

Frost and Permafrost Definitions

The following list of terms used in current literature on Frost and Permafrost has been prepared and approved by the Highway Research Board Committee on Frost Heave and Frost Action in Soil. Special credit is due Frank Hennior, chairman of the subcommittee which prepared the list for approval by the main committee.

GENERAL

Arctic. The northern region in which the mean temperature for the warmest month is less than 50 F. and the mean annual temperature is below 32 F. In general, arctic land areas coincide with the tundra region north of the limit of trees.

Subarctic. The region adjacent to the Arctic in which the mean temperature for the coldest month is below 32 F., the mean temperature for the warmest month is above 50 F., and where there are less than four months having a mean temperature above 50 F. In general, subarctic land areas coincide with the circumpolar belt of dominant coniferous forest.

Break-up period. The period of the spring thaw during which the ground surface is excessively wet and soft, and ice is disappearing from streams and lakes. Duration of the break-up period varies from one to six weeks, depending on regional and local climatic conditions.

Freeze-up period. The period during which the ground surface freezes, and during which ice cover is forming on streams and lakes. The duration of the freeze-up period varies from one to three months, depending on regional and local climatic conditions.

Frost-melting period. An interval of the year during which the ice in the foundation materials is returning to a liquid state. It ends when all the ice in the ground has melted or when freezing is resumed. Although in the generalized case there is visualized only one frost melting period, beginning during the general rise of air temperatures in the spring, one or more significant frost melting intervals may occur during a winter season.

Normal period. The time of the year when there is no reduction in strength of foundation materials due to frost action.

Period of weakening. An interval of the year which starts at the beginning of the frost-melting period and ends when the subgrade has begun to regain its strength.

SOIL-AND-FROST

Permafrost. Perennially frozen ground.

Suprapermafrost. The entire layer of ground above the permafrost table.

Permafrost table. An irregular surface which represents the upper limit of permafrost.

Annual frost zone. The top layer of ground subject to annual freezing and thawing. In arctic and subarctic regions where annual freezing penetrates to the permafrost table, suprapermafrost and the annual frost zone are identical. (Sometimes referred to as active layer or active zone).

Residual thaw zone. A layer of unfrozen ground between the permafrost and the annual frost zone. This layer does not exist where annual frost extends to permafrost.

Frost action. A general term for freezing and thawing of moisture in materials and the resultant effects on these materials and on structures of which they are part or with which they are in contact.

Frost thrust. A lateral displacement due to frost action.

Frost heave. The raising of a surface due to the formation of ice in the underlying soil.

Percent heave. The ratio, expressed as a percentage, of the amount of heave to the depth of frozen soil before freezing.

Frost boil. The breaking of a localized section of a highway or airfield pavement under traffic and ejection of subgrade soil in a soft and soupy condition caused by the melting of the segregated ice formed by frost action.

Frost-susceptible soil. Soil in which significant (detrimental) ice segregation will occur when the requisite moisture and freezing conditions are present.

Non-frost susceptible materials. Cohesionless materials; such as, crushed rock, gravel, sand, slag and cinders in which significant (detrimental) ice segregation does not occur under normal freezing conditions.

Homogeneously frozen soil. A soil in which water is frozen within the material voids without macroscopic segregation of ice.

Heterogeneously frozen soil. A soil in which a part of the water is frozen in the form of macroscopic ice occupying a space in excess of the original voids in the soil.

Ice segregation. The growth of ice as distinct lenses, layers, veins and masses in soils commonly, but not always, oriented normal to the direction of heat loss.

Ice wedge. A vertical wedge-shaped ice mass in permafrost usually associated with fissure polygons.

Ice lenses. Ice formations in soil occurring essentially parallel to each other, generally normal to the direction of heat loss, and commonly in repeated layers.

Ice content. The ratio, expressed as a percentage, of the weight of ice phase to the dry weight of soil.

Tangential adfreezing strength. Unit bond strength between frozen ground or ice and another material.

Pavement pumping. The ejection of water and subgrade soil through joints, cracks, and along edges of pavements caused by downward slab movement actuated by the passage of heavy axle load over the pavement after the accumulation of free water on the subgrade.

Open system. A condition in which free water in excess of that contained originally in the voids of the soil is available to be moved to the surface of freezing, to form segregated ice in frost-susceptible soil.

Closed system. A condition in which no source of free water is available during the freezing process beyond that contained originally in the voids of soil.

TEMPERATURE

Average daily temperature. The average of the maximum and minimum temperatures for one day or the average of several temperature readings taken at equal time intervals during one day, generally hourly.

Mean daily temperature. The average of the average daily temperatures for a given day for several years.

Average monthly temperature. The average of the average daily temperatures for a particular month.

Mean monthly temperature. The average of the average monthly temperatures for a given month for several years.

Average annual temperature. The average of the average daily temperature for a particular year.

Mean annual temperature. The average of the average annual temperatures for several years.

Degree-day. The degree-days for any one day equal the difference between the average daily air temperature and 32 F. The degree-days are minus when the average daily temperature is below 32 F. (freezing degree-days) and plus when above (thawing degree-days).

Degree-hour. A variation of one degree Fahrenheit from 32 F. for a period of one hour. The degree-hour is negative if below 32 F. and positive if above 32 F.

Freezing season. That period of time during which the average daily temperature is generally below 32 F.

Thawing season. That period of time during which the average daily temperature is generally above 32 F. Note: The definitions for "freezing season" and "thawing season" are applicable to conditions in arctic and subarctic regions where frequent oscillations about the freezing point are uncommon.

Freezing index. The number of degree-days between the highest and lowest points on a curve of cumulative degree-days versus time for one freezing season. It is used as a

measure of the combined duration and magnitude of below-freezing temperatures occurring during any given freezing season. The index determined for air temperatures at 4.5 feet above the ground is commonly designated as the air freezing index, while that determined for temperatures immediately below a surface is known as the surface freezing index.

Mean freezing index. The freezing index determined on the basis of mean temperatures. The period of record over which temperatures are averaged is usually a minimum of 10 years and preferably 30.

Thawing index. The number of degree days between the lowest and highest points on the curve for cumulative degree-days versus time for one thawing season. It is used as a measure of the combined duration and magnitude of above-freezing temperatures occurring during any given thawing season. The index determined for air temperatures at 4.5 feet above the ground is commonly designated as the air thawing index, while that determined for temperatures immediately below a surface is known as the surface thawing index.

Mean thawing index. The thawing index determined on the basis of mean temperatures.

Correction factor. The ratio between the surface index and air index for either freezing or thawing.

HEAT TRANSFER

Thermal regime. The temperature pattern existing in a body.

Thermal conductivity. The time rate of heat flow through unit area of a substance under a unit temperature gradient. Common units are Btu per hour per square foot per degree F. per inch or foot of thickness.

Thermal resistivity. The reciprocal of thermal conductivity.

Thermal conductance. The time rate of heat flow through a substance for an area of 1 square foot and a difference of temperature of 1 F. between surfaces.

Thermal resistance. The reciprocal of thermal conductance.

Volumetric heat capacity. The number of Btu. necessary to raise the temperature of 1 cubic foot of a material 1 F.

For dry soils it is cd ; for wet soils it is $d(c+1.0 \frac{w}{100})$,

and for wet, frozen soils it is $d(c+0.5 \frac{w}{100})$,

where c = specific heat of the dry material

d = dry density of a soil in lb. per cu. ft.

and w = water content of a soil in percent of dry weight.

Diffusivity. An index of the facility with which a material will undergo temperature change. It is numerically equal to the quotient of the thermal conductivity and the volumetric heat. The diffusivity of a soil is increased by freezing, by an increase of moisture, and by an increase in density.

Latent heat of fusion. The number of Btu. necessary to melt one pound of ice without a change in temperature.

Volumetric latent heat of fusion. The number of Btu. necessary to melt the ice in 1 cubic foot of soil without a change in temperature.

Specific heat of soil. The number of Btu. necessary to raise the temperature of one pound of dry soil 1 F.

TERRAIN

Patterned ground. A general term describing ground patterns resulting from frost action such as soil polygons, stone polygons, stone circles, stone stripes, and solifluction stripes. The most common type of soil polygon is known as a fissure polygon.

Creep. Extremely slow downslope movement of superficial soil or rock debris usually imperceptible except to observation of long duration.

Solifluction. The perceptible slow downslope flow of saturated non-frozen soil over a base of impervious or frozen material. Movement occurs primarily when melting of segregated ice or infiltration of surface runoff results in concentration of excess water

in the surface soils.

Frost mound. A localized upwarp of land surface caused by frost action or hydrostatic pressure.

Pingo (hydrolaccolith). A large frost mound not uncommonly a hundred feet high or more containing a core of ice.

Icing. A surface ice mass formed by freezing of successive sheets of water.

Tundra. A treeless region of grasses and shrubs characteristic of the Arctic.

Muskeg. A shallow, poorly drained, peat-filled depression supporting bog vegetation.