I.3. INFLUENCE OF SURFACE CONDITIONS ON GROUND TEMPERATURES

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(Summary)*

In 1960, a parking lot on the grounds of the National Research Council, Ottawa, Canada was abandoned and a new one constructed nearby. This provided an opportunity to compare temperatures under two non-vegetated surfaces, one snow-covered in winter and the other cleared of snow, with temperatures under a grassed surface about 100 feet away. The temperatures under the grassed surface had been observed since 1957. Temperature measuring probes similar to that at the grassed site, were installed at the centre of each of the two parking lots.

The observations demonstrated the influence of two factors on the difference between average air and corresponding ground surface temperatures - snow cover and size of the convective component. The major source of heat at the earth's surface is solar radiation. This heat is dissipated by conduction into the ground, radiation, water vapour transfer and convection. In general, the smaller the water vapour transfer for given absorbed solar radiation, the larger the convective loss and the higher must be the surface temperature relative to the air temperature. It was observed that in summer the monthly average surface temperature at the grassed site was within 3°F of the monthly average air temperature, whereas the monthly average parking lot surface temperatures were up to 14°F warmer than the corresponding air temperature.

Snow cover provides an insulating blanket in winter. The monthly average surface temperature of the snow-covered parking lot and grassed site was relatively constant during this period and about 18°F warmer than the minimum monthly average air temperature. The monthly average surface temperature at the cleared parking lot was about equal to the corresponding average air temperature. Average snow depth at time of maximum was about 20 inches during the winters of 1961-62 and 1962-63.

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*The full paper will be published in the Canadian Geotechnical Journal.

The annual average surface temperature for the cleared site was about equal to that for the grassed site, indicating that in this case the increase in the surface temperature of the parking lot in summer due to lack of vegetation was about equal to the decrease in winter due to lack of snow. Both annual average surface temperatures were between 4.5 and 6.5 °F warmer than the annual average air temperature. Snow cover on the second parking lot caused its annual average surface temperature to be about 2°F warmer than at the other two sites. Changes with time in the annual average surface temperature, particularly that of the parking lot cleared of snow, closely followed those in the annual average air temperature.

Snow cover was not allowed to accumulate immediately on the abandoned parking lot. The observations showed that when it was allowed to accumulate naturally, it was responsible for increasing the annual average ground temperature at the 20 foot depth by about 0.6 °F in a period of one year.

It was observed that the difference between the monthly average air temperature and corresponding parking lot surface temperature correlated well in summer with incoming solar radiation. It is considered that similar correlations could be found for other surface types. This suggests a possible empirical technique for estimating monthly average surface temperatures from standard solar radiation and air temperature observations. The air temperatures should be measured over a standard surface in the same region as the surface for which temperatures are to be calculated.

The observations demonstrate the influence that surface characteristics can have on ground temperatures. This influence may be of no great practical significance in many areas of Canada, but it can be particularly important in regions where discontinuous permafrost occurs. Although man may have little influence on weather and climate, he can change readily the thermal properties of a surface. It is necessary to have at least a qualitative understanding of the factors that control the exchange of heat and moisture between the air and the ground in order to be able to interpret field conditions and to ensure that any changes in those conditions will be beneficial, or at least will not introduce serious problems.

Discussion

P.J. Duffy stated that forestry research at Chalk River, Ontario, showed that there was actually no frost-free season in some forest areas. He asked whether it is possible to establish the energy interchange at the ground surface for agricultural and forestry purposes. He remarked that in forestry work it is important to know the effect on soil temperatures of such activities as clearing, drainage, construction of access roads, etc. Finally, he wished to know the quantity of heat that theoretically can enter at any point in Canada and available methods of establishing this. The author replied that the Meteorological Branch, Department of Transport, has air temperature and other meteorological data available. The Departments of Geography and Meteorology at McGill University are studying the heat balance in various areas with emphasis on the arctic. With regard to carrying out such studies, it is necessary to develop knowledge of the subject to find out what measurements are required. Then it is necessary to find out what instrumentation is available.

K.A. Linell remarked that similar studies have been in progress in the United States for some years. He mentioned the theoretical work of Dr. R.F. Scott, Department of Civil Engineering, California Institute of Technology, Pasadena, California, who was carrying out mathematical analyses of the engineering significance of such meteorological factors as air temperature, radiation, and cloud cover.

J.G. Fyles asked whether the ground temperatures required to study the heat exchange at the ground surface are being measured by the Meteorological Branch. If they are not being measured, what additional observations are required? L.W. Gold replied that ground temperatures change with time and from one location to another. In his opinion, ground temperature observations should be considered as weather observations. These should be made by an organization having the proper facilities and framework.

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