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Geotechnical Safety and Reliability

Honoring Wilson H. Tang



Edited by

C. Hsein Juang, Ph.D., P.E.;
Robert B. Gilbert, Ph.D., P.E., D.GE;
Limin Zhang, Ph.D.; Jie Zhang, Ph.D.;
and Lulu Zhang, Ph.D.

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HONORING WILSON H. TANG

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Preface

Modeling, analysis, and design are tasks that engineers almost always have to perform in the face of uncertainties. The late Professor Wilson H. Tang (1943-2012) was one of the world's early pioneers and a prominent leader in the field of engineering uncertainties and reliability analysis. He was a great researcher and a great teacher, and his ability to explain difficult or abstract concepts to students and colleagues was one of his greatest gifts to the profession. Although recognized for his outstanding contributions in developing probabilistic methods for geotechnical engineering applications, Professor Tang's work extended well beyond the geotechnical realm, encompassing problems in civil engineering, codified design in structural engineering, risk assessment in hydraulic systems, probabilistic modeling of geotechnical systems, and the reliability of transportation systems. To commemorate and honor Professor Tang's lifetime contributions, this Geotechnical Special Publication (GSP) was initiated and completed by his former students, colleagues and friends, and published by the American Society of Civil Engineers.

This GSP contains the abstracts of 7 representative papers of Professor Tang and 17 invited contemporary contributions. These papers are categorized into seven topics: (1) site exploration; (2) uncertainty characterization and model calibration; (3) reliability methods; (4) reliability of foundations; (5) Bayesian updating; (6) risk assessment; and (7) monitoring and quality assurance. In each topic, an abstract of one of Professor Tang's papers is first presented, followed with invited contemporary contributions. These abstracts and new contributions represent the classic work of Professor Tang and the most relevant new developments in each topic area.

The editors wish to acknowledge tremendous efforts of the invitees for their contributions. Following the ASCE-GI publishing standards and requirements, their submissions were accepted following a rigorous review process. Criteria for acceptance required at least two positive reviews from two to three anonymous peer reviewers. Discussions of the new papers included in this GSP can be submitted to the ASCE Journal of Geotechnical and Geoenvironmental Engineering. All papers included in this GSP are eligible for ASCE-GI awards.

The editors also wish to acknowledge the tremendous efforts of our reviewers in reviewing these articles, without which this GSP could not have been published. The reviewers of this GSP are listed and acknowledged as follows:

Zijun Cao	Jianye Ching	Michele Calvello	Raymond Cheung
Robert B. Gilbert	Wenping Gong	Jingsong Huang	Maximilian Huber
Jian Ji	C. Hsein Juang	Dianqing Li	Zhongqiang Liu
Zhe Luo	Shadi Najjar	Ming Peng	Kok-Kwang Phoon
Nick Sartain	Armin W. Stuedlein	Wing Sun	Marco Uzielli
Yu Wang	Tien Wu	Limin Zhang	Lulu Zhang

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In organizing this special publication, emphasis was placed on connecting the theory of geotechnical risk analysis to its practical applications, a trait frequently exhibited in Professor Tang's publications. The editors expect that this special publication, focusing on practical geotechnical applications of probabilistic methods and authored by a group of distinguished scholars will be both stimulating and inspiring to their readers, and serve as a classic reference on the subject of geotechnical safety, reliability and risk assessment.

Editors
C. Hsein Juang (Clemson University)
Robert B. Gilbert (University of Texas at Austin)
Limin Zhang (Hong Kong University of Science and Technology)
Jie Zhang (Tongji University)
Lulu Zhang (Shanghai Jiao Tong University)

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Biograph

Professor Wilson H. Tang was an eminent teacher and researcher in the field of civil engineering, was known globally for his development and application of probabilistic and reliability-based approaches to geotechnical engineering systems and other civil infrastructures. Much of his innovative and pioneering studies greatly enhanced the practice of geotechnical engineering through more systematic analysis of uncertainties and their effects on safety, design and risk mitigation. His works have been published in over 200 papers, and he co-authored two well-known text books on probability concepts in engineering planning and design which have been translated into five languages. The probability methods which he championed are now widely accepted as a versatile tool in civil engineering for code development, risk assessment, design optimization and decision making.

During his career Dr. Tang served in several leadership roles, especially in promoting the use of probabilistic and reliability-based methods. He was Fellow and Honorary Member of ASCE, Vice President of Hong Kong Academy of Engineering Sciences, President of American Society of Civil Engineers-Hong Kong Section, Chairman of ASCE's Technical Committee on Reliability of Offshore Structures, and Chair of National Research Council Committee for Workshop on Reliability Methods for Risk Mitigation in Geotechnical Engineering. He served as a consultant to various industrial and government agencies on the reliability evaluation of structural and geotechnical performances. Some of his clients were the Housing Department (HKSAR), the Geotechnical Engineering Office (HKSAR), DNV Technica (Hong Kong), Golder Associates (Hong Kong), Atkins China and Victor Li & Associates, Norwegian Geotchnical Institute, PMB Engineers (Bechtel), Yukon Pacific Corporation, Alyeska, Exxon Production Research Company, Sargent & Lundy, TAM Engineers, Hanson Engineers, American Petroleum Institute, Montgomery Elevators, and the Pitkins Group.

Professor Wilson H. Tang was also the recipient of numerous awards for his lifetime of service to the geotechnical engineering profession, the most notable of which were the L F Harza-Best Paper award (2000), the T K Hsieh Award (2001), the US Offshore Energy Center's Hall of Fame (2002), the Natural Science Award (1st class) (2011), and the Hall of Fame Paper for the Offshore Technology Conference (2013). The prestigious Wilson Tang Lecture was also established to recognize and honor Professor Tang's significant work in geotechnical reliability and risk. Previous lecturers of this keynote lecture series at the International Symposium on Geotechnical Safety and Risk conference have been H. Wu (2009), Yusuke Honjo (2011), Suzanne Lacasse (2013), K.K. Phoon (2015) and Gordon Fenton (2017).

Finally, the Wilson Tang Memorial Fund established in 2012 at the Hong Kong University of Science and Technology offers scholarships to students in need, sponsor student exchange activities and promotes the education of probability concepts to both undergraduate and postgraduate students

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EDUCATION

B.S. 1966 and M.S. 1967, Massachusetts Institute of Technology
C.E. and Ph.D. 1969, Stanford University

PROFESSIONAL REGISTRATION

Registered Structural Engineer in Illinois (1973-)
Registered Professional Engineer in Illinois (1972-)

PROFESSIONAL AND SOCIETY MEMBERSHIP AND ACTIVITIES

Fellow and Honorary Member, American Society of Civil Engineers (ASCE)
Fellow, Hong Kong Institute of Engineers (HKIE)
Vice President, Hong Kong Academy of Engineering Sciences
Co-Chair, Technical Committee on Reliability of Offshore Structures, ASCE, 1981-1984
Chairman, Technical Committee on Reliability of Offshore Structures, ASCE, 1984-1987
Co-Chair, Committee on Reliability and Probability Concepts in Geotechnical Engineering Design, ASCE, 1984
President, American Society of Civil Engineers-Hong Kong Section, 1999-2000
Chair, National Research Council Committee for Workshop on Reliability Methods for Risk Mitigation in Geotechnical Engineering, 1992-1995
Vice Chair, ASCE Technical Committee on Geotechnical Reliability, 1995-1998
Member, American Society of Engineering Education, 1980-
Member, International Society of Soil Mechanics and Foundation Engineering (ISSMFE), 1985-
Member, Executive Committee of Int. Assoc. for Civil Engineering Reliability and Risk analysis (CERRA), 1987-
Member, Executive Board of the International Association for Structural Safety and Reliability (IASSAR)
Member, Committee on Stochastic Methods on Structural Engineering, IASSAR, 1988
Member, Geotechnical Board, National Research Council, 1990-1992
Member, Control Group Member, Committee on Reliability and Probability Concepts in Geotechnical Engineering Design, ASCE, 1973-1984
Member, Task Committee on Risk and Reliability of Hydraulic Design, ASCE, 1978-1980
Member, Committee on Structural Safety and Reliability, ASCE, 1984-1987
Member of Review Panel for Fulbright Scholars Selection, 1994-1996
Member, Committee of Geotechnical Division, HKIE, 1996-2000
Member, RGC Panel on Built Environment 1997-2002
ISSMFE, Technical Committee on Risk Assessment and Management, 1999-2001
Member, Land and Building Advisory Committee, HKSAR, 1999-2001
Member, (Research Assessment Team) Hong Kong University Grants Committee, 2000

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Member, Transport Advisory Committee, HKSAR 2001- 2003
Member, IFIP WG 7.5 Reliability and Optimization of Structural Systems 2003-
Member of Editorial Board, Journal of Structural Safety
Member of Editorial Panel, Geotechnical Engineering, Journal of the South East Asian Geotechnical Society 2001-
Member of Editorial Board, Uncertainties in Engineering Mechanics 2004-
Member of International Editorial Board, Computational Structural Engineering 2004-
Member of Editorial Board, GeoRisk, International Journal, 2007-
Member of Editorial Board, Chinese Journal of Geotechnical Engineering

EXPERIENCE

1969-1974	Assistant Professor, Department of Civil and Environmental Engineering, Univ. of Illinois at Urbana-Champaign (UIUC)
1974-1980	Associate Professor, Department of Civil and Environmental Engineering, UIUC
1980-1995	Professor, Department of Civil and Environmental Engineering, UIUC
1989-1991	Professor and Associate Head, Department of Civil and Environmental Engineering, UIUC
1996-2001	Professor and Head, Department of Civil Engineering, Hong Kong University of Science & Technology (HKUST)
2002-2009	Chair Professor, Department of Civil Engineering, HKUST
2009-2012	Professor Emeritus, Department of Civil Engineering, HKUST
1966 Summer	Structural Engineer, Fay, Spofford and Thorndike, Boston, USA
1971 Summer	Consulting Engineer, Sargent and Lundy, Chicago, USA
1976-1977	Guggenheim Fellow, Norwegian Geotechnical Institute, Oslo, Norway Imperial College, London, UK
1983 Fall	Visiting Professor, National University of Singapore
1995 Spring	Visiting Professor, Hong Kong University of Science & Technology
2011	Kwang-Hua Chair Professor, Tongji University, Shanghai, China

HONORS AND AWARDS

Engineers of Distinction (Engineering Joint Council), 1970
Phi Tau Phi (Honorary Society for Chinese American Scholars), 1975
John Simon Guggenheim Fellow, 1976
Civil Engineering Outstanding Teacher Award, Univ. of Illinois, 1980
Who's Who in Mid West 1981
Distinguished Lecturer, National Taiwan University, ROC, 1982
Who's Who in America, 1983
Distinguished Lecturer, Chengdu University of Science and Technology, 1987
Distinguished Lecturer, Tsinghua University, 1987
Distinguished Lecturer, Wuhan Institute of Hydraulic and Electrical Engineering, 1987
Distinguished Lecturer, Chengkung University, ROC, 1989
Who's Who in Engineering, AAES, 1990

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ASCE State of the Art of Civil Engineering Award, 1990
Urbana-Champaign Campus Award for Excellence in Undergraduate Instruction, Univ. of Illinois, 1991
Honorary Professor of Hohai University, 1999
L F Harza-Best Paper award, 2000
Honorary Professor in Shenyang Architectural and Civil Engineering Institute, China, 2000
T K Hsieh Award, Institution of Civil Engineers, UK, 2001
US Offshore Energy Center's Hall of Fame, 2002
Fellow, Hong Kong Academy of Engineering Sciences, 2003
Fellow, Hong Kong Academy of Engineering Sciences
Fellow, ASCE 2003
Honorary Member of ASCE, 2003
Visiting Chair Professor, National Taiwan University of Science and Technology, 2008
Inauguration of Wilson Tang Lecture, ISGSR Gifu, Japan, 2009
Natural Science Award (1st class) for Research Excellence, Ministry of Education of China, 2011
Kwang-Hua Chair Professor, Tongji University, China, 2011
Inauguration of Wilson Tang Best Paper Award, APSSRA 2012, Singapore
Establishment of Wilson Tang Memorial Fund, 2012, the Hong Kong University of Science and Technology
ASCE OTC Hall of Fame Award 2013

SPONSORED RESEARCH

Professor Tang has served as principal investigators in many sponsored research projects. Sponsors include US National Science Foundation, American Petroleum Institute, Office of Solid Waste Research, Department of Defense, and Department of Transportation. Projects are generally related to the probabilistic site characterization, uncertainty modeling and formulating reliability-based design procedures for geotechnical (and geo-environmental) problems, risk assessment of transportation systems. Some selected sponsored research projects in Hong Kong are:

- Construction Research Centre- Phase I Geotechnical Centrifuge Modeling (CRC Grant)
- Behavior of loose fill slopes and its stabilization with soil nails (Central Allocation)
- Development of methodology for comprehensive slop stability reliability assessment in Hong Kong
- Calibration of landslide probability from observed performance
- Reliability of deteriorated slopes
- Reliability analysis and optimal design of road networks
- Quality assurance and reliability of pile foundations
- Reliability-based displacement criteria for pile design
- Probabilistic evaluation of slope performance model error from field and reduced scaled tests model error

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Publications

1. Structural reliability based design

Tang, W.H. (1969) “Statistical Evaluation of Load Factors in Structural Design.” Technical Report No.103, Stanford University.

Niyogi, P.K., Shah, H.C., Doshi, K.D., and Tang, W.H. (1969) "Statistical Evaluation of Load Factors for Concrete Bridge Design,” Proceedings, 2nd International Symposium on Concrete Bridge Design, Vol.1, paper SP 26-3, 49-74.

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Shah, H.C., and Tang, W.H. (1970) "Statistical Evaluation of Load Factors in Structural Design,” Annals of Reliability and Maintainability, 9, 650-658.

Tang, W.H. (1971) "A Reliability-Based Evaluation of Load Factors in Structural Design,” ASCE Structural Engineering Conference, Baltimore, April.

Tang, W.H., and Yen, B.C. (1972) "Hydrologic and Hydraulic Design Under Uncertainties,” Proceedings, International Symposium on Uncertainties in Hydrologic and Water Resources Systems, Tucson, December.

2. Reliability in Hydraulics

Yen, B.C., Tang, W.H., and Mays, L.W. (1974) "Designing Storm Sewers Using the Rational Method,” Water and Sewage Works, Part I, 121(10), 92-96; Part II, 121(11), 84-85.

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Tang, W.H. (1973) "Modeling, Analysis and Updating of Uncertainties," ASCE National Meeting on Structural Engineering, San Francisco; Preprint No. 2016.

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Tang, W.H., Sidi, I., and Gilbert, R.B. (1989) "Average Property in a Random Two-State Medium," Journal of Engineering Mechanics, ASCE, 115(1), 131-144.

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Halim, I.S., and Tang, W.H. (1991) "Reliability of Undrained Clay Slope Considering Geologic Anomaly," Proceedings, ICASP, Mexico City, 776-783.
Halim, I.S., and Tang, W.H. (1993) "Site Exploration Strategy for Geologies Anomaly Characterization," Journal of Geotechnical Engineering, ASCE, 119(GT2), 195-213.
Cheung, R.W.M., and Tang, W.H. (2000) "Bayesian Calibration of Slope Failure Probability," Geotechnical Special Pulication, ASCE, GeoDenver Conference 'Slope Stability 2000', Denver, CO, USA, 5 - 8 August, 72-85.

6. Reliability and risk assessment of slopes

Yucemen, M.S., Tang, W.H., and Ang, A.H-S. (1973) "A Probabilistic Study of Safety and Design of Earth Slopes." Civil Engineering Studies, Structural Research Series No. 402, University of Illinois at Urbana-Champaign, Urbana, Illinois, July.

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Yucemen, M.S., and Tang, W.H. (1975) "Long-Term Stability of Soil Slopes--A Reliability Approach," Proceedings, 2nd International Conference on Applications of Statistics and Probability to Soil and Structural Engineering, Aachen, 215-229.

Tang, W.H., Yucemen, M.S., and Ang, A.H-S. (1976) "Probability-Based Short Term Design of Soil Slopes," Canadian Geotechnical Journal, 13, 201-215.

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Chowdhury, R., and Tang, W.H. (1987) "Comparison of Risk Models for Slopes," Proceedings, ICASP5, Vancouver, 863-869.

Chowdhury, R., Tang, W.H., and Sidi, I. (1987) "Reliability Model of Progressive Slope Failure," Geotechnique, 467-481.

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Hayashi, H., and Tang, W.H. (1994) "Probabilistic Evaluation on Progressive Failure in Cut Slope" Journal of Structural Safety, 14(1&2), 31-46.

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Tang, W.H. (1998) "Landslide Risk Management," Proceedings of First China-USA-Japan Workshop on Civil Infrastructure Systems, Zhang, X et al, eds., 292-304.

Liu, N., and Tang, W.H. (1999) "System Reliability Assessment for Soil Slope Stability," Proceedings of the International Conference Applications of Statistics & Probability (ICASP8), The University of Newcastle, Sydney, Decmeber 1999, 453-460.

Tang, W.H., Stark, T., and Angulo, M. (1999) "Reliability in Back Analysis of Slope Failures," Soils and Foundation, 39(5), 73-80.

Cheung, R.W.M., and Tang, W.H. (2001) "Use of Reliability Method in Slope Design Option Selection," Geotechnical Engineering Meeting Society's Needs, Proceeding of SEAGC, K.K.S. Ho and K.S. Li, eds., 731-736.

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Former Graduate Students

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Students at the Hong Kong University of Science and Technology

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A Wilson Story by David C Chan*

Professor Wilson Tang Hon Chung Inducted into Hall of Fame at 2013 ASCE OTC Hall of Fame Gala Dinner

PREFACE

Via Bernadette's March 15, 2013 email, most of us first learned of the good news that the world renowned Dr. Wilson H. Tang, (Professor Wilson Tang Hon Chung), our late La Salle classmate was to be honored at the 2013 ASCE OTC Hall of Fame Gala Dinner on May 7, 2013, in Houston, Texas, USA. It was also the first time I became aware of the synergism by the sponsoring organizations: American Society of Civil Engineers and Offshore Technology Conference (OTC). The former is a professional association while the latter is an oil and gas trade association, with its technology hub where energy professionals meet to explore ideas and opinions to advance scientific and technical knowledge for offshore resources and environmental matters.

INTRODUCTION

Since 1969 the Offshore Technology Conference (OTC) has become an annual trade show whose agenda includes conference and exhibition, with an emphasis on the development of offshore energy resources, primarily oil and natural gas. Held annually during the first week of May in Houston, Texas, USA, it is considered the largest oil and gas trade show in the world. Culminating this event is the Hall of Fame Gala Dinner at which time ASCE will honor the authors of extraordinary papers with ASCE OTC Hall of Fame. Though presented in the earlier years of OTC, those papers now form the core of current practice worldwide. They have provided the industry with innovation, direction and lasting impact on the design, construction or installation of the offshore infrastructure. Dr. Wilson H. Tang and fellow co-author Dr. John H. Pelletier presented their OTC Paper 6379 in 1990: Performance Reliability of Offshore Piles was so selected under this criterion.

Representing her late husband Dr. Wilson H. Tang, Bernadette would attend the function and accept Wilson's award. Her guests at the Gala would include Wilson's sister Selina Lo, her husband Clement Lo and Prof. Robert B. Gilbert of the University of Texas (Wilson's former student). Because I live in the suburb between Dallas and Fort Worth area, in relatively close proximity from Houston, the venue of the Gala Dinner, and because of my background in engineering albeit in a different industry (aerospace) I was persuaded by fellow classmates to join Bernadette and her guests. My task was to attend the event, observe and provide firsthand account of the special event, reduce that to writing for dissemination in the La Salle Class of 1961 Website for the benefit of our own class of '61, as well as for the La Salle College, students and alumni alike. Photo 1 shows Bernadette and her guests.

*David is Wilson's high school classmate at LaSalle College in Hong Kong.

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