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A Semidefinite Model to Quantify Dynamic Forces in the Powertrain of Torque Regulated Bascule Bridge Machineries

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Abstract : The reassessment of existing movable bridges in The Netherlands has created the need for acceptance/rejection criteria to assess whether the machineries are meet certain design demands. However, the existing design code defines a different limit state design, meant for new machineries which is based on a simple linear spring-mass model. Observations show that existing bridges do not confirm the model predictions. In fact, movable bridges are nonlinear systems consisting of mechanical components, such as, gears, electric motors and brakes. Next to that, each movable bridge is characterized by a unique set of parameters. However, in the existing code various variables that describe the physical characteristics of the bridge are neglected or replaced by partial factors. For instance, the damping ratio ζ, which is different for drawbridges compared to bascule bridges, is taken as a constant for all bridge types. In this paper, a model is developed that overcomes some of the limitations of existing modelling approaches to capture the dynamics of the powertrain of a class of bridge machineries First, a semidefinite dynamic model is proposed, which accounts for stiffness, damping, and some additional variables of the physical system, which are neglected by the code, such as nonlinear braking torques. The model gives an upper bound of the peak forces/torques occurring in the powertrain during emergency braking. Second, a discrete nonlinear dynamic model is discussed, with realistic motor torque characteristics during normal operation. This model succeeds to accurately predict the full time history of the occurred stress state of the opening and closing cycle for fatigue purposes.

Keywords : Dynamics of movable bridges, Bridge machinery, Powertrains, Torque measurements
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