A SEMI-GROUP APPROACH TO A SEMI-LINEAR SUSPENSION BRIDGE MODEL WITH POINT-WISE DISSIPATION

Abstract. We investigate a semi-linear suspension bridge model consisting of a coupled string–Euler–Bernoulli beam system with localized point-wise dissipation. The model describes the interaction between the sustaining cable and the bridge deck through an elastic coupling, while the dissipation is concentrated at prescribed interior points of the structure.

The main contribution of the work is the development of a semi-group framework that allows the exponential stability of the coupled linear system to be established without resorting to multiplier techniques or observability inequalities. The approach is based on a comparison principle involving the essential growth bound of suitable auxiliary semi-groups together with the invariance of the essential spectrum under compact perturbations. This reduces the stability analysis of the coupled problem to the study of simpler decoupled systems and the exclusion of purely imaginary eigenvalues.

The linear stability result is then used to study the corresponding semi-linear model. Under suitable locally Lipschitz assumptions on the non-linear terms, we prove global well-posedness and exponential decay of solutions. Finally, using the dissipative structure of the system together with compactness properties of the non-linear dynamics, we establish the existence of a compact global attractor and an exponential attractor, providing a complete description of the long-time behaviour of the solutions.

The proposed methodology is sufficiently robust to be adapted to a broader class of coupled evolution equations with localized damping.

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