

## Civil Engineering and Engineering Mechanics

**Raimondo Betti**

PROFESSOR OF CIVIL ENGINEERING  
AND ENGINEERING MECHANICS

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Raimondo Betti's research focuses on the area of structural health monitoring, a crucial area for the safety, maintenance and rehabilitation of our nation's infrastructure system. His main interests range from the development of numerical algorithms for the identification of high-fidelity models of buildings and bridges to the development of methodologies for the assessment of the internal conditions of main cables of suspension bridges and for the estimation of their remaining strength.

In the area of structural system identification, Raimondo Betti works in developing computer algorithms that use the recorded response of buildings and bridges to natural excitation (e.g. wind, earthquake, traffic) to determine numerical models of buildings and bridges that can be used either for future structural response prediction or for damage assessment. Today, modern buildings and bridges are built with a large number of built-in sensors that record the motion of the structures (e.g. acceleration, displacements, etc.) at various locations. Betti has developed a variety of novel techniques that analyze these data in order to obtain models that are representative of the actual conditions of the structure: by comparing models of the same structure corresponding to different times it is possible to locate and estimate the extent of structural damage, without this being visible to the naked eye.

In the area of condition assessment of main cables of suspension bridges, Raimondo Betti has developed a multi-sensor network that can be installed in the interior of a main cable of a suspension bridge. These cables are made by tens of thousands of high-strength steel wires and are very difficult (and expensive) to inspect. The sensor network developed by Betti and his team measures environmental quantities like temperature and relative humidity as well as corrosion rates at various depths in the cross section and provide continuous monitoring of the cable conditions. By using these recorded data, Betti and his team have developed methodologies that are capable of estimating the remaining strength of such cables over many years of service. They are currently studying the effects of fire on main cables of suspension bridges.

Betti received a Laurea (Magna cum laude) in civil engineering from the Università degli Studi di Roma, "La Sapienza" (Italy) in 1985 and a PhD in civil engineering from the University of Southern California, in 1991. He is a member of the American Society of Civil Engineers and serves on the Board of Governors of the International Association of Structural Control and Monitoring. He also serves as Expert Advisor for Bridge Monitoring and Cable Corrosion for the Metropolitan Transportation Authority. He is the

recipient of the 2017 Aftab Mufti Medal by the International Society of Structural Health Monitoring of Intelligent Infrastructure.

### **RESEARCH INTERESTS**

Structural health monitoring, system identification, damage assessment in civil infrastructure, deterioration mechanisms in main cables of suspension bridges.

### **RESEARCH AREAS**

Dynamics, modeling, materials, sustainability, simulation

### **OTHER INTERESTS (if any)**

### **PROFESSIONAL EXPERIENCE**

- Chair of civil engineering and engineering mechanics Columbia University, 2010-2013;
- Professor of civil engineering and engineering mechanics, Columbia University, 2002-present
- Associate professor of civil engineering and engineering mechanics, Columbia University, 1996–2002
- Assistant professor of civil engineering and engineering mechanics, Columbia University, 1991–1996

### **PROFESSIONAL AFFILIATIONS**

- American Society of Civil Engineering (ASCE)
- International Association of Structural Control and Monitoring (IASCM)
- International Society for Structural Health Monitoring of Intelligent Infrastructure (ISHMII)

### **HONORS & AWARDS**

- The Aftab Mufti Medal awarded by ISHMII, 2017
- Columbia University Great Teacher Award, 2000
- Research Award for Foreign Specialists, PWRI, Japan, 1997
- Columbia University, SEAS, Distinguished Faculty Teaching Award, 1996
- National Young Investigator Award, NSF, 1994

### **SELECTED PUBLICATIONS**

- Miraglia, G., Lenticchia, E., Ceravolo, R., and Betti, R.: "Use of Plackett-Luce rank aggregation strategies in the optimization of FE models for monitored buildings", *Journal of Structural Control and Health Monitoring*, (in press).
- Sloane, M., and Betti, R.: "Heat Transfer on a Disk: a Closed-form Solution for Suspension Bridge Main Cables exposed to Fire", *ASCE Journal of Engineering Mechanics*, Vol. 145, No. 3, 2019.
- Bernagozzi, G., Mukhopadhyay, S., Betti, R., Landi, L. and Biotallevi, P.P.: "Output-only Damage Detection in Building Structures Using Proportional Modal Flexibility-Based Deflections", *Engineering Structures*, Vol. 167, 2018, pp. 549-566.
- Karanci, E. and Betti, R.: "Modeling Corrosion in Suspension Bridge Cables. 1: Annual Corrosion Rate", *ASCE Journal of Bridge Engineering*, Vol. 23, No. 6, 2018, DOI: 10.1061/(ASCE)BE. 1943-5592.00001233, nominated for the 2019 ASCE Arthur M. Wellington Prize.

- Karanci, R. and Betti, R.: "Modeling Corrosion in Suspension Bridge Cables. 2: Long-term Corrosion and Remaining Strength", *ASCE Journal of Bridge Engineering*, Vol. 23, No. 6, 2018, DOI: 10.1061/(ASCE)BE.1943-5592.00001234, nominated for the 2019 ASCE Arthur M. Wellington Prize.
- Priori, C., De Angelis, M., and Betti, R.: "On the Selection of User-Defined Parameters in Output-Only Identification", *Mechanical Systems and Signal Processing*, Vol. 100, No. 1, 2018, pp. 501-523.
- Phan, M.Q., Vicario, F., Betti, R., and Longman, R.W., "State-Space Model and Kalman Filter Gain Identification by a Kalman Filter of a Kalman Filter," *ASME Journal of Dynamic Systems, Measurement and Control*, Vol. 140(3), 2018, DOI: 10.1115/1.4037778
- Mukhopadhyay, S., Lus, H., and Betti, R.: "Output-only structural identification with incomplete instrumentation and independence of measured information", *Earthquake Engineering and Structural Dynamics*, Vol. 45, Issue 2, 2016, pp. 273-296.
- Sun, H., Waisman, H., and Betti, R.: "A sweeping window method for detection of flaws in a large structure using an explicit dynamic XFEM and absorbing boundary layers", *International Journal for Numerical Methods in Engineering*, Vol. 105, 2016, pp. 1014-1040.
- Mukhopadhyay, S., Lus, H., and Betti, R.: "Probabilistic Structural Health Assessment with Identified Physical Parameters from Incomplete Measurements", *ASCE/ASME Journal of Risk and Uncertainty in Engineering Systems*, Vol.2, No. 3, 2016, DOI: 10.1061/AJRUA6.0000838.
- Betti, R., Sloane, M., Khazem, D., and Gatti, C.: "Monitoring the structural health of main cables of suspension bridges", *Journal of Civil Structural Health Monitoring*, Vol. 6, Issue 3, July 2016, pp. 355-363, awarded **Best Paper of 2016** by the ISHMII.
- Mukhopadhyay, S., Lus, H., and Betti, R.: "Structural Identification with Incomplete Instrumentation and Global Identifiability Requirements under Base Excitation", *Journal of Structural Control and Health Monitoring*, Vol. 22, No. 7, 2015, pp. 1024-1047.
- Phan, M.Q., Vicario, F., Betti, R. and Longman, R.W.: "Output-Only Observer/Kalman Filter Identification (O<sup>3</sup>KID)", *Journal of Structural Control and Health Monitoring*, Vol. 22, No. 5, 2015, pp. 847-872.
- Balsamo, L., Betti, R., and Beigi, H.: "A Structural Health Monitoring Strategy Using Cepstral Features", *Journal of Sound and Vibration*, Vol. 333, 2014, pp. 4526-4542
- Montoya, A., Deodatis, G. Betti, R., and Waisman, H.: "A Physics Based Stochastic Model to Determine the Failure Load of Suspension Bridge Main Cables", *ASCE Journal of Computing in Civil Engineering*, Vol. 29, No. 4, 2015, DOI: 10.1061/(ASCE)CP.1943-5487.0000393, 2014.
- Reggio, A., De Angelis, M. and Betti, R.: "A State-space Methodology to Identify Modal and Physical Parameters of Non-viscously Damped System", *Mechanical Systems and Signal Processing*, Vol. 41, 2013, pp. 380-395.
- Hong, A.L., Betti, R. and Ubertini, F.: "A New Stochastic Subspace Approach for System Identification and Its Application to Long-Span Bridges", *ASCE Journal of Engineering Mechanics*, Vol. 139, No. 6, 2013, pp. 724-736.
- Sloane, M.J., Betti, R., Hong, A.L., Marconi G. and Khazem, D.: "An Experimental Analysis of a Non-Destructive Corrosion Monitoring System for Main Cables of Suspension Bridges", *ASCE Journal*

*of Bridge Engineering*, Vol. 18, Issue 7, 2013, pp. 653-662.

**IN THE NEWS**

- Daily Planet, Discovery Channel: 2006
- 'Stressing a cable for bridges' sake", New York Times: 2008
- All Things Considered, National Public Radio: 2008