

TECH SOLUTIONS 605.0 CALCULATING INSULATION NEEDS TO FIGHT FROST HEAVE BY COMPARING FREEZING INDEX AND FROST DEPTH



To calculate the amount of insulation needed to protect highways, railroads, airport runways, utility lines and building foundations against frost heave, it's important to know the amount of frost penetration. There are two ways to calculate frost penetration: theoretically or actual field monitoring. Dow uses both methods. A theoretical formula that predicts frost depth with freezing index information provides a quick

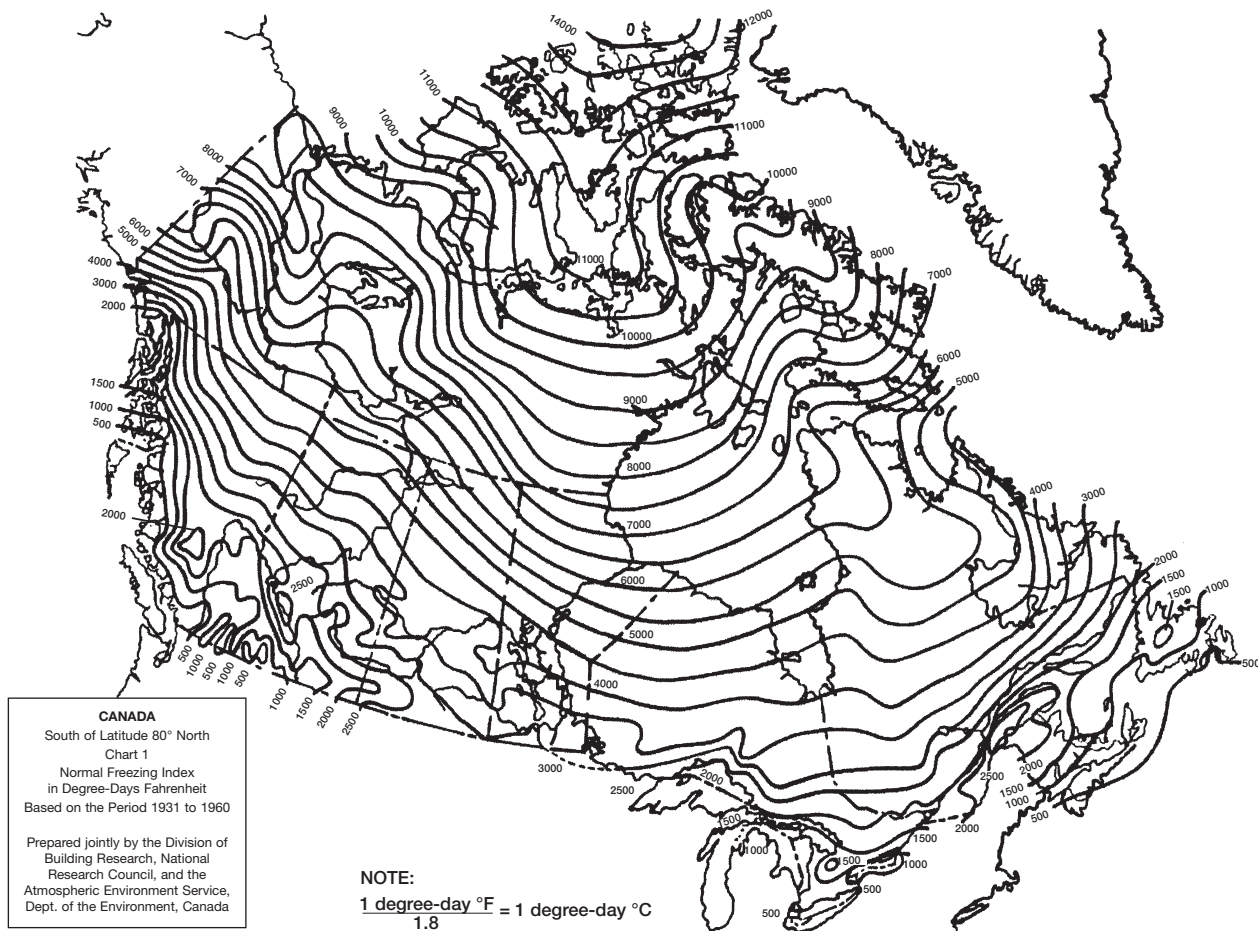
estimate. Obtaining actual field data provides the most accurate information.

The freezing index is defined as the number of degree-days (above and below 32°F [0°C]) between the highest point in the autumn and the lowest point in the spring on the cumulative degree-day time curve for one winter season. Or, simply the total number of degree-days of freezing for a given winter.

To help with calculations, this information sheet includes:

- maps of Canada showing the normal (mean) value of freezing index
- listings of normal freezing index data for major areas across Canada
- charts showing the relationship between freezing index and frost penetration as prepared by the Ministry of Transportation of Ontario

Figure 1: Freezing Index Map for Canada



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Figure 2: Freezing Index Map for Southern Ontario

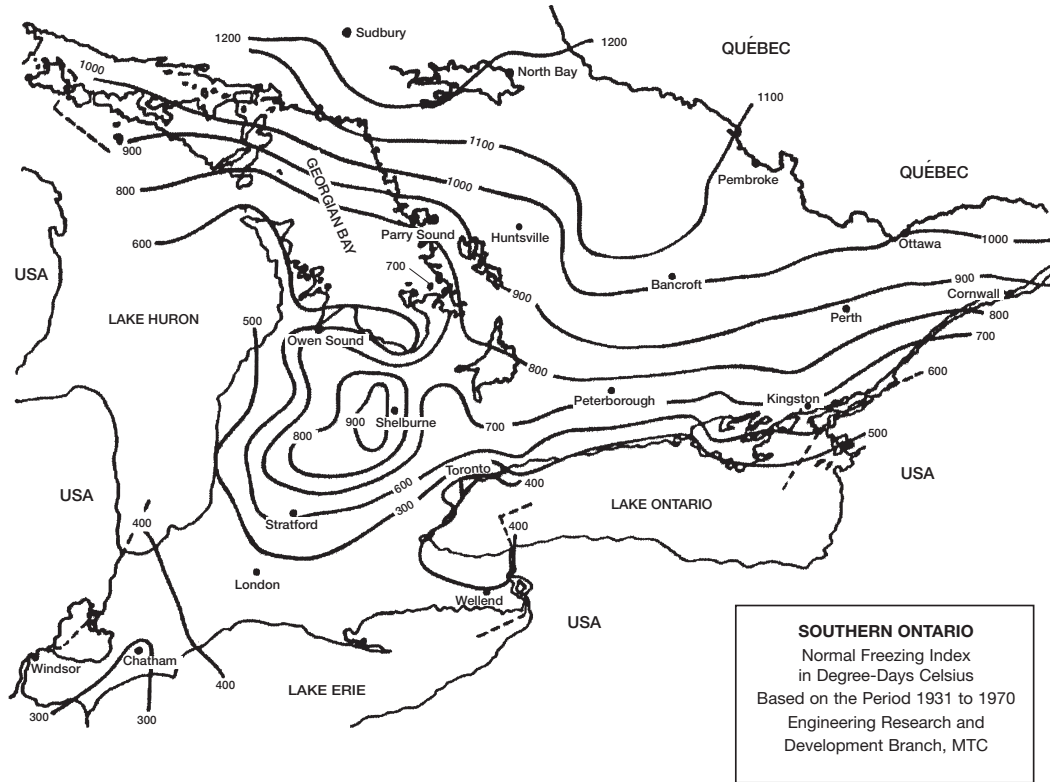
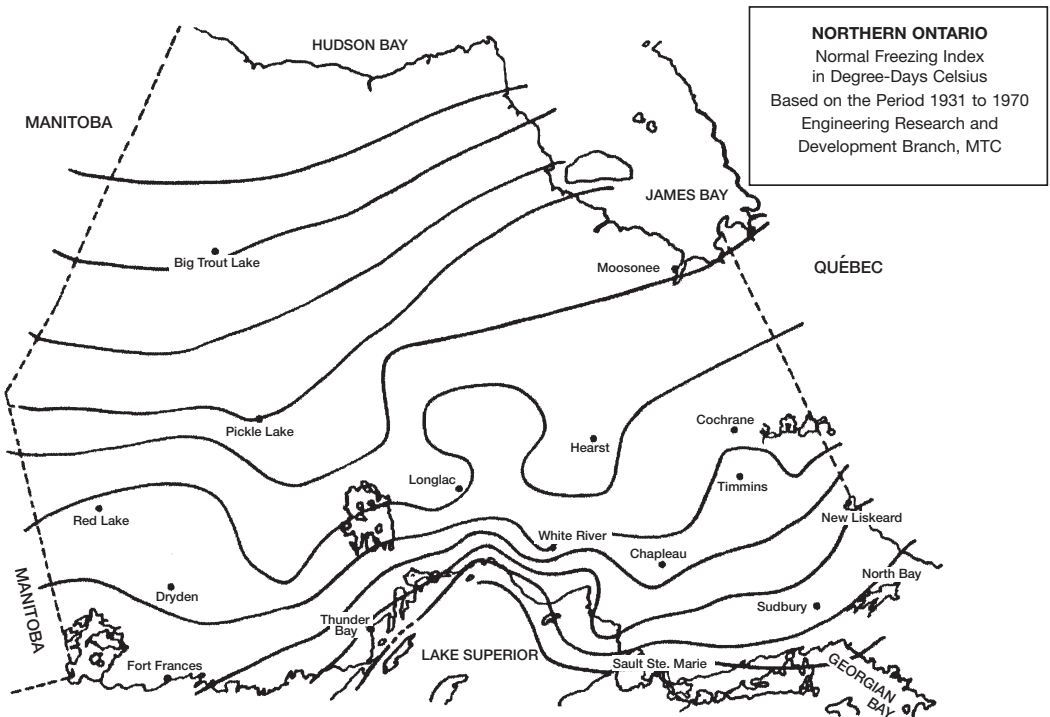


Figure 3: Freezing Index Map for Northern Ontario



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Figure 4:
Relationship between air freezing index, surface cover and frost penetration into homogeneous soils

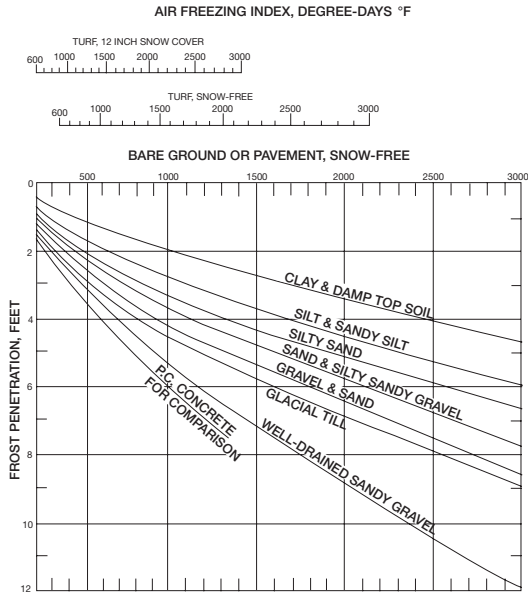


Figure 5:
Relationship between air freezing index, surface cover and frost penetration into a granular soil overlying a fine-grained soil

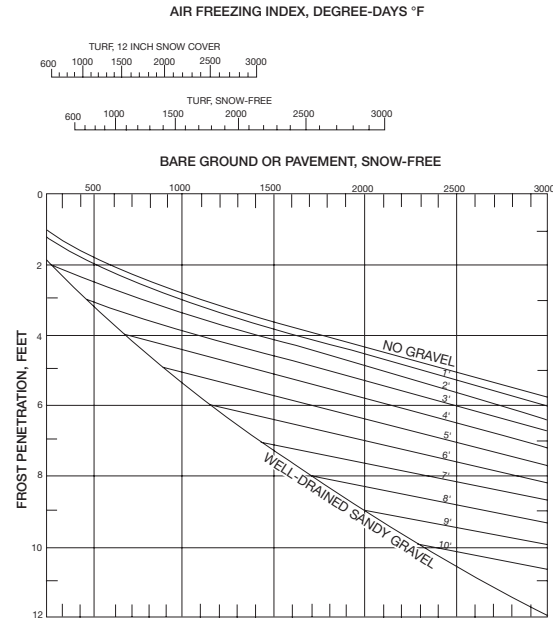
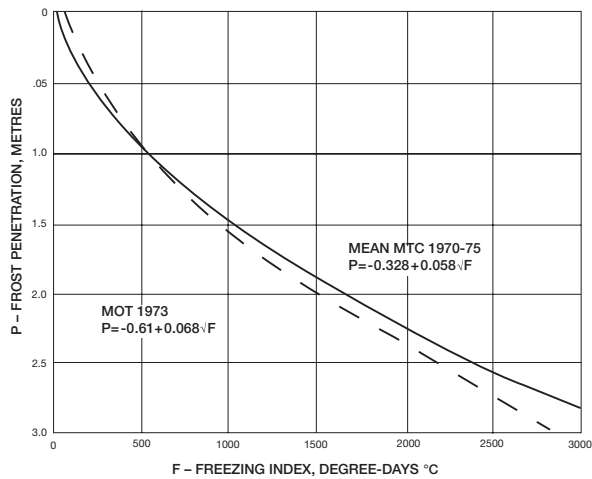


Figure 6:
Frost Penetration in Ontario 1970-1975



CALCULATING INSULATION NEEDS TO FIGHT FROST HEAVE BY COMPARING FREEZING INDEX AND FROST DEPTH

TABLE 1: FREEZING INDICES FOR CANADA

| Station | Freezing Index | |
|------------------------------|----------------|----------------|
| | Degree-Days °F | Degree-Days °C |
| British Columbia | | |
| Abbotsford A ⁽¹⁾ | 45 | 25 |
| Beaton River A | 3,893 | 2,164 |
| Comox A | 596 | 331 |
| Cranbrook A | 1,314 | 730 |
| Dog Creek A | 1,457 | 809 |
| Fort Nelson A | 4,523 | 2,513 |
| Fort St. John A | 2,848 | 1,582 |
| Kamloops A | 603 | 335 |
| Kimberley A | 1,434 | 797 |
| New Westminster | 35 | 19 |
| Penticton A | 313 | 174 |
| Port Hardy A | 33 | 18 |
| Prince George A | 1,670 | 928 |
| Prince Rupert A | 64 | 36 |
| Princeton A | 1,111 | 617 |
| Quesnel A | 1,457 | 809 |
| Sandspit A | 35 | 19 |
| Smithers A | 1,498 | 832 |
| Smith River A | 4,866 | 2,703 |
| Terrace A | 637 | 354 |
| Tofino A | 20 | 11 |
| Vancouver A | 31 | 17 |
| Victoria A | 28 | 16 |
| Williams Lake A | 881 | 489 |
| Yukon Territory | | |
| Aishihik A | 5,038 | 2,799 |
| Dawson | 6,174 | 3,430 |
| Haines Junction | 4,498 | 2,499 |
| Mayo | 5,454 | 3,030 |
| Snag A | 6,477 | 3,598 |
| Teslin A | 3,754 | 2,086 |
| Watson Lake A | 3,281 | 1,823 |
| Whitehorse | 3,574 | 1,986 |
| Northwest Territories | | |
| Cape Dyer A | 7,058 | 3,921 |
| Coral Harbour A | 8,552 | 4,751 |
| Fort McPherson | 7,747 | 4,304 |
| Frobisher Bay A | 7,026 | 3,903 |
| Hay River A | 5,512 | 3,062 |
| Inuvik A | 8,424 | 4,680 |
| Norman Wells A | 7,026 | 3,903 |
| Resolute Bay A | 11,166 | 6,203 |
| Tuktoyaktuk | 8,855 | 4,919 |
| Yellowknife A | 6,506 | 3,614 |
| Alberta | | |
| Banff | 1,963 | 1,091 |
| Calgary A | 1,791 | 995 |
| Cold Lake A | 3,174 | 1,763 |
| Cowley A | 1,413 | 785 |
| Edmonton A | 2,593 | 1,441 |
| Embarras A | 4,439 | 2,466 |
| Fort McMurray A | 4,024 | 2,236 |
| Grande Prairie A | 2,967 | 1,648 |
| Jasper | 1,885 | 1,047 |
| Lake Louise | 2,810 | 1,561 |
| Lethbridge A | 1,326 | 737 |
| Medicine Hat A | 1,809 | 1,005 |
| Peace River A | 3,805 | 2,114 |

(1) A indicates an airport data station.

TABLE 1: CONTINUED

| Station | Freezing Index | |
|----------------------------|----------------|----------------|
| | Degree-Days °F | Degree-Days °C |
| Alberta – continued | | |
| Penhold A | 2,586 | 1,437 |
| Red Deer | 2,382 | 1,323 |
| Suffield A | 2,259 | 1,255 |
| Vermilion A | 3,222 | 1,790 |
| Saskatchewan | | |
| Broadview A | 3,244 | 1,802 |
| Dafoe A | 3,722 | 2,068 |
| Estevan A | 2,646 | 1,470 |
| Moose Jaw A | 2,555 | 1,419 |
| North Battleford A | 3,378 | 1,877 |
| Prince Albert A | 3,739 | 2,077 |
| Regina A | 3,175 | 1,764 |
| Saskatoon A | 3,284 | 1,824 |
| Swift Current A | 3,323 | 1,846 |
| Uranium City A | 5,551 | 3,084 |
| Yorkton A | 3,563 | 1,799 |
| Manitoba | | |
| Brandon A | 3,388 | 1,882 |
| Churchill A | 6,698 | 3,721 |
| Flin Flon | 4,279 | 2,377 |
| Gimli A | 3,417 | 1,898 |
| MacDonald A | 3,038 | 1,688 |
| Neepawa A | 3,282 | 1,823 |
| Portage La Prairie A | 2,855 | 1,586 |
| Rivers A | 3,315 | 1,842 |
| Winnipeg A | 3,251 | 1,806 |
| Ontario | | |
| Algonquin Park | 2,147 | 1,193 |
| Belleville | 1,143 | 635 |
| Brampton | 1,026 | 570 |
| Brantford | 790 | 439 |
| Chalk River | 2,096 | 1,164 |
| Chatham | 531 | 295 |
| Cochrane | 3,309 | 1,838 |
| Collingwood | 975 | 542 |
| Dryden | 3,395 | 1,886 |
| Georgetown | 1,084 | 602 |
| Guelph | 1,055 | 586 |
| Hamilton | 663 | 368 |
| Huntsville | 1,656 | 920 |
| Iroquois Falls | 3,388 | 1,882 |
| Kapuskasing A | 3,439 | 1,911 |
| Kenora A | 3,172 | 1,762 |
| Kingston | 1,220 | 678 |
| Kirkland Lake | 3,244 | 1,802 |
| Kitchener | 983 | 546 |
| Lindsay | 1,445 | 803 |
| London A | 863 | 479 |
| Moosonee | 4,081 | 2,267 |
| Niagara Falls | 684 | 380 |
| North Bay | 2,210 | 1,228 |
| Orangeville | 1,423 | 791 |
| Orillia | 1,495 | 831 |
| Ottawa A | 1,829 | 1,016 |
| Owen Sound | 995 | 553 |
| Parry Sound | 1,517 | 843 |
| Peterborough | 1,365 | 758 |
| Port Arthur (Thunder Bay) | 2,541 | 1,412 |

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| TABLE 1: CONTINUED | | |
|----------------------------|----------------|----------------|
| Station | Freezing Index | |
| | Degree-Days °F | Degree-Days °C |
| Ontario – continued | | |
| St. Catharines | 506 | 281 |
| St. Thomas | 710 | 394 |
| Sarnia | 670 | 372 |
| Sault Ste. Marie A | 1,663 | 924 |
| Simcoe | 751 | 417 |
| Sioux Lookout A | 3,450 | 1,917 |
| Stratford | 1,072 | 596 |
| Sudbury A | 2,401 | 1,334 |
| Timmins A | 3,160 | 1,756 |
| Toronto | 629 | 349 |
| Toronto A | 897 | 498 |
| White River | 3,344 | 1,858 |
| Windsor A | 565 | 314 |
| Woodstock | 929 | 516 |
| Québec | | |
| Bagotville A | 2,867 | 1,593 |
| Baie Comeau A | 2,518 | 1,399 |
| Chicoutimi | 2,536 | 1,409 |
| Drummondville | 1,827 | 1,015 |
| Gagnon A | 4,216 | 2,342 |
| Gaspé | 2,012 | 1,118 |
| La Malbaie | 2,043 | 1,135 |
| Mont Laurier | 2,325 | 1,292 |
| Montréal A | 1,583 | 879 |
| Québec | 1,822 | 1,012 |
| Québec A | 2,059 | 1,144 |
| Sept-Iles A | 2,746 | 1,526 |
| Sherbrooke | 1,581 | 878 |
| Sorel | 1,997 | 1,109 |
| Tadoussac | 2,038 | 1,132 |
| Three Rivers | 2,139 | 1,188 |
| New Brunswick | | |
| Edmundston | 2,219 | 1,233 |
| Fredericton A | 1,561 | 867 |
| Moncton A | 1,397 | 776 |
| Pennfield Ridge A | 1,178 | 654 |

| TABLE 1: CONTINUED | | |
|----------------------------------|----------------|----------------|
| Station | Freezing Index | |
| | Degree-Days °F | Degree-Days °C |
| New Brunswick – continued | | |
| Sackville | 1,174 | 652 |
| St. George | 1,115 | 619 |
| Saint John | 1,002 | 557 |
| Saint John A | 1,137 | 632 |
| Sussex | 1,337 | 743 |
| Woodstock | 1,701 | 945 |
| Nova Scotia | | |
| Annapolis Royal | 593 | 329 |
| Cheticamp | 955 | 531 |
| Debert A | 1,136 | 631 |
| Greenwood A | 815 | 453 |
| Halifax | 556 | 309 |
| Halifax A | 856 | 476 |
| Ingonish Beach | 828 | 460 |
| Liverpool | 453 | 252 |
| Shearwater A | 699 | 388 |
| Springfield | 933 | 518 |
| Sydney A | 811 | 451 |
| Truro | 1,025 | 569 |
| Yarmouth A | 415 | 231 |
| Prince Edward Island | | |
| Alliston | 1,000 | 556 |
| Charlottetown A | 1,201 | 667 |
| Summerside A | 1,242 | 690 |
| Newfoundland | | |
| Argentia A | 475 | 264 |
| Bonavista | 853 | 474 |
| Buchans A | 1,724 | 958 |
| Churchill Falls A | 4,818 | 2,677 |
| Corner Brook | 1,120 | 622 |
| Gander International A | 1,207 | 671 |
| Goose A | 3,268 | 1,816 |
| Grand Falls | 1,394 | 774 |
| St. John's | 648 | 360 |
| Stephenville A | 925 | 514 |
| Wabush Lake A | 4,688 | 2,604 |

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