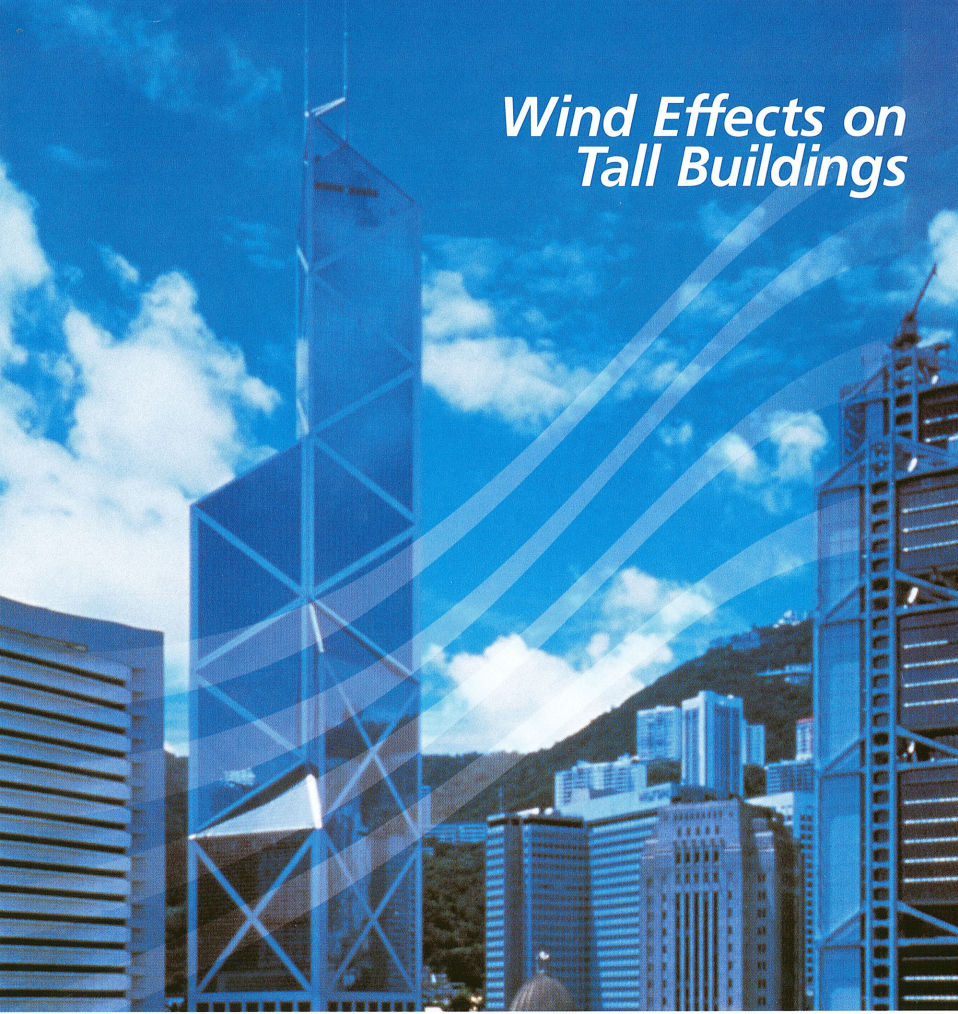
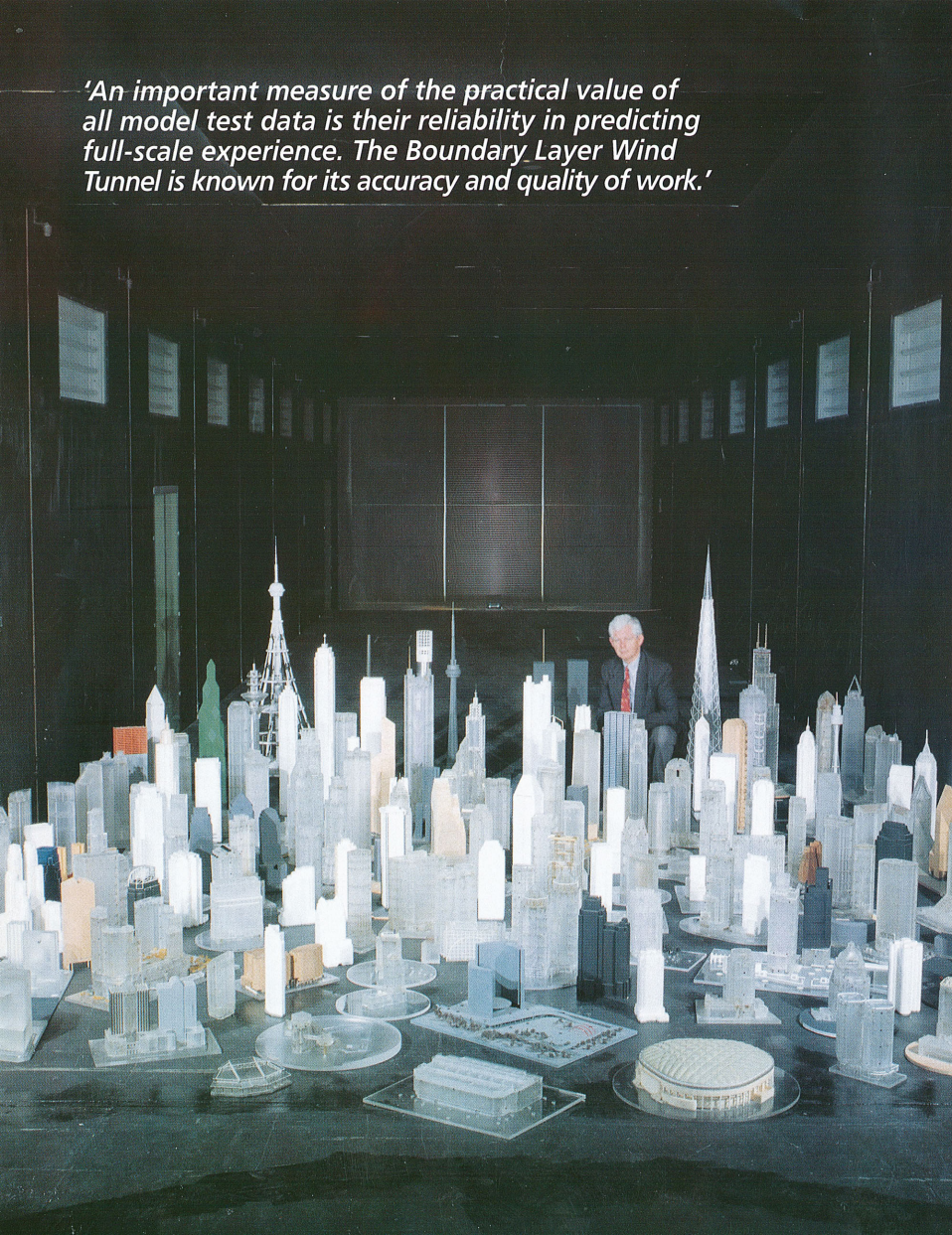
Wind Effects on Tall Buildings

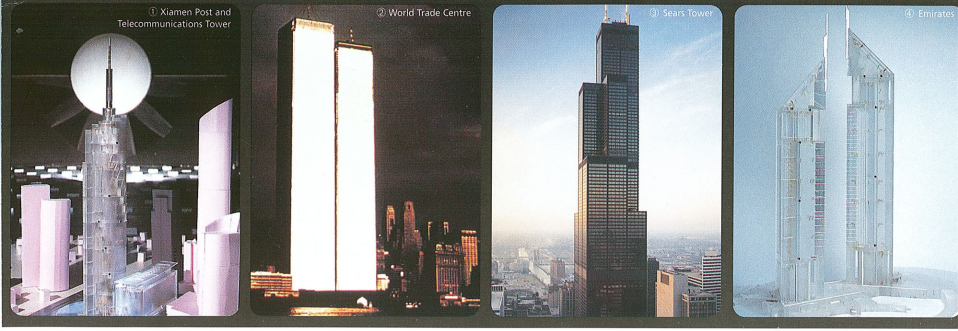


Alan G. Davenport
Wind Engineering Group

The Boundary Layer Wind Tunnel Laboratory

'An important measure of the practical value of all model test data is their reliability in predicting full-scale experience. The Boundary Layer Wind Tunnel is known for its accuracy and quality of work.'





Determining Wind Effects

Wind tunnel model testing with the Boundary Layer Wind Tunnel Laboratory (BLWTL) is a reliable method of determining wind effects on tall buildings. Wind tunnel investigations are accepted alternatives to Codes in situations where more precise information is sought, or where potential wind sensitivity falls outside existing experience. Such studies improve the reliability of performance and/or economy of design.

QUALITY WORK

The BLWTL is known for its accuracy and quality of work. Not only do we use the most advanced technologies available; we are continually making further refinements to our testing and analysis systems.

An important measure of the practical value of all model test data is their relation to full-scale experience. Unique among comparisons with full scale experience are the response measurements on the Allied Bank Building in Houston during Hurricane Alicia, when the building withstood design wind forces. Agreement between full scale and model predictions is excellent.

EXPERIENCED STAFF

The BLWTL staff are professional and experienced. Since its inception in 1965, the BLWTL has played a leading role in developing the field of wind engineering. We have assisted designers of international renown by evaluating wind effects for many of the world's tallest buildings.

VALUABLE EXPERTISE

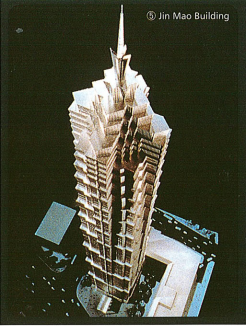
The BLWTL staff capably determine the wind-induced loads and responses of buildings and, where appropriate, arrive at innovative approaches to new design challenges. BLWTL model studies frequently lead to cost savings since the derived wind loads, in many circumstances, can fall below code-specified values.

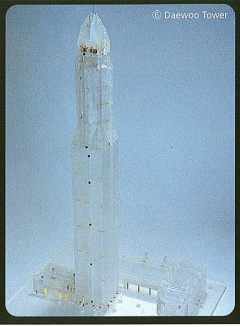
TIMELY COMMUNICATIONS

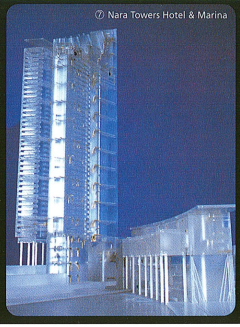
An early involvement of BLWTL wind experts results in the greatest benefits. Wind tunnel model studies are particularly valuable if they are carried out at an early stage when design adjustments can still be made. By working closely with our clients on an ongoing basis, we assist in identifying needs in order to provide timely and accurate design information at a reasonable cost.

BLWTL model studies are important to:

- improve the reliability and cost effectiveness of structural design
- ensure an adequate measure of safety against aerodynamic instabilities for tall, slender, and flexible buildings, or buildings of unusual aerodynamic shape
- increase human comfort and safety, through information on sway and twist accelerations, and torsional velocities
- allow for the proximity to prominent topographic features and other structures
- assist with the design of the building envelope
- achieve acceptable ventilation and air quality in exterior and interior spaces
- assure human comfort and safety in outdoor areas







WIND LOADS AND RESPONSES OF STRUCTURES

Force Balance Tests are a fast and cost effective method to measure the mean and quasi-steady dynamic forces. Test results are combined with the dynamic properties of the building to:

- determine the deflection of the building
- determine the acceleration at the top floors
- calculate the resonant dynamic component of the wind loads and responses
- determine the overall overturning moments acting on the building
- estimate the equivalent static design load distribution over the height of the building
- carry out parametric studies on the variation of dynamic properties such as natural frequency, mass and damping

Instantaneous Pressure Measurements integrated over the exterior surfaces of the building allow the determination of dynamic loads on the entire building and on selected building components. The latter measurements can provide all of the results associated with the force balance test. The model used to gather data for this analysis is also used in the study of cladding pressures, providing an economy in testing and model construction.

Aeroelastic Model Tests are used for particularly complex geometries or structures, or where the motion of the building itself may affect the aerodynamic forces. Results from aeroelastic tests also include the basic scope as described in the force balance test.

FORCES ON COMPONENTS OF THE BUILDING

Pressure test data are analyzed to provide design information for windows, cladding, curtain walls, panels, etc. This information is generally used for the design of relatively small structural components.

Estimates of internal pressures resulting from operable windows and doors can be determined, and are also important to design.

ADDITIONAL SERVICES

Environmental Problems

- Winds in city streets and other public areas
- Dispersion of gaseous and particulate pollutants
- Rain penetration
- Influence of wind on HVAC
- Information provided to assist with curtain wall testing

Full-scale Monitoring

- Monitoring of wind response of full-scale structures

Wind Climate Studies

- Hurricane and severe storm effects
- Influence of large-scale topography on wind patterns
- Monte Carlo simulation of hurricane winds

Computational Fluid Dynamics (CFD)

- Internal flows
- Rain wetting and runoff

Damping of Structures

- Estimation of inherent damping of buildings and structures
- Visco-elastic, tuned mass and tuned liquid dampers, and other damping systems

Other Design Challenges

- Aerodynamic efficiency of shapes and profiles
- Dynamics of foundations and structures
- Wind hazard assessment
- Fatigue and load cycle evaluation
- Snow drifting and accumulations on roofs and at ground level

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