

LEGALETT[®]

WORLDWIDE

Canada / USA | Finland | Germany | Japan | Lithuania | Norway | Poland | Sweden

LEGALETT®



Comfort

What is an Air Heated Floor?



- **Project Definition**

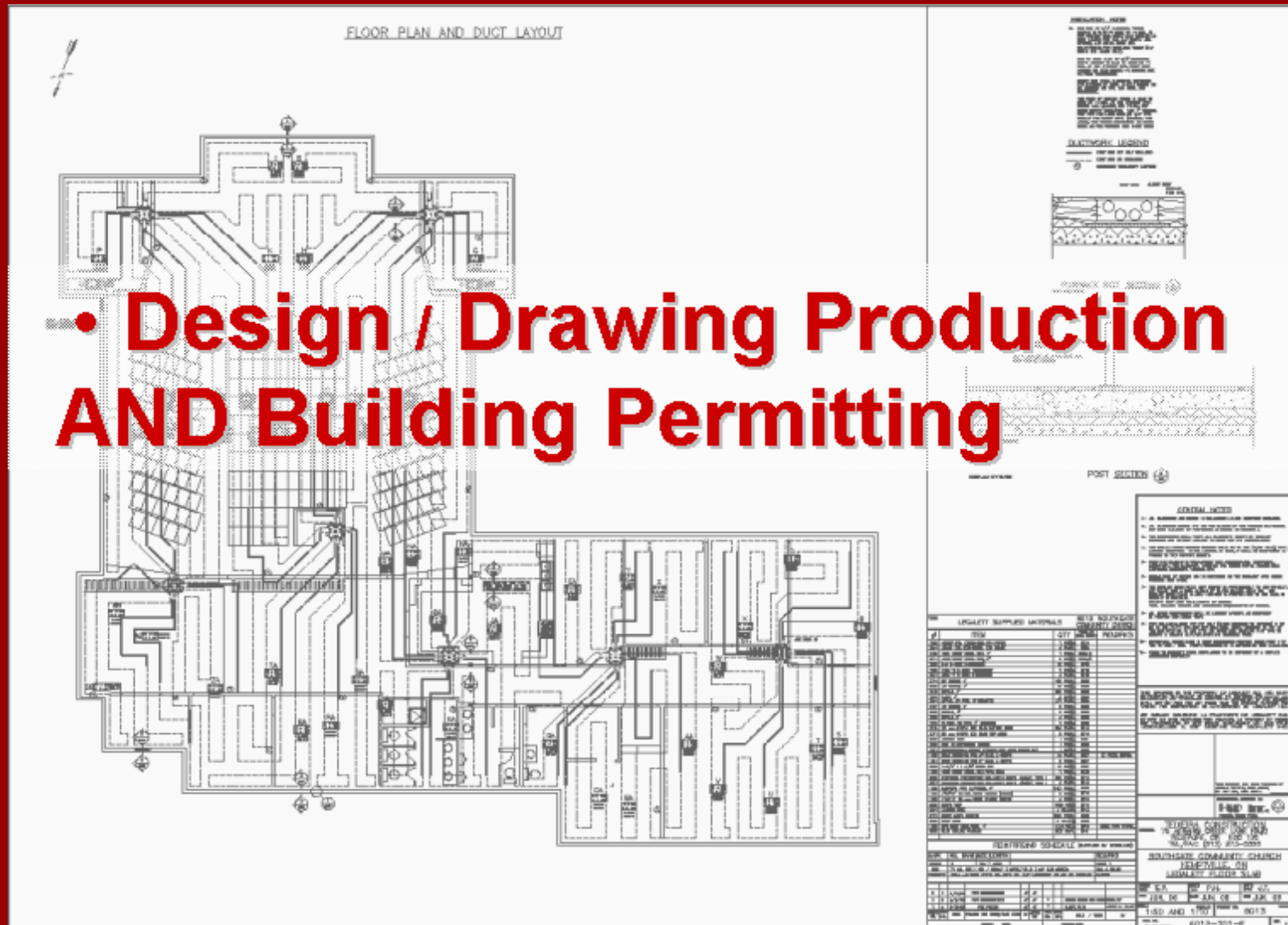


- **Application Engineering**



- **Pre-Sales Technical Support and Costing**

**• Design / Drawing Production
AND Building Permitting**



The **LEGALETT**® Way

- **Materials Delivery**



The **LEGALETT** Way

• Installation



The **LEGALETT**® Way



- **Construction Technical Support**

The

LEGALETT®

Way

• Quality Assurance Inspections

LEGALETT INC.

Legalett Site Inspection Form - Pre-Pour

Part 1. Immediately Prior to Placing Concrete (90% of installation to be completed)

Legalett Project #		Service Rep.	
Order Date		Installer	
Dwg. Delivery Date		Location	
Matl. Delivery Date		Project Title	

Site Control List - Structural

- Edge Element
 - Outside dimensions _____ X _____
 - Length of diagonal 1 _____
 - Length of diagonal 2 _____
 - Calculated length of diagonal _____
 - Height above slab EPS _____
 - Exterior fill completed before pour or gravel or braces up against _____
- EPS Under Slab
 - Type _____
 - Staggered joints _____
- Reinforcement
 - Continuous top and edge top and bottom WWM as per drawing
 - WWM chairing
 - WWM under 1 story (1 layer) and 2 story (2 layers) bearing walls
 - WWM under 1 story (2 layers) and 2 story (4 layers) posts
 - Rebar under 3 story or high load bearing walls or posts
 - 2/3 story top steel for 2/3 story or high load buildings
- Elevation and Drainage
 - Elevation of slab allows for adequate drainage. 5% slope minimum 10' away from edge element)
 - Gravel drainage layer drains to daylight
- Deficiencies to correct before pour _____
- Comments _____

LEGALETT INC.

Legalett Site Inspection Form - Pre-Pour

Site Control List - Mechanical

- Heating Box (insert not yet installed)
 - Quantity and type ☐ 1) 4000W ☐ 2) 4000E
 - Location in plan _____
 - Vertical placement from top of slab, lid flush with finished surface or slightly above
 - Box properly supported on sand or foam
 - Box firmly anchored with grout or cement block on box to prevent flotation when the concrete is poured
 - Conduits installed for electrical, including power and thermostats
 - Conduits installed for 24V supply and optional boiler interlock (both optional for electric units for future conversion to water units)
 - Conduits or sleeves with water lines for water supply and return lines (optional for electric units for future conversion to water units)
- Pipe Loops
 - Location and number of elbows as per plan - check each loop
 - Inlets to box connected or capped as per plan
 - Outlets from box connected or capped as per plan
 - Insulation as per plan
- Deficiencies to correct before pour _____
- Comments _____
- Attach a minimum of three photographs of pre-pour illustrating:
 - Reinforcing
 - Furnace box and
 - Edge Element insulation

Date _____ Signature _____

LEGALETT CANADA INC.

Legalett Site Inspection Form - Start-Up

Part 2. Start-Up of System

Legalett Project #		Dealer	
Order Date		Installer	
Dwg. Delivery Date		Location	
Matl. Delivery Date		Project Title	

- Client mailing address _____
- Client courier address, if different _____
- Client phone number _____
- Connections
 - Electrical power connection correct, correct gauge, amperage and voltage ☐
 - Thermostats installed in correct locations for zones ☐
 - Hot water pipe connections for water units, including checking for leaks and air entrainment, and installation of shut off valves ☐
 - Local disconnect installed ☐
 - Fan starts and stops in response to the thermostat (delayed response for water) ☐
 - Installed boiler/hot water heater capacity _____ kW / Btu/hr ☐
- Inner lid fully seated, insulation installed, and outer cover installed and flush with top of floor. ☐
- Construction heater usage during time building is closed in _____ days ☐
 Floor temperature recorded during construction heater usage _____ F/C ☐
- Trial Run ☐
- Deficiencies to correct _____
- Comments _____

Date _____ Phone _____

The Legalett Way

The **LEGALETT**® Way

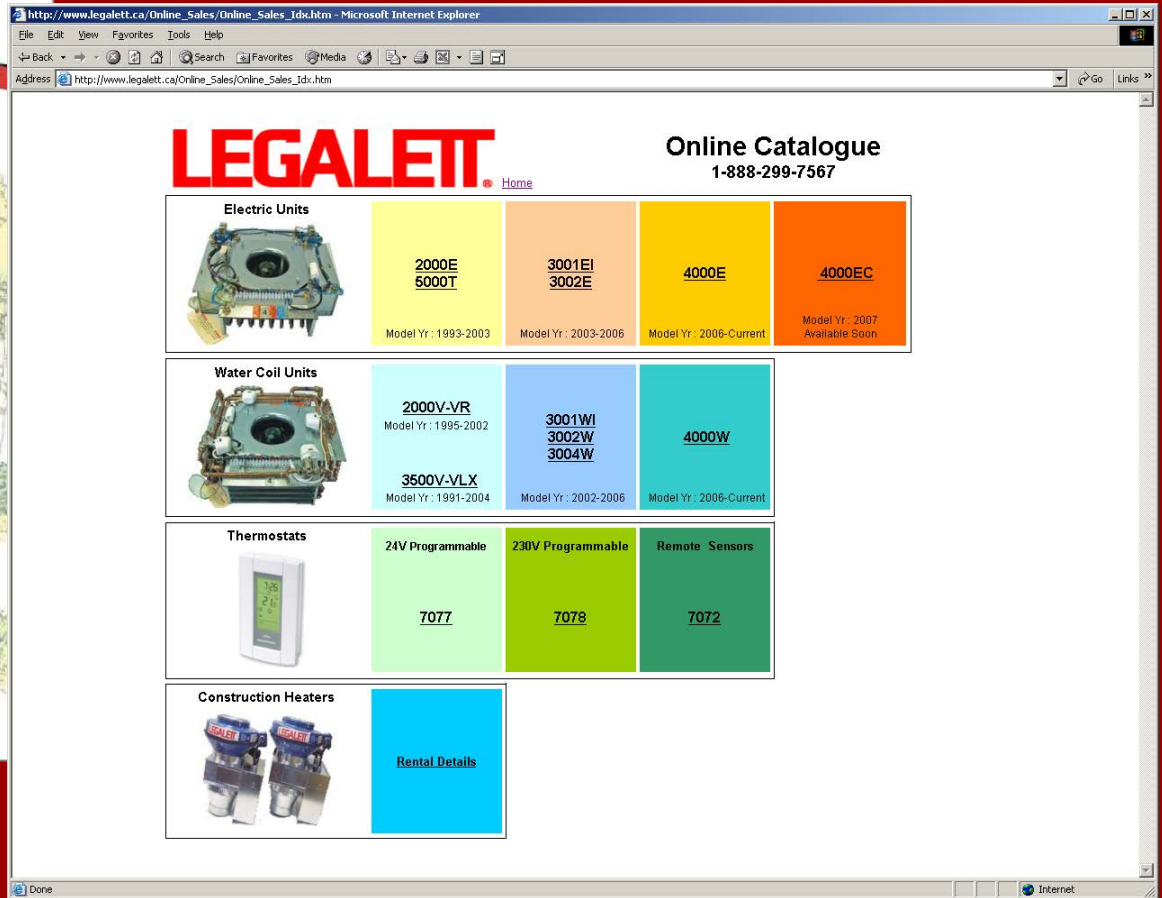
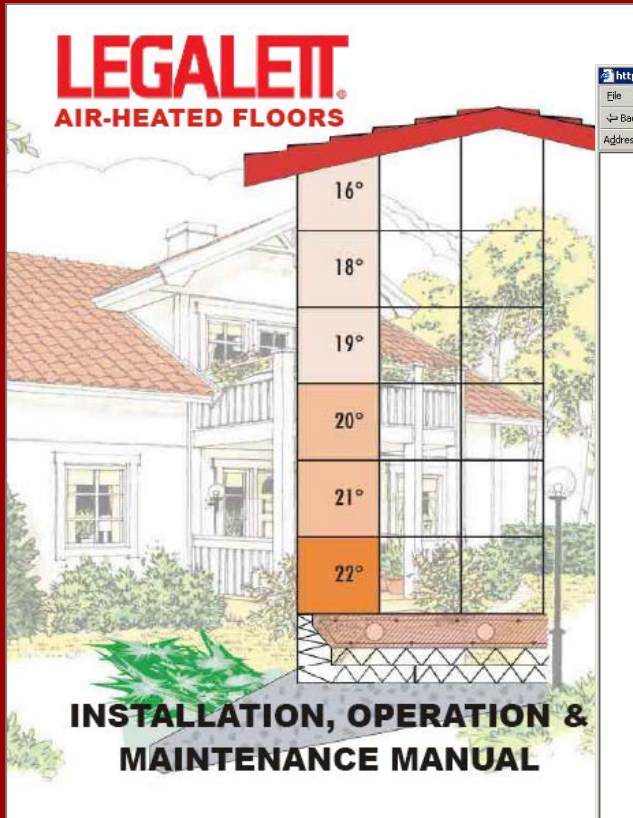
Happy Customers



The Legalett Way



The LEGALETT Way



• After Sales Service

The Legalett Way

LEGALETT®

Quality



Quality – Rokas Residence

LEGALETT®

Quality



Quality - Vrana Residence

LEGALETT®

Quality



Quality - Log Home - Mille Isle, QC

LEGALETT®

Residential Homes, Townhouses, Schools, Day Cares,
Assembly Buildings, Commercial and Industrial Buildings,

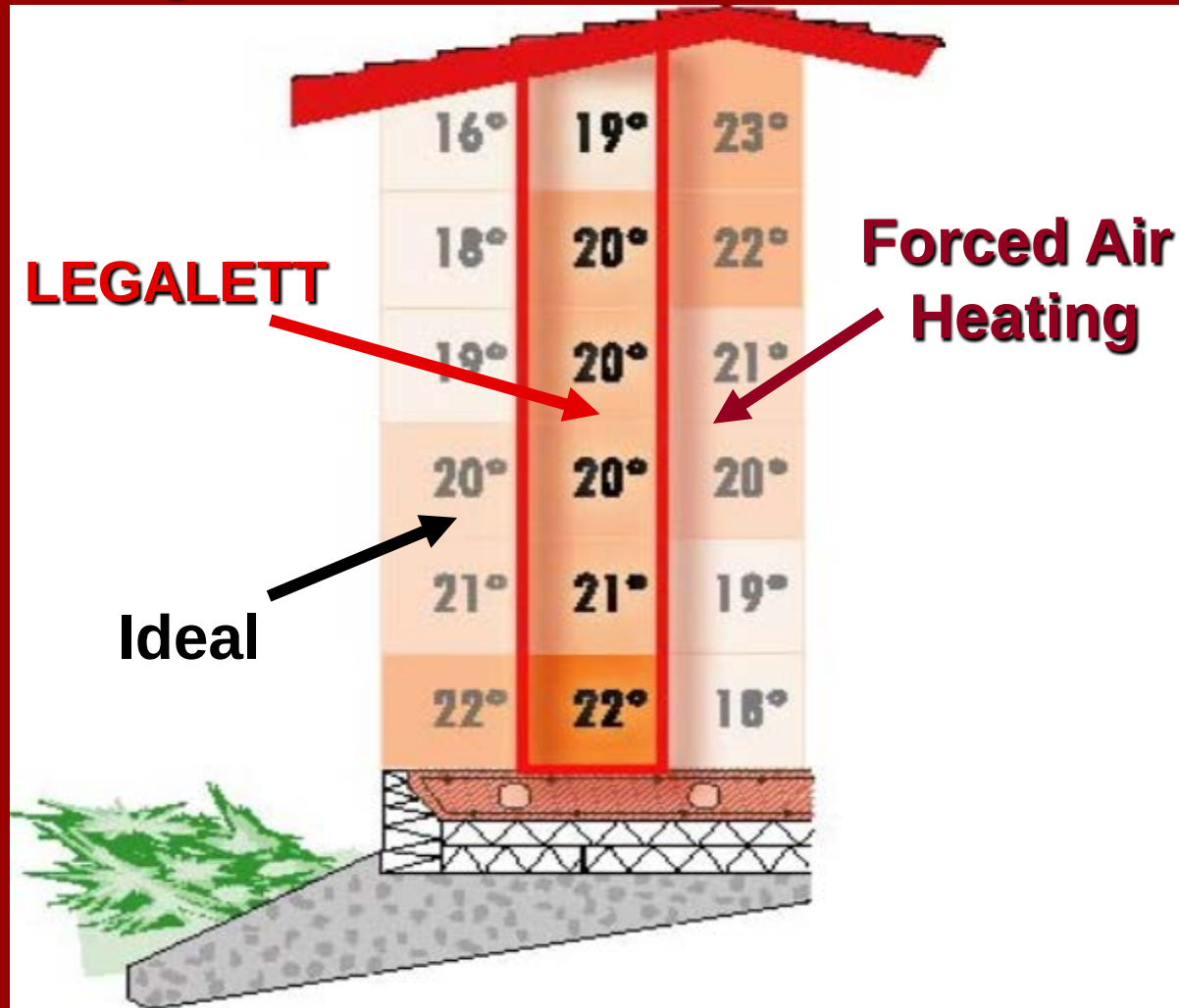
Legalett is suitable for all



All Types of Construction

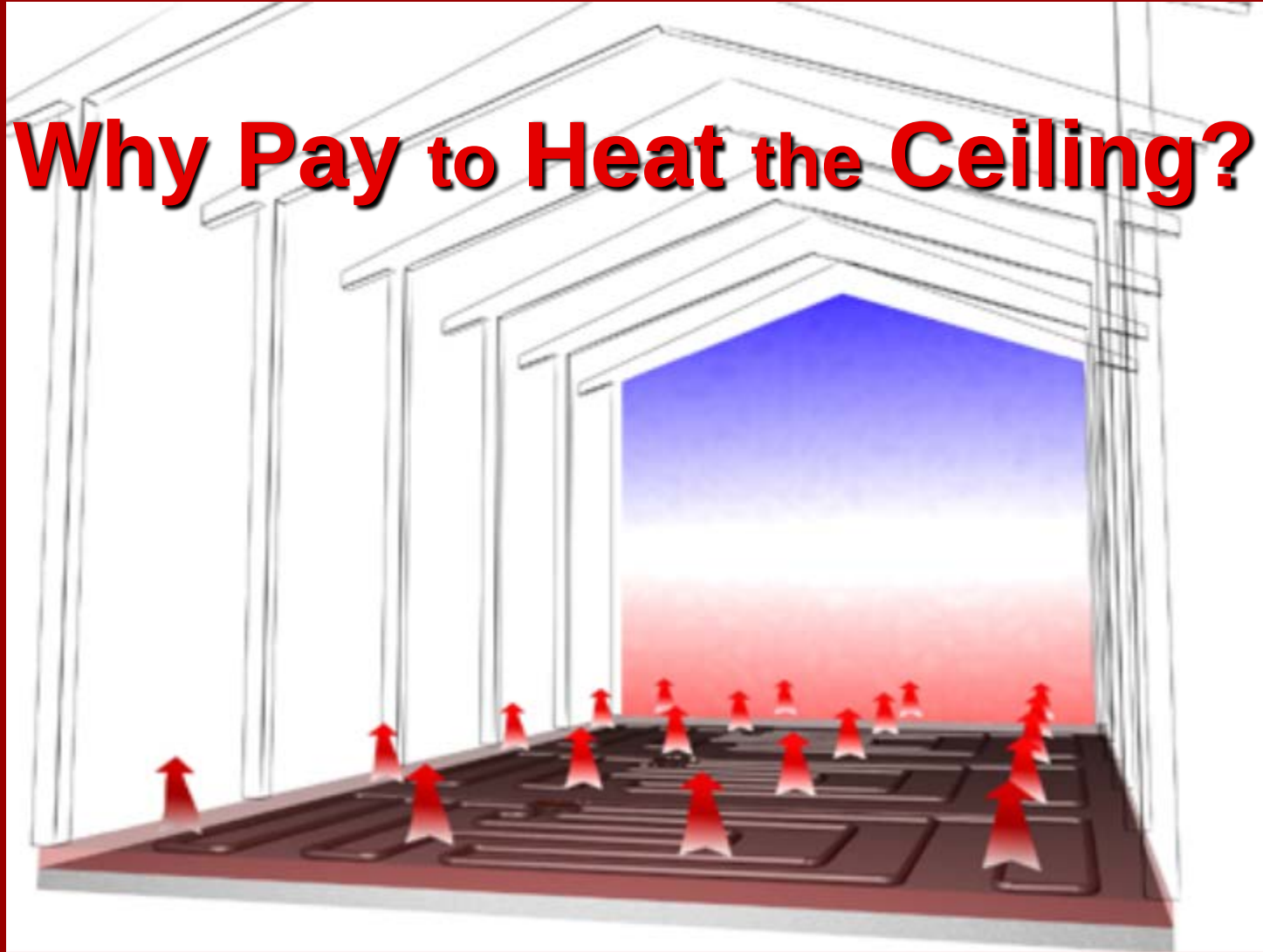
LEGALETT®

Temperature Stratification



Warm Feet - Cool Heads

Why Pay to Heat the Ceiling?

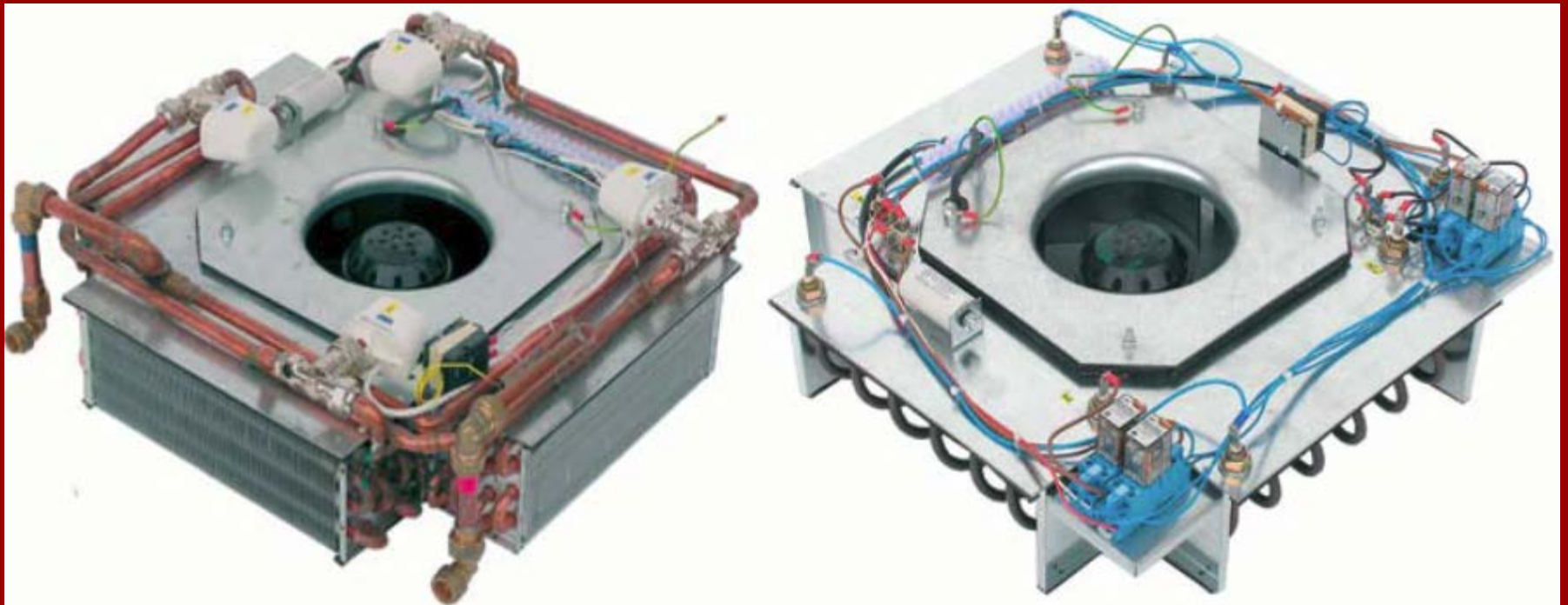


Why Pay to Heat the Ceiling?

LEGALETT®

Comfortable In-Floor Heat

Water Coil Heater or **Electric Heater**



Heater Inserts

LEGALETT®

**Radiant Heat provides
with No Drafts**



HRV controls the Air

Air You Breathe / No Drafts

Multiple Zone Control systems available in 4" or 2" inch Pipe Layouts

- Standard Design - **30 W/m²** or **10 Btu/hr/ft²** -

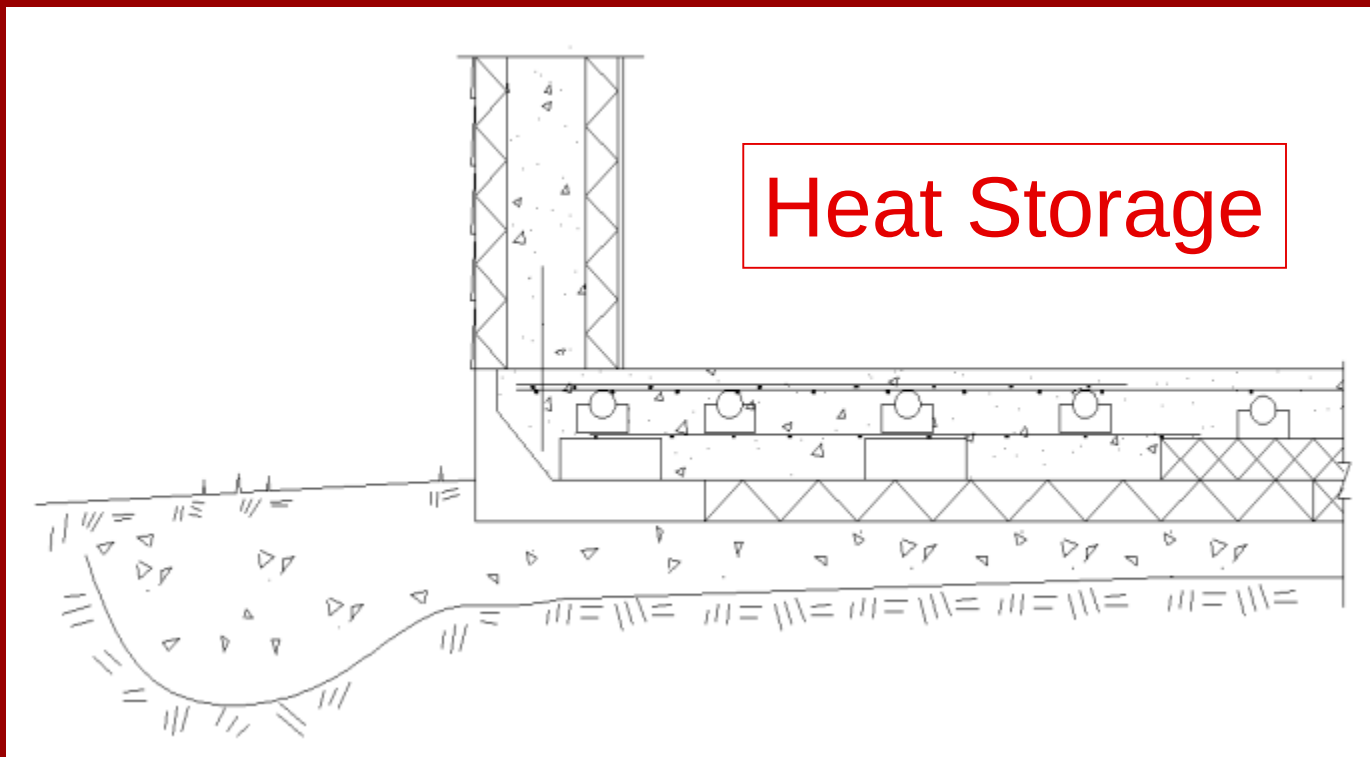


2" and 4" Piping / Standard Heat Density

During Power Outage

2" Pipe / 5" Slab system

will drop ~ 1°C (2°F) 12 hours



2" Pipe / 5" Slab – Heat Storage

LEGALETT®



2" Heater Box

LEGALETT®

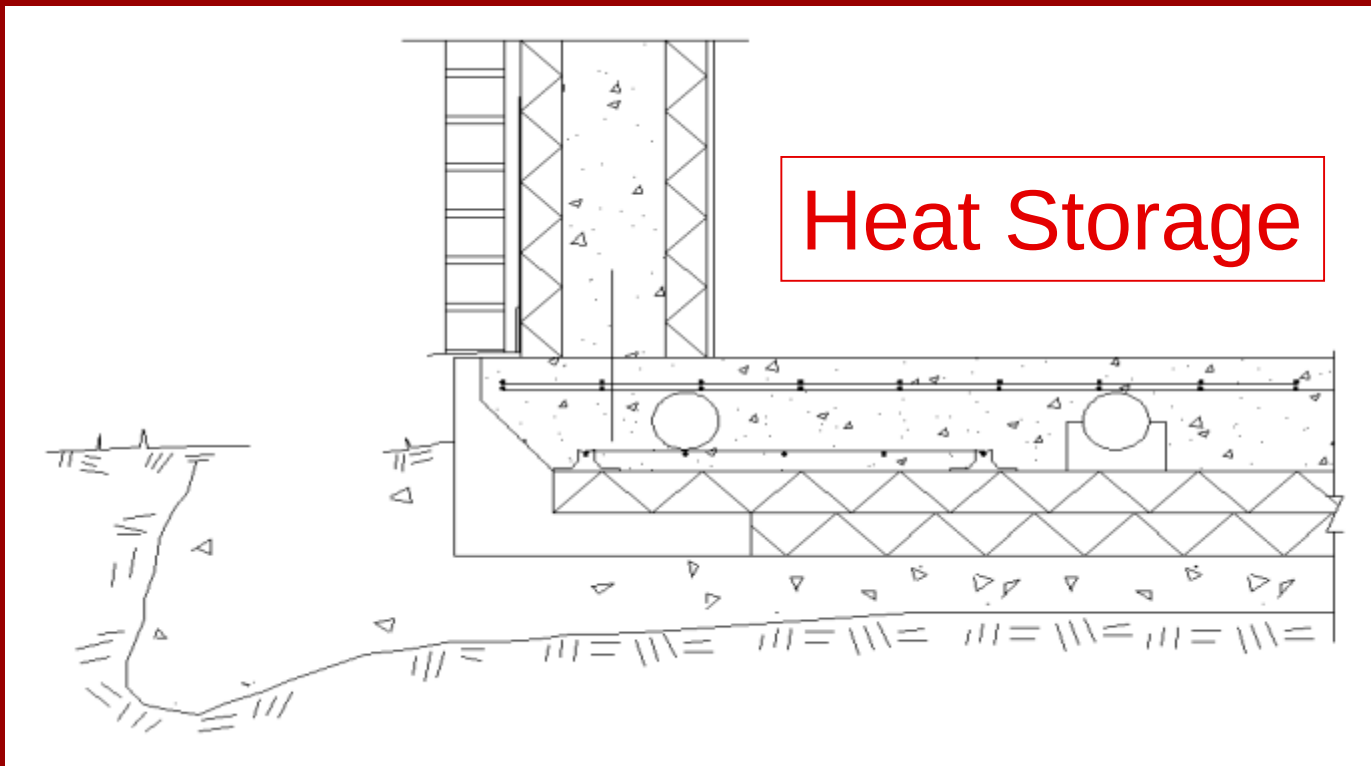


2" Box with Water Coil Insert

During Power Outage

4" Pipe / 8" Slab system

will drop ~ 1°C (2°F) 24 hours



LEGALETT®

ENERGY SAVINGS

of Over

15%

VS.

**Forced Air
Heating Systems**



19°

20°

20°

20°

21°

22°

Energy Savings

Cornwall, ON - Residence - AFI 800 @ Design Condition – 10 Btu/hr/ft²

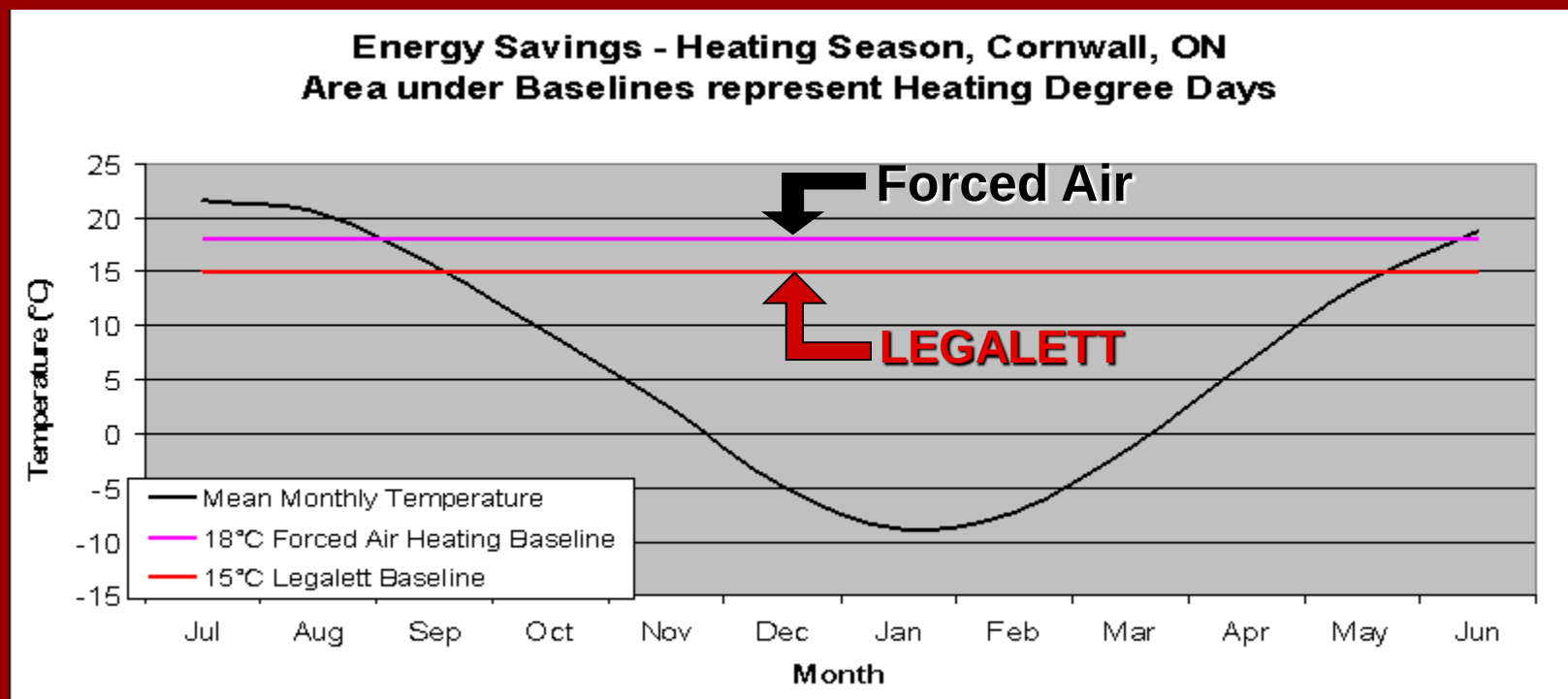
=8.3% SAVINGS

Energy Saving at design Condition 10 Btu/hr/ft²				Residential Single Story 1282 ft²	
Area	Forced Air Btu/hr	Legalett Btu/hr	Reduction Btu/hr	% Reduction	% Reduction of total heat loss
Flat Ceiling Heat Loss	2,596	2,231	365	14.1%	2.5%
Wall Heat Loss	3,408	3,181	227	6.7%	1.5%
Window Heat Loss	3,864	3,607	258	6.7%	1.8%
Door Heat Loss	862	805	57	6.7%	0.4%
Infiltration Heat Loss	1,794	1,675	120	6.7%	0.8%
Slab Area Heat Loss	813	914	-102	-12.5%	-0.7%
Slab Edge Heat Loss	996	780	216	21.7%	1.5%
Slab Perimeter Heat Loss	387	311	76	19.6%	0.5%
Total	14,721	13,504	1,218	8.3%	8.3%

Savings over a Heating Season

3°C Reduction in Indoor Temperature

=18.6% SAVINGS



Heat Loss for a Building

• Conduction - **LEGALETT**

• Natural Infiltration - 0.12 Air Changes per Hour
(Equivalent to 1.5 ACH @ 50 Pa)

• Ventilation - By Others

LEGALETT CANADA INC.
Legalett Installer Heat Loss Calculation

Project #	Service Rep.	
Order Date	Installer	
Dwg. Deliver Date	Location	
Matl. Delivery Date	Project Title	

All values for calculations in this document are in imperial units, with the exception of the KW conversion at the end.

Choose Temperatures from the following chart

Outdoor Design Temp. (°C)	Indoor Design Temp. (°C)	House Delta Temp. (1) °F	Soil Design Temp. °C	Slab Temp °C	Slab Delta Temp. (2) °F
-22 °C	22 °C	84.6 °F	8 °C	24 °C	28.8 °F

Enter R-values for building materials

Wall	R (3)
Flat Ceiling	R (4)
Cathedral Ceiling	R (5)
Window	R (6)
Solid Door	R (7)

Enter Building Parameters (Heated Areas Only)

Slab Perimeter (total outside measurement of edge element) _____ ft. (8)

Slab Area (total area of heated slab, including edge element) _____ sq.ft. (9)

Flat Ceiling Area _____ sq.ft. (10)

Cathedral Ceiling Area _____ sq.ft. (11)

Window Area from Window Worksheet on Page 2 _____ sq.ft. (12)

Door Area from Door Worksheet on Page 2 _____ sq.ft. (13)

Total Non-Wall Area = Window Area _____ sq.ft. (12) + Door Area _____ sq.ft. (13) = _____ sq.ft. (14)

Wall Height _____ ft. (15)

Gross Wall Area = Perimeter _____ ft. (8) x Wall Height _____ ft. (15) = _____ sq.ft. (16)

Net Wall Area = Gross Wall Area _____ sq.ft. (16) - Non-Wall Area _____ sq.ft. (14) = _____ sq.ft. (17)

	Net Wall Area x	House Delta Temp /	R-value =	Wall Heat Loss	% of total	Ratio
	sq.ft. (17) x	84.6 °F (1) /	R (3) =	Btu/hr	#DIV/0!	
Window Area x	sq.ft. (12) x	84.6 °F (1) /	R (6) =	Btu/hr	#DIV/0!	
Door Area x	sq.ft. (13) x	84.6 °F (1) /	R (7) =	Btu/hr	#DIV/0!	
Flat Ceiling Area x	sq.ft. (10) x	84.6 °F (1) /	R (4) =	Btu/hr	#DIV/0!	
Cathedral Ceiling Area x	sq.ft. (11) x	84.6 °F (1) /	R (5) x 1.1 =	Btu/hr	#DIV/0!	
House Volume x	cu.ft. (11) x	84.6 °F (1) /	0.00216	Btu/hr	#DIV/0!	
Slab Area x	sq.ft. (9) x	28.8 °F (2) /	0.16 Factor =	Btu/hr		

Legalett Engineering Protocols:

- Optimal Heater Box Location

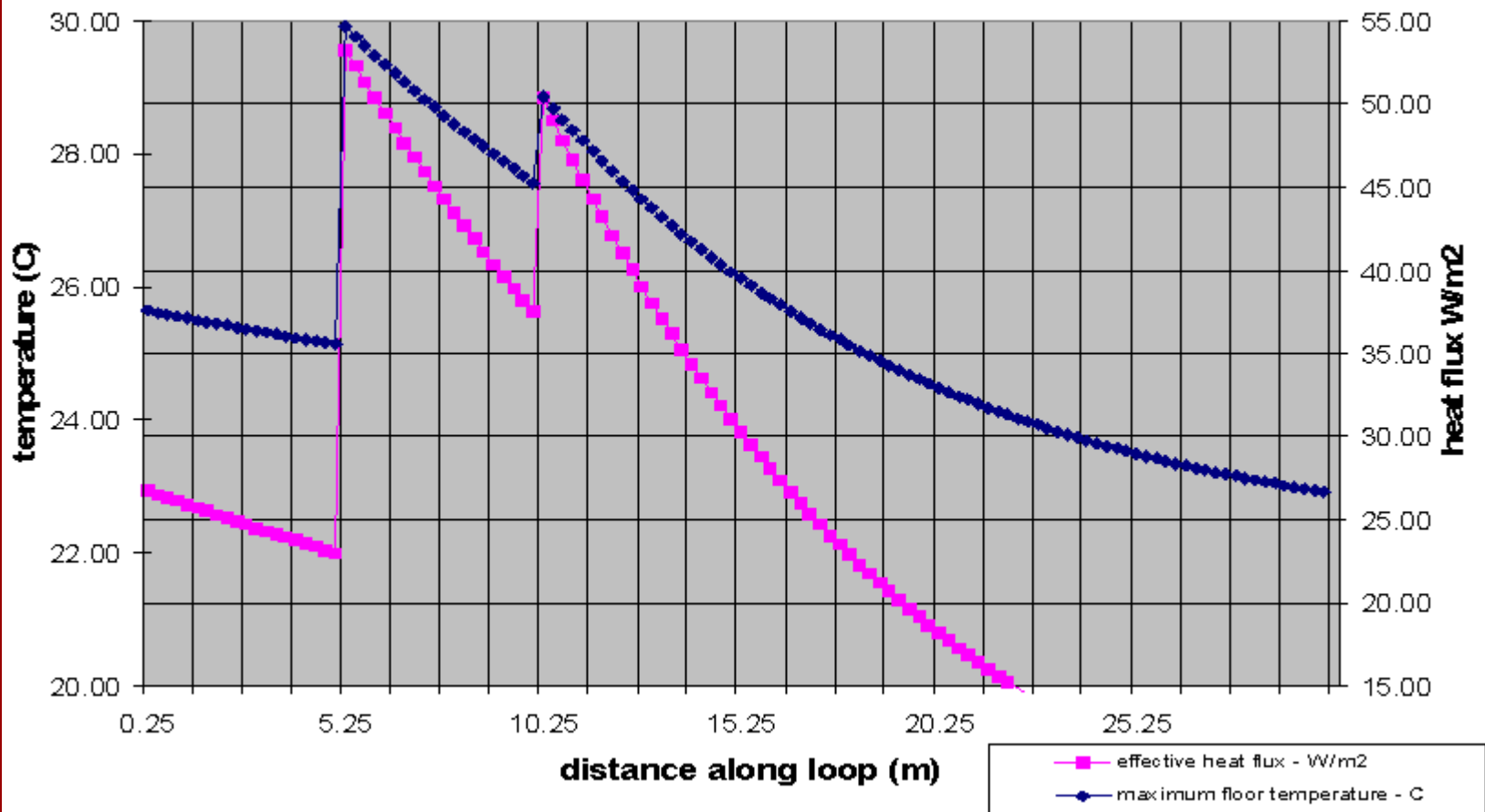
- Optimal Piping Design Density and Layout

- Piping Insulation Placement

LEGALETT 4000 series Design Parameters PAGE 1 of 2									
Project #		6037		Name:		SEA 136 House			
Location		Snve, QC							
Area		100		square feet					
Area		100		square meters					
Building perimeter		117		feet					
Building perimeter		36		meters					
Indoor design temperature		22		Degrees Celsius (normally 22 C)					
Outdoor design temperature		-23		Degrees Celsius					
Mean Soil Temperature		9		Degrees Celsius					
Average Air Freeze Index		808		Degree Days-Celsius					
Mean Annual Temperature		7.2		Degree Celsius					
Heat Load		10.55		Btu per hour per square foot					
Heat Load		33.26		Watts per square meter					
Heat Density		10.55		Btu per hour per square foot					
Heat Density		33.26		Watts per square meter					
Slab on Grade		☒ Choose		tile, vinyl, linoleum, laminate		☒ Choose			
Upper Floor		☒ Choose		hardwood, 1/2" carpet&pad		☒ Choose			
Basement		☒ Choose		1" carpet& pad, wool carpet&pad		☒ Choose			
pipe system		☒ Choose		50 mm		☒ Choose		100 mm	
Heater coverage		119.00		m ²		(standard coverage 127 m ²)			
Design Equivalent Length		30		m		45		m	
Pressure Drop Loop		418		Fan 419		N/A		Pa	
Air Volume flow per coil		0.051		m ³ /sec		N/A		m ³ /sec	
Required air Temp in pipe		30.58		C		N/A		C	
Predicted air return Temp pipe		26.70		C		N/A		C	
Water Flow Rate per coil		N/A		l/sec		N/A		l/sec	
Total Required watts per loop		197.90		W		N/A		W	
Predicted watts per coil		198.99		W		N/A		W	
Required watts per coil		0.99		kW		N/A		kW	
Predicted watts per coil		0.99		kW		N/A		kW	
Total exchanger Output		1.00		kW		2.35		kW	
Required inlet water temp.		n/a		C		55		C	
Pressure Drop across coil		0		Pa		76		Pa	
Air Temp out of coil		44		C		41.00		C	
Average spacing of pipes		0.30		m		N/A		m	
# of Heaters Required		0.8				N/A			
# of Loops Required		16.2				N/A			
# of Loops to Install		17				N/A			
Actual loop spacing-perimeter		250		mm		N/A		mm	
Actual spacing of loops-2nd		250		mm		N/A		mm	
Actual spacing of loops-interior		296		mm		N/A		mm	
Total heat output		3.383		W		N/A		W	

Temperature and Heat Flux vs Distribution Loop

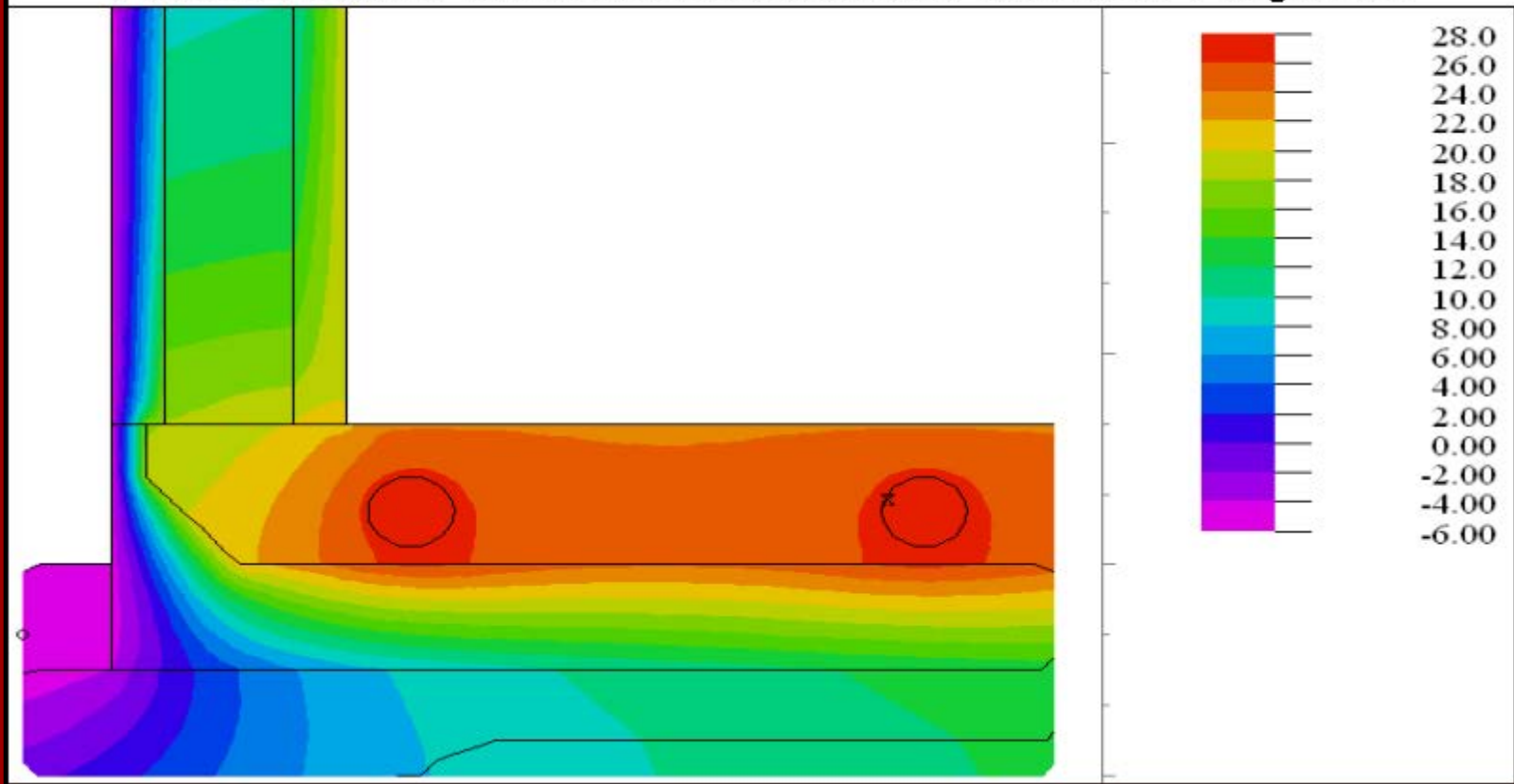
5" Slab / 2" Pipe system – Project # 6037- SAE 136 House



Slab Surface Temperature / Heat Flux along Pipe Loop

Heat Loss through Slab and EPS/Slab Surface Temperatures

-Finite Element Conduction Simulation Software Programs-



13.2.5 Slabs with beams between all supports

The minimum thickness, h_b , shall be

$$h_b \geq \frac{\ell_n(0.6 + f_y/1000)}{30 + 4\beta\alpha_m} \quad (13-3)$$

where ℓ_n is the longer clear span, α_m shall not be taken greater than 2.0, and the value α may be determined by taking l_b equal to

$$l_b = \frac{\Delta_b h^3}{12} \left(2.5 \left(1 - \frac{h_b}{h} \right) \right) \quad (13-4)$$

13.2.6 Slab bands

The minimum thickness of slab bands shall be that required for beams in Table 9.2.

13.2.7 Computation of slab deflections

A slab thickness less than the minimum thickness required by Clauses 13.2.2 to 13.2.5 may be used if computation show that deflection will not exceed the limits specified in Table 9.3. Deflections shall be computed by taking into account the span and the nature of the loads. The nature of the loads shall be taken into account in the computation of the effective moment of inertia of the concrete slab. The effective moment of inertia of the concrete slab shall be computed in accordance with Equation (9-1). The moment M_d shall take into consideration loads, such as construction loads, that extend the cracked region. Other values of I_g may be used if the computed deflection is in reasonable agreement with the results of comparative tests. The effective modulus of elasticity of the concrete shall be taken as one-half of the value specified in Clause 9.8.2. The effective moment of inertia shall be computed as specified in Clause 9.8.2.

13.3 Design procedures for shear for slabs without beams

13.3.1 General

In the vicinity of concentrated loads or reactions, the factored shear stress resistance, v_v , shall be equal to or greater than the maximum factored shear stress, v_f , for the slab. The maximum factored shear stress, v_f , shall be determined by dividing the maximum factored shear force, V_f , by the effective cross-sectional area of the slab at the location of the maximum shear force. The maximum shear force, V_f , shall be determined by loading the slab with the factored loads.

13.3.2 One-way and two-way shear

Slabs in the vicinity of columns shall be designed for two-way shear as specified in Clauses 13.3.3 to 13.3.5. Slabs shall also be designed for one-way shear as specified in Clause 13.3.6.

13.3.3 Critical shear section for two-way action

13.3.3.1

The critical section for two-way action shall be a section perpendicular to the plane of the slab and located so that its perimeter, b_o , is a minimum, but the section need not approach closer than $d/2$ to the perimeter of the concentrated load or reaction area.

13.3.3.2

At changes in slab thickness, a critical section located in the thinner portion at a distance not greater than $d/2$ from the face of the thicker portion and located such that the perimeter, b_o , is a minimum, shall also

13 Two-way slab systems

13.1 General

13.1.1 Clause 13.1 shall apply to two-way slab systems that are required to resist bending in more than one direction, with or without concentrated loads or reactions.

13.1.2

A slab system may be supported on columns or walls.

13.2 Minimum slab thickness

13.2.1 The minimum slab thickness, h_b , shall be not less than 120 mm.

13.2.2 Two-way slab systems

13.2.2.1 The minimum thickness, h_b , shall be specified in Clause 9.8.2.6 to show by computation that the slab thicknesses provided are not less than the minimum thicknesses specified in Clauses 13.2.3 to 13.2.6.

Note: It is possible that the minimum thickness specified in Clauses 13.2.3 to 13.2.6 will not be adequate for certain sequences of shoring during construction or for large live to dead load ratios.

13.2.3 Slabs without drop panels

13.2.3.1 The minimum thickness, h_b , shall be

$$h_b \geq \frac{\ell_n(0.6 + f_y/1000)}{30 + 4\beta\alpha_m} \quad (13-1)$$

where ℓ_n = the longer clear span
At discontinuous edges, an edge beam shall be provided with a stiffness ratio, α , of not less than 0.80, or the thickness required by Equation (13-1) shall be multiplied by 1.1 in the panel with the discontinuous edge or edges.

13.2.4 Slabs with drop panels

The minimum thickness, h_b , shall be

$$h_b \geq \frac{\ell_n(0.6 + f_y/1000)}{30 + 4\beta\alpha_m} + \frac{2x_d}{\ell_n} \Delta_b \quad (13-2)$$

where ℓ_n is the longer clear span and Δ_b is the additional thickness of the drop panel below the soffit of the slab and shall not be taken larger than h_b .

In Equation (13-2), $(2x_d/\ell_n)$ is the smaller of the values determined in the two directions and x_d shall not be taken greater than $(\ell_n/4)$.

At discontinuous edges, an edge beam shall be provided with a stiffness ratio, α , of not less than 0.80, or the thickness required by Equation (13-2) shall be multiplied by 1.1 in the panel with the discontinuous edge or edges.

Structural Design

Legalett Foundations are designed by Professional Engineers

in accordance with the NBC and IRC

EPS

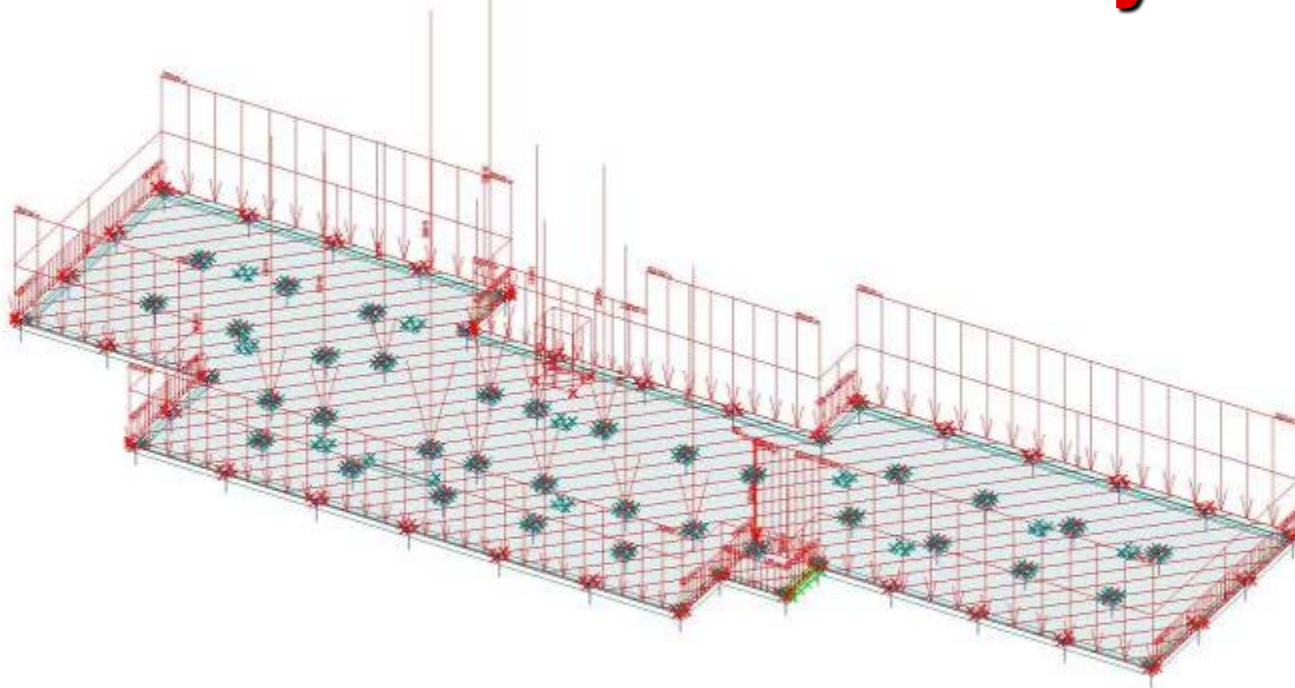
- ASTM C-578
- CSA CAN/ULC-S701-01
- Type II – 1.35lb/ft³ (21.6kg/m³)
- 15 psi (104 kPa) compressive strength
- LEGALETT Design - 50 kPa for long term loads

Soil Loading

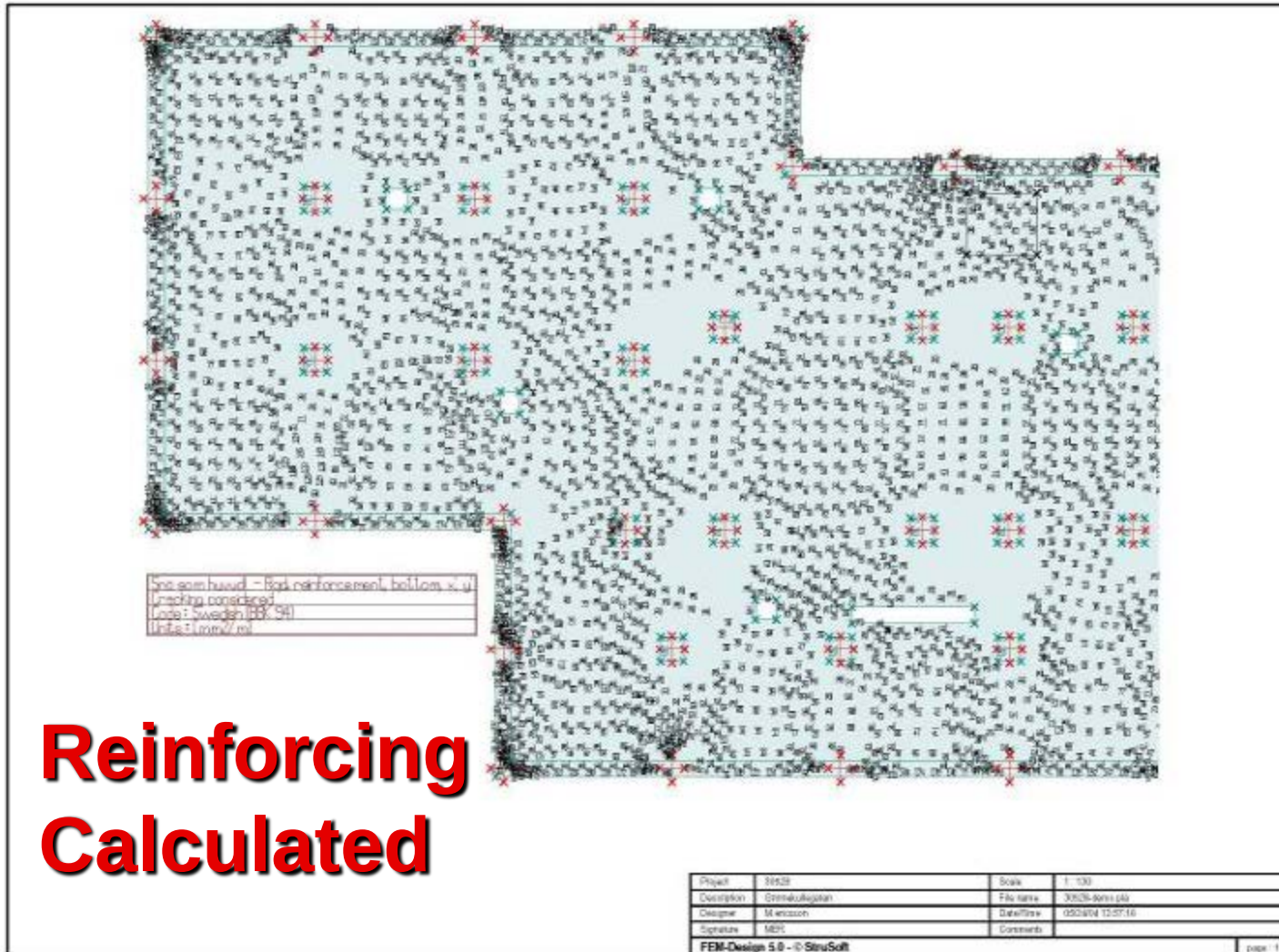
Design Bearing Capacity
75 kPa vs. 150 kPa

With the possibility of reducing
to 17 kPa in problem soils
with little change in design

Loads are Analysed

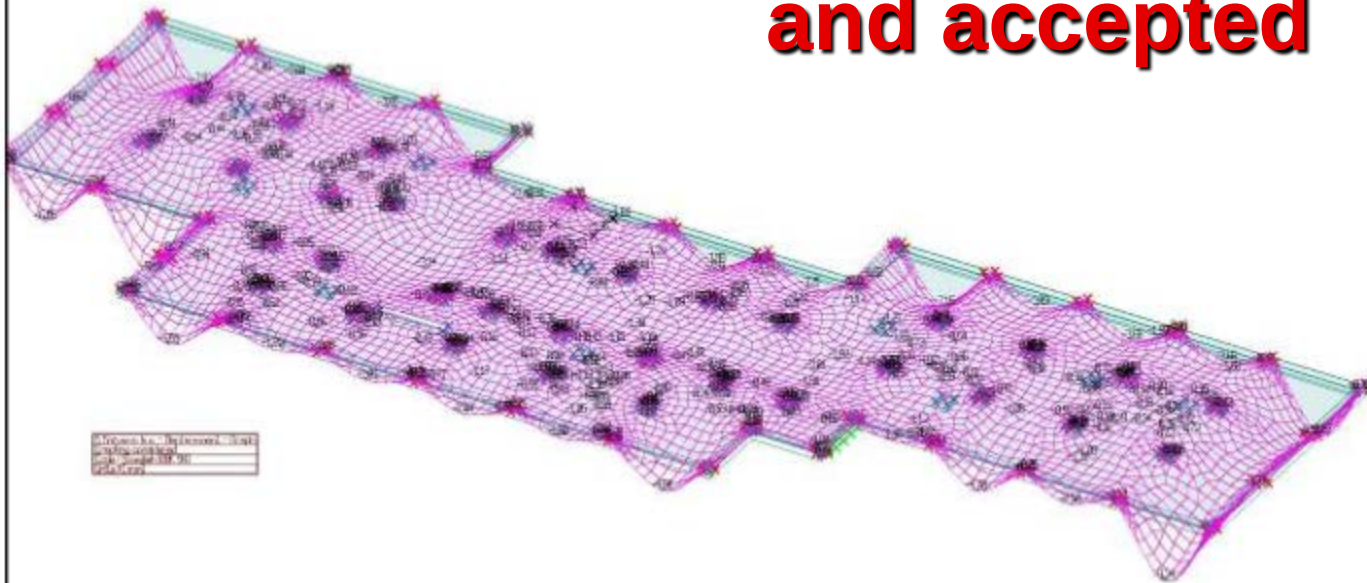


Project	20020	Scale	1 : 200
Description	Strukturkalkulation	File name	30020-0000.pjt
Designer	M. Kucuk	Date/Time	02/04/12 12:00
Signature	M201	Comments	
FEM-Design 5.0 - © StruSoft		page 1	



Reinforcing Calculated

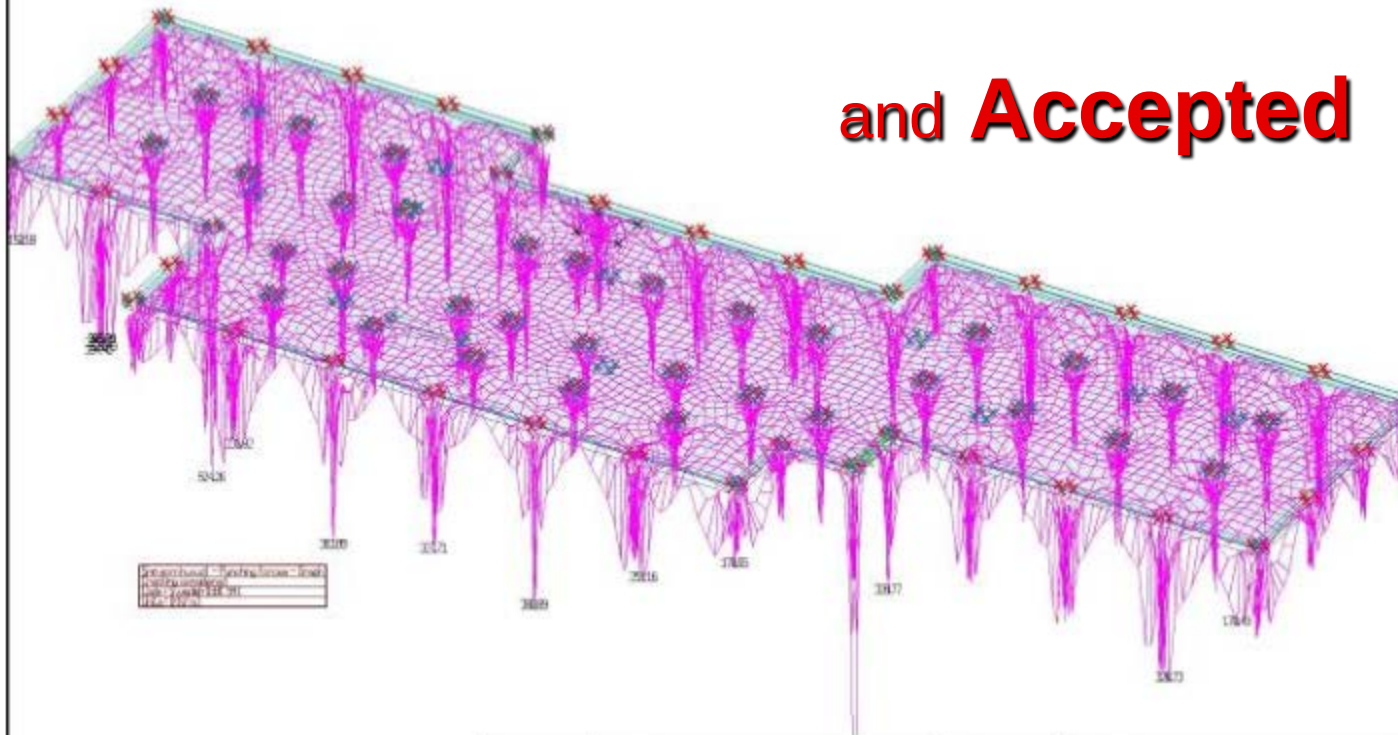
Deformations Reviewed and accepted



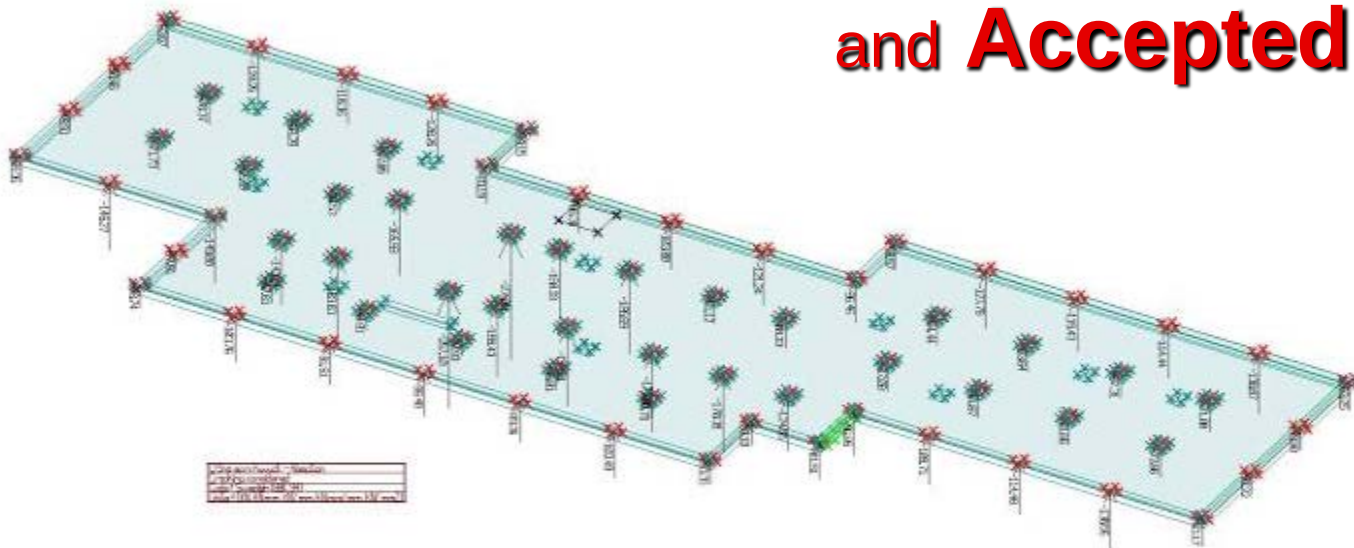
Project	19128
Description	Strukturplanung
Designer	M. Wenzel
Signatur	MBZ

Project	19128	Scale	1:210
Description	Strukturplanung	File name	20076-Struktur.dwg
Designer	M. Wenzel	Date/Time	08.04.18 12:20:08
Signatur	MBZ	Comments	
FEM-Design 5.0 - © StruSoft			page 1

Shear Stress Reviewed and Accepted



Bearing Pressure Reviewed and Accepted



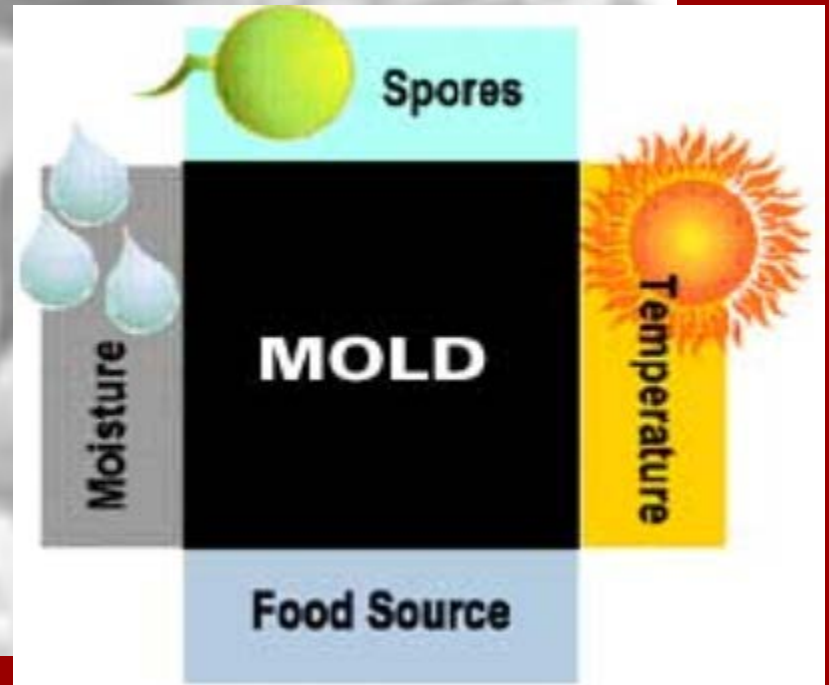
Project	20120	Scale	1:200
Description	Strukturplanung	File name	20120-Struktur.dwg
Designer	M. K. K. K.	Date/Time	05.04.04 12:30:00
Signature	M. K. K. K.	Comments	

FEM-Design 5.0 - © StinuSoft

page: 1

Moisture Control

- Under slab stone minimum 4 inch
- Under slab insulation minimum 6 inches



LEGALETT®

Construction Heater

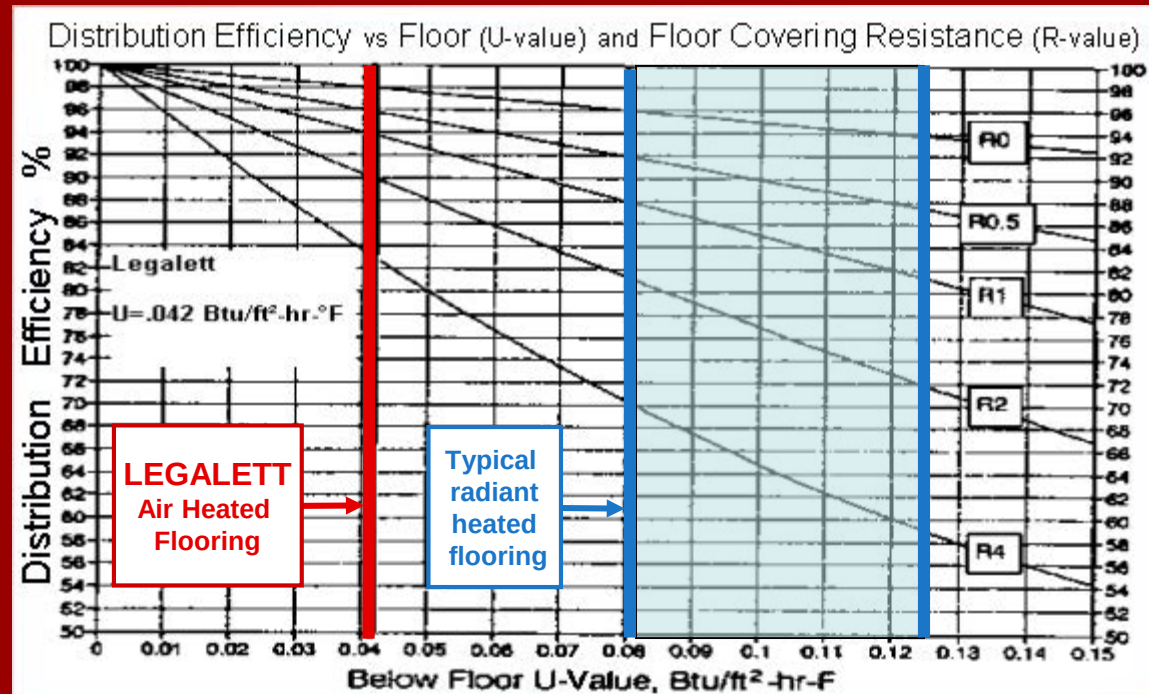


Construction Heater

Floor Coverings

Typical R-values:

- ½" Wool Carpet with ½" Underlay = R-4.25
- ½" Synthetic Carpet with ½" Underlay = R-3.6
- ½" Synthetic Carpet with ¼" Underlay = R-2.5
- ¾" Plywood = R-0.825
- ¾" Solid Maple = R-0.75
- 5/8" Engineered Wood Flooring = R-0.5
- ¼" Ceramic Tile = R-0.25



What is a Frost Protected Shallow Foundation?



Frost Protected Shallow Foundation (FPSF)

LEGALETT®

Scandinavian Experience



Scandinavian Experience

LEGALETT[®]

American Experience



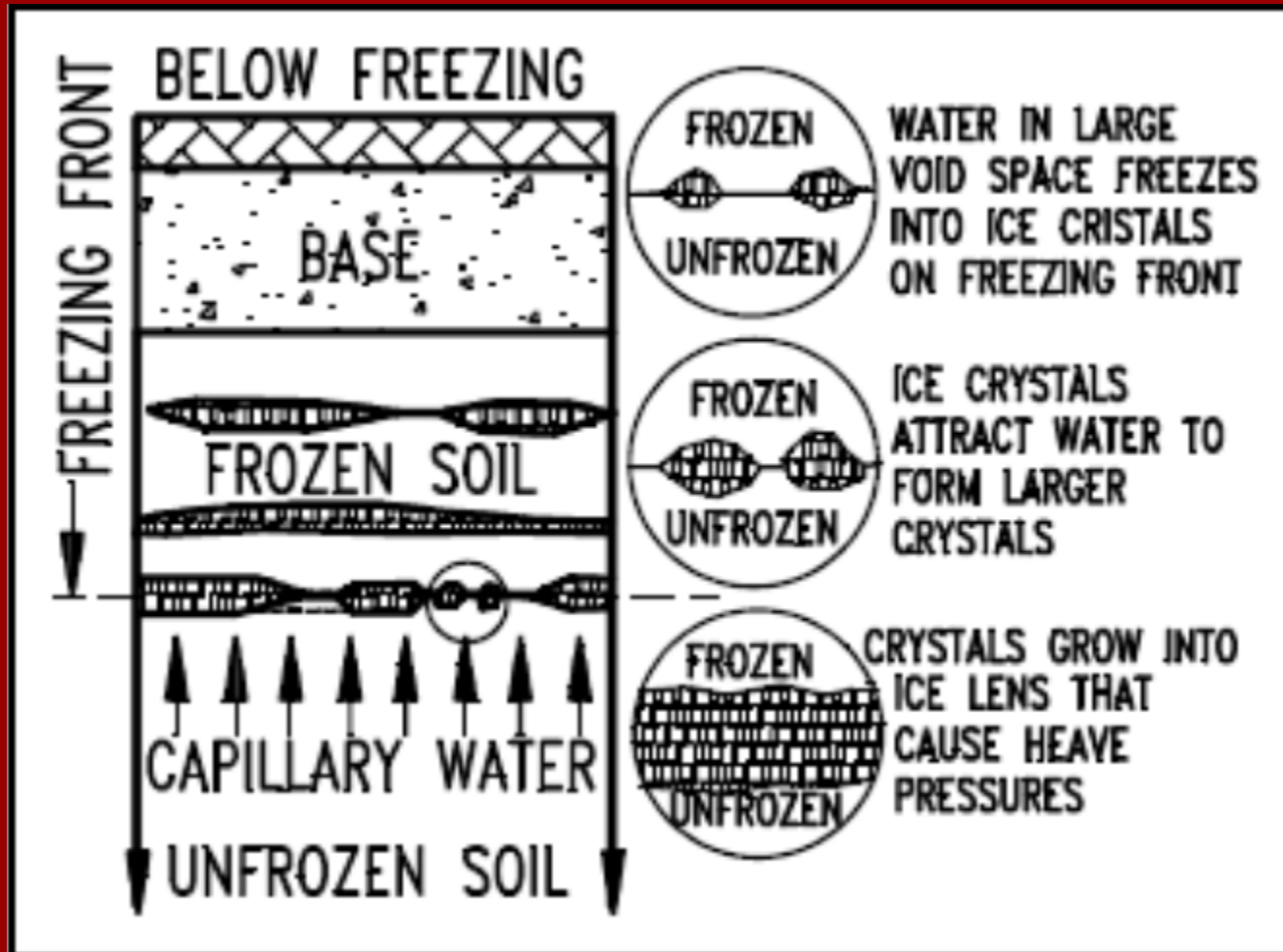
American Experience

Codes and Practices

European – ISO 6946 and ISO 13793

**American – International Residential Code
and SEI/ASCE 32-01**

What is Frost Heave?



What is a Frost Susceptible Soil?

Table 7-1. Frost-susceptible soil groups.

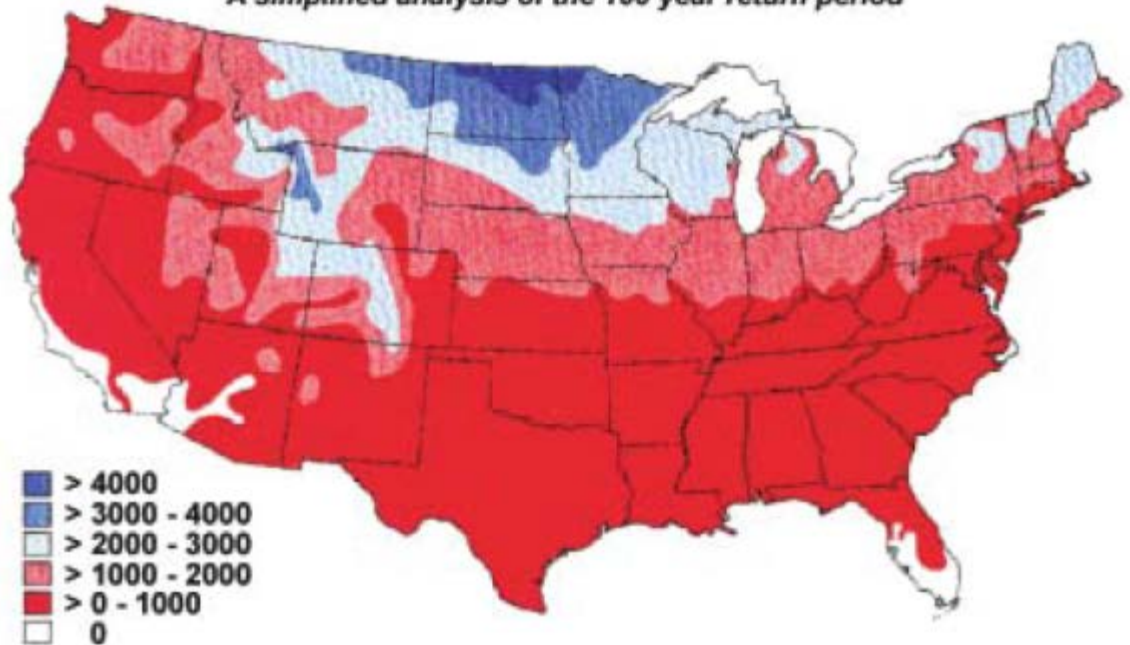
Frost Group	Kind of Soil	Percentage Finer Than 0.02 mm by Weight	Typical Soil Types Under Unified Soil Classification System
F-1	Gravelly soils	6 to 10	GM, GW-GM, GP-GM
F-2	Gravelly soils	10 to 20	GM, GW-GM, GP-GM
	Sands	6 to 15	SM, SW-SM, SP-SM
F-3	Gravelly soils	Over 20	GM, GC
	Sands, except very fine silty sands	Over 15	SM, SC
	Clays, $PI > 12$	—	CL, CH
F-4	All silts	—	ML, MH
	Very fine silty sands	Over 15	SM
	Clays, $PI > 12$	—	CL, CL-ML
	Varved clays and other fine-grained, banded sediments	—	CL and ML; CL, ML; and SM; CL, CH, and ML; CL, CH, ML, and SM

Air Freezing Index - Canada



Air Freezing Index - USA

A simplified analysis of the 100 year return period

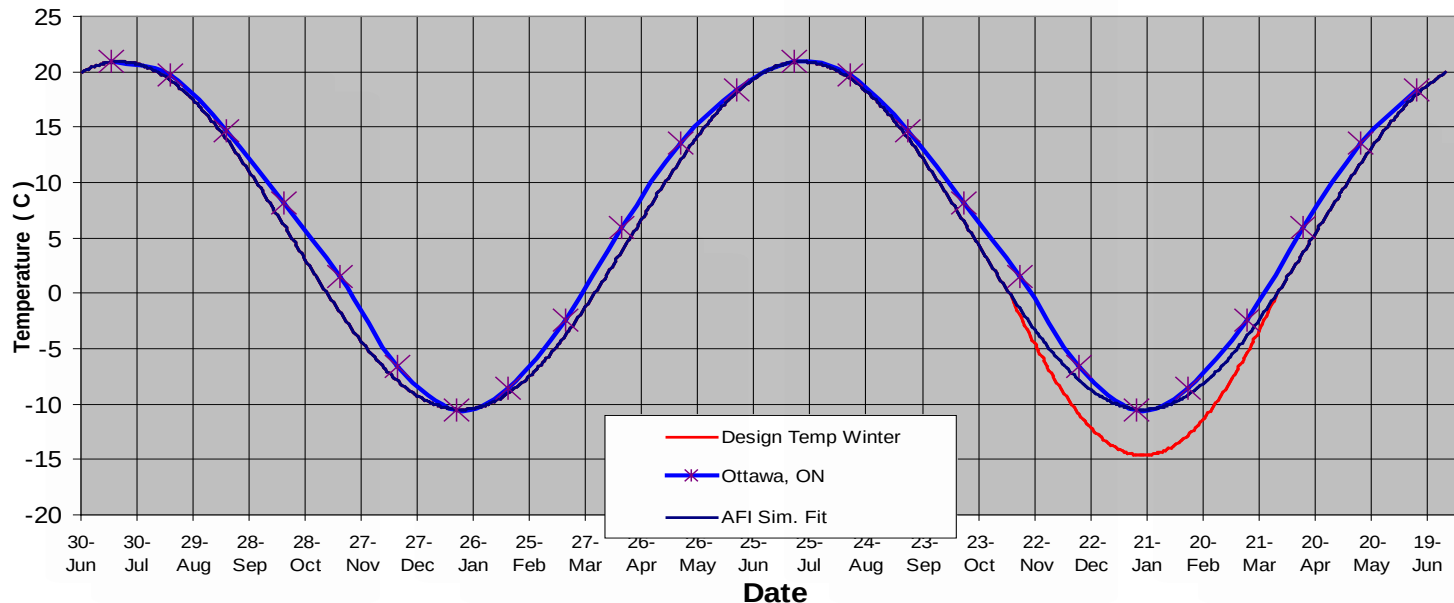


The amount of insulation needed to protect a building foundation is determined by the Air-Freezing Index.

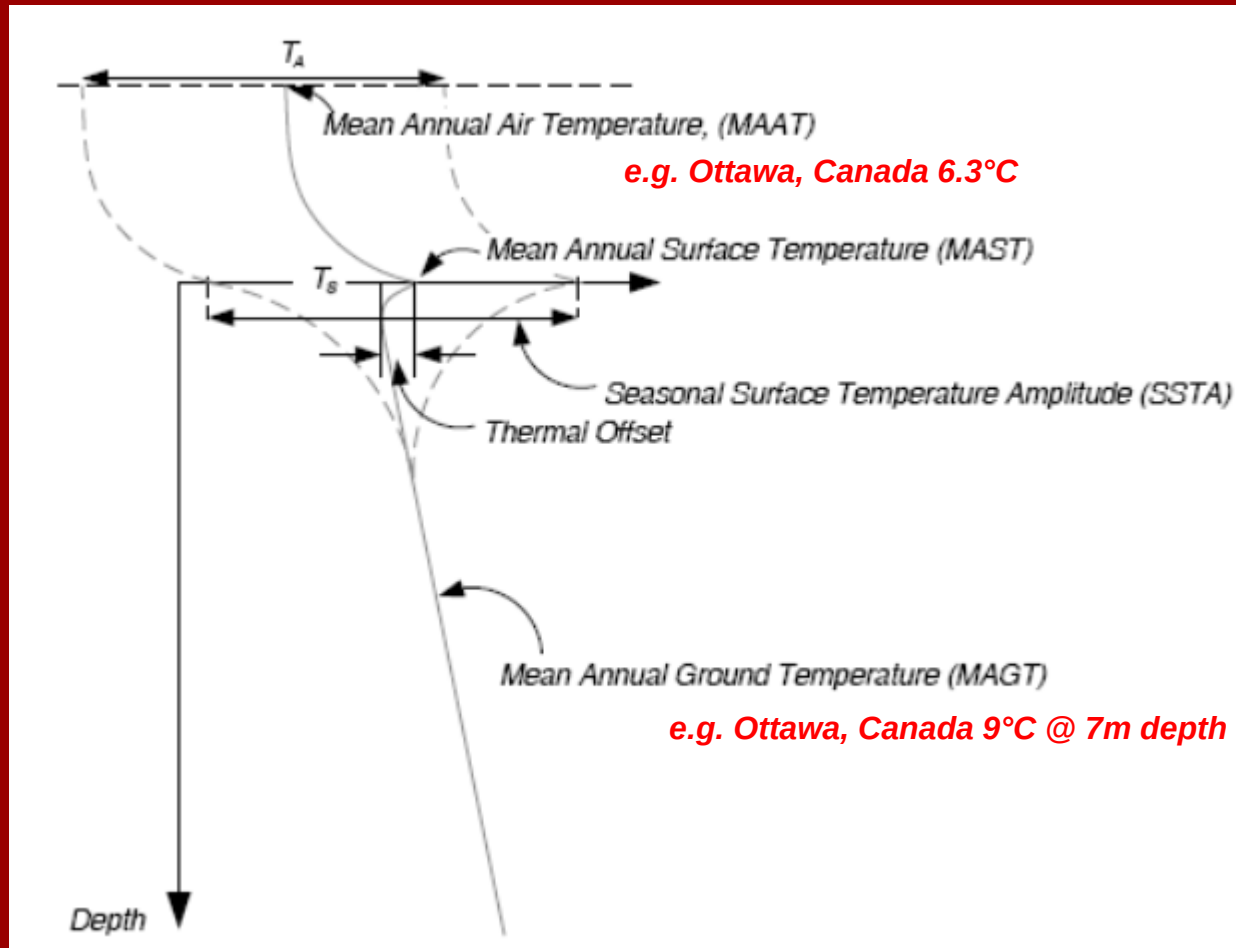
Design Data – Frost Line Modeling

Ottawa, ON		MAAT	6.3	MAGT		9
Mean AFI	963	Start Date	1-Jul	Speed km/hr		12.9
Design AFI	1,342	Minimum Mean Temp	-10.50	Date		Dec-06
Mean Simulation AFI	976	severity multiplier	1.39			
Design Simulation AFI	1,360	Minimum Design Temp	-14.6	Reviewed		
Outdoor Nfactor	0.90	IC Transient Ground Te Adjustment				1

Yearly Temperature



Relationship between MAAT and MAGT



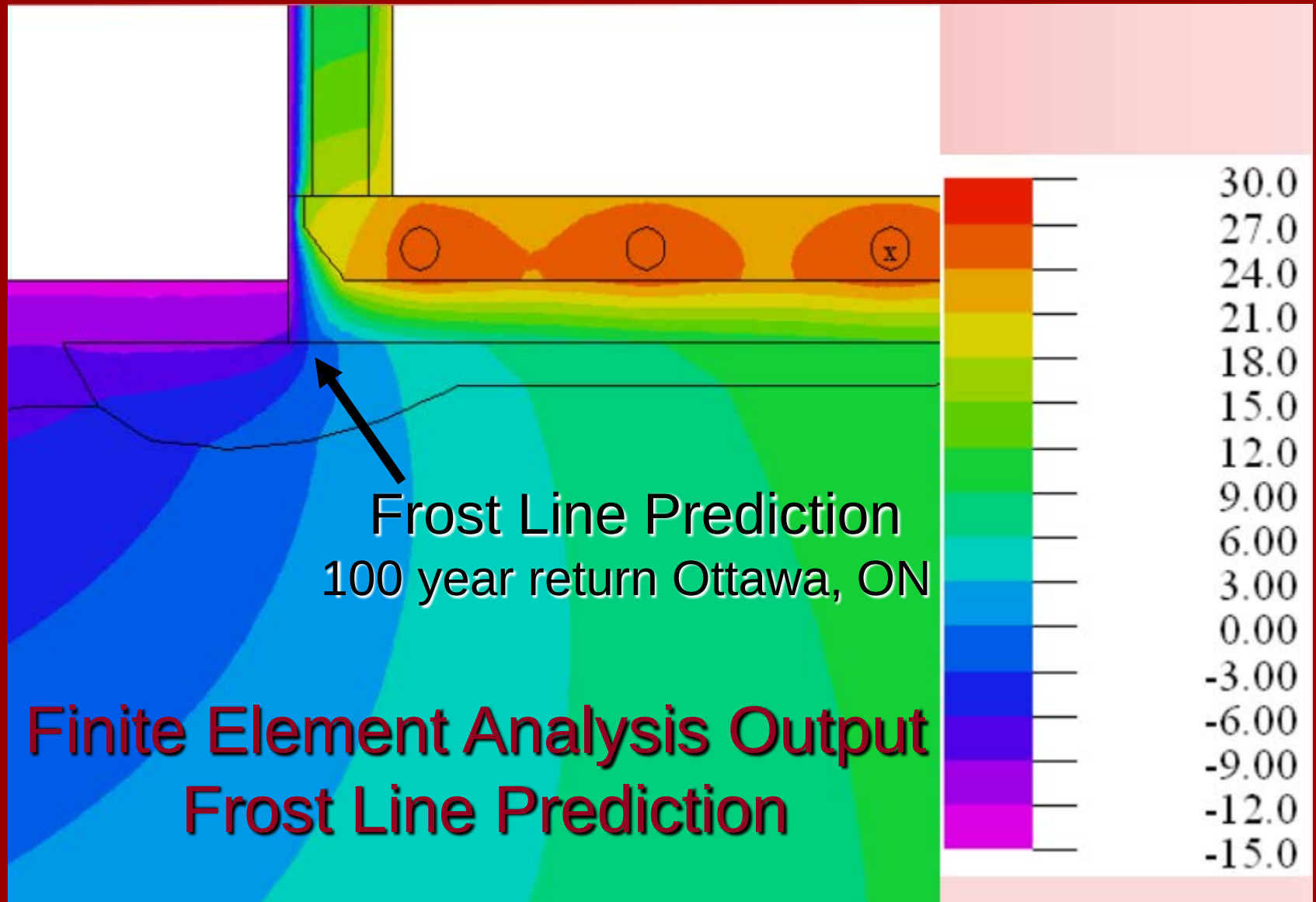
Legalett's conservative approach

Legalett assumes all soils are frost susceptible

Legalett assumes 70-80% soil moisture content

Legalett assumes no ground or snow cover

Legalett models the worst winter in 100 years





LEGALETT®

Products

In addition to 5/6/8 inch Air Heated Floors

Legalett supplies

Unheated Slabs on Grade for

- **Heated Buildings and**
- **Unheated Buildings**

The background of the slide is a grayscale photograph of a construction site. A worker wearing a dark jacket and a hard hat is kneeling on a grid of steel reinforcement bars (rebar). The worker is positioned in the center-left of the frame, facing away from the camera. In the foreground, there is a white rectangular object, possibly a piece of equipment or a container, with several circular holes on its side. The overall scene is a construction site for a concrete slab, with the rebar grid extending across the entire visible area.

LEGALETT®

Installation

Simple and Cost Effective

Installation

Strip Organic Material - Topsoil



Strip Organics

LEGALETT®

Place Clear Stone



Place Drainage Layer

LEGALETT®

Rough-in Electrical and Plumbing



Rough-in Electrical and Plumbing

LEGALETT®

Place Edge Element



Place Edge Element

LEGALETT®

Place EPS



Place EPS under slab

LEGALETT®

Place Heater Box



Place Heater Box

LEGALETT®

Install Wire Mesh – Piping and Piping Insulation



Install mesh, piping and piping insulation

LEGALETT®

Pour and Finish Concrete



Pour and Finish Concrete

LEGALETT®

Run Construction Heater



Run Construction Heater

LEGALETT®

Install Thermostats



Install Thermostats

LEGALETT®

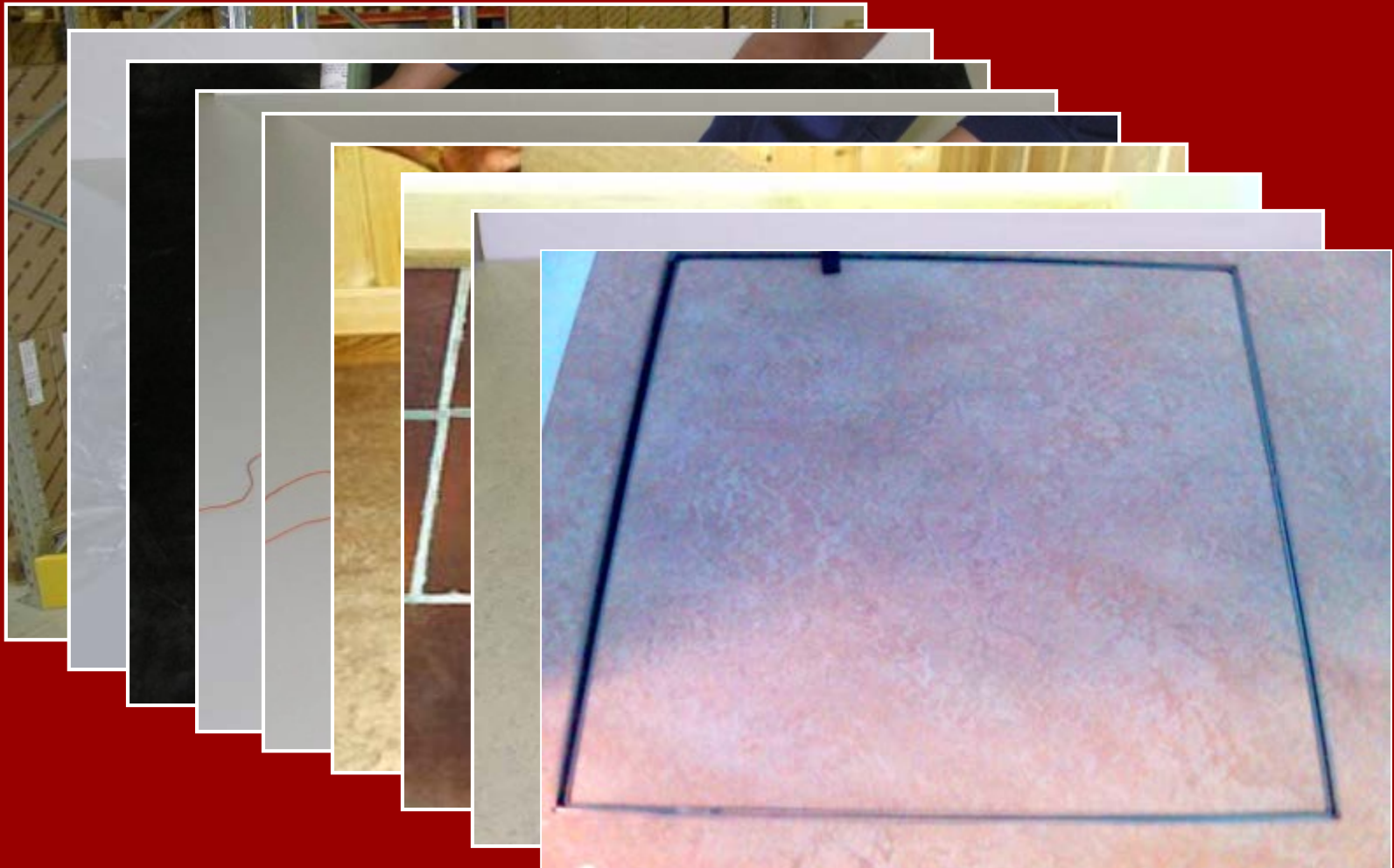
Heater Cover Finishes



Place Heater Box Anywhere

LEGALETT®

Heater Cover Finishes



Place Heater Box Anywhere



LEGALETT®

Installation time of Legalett system



7 man-hours per 100 ft²

LEGALETT®



2" System Ready for Pour

LEGALETT®



2" System Pour

Review Advantages Discussed

- Superior Comfort
- Lower Capital Costs
- Lower Operating Costs
- Ability to Build on Poor Soils
- Prolonged Construction Season
- Elimination of Mold and Mildew
- Heat During Power Outages

Other Advantages

- Easy to Provide Heated Garage
- Easy to add Cold Porches
- Ideal for Physically Challenged
- No Water Leaks
- Simple Controls
- Low Maintenance Costs

Environment

- **No Effect on Ground Water**
- **Does Not Kill Mature Trees**
- **Can Use Passive Solar Energy**
- **Reduces Energy Requirements**
- **Uses People Friendly Materials**

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Thank you
for allowing us to share

The  **Way**

www.legalett.com