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EVALUATION OF SLIDING AMOUNT AT BACKLASH JOINTS AND ITS EFFECTS ON NONLINEARITY DURING FREE VIBRATION OF EXTENSIBLE TRUSS

Abstract

This study evaluates the sliding amount at backlash joints on extensible space truss and examines its effects on the nonlinear vibration response. Extensible space truss structures have many mechanical joints in extension mechanism. Such joints have a certain amount of backlash. The backlash affects structural damping and modal frequency because it involves friction as damping behavior and stiffness, and other factors. [1] Therefore, it is necessary to understand the details.

We have setup experiments to investigate the effect of the sliding amount at the backlash. Free vibration was measured by adding backlash to the joint of a four-stage truss and applying initial displacement. The truss used in the experiment has pin joints and the backlash exists in the pin axial and pin radial direction. This research proposes a method of capturing the sliding amount at backlash joints on extensible truss structures as displacement. Hence, we attached acceleration sensors to each of horizontal and vertical members of the truss, and considered finding sliding amount at backlash joints by taking difference of the acceleration data at each member of the truss and integrating them numerically.

As a result, we were able to estimate the relative displacement between the pin axis of the joint and the truss. Thus, it is possible to quantitatively measure the sliding amount at backlash joints on the extensible truss by using this method. It was also shown that the sliding amount at backlash joints is estimated to change with the initial displacement.

Moreover, time-frequency analysis of the truss was performed. We used the wavelet transform, which allows greater degree of freedom in selecting the time-frequency domain. The wavelet transform was applied to each of the acceleration data of the free vibration and difference between the data of the vertical and horizontal members. It was shown that in the initial stage of vibration, two frequencies different from the first order mode frequency of the free vibration occurred in the pin axis direction. This tendency was more strongly expressed when the sliding amount at backlash joints was larger.

Reference: [1] Onoda, Junjiro, Tetsuji Sano, and Kenji Minesugi, Passive damping of truss vibration using preloaded joint backlash, AIAA journal 33.7 (1995), pp.1335-1341.