Design and Installation of Hydronic Snow and Ice Melting (SIM) Systems to Optimize Performance and Efficiency

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Introduction

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Introduction to the Plastics Pipe Institute

PPI is a non-profit trade association representing the plastic pipe industry

- PPI's five divisions focus on solutions for multiple applications:
  - **Building & Construction Division (BCD)**
  - Corrugated Plastic Pipe Association (CPPA)
  - Energy Piping Systems Division (EPSD)
  - Municipal & Industrial Division (MID)
  - Power & Communications Division (PCD)

PCD: HDPE Conduit for fiber optic

EPSD: Gas distribution piping

MID: HDPE water mains

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Introduction to the Plastics Pipe Institute

PPI's Building & Construction Division (BCD)

- BCD is focused on plastic pressure pipe and tubing systems used within buildings and on building premises for applications such as plumbing, water service, fire protection, hydronic heating and cooling, snow and ice melting and ground source geothermal piping systems: **PEX, CPVC, PE-RT, PP-R**
- **BCD is involved with many industry groups:**

American Water Works Association

ASPE American Society of Plumbing Engineers

ASME Setting the Standard

ASHRAE

ASTM International Standards Worldwide

CSA Group

ICC ES PMG

NSF International

UPC

Proud member of the RPA

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What Is A Hydronic SIM System?

- **Snow and Ice Melting** (SIM) systems are hydronic systems designed to remove snow and ice by circulating a heat transfer fluid through tubing installed in an outdoor surface

- SIM systems are used across North America in all climates

- The piping material for SIM systems is typically:
  - PEX: Crosslinked Polyethylene (see CSA B137.5)
  - PE-RT: Polyethylene of Raised Temperature resistance (see CSA B137.18)
  - PP-R: Random Copolymerized Polypropylene (see CSA B137.11)
  - Type K soft copper tubing

- Learn more about these materials at http://plasticpipe.org/building-construction/

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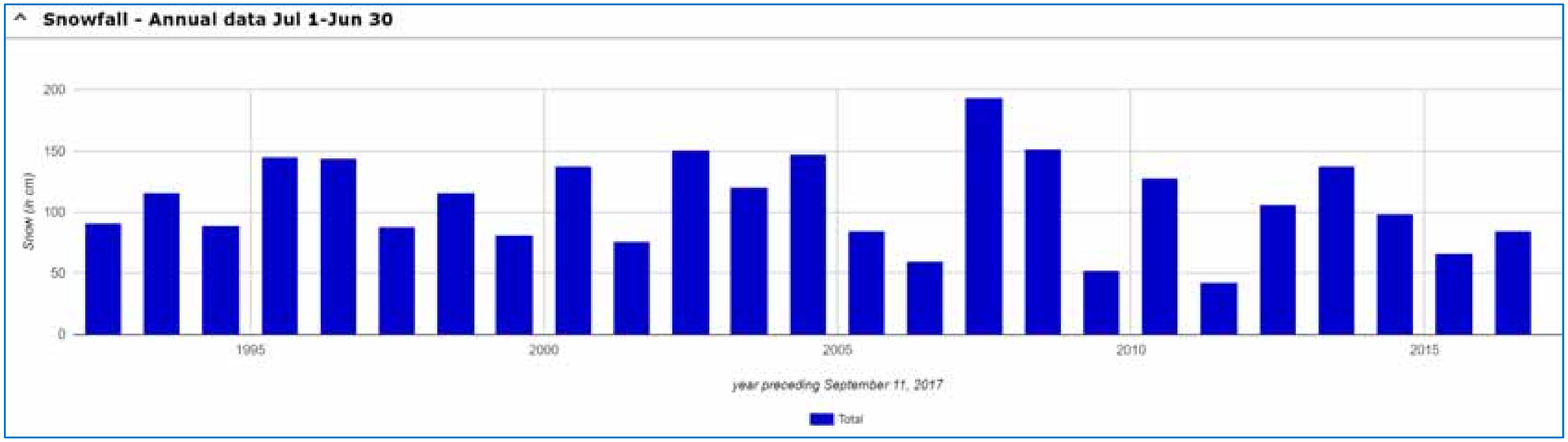
Relevance of Hydronic SIM Systems

1. The safety, convenience and savings provided by a SIM system are more beneficial than ever, as changing weather patterns increase snowfall in many regions
2. Clearing slippery outdoor surfaces over a long winter is a high maintenance cost and involves the expense of harsh chemicals which can damage surfaces
3. Aging populations need access to services, yet may have limited mobility
4. Snow and ice melting systems can reduce liability while improving access
5. Operating costs for a hydronic SIM system are often much less than mechanical snow removal, saving facility owners money while reducing risks

Relevance of Hydronic SIM Systems

Annual snowfall data for **Toronto 1995-2016** shows blips, not trends
- Winters are unpredictable but reliable
- Data at https://toronto.weatherstats.ca/metrics/snow.html



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Course Outline

This course will:

1. Indicate the typical benefits of SIM systems

2. Describe the three most common installation techniques

3. List a selection of typical applications

4. Introduce the five main design steps

5. Discuss the most common control strategies

6. Comment on operating costs

1. Benefits of Snow and Ice Melting Systems

This section will explain at least six benefits of SIM systems

- Better safety
- Reduced liability
- Healthier convenience
- Lowered maintenance costs
- Minimized environmental impact
- Long-term reliability

Benefits of Snow and Ice Melting Systems

Better Safety

- Snow and ice melting systems eliminate build-up of snow and ice, keeping surfaces clear during snowfall events and evaporating water to prevent freezing
- Systems provide better safety for walkers and drivers than mechanical snow removal

Courtesy NIBCO

Benefits of Snow and Ice Melting Systems

Reduced Liability

- Keeping residences and businesses free of snow and ice improves access and safety, while eliminating a source of liability risk in winter
- Snowbanks and trip hazards are practically eliminated
- Liability insurance premiums might even be reduced, reducing ownership costs

Bus station loading area.

Unfortunately, no tubing in the curb.

Benefits of Snow and Ice Melting Systems

Healthier Convenience

- For the ultimate in snow removal convenience, SIM systems clear outdoor surfaces, leaving them dry
- No snow banks are left behind
- For residential customers, this eliminates potential health risks of aching backs and heart attacks

Courtesy Ridgeway Home Services

Benefits of Snow and Ice Melting Systems

Lowered Maintenance Costs

- Traditional snow removal is very expensive and unpredictable
- Facility owners can pay $10,000s per year for labor, equipment, supplies
- Hydronic SIM systems are usually less expensive to operate than mechanical removal
- Indoor maintenance costs are reduced by avoiding sand and salt getting tracked inside

Benefits of Snow and Ice Melting Systems

Minimized Environmental Impact

- Hydronic SIM systems are powered by heat sources such as high-efficiency boilers, electricity, thermal solar, geothermal heat pumps or waste heat (commercial, industrial)
- They extend lives of surfaces by eliminating scraping, salting and sanding operations
- Run-off of deicing chemicals (e.g. salt) onto lawns and drains is eliminated
- Less fuel is used to power boilers than to power trucks (lower CO_2 emissions)
- These factors can reduce environmental impacts

Benefits of Snow and Ice Melting Systems

Long-term Reliability

- Plastic tubing does not corrode on the inside or outside
- Hydronic boilers, circulators and piping components are highly reliable
- With proper design and installation, hydronic SIM systems provide decades of reliable operation with virtually no maintenance to piping systems
- The piping material for SIM systems is typically:
  - **PEX**: Crosslinked Polyethylene (see CSA B137.5)
  - **PE-RT**: Polyethylene of Raised Temperature resistance (see CSA B137.18)
  - **PP-R**: Random Copolymerized Polypropylene (see CSA B137.11)



Benefits of Snow and Ice Melting Systems

Summary: Typical benefits include

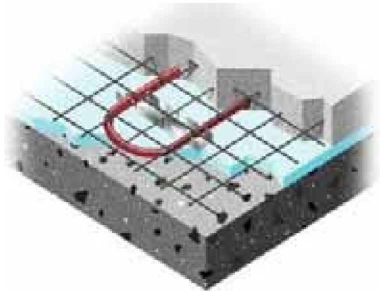
- Better safety
- Reduced liability
- Healthier convenience
- Lowered maintenance costs
- Minimized environmental impact
- Long-term reliability

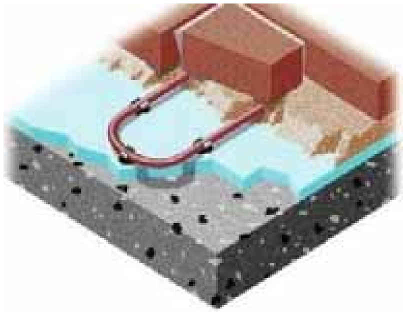
2. SIM Installation Techniques

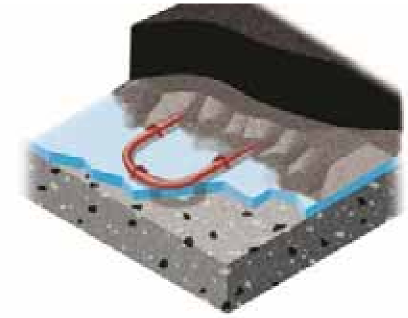
This section describes three common installation types for outdoor surfaces

1. Poured concrete
2. Interlocking pavers
3. Asphalt

Hydronic snow and ice melting systems can be successfully installed in practically all types* of external surfaces **Permeable concrete is the most difficult surface*







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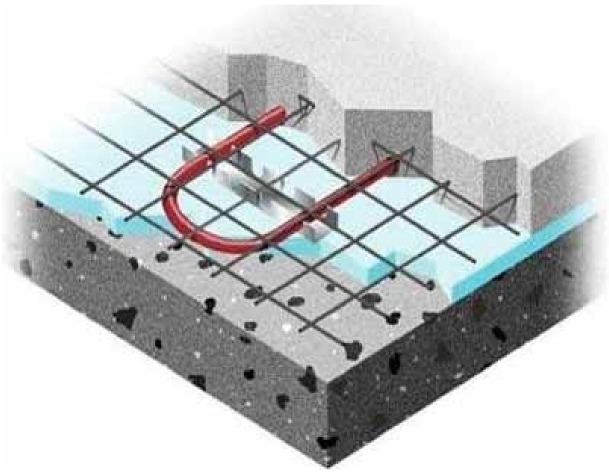
SIM Installation Techniques

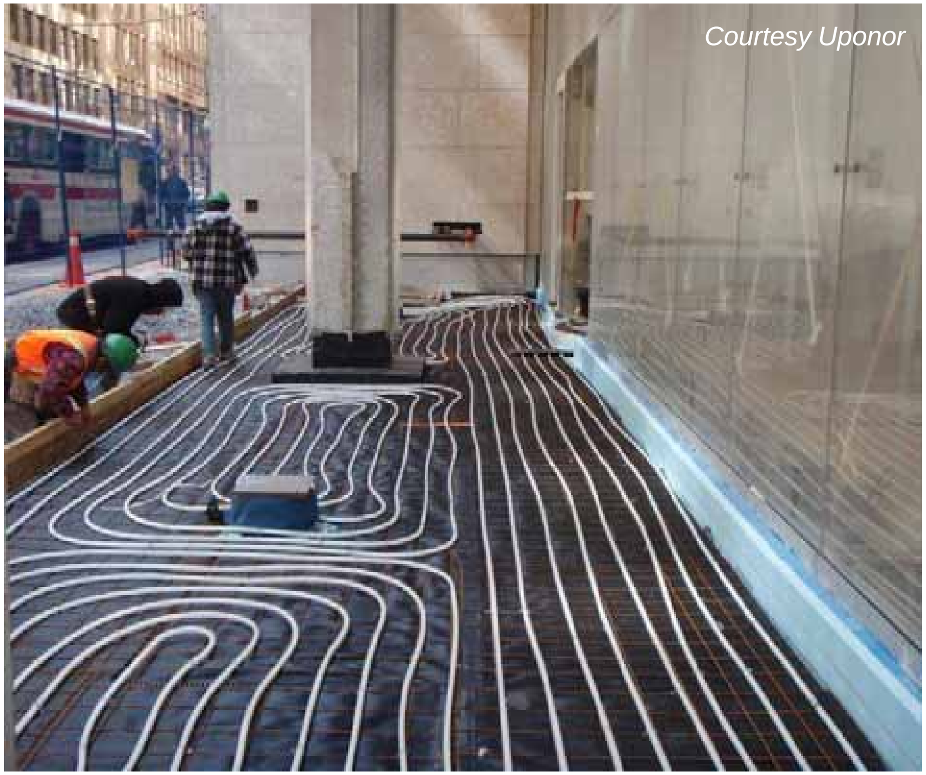
Tubing embedded within poured concrete

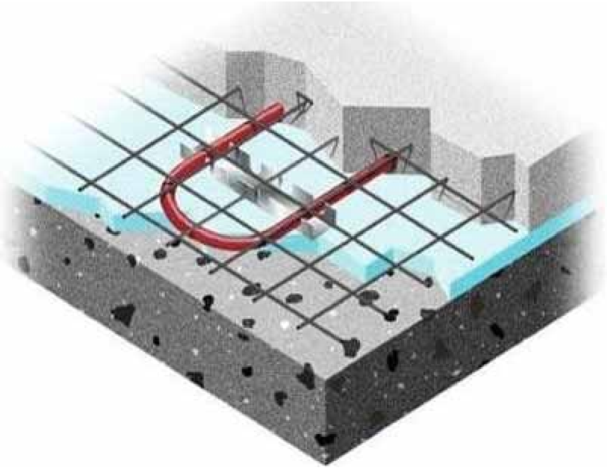


- In poured concrete, the tubing is simply embedded within the concrete
  - Very popular for stained concrete
- Recommended to place the tubing 2 to 3 in. (5 - 8 cm) below the surface for faster response time (this is not always practical)
- Tubing is often stapled directly onto the insulation board or tied to rebar or wire mesh within the poured structural concrete
- Some insulation board has the integrated “knobs” for holding the tubing
- This is a simple and affordable technique for installing SIM piping

SIM Installation Techniques

Tubing embedded within poured concrete

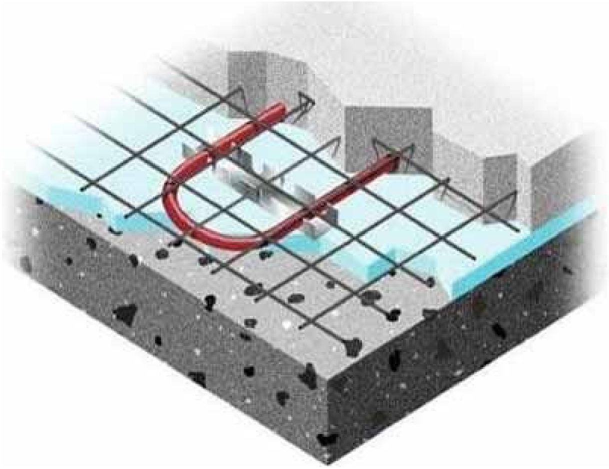




Poured concrete with tubing embedded 2 to 3 inch from top surface

SIM Installation Techniques

Tubing embedded within poured concrete

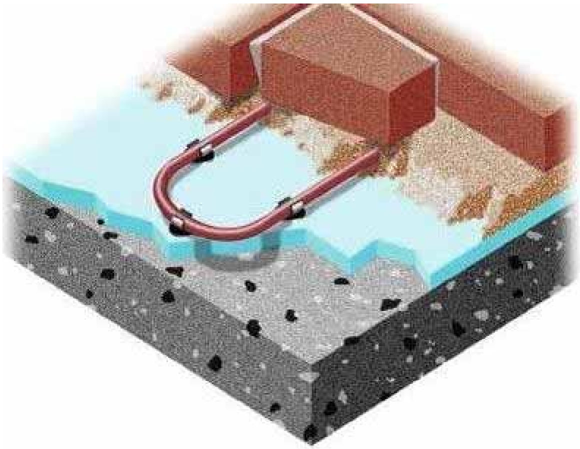


Poured concrete with tubing embedded 2 to 3 inch from top surface

SIM Installation Techniques

Tubing installed under interlocking pavers

- Plastic tubing is installed above insulation using plastic rails, staples or screw clips
- Tubing is encased within 1 1/2 in. (4 cm) of sand bed, compacted to 1 1/8 in. (3 cm)
- Pavers are placed above sand bed and installed normally
- Technical specifications and drawings of SIM systems with pavers can be found at www.icpi.org

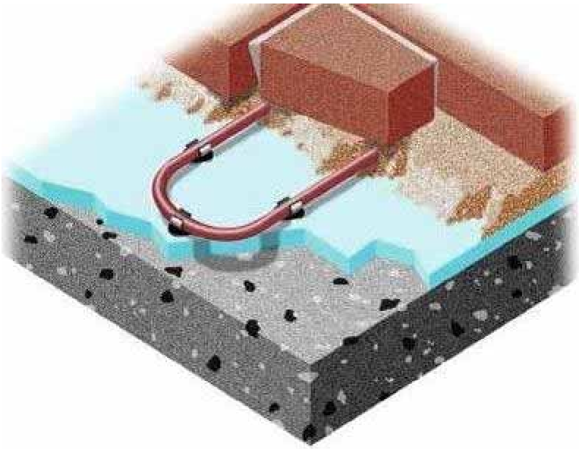


Media

- Compacted sand bed is recommended
- Stone dust loses strength when wet, and can heave when frozen

SIM Installation Techniques

Tubing installed under interlocking pavers

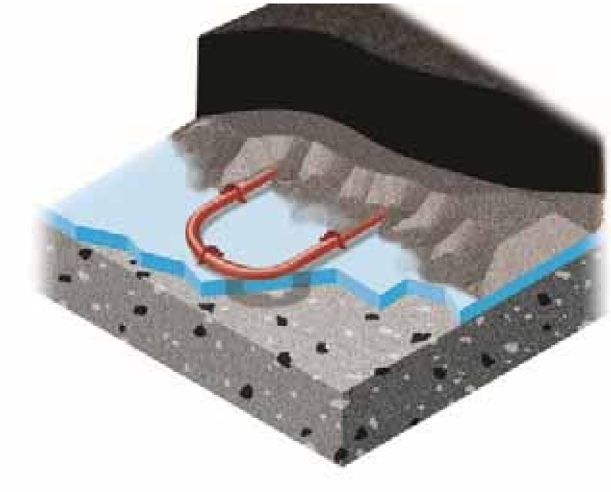


Pavers installed over sand bed with embedded heating tubing

SIM Installation Techniques

Tubing installed under asphalt

- Plastic tubing is installed above insulation using plastic rails, staples or screw clips
- Tubing is encased within 3 in. (7.5 cm) of stone dust or sand media, compacted
- Asphalt is placed above the media and compacted normally
- Cold water is flushed through pipes during placement of asphalt and until it cools
- Water flow is regulated to be less than 150°F (65°C) at the manifold outlet to keep the tubing "cool"



Media: Compacted stone dust works best. No pea stone or crushed gravel.

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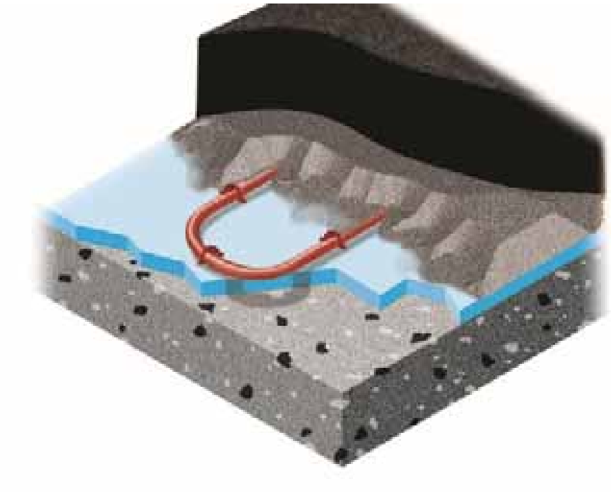
SIM Installation Techniques

Tubing installed under asphalt



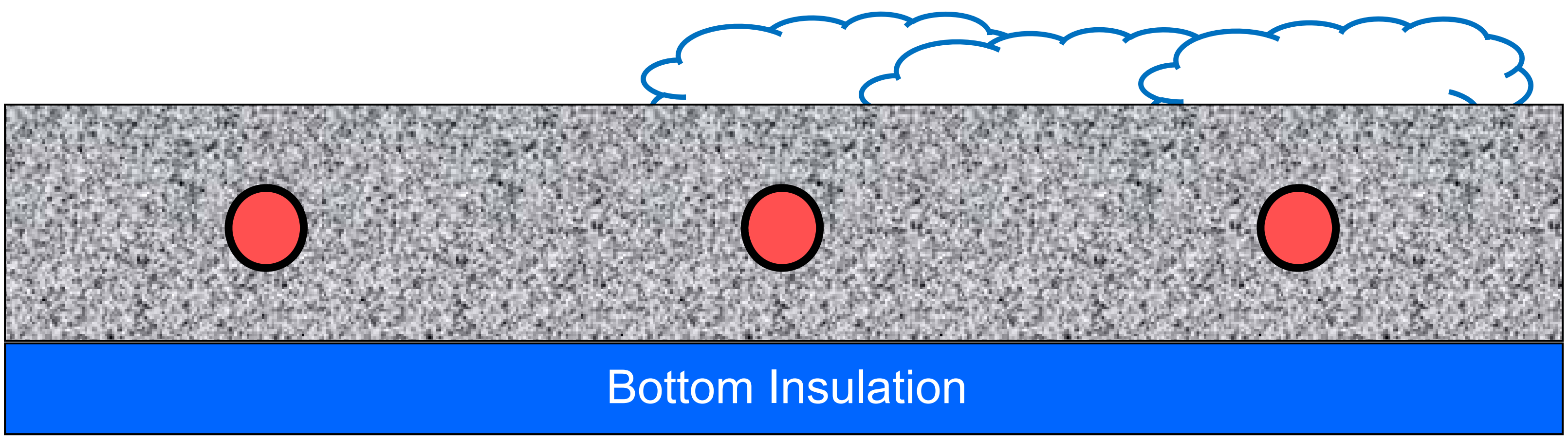
Tubing embedded within sand or stone dust below asphalt

SIM Installation Techniques

Importance of Insulation

- A significant amount of heat can be conducted to the frozen earth below the SIM surface if appropriate insulation is not installed
  - Without insulation, downward losses can exceed **50%** of all the energy supplied to the area (so double the size of heat source and circulators!)

● = Tubing filled with warm glycol



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SIM Installation Techniques

Importance of Insulation

- Insulation may be extruded polystyrene (XPS), polyurethane (PU), or expanding foam that is sprayed onto existing concrete or the earth to follow contours
- CSA B214-16 requires **at least R-5** insulation below SIM areas, but many designers specify **R-10**, since insulation also improves response time
    - Typical insulation thickness is 1 in., 1 ½ in. or 2 in. (25 mm, 38 mm, 50 mm)
- Be sure the insulation is rated for outdoor use and meets the expected compressive loading from vehicles, or settling can occur

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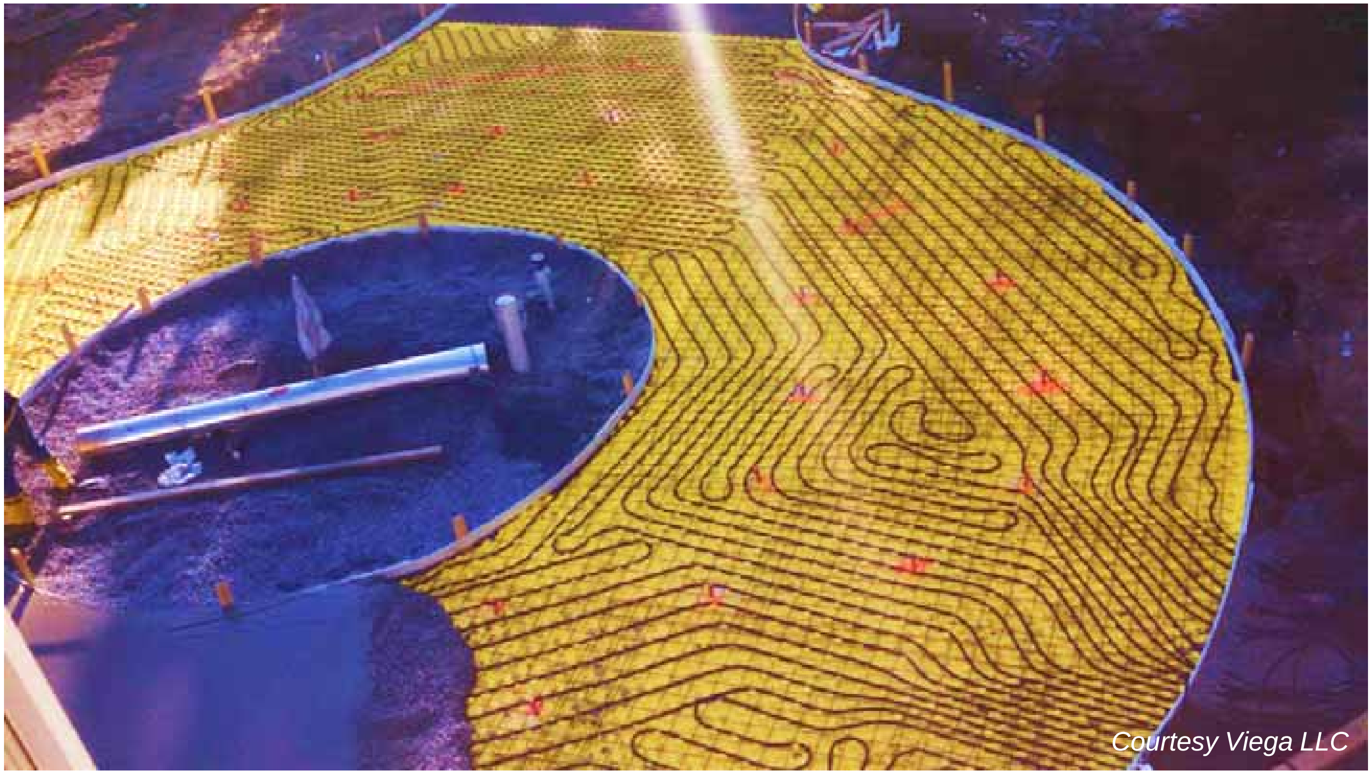
SIM Installation Techniques

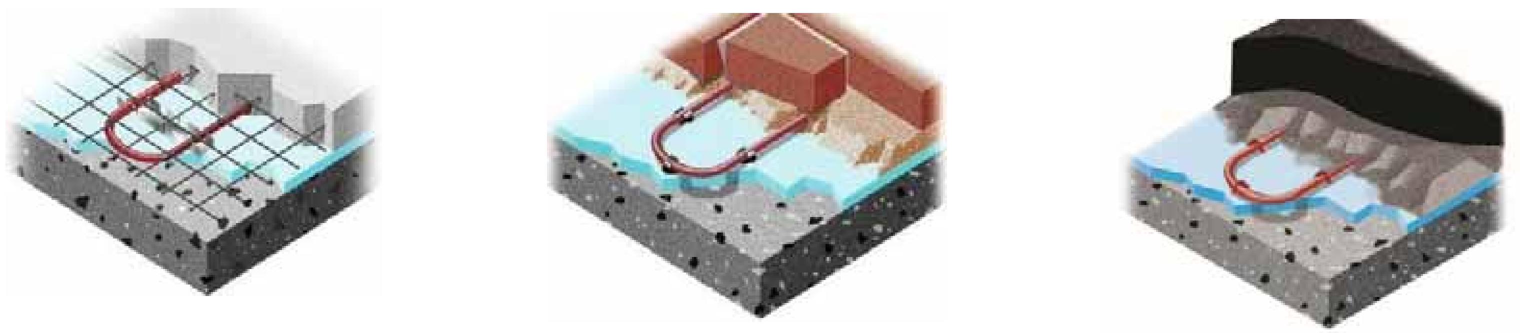
Importance of Insulation



SIM Installation Techniques

Summary: This section described three installation types for outdoor surfaces

1. Poured concrete
2. Interlocking concrete pavers
3. Asphalt



Images Courtesy REHAU

3. Typical applications of SIM systems

This section gives examples of application types

1. Sidewalks
2. Steps
3. Driveways
4. Ramps
5. Roads
6. Parking garages
7. Hangers
8. Pool decks
9. Train stations
10. Aviation
11. Melting “hot pads”

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Typical applications of SIM systems

Sidewalks

- Private home

Typical applications of SIM systems

Sidewalks

- Commercial building

Typical applications of SIM systems

Sidewalks

- Municipal building

Courtesy Klimatrol

- University (handicapped parking)

Typical applications of SIM systems

Sidewalks

- Hotel

Typical applications of SIM systems

Steps

- Public and commercial spaces


Courtesy REHAU


Courtesy NIBCO

Typical applications of SIM systems

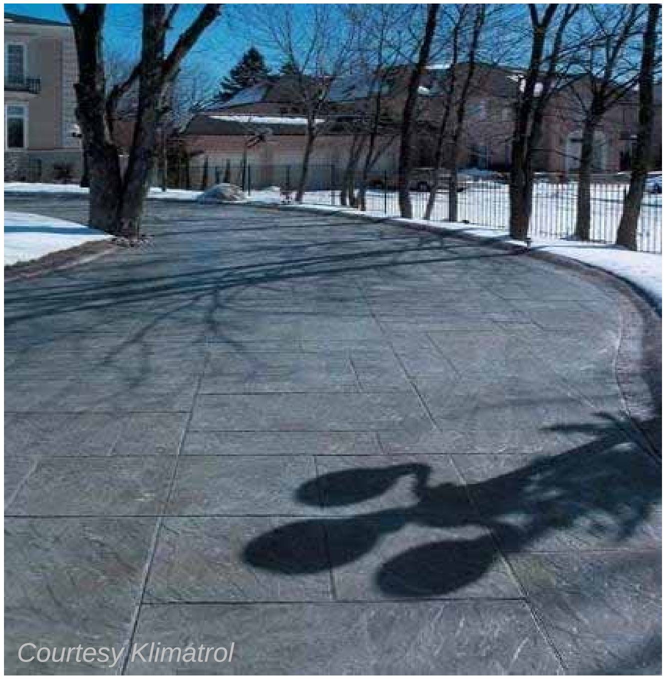
Steps

- Residential installations

Typical applications of SIM systems

Driveways

- Under stained concrete or pavers


Courtesy Klimatrol


Courtesy Ridgeway Home Services

Typical applications of SIM systems

Driveways

- Under stained concrete or pavers

Typical applications of SIM systems

Driveways

- Under stained concrete or pavers

Courtesy Thornton Plumbing & Heating

Typical applications of SIM systems

Ramps

- Pedestrian and vehicle ramps

Typical applications of SIM systems

Ramps

- Pedestrian and vehicle ramps


Courtesy REHAU

Typical applications of SIM systems

Roadways

- SIM systems add safety with steep inclines

Typical applications of SIM systems

Parking garages

- SIM in the inclined ramps and in exposed levels of ramps

Typical applications of SIM systems

Hanger doors and aprons

- SIM prevents sliding doors from freezing

Courtesy VIEGA LLC

Typical applications of SIM systems

Pool decks

- Facilitates winter access
- Tubing can also be used to extract heat from surface in summer to cool the deck
- Same heat can be "pumped" back into the pool

Typical applications of SIM systems

Train stations

- Add safety and convenience to outside train stations and platforms

Typical applications of SIM systems

Aviation

- Train tracks at airports

Typical applications of SIM systems

Aviation

- Medivac landing pads

Typical applications of SIM systems

Aviation

- Ramps, taxiways, runways

YYZ Pearson does not have a SIM system!

Fleet of scrapers, blowers, melters, and fuel trucks

Typical applications of SIM systems

Aviation

- Alternative…

Typical applications of SIM systems

Melting Hot Pads

- What to do with all that snow?
- Build a hydronic SIM system surrounding drains
- Push snow onto the "hot pad" or "melting pad" and melt away
- Just like a Zamboni melting pit!

- Critical in cities and commercial facilities

Typical applications of SIM systems

Summary: This section listed examples of applications

1. Sidewalks
2. Steps
3. Driveways
4. Ramps
5. Roads
6. Parking garages
7. Hangers
8. Pool decks
9. Train stations
10. Aviation
11. Melting “hot pads”

4. SIM Design Steps

Melting snow is basically a three-step process:

1. Warm the snow or ice to the melting temperature by applying 0.51 Btu/lb

2. Melt the snow into cold water; the latent heat of fusion for melting is 144 Btu/lb

3. Evapourate the water (or let it drain off)

SIM Design Steps

SIM heat loads are based on several factors:

- Slab temperature at start of snowfall
- Air temperature when snowing/melting
- Rate of snow fall
- Snow density
- Wind velocity
- Apparent sky temperature
- Humidity level of the atmosphere

These issues must be taken into account when predicting SIM loads

SIM Design Steps

This section will introduce the five main design steps

1. Select the appropriate performance level for the customer
2. Determine the required heat output/heat flux
3. Select and size heat source to meet the peak load
4. Design the piping distribution system in terms of size, spacing, circuit lengths
5. Size hydronic equipment such as circulator pumps, expansion tanks, etc.

Courtesy Arndt & Son

SIM Design Steps

1. Select the Appropriate Performance Level

- ASHRAE HVAC Applications "Ch. 51 Snow Melting and Freeze Protection" includes tables showing *Frequencies of snow-melting surface heat fluxes at steady state conditions* for major US cities
  - For cities not found in that table, a series of 14 calculations can be used to estimate the loads based on historical weather data for that location
- The designer and customer agree to the most appropriate Snow-Free Area Ratio and Frequency Distribution
- Then, the specific heat loads can be selected from the published data, weather research or case studies

SIM Design Steps

1. Select the Appropriate Performance Level

- ASHRAE HVAC Applications "Ch. 51 Snow Melting and Freeze Protection" provides relevant information for US cities for these calculations (with some assumptions)
- Designers can pick a similar Canadian city and use the Table
- Historical Weather Data found at http://climate.weather.gc.ca/index_e.html

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SIM Design Steps

1. Select the Appropriate Performance Level

- ASHRAE HVAC Applications "Ch. 51 Snow Melting and Freeze Protection"
- See excerpt below for Madison, WI:

Table 1 Frequencies of Snow-Melting Surface Heat Fluxes at Steady-State Conditions[a] (*Continued*)

Location	Snowfall Hours per Year	Snow-Free Area Ratio, A_r	Heat Fluxes Not Exceeded During Indicated Percentage of Snowfall Hours from 1982 Through 1993, Btu/h·ft² [b] 75%	90%	95%	98%	99%	100%
		1	81	108	123	150	170	233
Lexington, KY	50	0.5	49	65	74	85	95	197
		0	16	30	39	46	55	162
		1	99	138	164	206	241	449
Madison, WI	161	0.5	61	82	98	129	163	245
		0	23	39	60	91	113	194

- **Frequency Distribution** makes sense, but what about **Snow-Free Area Ratio**?

SIM Design Steps

1. Select the Appropriate Performance Level

Snow-Free Area Ratios:

- **Ar = 1.0 Snow-Free Area of 100%**
  No accumulation during snowfall

- **Ar = 0.5 Snow-Free Area of 50%**
  Some accumulation during snowfall

- **Ar = 0.0 Snow-Free Area of 0%**
  Surface may be covered with snow during heavy snowfall, melting snow from the bottom of the layer

Courtesy Thornton Plumbing & Heating

*Ex: **Ar = 0.5** is 50% snow-free during snow fall*
Snow will be completely melted, evaporated and dried before system turns off

SIM Design Steps

1. Select the Appropriate Performance Level

- Suggested Performance Levels:

SIM Application Type	Free Area Ratio (Ar)	Frequency Distribution (%)
Residential Sidewalk, Steps	0.5 or 1.0	75 or 90
Residential Driveway	0.0 or 0.5	75 or 90
Commercial Sidewalk, Steps	1.0	90 to 95
Commercial Parking Lot	0.5	75 or 90
Commercial Parking Ramp	0.5 to 1.0	90 to 95
School Sidewalk, Steps, Ramp	1.0	90
School Parking Lot	0.5	90
Fire/Rescue Station Vehicle Ramp	1.0	98 to 99
Hospital Sidewalk, Steps, Ramp	1.0	98 to 99
MediVac Landing Pad	1.0	99

Note:
These are friendly suggestions to help manage expectations.

Each customer should decide and confirm what is expected for their project.

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SIM Design Steps

1. Select the Appropriate Performance Level

- Sample heat flux values (for a climate similar to Boston, MA):

SIM Application Type	Free Area Ratio (Ar)	Frequency Distribution (%)	Required Heat Flux (Btu/hr-ft^2)
Residential Sidewalk, Steps	0.5 or 1.0	75 or 90	65 to 125
Residential Driveway	0.0 or 0.5	75 or 90	40 to 100
Commercial Sidewalk, Steps	1.0	90 to 95	125 to 175
Commercial Parking Lot	0.5	75 or 90	65 to 100
Commercial Parking Ramp	0.5 to 1.0	90 to 95	100 to 175
School Sidewalk, Steps, Ramp	1.0	90	125
School Parking Lot	0.5	90	100
Fire/Rescue Station Vehicle Ramp	1.0	98 to 99	200 to 225
Hospital Sidewalk, Steps, Ramp	1.0	98 to 99	200 to 225
MediVac Landing Pad	1.0	99	225

SIM Design Steps

1. Select the Appropriate Performance Level

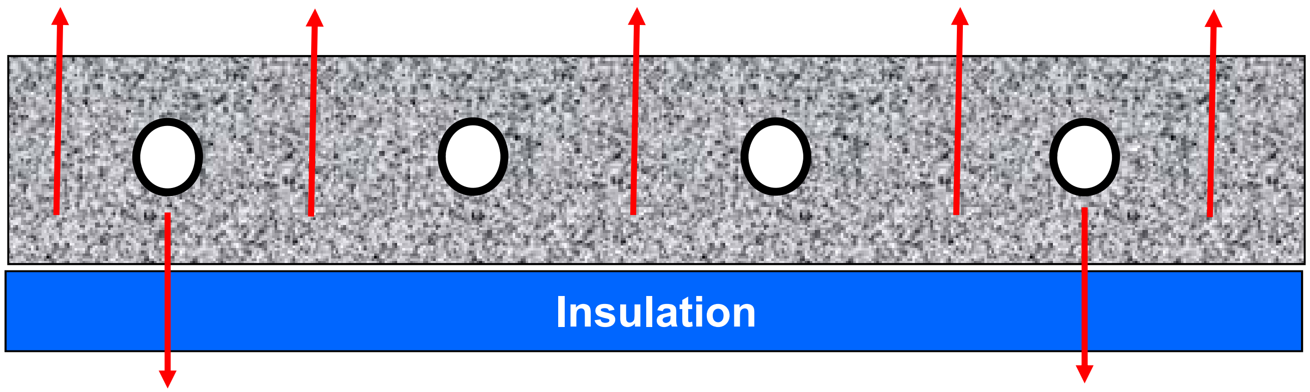
Example: Parking Ramp in Hamilton, Ontario

- Owner requests system to be **100%** snow-free during **95%** of snowfall events
- Owner agrees that even in more severe weather, this system will be adequate
- This means **Ar = 1.0 @ 95%** frequency distribution
- Melting area: **1,000 ft²** (92 m²)

SIM Design Steps

2. Determine Required Heat Output: Melting Operation

- Designer determines that for this project and location, with **Ar = 1.0 @ 95% frequency distribution**, system must supply **150 Btuh/ft^2** output (based on weather research)
- Must also expect 20% downward loss: **150 Btuh/ft^2 x 1.2 = 180 Btuh/ft^2**
- Required output is **180 Btuh/ft^2**



SIM Design Steps

3. Select and Size Heat Source

- Total load: 1,000 ft^2 x 180 Btuh/ft^2 = **180,000 Btuh** required output
- This is the total heat load for sizing the source, circulator, and piping network

Heat source options:

- Dedicated boiler sized for this load
- Shared boiler sized for the SIM load *plus* heating loads or swimming pool or radiant heating
  - Be sure the SIM portion contains glycol antifreeze
- Approved combi-heater unit
- Geothermal water-to-water heat pump
- Waste heat from industrial processes
- Rejected heat from commercial cooling system

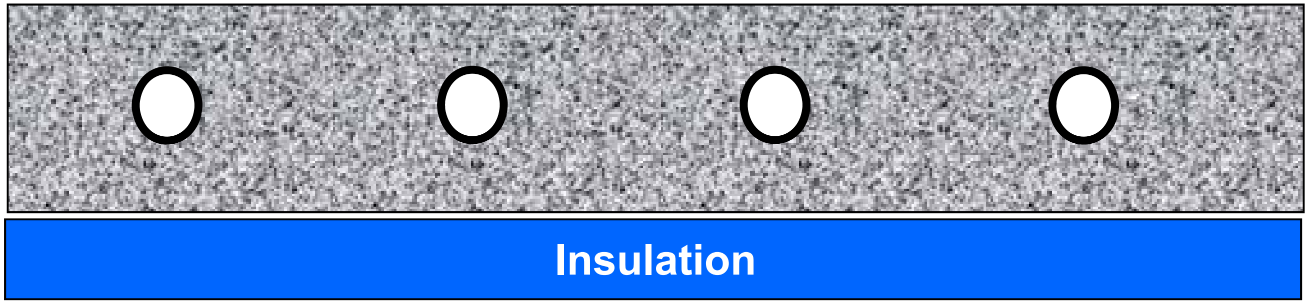
This system will use a dedicated boiler

SIM Design Steps

4. Design the Piping Distribution System

The designer selects:

a. Tube size (**3/4 NTS tubing is typical;** 1/2 in. and 5/8 in. tubing is sometimes used)
b. Tube spacing (6 to 9 inch tube spacing is typical, based on width of area)
c. Tube circuit lengths (100 ft. to 300 ft. circuit length is typical, but this is based on load, tubing size, heated area and the selected circulator)



Poured concrete with tubing embedded 2 in. to 3 in. from top surface is ideal for faster response time

SIM Design Steps

4. Design the Piping Distribution System

The designer selects:

a. **¾ Tube size** (¾ NTS tubing is typical; 1/2 and 5/8 tubing sometimes used)
b. **8 in. Tube spacing** (6 to 9 inch tube spacing is typical, based on width of area)
c. **250 ft. Circuit lengths** (100 ft. to 300 ft. circuit length is typical, based on heat load, tubing size, heated area and the selected circulator)

Poured concrete with tubing embedded 2 in. to 3 in. from top surface is ideal for faster response time

SIM Design Steps

4. Design the Piping Distribution System

- Reference, CSA B214-16 (www.shopcsa.ca)

Table 3
Loop lengths for snow and ice melt systems
(See Clause 17.3.3.)

Nominal size	Maximum active loop length, m (ft)	Total loop length, m (ft)
PEX or PE-RT tubing		
1/2	40 (130)	45 (150)
5/8	70 (225)	75 (250)
3/4	90 (300)	100 (325)
1	135 (450)	145 (475)
Copper tube*		
1/2	—	43 (140)
3/4	—	85 (280)

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SIM Design Steps

4. Design the Piping Distribution System

- Chosen design uses 3/4 in. tubing @ 8 in. spacing
- This spacing requires 1.5 ft. tubing per ft^2, based on simple math 12”/8” = 1.5

- 1,000 ft^2 x 1.5 ft. tubing per ft^2 = **1,500 ft.** of tubing total requirement

- Divide the 1,500 ft. total length into 6 equal circuits:

- 1,500 ft. ÷ 6 Circuits = **250 ft/circuit** (each circuit covers 167 ft^2)

- Heat load per circuit: **180,000 Btuh ÷ 6 = 30,000 Btuh per circuit**

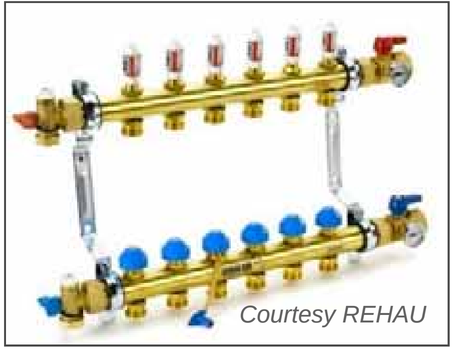
SIM Design Steps

4. Design the Piping Distribution System

- **Tubing layout will have 6 equal circuits, each delivering up to 30,000 Btuh, through a nearby manifold**

- Using 50% Glycol and a 25ºF ΔT:

- $\frac{180{,}000 \text{ Btuh}}{11{,}030 \text{ Btu/GPM}}$ = **16.3 GPM** flow rate (2.7 GPM/circuit)



Courtesy REHAU

- This info can be used to determine head loss through the piping network using the PPI **Plastic Pressure Pipe Design Calculator**

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SIM Design Steps

4. Design the Piping Distribution System

- Evaluate head loss with 2.7 GPM in ¾ PEX or PE-RT:
- PPI **Plastic Pressure Pipe Design Calculator** www.plasticpipecalculator.com
- Head loss is 17.0 feet (velocity is 2.4 ft/s) in the distribution pipes

PRESSURE DROP / HEAD LOSS

Input	
Pipe Selection:	PEX (ASTM F876/CSA B137.5)
	SDR 9 / 3/4"
Flow Rate:	2.7 USGPM
Length of Pipe:	250 ft
Fluid Type (Water or % Glycol):	50% Propylene Glycol
Average Fluid Temperature*:	60 °F

Calculate

Results		
Flow Regime:	Laminar	
Pressure Drop:	7.4 Psi	50.9 kPa
Head Loss:	17.0 ft water	
Velocity*:	2.4 ft/s	0.7 m/s

Calculation Details Print Email

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SIM Design Steps

5. Perform Hydronic Calculations

- Size heat source piping, circulator, valves, etc. around this flow requirement
- Size expansion tank considering large range of temperatures
- Size the piping to the manifold to minimize head loss (probably 1 ¼” PEX)
- Calculate head loss through each component which is in series to determine the total head loss value for selecting circulator


Courtesy Arndt & Son

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SIM Design Steps

Summary: This Learning Objective introduced the five main design steps

1. Select the appropriate performance requirement
2. Determine the required heat output
3. Select and size heat source to meet the load
4. Design the distribution system in terms of size, spacing and layout
5. Perform hydronic calculations for sizing equipment such as circulator pumps, expansion tanks, etc.

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5. Control Strategies

This section discusses three control strategies

a. On/Off – System turns on with moisture + cold, turns off when dry
- The most economical in terms of annual operating costs
- May be fully automatic, or use outdoor moisture sensor (options)

b. Idle/Melt – Idles when dry, heats up with moisture + cold
- Reduces response time to start melting
- Consumes much energy to stay warm in between events

c. Always On – Constantly keeps outdoor surface warm, always ready to melt
- Electronic control will monitor supply/return fluid temperatures to modulate the fluid temperature and the heat output, as needed

Control Strategies

a. On/Off – System turns on with moisture + cold, turns off when dry

- Cold start each time there is snow or ice
- A "semi-automatic" control provides electronic slab temperature control with fluid temperature modulation, starting with human initiation

Pros

- "Semi-automatic" control lowers capital cost, good for many residential systems
- A "fully automatic" control with moisture and temperature detection operates autonomously, provides lots of *tuning* possibilities

Cons

- With "semi-automatic", a human needs to turn it on and set the timer
- Can underperform if not operated correctly, can waste energy if overused

Control Strategies

b. Idle/Melt – Idles when dry, heats up with moisture + cold

- Reduces response time to start melting operation
- Typical idle temperature is 28°F (-2°C) - adjustable
- Typical melting temperature is 38°F (4°C) – adjustable
- Can program “cold weather cut-off” to prevent heating when it’s too cold to snow

Pros

- Reduces response time to start melting
- Avoids heat/cool cycles for delicate outdoor surfaces
- Automatic controls can improve safety and save energy

Cons

- Idling consumes much energy, to stay warm in between events
- May increase annual energy consumption by 4 to 8 times due to Idling

Control Strategies

c. Always On – Constantly keeps outdoor surface warm, always ready to melt

- Electronic control will monitor outdoor surface temperature and modulate the fluid temperature and the heat output, as needed, to keep surface warm
- May be suitable when the SIM load is a fraction of the total building heat load
  Ex: Entrance to a hospital, sidewalk in a university campus

Pros

- Always ready, ultimate safety
- Avoids complexity of controls
- Great way to reject process heat or excess building heat
- Warm sidewalks feel good in winter!

Cons

- Always using energy

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Control Strategies

Moisture and temperature sensors are installed in ramps, sidewalks, driveways

Sensor socket before concrete

Sensor within a ramp

Sensor close-up

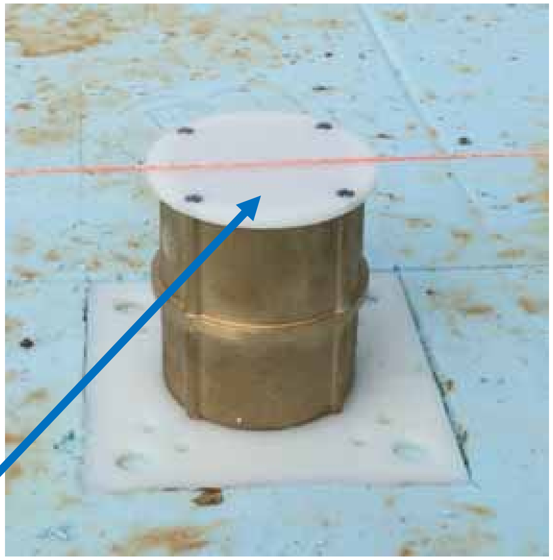
Control Strategies

Moisture and temperature sensor placement recommendations:

- Install in the *first area* to be hit with blowing or falling snow
- The *last place* to be warmed by the sun
- Last place to be dried due to drainage
- Align sensor surface parallel to the slope of the surface
- Brush off sand and dirt regularly

Avoid placing sensors:

- Under parked cars
- In vehicle tire tracks
- In protected areas, like beside bushes or under the roof



Sensor height being aligned with future top surface

Control Strategies

This section discusses three control strategies

- We didn't even mention smart web-based controls, or "apps"
- There are many specific options available from experienced firms

6. Comments on Operating Costs

This section discusses methods to estimate SIM operating costs

The math is simple if you can predict or estimate:
- Location
- Melting area (of the surface)
- Annual hours of operation (melting)
- Number of events (for pick-up loads)
- Annual hours of idling (not operating)
- Heat flux/load during operation
- Heat flux/load during idling
- Fuel type
- Fuel cost
- Efficiency of heat source

Comments on Operating Costs

Example: 1,000 ft^2 ramp in Hamilton, Ontario. No idling

- Location: Hamilton, ON
- Melting area: **1,000 ft^2** (92 m^2)
- Annual hours of operation: **120 hours**
- Number of events: **10 times** (12 hours/event)
- Annual hours of idling: no idle
- Heat flux/load during operation: **180 Btu/hr-ft^2** (max.)
- Heat flux/load during idling: no idle
- Fuel type: **Natural gas**
- Fuel cost: Approximately **\$0.30/m^3** (see next slide)
- Efficiency of heat source: **95%** AFUE boiler

Comments on Operating Costs

Example: 1,000 ft^2 ramp in Hamilton, Ontario. No idling

- Location: Hamilton, ON
- Fuel type: Natural gas
- Fuel cost: see *Rate M1 South* Union Gas
- Summary: Approximately **$0.30/m^3**

CHARGES	RATES at Jul. 1, 2017
Gas Used	16.2902 ¢/m³
Gas Price Adjustment	2.9432 ¢/m³
Transportation to Union Gas	0.0000 ¢/m³
Storage	0.7153 ¢/m³
Storage Price Adjustment	0.0000 ¢/m³
Delivery First 100 m³ Next 150 m³ All over 250 m³	 8.0575 ¢/m³ 7.8164 ¢/m³ 7.1934 ¢/m³
Delivery Price Adjustment	0.0000 ¢/m³
Monthly Charge	$21.00
Total Annual Impact	

Comments on Operating Costs

Example: 1,000 ft^2 ramp in Hamilton, Ontario. No idling

Part 1: Energy Demand

- Operation: 120 hours x 180 Btu/hr-ft^2 x 1,000 ft^2 = 21,600,000 Btu/year
- Pick-up: 10 events x 350,000 Btu/event = 3,500,000 Btu/year
- Total Annual Load: 21.6 + 3.5 = **25.1 million Btu/year**

Part 2: Cost of Energy Produced

- Fuel cost: Approximately \$0.30/m^3
- Efficiency of heat source: 95% AFUE boiler
- Energy Content of gas: 36,000 Btu/m^3 (published)
- Cost per 1 million Btu = \$0.30/m^3 ÷ 36,000 Btu/m^3 ÷ 95% x 1 million

= **\$8.7 per million Btu produced**

Comments on Operating Costs

Example: 1,000 ft^2 ramp in Hamilton, Ontario. No idling

Part 3: Annual Cost Estimate

- 25.1 million Btu/year x $8.7 per million Btu produced = **$220/year**

- Plus incremental electrical costs for circulator/s
- Compare with typical contracting costs for mechanical snow removal, plus sanding and salting (and the inconvenience and cost of snow banks left behind)
  - Savings could be **75% or more** compared with mechanical snow removal costs

Comments on Operating Costs

Summary: This section discussed methods to estimate SIM operating costs

Hydronic SIM systems are efficient, reliable and can reduce operating costs

Course Summary

This course did:

1. Indicate the typical benefits of SIM systems

2. Describe the three most common installation techniques

3. List a selection of typical applications

4. Introduce the five main design steps

5. Discuss the most common control strategies

6. Comment on operating costs

Winter's coming!

Design and Installation of Hydronic Snow and Ice Melting (SIM) Systems to Optimize Performance and Efficiency

Thank you!