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Near-surface flow in glaciers obeying Glen's law. (English) Zbl 0616.76007
Q. J. Mech. Appl. Math. 37, 273-291 (1984).

In determining the gravity-driven flow of a glacier or ice sheet which obeys Glen's flow law, previous methods have predicted infinite longitudinal stress at the glacier's surface. This physically unacceptable occurrence is due to a break-down in the mathematical methods used to obtain the solution. Using the method of matched asymptotic expansions, the solution valid in the near-surface region of a steady-state glacier is determined. The size of the near-surface or boundary-layer region is found to be of order $\delta \ln$, where $\delta = h_0/L$ is the assumed small ratio of the characteristic thickness and length of the ice sheet and n is the exponent in Glen's power law. The solution is obtained for ice sheets on both a steep and gentle base slope. The stress field in the near-surface region is obtained and we find that the boundary layer does not significantly affect the surface velocities or the glacier profile.

MSC:

[76A05](#) Non-Newtonian fluids
[86A60](#) Geological problems

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Keywords:

gravity-driven flow; Glen's flow law; infinite longitudinal stress; glacier's surface; method of matched asymptotic expansions; near-surface region; a steady-state glacier; boundary-layer region

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