Daffodils help inspire design of stable structures
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"You will immediately feel that your arm will be forced to move up and down," explains Haecheon Choi of Seoul National University.

This phenomenon, called von Kármán vortex shedding, affects any elongated structure caught in wind or water currents such as lampposts, high rises and the long vertical pipes used for drilling oil at sea.

In the case of the Tacoma Narrows Bridge, the frequency of these periodic forces happened to hit its resonant frequency.

"This vortex shedding triggered the twisting mode of the bridge," Choi said, "and finally the bridge collapsed."

To find a way to reduce these forces, the researchers looked to nature for inspiration. Specifically, they studied the shape of a daffodil stem, whose twisting, lemon-shaped cross-section enables it to turn away from wind and protect its petals.

The researchers used computer simulations to explore the fluid dynamics around the daffodil stem's shape: a helically twisted, elliptical cylinder. They tested different variations—some with more elliptical cross-sections or with more twists, for example—in smooth, laminar airflow or a more turbulent wind.

In both cases, the daffodil shape made a big difference.

"Some helically twisted cylinders annihilated the vortex shedding, resulting in drag reduction and zero side-force fluctuations," Choi said. Compared to a round cylinder, the daffodil shape reduced drag by 18 and 23 percent, respectively, for laminar and turbulent flows.

The unique geometry of the daffodil stem could be
used to design more stable structures. Although such a shape probably doesn't make sense for a bridge, it could work for things like antennae, lampposts, chimneys, underwater oil-drilling pipes, skyscrapers and even golf clubs. In fact, Choi said, the researchers already have a patent for a helical golf club.


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