DOI	doi.org/10.1016/j.engstruct.2017.08.066
Title	Operational modal analysis of an eleven-span concrete bridge subjected to weak ambient excitations
Background	
Why this paper? How'd you find it?	My research project involves modal identification of concrete bridges. I wanted an example study that is grounded in a well-established lineage of state space system identification methods. Found with Google Scholar and following references and relatively well-cited articles.
Study Objective	Assess modal analysis methods for ambient/low excitation/low SNR vibrations.
Intended gaps to fill	- Ambient vibration to forgo the need for excitation equipment - Bridges with stiff, short to moderate span lengths
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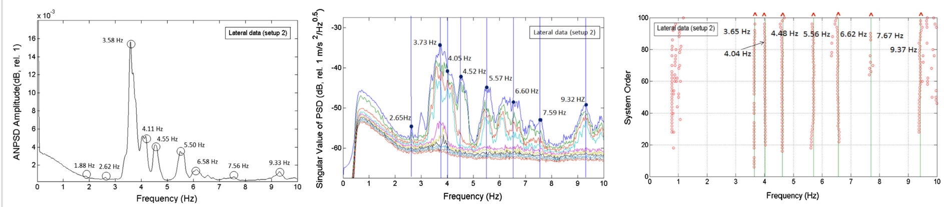
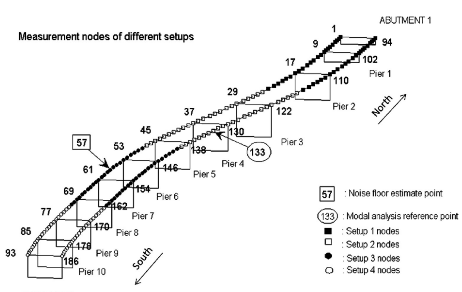
Historical Context	1960s: Filtering/Control with state space dynamics, aerospace navigation (Kalman) 1980s: Modal identification with state space system identification, aerospace/EE (Juang/Pappa/Longman) 1990s: Stochastic system identification, optimal control/EE (van Overschee/de Moor) 2000: Modal identification with stochastic system identification, civil structures (Peeters/de Roeck) 2010s: Model updating for civil structures
Relationship to SEMM	Works with equation of dynamic equilibrium
Methods	
Given:	Ambient (assume zero-mean Gaussian white noise excitation) vibration measurements from densely-instrumented concrete bridge deck
Find:	Natural frequencies, mode shapes, and damping ratios for vertical and lateral modes of the deck
Experimental Design	46 low-cost tri-axial MEMS sensors at 186 locations along deck. For baseline of modes and to guide sensor placement, ANSYS finite element model with elastic beam elements, free rotation associated w/bending at hinge and abutments. Vibrations preprocessed and analyzed with Peak Picking (PP), Frequency Domain Decomposition (FDD), and Data-Driven Stochastic Subspace Identification (SSI) to obtain modal properties. 
Test Subjects	Nelson St. off-ramp bridge in Auckland, New Zealand while closed to traffic. 11 short-medium spans, vertical and horizontal curvature, on 10 pile or footing piers, one pile-bent abutment with sliding bearings and one gravity abutment, one hinge with pot bearing between pier 4 and 5. 
Results	
Baseline for comparison	Compare among methods and against finite element model
Metric for comparison	Frequencies and damping: % difference; Mode shapes: Modal Assurance Criterion (MAC)
Difference from baseline	Frequencies: w/in 0.9% difference and 0.04Hz stdev, but FDD and SSI missed the fundamental lateral mode; Mode shapes (FDD and SSI only): most MAC > 0.9, and MAC decreased for higher order modes; Damping: (SSI only) stdev of 0.2-0.5%
Conclusions	
Authors'	PP, FDD, and SSI can identify modal properties in this context but are pushed to their limits and must be used together.
Yours	Same as authors; would also like to know if any parameters of FE model or modal analysis methods were adjusted for the two to match better.
Applications	Structural health monitoring