HYDRAULIC STRUCTURES: USEFUL WATER HARVESTING SYSTEMS OR RELICS? FOREWORD / PRÉFACE

by Robert JANSSEN and Hubert CHANSON

Throughout the ages, the construction of hydraulic structures has supported the development of human civilisation. Around 3000 BC, masonry dams on the Nile provided irrigation water in Egypt, while in Mesopotamia canals were built for irrigation, draining swamps and transportation [2, 3, 5]. The 18th and 19th centuries saw the rapid development of water supply systems in response to the industrial development and the needs for reliable water supply [4, 7, 8] (Fig. 1 & 2). More recently, the 1940s to 1970s saw a worldwide boom in large water projects, mainly for consumption, irrigation, transport, hydropower and flood protection [3]. For example, the California Central Valley Project, built between 1933 and 1970, provides irrigation water to over 1.2 million hectares and generates over 1 million kW of power [3]. The rate of construction of new water projects in Europe and North America has dropped during the last few decades, and many of the original water harvesting system mega projects are now near, or even past, their original intended design lives. The question therefore arises whether the existing systems are redundant relics from the past that have reached their sell-by date, or do they still have an important role to play in modern society?

In the future, water scarcity may become the single most important development problem faced by mankind. The rate of increase in water use outstrips the rate of population growth, and as global population grows from 6 billion to 9 billion people by 2050 as estimated, the total water use is estimated to increase from about 5,500 km^3/year to 25,000 km^3/year [6]. To meet this demand, some innovative approaches to design, construction and operation of water harvesting systems are therefore needed. In fact, VEIGA DA CUNHA [6] observed that there is a belief that there will be greater changes in how we manage our limited water resources during the next 20 years than there have been in the last 2,000 years.

The high level of activity, even at a junior engineer and researcher level, in scientific meetings on hydraulic structures demonstrates that water harvesting systems are highly relevant to modern day needs. In these proceedings, the topics presented are driven by an urgent demand for practical solutions to real-world problems involving design, construction, maintenance and operation of systems for water management and water harvesting. It is clear that the demands on hydraulic structures are now imposed by a wide range of stakeholders, and the papers contained herein cover applications including flood protection, stormwater management, navigation, industrial water consumption, infrastructure, and energy dissipation.

Fig. 1 - The Paty dam (Barrage du Paty) in Caromb (France) in 1994 (Photograph H. CHANSON) - Gravity dam completed in 1766 in the Lauron valley

Fig. 2 - Goulburn weir (Australia) on 30 Jan. 2000 (Photograph H. CHANSON) - Flow rate: Q = 5.2 m^3/s, Step height: h = 0.5 m - Gravity overflow weir completed in 1891 on the Goulburn River (Victoria)

The First and Second International Junior Researcher and Engineer Workshops on Hydraulic Structures were organised by the IAHR Hydraulic Structures Technical Committee, jointly with the Instituto Superior Técnico (IST) and the Portuguese Water Resources Association (APRH) in 2006, and with the University of Pisa (Italy) in 2008. The growing success of this series of events led to the organisation of the Third International Junior Researcher and Engineer Workshop on Hydraulic Structures (IJREWHS'10) (Fig. 3 and 4). The IJREWHS'10 was held in Edinburgh, Scotland, on 2-3 May 2010. A half-day technical tour included the visit to Glenkinchie distillery and the "Falkirk Wheel" boat lift (Fig. 5).

The IJREWHS'10 workshop addressed both conventional and innovative aspects of hydraulic structures, their design, operation, rehabilitation and interactions with the environment. The workshop provided an opportunity for young researchers and engineers, typically post-graduate students, but also young researchers and engineers in both public and private sectors, to present ideas, plans, and preliminary results of their own research in an inspiring, friendly, co-operative, and non-competitive environment. The event was attended by 20 *junior* participants and by a number of national and international experts from consultancy and research in hydraulic engineering (Fig. 3 and 4). In total 17 lectures were presented including 2 keynotes, representing a total of 7 countries, namely Belgium, Germany, Italy, France, Latvia, Portugal, and the United States of America.

Dr Frédéric MURZYN (ESTACA, France) presented a keynote lecture on the hydraulic jumps. He highlighted a range of experimental techniques for the investigation of aerated, chaotic flow patterns in the transition from supercritical to subcritical flows. A comparison of physical data obtained by use of classical and modern, intrusive and non-intrusive measuring devices was presented. The second invited lecture was given by Prof. Jorge MATOS (IST Lisbon, Portugal), on the state of the art in stepped spillway hydraulics. Prof. MATOS summarised past research activities and resulting design approaches, and he pointed out the needs for further research for a safe operation of stepped spillways.

During the workshop, the junior participants themselves chaired sessions, played the role of "advocatus diaboli" (devil's advocate) and prepared the reports for all sessions to identify key scientific elements and pending questions (Fig, 4). The active involvement in the workshop organisation and management is considered a main feature of the International Junior Researcher and Engineer Workshops on Hydraulic Structures series. In order to help junior participants in these tasks, specific guidelines were provided. Another interesting feature of the workshop was the presence of engineering consultants and research experts, with the aim to stimulate the debate during the presentations, between junior and senior participants, as well as during the subsequent round table discussion (Fig. 4D).

The publication of the workshop papers marked the successful conclusion of this event. The proceedings were edited by two active members of the Hydraulic Structures Technical Committee, including the Committee Chair. They contains 15 papers including a keynote lecture paper involving 37 authors from 6 countries and 2 continents, plus 6 session reports and 9 pages of photographs of hydraulic structures from around the world, in addition to the photographs of the

workshop and of the technical visit (Fig, 3 to 5). Each paper was peer-reviewed by a minimum of two experts. The discussion reports were included for the benefit of the readers.

The proceedings regroup a keynote lecture paper on the hydraulic jump flow phenomenon, 8 technical papers dealing with the design of hydraulic structures and their physical modelling, 3 papers discussing the interactions between sediment processes and hydraulic structures, and 3 papers related to the numerical modelling of open channel flows. These are followed by 6 discussions reports.

Innovative designs for overflow weirs are presented in two papers. An improved understanding of performance of existing hydraulic structures is discussed in several papers on flow characteristics and hydrodynamics along and downstream of spillways. The requirement for water in industrial applications is addressed by papers on optimization of applied designs for navigation, hydropower and cooling water intakes. As human development encroaches further on the natural water systems, the interaction between hydraulic structures and nature, and minimization of the potential impacts of structures on natural river processes, is presented in the papers on bridge pier scour. Finally, the use of computer programs to assist in studying, understanding and designing of water related infrastructures is addressed in three papers on numerical modeling techniques.

The full bibliographic reference of the workshop proceedings is:

JANSSEN, R., and CHANSON, H. (2010). "Hydraulic Structures: Useful Water Harvesting Systems or Relics?" *Proceedings of the Third International Junior Researcher and Engineer Workshop on Hydraulic Structures (IJREWHS'10)*, 2-3 May 2010, Edinburgh, Scotland, R. JANSSEN and H. CHANSON (Eds), Hydraulic Model Report CH80/10, School of Civil Engineering, The University of Queensland, Brisbane, Australia, 211 pages (ISBN 9781742720159).

Each paper of the proceedings book must be referenced as, for example:

MURZYN, F. (2010). "Assessment of Different Experimental Techniques to Investigate the Hydraulic Jump: Do They Lead to the Same Results?" in "Hydraulic Structures: Useful Water Harvesting Systems or Relics?", *Proceedings of the Third International Junior Researcher and Engineer Workshop on Hydraulic Structures (IJREWHS'10)*, 2-3 May 2010, Edinburgh, Scotland, R. JANSSEN and H. CHANSON (Eds), Hydraulic Model Report CH80/10, School of Civil Engineering, The University of Queensland, Brisbane, Australia, pp. 3-36 (ISBN 9781742720159).

REFERENCES

[1] GINOCCHIO, R. (1978). "L'Energie Hydraulique." ('The Hydraulic Energy'.) *Eyrolles*, Collection Direction des Etudes et Recherches d'Electricité de France, Paris, France, 598 pages (in French).

[2] SCHNITTER, N.J. (1994). "A History of Dams : the Useful Pyramids." *Balkema Publ.*, Rotterdam, The Netherlands.

[3] ROBERSON, J.A., CASSIDY, J.J., and CHAUDHRY, M.H. (1998). "Hydraulic Engineering."

John Wiley & Sons, Inc., 2nd Edition, 653 pages

[4] SCHUYLER, J.D. (1909). "Reservoirs for Irrigation, Water-Power and Domestic Water Supply." *John Wiley & sons*, 2nd edition, New York, USA.

[5] SMITH, N. (1971). "A History of Dams." *The Chaucer Press*, Peter Davies, London, UK.

[6] VEIGA DA CUNHA, L. (2009). "Water: how to live and deal with change." *Reflections on Water*, APRH , Portuguese Water Resources Association. L. VEIGA DA CUNHA, A. SERRA, J. VIERA DA COSTA, L. RIBEIRO, and R. PROENCA DE OLIVEIRA Editors, 190 pages. Originally published in Portuguese in 2007.

[7] WEGMANN, E. (1911). "The Design and Construction of Dams." *John Wiley & Sons*, New York, USA, 6th edition.

[8] WEGMANN, E. (1922). "The Design and Construction of Dams." *John Wiley & Sons*, New York, USA, 7th edition.

Fig. 3 - Attendees of the 3rd International Junior Researcher and Engineer Workshop on Hydraulic Structures (Courtesy Mario OERTEL)

Fig. 4 - Lectures and round tables at the 3rd International Junior Researcher and Engineer Workshop on Hydraulic Structures (Courtesy Aysha AKTER)

(A) Keynote lecture by Professor Jorge MATOS

(B) Keynote lecture by Dr Frédéric MURZYN

(C) Oral presentation

(D) Round table discussion

Fig. 5 - Field Trip to "Falkirk Wheel" boat lift

(A) General view (Courtesy of Daniel BUNG)

(B) Details (Courtesy of Aysha AKTER)