# HR-361 Development of a Model for Ice Scraping Forces

**Key Words: Ice Scraping, Winter Maintenance, Plow Blades, Scraping Forces**

## ABSTRACT

A laboratory study has been conducted with two aims in mind. The first goal was to develop a description of how a cutting edge scrapes ice from the road surface. The second goal was to investigate the extent, if any, to which serrated blades were better than un-serrated or "classical" blades at ice removal.

The tests were conducted in the Ice Research Laboratory at the Iowa Institute of Hydraulic Research of the University of Iowa. A specialized testing machine, with a hydraulic ram capable of attaining scraping velocities of up to 30 m.p.h. was used in the testing.

In order to determine the ice scraping process, the effects of scraping velocity, ice thickness, and blade geometry on the ice scraping forces were determined. Higher ice thickness lead to greater ice chipping (as opposed to pulverization at lower thicknesses) and thus lower loads. Similar behavior was observed at higher velocities. The study of blade geometry included the effect of rake angle, clearance angle, and flat width. The latter were found to be particularly important in developing a clear picture of the scraping process. As clearance angle decreases and flat width increases, the scraping loads show a marked increase, due to the need to re-compress pulverized ice fragments.

The effect of serrations was to decrease the scraping forces. However, for the coarsest serrated blades (with the widest teeth and gaps) the quantity of ice removed was significantly less than for a classical blade. Finer serrations appear to be able to match the ice removal of classical blades at lower scraping loads. Thus, one of the recommendations of this study is to examine the use of serrated blades in the field. Preliminary work (by Nixon and Potter, 1996) suggests such work will be fruitful.

A second and perhaps more challenging result of the study is that chipping of ice is more preferable to pulverization of the ice. How such chipping can be forced to occur is at present an open question.