

Workplace Health and Safety Bulletin



Travelling, Standing and Working on Ice Requires Caution

Given Alberta's climate, it is not unusual for work to progress because of, or in spite of, cold temperatures. Ice sheets that grow on lakes, ponds, and rivers can become ice roads, ice bridges, and construction platforms. Knowing when the ice is thick enough for these purposes is very important.

The strength of an ice sheet depends on several factors including its thickness, the presence of cracks, whether the ice is clear or white (sometimes called "snow ice", the white colour is due to trapped air bubbles), and the air temperature over the previous several days. Further, ice formed over moving water may be thinner than ice formed over calm or non-moving water, meaning that ice thickness needs to be assessed before work on it begins.

Calculating effective ice thickness

The load bearing strength of clear, blue ice is easily assessed by measuring its thickness. However, white or "snow ice" includes trapped air bubbles that reduce its load bearing strength. To compensate for this reduction in strength, an effective strength of the full thickness layer of ice needs to be determined. If white ice makes up part of the total ice thickness, it should be counted only as half as much clear ice.



The formula for calculating total effective ice thickness is:

$$(0.5 \times T_{\text{WHITE}}) + T_{\text{CLEAR}} = T_{\text{EFFECTIVE}}$$

where T is the thickness of the respective ice layers.

Example: A worker measures the ice on a pond as being made up of 300 mm of white ice on top of 400 mm of clear ice. The white ice should only be considered equal to 150 mm of clear ice. Therefore this ice sheet (150 mm equivalent clear ice plus 400 mm actual clear ice) is equal in load bearing capacity to a 550 mm thick cover of clear ice.

If water lies between layers of ice, only the depth of the top layer of ice should be used in the calculation.

Temperature variations

Daily air temperatures must be constant over a given period so that ice thickness will withstand the permissible loads as outlined in Tables 1 and 2.

When ice is

- less than 500 millimetres thick, the air temperature should have been constant for the three days prior to loading,
- between 500 and 1000 millimetres thick, the air temperature should have been constant for the four days prior to loading, and
- more than 1000 millimetres thick, the air temperature should have been constant for the five days prior to loading.

During a sudden drop in temperature and for three to five days following such a drop, the minimum ice thickness should be adjusted as shown below. If the temperature drop is excessive, severe thermal stressing or cracking of the ice will require caution and temporary load restrictions.

If the temperature drop is

- 5 degrees Celsius or less — multiply the minimum ice thickness by a factor of 1.4
- 5 to 10 degrees Celsius — multiply the minimum ice thickness by a factor of 2.0
- 10 degrees Celsius or more — multiply the minimum ice thickness by a factor of 2.4

Table 1 Effective Ice thickness for moving loads

Note: This table does not apply to parked loads, or where ice cracks are present.
 This table is intended to provide guidance only.

Permissible load (clear, blue ice)	Effective ice thickness in millimetres	
	Lake	River
One person on foot	50	60
Group, in single file	80	90
Passenger car 2000 kilograms	180	210
Light truck 2500 kilograms	200	230
Medium truck 3500 kilograms	260	300
Heavy truck 7000 to 8000 kilograms	350	410
10,000 kilograms	380	440
25,000 kilograms	630	730
45,000 kilograms	800	920
70,000 kilograms	1000	1150
110,000 kilograms	1250	1440

Table 2 Effective ice thickness for stationary loads

Note: This table applies to loads that will be stationary on ice for more than two
 hours. This table is intended to provide guidance only.

Permissible load (clear, blue ice)	Effective ice thickness in millimetres	
	Lake	River
1,000 kilograms	200	230
2,000 kilograms	300	350
4,000 kilograms	450	520
8,000 kilograms	600	690
25,000 kilograms	1100	1270
45,000 kilograms	1500	1730
70,000 kilograms	1800	2070
110,000 kilograms	2300	2650

Under thawing temperatures where the average air temperature exceeds 0 degrees Celsius, increase the required ice thickness given in the tables by 20 percent or reduce the allowable weight by one-third.

Additional precautions

Continuous use areas

Construction of flooded areas for ice crossings, parking areas or bridge erection requires daily measurement of ice thickness, air temperature and ice cracks. Currents beneath the ice can wear away the ice, reducing its thickness.

Vehicle speed

Vehicle speed should be reduced as ice thickness and water depth decrease. Water pressure waves created beneath the ice by moving vehicles can affect the strength of the ice.

Vehicle speeds should be less than 30 kilometres per hour for safe passage on ice having the thicknesses shown in Table 1, over water having a depth of less than 15 metres. Vehicle speeds should be less than 15 kilometres per hour when approaching shore or travelling parallel and close to shore.

Heavy lifts

Weight distributing mats should be used to increase the load bearing surface area on ice to support crawler tracks and outrigger pads when using mobile cranes to hoist heavy loads.

Other precautions when travelling on lakes

The following precautions should be followed when travelling on lakes:

- When travelling in convoy, the distance between vehicles should be approximately 100 times the applicable minimum ice thickness shown in Table 1. At thicknesses greater than the minimum ice thickness, this spacing can be reduced.

- There should be an accompanying vehicle when travel is in isolated areas and over great distances.
- Continuous travel will fatigue ice and cause failure. Ice roads should be changed frequently.

Other precautions when travelling on rivers

The following precautions should be followed when travelling on rivers:

- Ice bridges should be located where channels are narrowest and deepest. Shallow water and sand bars should be avoided.
- Ice bridges installed for the full winter season should be given a 100 millimetre thickness flood once a month.

Additional information

 www.crrel.usace.army.mil/ierd/tectran/ieieb13.pdf
Safe Loads on Ice Sheets

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