Recent Wind Engineering Developments in the Philippines: 2007-2009

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ABSTRACT: This country report describes recent developments in the field of wind engineering and disaster mitigation in the Philippines from global, national, and project perspectives. The first development is on the completion of a global risk assessment study which presents very important disaster risk exposure information on the Philippines and other, mostly Asia-Pacific countries. From a national perspective, three developments are discussed: on the update of the National Structural Code of the Philippines which embodies the governing wind loading codes in the country; on the development of visual assessment procedures for structures usually damaged by strong typhoons; and lastly, though there are no recent developments, on existing relevant local laws and regulations related to wind environmental specifications. The next development is on the completion of the St. Francis Shangri-La Place twin residential towers which use an innovative system to control both wind and seismic response. Lastly, the establishment of the Institute of Civil Engineering in the University of the Philippines, Diliman, Quezon City, where there are planned two boundary layer wind tunnel laboratories planned, is briefly discussed.

KEYWORDS: Philippines, wind loading code, visual assessment, wind response control, wind environmental regulations, wind tunnel laboratories.

1 INTRODUCTION

This country report is being presented at the 5th Workshop on Regional Harmonization of Wind Loading and Wind Environmental Specifications in Asia-Pacific Economies (APEC-WW) in Taiwan on November 12-14, 2009. It describes recent developments in the field of wind engineering and disaster mitigation in the Philippines from 2007 to the present and is meant as a continuation of the country report (Ref. 1) prepared by the same authors and presented at the 4th APEC-WW in 2007 in Shanghai, China.

2 GLOBAL TROPICAL CYCLONE RISK STUDY

The United Nations International Strategy for Disaster Reduction (UNISDR) Global Assessment Report 2009 (Ref. 2) describes natural hazards and associated risks around the world. It talks about how the Philippines would be of similar exposure to tropical cyclones such as Japan but are more at risk, and that property equivalent to nearly 20% of the Philippines' GDP are exposed to tropical cyclones yearly. A related risk mapping tool has been made freely available on the web, at http://www.preventionweb.net/english/maps/. Strategic goals have been formulated and actions prioritized for disaster reduction in many countries, including the Philippines.

3 NATIONAL WIND LOADING, WIND DISASTER MITIGATION, AND WIND ENVIRONMENTAL SPECIFICATIONS

3.1 *Update of NSCP Wind Loading Code Provisions*

3.1.1 *Background and initial activities*

Starting in 2007 (Ref. 3), the Association of Structural Engineers of the Philippines (ASEP), the group which prepares and updates the National Structural Code of the Philippines (NSCP), has started a long-term program to regularly update the NSCP to the state-of-the-art, recognizing it was time to update what is currently the 5th edition of the NSCP Volume 1 (Ref. 9), or more commonly known as NSCP 2001. This involved:

- The formation of the ASEP Codes and Standards Committee (ASEP-CSC) with members under 3-year terms for continuity over the yearly changing ASEP Board of Directors and Officers, and conducting regular monthly meetings (Ref. 3).
- The involvement of all practicing structural engineers, people in research, in the academe, and from the government, and all others involved in designing safe and economic structures, by holding forums and workshops, the first being the ASEP Forum on Loads and Actions held in December 2007 (Ref. 3).

During the December 2007 Forum, relevant presentations were made on “Disaster Mitigation and Preparedness, Typhoon Engineering, and Wind Speed Maps,” by B.M. Pacheco, and on “Wind Meteorology,” by E.L. Juanillo, to further the participants’ understanding of wind and typhoon engineering issues. (See Ref. 3.)

3.1.2 *Code basis of new NSCP wind loading provisions*

The NSCP wind loading provisions has been historically based on the Uniform Building Code (or UBC; e.g. Ref. 10) of the USA, except the most recent NSCP whose wind loading provisions are based on the ASCE7 Standard (i.e. Ref. 11).

Table 1. Code bases of the NSCP wind loading provisions

NSCP Edition	Code basis
NSCB-1972, 1977 (1st ed.)	UBC 1970
NSCB-1982 (2nd ed.)	UBC 1978
NSCP-1987 (3rd ed.)	UBC 1985
NSCP-1992 (4th ed.)	UBC 1988
NSCP-2001 (5th ed.)	ASCE7-95

It was suggested that codes from other countries are to be reviewed for suitability of use in the NSCP, but owing to the desire to have a code which “felt familiar” to structural designers who use them regularly and which was compatible with earlier versions of the NSCP, it was decided to use US-based codes again.

3.1.3 *Features and limitations of new wind loading provisions*

While the 2006 International Building Code (or IBC 2006, the successor of the UBC; Ref. 12) was considered as the model code for the updated NSCP as a whole, the ASCE/SEI 7-05 (Ref. 13) has been considered for the wind loading provisions, being a reference code of the IBC 2006. The new NSCP wind loading provisions reflect the updates to the ASCE7 Standard from the 1995 version (Ref. 11, basis of the previous NSCP edition) to the 2005 version (Ref. 13, basis for the new NSCP edition), together with a new wind speed map (see next section). The following are thus the features being considered for the new NSCP wind loading provisions (from draft version; Ref. 14):

a. New wind speed map
b. Provision for a simplified procedure for small, regular buildings
c. Reduction factor for large-volume buildings
d. Explicit definition of wind directionality factor

e. Provision of formulas for gust effect factor for both "rigid" and "flexible" structures to account for along-wind dynamic and wind gust buffeting effects
f. Formula for eccentric wind loading
g. External pressure coefficients for more types of building and structure shapes, including wind loading guidance for antennas and antenna-supporting structures (based on ANSI/EIA/TIA-222-G-2005; Ref. 15)
h. Provision on wind-borne debris

The new NSCP will likely retain provisions for Terrain Exposure Category A (highly urbanized terrain). In contrast, ASCE/SEI 7-05 has removed provisions for Exposure A and recommends wind tunnel testing to be considered for those structures.

Note also that the NSCP wind load factors and definitions of the basic wind speed are generally similar to those in the ASCE/SEI 7-05.

The new NSCP wind loading provisions may need supplementary guides to cover the following, among other items:

a. City-specific directionality factors
b. Provisions to allow for database-assisted design
c. Guidance on natural frequency and damping estimates
d. Provisions for mode shape corrections
e. Provisions to account for across-wind and torsional effects
f. Provisions for estimating building deflection and accelerations
g. Guidance on building deflection and acceleration limits for serviceability and/or occupant comfort
h. More specific design provisions for wind-borne debris

Items c, f, and g above are addressed in the ASCE7 Commentary (not in the Provisions; see Ref. 13), which are not intended to be included in the NSCP wind loading provisions.

3.1.4 *New wind zone map*

It was found beneficial to update the current wind zone map found in the NSCP 2001 (Fig. 1a; from Ref. 9). The current map divides the country into 3 wind zones, with basic wind speeds defined as 50-year return period, 3-sec gust speeds of 250 km/h, 200 km/h, and 125 km/h (Zone I, II, and III respectively), that have been generated from extreme value analysis of 35 years of monthly peak gust data and using the concept of "super stations" to increase the data size.

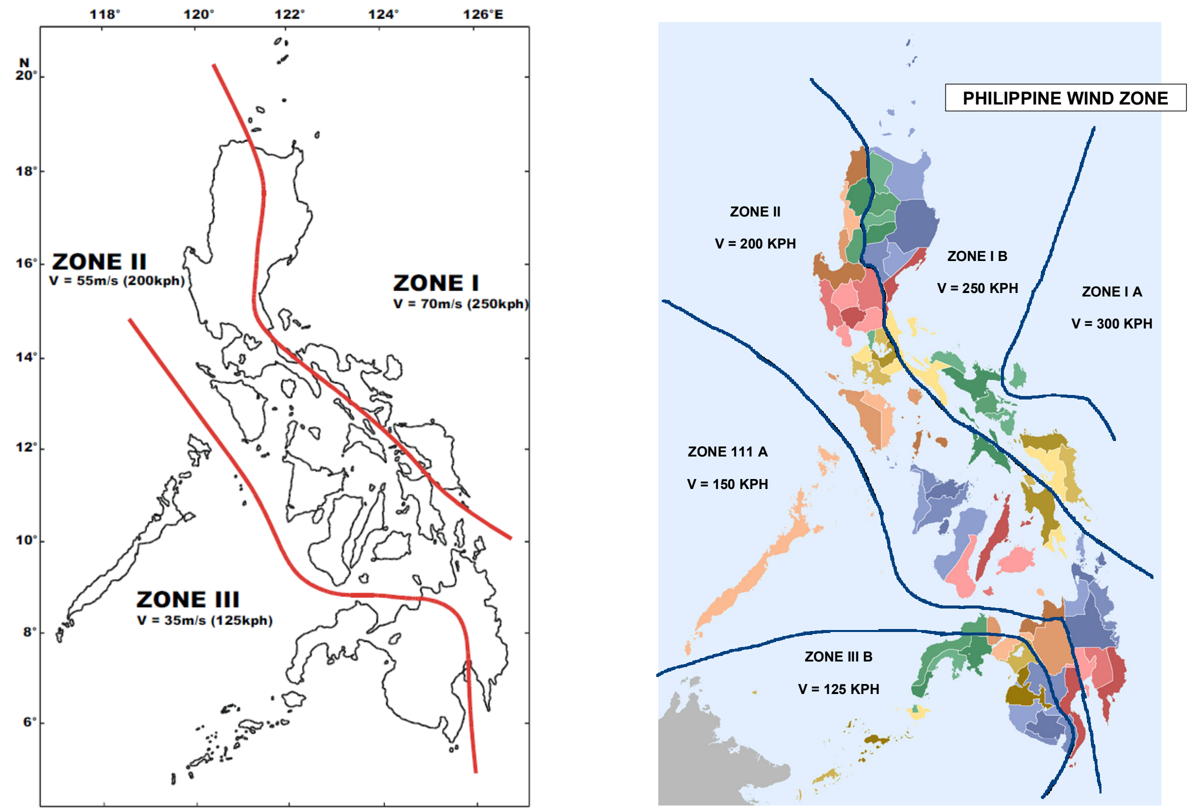
The new map being considered (Fig. 1b; from Ref. 14), based on more recent analysis work with additional years of data, divides the country into 5 wind zones. The new wind zones have basic wind speeds of 300 km/h, 250 km/h, 200 km/h, 150 km/h, and 125 km/h. The new wind map has been generated from extreme value analysis of 40 years of daily peak gust data. Additionally, it shows the boundaries of different political regions in the country for easier use by design engineers.

3.1.5 *Wind loads on bridges and residential structures*

It was discussed during the committee meetings that the NSCP Volume 2 for Bridges is also scheduled to be updated. There is no word yet on the direction for the update. It was also discussed during the committee meetings that a new NSCP Volume 3 for Residential Buildings shall be released, which is envisioned to contain the simplified procedure for small, regular buildings. (See Ref. 3.)

3.2 *Rapid Visual Assessment Procedures for Existing Structures*

Steel "billboard" structures (large outdoor advertisement boards) were damaged due to strong typhoon winds, most recently from a typhoon that directly hit Metro Manila in 2006, "Typhoon Milenyo/Xangsane". (See Ref. 1. and Fig. 2)



(a) (b)

Figure 1. Current (a) and new proposed (b) wind speed maps in the NSCP, from Refs. 8 and 13 respectively.

(a) (b) (c)

Figure 2. (a) Damaged billboard structure (photo courtesy of www.manildailyphoto.com), (b) billboard collapsing on vehicle (photo courtesy of www.bettylopez.i.ph), and (c) billboard collapsing on adjacent structure (photo courtesy of www.manildailyphoto.com).

The national government, most notably the Department of Public Works and Highways, saw the need to set-up a task force to evaluate existing steel lattice structures commonly used as billboards. The situation highlights the importance of updating the NSCP to be used for new or future similar types of structures, as well as the urgency of evaluating existing structures and retrofitting as maybe found necessary. Indeed the ASEP held a Forum on Billboards in December 2006 (Ref. 4), and a training workshop on assessment of billboard structural design in August 2009 (Ref. 5). Meanwhile at the 14th ASEP International Convention in May 2009, a paper (Ref. 6) was presented on a proposed procedure for rapid visual assessment of "steel tower billboards."

Similarly, the Philippine Institute of Civil Engineers (PICE) with its National Committee on Disaster Mitigation and Preparedness Strategies (DMAPS), of which the first and third authors are members of, are developing rapid visual assessment procedures for falling hazards from strong winds, together with procedures for other typhoon-related disasters such as typhoon-induced flooding, and typhoon-induced landslides.

3.3 *Wind Environmental Specifications*

3.3.1 *Background*

There are no specific codes and standards, or laws and regulations in the Philippines on pedestrian-level comfort criteria, as would apply to the wind environment in zones or clusters of structures.

Civil engineers would need to work together with architects, chemical engineers, and meteorologists, among others, to develop engineering procedures and criteria not only for wind loading considerations but also for physical, chemical, and thermal characteristics of the wind environment.

3.3.2 *Relevant local laws and regulations*

Insofar as air quality is concerned, the relevant local laws and regulations are given in Republic Act No. 8749, or the "Philippine Clean Air Act of 1999," (Ref. 16) and its Implementing Rules and Regulations (IRR) embodied in the Department of Environment and Natural Resources (DENR) Administrative Order No. 81 Series of 2000 (Ref. 17). These laws and regulations are based on similar laws enforced by the US Environmental Protection Agency.

The above-mentioned laws and regulations provide specifications for, among others:

- National Ambient Air Quality Guideline Values for Criteria Pollutants
- National Ambient Air Quality Standards for Source Specific Air Pollutants from Industrial Sources/Operations
- National Emission Standards for Source Specific Air Pollutants (NESSAP)
- Limits of air pollutant concentration at the point of emission from stationary sources
- Daily and Half Hourly Average Limits, and Limits for Metals, Dioxins and Furans – Treatment Facilities Using Non-burn Technologies
- Emission limits for pollution from different types of motor vehicles, as well as at steady-state conditions
- Fuel Specifications
- Test Procedures to Determine Exhaust Emissions and Other Standards

A copy of these laws can be found in the DENR Environmental Management Bureau website at www.emb.gov.ph.

4 WIND RESPONSE CONTROL FOR OCCUPANT COMFORT IN TALL BUILDING

The 60-story, approx. 210m-tall St. Francis Shangri-La Place twin towers, the tallest residential buildings in the country, has been recently topped out. (See Ref. 7.) It is in an area of high seismicity, and under the NSCP 2001 Wind Zone II (50-year return period, 3-second basic gust wind speed of about 200 km/h or 55 m/s). Under more frequent winds, it was necessary to establish and meet building deflection and acceleration limits for serviceability and/or occupant comfort. Guidance on such limits is not available in the current NSCP (Ref. 9), and instead the relevant ISO standard was used. Typically to address such concerns, one would need to increase the stiffness of the building, which entails costs and precious sellable space.

A tuned mass damper (TMD) system is often used instead to limit the wind-induced displacement and/or acceleration response, but such are not effective under earthquake loads, hence there would still be a need to design the building and its structural components for the same design earthquake forces.

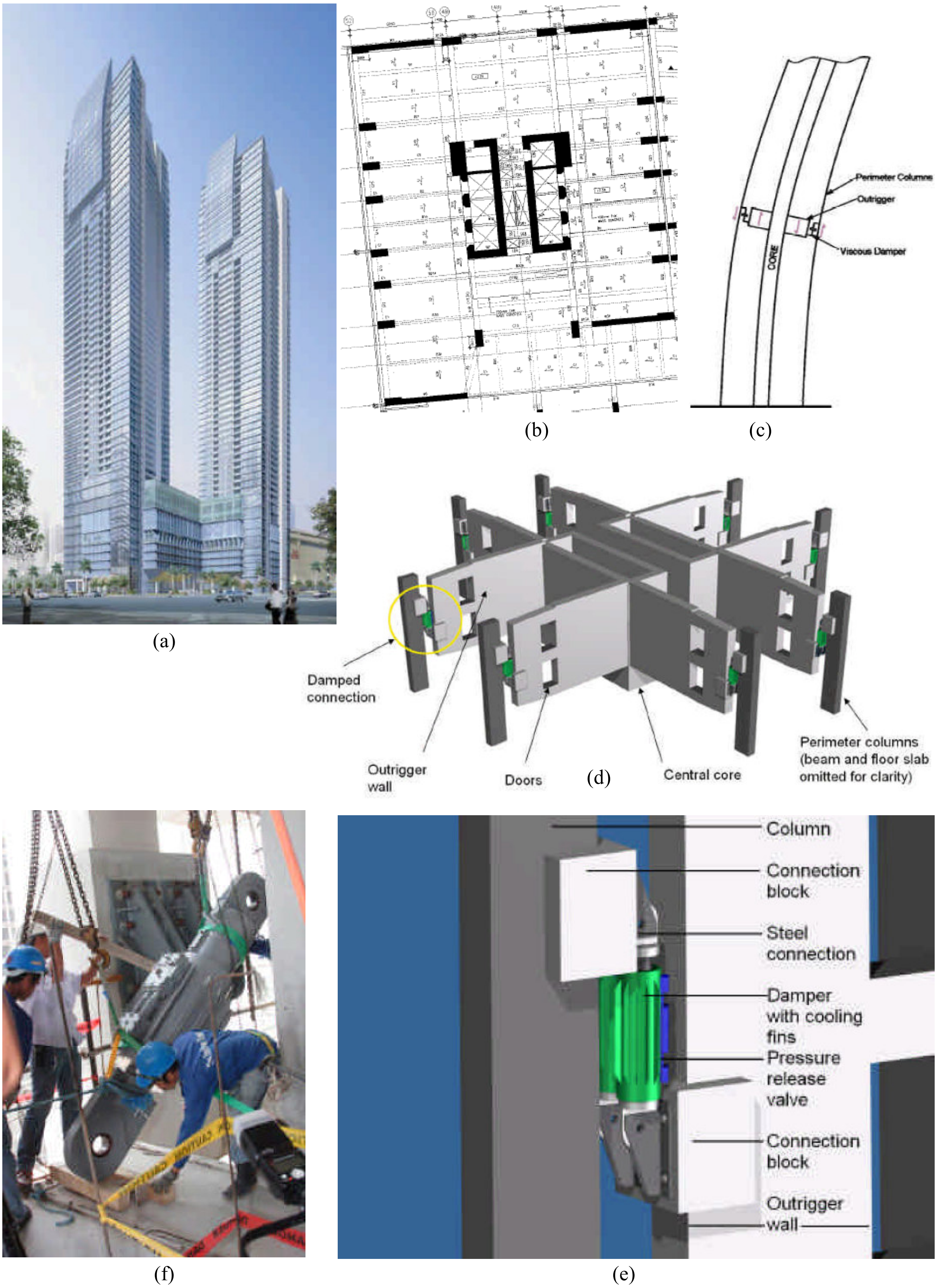


Figure 3. Clockwise from top left: St. Francis Shangri-La Place (a) architectural rendition and (b) typical structural plan, designed with Arup Damped Outrigger System, patent pending: (c) concept, (d) damper layout around core wall, (e) close-up view of damper, (f) installation of actual dampers. All images from Ref. 7.

The St. Francis Shangri-La Place building uses a damped outrigger system (Refs. 7 and 18) with viscous dampers vertically-placed between the outrigger beams connected to the core wall, and the perimeter columns. The innovative concept took off after identifying the need to perform a performance-based structural design for the tall building. Use of viscous dampers was selected to meet the wind serviceability criteria such as occupant comfort, as well as reduce the seismic design forces. The results of a comparative analysis of the wind response of the building show that the wind overturning moment predicted by the wind tunnel testing is larger than that by the current NSCP.

5 ESTABLISHMENT OF THE U.P. INSTITUTE OF CIVIL ENGINEERING

The College of Engineering (CoE) of the University of the Philippines (UP) within its Diliman Campus has spearheaded the establishment of the new UP Institute of Civil Engineering (UP-ICE), lead by the first author who is now the current UP-ICE Director, converting what was only previously a Department of Civil Engineering under the UP CoE (Ref. 8). The ICE now retains mostly PhD-level faculty. It has the first and only PhD in Civil Engineering program in the country. The UP-ICE has also started the construction of its own building complex. The UP-ICE has plans for the construction of two wind tunnel testing laboratories within its own building complex. However, the construction of a new earthquake shaking table testing laboratory and a fire engineering laboratory has been prioritized.

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