NEEDHAM & ASSOCIATES
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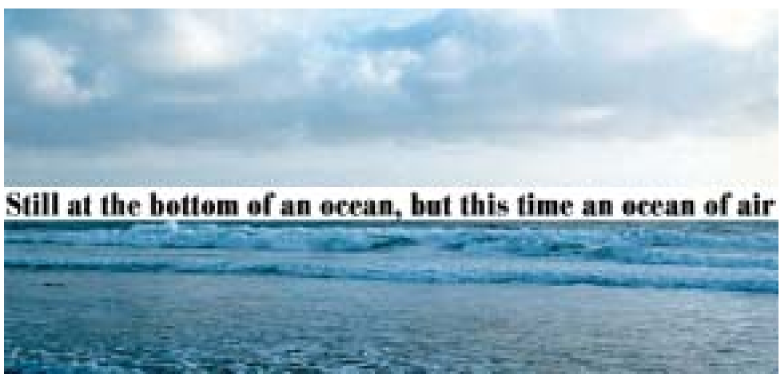
Swimming in the Deep Blue Sea *(of Air)*

Most of the Midwestern United States was once at the bottom of a large, shallow sea. In a very real sense, it is still at the bottom of an ocean, but now it is an ocean of air. Like water, that air presses down on us constantly. Since we are extremely well adapted to living at the bottom of this ocean of air, we don't notice the pressure. It is only when the air is in motion that we can see and feel the power we call wind. If you have ever been on a sailboat or tried to drive your car down a road in crosswinds, you are familiar with the power of wind.

When engineers determine the design wind load, described as force per unit area, they must consider not only the wind velocity, but terrain where the building is to be located, the height of the structure and the usage of the structure. If the building is located atop a ridge or hill, the wind velocity will be higher than for a structure located on flat ground. Similarly, the wind velocity will be lower for a building located in the center of a built-up area than for a building located by the shore of a lake or ocean.


Still at the bottom of an ocean, but this time an ocean of air

When the structure will be occupied by a large number of people or has an essential function, building codes mandate a higher importance factor, which has the effect of increasing the design load on the structure.

It should be noted that the loads required by building codes are minimums. If the proposed building will have extremely valuable contents or the consequences of even a partial failure would be severe, it is reasonable to increase the recurrence interval, which decreases the chance of the loads being met or exceeded in any given year.

The structures we build are also affected by wind forces. If a structure is to remain undamaged by years of wind pressure, proper design is essential. This article offers a brief, non-technical explanation of the aspects of proper design needed to resist wind loads. As a warning to engineers, please note that this article will contain no Greek letters or subscripts.

The first step in designing for wind is to determine the design wind velocity. Building codes usually specify a minimum design wind velocity, which is shown as contours on a map of the country. The velocities shown represent the wind velocity that occurs during a gust lasting three seconds. Statistically, that wind velocity can be expected once every fifty years. Thus, there is a 2% chance of the velocity being met or exceeded in a given year.

> **" . . . when the air is in motion we can see and feel the power we call wind. "**

Once the wind loads are determined, the structure is designed for the various forces that are developed using the building code procedures.

(cont on back)

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Swimming in the Deep Blue Sea (of Air) *cont.*

When wind strikes a building, pressures and suctions are produced that vary in intensity with both the wind speed and the direction. Since building codes use a procedure that applies the maximum forces simultaneously, a slight reduction in wind load is permitted for building components supporting large areas. This is logical since the maximum force at any point on the building does not occur simultaneously with the maximum force at all points at the same time.

There are certain areas of structures, however, that experience extreme wind loads. There are places where the building surfaces change direction abruptly, such as the corners of a building or the edge of a roof plane. For these areas, the codes mandate much higher wind forces. In a properly designed structure, the members directly supporting the exterior walls and the roof could be expected to be at closer spacing than those members which are located some distance away from the edges of a building.

In summary, designing a structure for wind isn't just about things blowing over. It's also about making sure that all of the building components remain firmly attached to the structure and functional when the tides and currents of our ocean of air try to find a way inside the structures where we live, work and play.

acarter@needhamassoc.com

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- In the past, asphalt has gained a reputation for being the material of choice for exterior pavements based on low initial cost. As shown on the graph, the low initial cost advantage is not as great today as it was in 1999. Perhaps the use of concrete for parking areas should get another look as well.
- Although the comparative design thicknesses for asphalt and concrete pavements have not changed much, the comparative initial costs have gotten much closer.

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jrneedham@needhamassoc.com

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