

調頻液柱阻尼器 TLC 與結構扭轉向之互制行為

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摘要

近年來隨著建築材料及工法日益進步，質量輕且跨度長的橋梁結構愈形普遍，尤其以懸索橋或斜張橋為主的跨海大橋相繼在許多國家出現。但此類橋梁之受風反應卻相對敏感，因此裝設減振裝置如調頻液柱阻尼器(Tuned Liquid Column Damper, TLCD)有其必要性。目前 TLCD 之應用大多集中於建築物，甚少有橋梁上之應用，若將其運用於橋面板扭轉向之制振行為，則需考慮 TLCD 與結構扭轉向互制行為之運動方程式。本論文考慮受風之單自由度結構裝設非等斷面 TLCD，以能量法進行基本理論推導，結果顯示存在一修正項為前人文獻所忽略。為釐清該修正項之重要性，本研究建構大尺度結構與 TLCD 進行驗證，首先以自由振動及強制振動方式分別進行結構與 TLCD 元件之識別，然後再以強制振動方式進行 TLCD 與結構互制之反應量測，與考慮修正項之理論式進行比較。實驗結果顯示，考慮修正項時所得之理論分析結果較接近實驗結果，因此互制運動方程式的確須考慮此修正項。

關鍵字：調頻液柱阻尼器 TLCD、扭轉向運動、互制行為，水頭損失係數，強制振動

Interaction of non-uniform Tuned Liquid Column Damper and Structure in Torsional Motion

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ABSTRACT

In this paper, the equations of motion for the interaction between a non-uniform tuned liquid column damper (TLCD) and a single-degree-of-freedom structure in the torsional motion was derived based on energy principle. It was found that, in the equations of motion, there exists a modified term which was not considered in the literature. Thus, under the excitation of harmonic loading, the analytical solution is derived from the equations of motion. To justify the importance of this modified term, a large scale TLCD and spring-constrained rotational structure, which is composed of a steel beam pivoted at the mid span, were constructed and experimental verification was performed. Prior to the interaction tests, the properties of the TLCD and structures were also identified respectively and the values obtained were used to compute the analytical solutions from the interaction equations for comparison. The experimental results from the interaction tests show that they are closer to the analytical solution with the modified term considered than without the modified term considered. Therefore, the incorporation of the modified term in the interaction equations of motion is essential.

Keywords: Tuned Liquid Column Damper (TLCD); Torsional Motion; Interaction; Head Loss Coefficient; Forced Vibration