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# 抗拉柔性铰链的理论建模及有限元分析

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# Theory modeling and finite element analysis of tensile flexure hinge

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**摘要** 为了在保持转动刚度变化不大的情况下,使得LET (Lamina Emergent Torsion)柔性铰链能够适用于存在轴向载荷的场合,即拥有较大的轴向刚度,本文对LET的结构进行了适当改进,设计了一种新型柔性铰链--抗拉LET柔性铰链。基于抗拉LEMs (Lamina Emergent Mechanisms)柔性铰链结构,将整个抗拉LET柔性铰链等效为弹簧刚度模型,并对该弹簧刚度模型进行理论建模,得到封闭解。之后采用ANSYS软件,建立其有限元模型,分析其在转动载荷和轴向载荷两种不同场合下的形变,并同之前的理论模型进行比较。结果表明,采用弹簧刚度模型得到的等效刚度解与仿真分析结果较为一致,抗拉LET柔性铰链的弯曲刚度仅是传统LET柔性铰链的1.12倍,而拉伸刚度却是它的76.43倍。在弯曲刚度没有大幅变化情况下,抗拉LET柔性铰链的抗拉刚度明显增大,抗拉能力大大提高,表明抗拉LET柔性铰链的结构设计符合预期要求。

**关键词** : 抗拉柔性铰链, LEMs, LET, 弹簧刚度模型, 有限元分析

**Abstract** : To increase the axial stiffness of a Lamina Emergent Torsion( LET) under the condition of invariable rotational stiffness, a new tensile flexure hinge was designed by improving traditional LET structures. Base on the structure of Lamina Emergent Mechanisms(LEMs), the whole LET structure was equal to a spring stiffness model. By modeling the spring stiffness model in theory, the closed-form solution was obtained. Then, a Finite Element Analysis ( FEA) model was set up by the ANSYS to analyze the deformations under the rotating load and axial load and to compare with the previous theoretical model. Results show that the equivalent stiffness solution based on spring stiffness model is consistent with that of the simulation analysis, in which the bending tensile stiffness of the tensile LET is only 1.2 times that of the LET, but tensile stiffness is 76.43 times that of the LET. It indicates that the bending stiffness does not increase obviously, but the tensile stiffness of the tensile LET has significantly increased effectively and the tensile capacity of the LET is improved greatly. The design of the tensile LET meets expectation.

**Key words** : tensile flexure hinge Lamina Emergent Mechanism(LEM) Lamina Emergent Torsion(LET) spring stiffness model Finite Element Analysis(FEA)

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