Aalto University

DEM for Ice Mechanics Research at the Aalto University

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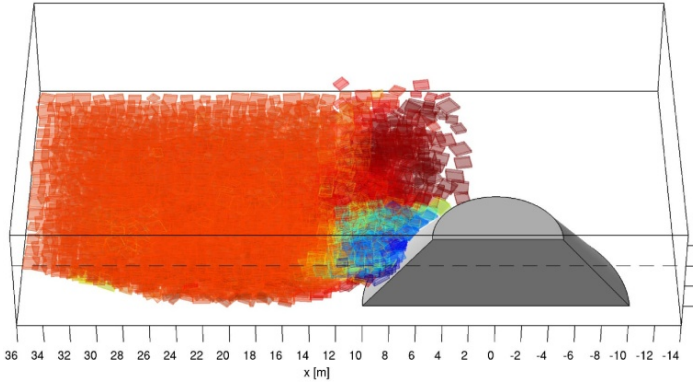
Discrete Approach for Ice Mechanics

Motto: Several problems in ice mechanics can be effectively studied by using a discrete approach, by modeling the failure process of ice.

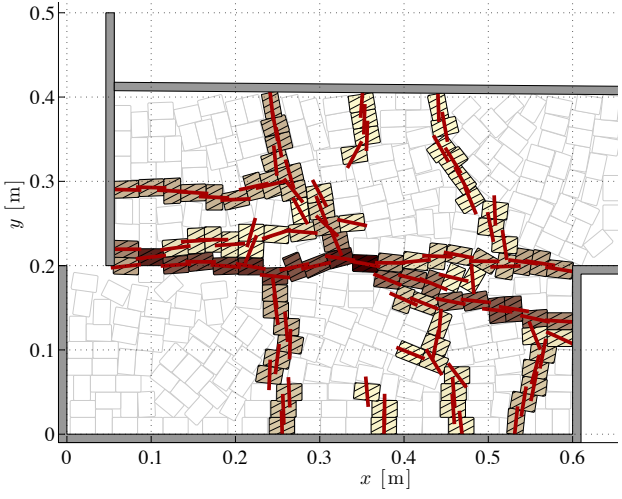
→ Development and use of DEM, the Discrete Element Method

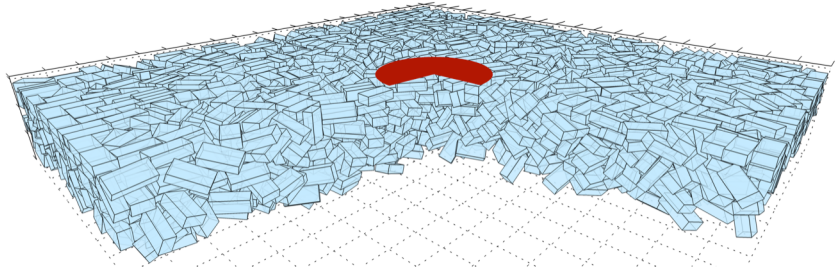


Ridges and Ridge Loads

Arttu Polojärvi
Jukka Tuhkuri

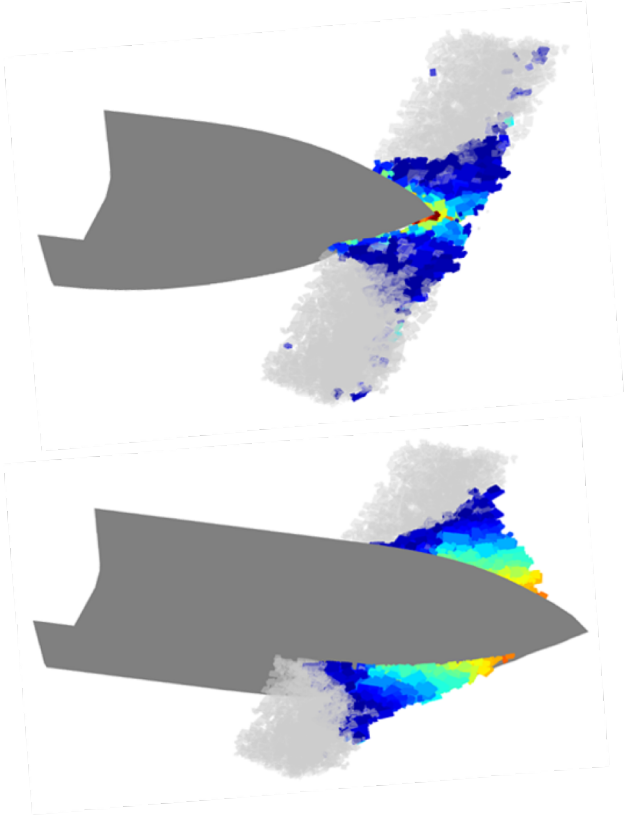
- Mechanical properties of unconsolidated ice rubble: DEM and lab tests
- Force-chains: DEM and lab tests
- Ridge keel freeze-bonds

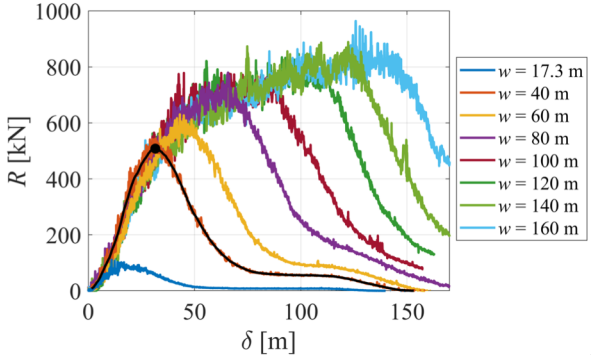


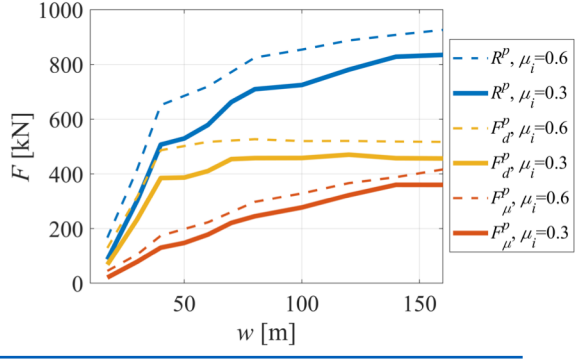


DEM & Ridge Resistance

Hanyang Gong
Arttu Polojärvi
Jukka Tuhkuri







Ice Sheet & Inclined Structure FEM-DEM

Jani Paavilainen
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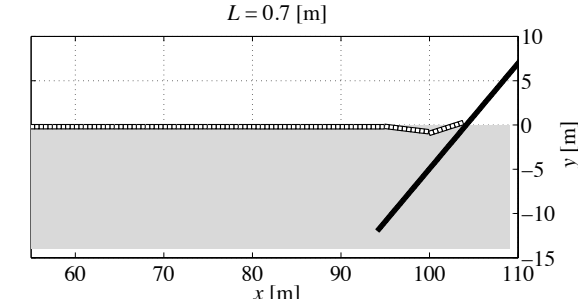
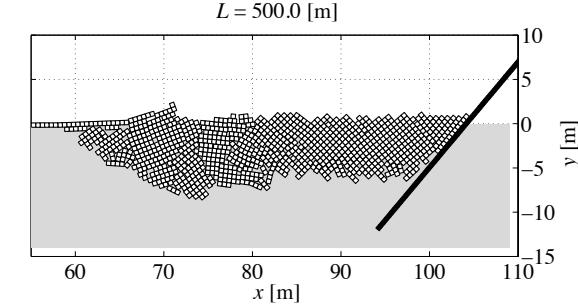
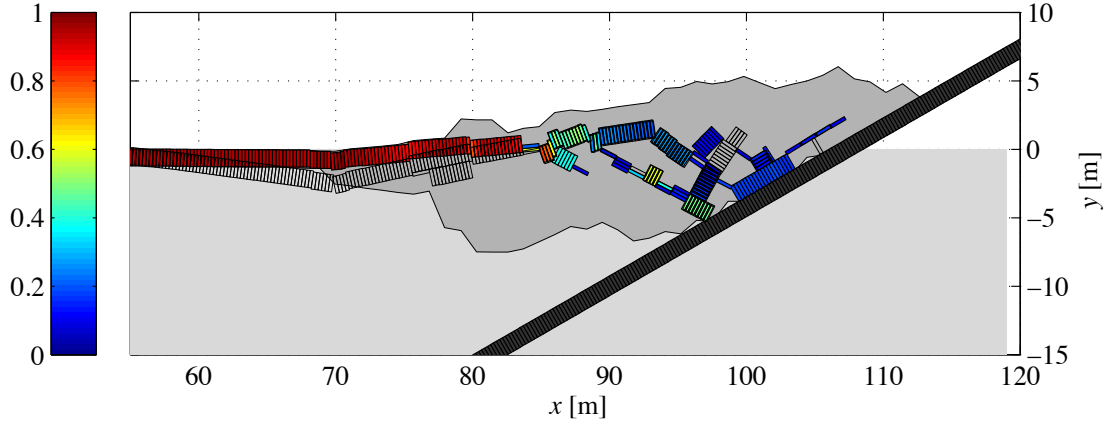
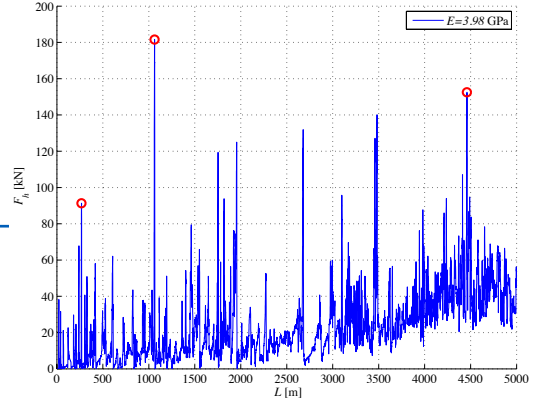
Jukka Tuhkuri

- Varied: Ice thickness, ice-ice friction, ice strength, etc
- Observed: pile-up, ride-up, shear, pile collapse, etc.
- Load appear random
- Load transmitted through the rubble by force chains which define the max ice load.



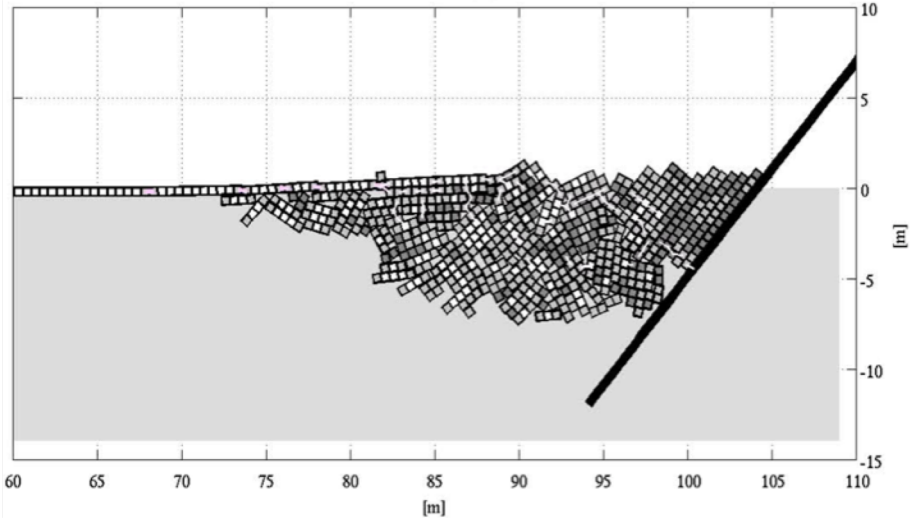




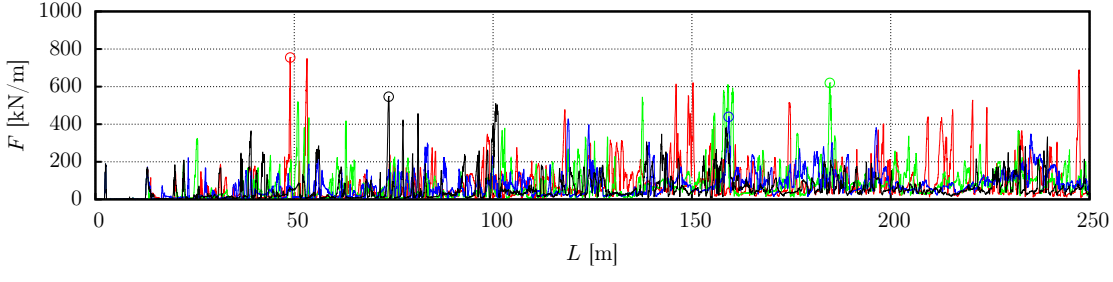


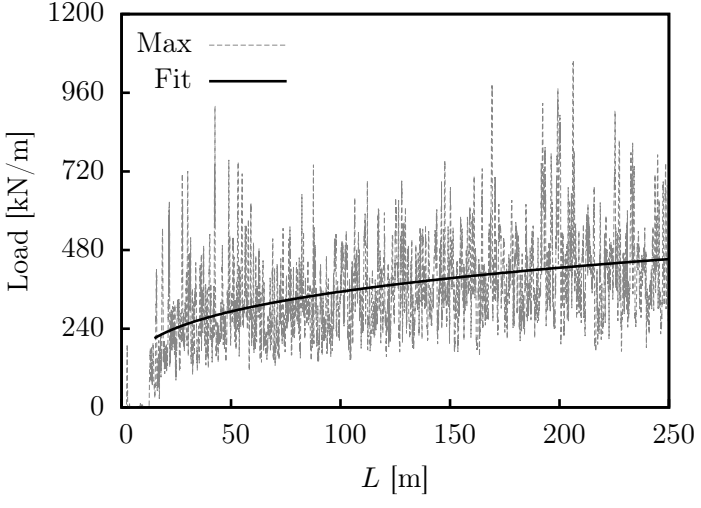
DEM & Ice Load Statistics

Janne Ranta
Arttu Polojärvi
Jukka Tuhkuri



- Simulations on ice-sheet failure are sensitive to initial conditions → Possibility to create data.
- The key parameter identified: h
- Ice load increase during the failure process.
- Peak load mechanisms identified.

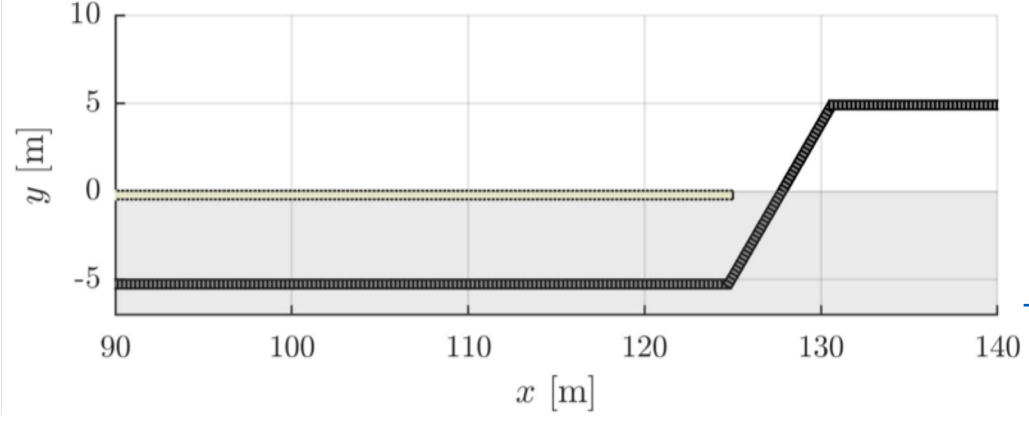


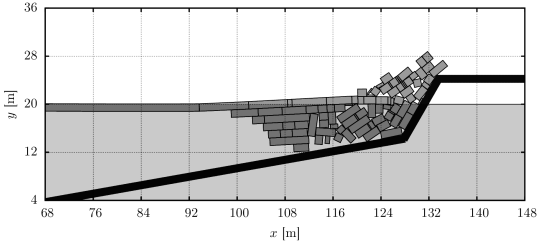


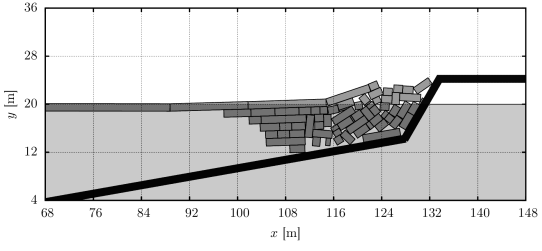
Ice-Loads on Structures in Shallow Water

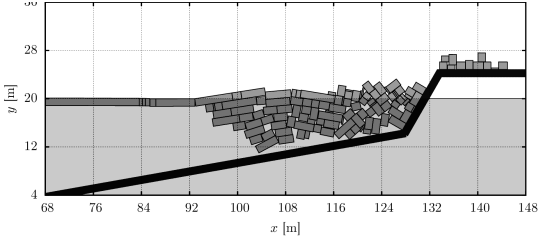
Ida Lemström
Arttu Polojärvi
Jukka Tuhkuri

- In shallow water ice rubble piles may ground.
- 2D FEM-DEM and experiments.
- Commonly assumed: grounding reduces ice loads.
- Simulations: grounding may increase the ice loads.









Beam-lattice Modeling of an Ice Sheet

Ville-Pekka Lilja
Arttu Polojärvi
Jukka Tuhkuri

- Modelling a 3D ice sheet using FEM with shell elements is too heavy.
- Solution: discrete elements and a beam lattice
- Drawback: size-dependency.
- Size-dependency of the model was studied and quantified successfully.
- Model was shown to be applicable for modelling plate on elastic foundation.