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论文

含周期性裂纹正交各向异性板平面问题的应力场分析

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摘要：

通过引入适当的Westergaard应力函数，采用复变函数方法和待定系数法对含周期性裂纹正交各向异性纤维增强复合材料板的Ⅰ 型、Ⅱ型问题中裂纹尖端附近的应力场进行了力学分析。在远处对称载荷与斜对称载荷作用下，先给出Ⅰ型、Ⅱ型问题在裂纹尖端处的应力强度因子，然后导出用应力强度因子表示的Ⅰ型、Ⅱ型裂纹问题应力场的解析表达式。此外，应力场大小与材料常数有关，这是正交各向异性材料不同于各向同性材料的特征。由于裂纹的周期分布，应力强度因子的大小取决于形状因子。结果表明，形状因子随着裂纹长度的增加而增大，随着裂纹间距的增大而逐渐下降，当裂纹间距趋于无穷大时，退化为含单个中心裂纹正交各向异性纤维增强复合材料板的结果。

关键词： 正交各向异性板 周期性裂纹 Westergaard应力函数 应力强度因子 应力场

Analysis of stress fields for plane problem of periodic cracks in orthotropic composites

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Abstract:

By introducing proper Westergaard stress function, the stress fields for mode Ⅰ and Ⅱ problems of periodic cracks in orthotropic composites were analyzed using the complex variable function method and approach of undetermined coefficients. Firstly, the stress intensity factors (SIFs) at the crack tip for mode Ⅰ and Ⅱ problems were presented under symmetrical loadings and skew-symmetrical loadings at infinity. The analytic expressions of the stress fields are then induced by the SIFs. In addition, the stress fields are related to the material constants, which is the characteristic of orthotropic materials different from the isotropic materials. Due to the distribution of periodic cracks in an orthotropic plate, the SIFs are determined by the shape factor. The results show that the shape factor increases as the crack length becomes longer, but decreases as the crack spacing becomes larger. Especially, the present result can reduce to the case of the central crack in an orthotropic plate when the crack spacing tends to infinity.

Keywords: orthotropic plate periodic cracks Westergaard stress function SIFs stress field

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