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Fuzzy optimal schedule of high speed train operation to minimize energy consumption with uncertain delays and driver's behavioral response

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Abstract-

Energy efficiency is an important concern in for railway administrations and operators. Strategies focused on traffic operation can achieve energy savings in short term and with associated low investments. For that purpose the main strategies are the design of efficient timetables and driving (ecodriving). The ecodriving applies coasting commands (null traction force) to reduce energy consumption, taking into account downhill slopes, speed reductions, etc (Acikbas and Soylemez, 2008). However, timetable models in literature do not typically consider energy minimization as a goal, and punctuality requirements under uncertainty. In this paper a model for the joint design of ecodriving and timetable under uncertainty for high speed lines is proposed where the railway operator and administrator requirements are incorporated. Uncertainty in delays is modeled as fuzzy numbers and punctuality constraints, and the timetable optimization model is a fuzzy linear programming model, in which the objective function includes the consumptions of delayed scenarios and the behavioral response of the driver that will affect the consumption. The ecodriving design is based on a Genetic Algorithm that makes use of a detailed simulation model, taking into account the specific characteristics of high speed lines and trains. The proposed method is applied to a real Spanish high speed line to optimize the operation and it is compared to the current commercial service in order to evaluate the potential energy savings.

Index Terms- energy efficiency, ecodriving, railway operation, fuzzy, Genetic Algorithm, simulation

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