Insulated highways for Canada's North

In the permafrost areas of Canada, granular earth materials such as sands and gravels are needed not only to provide a stable load-bearing strata but also as thermal insulation in the construction of highways, airport runways and railway embankments.

These materials, placed on the ground in sufficient thickness, prevent heat absorption by the surface from thawing the ice-rich permafrost and turning it into a soupy mass capable of swallowing lenghty sections of roadbeds or runways.

The North is currently in a construction boom period and sources of granular materials in many northern areas are neither plentiful nor easily accessible. In a search for ways to lessen the demand for such material interest is being shown in a technique using extruded polystyrene foam originally developed for combating frost-heaving in fine-grained soils found in parts of southern Canada.

This method of using plastic foam boards in combination with gravel to keep permafrost frozen is being investigated by group from the Department of Indian and Northern Affairs, Department of Public Works, Ministry of Transport and the National Research Council of Canada, together with Dow Chemical of Canada Limited. The chairman is K.W. Stairs, Assistant Director of the Technical Services Branch of the Department of Indian and Northern Affairs.

Testing method

The idea calls for insulation boards to be placed directly over the permafrost and a layer of gravel applied over these boards to prevent crushing and to provide a riding surface. A section of the Mackenzie Highway in the Northwest Territories is being used in experiments to determine whether it can be used for road construction in the North and to determine the thickness required in relation to the climate and soil conditions.

Test sections were installed in April and September of 1972 on a stretch of the highway, 15 miles southeast of Inuvik in the Northwest Territories.

The sections, 125 feet long, consist of two control sections and five insulated test sections of styrofoam, 1½, 2, 3½ (two sections) and 4½ inches in thickness. The insulation extends from shoulder to shoulder and is 30 feet in width. All insulated sections have a levelling course over the uneven permafrost surface about 1½ feet thick between the insulation and the permafrost and a 2-foot thickness of fill above the insulation.

National Research Council

Sub-base material is placed over polystryne insulation at Sudbury, Ontario.

While all the data have not been analyzed the initial results are significant and work began again in September 1973 to put in automatic temperature-measuring equipment that will give continuous temperature data from some 360 thermocouples installed in the test section.

The settlements measured after one summer's thaw were about 1.3 feet on the control section, 0.4 foot in the 2-inch insulated section and 0.1-0.2 foot in the 3½-inch insulated test section. The settlement on the control section was owing partly to thawing of the 6-inch layer of snow on which the original fill was placed last autumn and partly to thawing and consolidation of the fill and the permafrost below. In both insulated sections the thawing zone remained within the fill section. In the control section the depth of thaw ranged from two to three feet below the original ground surface.

No traffic hold-up

The advantage of using artificial insulation for remedial purposes is that the road has to be excavated only to a depth of about 15 inches. One lane is insulated at a time and the traveller is not inconvenienced too much. Before road insulation was available the subgrade had to be removed to a depth of several feet, depending somewhat on the depth of frost penetration, to replace the frost-susceptible soil with gravel. This could not be done one lane at a time, which meant building a by-pass road.

The added convenience has justified millions of board-feet of insulation being used annually for this purpose. Manitoba was the first province to try this construction technique, Saskatchewan and Quebec have tried it to a limited extent, while the Atlantic Provinces are testing it. In Ontario, an estimated five to six million board-feet of styrofoam have been used since 1969 and some two million board-feet are being used annually.