Tony Rofail

Director, Windtech Consultants

Rofail has been with wind engineering consultants Windtech since it was founded in 1991. He discusses some of the challenges involved in testing bridge sections.

Can you tell us about your new rig for testing bridge sections?

We've come up with a fairly clever design which allows us to easily manipulate the relative stiffness in the torsional mode, as well as the lift mode for a bridge section. It's also easy to adjust for the structural density and all those things.

Every bridge deck has its unique dynamic behaviour, so it's quite easy to hone in on the dynamic properties of that particular section. That improves the accuracy of the model in terms of dynamic behaviour. It's quite advanced in that regard. This helps expedite the process of actually setting up the dynamic model. It reduces the lead time and obviously the cost associated with the test. There's a lot of benefits from having such an advanced test rig.

Is this for things like that famous footage of the Tacoma Narrows Bridge in America?

That is essentially what we're talking about. There's the inherent instability, which is what happened there. We need to test first for instabilities in lift and torsion before we can determine the overall wind loads. It's the aerodynamic stability which is probably the most crucial in terms of the design, and that may lead to the need to refine the design. Once we've eliminated that risk, we then go in and do a static test to get the right combinations of torsion, lift, and drag using the static section model. The first step is to do the check on aerodynamic stability for the particular deck section.

Is a tunnel the only way to do that?

At the moment, yes. There are some applications with computational fluid dynamics (CFD) software. Provided it's set up properly with dense enough meshing and so on, you can use CFD as a good tool for a parametric comparison between different designs and try to have a good starting point before you embark on physical modelling.

> *"It's the aerodynamic stability which is probably the most crucial in terms of the design."*

There are significant inherent inaccuracies with CFD. Because of the fact that wind tunnel testing is still the only method that has stood the test of time and has been verified against field observations for many years, it's still the only way to do your final test, at least for the final design.

What are the inherent inaccuracies for bridges with CFD?

It's still a developing field and CFD's strength lies mostly in modelling internal flows in buildings. That's changing very slowly and some people are claiming that they can, with the right type of turbulence models, generate reasonably good predictions.

They always come back to benchmarking against wind tunnel measurements, for example. There's a constant tendency to calibrate the turbulence models against wind tunnel results.

Do you do research here as well?

We have a fairly involved collaboration with the University of New South Wales, supervising undergraduate honours thesis students who are doing their majors in computational fluid dynamics. We're tapping into that resource to help research into different modelling techniques.

We've also come up with some designs for dampers that have never been done before, using a water-based damper system that works almost like a visco-elastic damper. For about a tenth of the price you can get a similar effect.

There is an interesting statue in your foyer. Was that very complicated to test?

That's a statue of Shiva in central India. It's 107 m high, taller than the Statue of Liberty. It's not smooth, so what happened is they actually had an artist hand carve the original model and 3D scanned it. Then they sent it to us so that we could 3D print the model and do a wind analysis. ●