

机械工程

基于SPH耦合有限元法的喷丸残余应力场数值模拟

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摘要:

针对有限元方法不能有效模拟喷丸加工过程中大量弹丸反复冲击的现状,使用光滑粒子流体动力学法(smoothed particle hydrodynamics,SPH)耦合有限元法(finite element method, FEM)模拟喷丸强化过程。工件采用FEM建模,弹丸采用SPH建模,通过接触算法实现SPH和FEM的耦合以模拟弹丸对工件的强化作用。提出弹丸流的材料模型,分析了相关参数对工件残余压应力分布和能量利用率的影响。结果表明,随着弹丸打击次数的增加,工件表面残余压应力分布逐渐趋于稳定;高覆盖率能有效改善工件表面残余压应力分布,低覆盖率则会降低喷丸效果;适当提高弹丸速度虽然可以使残余应力层深度和最大残余压应力值增加,但会降低能量利用率。通过与相关实验数据的比较,验证了仿真模型和结果的正确性。

关键词: :喷丸强化 SPH耦合有限元 弹丸流材料模型

Numerical simulation for compressive residual stress of shot-peening based on SPH coupled FEM

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Abstract:

In dealing with shot-peening simulation, FEM(finite element method)can not simulate a mass of shots impinging the target. To overcome the defect of FEM, the SPH (smoothed particle hydrodynamics) coupled FEM modeling for shot-peening was presented, in which the shots were modeled by SPH particles and the target material was modeled by FEM. The two parts interact through a contact algorithm. The material model for shot flow was established, and the relationships between compressive residual stress and peening frequencies, coverage, velocities were analyzed. Steady compressive residual stress can be obtained by repetitious peening, higher coverage can improve the distribution of compressive residual stress, higher velocities can induce higher and deeper residual stress in the target surface. The simulation results agree well with the experimental data.

Keywords: shot-peening SPH coupled FEM material model for shot flow

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