รายงานวิจัยฉบับสมบูรณ์

Control Performance of Semi-active Tuned Liquid Column Damper for Damage Reduction of Inelastic Buildings under Moderated Ground Motions

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ABSTRACT

This paper reports the elliptical flow path estimation method. This newly proposed numerical method can be employed to simulate the vibration characteristics of the tuned liquid column dampers (TLCDs) and to validate their experimental results tested on the shake table. A TLCD is comprised of two vertical liquid columns connected by a horizontal cross-over duct of the same width. A variation of these with non-uniform vertical column and the horizontal cross-over duct is denoted as a liquid column vibration absorber (LCVA). In previous research, the simulation of the vibration characteristics of these dampers was based on the assumption that the liquid velocity within each leg of these dampers is constant and the transition between the vertical and horizontal flows occurs at a single point. This assumption is valid only for TLCD and LCVA in which the widths of both horizontal cross-over duct and vertical column are small compared to the overall dimension of the damper. For buildings with limited space, it is necessary to configure a TLCD whose column width is not small with respect to the overall dimension of the damper. This type of TLCD configuration has been hardly investigated in previous research. In this case, the variation of liquid velocity in the relatively large transition zone between the vertical columns and the cross-over duct cannot be ignored. A numerical potential-flow method, known as the numerical panel method, is then utilized to simulate the vibration characteristics of TLCDs and LCVAs with the aforementioned configuration. The results obtained from the numerical panel method lead to the improved prediction of the vibration characteristics of TLCDs over a wide range of configurations. Unfortunately, the numerical panel method is too complicated to formulate and it cannot give the empirical form for TLCDs' characteristics. As a result, the elliptical flow path estimation method is proposed to simulate the TLCDs' vibration characteristics. The results obtained from the numerical model are compared with those obtained from the tests on the shake table. A significant improvement in the model accuracy can be obtained and this feature is essential in the control problem for the optimum performance of a building. Furthermore, the elliptical flow path estimation method can be utilized to investigate their efficiency as a vibration absorber.

KEYWORDS: LCVA, TLCD, Panel method, Elliptical flow path estimation method, Natural frequency