The thermo-mechanical behaviour of pseudoelastic shape memory alloy helical springs is of concern discussing stabilised and cyclic responses. Constitutive description of the shape memory alloy is based on the framework developed by Lagoudas and co-workers incorporating two modifications related to hardening and sub-loop functions designated by Bézier curves. The spring model takes into account both bending and torsion of the spring wire, thus representing geometrical non-linearities. Simplified models are explored showing that a single point in the wire cross section is enough to represent the global spring behaviour in spite of complex stress–strain distributions. The experiments are carried out considering different deflection amplitudes, frequencies and ambient temperatures, which influence the spring behaviour to different extents. The model is fitted against a calibration data set resulting in 1.3% residual standard deviation relative to the full range force. Compared to the validation data set, the errors are below 10% relative to the full range of the complex modulus. Uncertainty analysis of the model parameters using a Markov chain Monte Carlo technique shows low to high parameter correlation, and the relative uncertainties are less than ±12%. Both the heat capacity and the convection coefficient are clearly identifiable from the performed experiments.