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Integrated Optimal Life Cycle Design of Super Tall Buildings with Viscous Dampers

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Abstract

The life cycle of a super tall building has many stages such as design, construction, operation, maintenance and so on. The life cycle cost of the structure is mainly composed of the construction, maintenance and disaster lost costs. Viscous dampers can effectively improve the energy dissipation capacity of super tall building structures under earthquakes. And life cycle cost could be reduced by the introduction of viscous dampers due to two facts. One is that the structural members can be further optimized for considering the reduction of earthquake actions due to additional damping, and the other is that the structural damage could be alleviated with the viscous dampers to reduce the maintenance and disaster lost. The integrated optimal design of the life cycle cost about the main structural members using viscous dampers was addressed in this paper. Integrated optimal design was applied to minimize the sizes of structural members. The sensitivity analysis of structure used in this paper is based on the virtual work principle. According to the sensitivity indices, we can easily obtain one component's contribution to the monitoring parameter, and it is convenient to obtain the effectiveness of the structural system, the rationality of layout and the sensitivity of the components for several criteria[1]. A life cycle cost assessment method was then proposed to evaluate the whole life cycle cost of buildings which include construction, maintenance and disaster lost costs. Life cycle cost assessment method is used to evaluate the lost cost in this paper, and to guide engineers how to select a safer and more economical scheme. We can easily obtain the performance level and loss coefficient of components with finite element analysis software, then we can gain the lost cost. A 250-meter-high super high-rise building with 63 floors and 3 mechanical floors was adopted in the final part of this paper to illustrate the effectiveness of the proposed optimal life cycle design method. The Lost cost of integrated optimal structure is much smaller than the cost of uncontrolled structure with the energy dissipation of viscous dampers. And the lost cost is smaller with the increase of viscous dampers. The optimal life cycle cost scheme is the scheme with 8VDs after calculation. Optimization calculation results showed that the integrated optimal design of viscous dampers is reasonable and can be guidance to other designs of super tall buildings.

References

[1] Baker, W. F. Stiffness Optimization Methods for Lateral Systems of Buildings: A Theoretical Basis. Electronic Computation. Indianapolis, Indiana: American Society of Civil Engineers, 269278, 1991

[2] Wen Y K, Kang Y J. Minimum building life-cycle cost design criteria. I: Methodology[J]. Journal of Structural Engineering-Asce. 2001, 127(3): 330-337.