

Mathematical model and numerical simulation of an elastohydrodynamic problem arising in magnetic reading

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In magnetic reading devices the gap between the reading head and the tape (where the information is stored) has a determining effect on the quality of the signal that is received. In fact, the air film on which the head flies must be thick enough to prevent from material interactions; yet it must also be thin enough to give a sufficiently large recording signal. The tape movement causes the entrance of a thin air layer between the tape and the head at the beginning of the reading process, so that the head–tape contact only takes place both at the initial and final moments. Any tape movement affects the air pressure and this one also influences the tape displacement. Therefore, we face a typical elastohydrodynamic problem, where the air pressure and the tape deformation are highly related.

In the present work, a new elastohydrodynamic model is proposed, mathematically analyzed and numerically solved. In this model, the hydrodynamic part is governed by a steady first order slip compressible Reynolds equation in two spatial variables [Bhushan, 1990]. The main feature of the coupled problem consists in proposing a Koiter shell model for the tape displacement. We establish a result of existence of solution and we address the numerical solution of the problem. For this, we introduce a fixed point algorithm between hydrodynamic and elastic subproblems, and we describe the different numerical techniques used in each subproblem.