THE WORKING GROUP ON LEVEES AND FLOOD DEFENCES UNDER THE EUROPEAN CLUB OF ICOLD

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LEVEES Working Group Newsletter

Aerial view of Eemdijk test, left the reference test and right the sheet pile wall test before the sheet piles were installed. Full scale dike testing, page 4.

Note from the Chairman

Rémy Tourment

The first ICOLD congress to include levees so visibly in its program will do so in a big way. One only has to look at the list of meetings and activities to be convinced. The program includes meetings and workshops of Technical Committees, like in any ICOLD annual meeting, but also specific sessions devoted to Levees in Question 103 (Small Dams and Levees). See page 2 for the further detail on the relevant agenda items which relate to the bracketed numbers in this article.

The meeting of our LFD WG (1) will be of special importance this year, as having been successful during last year's Prague ICOLD meeting in the creation of a Levees ICOLD TC, we thought that our WG would come to an end after the Vienna Congress. Well, after some thinking and discussions, we are now considering keeping the WG alive, with new objectives; this meeting will be the moment to present our current achievements, and agree on new Terms of Reference (ToR). These ToR will then be presented for approbation during the EUCOLD board meeting (3).

The meeting of the new ICOLD Technical Committee (2) will be of equal importance. We will have to agree on the final Terms of Reference for the TC, which will have to be presented during ICOLD General Assembly on Tuesday 3 July. We will also discuss future activities, and the way to conduct them. And, as it is a first meeting, members will have to introduce themselves in order for us to get to know one another better.
The workshop on Levees (6), co-organized by our WG and the LE TC, will be the moment to actually exchange ideas on levees, both technical as well as organizational. Presentations will introduce interactive discussions. We will also discuss both our reports (levee situation and dams/levees comparison).

Regarding Question 103, 47 Reports were sent from 26 different countries in response to this question. 20 reports concern small dams, 20 reports concern levees, 3 reports focus on canal or basin embankments and 4 reports focus on techniques that apply to small dams and levees. Note that the reports that concern levees mainly come from European countries and the USA, which corresponds to the core of the new "Levees" Technical Committee, but since the issue is new within ICOLD, we can only imagine that the number of contributing countries will grow in the future. The presentation of the General Report (7) will offer a synthetic view on the issues detailed in the Reports, but also a more general view based on existing material, from ICOLD TCs for dams and from our own LFD WG as well as from the ILH for levees. Based on presentations by the Reports' authors, the four parallel sessions for Q103 (8) will successively deal with:

- Governance and operation of small dams in regard to safety issues (management, surveillance and maintenance, regulation and control by authorities) – 10 presentations
- Governance and operation of levees in regard to safety issues (management, surveillance and maintenance, regulation and control by authorities) – 6 presentations, based on 9 Reports
- Case studies of small dams and levees: damages and repairs (including the study of deterioration and failure mechanisms) – 9 presentations
- Techniques for construction and rehabilitation suitable for small dams and/or levees (including techniques for surveillance); specific design criteria and approaches for these works – 10 presentations

Reports that were not selected for oral presentation will have, in addition of their inclusion in the General Report, a chance to be presented as posters.

As Chairman for both EUCOLD LFD WG and ICOLD LE TC and as General reporter for Question 103, I hope that you will all be able to join us during this very important week in Vienna, and that you will enjoy all these occasions to exchange ideas and to participate in our emerging Community of Practice on levees, allowing them to be successful. And during the remaining time (…) you will have the opportunity to attend other interesting sessions related to dams, as well as enjoy the beautiful city of Vienna and the non technical activities. I hope to meet you there!

IN THIS ISSUE

VIENNA ICOLD 2018

26th Congress – 86th Annual meeting

1 July – 7 July, Vienna (Austria)

The following list of dates and times outline the agenda items relating to our levees and flood defences group.

1. **Sunday 1 July, 8:00-10:00:**
formal meeting of the EUCOLD Levees and Flood Defences Working Group
Who: all WG members and guests
2. **Sunday 1 July, 10:30-12:30 & 14:00-16:00:**
formal meeting of the ICOLD Levees Technical Committee
Who: all TC members and guests
3. **Sunday 1 July 16:30-18:30**:
Board Meeting of the European Club of ICOLD
Who: all EUCOLD board members and key members of EUCOLD WGs
4. **Monday 2 July morning 8:00-9:00:**
Meeting with the Embankment Dams ICOLD Technical Committee
Who: Board and key members of "Levees" and "Embankment Dams" TCs
5. **Monday 2 July 10:30-11:30:**
Preparatory meeting for Q103
Who: General Reporter, Chairman, Vice-Chairman, Secretary, Speakers
6. **Monday 2 July 14:00-17:30:**
workshop of Levees Technical Committee and EUCOLD LFD WG
Who: all WG and TC members, all interested ICOLD congress attendees (open workshop)
7. **Thursday 5 July 14:16:00:**
General Reports of ICOLD Congress Question 102 (Geology and Dams) & 103 (Small Dams and Levees)
Who: all congress attendees
8. **Thursday 5 July 16:30-18:30 and Friday 6 July (8:00-16:00):**
Congress presentations relating to ICOLD Congress Question 103 on Small Dams and Levees
Who: all congress attendees

FRENCH FLOODS

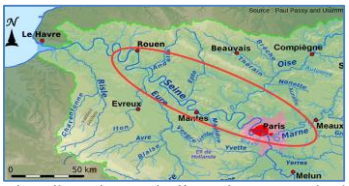
The Seine River flood of January 2018

By Bruno Beullac

The Seine River and Marne River experienced a ten year return period flood at the end of January 2018. The tributaries associated with these two river systems were inundated by this event.

This flood, which reached the level of 5.84 m in Paris, the reference ordinary level being between 1 m and 2 m, is the sixth most significant registered flood event for the Seine river in Paris. In fact, it comes after the floods of 1910 (8.62 m in Paris), 1924 (7.32 m in Paris), 1955 (7.12 m in Paris), 1982 (6.18 m in Paris) and 2016 (6.10 m in Paris).

Many levee systems were loaded during this event, leading to local leakages and damages. This resulted from pre-existing deteriorations, which often occur in the rarely loaded upper parts of levees. However, no breach was observed. These structural consequences led levee managers to reinforce levees and to improve their monitoring, inspection and maintenance proceedings.



The tributaries and effected areas on both the Seine and Marne Rivers

In some cases levee systems suffered hundreds of meters of overflowing flood waters. These events led to the inundation of inhabited areas, for example in the municipalities of Gournay, Noisy-le-Grand and Villeneuve-le-Roi.

These overflowing events, which did not cause human casualties, led to the evacuation of many people and cut off electricity for hundreds of households. Since reports on flood consequences generally include all flooded areas (protected and unprotected areas), there is yet a precise assessment of the consequences of the identified levee overflowing events.

FINNISH FLOODING

Spring flood levels exceeded

By Eija Isomäki

Every spring the melting snow causes flooding in Finland. This year the flood situation was fierce and caused trouble especially in Southern Ostrobothnia (Finland) in April and in Northern Finland in May. Many roads were closed and flood embankments were in high use. In some rivers, the excess flow was rerouted into fields to prevent serious damage. Severe flooding was expected in Northern Finland and flood embankments were raised to be on the safe side. Luckily, the predicted rain did not appear.

Temporary raising flood embankments in Tornio. Photograph by Timo Alaraudanjoki

A CALL FOR CONTRIBUTIONS

- *News, media or press releases on current storm events involving levees and flood defences.*
- *Current, ongoing or recently complete research projects with web links.*
- *Documents related to levees or flood defences: handbooks, guidance, reports and regulations.*
- *Information on events relating to levees or flood defences*
- *Links to informative/educational web sites and related organisations.*
- *Contact the WG –* lfd-eurcold@irstea.fr

LEVEE SAFETY PARTNERSHIP

International risk assessment exercise

By Claire Hollingsworth

The Levee Safety Partnership is a long running knowledge sharing partnership between the English Environment Agency (EA), Dutch Rijkswaterstaat (RWS) and American Army Corps of Engineers (USACE). In October 2017 there was a very successful technical exercise of the partnership on a joint risk assessment in St Louis.

The exercise was devised and developed between the 3 agencies to learn about, and compare, how the 3 countries assess the risk associated with their flood assets, by applying all 3 methods to the same levee (see Figure 1). It included a site visit to the chosen levee in St Louis, USA (chosen due to known concerns which yielded interesting assessment and comparison), followed by three one day workshops. Each country lead one workshop, demonstrating and taking all attendees through their method for assessing the risk of that levee. A peer review of each country's presented methodology was then completed. The exercise finished with a wrap up session to discuss and compare results and methods.

St Louis Levee System

The project was all about comparison to enable improvement. It was critical to the success of the exercise that the demonstrations were immersive workshops allowing attendees to actually perform assessments using all methods, rather than just presentations of how it would be done.

Throughout the exercise it became clear that the methodologies applied are consistent in terms of the fundamental concepts and principles. There are however, noticeable and interesting differences that arise in terms of their application in practice, for reasons relating to geographical/topographical differences, program objectives, and political requirements.

By comparing the results of the 3 methods, major differences could be identified to see if one of the methods seems to be vastly over or under estimating the risk.

Both the Dutch and American methods output a quantitative assessment of the probability of failure of the asset and the associated risk to life. The Environment Agency method does not directly produce either of these figures, instead outputting economic analysis in the form of average annual damages associated with the levee and its potential failure. The annual probability of failure for each section of the levee is however calculated within the Environment Agency modelling tool to feed into the damage calculations, the team were therefore able to calculate this to allow direct comparison between results from all 3 countries. Risk to life figures could also be directly compared between the US and Dutch methods.

Given the known limitations of applying a method based on standard (generally smaller scale and differing construction style) UK assets to an international asset, along with the time and budget constraints for the EA and RWS analysis on a USACE levee, we can conclude that the assessments yielded broadly comparable results, giving confidence to each country in their current methodologies.

This innovative exercise has tested and proved the reliability, the validity and the functionality of all our asset risk assessments. It is very challenging to calibrate and test the results of such assessments, as flood loading is highly uncertain and infrequent and every asset is different. It is therefore important to find ways to validate our methods, and direct comparison with other international approaches like this is an ideal way.

As well as validation, each country was also looking to learn from the others on how to improve their assessments. Each agency is now busy taking the learning and feedback and applying it to develop and improve their own assessments to increase overall understanding of risk in all our assets.

A joint paper is currently under preparation to describe this successful exercise and its findings in detail.

GRASS REVETMENTS

Wind waves in rivers during floods

By Marcel Bottema and Arjan Sieben

Most of the Dutch river levees have grass revetments on their outer slopes, rather than the hard revetments that are typical of levees along the coast and along large lakes.
Recently, safety standards for many river levees have been raised to probabilities of 1/10000 or even 1/30000 per year, while safety is being assessed in a more probabilistic (and thereby risk-based) way. Probabilistic assessments also made clear that outer slope grass revetments should not only be evaluated for situations with extreme water levels and relatively moderate winds, but also for cases of somewhat lower water levels with (severe) storm winds. In the latter case, model calculations suggest that levees along broader flood plains may be loaded by waves greater than 1 meter, which is likely to damage any grass revetment, and could in the worst case even cause levee failure.

Undocumented visual observations during floods suggest that currents and vegetation may strongly reduce the wind waves. If one can prove that the wave model is far too pessimistic, many grass revetments can stay as they are. However, measuring wind waves on rivers during storm is a real challenge due to the small size of the waves and the rarity of the events. Nevertheless, Rijkswaterstaat is preparing a 'Quick Reaction Force' that can carry out such wind-wave and flood-plain current measurements during future flood and storm events.
In January 2018, the central part of The Netherlands was hit by the strongest storm in 11 years, shortly after a once-per-3-year river flood. No measuring equipment was available yet, but numerous useful visual observations were made, confirming that large waves greater than 0,5 meter tend to be restricted to the main flow channel, and that wave conditions in the flooded parts of the flood plain were generally milder.

FULL SCALE DIKE TESTING

Dike tested with sheet pile reinforcement

By Meindert Van

The climate is changing, the sea level is rising and the Netherlands are subsiding. Never before has the Netherlands been faced with the need for such a major programme of dike upgrades. Recently the standards have been made stricter and so one third of the primary Dutch dikes now fail to meet the new safety requirements. A total of no less than 1,100 km will require strengthening between 2018 and 2028. That can only be achieved within budget and with the minimum impact for people living on and near the dikes, by using smart, innovative solutions.

Sheet pile push over tests

A reinforced dike with a sheet pile wall is tested at Eemdijk in The Netherlands. This full scale test studies how dikes behave in extreme conditions such as high water levels in, under and along the dike. Sheet pile walls in dikes are the most common option for not removing nearby houses in a densely populated country like The Netherlands. However, sheet pile walls are relatively expensive compared with berm solutions. The sheet pile wall test will allow us to optimise the type and thickness of the sheet piles, resulting in major savings in the dike reinforcement projects.

Test view, after failure of the sheet pile wall

In the sheet pile wall reinforced dike test, the deformation behaviour and the strength of a structure is studied. In addition, a reference dike without sheet piles is tested and a number of smaller push over tests on sheet piles in the ground are executed. The test is executed by the POVM (projects research on Macro Stability) in close collaboration with the Vallei en Veluwe water authority, Deltares research institute, experts from many Dutch consultancy firms, private bodies, Universities and government authorities. Experts from the USA and Korea are also involved.

This Macrostability full scale test is part of the national Flood Risk Management Programme in which Rijkswaterstaat collaborates with the water authorities. In the years to come, the Flood Risk Management Programme will be facing the challenge of completing more than 1100 km of dikes, and 256 locks and pumping stations before 2028 in 300 projects throughout The Netherlands: along the coast, the major rivers and lakes. The Flood Risk Management Programme has earmarked € 7.4 billion for this operation.

INTERNAL EROSION

European Working Group on Internal Erosion

By Stéphane Bonelli and Rodney Bridle

The European Working Group on Internal Erosion (EWGIE) was set up in 1993 under the chairmanship of Dr Andrew Charles (Building Research Establishment). 47 case histories were collected and preliminary conclusions drawn as to the features that increase the vulnerability of dams to internal erosion. Following a number of serious incidents and failures in Europe due to internal erosion, research funding became available, with chairmanship of the EWGIE passing to Dr Jean-Jacques Fry (EDF CIH). An inaugural workshop on definitions and research needs was held at Aussois in April 2005, with subsequent and ongoing annual workshops.

Jean-Jacques Fry (France) and Rodney Bridle (UK) coordinated the writing of ICOLD Bulletin No°164 “Internal erosion of existing dams, dikes and levees, and their foundations” (two volumes), published from 2015. This Bulletin, being the culmination of interactions which had actually commenced in 1993, is the first ICOLD Bulletin devoted to internal erosion. It is the first publication to assemble knowledge on the mechanics of the four modes of internal erosion: contact erosion, backward erosion, concentrated leak erosion and suffusion.

EWGIE had a remarkable meeting in Sept 2017 at Deltares, when ICOLD extended in July its field of action to include dikes and levees and formed the ICOLD Technical Committee on Levees, which will meet at ICOLD in Vienna in July 2018. A joint meeting with the ICOLD Technical Committee on Embankment Dams is planned. Politecnico di Milano will organise the 26th EWGIE annual workshop the second week of September 2018.

This European Working Group on Internal Erosion (EWGIE) welcomes experts and scientists from over 25 countries in Europe and all other countries (USA, Canada, Australia, Japan, ...). The floor is also given to young dam engineers, young researchers, and PhD students. It is mainly a place for exchanges between practitioners and scientists, and between experts, young engineers and researchers. This working group is linked to the ICOLD Technical Committee on Embankment Dams through Jean-Jacques Fry (Member for France) and Rodney Bridle (UK Member). EWGIE information is disseminated via a mailing list of more than 300 subscribers from around the world. The presentations of the annual meetings have been gathered since 2004 on a website (https://internal-erosion.irstea.fr/ewg/). Please contact Stéphane Bonelli (Irstea, stephane.bonelli@irstea.fr), current Chairman, for any information

SPATIAL ADAPTION

‘Living Lab’ of the Hedwige-Prosper Polder

By Patrik Peeters and Ludolph Wentholt

Adaptation to the effects of climate change is a high priority in many countries, and the Netherlands and Flanders are no exception. In the Netherlands, the report 'Working Together with Water: A Living Land Builds for its Future' by the Second Delta Committee (2008) has given rise to many new ideas and innovative developments in the domain of flood protection policy. Flanders has incorporated its ideas on flood protection under climate change in its Flemish Adaptation Plan, the Sigma Plan and Integrated Coastal Safety Plan. The updated Sigma Plan (2005) designates particular expanses along the River Scheldt for reconstruction as water storage areas, in order to protect other places along the river from flooding. One of the ideas put forward is to make levees more resistant to overflowing (or overtopping). This is in line with the spatial adaptation objective of increasing the area available for water storage during extreme events – and in doing so, capping off high water peaks.

Arial photograph of the Hedwige-Prosper Polder along the left bank of the (Wester)Scheldt just downstream of Antwerp. Source: Flemish-Netherlands Scheldt Committee

The notion of ‘spatial adaptation’ has been applied in the Netherlands and in Flanders, respectively, in the 'Room for the River' programme and in the ‘Sigma Plan’. Both allow for the (occasional) storage of water in areas designed especially for that purpose, in order to lower river water levels. To make such controlled flooding possible, special infrastructure works are constructed. However, these special works (including flood-resistant levees) are seldom used, and so there is still very little real understanding of how they actually perform in extreme conditions.

Managed re-alignment Hedwige-Prosper Polder (depoldering) offers a unique chance for large-scale ground-testing of levee flood resistance under extreme conditions. By precisely measuring and monitoring factors and processes during destructive tests, valuable information can be obtained about erosion processes and the erosion resistance of vegetation cover/revetments due to overflow and/or overtopping under extreme conditions, as well as the role and behaviour of forelands during a levee breach, and the behaviour and effect of the subsurface. Insights into all of these factors and processes will yield a better technical understanding of the residual strength of levees, which is necessary for optimising design and evaluation specifications for flood-resistant levees. In addition, there will be opportunities to test emergency measures, such as evacuation procedures, as well as deliberate breaching of levees for testing.

In order to maximize the opportunities and outcomes provided by ‘living lab’ of the Hedwige-Prosper Polder, Flanders Hydraulics Research (BE) and STOWA (NL) have joined forces. This international collaborative initiative is aligned with the ongoing political-administrative and operational cooperation between the Netherlands and Flanders regarding policy on and management of the Scheldt estuary.

Intensive involvement of flood defence infrastructure managers in the 'living lab’ of the Hedwige and Prosper Polder will produce a multitude of opportunities for joint learning, and thus for expanding and improving the operational planning and practices of infrastructure managers. In addition, the Hedwige-Prosper Polder ‘living lab’ will offer scope for student participation and initiatives proposed by interested third parties, thereby helping to unleash the innovative potential of business and industry in Flanders and the Netherlands. The newly developed knowledge, expertise, and methods, finally, can be leveraged in high-value export products in other parts of the world.

Interested? Please contact …
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Ludolph Wentholt (wentholt@stowa.nl)

DIKE RESEARCH

Two experimental platforms

By Thibaut Faisant

As part of the French research and development programs DigueELITE (www.digueelite.fr) and Digue2020 (www.digue2020.fr), two experimental platforms are built in the South of France to study in real scale the behaviour of embankments in response to hydraulic loadings.

The construction of DigueELITE platform was completed on August 2015 and the Digue2020 platform will be built in 2019. In DigueELITE program, the experimental dike is part of the rehabilitation work of the dike network along the river Vidourle. The dike is located in the Vidourle floodplain, along a meander. In Digue2020 program, the experimental platform will be located in a marine environment, in the regional natural reserve of Camargue. This platform will be built on an existent dike (Figure 1).

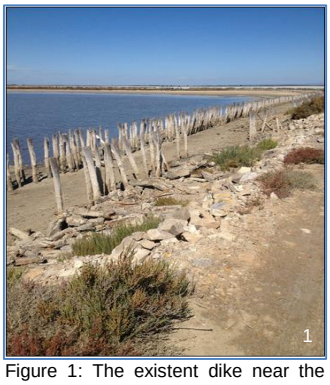

Figure 1: The existent dike near the site of the future platform Digue2020

Both platforms are made of one part built with natural and local material, and another part built with the same material treated with lime. The treatment with lime has been used to study and compare the impact on the general behaviour of the structures, especially resistance to different erosion phenomena.

In addition, sensors are implanted into the embankments of the two platforms to record parameters, such as water content, temperature, pressure and suction. Those sensors provide a close oversight of the interactions between the dikes and their environment. This knowledge of parameters evolution during the structures lifetime also allows the comparative study of non-treated and treated soil behaviours.

The expected results focus on the following issues:

- estimate dike durability by monitored site visits and physical measurements: in-situ tests and parameters recorded by sensors
- quantify by in-situ experimentations the resistance against erosion (internal erosion and surface erosion)
- test in real situation of geophysical measures on embankments with a well-known structure

In the case of Digue2020 platform, expected results are also :

- quantify the hydraulic and chemical influences of the sea on materials
- study of the perception and the social representation of the risk of marine submersion
- implement monitoring system to quantify material and dike durability

An onsite device was developed by Irstea to quantify the resistance to overflowing erosion under the DigueELITE program. The experimental device is in a 15 m long and 61 cm wide channel, covering the downstream slope and the downstream platform. A series of flows are carried out, with increasing flow-rate; between each flow, erosion which occurred during the flow is measured by means of terrestrial Lidar scanner. The maximum flow-rate was up to 0.6 m^3/s, with maximum flow velocity close to 6 m/s. In the DigueELITE program, a test campaign consisted in more than 15 h of flow.
Figures 2, 3, 4 show the DigueELITE experimental dike, a view during an overflowing test and erosion measured at the end of campaign, by terrestrial LIDAR, on treated and non-treated soil.

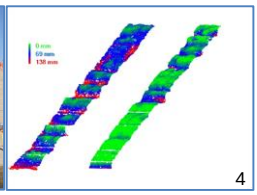

Figure 2,3 & 4: Simulation test site along with terrestrial LIDAR measured erosion

SHARED RESEARCH

International information on levees and flood defences

By Robert Slomp

As the European Levee Working group we would like to use the website: https://lfd-eurcold.irstea.fr/ to share information on research in our countries. The Netherlands has made an overview of which research is being carried out by different institutions. A brief summary is given below, a more extensive overview will be published on the website.

Research at universities includes for example:

- SafeLevee project, studying failure mechanisms and developing a levee failure database to facilitate sharing of data on levee failure and breach phenomena; lead partner is university of Delft.
- AllRisk project, lead partner is the university of Delft; to find reliable and cost effective measures to reduce the probability of flooding.
- Coastal Systems,"KustGenese", lead partner Rijkswaterstaat; optimizing coastal nourishment strategies, as well as their effects on ecology.
- RiverCare, lead partner University of Twente. The main goal is to understand the effect of measures in the river on hydraulics, morphology and ecology and to improve the current models. See https://ncr-web.org/projects/rivercare/

Research on the national level at Rijkswaterstaat, the national water authority, together with the meteorological office KNMI and with Deltares, including for example:

- Evaluate extreme wind and precipitation statistics from large model data sets rather than from limited-length observation records, to reduce statistical uncertainty and to better account for the physics under such conditions.
- Research on sea level scenario's which influence the North Sea Area
- Wind, wave and run-up measurements on large lakes, rivers and coastal areas.
- Piping, internal erosion: a more precise and less conservative description of this failure mechanism
- Revetment failure; a more precise and less conservative failure mechanism description, by better including time dependency as well as erosion after initial damage.

Research by STOWA, for regional flood defences; different projects on managing flood defences

Research by the managers of flood defences, paid by the national program for the reinforcement of flood defences "HWBP". In order to overcome conservative and costly design practices, several projects review current practices for working with failure modes and hydraulic boundary conditions, or experiment with new solutions considering for example piping, slope stability, revetments as well as cables and conduits, the role of foreshores, etc.