论文

评估环圈光纤机械可靠性的模型

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摘要：

为评估应用于光纤陀螺和光纤电流传感器等传感领域的光纤环圈的机械可靠性,排除光纤涂覆和环圈灌胶等因素,必须评估所用光纤在弯曲状态下的机械可靠性.在已被广泛接受的均匀拉伸应力状态下通信光纤的机械可靠性模型基础上,根据这种环圈光纤在弯曲状态下的一般应力分布,对于绕环张力和弯曲应力同时存在的情形,建立了评估这种环圈光纤的机械可靠性的一种模型.该模型通过采用弯曲状态下光纤表面的最大弯曲应力值,和由于一般情况下弯曲中轴内侧的压缩应力远小于外侧拉伸应力的这一事实而忽略内侧的压缩应力,从而简化了弯曲应力的不均匀分布;同时通过该模型中所含的多个参量的选择给出了最为保守的结果.利用该模型进行的数值计算预测了采用不同直径的光纤分别绕制的不同环圈直径的环圈光纤在不同服役条件下的机械可靠性.结果表明,除了光纤半径和疲劳因子等这些光纤自身的固有因素外,绕环张力、环圈半径和筛选张力等工艺参量对环圈光纤的机械可靠性也是有重要影响.

关键词： 光纤　失效概率　机械可靠性

A Model for Evaluating the Mechanical Reliability of Coiled Fibers

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Abstract:

It is necessary to evaluate the mechanical reliability of the coiled fibers to evaluate the mechanical reliability of fiber coils applied in sensing fields, such as fiber-optic gyroscope and current sensors, besides the causes of fiber coatings and loop glues. A model is proposed for evaluating the mechanical reliability of the coiled fibers, which is based on the mechanical reliability model of the haul-distance telecommunication fibers by incorporating the bend-induced stress and the coiling tension. The model can simplify the inhomogeneous bending stresses distribution with the maximum stress value and the fact that the compressed stress in the inner side of the fiber natural axis is far small than the stretch stress outside. By these and the choosing of the parameters involved in the model, the conserved results are given using this simplified model. Several numerical caculations of mechanical reliability of various fiber coils with different fiber and bending radius are carried out using this model. The results show that besides fiber own inherent factors including the fiber radius and the fatigue factor, some process parameters, such as the circling tension, the ring radius and the screening tension also have a major impact on the mechanical reliability of coiled fibers.

Keywords: Optical fibers　Failure probability　Mechanical reliability

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