International Association for Hydro-Environment Engineering and Research

Hosted by Spain Water and IWHR, China

2023 IAHR-SHCS

International Workshop on Scour around Hydraulic and Coastal Structures

September 4-6, 2023 Nanjing, China

PROGRAM

河海大學 HOHAI UNIVERSITY

THE UNIVERSITY OF AUCKLAND Te Whare Wananga o Tamaki Makaurau NEW ZEALAND

四川大學 SICHUAN UNIVERSITY

Nature Way 坤泽科技

CONTENTS

General Information

Dates: September 4 (Monday) - September 6 (Wednesday), 2023
Place: Science Hall, Hohai University
Official language: English

Organizers

Hohai University
The University of Auckland

Co-organizer

Sichuan University

Honorary Sponsor

International Association for Hydro-Environment Engineering and Research (IAHR)

Sponsor

Jiangsu Kunze Technology Co., Ltd

On-site Registration

The registration desk is open at Junheng Hotel Lobby on **September 4, 2023**, from **13:00 to 21:00.**

Venue

The IAHR-SCHS will be held at **Hohai University**, China. The university is located very near the city center. The weather in September is comfortable, with daytime temperatures around 27-30 °C. Sufficient hotel accommodation is available.

For any unclear issues and details, please feel free to contact our staff at information desk or call the organizers in the contact person list of service guide.

Email: schs2023@163.com Website: www.iwschs.org

International Scientific Committee

- **Committee Chairs**

Prof. Hongwu Tang *Hohai University, China*

Academician of the Chinese Academy of Engineering

He has long been committed to research and practice in the field of river dynamics. He has made a series of innovative achievements in the theoretical methods and engineering technology systems of multi-scale hydro-dynamics reconstruction in weak dynamic areas of plains. These achievements have been successfully applied to over 150 major river and lake regulation engineering plans, designs and operations in plains areas such as the Yangtze River Delta, Huaihe River. He has been awarded Second-Class National Science and Technology Progress Awards 4 times and Provincial and Ministerial-level Special Awards / First-Class Awards 5 times. He currently serves as Chairman of Hohai University Council.

Prof. Bruce Melville *The University of Auckland, New Zealand*

Fellow of the Royal Society of New Zealand

He is a world-renowned researcher in the field of fluvial sediment transport. His expertise encompasses most aspects of water resources engineering, including hydraulic, hydrological, river and environmental engineering. His book on bridge scour is widely used by bridge hydraulics engineers throughout the World. He is the Associate Editor of Journal of Hydraulic Engineering-ASCE, has served on local and international research committees, and has been a member of many tribunals for water consent hearings. He received the ASCE Hydraulic Structures Medal, the R.J. Scott Medal from RSNZ, the Dobson Supreme Technical Award and the Henderson Oration Award for his research contributions in fluvial hydraulics.

- **Executive Chair**

Prof. Jinhai Zheng *Hohai University, China*

Distinguished Young Scholar of NSFC

His research mainly focuses on harbor, waterways, coastal, and offshore engineering. His advanced coastal dynamics simulation methods have been widely adopted by many institutions including the US Army Corps of Engineers. He has received 1 Second-Class National Science and Technology Progress Award, 2 National Teaching Achievement Awards, 2014 ASCE-J WW Best Paper Award, 2020 Ahmet Cakmak Award. His student team won XPRIZE Carbon Removal Student Award in 2020. He was awarded the distinguished visiting fellowship of the UK Royal Academy of Engineering in 2016. He currently serves as a Vice-president of Hohai University.

- **Committee Members**

Prof. B. Mutlu. Sumer *BMSUMER Consultancy & Research, Turkey*

Previously Professor at the Technical University of Denmark

He is one of the leading engineers and scientists with more than 40-year experience in the seabed-structure interaction, including scour mechanism and scour protection around offshore wind farms, marine structures and submarine pipeline. He has published more than 200 peer-reviewed scientific papers and received more than 16000 citations. He received 2005 Karl Emil Hilgard Hydraulic Prize-ASCE and 1991 Science Award of TUBITAK for his contributions among many others.

Prof. D. Max Sheppard *University of Florida, USA*

Editor of Bridge Scour Manual in Florida, USA

He has more than 50 years research experiences in bridge scour, coastal and riverine hydraulics, and aeolian sand transport. As a leading scientist in the field of bridge scour, he developed the Florida Scour Manual which covers most aspects of bridge scour. His empirical equations for bridge scour prediction have been included in the U.S. Federal Highway Department's Hydraulic Engineering Circular (HEC-18) and extensively applied in bridge designs worldwide.

Prof. Fabian Bombardelli *University of California, Davis, USA*

Chief Editor of Journal of Hydraulic Engineering-ASCE

He is a leader in the development of new theoretical and numerical models for multi-phase flows, as well as in their observation in the laboratory and the field. He has published more than 70 scientific papers in major research journals of physics, hydraulic engineering and water resources, and more than 140 articles in total. Recently, he has been inducted as Member of the Academy of Engineering of Buenos Aires State, Argentina.

Prof. Robert Ettema *Colorado State University, USA*

Vice President of IAHR

He is widely known for advancing insight and engineering methods regarding sediment transport processes at bridge waterways and other hydraulic structures, and sediment transport under ice covers. He has published more than 300 journal and conference papers. He was honored for his exceptional contributions with the Hans Albert Einstein Award and the Karl Emil Hilgard Hydraulic Prize from ASCE. He had served as the Editor of Journal of Hydraulic Engineering.

Prof. Yee-Meng Chiew *Nanyang Technological University, Singapore*

Associate Editor of Journal of Hydraulic Engineering-ASCE

He has long been committed to research in the fields of local scour around riverine, coastal, and offshore structures, such as jets, submarine pipelines, ship propellers, catenary risers, etc. He has published more than 200 scientific papers and received more than 7000 citations. He received the Karl Emil Hilgard Hydraulic Prize-ASCE (2021) and the Award for Distinguished Contributions to Sediment Research (2023, by WASER). He also serves as the Associate Editor of International Journal of Sediment Research.

Prof. Liang Cheng *South China University of Technology, China*

Fellow of the prestigious Australian Academy of Technology and Engineering

He has more than 20 years' experience in research areas covering vortex-induced vibrations, scour, flow/structure/seabed interactions and computational fluid dynamics (CFD) modelling. He has published more than 300 scientific papers in these areas which received more than 5000 citations, and been working closely with industry on consulting and contract research projects. He currently serves as the Dean of School of Marine Science and Engineering at South China University of Technology.

Prof. Niansheng Cheng *Zhejiang University, China*

Expert of the National Recruitment Program of China

He has long been committed to research in the fields of hydraulics and sediment transport, with special emphasis on particle-flow interactions and their applications in environmental and river processes. He has published more than 150 journal papers. He is the recipient of Scientific and Technological Achievement, Ministry of Transportation, China and Karl Emil Hilgard Hydraulic Prize-ASCE, as well as named in Stanford University's "Top 2% of Global Scientists" list.

Prof. Michele Mossa *Polytechnic University of Bari, Italy*

Associate Editor of Journal of Hydraulic Research

He has long been committed to research in the fields of maritime, river and environmental hydraulics, including wave mechanics, sea currents, erosion processes and problems of the diffusion of pollutants in water bodies. He has published more than 200 papers in Journal of Hydraulic, Coastal Engineering, etc. He was selected within the Stanford University's "Top 2% of Global Scientists" list during the calendar year 2019 and 2020. Very recently, he was elected as the President of the Technical Committee on Ecohydraulics of the IAHR.

Prof. David R. Fuhrman *Technical University of Denmark, Denmark*

Editor of Applied Ocean Research

He has long been committed to research in the fields of coastal and ocean engineering, including sediment transport, coastal morphology and dynamics, scour, turbulence modelling. He has authored or co-authored approximately 80 scientific papers, as well as the book Turbulence in Coastal and Civil Engineering published by World Scientific. He also serves as the Associate Editor for Journal of Waterway, Port, Coastal & Ocean Engineering and the Editor board member of Coastal Engineering.

Prof. Terry Sturm *Georgia Institute of Technology, USA*

Previously Chief Editor of Journal of Hydraulic Engineering-ASCE

He has been dedicated to the research in the fields of sediment-water interface in natural watercourses and the hydrodynamic processes that occur there such as flow resistance. His research has been widely adopted by many institutions such as the US National Academy of Sciences, U.S. Geological Survey, and the U. S. Army Corps of Engineers. He is a life member of ASCE and received the ASCE-EWRI Hunter Rouse Hydraulic Engineering Award.

Prof. Jisheng Zhang *Hohai University, China*

Editorial Board member of Applied Ocean Research

He has been dedicated to the research of marine renewable energy and wave-seabed-structure interactions. He has published over 100 high-quality papers, received three international academic awards including the Best Paper Award from the journal "Soil Dynamics and Earthquake Engineering," and authored three academic monographs. He currently serves as the Associate Dean of the College of Harbour, Coastal and Offshore Engineering at Hohai University and Deputy Secretary General of the Chinese Society of Ocean Engineering.

Prof. Naresh Singhal *The University of Auckland, New Zealand*

Editorial Board member of MDPI Environments

He has long been committed to research in the fields of contaminated sites remediation, groundwater flow and transport, water quality modelling, bioinformatics, greenhouse gas emissions, antimicrobial gene resistance, and storm water management. He has published more than 150 scientific papers and has received more than 3000 citations. He served as Guest Associate Editor of Frontiers in Microbiology and the Associate Editor of Environmental Engineering Research Journal.

Prof. Asaad Y. Shamseldin *The University of Auckland, New Zealand*

Editorial Board Member of Hydrology

He has considerable research, consultancy, and technology transfer experience in the field of hydrology and water recourses, authoring a distinguished record of publications in peer refereed high-citation international journals, books and conference proceedings. He acted as a reviewer for engineering design guidelines both nationally and internationally. He is currently Vice Chair for the IAHR Sustainable Development Goals Working Group. He is also a member of the executive committee for the IAHR Asia Pacific division (IAHR-APD).

Prof. Dawei Guan *Hohai University, China*

Outstanding Young Scholar of NSFC

His research specializes in the field of sediment transport, local scour, and experimental fluids. He has published more than 60 papers in renowned international journals and conference proceedings of hydraulic/coastal engineering research, and serves as a Youth Editor of China Ocean Engineering. He has received ASCE-J.C. Stevens Award (2022) and the Award for Distinguished Contributions to Sediment Research (2023, by WASER).

A/Prof. Lu Wang *Sichuan University, China*

Young talents of Sichuan Province, China

His research focuses on sediment related fluvial disasters in mountain rivers. He has published over 40 papers including 18 papers on leading journals such as Science, Water Resources Research, Journal of Hydrology, Journal of Hydraulic Engineering. He is a winner of the ASCE J.C. Stevens Award (2022), and has been selected as a Special Expert of Sichuan Province.

Local Organizing Committee

- **Committee Chairs**

Prof. Dawei Guan	Hohai University, China
Prof. Naresh Singhal	The University of Auckland, New Zealand

- **Committee Members**

Prof. Jisheng Zhang	Hohai University, China
Prof. Asaad Y. Shamseldin	The University of Auckland, New Zealand
Prof. Lu Wang	Sichuan University, China
Prof. Titi Sui	Hohai University, China
Dr. Xiangfeng Lin	Hohai University, China
Mr. Zishun Yao	The University of Auckland, New Zealand

- **Workshop Secretary Team**

➢ **Secretary Chairs**

Dr. Xiangfeng Lin	Hohai University, China
Mr. Zishun Yao	The University of Auckland, New Zealand

➢ **Secretary Members**

Mr. Zihao Tang	The University of Auckland, New Zealand
Mr. Yingzheng Zhou	Hohai University, China
Mr. Jialin Zhao	The University of Auckland, New Zealand
Mr. Qibo Zhang	Hohai University, China
Miss. Fangyu Wang	Hohai University, China

Workshop Program

IAHR International Workshop on Scour around Hydraulic and Coastal Structures (IAHR-SHCS)			
Date	**Time**	**Workshop Program**	**Location**
September 4 (Monday)	13:00-21:00	Registration	Junheng Hotel Lobby
	18:00-20:00	Dinner	Buffet-canteen 1st floor, Junheng Hotel
September 5 (Tuesday)	08:00-08:15	Opening Ceremony	Science Hall Room 301
	08:15-08:30	Group photo	
	Keynotes Chaired by *Prof. Jisheng Zhang*		
	08:30-09:10	**Keynote Speech**: Scour at various hydraulic structures, *Prof. Bruce Melville / The University of Auckland*	
	09:10-09:50	**Keynote Speech**: Scour and scour protection at offshore substations, *Prof. B. Mutlu. Sumer / BM SUMER Consultancy & Research*	
	09:50-10:10	Coffee break	
	Keynotes Chaired by *Prof. Naresh Singhal*		
	10:10-10:50	**Keynote Speech**: On the use of the Phenomenological Theory of Turbulence (PTT) to provide a universal jet-scour formula, *Prof. Fabian Bombardelli / University of California, Davis*	
	10:50-11:30	**Keynote Speech**: Design and installation of scour protections around monopile foundations– lessons learnt from field experiences, *Prof. Liang Cheng / South China University of Technology*	
	12:00-14:00	Lunch and rest	Buffet-canteen 1st floor, Junheng Hotel
	14:00-17:15	**Parallel Sessions**: Invited Speeches & Presentations A: Scour around Hydraulic Structures B: Scour around Coastal Structures	Science Hall Room 101 Room 102
	18:00-20:00	Evening Banquet	Zijin Hall, 3rd floor, Junheng Hotel

Workshop Program

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<tr><th>Date</th><th>Time</th><th>Workshop Program</th><th>Location</th></tr>
<tr><td rowspan="14">September 6

(Wednesday)</td><td colspan="2">Keynotes Chaired by Prof. Dawei Guan</td><td rowspan="8">Science Hall
Room 301</td></tr>
<tr><td>08:00-08:40</td><td>Keynote Speech: Predicting structure-induced sediment scour rates, Prof. D. Max Sheppard / University of Florida</td></tr>
<tr><td>08:40-09:20</td><td>Keynote Speech: Scour mechanism of vibrating submarine pipelines, Prof. Yee-Meng Chiew / Nanyang Technological University</td></tr>
<tr><td>09:20-10:00</td><td>Keynote Speech: Re-visiting regression equations for equilibrium scour depths and time scales for monopiles, Prof. David R. Fuhrman / Technical University of Denmark</td></tr>
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<tr><td colspan="2">Keynotes Chaired by Prof. Asaad Y. Shamseldin</td></tr>
<tr><td>10:20-11:00</td><td>Keynote Speech: Extended applications of the concept of hydraulic radius, Prof. Niansheng Cheng / Zhejiang University</td></tr>
<tr><td>11:00-11:40</td><td>Keynote Speech: Simulation of scour around jacket foundations of offshore wind turbines in sandy seabed, Prof. Jisheng Zhang / Hohai University</td></tr>
<tr><td>12:00-14:00</td><td>Lunch and rest</td><td>Zijin Hall, 3rd floor, Junheng Hotel</td></tr>
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A: Scour around Hydraulic Structures
B: Scour around Coastal Structures</td><td>Science Hall
Room 101
Room 102</td></tr>
<tr><td>17:10-17:30</td><td>Closing Ceremony
(Including announcement of Best Poster selection results)</td><td>Science Hall
Room 101</td></tr>
<tr><td>18:00-20:00</td><td>Dinner</td><td>Zijin Hall, 3rd floor, Junheng Hotel</td></tr>
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Parallel Session: Tuesday, September 5

Session A: Scour around Hydraulic Structures (Chairs: *Lu Wang, Yifan Yang*)	
14:00-14:20	**Invited speech:** PIV measurements of flow in the scour hole induced by different types of plane jets, *Xikun Wang / Jiangsu University*
14:20-14:40	**Invited speech:** Flow-sediment interaction and formation mechanism of sediment longitudinal streaky structures in smooth channel flows, *Qiang Zhong / China Agricultural University*
14:40-15:00	**Invited speech:** Dual breach erosion in dams by overtopping, *Asaad Y. Shamseldin / The University of Auckland*
15:00-15:20	**Invited speech:** Experimental and numerical study on the local scour of caisson during construction, *Kai Wei / Southwest Jiaotong University*
15:20-15:45	Coffee break
15:45-16:00	**Presentation:** Seepage effects on flow and sediment transport rate, *Deping Cao / Tongji University*
16:00-16:15	**Presentation:** Time scale and equilibrium depth of local scour around a vibrating pipeline, *Zhimeng Zhang / Tianjin University*
16:15-16:30	**Presentation:** Critical shear stress for erosion of mud and sand-mud mixtures, *Dake Chen / Nanjing Hydraulic Research Institute*
16:30-16:45	**Presentation:** Experimental study on the influence of plane layout on the scour of straight-closed guide bank, *Wenjie Yang / Beijing Jiaotong University*
16:45-17:00	**Presentation**: Effect of approaching bedforms on the local scour depth at rock weirs, *Wen Zhang / Chongqing Jiaotong University*
17:00-17:15	**Presentation:** Numerical study on the erosion protection effect of a spoiler structure, *Hui Li / China Huaneng Clean Energy Research Institute*

Parallel Session: Tuesday, September 5

Session B: Scour around Coastal structures (Chairs: *Chunning Ji*, *Titi Sui*)	
14:00-14:20	**Invited speech:** Research and application on scouring at the seawalls foot for the seawall safety engineering in Zhejiang province, *Jian Zeng / Zhejiang Institute of Hydraulics and Estuary*
14:20-14:40	**Invited speech:** Scour mechanism around windfarm monopile foundations subjected to lateral cyclic loadings, *Dawei Guan / Hohai University*
14:40-15:00	**Invited speech:** Introducing metagenomics as a tool to study microbially induced calcium carbonate precipitation in natural systems, *Naresh Singhal / The University of Auckland*
15:00-15:20	**Invited speech:** Experiment investigation of local scour around subsea porous caissons, *Guoqiang Tang / Dalian University of Technology*
15:20-15:45	Coffee break
15:45-16:00	**Presentation:** ISPH simulation of local scour around coast structures and turbulent flows under breaking waves, *Dong Wang / Dalian Maritime University*
16:00-16:15	**Presentation:** Scour around a pile in silt under codirectional combined waves and current, *Chunguang Yuan / Tianjin Research Institute of Water Transport Engineering*
16:15-16:30	**Presentation:** Numerical simulation of seawall breach erosion and inundation due to influx of floodwater — using Typhoon Maria (1808) as a case study, *Cheng Chen / Fuzhou University*
16:30-16:45	**Presentation:** Time development of clear-water scour around a pile foundation: a first principle-based approach, *Wengang Qi / Institute of Mechanics, Chinese Academy of Sciences*
16:45-17:00	**Presentation:** Tidal currents-induced scour development around pile foundations: effects of flow velocity hydrograph, *Shunyi Wang / Institute of Mechanics, Chinese Academy of Sciences*
17:00-17:15	**Presentation:** Scour characteristics around the tripod foundation of a tidal stream turbine, *Xiangfeng Lin / Hohai University*

Parallel Session: Wednesday, September 6

Session A: Scour around Hydraulic Structures (Chairs: *Xikun Wang, Kai Wei*)	
14:30-14:50	**Invited speech:** Rapid bed degradation in mountain rivers: challenges and countermeasures, *Lu Wang / Sichuan University*
14:50-15:10	**Invited speech:** Grain sorting in sediment dynamics: new insights from a particle-level investigation of granular segregation, *Lu Jing / Tsinghua University*
15:10-15:30	**Invited speech:** Some aspects of the local scour and erosion processes in rivers and seas, *Michele Mossa / The Polytechnic University of Bari*
15:30-15:50	**Invited speech:** Fluvial scour in short- and long-term dynamic and changing environments, *Yifan Yang / The University of Waikato*
15:50-16:15	Coffee break
16:15-16:30	**Presentation:** Process-based design method for pier local scour depth under clear-water condition, *Quanshuai Liu / Hohai University*
16:30-16:45	**Presentation:** Characterization of sand motions around vibrating monopile foundations, *Zishun Yao / The University of Auckland*
16:45-17:00	**Presentation:** Scour mitigation and erodibility improvement using soybean urease-induced carbonate precipitation, *Yingzheng Zhou / Hohai University*
Session B: Scour around Coastal Structures (Chairs: *Guoqiang Tang, Wengang Qi*)	
14:30-14:50	**Invited speech:** Theoretical methods of prediction-monitoring-assessment and new technology of prevention and control of offshore wind power pile scour process, *Xuguang Chen / Ocean University of China*
14:50-15:10	**Invited speech:** Effects of the gap on the local scour around two tandem piles in shallow flows, *Chunning Ji / Tianjin University*
15:10-15:30	**Invited speech:** Applications of anti-scour solidified soil on marine structures and hydraulic engineering, *Xiao Wang / Jiangsu Kunze Technology Co., Ltd.*
15:30-15:50	**Invited speech:** Span shoulder migration in three-dimensional scour around pipelines with wave plus current conditions, *Titi Sui / Hohai University*
15:50-16:15	Coffee break
16:15-16:30	**Presentation:** Experimental study of local scour around circular-crossing and square-crossing piles in waves and current, *Shengtao Du / Ningbo University*
16:30-16:45	**Presentation:** Experimental study of scour countermeasures for offshore wind turbine monopile foundations, *Zihao Tang / The University of Auckland*
16:45-17:00	**Presentation:** Smart sediment particle for studying particle entrainment mechanism, *Yushu Xie / The University of Auckland*

Keynote Speeches

- **Keynote speech on September 5, 08:30-09:10 am**

Scour at Various Hydraulic Structures

Prof. Bruce Melville, The University of Auckland

Three cases of scour at hydraulic structures are discussed as shown in the photographs. Experimental data analyses are used to derive simple design relationships, the data being derived from flume tests undertaken at The University of Auckland (UoA) as well as other data where appropriate. A common theme is testing under mobile bed flow conditions using the water and sediment recirculating flumes at UoA, these including 2400 mm wide and 1500 mm wide flumes, both capable of generating flows exceeding 1 m^3/s. For each type of scour, countermeasures are discussed.

Research of scour at offshore monopile foundations is being undertaken currently (at the time of writing) as part of a major project headed by Hohai University. Laboratory studies at UoA are presented, namely the effects of monopile vibration on scour depth, with and without riprap protection. The experiments are being done in the 2400 mm flume under clear-water and live-bed conditions, for a range of vibration amplitudes and frequencies. Results to date show that vibration amplitude leads to deeper scour. The riprap protection experiments show that larger riprap is more effective as a countermeasure, as expected.

An extensive, current (at the time of writing) UoA laboratory program of scour due to superstructure submergence ('pressure scour' at bridges) is presented. The results are used to show the effects of the independent parameters (flow intensity, superstructure geometry and superstructure submergence) on scour depth under clear-water and live-bed conditions.

Laboratory data for scour downstream from sluice gates are presented and analyzed to derive a simple design methodology. The dataset comprises previous UoA experiments and data from other studies, but are dated. In the authors opinion, new experimental studies of this important topic are warranted. Young researchers are encouraged to consider this topic.

Figure 1. Three cases of scour at hydraulic structures.

- **Keynote speech on September 5, 09:10-09:50 am**

Scour and Scour Protection at Offshore Substations

Prof. B. Mutlu Sumer, BM SUMER Consultancy & Research

In this keynote address, the highlights of an extensive study on scour and scour protection at an offshore substation (OSS, see Fig.1) in the North Sea will be presented. The presentation is organized in two parts, namely (1) scour, and (2) scour protection.

Regarding the former, the work associated with this part of the presentation may be summarized as follows. In a desktop study, scour at the OSS structure has been assessed, starting with the simplest case, namely the isolated pile, followed by, with increasing complexity, assessing the influence of neighboring pile (the pile-group effect), that of other near-bed elements (J tubes, horizontal members and cables), and that of global scour at the corners of the footprint of the OSS platform, the most critical locations as far as the scour is concerned. This assessment exercise has been conducted in current only, as the latter metocean condition constitutes the most unfavorable condition. To test and verify the results, a series of laboratory experiments in a physical modelling study have been carried out in a test basin, located at the ITU Hydraulic Laboratory. We note that a special attention has been paid to the similarity conditions and scaling laws, and the aforementioned physical modelling experiments have been designed according to these conditions/laws.

Regarding the second part, namely, the scour protection, the work associated with this part of the presentation may, likewise, be summarized as follows. Similar to the first part of the study, scour protection for the present OSS has been designed in a desktop study whereby a two-layer protection system (comprising a top armor layer and a bottom filter layer) has been considered, taking into consideration the scour assessment made in the first part of the study. In the design of the protection layer, various criteria (related to several hydrodynamic processes such as hydrodynamic stability of armor stones, winnowing, filter criteria, bedform destabilization, edge scour, liquefaction, among others) have been checked. Similar to the first part associated with the scour study, to test and verify the results of the desktop study, an extensive series of laboratory experiments in a physical modelling exercise have been conducted in the same test basin. The metocean conditions tested in the experiments comprise various combinations of waves and current. Similarity conditions and scaling laws related to the scour-protection processes, likewise, have been worked out, and the experiments have been designed according to the latter.

The presentation will also discuss future prospects (use of CFD and also cutting-edge laboratory methods) in studies of scour and scour protection at OSS or similar structures in the offshore environment.

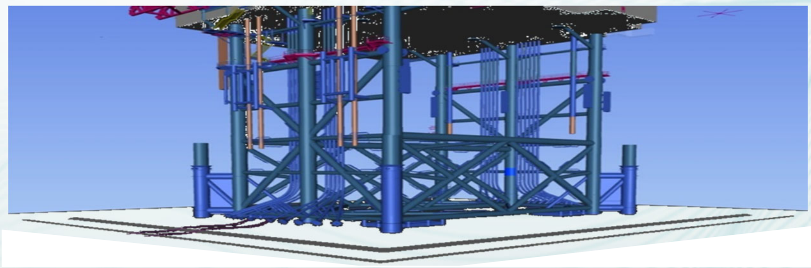


Figure 1. An offshore substation with near-bed structural elements visible, namely, main piles, pin piles, J-tubes, horizontal and diagonal structural elements, etc.

- **Keynote speech on September 5, 10:10-10:50 am**

On the Use of the Phenomenological Theory of Turbulence (PTT) to Provide a Universal Jet-Scour Formula

Prof. Fabian Bombardelli, University of California, Davis

Scour induced by jets constitutes a classic problem of fluid mechanics, for which no unique solution has been achieved for all combinations of sediment sizes and flow intensities. The safety of hydraulic structures might be compromised by the level of scour nearby. For almost one hundred years now, a number of widely-used, experimental formulas have been proposed around the world for the equilibrium scour depth (Schoklitsch, 1932; Mason and Arumugam, 1985; Bormann and Julien, 1991; and Hoffmans and Verheij, 1997). Most formulas have been developed on dimensional analysis and heuristic arguments; further, they possess experimentally-determined free exponents. Also, laboratory tests have been devoted to investigate the time evolution of the scour depth (Laursen, 1952; Blaisdell et al., 1981), and diverse expressions have been obtained. One key feature of those very useful formulas is that they are not easy to extrapolate to field situations where the flow and sediment conditions significantly differ from those at the laboratory.

As an alternative to the purely empirical formulas, some semi-theoretical expressions have been put forward, such as those of Bormann and Julien (1991), and Stein et al. (1993), with the ability to represent not only the equilibrium state but also the transient scour phenomenon.

Recently, a radically-different approach was pioneered by using the Phenomenological Theory of Turbulence (PTT) applied to the eddies of the scour process (Bombardelli and Gioia, 2005, 2006; Gioia and Bombardelli, 2005; Bombardelli et al., 2018; Di Nardi et al., 2022 and 2023). In this presentation, we introduce the theory and walk through its different levels of prediction, which can be obtained to represent equilibrium as well as the time-dependent scour depths.

PTT applies to fully-developed flow turbulence, and addresses the steady production of turbulent kinetic energy (TKE). It follows two principles: (i) TKE per unit mass is determined by scales associated with the largest (energy-containing) flow scales or eddies, being independent of viscosity; (ii) such turbulent energy, which is introduced at a rate ε, is transferred ("cascades") from large to small scales at that rate ε, until its dissipation into internal energy at sufficiently-small scales.

In the case of jets, the large scales are dictated initially by the thickness of the water layer where the jet impacts. Such layer enlarges as the scour proceeds, and the energy-containing eddies increase their size, concomitantly. By assuming that eddies harbored in the coves in between the roughness elements are within the inertial sub-range, we can use the Taylor-Kolmogorov scaling to relate the velocity scales of the two sizes of eddies. Then, by adopting a physically-based expression for bed shear stress, an equation is derived as a function of the velocity scale of the largest eddies. Finally, by using Shields criterion for incipient sediment motion, a formula for the scour depth can be derived. This methodology has been checked to offer accurate predictions of the scour depth for laboratory tests, at the time of bringing more physical insight into the interpretation of the problem.

The theory was also validated at large scales in Palermo et al. (2021), and it was successfully applied to conditions of variable jet discharges (see, for instance, Di Nardi et al., 2022 and 2023).

In addition to discussing previous developments and validations, we present herein a description of current efforts to generalize the theory to all sizes and flow conditions, hoping to uncover a "universal" theory for scour.

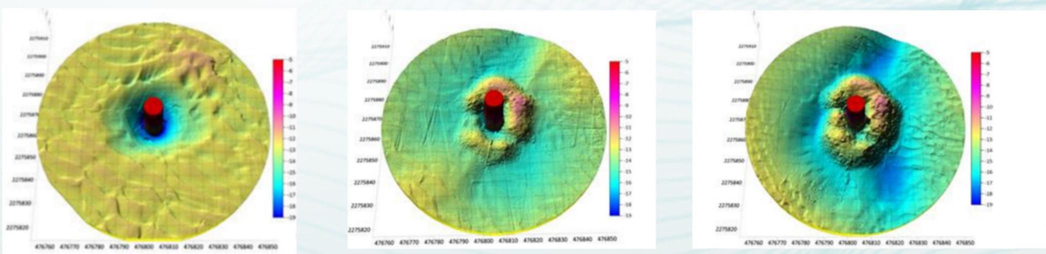
- **Keynote speech on September 5, 10:50-11:30 am**

Design and Installation of Scour Protections around Monopile Foundations– Lessons Learnt from Field Experiences

Prof. Liang Cheng, South China University of Technology

Scour protection measures are often installed around monopile foundations of offshore wind turbines installed on erodible seabeds in shallow waters to prevent the erosion of sediments around monopile foundations (e.g. Whitehouse et al. 2011; Sumer and Fredsoe 2002). Although scour protection measures are intended to protect wind turbines from the impact of environmental conditions, they may have negative impacts on the wind turbine systems if they are not adequately designed and in-stalled. A number of incidents related to scour protection measures have occurred worldwide, leading to lengthy operational downtimes and significant maintenance costs. The talk will present lessons learnt from field survey data from Europe and China and potential solutions of the problems identified, based on existing knowledge and some preliminary results of physical model testing conducted purposely.

Ripraps are one of the most commonly used scour protection measures for monopile wind tur-bines installed offshore (Whitehouse et al. 2011). Riprap scour protection is normally formed by placing rock particles around the pile to prevent the erosion of sediments. Ripraps can be installed either prior to or after the installation of monopoles, which are referred to as pre-installations or post-installations respectively hereafter. Field experiences suggested that pre-installations of ripraps appeared to work well in preventing excessive local scour around the wind turbines surveyed in a number of European offshore wind turbines (Whitehouse et al. 2011). On the other hands, significant secondary local scour was observed around wind turbines with post-installations of ripraps, based on the observations from wind turbines installed in European (Whitehouse et al. 2011) and Chinese waters. Subsequent remedial works through more rock dumping in some of the projects did not achieve the expected outcomes and even worsened the conditions. The excessive secondary scour around some of those wind turbines adopting post-installations has led to the exposure of buried cables and structural damages of power cables at locations near the wind turbines. An example of field survey results of excessive secondary scour after the post-installation of riprap scour protection in one of the offshore wind turbines is shown in Figure 1. The present talk provides interpretations of the occurrence of excessive secondary scour, based on the existing knowledge and the outcomes from purposely designed physical model tests. Finally methods for remedial rock dumping and cable protection are suggested.



(a) August 7,2021 (b) March 3,2022 (c) October 6,2022

Figure.1 Field survey of local scour around an offshore wind turbine foundation.

- **Keynote speech on September 6, 08:00-08:40 am**

Predicting Structure-Induced Sediment Scour Rates

Prof. D. Max Sheppard, University of Florida

The vast majority of structure-induced (local) sediment scour research has been devoted to understanding the complex flow and sediment transport processes and to predicting equilibrium scour depths. Much has been learned over the last few decades through laboratory and field testing and ever improving numerical computation models. As a result, the accuracy of equilibrium scour depth prediction models has improved significantly. Less studied, but also important, is the rate at which local scour occurs. The ability to predict scour rates allows more accurate estimates of design scour depths for real world situations where the design flow is time dependent and/or the sediment properties are depth dependent. A methodology for predicting local scour rates at structures with complex geometries under clearwater flow conditions is discussed along with examples that illustrate where and how the methodology can be used. The time dependent local scour depth, y_s, is expressed as:

$$y_s = \mathrm{y_{se}} \tanh\left[C\left(\frac{t}{t_{\mathrm{ne}}}\right)^{n_1}\right] \quad (0.1)$$

where

$y_{\mathrm{se}} \equiv$ equilibrium scour depth,

$t \equiv$ time, $t_{\mathrm{ne}} \equiv$ time required to reach near equilibrium depth, and

$C, n_1 \equiv$ parameters dependent on quantities that will be known to the user.

The local scour rate is:

$$\frac{\mathrm{d}y_s}{\mathrm{d}t} = \frac{y_{\mathrm{se}} n_1 C}{t_{\mathrm{ne}}}\left(\frac{t}{t_{\mathrm{ne}}}\right)^{n_1\text{-}1} \mathrm{sech}^{\,2}\left[C\left(\frac{t}{t_{\mathrm{ne}}}\right)^{n_1}\right] \quad 0.1 \le \frac{t}{t_{\mathrm{ne}}} \le 1 \quad (0.2)$$

The time required to reach a specified ratio of scour depth to equilibrium depth is:

$$t_{y_s} = \mathrm{t_{ne}}\left[\frac{1}{2\mathrm{C}} ln\left(\frac{1+(y_s/y_{\mathrm{se}})}{1\text{-}(y_s/y_{\mathrm{se}})}\right)\right]^{1/\mathrm{n_1}} \quad 0.1 \le \frac{y_s}{y_{sne}} \le 1 \quad (0.3)$$

and by substituting t_{y_s} from Eq. (1-3) into Eq.(1.2), an expression for the scour rate as a function of scour depth can be obtained:

$$\frac{\mathrm{d}y_s}{\mathrm{d}t} = \frac{y_{\mathrm{se}} n_1 C}{t_{\mathrm{ne}}}\left(\frac{t_{y_s}}{t_{\mathrm{ne}}}\right)^{n_1\text{-}1} \mathrm{sech}^{\,2}\left[C\left(\frac{t_{y_s}}{t_{\mathrm{ne}}}\right)^{n_1}\right] \quad 0.1 \le \frac{t_{y_s}}{t_{\mathrm{ne}}} \le 1 \quad (0.4)$$

The equilibrium scour depth (for both simple and complex structures) is to be computed using the methods presented in Sheppard et al., (2023).

Laboratory time history local scour data was used to develop expressions for coefficients C and n_1.

Information that will be needed to extend and improve the accuracy of this model is discussed followed by examples of how the model can be used for estimating design scour depths for situations where the model is applicable.

- **Keynote speech on September 6, 08:40-09:20 am**

Scour Mechanism of Vibrating Submarine Pipelines

Prof. Yee-Meng. Chiew, Nanyang Technological University

Submarine pipelines constructed in the riverine, coastal, and offshore environments are important engineering structures for a myriad of purposes. In the coastal and offshore environments where such pipelines often are used to convey hydrocarbon across a body of water, their failure not only has severe economic consequences, but also causes serious adverse environmental impact. One of the main causes of submarine pipeline failure is the formation of a scour hole in its vicinity. Moreover, the scour length sometimes can induce vortex-induced vibration of the pipeline, causing rupture. Scouring generally is attributed to the formation of local vortices which enhance the shear stresses and turbulence, thereby causing soil erosion and scour hole formation. Earlier research studies, e.g., Chiew, 1990, were conducted using a static pipeline to induce the formation of a 2-dimensional scour hole in both laboratory and numerical studies. Very few of studies had included vibration effects on scour because a 2D rigid pipeline was investigated.

In recent years, researchers, e.g., Wu and Chiew, 2012, began working on 3-dimensional pipeline scour where both the scour depth, width and length are formed and measured in the tests. When the scour hole reaches a certain length, self-induced vibration due to the exposure of the pipeline can occur. Besides the occurrence of self-induced vibrations, forced vibration that is attributed to the movement of the pipeline due to the local hydrodynamic forces also occurs. One of the earliest works on vibrations effects on scour hole formation was that by Li et al., 2013, who examined how a 3-dimensional pipeline vibrating in all 3 dimensions affects pipeline-scour; which resembles a vibrating catenary riser. Their work reveals that the scour hole profile (Figure) is different from those formed with a rigid, 2-dimensional pipeline. This pioneering work shows, amongst other things, that the effect of vibration, which often is present in the field, should be included to have a better understanding on pipeline-scour and so that failure can be minimized.

This paper outlines some of the state-of-the-art laboratory works on vibration effects on submarine pipeline scour. It presents how both self-induced and force-induced vibrations affect scouring, showing that the scour mechanism is markedly different from that of a rigid, 2-dimensional scour with a rigid pipeline where vibrations are absent. The main finding shows that 1-dimensional vertical vibrations can cause the pipeline to move up and down from the seabed, creating a gap to be present which allows a gap-flow between the underside and the pipe and the seabed. This creates a nozzle effects. Moreover, depending on whether the pipeline pounds on the seabed during its descend towards the bed (pounding effect), the result on local vortex formation and seabed erosion can be very different. The extent of the vibration acceleration and frequency also can affect the formation of the scour hole.

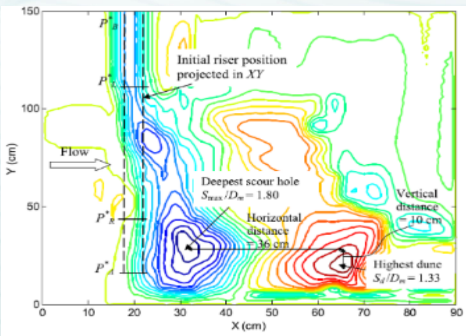


Figure 1. Pipeline-scour profile with vibration (Li et al., 2013).

- **Keynote speech on September 6, 09:20-10:00 am**

Re-Visiting Regression Equations for Equilibrium Scour Depths and Time Scales for Monopiles

Prof. David R. Fuhrman, Technical University of Denmark

Empirical formulations for the engineering prediction of live-bed equilibrium scour depths, as well as time scales (for both scour and backfilling), are re-visited for monopiles. Following prior work (Larsen et al. 2017), it is argued on physical grounds that dimensionless time scales ought to scale proportionally to the Shields parameter raised to the −3/2 power, based on scaling common to numerous sediment transport rate formulae. This is in contrast to stronger power dependence found in many existing formulations based on laboratory experiments, which may become unreliable when extrapolated to field-scale storm conditions. In light of this, existing data sets for scour and backfilling time scales are re-analyzed. Novel parameterizations are developed for their prediction which are in line with the argument above, while maintaining similar coherency with existing data as in previous parameterizations. Re-analysis of existing data sets for equilibrium scour depths is likewise performed. An existing framework (Sumer & Fredsøe 2002) valid for slender monopiles is extended to incorporate the so-called large monopile regime (non-negligible diffraction), especially important e.g. for modern wind turbine installations. An example of the latter is demonstrated in Figure 1, depicting the dimensionless equilibrium scour depth-to pile diameter ratio (S_{eq}/D) versus wave-current parameter (m=0: pure waves, m=1: pure current) for a wide range of Keulegan-Carpentar numbers KC.

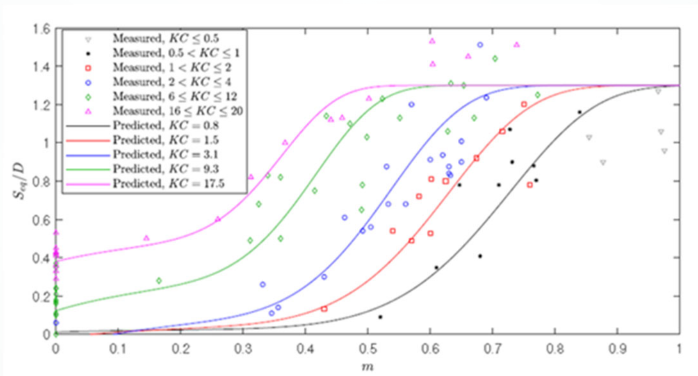


Figure 1. Comparison of measured (Sumer & Fredsøe, 2001; Qi & Gao, 2014; Sumer et al., 2013; de Lemos et al., 2023) and predicted equilibrium scour depths around a monopile in waves-plus-current conditions, as a function of wave-current parameter m and Keulegan-Carpentar number KC. Predicted lines utilize the average KC of the corresponding group of measurements having the same color.

- **Keynote speech on September 6, 10:20-11:00 am**

Extended Applications of the Concept of Hydraulic Radius

Prof. Niansheng Cheng, Zhejiang University

The hydraulic radius has been widely used to evaluate resistance and average velocity for pipe and open channel flows in hydraulic engineering. It is defined as the ratio of the area to wetted perimeter for a cross section in an open or closed channel. It has a dimension of length, being equivalent to the flow depth for wide channels and half the width for narrow channels.

In spite of the fact that the hydraulic radius is a geometric parameter for a cross section, it also serves as a measure of the size of dominant eddies in turbulent flow. With this understanding, Gioia & Bombardelli (2001) showed that the hydraulic radius is helpful in theoretically explaining the Manning equation in terms of turbulent energy cascade.

By applying the concept of hydraulic radius to a three-dimensional domain, the resistance induced by vegetation in open channel flows can be conveniently estimated in terms of drag coefficient and Reynolds number, of which both are defined based on vegetation-related hydraulic radius (Cheng & Nguyen, 2011).

Furthermore, the concept of hydraulic radius can be used to compare equilibrium scour depths at bridge piers, abutments and culverts. In these scour cases, the hydraulic radius measures the eddy size that dominates the incoming turbulent flow, and potentially the scour hole (Cheng & Wei, 2019; Cheng et al., 2011). By analyzing experimental data collected under the clear-water scour conditions, we show that the scour depth, when normalized with the redefined hydraulic radius, depends solely on the densimetric Froude number. The functional relation holds for all scour cases involving piers, abutments, culvert and wall jets.

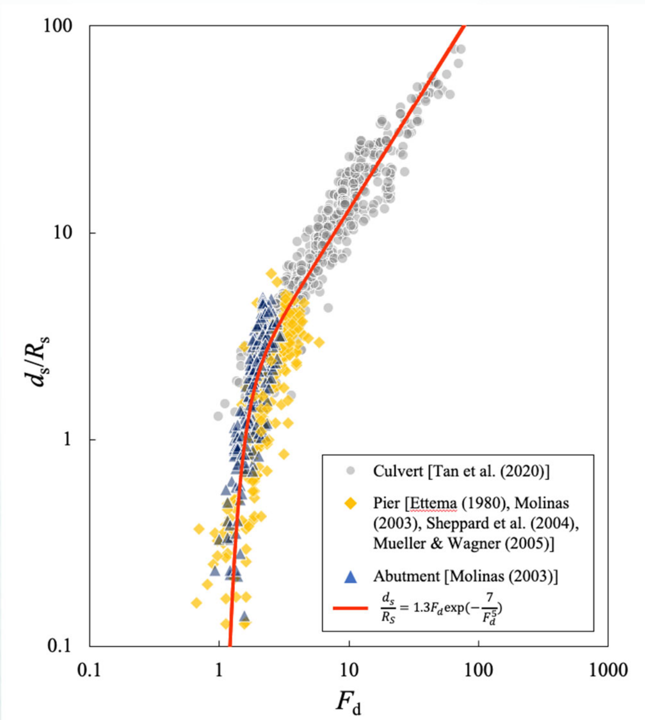


Figure 1. Dependence of scour depth normalized with redefined hydraulic radius on densimetric Froude number.

- **Keynote speech on September 6, 11:00-11:40 am**

Simulation of Scour around Jacket Foundations of Offshore Wind Turbines in Sandy Seabed

Prof. Jisheng Zhang, Hohai University

Exploration of offshore wind energy has been a vital alternative to mitigate environmental pollution due to continuous consumption of fossil fuels. Among all types of foundation supporting the offshore wind turbines, the jacket foundation is well known for its application in mild and deep- sea areas.

Physical model tests were firstly conducted to investigate scour process around the jacket foundation under complex hydrodynamic loadings. In the cases of steady currents without foundation angle, local scour around the jacket foundation could be classified into three types, i.e., independent development type, weak interference type and strong interference type, based on the influence of flow intensity. With the increasing flow intensity and decreasing water depth, local scour intensifies although the maximum scour depth always occurs at the upstream side of front pile. However, the foundation angle would alter shelter effects from the front pile and make the maximum scour depth occur at the back pile or the middle piles. Compared to the steady current, the bi-direction currents would lead to a reduction about 20% in the maximum scour depth. The location of the maximum scour depth also alternately changed between the front and back piles.

The effects from wave on local scour around the jacket foundation were also studied. For example, the maximum scour depth was found linearly related to wave height, water depth and wave period. For the combined wave-current conditions, scour process was divided into the clear-water scour and live-bed scour. In the case of clear-water scour, the maximum scour depth increased with an increasing KC number, which differs from that of live-bed scour.

In addition to physical investigation, numerical techniques were also employed to study scour process around the jacket foundation. a scour numerical model for the jacket foundation was developed using the three-dimensional Reynolds-Averaged Navier-Stokes (RANS) equations. The sand bed sediment surface was handled using the immersed boundary method, and the wall shear stress was incorporated into the local scour simulation around the jacket foundation. This model has been validated based on the physical experiment in this work. The model properly reproduces the local scour around the jacket foundation.

Figure 1. Jacket foundation application in offshore wind energy industry.

Figure 2. The jacket foundation model.

Service Guide

Workshop Site
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Hotel Information and Traffic Routes

Location and Contact Information of Hotel

✓ **Junheng Hotel**
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Tel: (+86 25) 69627788

Traffic Routes from Nanjing Railway Station to Hotel

✓ ① Take **Subway Line 1** to GuLou Station, exchange to **Bus No. 20** to XiKangLu Station, and walk 189 meters towards north. ② Taking a taxi will cost you around 25 RMB.

Traffic Routes from Nanjing South Railway Station to Hotel

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You are sincerely suggested to reach your hotel by taxi.
The route from the hotel to the workshop site is shown in the following map:

Route from the hotel to the workshop site

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