# Development of a New Numerical Model Coupling Flow and Human Motion for Assessment of Snow Avalanche Impact on a Human body

*Naoto Sakaki and Takashi Nakamura
Tokyo Institute of Technology

In many countries which have heavy snowfall, snow avalanches have been produced numerous victims. It has been suggested that the snow avalanche will occur more frequently in the recent future due to the ongoing global warming. Thus, science based risk assessment of the snow avalanche is being needed. While various numerical models have been proposed to assess a movement of snow avalanche on complex terrains, there are few researches considering the impact of snow avalanche affecting on a human body that can change the posture depending on the force from avalanche. In this work, toward the accurate evaluation of impact affecting on a human body when snow avalanche strikes to a human, a new numerical model has been developed.

In the model, while a three-dimensional motion of snow avalanche is modeled with a Bingham fluid [1], a human body is modeled with a link segment model [2]. In the solution of snow avalanche, a simple Cartesian mesh is used and the Constrained Interpolation Profile (CIP) scheme is applied. At each time step, continuous pressure distribution is solved by applying the Poisson equation over a whole computational domain. By integrating the pressure over a whole surface of human body, force affecting from the snow avalanche are estimated. In the solution of human body, we assume that a human body consists of ten rigid segments connected with nine joints. The motion and change of posture of human body are tracked by solving the equation of motion for all segments. In addition to the force from snow avalanche, forces affecting on joints are also estimated so that a connection of neighbor two segments is kept and angle of joint is limited in a certain range.

The developed model is applied to a snow avalanche over a simple slope and a strike to the standing human is calculated. By comparing with an experimental result [3], it is found that the model can calculate a motion of snow avalanche accurately. Furthermore, by comparing the calculated impact force with the solution in that the posture is fixed, it is found that the change of posture can have a large influence on the impact force from the snow avalanche.

**Reference:**

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Yeong-Bin Yang
Chao-An Lin
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Chuin-Shan (David) Chen

National Taiwan University