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Hydraulic Design at KTH

James Yang

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Team of Hydraulic design

Post-doc Dr. SC Li

PhD student U Farooq

PhD student JF Chen

Visiting scholars

Professor A Ansell

J Yang

2–8 x-jobbare/year

Industry group

S. Åstrand & F. Midböe, Fortum

C-O Nilsson, Uniper

R. Wolfsborg, Vattenfall

G. Hellström, LTU

M. Billstein, Vattenfall R&D

K. Kemling, SVK

J. Persson, Norconsult

P. Stenström, Sweco

A. Halvarsson, WSP

One of SVC's goals: dam safety & hydraulics

To understand phenomena,

To propose measures &

To ensure safe operation & life span of hydro facilities

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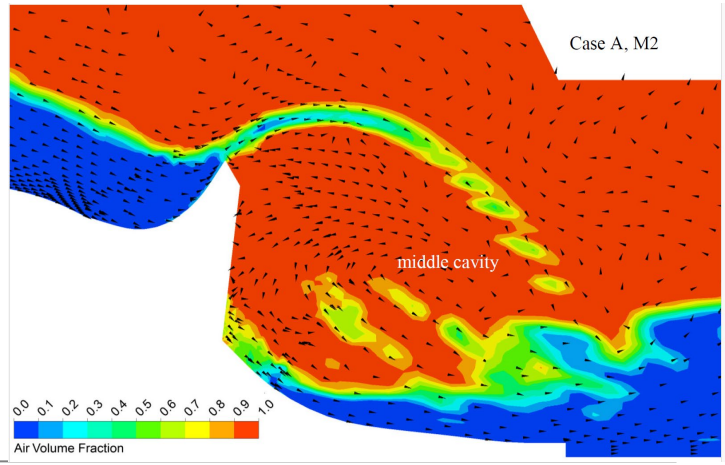
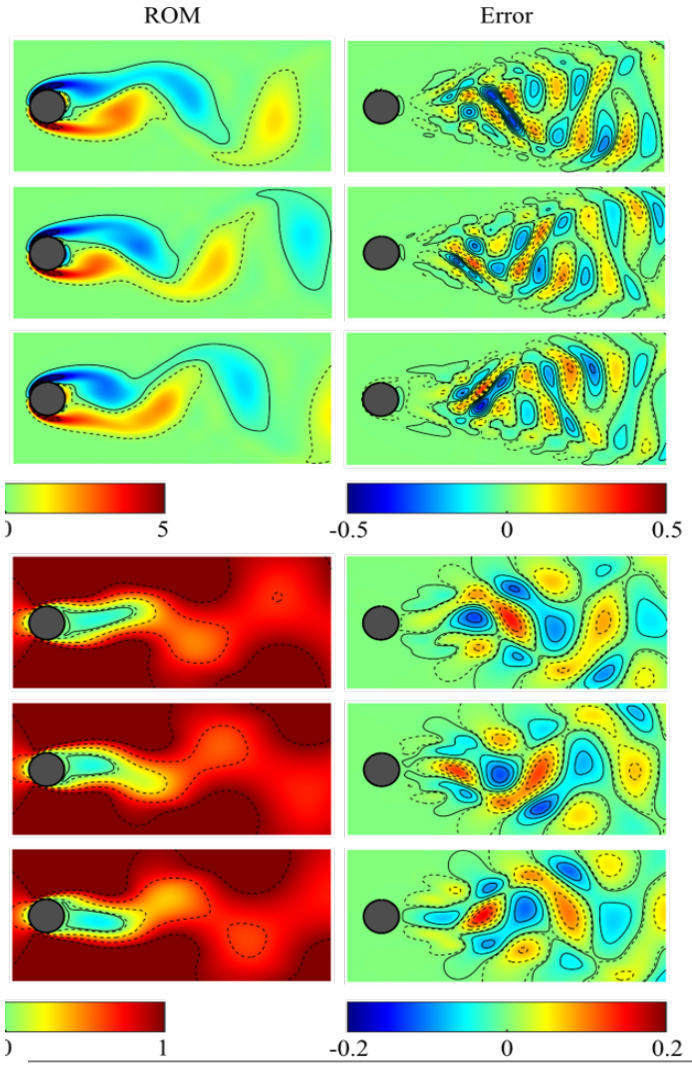
Activities at KTH

- Advanced CFD modeling (Switzerland, Finland, etc)
- Experimental studies (Älvkarleby, Taiwan)
- AI – Machine & deep learning etc.



Research areas

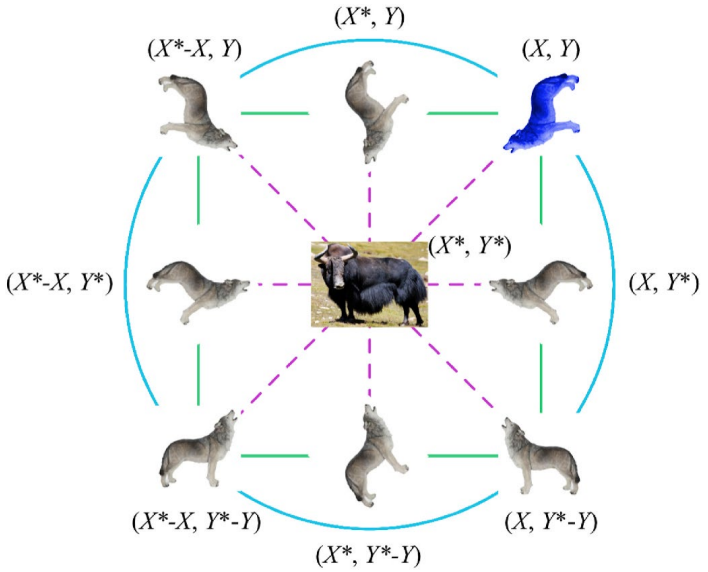


- Hydrology & river flows
- Dam spillway hydraulics (SVC)
- Environmental issues
- Diploma work projects
- "Uppdragsforskning"

  (dam owners, consulting companies)

Current SVC projects

- Spillway discharge safety – quality and trust in CFD
- Stilling-basin damages for reliable upgrade
- Design and experimental-numerical studies of Piano-Key Weirs
- Improvement on energy dissipation in spillway chutes



Algorithm of deep learning

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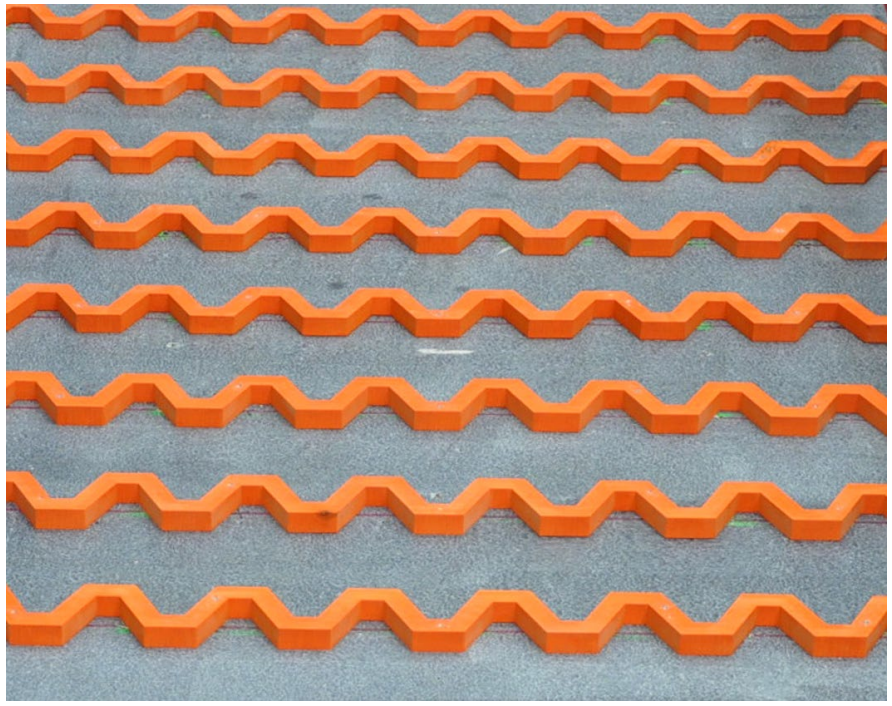
Energy dissipation with labyrinth roughness elements



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Hydraulic Design

Motivation (for existing dams)

- Higher design floods (RIDAS)
- Energy dissipation is indispensable to avoid dam failure
- Blasting in rebuilding is not desirable.
- Chute is not used for energy dissipation
- To construct bottom roughness is cost-effective

Aim

- **To adopt** roughness to dissipate **part** of energy & increase discharge safety
- **To provide** spillway upgrade with a cost-effective solution

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Execution

- To design roughness elements
- To conduct experiments and evaluate hydraulic behaviors (efficiency)
- To perform CFD for explanation of mechanism.

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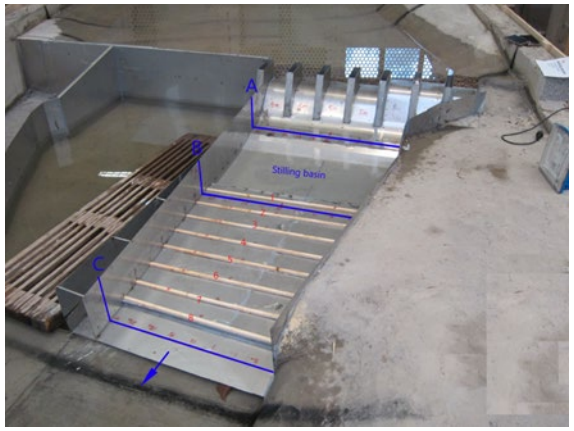
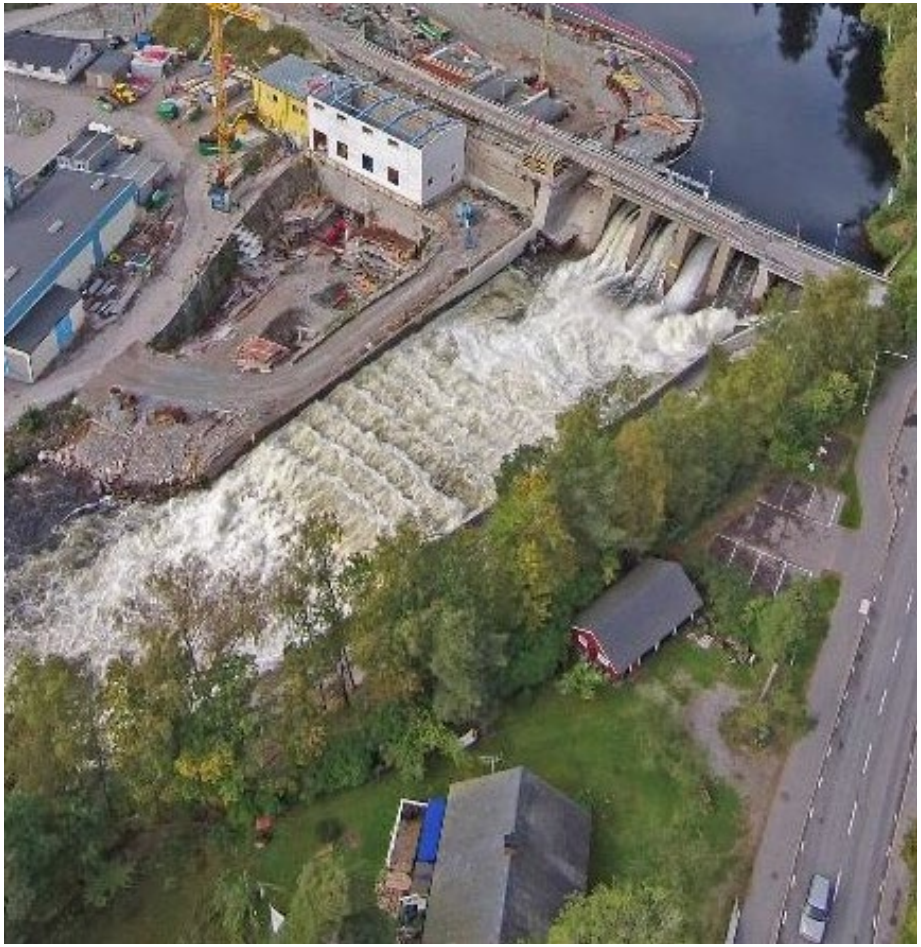
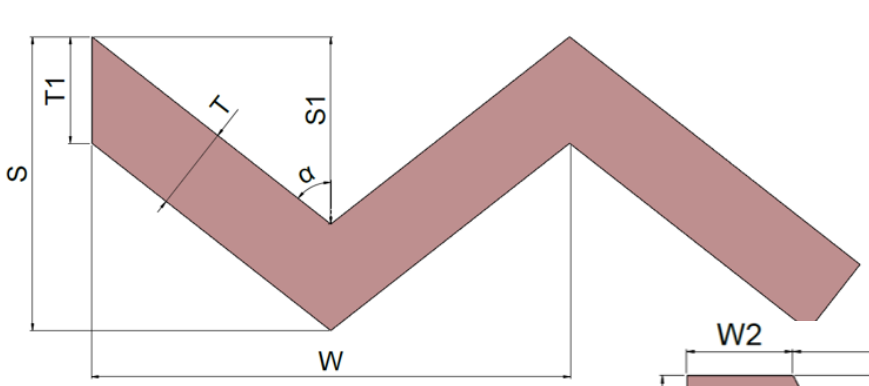
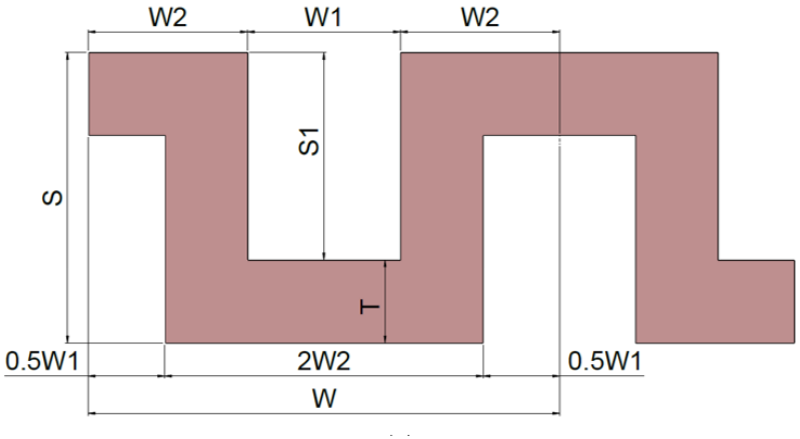
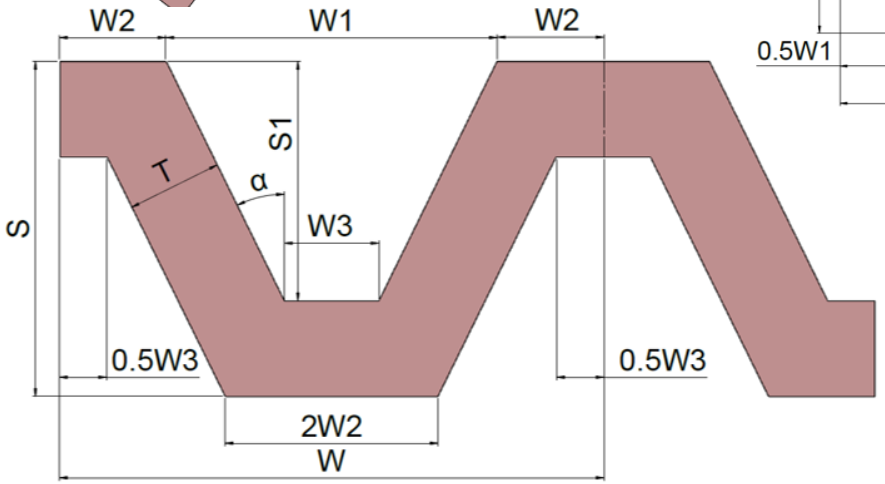
Existing facility – Långed dam






T1
T
S1
S
α
W


W2
W1
W2
S1
S
T
0.5W1
2W2
0.5W1
W


W2
W1
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α
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W3
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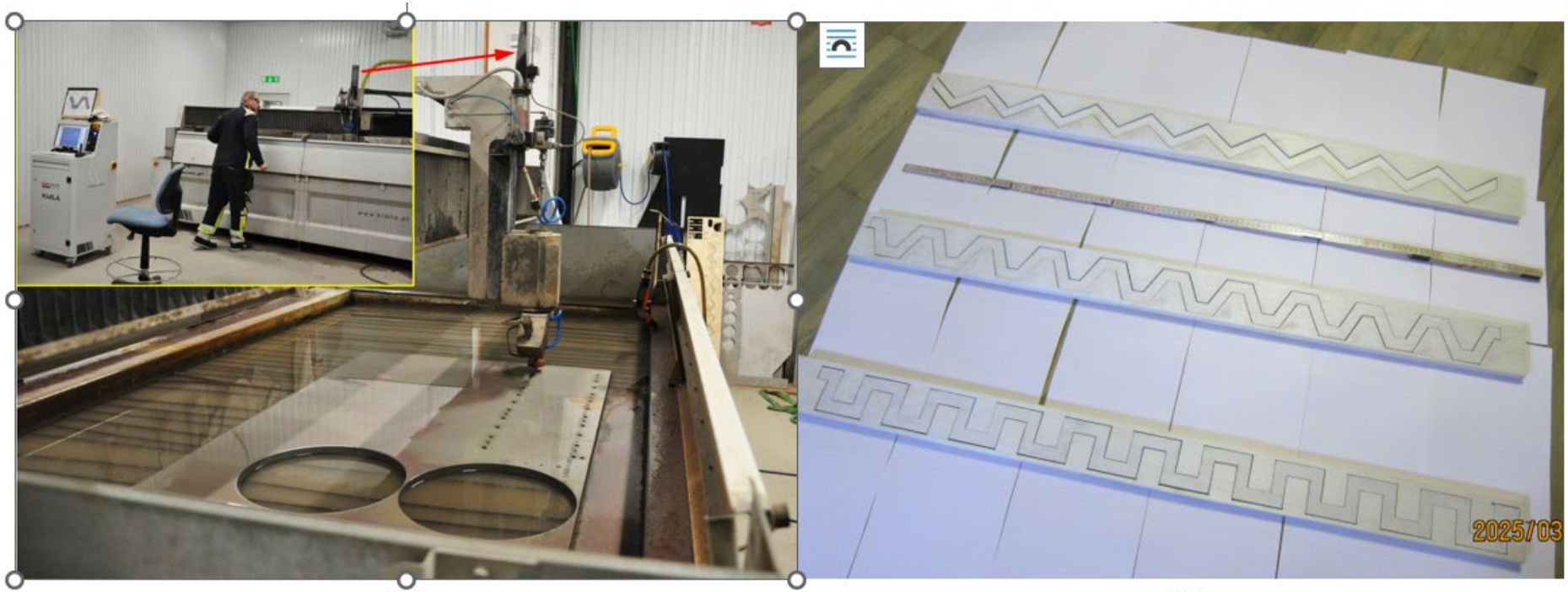
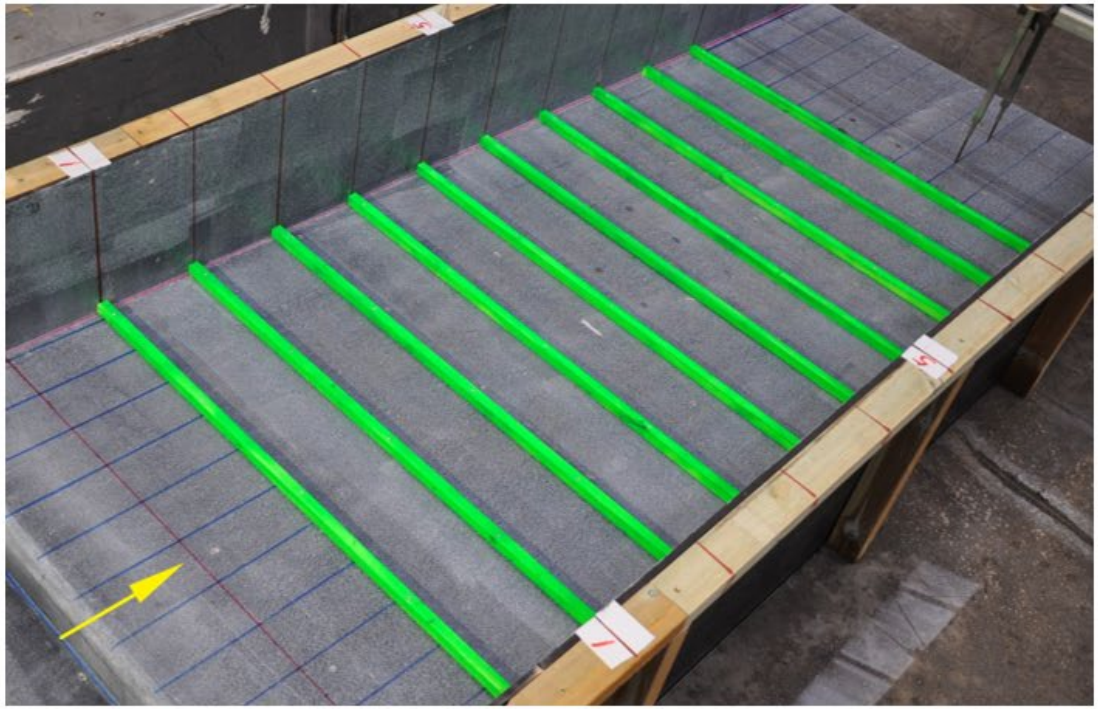
0.5W3
2W2
W

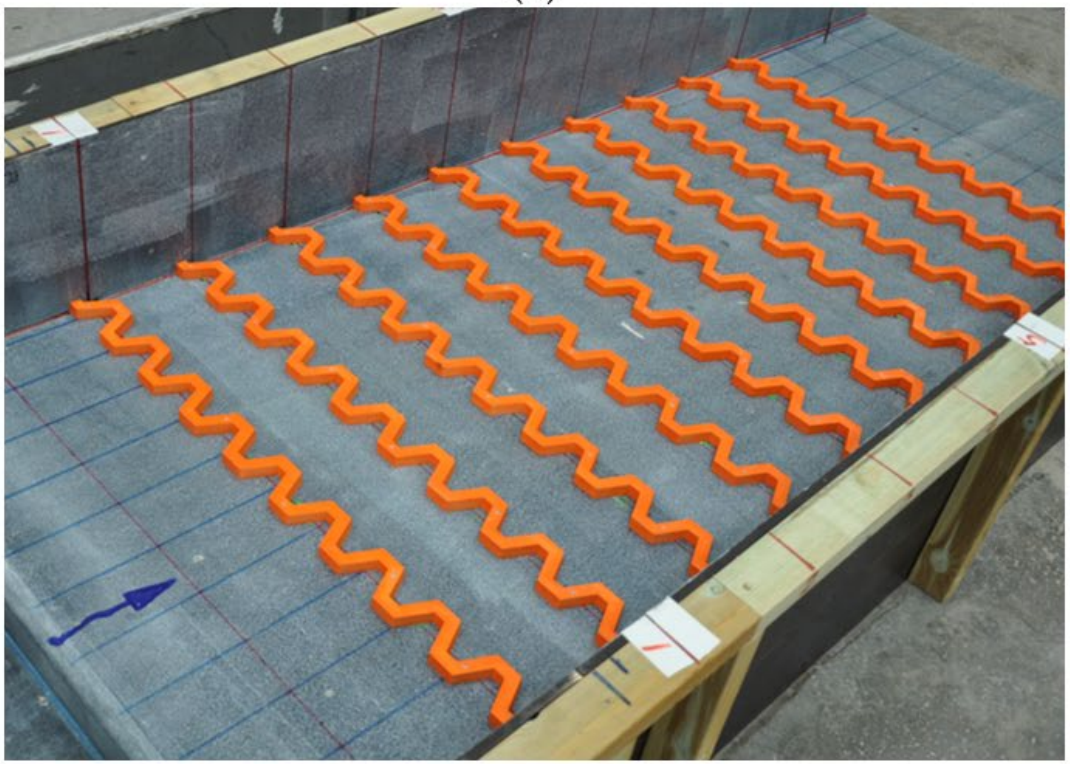

2025/03

(a) (b)

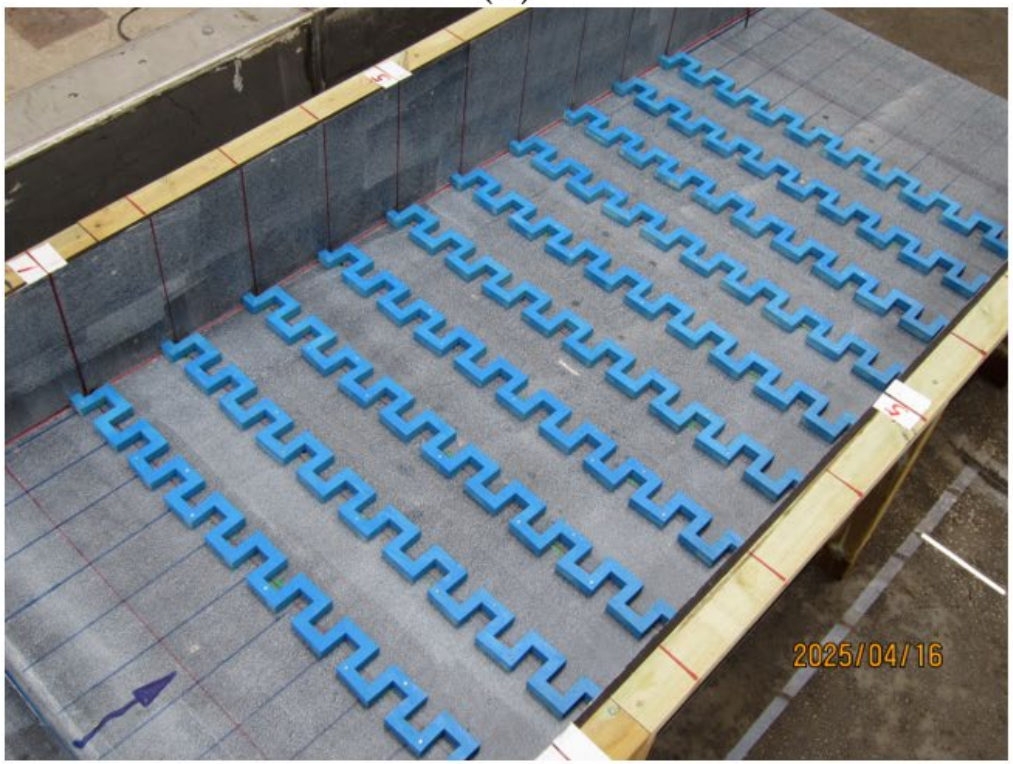


(a)

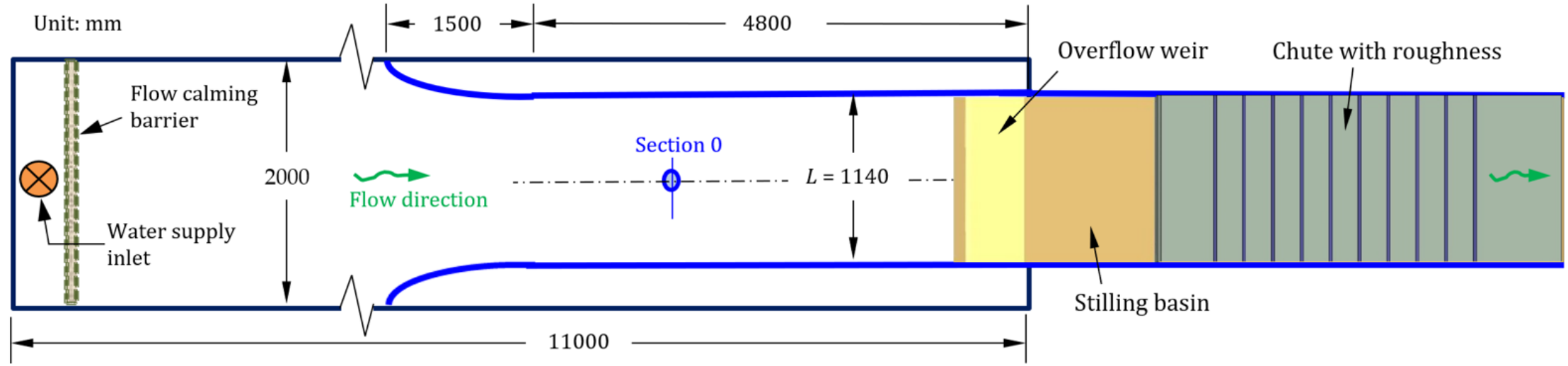
(b)

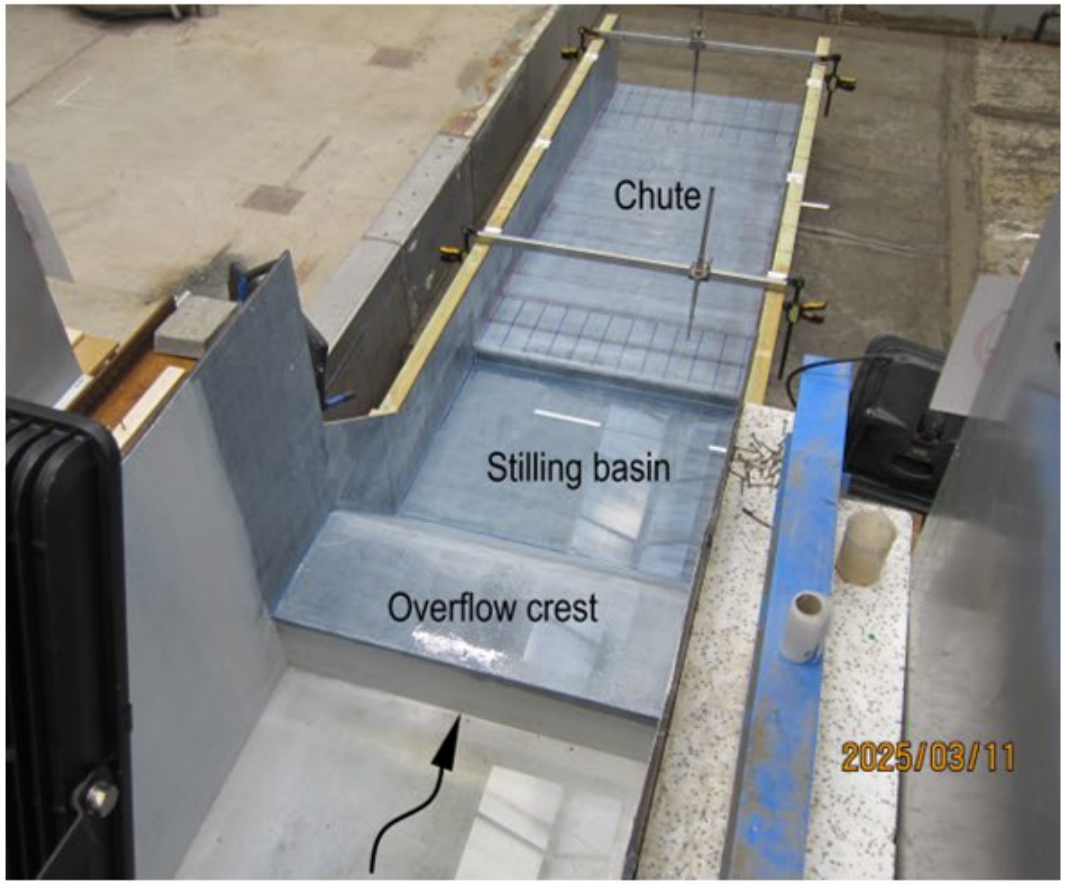


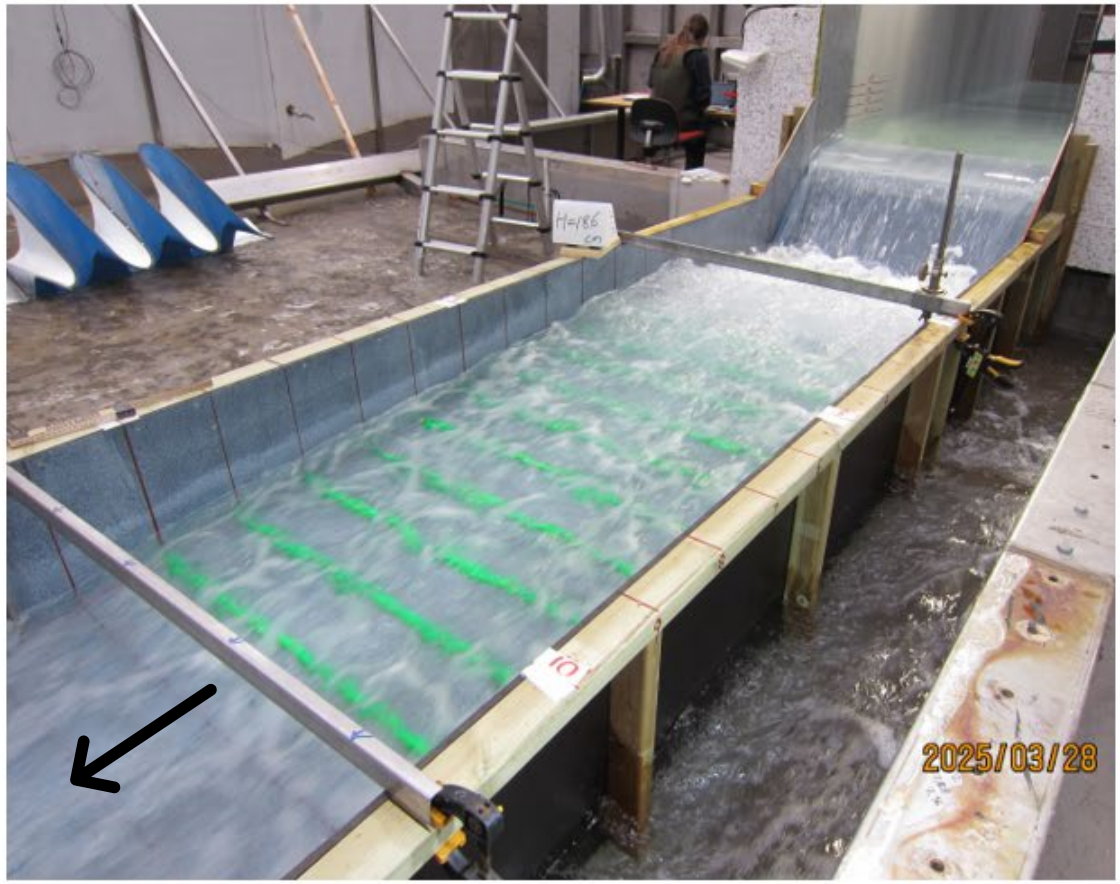
(c)



(d)


Unit: mm
1500
4800
Overflow weir
Chute with roughness
Flow calming barrier
Section 0
2000
Flow direction
L = 1140
Water supply inlet
Stilling basin
11000


Chute
Stilling basin
Overflow crest
2025/03/11


2025/03/28

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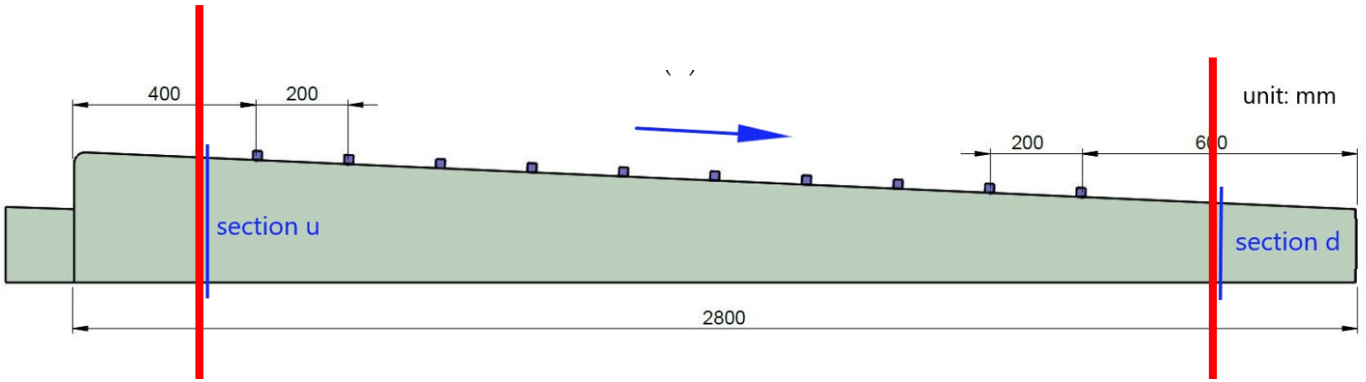
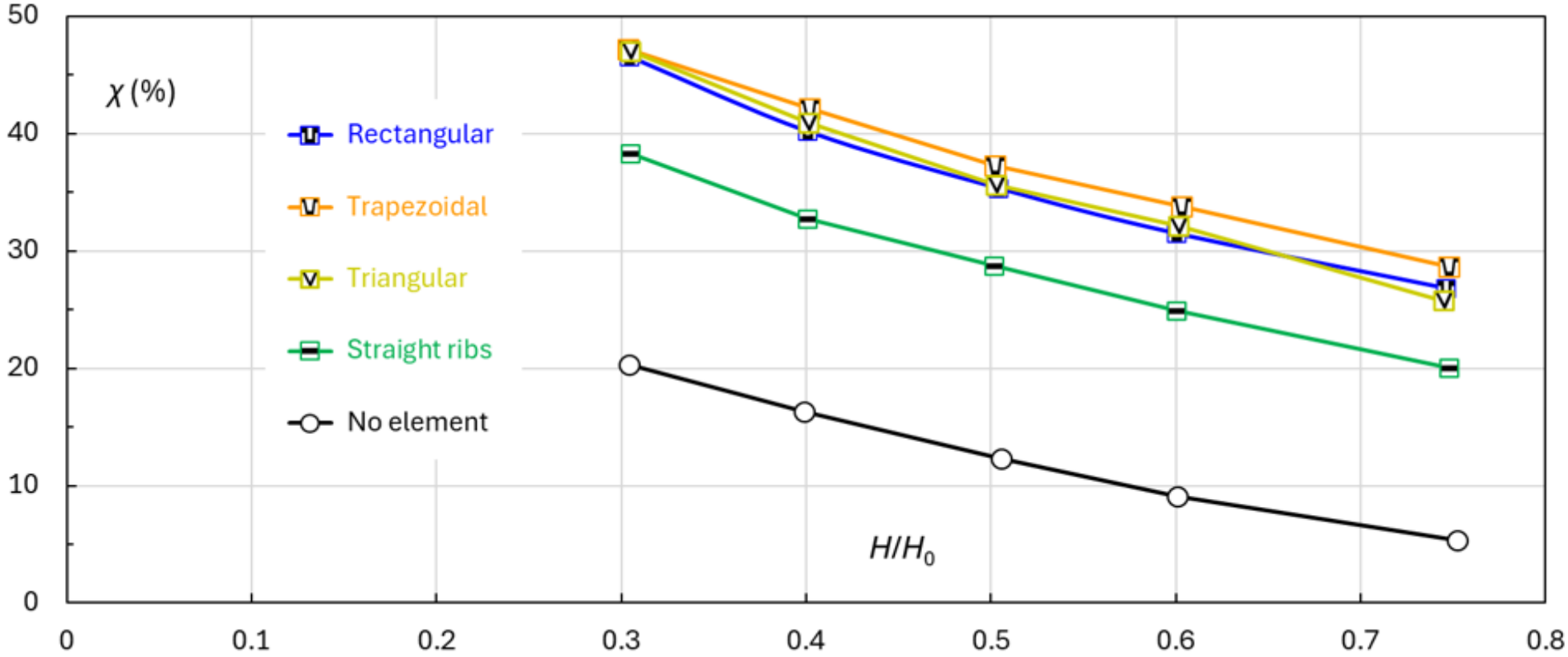
Result in brief



$$\chi = \frac{E_u - E_d}{E_u}$$



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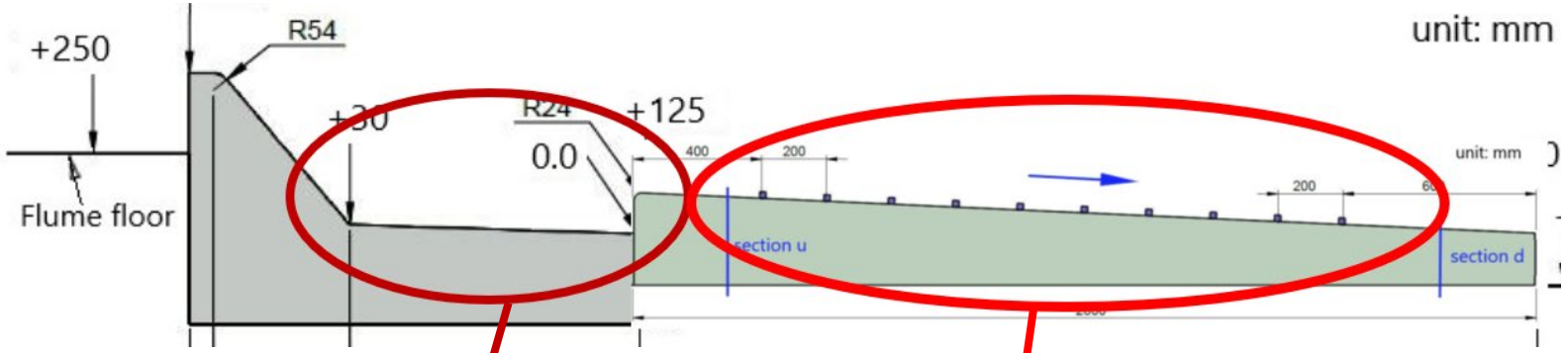

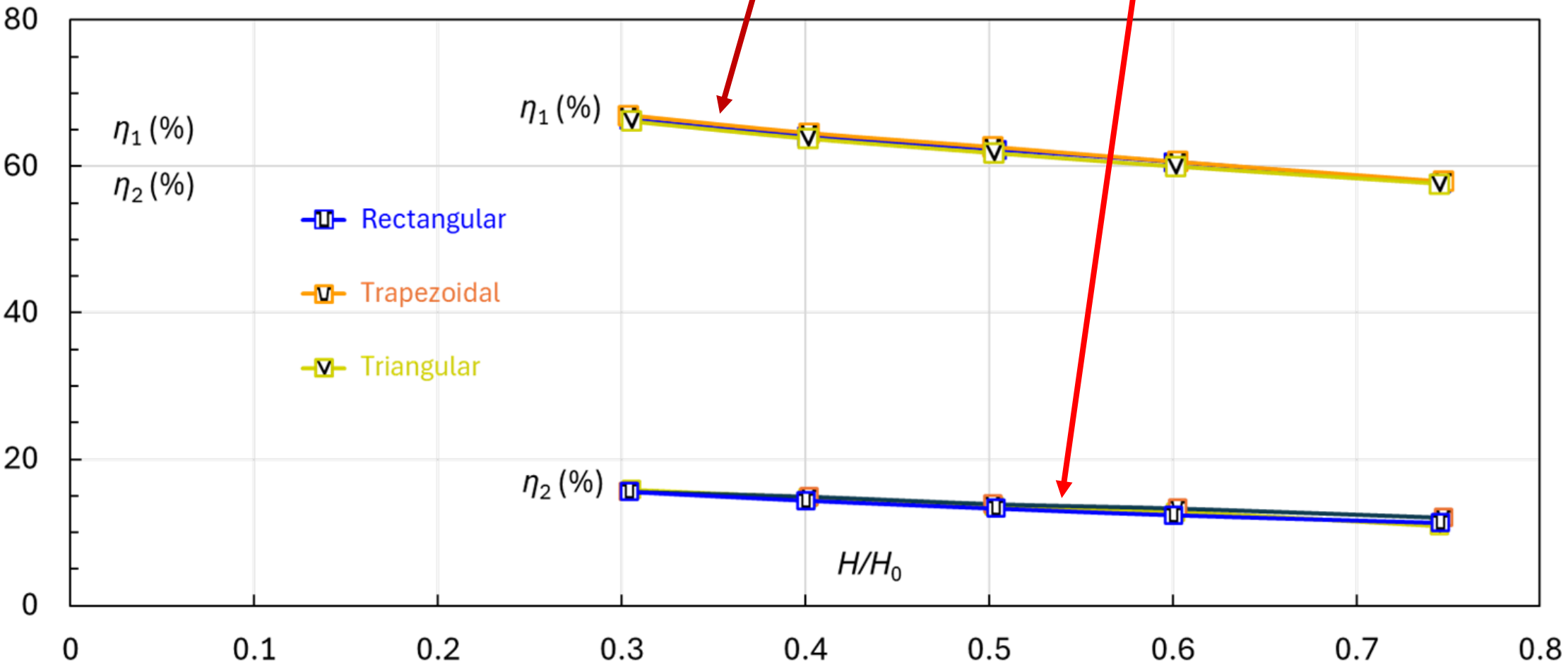

Malarce dam by EDF

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Conclusion in brief

- Four types of roughness evaluated
- Differences among triangular, trapezoidal & rectangular are minor.
- The labyrinths outperform the straight by 16–35%
- A significant number of elements = stilling basin

- Any use for fish migration?

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water

Energy Dissipation in Chute Spillway with Labyrinth Roughness Appurtenances

by James Yang [1,2], Shicheng Li [2,*], Umar Farooq [2] and Anna Helgesson [1] *Water* **2025**, *17*(23), 3417

Application of Roughness Elements for Effective Energy Dissipation in Chute Spillways

O. Lundahl, LTU 2025

CFD modeling labyrinth roughness elements

manuscript

Project team

A Sjödin, resource coordination

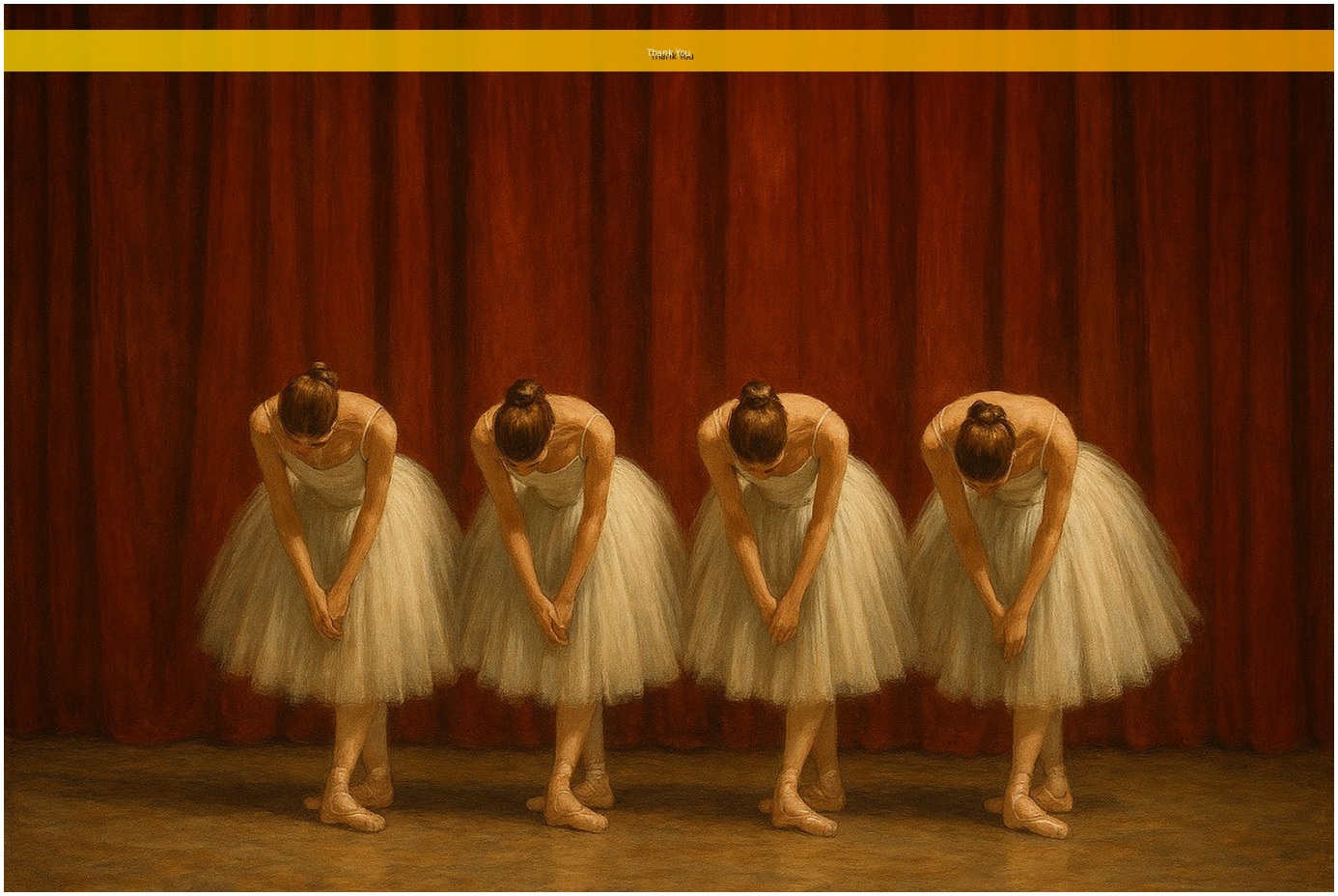
E Skepparkrans, CAD/construction supervision

J Eriksson & M Delic, model construction

M Lagerkvist & D Ek, waterjet cutting

P Lidberg & M Östlund, instrumentation

A Helgesson, SC Li, U Farooq, model tests



Questions are welcome!