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最新目录 | 下期目录 | 过刊浏览 | 高级检索   ◀◀ ◀◀ 前一篇 | 后一篇 ▶▶ ▶▶

隔震高层结构的悬臂梁模型的地震反应研究

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EARTHQUAKE RESPONSE ANALYSIS OF CANTILEVER-BEAM MODEL OF ISOLATED HIGH-RISE STRUCTURE

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- 摘要
- 图/表
- 参考文献
- 相关文章

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摘要 对底部隔震悬臂梁的地震等效作用和效应进行了研究。水平力作用下具有弯曲型侧移曲线的悬臂梁在动力特征上与高层结构接近, 隔震悬臂梁可作为隔震高层结构的一种等效的简化模型。采用伯努利-欧拉梁理论推导出底部隔震悬臂梁的周期和振型, 利用振型反应分解谱法分析隔震悬臂梁的地震效应, 研究隔震前后各振型的等效地震作用的变化。研究发现隔震高层减振的主要原因在于调整了各振型对内力的贡献比例, 延长了高阶振型的周期, 从而降低高阶振型的影响, 实现减振的目的; 隔震对结构上部和底部作用也不同, 且对剪力影响大于弯矩; 隔震层刚度越弱, 对高阶振型的抑制作用越明显, 隔震后与隔震前1 阶振型的周期比大于1.4 可取得较好的隔震效果, 规则的隔震高层结构可只采用2 个振型计算。

关键词: 高层建筑 隔震 简化模型 悬臂梁 地震反应

Abstract: Earthquake actions and seismic effects are studied for base-isolated cantilever beam. Based on the assumption that the dynamic characteristics of cantilever beams, with bending deformation curve of lateral displacement when subjected to lateral forces, are similar to those of high-rise structures, the base-isolated cantilever beam is investigated in this study as an equivalent simplified model of high-rise structures. Vibration periods and modes are derived from the Bernoulli-Euler theory, and earthquake responses are calculated with the mode decomposition response spectrum method. The seismic modal effects of pre- and post- isolation are then examined. It is found that seismic-effect adjustment of each mode is the main mechanism of seismic reduction of isolated high-rise structures and that the higher modes contribution is reduced with periods of the higher modes elongated. Other findings include that base-isolation influence on the substructure is different from the upper-structure, that earthquake-response variation of shear is more significant than that of the moment, and that the reduction of the higher modes is more significant with lower isolation stiffness. It is suggested that the fundamental period ratio of the post- and pre- isolation be over 1.4, and that seismic effect of base-isolated regular high-rise structure can be calculated with two lowest modes alone.

Key words: high-rise structure isolation simplified model cantilever beam earthquake response

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