International Working Group on Overflow and Overtopping Erosion

Kick-off meeting
Ottawa 14 June 2016

EURCOLD

Outline

1. Presentation and discussion of the draft ToR (Jean-Robert, all)
2. Presentation of context, issues and objectives of each sub-group
    - Sub-group 1 (Mark)
    - Sub-group 2 (Mike and Frédéric)
    - Sub-group 3 (Jean-Robert on behalf of Tim and Myron)
    - Sub-group 4 (Jean-Robert on behalf of Miguel Ángel and Rafael)
3. Large scale experimental project in the NL and Belgium (André)
4. Discussion on meetings: frequency, dates, locations… (All)

Presentation of the draft ToR

1. Context
2. General objective declined in items
3. Structure
4. Organization

EURCOLD

Context (1/2)

- Overflow erosion of embankment dams and levees, overflow erosion downstream of concrete dams, overtopping erosion of embankment dams and levees (in particular coastal levees) are of major concern for dam owners and asset managers.

- The state of the art still need to improve in order to built and maintain safe and sustainable hydraulic structures and to face the risks caused by overflow and overtopping erosion.

- In December 2017, EDF organized in Aussois, France, a workshop dedicated to presenting and discussing the owners’ issues, current practices of engineers, the progress of research and the gaps which need to be filled.

Context (2/2)

- The feed-back from the Aussois workshop pointed out the need to improve international collaboration in this field.
- A book including most of the communications presented during the Aussois workshop is under preparation => going to be edited by the end of 2019.
- In the continuation of the Aussois workshop, it was decided to launch a new working group on overflow and overtopping erosion => IWGOOE.
- This WG is under the umbrella of the EURCOLD

General objective

The general objective of this WG is to help reduce the risk of failure of water retaining structures by overflow and overtopping erosion and the associated consequences **all over the world.**

General objective declined according to the following items

- Sharing issues and problems to solve exposed by dam and levee owners, in all locations and load situations
- Sharing current state of practice and gaps in the toolbox available to practicing engineers
- Sharing progress and advances from academic research and helping to pilot this research from the practioner's perspectives and needs
- Sharing the state of the art of the protection technology in order to increase the safety of dams and levees in overtopping scenarios
- Facilitating international collaboration to speed-up research progress and help dissemination of results.

EURCOLD

Although this working group is hosted by the European Club of ICOLD, it is open to owners, flood risk managers, consulting engineers and academic researchers **from all over the world**.

Dissemination of knowledge and the most recent results of research to practitioners **from developing countries** is also an important objective of this working group.

EURCOLD

Structure

Hosted by the European Club of ICOLD

IWGOOE

Chair: J.-R. Courivaud

Sub-Group 1

Embankment dams and levees

Co-chairs: S. Bonelli, M. Morris

Sub-Group 2

Concrete dams and Spillways

Co-chairs: F. Laugier, M. George

Sub-Group 3

Coastal levees

Co-chairs: M. Van Dame, T. Pullen

Sub-Group 4

Protections

Co-chairs: M.Á. Toledo, R. Moran

Organization

- Attendance to the IWGOOE is free
- Attendance is open to all professionals interested in contributing to these topics
- Protections conference series become the periodic meeting of IWGOOE (organized every 2 years)
- Conference fees and associated travel/accomodation costs payed individually by each attendee.

Protections 2020

4th International Seminar on Dam Protection against Overtopping

Madrid, Spain

11-13 November, 2020

- Overflow Erosion
- Erosion Protection
- Physical Modeling
- Numerical Modeling
- Innovative Solutions
- Case Histories
- Embankments
- Levees
- Spillways
- Sea Dikes

Who contact to join?

Jean-robert.courivaud@edf.fr

Sub-group 1

Mark.morris@samui.co.uk

Stephane.bonelli@irstea.fr

Sub-group 2

Frederic.laugier@edf.fr

mgeorge@bgcengineering.ca

Who contact to join?

Sub-group 3
M.vanDamme@tudelft.nl
t.pullen@hrwallingford.com

Sub-group 4
Miguelangel.toledo@upm.es
r.moran@upm.es

ICOLD 2019
87th Annual Meeting
9-14 June, Ottawa

CIGB 2019
87ème Réunion Annuelle
9-14 Juin, Ottawa

INTERNATIONAL WORKING GROUP
ON OVERFLOWING AND OVERTOPPING EROSION

IWGOOE

Sub-group 1
Overflow Erosion of Embankment Dams and Fluvial Levees

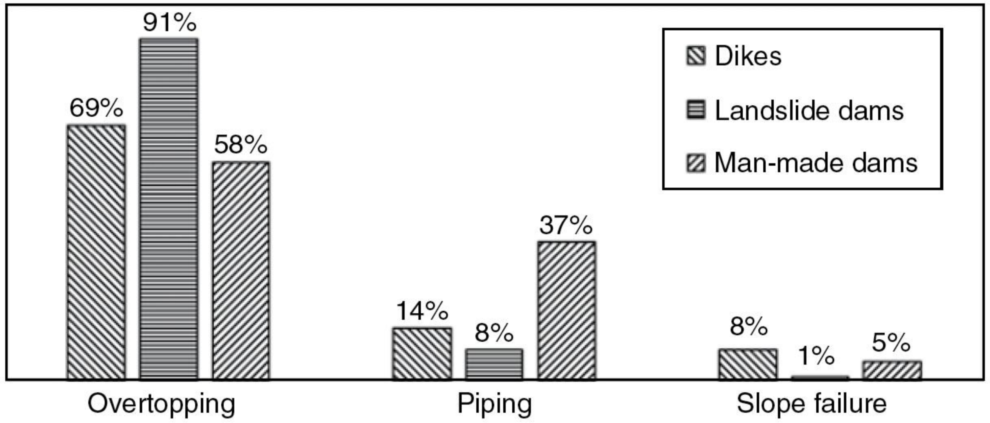
Co-chair
Stéphane BONELLI, Irstea and Aix-Marseille University (France)
Mark MORRIS, HR Wallingford (UK) and SAMUI (France)

Statistics

- **1443 cases of dam failure from the litterature**
  (USCOLD 1975, 1988; Vogel 1980; Stanford University 1994; Singh 1996; Xu and Zhang 2009)

- **The failures cases are from 50 countries, y/c USA, India, the UK and China**

- **Embankment dams:**
  most reservoirs < 10^8 m^3
  50% H<15 m , 26% H=15 to 30 m
  most likely to fail within their 5 years of service

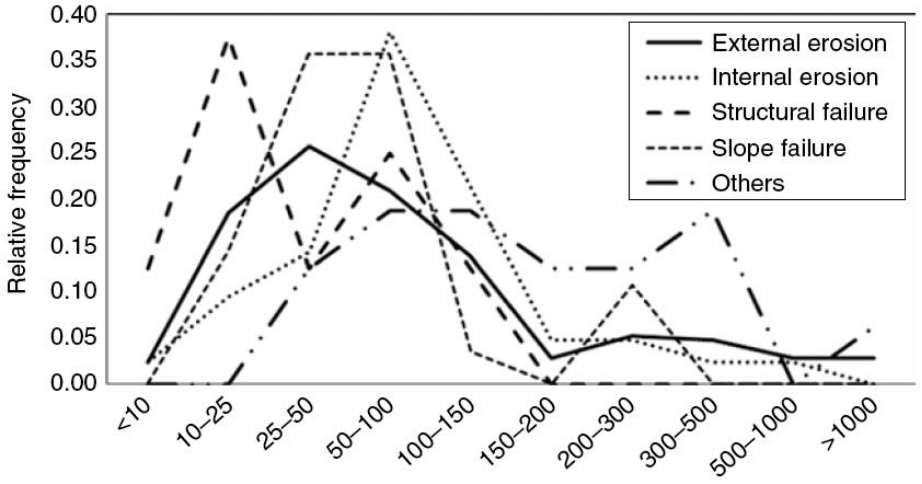


Frequency of failure (2015) (Zhang et al., 2016)

- **1004 cases of dike failure from the litterature**
  (Li et al. 2003, Nagy and Toth 2005, NSF 2006, USACE 2007, URS 2008, van Barrs and van Kempen 2009, Bayoumi and Meguid 2011, Danka and Zhang 2015)

- **The majority of cases (mainly river or canal dike) were reported from Hungary, Germany, China, USA and the Netherlands**

- **Most dikes H=2 to 4 m**

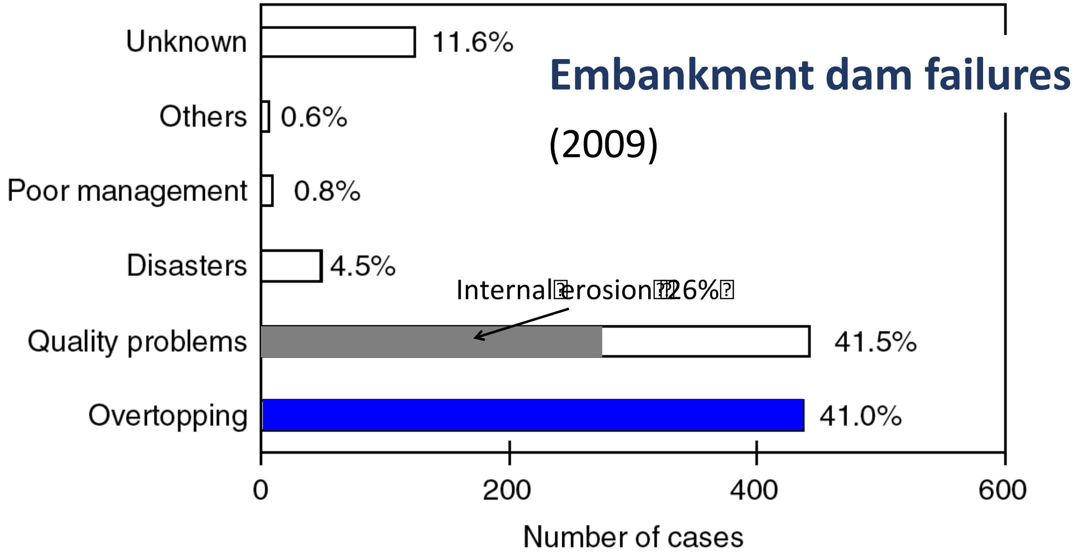


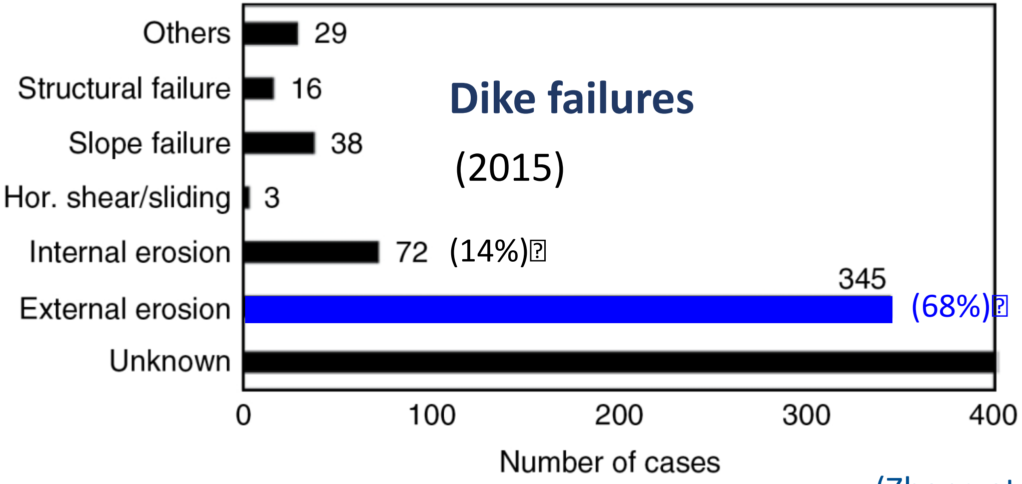
(Zhang et al., 2016)

Dike breach width as a function of breaching mech. (2015)

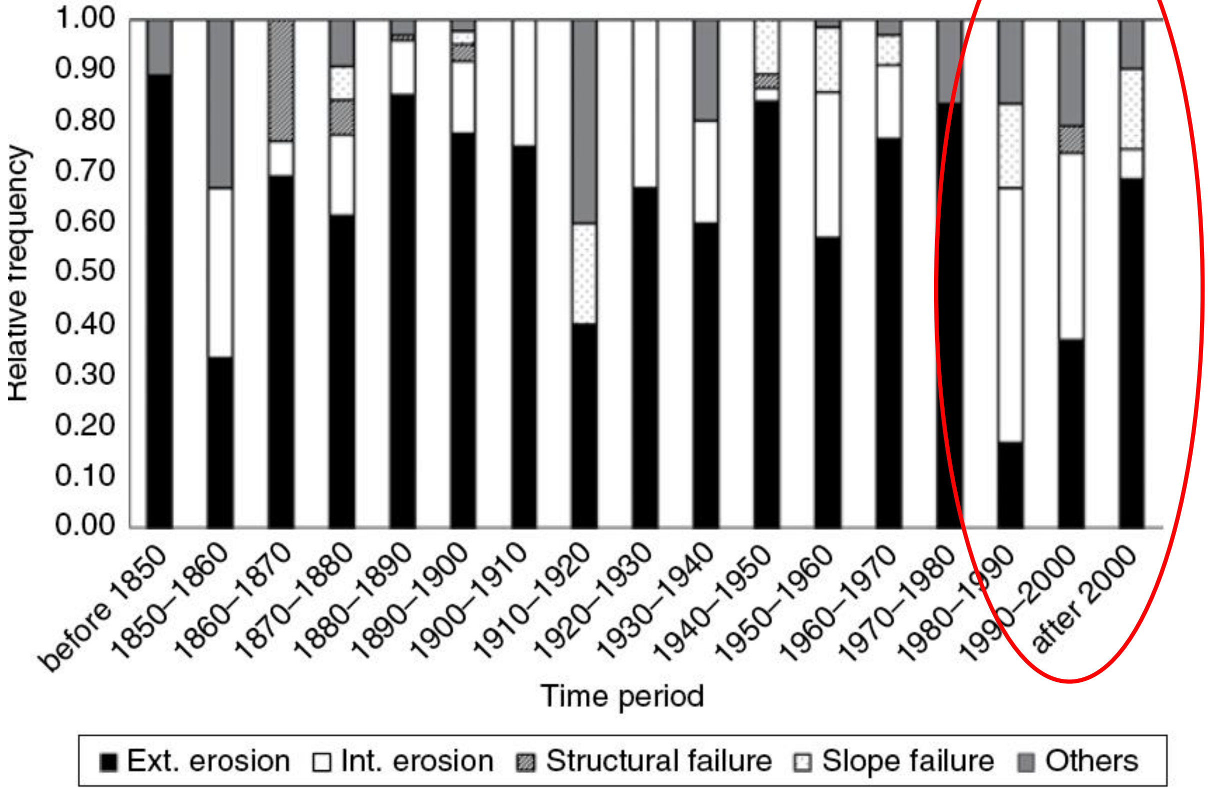
Statistics

Extreme flood events with record-breaking flood levels observed all around the world



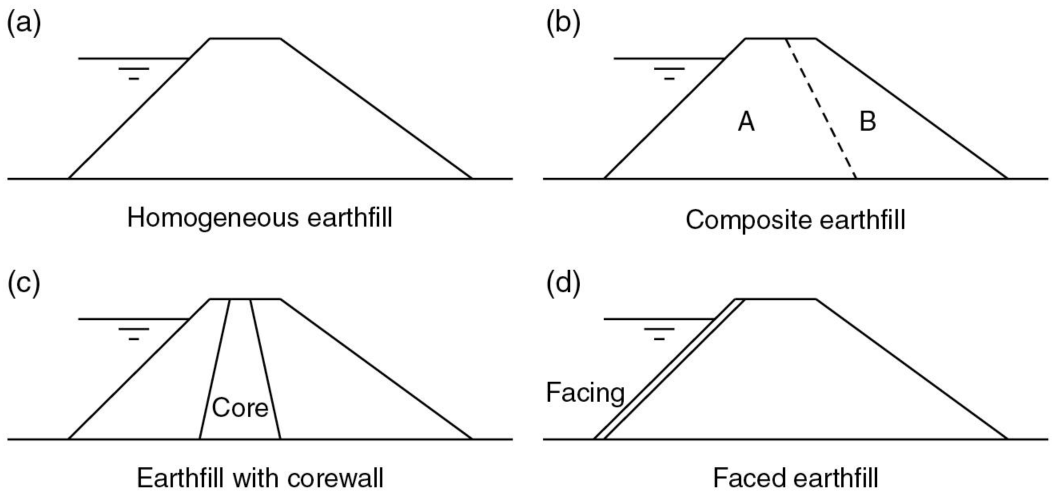


Frequency of breaching mech. on time scale (2015)



(Zhang et al., 2016)

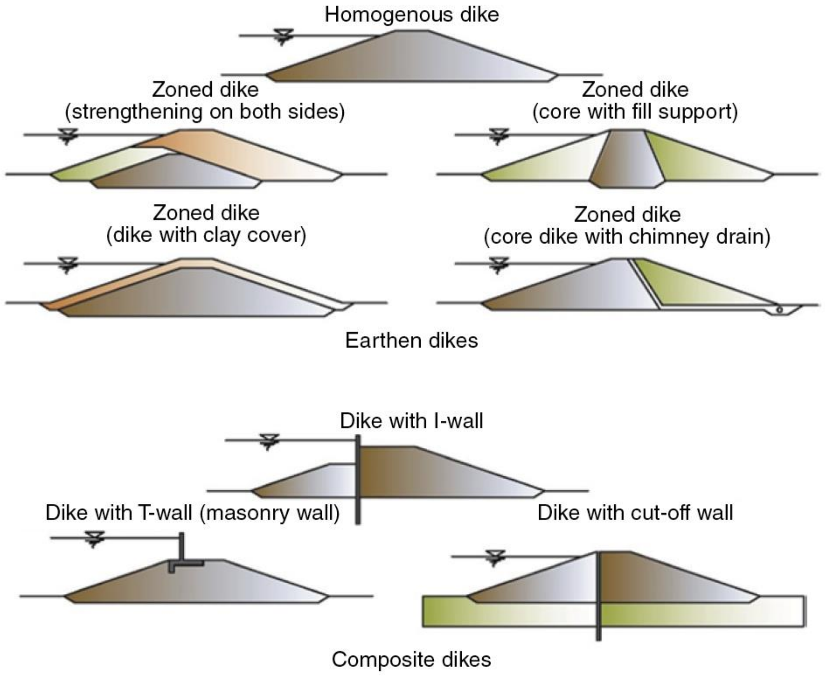
Types of embankment dams and dikes



Dam type	Overtopping	Piping	Other quality problems	Poor management	Disasters	Sum
Homogeneous earthfill dams	23	26	5	1	3	58
Composite earthfill dams	18	17	6	—	1	42
Earthfill dams with corewall	13	6	1	—	1	21
Concrete faced rockfill dams	—	2	—	—	—	2

Failure causes for four types of embankment dams

(Zhang et al., 2016)



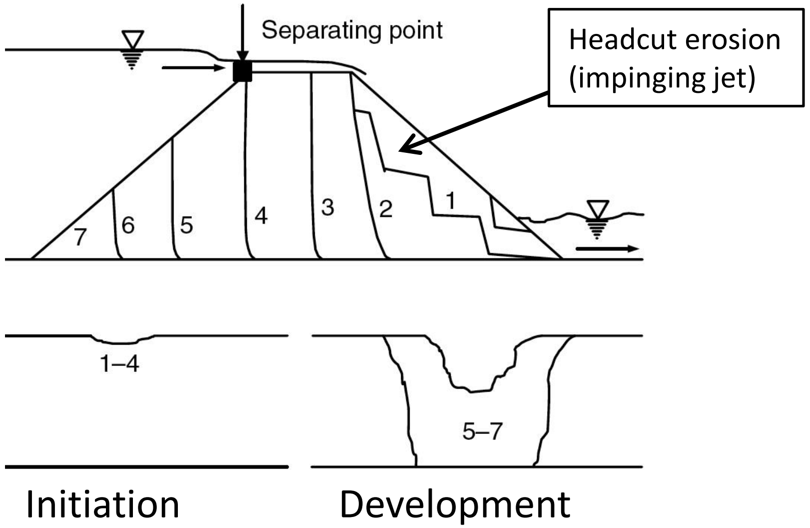
Types of dikes

(any statistics of failure causes for each type ?)

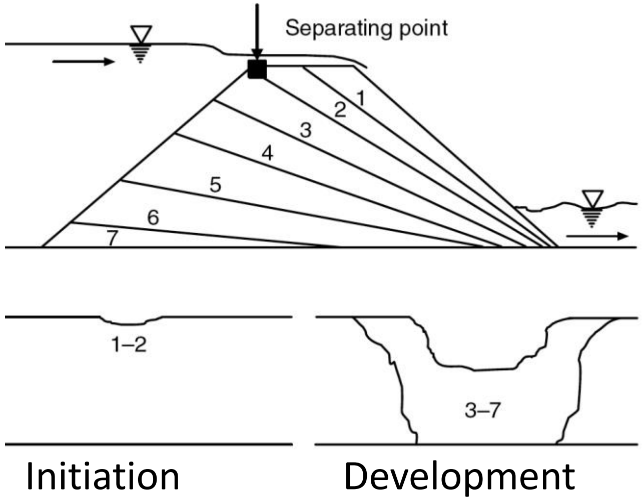
Differences between dams and dikes

	Dams	Dikes
Breach water supply	Limited by the amount of storage water	Governed by meteorological and hydrological conditions
Floodwater control	Better control (spillways)	No spillway for most dikes
Foundation Scour	Good quality, foundation scour is less likely	Weak soils, foundation scour can be bigger than dike height (factor up to 2)
Breach height	50% H<15 m , 26% H=15 to 30 m H up to 100 m -> scale effect Breach height ≈ Dam height	Dike height<5 m Breach height up to 3 dike height
Breach width	A few dozen of meters Many empirical eq.	Up to several hundred meters Critical parameter, few empirical eq.
Upstream velocity	Reservoir No longitudinal water velocity	River or canal Velocity with possible angle of incidence (curves) Lateral erosion on the river/canal side
Breach development	Mostly symmetric (depending on rock abutment, spillway, etc)	Always unsymmetric due to river/canal velocity

Four types of breaching process



1. Cohesive soil embankment by overtopping



2. Fine-grained embankment by overtopping

3. Coarse-grained : unknown yet

4. Rockfill dams

coupling between free surface flow and seepage flow

(Pictures from Zhang et al., 2016)

Main questions

1. Loading	What are the loading conditions?
2. Protection	What is the protection efficiency in preventing erosion?
3. Initiation of erosion	What are the possible elementary mechanisms of initiating erosion?
4. Location of erosion	What are the possible locations of initiating erosion?
5. Breach formation	What are the possible elementary mechanisms of breach formation ?
6. Breach development	What are the possible elementary mechanisms of breach development?

Physics

	Physics
1. Loading	Free surface flows, aerated flows, turbulent flows, large roughness: **skimming flows** Knowledge from the experimental work in the field of stepped spillways of mild to steep slope Impinging jet, two-phase flows *How to compute the hydraulic stress* ?
2. Protection	Depending of the protection solution (if any), onset of degradation as a function of flow and time -> sub.group 4 ?
3. Initiation of erosion	**Soil critical stress** -> onset on erosion Critical velocity
4. Location of erosion	Depending of i) type of dam or dike, ii) embankment soil and foundation
5. Breach formation	Elementary mechanisms as a function of soil: i) cohesive soil, ii) fine grained soil, iii) coarse grained soil, iv) rockfill
6. Breach development	**Coefficient of erosion** -> erosion rate Coupling erosion and slope instability Symmetric flow (dams) vs. unsymmetric flow (dikes), secondary flows Large scour in foundation (dikes)

Laboratory tests

	Laboratory tests
1. Loading	
2. Protection	Laboratory hydraulic canals Ciria curves, -> sub.group 4 ?
3. Initiation of erosion	
4. Location of erosion	
5. Breach formation	
6. Breach development	

Laboratory Flume Test

Laboratory Jet Erosion Test (JET)

Erosion Function Apparatus (EFA)

Other physical quantity ?
(soil shear strength, tensile strength, ...)

Field tests

	Laboratory tests
1. Loading	
2. Protection	
3. Initiation of erosion	
4. Location of erosion	
5. Breach formation	
6. Breach development	

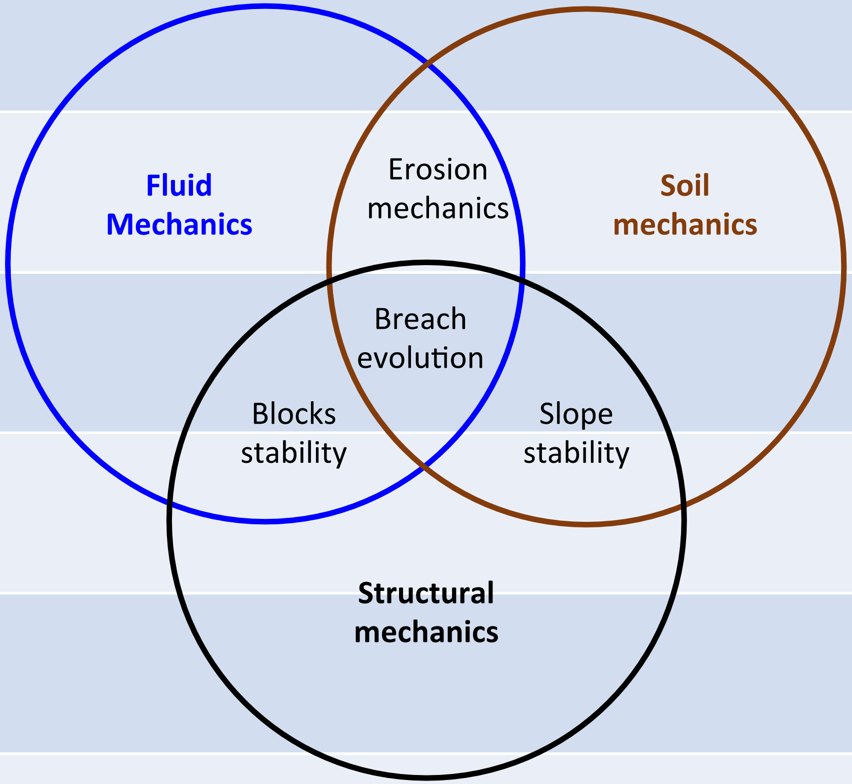
Field Jet Erosion Test (JET)

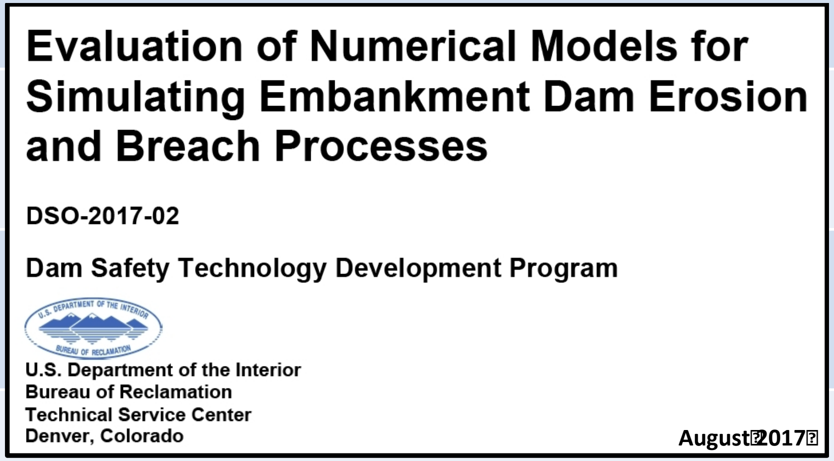
Field Overflowing Test (FOT)

Large scale test (Impact Project, 2002)

Numerical codes

	Laboratory tests
1. Loading	
2. Protection	
3. Initiation of erosion	
4. Location of erosion	
5. Breach formation	
6. Breach development	





Evaluation of Numerical Models for Simulating Embankment Dam Erosion and Breach Processes

DSO-2017-02

Dam Safety Technology Development Program

U.S. Department of the Interior
Bureau of Reclamation
Technical Service Center
Denver, Colorado

August 2017

Conclusion

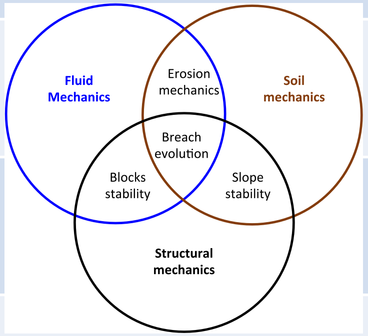
- Overflowing is the main cause of failure of embankment dams and dikes
- Physics process: hydraulics / geotechnics / structural response, overall, little known
- Laboratory test: tools exist, but no general method
- Field test: tools exist, but no general method
- Numerical modeling: tools exist, developments are still needed
  a need for input data, a need for validation data
- Safety assessment: no general method (no recent Icold Bulletin)
- Due to lack of knowledge and lack of tools, models for dams are often applied to dikes
- ...

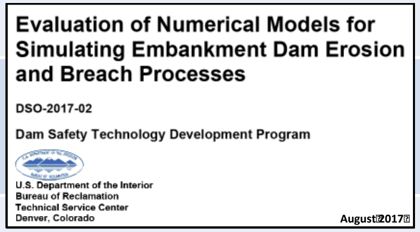
Building the Road Map together

	Data	Physics	Lab tests	Field tests	Models	Safety assessment
1. Loading	X	X				
2. Protection	X	X				
3. Initiation of erosion	X	X				
4. Location of erosion	X	X				
5. Breach formation	X	X				
6. Breach development	X	X				








Evaluation of Numerical Models for Simulating Embankment Dam Erosion and Breach Processes

DSO-2017-02

Dam Safety Technology Development Program

U.S. Department of the Interior
Bureau of Reclamation
Technical Service Center
Denver, Colorado

August 2017

several levels of analysis, from a synthetic view to a detailed analysis

several methods of analysis (functional, behavioral, numerical, ...)

Last Icold Bulletin : Dam-Break Flood Analysis, *Review and Recommandations*, Bulletin 111, 1998

Actions to be identified

- Maintaining an up to date list of research programmes/project underway worldwide
- Consolidate our documented case study databases
- Gather the state of knowledge of physical phenomena
  List open questions
- List available laboratory equipment (both academic and industry)
  List development needs
- List existing field equipment (both academic and industry)
  List development needs
- List available numerical codes (both academic and industry)
  List development needs
- ...

International Working Group on Overflowing & Overtopping Erosion

Sub-Group 2: Concrete Dams & Spillways

Chairs:

Frédéric Laugier, EDF

Mike George, BGC Engineering

Focus

“Overflowing erosion of bedrock downstream of concrete dams and overflowing erosion of spillways”

A 2017 workshop in Aussois, France highlights the state-of-the-art…

Dam owners perspective:

Verbund – Floarian Landstorfer

Alpiq – Raphael Leroy

EDP – Irene Fernandes

SHEM – G. Desperoux

EDF – Frederic Laugier

Uniper/Sweden – Carl-Oscar Nilsson

Norway – Leif Lia

British Dam Society – Alan Brown

Vietnam – Michel Ho Ta Kanh

Hydro Quebec – Marco Quirion

USBR – Tony Wahl

Oroville IFT - John France

State-of-the-art/current research:

Stefano Pagliara - University of Pisa

Luis Castillo - University of Cartagena

Yvan Bercovitz & Gregory Guyot - EDF

Tony Wahl – USBR

Ali Saedi & Lamine Boumaiza UQAC

Johannes Wibowo – USACE

Pedro Manso – EPFL

Lucie Alazard & Thierry Vincent - ARTELIA

George Annandale

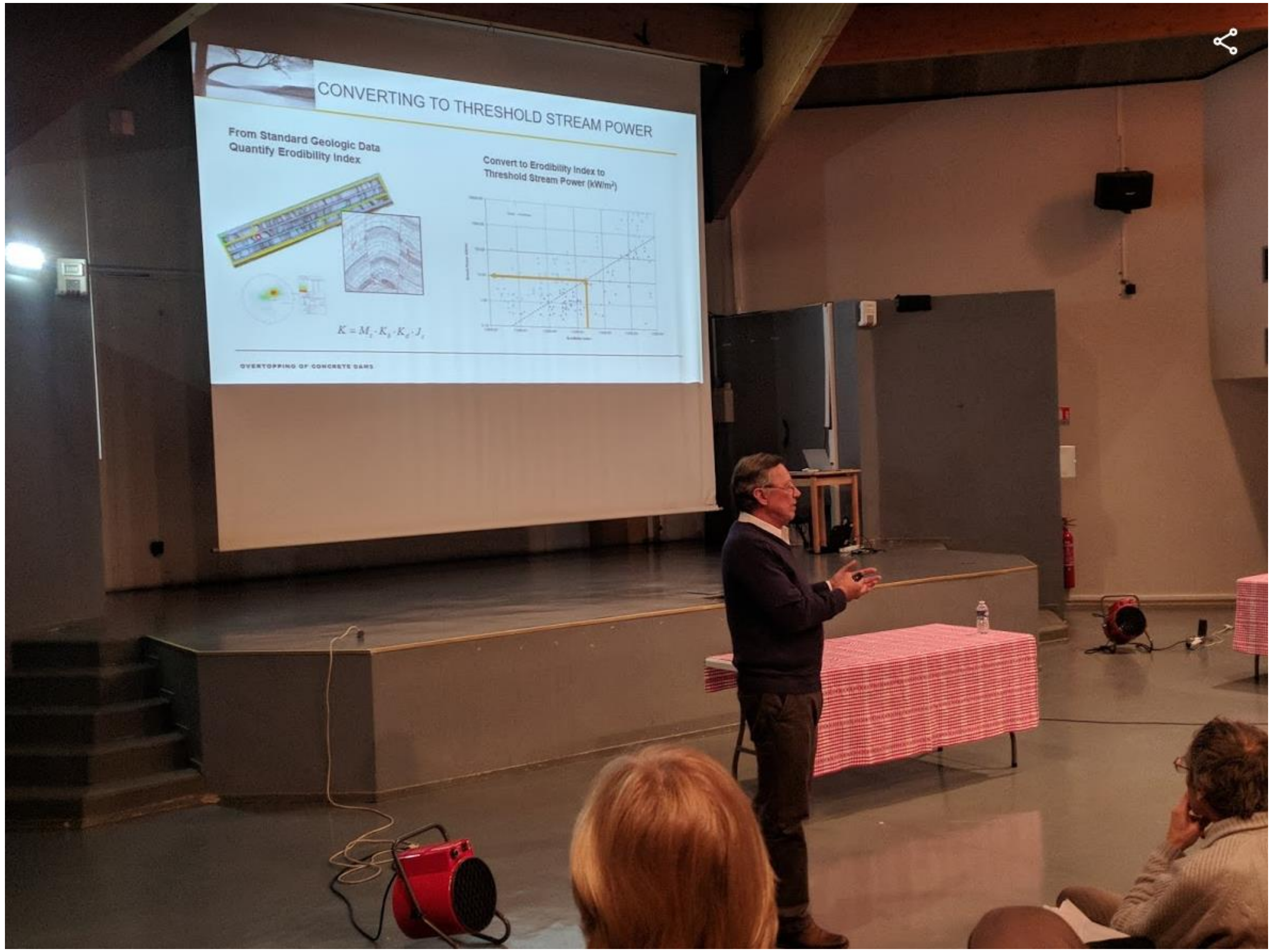
Stephen Pells – Pells Consulting

Mike George – BGC Engineering

Anton Schleiss – EPFL

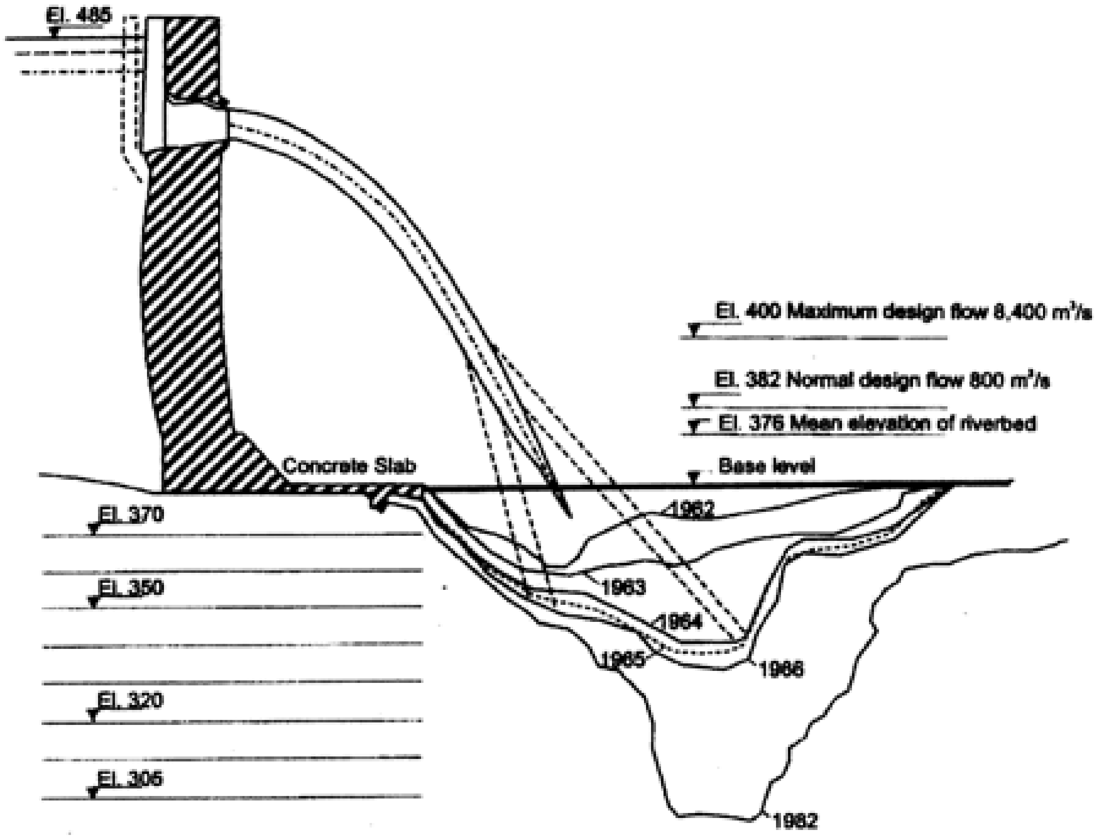
…but also identifies data gaps…

- Erosive capacity of water
- Time rate of rock scour
- Geologic controls
- Case studies / monitoring / database
- Numerical modeling
- Mitigation



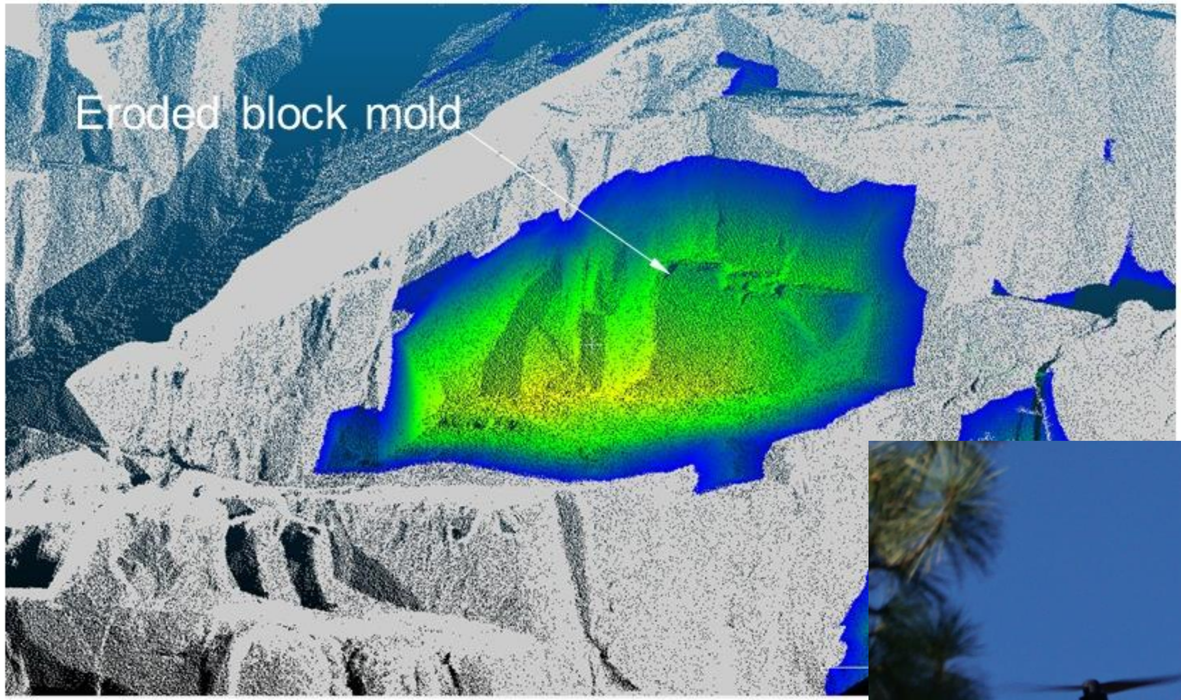
Initial areas of focus - DATABASE

- NEED - Construction of large database on scour / non-scour events
  - Spill events are large erosion tests – *if documented adequately*
  - Make available to dam community to calibrate existing / new scour models
  - Anonymous information – confidentiality
  - Management
- Data
  - Before/after geometry
  - Flood hydrographs
  - Hydraulic structure data (e.g., rating curves)
  - Geologic / rock mass data
  - Video of spills



Initial areas of focus - DATABASE

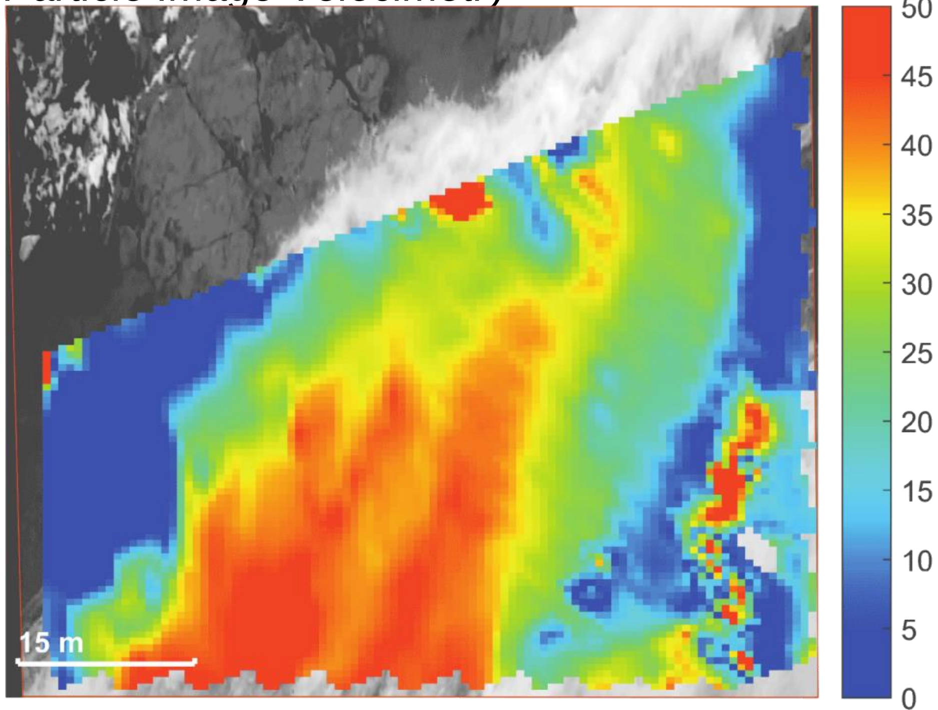
- High-resolution monitoring



Oct 2017 – Showing subtracted difference (ft)

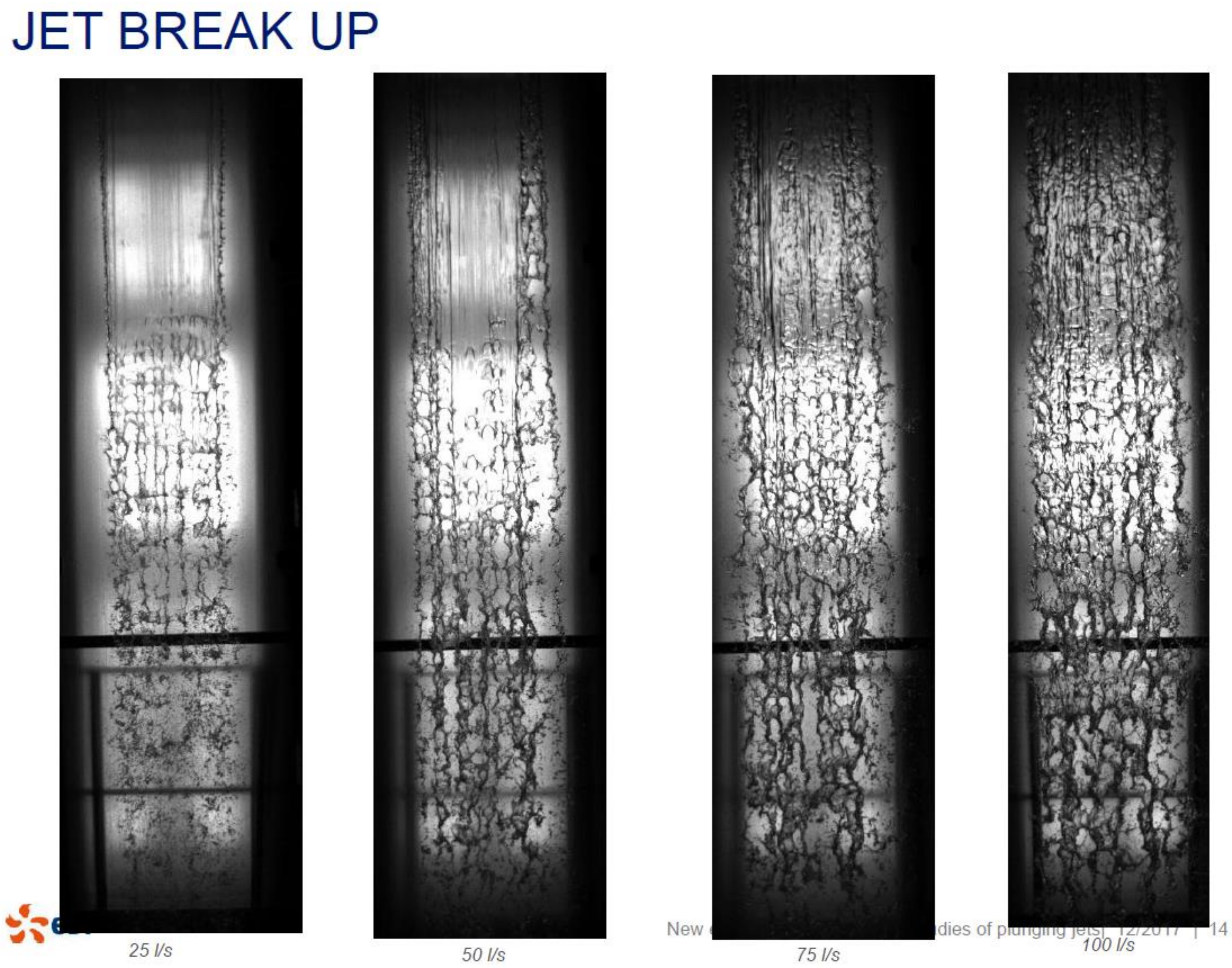
Video

Particle Image Velocimetry



Initial areas of focus – Experimental Goals

- Engage partners (dam owners, researchers)
- Testing and calibrating sensors and devices for “higher” and more powerful experiments : pressures sensors, air/water sensors, high frequency videos



Guyot & Bercovitz (2017)

Initial areas of focus – Experimental Goals

- EDF Facility

Typology	Characteristics
Weir	Thin crest (can be changed)
Overflowing length	1000 mm
Tray length	2.9 m
Calming means	Head lost + Honeycombs
Tray positions (Tray bottom / slab)	4 postions (8.4 m ; 6.4m ; 3.9m ; 1.5 m) go to plane for mor details
Maximum height of fall	9.5m / slab 15 m / bottom of the pool (4 m of water heigth)
Flow	0 - 400 l/s
Measurment technics	ADV LS-PIV Photogrammetry 4 High speed cameras (2000 fps for 1080 x 1080) 33 pressure sensors (100 Hz) – can move along the rails 11 pressure sensors (20000 Hz) LDV

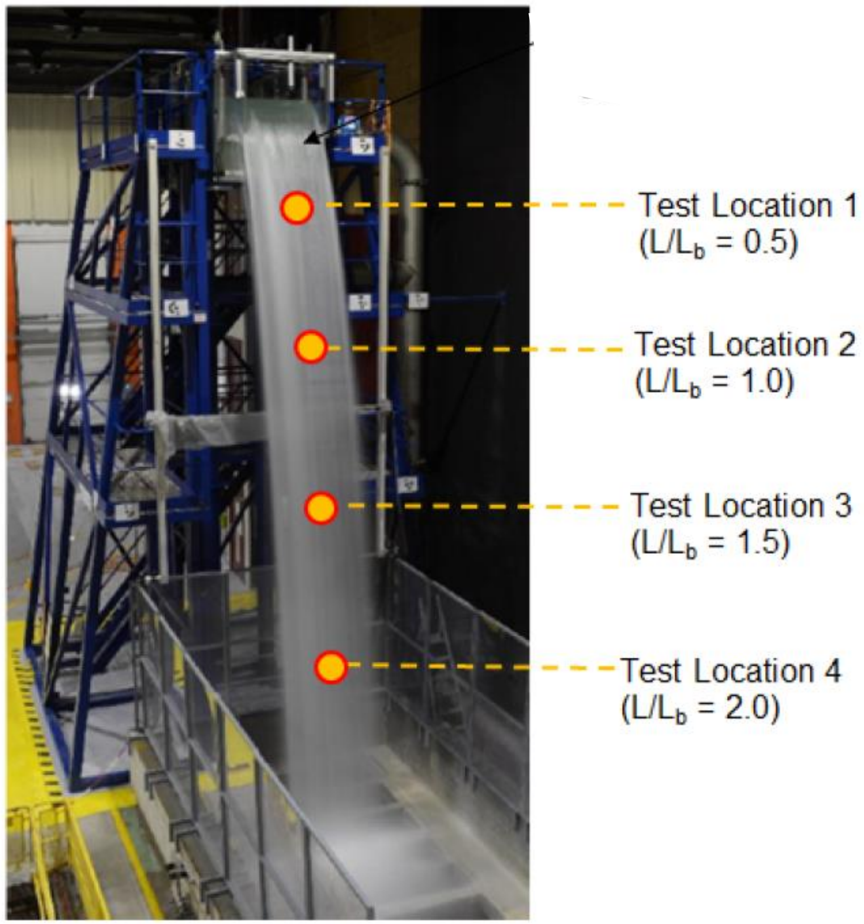
"Angel Jump"

Overflow for 220 l/s

Initial areas of focus – Experimental Goals

- Dam overtopping – abutment scour

Proposed Physical Hydraulic Model Set-Up



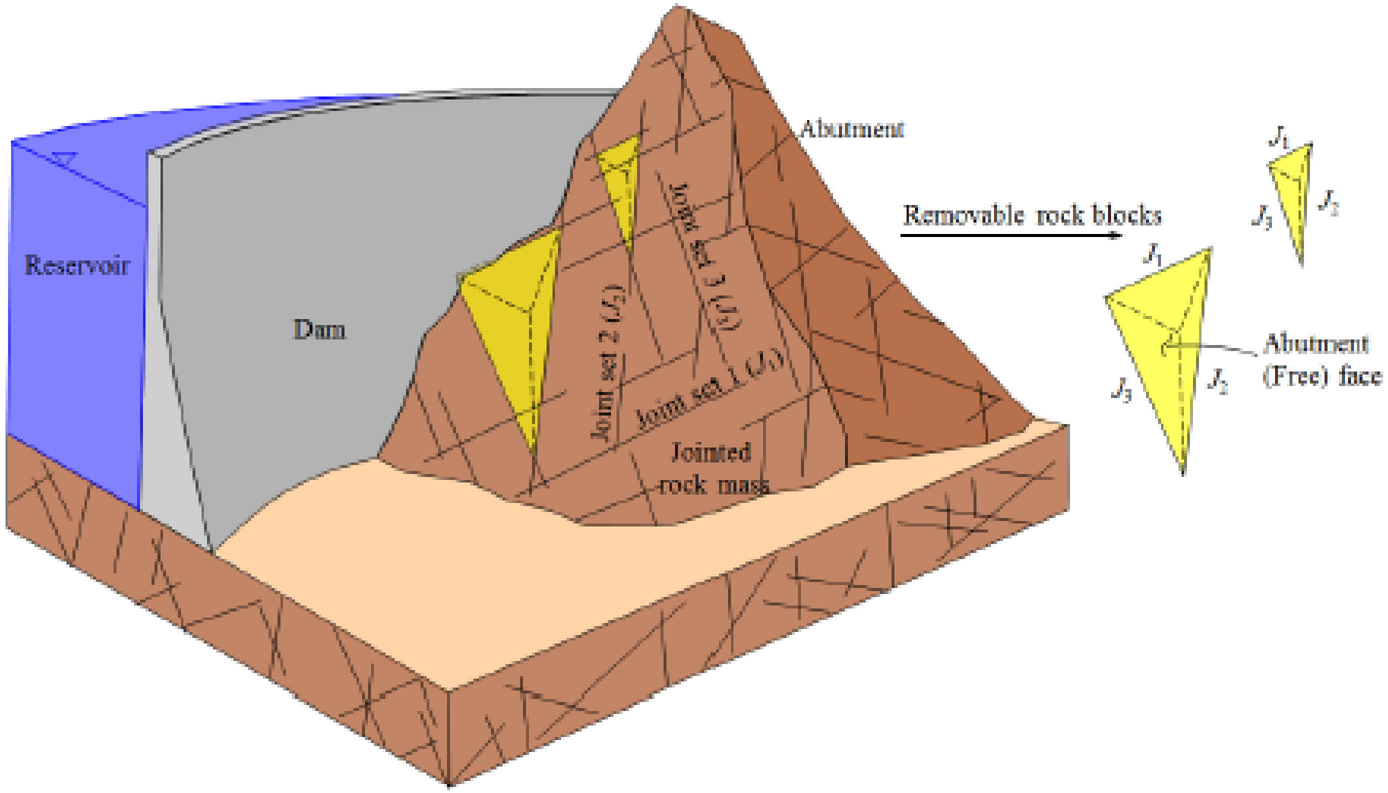


Figure 11A-13 - Schematic for removable dam abutment rock blocks.

M.F George (2018)

Initial areas of focus – EXPERIMENTAL GOALS

- Prototype Scale Testing

Unlined spillway / instrumented rock blocks / rock mass
(M.F George 2015)

Initial areas of focus – EXPERIMENTAL GOALS

- Prototype Scale Testing – EDF Arch Dam Overtopping

Initial areas of focus – EXPERIMENTAL GOALS

- Hydro Quebec – UQAC Research
- Two small-scale spillways will be constructed and used for a series of tests to analyze the different parameters
- The first model will be at the laboratory scale and it will be built in the hydraulic laboratory of UQAC.
- The second, on a semi-real scale (Pilot Plant), will be set up on Lake Simoncouche territory managed by UQAC and located on the high plateau of Laurentides about 20 kilometers south of the UQAC campus

Simoncouche site

UQAC cottage

Pilot Plant spillways

How to get involved…

- Partners to share:
  - Data on scour events
  - Input on needs/research
  - Financial support
  - Participation

- Email:
  - Frédéric Laugier, frederic.laugier@edf.fr
  - Mike George, mgeorge@bgcengineering.ca

Wave overtopping, discharges, hazards and downstream erosion

Jean-Robert Caurivaud

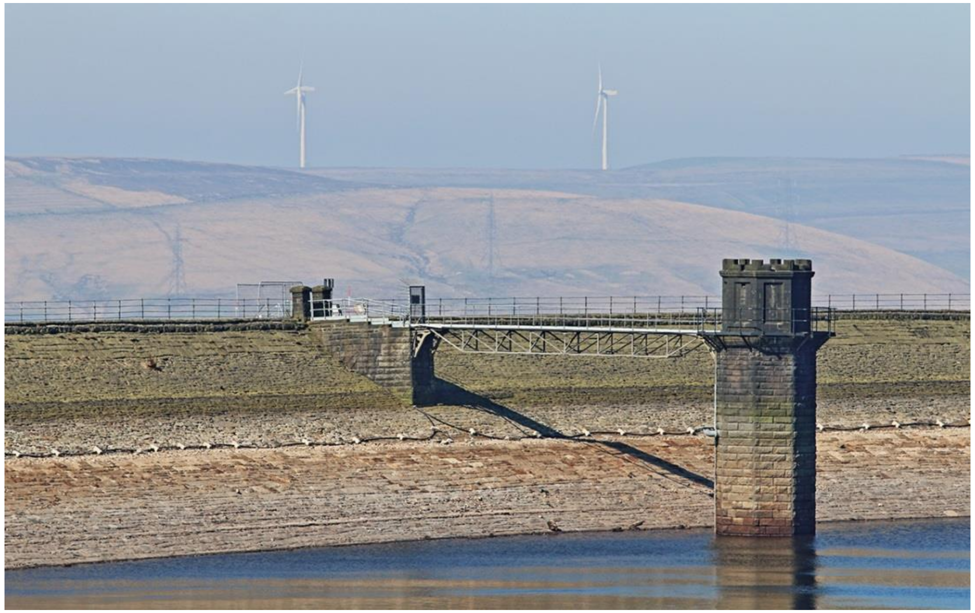
Dr. Tim Pullen

Dr. Myron van Damme

2017

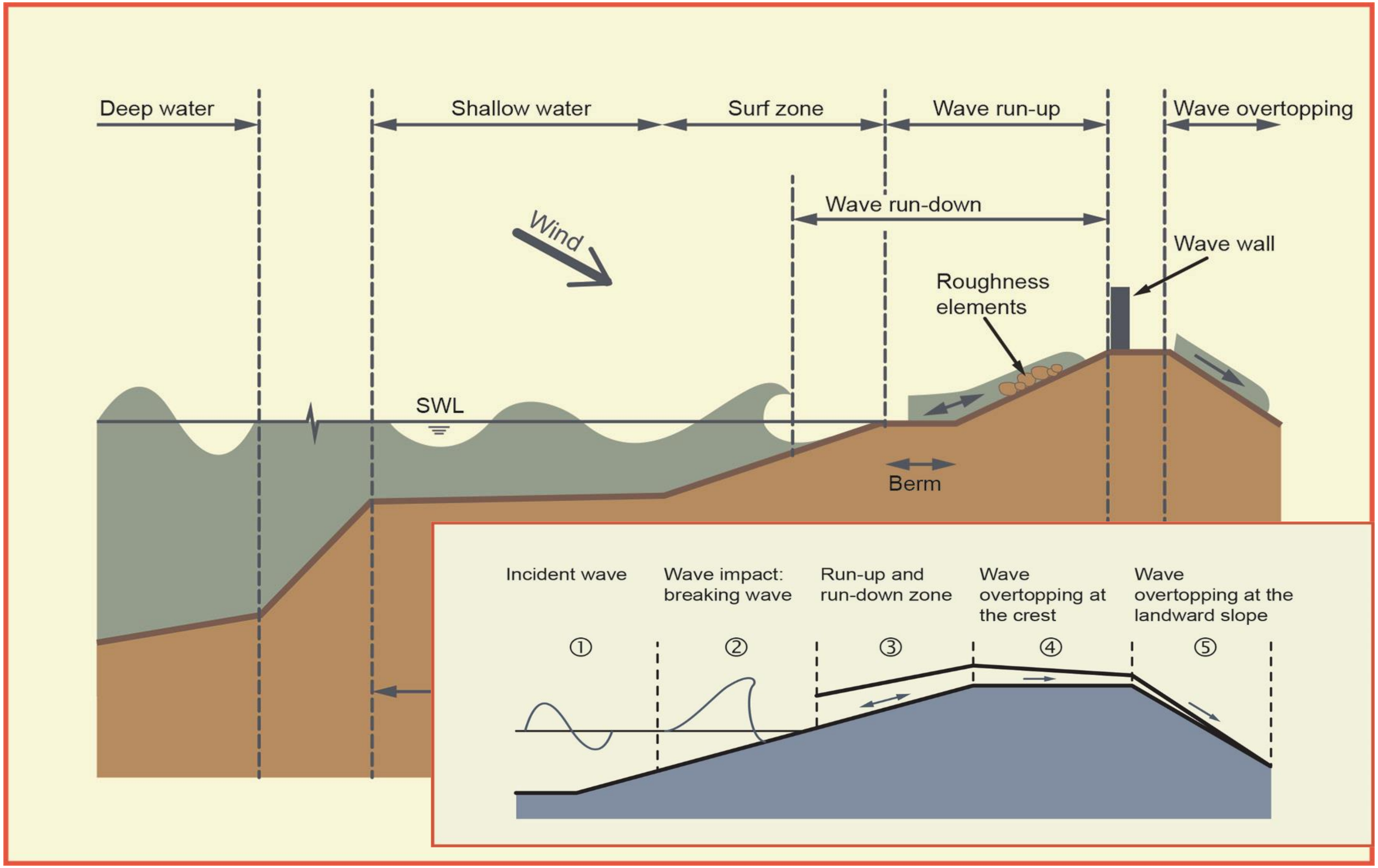
Introduction

Typical reservoir embankment



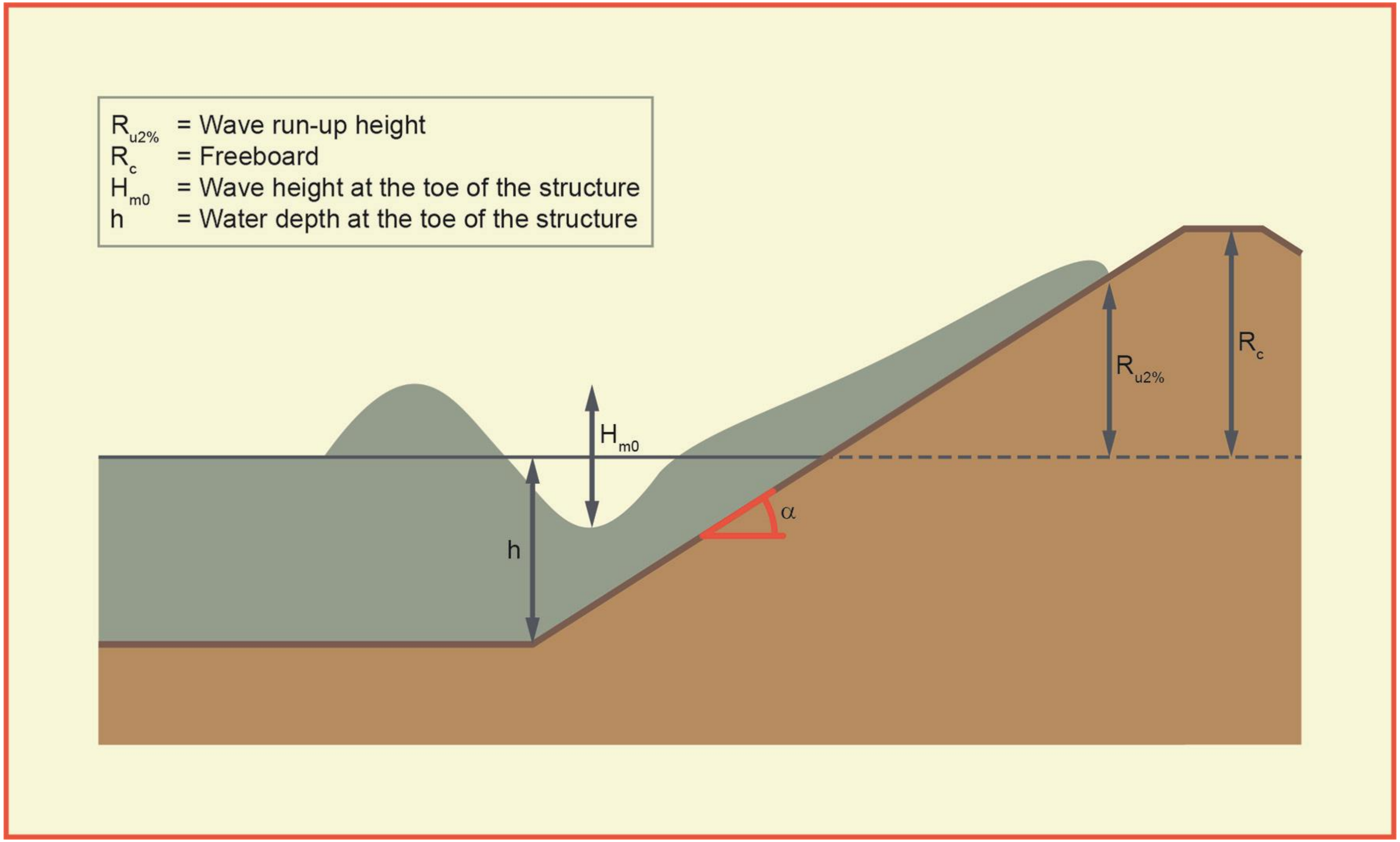
Typical coastal embankment

Overtopping overview

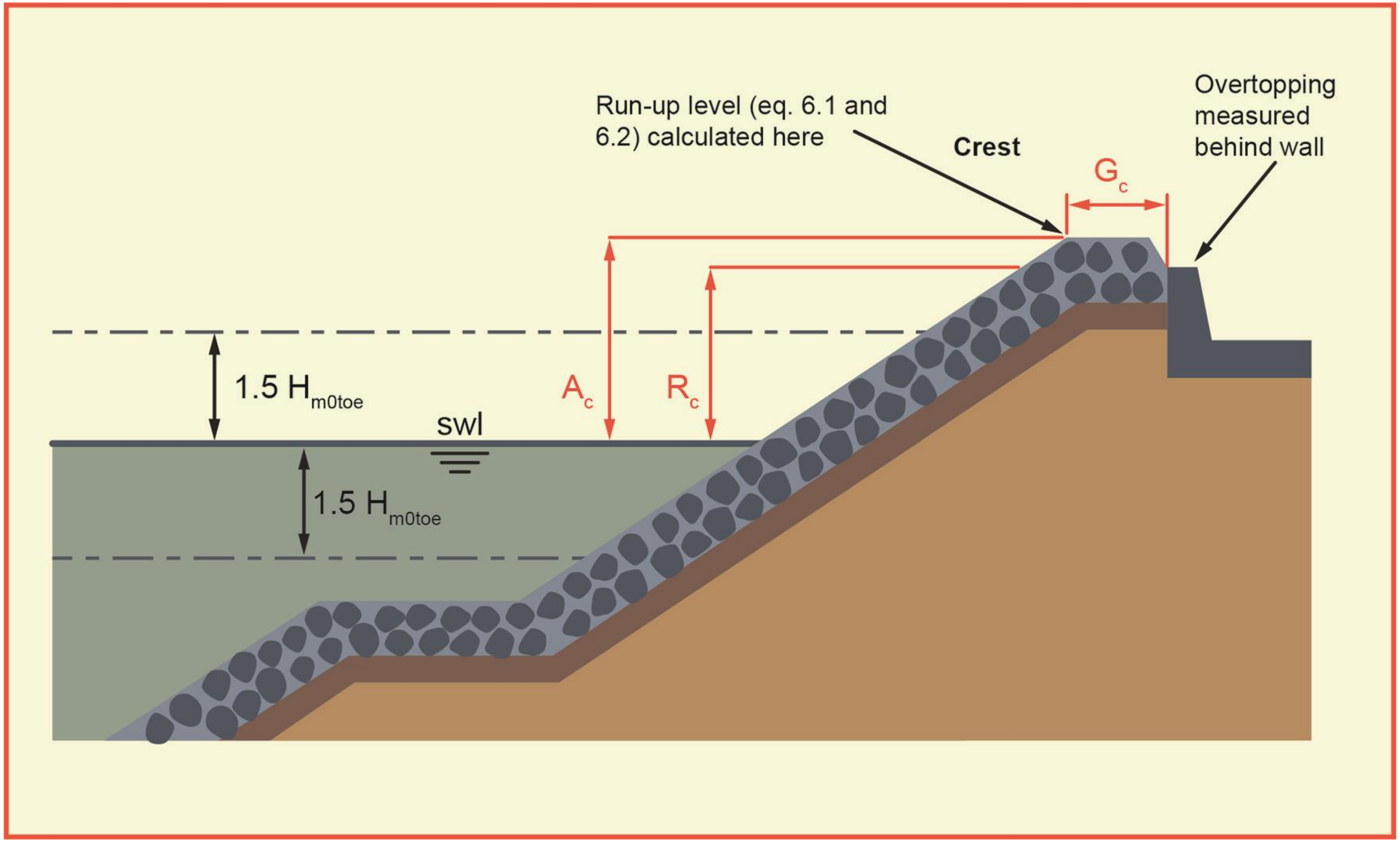


Wave overtopping on sloping structures

- Key parameters, wave run-up, and then overtopping



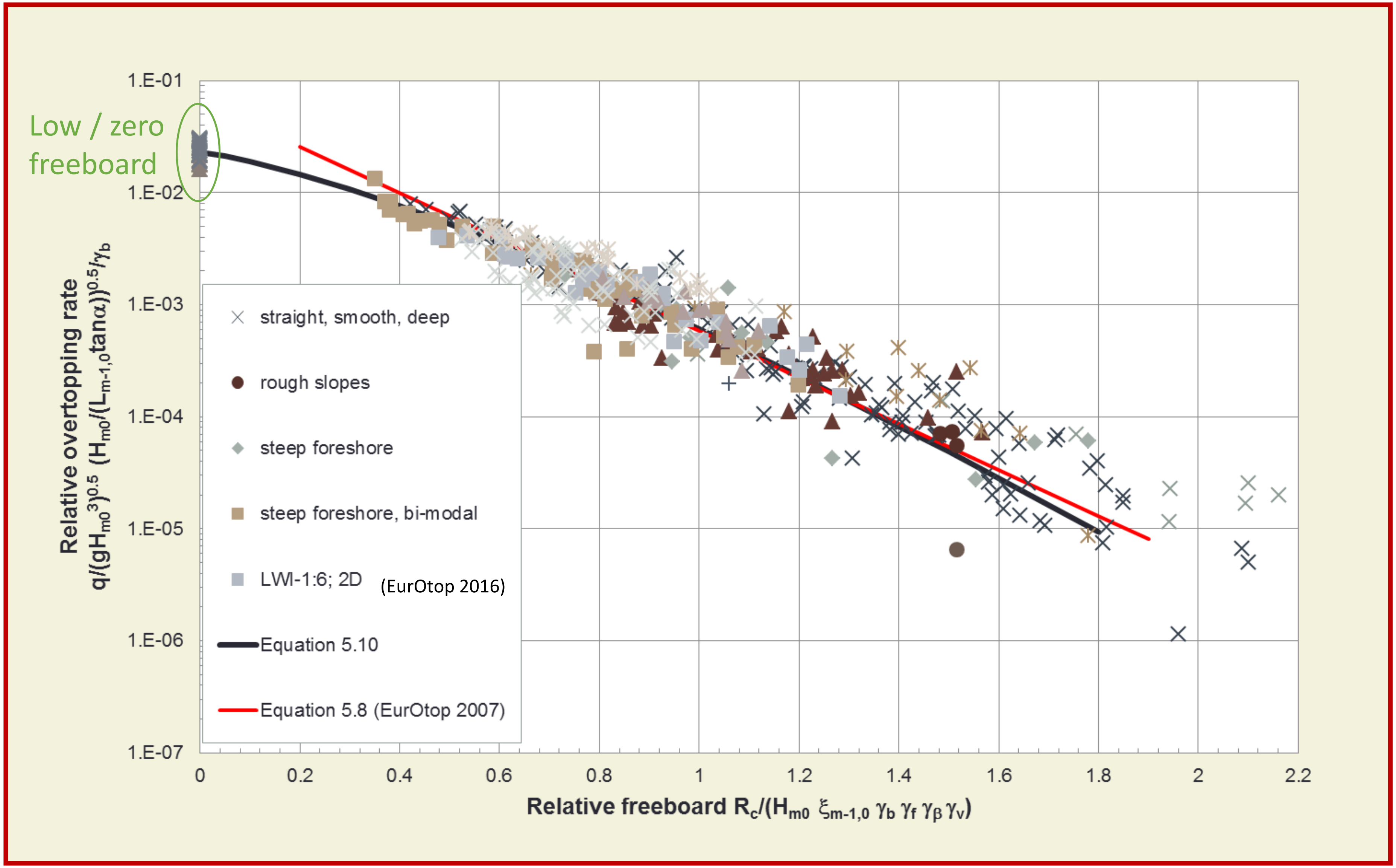
Wave overtopping on armoured / roughened structures



Generic empirical overtopping formula

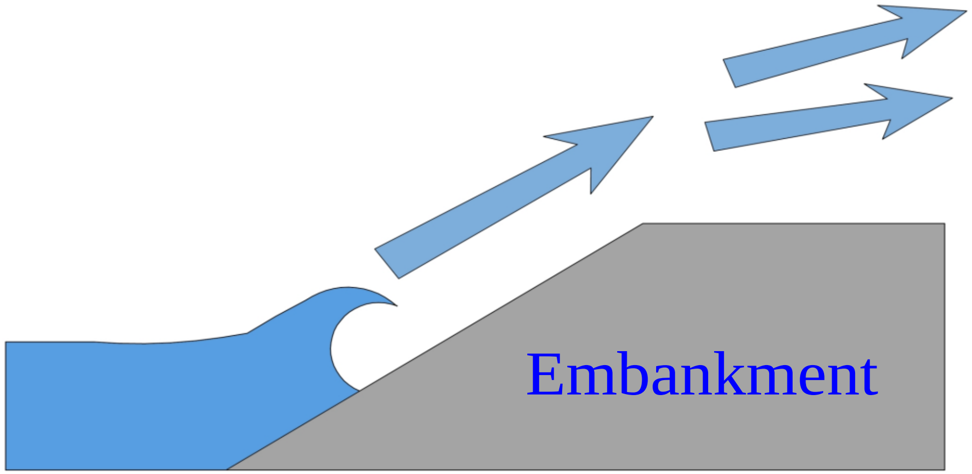
- Mean overtopping discharge q
  - Mean overtopping discharge: q (m^3/s per m or l/s per m(x1000))
  - Dimensionless overtopping discharge: $q/\sqrt{gH_{m0}^3}$
  - Dimensionless relative freeboard: R_c/H_{m0}
  - Basic formula: $$\frac{q}{\sqrt{gH_{m0}^3}} = a\exp(-bR_c/H_{m0})$$

Prediction on mean overtopping discharges (q (l/s/m))



Overtopping hazards

Overtopping hazards



Embankments and slopes: overtopping velocities generally up to:

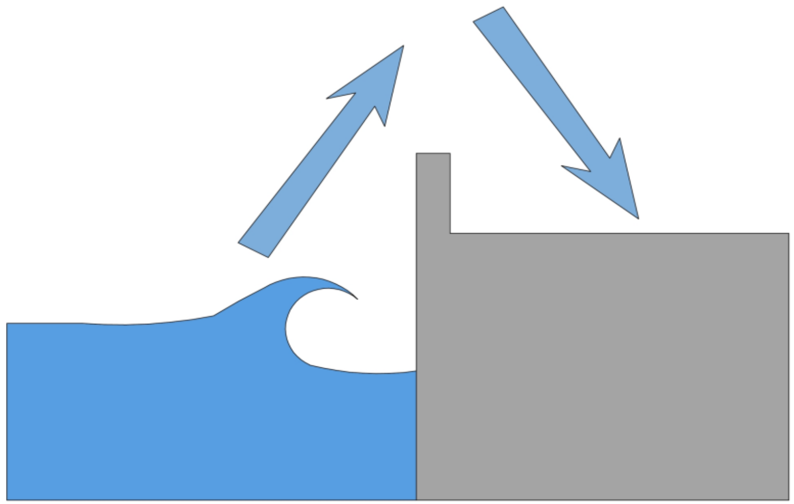
$u_z \approx 1 - 3\ c_i$

(where c_i is wave speed)

Vertical, battered and composite walls: overtopping velocities often up to:

$u_z \approx 2 - 10\ c_i$

(where c_i is wave speed)



Overtopping discharges for structural design

Limits for wave overtopping for structural design of breakwaters, seawalls, dikes and dams

Hazard type and reason	Mean discharge q (l/s per m)	Max volume V_{max} (l per m)
Rubble mound breakwaters; H_{m0} > 5 m; no damage	1	2,000-3,000
Rubble mound breakwaters; H_{m0} > 5 m; rear side designed for wave overtopping	5-10	10,000-20,000
Grass covered crest and landward slope; maintained and closed grass cover; H_{m0} = 1 – 3 m	5	2,000-3,000
Grass covered crest and landward slope; not maintained grass cover, open spots, moss, bare patches; H_{m0} = 0.5 – 3 m	0.1	500
Grass covered crest and landward slope; H_{m0} < 1 m	5-10	500
Grass covered crest and landward slope; H_{m0} < 0.3 m	No limit	No limit

EURCOLD

Overtopping discharges for property

General limits for overtopping for property behind the defence

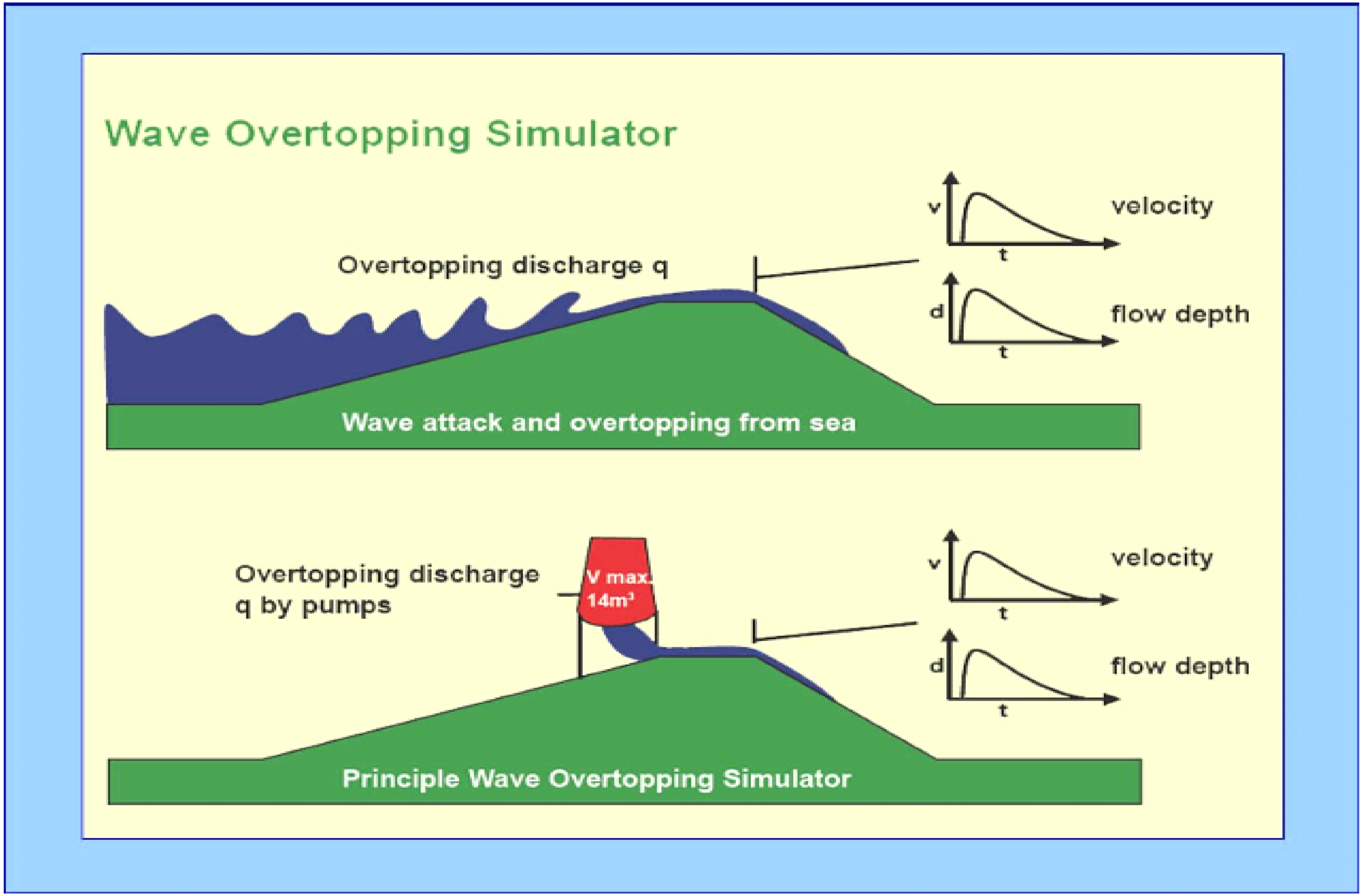
Hazard type and reason	Mean discharge q (l/s per m)	Max volume V_{max} (l per m)
Significant damage or sinking of larger yachts; $H_{m0} > 5$ m	>10	>5,000 – 30,000
Significant damage or sinking of larger yachts; H_{m0} = 3-5 m	>20	>5,000 – 30,000
Sinking small boats set 5-10 m from wall; H_{m0} = 3-5 m Damage to larger yachts	>5	>3,000-5,000
Safe for larger yachts; $H_{m0} > 5$ m	<5	<5,000
Safe for smaller boats set 5-10 m from wall; H_{m0} = 3-5 m	<1	<2,000
Building structure elements; H_{m0} = 1-3 m	≤1	<1,000
Damage to equipment set back 5-10m	≤1	<1,000

Overtopping discharges for people & vehicles

EURCOLD

Hazard type and reason	Mean discharge q (l/s per m)	Max volume V_{max} (l per m)
People at structures with possible violent overtopping, mostly vertical structures	No access for any predicted overtopping	No access for any predicted overtopping
People at seawall / dike crest. Clear view of the sea.		
$H_{m0} = 3$ m	0.3	600
$H_{m0} = 2$ m	1	600
$H_{m0} = 1$ m	10-20	600
$H_{m0} < 0.5$ m	No limit	No limit
Cars on seawall / dike crest, or railway close behind crest		
$H_{m0} = 3$ m	<5	2000
$H_{m0} = 2$ m	10-20	2000
$H_{m0} = 1$ m	<75	2000
Highways and roads, fast traffic	Close before debris in spray becomes dangerous	Close before debris in spray becomes dangerous

Assessment of overtopping discharges for dike erosion



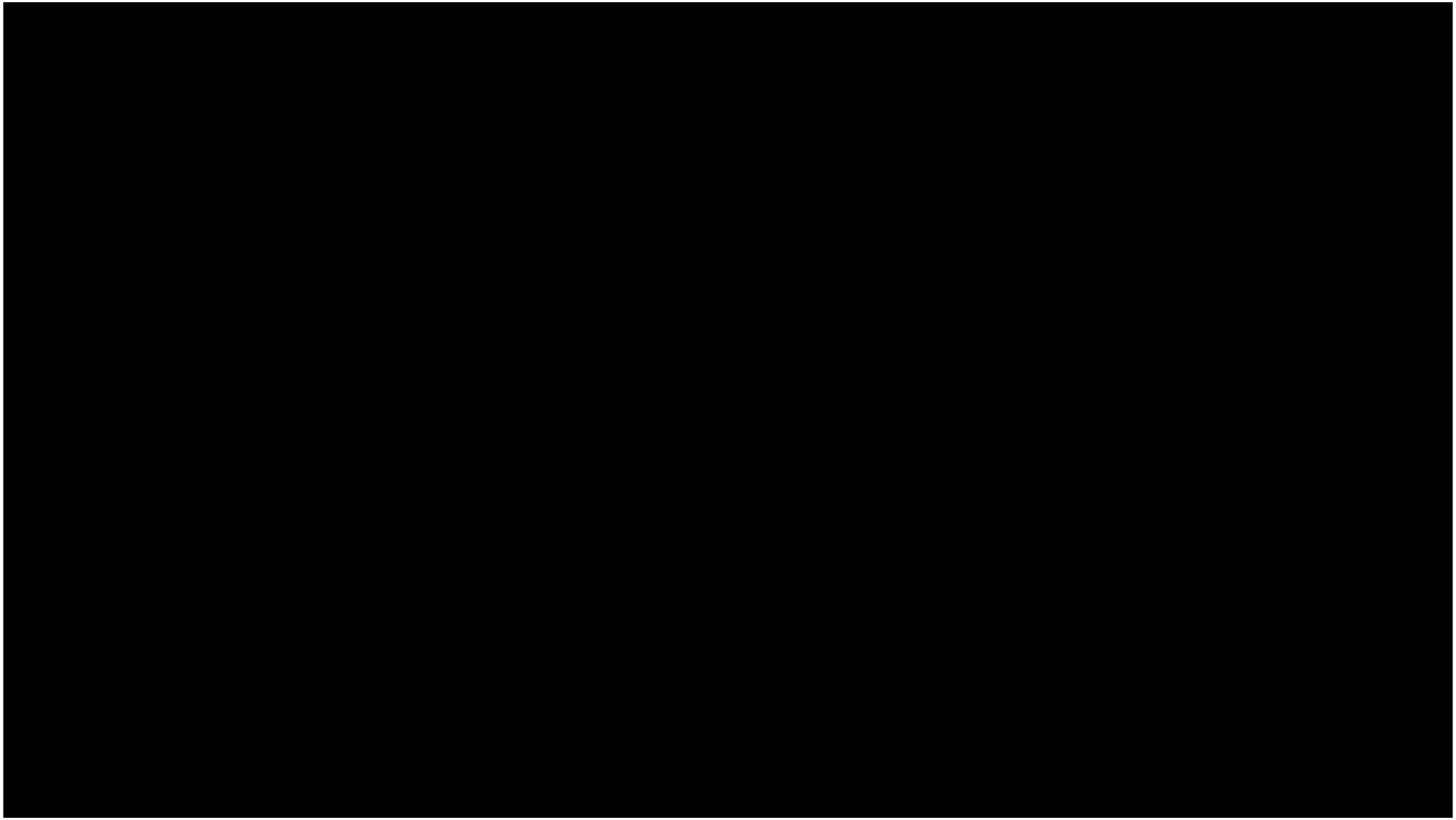
- Basis of Overtopping Simulator

Overtopping simulator for dike stability

EURCOLD

Overtopping simulator for dike stability

Variation in overtopping volumes (V) (Vmax can be 1000xq(the mean discharge))



Downstream erosion due to overtopping

Boonweg dike; after 75 l/s per m

Damage at transition slope - horizontal (hidden brick path)

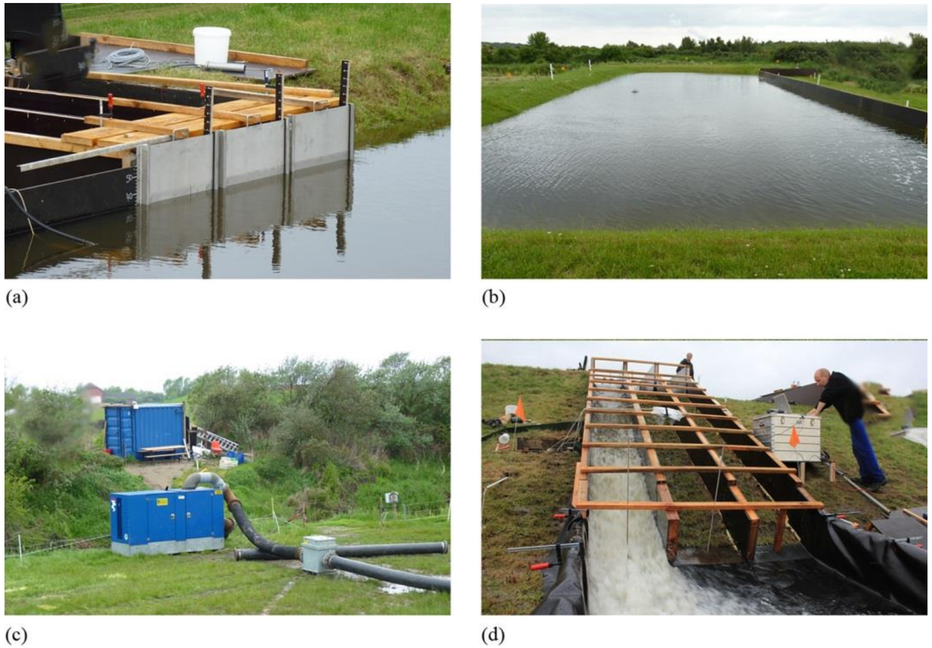
Downstream erosion due to overtopping

Downstream erosion due to overtopping

Kattendijke: extensive damage at maintenance road

Damage of grass due to overtopping initiates at overtopping discharges of O (1-10 l/m/s)

Grass can withstand overflow discharges of the order of 100 l/m/s.



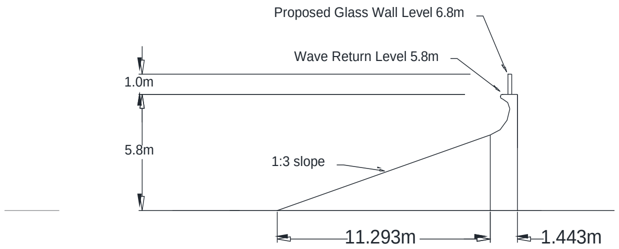
Some observations

- Damage due to overtopping often initiates at a transition
- Different empirical methods for predicting the onset of failure exist
- The processes of failure (of grass) are poorly understood.
- The processes between overtopping erosion and overflow erosion differ
- It is unknown how design and maintenance strategies contribute to the overtopping resistance of grass.

Methods to reduce overtopping

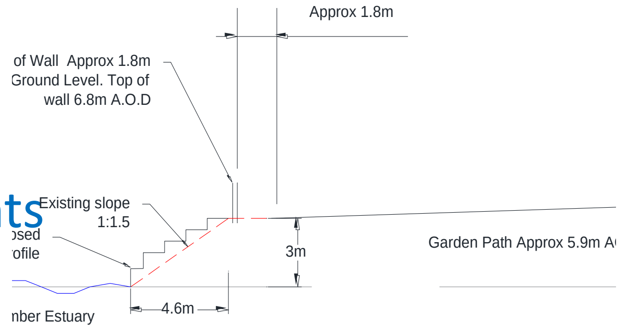
Methods to reduce overtopping

- Recurve Wall
  - Glass wall pressures
  - Overtopping



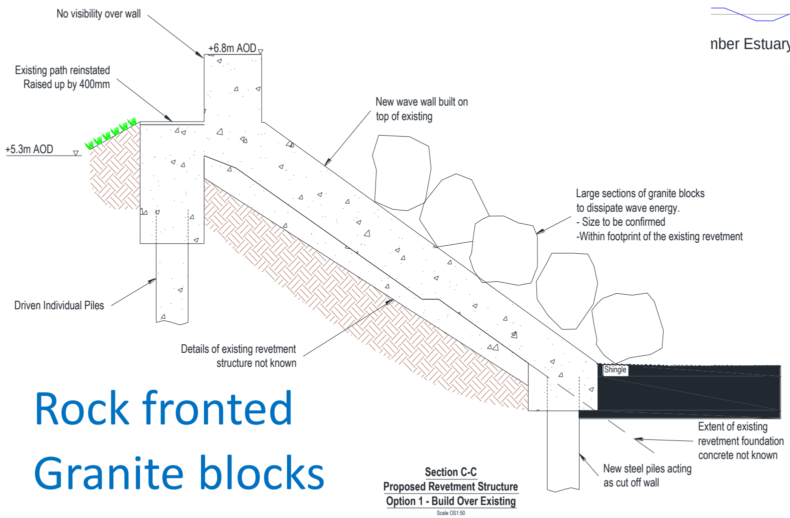
TYPICAL CROSS SECTION
Section E-E

- Rock on concrete
  - Overtopping
  - 2 different revetments



TYPICAL CROSS SECTION
Section F-F

Stepped



Rock fronted

Granite blocks

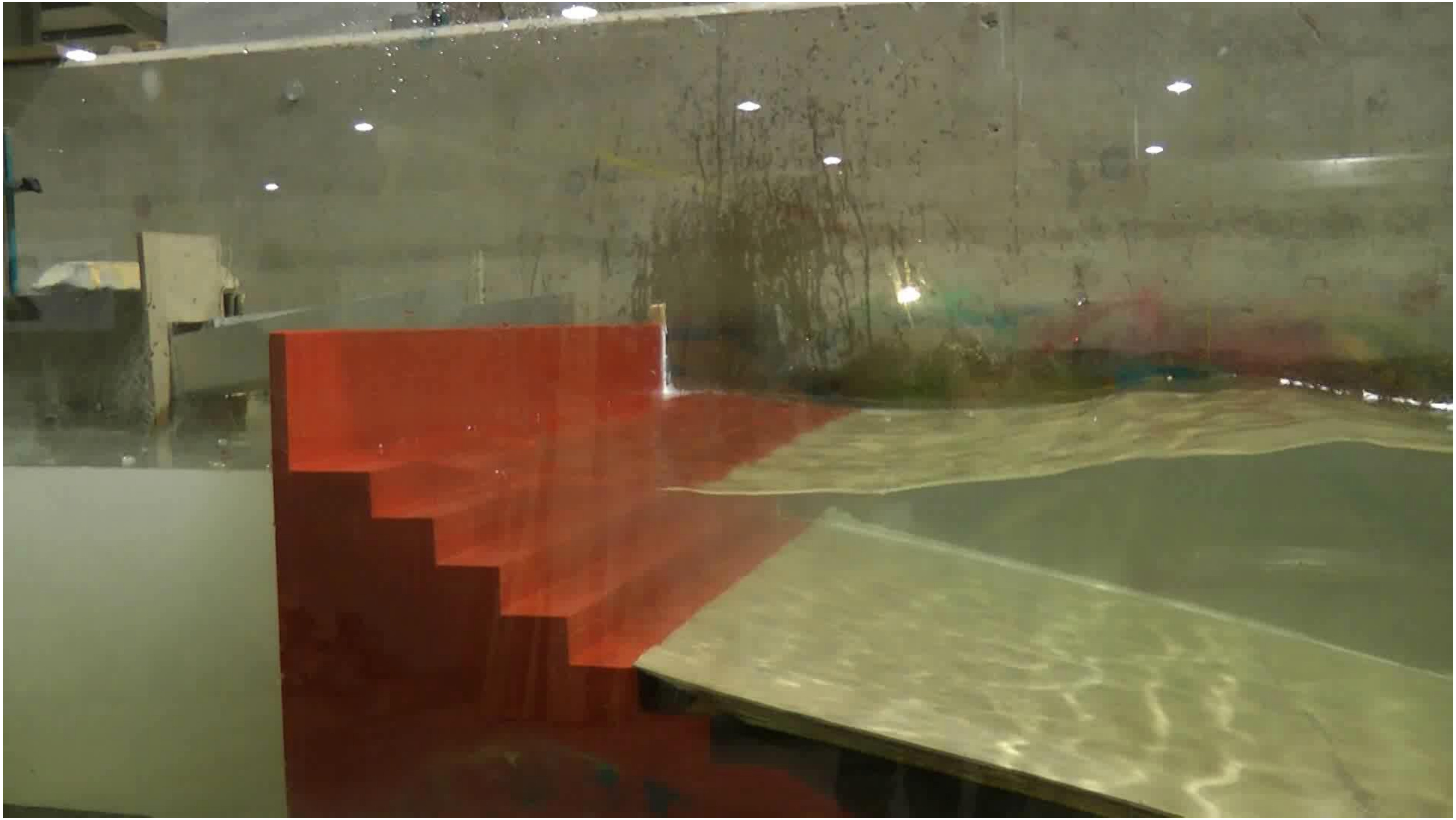
1 to 3 ton

D_{n50} ~ 0.90 m

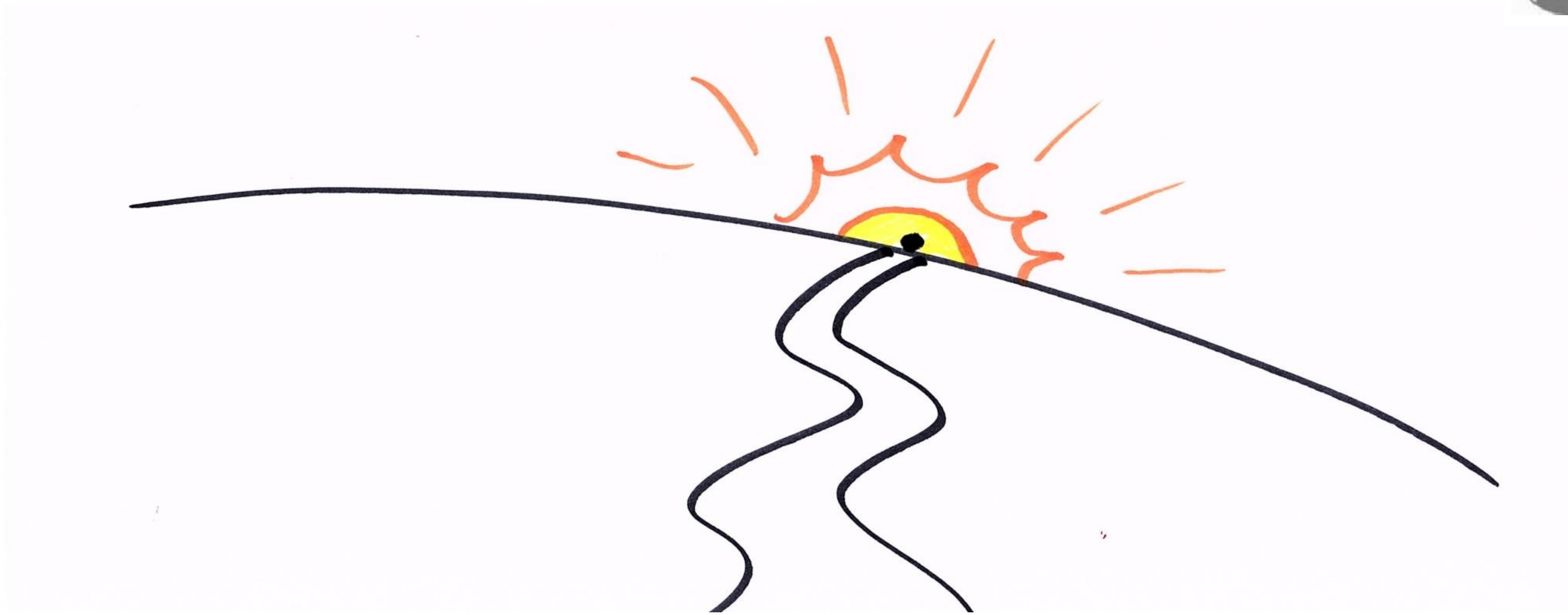
M_{50} ~ 2100 kg

Reduction of overtopping by a recurve parapet wall

Reduction of overtopping by a stepped revetment



Reduction of overtopping by rock armour



Proposed objectives

Proposed objectives

The ***objectives*** *of the sub-group of overtopping of sea dykes are*

- *To identify and share issues, related to overtopping erosion*

- *To share best practices for defining the overtopping erosion resistance and erosion rates, and identify research gaps*

- *To facilitate sharing data, knowledge, and experiences to facilitate dissemination, and bridge the gap between practitioners needs and academic research*

EURCOLD

Link to running projects

- Environment Agency (UK) plans to update the CIRIA 116 guidelines on grass
- The FutureDikes research proposal (NL) plans to investigate which grass species are most overtopping resistant
- Living Lab Hedwige Prosperpolder (EU Interreg 2 seas research project proposal) which facilitates large scale experiments to the failure of grass.
- …

EURCOLD

Actions

Please

- Inform us of your contact details if you want to become involved in this sub-group
- Inform us on any research projects which may be of interest to this sub-group.

Contact details:
Tim Pullen: t.pullen@hrwallingford.com
Myron van Damme: M.vandamme@tudelft.nl

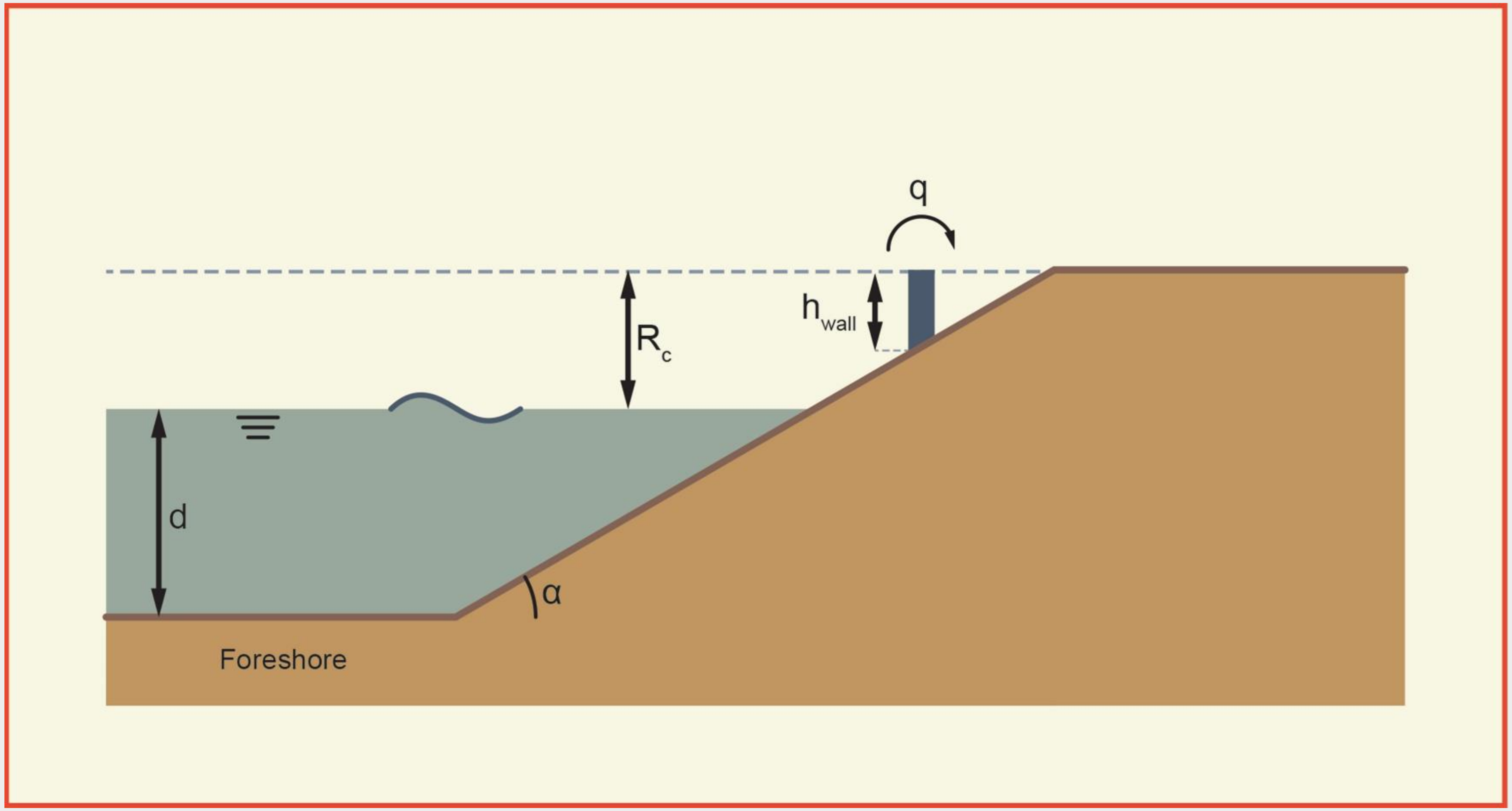
We hope to see you in Madrid

- Jean-Robert Courivaud, Dr Tim Pullen, and Dr Myron Van Damme

Wave walls and promenades

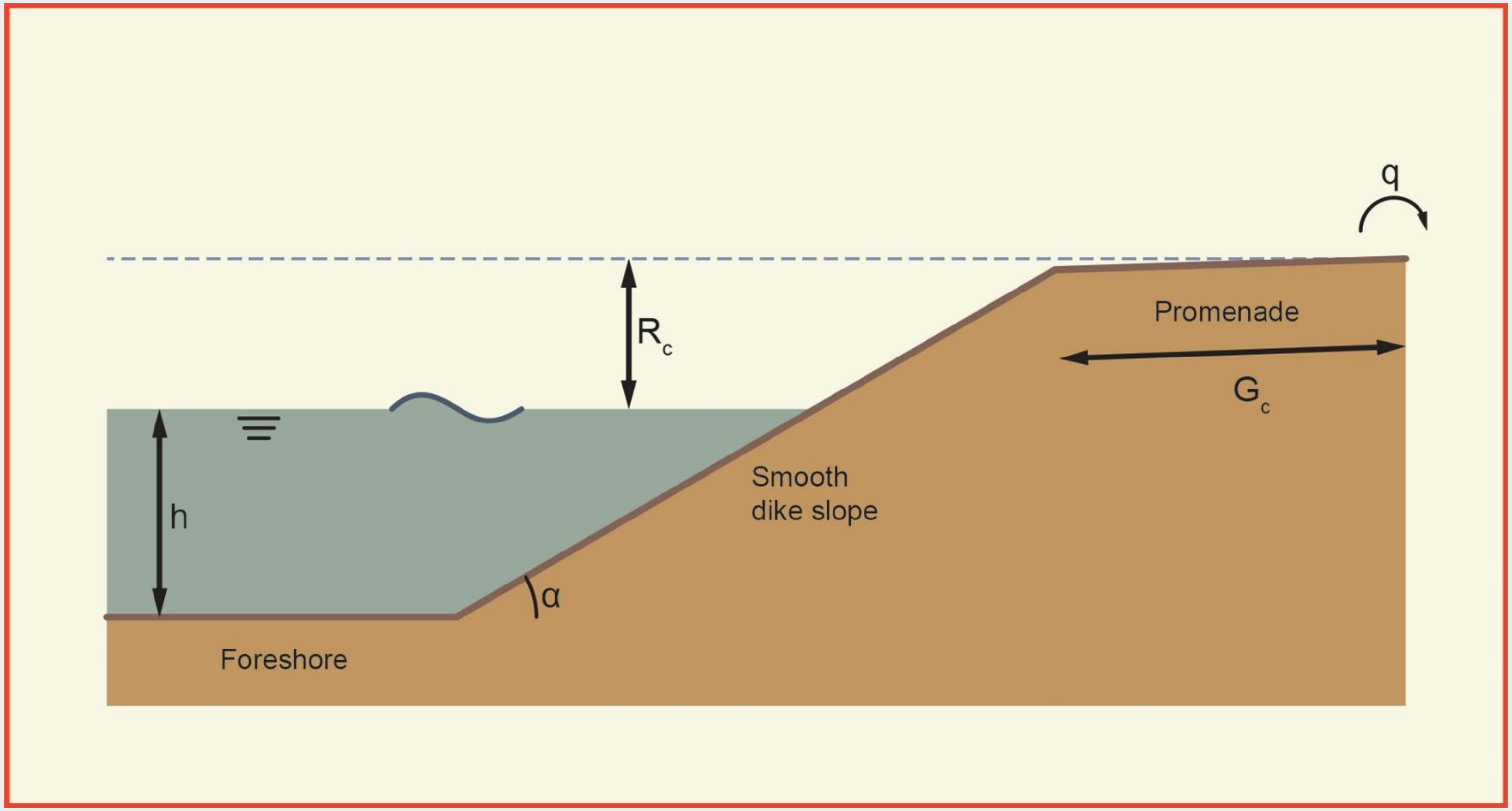
Modify discharges with gamma coefficients ($\gamma^*=\gamma_{modifier}$)

Typically $\gamma_v = exp\left(-0.56\frac{h_{wall}}{R_c}\right)$



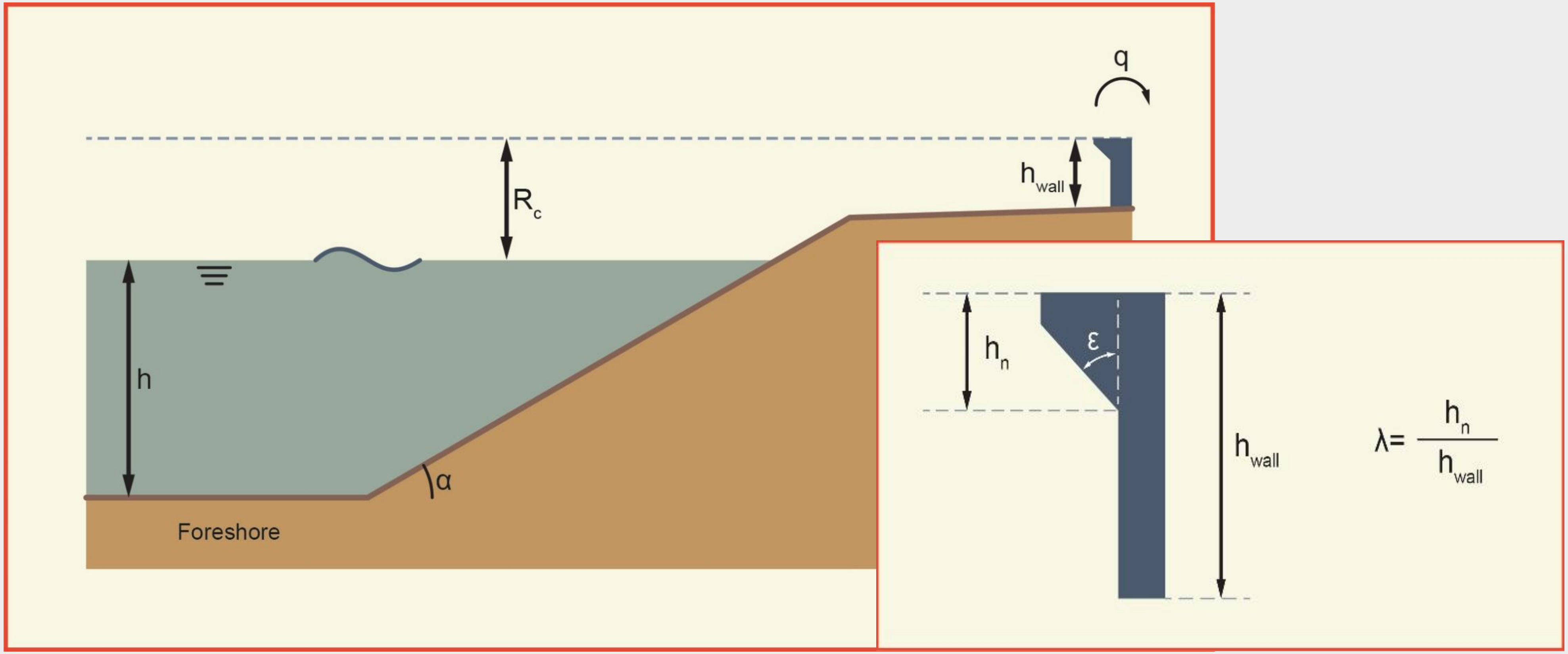
Wave walls and promenades

$$\gamma_{prom} = 1 - 0.47\frac{G_c}{L_{m-1,0}}$$



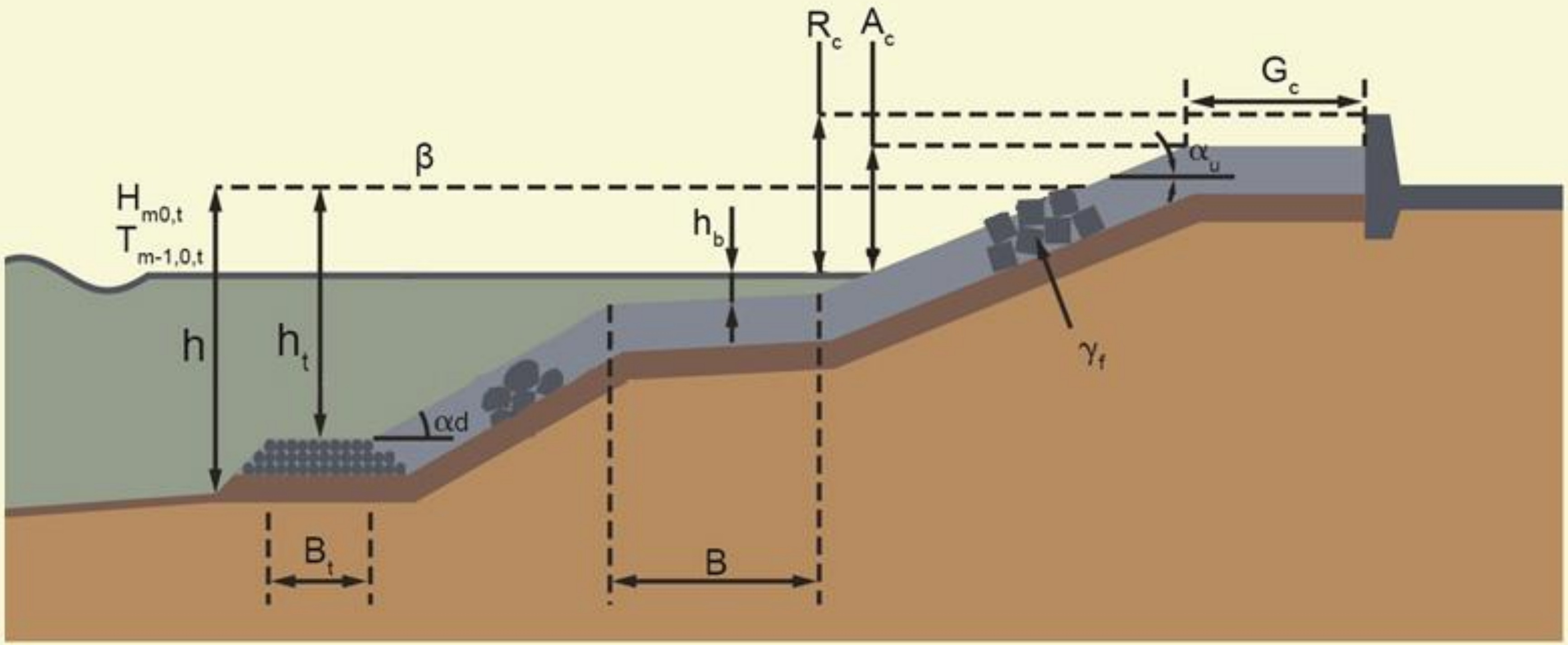
Wave walls and promenades

$$\gamma_{prom\_v\_bn} = 1.19\gamma_{prom\_v}\,\gamma_{bn}$$

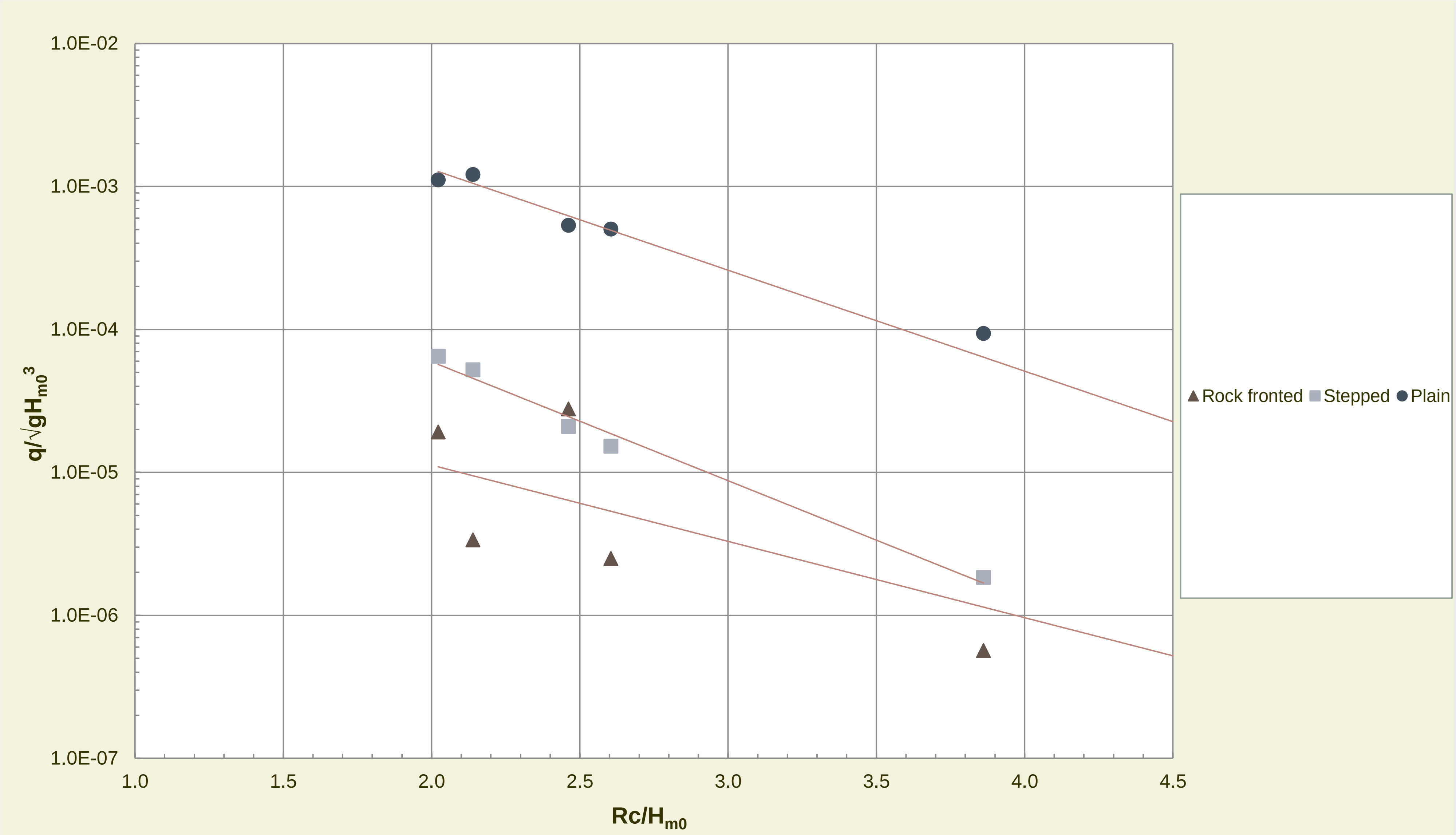


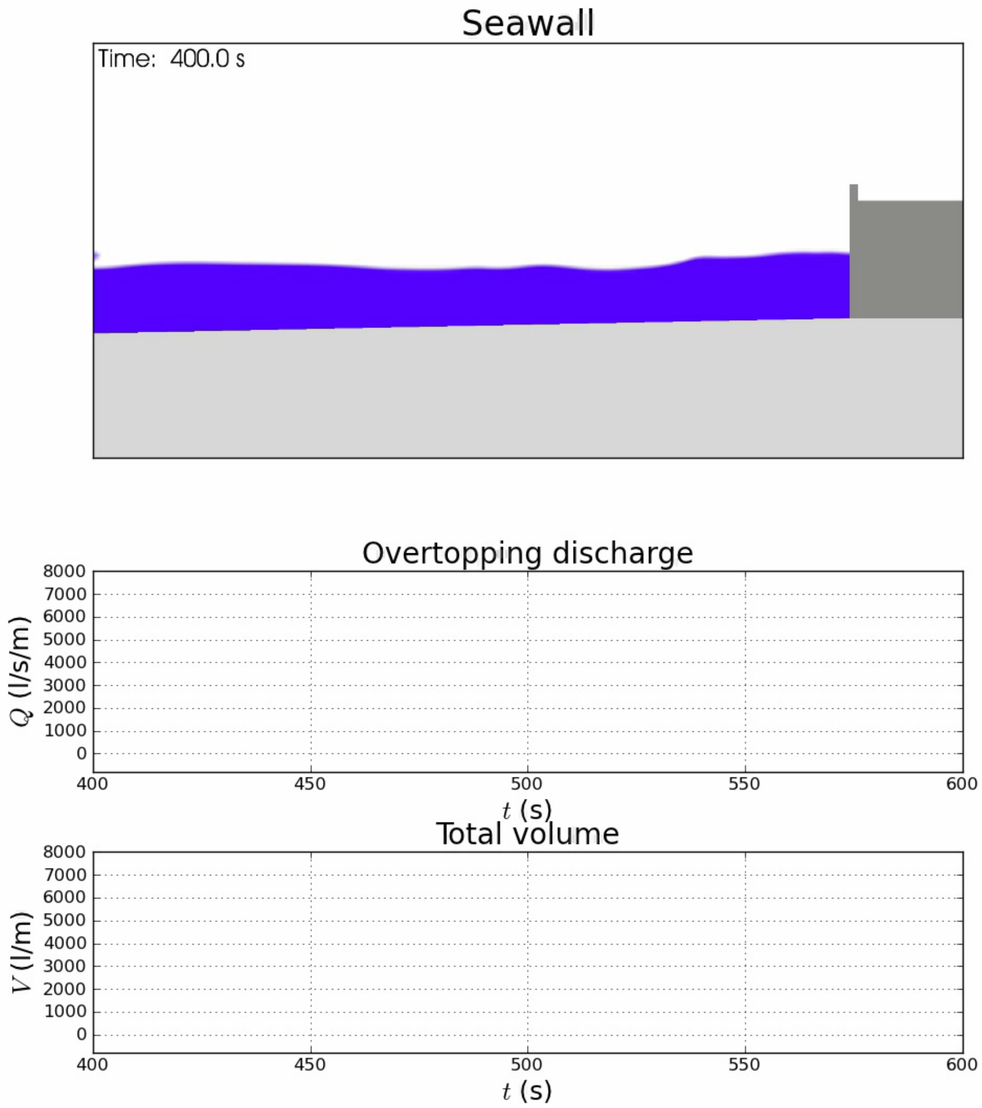
Generic overtopping parameters

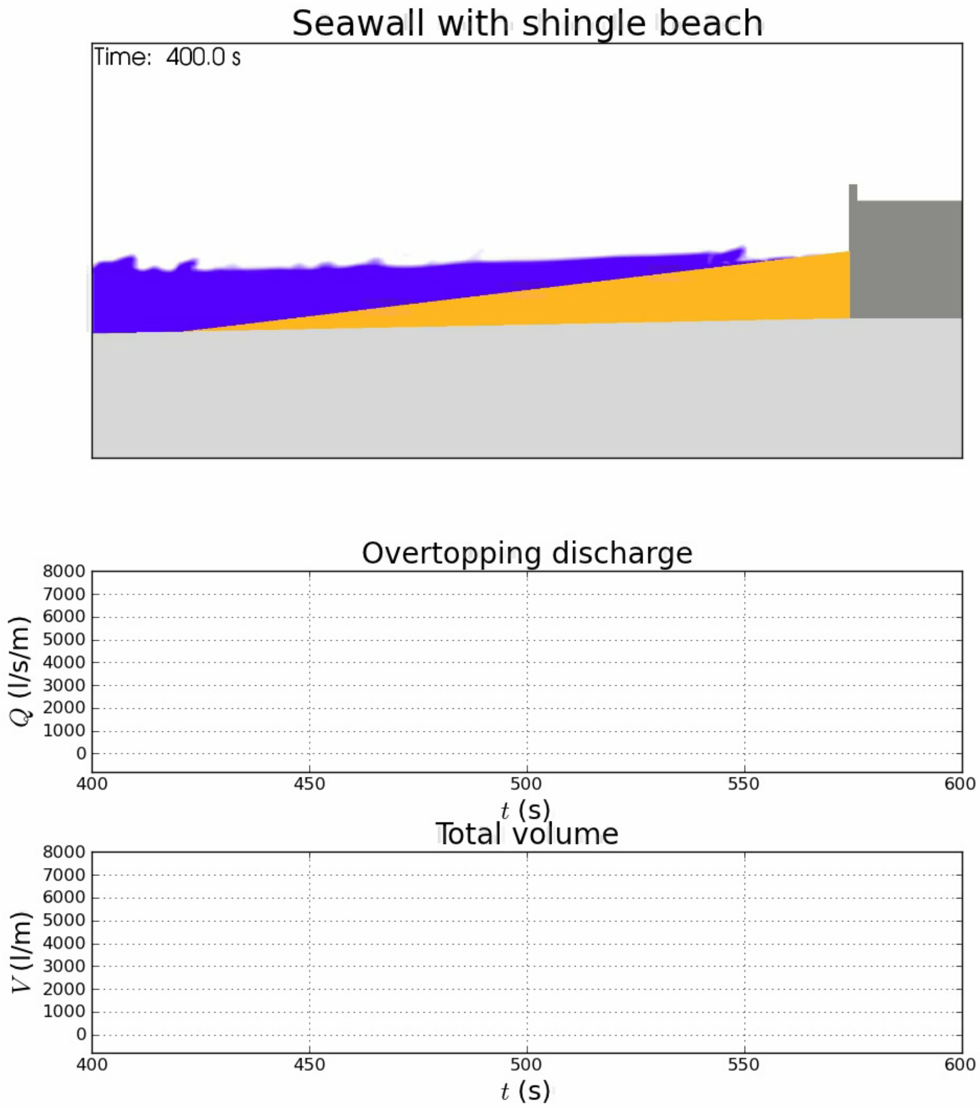
Hydraulic and structural parameters



Revetment comparison







OpenFOAM model (*in development, Cuomo, Richardson & others*).

International Working Group on Overflowing and Overtopping Erosion

Subgroup 4. Protections against overflowing erosion of dams and levees

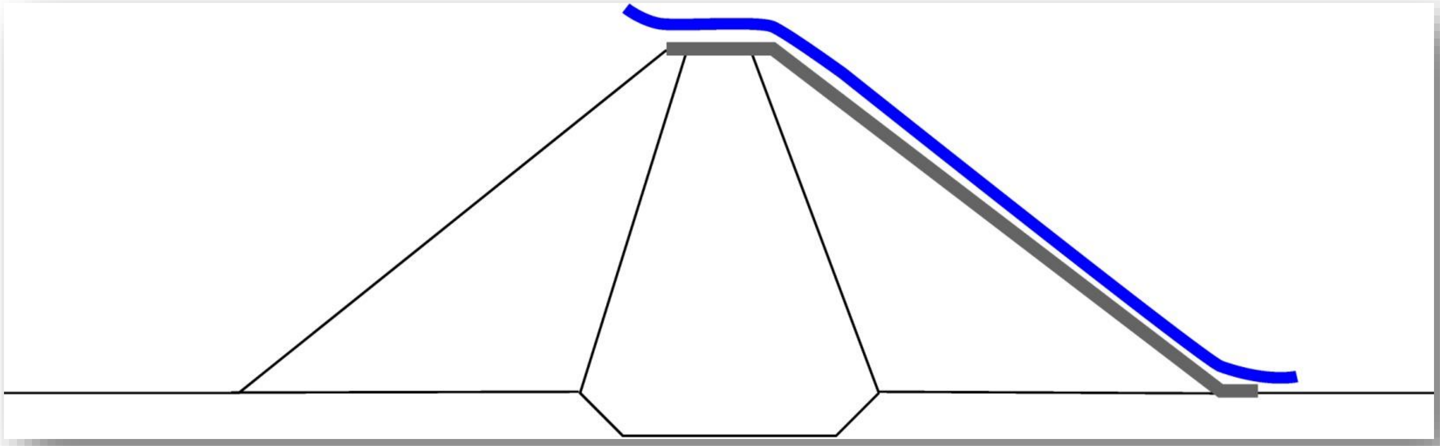
Challenges

How overflowed dams fail?

How should we protect them?

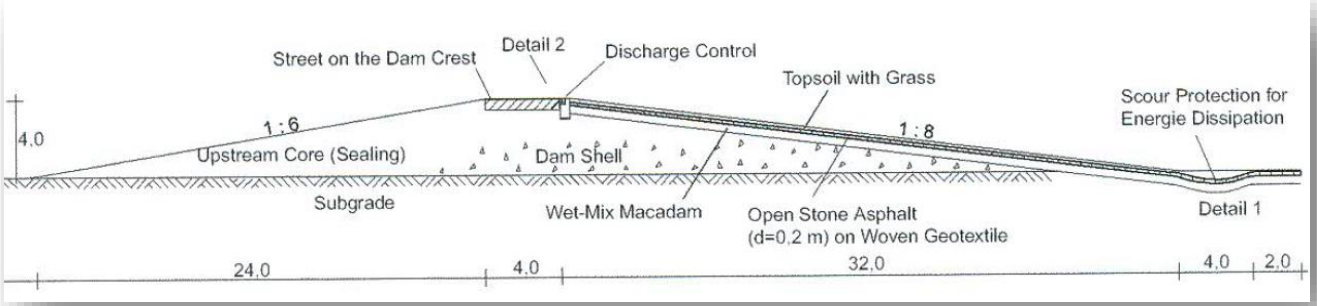
Consequences of protecting dams and optimal decision-making strategies

Hard Protections

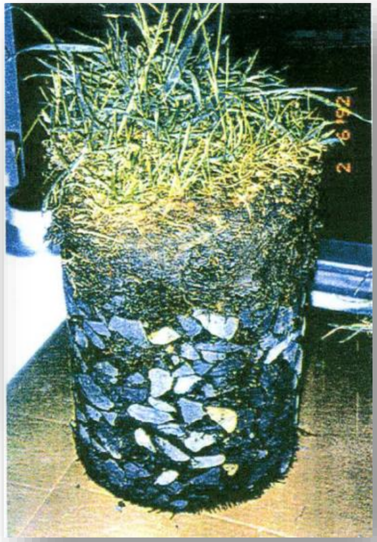


Hard Protections

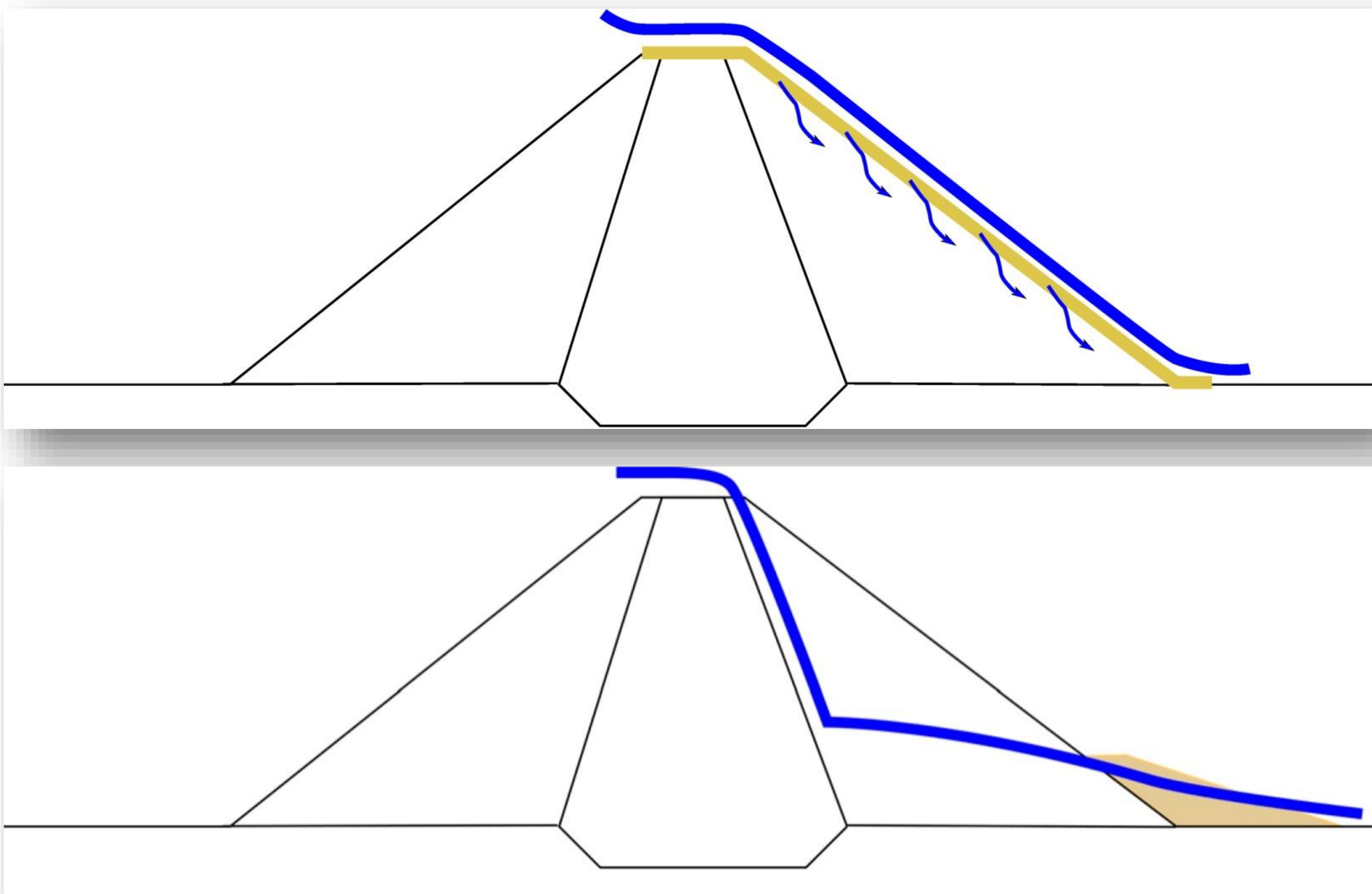
I. Rolled Compacted Concrete
II. Continuously-reinforced concrete slabs
III. Wedge – shaped blocks
IV. Open stone asphalt



(Bieberstein, Quieber et al. 2004)



Soft Protections



Soft Protections

I. Articulated concrete blocks
II. Gabions
III. Vegetative cover and turf revetments
IV. Rip-rap
V. Geosynthetics
VI. Reinforced rockfill

(Nilsson 2009)

1st International Seminar on Dam Protections against Overtopping and Accidental Leakage

Madrid. Spain, 24-26 November 2014

2nd International Seminar on Dam Protections

Fort Collins, Colorado, USA
Protections 2016
Concrete Dams • Embankment Dams • Levees • Tailings Dams
www.protections2016.com
7th–9th September 2016

Colorado State University

Fort Collins. USA, 7-9 September 2016

3rd International Conference on Protection against Overtopping

PROTECTIONS 2018

3rd International Conference on Protection against Overtopping

HR Wallingford

Grange Over Sands. UK, 6-8 June 2018

4th International Seminar on Dam Protections against Overtopping (Upcoming)

Protections 2020

Madrid (Spain)
11-13 November 2020

http://www.protections2020.com/

Contact: damprotections.caminos@upm.es

Blog: http://blogs.upm.es/damprotections/

Dam Protections against Overtopping
and Accidental Leakage

Browse: Home / who we are

Publications

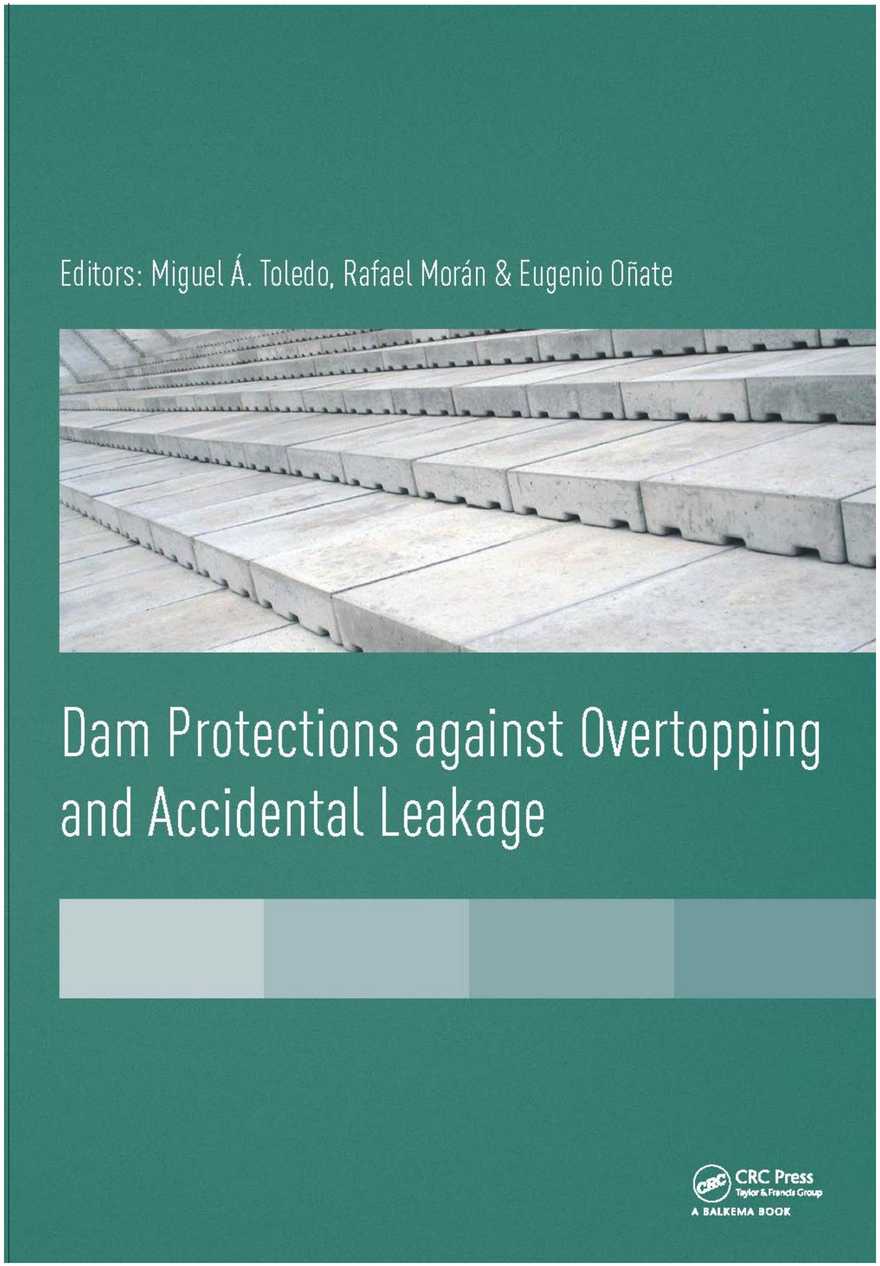
Protections 2014
Hard cover book
3 Keynote Lectures
18 Proceedings

Protections 2016
Open access publication (online)
3 Keynote Lectures
20 Proceedings

https://mountainscholar.org/handle/10217/179778

Protections 2018
Open access publication (online)
2 Keynote Lectures
30 Proceedings

http://eprints.hrwallingford.co.uk/view/events/Protections_2018_=283rd_International_Conference_on_Protection_against_Overtopping=29.html



General conclussions

1 Understanding on the overtopping failure processes is advancing

2 Effective protection technologies are available nowadays

3 Decisions must be based on REAL risks

International Working Group on Overflow & Overtopping Erosion

①

Name	Affiliation	Email
Mark Morris	Samui / HR Wallingford	m.morris@hrwallingford.com
MIKE GEORGE	BGC ENGINEERING	mgeorge@bgcengineering.ca
Frederic LAUGIER	EDF	frederic.laugier@edf.fr
Claudia Correa	Hydro-Québec	correa.claudia@hydro.qc.ca
Hiroyuki Sato	Japan Ministry of construction	~~satou-hiroyuki~~ satou-h92ta@mlit.go.jp
Daniel PUIATTI	DPST Consulting - France	daniel.puiatti@dpst-consulting.eu
HOLLY HAMPTON	Ontario Power Generation	Holly.HAMPTON@OPG.COM
Will Kettle	Ontario Power Generation	will.kettle@opg.com
Fabien SZYMKIEWICZ	IFSTTAR, FRANCE	fabien.szymkiewicz@ifsttar.fr
Veronika Stoyanova	ARUP	veronika.stoyanova@arup.com
ANDRE KOELEWIJN	DELTARES	ANDRE.KOELEWIJN@DELTARES.NL
Meindert Van	Deltares	meindert.van@deltares.nl
Rémy TOURMENT	IRSTEA	remy.tourment@irstea.fr
MARCEL BOTTEMA	RIJKSWATERSTAAT	MARCEL.BOTTEMA@RWS.NL
JONATHAN SIMM	HR WALLINGFORD	j.simm@hrwallingford.com
François DELORME	EDF (retired)	delorme.francois@wanadoo.fr
MALLET Thibaut	SYMADREM	thibaut.mallet@symadrem.fr
JONATHAN FANNIN	UBC	jonathan.fannin@ubc.ca
EMMANUEL LEMIEUX	HYDRO-QUEBEC	LEMIEUX.EMMANUEL@HYDRO.QC.CA
DES HARTFORD	BC HYDRO	des.hartford@bchydro.com
STEFAN VAN DEN BERG	RIJKSWATERSTAAT	STEFAN.VANDEN.BERG@RWS.NL
HANS JANSSEN	RIJKSWATERSTAAT	hans.janssen@rws.nl
Olivier HURLEY	HYDRO-QUÉBEC	hurley.olivier@hydroqc.ca

NAME	AFFILIATION	EMAIL
ERPICUM SEBASTIEN	ULIEGE	S.ERPICUM@ULIEGE.BE
CROOKSTON, BRIAN	Utah State University	brian.crookston@usu.edu
VIKLANDER, PETER	Vattenfall	peter.viklander@vattenfall.com
BOUCHARD, Judith	Hydro-Québec	bouchard.judith@hydro.qc.ca
ADRIAN RUSHWORTH	ENVIRONMENT AGENCY	adrian.rushworth@environment-agency.gov.uk
CHRISSY MITCHELL	ENVIRONMENT AGENCY UK	christabel.mitchell@environment-agency.gov.uk
Annick Bigras	Hydro-Québec	bigras.annick@hydro.qc.ca
Ali saeidi	UQAC	ali_saeidi@uqac.ca
INGVAR EKSTRÖM	SWECO	ingvar.ekstrom@sweco.se
Robert Slomp	Rijkswaterstaat	robert.slomp@rws.nl
Christophe Picault	Compagnie Nationale du Rhône	c.picault@cnr.tm.fr
Malcolm Barker	GHD	malcolm.barker@ghd.com
Steven Doré Richard	Hydro-Québec	doré-richard.steven@hydro.qc.ca