Photogrammetry of Kalhovd dam

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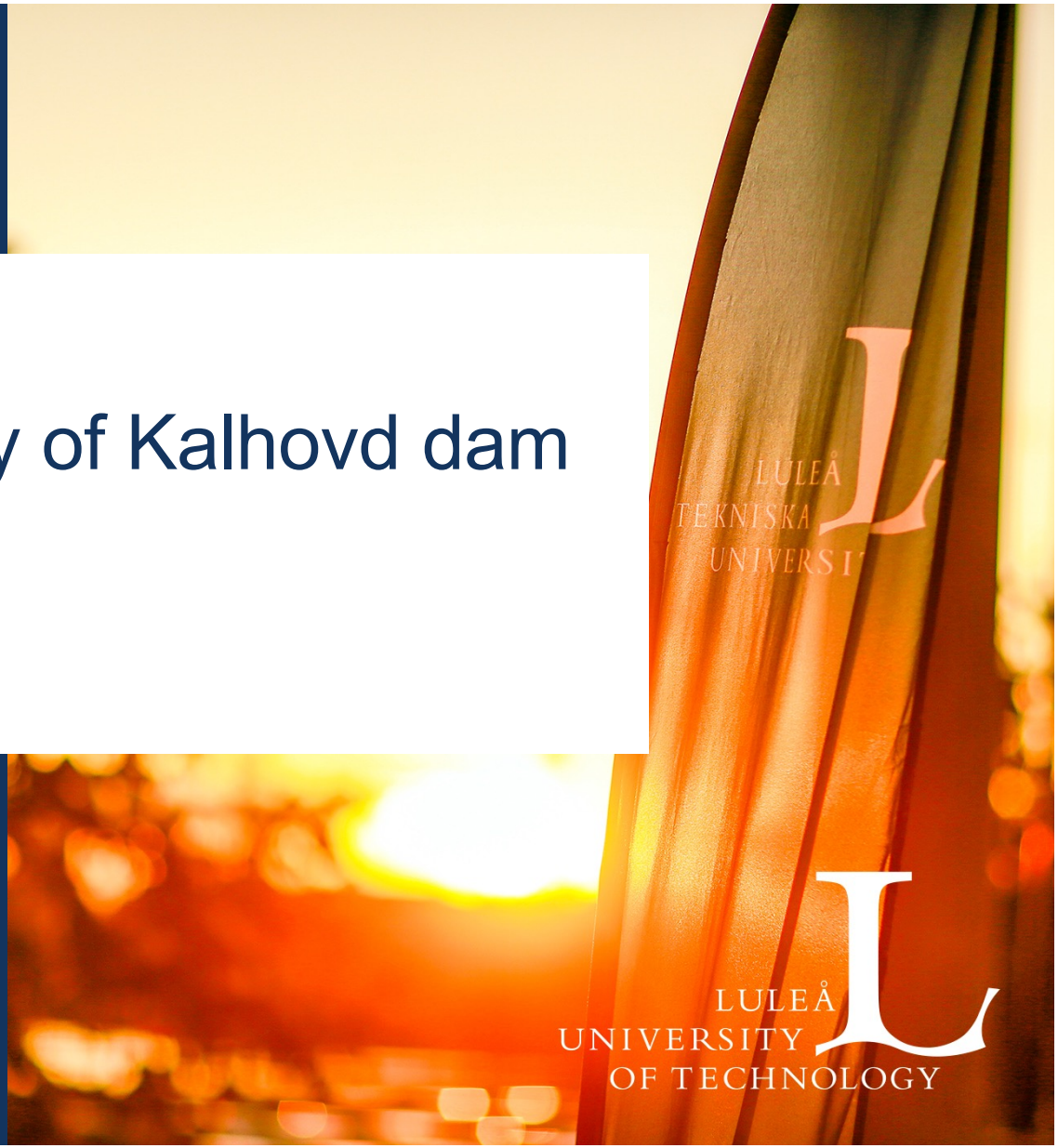
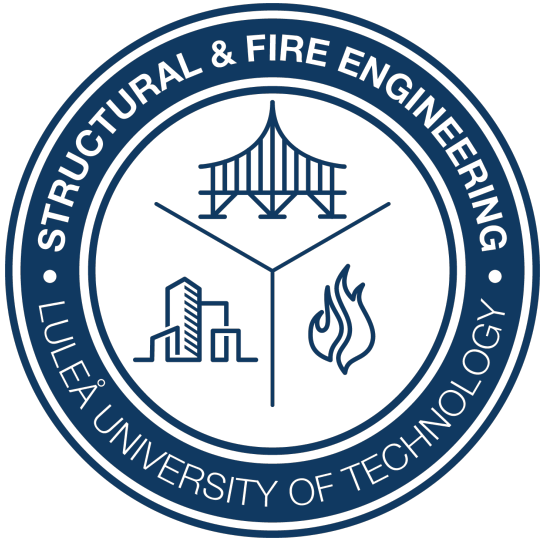


MCE
Laboratory

Concrete
structures

Bridge
engineering



Composite
&
steel structures

Fire
engineering

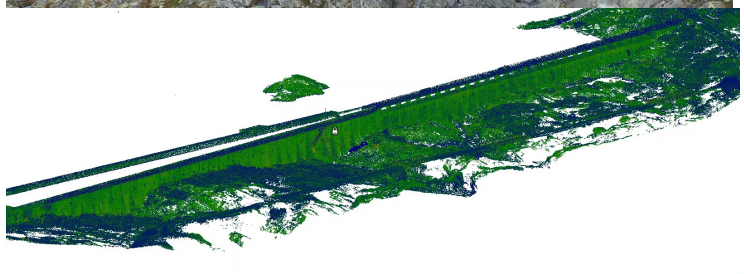
Timber structures

Photogrammetry

What is it?

Kalhovd Dam

Case study of Stable Dams (2015-2019)



386 m long, 10 m high

66 pillars

5 m span

Norway, Telemark

1940 - 1948

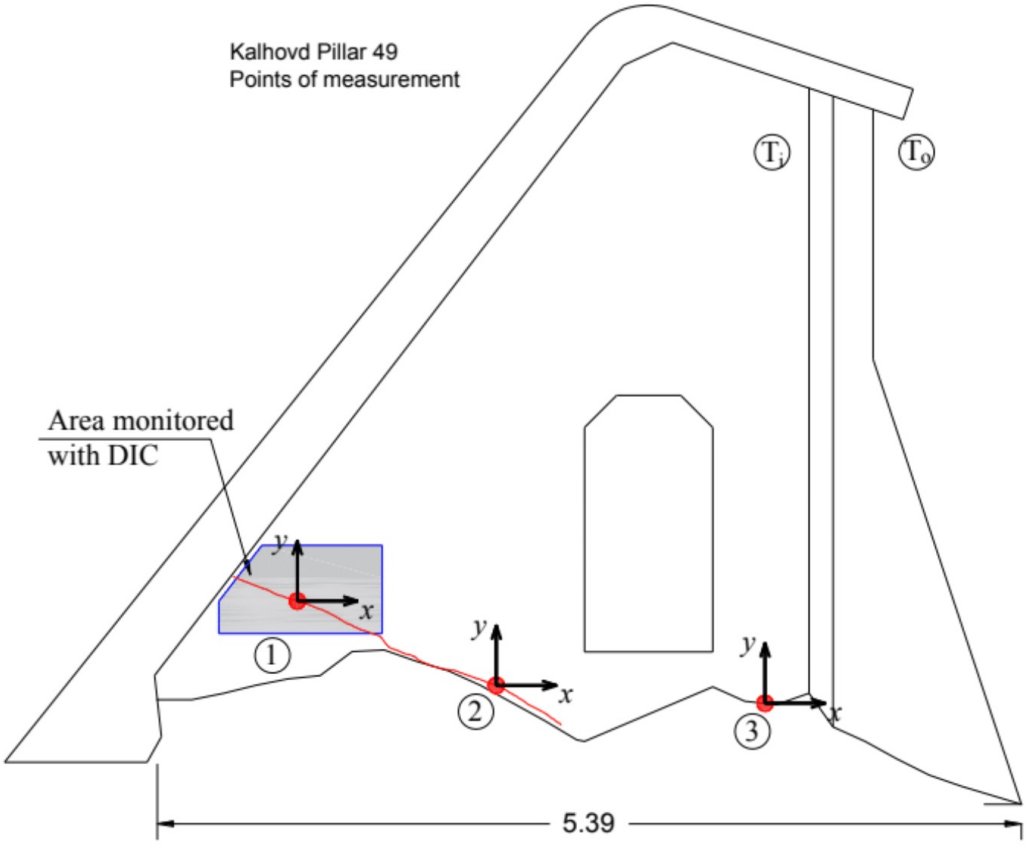
Sliding safety

“Good” condition

Pillar 49: condition assessment

1. What caused the crack in concrete and the crack at interface ?
2. Is the process still active?

Pillar 49: Long term - monitoring plan



- Displacements:

  3 points along the interface

- Crack evolution:

  Photogrammetry -DIC

- Temperature:

  inside & outside

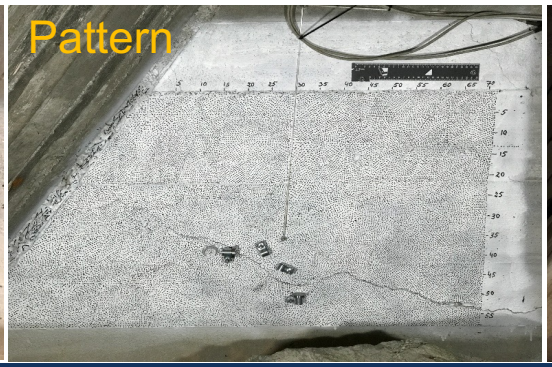
Photogrammetry for crack evolution

Measurement plan

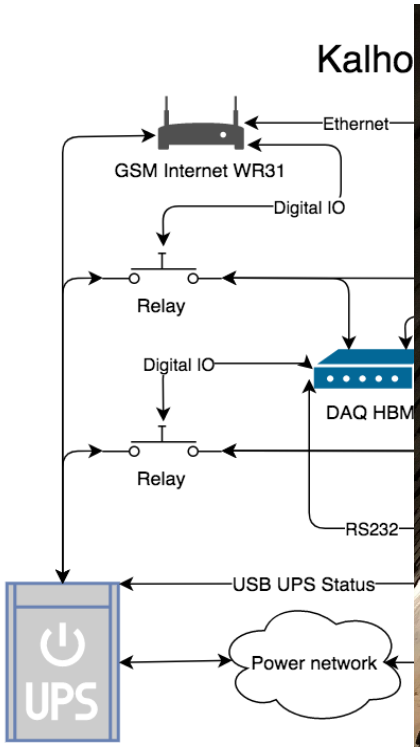
- 2D digital image correlation
- Area monitored (700 × 550 mm)
- Photos every 90 minutes

Equipment

- Canon 80D
  - 24 megapixels
  - APS-C sensor (i.e. not full frame)
- Canon EF 35mm wide-angle prime lens
- Two led lamps
- Carbon fiber tripod

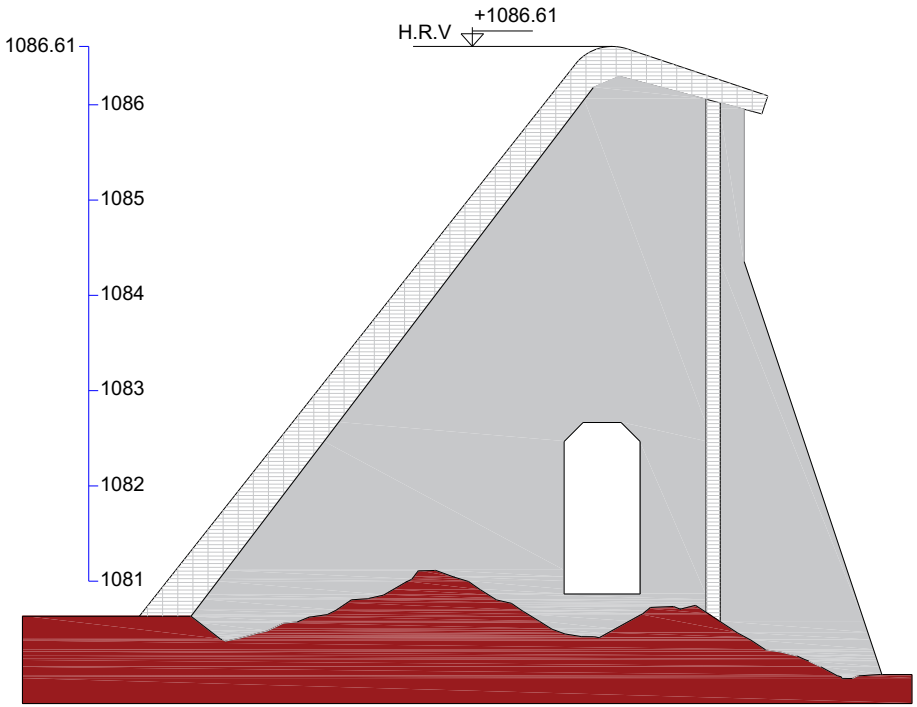


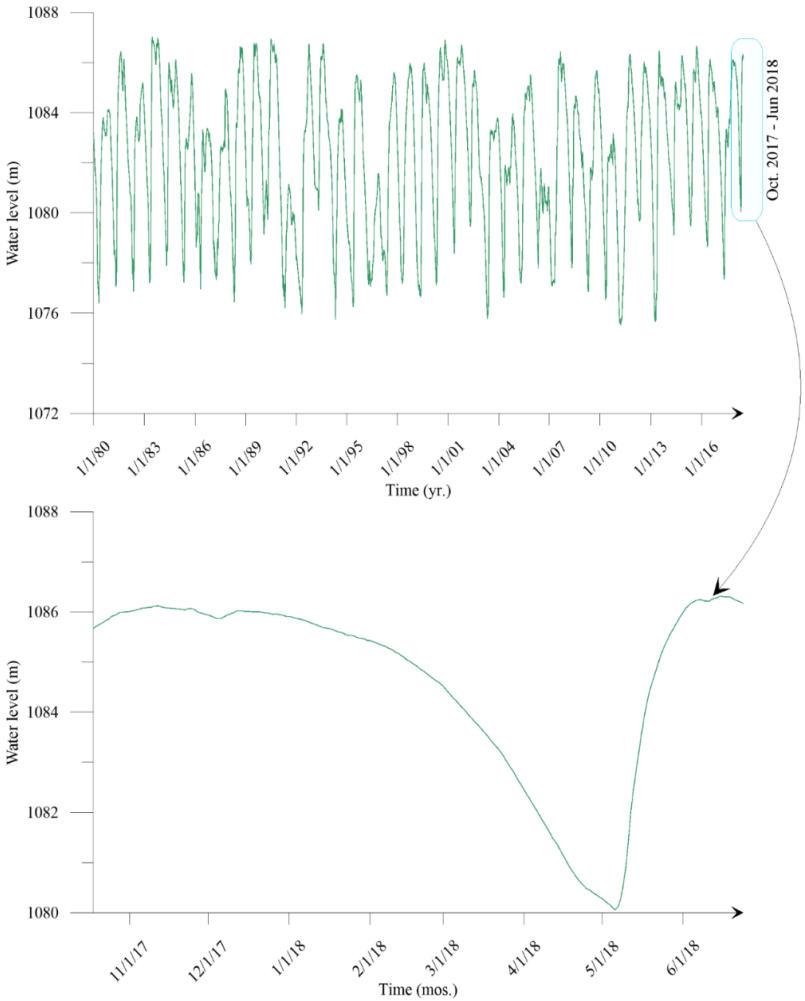
Photogrammetry for crack evolution



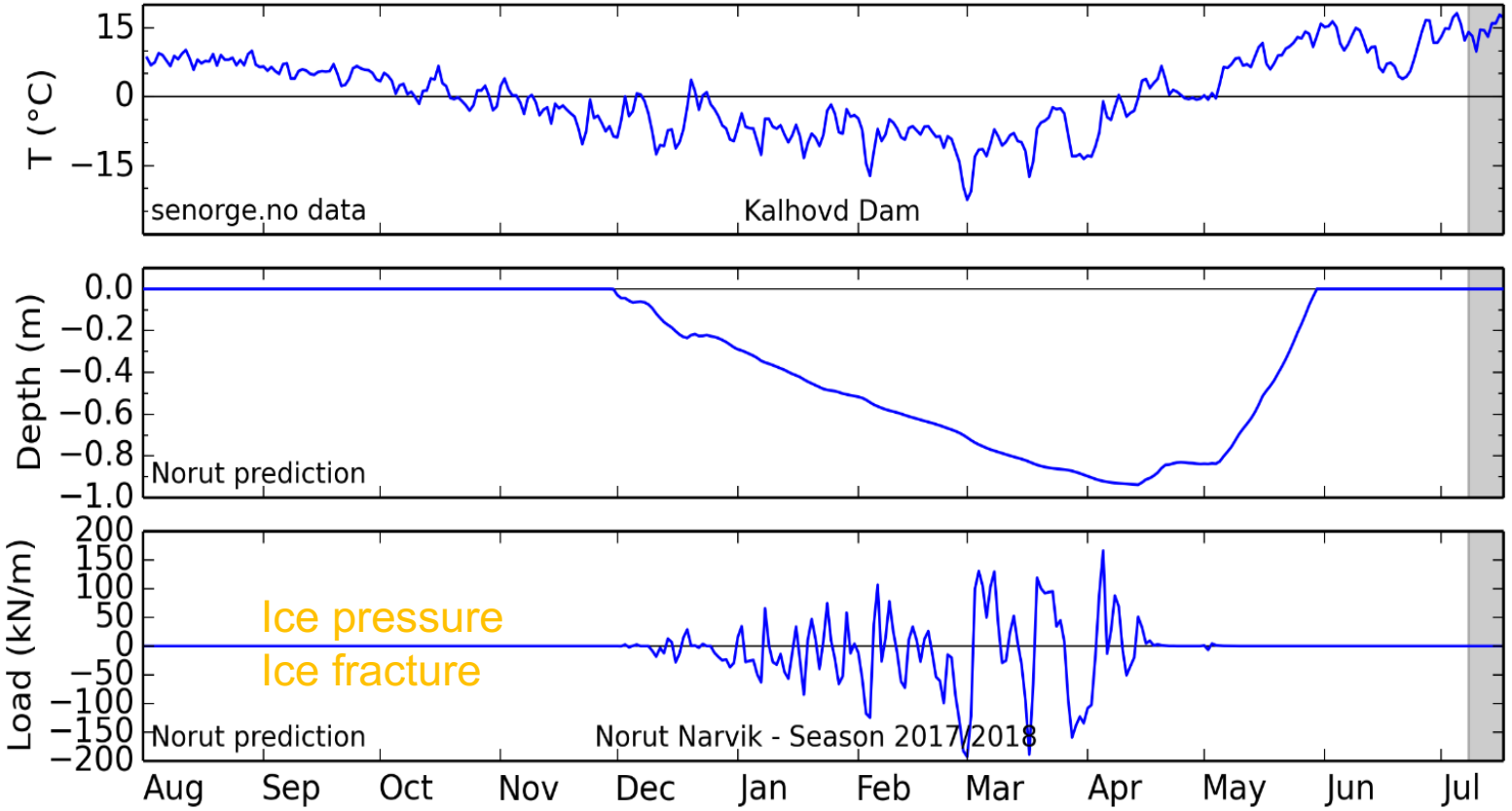
Wall mounted enclosure

Results: Water level



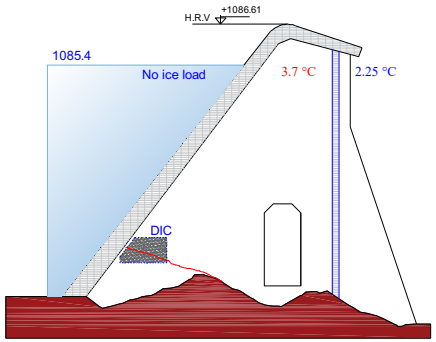


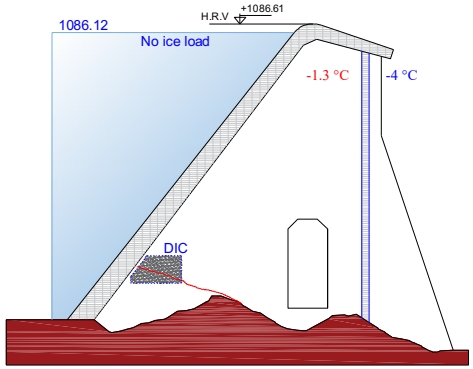
Results: Ice load prediction

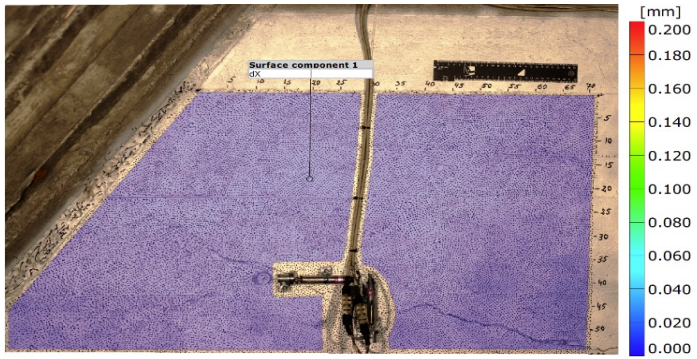


Ice loads predictions based on daily temperature variations (**https://ndat.no/sd/**).
Calculations based on Petrich et al. (2015).

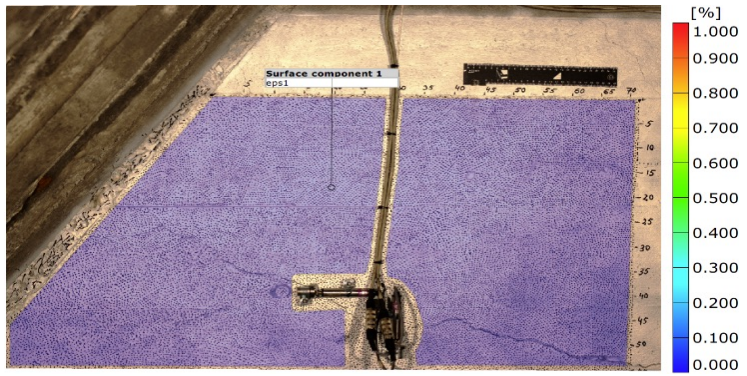
Results: Photogrammetry – DIC – max water level



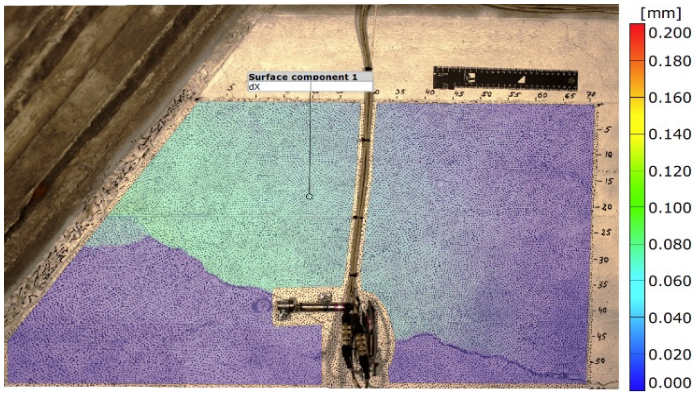




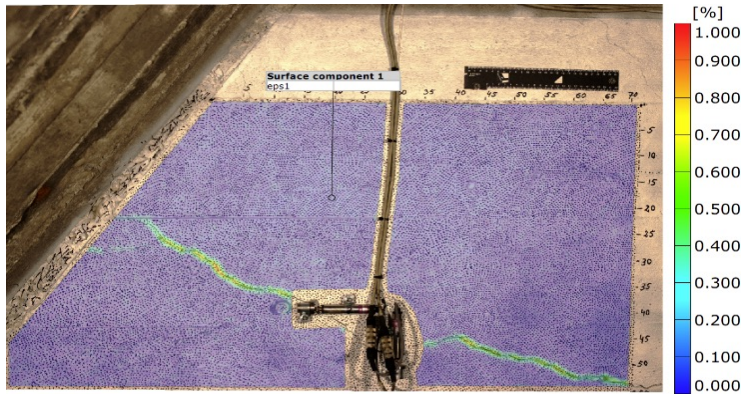
Reference image (2017.10.18) – *dx*



Reference image (2017.10.18) – *eps*

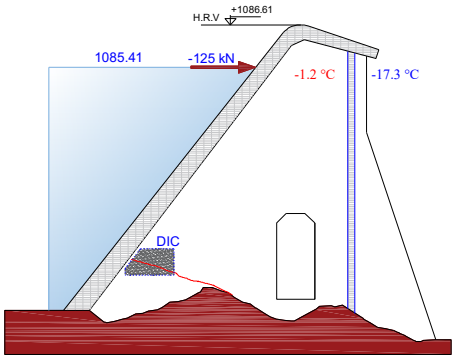


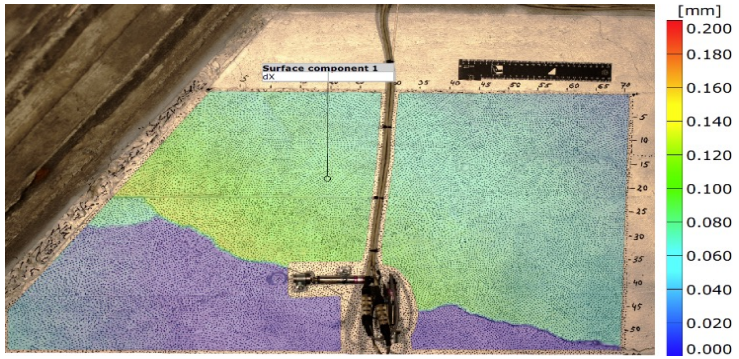
Max water level #1 (2017.11.11) - dx



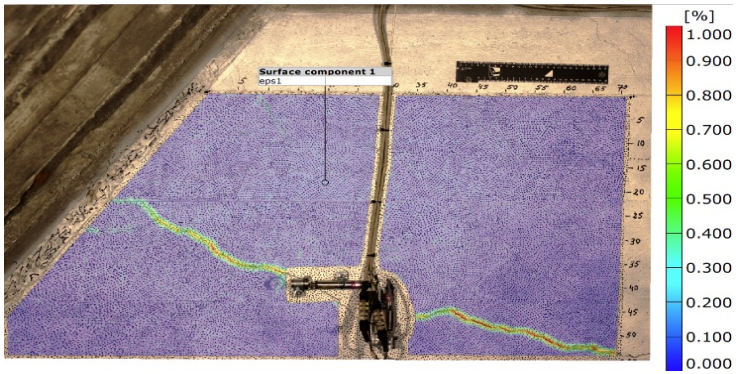
Max water level #1 (2017.11.11) - eps

Results: Photogrammetry – DIC – peak ice load

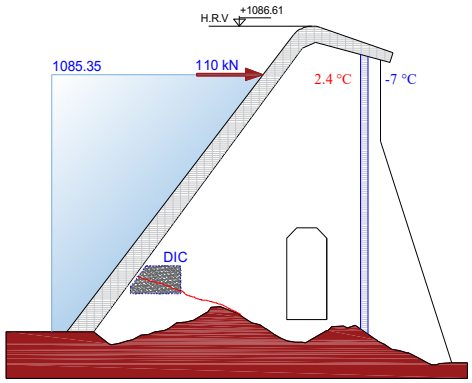


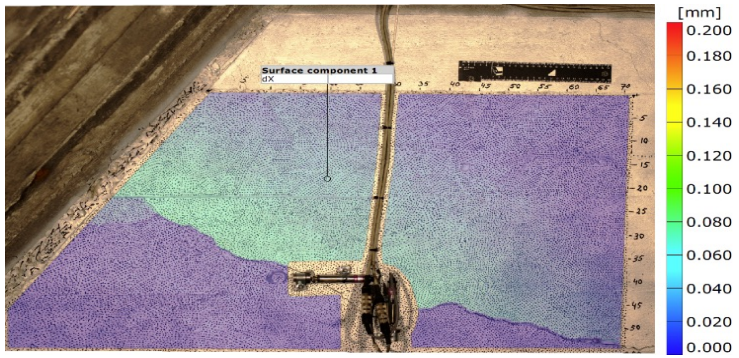


1st “peak” ice fracture (2018.02.02) – dx

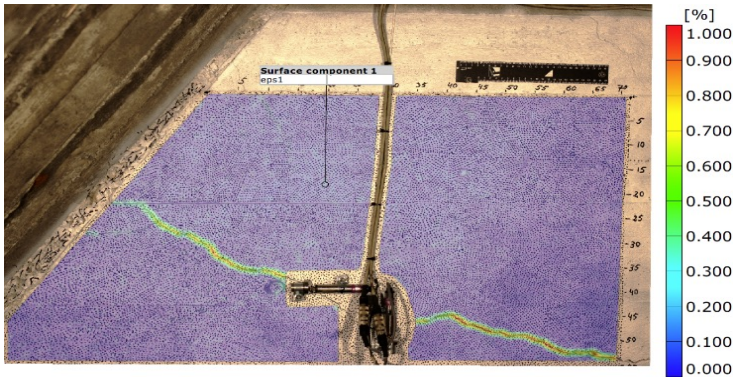


1st “peak” ice fracture (2018.02.02) – eps



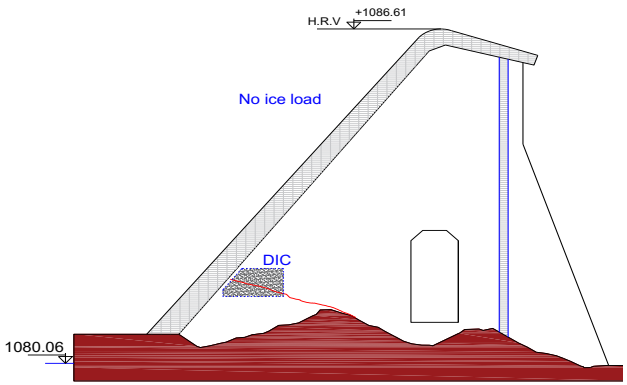


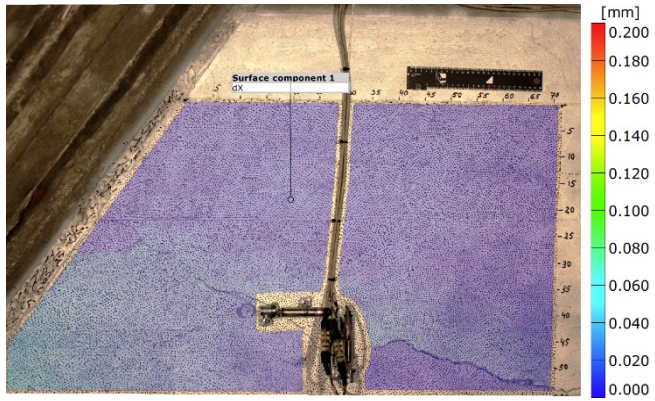
1st “peak” ice load (2018.02.05) – dx



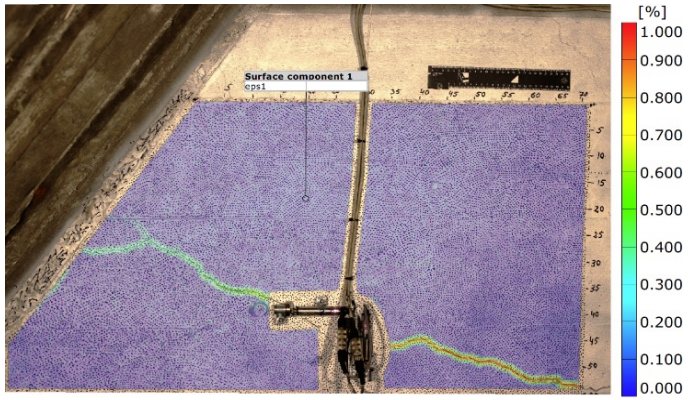
1st “peak” ice load (2018.02.05) – eps

Results: Photogrammetry – DIC – no water





Min water level (2018.05.06) – dx



Min water level (2018.05.06) – eps

Analysis

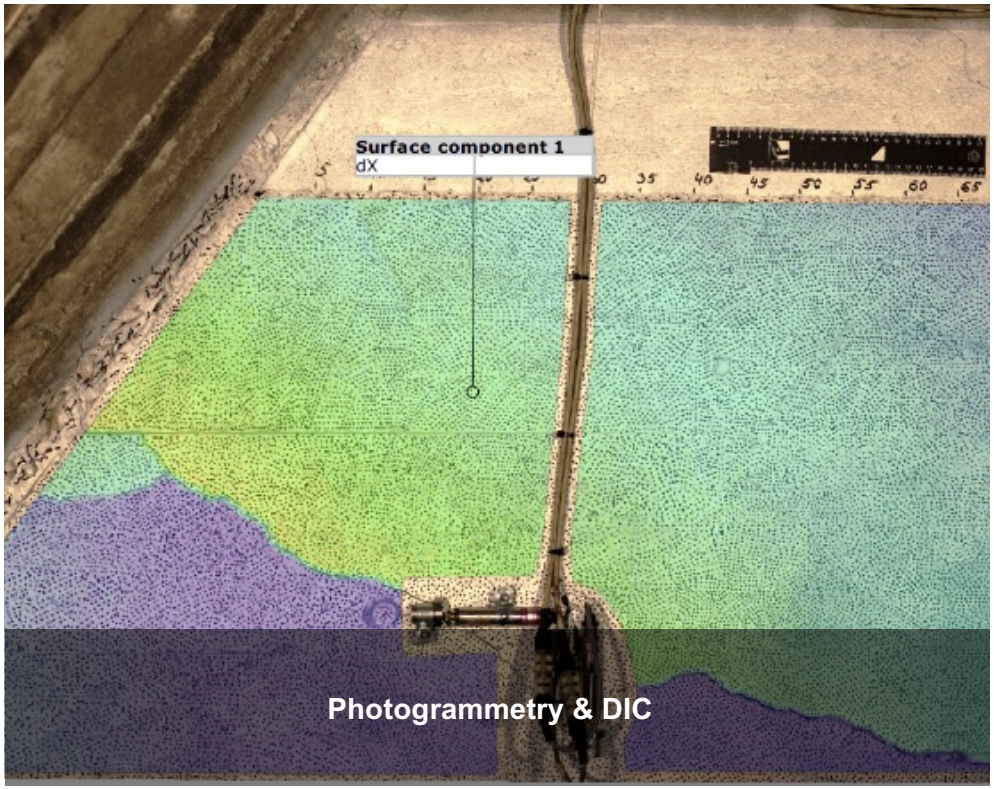
October to mid - February

- Max water level observed
- Peak ice loads 100 kN/m
- Predominantly sliding movement of the pillar

Mid-February – onwards

- Water level dropped and increased rapidly
- Max ice loads 160 kN/m and drops to zero in April
- Trend suggest the the pillar is “silding back” towards its original position

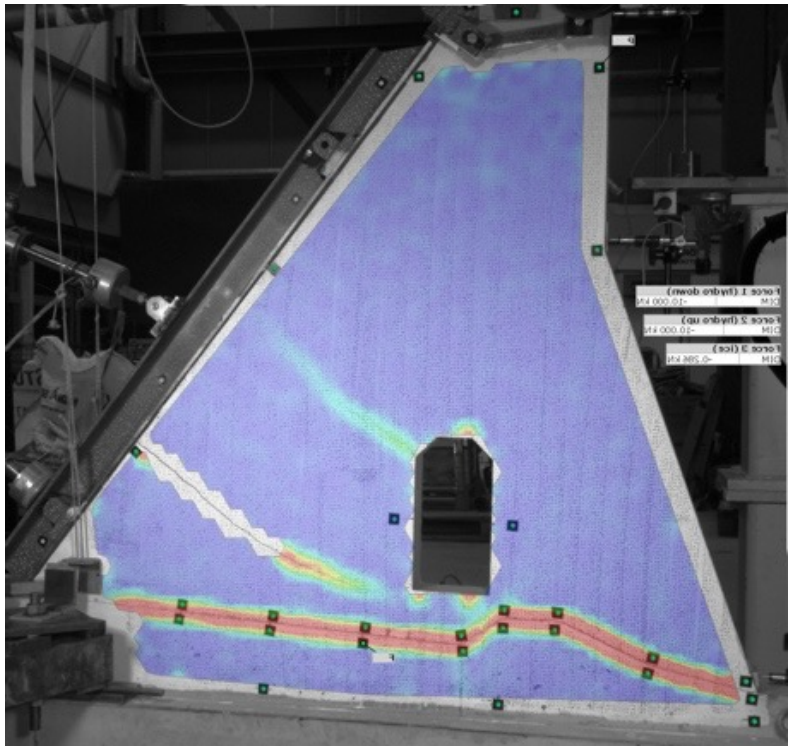
Summary of the pilot study

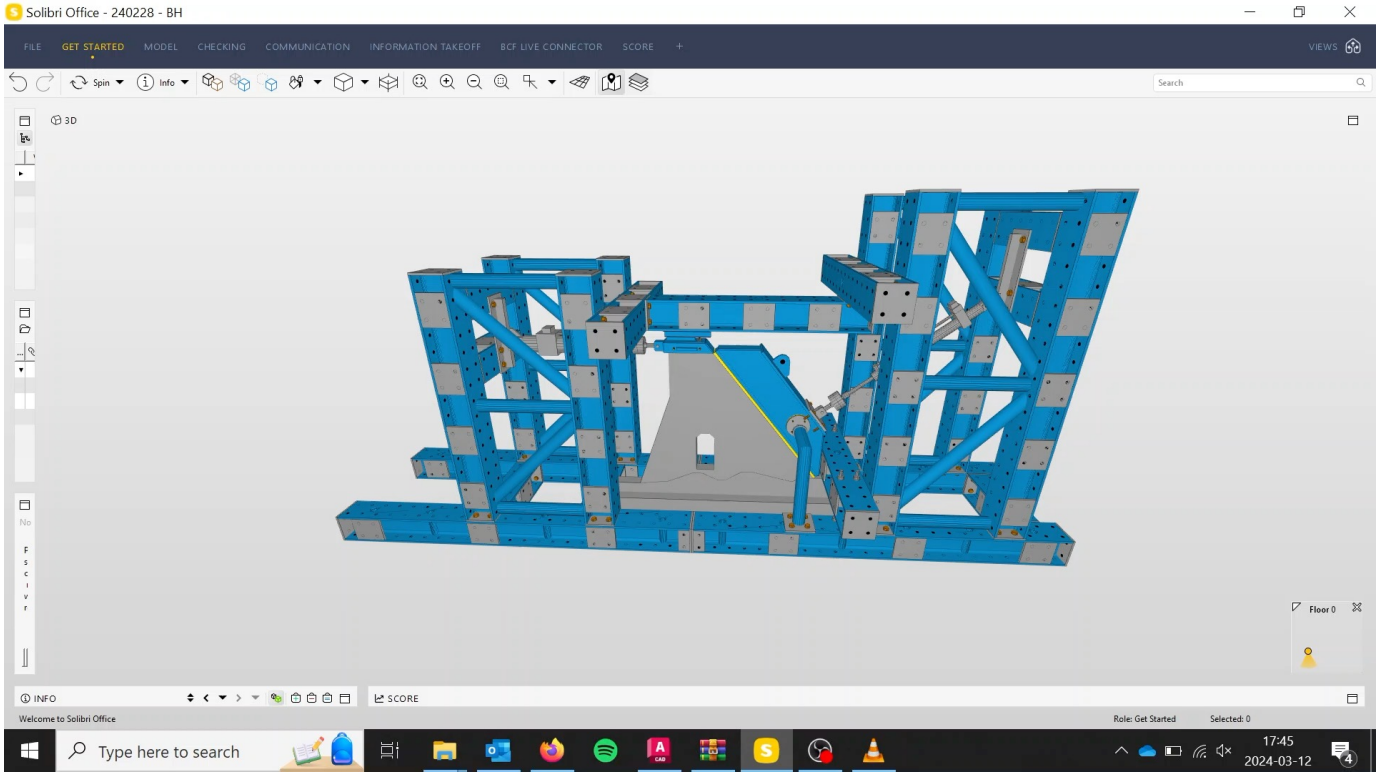


Photogrammetry & DIC


The SHM system

DIC on model tests in 2018 and new model tests in 2024

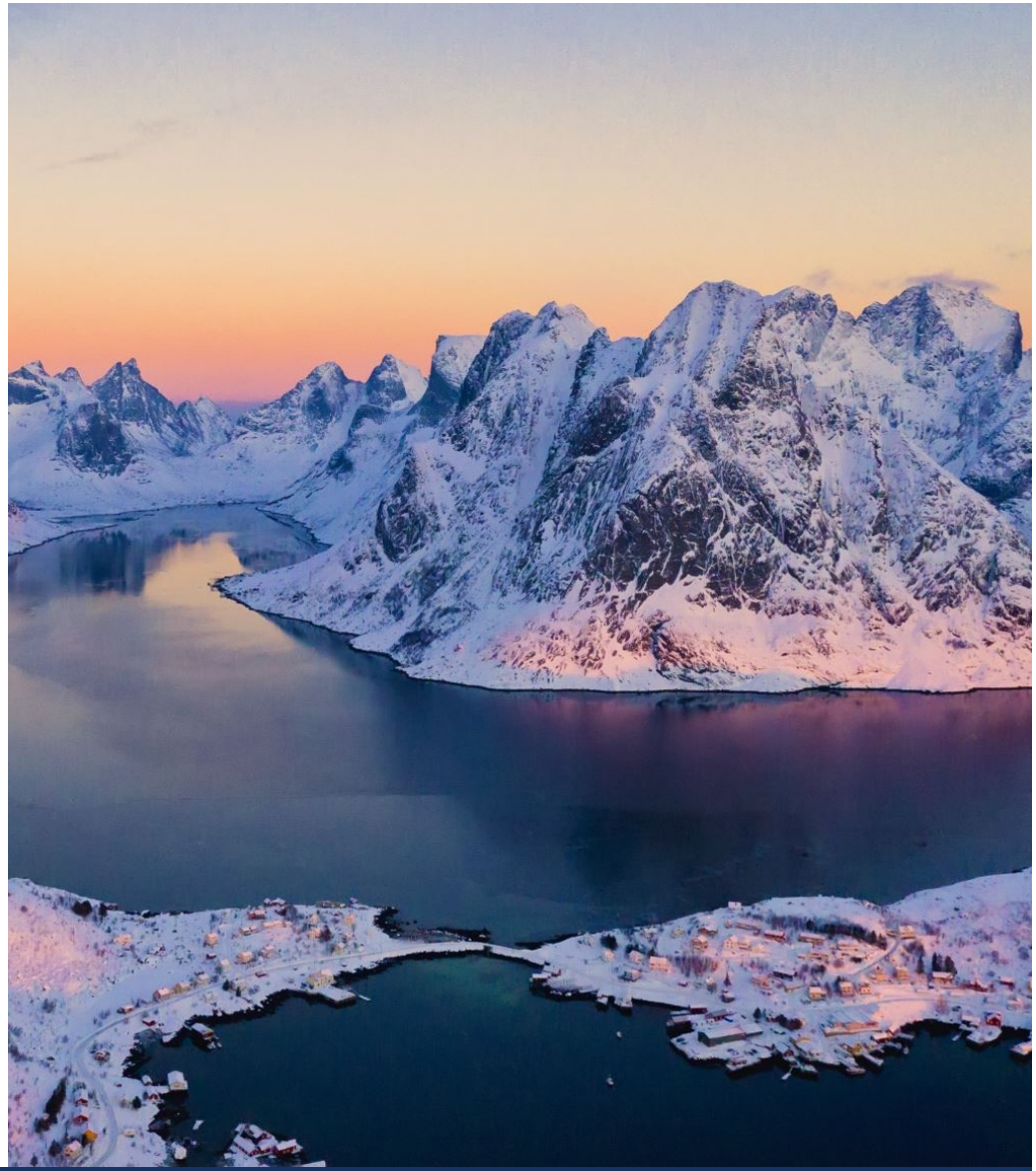




Automated damage inspection based on photogrammetry

Acknowledgements

- Sintef Narvik (Norut)
- Research Council of Norway
- Stable Dams partners
- Formas
- Energiforsk & SVC

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