The Aerodynamic Optimisation of Building Envelopes for Super High-Rise

Stefano CAMMELLI
Head of Wind Engineering
BMT Fluid Mechanics
Teddington, UK
scammelli@bmtfm.com

Stefano Cammelli received his civil engineering degree from the University of Genoa, Italy. He joined BMT Fluid Mechanics in 2003 where he is currently in charge of the wind engineering work for the civil construction and oil & gas industries.

Melissa BURTON
Regional Manager
BMT Fluid Mechanics
New York City, NY, USA
mburton@bmtfm.com

Melissa Burton received her degree in mechanical engineering from the University of Waterloo and then a PhD in wind engineering from the Hong Kong University of Science and Technology. She worked at Arup in London before joining BMT Fluid Mechanics in 2011.

Volker BUTTGEREIT
Managing Director
BMT Fluid Mechanics
Teddington, UK
vbuttgereit@bmtfm.com

Volker Buttgereit received his degree in aeronautical engineering and a PhD in unsteady aerodynamics from Imperial College in London. He worked for Airbus Industry in Germany and Arup in London before joining BMT Fluid Mechanics in 1999.

Summary

This paper presents a framework that has been developed to allow fully interactive dynamic wind tunnel workshops to be held. These interactive sessions enable key structural performance indicators (e.g. peak dynamic wind base loads and wind-induced peak accelerations) to be derived within minutes of acquisition of wind tunnel data. Rapid modifications can be made to the geometry of the wind tunnel model as well as to the structural numerical model, allowing responsive re-testing within an interactive and integrated environment. This technical approach allows architects and structural engineers to generate finely tuned aerodynamic building envelopes capable of minimising the potentially adverse effects of vortex-induced vibrations.

Keywords: Tall buildings; later-stability system; vortex-shedding; aerodynamics; wind tunnel testing; high-frequency force balance.

1. Introduction

At the turn of the millennium there were approximately 250 tall buildings with height in the excess of 200 m across the globe: the projections for the end of 2013 indicate that this number will soar to 850. Similarly the number of ‘super-tall’ buildings (>300 m), at present approximately 80 worldwide, has more than triplicated during the course of the last decade.

The dynamic response of such tall structures to external natural forces such as the ones generated by gusty winds and – perhaps even more importantly – the ones generated by aerodynamic features like vortex-shedding, has the potential to strongly influence the choice of the structures lateral-stability systems: it is within this context that the aerodynamic shape plays an important role in design.

The success of these super-tall buildings has only been possible thanks to the mature integration of architecture, structural engineering and applied aerodynamics. Wind tunnel studies have been, and still are, vital to the ultimate commercial and financial success of these schemes.

Whilst the authors of this technical paper fully recognize that, especially over the last decade, the architectural form of numerous tall and super-tall building projects have been heavily influenced by the outcome of wind tunnel testing, they are also fully aware of the fact that this has tended to be based on the approach of checking predetermined architectural forms for critical problems. The process here presented is different in that it is focused on the development of bespoke aerodynamic solutions which are specific to the project site and for the type of wind climate of the region of interest. There are no predetermined schemes, but only one very 'fluid' and initial baseline architectural form and a very preliminary and basic structural concept. This is the starting point from which the rest evolves in the wind tunnel as an integrated and collaborative effort between the architects, the structural engineers and the wind engineers.

The next sections of this technical paper will illustrate the technical developments which have

https://doi.org/10.2749/222137814814027828
Distributed by structurae