AIRPORT CONSTRUCTION IN NORTHERN QUÉBEC AND PERMAFROST RESEARCH

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In September 1983, as part of the implementation of the James Bay and Northern Québec Agreement, the governments of Québec and Canada signed a northern airport infrastructure program with a price tag of $ 110 million to build twelve (12) airfields in as many Inuit villages over the next decade.

Québec: this immense province in eastern Canada that dares to venture as far north as the Hudson Strait - far beyond the septentrional limit of the 60th parallel set for Canada's other provinces.

Québec: 1,500,000 square kilometres, half of which are affected by continuous, discontinuous or sporadic permafrost.

Québec: the province - the only one - that is engaged in the comprehensive development of its northern regions by virtue of a modern, innovative, original and substantial contract between the Québec government and its Cree, Naskapi and Inuit citizens living in coastal areas around James Bay, Hudson Bay and Ungava Bay.

Québec, in 1983, committed itself by "agreement" to enhance its northern lands with a network of modern, safe airports adapted to local geographic and climatic conditions.

For the benefit of those of you who are not intimately familiar with this region, briefly the vast area studied has the following general characteristics:

- considerable diversity of landscape;
- a wide range of soil types - from frost-susceptible to very stable, and well drained to ice-rich;
- significant ranges in permafrost temperatures (0 °C to -6 °C);
- and, thankfully for us engineers, an abundance of rock that is excellent for making crushed stone of all kinds.

Before the James Bay Agreement was signed, the ministère des Transports had never had the opportunity to build major infrastructures on permafrost or study the characteristics of perennially frozen ground. Of course road construction professionals had been called upon to make cuts in frost-susceptible materials containing ice lenses, but these isolated interventions did not have much in common with the challange of construction and maintenance of an airstrip, or the establishment of an air transportation network of 12 runways distributed over 2,000 km of coastal land along the arctic seas.

Eastern Canada is renowned for its profusion of imaginative and competent engineering consultants. Nevertheless, finding permafrost "specialists" with design and construction expertise in civil engineering works was no easy task.

These two handicaps were grounds enough for a decidedly original initiative that was to unveil the mysteries of and limits imposed by permafrost.

The circumstances were therefore ideal for the development of a full-scale systematic research program on "Québécois" permafrost. The stage was set.

The Department and its partners arrived at a consensus regarding objectives for a research program in conjunction with northern airport construction.

The objectives were:

(1) To make up a data bank needed to plan and develop the area,
(2) to produce a technical guide for construction works in permafrost regions, and
(3) to compile and commit to memory all technical lessons experienced, understood and learned during construction of airstrips, roads and buildings.

It was only natural that the ministère des Transports du Québec should take advantage of the construction work in the north and invite scientists from organizations already actively involved in permafrost research to the site. Such an effort in the direction of dialogue and exchange would inevitably lead to study findings that were cumulative, complementary and mutually supportive all at the same time.

Thus, over the past few years, the Nunavik area has been visited by researchers working in a vast range of disciplines — geologists, geomorphologists, geophysicists, engineers, geographers and biogeographers — as well as students affiliated with such institutions and organizations as the Centre d'Études nordiques of the Université Laval, the National Research Council of Canada, the Geological Survey of Canada, the Institut National de Recherches Scientifiques, the École Polytechnique of the Université de Montréal, and a number of private firms.

To meet the objectives I listed earlier, our partners proposed and set up a series of original projects that were tailor-made for

the territory and type of work we were going to undertake all around the Ungava peninsula and Hudson Bay and Hudson Strait:

— *By the Centre d'Études nordiques of the Université Laval and the Geological Survey of Canada:*

Permafrost and transportation infrastructures

Determination of spatial distribution of the different cryological facies of permafrost in terms of the geology and geomorphology of the Quaternary and the climate. All 12 sites to be visited.

— *By the Centre d'Études nordiques of the Université Laval and the Roads and Transport Association of Canada (RTAC):*

Geotechnical properties of ice-rich permafrost.

— *By the National Research Council of Canada:*

Testing of new passive thermal control technology for permafrost under structures (land-fill and buildings).

(a) heat extraction and recovery under a heated building with foundations consisting of a concrete slab floating on the permafrost.

(b) insulation of various types of land-fill (on extremely ice- rich clay) making up the foundations of roads and airstrips. Two sites.

— *By the École Polytechnique of the Université de Montréal:*

Preparation of a manual in French on civil engineering works in permafrost regions.

— *By the Centre d'Études nordiques and the Institut National de Recherches Scientifiques:*

Calibration of a mathematical model based on soil thermal data compared with local climatic data. When applied to landfill materials, the models (one for each site) make it possible to determine optimal landfill thickness for civil engineering works by providing seasonal thaw depth information for different types of soil, the active layer freezeback date, and minimum, maximum and average temperatures at different depths.

We already have all sorts of helpful, practical and handy information at our disposal, however the accomplishments of these research programs can be summarized as follows:

1. Development of a preliminary site investigation methodology adapted to Québec's northern lands based on regional geological conditions and surface indicators (patterned ground, topography, Quaternary geomorphology), by drilling, thermal measurement and geophysical methods.
2. Completion of a French language manual on the physical features required for engineering works; this guide will serve as an indispensable tool for the Department's engineers and technicians for years to come.
3. Development of numerical models for thermal analysis adapted to the region.
4. Evaluation of potential applications of innovative technology for thermal control of building and structure stability.

By the time the permafrost investigations in the Nunavik area have been completed, the ministère des Transports du Québec will have contributed around $ 1.1 million to this research... In addition to acquiring know-how and expertise, it will have supported university research and promoted cooperation between several research organizations.

This amount represents 1% of the total cost of the program... Might I make a wish - or express a desire - at this point? Why couldn't there be a Canadian standard for major projects north of the 55th parallel whereby 1% - or let's say .8% - of overall costs were earmarked for pure and applied research on permafrost? In the final analysis, this would cost the public treasury less than expensive settlements on claims stemming from problems that, although unaccountable, were nevertheless attributable to the undetected or undocumented presence of permafrost. I won't get into the quality or longevity of some of these works!

So, where do we go from here? What areas should be investigated?

To stimulate the debate and in the hopes of a productive discussion and enlightened suggestions, I would like to propose four (4) possible areas for permafrost research and investigation in cold regions.

(a) Climate change - or climate stability. What to do in the case of global warming - or cooling?
(b) Saline permafrost... in conjunction with overall development of the territory. Linear versus isolated investigations in the susceptible potentially saline clay covering large expanses of northern Québec.
(c) Hydrogeology in connection with icing and seasonal frost blister formation.
(d) Revegetation and thermal stabilization of ground and slopes disturbed by engineering works.

In the name of the Minister of Transport, Sam Elkas, and his Deputy Minister, Jean-Marc Bard, I would like to express my wishes for a productive conference... and, as a Québécois and a Laval graduate, welcome to these walls!