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Train-induced force variation and fatigue analysis of hangers for a tied-arch bridge based on Vector Form Intrinsic Finite Element method

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ABSTRACT

The hangers are important force-bearing members in tied-arch bridges. However, they seem more vulnerable to damage. This paper presents train-induced dynamic response and fatigue damage analyses for the hangers of a tied-arch railway bridge. A train-bridge interaction analysis is carried out using the Vector Form Intrinsic Finite Element (VFIFE) method with the advantage of avoiding the global stiffness matrix factorization and inversion in FEM computation. The variations of dynamic forces in the hangers under various train speeds are investigated. Excessive force variations of the short hangers near the anchorage were observed from the resonance during train passages. The fatigue damage to the hangers was estimated using the Palmgren Miner model (PMM) for linear fatigue damage accumulation and the continuum damage mechanics (CDM) method for nonlinear accumulation. Two probability distributions for train speed were considered for the current and future operating conditions with mean speeds of 220 and 300 km/h, respectively. The present study found that the fatigue lives estimated by the nonlinear CDM are significantly shorter than those estimated by the linear PMM. It was also found that the shortest hanger reflects the shortest fatigue life at the current operating speed, whereas a longer hanger may have the shortest fatigue life at an increased speed in the future.

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REFERENCES

Duan, Y.F. Wang, S.M. Yau, J.D. (2019) “Vector form intrinsic finite element method for analysis of train–bridge interaction problems considering the coach-coupler effect”, *Int. J. Struct. Stab. Dy.* ,**19**(2) 1950014.

Duan, Y.F. Wu, S.K., Wang, S.M., Yau, J.D., Ni, Y.Q. Yun, C.B., (2022) “Train-Induced dynamic behavior and fatigue analysis of cable hangers for a tied-arch bridge based on vector form intrinsic finite element”, *Int. J. Struct. Stab. Dy.*, **22**(2) 2250136.

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