



Michael Gebhardt

Working Group 166

Inflatable Structures in Hydraulic Engineering

PIANC InCom Commission
Meeting n° 74

Strasbourg, May 30-31, 2016

Rubber Gate Applications



Water-filled Rubber Gate (Navigation)

Rubber Gate Applications



Water-filled Rubber Gate (Hydropower)

Rubber Gate Applications



Air-filled Rubber Gate (Recreation)

Rubber Gate Applications



Water/Air-filled Rubber Gate (Storm Surge Barrier)

Steel-Rubber Gate Applications



Steel-Rubber Gate (Navigation)

Steel-Rubber Gate Applications



Steel-Rubber Gate (Hydropower)



Agenda

1. Composition and Objective of the Working Group
2. Past Activities and Meetings
3. Structure of the Report
4. Highlighting content
5. Conclusions and Outlook

Membership List, 20th January, 2016



- **Bart DE HEYDER**, Waterwegen en Zeekanaal nv
- **Philippe RIGO**, University of Liège
- **Timothee PIRE**, University of Liège (CM)
- **Jean-Luc BERTEROTTIÈRE**, Vinci-Construction
- **Julien AUBONNET**, BRL Ingénierie (YP)
- **Michael GEBHARDT**, Bundesanstalt für Wasserbau (Chair)
- **Thilo WACHHOLZ**, Gen.dir. Wasserstraßen und Schifffahrt (CM)
- **Jan-Willem LECHTENBERG**, Floecksmühle Energietechnik (YP)
- **Ichiro MARUYAMA**, Sumitomo Electric Industries Ltd.
- **Peter JANSEN**, Rijkswaterstaat
- **Don MASON**, Dyrhoff Ltd.
- **Timothy PAULUS**, U.S. Army Corps of Engineers
- **PJ Henscheid**, Avista Utilities (CM)



Meetings



- **n° 1 Maastricht**, September 2013
- **n° 2 Hannover**, March 2014
- **n° 3 Tokio & Osaka**, May 2014
- **n° 4 Paris & Dijon**, October 2014
- **n° 5 Gent & Aachen**, March 2015
- **n° 6 Albany & Burlington**, July 2015
- **n° 7 Nimes**, January 2016
- **n° 8 Utrecht**, June 2016 (final meeting)



Structure of the Report (number of pages)



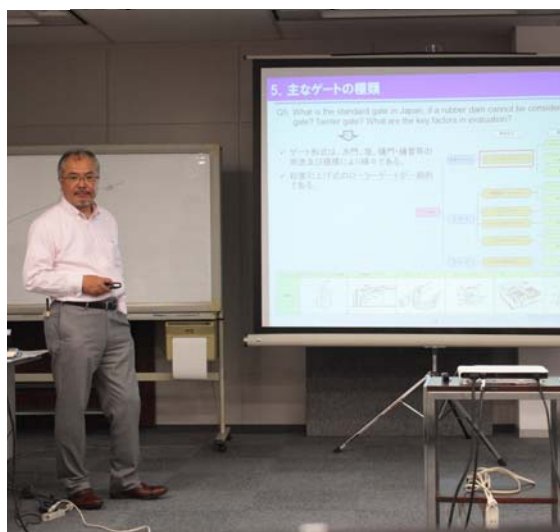
1. Preface (4)
 2. Overview (22)
 3. Materials & Manufacturing (11)
 4. General Considerations (14)
 5. Structural & Hydraulic Design of Rubber Gates (43)
 6. Structural & Hydraulic Design of Steel-Rubber Gates (22)
 7. Substructure (12)
 8. Mechanical and Electrical Equipment (22)
 9. Construction & Commissioning (21)
 10. Operation & Maintenance (18)
 11. Case Studies (74)
- Project Reviews (15 projects)
- References
- Appendix



Meetings with Administrations



- Japan Institute of Country-ology and Engineering (**JICE**) and Japan Association of Dam & Weir Equipment and Engineering (**JADWEE**) in Tokyo
- **Technical standards** for rubber gates since 1978 and steel-rubber gates since 2006 (in Japanese)
- **Questions were collected in advance**, translated and discussed during the meeting in detail
- **Parts of the standards will be made accessible for the reader of the PIANC-report** (in Japan roughly 4000 inflatable gates are installed, while 14 % of them reached or even exceeded a lifetime of 30 years)



Meetings with Operators



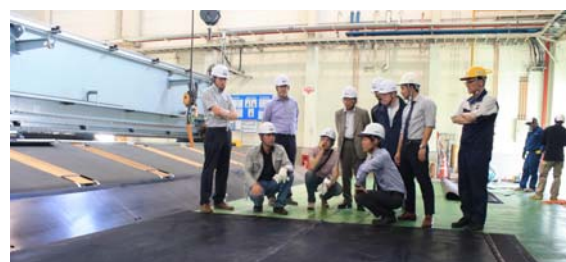
- Rubber Gates at **Marklendorf Dam** (2006) and **Bannetze Dam** (2009) in Germany operated by WSA Verden
- Steel-Rubber Gates at **Nikaryo-Kamikawara Dam** (2012) in Japan operated by MLIT
- Rubber Gates at **Itachi Dam** (2000), **Ikeda Dam** (1981), **Kamo dam** (2001), **Ishibe Dam** (2006) in Japan operated by MLIT
- Steel-Rubber Gates at **Auxonne** and **Gray Dam** (2011) in France operated by VNF
- Rubber Gates at **Palmer Falls** (1987), **Curtis Dam** (2003) and **Highgate Falls** (1994) in USA operated by Atlantic Power Corporation and Swanton Village



Meetings with Manufacturers



- Plant visit of Conveyor Belt Group **ContiTech, Northeim** and discussion on testing methods and specifications
- Technical excursion to manufacturer **Sumitomo Hybrid Company (SHC), Toyama**
- Technical excursion to manufacturer **Bando Chemical Industries, Ltd., Kobe**
- Technical excursion to supplier **Floecksmühle Energietechnik GmbH, Aachen**



Exchange on ongoing projects at waterways



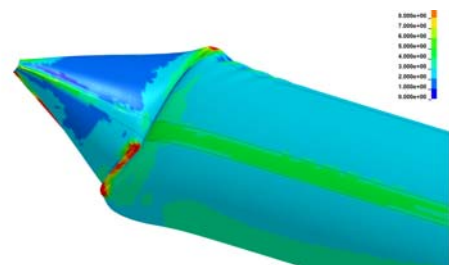
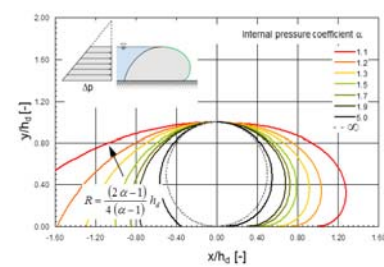
- **PPP Barrages Aisne et Meuse:** replacing 29 mainly needle weirs in Northern France by water-filled rubber gates (Voie Navigable de France)
- **Dender River Project** (Waterwegen en Zeekanaal NV, Belgium): replacing six weirs by steel-rubber gates
- **Weir Beihingen on Neckar River** (BAW): Water-filled Rubber Gate Project with a dam height of 4,5 m



Design approach



- Objective of the WG was to **define a general methodology for the analysis and design of inflatable structures**, in particular the membrane
- **Japan design codes could be found**, which were in the past the basis for several projects in Japan and abroad
- **Existing design approaches will be presented and discussed** (Japanese Standard, Storm Surge Barrier Ramspol, actual BAW-investigations on a design concept according to the Eurocode)



Case Studies, Failures & Conclusions



- About **15 case studies will be presented** based on interviews with operators
- **Report will provide a summary and conclusions** (operating mode, stress concentration, penetration of air into the rubber membrane, stable position when deflated and inflated, vibrations etc.)
- **Recent failures in USA will be discussed**, material testings were initiated and test results will be presented
- Failures (although small in number) pushed some operators to **return to the “standard steel technology”**.



Outlook



- **Final meeting** in Utrecht, June 2016, 20-24th
- **First draft of report** in July 2016 for InCom to review the technical content, **final version of report** end of 2016
- Short presentation of WG166 during **HYDROVISION 2016**, Minneapolis, **July 26-29th** (*abstract accepted*)
- Workshop during 8th International **PIANC-SMART Rivers Conference, September 2017**, Pittsburgh (*goal, not confirmed*)
- **PIANC-Colloquium (Short Course)** in Bonn, End 2016 or 2017, cooperation with neighboring sections (Belgium, Netherlands, ...) would be desirable (*not confirmed*)
- **Short courses in France** (VNF in Paris, Comité Français des Barrages et Réservoirs (*first thoughts*))
- Presentation of WG166 during **PIANC-World-Congress** in Panama in 2018 (*optional*)





Thank you for your attention!

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