COE Program TPU
Wind Effects on Buildings and Urban Environment

Wind Effects

Wind Effects on Buildings and Urban Environment

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INDEX

Summary of TPU COE Program and Future Prospects

Yukio Tamura, COE Program Director

The 21st Century COE Program "Wind Effects on Buildings and Urban Environment" has now come to the end of its five year term. It was proposed by the Architecture Course of the Graduate School of Engineering, Tokyo Polytechnic University (TPU), and approved by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) in 2003. It covers three main wind related projects: Project 1 for wind hazard mitigation, Project 2 for natural cross-ventilation and Project 3 for air pollution in urban areas and indoors.

The Wind Engineering Research Center (WERC) of TPU has played key roles in promoting the COE program and great efforts have been made to create an apex of center of research and education. The Wind Hazards Mitigation Center and the Wind Engineering Information Center were established to facilitate the advance of the COE program. Mid-term evaluation conducted by MEXT in 2005 stated that "The program has been carried out as initially planned, and the objectives of the program will be attainable by continuing the current effort". The highest evaluation was given. The mass media reported the evaluation results and listed our program as one of six excellent programs.

Motivation for studies on prevention of wind disaster, natural ventilation, air pollution and the wind environment are based on "affection for human beings", "affection for global resources", and "affection for atmospheric environment", respectively. All these are based on "affection" on human beings and the earth. With this awareness, we will be able to set up a meaningful goal, to create good ideas and to continue our efforts toward accomplishment of the study. We consider this to be an important impetus for education in wind engineering.

It is predicted that the existing study system based on individual research centers is being shifted to an international and more tightly organized study system on a center-to-center basis. In view of this trend, cooperative studies, organizing of workshops, and conclusion of an agreement for personnel interchange have been promoted and held with about 20 institutions around the world. By making efforts through buildup of the APEC Wind Engineering Network, we shall continuously develop activities – not merely to establish a global level research center but also to serve as a "hub" for connecting centers around the world.

In Asian countries, there are serious problems of frequent disasters due to typhoons or cyclones, and problems of air pollution and energy consumption due to rapid urbanization and concentration of populations in cities. Thus, researchers and engineers should be trained and educated from the international viewpoint, and this is being accomplished by the APEC short-term fellowship, internship of PhD students, lectures given in the English language, etc. In addition, series advanced school in APEC regions was held to cover the lack of relevant advanced professional training course in wind engineering.

After the adoption of the COE program, 17 international meetings have been held. Furthermore, 70 COE Open Seminars have been organized, and majority of them were given in English. The latest study achievements were widely circulated among researchers and students by these meetings and seminars. This improves the quality of education and research, and also provides the chance for young researchers and engineers to exchange information with excellent researchers inside and outside the country.

Experimental data, research materials and reports on the investigation of disasters are publicly presented on a website so that the study results can be shared throughout the world via the Internet. The information is also propagated through Newsletters in Japanese and Bulletins in English language. It is also attempted to reflect the study results in lectures to graduate students.

Cooperation with enterprises and other research organizations are very important from the viewpoint of learning through practice and for identifying social trends and seeds of studies. This is also very important as a part of our contribution to society. Positive efforts are being made to conclude a basic agreement on long term cooperative research with enterprises and advanced consultant activities for practical projects. They are based on the premise that these activities will have significant meaning for study and their results will be open to the public.

In future, we will continue our efforts in study and education to solve problems of prevention of wind disaster on buildings in urban areas, natural ventilation, diffusion of contaminants, and problems relating to air flow in cities and buildings. We aim to build the world's top center of study and education in wind engineering and prompt the research on Center-to-center base through the GLOBAL COE program that we are applying for. Cooperation with University of Notre Dame (Prof. Ahsan Kareem) on EVO (Engineering Virtual Organization) project will be conducted. Our final goal is to provide feedback from our study to the public and to contribute to the welfare of human beings and society.

In summarizing the activities of the COE program, I would like to express my sincere appreciation to Dr. Kenichi. Honda, the former TPU President, who encouraged us warmly in the application process and supported us continuously in promoting the COE program. Another distinguished contributor to the COE program is Dr. Nobuyuki Kobayashi, current TPU President, who is a pioneer in wind engineering research and education. We are greatly indebted to them for their strong and direct leadership. My special thanks are due to the COE Advisory Board, the COE Management and Operation Committee and the COE Assistance Office which was set up to help in the management of the COE program. The COE Advisory Board was organized to evaluate the activities of the entire operation of the COE program. Its members comprised some of the world's leading scholars and researchers in the wind engineering field and TPU Presidents. They were Prof. Giovanni Solari, Prof. Ahsan Kareem, Prof. S. Murakami, Prof. Masaru Matsumoto, Prof. Jan-Ming Ko, Dr. Nobuyuki Kobayashi and Dr. Kenichi Honda. They made very frank and constructive comments on the COE activities, both conducted and planned. This self-check external COE Advisory Board has played important roles in guaranteeing that the COE program proceeds efficiently. The COE Management and Operation Committee and the COE Assistance Office were organized inside the university also under the leadership of the TPU President to promote smooth progress of the COE program. Prof. Masao Otsuka (Former Dean of Faculty of Engineering), Prof. Yuichiro Kume (Dean, Faculty of Engineering), Prof. Shinichiro Wakao (Dean, Faculty of Arts), Mr. Koichi Sugawara (Director, Management) are the members of these committees and their contributions are greatly appreciated.

There are seven project members responsible for promoting this program. They are Prof. M. Ohba (Leader of Project 2), Prof. R. Yoshie (Leader of Project 3), Prof. T. Ohno, Prof. T. Ohkuma, Associate Prof. M. Matsui, Lecturer A. Yoshida and myself (Director, Leader of Project 1). In addition, Prof. N. Kobayashi served as the leader of Project 2 in 2003 and Associate Professor K. Ito served as a main member of this COE program from 2003-2006 before they moved to other positions. These researchers are in fields ranging from structural engineering to environmental engineering. In addition, Ms. S. Koizumi and Ms. M. Kobayashi worked diligently to facilitate the daily routine of the COE program. I would like to express my sincere thanks to all of them for their valuable efforts towards ensuring the success of COE program. Finally I would like to extend my gratitude to all the people who cooperated in and supported the COE program.

Report of COE Research Projects

Project 1: Wind Hazard Mitigation

The objective of this research project has been to promote and develop wind engineering technologies to contribute towers mitigating wind hazards. The outline of progress and results of related subjects were shown as follows.

1) Wind load distribution to estimate maximum load effects

In this research an equivalent static wind load (ESWL) distribution has been studied that reproduced the largest (i.e. maximum and minimum) load effects on structural members. As the conventional methods for estimating the ESWL were aimed at a specific load effect on a certain structural member, it was difficult to reproduce all largest load effects on all structural members. The universal ESWL that could reproduce the largest load effects on all structural members was proposed and investigated.

Some studies on theoretical background and improvements on the method were proposed. For example, the universal ESWL using the resonant largest load effects with the same sign as the mean load effects was not always shown a realistic load distribution. To overcome this problem a POD analysis was applied to the load effects (e.g. time series of the response) of the structural members. It was found that the first and second modes of the POD analysis gave an quite effective information to decide the maximum or minimum load effect of each structural member, and the universal ESWL of the decided load effect showed a realistic and smooth distribution which was the favorable to refer as practical design value.

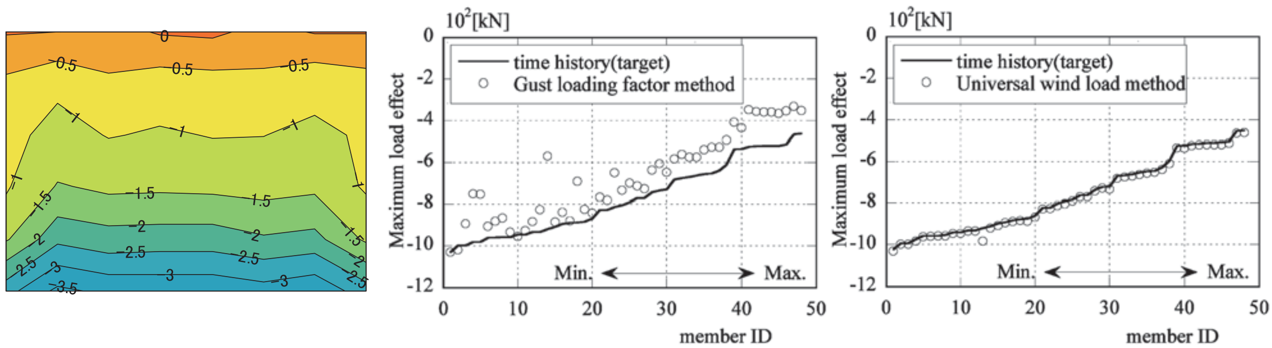


Figure 1. An example of UWL, comparison with the conventional method.

2) Wind response monitoring, system identification and urban hazard mitigation system

The objectives of the research were to develop a monitoring system for wind induced response of buildings using a Global Positioning system (GPS), to develop a health monitoring system for buildings with incorporating real-time observation and structural design parameters, those were updated by highly resolved system identification technique. Finally of these component, a wind hazard monitoring system for urban buildings were composed on the website.

As it was important to measure the mean component of response of buildings for wind load evaluation, GPS monitoring system was studied. A real-time kinematic (RTK) and real-time dynamic (RTD) were studied on their accuracy. An ambient vibration measurement and a wind induced response measurement were conducted on a transmission tower to identify its dynamic characteristics using frequency domain decomposition (FDD) and a multi-mode random decrement technique (MRD). Adopting these methods, highly accurate structural identification was achieved.

3) Design wind speed

Evaluating of design wind speeds is one of the most uncertain factors through the wind resistant design. The subjects in this research were to collect design wind speeds for many countries and areas for checking the continuity at the boundaries; to evaluate the design wind speeds considering the mixed wind climates; to develop an improved Monte-Carlo simulation method of typhoon winds.

Wind speed fields of tropical cyclones, especially on the vertical profiles were studied. Observed wind speed records were collected and studied both inside and outside the eye-walls of tropical cyclones. Track data of typhoons in the north-western Pacific region were collected as well as extreme wind data in Asian countries. Based on the typhoon track data with atmospheric pressure observation records, the typhoon pressure fields were analyzed. The parameters of the typhoon pressure fields were studied statistically and a probabilistic model was developed that could consider the correlation between parameters the Monte-Carlo simulations.

Differences between basic wind speeds in countries bordering Japan have been studied. The necessity of future cooperation with neighboring countries was emphasized to get more consistent basic design wind speeds maps in the APEC area.

4) Wind resistant design for low-rise buildings, wind resistant construction method considering practical situations in APEC countries

The objectives of the research were to study the present conventional construction system in APEC countries, to study the relationship between climate (wind and rainfall) and construction systems and study of wind force coefficients of roofs with eaves and roof verges projecting from buildings and propose of new construction systems and reinforcing methods considered wind for existing construction systems.

Basic information on construction systems in APEC countries were collected and arranged in a form. Meteorological records in APEC countries were collected. Referring to these information, typical construction system in each area was studied. Finally, reinforcing methods considered wind for existing construction system in East Asia are proposed. Wind force coefficients of roofs with eaves and roof verges are calculated through the wind tunnel test. The resulting wind forces at the eaves were found to be large values.

5) Wind disaster investigation and study on scenarios on wind induced damage to groups of buildings

The purposes of this research were to investigate the interaction of wind climates and structures including characteristics of extreme winds not only in Japan but also in other countries, and damage propagation process of buildings. Based on the site investigations, realistic scenarios have been studied to consider how mitigate the wind induced disasters.

A lot of post disaster investigations of typhoons, tornadoes and downbursts were conducted. From 2003 to 2007, 12 site investigations for 8 typhoons and hurricanes were conducted. Not only typhoons and hurricanes, tornadoes induced damage was also investigated. From 2003 to 2007 16 site investigations were conducted on damage induced by tornadoes and other gusts. Through these investigations, important items for mitigation of wind damage to buildings and urban environments were identified. These were countermeasures to flying debris, design of claddings, sudden increase in internal building pressures and subsequent accidents, design concept of temporal structures, and evaluation of crossing rate of line-like facilities such as railroads. These reminded us of the importance of prediction or forecasting, in order to protect human lives against gust disasters. Recommendations were announced by the program leader and accompanying members. Furthermore, contributing factors, climates, and observation records were studied for past wind induced disasters based on existing materials agencies and academic societies.

Photo. Collapse of wind power plant and damage to wall by a missile (at Miyakojima, T0314)

6) Disclosure of research results as IT contents (Aerodynamic database and other reports)

Most of the above mentioning results were disclosed as IT contents on the website of the COE program.

Project 2: Design Method for Natural/ Cross-Ventilation

Increasing social consciousness of environmental protection and energy saving has given rise to a demand for natural energy utilization in buildings and houses. Various technologies have been studied, and of these, cross-ventilation has lately attracted considerable attention. Attempts have been made to effectively utilize natural ventilation, particularly in commercial buildings. In order to effectively promote the utilization of cross-ventilation, many problems need to be overcome to obtain more accurate prediction of ventilation flow rate under actual conditions. Project 2 is aimed at developing a cross-ventilation design method. The main research results obtained in the five-year study period are reported as follows.

1) Analysis of airflow structure in cross-ventilated building

Cross-ventilation is a phenomenon of very complicated turbulent flow due to the interaction of internal flow with envelope flow. Pressures near openings exhibit reversible and irreversible changes of energy between dynamic pressure and static pressure associated with extreme deformation of airflows. It is difficult to experimentally reproduce the spatial distribution of these pressures. This hinders the elucidation of the problem. Thus, we accurately identified ventilation phenomena through simultaneous use of experiments and CFD. Figure 2 indicates the comparison of velocity vector distribution in cross-ventilated building model. A feature of the airflow during cross-ventilation is extreme downfall of inflow. To elucidate the cause of this, we evaluated the momentum balance along the axis through the center of the opening. We concluded that the primary cause of the downfall is the pressure gradient due to the re-circulation at the lower portion of the windward surface.

2) Proposal of high-precision model for ventilation flow rate

The currently used method for calculating ventilation flow rates is a conventional orifice flow model, assuming a constant discharge coefficient independent of the approaching flow angles. The influence of wind direction is not taken into account in the ventilation calculation formula. However, the discharge coefficient at the opening is highly dependent on wind direction angle. Most actual wind directions are not normal to the opening. Under these conditions, the prediction accuracy of ventilation flow rates by the conventional orifice flow model may greatly decrease.

Based on CFD and experimental results, we proposed a local dynamic similarity model that expresses the relative pressure balance between the cross-ventilation driving pressure and the interfering cross-flow dynamic pressure in the vicinity of an opening, as shown in Figure 3. A discharge coefficient is selected to adequately match the approaching flow angle. The proposed local dynamic similarity ventilation model indicates that the discharge coefficient can be predicted accurately from dimensionless room pressure for most opening positions, even if the approach flow angle is varied or there is another building near the opening.

3) Prediction accuracy of ventilation flow rates by local dynamic similarity model

The prediction accuracy of ventilation flow rates by this model was evaluated for a basic opening in an inflow surface. The local dynamic similarity model indicated better prediction accuracy than that with the conventional orifice flow model even when the discharge coefficient greatly decreased with change in wind direction.

4) Ventilation performance database for various types of inflow openings

The local dynamic similarity model was used to develop a new method for evaluating the ventilation performance of window openings. The obstructive effect of model size on flow fields in a wind tunnel were avoided by installing the opening parallel to the wind tunnel floor. The ventilation performance for various types of inflow openings was assessed by the ventilation performance evaluation system. The discharge coefficient was expressed by an approximate expression using dimensionless room pressure. A ventilation performance data was thus produced.

5) Applicability of roof windows in highly dense city blocks for cross-ventilation

In highly dense city blocks as in Tokyo, it is very difficult to obtain high enough ventilation flow rates when opening windows are attached to building walls. The use of night cross-ventilation is also impractical for security reasons. However, roof windows have high security performance and do not have large effects on gross building coverage ratio. Therefore, we investigated the applicability of roof windows in highly dense city blocks for cross-ventilation. As a result, we found that the wind passage between leeward wall and roof is very effective in achieving cross-ventilation flow rates.

6) Evaluation of thermal comfort in cross-ventilated environments

A field experiment to determine thermal comfort was conducted in a condominium as shown in Figure 4. The thermal comfort of occupants in the cross-ventilation environment was investigated using 6 adult males, 3 adult females and a thermal mannequin in a sitting position on chairs. The subjects voted their feelings on airflow, warmth and chilliness and how they felt about their thermal comfort during the experiment. Furthermore, power spectrum analyses of skin surface temperatures under cross-ventilation and airflows of the air-conditioning unit were investigated using infrared thermograph at a frame time of 30 Hz. Figure 5 indicates an infrared image on thermal mannequin. We constructed a method for analyzing 30Hz infrared animation images for estimating sensible heat distribution on the thermal mannequin by introducing correction rate Gamma. It was found that under cross-ventilation, the fingers showed larger power at low frequency than the upper arms. Wet parts of uniforms on the chest showed larger power at low frequency. In airflows of the air-conditioning unit, the power in almost all classes was lower at low frequency than under cross-ventilation.

7) Design method for cross-ventilation and future work

Basic studies were carried out to formulate a guideline for a cross-ventilation design method. The obtained research results were reported in the COE International Advanced School in March and December, 2007. Future work is required for building energy simulation using a coupled local dynamic similarity model using COMIS and TRNSYS, which are widely used for energy conservation simulation. Compared to the CFD method, the coupled model can easily and promptly calculate the ventilation flow rate. It can also produce an optimum layout of window openings for cross-ventilation. The technique is expected to promote the utilization of natural ventilation.

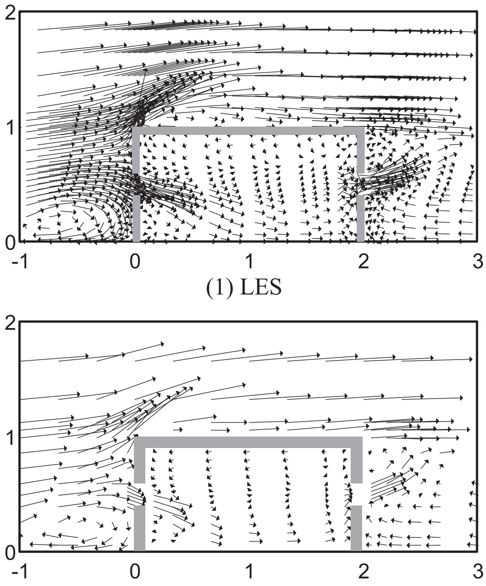


Figure 2. Comparison of velocity vector distribution in cross-ventilated building model

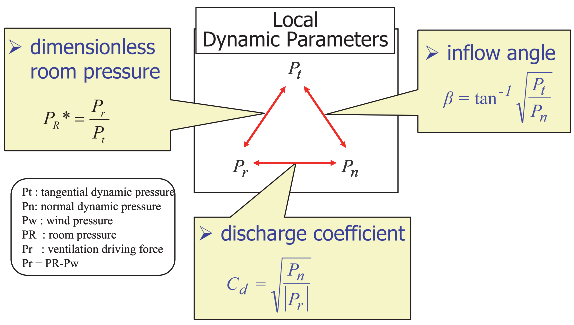


Figure 3. Local dynamic similarity model

Figure 4. Field experiment on thermal comfort in cross-ventilated environment

Figure 5. Infrared image on thermal mannequin in cross-ventilated environment

Project 3: Moderate Wind Field

Project 3 dealt comprehensively with the issues of air contamination and thermal contamination in indoor and urban environments.

1. Indoor air environment field

1) Indoor air physics

Indoor environment studies currently focus on phenomena around the human body at the microclimate level, so more realistic and detailed human body models are needed. The aim of this project was to develop Virtual Manikins that represent human body proportions for adult males and females as well as children (around seven years old). These manikins cover two types of posture models. They are divided into 17 parts to enable control and analysis of radiation heat transfer, surface temperature, and other factors of each part. We examined the accuracy of indoor environment prediction by conducting a coupled convection and radiation analysis in a simple room. As a result, we confirmed that the thermal environment could be predicted with sufficient accuracy in the analysis of microclimates around the human body.

Furthermore, detailed CFD analyses of the flow field and temperature distributions around Virtual Manikins were carried out to estimate the convective heat transfer coefficient for each human body segment. A total of 750 CFD analyses were carried out with boundary conditions that included changes in air velocity, direction and turbulence intensity. In this project, we proposed simplified formulas for determining the mean convective heat transfer coefficient targeting the geometry of the seated human body.

The geometry and detailed grid data for the Virtual Manikin may be made available for downloading from our Internet website, and information concerning the file structure and format could also be given. We intended to apply the grid data for the Virtual Manikin using a commercial CFD code, such as FLUENT/ANSYS, Star-CD, or SCRYU/Tetra. The URL of the download site is: http://www.arch.t-kougei.ac.jp/ito/

2) Indoor air chemistry

The overall goal of this project was to develop a numerical method for reproducing the transportation of pollutants, such as volatile organic compounds, suspended particles and cluster ions in indoor air. The numerical models are based on fundamental physiochemical and electrical principles of convection, diffusion, deposition, recombination and self-attenuation (damping) in room air. To be more precise, an electrophoretic migration model, a wall surface deposition model based on molecular diffusion and electrophoretic migration, and a uni-molecular and bi-molecular reaction model were proposed. Coupled analysis of CFD (Computational Fluid Dynamics) and proposed numerical pollutant transportation models were carried out for a 2-dimensional room model and a commuter train.

3) Indoor air biology

In recent years, health damage due to microorganism exposure, as well as to chemical exposure, has become a serious problem. Studies in many countries have recognized the association between respiratory symptoms, moisture problems, and fungal growth in buildings. The overall objective of this project was to develop a numerical model based on logistic equations for predicting fungal proliferation and colony formation taking into account the influence of moisture, temperature and surface characteristics of building materials on various fungi. To this end, fundamental experiments were carried out to measure the responses of fungal mycelium length and colony size on culture media under various environmental conditions. The purpose of this experiment was to produce a suspension that strictly controls the density of spores, and to execute both a mycelium growth experiment on a glass plate and a colony formation experiment on culture media with the same slurry of fungal spores. We focused on temperature and humidity effects on fungal growth, and mycelium lengths were directly measured using digital image data with a microscope that took a picture every 24 hours. Obvious relative humidity dependence of fungal growth was thus confirmed.

2. Outdoor air environment field

In the outdoor air environment field, emphasis was placed on moderate wind areas in urban areas, and behind buildings. We verified a method for predicting the spread of heat and pollutants through computational fluid dynamics (CFD) and conducted investigative research into the impact of urban configurations on breezes and temperatures in urban areas.

1) Verification of method for predicting spread of heat and pollutants through computational fluid dynamics

We developed nonisothermal calibration equipment for hot-wire flow meters and a simultaneous measurement system to determine velocity, concentration, and temperature (Figure 6). We then used these in conducting a wind tunnel test to investigate the spread of heat and pollutants in areas where weak nonisothermal winds flow behind buildings and in urban areas. Through this test, we were able to collect the various statistics on turbulent air flows necessary to verify CFD and compile a database. Based on this data and comparative verification through CFD analysis using various RANS models and LES, it became apparent that it is essential to reproduce cyclic wind speed fluctuations due to turbulence release from buildings and intermittent wind velocity fluctuations from the street to the sky in order to make accurate predictions for both a flow field in an area behind a single building and a flow field in an urban area.

2) Impact of urban configurations on breezes and temperatures in urban areas

In order to contribute to the establishment of an air ventilation assessment system in Hong Kong, we conducted a wind tunnel test for varying configurations of buildings with the high-rise building clusters of the Hong Kong's cityscape as reference. The test indicated that, if building heights are uniform and ventilation is considerably worse than that of urban areas in Japan, ventilation can be greatly improved under conditions where the average ventilation in urban areas can be evaluated by gross building coverage ratios, when the impact of floor area ratios is small, and when the heights of buildings are varied. In addition, we found that wind velocity ratios at the level of pedestrians can be evaluated universally by using average vertical building coverage ratios as one index if buildings heights are varied (Figure 7).

3) Future prospects

It is expected that CFD will become an effective and practical method for predicting the heat island phenomena and pollution issues in the future. The Architectural Institute of Japan organized a working group (chairperson: Ryuichiro Yoshie) to study this method, and this group has been performing comparative verifications on our wind tunnel test database and CFD analysis. In the future, we would like to prepare a guide for fluid numerical analysis for the prediction of the heat island phenomena and air pollution.

We would like to continue to cooperate on the establishment of the air ventilation assessment system in Hong Kong. With regard to what research on the system has revealed on the passage of vertical wind (that is, the average vertical flow (advection) and the spread of vertical turbulent air flows generated around buildings), we would like to conduct a more detailed survey on the effects of sending fresh, cold midair flows down to areas close to the ground, and of blowing pollutants upward and generating heat near the ground in order to make a proposal for measures to address the heat island phenomena and air pollution through ingenious urban configurations.

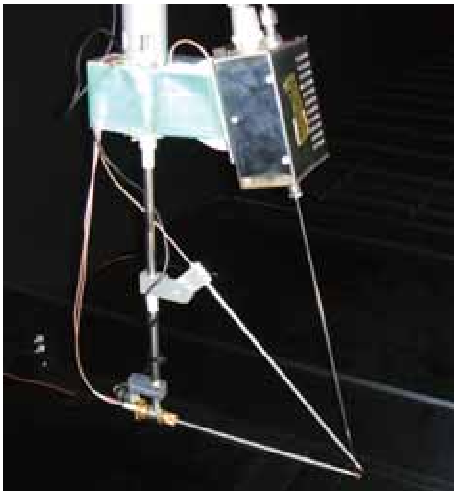


Figure 6. Simultaneous measurement system for velocity, concentration, and temperature

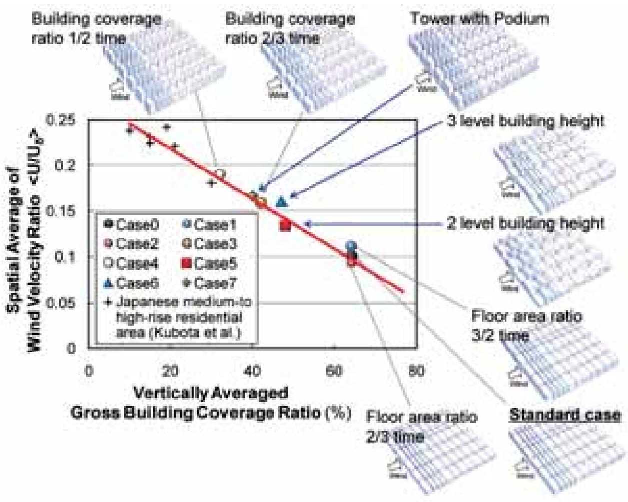


Figure 7. Relationship between gross building coverage ratio and wind velocity ratio

Comment of Advisory Board Member

Giovanni Solari, Professor, University of Genova

When in 2003 Prof. Yukio Tamura invited me to become a member of the Centre Of Excellence (COE) Programme Advisory Board on Wind Effects on Buildings and Urban Areas, at the Tokyo Polytechnic University (TPU), Japan, I was certain that an important initiative was about to begin and that the new centre would be a great success. What I saw with my own eyes and which I had the honour of being a part of in the five years spent on the board went far beyond even my most op-timistic expectations.

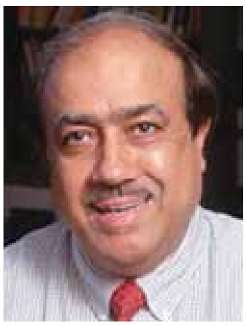
The distinctive elements of the centre created and run by prof. Tamura have been the high-level scientific production, the transfer of the acquired and produced knowledge to both the Japanese and international community, an extraordinary capacity for aggregation and a drive towards new devel-opments.

The scientific activity, witnessed by the quality and quantity of the research products, and charac-terised by the considerable breadth and transversality of the themes tackled, has developed around a world leader in the field of wind engineering, a group of keen and very well prepared researchers, numerous young people coming from all over the world along with a set of equipment for the labo-ratory tests and truly of great quality and in continual evolution. Their research has had a profound impact on the Japanese and international community, thanks to numerous scientific publications in the most prestigious journals and to the organisation of numerous conferences and international workshops held in Japan and in various other countries, always giving great support to prestigious speakers, to colleagues from developing countries and to even the youngest researchers. The impact of these research activities has also been essential to the codification panorama in both Japan and internationally, which more and more draws on the great progress made or supported by the COE-TPU. Finally, of great importance was the dissemination activity carried out both in Japan and in other countries to reinforce scientific and technical culture in the field of wind engineering, through wide-ranging courses of extremely high quality.

I have lived through this experience in the dual role as member of the board and as first president of the International Association for Wind Engineering (IAWE). Above all, in this second capacity I feel that I can say that I do not know other centres or great projects which, over recent years, have had such a deep and innovative impact on the international community of wind engineering. The initiatives developed have contributed to creating a network of knowledge and scientific and techni-cal collaboration, especially in the Asia-Pacific Region, of extraordinarily effective and very broad prospects.

Prof. Tamura was recently elected as the new president of the IAWE, and I feel very honoured to have left the running of our association in his hands. His nomination is a worthy recognition of the work that he has carried out and what he has managed to create at the TPU. I am sure that the same work will produce great benefits for the growth and development of wind engineering, both at the highest scientific levels and in relation to the dissemination of the subject in developing countries, just as the COE-TPU itself has grown and developed. In fact I believe that the collaboration be-tween the IAWE and COE has been a cornerstone for our discipline, on which to project and achieve new and important developments.

Therefore, I most sincerely hope that for Prof. Tamura, Prof. Kobayashi, Prof. Honda, the TPU and our community that the COE programme can carry on and further strengthen itself with the new Global COE programme. What has been created in these years must necessarily go on and grow even more.



Ahsan Kareem, Profe-ssor, University of Notre Dame

First of all I will like to commend the funding agencies in Japan to have the vision to award the 21st century COE(Center of Excellence) program "Wind effects on buildings and urban environment" at Tokyo Polytechnic University. The need for such a program, underscored by the escalating world wide damage caused by wind, and its award to the Wind Engineering Center at Tokyo Polytechnic University with the juxtaposition of its physical and intellectual infrastructure and its proven track record in research could not be any more fitting. My association with the center as an Advisory Board members has kept me abreast of the progress made by the center over it tenure. I am pleased to state that the staff of the COE at TPU under the visionary leadership of Prof. Tamura has availed every opportunity offered by this COE award. During the tenure of COE major strides have been made in the area of quantifying the characteristics of extreme winds in super typhoons, tornados and downburst; unveiling many complexities involved in the extreme wind-structure interactions through wind tunnel experiments, full-scale monitoring and model based simulations; development of advanced system identification techniques to estimate dynamic features, especially damping from full-scale data. This work in basic research has helped in developing design tools and input to improve and enhance codes and standards that help to transfer technology, an essential role in my opinion of a COE. In this area over the last few years the COE researchers have developed unique databases for wind loads on buildings, load combination and equivalent static loads for design of buildings and structures. In this regard, the COE has not only benefited the Japanese designers and professionals, but went beyond to APEC countries through its initiative of harmonizing the buildings codes. Through yearly meetings in different APEC countries, COE has been very successful in achieving the goal of code harmonization, a phenomenal and unprecedented success story! The COE has also been very effective in running a very impressive list of speakers at its Seminar Series and its organization of very topical International Symposium Series on wind effects on buildings and urban environment and in hosting of the quadrennial conference on Computational Wind Engineering. A number of young researchers have also benefited from the education and training at the COE and their participation in many international events. COE also has served the national and international community through its web-site contents which include, naming a few, useful tech notes and extensive PowerPoint slides of a series of lectures by the director on the topic of wind effects on structures. While my comments have been focused on the structural aspects of the COE, as an observer I have seen the environmental side of the COE to be equally effective in achieving their respective goals.

The COE responded very quickly during its tenure to the advice and guidance provided by the Advisory Board. My personal experience of association with the COE and individually with a number of researchers has been extremely rewarding as I view the fundamental contributions of the COE to be not only singularly unique, but also very effective in technology transfer through design aids and tools, conferences, symposia and seminars and its educational program. I wish continued success to the elaborate research program COE has helped to establish at TPU.

Masaru Matsumoto, Professor, University of Kyoto

At the final stage COE project at TPU entitled " Urban Wind Engineering- toward to establish the international research center in Japan", I would like to summarize the its COE project for last five years as a member of Advisory Committee. This project has been directed by of drive Professor Yukio Tamura. In this COE project, several professors and young research fellows are included to research individual research fields related wind engineering. During last five years a number of young foreign researcher have been invited to join research projects planned at COE project and educated. Moreover, many times international seminars as well as domestic ones have been organized by invited internationally well known senior researchers. All members included in this COE program have prominently contributed to carry out fundamental research related to wind engineering, provision of codification of buildings, mitigation of wind-induced disaster of structures and life-line objects. In particular, Professor Yukio Tamura organized many international workshops in various countries and promoted the research works and education related to wind engineering at those countries. He has already established the international networks to communicate and exchange the all kinds of information on research works and education related to wind engineering. I definitely believe that related wind engineering Professor Yukio Tamura spread his wings to environmental fields , Energy issues, Disaster mitigation, more reasonable design of structures as a key person of international leaders. In fact Professor Yukio Tamura has selected as second president of International Wind Engineering Association(IAWEA), and he played actively initiatives of international wind engineering activity. Professor Yukio Tamura has seeded concerning domestic/international education in Japan/various countries, in consequence. These fruitful results definitely should be proceeded to next Global COE directed Professor Yukio Tamura.

On the Moment when the 21st Century COE Program "Wind Effects on Buildings and Urban Environment" is Completed

Dr. Nobuyuki Kobayashi
President of Tokyo Polytechnic University

The 21st Century COE Program "Wind effects on buildings and environment" of Tokyo Polytechnic University was started in 2003 and will finish in March 2008. During these five years, the COE program has carried out many researches on wind hazard mitigation, natural cross-ventilation and air pollution in urban areas and indoors, and has harvested many excellent results. Furthermore, a lot of international symposiums and workshops were held to promote exchanges of wind engineering information. Wind engineering information was also provided and shared through the activities of the APEC Wind Engineering Information Center and Wind Engineering Technical Room, in order to contribute to wind hazard mitigation and environmental protection internationally. In order to promote the training of human resource, the COE program accepted many PhD students and researchers from overseas and held several COE Advanced Schools. The university supported the COE program in many ways, including supplying full cooperation by the section of education and research, waiving tuition fees for the graduate students, supplying facilities and space for COE activities and so on.

Through its activities during the past five years, the Wind Engineering Research Center of Tokyo Polytechnic University has grown to become a world class research and education base. It has thus achieved the purpose of the COE programs set by the Ministry of Education, Culture, Sports, Science and Technology (MEXT). Mid-term evaluation given by MEXT and the advisory Board evaluated highly our COE program. The high level activities of the COE program also encouraged teachers and students of our university, and contributed greatly to the improvement of the research and education level of our university. The university will continuously support the Wind Engineering Research Center in performing as a world class research and education base on wind engineering.

Needless to say, a great deal of effort and perseverance and strong spirit are necessary to promote the COE program. I would like to express my sincere gratitude to Prof. Yukio Tamura, the director of the COE program, and Prof. M. Ohba and Prof. R. Yoshie and other program members. My thanks are also due to the Advisory Board members, lecturers of COE Open Seminars, COE researchers and all the people related to COE program.

Report on 2nd WERC International Symposium on Architectural Wind Engineering

Date: November 5-6, 2007
Venue: Tokyo Polytechnic University, Kanagawa, Japan

The 2nd WERC International Symposium on Architectural Wind Engineering was held at the Tokyo Polytechnic University, Kanagawa, Japan by the 21st Century COE Program of the Tokyo Polytechnic University for two days from November 5 to 6, 2007. The latest wind engineering research results were presented by eight invited speakers from overseas as well as twelve lecturers related to the wind engineering research center (WERC). Over 60 people participated in the symposium. The invited speakers are introduced below.

Invited speakers

From left photo : Q.S. Li, J. Wang, Y. Li, K. Cho

From left photo : E. Ng, T. Kim, B. Lin, D. Etheridge

Report of "4th Workshop on Regional Harmonization of Wind Loading and Wind Environmental Specifications in Asia-Pacific Economies" (APEC-WW2007)

Date: November 19-20, 2007
Venue: YiFu Center, Tongji University, China

The 4th workshop on Regional Harmonization of Wind Loadings and Wind Environmental Specifications in Asia-Pacific Economies (APEC-WW2007) was held at the YiFu Center of Tongji University, China from November 19-20, 2007. It was co-hosted by the State Key Laboratory for Disaster Reduction in Civil Engineering of Tongji University and the 21st Century COE Program of Tokyo Polytechnic University. It was the last of the series of APWC-WW workshops. The first was in Nov. 2004 at TPU, Japan; the second in Dec. 2005 at HKUST, Hong Kong; and the third in Nov. 2006 at India International Centre, New Delhi, India. The purpose of the APEC-WW was to harmonize structural loading standards/codes and bylaws/specifications on wind environmental problems in the APEC area. The workshop participants comprised 26 delegates from 13 APEC economies, including 4

delegates from Japan.

On Nov. 19, the workshop started with the opening remarks of Prof. Ge (Chairman) and Prof. Xiang (Honorary Chairman). They emphasized the significance of collaboration, harmonization, and exchange of information on wind loading and wind environment related codes and recommendations in APEC economies. Then, in accordance with the concept of this workshop, the delegates from 13 economies reported their individual activities in the wind engineering field, and this was followed by very animated discussion. On November 3, the participants were separated into two groups to discuss wind loadings and wind environment. In the wind loading session, design wind loads for three example buildings (Example 1 - A steel-framed warehouse in an urban area, Example 2 – A medium height office building in a tropical city, Example 3 – A tall building in a city centre) based on the structural loading code of each country or economy were compared and discussed. In the wind environment session, the participants exchanged information on the current status of specifications on outdoor air quality, indoor air quality and measurement method, and the method for evaluating the wind environment of each economy. As a result of the two-day workshop, resolutions for wind loading and wind environment fields were made and approved individually. Future research work associated with APEC-WW2007 was confirmed. The APEC-WW meeting will be organized for the period of APECWE-VII to be held in Taiwan in 2009.

Report on COE International Advanced School on "Wind Resistant Design of Buildings and Structures" (COE-IAS3)

Date: November 21-23, 2007
Venue: Lecture Hall of Bridge Department, Tongji University, China

The COE International Advanced School on "Wind Resistant Design of Buildings and Structures", co-hosted by the 21st Century COE Program of Tokyo Polytechnic University and the Department of Bridge Engineering of Tongji University, as held from Nov.21 to 23 at the Lecture Hall of the Bridge Department, Tongji University, China.

This advanced school was the third in the series COE International Advanced Schools. The first one was on computational wind engineering in July 2006 at Atsugi city and the second was on both structural and environment engineering at Tokyo Forum in March 2007. It was the first COE advanced school held overseas, and it focused on structural wind engineering. The invited lecturers were:

Yaojun Ge – Tongji University, China
John D. Holmes – JDH Consulting, Australia
Ahsan Kareem – University of Notre Dame, USA
Michael Kasperski – Ruhr University, Germany
Kenny C.S. Kwok – Hong Kong University of Science and Technology, Hong Kong
Giovanni Solari – University of Genova, Italy
Yukio Tamura – Tokyo Polytechnic University, Japan

The COE-IAS3 began with opening remarks by Prof. Y. Tamura. He stated that 85% of economic losses due to natural hazards around the world are caused by wind damage, so that wind resistant design of buildings and structures is very important, especially in China where many high-rise buildings and large structures are under construction. However, few universities had curriculums in this area. The Advanced School intended to cover this lack of relevant advanced professional training. The lectures in the advanced school dealt with wind disaster, wind load and structural aerodynamics.

Totally 92 students, technicians and researchers attended this advanced school, among whom 6 were from overseas. The students came from 15 universities and research institutes from the mainland of China. They were wholly absorbed in the lectures, and discussed various topics with the lecturers very enthusiastically. At the closing of the advanced school, participants made short speeches to thank all the lecturers for their state-of-the-art lectures, and presented flowers to them.

Report on COE International Advanced School on "Environmental Wind Engineering" (COE-IAS4)

Date: December 6-8, 2007
Venue: Soongsil University, Korea

The 4th COE International Advanced School on Environmental Wind Engineering (COE-IAS4) was held jointly by the 21st Century COE Program of Tokyo Polytechnic University and the Wind Engineering Institute of Korea at Soongsil University in Seoul for three days from December 6 to December 8, 2007.

The themes covered at COE-IAS4 related to urban and indoor environments and included the passage of winds through buildings, the spread of contaminated substances, the heat island phenomena, the efficiency of ventilation, and breezes. Instructors and their seminars are listed below:

Young-Duk Kim – Kwandong University, Korea
- Wind tunnel tests for natural ventilation

Ryuichiro Yoshie – Tokyo Polytechnic University, Japan
- Guideline for practical applications of CFD to prediction of wind environment and air quality around buildings
- Technique for Simultaneously Measuring Fluctuating Velocity, Temperature and Concentration in Non-isothermal Flow

Akashi Mochida – Tohoku University, Japan
- Modeling of turbulent flow in urban area with various small scale flow obstacles
- Management, control and design of urban climate based on the heat balance analysis of outdoor space

Masaaki Ohba – Tokyo Polytechnic University, Japan
- Analysis of airflow of wind-driven cross-ventilated buildings based on CFD and wind tunnel experiments
- Study on predicting wind-driven cross-ventilation flow rates and discharge coefficients based on Local Dynamic Similarity Model

David Etheridge – University of Nottingham, UK
- Design procedures for natural ventilation
- Scale modeling of natural ventilation
- Theoretical modeling of envelope flow – steady and unsteady
- External flow effects on flow through small openings and leakage measurement

Shinsuke Kato – Institute of Industrial Science, University of Tokyo, Japan
- Amazing world of CFD – Applications concerning building environmental engineers
- Ventilation efficiency analysis with CFD and its application to buildings

Michael Schatzmann – University of Hamburg, Germany
- Dispersion of air pollutants within the urban canopy layer

Sang Joon Lee – Pohang University of Science & Technology, Korea
- Advanced experimental techniques (particle image velocimetry, pressure sensitive paint, etc) for wind engineering experiments
- Practical evaluation of wind environments inside factory buildings and outdoor open space in urban area.

A total of 30 people, including Korean students and corporate researchers and engineers, attended COE-IAS4. Members of the audience eagerly asked questions during the seminars and also during recesses. We would like to take this opportunity to extend our gratitude to Professor Sang Joon Lee, Professor Jong-Rak Kim (the Chairman of the Wind Engineering Institute of Korea), Professor Young-Duk Kim (the former Chairman of the Wind Engineering Institute of Korea), and many other Korean people for their assistance in making the COE-IAS4 a great success.

Executors of the 21st COE Program
Wind Effects on Buildings and Urban Environment

Diretor

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