第二届管道两相瞬变流及其应用国际研讨会

会议手册

会议时间：2020年12月10日8：00-18：00

会议形式：MicrosoftTeams

（微信扫描右侧二维码加入会议群）

主办单位：河海大学水利水电学院

天津大学建筑工程学院

承办单位：河海大学水利水电学院国际合作与交流办公室

组织机构

主　席：周　领（河海大学）　练继建（天津大学，河北工程大学）

副主席：侯庆志（天津大学）

主办单位：　河海大学水利水电学院

天津大学建筑工程学院

承办单位：河海大学水利水电学院国际合作与交流办公室

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会议议程

时间	汇报人	单位	内容
主持人：周　领（河海大学）			
8:20-8:30	开幕式		
主持人：周建旭（河海大学）			
8:30-9:00	Bryan KARNEY	University of Toronto	Air-water interactions in conveyance systems–beginning to face the challenging movefrom lab and computer results to real water systems
9:00-9:30	Jose G. VASCONCELOS	Auburn University	Combining 1D and 3D modeling tools to understand air-water interactionsin a deep stormwater storage tunnels
9:30-9:40	中场休息&合影		
主持人：黄　标（宁波大学）			
9:40-10:10	Jose G. VASCONCELOS	Auburn University	The work of the ASCE task committee in two-phase flows in urban water systems
10:10-10:40	Ahmad MALEKPOUR	University of Toronto	What is a safe filling velocity in water and wastewater pipelines?
10:40-11:10	段焕丰	香港理工大学	Interaction of fluid transients with air pockets in water pipelines
主持人：**Bryan KARNEY（University of Toronto）**			
11:10-11:50	专题讨论		
主持人：万五一（浙江大学）			
14:00-14:30	谭　超	天津大学	Ultrasonic sensing technique for two-phase flow measurement
14:30-15:00	黄　标	宁波大学	Numerical modeling of air-water interactions in rapidly filling pipe with entrapped air
15:00-15:30	张博然	浙江大学	Water hammer control analysis of an intelligent surge tank with auxiliary self-adaptive control system
15:30-15:40	中场休息&合影		
主持人：段焕丰（香港理工大学）			
15:40-16:10	Janek LAANEARU	Tallinn University of Technology	Free-surface and stratified flow in the sewers with restricted ventilation
16:10-16:40	Anton BERGANT	Litostroj Power d.o.o.	Developments in unsteady vaporous cavitating pipe flow modelling
16:40-17:10	Arris S. TIJSSELING	Eindhoven University of Technology	Dancing manhole covers
主持人：**Arris S. TIJSSELING（Eindhoven University of Technology）**			
17:10-17:50	提问与讨论		

DAILY AGENDAS (English Version)

Beijing time(CST)	*Local time*	*Name*	*Topic*
Chair: Ling ZHOU(Hohai University)			
8:20-8:30	CST	**Leader's speech**	Opening
Chair: Jianxu ZHOU(Hohai University)			
8:30-9:00	Toronto, 19:30-20:00	Bryan KARNEY	Air-water interactions in conveyance systems–beginning to face the challenging move from lab and computer results to real water systems
9:00-9:30	Auburn, 20:00-20:30	Jose G. VASCONCELOS	Combining 1D and 3D modeling tools to understand air-water interactions in a deep stormwater storage tunnels
9:30-9:40	**Stretch Break&Group Photo**		
Chair: Biao HUANG (Ningbo University)			
9:40-10:10	Auburn, 20:40-21:10	Jose G. VASCONCELOS	The work of the ASCE task committee in two-phase flows in urban water systems
10:10-10:40	Toronto,21:10-21:40	Ahmad MALEKPOUR	What is a safe filling velocity in water and wastewater pipelines?
10:40-11:10	CST	Huanfeng DUAN	Interaction of fluid transients with air pockets in water pipelines
Chair: Bryan KARNEY			
11:10-11:50	**Panel Discussion**		
Chair: Wuyi WAN (Zhejiang University)			
14:00-14:30	CST	Chao TAN	Ultrasonic sensing technique for two-phase flow measurement
14:30-15:00	CST	Biao HUANG	Numerical modeling of air-water interactions in rapidly filling pipe with entrapped air
15:00-15:30	CST	Boran ZHANG	Water hammer control analysis of an intelligent surge tank with auxiliary self-adaptive control system
15:30-15:40	**Stretch Break& Group Photo**		
Chair: Huanfeng DUAN			
15:40-16:10	Estonia, 9:40-10:10	Janek LAANEARU	Free-surface and stratified flow in the sewers with restricted ventilation
16:10-16:40	Slovenia, 9:10-9:40	Anton BERGANT	Developments in unsteady vaporous cavitating pipe flow modelling
16:40-17:10	Netherlands, 9:40-10:10	Arris S. TIJSSELING	Dancing manhole covers
Chair: Arris S. TIJSSELING			
17:10-17:50	10:10-10:50	**Questions and Discussion**	

PanelDiscussion: Professors Bryan Karney, Jose Vasconcelos and other Delegates will have interactive dialogue to explore the (im)possibilities in the modelling, computing and validating of air-water two-phase transient flow.

Questions:

1. For single-phase fluids or pure water hammer problems, we rely on our established one-dimensional models. But can we do so for two-phase fluids?
2. Can our 1-D models be improved to account for interactions in unsteady two-phase flows?
3. Do we need to go fully three-dimensional using CFD?
4. Can we currently identify all existing shortcomings of either (1D-3D) modelling strategies?
5. Aren't the phenomena too complex and too unstable to be analyzed?
6. What experimental and field studies can we do to help us understand unsteady multi-phase transients?
7. Is it worth spending any money on research in this direction?
8. Can we currently assess all costs and impacts of unsteady multi-phase transients in engineered systems?

All Delegates should have experiences with this topic – please prepare your opinions.

KEYNOTE SPEECH

01.Air-water interactions in conveyance systems–beginning to face the challenging move from lab and computer results to real water systems

Bryan KARNEY
University of Toronto, Canada
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BIOGRAPHY:
Bryan Karney graduated from the University of British Columbia with a B.A.Sc. degree in 1980 and a Ph.D. in Civil Engineering in 1984.His first academic appointment was at the University of Calgary in 1985 but he has been at the University of Toronto since 1987.Bryan is currently a professor of Civil Engineering and has been the Associate Dean of the Cross-Disciplinary Programs office in the Faculty of Applied Science and Engineering since 2006. Bryan is also a principal of HydraTek with more than 30-years experience in providing comprehensive hydraulic and hydraulic transient consulting services on a wide range of fluid systems, including water, wastewater, storm, oil, gas, and jet fuel. Bryan has spoken and written widely on subjects related to water resource systems, energy issues, hydrology, climate change, optimization, engineering education, and engineering ethics. He was Associate Editor for the ASCE's Journal of Hydraulic Engineering from 1993 to 2005 and has been an Associate Editor for IAHR's Journal of Hydraulic Research since 2016.He has written numerous papers and has been awarded a number of teaching and research awards.

ABSTRACT:
Researchers have long recognized that intrinsic fascination of air-water interactions in pressurized pipe systems.Such phenomena tend to be complex and thus challenging both numerically and experimentally, but with sometimes dramatic and threatening outcomes to real systems.Such recognitions have long fostered detailed studies of air-water interactions both in the lab and computer contexts, with a few real-world case studies, often of the forensic type of attempting to determine what went wrong.There have detailed studies of filling and draining scenarios with a clear and strong fascination with rapid filling of lines with air pockets or entrapped air.But, as important as such studies are no doubt are,they still a long-way removed from the design and analysis challenges of real pipelines systems.In an envisioned or operational pipeline, one seldom knows either the initial or the boundary conditions in any detail, particularly over the likely long and evolving operational life of the system.Desired system functions, operational state, and both the operational and maintenance protocols are invariably uncertain and evolving. In the case of storm sewers, the inputs are highly uncertain and stochastic and are NEVER known in advanced except perhaps in a probabilistic sense. This paper will raise key questions about the need to begin to bring a "risk and uncertainty" framework to our approach to system design and analysis. The interim goal will be to start looking more directly for tradeoffs between cost, operational flexibility, needed system constraints and how these actions influence the risk of failure or misbehavior.

02.Combining 1D and 3D modeling tools to understand air-water interactions in a deep stormwater storage tunnels

Jose G. Vasconcelos
Auburn University, USA
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BIOGRAPHY:

Dr. Vasconcelos is an Associate Professor with the Department of Civil Engineering in the Samuel Ginn College of Engineering at Auburn University since January 2010. Dr. Vasconcelos taught previously for 3.5 years at the Department of Civil and Environmental Engineering at the University of Brasilia, and had 7 years of consulting and working experience in waterworks and infra-structure companies. He obtained his Ph.D. in Environmental Engineering from the Department Civil and Environmental Engineering at the University of Michigan in 2005.

Dr. Vasconcelos publication record includes over thirty peer-reviewed journal articles, fourteen book chapters in monographs and over forty conference papers in the area of water resources engineering, water distribution systems, stormwater hydraulics and numerical methods. Currently he serves as an Associate Editor of the Journal of Hydraulic Engineering, Senior Editor (Transient Flows and Numerical Models) for the Journal of Water Management Modeling published by Computational Hydraulics International, and as reviewer with various journals. The serves as chair of the ASCE-EWRI Hydraulic Structures Committee and the ASCE-EWRI Unsteady Two-phase Flow in Urban Water Systems Task Committee.

Dr. Vasconcelos was one of the recipients of the2018 Telford Premium for the best paper in the Engineering and Computational Mechanics Journal from the ICE, as well the 2014 James M. Robbins National Excellence in Teaching Award and the 2014 Chi Epsilon Excellence in Teaching Award for the Southern District.

ABSTRACT:

Cities have been faced with significant challenges in the management of stormwater during intense rain events. Combined sewer overflow (CSO) episodes have been a key concern for environmental agencies as they create tremendous impacts in receiving water bodies, and in this context below-grade stormwater storage tunnels have been proposed as solutions to decrease CSO frequency in densely urbanized areas. However, air-water interactions have been known to create a host of adverse effects in such systems, such as stormwater geysers, manhole cover displacement, pavement heaving, structural damage, among others. This presentation summarizes the investigation of such sever inflow events in an large urban area in US, where a 1-D model (HAST3) has been combined with a 3-D model (OpenFOAM) to study potential issues linked with air entrapment and release. This study was useful in determining the locations where air pockets were most likely to appear during intense rain events. The 3-D modeling was useful in adjusting dropshaft geometries to mitigate problems with the air displacement linked with uncontrolled air pocket release. Such combination of tools is viewed as a potential way forward to other urban areas as a means to proactively identify problems and avoid costly retrofit repairs.

03.The work of the ASCE task committee in two-phase flows in urban water systems

ABSTRACT:
The Environmental and Water Resources Institute at the American Society of Civil Engineers have been sponsoring a task committee to provide guidance to practitioners on practical issues associated with gas-liquid interactions in urban water systems. A wide range of practical problems fall in this category, ranging from priming or water pipelines, emptying water mains, rapid filling of stormwater systems, uncontrolled release of air from closed conduit flows, among others. There has been contributions in the past decades in these types of problems, but there is a perceived gap between the academic contributions and what has been adopted in engineering practice. A monograph is its production stages with a wide group of researchers across the Americas, Europe, and Asia. It is hoped that this could be a first step into bringing awareness of these types of problems and newly developed mitigation strategies, yielding more robust and resilient urban water systems.

04. What is a safe filling velocity in water and wastewater pipelines?

Ahmad MALEKPOUR
University of Toronto, Canada
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BIOGRAPHY:

Dr. Malekpour is a Hydraulic Specialist with more than 20 years of direct engineering, research, and consulting experience. He obtained his bachelor and master degrees in Irrigation and Reclamation Engineering in Iran, and his doctorate degree in Civil Engineering at the University of Toronto. Dr. Malekpour is one of the world's experts on open channel and mixed flow hydraulics, especially on the topics of managing and controlling air in such systems for which he has received several best paper awards by ASCE and ASME. He has managed many large and complex hydraulic projects internationally, and has published several journal articles on hydraulic design, optimization, and hydraulic model theory. He has also developed a variety of innovative hydraulic models, and is an expert in interpreting and critically reviewing hydraulic and CFD models. Presently, Dr. Malekpour is serving as the president and managing director of Innovative Hydraulic Group Inc., a Canadian based company providing advanced hydraulic design, modeling and investigation services.

ABSTRACT:

Filling of water and wastewater pipelines may expose them to complex transient two-component (air and liquid) flow. If the induced two-component flow is not properly controlled, the resulting transient response may impose significant positive and/or negative pressures on the pipeline system. Presently no computational method is available to evaluate and define a filling procedure. It has become common practice in the industry to designate a filling velocity of 0.3 m/s as proposed in various documents such as AWWA (AWWA M23). This 0.3 m/s filling guideline does not have a scientific basis and is developed based on the simple idea that an abrupt cessation of flow will not produce significant overpressures in the system. However, such a low velocity significantly prolongs the filling procedure, particularly in long pipelines, and even if the resulting overpressures are not significant, their reflection may still give rise to negative pressures in the system.

This presentation discusses a simplified numerical model considering two-phase flow and simulating the transient response of water and wastewater pipelines during filling. The model numerically solves the waterhammer equations on an expandable computational network to account for water column elongation during filling. An air valve boundary condition is included to both calculate the air flow exchange between the pipeline and environment and to account for the two-component flow formed in the pipe downstream side of the air valve. The validity of the proposed model is justified by the aid of both experimental study and some theoretical convergence tests.

The model is then utilized to conduct numerical experiments with a hypothetical rising pipeline subjected to various filling velocities. The result shows that filling can induce significant positive and negative pressures in the system.

The mechanism leading to the overpressure is found to be the occurrence of a column-separation like phenomenon at the air valve location. When the last air in the pipeline escapes through the air valve, the two adjacent water columns collide with different velocities whereby a secondary transient overpressure is onset. The numerical experiments also show that by restricting the air release from the air valve, the two adjacent water columns rejoins with lesser velocity difference and the resulting overpressure is significantly reduced.

This study also shows that the reflection of the induced overpressure at the filling water column front and at the upstream boundary of the system may induce negative pressures in the system. It is also found that the negative pressures can be mitigated by controlling the overpressures at the air valve.

The presentation finally concludes that : 1) the transient conditions and pressure depends on the shape and the number of undulations in the profile of the pipeline; 2) the affirmation that the severity of the resulting transient pressures increases as the filling velocity increases; 3) irrespective of the filling velocity, undesirable transient conditions can be mitigated by properly sizing key air valves in the system; 4) and even a low filling velocity of 0.3 m/s may induce negative pressures in the pipeline when a high enough overpressure onset at an air valve is reflected back at the filling water column front.

05.Interaction of fluid transients with air pockets in water pipelines

HuanfengDUAN
The Hong Kong Polytechnic University, China
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BIOGRAPHY:

Dr. HF Duan is currently an Associate professor at the Department of Civil and Environmental Engineering of the Hong Kong Polytechnic University (HKPU). Heobtained his Ph.D. in Civil Engineering (Hydraulics & Water Resources) from the Hong Kong University of Science and Technology (HKUST) in 2011, with receiving the PhD Research Excellence Award from the university. Dr. Duan's research interests and fields include water distribution system analysis (simulation and optimization), hydraulic and transient modelling, pipe defects detection (leakage and blockage), urban stormwater drainage and flash flood analysis (design and management), and coastal fluid-structure interaction (storm surges and floating structures). To date, he has published over 80 papers in the peer-reviewed and leading journalsin above-mentioned research fields (e.g., JHE, JHR, WRR, JWRPM, MSSP, RMRE, etc.). Currently, Dr. Duanserves astheAssociate Editorsfor the Journal of *Engineering Applications of Computational Fluid Mechanics* (JCR Q1, IF-2019 = 5.800) and the *IWA Journal of Water Supply: Research and Technology – AQUA*(JCR Q3, IF-2019 = 1.319). He is also active member for the IAHR, ASCE and ASME, and the Executive Committee of IAHR–HK Chapter (since 2014). Dr. Duan is now the Leader of Hydraulics Unit, the Director of Fluid Mechanics & Hydraulics Laboratories, and the Deputy Leader of the Civil Engineering (HD)Programme in his department at HKPU.

ABSTRACT:

The presence of entrapped air in water supply pipeline systems can reduce pumping efficiency and increase pressures experienced during surges, causing or exacerbating system damage. At present, air pockets/cavities in pipelinescan only be located using methods impractical for large networks. Fluid transients are a potential diagnostic tool for detecting entrapped air pockets in water pipelines. In fact, transients have been used to detect different pipe defects, such as leaks, blockages and branches, but further theoretical and experimental researchesare required to quantify the effect of entrapped air pockets in pipes. Usually, air pockets or cavities may exist in pipes with two forms – inline and offline air pockets, according to their lumped locations and dynamic interactions with the main water flow streams along pipeline. In consequence, understanding and quantifying the interactions of fluid transients with different air pockets will be useful and necessary to the development and application of transient-based diagnosis (locating and sizing) of air pockets/cavities in water pipelines.

This seminar will present the results and findings through a series of numerical and experimental studies on the underlying mechanism and evolution process of the interactions

of fluid transients with airpockets in water pipelines (i.e., transient wave-water-air interactions). Both situations of inline and offline air pockets are examined by the laboratory experiments for the effects of air pocket configurations on transient behaviors in pipelines, followed by the comparison of different numerical models and simulation methods for their different capabilities and limitations of reproducing the interactions of transients with air pockets. The time-domain wave analysis and the frequency-domain spectra analysis are adopted for the results analysis and discussion, so as to clearly understand and quantify the impacts of air pockets on the transient wave behavior and propagation along pipeline. Finally, the obtained results are discussed for the implication of utilizing fluid transients for the analysis and detection of airpockets (or air blockages) in water pipelines.

06.Ultrasonic sensing technique for two-phase flow measurement

Chao TAN
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BIOGRAPHY:

Chao Tan, Professor in School of Electrical and Information Engineering at Tianjin University.His research interests include process parameter detection and control systems, multiphase flow measurement and instrumentation, industrial process tomography and multisensor/data fusion. He is a senior member of IEEE, and member of ISIPT, an associate editor of <IEEE Transactions on Instrumentation and Measurement>, <IEEE Sensors Journal> and <Transactions of the Institute of Measurement and Control>. He has published more than 80 papers on peer-reviewed journals, holds more than 30 patents and 4 software copyrights in China, 1 book chapter and edited 1 conference proceeding for multiphase flow measurement. He received many academic awards in international conferences and journals such as IMEKO world congress, and IEEE-IST.

ABSTRACT:

Ultrasonic sensors are non-destructive, radiation-free and easy to install on pipeline, thus have attracted increasing attentions in multiphase flow measurement in recent years, such as in petroleum production, fuel cell battery, chemical engineering, food processing and biomedical engineering. There are, however, still many theoretical and technical challenges of applying ultrasonic sensors to measure the industrial multiphase flow. This talk will introduce the measurement of two-phase flow fraction, velocity and flow patterns by using ultrasonic sensors, with dedicated transducers, systems, models and algorithms, which have been experimentally validated and some have been applied in field trial. The two-phase flow studied in this talk include gas-liquid two-phase flow, liquid-liquid two-phase flow and solid-liquid two-phase flow.

07.Numerical modeling of air-water interactions in rapidly filling pipe with entrapped air

Biao HUANG

Ningbo University, China

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BIOGRAPHY:

Dr. Biao Huang is an associate professor in the College of Civil and Environmental Engineering at Ningbo University, China. He received his Ph.D. in Hydraulic Engineering from Nanjing Hydraulic Research Institute, China, and a joint Ph.D. at the University of Alberta, Canada. He has been working on urban hydraulics and CFD modeling since the beginning of his academic career, 2011. He currently serves as a member of EWRI CFD Committee. His current research interests lie in the areas of CFD applications in urban water systems, and smart monitoring and modeling of sewers.

ABSTRACT:

Rapid filling in pipes with entrapped air is generally encountered in engineering, during which the over-pressurization may cause unexpected infrastructure failures and safety concerns. Numerical modeling is widely adopted for such problems. Three basic types have been developed in this area, namely (1) theoretical or analytical model, (2) one-dimensional mathematical model, and (3) three-dimensional computational fluid dynamics model. Areview of models currently in use is presented, with the purpose of providing useful information on avoiding misconception of the phenomena, misinterpretation of the flow, misunderstanding of the physics, and misapplication of the models.CFD modeling of real-world cases and large-scale experiments are still in great demand.

08.Water hammer control analysis of an intelligent surge tank with auxiliary self-adaptive control system

Boran ZHANG

Zhejiang University, China

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BIOGRAPHY:

Boran Zhang is a final grade PhD candidate in Zhejiang University, and currently also a visiting scholar in University of Cambridge (UK). He studies fluid mechanics including in-pipe transient flows, scour of sediment and sand tune movement. He has participated in many research projects in collaboration with industry and international groups including Huadong Engineering Corporation limited (Hangzhou, China), Zhejiang Design Institute of water conservancy (Hangzhou, China), CSIC (Cambridge, UK) and PROVECTUS INTERNATIONAL (London, UK).

ABSTRACT:

Water hammer can cause great risk in water supply pipe systems. A surge tank is a kind of general water hammer control device. In order to improve the behavior of the surge tank, a self-adaptive auxiliary control (SAC) system was proposed in this paper. The system can optimize the response of the surge tank according to the transient pressure. The numerical model and the matched boundary conditions were established to simulate the improved surge tank and optimize the SAC system. Then various transient responses were simulated by the proposed model with different parameters set. The proposed system is validated by comparing the water hammer process in a river-pipe-valve (RLV) system with and without SAC. The results show the SAC can greatly improve the water hammer control of the pipeline and the water level oscillation of the surge tank. With the SAC system, the required vertical size of the surge tank can be significantly reduced with the desired water hammer control function.

09.Free-surface and stratified flow in the sewers with restricted ventilation

Janek LAANEARU
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BIOGRAPHY:

Janek Laanearuis Associate Professor (docent) of Fluid Mechanics in the School of Engineering at Tallinn University of Technology. Within his current role, he has delivered several lecture courses in the fields of Fluid Mechanics, Hydraulics, Coastal Engineering and Environmental Engineering. In addition, he has been an invited lecturer in a number of water engineers training schools in Estonia. He is author of Fluid Mechanics textbook (2019) in Estonian. He has significant experience working in national and transnational research groups in the broad field of build environment. His expertise originates from working at a number of European universities. He has collaborated with researchers atTartu & Tallinn (Estonia), Stockholm & Gothenburg (Sweden) and Dundee & Edinburgh (Scotland, UK), and also from active participation in international scientific projects hosted in Tianjin (China), Delft (The Netherlands), Trondheim (Norway) and Toulouse & Grenoble (France).

ABSTRACT:

The study explains the dynamics of air-water stratified flow in the sewer system with restricted ventilation. Hydraulic models can produce well the quasi-steady solutions of free-surface flow in sewer system, where the ventilation is not issue due to presence of a number of manholes. In the case of restricted ventilation conditions, the air flow becomes more important in sewer system. This is due to the nature of the problem that is related to the air-water interactions in closed conduit. In the case of free-surface flow modelling, no drag between the liquid and gas phases is considered, and thus liquid flows similar to the open-channel flow. In the case of stratified flow, the fluids (e.g. air and water) are coupled not only due to pressure but also due to drag, and the two-phase flow reveals the dynamics due to the presence of interface.

10.Developments in unsteady vaporous cavitating pipe flow modelling

Anton BERGANT
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BIOGRAPHY:

Dr. Anton Bergant graduated in Mechanical Engineering from the University of Ljubljana, Slovenia on June 25, 1981. The topic of his BSc Thesis was: Treatise of hydraulic transient phenomena in hydroelectric power plants with Francis turbines. On April 18, 1985 he completed his MSc studies in Mechanical Engineering from the University of Ljubljana. The topic of his MSc Thesis was: Unsteadiness and vibrations in hydraulic systems. On December 9, 1985 he successfully passed an exam at the State Committee for Industry and Civil Engineering and became Professional Engineer. He successfully defended his Doctoral Thesis at the Faculty of Mechanical Engineering, University of Ljubljana on May 6, 1993. The topic of his thesis was: Transient cavitating flow in piping systems. From January to May 1987 he was visiting research fellow at the University of Leeds, United Kingdom specializing numerical modelling of hydraulic transients in piping systems. From April to June 1995 and from February to April 1997 he was a postdoctoral fellow at the University of Adelaide, Australia conducting research on transient cavitating flow in pipelines. On March 30, 2010 he was elected as an Associate Member and on February 23, 2017 as a Full Member of the Slovenian Academy of Engineering.

Dr. Bergant has been employed with Slovenian water turbine manufacturer Litostroj since 1980, except from October 1989 to January 1993 when he was employed as research officer with the University of Adelaide, Australia. He is currently employed full-time with company Litostroj Power d.o.o., Ljubljana and part-time with Faculty of Mechanical Engineering, Ljubljana. He is head of Department of Technical Research and Computations at Litostroj Power. In addition, he is head of the state registred research group 2836-001 Hydraulic Machinery and Systems. In Litostroj he was a principal investigator of a number of research and industrial projects for the customers worldwide. From 2006 to 2014 he has been president of the Works Council in the company fostering the research activities and international collaboration. He has served as president of the Slovenian Association for Hydraulic Research for twelve years.

ABSTRACT:

This lecture presents an effective and accurate transient vaporous cavitating pipe flow model that is first verified and than validated against numerous laboratory test results. Vaporous cavitation occurs in pipelines when the liquid pressure drops to the vapour pressure of the liquid. The amount of free and/or released gas in the liquid is assumed small. This is usually the case in most industrial piping systems. Transient vaporous cavitation significantly changes the water hammer waveform. Cavitation may occur as a localized cavitation with a large void fraction, such as when a cavity forms at a boundary or at a high point along the pipeline, or as distributed

cavitation with a small void fraction, such as when cavity bubbles are distributed homogeneously in liquid. A number of numerical models have been developed to describe vaporous cavitation including the discrete vapour cavity model (DVCM), the discrete gas cavity model (DGCM) by utilizing a low gas void fraction ($\alpha_g \leq 10^{-7}$) and the interface vaporous cavitation model (GIVCM). The numerical solution of the DGCM is first examined for the convergence and stability criteria. Convergence relates to behaviour of the solution as Δx and Δt tends to zero while stability is concerned with round-off error growth. The influence of different numbers of computational reaches $N = \{16, 32, 64, 128, 256\}$ is investigated. Then the numerical results are compared with the results from laboratory measurements including single and multiple-valve closure cases. The computed and measured results agree well. The discrete gas cavity model with consideration of unsteady friction is simple and performs accurately over a broad range of input parameters and it is recommended for engineering practice.

11.Dancing manhole covers

Arris S. TIJSSELING
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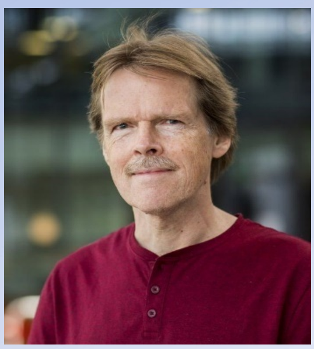

BIOGRAPHY:
Arris S. Tijsseling received an M.Sc. in Applied Mathematics(1986) and a Ph.D. in Civil Engineering (1993) from the Delft University of Technology in The Netherlands. He worked on water hammer and fluid-structure interaction in pipe systems from 1986 to 1993 at Delft Hydraulics and Delft University, and from 1993 to 1999 at the University of Dundee in Scotland. Since 1999 he has been at the Eindhoven University of Technology in The Netherlands. His research interests include hydraulic transients, fluid-structure interaction, multi-phase flow, sloshing, and the history of science.

ABSTRACT:
Manholes are vertical shafts connecting underground sewers with street-level terminals. They are covered by heavy lids. During periods of heavy rainfall, the air column in the upper part of the manhole may be compressed to such high level that the lid moves up. Of course, this is a dangerous situation for pedestrians and road traffic. Bolting the lid may provide a solution to the problem, but it is known that air pressurization underneath can result in structural damage. A simple model is proposed to describe the lifting of the lid (manhole cover). When the lid moves up, air is allowed to escape so that the lifting pressure decreases and the lid moves down, whereupon the air pressure increases again. This repetition might lead to the realistic phenomenon of the dancing manhole cover. Since the model is strongly nonlinear, interesting dynamic behavior is expected.