Termel - Simulation of thermoelastic oscillations of structures

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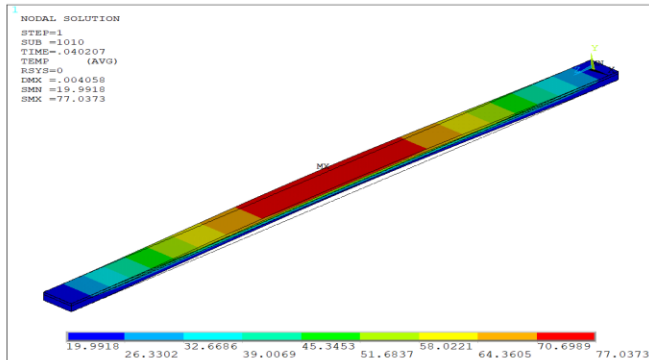

Figure 1: Computer simulation of the heat distribution in a bi-material beam subjected to harmonic loading and temperature flow.
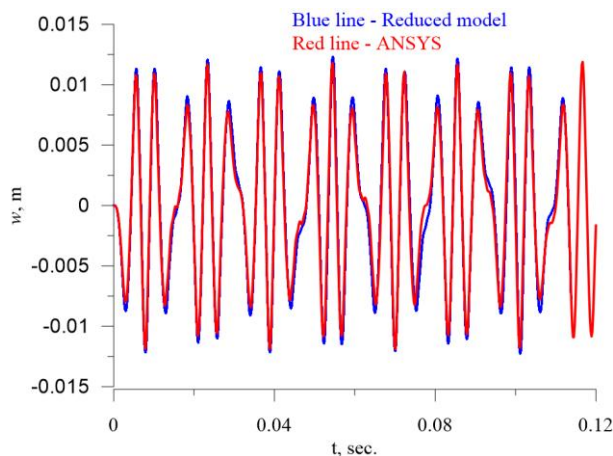

Figure 2: Time history diagram of the response of the bi-material beam subjected to harmonic loading and elevated temperature $\Delta T=50^{\circ}$.

❖ Description of the problem

Mathematical modelling has been performed and computer cods have been created for simulation of oscillations of elastic structures - beams and plates. In parallel, finite element models have been created for the same structures and the same processes using the ANSYS ADPL.

The models include the presence of layers (composite structures) and the shear forces have been taken into account. Reduced order models of the problems have been created, which are solved numerically and analytically (using the methods of harmonic balance and multiple scales), which allow solutions in the frequency domain. The created models allow the study of complex nonlinear phenomena, such as buckling and non-periodic oscillations. Coupled thermoelastic vibration in both directions were studied separately, using the finite difference method and the finite element method.

To obtain the simulation results, a cluster of high-performance servers purchased under the IICT CVP project was used. 56,000 square 3D elements with 257,675 nods were used for the finite element modeling of a 2-material beam, and 2,700 elements with 2,884 nodes were used for a circular plate.

❖ Use of HPC Infrastructure

To obtain the results from the simulation, a cluster of high-performance servers purchased under the IICT CVP project was used. For the finite element modelling of a 2-material beam, 56000 square 3D elements with 257675 nodes were used, and for a circular plate - 2700 elements with 2884 nodes.

❖ Results

To obtain the response time of 0.15 seconds of a bi-material beam subjected to mechanical loading and elevated temperature, it is necessary to use one calculation unit for about 1 week, and for the bi-material beam subjected to heat flux and mechanical load - about 2 weeks.
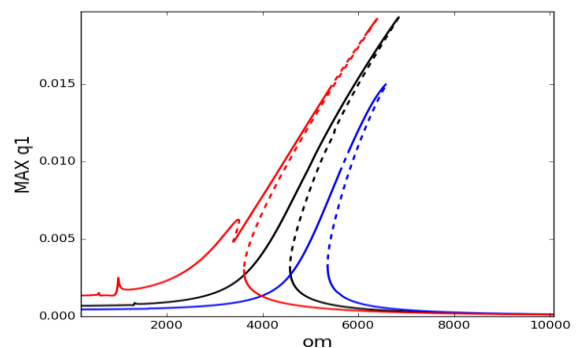

Figure 3: Resonant curves of the reaction of a circular plate at 3 different (-20°- blue line, 0°- black line, 20°- red line)