Design / Construction Problems in the Arctic

Nunavut
Presentation Outline

- Where, What, Who is Nunavut
- Permafrost
- Climate
- Logistics
- Costs
- Closure

25 minutes vs 25 years
Broad overview
Building Related
Not Show Horrendous Problems
Discuss typical issues and challenges
Start with General introduction
Where, What, Who

- Located entirely north of the 60th parallel
- Furthest Mainland Southerly Point - Manitoba Border
- Furthest Northerly Point - North Pole
- Spans Three Time Zones
- Includes 21% of Canada's Entire Landmass (2M Sq Kms)
- Includes 0.1% of Canada's Entire Population (32,000)
- 83.6% of Persons Identify Themselves as Inuit
- Number of Communities: 25
- Number of Communities Population < 1000 = 14
- Number of Communities Population > 2000 = 3
- Furthest Northern Settlement CFS Alert 82.28 Lat
- Kms of Roads Connecting to Southern Canada: 0.00
- Kms of Roads Between Communities: 0.00
IMAGES FROM NUNAVUT
PLACES, PEOPLE, THINGS
PERMAFROST
Permafrost

Definition:
Permafrost is a layer of soil or rock, at some depth beneath the surface, in which the temperature has been continuously below 0 °C for at least some years. It exists where summer heating fails to reach the base of the layer of frozen ground.

- Could be Rock
- Could be Granular Materials
- Could be Organic
- Could be Ice
- Could be Fresh Water Ice or Could be Saline Ice
- Could be Ice & Some Other Materials
- Usually an Upper Active Layer That Thaws in Summer
- Below Active Layer It is Permanently Frozen
PERMAFROST DEGRADATION
HEATED CRAWLSPACE, STRIP FOOTINGS, CONTINUOUS PONY WALLS, DRAINAGE PROBLEMS
PERMAFROST SWELLING
SLAB ON GRADE; 20 FEET GRANULAR FILL; DRAINAGE ISSUES; WATER LEAKAGE INTO SUBGRADE
PERMAFROST VARIOUS ISSUES
CONSTRUCTION SEQUENCING; PILE SLIPPING; DRAINAGE ISSUES; THAWING UNDER SLAB, STUPIDITY
CLIMATE
Climate

* Keep in Mind:

Despite what the rest of Canada has been telling you all your life, as a Winnipegger, you are a Southerner. In the Arctic, the snow is different, the wind is different and the cold is different.

* Sustained Cold Weather (-65c for weeks)
* Sustained High Winds (Week Duration Storms Common)
* Snow Can be Like Talcum Powder (Gets into Everything)
* Snow Can be Like Concrete - Hard Packed
* Low Snow Fall (arctic desert) BUT High Accumulations
* Long Winters + Snow Accumulation = Clearing Issues
* Snow and Ice Can Remain Year Round
* High Tides (Iqaluit Has Second Highest Tides on Earth)
SNOW
UNDER, OVER, AROUND AND INSIDE
WIND
HIGH SUSTAINED WINDS, EXTREMELY COLD, NO SHELTER
COLD
LONG LONG WINTERS
<table>
<thead>
<tr>
<th>Daily Average</th>
<th>Winnipeg</th>
<th>Rankin</th>
<th>Alert</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>-17.8</td>
<td>-31.9</td>
<td>-32.4</td>
</tr>
<tr>
<td>February</td>
<td>-13.6</td>
<td>-30.1</td>
<td>-33.4</td>
</tr>
<tr>
<td>March</td>
<td>-6.1</td>
<td>-25.2</td>
<td>-32.4</td>
</tr>
<tr>
<td>April</td>
<td>4</td>
<td>-16.3</td>
<td>-24.4</td>
</tr>
<tr>
<td>May</td>
<td>12</td>
<td>-5.9</td>
<td>-11.8</td>
</tr>
<tr>
<td>June</td>
<td>17</td>
<td>4.2</td>
<td>-0.8</td>
</tr>
<tr>
<td>July</td>
<td>19.5</td>
<td>10.4</td>
<td>3.3</td>
</tr>
<tr>
<td>August</td>
<td>18.5</td>
<td>9.5</td>
<td>0.8</td>
</tr>
<tr>
<td>September</td>
<td>12.3</td>
<td>3.4</td>
<td>-9.2</td>
</tr>
<tr>
<td>October</td>
<td>5.3</td>
<td>-5.3</td>
<td>-19.4</td>
</tr>
<tr>
<td>November</td>
<td>-5.3</td>
<td>-17.8</td>
<td>-26.4</td>
</tr>
<tr>
<td>December</td>
<td>-14.4</td>
<td>-26.7</td>
<td>-30.1</td>
</tr>
<tr>
<td>Year Average</td>
<td>2.6</td>
<td>11.0</td>
<td>-10</td>
</tr>
<tr>
<td>Precipitation (Annual)</td>
<td>513.7</td>
<td>270.4</td>
<td>150</td>
</tr>
</tbody>
</table>
Logistics

- 0.00 Kms of Roads to Southern Canada
- Estimated Total of 853 Kms of Roads in Nunavut
- 0.00 Kms of Roads Between Communities
- 0.00 Kms of Rail
- Two Paved Air Strips
- Jet Service to Rankin Inlet & Iqaluit Only
- Each Community Has an Air Port
- Air Transport Difficult due to Weather (Wind, Snow & Vis)
- All Communities on Ocean (High Tides)
- Ocean freezes in Winter
- Shipping Season Usually August to September
TRANSPORTATION OF GOODS
AIR; SEA BARGE
Costs

✴ 4 litre of Milk = $16.00
✴ Hamburger & Fries = $29.00
✴ 1 Kilowatt of Electricity = $0.50
✴ Return Air Ticket Winnipeg to Rankin = $2,200.00
✴ Return Air Ticket Winnipeg to Resolute = $4,400.00
✴ Charter Aircraft to Gjoa Haven = $22,000.00
✴ One Sheet of 16mm T&G Plywood = $60.00 (Arviat)
✴ Cost of New Correctional Centre = $12,000 per Sq Metre
✴ Cost of New Community Hall = $7,500 per Sq Metre
✴ Cost of One Bedroom Apartment (Rankin) = $1,400 / Mo
✴ Cost of Engineering Mistakes .......................Priceless
Closure

- There are Huge Challenges to Working in Nunavut
- Many Mistakes Have Been Made in Past
- What Works in Winnipeg May Not Work in Nunavut
- There are Additional Rules and Regulations
- Construction Techniques Are Different
- Must Consider All Stages of Development & Effects
- Skills of Workers, and Operators are Limited
- Staff Turnover is Severe
- There are No (or few) Redundant Services
- Very Short Construction Season
- Reliability, Durability, and Redundancy of Systems
Thank You

Ken Drysdale, P.Eng., P.E.
President & CEO
Accutech Engineering Inc.

605 - 287 Broadway
Winnipeg, Manitoba
R3C 0R9

(204) 944 - 1555
drysdale@acquotecheng.ca