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一种基于有限元法和弹性接触理论的齿轮啮合刚度改进算法

A modified method for determining mesh stiffness of gears based on finite element method and elastic contact theory

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中文关键词: 啮合刚度 载荷分布 有限元法 线接触理论 非线性啮合刚度

英文关键词:mesh stiffness load distribution finite element method line-contact theory nonlinear mesh stiffness

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中文摘要:

提出了一种将有限元法和弹性接触理论相结合的齿轮啮合刚度计算方法.该方法利用子结构法提取齿面原始柔度矩阵并分离出接触点弯曲变形，根据线弹接触变形解析公式计算接触变形，通过求解非线性变形协调方程得到齿轮时变啮合刚度和齿面载荷分布.以一对齿轮副为例，计算的啮合刚度与航空标准计算结果相差在6%以内.该方法发挥了有限元法在预测物体整体变形方面的优势，同时结合弹性接触理论能够准确计算局部接触变形的优点，与常规有限元法相比，能够有效地提升计算效率.由于接触变形问题的非线性，啮合刚度随总啮合力增加呈现非线性增大的趋势.

英文摘要:

A method for determining mesh stiffness of gears was presented using a combination of the finite element method and elastic contact theory. The contact point bending deformations were separated from the original compliances matrix which was obtained using sub-structure method, while contact deformations were derived using an analytical formula of elastic line contact deformation. The time-varying mesh stiffness and load distributions of tooth could be obtained by solving the nonlinear deformation compatibility equations. Taking a gear pair as an example, the mesh stiffness using the presented method is within 6% difference with the aerospace standard. As finite element method has an obvious advantage in predicting global deflection and the elastic contact theory can compute local contact deformation accurately, the method pressented combines these advantages to increase the computation efficiency compared to conventional finite element method. Given the nonlinearity of contact deformations problem, the mesh stiffness is increasing nonlinearly with the increase of total mesh force.