The Australasian Wind Engineer

www.awes.org

Greetings Wind Engineers to the first AWES Newsletter of the year!

And I can assure you folks, it has been worth the wait! Our contributors have sent through some fantastic stories and photos of what has been happening both here and abroad in the world of wind engineering.

We have some news about the second amendment to AS/NZS1170.2, a great story *Dropwindsonde* profiles in Hurricanes, news from the High Performance Yacht Design conference, and information on the new research work being conducted by some of our members on "Design certainty for wind performance of multi-storey buildings".

In addition, Richard Flay has provided an in-depth look at his recent sabbatical leave in Valencia, showing it's not just hard work when you're working with the Weather Team for the Alinghi syndicate!

We also have the usual bits of information about people, upcoming conferences and some information on new wind tunnels in the Australasia region.

Finally, the 12th International Conference on Wind Engineering in Cairns is just around the corner, and I'm sure all our members are looking forward to the chance to catch up, take in the sun, and put on a great conference for the international wind engineering community.

See you in Cairns!

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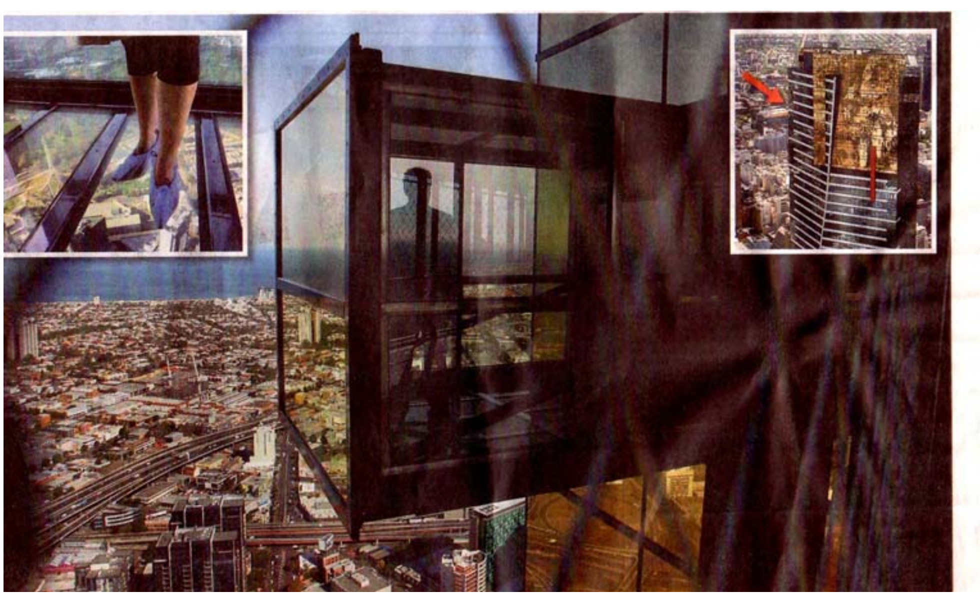


"The Edge", a six tonne glass cube that juts out from the 88th storey of the 92-storey Eureka Tower, 285m. Patrons can view the Melbourne skyline all year round, except when winds exceed 70km/hr.

AS/NZS 1170.2 News

Contributor: John Holmes

Subcommittee BD006-02 of Standards Australia/Standards New Zealand has been working steadily since mid-2005 on a second Amendment to AS/NZS1170.2 - Wind Actions. Matters resolved, or under consideration, include:

- The Action Combination Factor, K_c. Since its introduction in the 2002 Standard, the K_c factor has been a little controversial, due to some problems with the definition of 'surface', and some ambiguity with Table 5.5. A revised section, that will hopefully resolve these problems, has been drafted.

- Following observations of many structural failures in extreme wind events initiated by door failures – particularly roller doors, Section 5.3.2 concerning assumptions about dominant openings will be 'tightened' – essentially requiring door openings to be treated as such for the calculation of internal pressure.

- The local pressure factors for small areas of cladding at the corners of roofs will be increased, following the observations of very high local pressures in full-scale measurements in Texas.

- Pressures on internal partitions, including inter-tenancy walls, have been extensively discussed, following numerous requests for information from users of the Standard. Most likely information will be provided in the Commentary in the first instance.

- Structural damping. It has been noted that the damping specified in AS/NZS1170.2 for dynamic response, for ultimate limit states design, is significantly higher than in other major standards, particularly for reinforced concrete buildings. The sub-committee has resolved that structural damping should not be specified in the Standard, but advisory information will be incorporated into the Commentary. Existing knowledge is being reviewed before re-drafting the Commentary clauses; however, designers may use data from any source in preference to that given in the Commentary.

The Amendment will also incorporate a large number of minor changes, including some typographical errors. However, if past history is any guide, it could be up to two years after drafting by BD006-02, before Amendment No. 2 is finally accepted by the higher Standards committees, and for the Building Codes of Australia and New Zealand.

High Performance Yacht Design Conference

Contributor: Richard Flay

The Second High Performance Yacht Design Conference was held at the University of Auckland on 14-16 February 2006, organised by the NZ branch of the Royal Institution of Naval Architects, and the Yacht Research Unit at University of Auckland. This conference was very successful, like the first, and is regarded as the best technical conference on this subject in the world. Of particular interest was the special session on Canting Keels, and various design aspects thereof. This was of current interest as the Volvo Ocean Race 2005 – 2006 was underway, and many of the yachts had suffered various kinds of structural and hydraulic failures related to their canting keels. The Third conference in this series is planned for December 2008 at The University of Auckland, and will be chaired by David Le Pelley.

Dropwindsonde Profiles in Hurricanes and Engineering Applications

Contributor: John Holmes

Since 1997 the National Oceanic and Atmospheric Administration (NOAA) and the U.S. Air Force have been deploying GPS-based dropwindsondes (or 'dropsondes') into hurricanes in the Atlantic and eastern North Pacific oceans. These have generated vertical profiles of wind and thermodynamic parameters from flight level (typically about 300 metres) down to sea level. It should be noted that dropwindsondes are not normally deployed over land.

A dropwindsonde consists of a small cylindrical probe containing GPS equipment, and other sensors, attached by a length of cord to a square cone plastic parachute. The latter keeps the cylinder approximately vertical and slows the vertical fall velocity component. Typical deployments last about seven minutes for the sonde to fall from the flight-level height of about 3000m to the surface. Horizontally, it rapidly reaches the local horizontal wind speed, and adjusts to the generally lower values at lower heights.

One of the main purposes of the dropsonde deployments is to obtain an average ratio between surface (10 metres) and flight level (nominally 1-minute) wind speeds for forecasting purposes in the U.S. Wind profiles have been averaged separately for the eyewalls of hurricanes, and for the outer vortex regions.

In a well-known paper in 'Nature' in 2003[1], Powell *et al* analysed the data and fitted logarithmic profiles for various speed ranges. In contradiction to previous extrapolations for wind over the ocean, they found that the surface drag coefficient and roughness length did not continue to increase beyond U_{10} equal to 30 m/s, in fact, the roughness length decreased from about 3 mm to 1mm between 33 and 50 m/s.

Nature of dropwindsonde profiles

The horizontal wind speed is determined from the position of the sonde sampled every 0.5 seconds, and assuming that the sonde is travelling at the wind speed. However, corrections are made based on the horizontal and vertical accelerations.

Since the probes translate circumferentially through the hurricane, as well as fall vertically, the individual dropwindsonde profiles reflect the larger scale turbulent eddies. Smaller scale turbulence as would be observed by a high-response anemometer on a fixed mast, is not included due to the sampling interval, the response of the probe and its movement in 'following the eddies'. However, ensemble averaging of many individual normalized profiles should give expected mean vertical velocity profiles of horizontal velocity.

There is some debate about the validity of the corrections to the profiles when the probe horizontal speed is different to the wind speed – for example as the sonde falls it will tend to have a higher wind speed associated with a greater height. However, the corrections are already quite small, and improvements to the correction method will be unlikely to significantly change the profiles, and have negligible effect on the ensemble-averaged mean profiles.

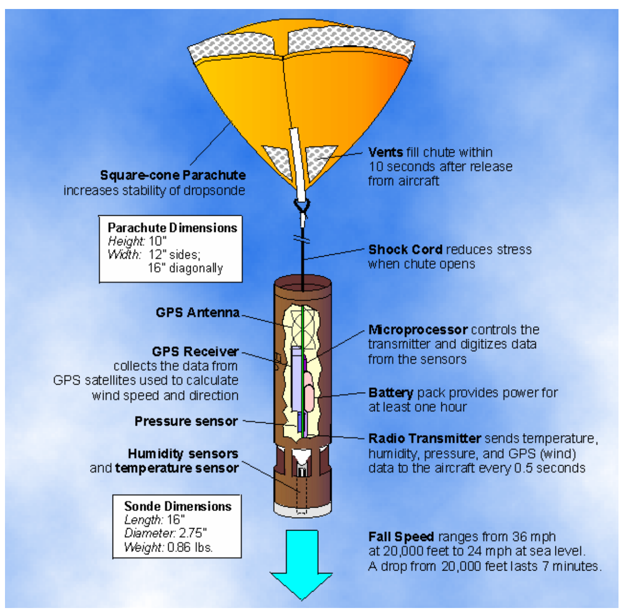
Engineering Applications

From a engineering design point of view, the analysis of dropwindsonde data near the surface has produced some significant results:

- A logarithmic law for the mean wind speed appears to hold in the eyewall region for heights above the surface up to about 3000 metres. Above that height, the rate of increase is much smaller with a maximum mean velocity at about 500 metres. Above 500 metres, the velocity falls significantly in the eyewall region.
- For mean velocities at 10 metres height above water surface of about 33 m/s, the roughness length reaches a maximum value of about 3 mm, *falling* to 1 mm for velocities of 50 m/s.

The values of roughness length found are significantly lower than those currently used for design of buildings for off-water winds from hurricanes or tropical cyclones.

Since dropwindsondes are only deployed over the ocean, there are no profiles available for wind over land from hurricanes, as required for the design of most structures. It also should be noted that the dropwindsonde profiles do not give any useful information on turbulence intensities, and hence on peak gust envelope profiles as used in many design codes or standards, (such as ASCE 7 or AS/NZS1170.2). However it would not be expected that the latter would differ significantly from the mean velocity profiles.



The Australia / New Zealand Standard AS/NZS1170.2 since 1989 has had a gust profile for cyclonic regions based on measured tropical cyclone data from the late 1970s and early 1980s from the NW Cape mast near Exmouth Western Australia. These showed a sharp increase in wind speed from the lowest anemometer (9 m height) to about 100 metres, and then relatively uniform wind speeds to the highest anemometer on the mast. These profiles differ considerably from those measured by the dropwindsondes. It is possible that the lowest anemometer reading from the NW Cape mast was influenced by the inner boundary layer as the surface changed from water to land.

The Australian Standard also assumes increasing roughness length with increasing wind speed over water – this has been shown to be an incorrect assumption over 30 m/s in hurricanes by the dropwindsonde data.

[1]M.D. Powell, P.J. Vickery and T.A. Reinhold, Reduced drag coefficient for high wind speeds in tropical cyclones, Nature, Vol. 422, pp 279-283, 20 March 2003.

Design Certainty for Wind Performance of Multi-Storey Buildings

Contributor: Richard Flay

The University of Auckland has combined forces with Opus International Consultants, Buller George Engineers, Compusoft, Steel Construction New Zealand Ltd, as well as with our friends at JDH Consulting and the Hong Kong University of Science and Technology, to apply to the NZ Government for funding to study "Design certainty for wind performance of multi-storey buildings". It is intended that this research will optimise the design of medium-rise (8–30 storey) buildings for occupant comfort against wind-induced sway, while maintaining design integrity against seismic events. By coupling the analysis of full-scale buildings with detailed wind tunnel and computer model simulations, the research programme will establish inter-relationships between wind action, building response and human comfort. The new knowledge will lead to new design methodologies and design tools to provide improved wind-design-certainty.

Our thanks to Peter Cenek and his team at Opus for preparing the grant application with a little help from us and others. Now we have our fingers crossed.

Richard Flay's Research and Study Leave

Contributor: Richard Flay

Richard Flay took his Sabbatical Leave in 2006, and spent 8 months in Valencia, Spain working in the Weather Team for the Alinghi syndicate, who are the current holders of the America's Cup. His work was measuring and analysing wind data in order to predict changes on the race course over the first leg of the race. But firstly, some remarks about Valencia.

Valencia

Paella

Valencia's traditional dish is paella, and a large dish of paella can be seen in the photo being prepared for an America's Cup party.

The reason that paella is so popular is that just south of Valencia in the park "Parc Natural De L'Albufera De Valencia" is a large shallow lake surrounded by a large region of paddy fields growing rice, so rice is common in local dishes. Apparently in Roman times, this region around L'Albufera was one of the most important food growing areas in Europe. Valencia is also known for its oranges, and certainly fresh orange juice was readily available and tasted superb.

Ciudad de las Artes y de las Ciencias (City of Arts and Sciences)

Valencia was built along the River Turia which flooded periodically. After a particularly bad flood in 1957, approval was granted for the river to be redirected around the south of the city, and this left a 7 km long dry river bed which is now called the Jardin del Turia. The city has made tremendous use of this space by building landmark buildings, many designed by the famous Spanish architect Santiago Calatrava. In addition, the river has many parks, gardens, playgrounds, sports fields, walking and cycle tracks. The Flay family lived in an apartment near the eastern end of the Jardin del Turia about 5 minutes walk from where the photo below was taken, which shows some of the buildings making up the Arts and Sciences complex. (http://www.spanish-living.com/regional/Valencia_city-of-arts-and-science.php)

More examples of Calatrava's work can be seen at this web site:

http://www.arcspace.com/architects/calatrava/camino_moreras/index.htm

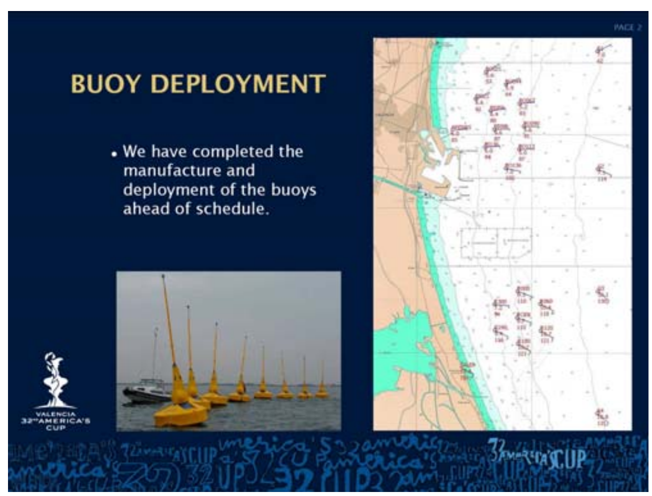
Race course wind measurements and instrumentation

In past America's Cups individual teams would spend money (in many cases over one-million euros) to gather information on the wind and waves at an America's Cup venue and then interpret it. In the 32nd America's Cup at Valencia, the Meteorological Data Service (MDS) was developed, which is a shared programme under the America's Cup Management, which collects weather data from the race course areas off Valencia and distributes it to the teams. Further details can be found at: http://www.americascup.com/en/scripts/print/popup_print.php?idRubrique=35&idContent=5229&lang=en

The MDS provides raw weather information (wind direction and speed, barometric pressure, humidity) from purpose-build weather buoys placed on the North (Romeo) and South (Juliet) race course areas. A software program developed by the MDS team displays all the data collected and shows the wind field across the race course areas. As each of the 12 teams are given the same raw data, how they process and interpret the information is where they can gain an advantage on the competition. The buoys were designed and built in-house, tailored to the exact needs of the programme. They were constructed in New Zealand, and assembled in a MDS workshop at the Club Nautico in Valencia. They gather and transmit data in real time to a central MDS server where the teams can log-on to collect the data.

A Gill Windsonic is used as the wind sensor. It measures horizontal wind components only, and has proved to be very reliable. It is attached to a pole at a height of 6 m above sea level. The buoys do not sway much due to the damping provided by lots of very heavy chain hanging from the base. An electronic compass inside the buoy measures the orientation so that the output obtained is true wind speed and true wind direction, updated at 15 second intervals. The anemometer and buoy are shown in the following photo.

There are 21 buoys deployed at locations as shown in the MDS slide below, with 10 around the north (Romeo) course to the east of Valencia, and 7 located around the South (Juliet) course. There are 4 more buoys in a north-south line further east. There is also a sensor on the breakwater at Arenas, west of the North course.



Research Project

I was able to arrange a very interesting research programme with a former student of Mechanical Engineering, Mr Jon Bilger, who is the head of the Weather Team within the Alinghi syndicate. Weather teams in yacht racing syndicates work to analyse race course wind data in order to give the sailors their best wind and weather predictions prior to the race. In the case of the America's Cup races, communication with the yacht must cease 5 minutes before the start gun is fired and so the weather team must communicate its predictions to the sailors prior to this time. My research programme was aimed at developing special tools for the weather team. The tools were computer programs which used historical wind data to attempt to predict the way the wind speed and direction could be expected to vary over the race course for the duration of the race, and particularly during the first leg, as strategically, this is the most important. This work had some parallels with my PhD research in the 1970s, where I studied wind data recorded by anemometers mounted on towers in a field in the Canterbury Plains of the South Island, except that in Valencia the data were more extensive, and the analysis process using PCs was much more convenient!

The prediction tools that I developed were tested during the racing of Acts 10, 11 and 12 in 2006, and refined by using historical data. Alinghi is regarded as having the strongest weather team of all the current America's Cup Syndicates, and I was fortunate to be able to work with experienced forecasters and meteorologists. In my work I believe that I developed a novel method to make wind predictions on a race course, and it is an area that the Yacht Research Unit can pursue further after the 32nd America's Cup is over in July 2007.

The importance of being able to predict how the wind will swing during a race cannot be overemphasised. The differences in America's Cup yacht speeds are very small and typically only of the order of metres per minute – this is why it is very hard to carry out two-boat testing, and any external perturbation can contaminate the results. Changes in wind direction can have a very large effect. Consider for example the effect of a change in the wind direction at the 275 m long start line. If the yachts start a race evenly, one at each end of the line, and then there is a 5° wind shift, one yacht will be advantaged by 24 m (about 1 boat length) a very significant margin which would take 24 minutes to make up if the trailing yacht sailed 1 m/minute faster than the leading yacht.

I did not spend much time out on the water, but the following photo shows me being groomed to be a possible substitute helmsman, in case the job is too big for Peter Holmberg or Ed Baird!

For those of you interested in the America's Cup racing, further details can be found at: http://www.americascup.com/en/

The Louis Vuitton Cup is now underway (as at 27 April 2007) with Round Robins 1 & 2 due to finish by 9 May. At the end of these round robins, 7 of the 11 challenging syndicates will be eliminated leaving the top 4, who then go into the semi-finals which are scheduled for 14 – 25 May. The Louis Vuitton Finals are scheduled for 1 – 12 June, and the winner will be the Challenger. The actual America's Cup races are scheduled for 23 June to 7 July, where the Challenger will sail against the current Cup holder Alinghi. The final races are very likely to be sailed during the 12 ICWE in Cairns later this year.

It was very invigorating to have a complete change from my normal University activities, and I would like to thank my colleagues in the Department who covered extra teaching and other duties while I was on leave, especially Peter Richards. However, now in 2007 it is his turn for leave, and I am envious that he will be spending some time in Valencia in May to watch the Louis Vuitton Cup semi-final races.

Upcoming Conferences

12th International Conference on Wind Engineering, July 1st - 6th, 2007.
Cairns, Queensland, Australia
(www.awes.org/icwe12)

People

- **Chris Letchford**

After 8 years in the US, Chris Letchford and his family are moving back to Australia in June 2007. Chris will take up the Chair of Engineering at the University of Tasmania based in Hobart. The school is much smaller (~500 students & 20 faculty) than Texas Tech (~3500 students, 120 faculty) where Chris has served the last 8 months as Senior Associate (Deputy) Dean. Although there has been no tradition of wind engineering at UTAS, Chris will join a strong fluid mechanics group. The Australian Maritime College in Launceston is also in the process of merging with the University of Tasmania and Chris looks forward to working with colleagues at that institution, particularly in his new interest of wind/wave interaction. While Hobart may be as isolated as Lubbock, it is infinitely more beautiful and there is lots of water to sail on! So AWES members, please think about attending the next Workshop in Hobart around Christmas 2008!

- **Graeme Wood**

Graeme Wood has recently left the folds of academia at the University of Sydney to take on a role as director of CPP-Sydney.

- **Matthew Glanville**

Matthew has recently been appointed a director of CPP-Sydney.

- **John Holmes**

The second edition of “Wind Loading Structures” by John Holmes is now available.

Wind Tunnel News

With the recent surge of national and international projects requiring wind engineering services, several new wind tunnels are proposed for the Australasia region.

A new wind tunnel has been completed at City University in Hong Kong, in which JDH Consulting designed.

City University Wind Tunnel, Hong Kong

The School of Mechanical Engineering at the University of Adelaide have recently commissioned a wind tunnel for both research and consultancy work.

Well, that’s it for this edition of the AWES Newsletter. Many thanks to those who contributed.

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.

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