

FROST HEAVE & FROST BOILS

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SUBJECT:	Frost Heaves/Boils

Frost action is a detriment to the roadways in North Dakota. Frost heaving occurs in roadways that contain subgrade materials that are susceptible to frost. Typically, roadways with embankment consisting of silty clay or silty material are most susceptible. For frost heaving to occur the materials underneath the roadway need a source of water. As the subgrade freezes, the frost action pulls water from the water table, up through the frost susceptible soil via capillary action, to the frost line. These frost lenses cause the soil heave upward resulting in movement of the materials above.

Frost Heave

In the winter months, roadways may experience differential movement. This occurs when adjacent soils have different frost heaving characteristics. Abrupt soil changes can lead to areas where one soil undergoes frost heaving and the other soil does not. When this happens, bumps or even abrupt cracking can form in the pavement. Frost heaving occurs most commonly on NDDOT roadways at cut/fill transitions or at culvert installations.

Frost Boil

As the frost comes out of the ground the ice lenses begin to melt from the top down, leaving a frost layer of frozen soil below the thawing line for a period of time. This frozen layer below the thawing line does not allow water to drain out of the subgrade and leads to a period when the base and subgrade is saturated and in a highly weakened state. As traffic travels over the roadway the surface becomes damaged due to insufficient support from the underlying materials. This phenomenon is typically referred to as a frost boil. As the base and subgrade drain the moisture after the subgrade has completely thawed, the base and subgrade will eventually come back to a state that can handle the traffic loads.

Frost action occurs on a yearly basis in North Dakota. This spring there has been a unusually high amount of spring roadway damage. The fall flooding that had been experienced could have negatively affected the roadways ability to resist the detrimental effects of frost in the following ways

1. The significant amount of moisture in the fall raised the elevation of the water table enough that the frost heaving action could occur in locations that were not usually susceptible to frost heaving. (The higher water table became close enough to the frost line that frost heaving could occur when on most years the distance from frost line to water table is too great).
2. The fall flooding increased the in-situ moisture content of the existing roadway embankments to a level much higher than at which they typically enter winter. Then as frost heaving occurs in the winter even more moisture is pulled into the embankment. Thus leading to an even higher than normal level of oversaturation during the spring thaw period.