表1　不同工况下桥梁首次进入塑性的位置与时间对比

Tab.1　Comparison among the first occurrence location and time of plasticity hinges of the bridge under different cases

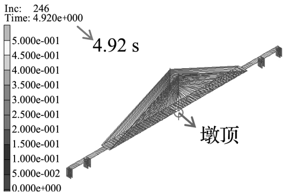
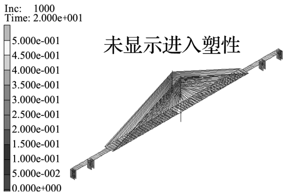
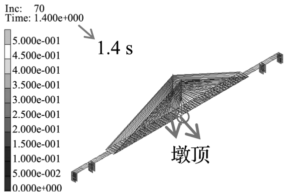
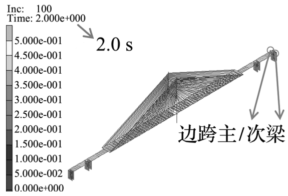
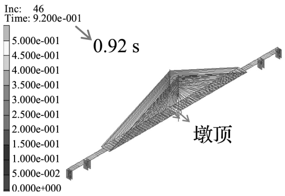
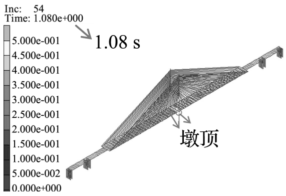
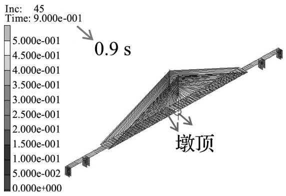
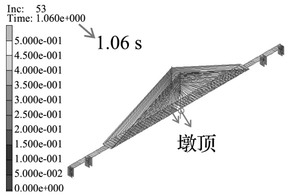
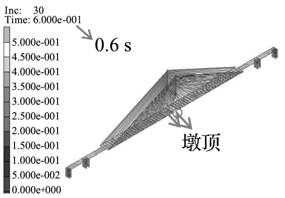
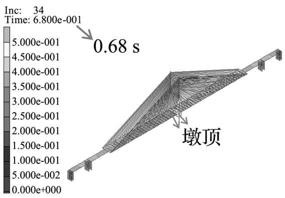
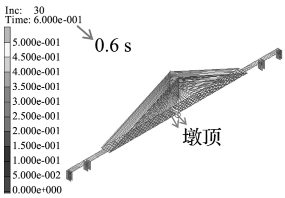
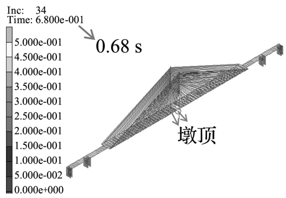
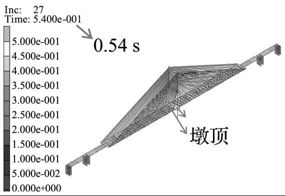
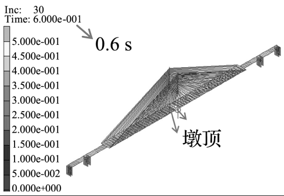
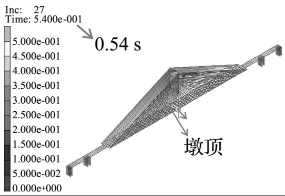
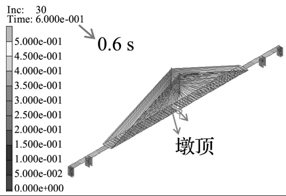
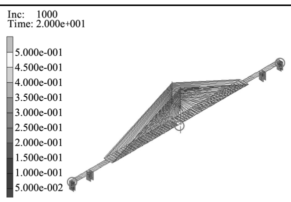
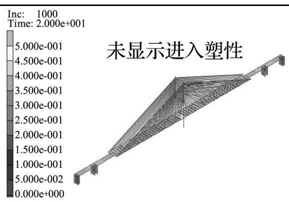
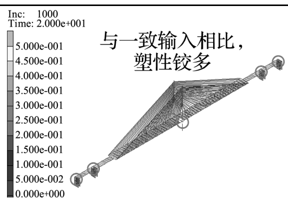
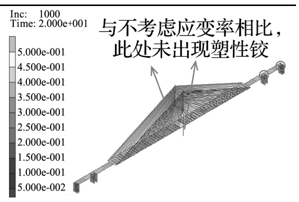
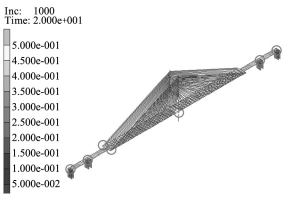
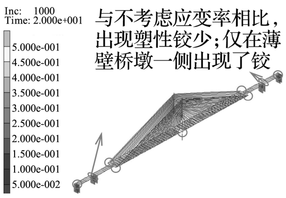
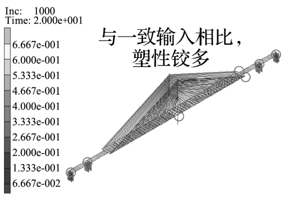
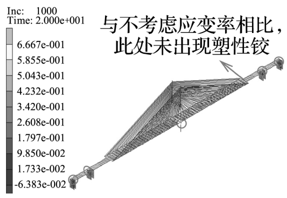
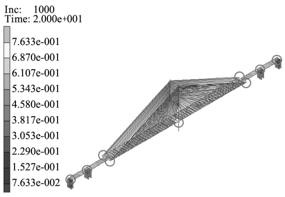
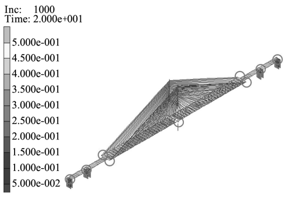
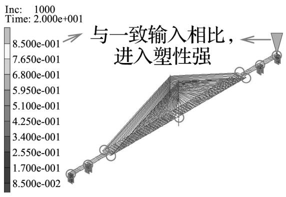
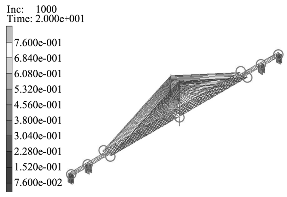
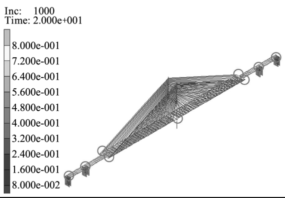
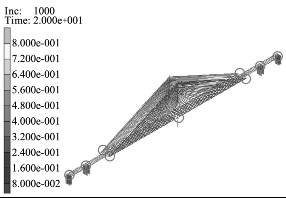
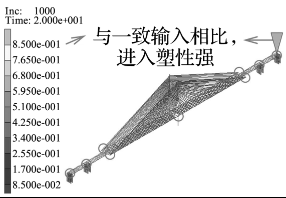
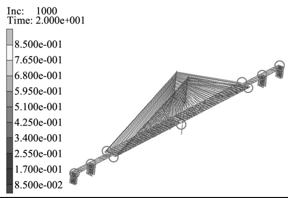
峰值	Case 1	Case 2	Case 3	Case 4
0.25 g				
0.4 g				
0.8 g				
1.0 g				

表2　不同工况下桥梁计算末态时刻的塑性状态对比

Tab.2　Comparision among the final plastic state of the bridge under different cases

峰值	Case 1	Case 2	Case 3	Case 4
0.25 g				
0.4 g				
0.8 g				
1.0 g				

6 结 语

本文结合工程实际,分别从可视化接口、地震动输入、程序开发和材料应变率效应方面所做工作总结如下。

(1) 开发了可视化 Civil2MARC 转化接口,验证了程序的可靠性,可大大降低前处理建模时间。

(2) 开发了可视化基于地表功率谱的多点地震动程序 MEMS_b,相干性、拟合目标功率谱与规范反应谱吻合良好,验证了程序可信性。

(3) 简要解释了位移-速度多点计算模型理论完备性,避免位移输入理论模型底部单元结果不收敛的固有缺陷,并进一步说明通过 MSC. MARC 可以应用位移-速度多点计算模型,并应用于桥梁多点地震动计算。

(4) 首次出现塑性铰的位置,各种工况基本一致,为主塔桥墩墩顶这一薄弱环节;考虑应变率效应后,首次出现塑性铰的时间较不考虑应变率效应相对滞后,说明应变率效应有提高材料强度的作用,数值计算结果与已有试验及程序结果相一致。

(5) 计算末态塑性铰分布情况,多点地震动对结构体系最终进入塑性状态产生了不利影响;地震强度相对较小时,应变率效应使材料强度提高进而使结构进入塑性的部位减少;随着地震动峰值增大,应变率效应对最终塑性铰的分布位置未显示有影响。解释了地震动相对于大跨长周期结构理论上归为高频荷载作用于长周期结构,激励对结构的短周期高频振型分量产生作用,而对长周期低频振型分量贡献小甚至为零。

本文开发的工具有实用性,可供参考。

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Study on steel strain-rate and multiple earthquake motions effect on elasto-plasticity responses of 300 m span single tower cable-stayed bridge

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Abstract: Firstly, the 3D finite element model of single tower cable-stayed with a main span of 300 m is established using software MIDAS/Civil. A visual interface program named Civil2MARC for transforming the finite model from MIDASCivil to MSC. MARC is developed, and then the MIDAS model is transformed to MSC. MARC using the Civil2MARC. The consistency between the MIDAS and MARC finite model is compared to verify the accuracy of the interface program Civil2MARC. While, a visual program named MEMS_b is developed based on power spectra of ground is briefly introduced here. Further, the advantage of the displacement-velocity model is explicitly addressed, and the model is further applied to the cable-stayed bridge through the software MSC. MARC. Finally, to study the influence of multi-supported ground motions and material strain-rate on seismic response under earthquake motions, the subroutine considering strain-rate effect of steel and concrete is used to analyze the dynamic responses including weak parts, elasto-plastic response and so on. The results show that (1) The visual program Civil2MARC developed in this paper is characterized with convenient operation, stable running, high efficient transforming process and reliable transforming results. (2) The visual program MEMS_b developed in this paper has friendly user interface, flexible assignment and direct post-processing results display. (3) the displacement-velocity model is more reasonable and can be easily complemented through MSC. MARC. (4) The influence law strain-rate and multi-point earthquake motions effect on the plastic hinges occurrence location, time and final distribution of the cable-stayed bridge is analyzed and given. This paper involves theory model, program developing and engineering numerical computation, and can provide reference for revlevant engineering.

Key words: cable-stayed bridge; MIDAS; Civil2MARC; MSC. MARC; multi-point earthquake motion; elasto-plasticity; strain-rate

(上接第 485 页)

Decentralized robust control of building structure based on sliding mode theory

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Abstract: A decentralized robust control method was investigated and developed for large scale building structure. Based on large systems control theory, higher order structural system was decomposed into substructures. The interaction of subsystems and seismic disturbance were conducted as bounded generalized force acting on the subsystem and substructure model was established in the form of state equation. Taking advantage of anti-perturbation conditions of sliding mode theory, an overall stability sliding mode trajectory was designed. The control condition, which satisfies the global stability only using local state of substructure system, was analyzed and every substructure was regulated with parameter. Then the decentralized robust control algorithm was formulated. At the same time, the pseud-sliding mode control method was used to overcome the chattering of variable structure sliding mode. The effectiveness of the proposed method was demonstrated by the numerical simulation of a 20-story steel structure under seismic excitations.

Key words: large scale systems; decentralized control; sliding mode control; robust stability; seismic response