Snow & Ice Melting System Solutions

Introduction

This presentation was developed for a 30-minute timeframe in an industry conference

PPI has a more in-depth presentation Design and Installation of Hydronic Snow & Ice Melting Systems to Optimize Performance and Efficiency that contains more information about design, installation, controls, and operating costs

Developer Contact:
Lance MacNevin, P.Eng.
Director of Engineering – PPI Building & Construction Division
Tel (469) 499-1057 lmacnevin@plasticpipe.org

The Plastics Pipe Institute

PPI Represents All Sectors of the Plastic Pipe Industry

- PPI was formed in 1950 to research and develop test methods for plastic pressure pipes
- Today: Non-profit trade association serving North America, based in Irving, TX

PPI Mission: To advance the acceptance and use of plastic pipe systems through research, education, technical expertise, and advocacy

Members: Over 170 member firms involved with the plastic pipe industry

PPI Website: www.plasticpipe.org

The Plastics Pipe Institute

PPI 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 (radiant) heating & cooling, snow & ice melting, district heating & cooling, and ground source geothermal piping systems.

BCD Materials: CPVC, HDPE (Geothermal), PEX, PE-RT, PEX-AL-PEX, and PP (PP-R & PP-RCT)

BCD homepage: https://plasticpipe.org/building-construction/index.html

What Is A Hydronic SIM System?

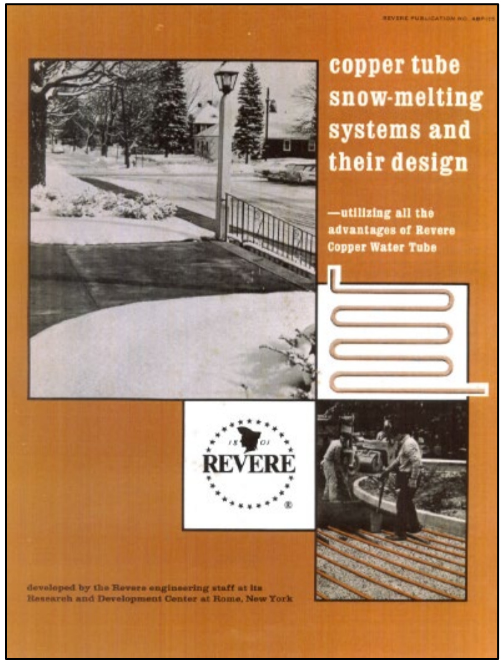
- **Snow & Ice Melting (SIM) systems** are hydronic systems designed to remove snow and ice by circulating a heat transfer fluid* through tubing installed in an outdoor surface
  **typically propylene glycol mixed with water at a ratio to prevent freezing*

- SIM systems are used across North America in **all climates**

- The piping material for SIM distribution systems is typically:
  - **PEX**: Crosslinked Polyethylene, or
  - **PE-RT**: Polyethylene of Raised Temperature Resistance

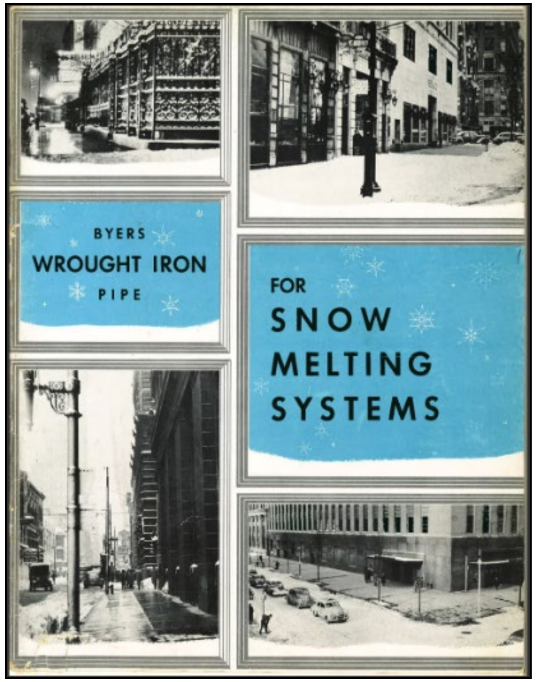
What Is A Hydronic SIM System?

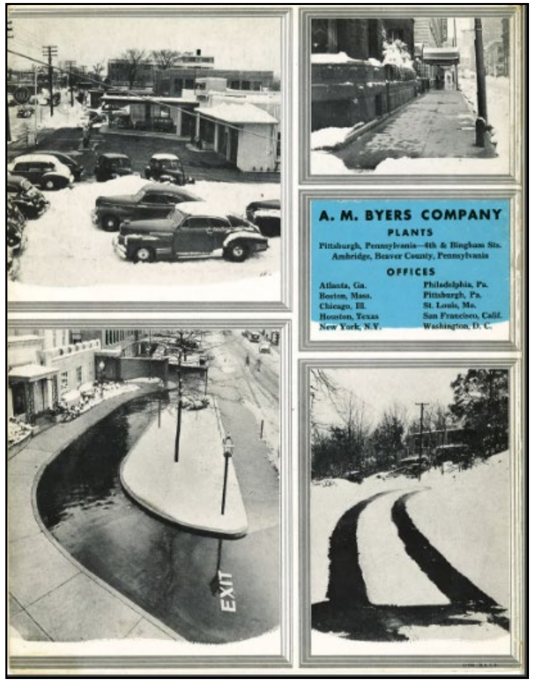
SIM systems are not new! They were pioneered in the 1930s, or earlier, using iron piping. Copper was the “new” material in the 1950s. Old industry manuals were excellent and thorough.



Revere no longer produces copper tubing

A.M. Byers closed in 1969





Outline

1. Benefits of SIM systems
2. Typical installation techniques
3. Common applications
4. Operating costs

Note: The PPI presentation *Design and Installation of Hydronic Snow & Ice Melting Systems to Optimize Performance and Efficiency* contains more information about design, installation, controls, and operating costs.

1. Benefits of Snow & Ice Melting Systems

This section will explain six benefits of SIM systems

1. Better safety
2. Reduced liability
3. Healthier convenience
4. Lowered maintenance costs
5. Minimized environmental impact
6. Long-term reliability

Benefits of Snow & Ice Melting Systems

1. Better Safety

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

Courtesy Viega LLC

Benefits of Snow & Ice Melting Systems

2. Reduced Liability

- Snowbanks, ice, and trip hazards are practically eliminated
- Improve access and safety, while eliminating a source of liability risk in winter for homes and businesses
- Liability insurance premiums might even be reduced, potentially reducing ownership costs

Plastics Pipe Institute
BUILDING & CONSTRUCTION

This is going
to hurt later.

Benefits of Snow & Ice Melting Systems

3. Healthier Convenience

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

Published via social media by American Heart Association in Feb. 2021

Benefits of Snow & Ice Melting Systems

4. Lowered Maintenance Costs

- Traditional snow removal is very expensive and unpredictable
- Facility owners can pay thousands of dollars per year for labour, 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

Snow removal equipment and supplies at airport parking garage

Salt at bank entrance

Benefits of Snow & Ice Melting Systems

5. Minimized Environmental Impact

- Hydronic SIM systems are typically powered by high-efficiency boilers, electricity, geothermal heat pumps, or waste heat
- Less fuel is used to power boilers than to power plows & trucks (= lower CO_2 emissions)
- SIM systems extend lives of surfaces by eliminating scraping, salting, and sanding operations
- Run-off of deicing chemicals (e.g., salt) onto lawns and drains is practically eliminated
- These factors can save energy and reduce environmental impacts


Courtesy REHAU

Benefits of Snow & Ice Melting Systems

6. Long-term Reliability

- Boilers, heat pumps, circulators, piping components are highly reliable
- Plastic tubing does not corrode - inside or outside
- With proper design and installation, hydronic SIM systems provide decades of reliable operation with virtually no maintenance to piping systems

Courtesy Zurn PEX

Benefits of Snow & Ice Melting Systems

6. Long-term Reliability

- Piping material for SIM systems is typically:
  - **PEX**: Crosslinked Polyethylene, or
  - **PE-RT**: Polyethylene of Raised Temperature Resistance

- PEX tubing is produced in accordance with standards **ASTM F876/F3253 & CSA B137.5**
- PE-RT tubing is produced in accordance with standards **ASTM F2623 & CSA B137.18**

- Tubing has long-term pressure ratings of 100 psi @ 180°F (690 kPa @ 82°C)
- These are tough and durable, yet flexible, products

Courtesy REHAU

Courtesy Dow

Benefits of Snow & Ice Melting Systems

Summary: Benefits include…

1. Better safety
2. Reduced liability
3. Healthier convenience
4. Lowered maintenance costs
5. Minimized environmental impact
6. Long-term reliability

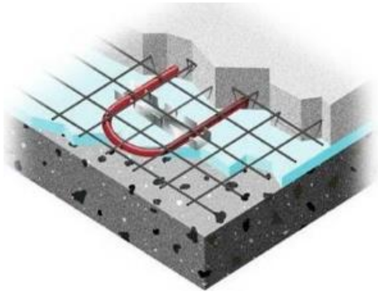
SIM Installation Techniques

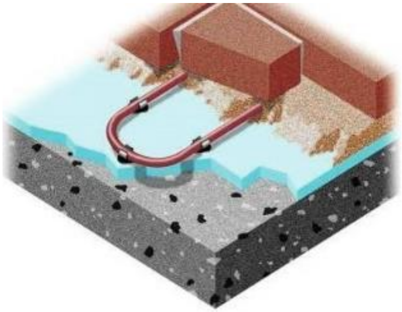
Three typical installation types for outdoor surfaces

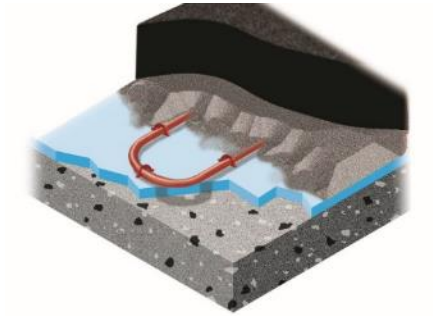
1. Poured concrete
2. Interlocking pavers
3. Asphalt

Hydronic snow & ice melting systems can be successfully installed in practically all types* of external surfaces

**Permeable concrete is the most difficult surface*





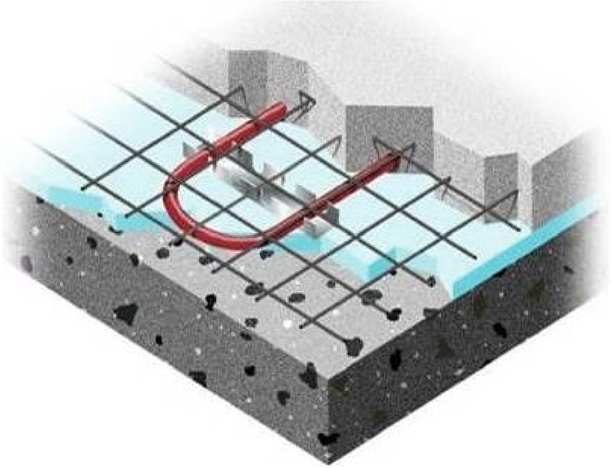


SIM Installation Techniques

1. 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 inches (5 to 8 cm) below the surface for faster response time (not always practical)
- Tubing is often stapled directly onto the insulation board, or tied to rebar or wire mesh within the poured concrete
- Some insulation board has integrated "knobs" for holding the tubing

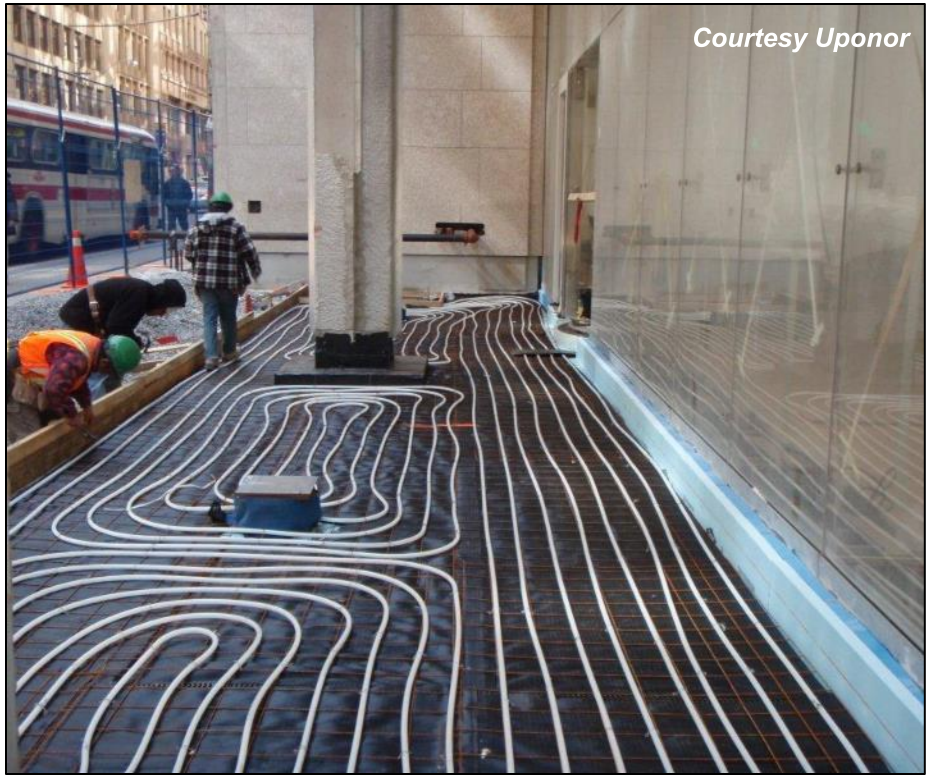
- This is a simple and affordable technique for installing SIM piping

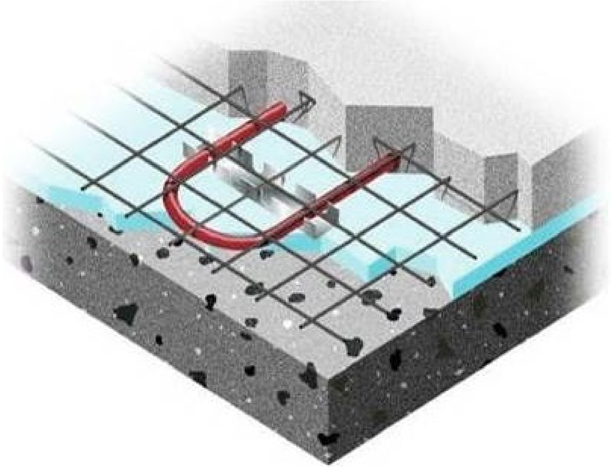


Poured concrete with tubing embedded 2 to 3 inch from top surface

SIM Installation Techniques

1. Tubing embedded within poured concrete

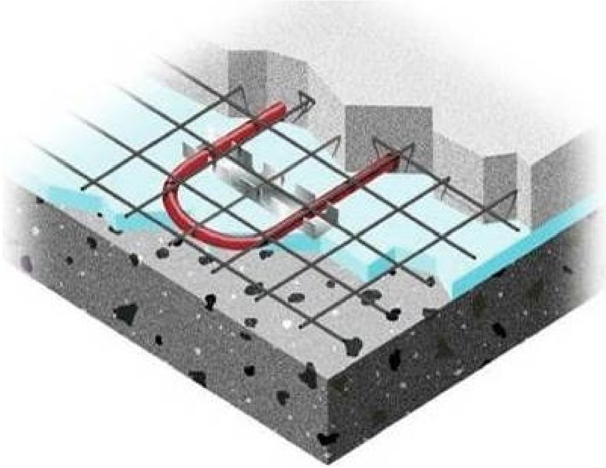




Poured concrete with tubing embedded 2 to 3 inch from top surface

SIM Installation Techniques

1. Tubing embedded within poured concrete



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

Plastics Pipe Institute
BUILDING & CONSTRUCTION

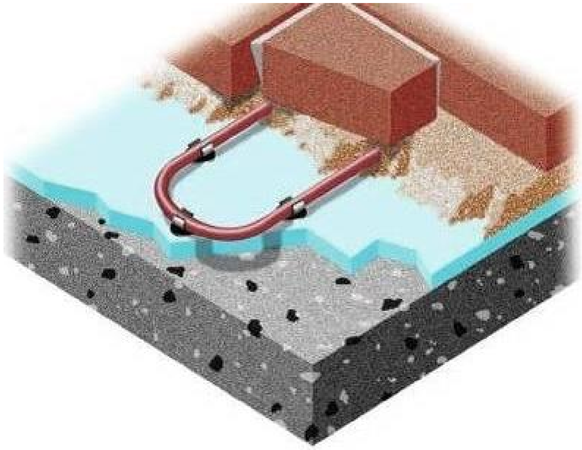
SIM Installation Techniques

2. 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 inches (4 cm) of sand bed, compacted to 1 1/8 inches (3 cm) thick
- 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

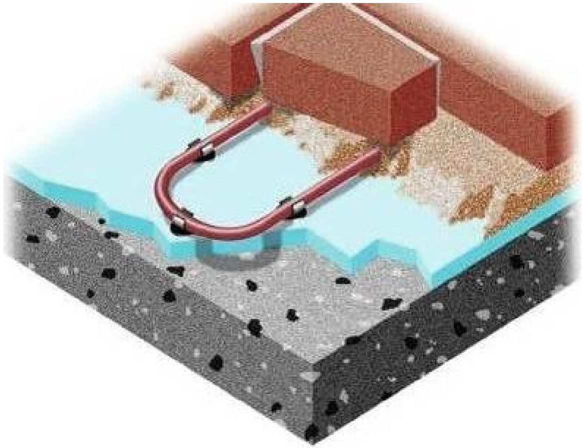
- Compacted sand bed is recommended
- Stone dust loses strength when wet, and can heave when frozen



Pavers installed over sand bed with embedded heating tubing

SIM Installation Techniques

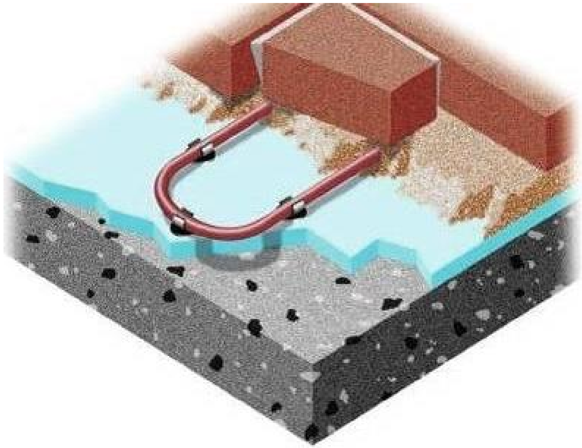
2. Tubing installed under interlocking pavers



Pavers installed over sand bed
with embedded heating tubing

SIM Installation Techniques

2. Tubing installed under interlocking pavers



Pavers installed over sand bed with embedded heating tubing

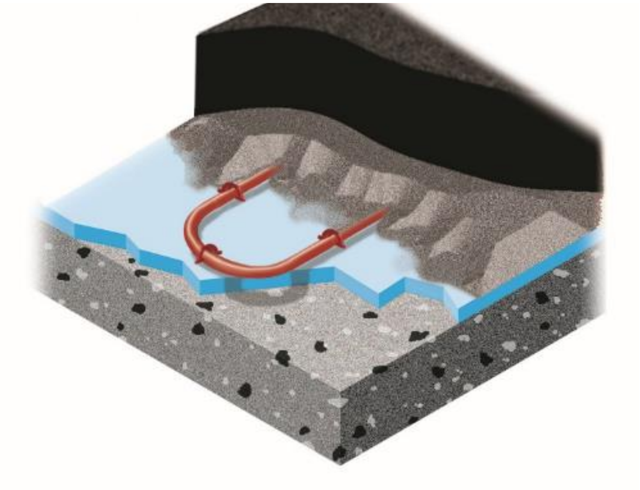
SIM Installation Techniques

3. Tubing installed under asphalt

- Plastic tubing is installed above insulation using plastic rails, staples or screw clips
- Tubing is encased within 3 inches (7.5 cm) of stone dust or sand media, compacted
- Asphalt is placed above the media (dust or sand) 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 from overheating until the asphalt cools off

Media

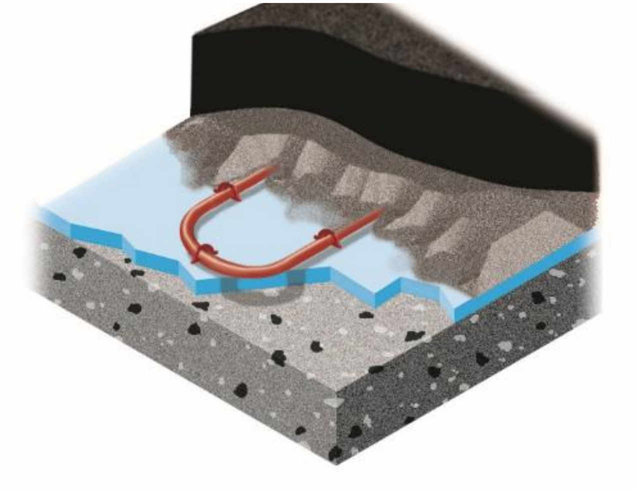
- Compacted stone dust works best
- No pea stone or crushed gravel



Tubing embedded within sand or stone dust below asphalt

SIM Installation Techniques

3. Tubing installed under asphalt



Tubing embedded within sand or stone dust below asphalt

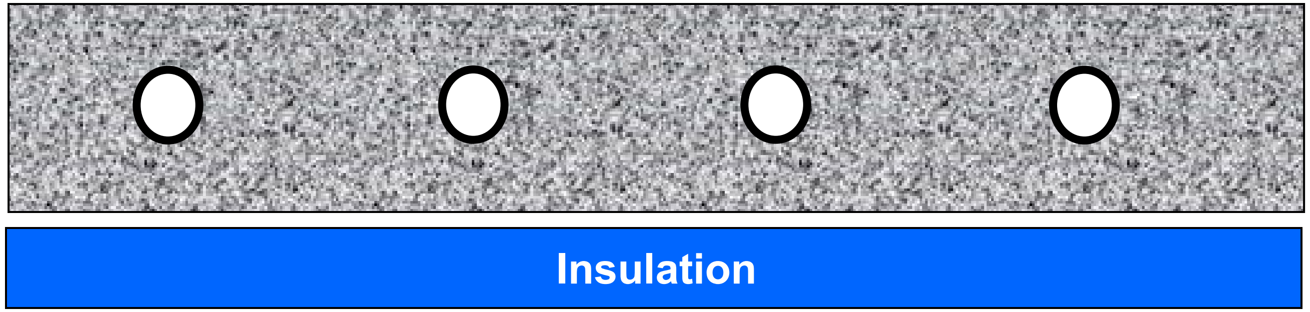
SIM Installation Techniques – Piping Design

The piping designer has several options:

a. Tube size (3/4 tubing is typical; 1/2 or 5/8 tubing is sometimes used (lower profile, shorter circuit)

b. Tube spacing (6 to 9 inch tube spacing is typical, based on heat load, width of area)

c. Tube circuit lengths (150 ft. to 300 ft. circuit length is typical, based on melting load, tubing size, heated area, and the selected circulator)



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

SIM Installation Techniques – Piping Design

Piping example:

a. Select ¾ **Tube size**

b. Install at **8 inch (20 cm)** on-center Tube spacing (works well for 20 ft. width)

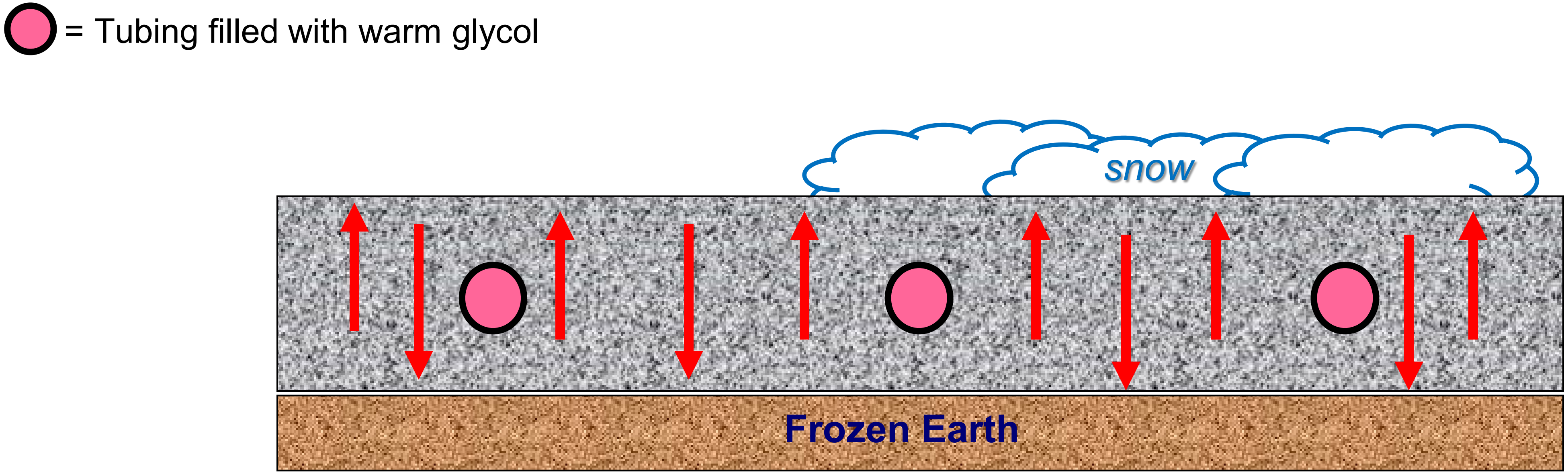
c. Design for **250 ft. (76 m) Circuit lengths** (to keep head loss low)

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

SIM Installation Techniques - Insulation

Importance of Appropriate Insulation

- A significant amount of heat is conducted to the frozen earth below the SIM surface, if appropriate insulation is not installed
- <u>Without insulation</u>, downward losses can exceed **50%** of all the energy supplied to the area (especially at cold start)
- You'd better double the size of heat source and circulators!

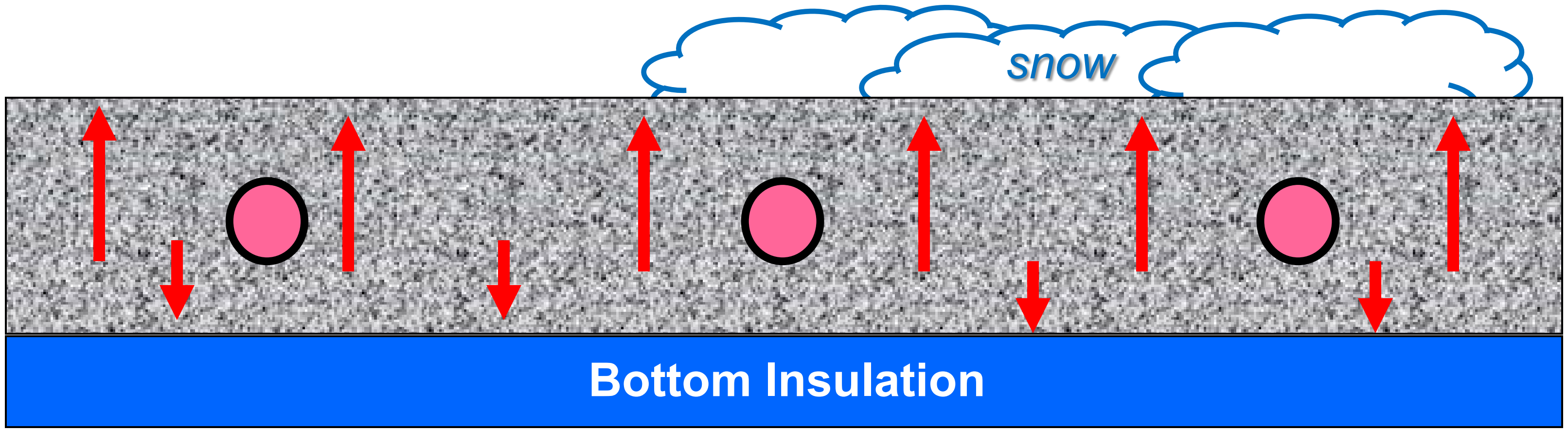


SIM Installation Techniques - Insulation

Importance of Appropriate Insulation

- A significant amount of heat is conducted to the frozen earth below the SIM surface, if appropriate insulation is not installed
- With insulation, downward losses are significantly reduced, better response time
- Smaller heat source and circulators, better efficiency!

= Tubing filled with warm glycol



SIM Installation Techniques - Insulation

Importance of Appropriate Insulation

- Most codes (e.g., CSA B214) require **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 expected compressive loading from vehicles, or settling can occur
- E.g., Use high compressive-load insulation for vehicle roadways, loading docks, etc.

Spray-foam insulation on old stone steps (church)

Medivac landing pad on hospital rooftop

SIM Installation Techniques - Drainage

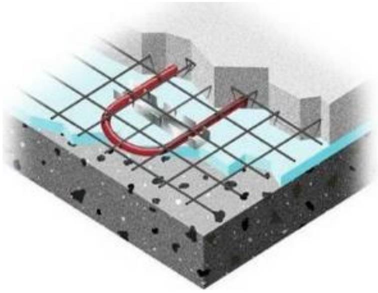
Importance of Drainage

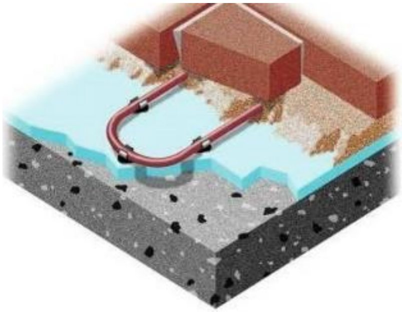
- Melted snow (just like rain) must have a good drainage path
- Slope surfaces for natural drainage
- Drain to lowest points of the property
- Control run-off so as not to create hazards
- Plan locations of trench drain box/s
- Be sure that drains will not freeze; use pipes around or under a drain (see image)
- Connect drain to available storm sewer system, within code requirements
- Some systems drain to a nearby pond

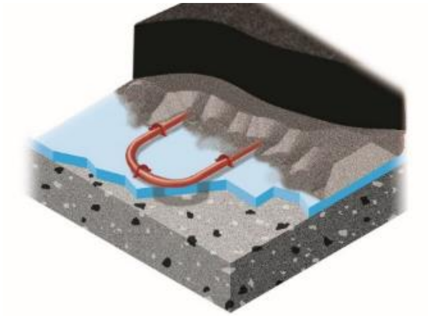
SIM Installation Techniques

Summary: Three installation types for outdoor surfaces

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







Images Courtesy REHAU

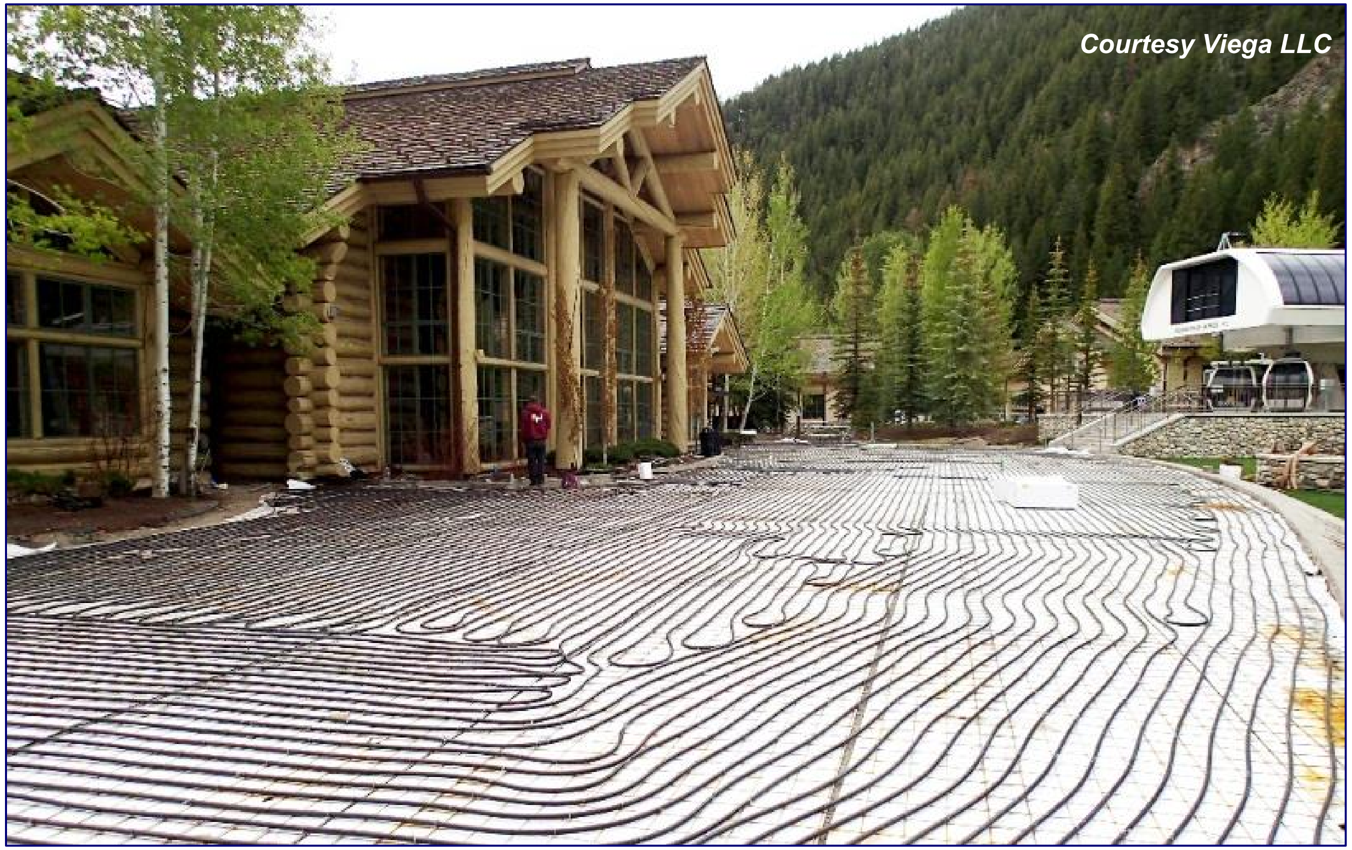
Note: See **CSA B214:21 *Installation Code for Hydronic Heating Systems*** for requirements on SIM installations
Latest 2021 edition released Jan. 15, 2021

Typical Applications of SIM systems

Common applications

1. Sidewalks
2. Steps
3. Driveways
4. Ramps
5. Pool decks

Snow & Ice Melting is popular at ski resorts, as is radiant floor heating inside the buildings



Typical Applications of SIM systems

1. Sidewalks

- Private homes

Typical Applications of SIM systems

1. Sidewalks

- Municipal buildings, universities, commercial building entrances


Courtesy Klimatrol


Courtesy Uponor

Typical Applications of SIM systems

2. Steps

- Residential installations

Typical Applications of SIM systems

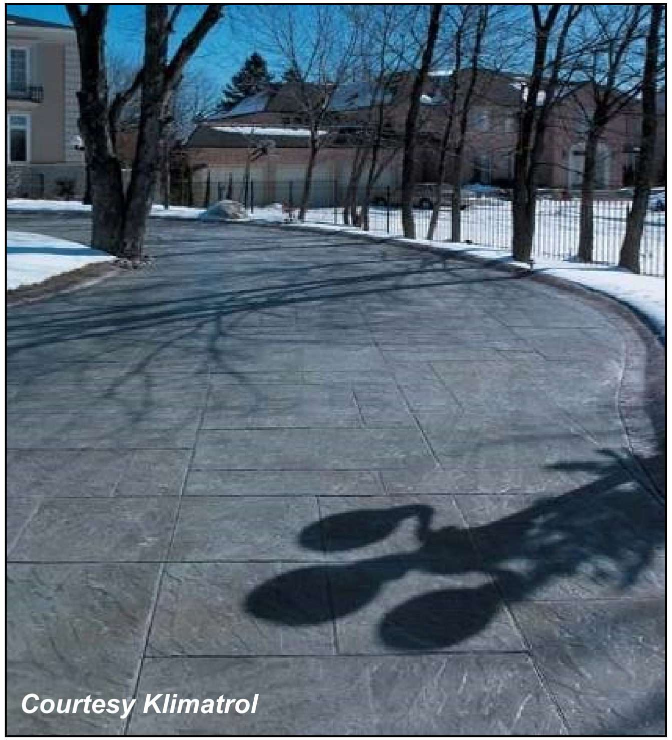
3. Driveways

- Under stained concrete

Typical Applications of SIM systems

3. Driveways

- Under stained concrete or pavers



Typical Applications of SIM systems

3. Driveways

- Under stained concrete or pavers

Typical Applications of SIM systems

3. Driveways

- Commercial applications


Courtesy Thornton Plumbing & Heating

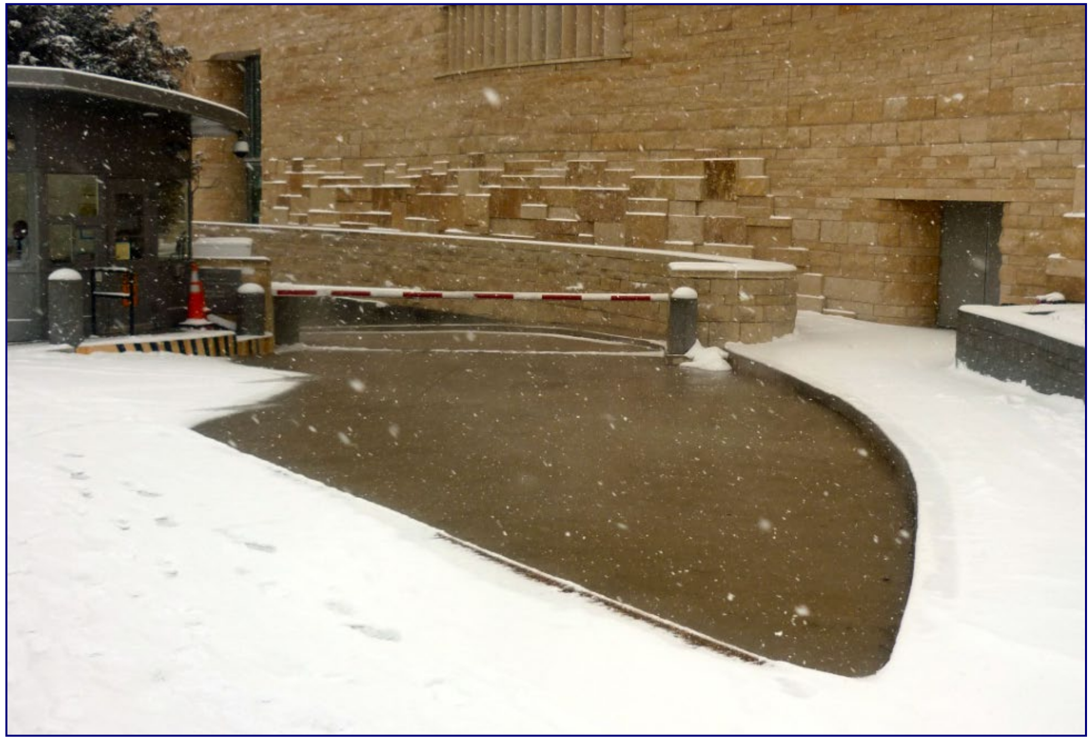
PPI
Plastics Pipe Institute
BUILDING & CONSTRUCTION

Typical Applications of SIM systems

4. Ramps

- Pedestrian and vehicle ramps


Courtesy REHAU

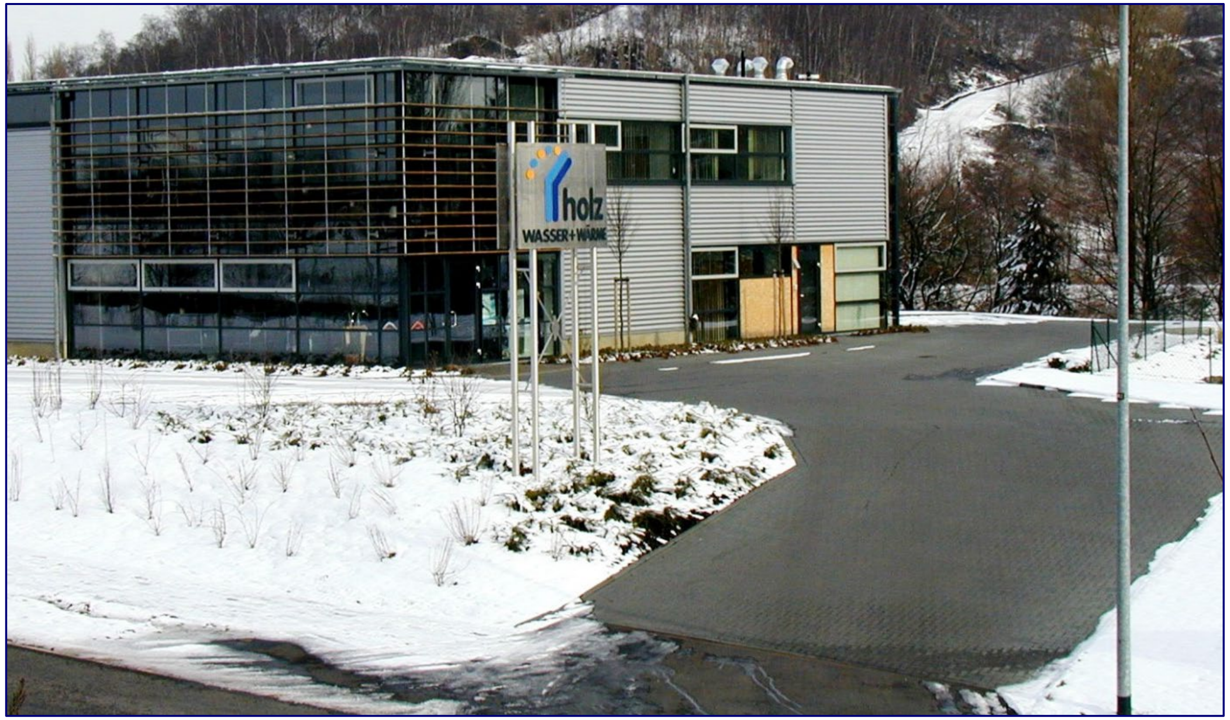


Typical Applications of SIM systems

4. Ramps

- Pedestrian and vehicle ramps


Courtesy Uponor x 2



Typical Applications of SIM systems

4. Ramps

- Parking garage ramps

Courtesy REHAU

Typical Applications of SIM systems

5. Pool decks/Hot tubs

- Facilitates winter access

Typical Applications of SIM systems

Summary: Common application types

1. Sidewalks
2. Steps
3. Driveways
4. Ramps
5. Pool decks

Operating Costs

Following a careful design, it is possible to estimate operating costs, if you know or can reasonably predict:

1. Project location (for weather data)
2. Melting area (of the surface)
3. Annual hours of operation (melting)
4. Number of events (for pick-up loads)
5. Heat flux/load during operation (melting load)
6. Annual hours of idling (a control strategy)
7. Heat flux/load during idling (if selected)
8. Fuel type (e.g., gas, electric, propane)
9. Fuel cost (cost of energy)
10. Efficiency of heat source (%)

Operating Costs

Example (USA): 1,000 ft^2 hotel entrance in <u>Albany, NY</u>

1. Location: Albany, NY
2. Melting area: **1,000 ft^2**
3. Annual hours of operation: **156 hours** (based on weather data)
4. Number of events: **10 times/year** (estimating 15.6 hours/event)
5. Heat flux/load during operation: **150 Btu/hr-ft^2** (maximum)
6. N/A (**no idling – Select On/off control**)
7. N/A (no idling – Select On/off control)

A. Energy Usage Estimate:

- Maximum energy usage: **150 Btu/hr-ft^2 x 1,000 ft^2 = 150,000 Btu/hr**
- Estimate annual energy usage: **32,500,000 Btu/year**

Operating Costs

Example (USA): 1,000 ft^2 hotel entrance in Albany, NY

8. Fuel type: **Natural gas**
9. Fuel cost: Approximately **$0.50/Therm**
10. Efficiency of heat source: **95%** AFUE boiler

B. Cost of Energy Estimate:

- Energy Content (gas): 100,000 Btu/Therm (this is a known factor)

- Cost per *1 million Btu* = $\frac{\$0.50/\text{Therm} \times 1{,}000{,}000}{100{,}000\ \text{Btu/Therm} \times 95\%\ \text{efficiency}}$

= **$5.25 USD per million Btu produced**

PPI
Plastics Pipe Institute
BUILDING & CONSTRUCTION

Operating Costs

Example (USA): 1,000 ft² hotel entrance in Albany, NY

C. Hourly Cost Estimate

- 150,000 Btu/hr x **$5.25** per million Btu produced = **$0.79/hour in fuel costs**

D. Annual Cost Estimate

- **32.5** million Btu/year x **$5.25** per million Btu produced = **$170.00/year in fuel costs***

**includes starting up the system 10 times, plus melting for 15.6 hours per snow event*

What would it cost for an annual snow removal contract?
Probably more than $1,000/year

Operating Costs

Example (Canada): 1,000 ft² (93 m²) ramp in Hamilton, Ontario

1. Location: Hamilton, ON
2. Melting area: **1,000 ft²** (93 m²)
3. Annual hours of operation: **120 hours** (based on weather data)
4. Number of events: **10 times/year** (estimating 12 hours/event)
5. Heat flux/load during operation: **150 Btu/hr-ft²** (maximum)
6. N/A (**no idling – Select On/off control**)
7. N/A (no idling – Select On/off control)

A. Energy Usage Estimate:

- Maximum energy usage: **150 Btu/hr-ft² x 1,000 ft² = 150,000 Btu/hr**
- Estimate annual energy usage: **25,000,000 Btu/year**

Operating Costs

Example (Canada): 1,000 ft^2 (93 m^2) ramp in <u>Hamilton, Ontario</u>

8. Fuel type: **Natural gas**
9. Fuel cost: Approximately **$0.25/m^3**
10. Efficiency of heat source: **95%** AFUE boiler

B. Cost of Energy Estimate:

- Energy Content (gas): 36,000 Btu/m^3 (this is a known factor)

- Cost per *1 million Btu* = $$\frac{\$0.25/m^3 \times 1{,}000{,}000}{36{,}000\ Btu/m^3 \times 95\%\ efficiency}$$

= **$7.30 CAD per million Btu produced**

Operating Costs

Example (Canada): 1,000 ft^2 (93 m^2) ramp in Hamilton, Ontario

C. Hourly Cost Estimate

- 150,000 Btu/hr x **$7.30** per million Btu produced = **$1.10/hour in fuel costs**

D. Annual Cost Estimate

- **25** million Btu/year x **$7.30** per million Btu produced = **$182.50/year in fuel costs***

**includes starting up the system 10 times, plus melting for 12 hours per snow event*

What would it cost for an annual snow removal contract?

Probably more than $1,000/year

Operating Costs

Result:

- SIM systems have the potential to reduce snow removal costs by 75% or more vs. mechanical removal
- Eliminate frequent sanding and salting, and the inconvenience and cost of snowbanks left behind
- Plus, the SIM system can be automatic (with the right controls) and is always on time!
- **Hydronic SIM systems deliver benefits and safety, plus cost savings for the owners**

Courtesy Thornton Plumbing & Heating

Operating Costs

Disclaimers, Caveats, Notices, etc.

- All figures were based on stated assumptions and estimates

- Other control strategies can affect costs (e.g., Idling the ramp between snowfalls)

- Electrical costs for heat source, circulator, controls are not shown, but these are minor in comparison

- All SIM systems should be designed by qualified experts with knowledge of local and jobsite conditions and consultation with project owners and managers

Further Disclaimer:

Predicting the weather a week in advance is difficult, so predicting an entire season with accuracy is impossible.
Therefore, every effort is made to explain assumptions based on known or assumed data, using historical averages.

Summary

1. Benefits of SIM systems
2. Typical installation techniques
3. Common applications
4. Operating costs

See article in <u>Modern Hydronics</u>, Fall 2017
<u>https://plasticpipe.org/building-construction/bcd-magazine-articles.html</u>

SNOW AND ICE MELTING SYSTEMS

Despite the fact that winter may seem a long way off, now is the time to discuss SIM with your customers.

MELTING SNOW IS A BEAUTIFUL THING

BY LANCE MACNEVIN

As I write this it is hard to think about winter, but I am pretty sure it will return this fall. Now is the time to help customers prepare by equipping them with hydronic snow and ice melting systems.

Traditional methods of snow and ice removal include "mechanical" removal by snow blowers and plows, manual shoveling, and chemicals such as salt and sand. Sometimes, overhead infrared heaters are used over concentrated locations. If you are lucky, maybe a teenager will do it for cash.

However, shoveling takes huge effort and can cause health issues. Snow blowers and plows are expensive pieces of equipment that consume much fuel and leave snowbanks behind, sometimes damaging landscaping. Salt and sand can damage both outdoor and indoor surfaces while creating environmental issues during run-off.

WHAT IS A SNOW AND ICE MELTING SYSTEM?

Modern hydronic technology can provide responsive and efficient solutions to these problems through snow and ice melting (SIM) systems. These systems have been used across North America in all climates for over 75 years. By heating the outdoor surfaces, snow and ice are melted and evaporated. These closed-loop systems include a heat source, circulating pump/s, controls and other mechanical devices such as expansion tanks.

Such systems were pioneered in the 1940s using wrought iron or steel pipes embedded in concrete, which started rusting shortly thereafter. Modern SIM systems use flexible PEX or PE-RT tubing, the same as used for radiant heating systems. In fact, some people think of SIM systems as outdoor radiant heating systems.

ADVANTAGES AND APPLICATIONS

Benefits include safety, convenience, reduced liability, lowered maintenance costs, minimized environmental impact and improved long-term reliability.

SIM systems are used in outdoor areas such as sidewalks, steps, driveways,

MH34 | FALL 2017 MODERN HYDRONICS WWW.HPACMAG.COM

Plastics Pipe Institute
BUILDING & CONSTRUCTION

Thank you to the following for images:

- American Heart Association
- Arndt & Son Contracting
- Dow
- Klimatrol
- REHAU
- Ridgeway Home Services
- Thornton Plumbing & Heating
- Uponor
- Viega, LLC
- Zurn PEX

Snow & Ice Melting System Solutions

For more information, visit PPI webpage on SIM systems: https://plasticpipe.org/building-construction/bcd-sim.html