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基于地脉动和地铁振动的钢筋混凝土建筑结构响应分析

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Structural response analysis of a reinforced concrete building based on excitation of microtremors and passing subway trains

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摘要 在北京城区的一栋钢筋混凝土建筑(Reinforced Concrete building,简称RC)中,进行历时两天的地脉动和地铁振动观测.介绍了利用地脉动和地铁振动信号研究RC建筑结构响应的观测方法、仪器设备、数据采集和数据处理方法.对观测数据进行两种分析:(1)对连续的地脉动背景噪声,采用H/V谱比法;(2)对经过的地铁列车作为震源产生的振动信号,采用地震干涉法,从而得到大楼的结构响应.这两种分析方法都表明:该RC大楼在东西向的共振频率是2.2 Hz,在南北向的共振频率是2.9 Hz.H/V谱比法表明,该大楼的噪声主要来源于东西方向的城市交通,主要包括地面交通和地铁.对地铁通过时产生的结构响应进行地震干涉分析,估算出这栋RC建筑的阻尼比是0.17,这能有效衰减共振.最后得出:利用地脉动背景噪声和沿线地铁振动作为信号输入,可能提供一种经济实用、灵活性好的结构响应分析方法,这是对仅利用强震动加速度分析进行建筑物易损性评估的传统分析方法的一种补充.

关键词: 脉动背景噪声 H/V谱比法 地震干涉法 共振频率 结构响应

Abstract: A period of more than 2 days measurements of the ambient seismic noise was conducted inside a reinforced concrete (RC) building in central Beijing. This paper presents the method of using the wave information from microtremors and vibration of passing subway trains to study the structural response of reinforced concrete buildings. It presents the observation method, instruments, data acquisition, and data processing methods. Two types of analysis were conducted to the measured data to extract the structural response of the building: (1) the horizontal to vertical (H/V) spectral ratio method to the continuous ambient noise; and(2) the seismic interferometry analysis with a deconvolution procedure to the seismic sources generated by the passing subway trains. Both analyses indicate the fundamental resonance frequency of this RC building is about 2.2 Hz in EW and 2.9 Hz in NS. The H/V analysis indicates that the major noise source comes to the building from EW direction, involving the urban traffic layout in central Beijing area. The seismic interferometry analysis of the structural response to the passing subway trains gives an estimate of the damping ratio of this RC building to be about 0.17, a very efficient level of damping to resonant vibrations. We conclude that structural analysis using the ambient seismic noise (microtremors) as excitation input may provide an economical and flexible way to supplement the traditional strong ground motion analysis using only accelerograms in building vulnerability assessment to seismic hazard.

Keywords: Ambient seismic noise H/V spectral ratio Seismic interferometry analysis Resonance frequencies Structural response

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