Geophysical Research Abstracts, Vol. 7, 08882, 2005
SRef-ID: 1607-7962/gra/EGU05-A-08882

Stress bridging around low-pressure subglacial channels

G. Lappegard

Department of Geosciences, University of Oslo, Norway, (gautelap@geo.uio.no)

Normal stress is recorded beneath Engabreen, northern Norway, where rock tunnels permit access to the ice/bedrock interface beneath the 210 m thick glacier. Eight vibrating-wire load cells are installed in the bedrock of the glacier sole along a 22 metre transect. The load cells have been logging at 15 minute intervals since 1993. Load cell signals reflect the normal stress of the basal ice on the bedrock. The measurements show the existence of stress bridging around low-pressure subglacial channels. These data contradict the commonly used assumption based on Nye's rigorous theory of creep closure of circular channels, where the free-slip boundary condition along the bed eliminates stress bridging. A 2-D finite element model (FEM) has been implemented to simulate the stress field around low-pressure subglacial channels. The model has been tested with different boundary conditions along the ice/bedrock interface. For a free-slip boundary condition the Nye solution with no stress bridging is achieved, whereas linear and non-linear sliding laws lead to stress bridging around the channel. The stress distribution away from the channel is strongly dependent on channel geometry (semi-circular, semi-elliptic and parabolic) as long as n=3, with largest values of stress bridging for parabolic channels, whereas the most far reaching stress bridging occurs for semi-circular channels. With n=1 the dependency on geometry vanishes.

Interpreted from the load cell measurements, closure rates seem to be at least one order of magnitude larger than those predicted by the Nye solution. By tuning the viscosity parameter B in Glens flow law, simulating softer basal ice, the FEM-model simulates closure rates close to those observed. The introduction of such a soft basal layer is motivated by the observation of dirty basal ice at Engabreen, where the thickness of the sediment rich layer varies from 0.2 m up to 2 m. The findings presented in this study are of importance for all models considering basal hydrology and basal deformation.

High normal stress concentrations along the channel wall will hinder basal melt water to enter the channel as long as the water pressure in the channel is low. The soft(dirty) basal ice layer will lead to higher basal creep rates.