Wind Effects News

New Frontier of Education and Research in Wind Engineering

Vol.20 January 2009

Wind Engineering Research Center
Graduate School of Engineering
Tokyo Polytechnic University

INDEX

TPU-TKU Wind Engineering Joint Workshop

開催日：8月27日（水） 11:00 – 17:30
会　場：東京工芸大学厚木キャンパス本館6階大会議室

2008年8月27日，東京工芸大学グローバルCOEプログラムと台湾の淡江大學風工学研究センター（TKU）との共催で，TPU-TKU Wind Engineering Joint Workshopが東京工芸大学にて開催された。淡江大學風工学研究センターは，10名のスタッフ（教授4名，准教授5名，PD1名）を擁し，3基の風洞設備を備えた台湾随一の風工学研究拠点である。本ワークショップは，東京工芸大学と淡江大學それぞれの風工学研究グループによる最新の研究活動についての情報交換と，相互協力を目指した意見交換を目的として企画されたものである。淡江大學からは学生を含む11名がワークショップに参加した。午前中の実験施設見学の後，午後からワークショップが行われた。田村教授によるグローバルCOEプログラムの紹介，C.M.Cheng教授による淡江大學風工学研究センターの紹介に続き，グローバルCOE客員教授のAlan Jeary教授（University of Western Sydney）の特別講義の後，淡江大學から4題，東京工芸大学から3題の研究発表があり，活発な意見交換が行われた。以下にその題目を示す。

- Opening Address & Introduction of Global COE, *Prof. Y. Tamura, TPU*
- Introduction of Wind Engineering Group of TKU, *Prof. C.M. Cheng, TKU*
- Some issues in estimating the maximum structural response to wind excitation, *Prof. Alan Jeary*
- Wind tunnel experiments to evaluate wind induced damage to buildings, *Prof. M. Matsui, TPU*
- Recent Wind Engineering Research Activities at Tamkang University, *Prof. C.M. Cheng, TKU*
- TPU aerodynamic database for low-rise buildings - Towards the achievement of EVO, *Prof. S. Cao, TPU*
- Full-scale structural measurements of GPS based sensor system for modelling evaluation, *Dr. Jean Li, TPU*
- Aerodynamic Database Development and ANN Application within the Model of e-wind, *Prof. J. Wang, TKU*
- Simulation study on ventilation flow rates and sensible cooling loads in detached house under wind-induced ventilation using network models, *Prof. M. Ohba, TPU*
- Identification of Aeroelastic Parameters and Some Other Basic Researches on Wind Engineering, *Prof. J.C. Wu, TKU*

第6回 International Colloquium on Bluff Body Aerodynamics and Applications（BBAA Ⅵ）参加報告

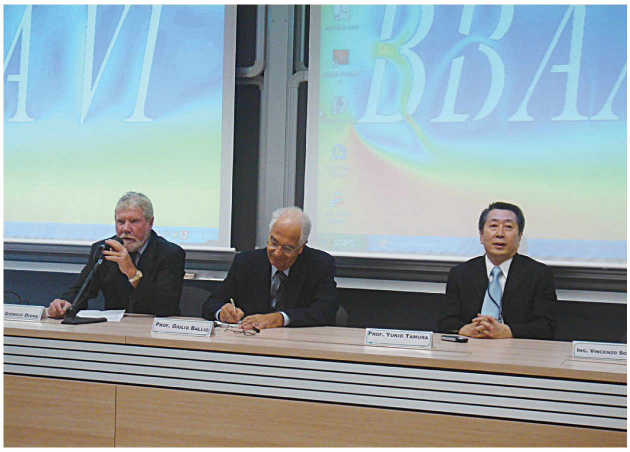
平成20年7月20日から24日にかけて，イタリア・ミラノのミラノ工科大学Bovisaキャンパスで，第6回International Colloquium on Bluff Body Aerodynamics and Applications（BBAA Ⅵ）が開催された。BBAAは風工学と深く関係する4年1度の会議で，今回Europe Africa地域で開催された第6回目は，ミラノ工科大学の

Diana 先生が Chairman を務めた。BBAA6 の登録参加者数が 146 人, 発表論文数が 115 編(うち, ポスターセッション 33 編) であった。なお, 下記4編の基調講演が行われた。

1. Pressure distribution and flow fields providing extreme aerodynamic forces （東京工芸大学田村幸雄先生）
2. The flow around high speed trains (Birmingham 大学 C.Baker 先生)
3. Insights into understanding of stay cable vibration (Johns Hopkins 大学 N.P. Jones 先生)
4. Applications of aerodynamics principles in the design of tall buildings （RWDI 社の P. Irwin 博士）

毎日午後に，ミラノ工科大学の風洞見学ツアーが行われた。ミラノ工科大学の風洞は，高速気流実験部断面（最大風速 55 m / s）と低速気流実験部断面（最大風速 16 m / s）上下二段に配置された回流式で，一般的な風工学の実験に使われる低速実験部は幅 14m，高さ 4m の巨大な空間である。

また，BBAA6 期間中に開催された BBAA 総会において，BBAA は国際風工学の傘下に戻ることが決められ，次回は Asia Pacific 地区に開催されることも決められた。



The 29th AIVC Conference in 2008 参加報告

開催日：2008 年 10 月 14 日 (火) -16 日 (木)
会　場：京都国際会議場

2008 年 10 月 14 日から 16 日にかけて、京都国際会議場で The 29th AIVC Conference in 2008 が開催された。本会議の Chairman は建築研究所の村上周三先生が務められており、建築研究所 , 国土技術政策総合研究所のメンバーが中心となって会議の準備，運営が行われた。当会議の参加人数は，200 名程度の参加があった。発表論文数が 156 編（うち､ポスターセッション 89 編）であった。なお、会議初日と最終日に下記 8 編の基調講演が行われた。

- Long-Term Strategy for Energy Saving in the Building Sector, Shuzo Murakami
- The IEA ECBCS: Research and Development for Near Zero Energy and Carbon Emission in Buildings and Communities, Morad Atif
- Energy building codes and IAQ concerns: status, opportunities and threats, C.Delmotte
- Integration of Design and Technologies for Responsive Buildings, Yuichiro Kodama
- Commissioning Process for Realization of Energy Efficient Building, Nobuo Nakahara
- Ventilation Requirements Historical Overview and Background, Willem de Gids
- Air Leakage of U.S. Homes, Max Sherman
- The current of air-tightness and ventilation system in houses of Japan, Hiroshi Yoshino

セッションは、下記のように多くの topic が用意されていたため、非常に興味ある発表が多く、全体を通して活発な質疑応答がなされていて非常に有意義な国際会議であった。

Natural ventilation / Mechanical Ventilation / Hybrid Ventilation / Air Filtering/ HAVC System for Non-Residential Building / Heating and Air-conditioning for Residential Building / Thermal Environment / Standard and Regulation for Ventilation and HAVC / Control Technology / Commissioning / Integration of Building Envelope and Services / Envelope Air Tightness / Condensation Prevention / Energy Retrofitting / Computer Simulation / Post Occupancy Evaluation and Surveys / Case Study Building / Air Distribution

Effect of porosity on net pressure on roof panel

Vu Thanh Trung, Ph.D student, TPU
Yukio Tamura, Professor, TPU
Akihito Yoshida, Associate Professor, TPU

1. INTRODUCTION

Roof panels with holes provide a solution to reducing temperature inside a building. Wind load on these roof panels depends on the difference between the upper and lower surface pressures. It is therefore important to be able to assess the effect of porosity on net pressures. Porosity allows air to flow across a roof panel tending to reduce mean pressures and to attenuate peak pressures, both of which reduce the total wind loading on the roof panel. The purpose of this study was to quantify the attenuation of wind loads on a porous roof panel as compared to that of wind loads acting on a similar non-porous roof panel in the same external flow field.

2. EXPERIMENT

A model (200mm high (H) × 470mm wide (B) × 710mm deep (D)) with roof panels was tested in a Boundary Layer Wind Tunnel, 2.2m wide by 1.8m high, in Tokyo Polytechnic University, Japan. The length and velocity scales were 1/50 and 1/4, respectively. Terrain category III (power law index 0.2) in AIJ-RFLB (2004) was chosen for the tests. The turbulence intensity at height 200mm was 0.26 and the wind speed was 7m/s. There were 3 test model cases to consider the effect of roof panel porosities (0%, 5% and 10%) with a total of 41 wind direction angles (0o to 360o in 10o steps and four wind directions angles: 45o, 135o, 225o and 315o). The model had sixteen roof panels one of which was porous with 128 holes, while four had pressure taps (A, B, C and D) (see Figure 1).

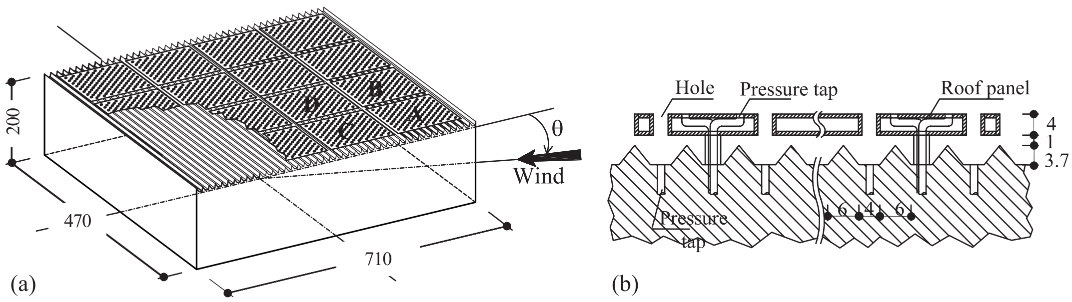


Figure 1. Test model (all dimensions in mm): (a) Geometry of test model; (b) Detail of roof section.

3. DATA ANALYSIS

The net pressure coefficient on the roof panel due to the combined effect of the upper and lower roof panel surfaces is

$$C_{p,net}(i,t) = C_{p,u}(i,t) - C_{p,l}(i,t) \qquad (1)$$

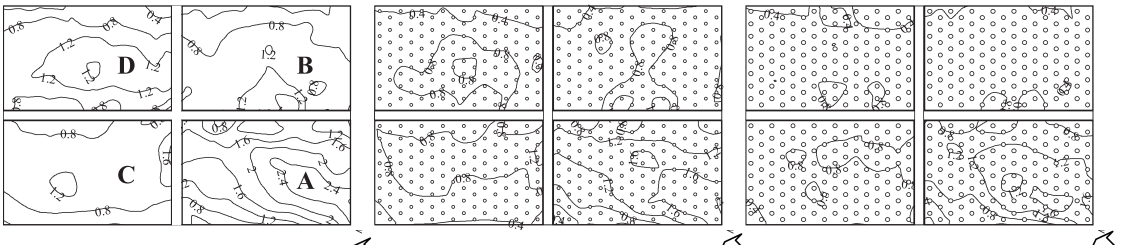
where $C_{p,u}(i,t)$ and $C_{p,l}(i,t)$ are wind pressure coefficients at measurement tap i at time t on the upper and lower surfaces of the roof panel, respectively; and $C_{p,net}(i,t)$ is the net wind pressure coefficient at measurement tap i at time t of the roof panels.

The time history of wind force coefficients was obtained by integrating the near-simultaneous pressure signals at all tap locations over both roof panel surfaces. The wind pressure coefficients and the net wind force coefficients were defined as positive in the vertically downward direction.

4. RESULTS AND DISCUSSION

Figure 2 shows the distributions of maximum peak net wind pressure coefficients ($\hat{C}_{p,net}$) on roof panels A, B, C and D for wind direction angle 45°. Generally, the pressure coefficients of the outer roof panels are always higher than those of the inner ones. Of these four roof panels, roof panel D had the lowest values. The values of $\hat{C}_{p,net}$ for 0% porosity were up to 50% and 100% higher than those for 5% and 10% porosities, respectively.

For wind direction angle 45°, $\hat{C}_{p,net}$ varied from 0.4 to 2.4. The pressures on roof panel A were higher than those on roof panels B, C and D due to conical vortices. The values of for $\hat{C}_{p,net}$ roof panels B and C were similar.



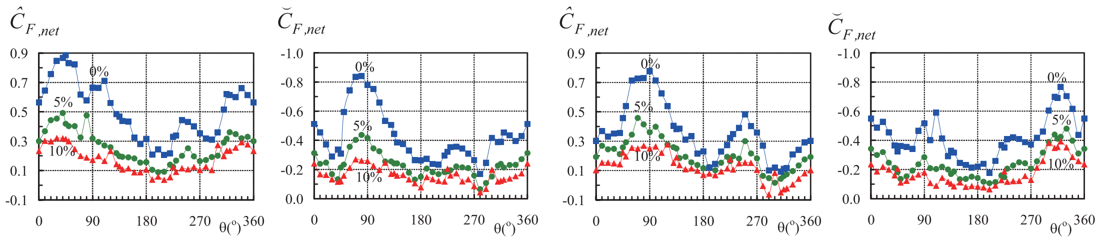
(a) Porosity 0% (b) Porosity 5% (c) Porosity 10%

Figure 2. Distributions of $\hat{C}_{p,net}$ at wind direction angle θ = 45°

Figure 3 depicts variations of maximum peak and minimum peak net wind force coefficients ($\hat{C}_{F,net}$, $\breve{C}_{F,net}$) for roof panels A and B for all wind direction angles. Generally, the net wind force coefficients for 0% porosity were the highest and those for 10% porosity were the lowest. The values of $\hat{C}_{F,net}$ were about 41% lower for 5% porosity and about 64% lower for 10% porosity than those for 0% porosity. These numbers were 37% and 49% for $\breve{C}_{F,net}$.

For the maximum peak values, there was a strong dependence between $\breve{C}_{F,net}$ and wind direction angles with a rapid change of these values for wind direction angles from 0° to 180°. The largest values of $\hat{C}_{F,net}$ for roof panels A and B were 0.89 and 0.78, respectively, corresponding to 0% porosity.

For the minimum peak values, the difference between the values of $C_{p,net}$ for 5% and 10% porosities was small. The ranges of values of $C_{p,net}$ were from -0.48 to -0.06 and from -0.39 to -0.04 for 5% and 10% porosities, respectively. The minimum peak values for 0% porosity also depended strongly on the wind direction angles, ranging from -0.84 to -0.17. Values of $C_{p,net}$ for roof panel A for 0% porosity changed quickly for wind directions angles from 0° to 180°.



(a) Panel A (b) Panel B

Figure 3. Variations of and of panels A and B with wind direction angles

5. CONCLUDING REMARKS

The effect of porosity on net pressures on the roof panels was investigated.

The maximum peak and minimum peak distributions over the surfaces of the roof panel were measured for several wind direction angles as well as for different porosities. Four roof panels had high-pressure fluctuations at wind direction angles from 0° to 180°.

From the analysis of results obtained in the tests, the pressures on the roof panels with 0% porosity were higher than those with 5% and 10% porosities. The porosities of the roof panels were most effective in reducing wind load on them.

ACKNOWLEDGEMENTS

This study was funded by the Ministry of Education, Culture, Sports, Science and Technology, Japan, through the Global Century Center of Excellence Program, 2008-2012, which is gratefully acknowledged.

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Advective and turbulent fluxes of pollutants within urban canopy

Klára Bezpalcová

Complex processes like the dispersion of car exhaust in street canyons or the dispersion of accidental releases of harmful substances in built-up areas are not yet fully understood. For a better insight of the driving phenomena it is helpful to study flow and dispersion of pollutants within an idealised urban setting first. The study of dispersion through large idealised arrays of building-like obstacles is an important method of obtaining a better understanding of dispersion through a real urban environment. We examined flow and passive tracer dispersion within 18 different configuration of the idealised urban area layouts during our experiment.

Experimental set-up

The experiment was carried out in the Boundary Layer Wind Tunnel at Wind Engineering Center of Tokyo Polytechnic University, Atsugi, Japan. The 14 m long facility provides test section with 1.2 m in width and 1 m in height. The researcher team of Wind Engineering Center of Tokyo Polytechnic University has developed new method for simultaneous measurement of velocity and concentration by the means of thermo-anemometry and flame ionization detection of the tracer gas (Yoshie et al., 2007). This set-up allows deriving turbulent fluxes related to the momentum and concentration. The flow measurement was conducted using a thermo-anemometer with split-fibre probe and constant temperature adjustment module. The concentration measurements were performed by fast flame ionisation detector.

The idealised urban canopy set-ups consisted of sharp edged wooden prism of side 70 mm and heights varied from 30 to 110mm. They were arranged in the regular aligned or staggered arrays with different obstacle spacing of 16, 25, and 34% as shown in Fig.1. Different building height distributions were also applied as shown in Fig.2. The basic cases with the uniform building height were complemented with set-ups, where the building heights follow a normal distribution with mean value 70mm=1H and standard deviation 0.17H and 0.33H, respectively (see Fig.3). The individual elements were randomly distributed. The arrangement parameters are shown in Table 1. The ground-level point source of the tracer gas ethylene (C2H4) was located in the wake of the cube at coordinates x=-5.43H, y=0, and z=0. The location was the same for all set-ups. The emission rate of the tracer gas was 300 cc/min, i.e. 18 *l* per hour. The scale of the model and of the modelled boundary layer was 1:400, i.e. the average building height would be equivalent to 28 m in the full scale. The approach boundary layer was described in Bezpalcova (2007) and it modelled atmospheric boundary layer above moderately rough terrain.

Vertical fluxes of passive pollutant

The ventilation of the urban canopy can be divided to the horizontal and vertical transport of pollution. Less dense and aligned set-ups allow higher wind speeds at the street level compared to denser and staggered set-ups and therefore the horizontal transport is enhanced in these cases. However, smaller concentrations at lower elevations in the case of the denser and staggered set-ups were observed. This is caused by the enhanced vertical transport of passive tracer. The vertical wind speed component and the concentration of passive tracer gas were measured simultaneously at one place to obtain the normalised vertical advective and turbulent fluxes $WC^*/U_H \cdot 100$ and $w'c^{*\prime}/U_H \cdot 100$, respectively. The turbulent, advective, and total vertical fluxes, as well as, a contribution of the turbulent to the total flux inside the urban canopy and above are shown in Fig.4 and 5, respectively. Inside the urban canopy the magnitude of the advective vertical flux is mainly influenced by individual buildings. The mean vertical velocity is negative in the windward regions and positive in the leeward regions of individual buildings following the well-know street canyon vortex layout (Oke, 1987). Therefore, the sign of the advective vertical transport is given. The biggest values of advective flux were obtained for denser set-ups (bold lines in Fig.4) and staggered set-ups (lower row of figures). The advective transport is predominant in the plume centreline, where the contribution of the turbulent flux to total flux approaches zero. However, the turbulent transport becomes important at the plume edges, where the concentration signal is highly intermittent with very small mean value there. Therefore, the advective flux is also very small. Nonetheless, the peak concentration values are significant and coincident with certain flow patterns resulting into significant values of turbulent vertical transport.

The turbulent transport reaches the same magnitude as the advective transport at the roof top level and higher, where the mean value of vertical velocity and also the advective vertical flux approaches zero. The vertical transport of pollution is enhanced at height of 1.5H for set-ups with non-uniform building height (red and orange colours in Fig.5). The magnitudes of both advective and turbulent transports are higher in the case of staggered set-ups with higher packing densities (bold lines in lower row in Fig.5). The contribution of the turbulent flux is significant for all set-ups.

Conclusion

Pollutant dispersion within an urban canopy is very complicated process. We have chosen an idealised canopy created by regularly placed cubes to simplify the situation. The comparison of the advective and turbulent fluxes within 18 different arrangements of idealised urban canopies has shown prevailing advective transport, but significant contribution of the turbulent transport at the edge of the plume and above the roof top level. The strongest downward and upward advective transport of the passive contaminant was found at building windward and leeward positions, respectively.

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Oke, T. R., Boundary Layer Climates, Routledge, London, 1987

Yoshie, R., Tanaka, H. and Shirasawa, T., Technique for Simultaneously Measuring Fluctuating Velocity, Temperature and Concentration in Non-isothermal Flow, Proceedings of the 12th International Conference on Wind Engineering, Cairns, Australia, pp.1399-1406, 2007

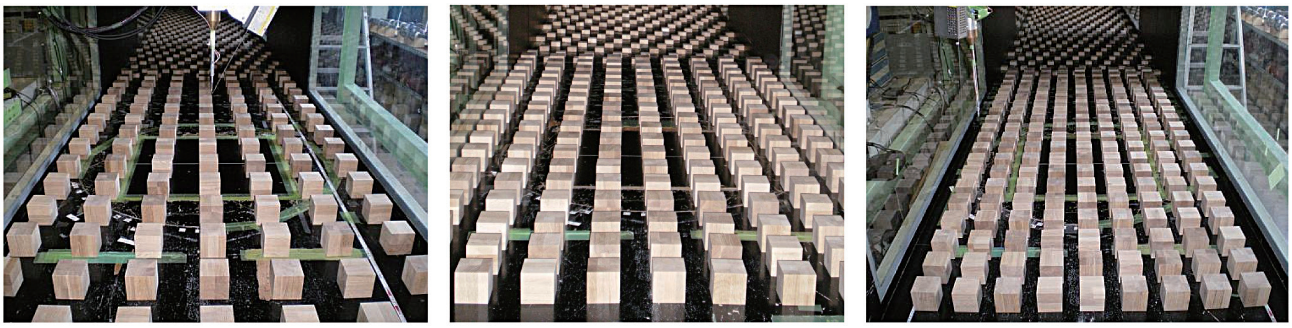

Figure 1: Idealised urban canopies with uniform building height and 16% (left), 25% (centre), and 34% (right) building coverage ratio.

Figure 2: Idealised urban canopies with non-uniform building height. Standard deviation of building heights is 0.17H and 0.33H in the left and right figure, respectively.

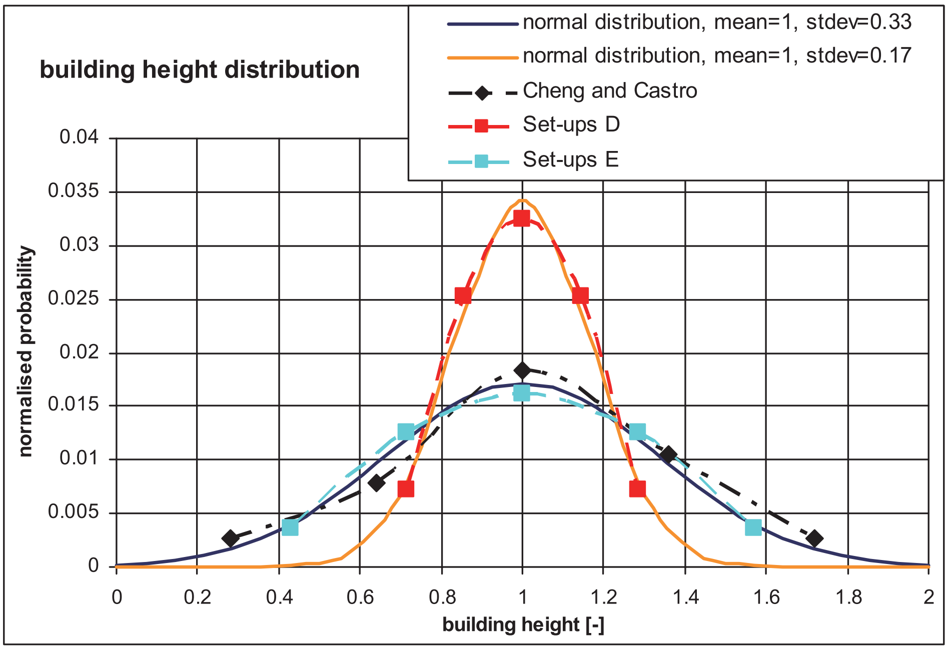

Figure 3: Normal distribution of the building heights.

Table 1: Experimental conditions.

Packing density	16%	16%	25%	25%	34%	34%
Arrangement	Aligned	Staggered	Aligned	Staggered	Aligned	Staggered
Height deviation						
uniform height	C_16_A	C_16_S	C_25_A	C_25_S	C_34_A	C_34_S
height σ=0.17	D_16_A	D_16_S	D_25_A	D_25_S	D_34_A	D_34_S
height σ=0.33	E_16_A	E_16_S	E_25_A	E_25_S	E_34_A	E_34_S

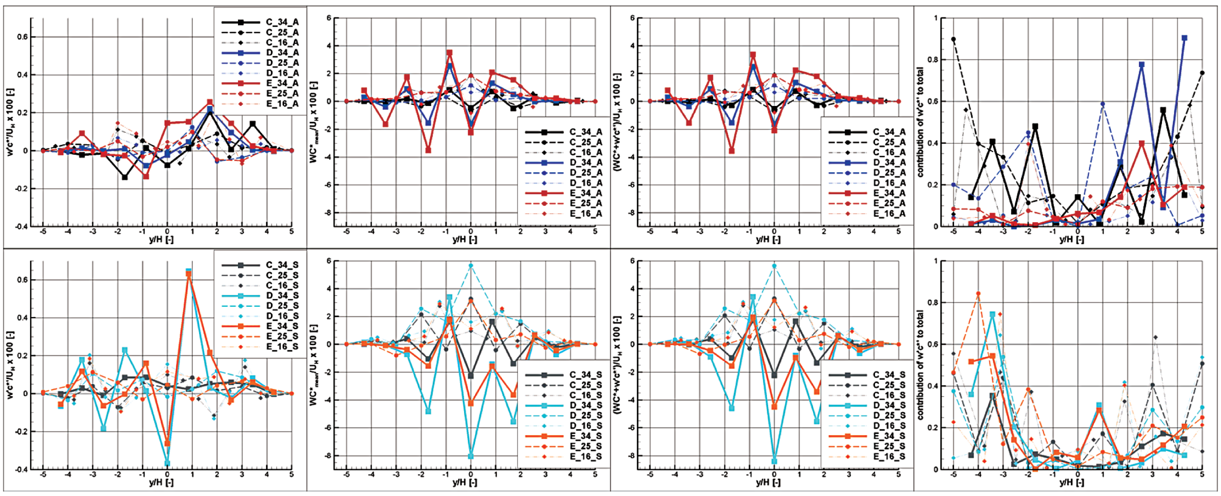

Figure 4: Horizontal profiles of normalised vertical turbulent flux (first column), advective flux (second column), total flux (third column), and contribution of the turbulent flux to the total flux (fourth column) in the middle of the fourth t street canyon behind the source at height 0.29 H.

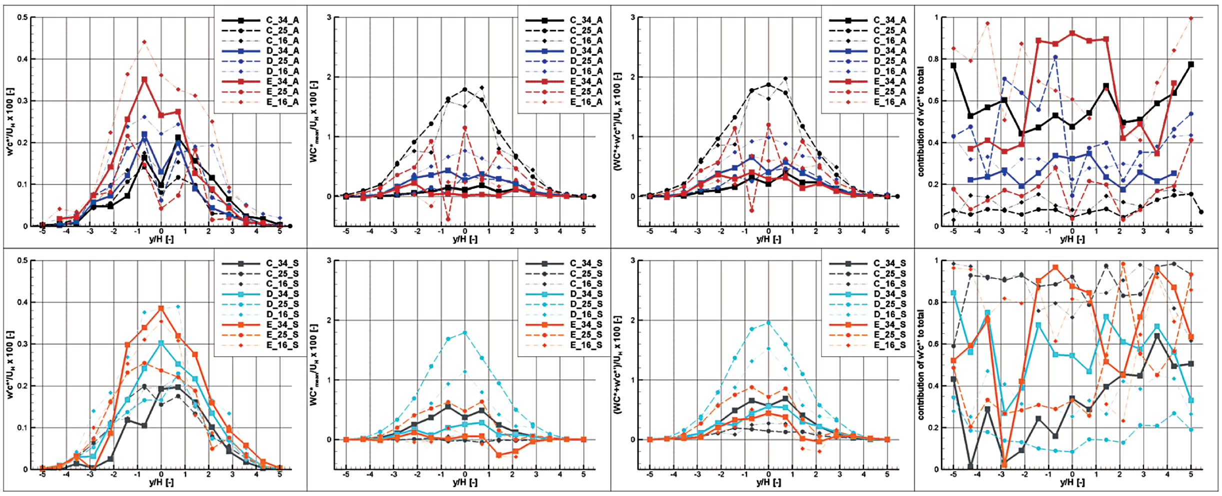

Figure 5: Horizontal profiles of normalised vertical turbulent flux (first column), advective flux (second column), total flux (third column), and contribution of the turbulent flux to the total flux (fourth column) in the middle of the fourth t street canyon behind the source at height 1.5 H.

GCOE　オープンセミナー

本 GCOE プログラムでは、どなたでも参加できる GCOE オープンセミナーを開催しています。これまでに開催された内容を以下にご紹介します。

第 1 回
日時：9 月 2 日 (火) 14:00-15:30
場所：東京工芸大学厚木キャンパス　APEC 強風防災センター 2 階　セミナー室

■ 講演者：
Alan Jeary (University of Western Sydney)
■ 講演タイトル：
Damping - History, measurement and issues

第 2 回
日時：9 月 13 日 (土) 14:00-15:30
場所：東京工芸大学厚木キャンパス　APEC 強風防災センター 2 階　セミナー室

■講演者：
Alan Jeary (University of Western Sydney)
■ 講演タイトル：
Factors influencing the risk of collapse for lattice structures

第 3 回
日時：2008 年 11 月 22 日 (土) 13:30-16:00
場所：東京工芸大学厚木キャンパス　APEC 強風防災センター 2 階　セミナー室

■ 講演者：
Chris Baker (University of Birmingham)
■ 講演タイトル：
The calculation of train pantograph displacement in cross winds

第 4 回
日時：10 月 7 日 (火) 14:00-16:00
場所：鉄道総合技術研究所

■ 講演者：
Chris Baker (University of Birmingham)
■ 講演タイトル：
The flow around high speed trains; The work of the Birmingham Centre for Rail Research and Education and Rail Research UK

第 5 回
日時：2008 年 11 月 22 日 (土) 13:30-16:00
場所：東京工芸大学厚木キャンパス　APEC 強風防災センター 2 階　セミナー室

■ 講演者：
西澤繁毅 (国土技術政策総合研究所)
■ 講演タイトル：
住宅地の通風計画のための風圧変動効果の評価

■ 講演者：
Klara Bezpalcova (JSPS Fellowship)
■ 講演タイトル：
Influence of building packing density and building heights distribution on pollution dispersion

GCOE オープンセミナーの予定は本学ホームページ (http://www.wind.arch.t-kougei.ac.jp/) でご覧いただけます。また、過去のセミナーの模様も、ストリーミングで視聴することができます。

お知らせ

- Cooperative Action for Natural Disaster Risk Reduction-(CADRR)
各種災害リスク低減のためのシンポジウム

開催日：2009 年 3 月 4 日（水）- 6 日（金）
会　場：国連大学内 U-Thant Hall および Elizabeth Rose Hall（東京都渋谷区神宮前 5-53-70）
主　催：国際風工学会（IAWE）、国連国際防災戦略（UN/ISDR）、国連大学（UNU）
　　　　アジア防災センター（ADRC）、東京工芸大学（TPU）

第 3 回　自然換気に関する国際ワークショップ

開催日：2009 年 3 月 16 日（月）10：00 ～ 17：00
会　場：建築会館ホール
主　催：東京理科大学、東京工芸大学 GCOE プログラム、（独）建築研究所

問い合わせ先：東京工芸大学工学研究科　GCOE プログラム　事務局
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URL: http://www.wind.arch.t-kougei.ac.jp/

グローバルCOEプログラム『風工学・教育研究のニューフロンティア』メンバー
工学研究科　建築学専攻

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