

EXPERIMENTAL STUDIES ON THE DENSIFICATION RATE OF
WATER-SATURATED FIRN IN THE ACCUMULATION AREA OF
TEMPERATE GLACIERS (ABSTRACT)

Katsuhisa KAWASHIMA¹, Tomomi YAMADA² and Gorow WAKAHAMA²

¹*Railway Technical Research Institute, 8-38, Hikari-cho 2-chome, Kokubunji-shi, Tokyo 185*

²*Institute of Low Temperature Science, Hokkaido University, Kita-19, Nishi-8, Kita-ku,
Sapporo 060*

To clarify the densification rate of the water-saturated firn layer (firn aquifer), which is formed just above the firn-ice transition in temperate glaciers during the ablation period, compression tests under constant load of water-saturated firn were carried out. The overburden pressures were changed from 0.01 MPa to 0.2 MPa. The experimental results were compared with existing field data measured on temperate glaciers.

At each experiment, the following relationship was obtained: $\ln \dot{\rho} = k - 0.8 \ln t$, where $\dot{\rho}$ is the densification rate of firn ($\text{kg/m}^3/\text{s}$) at a dry density ρ (kg/m^3), t is the time (s) and k is the constant. Using this empirical equation, the time required for firn with dry density of 500 kg/m^3 to transform into ice ($\rho=830$) was calculated. Consequently, it is suggested that water-saturated firn can transform into ice within the ablation period (2-4 months) at a pressure above 0.1 MPa. The pressure of 0.1 MPa equals 20 m depth of firn with density of 500 kg/m^3 . This result is considered to correspond with the fact that depths of firn-ice transition in the accumulation area of temperate glaciers are concentrated between 17 m and 32 m.

Furthermore, a linear relation was found between the logarithm of strain rate of densification and the logarithm of pressure, and the slope of proportionality changed at a pressure around 0.1 MPa, showing that the densification rate of water-saturated firn increased markedly above 0.1 MPa. This may be one of the most important phenomena determining the depth of the firn-ice transition in temperate glaciers.

(Received March 5, 1992; Revised manuscript received April 20, 1992)