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Seismic performance improving for the Yingxian wooden pagoda by using morden structure system

Yang Deng[1)], Yi-Feng Wu[2)], *Ai-Qun Li[3)]

[1), 2), 3)] *School of Civil and Transportation Engineering, Beijing University of Civil Engineering and Architecture, Beijing 100044, China*
[1), 2), 3)] *International Joint Laboratory of Safety and Energy Conservation for Ancient Buildings, Ministry of Education, Beijing 100044, China*
[1)] dengyang@bucea.edu.cn
[2)] wuyifeng@bucea.edu.cn
[3)] liaiqun@bucea.edu.cn

ABSTRACT

The Yingxian Wooden Pagoda is situated in Ying County, Shuozhou, Shanxi Province, China. Constructed in 1056, it is the oldest and tallest extant pure wooden tower in China, reaching a height of 67.31 meters. This architectural marvel represents the pinnacle of ancient Chinese wooden construction. Historical wooden buildings constitute a significant segment of the architectural heritage worldwide. However, these buildings are susceptible to component deterioration and structural inclination, potential collapse due to material degradation and the impact of external loads. The fundamental objective in protection conserving these historical wooden buildings is to safeguard them from such catastrophic failures, thereby preserving their intrinsic value and extending their longevity. To address this issue, a scientific control method based on the principle of minimum intervention has been proposed, termed the “zero-interference method”. This approach is designed to mitigate the progression of structural inclination and enhance the seismic resilience of ancient wooden structures without imposing any disruptive influences. The ancient wooden building is surrounded by an external protection structure (EPS) that is connected to the inclined part. This study uses the FE model of the Yingxian wooden pagoda in China to analyze the structural responses in both pre- and post-reinforcement, validating the effectiveness of the method. Additionally, the parameters of the EPS are discussed. The results reveal that the zero-interference method can effectively mitigate the progression of structural inclination and reduce the seismic responses of the wooden pagoda. The maximum reduction of story drift can reach over 50 %. The wooden pagoda is connected to an EPSwith concentrically braced

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[1)] Professor
[2)] Professor
[3)] Professor

support by using BRBs, improving the seismic performance. Notably, this study offers a valuable contribution to the field, presenting a methodological framework for augmenting the structural rigidity and curtailing displacement in historical wooden buildings.

REFERENCES

Li Y.H, Sun P, Li A.Q, et al. (2021), “Wind effect analysis of a high-rise ancient wooden tower with a particular architectural profile via wind tunnel test”. Int. J. Archit. Heritage, **17**(3): 1–20.

Yuan J, Peng S, Shi Y, et al. (2016), “Research on restoration scheme of Ying-Xian Timber Pagoda”. SAHC2016 10th International Conference on Structural Analysis of Historical Constructions.

Sha B, Xie L, Yong X.Q, et al. (2021), “An experimental study of the combined hysteretic behavior of dougong and upper frame in Yingxian Wood Pagoda”. Constr. Build. Mater, **305**[2023-07-21].