November 2008

The Australasian Wind Engineer

www.awes.org

Greetings Wind Engineers to the second AWES Newsletter of the year.

Thanks to our contributors we have a diverse collection of stories, ranging from Victorian-era wind speed measurement, to modern age numerical simulations.

John Holmes has kindly contributed an interesting story on the DINES anemometer, highlighting its history and workings in the Australian meteorology field.

Matthew Glanville, one of the directors at CPP's new facility in Sydney, has contributed an article that was recently published in Civil Engineers Australia discussing CFD simulations and their use in today's wind engineering practice. In addition - following its official launch, pictures of CPP's new wind tunnel facility are also included.

Another Sydney based company, Windtech Consultants, have also been busy constructing a new wind tunnel facility, and director Tony Rofail has kindly provided some information and photographs on this.

In international news, the International Association for Wind Engineering has now implemented its new logo, and details on this and the selection process are detailed within.

Finally there is the latest info on the upcoming AWES workshop to be held in a few weeks time in Tasmania, which will be a great opportunity to discuss what has happened in the world of wind this past year.

Enjoy the read, and I'll hopefully see you in December!!

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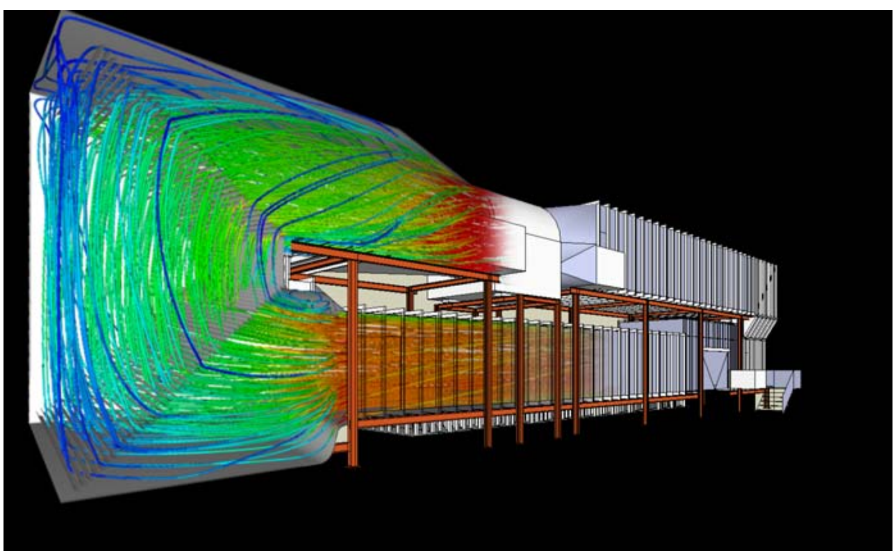


Application of CFD in the design of a wind tunnel in Sydney

AWES Workshop News

The Australasian Wind Engineering Society workshop is fast approaching!!

The 13th biennial workshop will be held in Hobart on December 4 & 5, 2008. As is traditional with these workshops all aspects of wind engineering are welcomed for presentation, with final submission of 4 page papers (following abstract submission) by November 28th.

The workshop program is single track with all presentations of 20-minute duration. A workshop dinner will be held on the Thursday evening. The School of Engineering at the University of Tasmania will host the workshop at its Sandy Bay Campus.

In conjunction with the workshop the Standards Australia wind load committee will be holding an all day meeting on Wednesday December 3 at the School of Engineering.

It is a great pleasure to have the keynote speech given by Professor Ahsan Kareem. He is the Robert M. Moran Professor of Engineering for the NatHaz Modelling Laboratory, University of Notre Dame Notre Dame, Indiana, USA. Professor Kareem will address the issue of modelling non-traditional extreme winds, including thunderstorm downbursts and their impact on the design of buildings. He will also link to issues involving climate change and wind energy.

Dines Anemometers: How Does (Did) they work?

Contributor: John Holmes

The Dines Anemometer was a remarkable piece of Victorian-era technology that has lasted over a hundred years.

Conceived in 1892 by the British meteorologist W.H. Dines, it has lasted almost without change in design for over a hundred years. It apparently was first introduced into Australia by the Bureau of Meteorology in the late 1930s at stations like Essendon and Mascot, although it had been in use for forty years in the U.K. by then. Several stations have 40-50 years of continuous record from a Dines anemometer. The instrument began to be phased out by the Bureau in about 1990, and there are now only a handful still in use in Australia – mainly located in the cyclone regions.

The Dines anemometer incorporated the concept of the pitot-static tube well before it was used in wind tunnels. Early versions had a flat pitot head (instead of spherical or ellipsoidal) and required a pressure coefficient considerably greater than 1.0. More interesting is the float system – the float drives the indicator pen to record wind speed on the paper chart, and incorporates a specially shaped buoyancy chamber that controls the float movement so that the vertical pen movement is proportional to wind velocity - not dynamic pressure. As shown in the figure, the pitot pressure is directed to the inside of the hollowed-out float and drives the float upwards as the wind velocity and the dynamic pressure increases.

In 1981 I set a student assignment at James Cook U. asking students to work out the correct shape to achieve this linearity, expecting it to take half a page. It actually took three pages of derivation, even though we neglected the volume of the pitot tube inside the float. In that case, it can be shown that the level of water outside the float stays the same during the float movement. The mass of the float is selected such that level O is at the water level (outside and inside) when there is no wind action. The sensitivity of the system (i.e. pen deflection per m/s of wind speed) is essentially determined by the float dimensions. At least three different floats, with different sensitivities, have been used in Australia.

A paper 'Wind in Britain' by E. Gold in the Quarterly Journal of the Royal Meteorological Society in 1936 (Vol.62, 167-206), describes the full theory of the float shape, and gives an early history of the installation of the Dines anemometer in the U.K. Many early wind charts are described with interesting observations on phenomena such as topographic effects, shielding and turbulence. It even shows a chart with a downburst at Cranwell, England, in 1935 (described as a 'squall'), looking very much like the many traces that have been recorded in Australia.

The Standards Committee responsible for AS/NZS1170.2 (BD006-02) has been concerned for some time about the differences in maximum gust speeds recorded by the Dines anemometers and nearby cup anemometers during the same wind event (members with long memories may recall that Greg Reardon wrote an article on this for the AWES Newsletter in 2000). The dynamics of the Dines anemometer is clearly complex with effects of the pressure tubing combined with the float dynamics. Despite the many years of use, and some empirical experimental work, there does not appear to be an adequate theory verified by experiment of the dynamics of the combined system. Some members of BD006-02 are currently trying to obtain funding for a project to investigate this aspect so the extreme gusts from past historical records can be corrected if necessary.

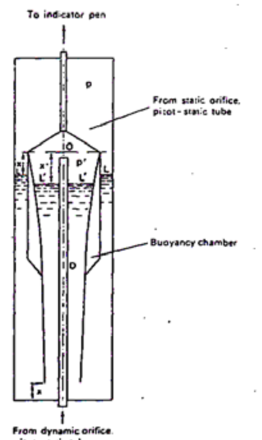


Figure 1 illustrating theory of float manometer (Dines anemometer).
p' = dynamic head and atmospheric pressure.
p = static orifice pressure, pitot-static tube.
Note. The pressure difference $p' - p$ lifts the float a distance x above the base of the container. The float buoyancy chamber is of variable section to enable a float movement which is linear with velocity and not pressure. The upper float rod drives a velocity-recording pen.

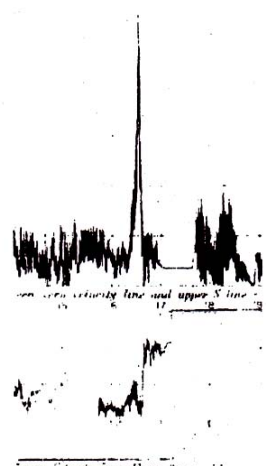


FIG. 24.—Cranwell, 14 h.-19 h., Aug. 8, 1935.

A figure from Gold's paper (1936) showing a Dines anemometer chart during a downdraft in the U.K. in 1935

IAWE Logo

In February of this year the International Association for Wind Engineering adopted it's new logo.

The IAWE LOGO project was started several years ago based on a competition among IAWE members. Prof. G. Solari, former IAWE President, made great efforts in this matter.

Several designs were proposed but none was able to get the full support of the former Executive Board, so all were rejected. Considering the necessity and urgency of having a symbol during IAWE activities, Yukio Tamura (IAWE President) supplied several options developed by a design office to the current Executive Board and asked them to select one by majority vote. The design shown below won from four options presented, and the Executive Board adopted it as the formal IAWE LOGO!

International Association for Wind Engineering

The IAWE LOGO incorporates the following meanings:

- The three ribbons of wind represent three regions: Europe & Africa; North & South America; and Asia & Oceania
- The three ribbons shape collaboration among researchers and engineers in the three regions
- The three ribbons also form a pigeon-like bird, which is a symbol of peace and safety
- The circle represents circulation of wind around the world and is also a symbol of tight collaboration among researchers in our wind engineering society

Simulating wind loads on buildings

Contributor: Matthew Glanville

In wind engineering, the wind tunnel is the traditional tool used by practitioners to understand the interaction of wind with the built environment, but computational fluid dynamics (CFD) is now perceived by some to be an alternative to wind tunnel testing. CFD is a form of finite difference simulation used to provide iterative solutions to the Navier-Stokes turbulent-flow equations along with heat transfer and material transfer equations.

CFD requires specialised software, significant processing power and trained specialists to run. Once the hardware and software are in place, the specialists recreate the environment and conditions to be tested. Running a CFD simulation can often take several days, depending on the number and power of processors used.

So what are suitable applications of CFD in building design, and how close is CFD to replacing wind tunnel testing of building structures, where peak responses are of most interest? The answer lies in our current understanding of a phenomenon that is part of our daily lives – turbulence. From the wind blowing across our cities to the blood pulsing through our major veins and arteries, practically all real fluid flows contain some degree of turbulence. Turbulence remains, to paraphrase Einstein, the most challenging unsolved problem of classical physics.

CFD has been shown to be most effective in building design applications where the level of turbulence is low and predicted levels of turbulence intensity are of less interest in gross flow predictions. CFD is particularly useful for many bounded flow applications such as air movement and natural ventilation where the wind tunnel has limitations with respect to viscous effects. Air conditioning performance is well suited to CFD simulation as a predictor for air distributions within enclosed building spacers between diffusers and return air where turbulence scales are low. Smoke dispersion under fire simulation and indoor pollution dispersion studies are applications where thermal stratification within the building space is a critical parameter well suited to CFD simulation.

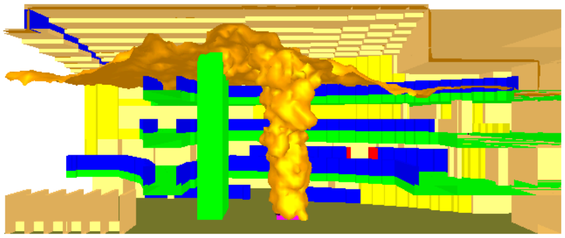
CFD has potential application for outdoor environmental gross flows around buildings where the mean component of the wind is of most interest provided the limitations of the output are properly understood and applied judiciously. For flows through buildings such as open-sided parking structures or natural-ventilation green buildings, the results from the wind tunnel can be used to determine the input boundary conditions for the CFD model.

Mean flows interacting with the exterior surfaces of the building however are influenced by the mechanical turbulence created by the highly complex separation and reattachment process, and are not reliably predicted by CFD. In typical atmospheric flows turbulence levels are high and add another 50% - 200% to the mean load component to produce the design peak load. In dynamically sensitive structures turbulence is the critical load component activating dynamic response, such as wind induced resonant accelerations in slender high-rise towers leading to motion sickness in some cases.

Turbulence in atmospheric flows impart complex and fluctuating loads on buildings that are computationally exhaustive even for simple and exposed geometries. In such cases, CFD predictions vary significantly depending on the input assumptions; such as the turbulence modelling algorithm and mesh geometry. An experienced operator is essential for the correct use of CFD on bluff bodies.

Contemporary research in wind engineering is focussed on benchmarking CFD results against wind tunnel of full-scale measurements. To date there have been four international symposia dedicated specifically to the use of CFD in wind engineering and there is yet to be a consensus on a standard set of modelling assumptions to be employed in research, let along the design office. Certainly there is no CFD quality assurance standard available to the practitioner and CFD is not listed as a suitable method of wind load prediction in any international standard, including AS/NZS1170.2.

At the most recent international conference in wind engineering held in Cairns this year, approximately 20 of nearly 300 papers related to CFD predictions of wind loads on buildings. At an academic level the limitations of CFD are well known and current research continues to rely on the wind tunnel and some well controlled full scale data as the only reliable method for assessing peak wind loads. To assess structural or cladding peak wind loads on a building exclusively using CFD in the design office would be irresponsible.



A smoke control simulation

Wind tunnel news

As many of you would know, CPP has now opened their laboratory in Sydney, with AWES members Graeme Wood and Matthew Glanville at the helm as directors. The image below has been provided to show the installation of their wind tunnel – obviously not as easy as installing a desk fan!

CPP's Wind Tunnel Fan being delivered to their new Sydney facility

In addition, Windtech have recently upgraded their capabilities with the construction and installation of a new wind tunnel at their facility in Sydney.

Contributor: Tony Rofail

WINDTECH's second wind tunnel facility incorporates a larger fan and test section than the first wind tunnel. Even with the larger test section, a higher maximum wind speed can be achieved. All components are made in Australia, from the fan to the turntable. The fan weighs 7tonnes and is approximately 4m in height, width and length. A specially modified centrifugal fan design was used to provide the most efficient output possible and to minimise energy consumption. The fan uses less than half the power used by other fans with the same output, as in the case of axial fans. The wind tunnel chamber consists of components bolted together and is designed so that it is fully demountable using semi-trailers, without the need for cranes or forklifts.

A model in Windtech's second wind tunnel facility

Upcoming Conferences

AWES Workshop: School of Engineering, University of Tasmania, December 4 – 5, 2008

Cooperative Actions for Disaster Risk Reduction (*CADRR*): The 4th International Symposium "Wind Effects on Buildings and Urban Environment", March 4 - 6, 2009, U-Thant Hall & Elizabeth Rose Hall, UN University, Tokyo, Japan http://www.wind.arch.t-kougei.ac.jp/ISWE4/index.html

ACWE11: 11th Americas Conference on Wind Engineering, San Juan, Puerto Rico June 22-26, 2009, www.pupr.edu/11acwe

UKWES Conference: Proceedings are now available to download from: http://131.227.181.10/~xarobins/Teaching/WES

Well, that's it for this edition of the AWES Newsletter.

As always, a newsletter cannot exist without news, so any stories, photos or information on upcoming events will always be appreciated.

Cheers,

Leighton Aurelius
AWES Newsletter Editor.

The Australasian Wind Engineering Society

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