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Life Cycle Vibration Sensation Rate Evaluation Model for the Optimal Human Comfort Design of Super Tall Buildings

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Abstract

The wind-induced vibrations of super tall buildings become excessive due to strong wind loads, super building height and high flexibility. In view of individual uncertainty and diversity of wind-induced vibration response, a life cycle vibration sensation rate model based on AIJES-V001-2004 [1] was proposed to evaluate human comfort performance of super tall buildings under wind load. The maximum acceleration was adopted as the quantitative index of the performance. Pseudo excitation method was employed in the frequency domain analysis for the calculation of the vibration sensation rate of the super tall building under random wind load. The randomness of the wind speed being taken into consideration, the vibration sensation rate of human comfort was obtained for the whole life cycle. A cost model for the wind-induced human comfort of super tall buildings was derived based on the vibration sensation rate model. This model evaluated the life cycle cost of different design schemes, which could help make design choice based on the minimum life cycle cost criterion. The proposed method was applied to the human comfort design choice of a super tall building with and without tuned mass damper (TMD), tuned liquid column damper (TLCD) or combined tuned damper (CTD) [2] device to illustrate its effectiveness and applicability.

Some conclusions are drawn as follows: (1) the initial investment and vibration control performance are different among the TMD, the TLCD and the CTD, the life cycle cost of them are also different. The life cycle cost of the TLCD-structure system is much less than that of the TMD-structure system, but the volume of TLCD is several times as large as that of TMD with the same mass ratio, which is no doubt with larger space required. The life cycle cost of the CTD-structure is between that of the TMD-structure and that of the TLCD-structure. It is concluded that the CTD can fully utilize the high effectiveness of a TMD and economical advantage of a TLCD, which makes it a competitive option. (2) It is strongly noted that it is hard to evaluate the costs of human comfort failure accurately because of strong variability of human subjective feelings and economic factors. There is also a large amount of work to do before the proposed method to be widely used. However, the proposed method provides an innovative idea for the optimal design of wind-induced human comfort performance for super tall buildings.

References

[1] Aij A I O J, *Guidelines for the Evaluation of Habitability to Building Vibration*. Tokyo, 2004.

[2] Tongji Architectural Design (Group) Co., Ltd. (China), *A combined tuned damper for wind-induced vibration control of super tall buildings*. CN, 20553346.X, 2015- 01-14.