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A REVIEW ONPERAMETRIC STUDY OF TALL R.C.C BUILDING FOR WIND LOAD

Nizam.M.Mistry[1], Kartik.K.Mandani[2],Anuj.K.Chandiwala[3]

[1]*Civil Department, Chhotubhai Gopalbhai Patel Institute of Technology, nizumistry@gmail.com*
[2]*Civil Department, Chhotubhai Gopalbhai Patel Institute of Technology, kartik.mandani847@gmail.Com*
[3]*Civil Department, Chhotubhai Gopalbhai Patel Institute of Technology, anuj.chandiwala@utu.ac.in*

Abstract—*Recent tall buildings tend to have irregular and unconventional shapes as a prevailing but unavoidable trend, which is very effective for suppressing across-wind responses. Suppression of a cross-wind responses is a major factor in safety and habitability design of tall buildings, and the so-called aerodynamic modification method is comprehensively used. While the effectiveness of aerodynamic modification in reducing wind loads has been widely reported, there have been few detailed investigations of pressure fluctuations. The tests were performed on two different models of tall buildings: a regular one with a prismatic shape; an irregular one whose external shape was inspired by that of Bank of China Tower in Hong Kong. The two models have the same square footprint and height. The two methods used to measure the wind effects were: the high frequency force balance, which allows to directly measure the global base reactions (two forces in the plane of the base, the two overturning moments and the torsional moment around the vertical axis); the synchronous multi-pressure sensing system, which measures the pressure in several points on the surface of the model, and allows, by means of numerical integration, to estimate both the floor loads and the base reactions.*

Keywords- Tall buildings, Wind tunnel testing, Wind effects

I. INTRODUCTION

It is difficult to distinguish the characteristics of a building which categorize it as tall. After all, the outward appearance of tallness is a relative matter. In a typical single-story neighbourhood, a five-story building may appear tall. A 50-story building in a city may be called a high-rise, but the citizens of a small town may point proudly to their skyscraper of six stories. A tall building cannot be defined in specific terms related to height or number of floors. There is no consensus on what constitutes a tall building or at what magic height, number of stories or proportion a building can be called tall. Perhaps the dividing line should be drawn where the design of the structure moves from the field of statics into the field of structural dynamics. From the structural design point of view, it is simpler to consider a building as tall when its structural analyses and design are in some way affected by the lateral loads, particularly the sway caused by such loads. Sway or drift is the magnitude of the relative lateral displacement between a given floor and the one immediately below it. As the height increases, the forces of nature particularly due to wind, begin to dominate. Therefore, structural framework for super-tall buildings is developed around concepts associated entirely with resistance to turbulent wind.Wind is the term used for air in motion and is usually applied to the natural horizontal motion ofthe atmosphere. Motion in a vertical or nearly vertical direction is called a current. Movement ofair near the surface of the earth is three-dimensional, with horizontal motion much greater thanthe vertical motion. Vertical air motion is of importance in meteorology but is of less importancenear the ground surface. On the other hand, the horizontal motion of air, particularly the gradualretardation of wind speed and high turbulence that occur near the ground surface, are ofimportance in building engineering. In urban areas, this zone of wind turbulence often referred toas surface boundary layer, extends to a height of approximately one-quarter of a mileaboveground. Above this layer, the horizontal airflow is no longer influenced by the retardingeffect of the ground surface. The wind speed at this height is called gradient wind speed, and it isprecisely within this boundary layer where human construction activity occurs. Therefore, howwind effects are felt within this zone is of concern in building design.

II. LITERATURE REVIEW

A. SHUGUO LIANG, Q.S. LI B, SHENGCHUN LIU, "WIND LOADS ON RECTANGULAR TALL BUILDINGS" ENGINEERING STRUCTURES 26 (2004) 129–137, VOL. 7, NO. 1, SEPTEMBER 2003

Shuguo LIANG, Q.S. Li b, ShengchunLIU The oscillations of tall buildings caused by wind action have been found to occur in the along-wind and across-wind directions, as well as torsional mode. Wind in duced torsional vibration of tall buildings can enlarge the displacement and acceleration near the peripheries of their cross-section; especially when the side faces of a rectangular tall building are wider,and/or it is asymmetric, and/or its lowest torsional natural frequency approaches either of itslowest translational natural frequencies, wind-induced torsional responses may become themain part of the total responses for the peripheral points of such a building. Meanwhile, habitants in a tall building are more sensitive to torsional motion than translational motion On the basis of the extensive experimental data obtained from a series of model tests in aboundary windtunnel; a mathematical model for evaluation of torsional dynamic wind loadson rectangular tall buildings is presented in this paper. Comparisons of the results betweenthe proposed model and the wind tunnel measurements verify the reliability and applicabilityof the developed model. A calculation method given in the Appendix of this paper ispresented based on the mathematical model to evaluate wind-induced torsional responses ofrectangular tall buildings in frequency domain. It should be pointed out that the mathematicalmodel of torsional dynamic wind loads presented in this paper is based on the wind tunnelmeasurements of isolated rectangular building models. In engineering practice, the usage ofthis model is limited if there are tall buildings or other structures located nearby, sinceinterference from surrounding buildings and structures could have a significant effect on thewind-induced torsional dynamic loads.

B YONG CHUL KIM ,JUN KANDA, "WIND PRESSURES ON TAPERED AND SET-BACK TALL BUILDINGS", JOURNAL OF FLUIDS AND STRUCTURES 39 (2013) 306–321, APRIL 2012

Yong Chul Kim ,Jun Kanda The current tallest building in the world is the 828 m-high Burj Khalifa, which is over 300 mhigher than Taipei 101, and the tallest buildings in the next decade will be Kingdom Tower(over 1000 m), which will be completed in 2018, making Burj Khalifa the third tallest building. Current trend of tall building construction, i.e., manhattanization with variousbuilding shapes, requires attention. Their free- wheeling building shapes are expressed bytaper, set-back, helical, openings, or combinations of these, reflecting architects' andengineers' challenging spirits for new forms. These irregular and unconventional buildingshapes are a resurrection of an old characteristic, motivated by new trends in architecture, butthey have the advantage of mitigating across-wind responses, which is a major factor insafety and habitability of tall buildings.The effectiveness of aerodynamic modifications in reducing wind loads has been widelyexamined, and they can be tentatively classified as corner modification and heightmodification (Kim and Kanda, 2010a). Corner modification includes corner cut, recess, chamfer and addition of fins (Kawai, 1998; Kwok et al., 1988), and height modificationincludes taper, set-back, opening, helical (twisting) and inclined (tilted) shape, and so on (Dutton and Isyumov, 1990; Kim and Kanda, 2010a, 2010b; Kim et al., 2011; Tanaka et al.,2012). In particular, Tanaka et al. (2012) conducted a series of wind tunnel tests to investigate aerodynamic characteristics and to evaluate the most effective building shape in windresistantdesign for 31 tall buildings with various aerodynamic modifications. Unlikestructural modification, which controls mass, spring and damping directly in a governingequation of motion, aerodynamic modification controls forces applied to tall buildings byaltering the separated shear layer or disturbing the alignment of the vortex over the wholeheight.

B. F. CLUNI, V. GUSELLA, S.M.J. SPENCE , G. BARTOLI "WIND ACTION ON REGULAR AND IRREGULAR TALL BUILDING",

F. Cluni , V. Gusella, S.M.J. Spence , G. Bartoli In last decades a large number of non-prismatic and irregular tall buildings have been proposed and built. The shape of these buildings makes them more sensitive to wind excitation than those with a regular shape. In fact, the irregular distribution of wind pressure on the surface involves significant coupled lateral and torsional effects (Chan et al., 2010) and requires to accurately describe the external pressure field acting on these increasingly irregular bluff bodies (Chen and Kareem, 2005). Moreover, there is a need to estimate boththe cladding loads and global loading schemes, necessary for the design of the main structure,which are capable of accurately estimating any number of generalized forces within the framework of modal analysis (Simiu, 1976; Kareem, 1981; Huang and Chen, 2007). Sincethe design codes do not allow the estimation of wind effects on buildings with significantly irregular geometries, but only on those with simple shapes such as the prismatic building ofthis work, experimental tests in wind tunnels are in general necessary. To this end, two methods may be adopted in specific experimental wind tunnel tests in order to estimate thewind action on rigid models of the actual building, namely the high frequency force balance (HFFB) method and the synchronous multi-pressure sensing system (SMPSS) technique. Two different models were used for each experimental setup. One of the models was the 1:500 scale reproduction of the external surface of Bank of China Tower in Hong Kong. The base of the model had dimensions of 103mm * 103 mm; the height of the model was 610mm.The other had a regular prismatic profile with the same square footprint and height of the previous model. The two models are shown in Fig. 1 Two versions of each model were used. The first one, used during the SMPSS measurements,was realized in a plastic material with internal wood frame stiffeners and instrumented with 287 (irregular model) and 315 (regular model) pressure taps; each tap has about the sametributary area; the number of pressure taps exceeds the number of available acquisition channels (126) since the model was designed so that several layouts of pressure measurementswere possible, Spence (2009); in the work presented in this paper, the layout which allows the measurement of the overall forces acting on the model was used. The second type ofmodel was used in the HFFB measurements and was constructed using steel sheets.

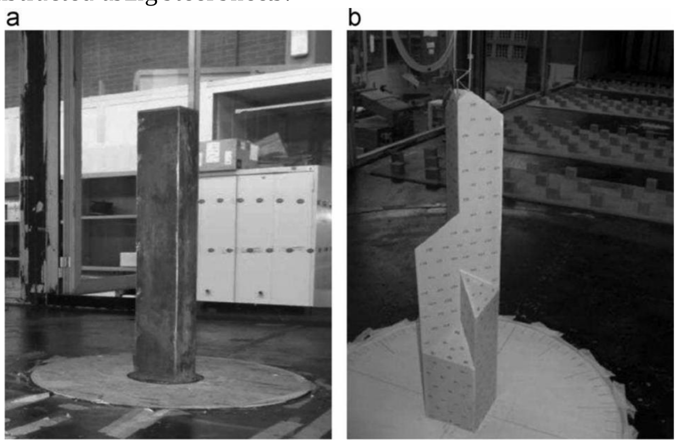

Fig.1 Experimental models :regular model for the HFFB measurements

III. CONCLUSION

The results of experimental wind tunnel tests carried out in a boundary layer tunnel, performed to estimate the wind action on regular and irregular tall buildings, have been presented. Two experimental techniques have been compared the high frequency force balance (HFFB), and the synchronous multi-pressure sensing system(SMPSS).There sults of these tests allowed for the characterization of the overall base action and, in case of the SMPSS, the estimation of the stochastic structure of the pressure fields, highlighting the in on Gaussian nature.

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