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学术论文

基于完全气弹模型风洞试验输电塔风荷载识别

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摘要：

按照基本缩尺律，设计、制作了输电塔完全气弹模型，并通过大气边界层风洞试验，测试了多种风速、风向条件下输电塔的位移与加速度响应。通过加速度响应功率谱识别出结构的固有频率，并采用Hilbert-Huang变换结合随机减量法识别出包含结构阻尼和气动阻尼的结构总阻尼。利用虚拟激励法建立了由测点位移响应来识别结构顺风向、横风向风荷载的方法。由识别出的风荷载谱曲线，利用非线性最小二乘法拟合得到输电塔顺风向、横风向风荷载经验公式。研究结果表明：风洞试验设计、制作的输电塔气弹模型，测试得到的模型第1阶自振频率与有限元计算结果吻合较好；横风向荷载谱形态与顺风向的相比有较大的区别，其能量分布在一个更宽的频带上，其峰值频率是顺风向的3～4倍。

关键词： 输电塔 气动弹性模型 风洞试验 荷载识别 虚拟激励法

Wind loading identification of transmission towers based-on wind tunnel tests of full aero-elastic model

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Abstract:

In light of basic scale laws, a full aero-elastic model of a transmission tower was designed and produced. Displacements and accelerations response of the aero-elastic model of the transmission tower under various wind speeds and various wind directions were investigated through boundary layer wind tunnel tests. The structure natural frequencies were identified by the acceleration power spectrum method and the structural total mode damping ratios including structure damping ratios and aerodynamic damping ratios were acquired by Hilbert-Huang transform method and random decrement technique. A method was introduced to identify dynamic wind load spectra in the along-wind and across-wind directions from displacement spectra based on pseudo-excitation method. As wind load spectrum curves of the transmission tower had been identified, the experiential formulas of the dynamic wind load models of the tower in along-wind and across-wind directions were established by nonlinear least squares regression. Analysis results show the full aero-elastic model of the tower produced in the test is very fine and its first order natural frequency is much closed to the one calculated by FEM. Comparison between across-wind and along-wind force spectra indicate that the energy of across-wind force spectra is distributed on a much wider frequency domain and their dominant frequencies are 3 to 4 times of those in along-wind direction.

Keywords: transmission tower aero-elastic model wind tunnel test loading identification pseudo-excitation method.

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