

学术论文

法门寺合十舍利塔结构整体模型振动台试验研究

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摘要:

法门寺合十舍利塔为特殊的竖向倒转收进结构, 主体结构为倾斜外挑内收的型钢混凝土筒体, 沿高度在两处形成拐点, 底层为框支转换层, 顶部通过型钢混凝土桁架连接形成连体结构。为了研究其抗震性能, 对其1/35整体模型进行了模拟地震振动台试验, 测试了模型结构的动力特性及其在7度多遇、7度基本、7度罕遇、8度罕遇水准地震作用下的加速度、位移反应等, 研究了模型结构的破坏机理和破坏模式, 并根据试验结果, 分析了原型结构的动力特性及地震反应。试验结果表明: 模型结构第1、2、3阶振型频率分别为6.348Hz(平动)、6.836Hz(平动)和14.746Hz(整体扭转), 原型结构对应的前3阶振型周期分别为0.933s、0.866s、0.401s, 扭转、平动周期比为0.43; 在7度基本及7度罕遇水准地震作用下结构最大层间位移角分别为1/754和1/453, 表明原型结构整体抗震性能较好, 能够满足中震基本弹性、大震不倒的抗震设防要求。建议采取适当措施缓解4层楼板标高附近筒体墙身的应力集中, 并进一步研究结构外挑端部及其上下楼层竖向反应及其与水平反应的耦联性。

关键词: 高层建筑 倒转收进 振动台试验 抗震性能 抗震设计

Shaking table model test on Palms Together Dagoba atFamen Temple

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Abstract:

Palms Together Dagoba at Famen Temple was designed to have a special layout with considerably vertical inversion and setback. The main structure is steel reinforced concrete tubes with inclined projecting and backsetting, and two inflection points are formed along the structural height. The first floor is transfer floor with framed pillars and beams. Tubes are connected by steel reinforced concrete trusses at the top. In order to investigate the seismic performance of this structure, a shaking table test of a 1/35 scaled model was carried out. The dynamic parameters, responses of acceleration, displacement of the model under different earthquake levels are studied. The failure mechanism is discussed as well. Then, the dynamic characteristics and the seismic responses of the prototype are deduced and analyzed based on the model test results. The frequencies of the first three modes of the model are 6.348Hz (translation), 6.836Hz (translation) and 14.746Hz (overall torsion) in turn. The corresponding periods of the first three modes of the prototype are 0.933s, 0.866s and 0.401s respectively. Thus the ratio of the period of the first torsion mode to that of the first translation mode is 0.43. The maximum inter-story drift ratios of the prototype under moderate and rarely occurred earthquakes of intensity VII with design basic acceleration 0.15g are 1/754 and 1/453 respectively. These all indicate that the prototype can satisfy the seismic criteria under different earthquake levels. Appropriate measures to release strain concentration of tube walls near the fourth floor slab are recommended. And further study on vertical response and the coupling effect with horizontal response at out-extended floor and floors near out-extended floor is necessary.

Keywords: high-rise building vertical inversion and setback shaking table test seismic performance seismic design

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