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弹性悬挂弯扭耦合颤振模型表面压力分布的时空特性及颤振机理分析

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Anlysis on the flutter mechanism and the charateristic of the surface pressure for the flexible suspension rigid model

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摘要 实际应用中, 桥梁颤振稳定性可用风洞试验的结果作为评估标准, 但颤振时断面的压力空间分布特征是不清楚的。本文对弹性悬挂的刚体模型在颤振时及固定时(来流风速与颤振风速一致)的表面压力进行采样, 首先分析模型在颤振时的表面各部分压力特性, 结果显示, 右部压力相位相当于左部具有滞后性, 表明是受迎风侧特征湍流影响的被动区域。随后运用本征正交分解(POD)方法分析模型表面压力分布特征与颤振发散性运动之间的关系, 结果显示, 所获得的本征模式中存在着与颤振扭转发散运动关联极强的‘主导颤振模式’, 该模式对总升力矩系数波动的贡献占绝对主导地位, 其主坐标频率与颤振频率一致且具有与振动位移一致的离散性, 但其归一化空间分布特征在断面颤振过程中不变化。结合模型在固定时的本征模式分析结果, 除颤振主导模式外, 其余模式均能在固定时的本征模式中找到类似空间分布的模式, 且与断面离散性运动的关联性很小。本文工作为今后颤振机理分析提供了一个新的思路与方法。

关键词: 弯扭耦合颤振 节段模型测压 POD分析 主导颤振模式 颤振机理

Abstract: AbstractThe flutter stability of bridges could be evaluated based on the wind tunnel test. However, the spatial distribution of the surface pressures on the section is unclear. In this paper, the surface pressures of the flexible suspension rigid model in the static and fluttering condition are both acquired with the same flow velocity. Based on analyzing the distribution of the surface pressures, the relationship between the pressures and flutter is gained by the proper orthogonal decomposition (POD) method. The result shows that one of the eigen modes has a strong association to the flutter with a dominant role to the torsion coefficient, so this mode is called ‘dominant flutter mode’. Meanwhile, its normalized spatial distribution remains unchange during fluttering with the same frequency and divergence of the vibration. The other modes are hardly relevance to the flutter. We can also find that the pressure of the right part of the section is lagged to the left part since the right part is the passive region with the impact of the characteristic turbulence of the windward. Comparing with the result of the static condition, there is no any other similar modes expect the ‘dominant flutter mode’. This paper will provide a new method to research the flutter mechanism.

Keywords: [coupled bending and torsional flutter](#), [pressure measure of the scale section](#), [POD](#), [dominant flutter mode](#), [flutter mechanism](#)

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