

RD 93-159

# AERODYNAMICS

## Aerodynamically Evaluating Bridges

Research in the Aerodynamics Laboratory involves model testing, numerical modelling, static and dynamic structural analysis, and full scale measurements. A number of staff studies and Grants for Research Fellowship (GRF) student projects are currently underway in each of these areas.

### Field Testing Bridges

Through a cooperative agreement with the Maine Department of Transportation, researchers from the Laboratory have installed wind and bridge motion sensors on the Deer Isle-Sedgwick Bridge to monitor the local wind climate and bridge response to wind loadings. Throughout its more than 45 years of service, this suspension bridge has exhibited considerable sensitivity to the wind. Wind tunnel investigations are being conducted on a 1:25 scale section model of the Deer Isle-Sedgwick Bridge. Bridge response to a variety of simulated wind conditions is being evaluated. This field and laboratory work has identified aerodynamic modifications which will significantly

improve the performance and safety of the existing structure.

A somewhat similar investigation is being conducted in cooperation with the Louisiana Department of Transportation and Development. However, in this case, the structure is a modern cable stayed bridge over the Mississippi River at Luling. An extensive program of labora-

tory testing for this bridge was completed a number of years ago. Currently, automated instrumentation on the bridge is being maintained by laboratory researchers to monitor the structure's performance in severe storms, particularly hurricanes.

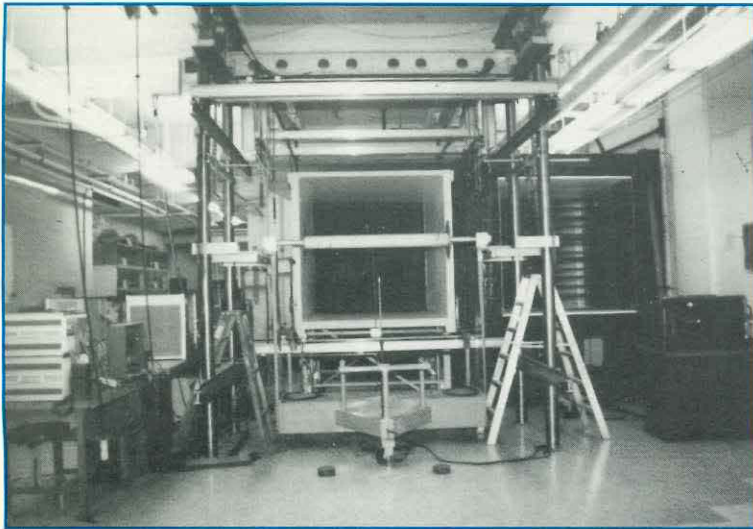
### More Efficient Simulations

A GRF project is well underway to develop new techniques in computational fluid dynamics to enable computer simulation of air flow around bridges and other highway structures. The aim here is to adapt or modify existing techniques which have been used primarily in other areas such as the space program. Attempts are being made to reduce the level of computer resources required for this simulation while retaining acceptable precision in the overall process.

### Evaluating Tapered Cylinders

Another GRF project is investigating the aerodynamic properties of tapered cylinders. Many highway structures such as signal and sign supports, light poles, and high light towers are comprised of tapered cylinders. These structures frequently vibrate as a result of wind loadings and several have actually collapsed in recent years. This project involves a review of literature on the subject and preliminary laboratory testing to establish the aerodynamic properties of representative sections.





## AERODYNAMICS LABORATORY

The Aerodynamics Laboratory at the TFHRC was completed in the late 1950's. The Laboratory was established to provide a better understanding of wind load effects on structures and to ensure the aerodynamic stability of transportation structures, particularly long-span bridges. The wind tunnel is used for evaluating aerodynamic stability of new designs; investigating response of bridges to wind load; studying the effects of turbulence on bridge stability;

developing retrofit measures for existing bridges; measuring and quantifying wind forces on bridges; and studying flow characteristics near and around bridges.

The Aerodynamics Laboratory consists of a relatively large room (12.2 by 22.9 by 5.5 m) containing a wind tunnel, several unique test fixtures, and an array of laboratory test equipment.

The wind tunnel is a low velocity, open-circuit tunnel. With its 1.83 by 1.83 m nozzle, this wind tunnel can generate extremely smooth (laminar) flow at speeds up to 15 m/s. This enables the simulation of prototype wind speeds up to 75 and 150-m/s using typical model scales between 1:25 and 1:100, respectively. For experiments where turbulent flow is desired, an active turbulence generator is inserted into the circuit between the wind tunnel nozzle and the test area. With this sophisticated system, large scale turbulence can be simulated in the vertical and along-wind directions, independently. The vertical angle of the wind can be changed by rotating the nozzle

up and down or by rotating the model around its longitudinal axis as needed.

Experiments are performed to measure wind forces, study aerodynamic stability, and investigate air flow around a structure. Wind forces are measured by installing a scaled model in the force-balance and placing the entire assembly in the test area. Structural stability is evaluated by mounting the model on a spring suspension system in the test frame. Flow studies are accomplished by installing velocity sensors on a motorized traverse system and surveying the flow field around the model.

Several data acquisition systems record test measurements. Wind forces, model responses, wind velocities, air temperature, barometric pressure, and wind tunnel speed are sampled and recorded automatically. Both the turbulence generator and the traverse system can be operated under computer control. A variety of pitot tubes as well as hot-wire and hot-film sensors study flow conditions.

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