17th Australasian Wind Engineering Society Workshop
Wellington, New Zealand
12-13 February, 2015

Bringing Wind Engineering Research into Practice – Does it need to Take Forever?

W.L. Coulbourne[1]

[1]Applied Technology Council
Wind and Flood Hazard Mitigation
Rehoboth Beach, Delaware, USA

Abstract

There is a lot of new information being learned in university laboratories and in the field labs provided to us by natural hazard events. That new information, if valuable to the practitioner, must one day be turned into engineering methods and practices that can be used to improve the buildings we design and build. However, if the normal processes of study, idea refinement, debate, or selective use of only part of the new information are always allowed to slowly rise to the level of importance until we decide to adopt the 'new' ideas into engineering standards or building codes, the practice loses the opportunities to improve the practices by actually using them until they are 'ready'.

Technology is changing at a very fast pace. We should harness that technology to bring important learning to the practice as rapidly as the practice can absorb the information and use it. We should take advantage of the practice testing new theories and methods while work is actually being done, yet we must also be cautious about making sure new ideas have been peer reviewed and thoroughly vetted to protect the public. This paper explores some ways to speed the pace of new idea acceptance.

Introduction

The normal way our building codes and construction practices change is when either sufficient research and study on a topic have been completed and it is believed ready to be debated and adopted for use, or when there is a catastrophe usually caused by a natural hazard, many people are killed and/or there are large property losses and the "powers at be" decide that improvements in the design and construction practices must be made to reduce those losses. The former process is lengthy; the latter process can be very short. But whichever path is taken from idea to implementation, there is almost never enough practitioner involvement thus making the transition of ideas from research to practice very uneven and incomplete. The current way we learn of change to codes and standards is in back rooms, committee meetings, side bars with colleagues, or industry announcements about upcoming changes. The code debate and adoption process is long and arduous and very few engineering or architectural professionals are involved. The outreach to the practice concerning changes to codes and standards is sporadic and is not coordinated by any particular organization. Volunteers usually offer help to put together presentations to give at conferences, or these same volunteers will contract with an organization to put together a webinar that addresses the proposed changes.

A premise

The following is my premise: the path travelled from a new design or construction idea must always go through the practitioner to be implemented – it will always speed up delivery of the idea into practice if the practitioner is part of the entire process – from idea to implementation. But how can this happen? The practitioner doesn't usually start the idea process; that is often started with a researcher at a university or non-profit (i.e. IBHS in the US). The practitioner doesn't usually present a new idea to the researcher and ask that the area be studied because the researcher needs funding to pursue the idea and the idea may or may not be part of his area of interest. Many, many research ideas come about from past research and eventually enough work is completed when the researcher determines the newly minted idea presents significant new findings – and findings that will have a dramatic effect on the way certain engineering is done.

It is very important for practitioners to understand the background behind code changes so they can be explained to clients. The US wind speed maps changed in 2010 to ultimate wind speeds representing much higher wind speeds than published in previous editions of the ASCE 7 standard. Yet with other changes to load combinations and Importance Factors, the wind pressures developed from these higher speeds were nearly the same as before. This caused confusion and made many practitioners wonder how they were going to explain this to clients (much less understand this themselves).

Examples of Practitioner Involvement

There are many examples of breakthrough ideas, but those breakthroughs took years to bring to the practice. One such example (in my mind anyway) is Building Information Modelling (BIM). It took years of both hardware and software development

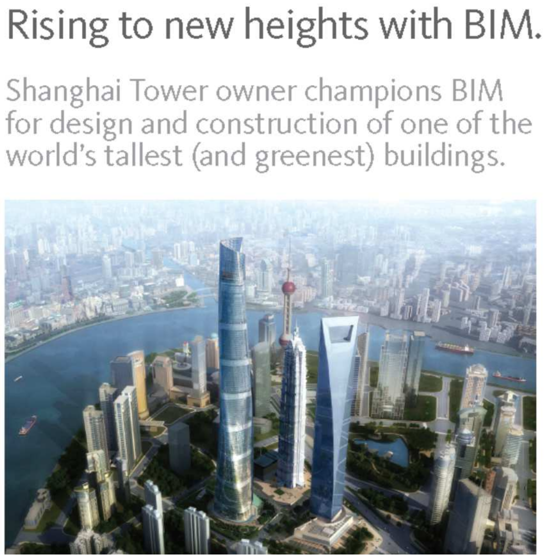

Figure 1 Illustration of a project that used BIM

to finally have a modelling tool that practitioners would use, and they would only use this tool when they saw the benefit for them – faster production, lower cost, fewer errors. Figure 1 illustrates a large project that used BIM. An example in future wind engineering might be the development of computational fluid dynamics (CFD). CFD might allow the practitioner to take a building modelled in a BIM system, and apply a wind field to the building using CFD so the structural frame could be designed as well as damping systems or torsional resistances as required for the wind speed, the exposure and the building shape. Figure 2 illustrates CFD being used to model the wind field around a race car.

The following are examples of ideas that needed to get into the market place quickly and the practice responded to those needs:

One is the development of reliable pressure coefficients to use for both roof- and ground-mounted solar panel installations. Just a few years ago, solar panels were a bit player in the energy field, now there are major installations of solar panel fields and entire roofs that are covered with them. The wind engineering industry did the testing necessary to develop pressure coefficients that anyone could use. The industry took on the work of writing engineering standards that included the pressure coefficients so there was a standard method for designing building and ground attachments for solar panel installations.

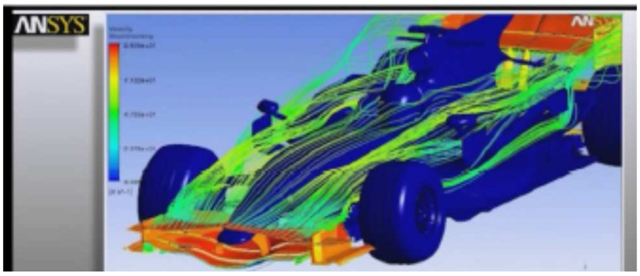

Figure 2 CFD being used to simulate flow around a race car

However, the new pressure coefficients and the standards written for their use are still several years away from being adopted by the practice and being placed in widespread use. The pressure coefficients for solar panels will be in ASCE 7-16 which is still 1-2 years away from publication and broad dissemination to the practice. The need to have this information available has been taken on in the US by the Structural Engineers Association of California (SEAOC) who have published a series of pressure coefficients to be used for solar panels that helps fill the current void for this information. The US contingent of wind engineers who conduct wind tunnel studies on solar panels (much of it proprietary) have indicated that the work of SEAOC is sound and could/should be used by the practice. However, how does a practitioner know this information is available? How does the practitioner know the data has been sufficiently peer reviewed and if there are important caveats about using the information, what those caveats are?

In the field of disaster investigations and reporting, the problem of coalescing damage information into meaningful best practices or possible building code changes is also an important activity that is not coordinated within the US practice. There are many players interested in damage investigations – some come from wind research universities, some from trade organizations, some from insurance company interests, some from federal government agencies such as the National Science Foundation (NSF), the Federal Emergency Management Agency (FEMA) and the National Institute of Standards and Technology (NIST), and some from the practice, particularly the American Society of Civil Engineers (ASCE) and the Applied Technology Council (ATC). There are so many players and interests that it is sometimes difficult to develop important best practices that can be easily articulated and understood and readily adopted into practice.

A recent example though of turning a disaster into useful design guidance comes from several US tornado events. The tornado events in 2011 and 2013 in the states of Missouri, Alabama, and Oklahoma killed over 400 people and destroyed or caused major damage to nearly 13,000 buildings. Seven of the fatalities were children killed in a school similar to that shown in Figure 3. While the news media and many others even in the engineering and construction industries think that designing to resist tornadoes is not feasible or practical, others in the profession believed that allowing our children to continue to be in harm's way of a tornado was not an acceptable solution either. So even though there has not been a significant amount of research on tornado wind effects on buildings, some important research that had been done was 'stretched' and 'stitched' into guidance that could be developed using the wind pressure equations in ASCE 7 that the practice is already using. In this case, the practice has come together to solve an important problem, and the effort largely has been led by ATC, a non-profit organization whose mission is to bring research in natural hazards to the practice.

Figure 3 Damaged school in Joplin, MO USA

Benefits of Speeding up Practitioner Involvement

In order to make changes in our approach of getting research into practice, there must be some perceived benefits. Some of those benefits might be saving lives, reducing damage from future natural hazard events, and getting input from practitioners on how to present changes to clients and colleagues, thus taking advantage of the concept of the whole is greater than the sum of the parts. Early involvement by practitioners in understanding and disseminating information about changes to the engineering standards will make transitions to those changes much easier. Speeding up the code or standards adoption process is not as important to the practice as the speed up of involvement by the practice in the creation and implementation of new ideas. There must be some restraint or caution at the same time however, since time for peer reviews and alternative ideas must be provided so future mistakes are not made because time was not adequate for full debate and comprehensive reviews. Both objectives can be achieved when the process involves the practice. The practice can start outreach early by offering webinars, workshops or seminars on important changes on the horizon for codes and standards. The results of those workshops should be published for dissemination to the practice. The technology in use today to transmit information is also rapidly changing and these changes should be explored to aid both researchers and practitioners in closing the gap in "research into practice".

In order to facilitate the various methods of outreach though, the practice needs a vehicle to participate. Likely candidates in the US are ASCE, the American Association of Wind Engineering (AAWE), or ATC. The wind engineering practice in the US needs a common voice to be able to advocate for the practice. The practice must also be open to exploring wind engineering issues around the world to determine if there is value in what other countries are doing with wind codes and standards. Staying home is too limiting and narrowing. We have a lot of work to do – there are many valuable ideas languishing in research labs and unread technical papers because we do not have a method for selecting the really good ideas to more fully explore and we do not have advocates or "champions" to push those good ideas toward use by the practice.

Conclusions

It is crucial to the practice of wind engineering (and all other technical areas) that the practice is actively involved in the development of engineering standards and codes and that changes primarily come from design lessons learned from using existing codes and standards. When there are new ideas that need to be brought to the standards or code arenas such as those presented by damage from natural hazard events, practitioners must be engaged in what ideas are important, they must weigh in on how to solve technical problems or how to improve methods currently in the standards or codes.

There are not many who would likely argue with the premise that practitioners must be engaged in the codes and standards. The question is how to accomplish this objective. One outstanding method for engaging the practice is to have an organization (or two) whose primary mission is to engage practitioners in interpreting the research of ideas and creating ways to inform the practice about those ideas. The practice must help with outreach, must teach, must test hypothesis and must always seek a balance between rapid adoption of new ideas and thorough peer review and time for vetting the ideas.

References

ANSYS, Computational Fluid Dynamics testimonial for Red Bull Racing, http://www.ansys.com/Products/Simulation+Technology/Fluid+Dynamics, 2015

Autodesk Consulting, Shanghai Tower example of using BIM, http://usa.autodesk.com/adsk/servlet/item?siteID=123112&id=19229418&linkID=14963435, 2015

Prevatt, D., Coulbourne, W., Graettinger, A., Pei, S., Gupta, R., Grau, D. (2013) Joplin, Missouri, Tornado of May 22, 2011, Structural Damage Survey and Case for Tornado-Resilient Building Codes, American Society of Civil Engineers (ASCE), Reston, VA, USA