



THE WIND ENGINEER

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Contribution of higher modes to the wind-induced responses of tall buildings with uniform and setback topologies

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In using aerodynamic boundary layer wind tunnel tests for estimating wind-induced responses of tall buildings, dynamic components of the responses are often computed by considering the contribution of fundamental vibration modes alone. However, the contribution of higher vibration modes may not always be negligible and could potentially affect the accuracy of estimated wind-induced responses. The significance of ignoring the contribution of higher modes on different wind-induced responses of tall buildings was assessed in this study using two 182.88m tall buildings. The first building has a uniform rectangular foot print of 30.48m x 45.72m while the second building has a similar foot print on the lower half height but the planar dimensions are reduced by 40% on the upper half height (shown in Figure 1(a) and 1(b), respectively). Aerodynamic wind tunnel tests were conducted for both buildings in which simultaneous pressure readings were taken at several locations on the building models. Dynamic properties of the buildings were also obtained from classical modal analysis. The aerodynamic data coupled with dynamic properties of the buildings was analyzed in the frequency domain to estimate various wind-induced responses of interest.

Results obtained from the study showed that the contribution of higher modes may not be negligible for some responses such as acceleration and shear though it could be minimal for others such as displacement and bending moment. For instance, the per-

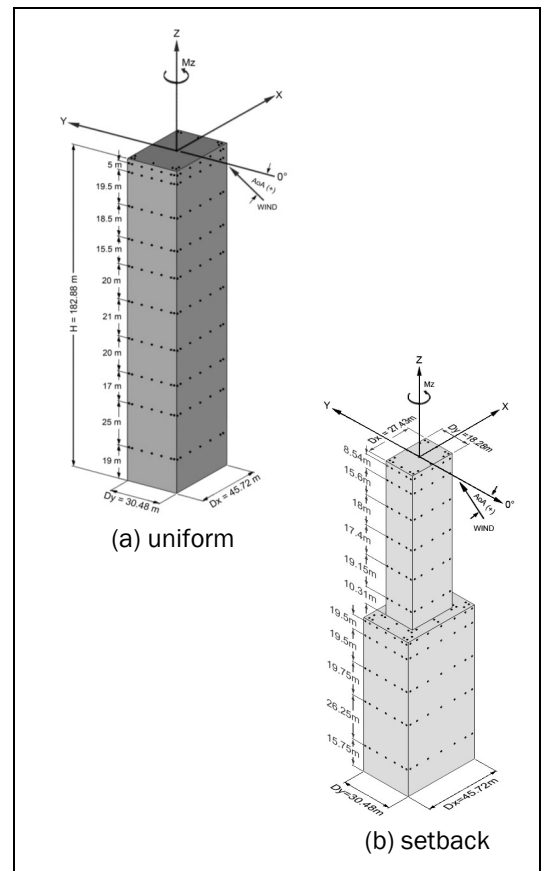


Figure 1: The two studied buildings.

centage deviations between considering three and six vibration modes to compute base shear response along the longer width of both buildings is shown in Figure 2.

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As it can be observed, as high as 30% and 17% deviations occurred on the responses of the setback and uniform buildings respectively. It can also be observed that the effect of higher modes could significantly vary with the building geometry. The number of modes required to consider the dynamic properties of a tall building effectively could vary with the building geometry. In this particular study, considering six vibration modes was found to be sufficient for both buildings. Results of the study also showed that ignoring the contribution of higher modes may not always lead to underestimation of responses it could also lead to overestimation of responses. In addition, the effect of higher modes could also be reflected significantly on the extreme wind-induced responses estimated after synthesizing the aerodynamic data with local climatological (directional wind speed) data of the construction site.

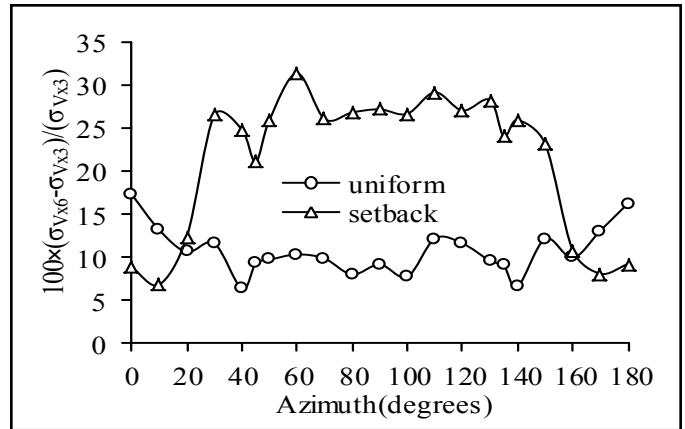


Figure 2: Higher mode effect on the base shear response along the x-axis

AWES16 Workshop

Leighton Cochran (leighton57@me.com)

The Australasian Wind Engineering Society held its 16th Workshop in mid July and it was very well attended, with about 60 researchers, practitioners and manufacturers present. The venue for the two-day workshop was the Marriott Hotel on the banks of the Brisbane River in the financial portion of the downtown. As a service to the local structural engineering community the day before the Workshop the members of the AWES held an all-day Wind Engineering Seminar that largely served to explain some of the details and history of the local code (AS/NZS1170).

The Workshop itself was broken up into seven sequential sessions that included topics ranging from Measuring, Predicting and Observing Severe Winds, to Environmental Turbulence, Mixing and Ventilation, to Wind Vulnerability and Resilience. A popular topic of discussion during the sessions, and in between them, was the relatively recent realization that the historical Australian wind records, using a Dines anemometer, had a much shorter averaging time than previously thought (about 0.2 s, rather than about 2 to 3 s). The impact of this on code windspeeds and loads, and how to deal with it, was extensively discussed.

We were fortunate enough to have two excellent keynote speakers, Bruce Harper (GHD) and Forrest Masters (UF). Bruce gave a provocative talk on the best practice associated with tropical cyclone wind hazard modelling, in which he pointed several key flaws, assumptions and data “holes” in the history of the field. Forrest was kind enough to fly out from Florida and tell us all about the recent work that has advanced the area of full-scale wind engineering at the University of Florida and elsewhere.

The Workshop dinner was held on a paddle steamer, called the “Kookaburra Queen”, that took us over much of the Brisbane River within the city - a great way to see the sights. The AWES17 will be held in New Zealand in about 18 months.



Bruce Harper



Forrest Masters

A Nonlinear Analysis Framework for Bluff-Body Aerodynamics: From Navier-Stokes Equations To Volterra Systems

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Significant nonlinear features concerning motion-induced and gust-induced forces on modern bridge decks, observed in wind tunnel studies recently, have placed increasing importance on addressing the nonlinear features in the design of long-span bridges for wind. A linear convolution scheme involving the first-order (linear) kernels for linear bridge aerodynamics is extended to the nonlinear convolutions involving higher-order (nonlinear) kernels for capturing nonlinear bridge aerodynamics utilizing a "peeling-an-onion" type procedure (Figure 1). A Volterra-type formalism is introduced for modeling the nonlinear convolutions.

The identification of Volterra kernels is based on the impulse function concept, which is accomplished through modeling of flow around the deck using computational fluid dynamics. Computational approaches employed in this study are validated through theoretical consideration, e.g., Blasius solution for the steady-state simulation and Theodorsen solution for

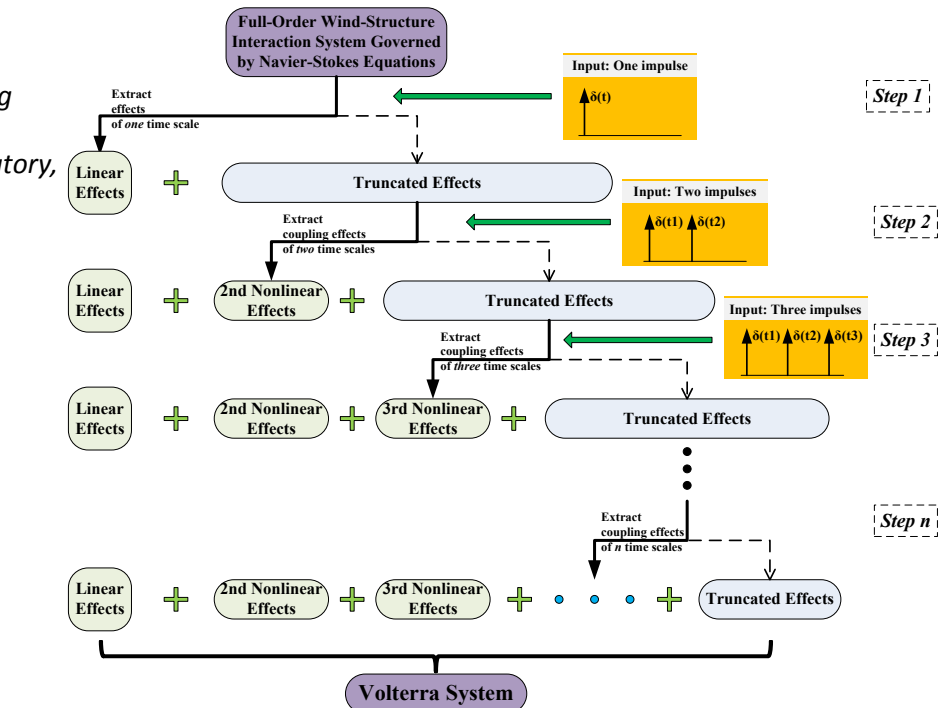


Figure 1: A schematic of the proposed "peeling-an-onion" type approach .

the dynamic-state simulation. The aerodynamic outputs (linear and nonlinear results) based on this reduced-order modeling scheme are obtained by the convolution of the identified kernels and the external inputs. It is demonstrated that the Volterra theory based nonlinear analysis framework of bluff body aerodynamics like a bridge deck is promising in capturing the essential aerody-

namics and offers an accurate approximation of the Navier-Stokes equations with high computational efficiency. Immediate applications of the established nonlinear aerodynamics analysis framework are abundant in the area of flutter and post-flutter analyses, buffeting, vortex-induced vibrations, active control of bluff-body aerodynamics and insect flight.

Request for Nominations

AAWE Award Nominations

The AAWE Best Paper Award is a recurring annual award. Please consider papers that have been or will be published in 2013 for possible submission for the next opportunity to present this award.

Nominations for the next Best Paper Award are due before January 31, 2014. Please send all nominations to the AAWE Awards Committee Chair, Anne Cope at acope@ibhs.org.

IAWE Award Nominations

The International Association for Wind Engineering awards process has recently changed from a quadrennial nomination, review and award period to an annual process, with nominations due on or before March 31 each year. Please consider nominating fellow AAWE members for these two prestigious IAWE awards:

- IAWE Senior Award (Davenport Medal), which is presented for a record of outstanding achievement, normally within the previous ten-year period, in at least two out of: i) significant and original contribution to wind engineering research; ii) applications to wind engineering practice; iii) educational contributions in the field of wind engineering; iv) international community involvement.
- IAWE Junior Award, which is presented for a record of outstanding achievement, within the previous five-year period, in at least one of: i) significant and original contribution to wind engineering research; ii) applications to wind engineering practice; iii) educational contributions in the field of wind engineering. Nominees should be under the age of forty years on January 1st of the year.

Nominations for the IAWE awards can be sent directly to the IAWE Secretary General, Shuyang Cao at cao@arch.t-kougei.ac.jp, or for assistance with submission you may contact the AAWE Awards Committee Chair, Anne Cope at acope@ibhs.org.

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