Sustainability briefing

Climate change and wind speeds

With basic wind speeds for conventional buildings in Saint Lucia increasing by about 12-14% with a corresponding 25-30% increase in forces, national codes are being revised. This raises the question of whether national codes in other countries may be based on out-of-date wind speeds

Meteorological hazards and long-term sustainability

The principal meteorological hazards in tropical and sub-tropical regions are high winds, rainfall, wind-driven waves and storm surge. The hazards of waves and storm surge are related to wind speeds. With increases in speeds it is reasonable to conclude that waves and storm surge will pose more intense threats in coming years. These threats will be further amplified by rising sea levels. Most of the economic activities of many tropical islands are located in coastal areas. Therefore the issues of global warming, rising sea levels, increased wave energy, more severe storm surge and increased wind speeds are of critical importance to the long-term sustainability of the economies of such regions. As a consequence, structural engineers living and working on projects in such regions, have a vested interest in all efforts worldwide to mitigate anthropological-induced climate change. Torrential rains may be affected by climate change. However, this issue is not associated with wind speeds.

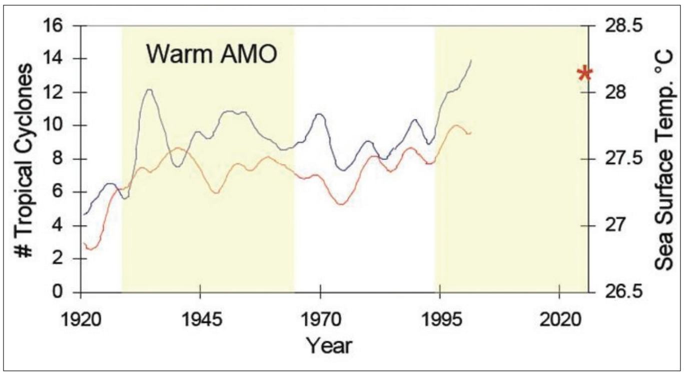
Reference is made to the UK's Technology Strategy Board report 'Design for Future Climate – opportunities for adaptation in the built environment'[1]. In it is mentioned the Association of British Insurers recommendation that design codes for buildings in the south east of the UK should incorporate increased wind speeds, although the document indicates that the effect of climate change on future wind loading is unclear.

Climate change

Hurricane Catarina made landfall in the north of Brazil on 27 March 2004. This was the first hurricane ever recorded in the South Atlantic. Hurricane Ivan struck the island of Grenada on 7 September 2004 with peak gust winds of 135mph (60ms^{-1}). According to the USA National Hurricane Centre, Ivan was '... the most intense hurricane ever recorded so close to the equator in the North Atlantic'. On 30 August 2008 a new world surface wind gust record for hurricanes was registered at the Paso Real de San Diego meteorological station in Pinar del Rio (Cuba) during Hurricane Gustav. The Dines pressure tube anemometer recorded a gust of 211mph (94ms^{-1}). Are these isolated incidents or portents of future climate?

In 2008 the World Bank funded a multi-faceted project of which one component was the investigation of the possible effects of climate change on wind speeds for structural design in the island of St Lucia in the Eastern Caribbean. The project was executed by the Caribbean Community Centre for Climate Change and the actual work was done by the International Code Council (a wholly USA organisation) using the services of Georgia Institute of Technology (principal researchers Judith Curry and Peter Webster), Applied Research Associates Inc (principal researcher Dr Peter J. Vickery) and Tony Gibbs.

Hurricane activity in the North Atlantic (including the Caribbean) follows multi-decadal cycles. The current warm phase of the Atlantic multi-decadal oscillation is expected to extend to the year 2025. By that time it is expected that the sea-surface temperatures would have risen by 1°F (0.56°C). The region experiences historically more hurricanes, and more severe hurricanes, during warm phases of Atlantic multi-decadal oscillations.



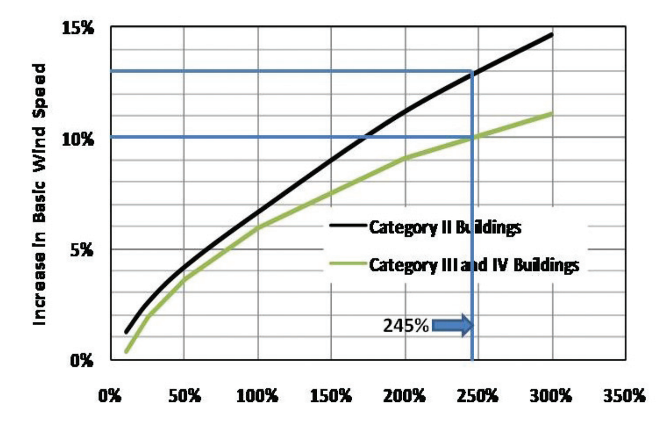
1 **North Atlantic Tropical Cyclones & SST – Decadal scale variations: 9-yr Hamming filter.** ***(Courtesy of Judith Curry, Georgia Institute of Technology)***

The number of tropical cyclones in the North Atlantic have averaged 10/year in the past 50 years and 14/year in the past decade, see Fig 1. This is projected to rise to 15-20/year by 2025. The combination of greenhouse warming and natural cyclical variability of the climate will produce unprecedented tropical cyclone activity in the coming decades.

Historical background

During the past 50 years, the evolution of wind speeds for structural design in the Commonwealth Caribbean (which consists of 17 former ((and current)) British colonies in the Caribbean) is as follows:

- Early 1960s – CP3: Chapter V: Part 2:1952 (This did not address hurricane force winds)
- Mid to late 1960s – South Florida Building Code (The procedures were very elementary.)
- 1970 – the first Council of Caribbean Engineering Organisations (CCEO) standard. (This followed the philosophy of the then yet-to-be published CP3: Chapter V: Part 2: 1972. The meteorological work was done by Harold C Shellard, formerly of the UK Meteorological Office and attached to the Caribbean Meteorological Institute 1967-70.)
- 1981 – Revision of the CCEO standard (It has since been adopted as the Barbados standard BNS CP28. The meteorological work was done by Basil Rocheford of the Caribbean Meteorological Institute (now Caribbean Institute for Meteorology and Hydrology).)
- 1985 – Caribbean Uniform Building Code (CUBiC) Part 2: Section 2 (The meteorological work was done by Alan Davenport, Dr David Surry and Dr Peter Giorgiou of the



2 Percentage increase in basic wind speed in St. Lucia vs. percentage increase in annual rates of Category 4 and 5 hurricanes. Based on work of Dr Peter Vickery of Applied Research Associates

Boundary Layer Wind Tunnel Laboratory, University of Western Ontario.)

- 2008 – Caribbean Basin Wind Hazard Study. (The principal researcher was Peter Vickery with D Wadhera of Applied Research Associates, Inc.) Tony Gibbs was directly involved with all of the listed work from 1969-70 to the present.

Effects on wind speeds

For conventional buildings (i.e. Category II in the American Society of Civil Engineers standard ASCE 7) the proposed Caribbean standard (based on ASCE 7) will adopt a 700-year return period wind speeds and for important buildings (i.e. Categories III and IV in ASCE 7) the 1700-year return period wind speeds will be adopted. (These return periods provide 'ultimatep' or failure wind speeds.)

There could be an average of three to four Category 4 and 5 hurricanes per year by 2025 in the North Atlantic (note these categories are of the Saffir-Simpson scale for hurricanes, not to be confused with the building categories in ASCE 7). This incidence of hurricanes represents a 210 to 280% (average 245%) increase in the number of Category 4 and 5 hurricanes compared to the long-term (1944-2007) average of 1.4 Category 4 and 5 hurricanes per year. If this turns out to be the case, the basic wind speeds for conventional buildings in Saint Lucia would be increased by about 12 to 14% (25 to 30% increase in forces), and the basic wind speeds for important buildings would be increased by about 10% (21% increase in forces). See Fig 2.

Although the studies were carried out specifically for St Lucia, the results are probably valid for most of the Eastern Caribbean and are generally indicative of what is in store for much of the North Atlantic. This work carries an important message for all countries. Serious consideration should now be given to modifying wind speeds in other countries where national codes may be based on out-of-date wind figures.

References

1 Technology Strategy Board, Design for Future Climate – opportunities for adaptation in the built environment, available at: http://www.innovateuk.org/_assets/pdf/other-publications/tsb-climatechangereport-0510_final1.pdf

Further information

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