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Smart dampers by Shape Memory Alloys in Civil Engineering: basic properties and technical applications

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A study of the Smart dampers using shape memory alloy (SMA) elements was realized, as the SMA undergoes one martensitic transformation, a solid-solid transformation, usually considered of the first order. The analysis includes the practical requirements of the application. In particular, two types of damping actions are considered. The first one aims to smooth oscillations induced by earthquakes in structures as a portico. The second one is to smooth oscillations induced in cables by wind, rain of traffic in stayed cables for bridges. The SMA appropriate properties are studied, i.e., the required fracture life, the self-heating and the external temperature effects and the long-term evolution of the alloys. The main characteristics of the damping devices are established, such as the length and the number of wires.

The bridges and the dampers are exposed to the changes of external temperature. For Western Europe, the minimal temperatures in winter are close to 253 K (-20°C). The use of the SMA dampers in bridges situated in South Canada or Northeast of Europe requires their proper performance to be ensured at temperatures as low as 233 K (-40°C) or less. An appropriate strain aging at 373 K (100°C) seems a reasonable solution, because this operation increases the SMA working temperature span.

The dampers are simulated by introducing the SMA phenomenological models in the finite element analyses. The parameters are determined by fitting polynomials to the experimental trajectories of the hysteresis cycle. The Clausius-Clapeyron (CCC) thermodynamic coefficient allows the analysis of the temperature effects. Experimental measurements permit a satisfactory evaluation of the CCC value.

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