methods like the finite element method (FEM) and the boundary element method (BEM) can overcome these limitations of approximate models. Commercial softwares such as Abaqus FEA and PZFlex use FEM, while CIVA has a 2D FEM solver [1-3]. In this work, we study the performance of the Nyström method (NM) [4,5], an alternative boundary integral equation solver to the BEM, in modeling ultrasonic scattering from defects. To handle larger problems, the Nyström method is accelerated by the multilevel fast multipole algorithm (MLFMA). We apply the NM to benchmark problems and compare its predictions with those of exact and approximate analytical models as well as with experimental results from the World Federation of NDE Centers (WFNDEC). Several examples will be presented to demonstrate the prediction of creeping waves by the NM while also illustrating its improved accuracy over the Kirchhoff approximation. We will conclude with a discussion on the validity and limitations of the NM in modelling practical NDE problems.

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References: