RECENT DEVELOPMENTS AND CHALLENGES IN WIND ENGINEERING

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ABSTRACT

This paper presents some recent developments and challenges in wind engineering. They include the aerodynamic characteristics of atypical super-tall buildings, database-assistant design, computational fluid dynamics, and a full-scale storm simulator.

KEYWORDS: ATYPICAL SUPER-TALL BUILDING, DATABASE-ASSISTANT DESIGN, COMPUTATIONAL FLUID DYNAMICS, FULL-SCALE STORM SIMULATOR

Introduction

This paper briefly presents some recent developments and challenges in wind engineering. For example, the aerodynamic characteristics of a large number of atypical super-tall buildings have been discussed by the authors' group to identify the most effective building shape for wind-resistant design. Database-assistant design, computational fluid dynamics, and full-scale test facilities have also been discussed.

Aerodynamic Characteristics of Atypical Super-Tall Building

As wind loads depend mainly on the building envelop, building shape is very important in wind-resistant design. Most typical (super-) tall buildings have a square and/or rectangular plan with conventional building shape. However, the design of recent (super-) tall buildings has been released from the spell of compulsory symmetric to free-style, and this has advantages with regard to aerodynamic properties for suppression of crosswind responses, which is a key issue in tall building wind-resistant design. Figure 1 shows examples of atypical super-tall buildings, including atypical models, pyramid models, helical models, opening models, multiple modification models with square plan, and those of polygonal plan. Comprehensive studies on the aerodynamic and response characteristics, and pedestrian level wind environment of atypical tall buildings have been carried out [Tamura *et al.* (2015)].

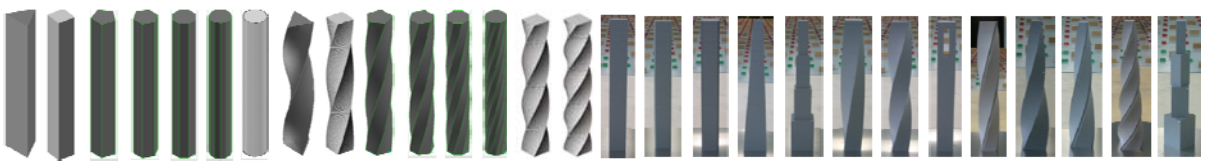

Figure 1: Examples of atypical super-tall buildings

Database-Assistant Design

For super-tall buildings and long-span roof structures with complicated configurations, 3D time domain dynamic response analyses based on SMPMS may be necessary for precise studies on wind-induced behaviors in practical design. However, preliminary studies on wind-induced responses and loading effects should be made based on easier and more expedient ways in the early stage of building design. One way of meeting this requirement can be a database-based design. Currently, aerodynamic databases by several groups are accessible, including the TPU Aerodynamic Database. This trend should be accelerated, and efforts should be made to accumulate and develop electronic aerodynamic databases.

Computational Fluid Dynamics (CFD)

Recent development of CFD techniques for wind engineering applications is very significant in both structural design and environmental assessment. It should be mentioned that the CFD technique is still incomplete and under development. Nevertheless, careful but positive applications and development of its scope of applications are very necessary, because improvement and maturity of a technology cannot be made without its usage.

Full-Scale Strom Simulator

Wind-related disasters such as Cyclone Nargis in Myanmar in 2008 and Cyclone Sidr in Bangladesh in 2007 have had significant impacts on those societies, especially in terms of the shocking number of deaths and injuries to people and the attendant property loss. It has been reported that 80-85% of natural disaster economic losses in the world are caused by extreme wind related events. Only realistic full-scale simulation of buildings and structures can give us useful and exact information when evaluating wind-resistant performance, especially of cladding and component systems. Detailed investigations need to be conducted under a controlled environment, giving rise to the necessity of a full-scale storm simulator as shown in Figure 2.

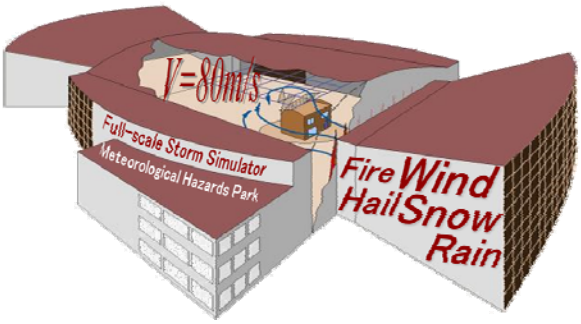

Figure 2: Full-scale storm simulator (proposed by Tamura Y.)

Concluding Remarks

This paper has discussed several topics on wind related issues, and there are many other issues. The authors hope that young researchers will try to meet these challenges to find solutions and directions to be taken in the future.

References

Tamura, Y., Tanaka, H., Ohtake, K., Kim, Y.C., Yoshida, A., Bandi, E.K., Xu, X., Yang, Q. (2015), "Aerodynamic control of wind-induced vibrations and flow around super-tall buildings", 6th International Conference on Advances in Experimental Structural Engineering, Urban-Champaign, Unite States, August 1~2.