Name of research institute or organization:

Versuchsanstalt für Wasserbau, Hydrologie und Glaziologie, ETH Zentrum

Title of project:

Forecasting the time of breaking off of large ice masses from hanging glaciers

Project leader and team:

Antoine Pralong, Martin Funk, and Martin Lüthi

Project description:

The prediction of large ice falls from hanging glaciers can reduce loss of life and damage to settlements. A common predictive method is based on the regular acceleration observed on large ice masses prior to the collapse. The time of breaking-off was forecasted recently quite accurately on a hanging glacier located on the south face of Mönch (Valais, Switzerland). The velocity-time function measured on the unstable glacier during the months preceding the ice fall was extrapolated.
Continuum damage mechanics describes the progressive deterioration of material subjected to loading. Jointly used with a level set method, it proves to be a promising approach to compute the interface motion of a damaged material.
For polycrystalline ice, a local isotropic damage evolution law (generalized Kachanow's law) applied to Glen's flow law allows the description of tertiary creep and facilitates the modeling of crevasse opening using a failure criterion based on damage accumulation. The use of a level set method permits to describe in a continuum approach the motion of a fractured glacier surface.
Using these methods, a model is developed. The ability of this model to describe phenomena connected to crevasse opening is presented. Therefore, the rupture of a large ice block from a hanging glacier is computed and analyzed. The regular acceleration of such an unstable ice block prior to his collapse is calculated and compared to the acceleration function obtained from measurements on the Mönch hanging glacier. A good agreement between both acceleration functions was found.

We could demonstrate the capability of continuum damage mechanics and level set methods to compute crevasses openings in glaciers. It does not offer a rigorous validation, but focuses on the similarities observed in nature and computed with the model.

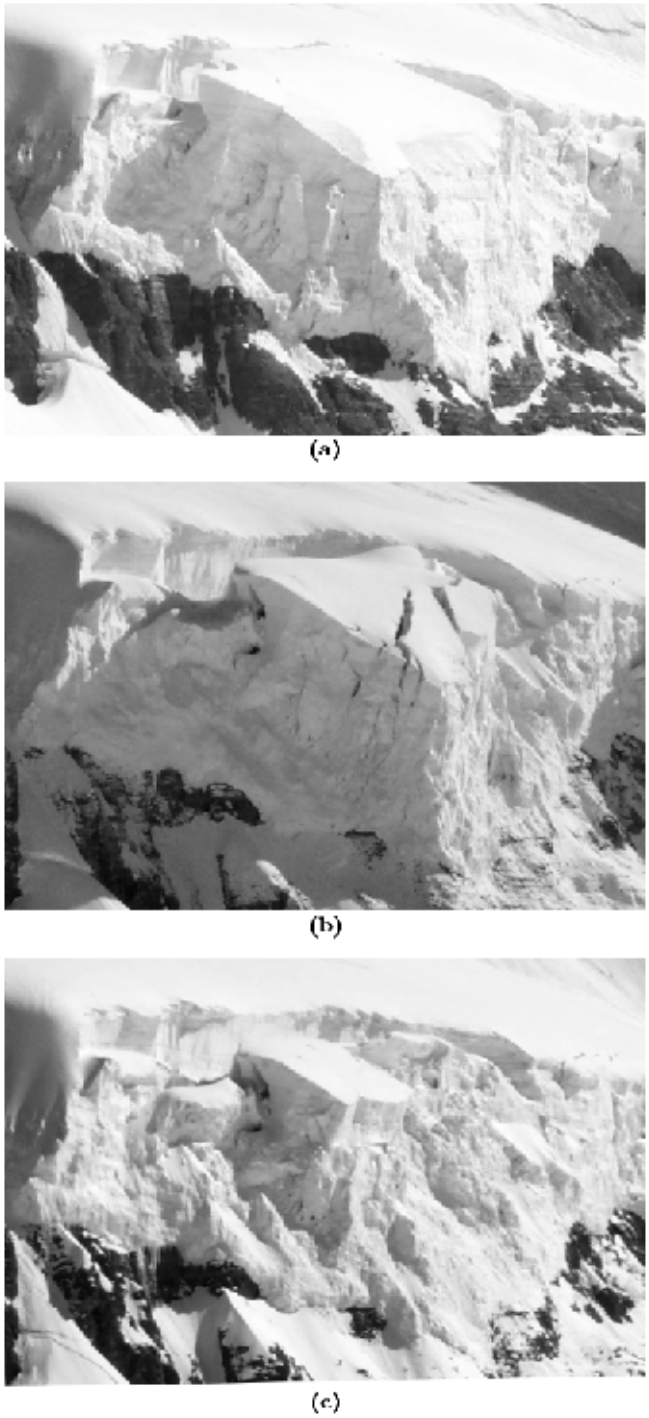

Figure 1
Evolution of an unstable ice chunk detached from a hanging glacier located at the south face of the Mönch (Bernese Alps, Switzerland). (a)~(9.06.2000) The large crevasse behind the ice block is well developed. (b)~(25.07.2000). Two secondary crevasses penetrate in the block (c)~(1.08.2000). The block is disintegrated due to the secondary crevasses.

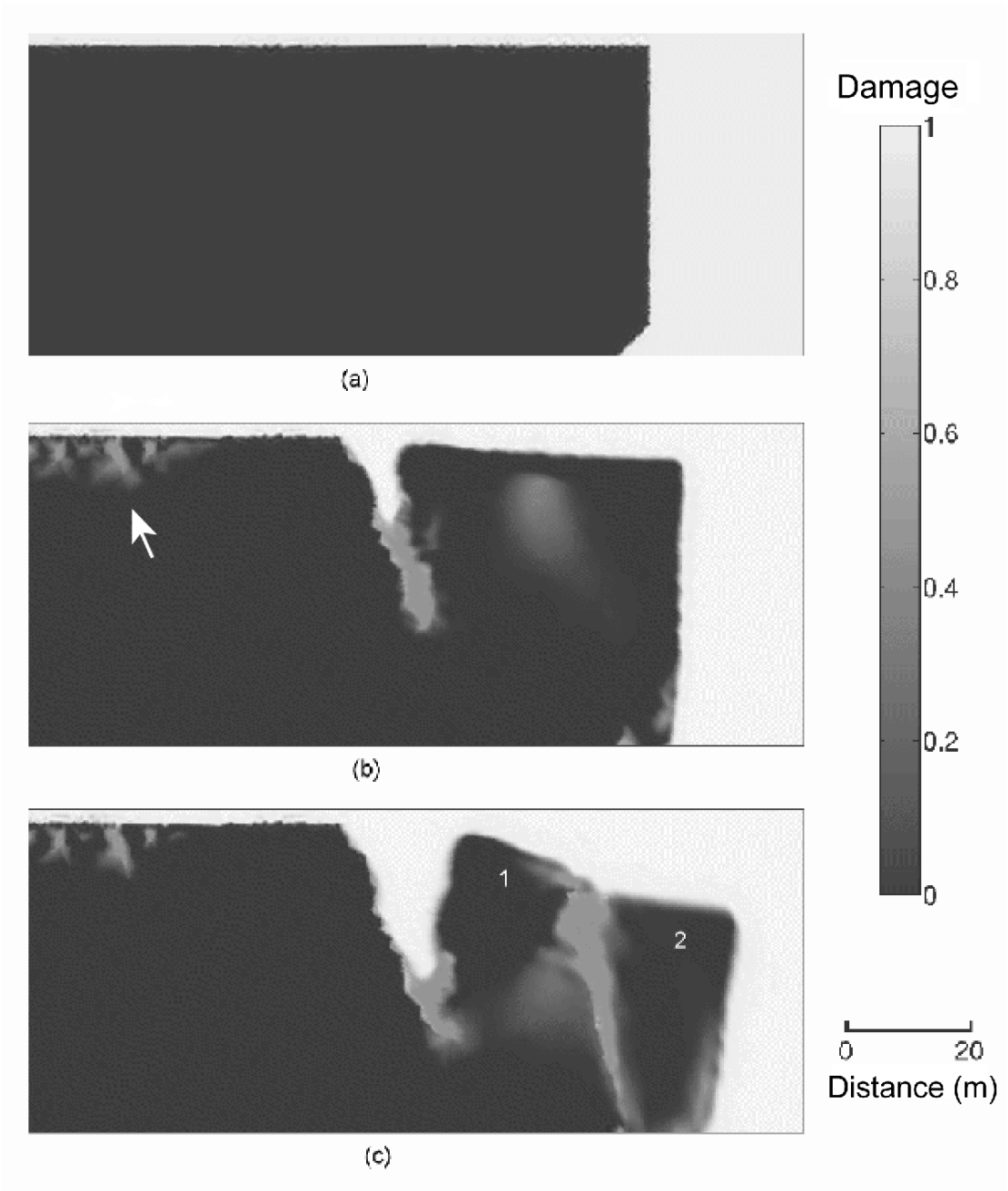

Figure 2
(a) Initial geometry of the ice block and global computational domain.
(b) Crevasse after 152 days. The arrow indicates the production of damage at the upstream side of the large crevasse.
(c) Unstable ice block before failure (199 days). Numbers 1 and 2 indicate the location of the points where velocities are discussed.

Key words:

Internet data bases:

Collaborating partners/networks:

Scientific publications and public outreach 2002:

Address:

Versuchsanstalt für Wasserbau
Hydrologie und Glaziologie
ETH Zentrum
CH-8092 Zürich
Switzerland

Contacts:

http://www.vaw.ethz.ch/