Modeling and optimizing a road de-icing device by a nonlinear heating

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De-icing a road pavement is an important issue in many countries subjected to winter weather conditions that have a strong impact on road maintenance and road safety. The use of salt spreader to ensure the de-icing of pavements can affect the environment close to the road. Also, devices have been implemented to heat the road : electric heating, infrared lamps above the road surface, circulation of a heat transfer fluid in pipes inserted in the road. Under the impulse of the European project R5G (Road of 5^{th} generation), recent research has been undertaken on heating the road by circulating a heat transfer fluid within a porous layer of the road. In this communication, in order to design a road de-icing device by heating, we consider in a two dimensional setting the optimal control of a parabolic equation with a nonlinear boundary condition of the Stefan-Boltzmann type. Both the boundary control and the corresponding state are subjected to a unilateral constraint. This control problem models the heating of a road during a winter period to keep the road surface temperature above a given threshold. The modeling of the road heating device is performed through the circulation of a coolant in a porous layer of the road. We first prove, under realistic physical assumptions, the well-posedeness of the direct problem and the optimal control problem. We then perform some numerical experiments using real data obtained from experimental measurements. This model and the corresponding numerical results allow to quantify the minimal energy to be provided to keep the road surface without frost or snow. We refer to [**?**] for details. The modeling of the heating thanks to the circulation of a coolant in a bonding porous layer of the road is described in Figure **??**.

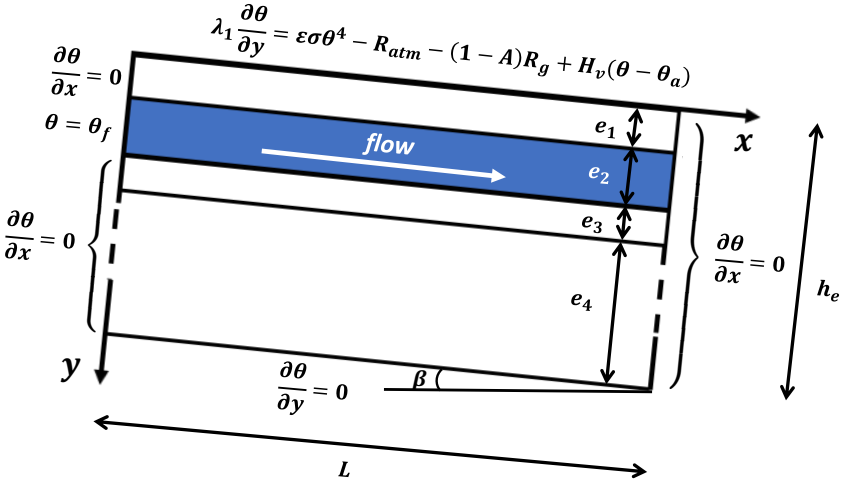

FIGURE 1 – Scheme of pavement structure with its limit conditions (θ_f, θ_a are the injection temperature of the fluid and the air temperature respectively).

Références

[1] F. Bernardin and A. Münch, *Modeling and optimizing a road de-icing device by a nonlinear heating*, ESAIM :M2AN, 53(3) 775-803 (2019).

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