Structural Modification Using Electro-Rheological Fluids

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ABSTRACT

Upon the application of electric field onto an electric-rheological (ER) fluid, the fluid manifests, on the order of miniseconds, its property change from Newtonian fluid to Bingham plastic. This energized fluid, when subjected to oscillatory strain, demonstrates a dramatic change in stiffness and damping capacity. This thesis aims on the study of using the ER fluid contained within electrode plates as a viable tool for * ?ace damping treatment on an existing structure which might suffer from vibration problem. This technique differs from the traditional surface damping treatment on the capability of vibration-tuning via controlled electric field. For different vibration modes, different surface treatments are studied in order to obtain the most effective structural modification. This study concentrates on both theoretical formulation and experimental verification of one-dimensional beam structures. The RKU equation for sandwich beam theory are modified for the configurations used in this investigation. Moreover, the associated finite element formulation and closed-form solution are also obtained. By incorporating the strain energy and dissipated energy concept suggested by Ungar & Kerwin, the resulted change in dynamic characteristics of the modified beam structure due to different amount of surface damping treatment, location of the treatment, and applied electric field is analyzed. The experimental results of cantilever beams with the proposed surface damping treatments incorporating a 50% weight fraction corn starch-silicone oil based ER fluid, although showing a non negligible inconsistency with the analytical simulations which might be due to the leakage of silicon oil and hence the change in the concentration of ER fluid within the specimens, demonstrate the feasibility of this tunable structural modification technique.Keyword：Electro-rheological fluid、Structural modification、Surface damping treatment、Smart beam

Keywords : 電流變液 ; 智慧型樑 ; 表面阻尼處理 ; 結構修正

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