01-82-01-10 PT. 1

Peyton, Harold R.

Arctic engineering

August 26, 1969

Fairbanks, Alaska

Series: Alaska Science Conference, 1969

Harold Peyton is introduced by the chairperson. Harold Peyton said he will deviate a bit from the average paper at a science conference. He will be selecting one environmental aspect rather than all of arctic engineering. He will be looking at permafrost. He wanted to show three things. Many of the environmental factors regarding permafrost are well known. The calculations are possible and performance is predictable. Optimization processes are available to us now. He has selected a few slides to go through.

He discusses the thermal regime that creates permafrost. In the summer when the soil is warmed above 32 F the ground is thawed. The permafrost mantle is always below 32 F. Not all materials are frozen at 32 F. The problems are mostly associated with how we change soil surface conditions when we do something –build a road, run a tractor across the tundra, construct a building, etc. There is an increase of seasonal amplitude at the surface. It gets colder in the winter and warmer in the summer. We thaw a bit of the permafrost from the surface down. The average soil temperature is changed. It thaws from the top and may thaw from the bottom.

One of the problems with almost any optimization process in dealing with frozen soils has to do with the original condition. The temperature of the permafrost will have extreme variability. He shows examples of standard disturbance at different latitudes. Thawing was half a foot with a small temperature disturbance. These changes can occur with drainage patterns. One concept used for preserving permafrost such as under roads and airfields is by adding fill. They've increased the soil temperature and increased the amplitude. They can design a fill that the new temperature envelope intersects the top of the permafrost right at 32 F. This design is calculable. This was done at Prudhoe Bay for the airstrip. The surface condition is changed but the permafrost remains the same. As they go north to south they run into trouble. He talks about difference in subgrade requiring twice the fill so there isn't failure. Further south with 32 F mean annual soil temperature the fill requirement becomes infinite. There is no way to preserve the permafrost if the mean annual soil surface temperature exceeds 32 F. He talked about using different materials and the depth required. In road construction in Canada they often use the clearing material under the gravel. The difference between north and south is dramatic. South of the Brooks Range construction cannot be accomplished to retain the permafrost in a frozen state. Without artificial refrigeration there will be permafrost melt as part of the design criteria south of the Brooks Range. As seen all over the Fairbanks Region permafrost melt does occur and is irrevocable. Examples of installations north of the Brooks Range include stations used for the DEW Line. They have worked well.

A very old installation that has worked well is the airfield at Umiat. He talked about permafrost melt being deep if the soils underneath have a high ice content. A similar example is hydrologic erosion. In the south vegetation doesn't need to be removed. In the Fairbanks area removing the vegetation and cultivating it and replanting it to perennial plants is too much of a disturbance. Permafrost melt is triggered and will continue indefinitely.

When a heated building is placed on high ice content there is melting. The settlement can be calculated. He gave an example of changes under a tank. They can now calculate the time temperature change. He discussed polygon pattern ground. He talked about the three kinds of ice which give problems: ice wedges, ice lenses, and massive ice formations.

The pipeline transects the entire state. The line contains permafrost north from the Chugach. Three alternate routes are proposed for the northern region of the pipeline: the Anaktuvuk route, Toolik route and the Sag River route. If dry gravel ground can be found there will be little impact. With soils with high ice content there will be serious problems. A great part of looking at a project like this involves selecting route according to soil. What kind of soils are where and how can they adjust routes on the basis of soil quality. Soils with ice content that exceed the natural void volume are ice rich soils. If the soil is thawed and there's not very much settlement those are ice poor soils. They would consider it a good route if they don't have any ice rich soils deeper than ten feet. He said the pipeline is bedded on a very stable foundation. He discusses the soil material conditions with the Anaktuvuk route, the Sagavanirktok River route, and the Toolik route.

There are two alternates for design. If hot oil is run down the pipeline there will be a thaw area below the pipeline. As the oil gets hotter and hotter the area of thaw gets larger and larger. They have the ability to calculate the rate of thaw, settlement, etc. Elevated pipeline will be constructed over poor soils. The road can't be constructed right next to the pipeline without thawing the soil.

He said permafrost covers many kinds of materials. A great number of calculations can be made. He closes with comments. He said as engineers the optimization process and coming up with the best solution has been a heritage of engineers. This applies to areas concerning conservation. He sees rightfully many people unfamiliar with optimization process doing their best to assure that construction doesn't damage something. He discussed best answers with everyone concerned.

The rest of the papers in the panel: Engineering and transportation aspects of northern petroleum development can be found in the Proceedings of the Twentieth Alaska Science Conference (Q 180 U5 A66a 20th 1969).