

电工理论与新技术

涡流无损检测中的广义索末菲尔德积分快速计算

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摘要: 广义索末菲尔德(Sommerfeld)积分的快速准确计算是涡流无损检测数值仿真的重要研究内容之一。对于积分核中含有2个贝塞尔(Bessel)函数乘积的广义Sommerfeld积分, 给出一种高效准确的数值算法。通过将原积分核中远谱渐近分量抽出, 广义Sommerfeld积分核可表示为具有快速收敛的积分核和渐近积分核2项之和的形式。对于渐近积分核部分, 推导了其闭式指数积分表达式; 对于快速收敛积分核部分, 确定了数值积分的积分上限和对应的积分误差限。数值算例表明, 与直接采用数值积分的算法相比, 在同等计算精度情况下, 该方法可提高计算效率10~100倍, 该快速算法可应用于了涡流无损检测数值仿真中。

关键词: 广义索末菲尔德积分 指数积分 涡流无损检测

Fast Approach for Calculating Generalized Sommerfeld Integrals in Eddy Current Nondestructive Tests

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Abstract: Fast and accurately calculating the generalized Sommerfeld integrals (GSI) is one of the key techniques in the study of eddy current non-destructive tests. A very efficient approach for calculating the GSI, whose integrand consists of the product of two Bessel functions of the first kind, was proposed in this paper. With extracting the asymptotic component corresponding to the far spectrum, the original GSI was decomposed into the sum of two parts, one of which was an analytical expression with the help of exponential integral and the other of which was the one that has a rapidly damping kernel. The truncation method and the error estimation were discussed in detail. The numerical examples showed that the proposed approach could dramatically improve the efficiency approximately 10-100 times compared to the one using the conventional quadrature. The proposed approach might be served as a fast and accurate candidate method to calculate Green's function when an eddy current non-destructive test forward problem is concerned.

Keywords: generalized Sommerfeld integrals exponential integral eddy current non-destructive test

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