

# 地震差动下边界-地基-斜拉桥体系破坏特征

柳国环<sup>1</sup>, 练继建<sup>1</sup>, 燕翔<sup>1</sup>, 刘伟<sup>2</sup>

(1. 天津大学 a. 建筑工程学院; b. 水利工程仿真与安全国家重点实验室, 天津 300072;  
2. 燕山大学 土木工程学院, 河北 秦皇岛 066004)

**摘要:** 同时考虑边界条件和地基-结构相互作用对大跨桥梁结构地震响应的影响是个复杂问题。本文以一大跨斜拉桥为例, 通过开发的系列程序建立了边界-地基-桩-斜拉桥结构的 ABAQUS 模型, 生成了目标场地多点地震动, 对比了不同地基边界条件对大跨斜拉桥结构自振特性的影响, 探讨了地表/地下多点地震动作用下、不同地基边界条件对大跨斜拉桥体系弹塑性发展过程及倒塌模式的影响规律。结果表明: (1) 进行大跨斜拉桥结构的抗震分析时, 有必要考虑地基边界条件的影响; (2) 地表多点地震动输入下, 考虑地基-结构相互作用时, 大跨斜拉桥结构的弹塑性发展过程和倒塌模式与单独斜拉桥不同; (3) 粘弹性人工边界条件考虑了周围土体对地基的作用, 地基相对变形较小, 对上部斜拉桥结构起到了一定的保护作用。

**关键词:** 大跨斜拉桥; 边界-地基-结构相互作用; 多点地震动; 弹塑性分析; 倒塌分析

中图分类号: TU311.3; U442.5+5 文献标识码: A 文章编号: 2095-0985(2016)01-0044-10  
DOI:10.13579/j.cnki.2095-0985.2016.01.008

## Elasto-plasticity Analysis and Failure Characteristics of Long-span Cable-stayed Bridge Considering Boundary-foundation Interaction Under Multiple-support Seismic Excitations

LIU Guo-huan<sup>1</sup>, LIAN Ji-jian<sup>1</sup>, YAN Xiang<sup>1</sup>, LIU Wei<sup>2</sup>

(1. a. School of Civil Engineering; b. State Key Laboratory Hydraulic Engineering Simulation and Safety, Tianjin University, Tianjin 300072, China; 2. School of Civil Engineering and Mechanics, Yanshan University, Qinhuangdao 066004, China)

**Abstract:** Seismic response effect of the long-span bridge structure considering both boundary condition and soil-structure interaction simultaneously is a complex problem. Taking a long-span cable-stayed bridge as an example, the boundary-foundation-pile-cable-stayed bridge model was established by a series of developed programs. The target site multi-support ground motions were also generated. The different boundary conditions on the vibration characteristics effect of the long-span cable-stayed bridge were compared. The effect of different boundary conditions on the elasto-plasticity development process and collapse mode of the long-span cable-stayed bridge was also discussed under surface/underground multi-support ground motions. The results indicate that: (1) It is necessary to consider the effect on the boundary conditions of the foundation in the seismic analysis of large-span cable-stayed structure; (2) When considering foundation-structure interaction, the elasto-plastic development process and collapse mode of the large-span cable-stayed bridge are different with the single cable-stayed bridge under the surface multi-support ground motion; (3) Accounting for the effect of soil surrounded by the foundation in the viscous-spring artificial boundary condition, the foundation deformation is relatively smaller and this plays a protective role in the upper cable-stayed structure.

**Key words:** long-span cable-stayed bridge; boundary-foundation-structure interaction; multi-supports-seismic excitations; elasto-plasticity analysis; collapse analysis

收稿日期: 2015-10-19 修回日期: 2015-11-03

作者简介: 柳国环(1980-) 男, 天津人, 副教授, 博士, 研究方向为工程结构动力计算 (Email: liugh@tju.edu.cn)

基金项目: 国家自然科学基金(51408409); 中国博士后科学基金(2011M500332); 天津市应用基础与前沿技术研究计划(15JCQNJC07400)