Japan Academy Prize to:

Yozo Fujino
Distinguished Professor, Institute of Advanced Sciences,
Yokohama National University
Emeritus Professor, The University of Tokyo

for "Vibration and its Control in Large Civil Structures"

Outline of the work:

Dr. Yozo Fujino's area of expertise is in vibration control in large civil structures, with a special focus on enhancing the performance of long-span bridges under various types of dynamic action, such as wind and earthquake loading. His countless research and applied contributions have been celebrated both nationally and internationally.

In the structural dynamics field, Dr. Fujino was the first person to identify the lateral vibration of pedestrian cable-stayed bridges caused by the synchronization of human walking, through a detailed vision analysis of video motion. This was in late 1980s, long before the well-known vibration problems of London's Millennium Bridge occurred in 2000. He pioneered the formulation of pedestrian-induced synchronization problems on pedestrian bridges, and served as an advisor to mitigate the vibration problems of Millennium Bridge. He also made significant academic contributions in modeling nonlinear vibrations in the stay cables of cable-stayed bridges. Furthermore, he pioneered the development of a design formula of dampers to suppress stay cable vibrations, which is now in widespread use in the design of cable-stayed bridges.

In the field of structural control, Dr. Fujino has been an international leader in the modeling and application of passive and active structural control systems since the 1990s. His innovative studies on tuned mass dampers (TMD), multiple tuned mass dampers (MTMD), and tuned liquid dampers (TLD) represent seminal work in the field, as is evident from their being widely cited and commercially adopted. He has made fundamental contributions to the development of design formulas for the application of TMD and MTMD on bridges and buildings, which has accelerated their adoption in practice. He also pioneered the development of the TLD, including the development of their operational principles and optimization of their deployment in the design and construction of large structural systems. In addition, he is involved in the modeling and application of seismic isolation systems for bridges, with a particular contribution to the modeling of laminated rubber bearings for seismic isolation. Furthermore, he has confirmed the seismic performance of isolation systems on bridges during the 1995 Great Hanshin-Awaji Earthquake and other earthquakes. These studies have led to the establishment of structural control as an exciting new high-tech area in the field of civil engineering.

Dr. Fujino has also made innovative contributions in the area of structural monitoring to understand the vibration behavior of large-scale civil structures. He pioneered the installation of dense sensor arrays for monitoring the ambient vibration behavior of the Hakucho Bridge (Hokkaido, Japan) under wind action, successfully extracting self-excited aerodynamic forces from measurement data. This work is the very first to

prove the validity of wind tunnel testing of bridge girders quantitatively, significantly impacting the entire field of wind engineering and bridge aerodynamics. He also made lasting contributions to the seismic monitoring of long-span bridges, with the Yokohama Bay Bridge as a main example. Using seismic monitoring data, he successfully identified the response characteristics of long-span, cable-stayed bridges and unwanted structural behaviors, and utilized the monitoring results to advise a seismic retrofit program of the major bridges in the metropolitan Tokyo area, ensuring their safe operation in future seismic events.

Dr. Fujino's scholarly contributions have been recognized nationally and internationally by numerous awarding bodies. He was awarded Medal with Purple Ribbon (2007) and the Hoko Award (2015). He has also received numerous international awards, such as the Raymond C. Reese Research Prize (2007), R. H. Scanlan Medal (2011), and George Winter Medal (2015) from the American Society of Civil Engineers (ASCE), and the Outstanding Paper Award (2014) and an honorary membership (2016) from the International Association for Bridge and Structural Engineering (IABSE). He was involved as an editor of *Encyclopedia of Structural Health Monitoring* in 2009, to which notable worldwide scholars in the research and development of monitoring technologies have contributed their works.

Within the professional bridge engineering community, Dr. Fujino is widely regarded as a visionary international leader. He served as vice president of the IABSE from 2005 to 2013 and the president of the International Association for Structural Control and Monitoring (IASCM) in 2008. Given his stature, Dr. Fujino has also served on the technical review committees for many signature bridges, such as the Akashi Kaikyo Bridges (Hyogo, Japan), the Tatara Bridge (Hiroshima and Ehime, Japan), and the Tokyo Rainbow Bridge in Japan. He has served as technical advisor on the Stonecutters Bridge in Hong Kong, on the design of an active control system used for the new Heathrow Airport Control Tower, and as the advisory committee chairman of the Padma Bridge in Bangladesh, among many others.

Major publications

Books

1) Fujino, Y., Kimura, K. and Tanaka, H. (2012) *Wind Resistant Design of Bridges in Japan–Developments and Practices*, Springer, Tokyo.
2) Boller, C., Chang, F.-K. and Fujino, Y. (2009) *Encyclopedia of Structural Health Monitoring*, Vols. 1–5, Wiley, Chichester.

Review papers

1) Fujino, Y. (2018) Vibration-based monitoring for performance evaluation of flexible civil structures in Japan, *Proceedings of the Japan Academy, Series B*, Vol. 94, No. 2, pp. 98–128.
2) Fujino, Y. and Siringoringo, D. M. (2016) A conceptual review of pedestrian-induced lateral vibration and crowd synchronization problem on footbridges, *Journal of Bridge Engineering*, Vol. 21, No. 8, C4015001.
3) Fujino, Y., Siringoringo, D. M. and Abe, M. (2016) Japan's experience on long-span bridges monitoring, *Structural Monitoring and Maintenance*, Vol. 3, No. 3, pp. 233–257.
4) Fujino, Y. and Siringoringo, D. M. (2013) Vibration mechanisms and controls of long-span bridges: A review, *Structural Engineering International*, Vol. 23, No. 3, pp. 248–268.
5) Fujino, Y. and Siringoringo, D. M. (2011) Bridge monitoring in Japan: the needs and strategies, *Structure*

and Infrastructure Engineering, Vol. 7, Nos. 7–8, pp. 597–611.
6) Fujino, Y. (2002) Vibration, control and monitoring of long-span bridges―recent research, developments and practice in Japan, *Journal of Constructional Steel Research*, Vol. 58, No. 1, pp. 71–97.

Technical papers

Vibration in large civil structures

1) Siringoringo, D. M. and Fujino, Y. (2018) Seismic response of a suspension bridge: Insights from long-term full-scale seismic monitoring system, *Structural Control and Health Monitoring*, Vol. 25, No. 11, e2252.
2) Siringoringo, D. M. and Fujino, Y. (2015) Seismic response analyses of an asymmetric base-isolated building during the 2011 Great East Japan (Tohoku) Earthquake, *Structural Control and Health Monitoring*, Vol. 22, No. 1, pp. 71–90.
3) Siringoringo, D. M., Fujino, Y. and Namikawa, K. (2014) Seismic response analyses of the Yokohama Bay cable-stayed bridge in the 2011 Great East Japan Earthquake, *Journal of Bridge Engineering*, Vol. 19, No. 8, A4014006.
4) Siringoringo, D. M. and Fujino, Y. (2008) System identification of suspension bridge from ambient vibration response, *Engineering Structures*, Vol. 30, No. 2, pp. 462–477.
5) Siringoringo, D. M. and Fujino, Y. (2006) Observed dynamic performance of the Yokohama-Bay Bridge from system identification using seismic records, *Structural Control and Health Monitoring*, Vol. 13, No. 1, pp. 226–244.
6) Nagayama, T., Abe, M., Fujino, Y. and Ikeda, K. (2005) Structural identification of a nonproportionally damped system and its application to a full-scale suspension bridge, *Journal of Structural Engineering*, Vol. 131, No.10, pp. 1536–1545.
7) Fujino, Y. and Yoshida, Y. (2002) Wind-induced vibration and control of Trans-Tokyo Bay Crossing Bridge, *Journal of Structural Engineering*, Vol. 128, No. 8, pp. 1012–1025.
8) Fujino, Y., Pacheco, B. M., Nakamura, S. and Warnitchai, P. (1993) Synchronization of human walking observed during lateral vibration of a congested pedestrian bridge, *Earthquake Engineering and Structural Dynamics*, Vol. 22, No. 9, pp. 741–758.

Vibration control and structural control

1) Johnson, E. A., Baker, G. A., Spencer, B. F., Jr. and Fujino, Y. (2007) Semiactive damping of stay cables, *Journal of Engineering Mechanics*, Vol. 133, No. 1, pp. 1–11.
2) Abe, M., Yoshida J. and Fujino, Y. (2004) Multiaxial behaviors of laminated rubber bearings and their modeling. I: Experimental Study, *Journal of Structural Engineering*, Vol. 130, No. 8, pp. 1119–1132.
3) Abe, M., Yoshida J. and Fujino, Y. (2004) Multiaxial behaviors of laminated rubber bearings and their modeling. II: Modeling, *Journal of Structural Engineering*, Vol. 130, No. 8, pp. 1133–1144.
4) Chaudhary, M. T. A., Abe, M., Fujino, Y. and Yoshida, J. (2000) System identification of two base-isolated bridges using seismic records, *Journal of Structural Engineering*, Vol. 126, No. 10, pp. 1187–1195.
5) Wilde, K., Gardoni P. and Fujino, Y. (2000) Base isolation system with shape memory alloy device for elevated highway bridges, *Engineering Structures*, Vol. 22, No. 3, pp. 222–229.
6) Jankowski, R., Wilde, K. and Fujino, Y. (2000) Reduction of pounding effects in elevated bridges during earthquakes, *Earthquake Engineering and Structural Dynamics*, Vol. 29, No. 2, pp. 195–212.
7) Jankowski, R., Wilde, K. and Fujino, Y. (1998) Pounding of superstructure segments in isolated elevated bridge during earthquakes, *Earthquake Engineering and Structural Dynamics*, Vol. 27, No. 5, pp. 487–502.

8) Warnitchai, P., Fujino, Y. and Susumpow, T. (1995) A non-linear dynamic model for cables and its application to a cable-structure system, *Journal of Sound and Vibration*, Vol. 187, No. 4, pp. 695–712.
9) Abé, M. and Fujino, Y. (1994) Dynamic characterization of multiple tuned mass dampers and some design formulas, *Earthquake Engineering and Structural Dynamics*, Vol. 23, No. 8, pp. 813–835.
10) Fujino, Y., Warnitchai, P. and Pacheco, B. M. (1993) Active stiffness control of cable vibration, *Journal of Applied Mechanics*, Vol. 60, No. 4, pp. 948–953.
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14) Pacheco, B. M., Fujino, Y. and Sulekh, A. (1993) Estimation curve for modal damping in stay cables with viscous damper, *Journal of Structural Engineering*, Vol. 119, No. 6, pp. 1961–1979.
15) Fujino, Y., Sun, L. M., Pacheco, B. M. and Chaiseri, P. (1992) Tuned liquid damper (TLD) for suppressing horizontal motion of structures, *Journal of Engineering Mechanics*, Vol. 118, No. 10, pp. 2017–2030.

Structural health monitoring

1) Nishikawa, T., Yoshida, J., Sugiyama, T. and Fujino, Y. (2012) Concrete crack detection by multiple sequential image filtering, *Computer-Aided Civil and Infrastructure Engineering*, Vol. 27, No. 1, pp. 29–47.
2) Nagayama, T., Moinzadeh, P., Mechitov, K., Ushita, M., Makihata, N., Leiri, M., Agha, G., Spencer, B. F., Fujino, Y. and Seo, J.-W. (2010) Reliable multi-hop communication for structural health monitoring, *Smart Structures and Systems*,Vol. 6, Nos. 5–6, pp. 481–504.
3) Rice, J. A., Mechitov, K., Sim, S.-H., Nagayama, T., Jang, S., Kim, R., Spencer, B. F., Agha G. and Fujino, Y. (2010) Flexible smart sensor framework for autonomous structural health monitoring, *Smart Structures and Systems*, Vol. 6, Nos. 5–6, pp. 423–438.
4) Monroig, E., Aihara K. and Fujino, Y. (2009) Modeling dynamics from only output data, *Physical Review E*, Vol. 79, No. 5, 056208.