

学术论文

轻型门式刚架抗震性能试验研究

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摘要:

进行了铰接柱脚变截面门式刚架的滞回加载试验, 刚架构件腹板的最大高厚比为94.05, 超过GB 50011—2001《建筑抗震设计规范》的限值。试验中刚架变形集中于梁柱连接节点和梁梁连接节点附近的梁段, 刚架最终破坏模式也为此处的屈曲破坏。试验得到了完整的荷载位移曲线, 并通过其骨架曲线得到了刚架的延性系数, 均值为3.09, 表明刚架延性较好。进行了单调和滞回加载的有限元分析, 通过与试验结果进行比较验证了有限元模型的可靠性。在试验和有限元结果的基础上, 对此类刚架的抗震性能进行了分析, 结果表明刚架因形成多个屈曲段而成为“机构”, 形成机构前有一定耗能能力, 地震作用下承受较小重力荷载的刚架水平位移限值可适当放宽。提出了单位能效比的概念, 定义为刚架耗能与刚架构件总用钢量的比值, 用于综合评价门式刚架钢结构的抗震性能和设计合理性。

关键词: 门式刚架 滞回加载试验 有限元分析 局部屈曲 抗震性能 单位能效比

Experimental research on hysteretic behavior of light-weight steel portal frame

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Abstract:

Light-weight steel portal frames were tested under vertical and cyclically horizontal loads, where the maximal width-to-thickness ratios of web reached 94.05, exceeding the limitation by current code of 'Code for seismic design of buildings' (GB 50011—2001). In the tests, the deformation concentrated in the beam segment nearby the beam-column connections and beam-to-beam connections, and at the same place local buckling appeared which led to the final failure of frames. Based on the experimental load-displacement curves the ductility factor was computed as 3.09, indicating that the deformability of frames was fine. Finite element analysis was carried out considering monotonic and cyclic loads. By comparing with tests results, the validity of finite element analysis was proved. Furthermore the seismic capacity of this type of frame was analyzed. The results indicate that the frames fail when local buckling occurs at several segments so that a hinge like mechanism forms, and the limitation of horizontal displacement may not be so strict as the current code if the frame is only subjected low gravity loads. The concept of unit energy efficiency ratio, defined as the ratio of frame energy absorption to steel consumption, is proposed to estimate the seismic capacity and design rationality.

Keywords: portal frame hysteretic loading test FEA local buckling seismic performance unit energy efficiency ratio.

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