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# Comparative Analysis of Tension Estimation Methods for Cable with Damper Using Feedforward Neural Networks (FNN)

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## 【Background】

In the maintenance of cable structures (e.g., cable-stayed and extradosed bridges), non-destructive tension estimation is critical for safety verification. Traditional elastic beam theory, relying on natural frequencies, faces challenges due to increased cable lengths, installed dampers, and low inherent damping. While finite element models (FEM) are computationally prohibitive, this study proposes a hybrid surrogate model combining physics-driven PDE-FDMD with feedforward neural networks (FNNs) to enhance accuracy and efficiency in tension estimation under complex conditions.

## 【Objective】

The proposed hybrid PDE-FDMD-FNN model achieves high accuracy and robustness across varying prestress and damping conditions, reduces computational costs compared to FEM, efficiently handles nonlinearities and parameter uncertainties, and integrates physics-based constraints to enhance reliability in real-world cable tension estimation.

## 【Approach】

This study integrates PDE-FDMD (a physics-based finite difference model) with Feedforward Neural Networks (FNNs) to estimate cable tension. The PDE-FDMD captures the cable-damper dynamics, while FNNs learn from experimental data, combining physical laws and data-driven approaches for accurate, efficient, and robust tension estimation under complex conditions.

## 【Publication plan】

・Engineering Structures
・MSSP

## 【Results】

The PDE-FDMD-FNN surrogate model demonstrates superior accuracy and robustness in cable tension estimation by synergizing physics-based dynamics with data-driven learning. It effectively addresses challenges from variable damping, long-span cables, and nonlinear interactions, offering computational efficiency and enhanced reliability over traditional methods, validated through real-world bridge applications.