APEC-WW Economy Report: Vietnam-2010

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ABSTRACT: This paper is submitted as country report of Vietnam which describes the wind damages during the period of 1990~2010, wind resistant design in practice and progress of wind loading code TCVN 2737-Chapter 6. Recent works relevant to wind engineering during also has introduced.

KEYWORDS: Wind engineering, Wind damages, Wind loading code, Vietnam.

1 WIND DAMAGES OF VIETNAM DURING 1990~2010

Statistical data of the wind-related disaster is obtained from official website of the Central Committee for Flood and Storm Control (CCFSC), http://www.ccfsc.org.vn and detail is given in the Table 1. In this table, damages of natural disasters during period of 1989-2009 and strong winds are presented for comparison. It is noted that, data of the year of 2004 is not included.

Evidence given in Table 1 makes clear that, strong winds made huge losses to the society. Statistics showed that, annually, there are more than 200 people were death and over 500 people were bad injured, more than 25,000 houses were destroyed and over 230,000 were in bad damaged after strong winds events.

In Vietnam, typhoon is always a subject at highest level of consideration by Government. However, looking into fatality due to tornado-likes annually, it can conclude that, tornado-likes contribute a considerable amount of losses in comparison with typhoons. Authors would like to emphasize the importance of the tornado-like related disaster in Vietnam as they occur more frequency than typhoon and to date have no report on the tornado-like intensity. The post-disaster investigation is necessary for risk management. The classification of strong winds and their prone-zone can be found in www.thoitietnguyhiem.net/ and Giang et al. (2009).

2 WIND RESISTANCE DESIGN FOR BUILDING AND STRUCTURE IN VIETNAM

This session outlines the current situation on the wind resistant design in Vietnam. The discussions are paid to the code of practice and the fact of the design wind load for buildings over country.

2.1 *Code of Practice for Wind Resistance Design of Building and Structures*

Wind loading plays an important rule of the Vietnamese Loading Codes for Design of Building and Structures (TCVN 2737). In general, almost practical codes that used for structural design in Vietnam have been converted from Russian codes. In case of environmental loading such as wind actions, the local condition of wind climate is stipulated for practical design of buildings/structures in Vietnam. Table 2 shows the development of wind loading codes in Vietnam along with TCVN 2737.

Table 1 Damages due to all natural disaster and wind related damages during period of 1989-2009 (data of the year of 2004 is not included)

List	Damage to	Classification	UNIT	All natural disaster	Due to strong winds	Due to Typhoon	Due to Tornado-like
1	Humanitarian	People killed	No.	9,679	4,060	3,144	916
		People injured	No.	14,241	10,916	7,782	3,134
2	Housing	Collapsed	1000	738	526	499	27
		Submerged and bad damaged	1000	11,364	4,668	4,443	225
3	School/ Education	Classrooms collapsed/washed away	1000 Room	37	23	21	2
		Classrooms damaged	1000 Room	162	100	95	5
4	Hospital (Clinic)	Collapsed/	No.	3,105	2,909	2,834	75
		Submerged and damaged	No.	28,258	24,414	23,975	439
5	Agriculture	Paddy inundated	1000 Ha	6,605	3,992	3,765	226
		Forest damaged	1000 Ha	164	157	155	2
		Trees collapse	1000	48,489	42,644	42,330	313
		Cattle killed	1000	126	69	68	1
		Pigs killed	1000	1,035	265	261	4
		Poultry killed	1000	9,584	2,847	2,794	53
6	Water Resources	Earth eroded, washed away	1000m3	181,134	42,708	42,520	188
		Rock eroded, washed away	1000m3	1,641	1,231	1,230.6	0.4
		Dykes eroded, washed away	1000m	3,243	1,252	1,251	780
		Revetment blew off	1000 m	246	153	152,6	0.4
		Canals blew off	1000 m	8,573	1,392	1,080	312
		Culverts under dykes collapsed, drifted	No.	6,049	3,243	1,440	1,803
		Small hydraulic structures collapsed	No.	5,698	1,950	1,921	29
		Small hydraulic structures damaged	No.	13,709	6,381	5,381	1,000
		Sluice gates drifted	No.	8,989	3,149	2,830	319
		Pumping stations submerged	No.	1,456	622	504	118
7	Transportation	Earth eroded, washed away	1000m3	63,317	31,218	29,460	1,758
		Rock eroded, washed away	1000m3	862	352	350	2
		Bridge, sewer collapsed	1000	13.7	6.3	6.157	0.148
		Bridge, sewer damaged	1000	49.5	8.15	7.6	0.55
		Roads damaged	1000 Km	7,297	76.997	76.771	0.227
		Surface of the road damaged	1000m2	6,338	3,006	3,006	0
8	Aquatic product	Fish and shrimp feeding area destroyed	1000 Ha	462.5	274.1	270.1	0.4
		Shrimp, fish lost	1000 ton	92.2	72.89	72.56	0.32
		Ships and boats sunk, lost	No.	16,727	12,081	11,295	786
		Ships and boats sunk, damaged	No.	13,092	10,483	10,252	231
9	Communication facilities	Telephone poles collapsed	No.	52,028	39,859	38,509	1,350
		Telephone wire broken	1000m	6,383	4,497	4,483	14
		Telephone switchboards damaged	No.	1,308	1,284	1,121	163

10	Energy facilities	High voltage electric towers broken	No.	13,706	10,947	10,767	180
		Electric distribution poles broken	No.	66,128	56,779	53,001	3,778
		Electric wire broken	1000m	5,957	4,613	4,454	159
		Transformer stations damaged	No.	783	580	573	7
		Transformer damaged	No.	81	31	23	8

Table 2 Development of Vietnamese Wind loading Code

Version	Basic information	Mother code	Notes
TCVN 2737-1978	N/A	Russian code/ Year of publication: N/A	- Code methodology based on Russian code
TCVN 2737-1990	- Basic wind speed: R5-year, 2-min mean wind, 10 m height above open-flat terrain - Davenport guts loading method	Russian code/ Year of publication: N/A	- Code methodology based on Russian code
TCVN 2737-1995	- Basic wind speed: R20-year, 3s-gust speed, 10 m height above open-flat terrain; - Davenport guts loading method	Russian code /version 1985 and Australia code version/1989	- Code methodology based on Russian code - Terrain categories and wind profiles based on Australia code
TCVN 2737-2006 (draft)	- Basic wind speed: R50-year, 3-gust speed, 10 m height above open-flat terrain - Davenport guts loading method	Russian code version 1985 and Australia code version 1989	- Never published
TCVN 2737-2010 (in progress)	- Basic wind speed: R50-year, 10-min mean wind, 10 m height above open-flat terrain; - Davenport guts loading method	Russian code version 2000?	Requested by MOC due to the too much ambiguous problem on the results of design wind load

After Vietnam joined WTO, and in order to harmonize with other international code/standards, in the year of 2009, the Ministry of Construction (MOC) published a legal document namely "QCVN02: 2009/BXD Vietnam Building Code/ Natural Physical & Climatic Data for Construction", which is highest level by law for using local climatic data in construction industry. For wind design, the basic wind pressure in correspondence of 3-s gust speed, R-20 year in open-flat terrain and wind speed along with 10 min- mean speed, R-50 year in open-flat terrain are available for application of International codes/standards. Conversion factors to obtain wind speed/pressure at higher return periods, say 50 to 100 year-return periods, also given in the QCVN02: 2009/BXD.

For structural design of the projects funded by Government, TCVN 2737-1995 is mandatory one. Incidentally, Ha and Giang (2008) reported on the wind load calculations given by TCVN 2737-1995 and other international codes of ASCE 7-05, GBJ-2001, AIJ/RLB 2004, AS/NZ 1170.2.2002 and Eurocode1-4. Their report pointed out that wind loads deduced by TCVN 2737-1995 are highest among codes that used in the comparison, say 2 to 2.5 times of the values calculated by other international codes. Other comparison can be seen in the paper of the Holmes and Tamura et al., (2010). However, detail discussion on the reason for ambiguous values of wind load deduced by TCVN 2737-1995 is out of scope of this paper.

2.2 *Current Situation of the Wind Resistance Design of Buildings in Vietnam*

As many developing countries in Asia, the use of steel for structures is expensive in comparison of concrete structures. The discussion will be presented for Non-engineering and Engineering structures with focusing on the wind damage pattern.

Non-engineering structures

All most houses in Vietnam were built by owners themselves. Common houses are made by brick walls with wooden/steel trusses, roof tiles/steel sheets. Annually, 25,000 houses were destroyed and over 230,000 were in bad damaged after strong winds events. Since 19070's, the Government have issued several recommendations for strengthen houses in typhoon prone regions. Since the year of 2000, along with economical development, the people started building houses with reinforce concrete roof, the damages seems to be reduced year by year.

Engineering structures

Projects funded by Government are requested to design in according to Vietnamese codes. Most of damages of engineering buildings in Vietnam are concentrated to the claddings (both wall panel and roof) and architectural objects that mounted in the buildings. Besides, several type of structures such as signboard, fences are often collapsed during tornado-like events. It is questioned of the wind data for any countries as wind data from tornado-like events are often not available.

Projects built under Foreign Investment are often designed by foreign consultants. For several huge projects, say over 40 stories in height, the wind tunnel testing have done for wind safety of main structure and façade design. However, wind environmental assessments for pedestrian wind have not done as Vietnamese Building Law did not request such an experiment/proof. As mentioned in session 3.1, for these types of projects, international codes are often employed in the design works.

3 RECENT WORKS RELEVANT TO WIND ENGINEERING DURING 2005-2010

This session presents a glance of wind engineering works have been done in Vietnam during 2005-210

3.1 *Revision of Wind Loading Code*

In 2006, daft version TCVN 2737-2006 has been proposed by conventional researchers of loading code committee. In this work, wind data until the year of 2000 was deployed and there was only one change of basic return period that shifted from R-20 to R-50 year. Unfortunately, this work was rejected by Ministry of Construction, because at several sites, ambiguous basic wind speeds were found and can not explained thoroughly by code-makers .

In OCT. 2008, Ha and Giang (2008a) reported ambiguous wind load results calculated by TCVN 2727-1995. Later discussions given by Ha and Giang (2008b) pointed out the reason for this strange. They concluded that the mixture of Russian code and Australia wind loading code without considering the "averaging time" of the wind speed and wind profile that used in calculating fluctuation component of wind load are main points that drove TCVN 2737-1995 to go off.

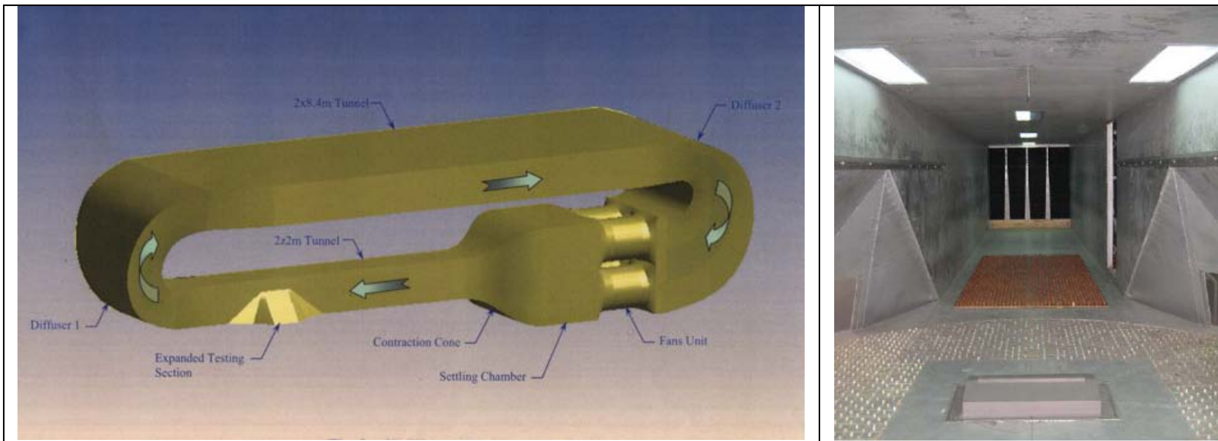
Jan 2009, IBST-Scientific Committee decided to revise TCVN 2737-1995. Russian codes have been chosen as mother-code. To date, TCVN 2737-1995 have been undergone by engineering design of 15 years. Therefore, the IBST-Scientific Committee fell into Russian methodology as they did not want a big change in practice. Nevertheless, Russian wind loading code seems to be changed to harmonize with Eurocode 1-4. In fact, the current code of earthquake resistant designs of Vietnam has adopted Eurocode 8 as mother code. Discussion for the strategy of Vietnamese wind loading code is continuing though new draft version of TCVN2737-2010 have just completed.

3.2 *Wind Tunnel Facilities*

By the end of the year 2007, the first wind tunnel facility in Vietnam had been built at Vietnam Institute for Building Science and Technology. This project was funded by Government with purpose of improving knowledge of researchers through actives of wind tunnel experiments and also carrying out wind engineering service through commercial projects. The key persons of IBST/Wind tunnel include Dr. Vu Thanh Trung/Head, Dr. Le Truong Giang/Ex. Head, Dr Nguyen Hong Ha/Ex. Head, Mr Vu Xuan Thuong and Mr Ho Huu Thang. An outline of the wind tunnel parameters are listed in the Table 3 and configuration of the wind tunnel is given in the Figure 1.

Table 3 Parameters of IBST/Wind Tunnel

Wind tunnel	Type	Close (vertical)
	Total length	36 m
	Turn table	2 turn tables of 4 m-diameter and 7 m-diameter
	Wind speed	0,5 → 50 m/s
	Turbulent	<1%
	Contraction Ratio	0.045
Fan	Type	Chicago Fans - Design 47 Vaneaxial (USA)
	Power	450Kw (4 fans)



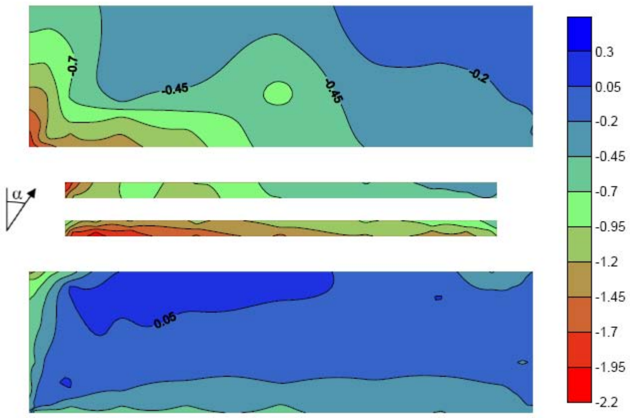
(a) (b)

Figure 1 (a): Sketch of IBST/Wind Tunnel, (b): Inside of testing section

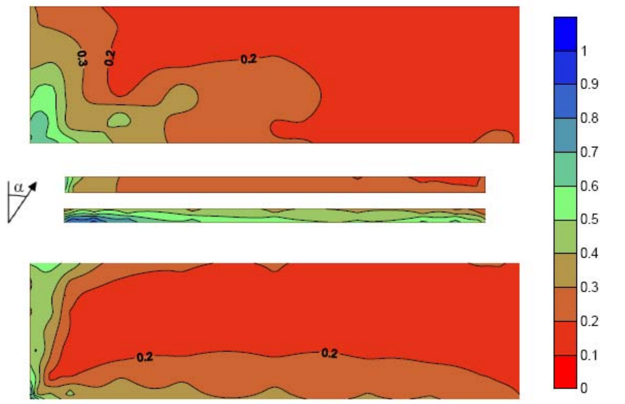
3.3 *Recent Research Projects Relevant to Wind Tunnel Testing*

The research project RD 39-07 conducted by Ha and Giang et al., (2008c) in which distribution of pressure coefficients on the roof of the typical low-rise industrial building. The main purposes of this project are: i) utilizing wind tunnel in research and practice, and ii) educating young research engineers at IBST. Figures 2 and 3 show the building model and results of wind pressure coefficients on the roof of the building model.

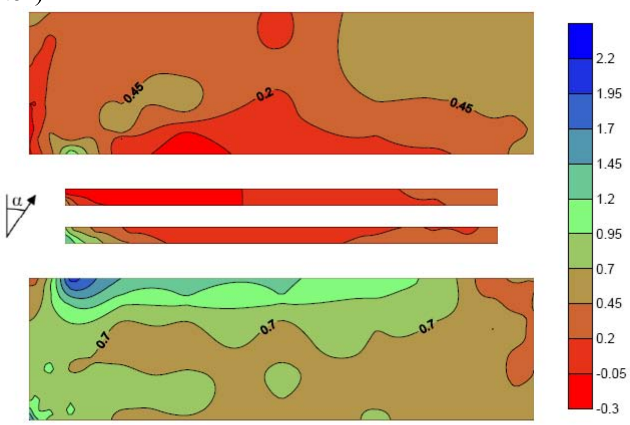
Figure 2 Testing model of an industrial building



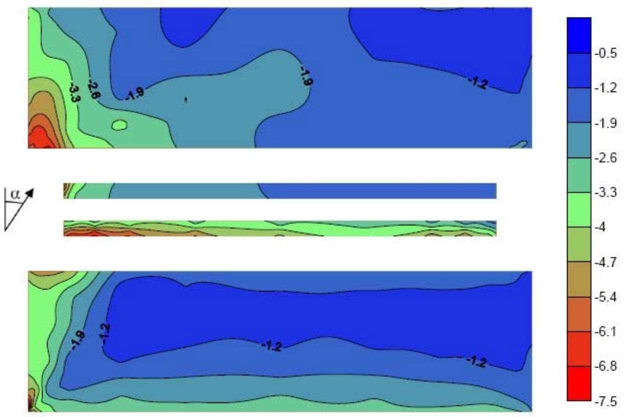
(a) Mean wind pressure coefficient $\overline{C}_p$ (Wind angle α = 45^{o})



(b) RMS wind pressure coefficient $C_p^{'}$ (Wind angle α = 45^{o})



(c)Positive extreme wind pressure coefficient $\hat{C}_p$ (Wind angle α = 45^{o})



(d) Negative extreme wind pressure coefficient $\check{C}_p$ (Wind angle α = 45^{o})

Figure 3 Testing results (roof)

3.4 *Cladding Test*

In Vietnam, steel profiled sheets are used popularly for roofing system of low-rise industrial buildings. The test for structural performance of them under wind loading is necessary. Recently, testing of 24 steel profiled sheets has been done to determine their load response characteristics and ultimate failure load under uplift conditions per ASTM E 1592-05. The detail results of these tests can be found at Trung (2010). Testing system includes an air box (0.5m high, 1.2 m wide and 0.5 m deep) and an air-pump system, and two manometers, and 6 displacement transducers and a data-logger system (see Figure 4a). Deformation shape of steel profiled sheet at ultimate failure load is displayed in Figure 4b.

(a) Equipments for testing of steel sheets

(b) Deformation shape of **a** steel profiled sheet at ultimate failure load

Figure 4 Equipments for testing of steel sheets

4 NEAR FUTURE WORKS

4.1 *Revising Wind Loading Code*

This work have been doing since Jan 2009 and continuing to clarify the code methodology and assignment of the terrain categories. Other points such as topographic-factor should be included in the new code. The key-persons of the wind loading committee seem to be waiting for the official new version of the Russian wind loading code. Besides, the improvement of the basic wind speed map is important. Incidentally, at moment, this work seems to be less important by authorities as it has been understood as work of meteorologists but structural research engineers.

5 CONCLUSIONS

The paper outlined the main wind engineering activities in Vietnam during last five years. By authors' view point, a long-term plan of research works should be set up as soon as possible for the development of wind engineering. Probably, in the near future, the consideration on the roofing system of low-rise is most necessary object of research works for wind hazard mitigation. In fact, Vietnam felt in to the urbanization unavoidably, impacts of high-rise building to wind environmental issue should be paid high consideration by both policy-makers and engineers.

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