The effect of CYCLIC LOADING on the mechanical stability of embankment dams and slopes

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Increasing flexibility means frequent change in water levels can influence the detoreation and safety of dams (and slopes in levees)

- Internal stability by increased particle movements
- Global stability by changing loading conditions and material behaviour

From Maria Bartsch 23.4.

- Measures incl more maintenance, monitoring and surveillance but also adaptation of operation and design
- Strive for solutions providing extra safety margins today & facilitate stepwise adaptation in the future

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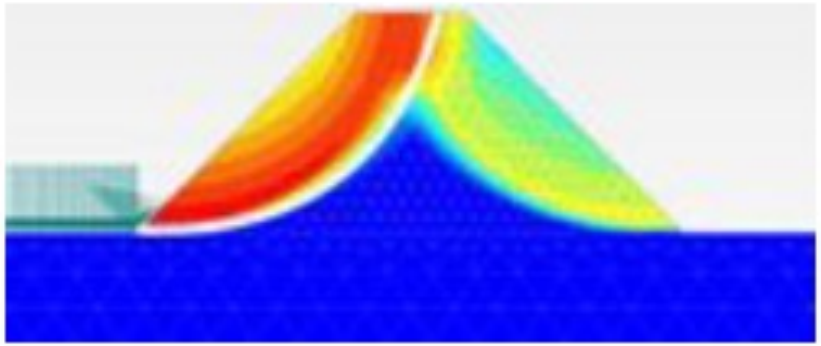

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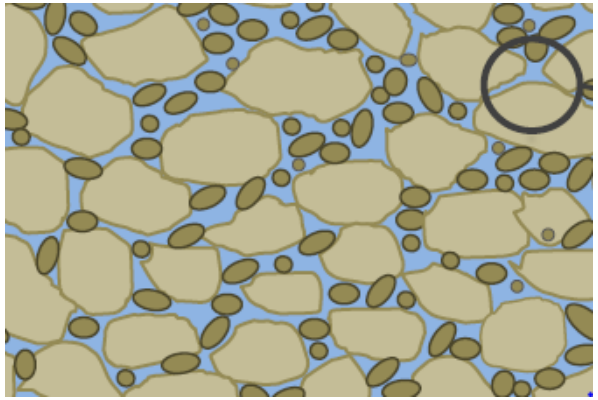
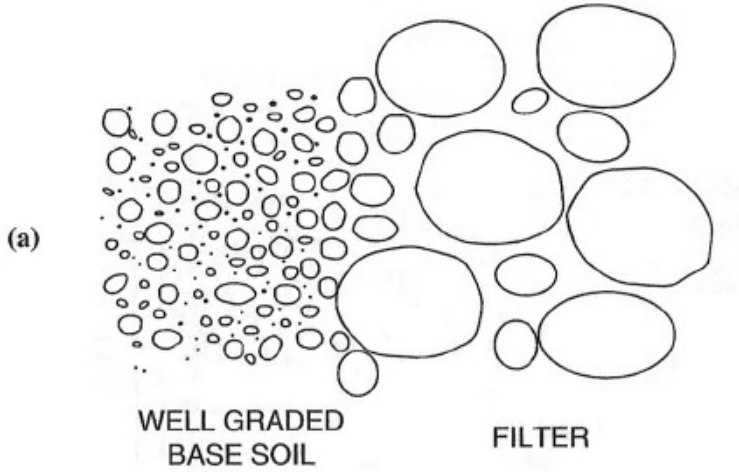
Internal stability:

- Erosion of particles in the core with the risk of internal erosion (gradient – stress state)
-



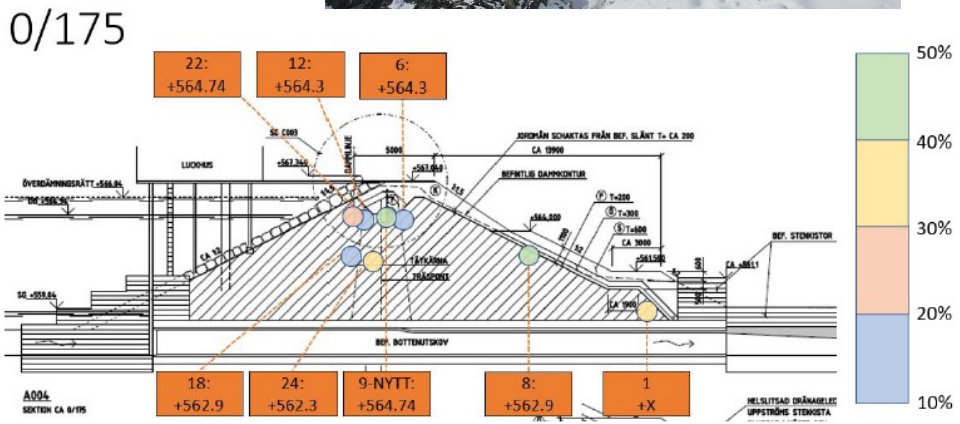


if everything is correct:
Filter will catch potential material, which might erode reaching a (steady state)

Internal stability:

But the reality even in steady state - particle movements with time

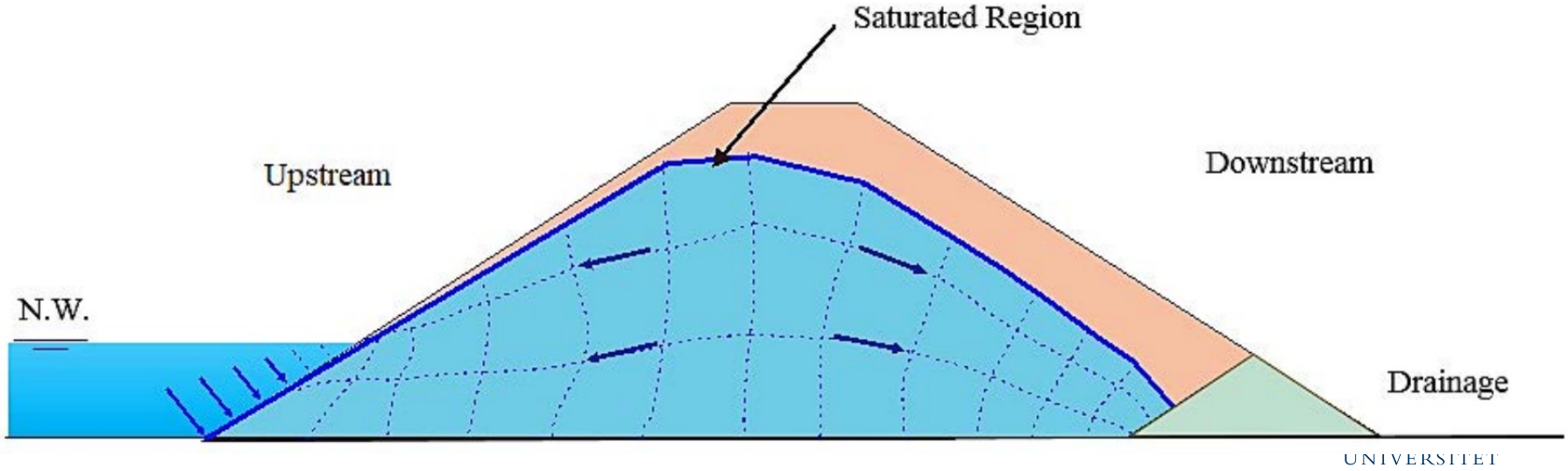
Ex: dismanteling of Burvatnet (non zoned dam) – Aging effects under stable loading conditions



Figur 5.1 Variation av finjordshalt, sektion 0/175.

Internal stability

- Loading scenario during lowering of water level
- Reversal of flow direction can influence the movement of mobile particles and destroy stable conditions



Internal stability related to particle movements

- How do particle inside the soil mass move and how much are particles held in place while the flow direction changes

- To which extend does the constricting stresses due to the self weight induced stresses at the location of the particles contribute to the stability or the risk of an increase in erosion

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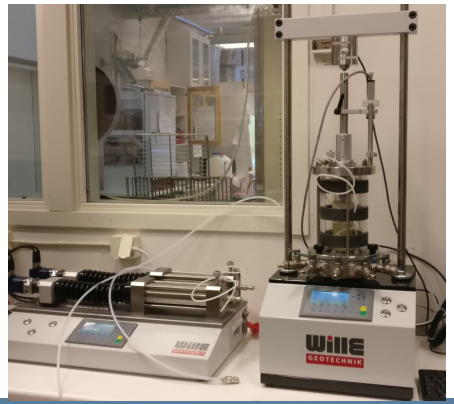
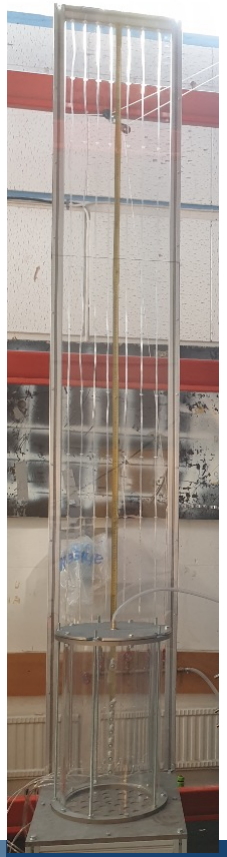
Upgrade of testing possibilities

Upgrade a triaxial apparatus to a permeameter to allow study erosion under real stress conditions



PhD Elin Bergliv



Visualise in a physical experiment the movement of particles during hydraulic loading by using “transparent” soils and Image processing

PhD Shane Aulestia

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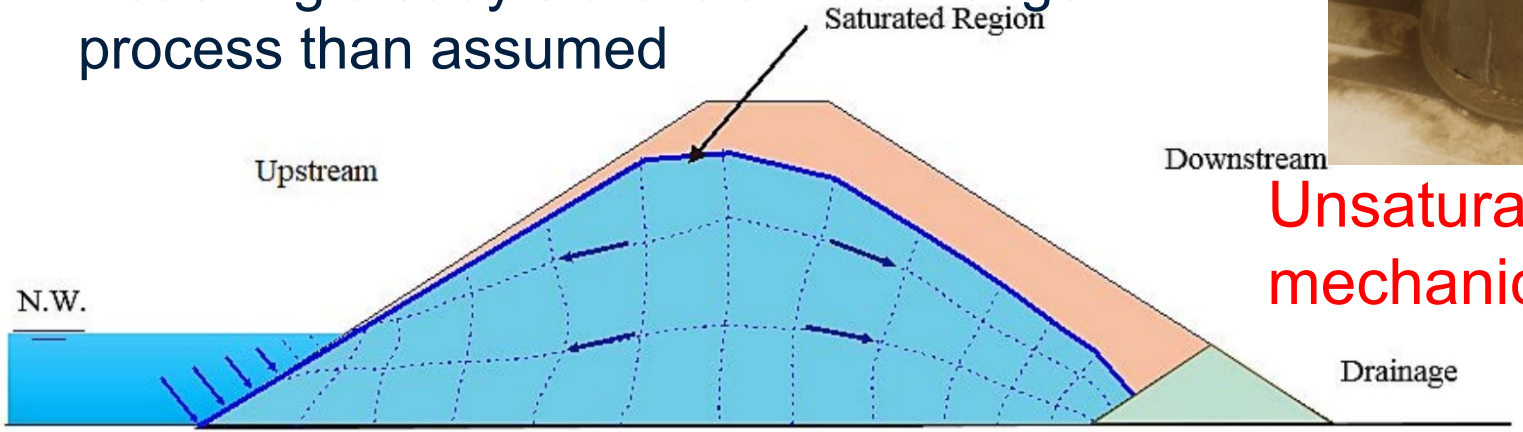
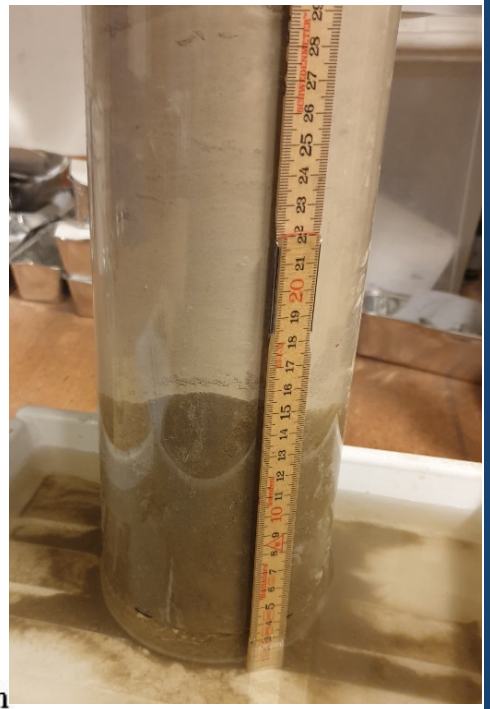
Global Stability

- Influence of transient conditions on the mechanical behaviour
- Mechanical behaviour changes with the degree of saturation
- Reaching steady state is a much longer process than assumed





Unsaturated soil mechanics

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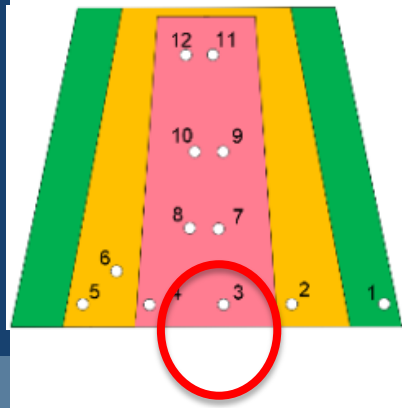
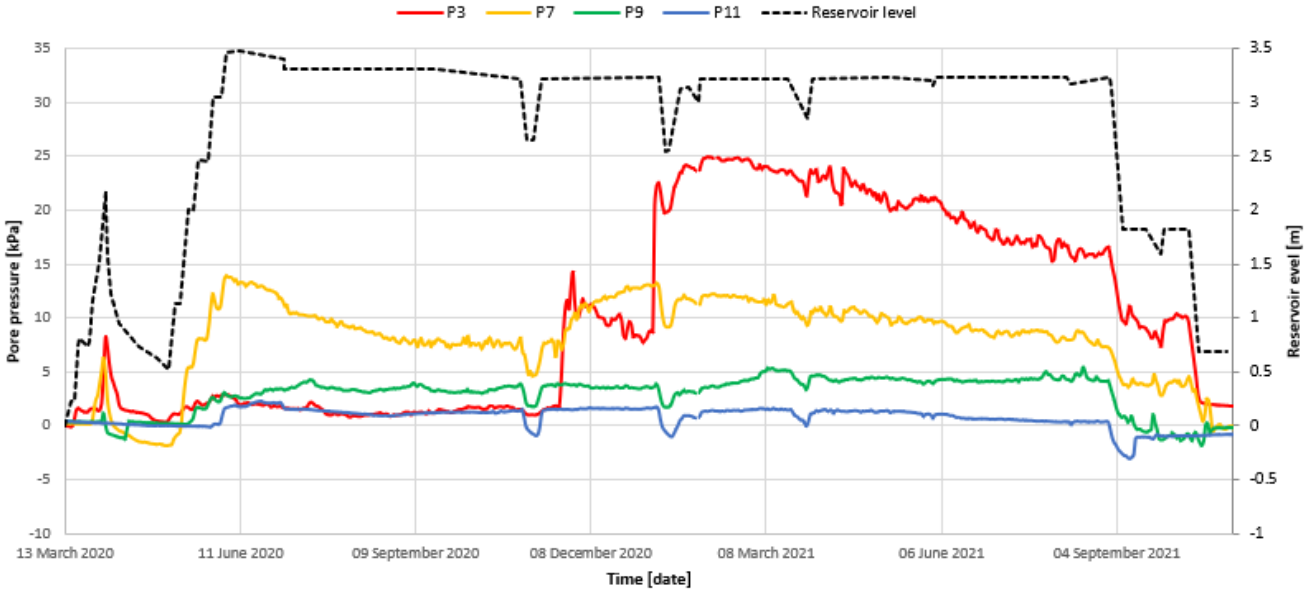
Global Stability

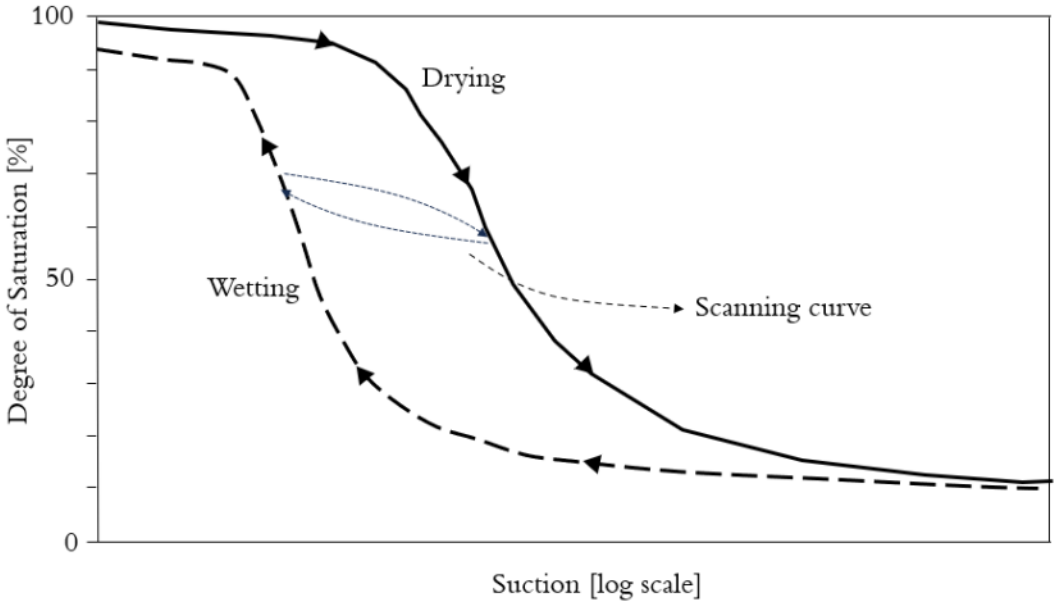
Pore pressure development during operation (1st and 2nd load step) Test Embankment Älvkarleby

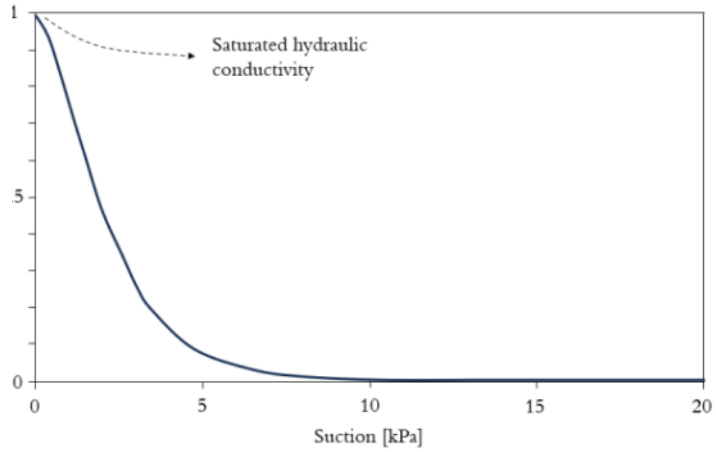




Global Stability

Changes in water content would have led to an inhomogeneus distribution of permeability





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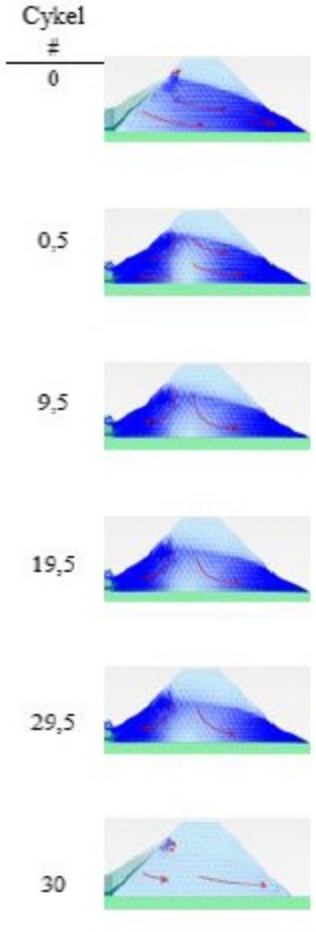
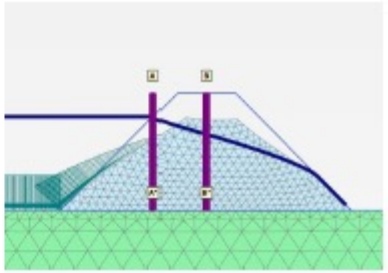
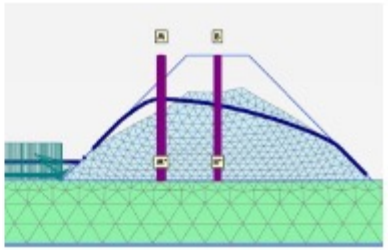
Make use of available monitoring to allow numerical models to reflect actual mechanism during cyclic loading interrupting the transition phase

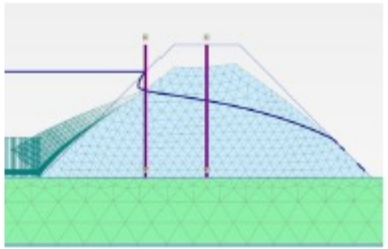
Study those influencing parameter in terms of dam safety

Encourage fully coupled models to be analysed



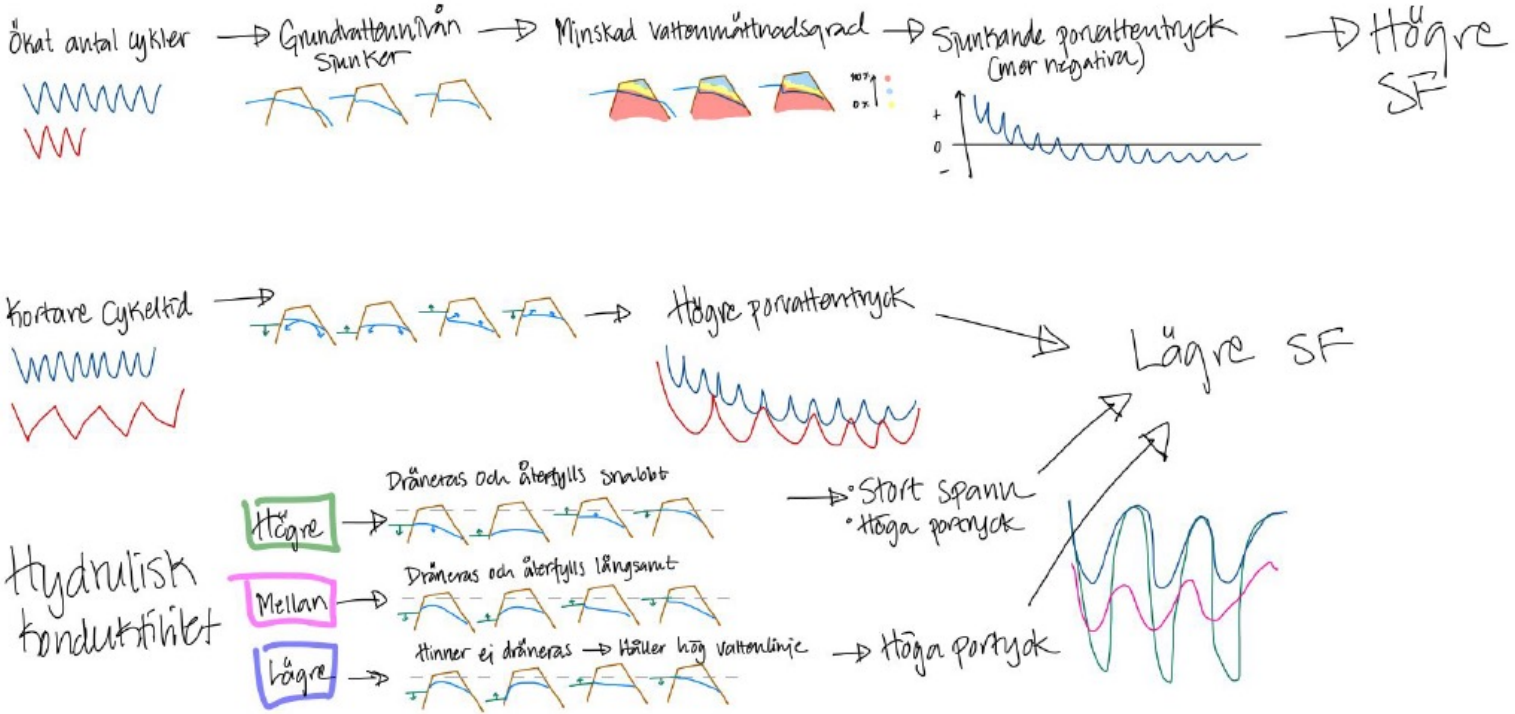






Post Doc Jasmina Toromanovic, MSc Emma Widen

Diskussion och slutsatser



MSc Emma Widen

Cyclic Loading

- Can be a factor increasing the risk of internal erosion
- Will effect global stability of embankment dams

- Needs to be considered also in natural slopes at the shore of lakes
- Needs to be considered when changing artificialy or naturally flow rates and levels of rivers

MSc Emma Widen

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Thank You

and do not forget the Arctic Conditions