SNOW CORNICE DEVELOPMENT AND FAILURE MONITORING

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ABSTRACT: Snow cornices are significant winter alpine and snow avalanche hazards. A cornice is a leeward growing mass of snow overhanging from a ridge or sharp break in slope (perpendicular to the ridgeline) due to windblown snow (Seligman, 1936). A cornice's usual topographic position and cantilevered slab structure, regularly above large avalanche prone slopes, makes cornices crucial to consider from a risk perspective. Although cornices are extensively controlled in avalanche operations, they have been given little attention in science. Only basic work has been done on their formation, development, structure and control, with limited focus and geographic extent (Kobayashi, 1988, McCarty et al., 1986, McClung and Schaerer, 1993, Montagne et al., 1968). Although significant work has been done on snow slab fracture mechanics, no work has been done on cornice failure and fracture mechanics.

Three meteorologically-related triggers of cornice failure have been recognized: 1. Snow loading of the cornice overhang during storm and wind events; 2. abrupt temperature changes at the surfaces of the cornice due to a) abrupt warming or cooling air temperatures, b) rain-on-snow events, c) heating by solar radiation; and 3. seasonal warming/prolonged midwinter warm periods. Failure from snow loading results when newly fallen or wind-blown snow accumulates on the cornice overhang at a rate that induces stresses that exceed the strength/fracture toughness of the cornice. Creep fracture is thought to be the primary mechanism for failure of this type. Rain-on-snow events (and the concurrent abrupt warming) on dry snow slabs are shown to immediately increase the creep rate in the surface layer of the snow slab resulting in decreased slab stability (Conway, 1998). This immediate effect may similarly influence cornice stability, as well as the delayed time effects of increased loading from rainfall and weakening due to longer-term warming. Abrupt changes in air temperature alone are thought to be a trigger of dry snow slab avalanches (McClung, 1996). Further circumstantial and anecdotal evidence suggests that cooling and warming of the snow surface from abrupt changes in air temperature and heating from solar radiation initiate slab avalanches and cornice failures.

I intend to monitor the development, physical properties (dimensions/geometry, structure, densities), fracture, and failure of a study cornice along with meteorological parameters on a ridge near Kootenay Pass, BC during two winter seasons. Monitoring the three-dimensional time-lapse development of the cornice will be achieved using periodic photography and terrestrial photogrammetry methods (Eos Systems Inc., 2004). Deformation and temperature inside the cornice will be measured using glide shoe-type instrument packages (Conway, 1998). These measurements will include linear displacement, tilt, and snow temperature. A nearby weather station will monitor air temperature, relative humidity, wind, snow depth, and radiation. The goal is to develop a numerical model based on these data in order to quantify and predict cornice deformation and failure.

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