THE UNIVERSITY OF AUCKLAND
FACULTY OF ENGINEERING

Dike and stopbank breaching due to overtopping

By

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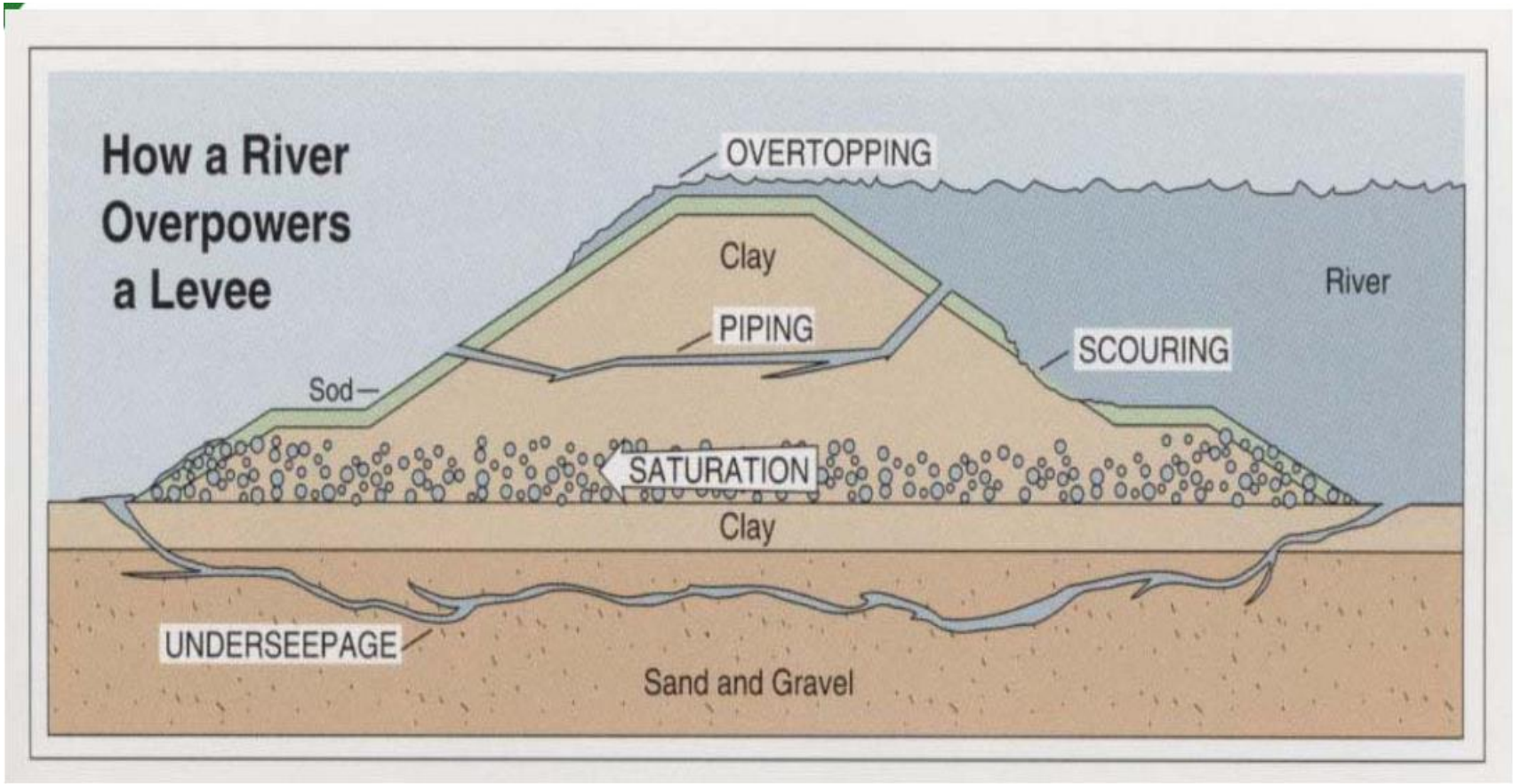
Background

Collapse of the water side slope of a stopbank due to scouring, Kōkōhinau Bend, 2004.

The storm surge produced by Hurricane Katrina overwhelmed numerous levees and caused failure of levees, New Orleans, 2005.

The reason of dike failures



Parameters in experiments

- Dike (stopbank) dimension (geometric design)
  - Dike (stopbank) shape
  - Dike (stopbank) size
- Material
  - Sediment diameter
  - Non-cohesive and cohesive material
  - Mixed material
  - …

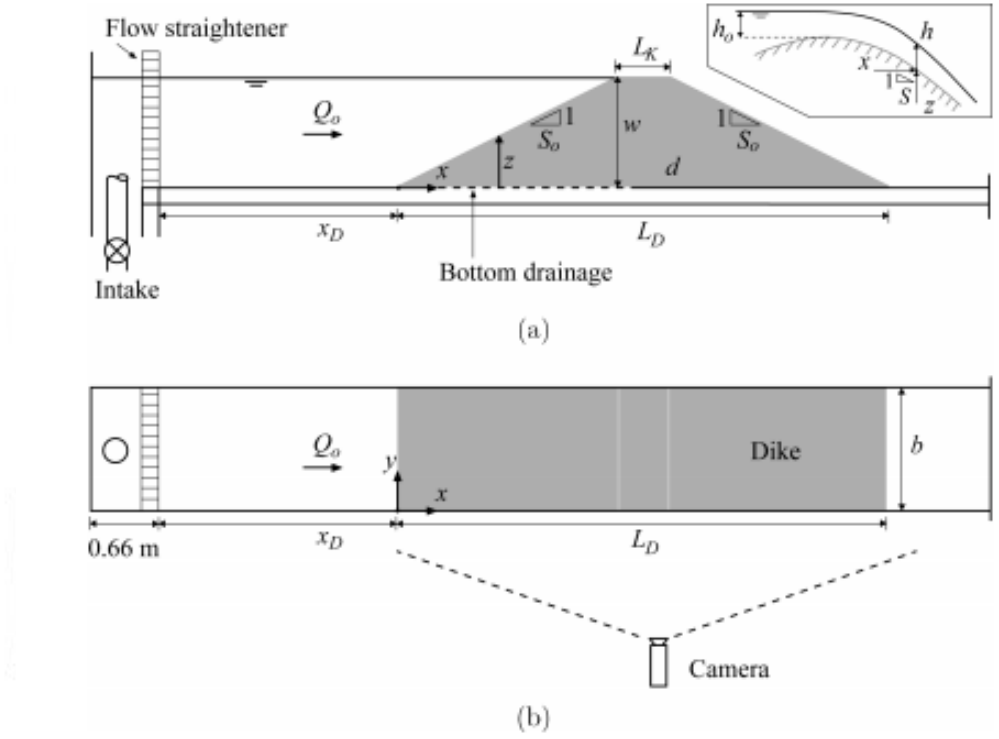
Parameters in experiments

- Hydraulic condition
  - Constant upstream water level
  - Constant inflow rate
  - Wave impact
  - Downstream boundary condition
  - …
- Compaction
- others

Previous physical experiments

Dike

- Experimental setup



Schmocker and Hager (2009)

Purpose:

Breach crest shape

Eliminate the effect of scale, side wall and cohesion

Shortcoming:

Plane breach mode

Coleman (2002)

Purpose:

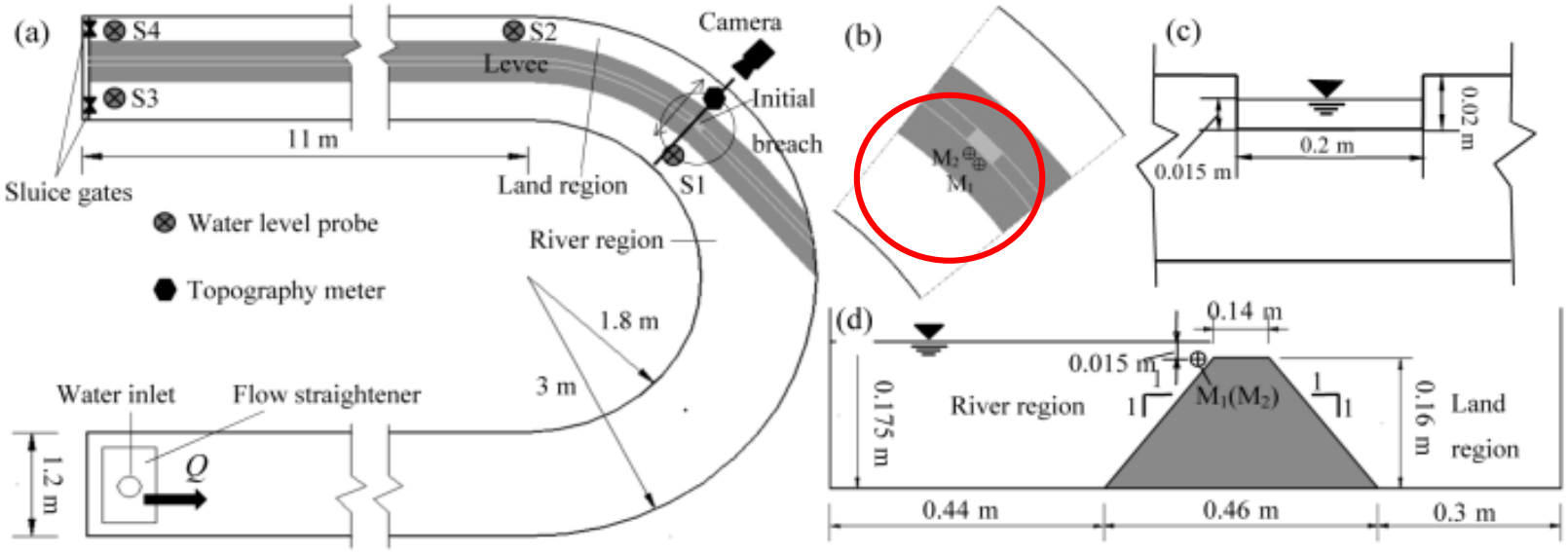
Shortcoming:

- Seepage affect
- Flow velocity field in the breach

Previous physical experiments

Stopbank

- Experimental setup



Wei (2016)

Purpose: breaching process

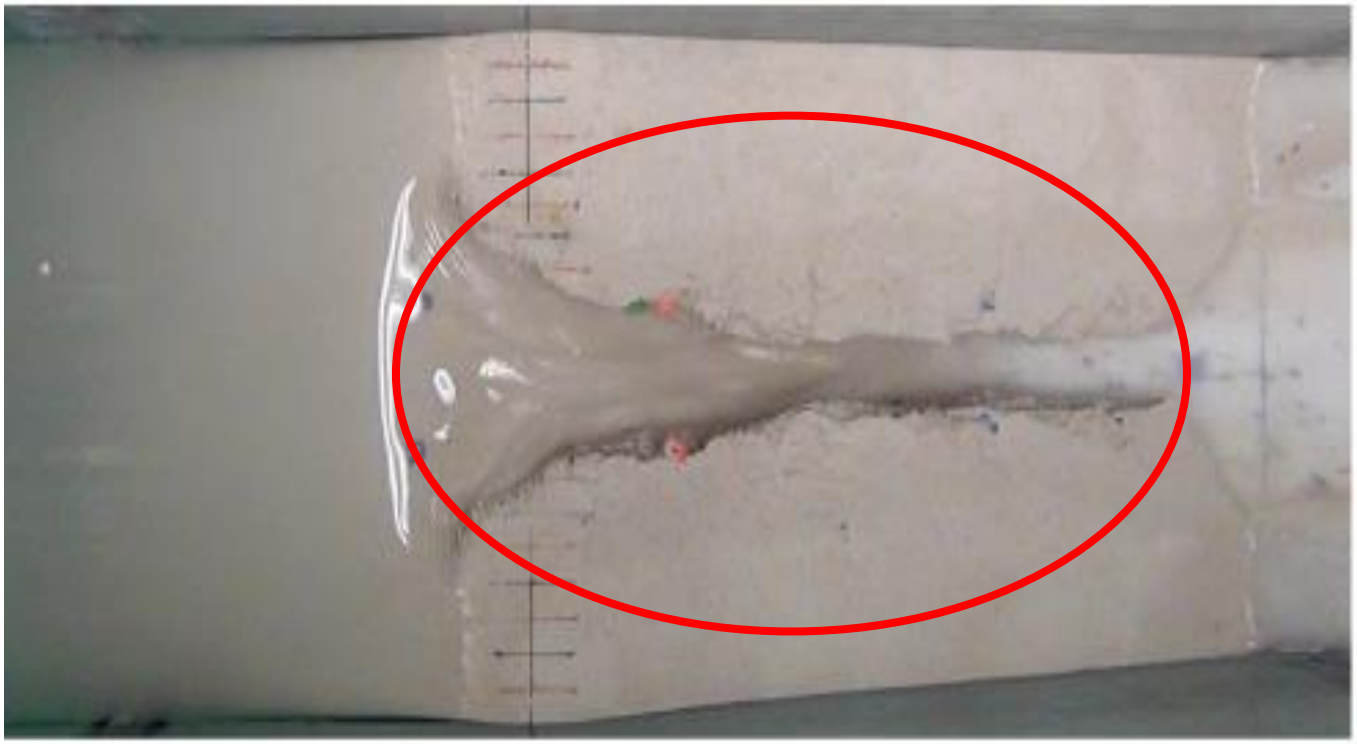
Shortcoming: seepage effect and not suitable velocity measurement

Wei (2015)

Purpose: breaching process of stopbank breaching

Shortcoming: use other data to deduce the velocity of maximum

Research gap and our aims

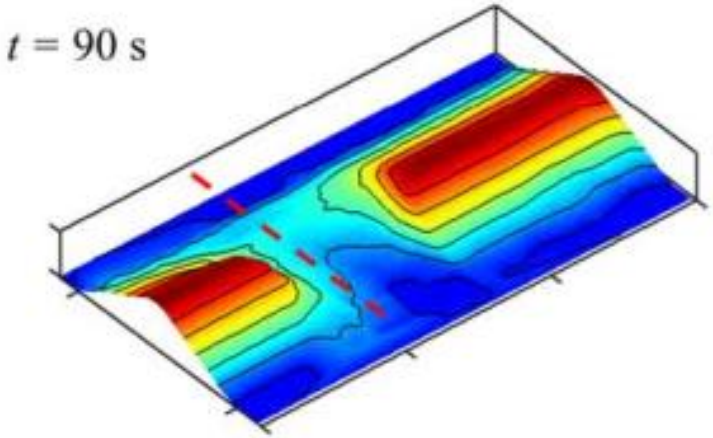


- Measure the flow velocity in the breach
- Find the relationship between varies observations
- Use formula to calculate velocity distribution in the breach
- Study the scale effect on dike erosion

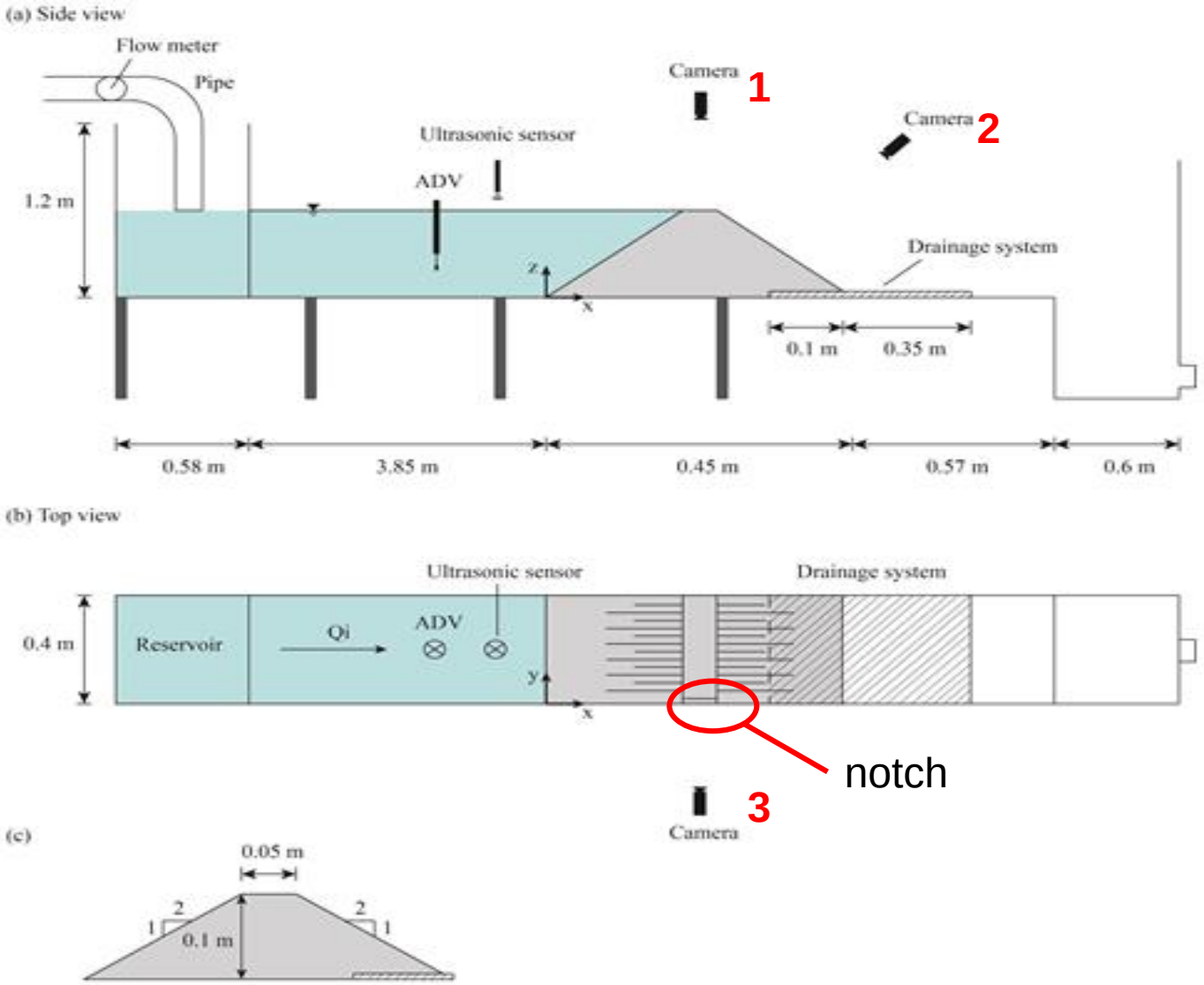
Differences between dike and stopbank

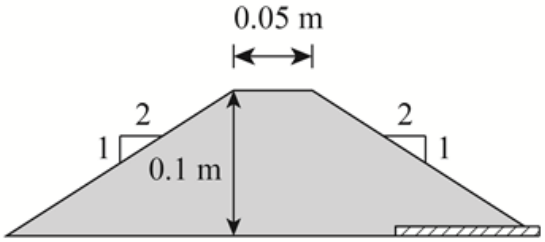
Differences

- Breach evolution
- Breach shape
- Flow velocity in the breach
- …



Dike experimental setup

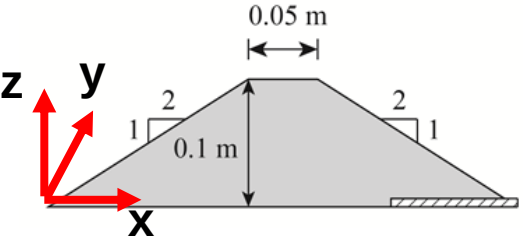




Experimental groups

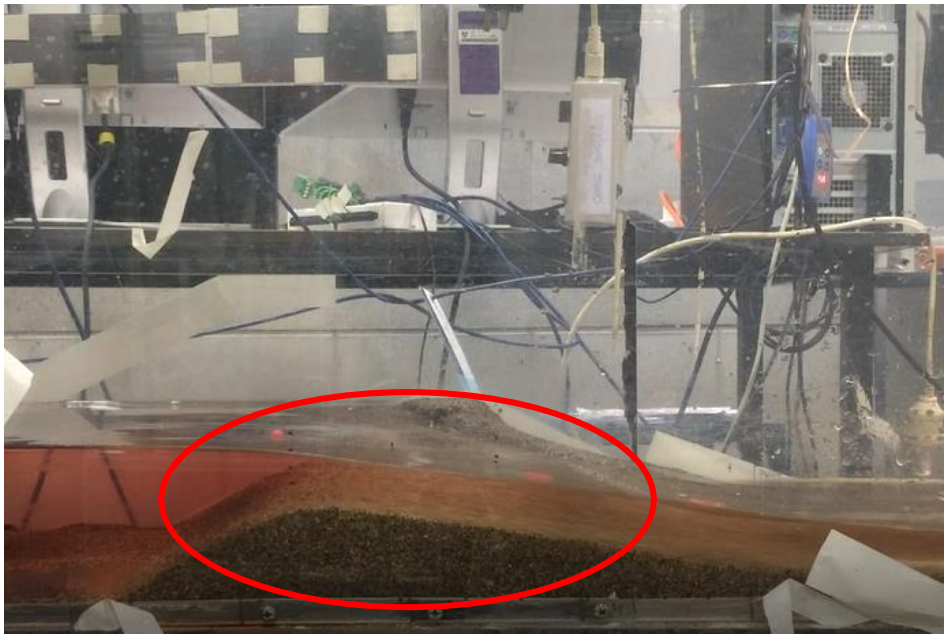
hmax=0.8m wmax=0.4m b=1.2m

Test	w(m)	h(m)	Slope	b(m)	d50(mm)	Qi(L/s)
Test 1	0.05	0.1	1:2	0.4	0.85	0.5
Test 2	0.05	0.1	1:2	0.4	0.85	0.8
Test 3	0.05	0.1	1:2	0.4	0.85	1.0
Test 4	0.05	0.1	1:2	0.4	0.85	1.2
Test 5	0.05	0.1	1:2	0.4	0.85	1.6
Test 6	0.05	0.1	1:2	0.4	0.85	2.0
	…	…	…	…	…	…

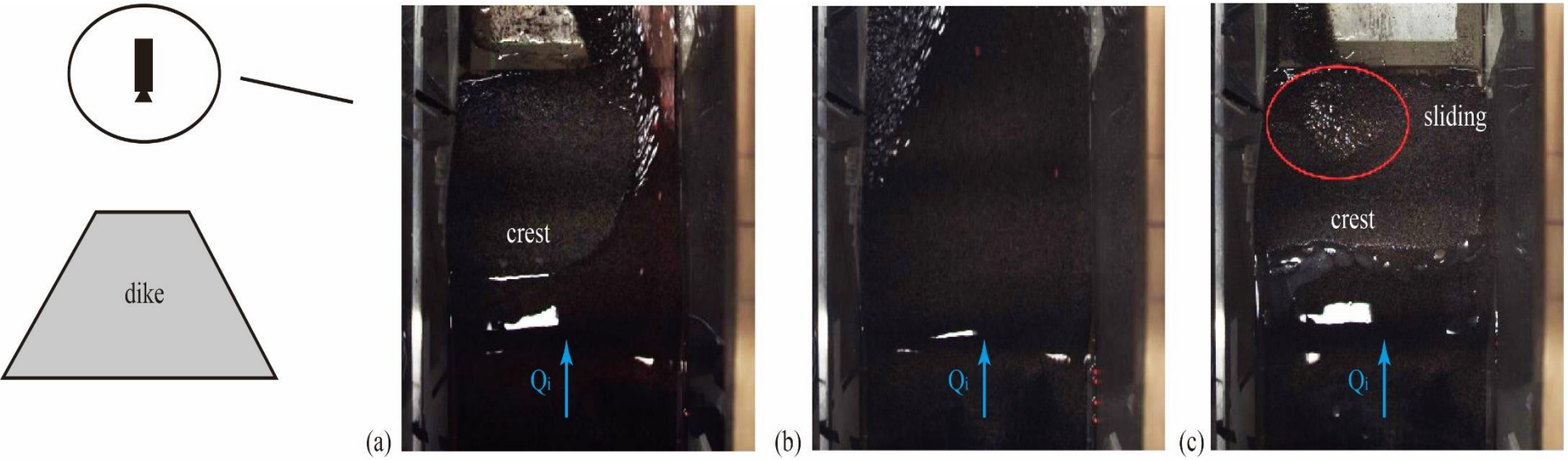


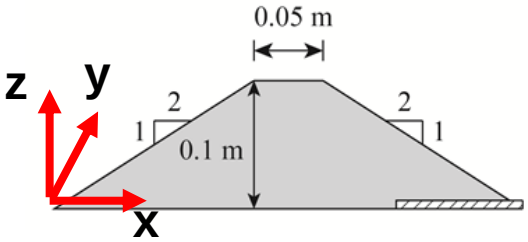
Erosion process

Spatial breach mode (0.5L/s)

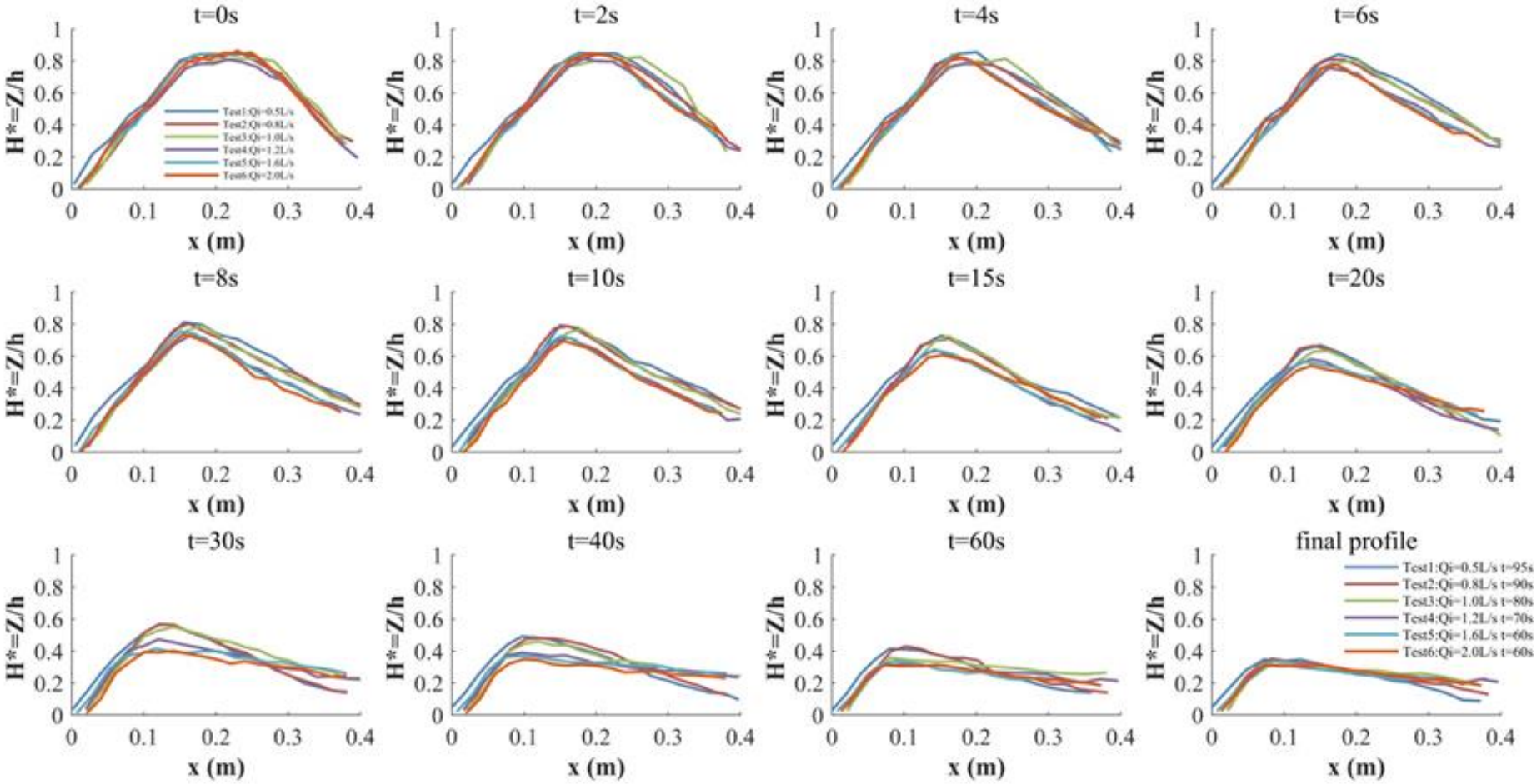


Plane breach mode (1.2L/s)


dike
crest
Q_i
(a)
Q_i
(b)
sliding
crest
Q_i
(c)



Erosion process



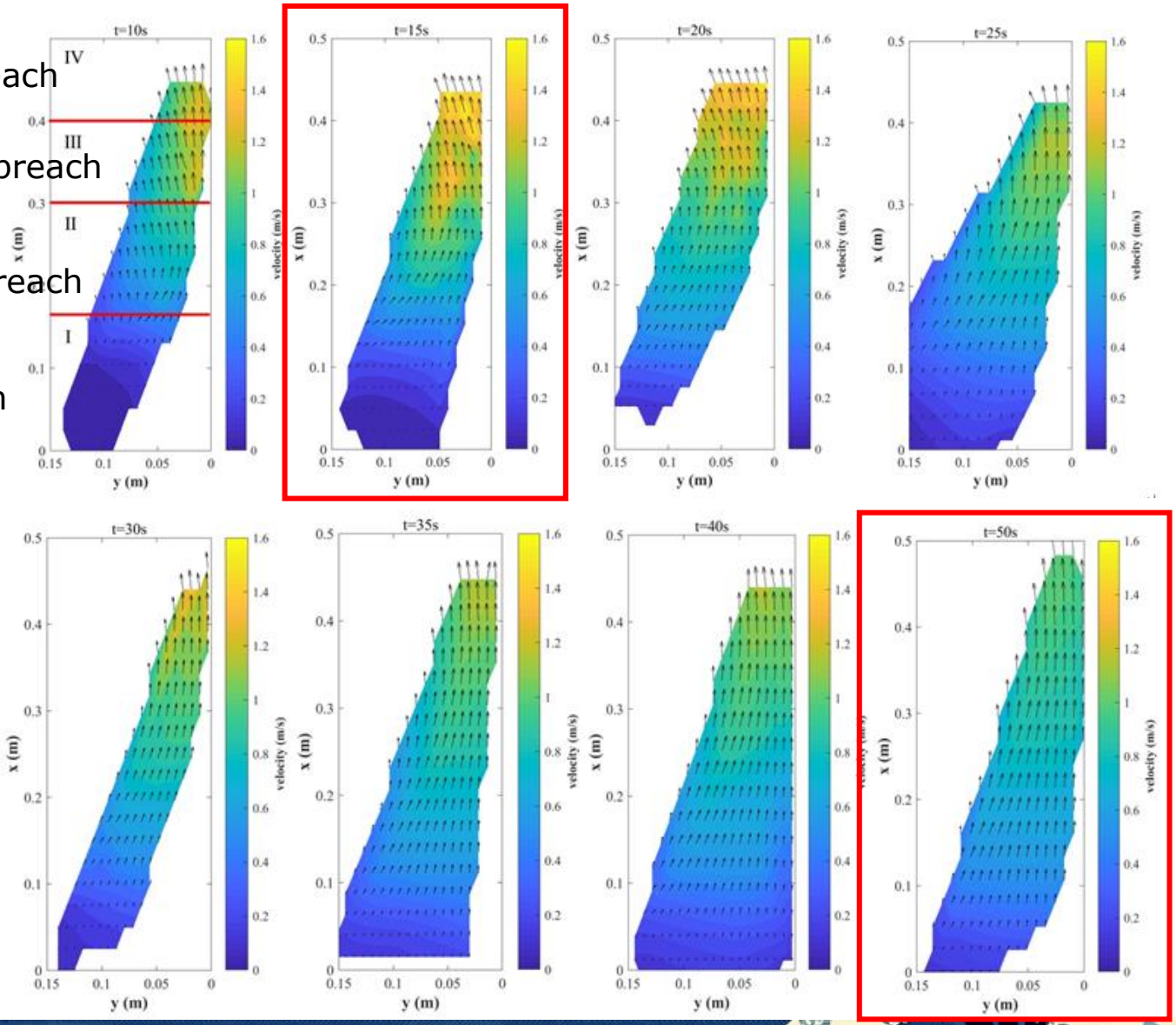
Flow velocity field

End of the breach

Middle of the breach

Front of the breach

Dike upstream



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Thanks!

Vertical and horizontal erosion rate