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Wind-induced fatigue study of flange connection welding details of self-standing steel chimney

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ABSTRACT

This study predicts the fatigue life of flange connection welding details of self-standing steel chimneys under wind load. A multi-scale finite element model of an 80m self-standing steel chimney was constructed using ABAQUS software. Using MATLAB to simulate the wind field, based on the rainflow counting method and Miner's cumulative damage criterion, the fatigue life of flange connection weld details was calculated using nominal stress method, hot spot stress method and equivalent structural stress method, respectively. The impact of TLD vibration reduction on the fatigue life of steel chimneys was analyzed. The results show that under the influence of mild wind conditions, the fatigue life of the weld details at the bottom of the steel chimney is the lowest, followed by the weld details at a height of 14m, both of which meet the design service life of 50 years. Under the influence of typhoons, the fatigue life of weld details is significantly reduced. The fatigue life of weld details at 0m under 55m/s super strong typhoon, 45m/s sub strong typhoon, and 35m/s normal typhoon is about 4.8 days, 54 days, and 1.1 years, respectively. The TLD vibration reduction design installed 6 layers of 48 circular water tanks arranged in a circular pattern. After adding TLD, the fatigue life of the weld seam at 0m was increased by 17%, 19%, 22%, and 49% under normal wind, normal typhoon, sub strong typhoon, and super strong typhoon, respectively.

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