Who Tuned the Sound of the Danjiang Bridge? Tamkang University Wind Engineering Research Center Provides Key Solution to Reduce Wind Noise

Campus focus

The Danjiang Bridge, the world's largest single-tower asymmetrical cable-stayed bridge by span length, is set to open to traffic soon. However, during recent testing, an irritating "wind noise" emitted from the pedestrian railing drew widespread public attention. Confronted with this challenge caused by the unique wind conditions at the mouth of the Tamsui River, the issue was ultimately resolved by a professional team led by Jen-Mu Wang, Associate Professor in the Department of Civil Engineering at Tamkang University and Director of the University's Wind Engineering Research Center (WERC). The team accurately identified the source of the noise and successfully developed a solution, ensuring the national landmark project could proceed toward completion as scheduled.

So where did the mysterious sound come from? Wang vividly described the bridge railings as "a giant harmonica stretching across the Tamsui estuary." He explained that while the bridge's original European design underwent wind tunnel testing focused primarily on overall structural wind resistance and safety, the effects of local details were not fully identified. When Level-4 winds exceeding 5 meters per second blow across the sharp edges of the railings at specific angles, airflow separation occurs and generates turbulent vortices. These vortices create uneven forces on the railings, inducing vibrations that match the structure's natural frequency and produce resonance, which in turn generates the audible noise.

To precisely diagnose the problem, the research team brought actual railing components into a wind tunnel laboratory in mid-March for testing. After identifying the resonance wind speed and vibration frequency, the team quickly proposed the most direct solution: modifying the shape of the structure. "As long as the airflow can pass smoothly and vortex formation

is reduced, the vibrations can be eliminated," Wang explained. WERC recommended that the Highway Bureau install "U-shaped anti-collision foam strips" on the vertical steel plates of the railings to round their sharp edges. Experimental results confirmed that covering every other plate was sufficient to achieve the same effect as fully covering all plates, significantly reducing construction time and material costs. Field measurements showed that the modification successfully disrupted the airflow and reduced noise energy by more than 30 decibels. Initial improvement work has already been completed, with further testing planned before replacing the foam strips with long-term aluminum clamp panels.

Responding to recent public concerns that the motorcycle lane on the bridge feels too narrow and may pose safety risks during strong winds, Wang noted that although the lane width complies with regulations, the bridge's unique wind environment requires additional safety considerations. He suggested that authorities "could restrict motorcycle access during periods of strong wind." As for the wind speed threshold that should trigger such restrictions, Wang stated that further on-site measurements are needed before establishing control standards.

Because Taiwan lies along the Pacific Ring of Fire, most civil engineering research in Taiwan traditionally focuses on earthquake engineering, while wind engineering has remained comparatively underdeveloped. Wang jokingly described wind engineering as "a niche field." Nevertheless, he added, "whenever wind assessment is mentioned, people immediately think of Tamkang University." During typhoon season, Tamkang's wind tunnel laboratory frequently becomes a focus of media attention for demonstrations and wind-related testing.

Since constructing its first atmospheric boundary layer wind tunnel in 1988, WERC has dedicated more than 30 years to wind engineering research and has participated in over a thousand domestic and international research and engineering service projects. The center currently operates two boundary-layer wind tunnels, a bridge-section wind tunnel, and an actively controlled array-fan wind tunnel. In addition to Wang, the center's core faculty members include Professors Cheng-Hsin Chang, Chieh-Hsun Wu, and

Huang Ming-Hui from the Department of Civil Engineering, along with several doctoral-level researchers. Research areas cover aerodynamic behavior of high-rise buildings and bridges, wind-resistant design standards, and the integration of artificial intelligence technologies.

Over the past three decades, the center has conducted wind engineering assessments for many of Taiwan's landmark infrastructure projects, including Taipei Twins (2006), the Taipei Dome (2007), the National Kaohsiung Center for the Arts (Weiwuying) (2008), the Fo Guang Shan Buddha Museum in Kaohsiung (2010), the Kaohsiung Music Center (2013), and Taipei Nan Shan Plaza (2014).


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