The Australasian Wind Engineer

www.awes.org

Welcome Wind Engineers to the May 2013 edition of the AWES Newsletter.

We lead with all the details of the upcoming 16th AWES Workshop being held in Brisbane next month. Details on the Wind Loading Seminar, held in conjunction with the workshop, are also here in full.

We also have an update from Harry Fricke on the AWES working group on Pedestrian Wind Criteria, providing some insight into the challenges associated with pedestrian comfort studies.

David Henderson and Matt Mason have provided a great article on the SWIRLnet project, looking into the deployment of portable anemometers during cyclone events.

Changing roles from engineering consultancy to the review of biographies, Bill Melbourne provides an enthusiastic review of the recent Alan Davenport biography, which looks to be a great read.

Last but not least, the AWES wish to congratulate Abdulghani Mohamed (shown below with his supervisor Prof. Simon Watkins) for winning the inaugural AWES Undergraduate Thesis Prize (which is appended to this edition). This is a great award, and hopefully it encourages the younger members that with dedication and hard work, *you too* could grace the cover of this esteemed publication!

Happy Reading!

Editor: Leighton Aurelius

BMT Fluid Mechanics
Email: newsletter@awes.org

2012 AWES Undergraduate Thesis Prize winner Abdulghani Mohamed with his supervisor Prof. Simon Watkins.

16th Australasian Wind Engineering Society Workshop and Wind Loading Seminar

The 16th Australasian Wind Engineering Society Workshop will be held at the Marriott Hotel in Brisbane on July 18 & 19, 2013. As always the workshop will provide a forum for practicing engineers and academics to openly present and discuss their latest work in the field of wind engineering.

The keynote speakers for this year's workshop will be Dr Bruce Harper from GHD and Associate Professor Forrest Masters from the University of Florida. Bruce will speak about his many years of experience in wind hazard modelling and outline some best practice procedures as well as highlighting outstanding issues. Forrest will speak about work he and a number of collaborators in the US have been doing on full-scale wind field measurement, full-scale structural load testing and pioneering work on characterising wind-driven rain and resulting water ingress.

Following the success of the Wind Loading Seminar Day held in conjunction with the 15th AWES Workshop in 2012, a second Wind Loading Seminar Day will be held in association with this year's workshop. The seminar day will be run immediately preceding the workshop on July 17 at the Brisbane Marriott. This series of lectures is an ideal opportunity for practicing engineers and postgraduate students to learn more about the fundamentals of wind engineering and their application within Australian/New Zealand wind loading standards.

The speaker list is made up of both academics and consulting wind engineers, all of whom play key roles in the drafting of AS/NZS1170.2 and AS4055. These shall include, Dr John Holmes, Professor Kenny Kwok, Associate Professor John Ginger, Dr Graeme Wood and Mr Tony Rofail.

For further information on the 16th AWES Workshop of the Wind Loading Seminar Day please visit the AWES website, www.awes.org or contact:

Ms Antoinette Woods
antoinette.woods@jcu.edu.au

Dr Matthew Mason (workshop chair)
matthew.mason@mq.edu.au

KEY DATES FOR AWES16

Abstracts submissions:	NOW OPEN
Abstract submission deadline:	20th May, 2013
Registration open:	NOW OPEN
Early bird registration close:	20th May, 2013
Acceptance emailed:	12th June 2013

2012 AWES Undergraduate Thesis Prize

In 2012 AWES introduced the AWES Undergraduate Thesis Prize for Engineering students undertaking their final year thesis/project work on a topic related to wind engineering. The aim of this prize is to not only encourage undergraduate students to enter the field of wind engineering, but to recognise some of the high-quality research that is done by students at this level.

For the inaugural running of this prize, AWES was pleased to receive 10 submissions from students studying at universities across the Australia, including James Cook University, University of Sydney, Monash University, RMIT University, University of New South Wales and University of Western Australia. Students were required to submit a three-page summary of their work, highlighting research methodologies and final outcomes.

Across the board the quality of entries was high, but the judging panel, made up of four AWES Life Members, finally awarded the prize to Mr Abdulghani Mohamed (RMIT) for his thesis "A numerical analysis of the updraft over a building model". The AWES would like to congratulate Mr Mohamed for his achievement. We are also pleased to note that Mr Mohamed is continuing this research and has recently begun doctoral studies at RMIT. The winning submission is appended in full to the end of this newsletter.

The AWES will again offer an Undergraduate Thesis Prize in 2013 and encourages all undergraduate students in the Australasian region working on wind engineering theses to submit an application. We also encourage all supervisors mentoring eligible undergraduate students to alert them to this prize and encourage them to make a submission.

Based on feedback received after the 2012 prize, a slightly revised format will be followed this year, with students now required to submit a five page summary of their work as well as a short statement summarising how their work builds upon existing wind engineering knowledge. More information about the 2013 prize can be found on the AWES Prizes webpage – visit http://www.awes.org/prizes/ for further details.

Pedestrian Wind Criteria Working Group Update

Contributor: Harry Fricke

"Pedestrian wind effects" is perhaps often regarded as a "soft science" amongst wind engineers. From the outside it appears to involve human subjective experience, people's feelings and other such trivialities that we engineers tend to shy away from and perhaps regard as not "real" engineering.

We make sure buildings stay upright, enormous bridges are stable, roofs stay put and people are safe in their homes when they retreat from the weather – a noble cause indeed.

But once we have ensured the safety of our buildings in extreme winds, the public's experience of the buildings we help to build is heavily influenced by the daily wind environment around those buildings. Calm, sunlit outdoor environments attract people and this is every building designer's dream; for their work to be enjoyed and even loved by the public. Wind engineers can help a great deal to make good designs in this regard but I have become convinced we face some problems, and they are centred on the choice and application of criteria.

The first problem is the various pedestrian wind criteria do not agree completely. Whilst there is some agreement between many of the well-known criteria under certain flow conditions (for example Bill Melbourne showed there was good agreement in low turbulence amongst several sets of criteria in his 1978 paper), there is definitely no universal agreement across a wide range of wind flow scenarios.

The second problem is there is no agreement amongst consultants on which criteria are to be used. Even on the question of acceptable winds for public safety we, as a profession, do not have a united, consistent opinion. I have seen examples of building designers getting markedly different opinions on this fundamental question depending on who they approach.

The lack of a consistent position leads to a loss of faith in our profession. If we are ambiguous on the important question of what winds knock people over we end up marginalising ourselves from the design and planning process.

How did I come to this conclusion?

There aren't that many wind engineering businesses in Australia, however, since my wind engineering career began, I seem to have contrived to have worked for four of them and reviewed the work of two others in my various roles. I have seen for myself there is not consistency amongst the various consultancies in terms of use of pedestrian safety criteria.

I know virtually all Australian wind engineering consultants (myself included) have criteria they have come to rely on. We have some understandings of what wind conditions would be acceptable for certain activities but opinions vary on what is safe for pedestrians, let alone what is comfortable.

What should be done?

As a first step, I believe we should, as a profession, agree on what constitutes *safe* conditions for the general public.

Comfort is another issue altogether, affected by temperature, sunlight etc. Safety is purely a wind speed and frequency related question and we should be able to agree on a value.

Should the planning authorities set the criteria?

Some planning authorities do specify criteria (e.g. Auckland, Wellington and Sydney City Councils) but these are rare and when they do exist they are often poorly defined – no return periods, no mention of gust or mean let alone gust durations!

Planning authorities set requirements based on advice from the relevant peak bodies. In the case of wind, that's us. So it's up to us to advise a suitable criterion.

Most wind consultants have a minimum criterion for general footpath areas. They apply this in the event that the planning authority has no specified criteria (usually the case) and the developer is proposing a development which is generating high wind conditions and they don't want to change the design.

This minimum criterion that all of us working in this field have, and beyond which we indicate the design needs to return to the drawing board, is usually an exceedence of one of the various safety criteria. My main aim at the moment is to achieve consistency in this minimum criterion.

So what is AWES doing about this?

From mid-October to mid-December last year a discussion was held on the social-media website "Linkedin" where AWES has a group forum.

A number of stakeholders were invited to participate in the discussion. Participants mostly consisted of Australian and New Zealand wind engineering consultants. The discussion was open to the public and a number of people joined during the discussion.

The participants were invited to consider themselves as an AWES Working Group with myself as the Chair.

The Working Group agreed AWES should provide a guidelines document recommending a minimum criterion for public safety. A draft will be available for review by AWES members by May 2013.

SWIRLnet - Portable Anemometers to improve knowledge on cyclonic wind speeds impacting our communities

Contributor: David Henderson and Matt Mason

Existing wind speed measuring systems are sparse in tropical regions of Australia. Less than 2% of tropical cyclones making landfall in Australia have crossed where there is a capability to measure their peak wind speeds (Harper et al, 2008). For example, there is a 200 km gap between Bureau of Meteorology anemometers in the area Cyclone Yasi made landfall and devastated communities. Gaps are greater still in lesser populated areas of coastline.

For many years post disaster damage investigations of communities across Australia have highlighted the difficulties in reliably determining peak wind speeds due to the sparse distribution of weather stations (e.g. Reardon et al., 1999; Henderson et al., 2006; Boughton et al., 2011). These investigations have typically relied upon back-calculating failure wind loads on bent simple steel structures, such as road signs, referred to as 'windicators', to estimate these gust speeds (Ginger et al., 2007).

However, accurate information on peak wind speed is important in understanding the vulnerability of housing and the effectiveness of current Standards and building regulations. More so, delays in announcing cyclonic wind speeds that impacted affected communities (or differing assessments of estimated wind speed) unfortunately promotes confusion and complacency in the building sector and public opinion.

With a grant from the Queensland Department of Community Safety and seed funding from Risk Frontiers at Macquarie University, the Cyclone Testing Station is developing a re-locatable network of anemometers for monitoring surface wind speeds during land falling tropical cyclones. And given all good observational projects need to have an acronym; the system has been named Surface Weather Information Relay and Logging Network, or SWIRLnet for short.

Initially we have developed six 3.0 m tall tripod units for deployment during the 2012/2013 season. Each unit will record and store data on wind speed, temperature, relative humidity and pressure. Each tower is built upon a custom freestanding tripod, equipped with a marine rated R.M. Young propeller anemometer, a pressure transducer, and a shrouded temperature and relative humidity sensor. Data is sampled at 10 Hz and stored on an internal CF card, with telemetry of summary data, i.e. maximum 3 second gust, 10 minute mean wind speed and direction and pressure, through a 3G modem to a dedicated JCU server every 10 minutes.

Towers were designed for rapid deployment in the 24-48 hours prior to TC landfall. Tower sighting will be determined through consultation with Bureau forecasters and local councils prior to and throughout the deployment phase. We are currently working with some Queensland councils to develop permanent fixed anchor locations embedded within populated communities.

In developing our units, we are grateful for the advice and support from John Schroeder and his team from Texas Tech University and Forrest Masters and Dave Prevatt from University of Florida. The authors are appreciative of the support for the project from the Queensland Government Department of Community Safety.

This is a significant and long term project for the Cyclone Testing Station. Anyone who feels that they can make a contribution to the success of the project is welcome to contact David Henderson on 0747814340 or david.henderson@jcu.edu.au.

Ginger, J., Henderson, D., Leitch, C. and Boughton, G., 2007. Tropical Cyclone Larry: Estimation of wind field and assessment of building damage, Australian Journal of Structural Engineering, Vol. 7, pp. 209-224.

Harper B., Stroud S., McCormack M. and West S., 2008. A review of historical tropical cyclone intensity in northwestern Australia and implications for climate change trend analysis, Australian Meteorological Magazine, 57, pp 121-141

Henderson, D. J., Ginger, J., Leitch, C., Boughton, G., and Falck, D., 2006. Tropical Cyclone Larry – Damage to buildings in the Innisfail area. TR51, CTS, JCU, Townsville, Australia.

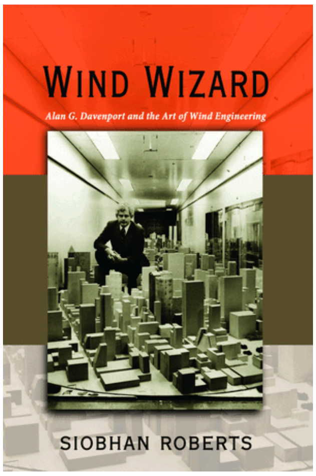
Reardon, G., Henderson, D., and Ginger, J., 1999. A structural assessment of the effects of Cyclone Vance on houses in Exmouth WA. TR48, CTS, James Cook University, Townsville, Australia.

Trial deployment in Queens Park, Townsville

Book Review: Wind Wizard

A book on Alan Davenport and the Art of Wind Engineering

Contributor: Bill Melbourne



The 'Wind Wizard' is a walk through the engineering of some of the world's most amazing structures of the last half century and the life of the man who was the primary leader of the evolution of the modern field of wind engineering to make them possible.

Alan Davenport was that man who pioneered the combining of the fields of structural dynamics, the fluid mechanics of the interaction between a turbulent fluid flow and a structure, meteorology, probabilistic descriptions of random processes and risk. Many have contributed to the parts and many are continuing, but Alan was the pioneer of putting all of these together. The field of wind engineering, embracing all the elements that Alan drew together, might reasonably be described as one of the most complex of all engineering fields.

All of this will be revealed to the reader of the 'Wind Wizard'. Siobhan Roberts has threaded through the technology to give both the lay reader and the engineer an amazing exposé of the human interactions and technology in the development of great engineering feats. The best incitement I can give to an aspiring reader is to list some of the most engaging stories in the book:

- The genesis of an idea, 'the application of Statistical Concepts to the Wind Loading of Structures'
- The World Trade Centre Towers, 'the design of the first really wind sensitive tall buildings with Les Robertson and the development of boundary layer wind tunnel testing'
- Wind speed probabilities, 'from which directions come the strongest winds and the probability of their alignment with the biggest responses'
- The Boston Hancock Tower, 'everything that could go wrong did go wrong, pressures, P-Delta, and the fallacy of ignoring turbulence in the wind tunnel modelling'
- The Citycorp Centre, New York, 'tuned mass damper, quartering winds and load combinations'
- The CN Tower, Toronto, 'world's tallest structure for many years'
- Full scale testing, 'from flat plates, to the monitoring of structures, to the Three Little Pigs Project and the start of Windee'

- The bridges longer and longer, ‘a lifelong fascination and the development of various modelling techniques’
- The 12th hole at Augusta National, ‘it is not all about structures’
- And many others too numerous to name…..

The book gives acknowledgements, as did Alan, to his many co-workers, in particular his colleagues at The Boundary Layer Wind Tunnel Laboratory, Nicholas Isyumov, Barry Vickery, Dave Surry, Peter King and Milos Novak.

Last, but by no means least, much note is given to the personal voyage of Alan’s life with his wife Sheila and family, whose lifelong support made much of the above possible, and the welcome to the legions of those who made the pilgrimage to the Boundary Layer Wind Tunnel Laboratory at the University of Western Ontario, London, Canada, to learn and enjoy.

This looks to me to be the best point on which to finish and commend the ‘Wind Wizard’ as compulsory reading for all structural and wind engineers, from students to seasoned practitioners, and anyone with an interest in the modern world’s greatest structures.

AWES Web Site

The new version of the AWES site is finally up and running! There are still a few things not up yet (e.g. workshop proceedings and image gallery) but most of the functionality is there now.

If you've forgotten, http://www.awes.org/

Member News

It is with great pleasure that the AWES committee has nominated Prof. Kenny Kwok for this year's IAWE Senior Award.

The AWES acknowledges and recognises Kenny’s continued and significant contribution to the field of wind engineering and are honoured to recommend him for this award. Best of Luck!

Well, that’s it for this edition of the AWES Newsletter. Many thanks must go to our contributors. 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.

A Numerical Analysis of the Updraft Over a Building Model

Abdulghani Mohamed* - *s3165510@student.rmit.edu.au*

Simon Watkins* - *simon@rmit.edu.au*

* *School of Aerospace, Mechanical, and Manufacturing Engineering*

INTRODUCTION

Harvesting energy from the surrounding environment offers the potential to significantly increase range and endurance of Unmanned Air Vehicles (UAVs). The possibility of using naturally occurring thermals or updrafts as an energy source to gain height remains relatively unexplored. An early encouraging study by Allen, (2005) concluded that the endurance of a representative UAV could be increased by up to 12 hours by using thermal lift. Cutler et al., (2010) presented an important study into the feasibility of energy harvesting using orographic lift during intelligence, surveillance, and reconnaissance, (ISR) missions. This study showed that when an energy source (such as a slope) is within 400 m of the target, no propulsive power was required for the selected UAV to orbit a target for ISR (the platform could maintain height using the vertical component of the flow up the slope). The complex flow patterns that occur in suburban environments are typical for UAV and Micro Aerial Vehicle (MAV) operations. These flow patterns can aid the vehicles to gain height and soar further or even recharge on-board batteries through regeneration. Understanding the flow patterns around buildings in suburban environments with particular attention to the updraft of airflow upstream of the building's roof top is therefore essential for UAV/MAV operations and energy harvesting applications.

Numeric models of the turbulent Atmospheric Boundary Layer (ABL) have been implemented for studying and analysing building envelopes, natural ventilation, wind loading, dispersion of air pollutants and other flow predictions (Tutar and Oguz, 2002). However, few if any studies have focused primarily on updrafts over rooftops. Most numerical studies focused on the general flow around single building models (Baskaran and Stathopoulos, 1989; Stathopoulos and Zhou, 1993; Paterson and Apelt, 1990) where the standard k-ε viscous turbulence model was implemented. Murakami et al, (1990, 1993); He and Song, (1992) used the Large Eddy Simulation approach. From these studies, the LES model seems to accurately predict the flow behavior compared to the other models. Hence, to develop an understanding of the energy potentially available near the tops of buildings for endurance extension through soaring, velocity magnitudes have been mapped in the region where updrafts are expected. Characterization of this updraft field provides an indication of the energy availability for harvesting and inform UAV/MAV configuration and design.

METHODOLOGY

The representative building selected for the study presented in this paper is Building 201, (43 meters high and 38 meters wide) of RMIT University's Bundoora Campus (Melbourne Australia). The buildings' unique position and environment matched the topography of a suburban terrain. In a separate paper by White et al., (2011) a 1/100th scale model of Building 201 was used for wind-tunnel testing and the results were validated by measurement from the roof of the actual building. The data from the wind-tunnel study are used for validation of the CFD results. The numerical study was conducted in 2D as a steady state problem, which then evolved into a transient 3D study. The 2D study allowed careful inspection of grid performance and domain size, which provides a basis for the 3D study. The 2D study has been simulated using the standard k-ε model with enhanced wall treatment, while the 3D study used the Large Eddy Simulation approach using the Smagorinsky-Lilly model for sub-grid scale. 2D analysis has some inherent limitations where the 3D effects are neglected assuming the cross section being analysed is infinitely wide. This results in some inaccuracy of the results since the flow around the building is expected to be highly three-dimensional. The setup and construction of the computational model is outlined by Mohamed et al., (2012a, 2012b).

RESULTS AND DISCUSSIONS

Two-dimensional Results

The flow features of the simulation show agreement with predicted behavior and work previously published by researchers. Please note that all the presented results are normalised to the buildings reference height, H_b. Consequently the scales of the contours can be viewed as velocity ratios to the wind speed at H_b. As predicted, the updraft region contains the highest magnitude of velocity. The y-axis velocity contour shows the y component of the flow's velocity near the rooftop. With the zero velocity clearly identified on the contour, it can be seen where there are updrafts and down-drafts. Regions with strong updrafts are clearly visible in Figure 1, which represent a region of interest for UAV/MAV flight.

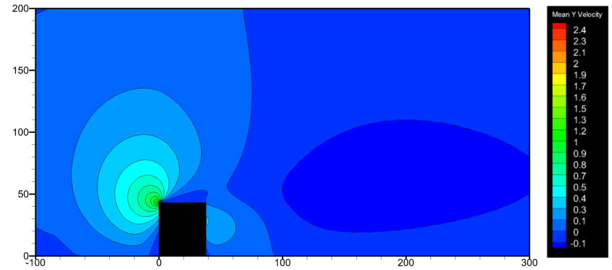


Figure 1. 2D averaged y-velocity contours in ms^{-1}

Three-dimensional Results

The flow features of the 3D simulation also show agreement with the work previously published by researchers, as the basic flow features were replicated. As predicted, the updraft region contains the highest magnitude of vertical velocity at the roofs edge. Figure 2 shows the velocity contours. It's important to note that the contours are positioned on the lateral center of the building (i.e. at z = 0). In order to visualize the 3-Dimensionality of the updraft region and its core strength, an iso-surface was created showing 4 different core intensities (see figure 3).

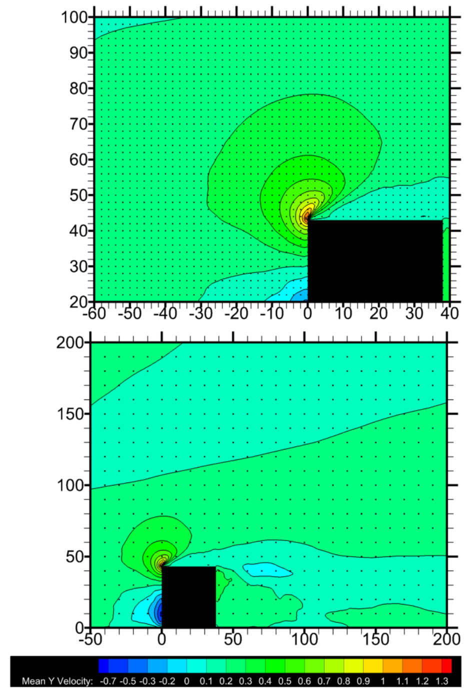


Figure 2. 3D mean vertical velocity contours.

Wind-tunnel Comparison

The same building geometry was tested in the wind tunnel at 1/100th scale with similar velocity and turbulence intensity profiles as presented by White et al., (2011). The wind-tunnel experiment used cobra probes to measure the velocity vectors in a spacial matrix in the vicinity of the building's rooftop. The same matrix was created in the domain of the numeric study for vector magnitude and direction comparison as illustrated in figure 4. Both sets of results presented have been normalised to H_b.

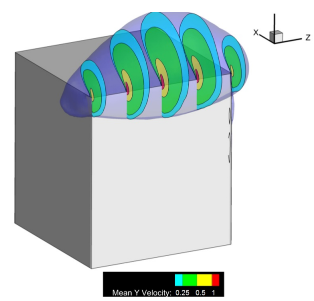


Figure 3. Iso-Surface showing 3 levels of mean vertical velocity.

It was observed that for the majority of the results, the difference was below 20%. This difference was expected because of a number of reasons. The velocity profile tested in the wind tunnel had a slightly varied shape compared with the theoretical profile used by the numerical analysis. The variation was also partially due to the roughness elements installed in the wind-tunnel to replicate the ABL. The wake from those roughness elements also affected the stagnation location on the face of the building as observed from figure 4, where the vectors at a height of 34.5m show almost stagnant flow in the case of the experimental results. Even the simulated Reynolds Number tested in the wind-tunnel was different, further contributing to the variation of results. The magnitude of the vectors is also different because the free stream velocity was about 3 times higher in the wind-tunnel experiment, which will also affect the flow angle upstream. Difficulties in numerical simulation of turbulent flow around buildings is another contributing factor.

CONCLUSIONS

The CFD model has accurately represented the flow behaviors as previously published. The 3D analysis showed significant vortex shedding and highly turbulent flow entering the domain which was a phenomenon that wasn't captured by the 2D case. When comparing results it is evident that the 2D case over-predicted the updraft region while the 3D case provided results more representative of those obtained from wind-tunnel testing. The LES approach gave reliable results compared with the *k-ε* model. It is hence a recommendation for further progress, that a finer mesh resolution should be used to improve the LES results in addition to testing various building configurations.

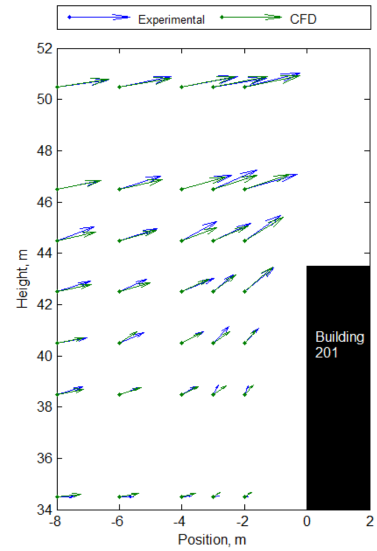


Figure 4. Velocity vector comparison.

REFERENCES

Allen, M. J. (2005), *Autonomous soaring for improved endurance of a small uninhabited air vehicle*, AIAA No. 2005-1025

Baskaran A., Stathopoulos T. (1989), *Computational evaluation of wind effects on buildings*, Building Environment 24: 325-333.

Cutler M. J., McLain T. W., Beard R. W., Capozzi B. (2010), *Energy harvesting and mission effectiveness for small unmanned aircraft*, AIAA

He J., Song C. C. S. (1992), *Computation of turbulent shear flow over surface mounted obstacle*, ASCE Journal of Engineering Mechanics

Mohamed, A., White, C., & Watkins, S. (2012a), *A numerical study of the updrafts over a building, with comparison to wind-tunnel results*, 15th Australasian Wind Engineering Society Workshop. Sydney, Australia, 23-24 February, 2012

Mohamed, A., White, C., Watkins, S. and Carrese, R. (2012b), *Energy harvesting from updraft over buildings by micro aerial vehicles*, Journal of Wind Engineering and Industrial Aerodynamics. (Submitted for Publication)

Murakami S. (1993), *Comparison of various turbulence models applied to bluff body*, Journal of Wind Engineering and Industrial Aerodynamics

Murakami S., Mochida A. (1990), *A 3-D numerical simulation of air flow around a cubic model by means of the k-ε model*, Journal of Wind Engineering and Industrial Aerodynamics

Paterson D. A., Apelt C. J. (1990), *Simulation of flow past a cube in a turbulent boundary layer*, Journal of Wind Engineering and Industrial Aerodynamics

Stathopoulos T., Zhou Y. S. (1993), *Numerical simulation of wind-induced pressures on buildings of various geometries*, Journal of Wind Engineering and Industrial Aerodynamics

Tutar M., Oguz G. (2002), *Large eddy simulation of wind flow around parallel buildings with varying configurations*, Fluid Dynamics Research.

White C., Lim E. W., Watkins S., Mohamed A., Thompson M. (2011), *A feasibility study of micro air vehicles soaring tall buildings*, Journal of Wind Engineering and Industrial Aerodynamics 103: 41-49.