COE Program
TPU
Wind Effects on Buildings and Urban Environment

Wind Effects News

Wind Effects on Buildings and Urban Environment

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Wind Engineering Research Center
Graduate School of Engineering
Tokyo Polytechnic University

INDEX

Purposes of the 21st Century COE Program at Tokyo Polytechnic University

President Kenichi HONDA

The 21st Century COE Program was driven by a plan started in 2002 by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) to form targeted research centers. This program was implemented to play a core role in world top-level education and research. In particular, it was aimed at developing Japan's research center, targeting areas where Japan is in a prominent research position in the world. Its purpose is to promote and lead academic work. Currently, the "Wind Effects on Buildings and Urban Environment" proposed by the Department of Architecture of our university has been adopted as part of this 21st Century COE Program. The research theme consists of three subjects: decreasing damage due to strong wind, ventilation utilizing natural energy and removing air pollution inside and outside buildings. These are subjects that must be tackled by the humankind, who will mostly live in urban areas in the 21st century.

Civilization has rapidly advanced, resulting in extensive urbanization. All creatures, including humankind, originally lived in a rural state. Only humankind created the urbanism. Other creatures are unaware of urban life. Thus, if urbanism is pursued without thought to the consequences, there is a danger that humankind will face currently unforeseen limits in urban life. Humankind currently enjoys technology advancement and wealth of urban life. However, there is a possibility that nature will retaliate against it in future, maybe in this century. Urban buildings need to undergo extensive investigations regarding safety against earthquakes, strong winds, etc.

It is no exaggeration to say that today's urbanization will lead to a highly advanced information-oriented society. Discussions regarding this society have totally neglected the energy consumption that is associated with this highly advanced information-oriented society. Of course cooling and heating of buildings are addressed, but popularization of computers and information equipment is ignored or unnoticed. One of the tasks for humankind living in the cities in the 21st century should be to investigate ventilation utilizing natural energy and to tackle air pollution as a challenging large energy consuming system.

This research program dealing with these subjects will place the core role in the Wind Engineering Research Center of Tokyo Polytechnic University. This university does not rely on conventional organizations such as those founded in other large universities that build up graduate schools on top of undergraduate courses. However, it plans to institute a multi-peak method where researches are carried out at several research centers in a more targeted manner. The Wind Engineering Research Center is one of the targeted research organizations. With the full support of the university using this center-oriented organization, researchers, experts and their successors will be trained, while the academic level will be further improved. Furthermore, the work will not be limited to Japan, but will be extended overseas with the aim of achieving an international information provider. As the first step, opinions will be exchanged with Southeast Asian countries near Japan. The aim of this university is to lead joint research and training of successors, playing the role of a center under the guidance of the 21st Century COE Program. Thus, we seek to deliver information and messages to Southeast Asia and the world.

To maintain the correct forward direction of these key projects, a self-check and appraisal system and external assessment by third parties are indispensable. With changing social environments, common sense working inside the closed community of the university has become unworkable, and we must recognize this fact. To this end, this program plans to invite experts as an advisory board not only from Japan but also from overseas so that the project direction can be independently reviewed.

The Program expects research projects to be self-propelled. It encourages continuing enthusiasm in research and education motivated by concern for the global environment and humankind. It also promotes the objectivity to review self-performance.

To be university adopted as center for the 21st Century COE Program

Professor Yukio TAMURA, Program Director

The proposal "Wind Effects on Buildings and Urban Environment" was approved for the 21st Century COE Program. The Department of Architecture, the Graduate School of Engineering, Tokyo Polytechnic University submitted the proposal to Ministry of Education, Culture, Sports, Science and Technology (MEXT). This was the only adoption in the wind engineering field. It is obvious that the objectives cannot be achieved without the support of concerned people. We wish to ask people to cooperate and support the program.

Professor Kenichi Honda, the President of Tokyo Polytechnic University, contributed immensely to the adoption of this COE. We felt that our domestic and overseas activities in research and academic society in the wind engineering field had made a reasonably significant contribution to academic advancement in this field. However, possibility of adoption was not thought to be high because of the smallness of our university. We owe a lot to president Honda for his strong support in the submission of this application.

Another distinguished contributor was Professor Nobuyuki Kobayashi, who is currently Vice President of Tokyo Polytechnic University and who majored in architectural environmental engineering. He entered Tokyo Polytechnic University 30 years ago. He encouraged wind engineering research in the university and has continuously promoted formation of research groups specializing in wind engineering.

Firstly, he invited Professor Masaaki Ohba to work in the same architectural environmental engineering field. A little later, he invited me to work in the structural engineering field. That was 20 years ago. The Architecture Department showed full understanding in directing the engineering division toward specialization in wind engineering. The Department was very supportive in budget appropriation and arrangement of facilities and space use.

Thanks to this foresight, the facilities for the Wind Engineering Research Center were constructed in 2000 after it was adopted as the Academic Frontier for private universities. As a result, facilities and manpower were further improved. Visiting researchers and PDs from overseas joined the Center. Professor Nobuyuki Kobayashi was appointed as the first Director of the Center. Assistant Professor Kazuhide Ito joined in the environmental engineering field. Associate Professor Masahiro Matsui and Research Associate Akihito Yoshida joined in the structural field. This gave us six experts in architectural wind engineering. Besides wind engineering experts inside and outside Japan, Professor Takashi Ohno, who majored in building construction, joined the Academic Frontier. His participation provided a large driving force to research and development in the area of wind resistant construction. Manning for research education staff was improved when Invited Professor Takeshi Okuma joined the faculty of the Graduate School last year.

These persons as a group proposed the program for forming the COE Research and Education Center.

Many of the COE proposals were submitted by groups of about 20 applicants. In the light of the fact that a fairly large number of proposals were from groups as large as 30 applicants, our group should have been too small. However, it was positively evaluated in such a way that the scope was sharply focused. Besides each applicant's efforts made in the past, the evaluation should have been based on the results of our Architecture Course efforts as a whole to become the characteristic institute.

As noted, the 21st Century COE Program started in 2002 by letting the "Subsidy for Research Base Formation" take effect as a new project of MEXT based on the "Policy of structural reform of (national) universities (June 2001)". The program's goal was to train persons to be creative and able to lead the world as competitive program that could rival the performance of the world's top universities. To accomplish this, the program seeks to improve the education and research levels of our country's universities. The objective was determined to be the establishment of top-level universities that are full of vitality and international competitiveness by promoting competitive environments and supporting the formation of world-level research and education centers.

Academic fields ranging from the cultural and the social science to the natural science were grouped into about 10 field. Selection was conducted by field for two years from 2002 to 2003. Candidates were of the level of graduate schools (doctoral course) of national, public and private universities. Items to be examined included the university president's leadership and the university's strategy. Support is planned for about five years at about 100 through 500 million yen per year per sub-project. For the post-launch evaluation, interim evaluation is carried out two years after the start and final evaluation is carried out at completion.

In the engineering field, the selection was conducted this year. 23 sub-projects were selected for adoption out of 106 applications. Many of the applications were in the mechanical engineering field. Seven to eight were in the civil engineering field. Two of them were of private universities.

In view of the fact that many excellent universities failed to have their projects adopted, it must be considered that large responsibilities are transferred to us.

The 21st Century COE Program: Wind Effects on Buildings and Urban Environment

The newsletter outlines the "Wind Effects on Buildings and Urban Environment"

Research and education will be conducted at the center in various areas concerning airflow problems and urban and architecture problems such as wind hazard, ventilation issues, diffusion of air contaminants, etc.

COE is planned to be formed with the core role taken by the Wind Engineering Research Center of the University, which will become the Department of Wind Engineering as an independent entity. It will be the only such research center in Asia. The center's importance in Asia will become very high, since Asia experiences frequent human and material damage due to typhoons, etc. and has many developing countries where there are serious air pollution problems. The center's activities are planned to focus not only on research and education on wind effects on buildings and urban environment, but also on human resource exchanges and information provision resulting in promotion of damage mitigation and environmental protection. This will be accomplished by setting up the APEC Wind Hazard Mitigation Center and APEC Wind Engineers Network.

The Wind Engineering Research Center, as the core of COE, has seven wind tunnels and is staffed by five professors, one associate professor and one assistant professor. These researchers are in the fields ranging from structural engineering to environmental engineering. The center conducts joint researches with world-class researchers and promotes PD and RA. Unlike in the seismic engineering and the fire resistance engineering fields, this research center for wind effects is unique in Japan. There are also only a few such centers overseas, such as Western Ontario University in Canada and Colorado State University in USA. This is the only such research center in Asia.

85% of the economic losses due to natural hazards in the world are caused by wind damage. It is especially important to decrease wind damages in Japan and Asia. This is because of the problems of closely-spaced tall buildings in large cities and high-density residential areas where the majority of houses are made of wood. Development of a ventilation design method is also considered to be important as a national level subject. It is aimed to save operating energy costs and to decrease the load on the global environment. Air pollution that seriously impacts human health is a critical issue, especially in Asia where the population density is high.

The scope of research work is evaluation of design wind speed, understanding of the characteristics of wind forces acting on buildings, establishment of a method for estimating wind responses, construction of and proposal for wind response monitoring systems for buildings during strong wind and wind hazard prevention systems for urban buildings (area of wind resistant structures), development of a method for designing openings for natural ventilation systems to promote the use of natural ventilation energy (area of ventilation), and realization of a sustainable society with low environmental load, sick houses, issues of the air environment around people, outflow of air contaminants to outdoors, air pollution in urban areas, (area of wind environment and air pollution). In addition, it is aimed to enhance human resources such as PD, etc. and research facilities. The scope of the center's activities includes technology dissemination through APEC Wind Hazard Mitigation Center, APEC Wind Engineers Network, etc. and information delivery to the society by disclosing a digital database for wind pressure and wind force using the Technical Information Room for Wind Engineering.

The APEC Wind Hazard Mitigation Center and the Technical Information Room for Wind Engineering will be set up in the Wind Engineering Research Center. It is planned to use the centers to carry out education and international information delivery focusing on wind engineering.

- To prepare education materials for wind effects on buildings and urban environment and contents for IT utilization.
- To implement the OJT in order to encourage good students in wind engineering to join the society (industry).
- To encourage engineers and researchers in APEC countries and to transfer wind hazard mitigation technology to fit the country's needs.
- To provide courses to working people in order to promote continuing education for them and to feed back information about wind engineering to society.
- To implement international joint research and to host international seminars in order to promote international exchanges of human resources and to encourage researchers who can play international leadership roles.

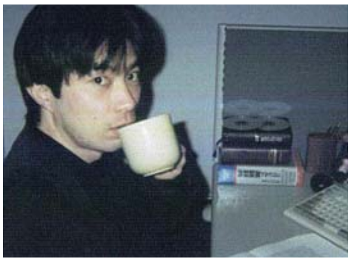
Research Project

Assistant Professor **Kazuhide ITO**

The newsletter will introduce the research projects to be executed in the 21st COE Program. The current newsletter presents a research project entitled "Indoor Air Pollution Control". Assistant Professor Kazuhide ITO is in charge of this project.

Issues on indoor air environments are being shifted from high-concentration short-term exposure, suspended particulate matters, etc. to low-concentration long-term exposure typically represented by sick buildings and the sick houses. The first is due to the incomplete combustion of the conventional open combustion equipment. The issue of the suspended particulate matters of mg/m^3 order and over is due to environmental tobacco smoke (ETS), etc. The last is due to the very small quantity of volatile organic compounds (VOC). Moreover, microbial contaminants such as molds, fungi, etc. due to damp building issues, etc. have complicated the problems of indoor air environments. The "quality" problem regarding the overall indoor environment is called IEQ (Indoor Environmental Quality). Recently, this area has increasingly attracted attentions with the increasing health consciousness of the residents. The Project 3 "Indoor Air Pollution Control" will be based on the analysis of the flow field that is formed indoors and will deal with IEQ control totally. Key words of this project are Contamination Control and Engineering Public Health.

This research will focus on air pollution issues that have a large influence on the health risk of indoor residents among the IEQ factors. The research fields are physical environmental factors such as indoor airflow, temperature field, humidity field, etc., and microbial contamination due to molds, fungi, etc. and chemical compounds contamination due to volatile organic compounds. Comprehensive research will be carried out on IEQ control from the physical, microbiological and chemical standpoints focusing on the above areas. In fact, the conventional approach is to study separately the individual issues of chemical compounds contamination and microbial contamination, and measures are also taken separately. However, the organic compound called MVOC (microorganism-origin volatile organic compound) has recently been measured. It has recently been pointed out that a certain correlation can exist between indoor microbial quantity and concentration of chemical compounds. This implies that indoor chemical compounds contamination due to the volatile organic compounds and microbial contamination due to mold, fungi, etc. are closely interrelated. Thus, it does not suggest separate treatment but the need to study the issues by linking both factors. As a matter of course, growth and breeding of microorganism such as mold, etc. and diffusion characteristics of chemical compounds are closely related to indoor physical environmental factors (thermal environment, humidity environment, air flow, etc.). Thus, comprehensive measures are necessary.



This project will carry out the researches on IEQ control as mentioned above from three aspects: (1) physical, (2) microbiological and (3) chemical. Studies dealing with the physical environment are directed to developing a high accuracy prediction method for the indoor physical environment based on several technologies in addition to the analysis of the indoor flow field based on CFD (Computational Fluid Dynamics), analysis of the temperature coupled with radiation heat transfer, analysis of the humidity field including condensation simulation, and analysis of contaminant diffusion, etc. Studies dealing with the microbiological environment are directed to developing a numerical model of microorganism growth based on the measurement of microorganism growth using a constant-temperature and constant-humidity test chamber. Studies dealing with the chemical environment are directed to developing a numerical model that can be the basis of prediction for the indoor chemical compounds concentration. This is accomplished by measuring the quantity of chemical compounds diffusion, the quantity of adsorption and desorption, and the quantity of chemical reaction using the room model type chemical-free chamber, boundary-layer-type chamber, etc. The final goal is to establish a high-accuracy IEQ prediction methods based on the CFD analysis technology.

Experimental facilities for microorganism environment system

clean chamber

constant-temperature and constant-humidity chamber

Experimental facilities for chemical substance environment system

Boundary-layer-type chemical-free chamber

Accommodation-type chemical-free chamber

COE Weekly Seminar

The 21st Century COE Program holds Weekly Seminars on Saturdays. They are open seminars that anyone can participate in freely.
The seminars held to date are listed below.

1st (10:00-12:00, August 23, Saturday in seminar room in Wind Engineering Research Center, TPU)

①■lecturer:
Dr. Yuan-Qi Li
■title:
Wind Loading and Its Effects on Single-Layer Reticulated Spherical and Cylindrical Shells


Dr.Yuan･Qi Li

②■lecturer:
Dr. Zhang Zhihong
■title:
Research on a type of large-span hybrid tension structure


Dr.Zhang Zhihong

2nd (14:00-16:00, September 13, Saturday in seminar room in Wind Engineering Research Center, TPU)

■lecturer:
Prof. Rima Taher
(New Jersey Institute of Technology, University Heights, USA)
■title:
Structural Solutions for the Design of a "Cyclonic" or Hurricane Resisting Home Adapted to Simple Construction Methods

3rd (10:00-12:00, November 1, Saturday in meeting room in the main building, TPU)

■lecturer:
Dr. Adam M. Goliger
(Construction Technologies, Wind Engineering, CSIR BOUTEK, South Africa)
■title:
Wind Engineering in South Africa

4th (14:00-17:00, November 8, Saturday in seminar room in Wind Engineering Research Center, TPU)

■lecturer:
Prof. Takeshi Ohkuma
(Kanagawa University)
(Invited Pref. of TPU)
■title:
Introduction to Wind Resistant Design of High-rise Buildings

5th (10:00-12:00, November 15, Saturday in 'Higashiyama' in Century Hyatt Tokyo)

①■lecturer:
Prof. Ahsam Kareem
(Notre Dame University, USA)
■title:
Wind Effects:
The Next Frontiers


Prof.Ahsam Kareem

②■lecturer:
Dr. Mehmet Celebi
(United States Geological Science,USA)
■title:
Real Time Monitoring of Building Responses


Dr.Mehmet Celebi

6th (13:30-16:00, November 29, Saturday in room 512 in TPU)

■lecturer:
Associate Prof. Motoya Hayashi (Miyagi Gakuin Women's College)
■title:
Actual status and improvement of indoor environment for houses

7th **(13:30-16:30, December 24, Wednesday in seminar room in Wind Engineering Research Center, TPU)**

①■**lecturer:**
Assistant Prof. Ajay Gairola (Indian Institute of Technology, Rookie University, India)
■**title:**
Scope and Prospects for Co-operative Research in Wind Engineering

②■**lecturer:**
Prof. Hiromasa Kawai (Disaster Prevention Research institute, Kyoto University)
■**title:**
Characteristics of Wind Pressure in Natural Wind

You can also see the schedule of COE Weekly Seminars on the COE part in home page of the Department of Architecture,TPU.
http://www.arch.t-kougei.ac.jp/COE/

APEC Wind Hazard Mitigation Center:APEC Short Term Fellowship

The APEC Short Term Fellowship started from January 2004 as an activity of the APEC Wind Hazard Mitigation Center.

The four engineers from India, Indonesia and China were invited as COE short term fellows for three months. It is planned to promote international exchanges of human resources and to transfer wind hazard mitigation technology through this program.

This program will be continued after this spring. Aspiring engineers and researchers from APEC Economies will be invited to next program.

You can confirm the details of this program through the leaflet "Invitation to Short Term Fellowship Program" or at the COE corner in home page of the Department of Architecture,TPU.
http://www.arch.t-kougei.ac.jp/COE/

First International Symposium on Wind Effects on Buildings and Urban Environment (ISWE1)

The First International Symposium on Wind Effects on Buildings and Urban Environment will be held at March 8 and 9,2004 in Tokyo.

【Invited Lecturers】

H. Akiyama (Nihon University, Japan)
C. Baker (The University of Birmingham, UK)
B. Bienkiewicz (Colorado State University, USA)
C.M. Cheng (Tamkang University, Taiwan)
J.D. Holmes (JDH Consulting Mentone, Australia)
M. Ito (President of IABSE, Japan)
A.P. Jeary (University of Western Sydney, Australia)
J. Kanda (University of Tokyo, Japan)
A. Kareem (University of Notre Dame, USA)
S. Kato (University of Tokyo, Japan)
H. Kawai (Kyoto University, Japan)
K.C.S. Kwok (Hong Kong University of Science and Technology, Hong Kong)
M. Matsumoto (Kyoto University, Japan)
R. Meroney (Colorado State University, USA)
S. Murakami (Keio University, Japan)
G. Solari (University of Genova, Italy)
T. Stathopoulos (Concordia University, Canada)
Y.L. Xu (The Hong Kong Polytechnic University, Hong Kong)

You can confirm the details of this conference at the COE corner in home page of the Department of Architecture,TPU.
http://www.arch.t-kougei.ac.jp/COE/isweb2004/

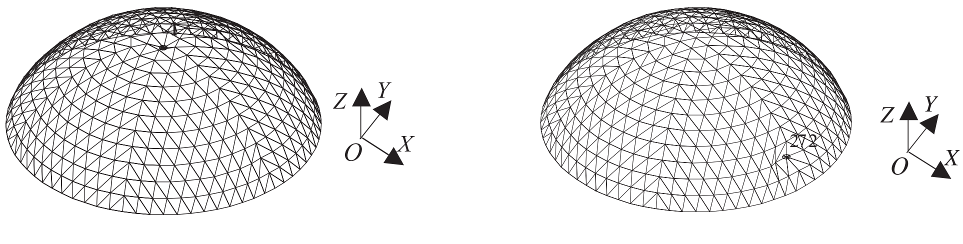
Abstracts for COE Weekly Seminars

Wind Loading and Its Effects on Single-Layer Reticulated Spherical and Cylindrical Shells

Yuan-Qi Li

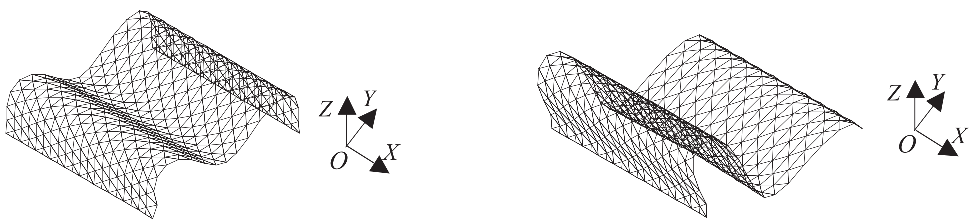
Single-Layer Reticulated Shells are a kind of space-latticed system with the features of bar system structures and thin shells. For structural design of such shells, wind loading is very important since this structural system is sensitive to external loading distribution and stability is a very important, even dominant problem. At present, usually equivalent static methods based on the quasi-steady assumption are used in wind-resistant design for such structures in practice. However, the estimated equivalent static wind loading may not reflect the actual effect of fluctuating wind loading on the stability of shells, which may lead to an unsafely higher limit load-carrying capacity. In this presentation, at first, wind pressure distributions on spherical and cylindrical shell were introduced based on rigid scaled models measured simultaneously in wind tunnel. Some special characteristics of the measured wind pressure, especially of its fluctuating component, were discussed, including the distributions of mean and fluctuating wind pressure coefficients, the auto- and cross-power spectral density (PSD) distributions of fluctuating wind pressure, the proper orthogonal decomposition (POD) of the measured wind pressure data and its utilization, the effects of length to span aspect ratios for cylindrical shells, etc.. Secondly, considering the special structural mechanical behaviors, the effects of wind loading, especially the fluctuating component, on the limit load-carrying capacity and the stability of shells were investigated by equivalent static analysis and dynamic analysis, respectively. Then, in order to get a reasonable estimation of wind load effect, suitable methods for estimating the equivalent static wind loading distribution for such shell structures were discussed. A framework in details for estimating the equivalent static wind loading distribution by the effective static loading distribution estimation method was introduced for such structural system. Furthermore, a new simple method from the stability point of view was presented to improve the efficiency of the effective static loading distribution estimation method, as well as to give a conservative estimation of the effect of wind loading on single-layer reticulated spherical shells in deformation and stability analysis. Finally, with comparison analyses, the efficiency of the presented method was proved, some advices for estimating wind loading distribution on single-layer reticulated spherical and cylindrical shells were given for practical wind-resistant design.

Keywords:single-layer reticulated spherical shells; single-layer reticulated cylindrical shells; wind tunnel test; limit load-carrying capacity; stability; wind pressure; equivalent static loading distribution; the effective static loading distribution estimation; the most unfavorable distribution estimation



(a) At Node 1 (b) At Node 272

Typical instability modes and their corresponding instability nodes for the spherical shell model.



(a) The symmetrical mode (b) The anti-symmetrical mode

Typical instability modes for the cylindrical shell model.

Research on a type of large-span hybrid tension structure

Zhang Zhihong

C.Oran Beam-Column element converges very difficultly in nonlinear stability analysis of pure bending problem. The classical T.L. or U.L. FEM has low efficiency in the stability analysis of a spatial structure with high axial force in each element. However, when the moment of element increases, the computational efficiency decreases dramatically by using C. Oran Beam-column element.

A numerical algorithm is presented in this paper to take account of the slippage of cable segments in continuous cable tension analysis. A simple example proves that this algorithm is right.

The equilibrium matrix theory is extended to cable-beam assembly and proved to be right by a Beam-String structure which has one Self-stress mode. In cable-Beam assembly, beam elements can not be actively tensioned. The distribution of initial internal force of all elements of a spatial structure composed of cable, bar and beam elements can be obtained by equilibrium matrix. It is useful to select the section of every element referring to such self-internal-force distribution, and it is helpful for the design of this kind of structure.

The dynamic relaxation method and the local arc-length method are integrated to search for the post-buckling path of reticulated spatial structures. This new method is proved to be right by classical examples in stability analysis of spatial reticulated structures.

A new method which is called local analysis method in this paper is put forward to solve the distribution of initial internal force of elements of the large-span reticulated tension spatial structure composed of cable, bar and beam elements. Moreover, another method is also presented to solve the same problem that is called as linear combination method of internal force vector caused by unit initial strain of actively tensioned cable. Based on the research on the shape determination theory a conclusion has been obtained: the distribution of the initial self-internal-force vector determines the initial shape of an assembly that has form-finding problem. At the same time, the magnitude of the self-internal-force vector affected its zero self-internal-force geometry. Another point is that the selection of element section can also affect its zero self-internal-force geometry. The zero self-internal-force geometry and the initial self-internal-force geometry mentioned here mean the geometry which take no account of the self-weight of element.

The determination of the property of element section when the self-internal-force of the element has been assigned, up to now, to the author's knowledge, this problem has not been discussed by any scholar home and abroad. The meaning consists in the feasibility of the construction of cable-bar assembly and cable-beam assembly. Namely, whether an assembly with initial self-internal-force which gotten from the equilibrium matrix theory can be constructed ideally or not, whether the design geometry presupposed can be accessed at last or not, whether the internal force of negatively tensioned element for example beam elements can release absolutely when actively tensioned elements are all set free. This problem has close relation with the construction of hybrid structure with first-order infinitesimal mechanism or higher-order ones. The solution of this problem supplements the equilibrium matrix theory. So it is very meaningful in theory and valuable in engineering application.

Based on the static analysis of large-span tension spatial structure composed of cable, bar and beam element, the proper distribution and magnitude of initial self-internal-force of element was analyzed in this paper.

The dynamic analysis of large-span tension spatial structure composed of cable, bar and beam element was also obtained in this paper. So a clear concept of the dynamic response of this type of structure was gotten. The parameter analysis of this kind of structure with different beam sections and pre-stress mode was also presented. In conclusion the internal loop of cable-system has the largest dynamic response.

The essence of post-buckling analysis was discussed in this paper. This argumentation of transform between kinetic energy and potential energy make it clear of the origin of kinetic energy of a structure when buckling phenomena occurs.

The dynamic relaxation method is applied to simulate the construction process of cable-bar system by using element transform method between bar element and catenary element. A little cable-bar system example was analyzed to prove it to be right.

Hope that this paper would be useful for further research of spatial reticulated structure.

Keywords: C.Oran beam-column element; catenary cable element; dynamic relaxation method; arc-length method; equilibrium theory; self-stress mode; form finding; force finding; distribution of element flexibility; suspen-dome; beam-string structure; stability analysis; construction simulation

Structural Solutions for the Design of a Cyclonic or Hurricane Resisting Home

Rima Taher
New Jersey Institute of Technology,University Heights,USA

This paper provides an overview of a recently completed research that relates to the design of a cyclonic or hurricane resisting home. The work is based on a prior research carried out at CSTB, Centre Scientifique et Technique du Batiment (Center for Building Science and Technology), France. In the prior research, and in order to study the influence of architectural forms on wind loads, home models of different configurations were extensively tested in the wind tunnel facility at CSTB. As a result of their testing, CSTB researchers developed a concept of a "cyclonic dwelling", that would function more efficiently under wind loads in hurricane conditions. The proposed cyclonic home incorporates some aerodynamic features and systems designed to reduce wind loads and pressures. The purpose of this recent cooperative work was to complete some other aspects of the design of this cyclonic home by looking mainly into the structural aspect of the design. This work also includes an analysis of damages caused to structures by high winds and hurricanes, and a comparative study of research results obtained by different researchers in relation to the influence of architectural forms on wind loads. A brief discussion of construction costs impacts is given. The research also offers some ideas to explore such as the possibilities of prefabrication.

Keywords: high winds, hurricanes, structural design, cyclonic home, construction.

Summary of Wind Engineering review of South Africa

Adam M.Goliger
Construction Technoiogies,Wind Engineering,CSIR BOUTEK,South Africa

South Africa is a country of large climatic diversity with climatic regions ranging from Subtropical and Mediterranean to Desert. (This is in contrast with most of the European countries, which can be characterised by fairly uniform and well-defined climates.) This situation results in a complex wind climatic conditions affecting the built environment.

Strong wind events in South Africa can broadly be divided into inland and coastal. Inland winds originate as a result of severe convective activity resulting in the development of thunderstorms, which can also produce extreme wind events like tornadoes and downbursts. Coastal winds are due to frontal low-pressure system. Figure 1a presents a photograph of a tornadic funnel, which developed in the northern part of the country and Figure 1b a winter storm off the coast of Cape Town.

On the basis of our research into the wind climate we identified three zones of Inland Winds and four zones of Coastal Winds. In Figure 2 the geographical extent of two of the inland zones is presented. It is of relevance to note that the zone corresponding to Intense Thunderstorms overlaps the commercial and industrial centre of the country.

There negative effects of strong winds in South Africa can range from: wind nuisance and danger at the street levels through to the damage to housing and industrial / commercial structures. Figure 3a presents the pedestrians in Cape Town under the south-easterly winds, Figure 3b a house devastated by a tornado and Figure 3c a 40 ton container crane blown over by the strong wind in the harbour of Port Elizabeth.

A data-base of wind damage in South Africa has been set-up. This data-base includes about one thousand wind damage events. An annual distribution of these events is presented in Figure 4. A trend, in which over the years the number of wind damage reports has increased, can be noted. This could be attributed to the increase in population density and better administrative / reporting procedures.

In South Africa the Wind Engineering activities have been conducted at the Council for Scientific and Industrial Research (CSIR) over the last twenty five years or so. These include:

- research into wind climatology,
- analysis of wind data,
- surveys and analysis of wind damage,
- development of statistics of wind disasters,
- development of wind loading codes,
- full-scale measurements and analysis,
- wind-tunnel research and commercial testing, and
- wind engineering consulting.

Figure 1a. Image of a tornado

Figure 1b. Coastal winter storm

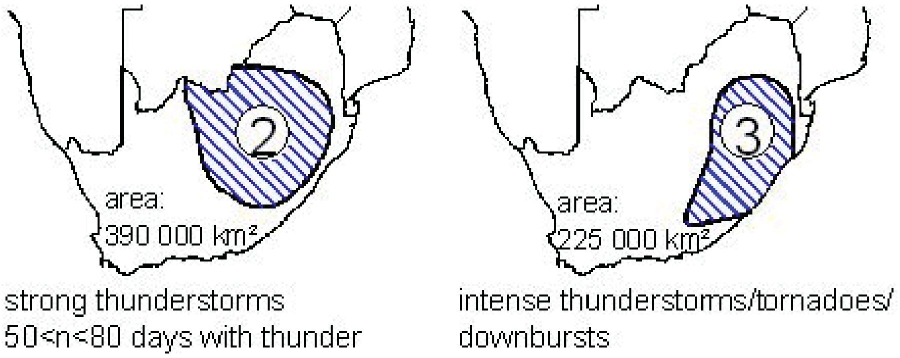


Figure 2. Climatic zones of Inland Winds

Figure 3a. Pedestrian wind environment

Figure 3b. Wind damage to a house

Figure 3c. Devastation of a container crane

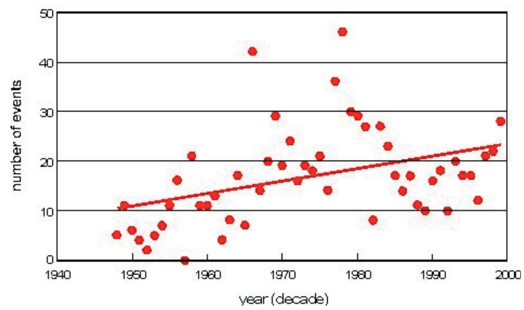


Figure 4. Annual distribution of wind damage events

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Wind Effects on Buildings and Urban Environment

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