

Practical Evaluation Method for Horizontal Vibration Characteristics Considering Roof Flexibility in One Story Steel Structures

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It is widely known that the roof deforms unexpectedly in its plane in such steel structures as gymnasiums, warehouses and plants with relatively flexible roofs when subjected to seismic loading. This type of structures magnify non-uniformly distributed horizontal acceleration response in the roof due to a different drift angle in each frame and a longer natural period as compared with the structures having almost rigid roof. The objective of this study is to propose a practical evaluation method based on a hand calculation for the vibration characteristics in steel structures with a roof not considered as rigid. The vibration characteristics for the elastically equivalent vibration system are approximately derived based on the Rayleigh-Ritz method. The variation of the natural period, the vibration modes and the participation factors are summarized with stiffness ratios and a mass ratio. Finally, the proposed methods are validated through comparison with the direct frame analysis for two gymnasiums having an angled roof and a flat roof with round bar roof braces and end frames stiffened by round bar braces as a practical example. The both methods estimate natural periods almost without an error and vibration modes within allowable margin of the error.