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AEROELASTIC INVESTIGATION USING PIEZOELECTRIC MATERIALS AS SENSOR AND ACTUATOR

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Summary: The aim of this work is to achieve the v-g/v-f diagram using piezoelectric materials as both sensor and actuator. One of the most commonly employed experimental techniques to perform an aeroelastic analysis is the Operational Modal Analysis (OMA). The OMA method estimates the natural frequencies and damping factors of any structures and can be applied in both flight and wind tunnel tests. However, this test methodology usually presents a high noise level since only the structure response is used to obtain the Frequency Response Function (FRF) which leads to inaccuracies in the data acquisition. Nonetheless, the quality of the acquisition can be improved when obtaining the FRF taking into account not only the structural response but also the excitation. This test methodology is more as known as Experimental Modal Analysis (EMA). The EMA technique can be applied to improved the data acquisition by ``forcing'' the input of correlated measures and thus decreasing noise. The non-correlated responses (such as noise) tends to disappear by using the average number of a set of acquisitions. Another advantage inherent to the application of the EMA technique in aerolastic analysis is the ability to efficiently excite the vibration modes, which sometimes are not adequately excited by aerodynamic/turbulence forces.
For this work an EMA was applied to wind tunnel test using one PZT (Lead Zirconate Titanate) actuator and a single PVDF (Polyvinylidene Fluoride) sensor. The modal parameters (natural frequencies and damping factors) acquired were used to plot the v-g/v-f diagram and the flutter speed was identified. To verify the accuracy of the test, the v-g/v-f diagram obtained using only piezoelectric materials was compared with a v-g/v-f diagram achieved using laser vibrometer responses. From the comparison a very good agreement was found between the results.