Ice Characteristics

New ice is usually stronger than old ice. Ice grows strongest and thickest during its formation. As ice decays, it can maintain its thickness, but still be unsafe. Decaying ice does not melt into a thin sheet, instead, the bond between the ice crystals decays or **candles** the ice into a dangerous porous condition. Ice at this stage can take on a black appearance as it absorbs water.

Weather is a key factor in ice formation and strength and also in its deterioration. A light wind speeds up ice formation, while a heavy wind slows it down, keeping holes open and forcing water beneath the edge of the ice, causing it to rot from below.

Snow acts in different ways. Snow first insulates strong ice and prevents it from melting, but can also insulate the surface against freezing, causing ice to form slowly or to deteriorate. Because of its weight, snow can depress the sheet of ice and reduce the capacity of weight it can bare. Snow also covers danger signs that mark hazardous areas.

Beware of slush and water. Slush is caused by rain, warmer temperatures, or by water rising through the cracks in ice. It is a sign that the ice is no longer freezing from below, as slush freezes from the top down. Standing water on top of ice erodes it, and dangerous vertical fractures occur as water percolates through the ice.

Daily temperatures and sunlight affect ice strength. When air temperatures stay below 0°C (32°F), ice is much stronger. Warmer temperatures weaken ice, causing melting, shifting, and contraction. Sunlight deteriorates the ice from below as it reflects off of sand or rock substrate on the bottom.

Changing air temperatures cause thermal expansion. This expansion of the ice causes cracks and pressure ridges. Generally, cracks in the ice refreeze to a strength similar to that of the original ice, however, wet cracks reach through to the water level, and can be hazardous. Dangerous soft ice often occurs near pressure ridges. Thermal expansion also causes the booming noises hear in ice on cold days as the ice expands and changes shape with the temperature.

The depth and size of a body of water affect the ice strength. Large, deep lakes take longer to freeze, but decay more slowly. Large lakes such as the Great Lakes may remain open due to wind, waves, and currents.

Ice closer to the shore is weaker. Shifting, expansion, and sunlight reflected from the bottom causes buckling and continual thawing and refreezing.

River ice is 15% weaker than lake ice due to the current. Currents and water velocity affect the strength of ice over moving streams. Smooth, straight stretches of ice are stronger than river bends, as the current is slower.

Water chemistry is an important factor in determining ice strength. Pure water freezes faster and deeper than water containing chemicals and pollutants. Pollutants concentrate along the boundaries of ice crystals as they form, causing porous, vertical streaks or **candling**.

Fluctuating water levels can weaken ice. Lower water levels weaken ice because the ice sheet lacks the support of water underneath it; this ice will stress and crack. Rain, seepage from wet cracks, and dam release all cause weak ice.

Obstructions affect the strength of ice. Rocks, logs, vegetation, and pilings give off heat and cause slow ice formation. Ice shifting and expansion create pressure cracks and ridges around the obstructions. Decomposing vegetation generates heat, hindering ice formation.

Underground springs weaken ice formation. Upwelling of warm water heats the surface and prevents ice formation. Spring-weakened ice may be camouflaged by snow.

Water fowl and schools of fish can prevent ice from forming. Movement causes vertical circulation, leading to the formation of thin spots of ice.

Ice Safety

The only absolute in ice safety is to stay off of the ice. A complete knowledge of ice formation, types of ice, and factors that affect strength can guide rescuers to effectively judge how to rescue an ice accident victim. The Minnesota Department of Natural Resources recommends the following minimum ice thicknesses (please note these estimates are for new, clear ice only). Refer to Appendix A for a useful chart regarding ice thickness and its suitability for vehicles.

2" or less
STAY OFF!!
5 Inches
Snowmobile or ATV
4 Inches
Ice Fishing
8 - 12 Inches
Car or Small Pickup
12 - 15 Inches
Medium Truck

Vehicles on Ice

Anyone travelling on ice should be aware of its inherent dangers. A light truck parked on a 12 inch thickness of ice depresses it 2-2.5 inches around it for approximately 200 feet. My moving a vehicle across the ice, it will bend up and down, forming long waves that roll out and away from a vehicle. The movement also creates a wave in front of the vehicle, which can create pressure ridge cracks if the vehicle is moving at the applicable **critical speed**.

Take different routes, and allow plenty of space between vehicles. A vehicle following closely behind another will interrupt the wave actions created by the first, causing cracks in the ice. Repeated use of the same path will increasingly weaken the ice. Extra caution should be used at night or during heavy snowfall when vision is impaired, as these conditions can obscure the thin ice or open holes.

There are several safety precautions to be followed when driving on ice.

- Drive with windows open
- Drive with seatbelt unbuckled
- Wear a personal flotation device (PFD) if possible
- Keep clothing zipped for added warmth and insulation
- Have a plan of escape in case the vehicle becomes submerged

If the vehicles plunges through the ice, quick action must be taken. Most vehicles can float for 30-45 seconds, but once it starts to sink the doors will be impossible to open. If no other escape route is possible, it may be necessary to force the front or rear window out of the frame by pressing against the corner of the window with feet or shoulder. If the above safety precautions have been taken, the best escape from a sinking vehicle is from the open windows. A vehicle will normally descend engine first and come to rest with the engine buried or upside down with the top buried.

Ice Monitoring

Local agencies monitor ice conditions of many bodies of water which sustain commercial or recreational winter activities. The US Coast Guard monitors conditions on the Great lakes to inform commercial boating traffic. Other smaller bodies of water are often monitored by city, county, and state parks or by the US Army Corp. of Engineers. There is valuable information available to ice recuers via these agencies, be sure to check with local park or Coast Guard authorities.