The Basics of GEO-Slab Foundation Systems

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The Basics of GEO-Slab Foundation Systems

Presented By: Legalett
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Description: Provides an overview of the components, advantages, design factors and the green and sustainable benefits of GEO-Slab foundation (GSF) systems. Course also includes a performance summary of GSF construction in the various LEED® and NGBS rating programs.

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Learning Objectives

At the end of this program, participants will be able to:

- describe the components of a GEO-Slab foundation (GSF) system that combine to create an energy efficient, cost-effective foundation alternative
- list the engineering disciplines that unite to create optimum engineering solutions for each individual GEO-Slab project
- state the performance and green benefits related to GSF systems, and
- discuss how GSF systems are recognized in various green building rating programs.

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Click on title to view

Green Building

Introduction

Buildings have a dubious reputation for being energy hogs. According to the U.S. Green Building Council, buildings in the United States account for:

- 71% of total electricity consumed
- 39% of total energy consumed
- 39% of total CO_2 emissions produced
- 30% of total raw materials consumed, and
- 30% of total waste produced.

Building green not only helps conserve valuable natural resources, it also makes economic sense. A recent industry study determined that green buildings deliver the following financial benefits:

- 13.2% lower operating costs
- 6.4% higher occupancy
- 6.2% higher rent
- 10.9% higher building values

(Source: McGraw-Hill Construction)

Life Cycle Assessment

Life cycle assessments show that energy savings is the single most important environmental issue.

Typically, operating energy outweighs embodied energy within the first ten years of a building's life.

Over a 75-year life of a non-residential building, about 85% of the impact of a building comes from its use phase, and only 15% is traced to the building material product, transport and demolition.

Insulated Concrete Forms

In terms of building materials, insulated concrete forms (ICFs) for walls significantly reduce energy consumption for the duration of the building's use phase. Providing an R-Value of 22 to 27, ICFs for walls generally offer a thermal performance that is significantly superior to the R-Value in the wall assembly.

Ongoing energy savings ranging from 30%–50% are commonplace.

In this course, we review the features and benefits of GEO-Slab Foundations (GSF), an insulated slab foundation system with similar performance characteristics to an ICF wall assembly, that offers a green and sustainable alternative to conventional footings.

GSF Construction: Serpent River Community Center, Ontario

GEO-Slab Foundation Technology

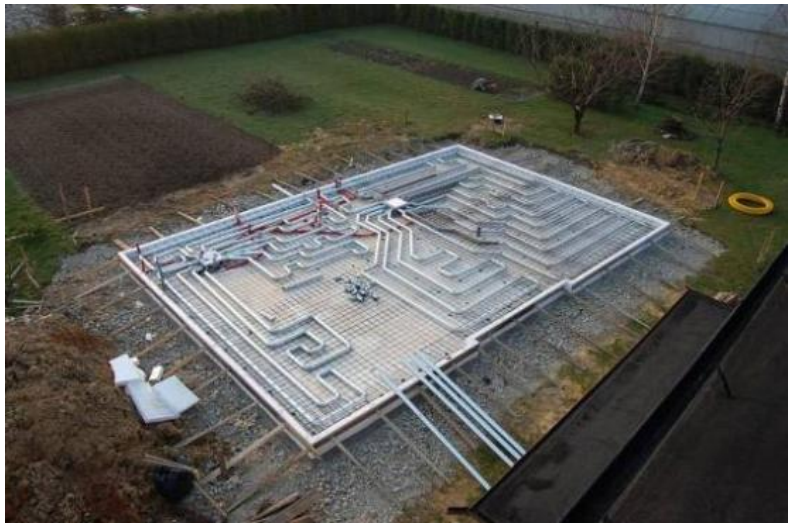
Introduction

A GSF is a type of slab-on-grade Frost Protected Structural Foundation (FPSF) System.

A GSF can be designed for three building types:

1. unheated building relying on geothermal heat,
2. heated building - unheated slab relying on the building's conventional heating system (i.e. HVAC system), or
3. heated slab supplied with any form of in-floor radiant heating from a hydronic or electric, closed loop warm air delivery system.

For the purposes of this presentation, closed loop warm air radiant heat will be featured.



EPS & Concrete

The GEO-Slab is a composite design based on a combination of reinforced and non-reinforced concrete and integral structural Expanded Polystyrene (EPS) insulation.

The combination of EPS and concrete is an ideal blend of building materials offering:

- high strength
- high insulation value
- versatility
- ease of use
- relatively low cost, and
- sustainability.

Built for multiple generations, concrete and EPS will stand the test of time.

Expanded Poly Styrene (EPS)

To reduce environmental impact, the EPS material used in a GEO-Slab does not contain any CFCs or HCFCs; it is shipped in a compact format, reducing transportation pollution; and there is no off-gassing once delivered to the site. EPS is cost-effective, highly moldable and has the ability to be used as a seismic buffer to reduce the magnitude of dynamic earth pressures.

Expanded Poly Styrene (EPS)

EPS Manufacturing

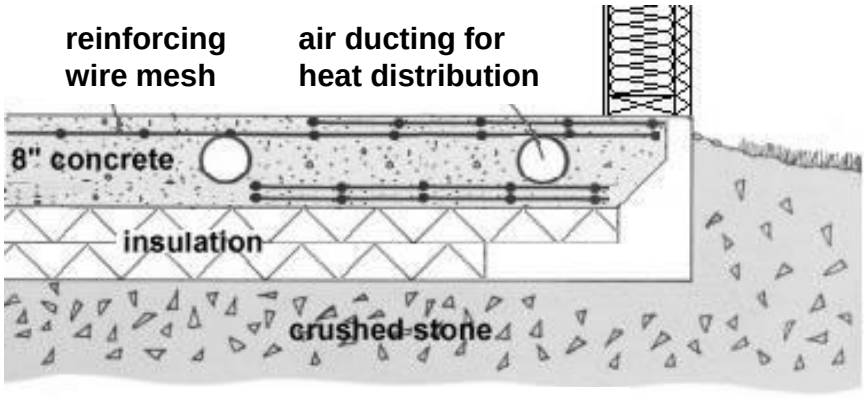
Wire-Cut EPS Foam Shapes

Wire-cut EPS forms in a GSF system are placed at the foundation edge and provide the following functions:

- create the stay-in-place concrete formwork
- provide for an optimum engineered design
- create integrated strip footings and pier pads within the EPS layout
- provide the durable and decorative exterior covering
- provide a continuous thermal break for the building foundation

Structurally Reinforced Concrete

Providing structural integrity, the concrete slab is reinforced to carry loads of interior and exterior walls, multiple levels, as well as the roof. It also supplies the enormous heat sink that is used to buffer the interior temperature of the structure.



Slab Section View

Piping

For an air-heated GSF, piping is available in 2” or 4” diameter.

Closed loop piping carries the warm air throughout the slab system, meaning no outside air enters or leaves the system.

Drafts and overall air movement are reduced to simply what is required for healthy ventilation, as provided by a heat recovery ventilator or similar system.

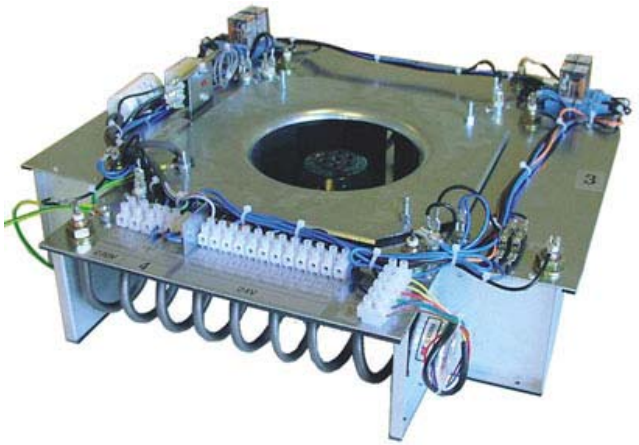
2” Diameter Piping

Furnaces

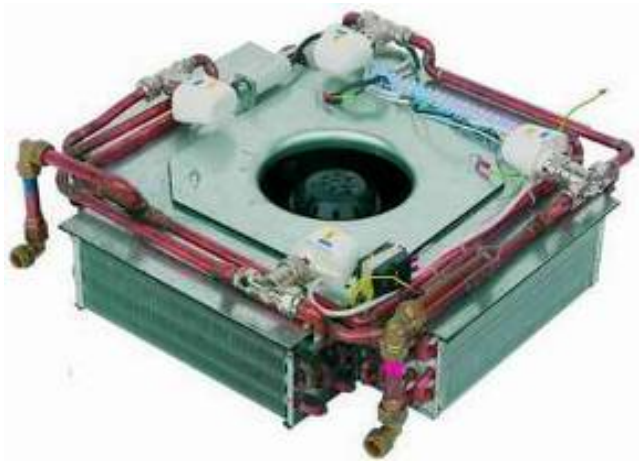
The furnace is used to heat the air, which circulates through the system. Two types of furnaces can be used with an air-heated GSF system: electric unit or water coil unit.

Up to two heating control zones per unit can be designed in a GSF, providing increased occupant comfort. Heating zones can range between 200 to 900 square feet.

The furnace is operated with simple wall-mounted programmable thermostats. All moving and mechanical components are contained within the furnace box, which can be easily opened and accessed for maintenance. The furnace box occupies very little space as it is recessed into the slab, and can eliminate the need for mechanical rooms, saving space in a home.



Electric Unit



Water Unit

Environmental Factors of GSF Components

GEO-Slab foundations are made with products that include recycled materials. (The bulk of the system is EPS insulation, PVC/steel piping and reinforcing steel.)

Expanded polystyrene foam is a byproduct of the natural gas industry. Recently, it has been designated a “technical nutrient” by MBDC (McDonough Braungart Design Chemistry).

This means it is a material that can be recovered and reprocessed repeatedly for reuse at a high level of performance. EPS can be reground or down-cycled for use in other products, such as trim molding.

Environmental Factors of GSF Components

Concrete can be crushed and reused, and much of the cementitious element can be replaced with recycled materials, like fly ash and slag.

Additionally, concrete is one of the better building materials for environmentally-sensitive people.

Some green programs reward sourcing local/regional materials, as they support local economies and reduce transportation costs.

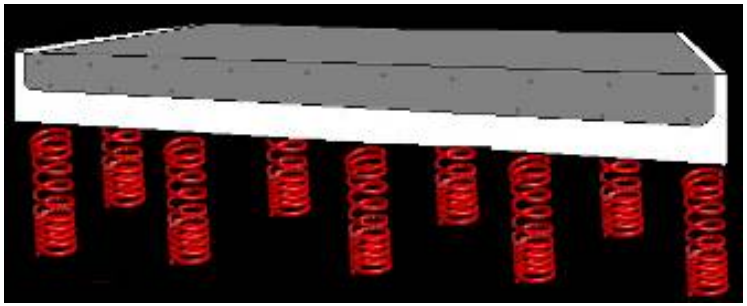
Concrete, aggregate, EPS, piping and other base materials are usually obtained through a local supplier.

Structural Engineering

Three engineering disciplines (structural, geotechnical and mechanical) are combined to work out optimum engineering solutions for each individual GEO-Slab project.

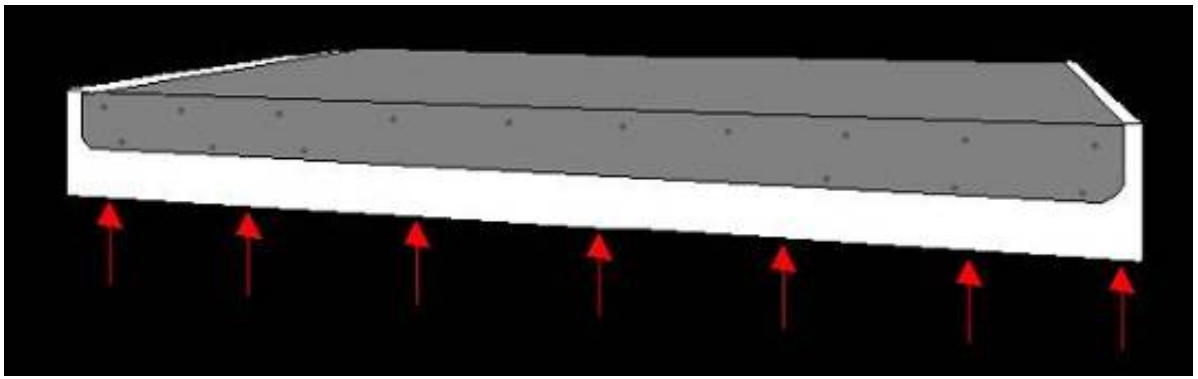
Structurally, a GEO-Slab behaves as a modified raft foundation resting on soil that is modeled as an infinite set of springs.

The GEO-Slab is engineered to accommodate point loads of up to 100,000 lbs. within the thickness of the slab, eliminating requirements for complicated formwork and additional excavation.



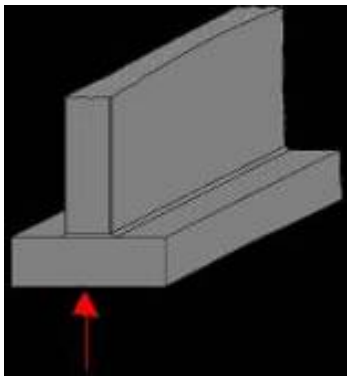
Structural Engineering

The raft-style foundation allows edge and interior point loads to be spread out to keep native-soil interface bearing pressures very low, in contrast with conventional footings, which concentrate loads.



GEO-Slab

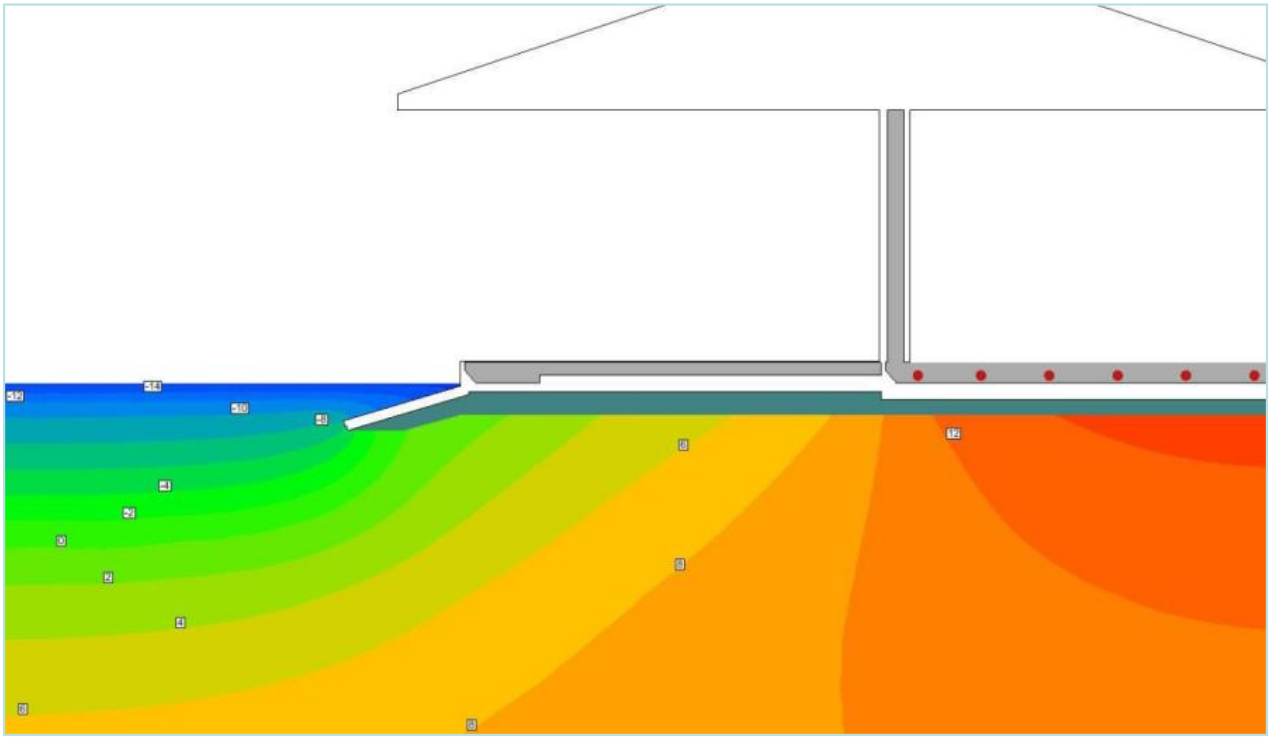
VS.



Conventional Footings

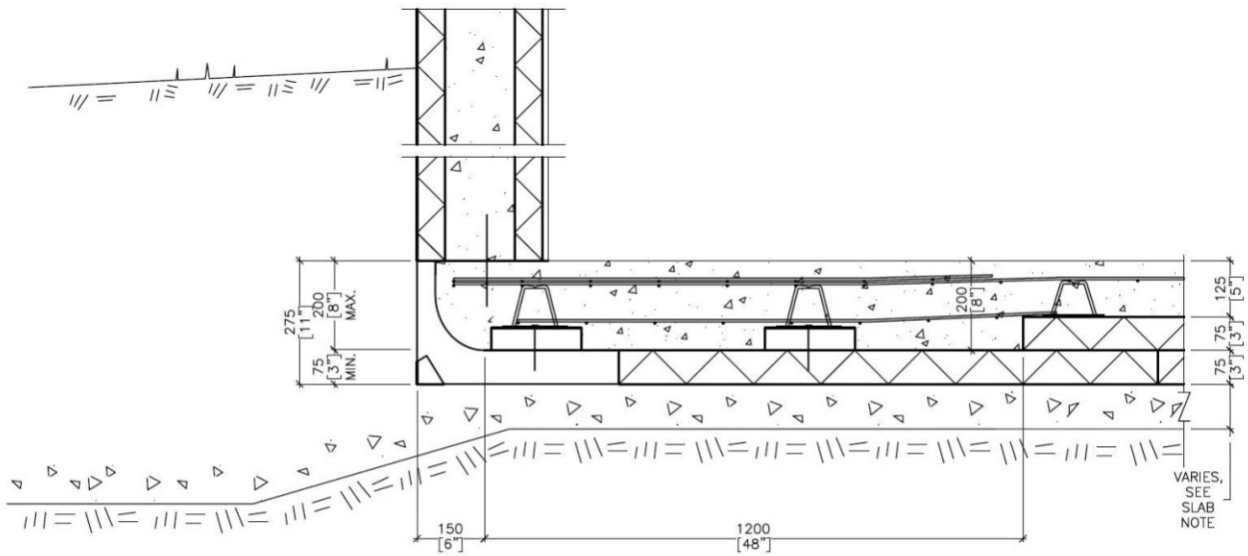
Geotechnical Engineering

Thermal modeling is factored into each design, considering such issues as climate, soil conditions, operating temperatures and air freezing index (AFI). AFI is a measure of the combined duration and magniture of below freezing temperature occurring during a given freezing season.



Geotechnical Engineering

GSF systems are typically built on-grade and eliminate the need for digging below the frost line. However, GSFs can also be installed below grade.



PARTIALLY BURIED ICF WALL
TYPICAL 5" UNHEATED SLAB THICKENED EDGE SECTION (A / 201)
(12/22/10)

Geotechnical Engineering

Thermal modeling indicates how the frost line behaves below the slab.

GEO-Slabs are designed in such a way that the frost line never penetrates underneath the slab edge, as it is managed by the combination of geothermal heat retention by exterior EPS and heat augmentation from site-specific building heating design.

What makes GEO-Slabs unique is the site-specific design for frost protection. Instead of relying on the standard design methods typically used for FPSFs, GEO-Slabs are designed more accurately on a job-by-job basis, eliminating the excessive material costs and difficult forming methods that would be encountered in a typical FPSF.

Geotechnical Engineering

Each project incorporates a site-specific design where soil bearing loads are determined and matched to soil bearing capacities.

A GEO-Slab can provide the foundation structure for any type of building. It is engineered to reduce soil bearings to less than 1/3 of that of conventional footings.

How is this accomplished? With the excavation of the surface topsoil, the mass of the soil is replaced with EPS, a much lighter material. The slab is also reinforced in such a way that it spreads the load more evenly over the bearing area of the slab, instead of concentrating it in one area.

Unheated garages, patios, porches, and exterior walkways can easily be incorporated into a GEO-Slab design. GEO-Slab style unheated slabs are also possible.

Mechanical Engineering

The air-heated GEO-Slab can be designed to operate at all temperatures.

For cold climates, GEO-Slabs can store energy in the slab for use during peak hours, providing substantial savings throughout the heating season.

Mechanical Engineering

Heat load of a building is determined by calculating:

- transmission losses (50-75% of total heating requirements)
- ventilation losses (10-15% of total heating requirements), and
- air infiltration losses (15-50% of total heating requirements).

Radiant air-heated floors provide even, comfortable, warmth, as there is less air movement. There are no drafts except for building envelope infiltration and/or mechanical ventilation. The thermal mass of the concrete evens out temperature fluctuations.

Typical energy density in a heated GEO-Slab is 10 btu/hr/sq.ft.; this can be increased up to 20 btu/hr/sq.ft. for homes with areas of high glazing.

As with any form of radiant heat, ventilation and infiltration losses must be provided by the required ventilation systems. Any air introduced into the occupancy space must be heated to ambient.

Uses of GSF Systems

A GEO-Slab foundation can be used on small additions and on a variety of buildings up to four stories in height, including multi-store commercial, multi-unit residential, community centers, schools and churches.

The GEO-Slab Advantage

Introduction

GEO-Slabs originated in Scandinavia, where over five million square metres have been built over the past 45 years. This technology has been utilized in North America for the past 25 years and has been gaining ground in the industry as more people realize its advantages.

To begin, GSF technology is a healthier solution. By eliminating a basement and building above ground, the risks of mold, mildew, contaminants and odors are removed. Bacteria, mold and mildew require a specific environment in which to thrive—typically a cold, damp area, which is common in many basements.

Furthermore, seasonal affective disorder (SAD) affects many people in northern latitudes as a result of too much exposure to artificial light and not enough exposure to natural light. SAD causes, among other things, mood swings, depression and disruptive sleep patterns. Natural daylight, which is gained when above ground, improves an individual's physical and mental health. Conversely, a basement is a prime example of a place where there is not much natural light.

Advantages of GSF Systems

GSF systems offer a cost-effective green solution, providing efficiencies in price and in materials consumed through simplification of the foundation design. The cost savings of a GEO-Slab are realized in a number of different areas.

- Minimal excavation is required (stripping of topsoil versus digging over 4’ into the ground).
- A single concrete pour for the slab is required, compared to two and sometimes three pours for footings and frost walls.
- Footing drainage is greatly reduced, as there is no worry about flooding.

Advantages of GSF Systems

- Savings are also realized with the labor time involved in assembling the slab. With the stay-in-place formwork for the GEO-Slab, an experienced crew can typically have everything installed and ready for pour for a 1800 sq. ft. home in two days.

- With the absence of a basement, there are reduced system maintenance issues, such as no expensive repairs for foundation leaks, and no risk of flooding from failed sump pumps, which in turn negates a need for insurance for these risks.

- Prerequisite 1 of Sustainable Sites category is erosion and sedimentation control. The builder must design an erosion control plan for the site to combat erosion that comes about due to site clearing and earth moving. With a GSF foundation system, there is less excavation, and less chance of site erosion and sedimentation of local waterways.

Advantages of GSF Systems

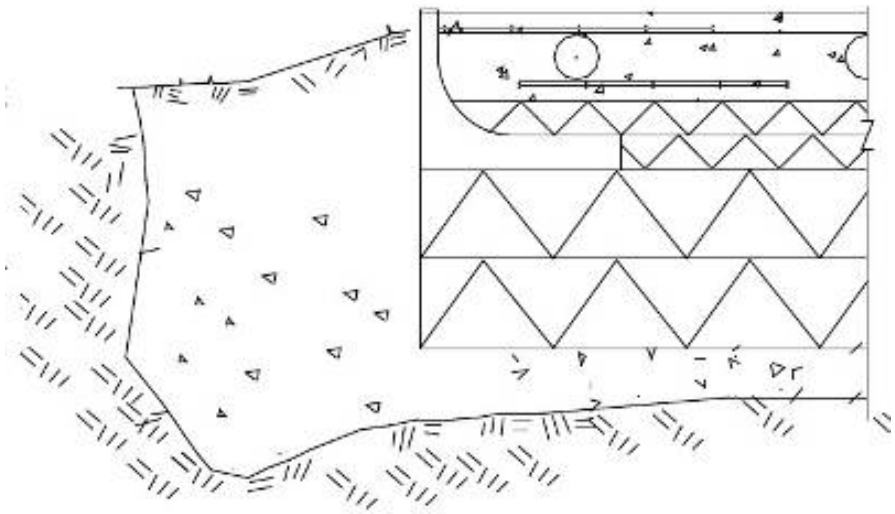
The use of EPS-shaped foam has opened the door to make some types of complicated slab-on-grade forming fast, easy and at great cost savings.

Reduced Soil Loading

Another advantage of a GEO-Slab is the ability to reduce soil bearing loads.

This allows cost-effective construction in areas where poor soils inhibit construction with conventional footings.

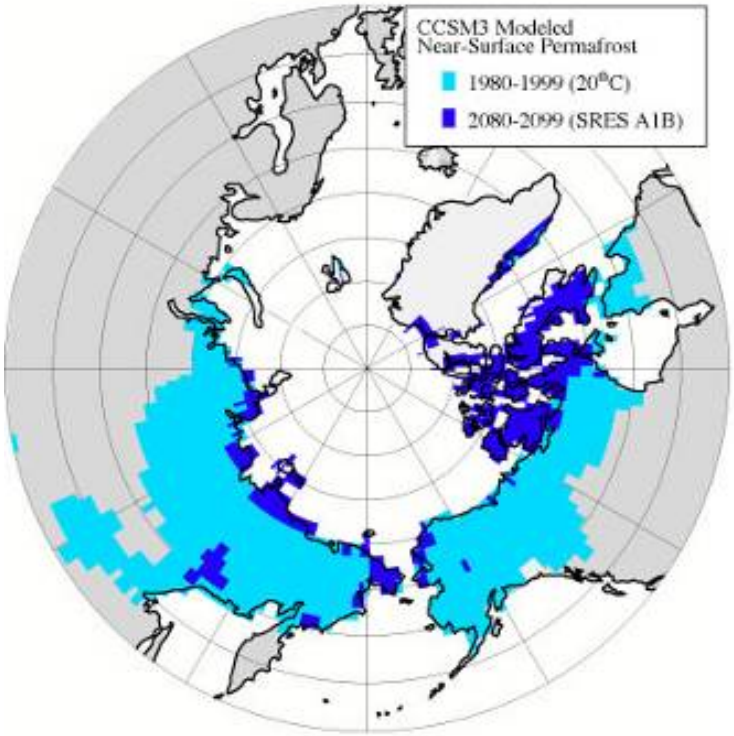
A compensated GEO-Slab can be used to create a zero net load on the native material. This is accomplished by establishing the weight of the building and removing an equal weight of soil. EPS is then laid under the slab to fill the void left by the removed soil.



Permafrost

Typically, when building on permafrost, the heat lost to the ground in combination with the weight of the building can melt the permafrost and potentially lead to ground movement. This can result in damage to the building.

Building on permafrost can be accomplished through the utilization of helical pilings with grade beams. With this method, the building is suspended a few feet above ground, which allows cold air flow under the building, preventing the permafrost from thawing. This a very costly method of construction.



GSF Systems & Permafrost

GFS systems provide an easy solution, as GEO-Slabs can be designed for permafrost using similar techniques to a compensated foundation.

With a GEO-Slab, the combination of heat loss and building weight are eliminated by using a thick layer of EPS to insulate the home beneath the slab.

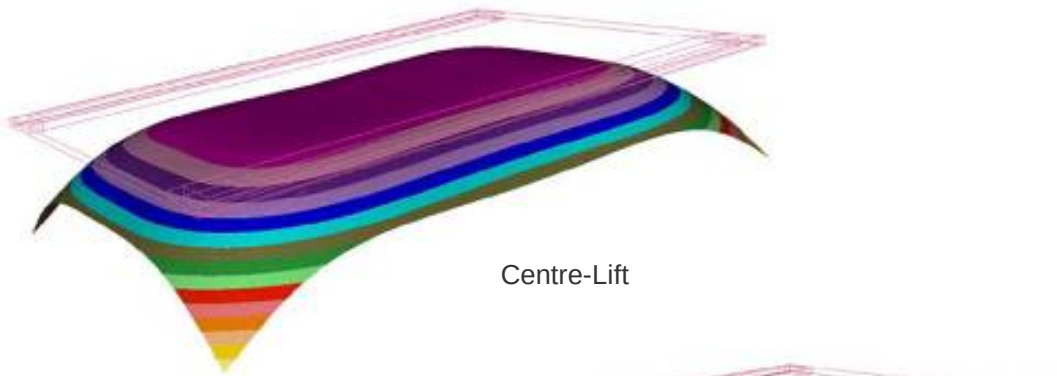
Additionally, the layer of EPS provides compensation so that the native soil doesn't incur much loading.

The GEO-Slab is also well-suited for expansive soils.

GSF Systems & Expansive Soils

As with building on permafrost, building on expansive soils is done the same way through the utilization of helical pilings with grade beams. With the depth of the pilings, the problems with expansive soils at the surface are eliminated; however, this method of construction is difficult and costly.

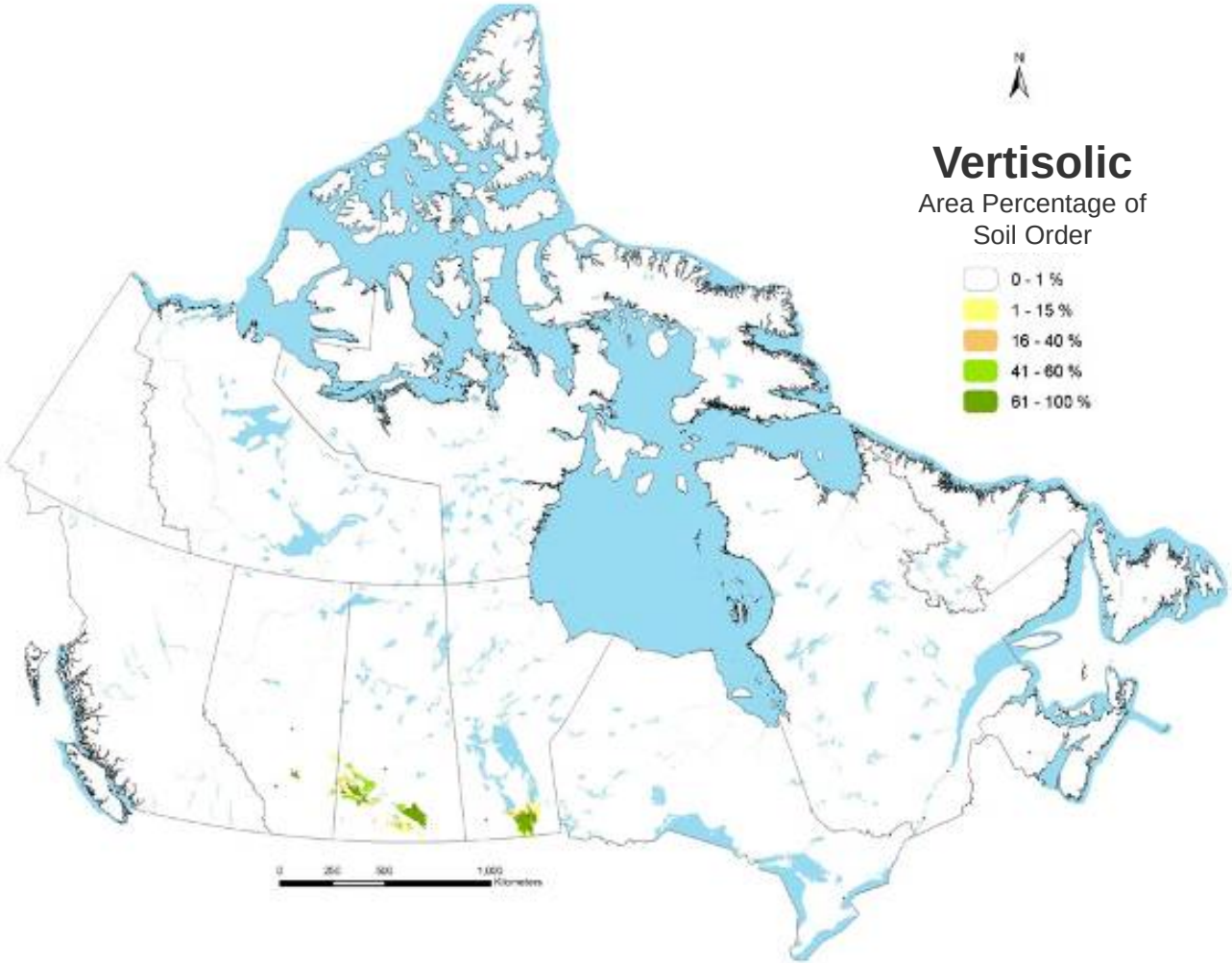
GEO-Slab construction eliminates these problems using a watershield design, which is designed to stabilize the thermal properties and moisture content below the slab and directs all water away from the soil close to the slab. A GSF system is a cost-effective alternative for expansive soils.



Centre-Lift

Edge-Lift

Canadian Expansive Soils



Vertisolic soils are highly expansive. In other areas of Canada, there may be a mix of soils that display some expansive characteristics.

USA Expansive Soils

Over 50 percent of these areas are underlain by soils with abundant clays of high swelling potential

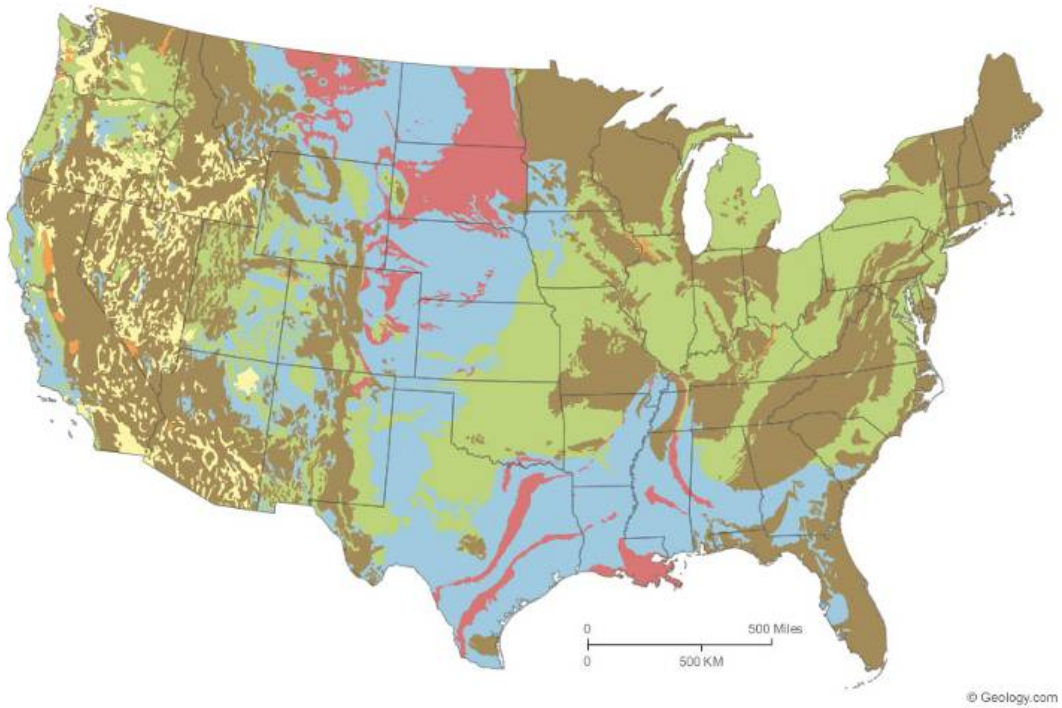
Less than 50 percent of these areas are underlain by soils with clays of high swelling potential

Over 50 percent of these areas are underlain by soils with abundant clays of slight to moderate swelling potential

Less than 50 percent of these areas are underlain by soils with abundant clays of slight to moderate swelling potential

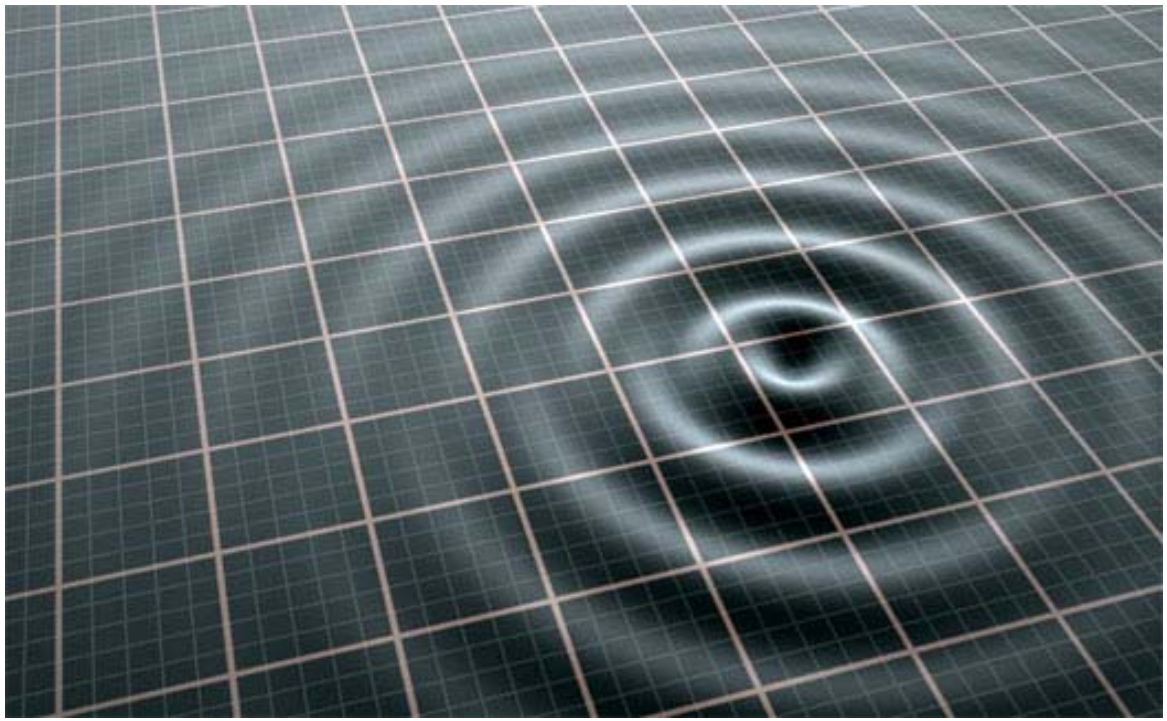
These areas are underlain by soils with little to no clays with swelling potential

Data insufficient to indicate the clay content or the swelling potential of soils



Reduced Sound Transmission

The EPS in a GEO-Slab can effectively reduce vibration or sound transmission, which is often required in sound-sensitive applications, such as building near railways or airports.



Water Table

The water table has many effects on a traditional foundation.

A traditional foundation basically acts like an inverted swimming pool. Instead of trying to keep water in, the foundation is trying to keep water out to prevent flooding, dampness, and foundation leaks.

Unlike a traditional foundation, a GEO-Slab is built on the ground and has no effect on the water table. The stone layer and EPS provide a capillary break to prevent moisture migration into the building from the ground.

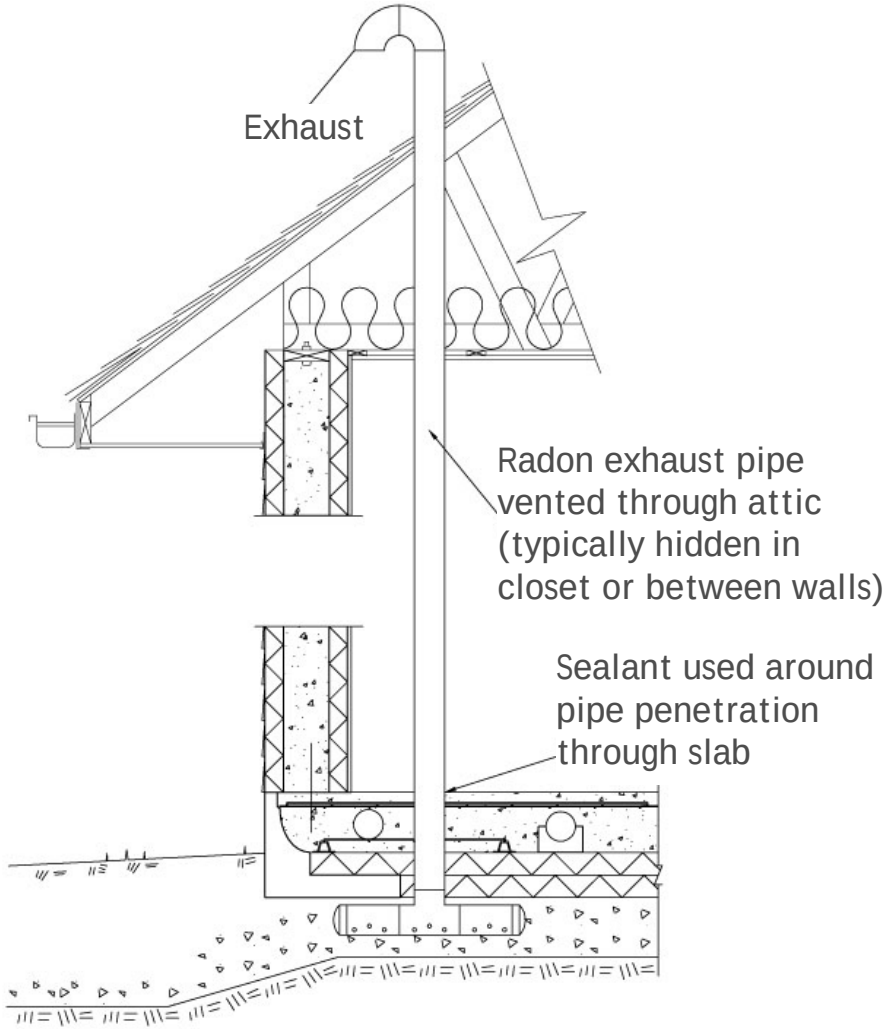
As well, damage to tree root systems and vegetation is reduced with GEO-Slab construction.

Water Table Effects

Radon Barrier

The combination of the continuous reinforced concrete slab, as well as the ¾" clear stone sub base that forms part of the GEO-Slab, becomes a radon barrier under the building.

Radon gas is vented from below the slab through PVC piping and up through the roof.



Underslab Radon Vent - Typical 8" Slab Edge

Barrier-Free Design

GSFs eliminate accessibility issues.

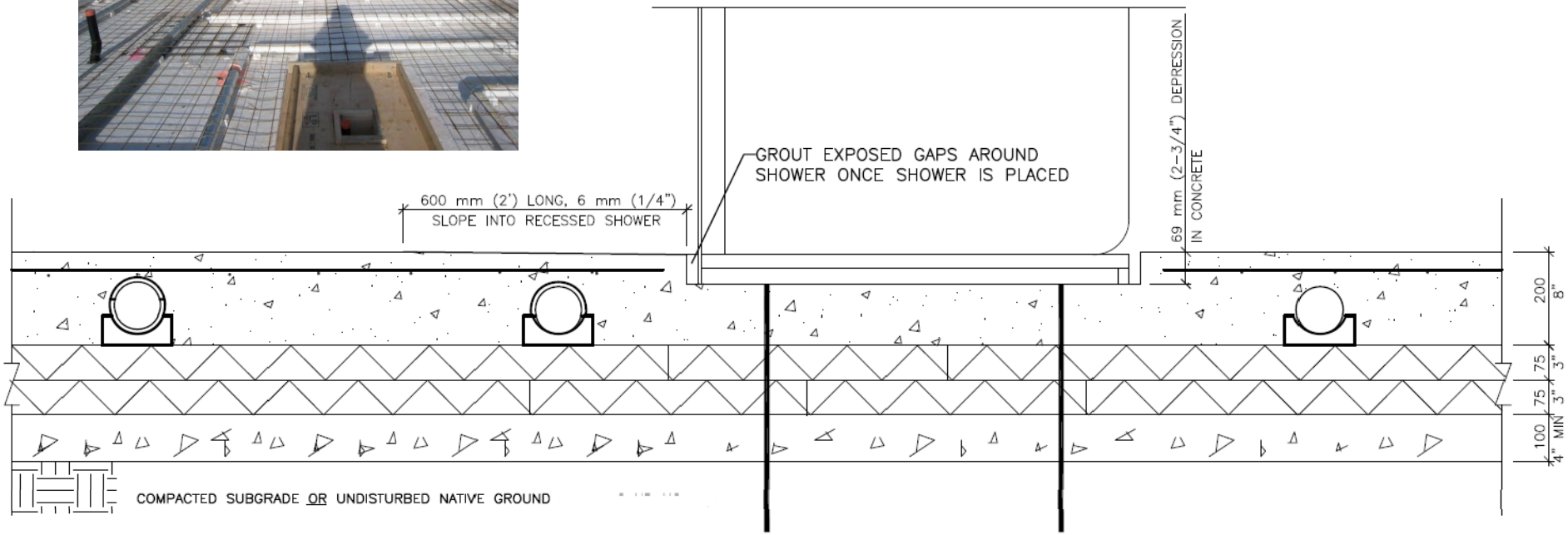
With the slab-on-grade design, ramps can be eliminated, making accessibility simple.

A stair-free dwelling can easily be accomplished with single level design.

MBQ Wellness Center, Tyendinaga, Ontario

Barrier-Free Design

EPS forms can easily be cut to provide the formwork for barrier-free showers and bathrooms.



ASSEMBLED SHOWER SECTION H 203

Design Factors

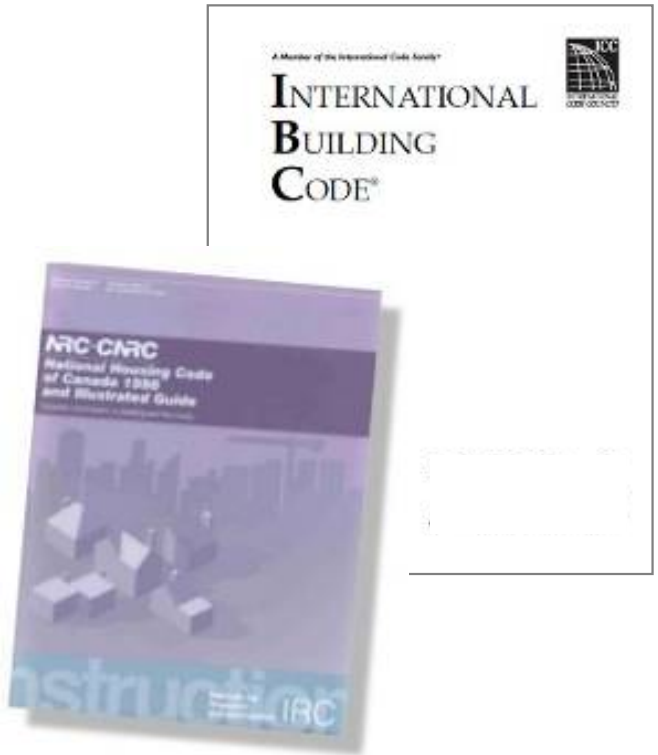
Introduction

Every GEO-Slab design is unique and depends on several factors, including:

- climate
- structural loads
- building use (heated, unheated, partial heat)
- earth contours, and
- soils.

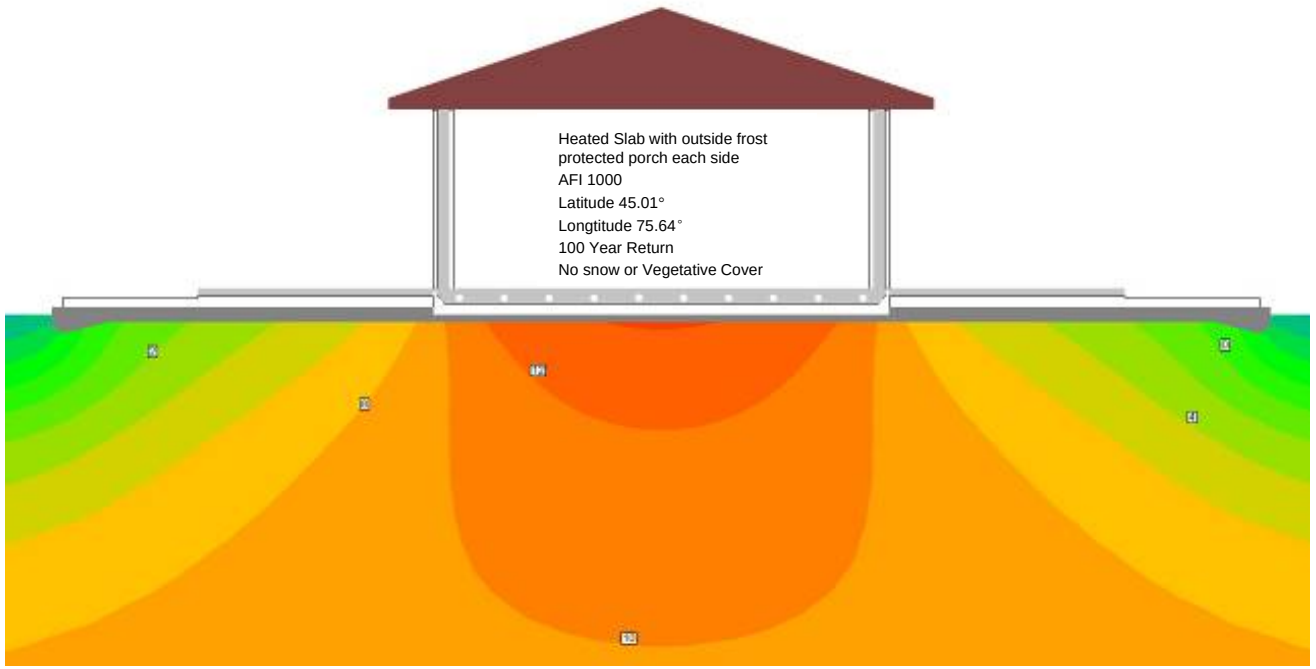
Frost Protected Shallow Foundations, similar to the GSF system, are compliant through local and national governing bodies.

Included in this section of the course are discussions of climate, structural loads and code compliance related to GSF systems.



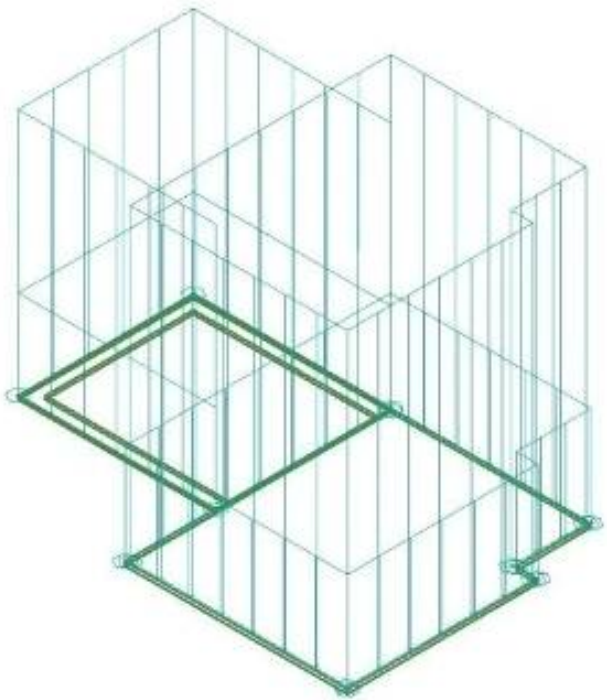
Climate

Designs are modeled according to climate specifics and building heating requirements to optimize frost protection and prevent frost heave. Modeled below is a heated home built with a GEO-Slab Foundation with frost protected porches on either side. It is modeled for the worst winter in 100 years, with no snow or vegetation—meaning there is nothing on the ground that could potentially insulate the ground and prevent frost from penetrating below (worst case scenario).

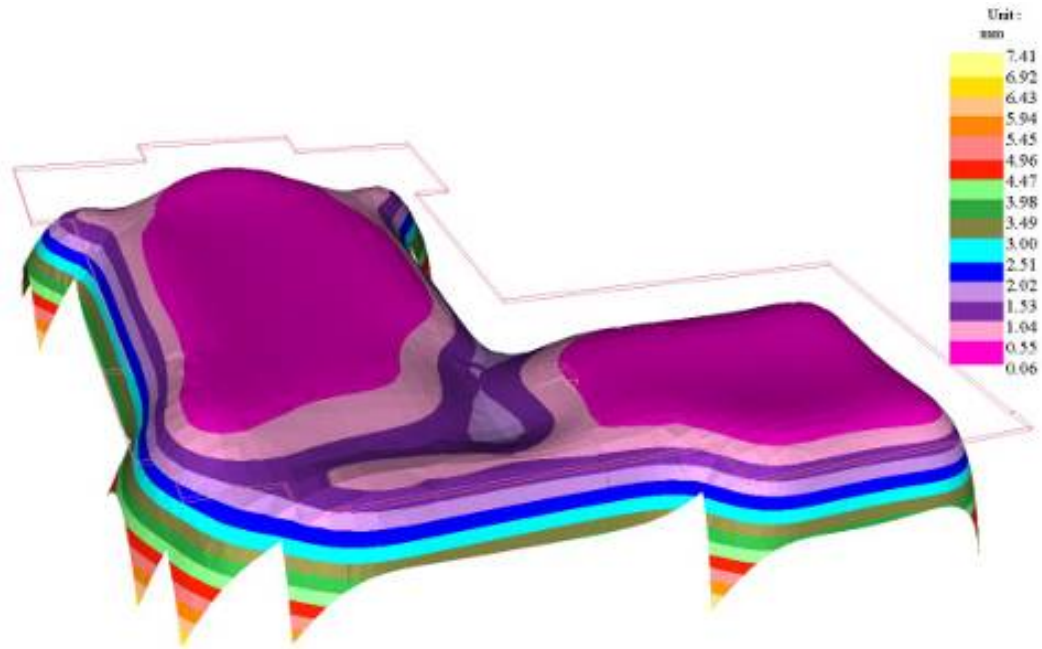


Structural Loads

GEO-Slabs are modeled structurally to analyze all bearing and point loads within the building. These loads are accommodated within the configuration of the GEO-Slab.

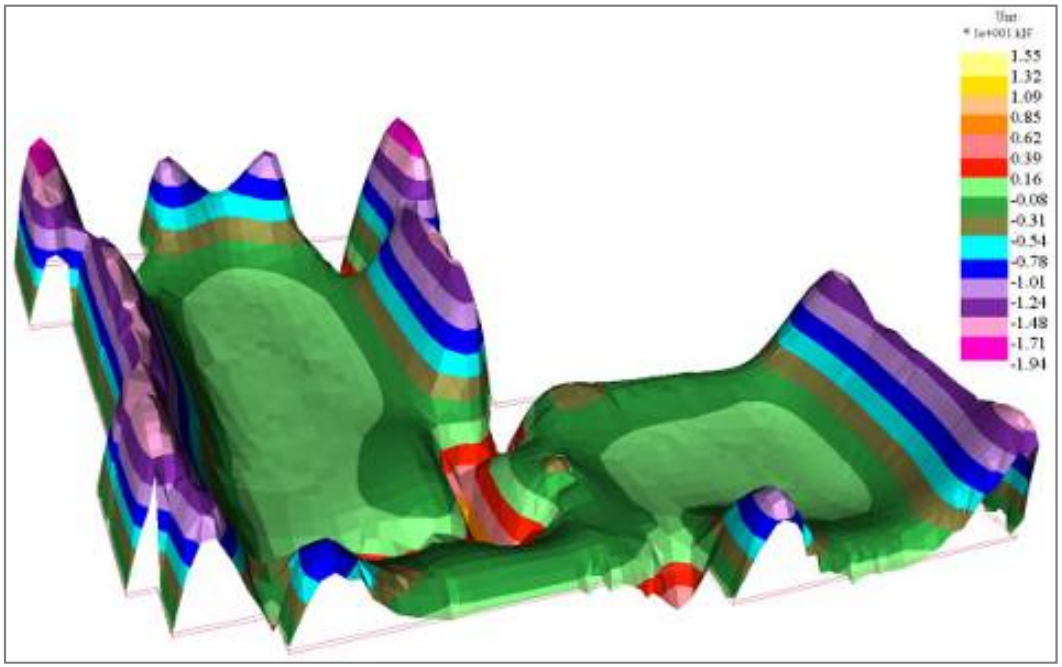


Line loads and point loads are applied to the slab to analyze behavior.



Deformation of the slab is analyzed and compared to deformation limits.

Structural Loads

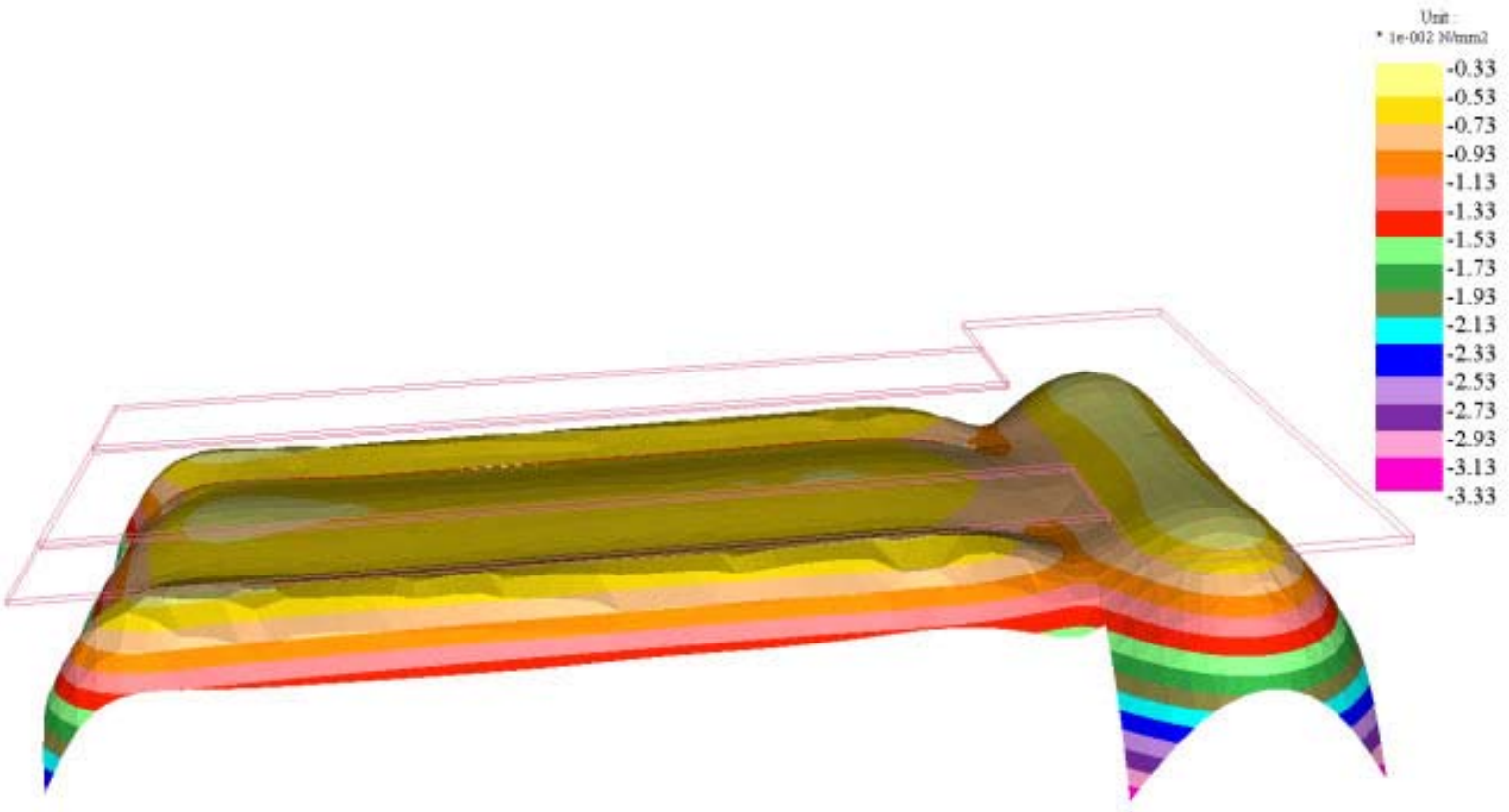


Moments at the edge of the GEO-Slab are examined for placement of reinforcement.

Reinforcement is derived from the modeled analysis to comply with site-specific requirements in accordance with the building code.

Structural Loads

Soil bearing is examined and compared to allowable soil bearing capacities.



Code Compliance

USA
EPS is governed by: ASTM C578-06 Standard for Rigid, Cellular PolystyreneThermal Insulation

CANADA
EPS is governed by: CAN/ULC-S701-05 Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering. (Type II EPS is the material of choice). In some applications Type III is used for its higher compressive strength and lower susceptibility to creep under load.

Code Compliance: EPS

USA
Building Code Requirements for Structural Concrete - ACI 318

CANADA
"Design of Concrete Structures" - CSA A23.3

Code Compliance: Concrete

USA
IRC (International Residential Code) section is R403.3 Frost protected shallow foundations.

ASCE SEI/ASCE 32-01 Design and Construction of Frost Protected Shallow Foundations

CANADA
The slab is designed in accordance with part IV of the NBC for frost protection.

Code Compliance: FPSF

Technical Support

GSF manufacturers provide a full suite of technical support services to ensure GSF installations are as fast and seamless as possible.

- Design and estimating resources are available, as are in-class and on-site training.
- GSF CAD details are typically available upon request.
- Installation guides are simple and easy to follow.

Construction and Installation

Introduction

A GEO-Slab is designed with stay-in-place formwork, which minimizes labor and makes for a simple and easy installation.

With a GSF system, the concrete is placed in a single continuous pour.

Unlike conventional construction, this eliminates multiple pours in the placement of footings, frost walls and slabs.

GEO-Slab Design

A typical GEO-Slab design includes:

- a flat, well-packed clear stone bed (min. 4”)
- two layers of 3” EPS insulation
- reinforcing mesh on top and at edge
- 8” of concrete with as little as 5” in the middle, and
- exterior edge protection, depending on climate.

The outer edge of the slab is insulated using edge elements which stay in place and are used as formwork for the concrete pour.

Ease of Construction

Experienced builders and contractors find GEO-Slab construction to be an extension of general construction practices.

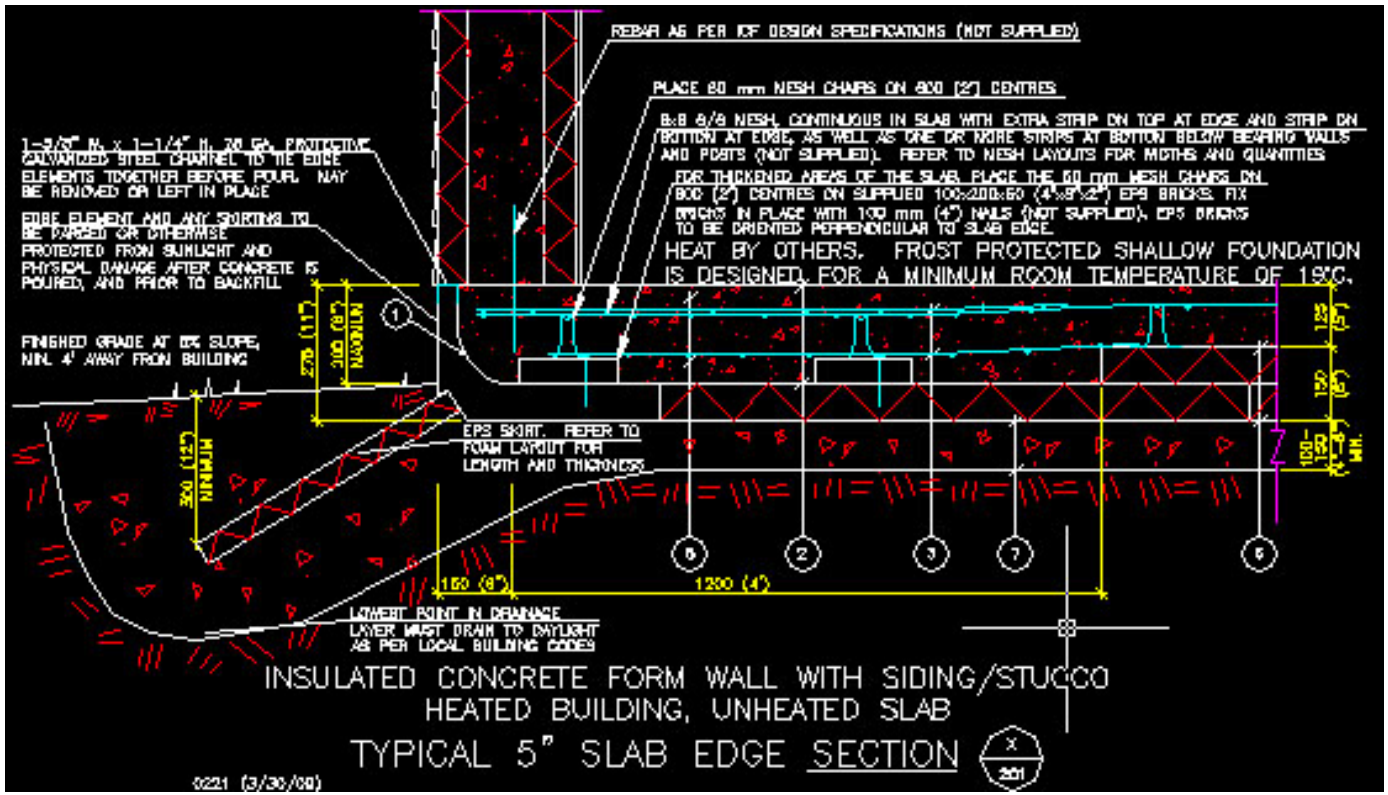
Building GEO-Slabs requires few specialized tools. In fact, most procedures can be accomplished with a simple handsaw and cordless drill.

Engineering Approval

Prior to concrete placement, heating components and reinforcement are reviewed by an authorized party and signed off by the manufacturer's engineering department.

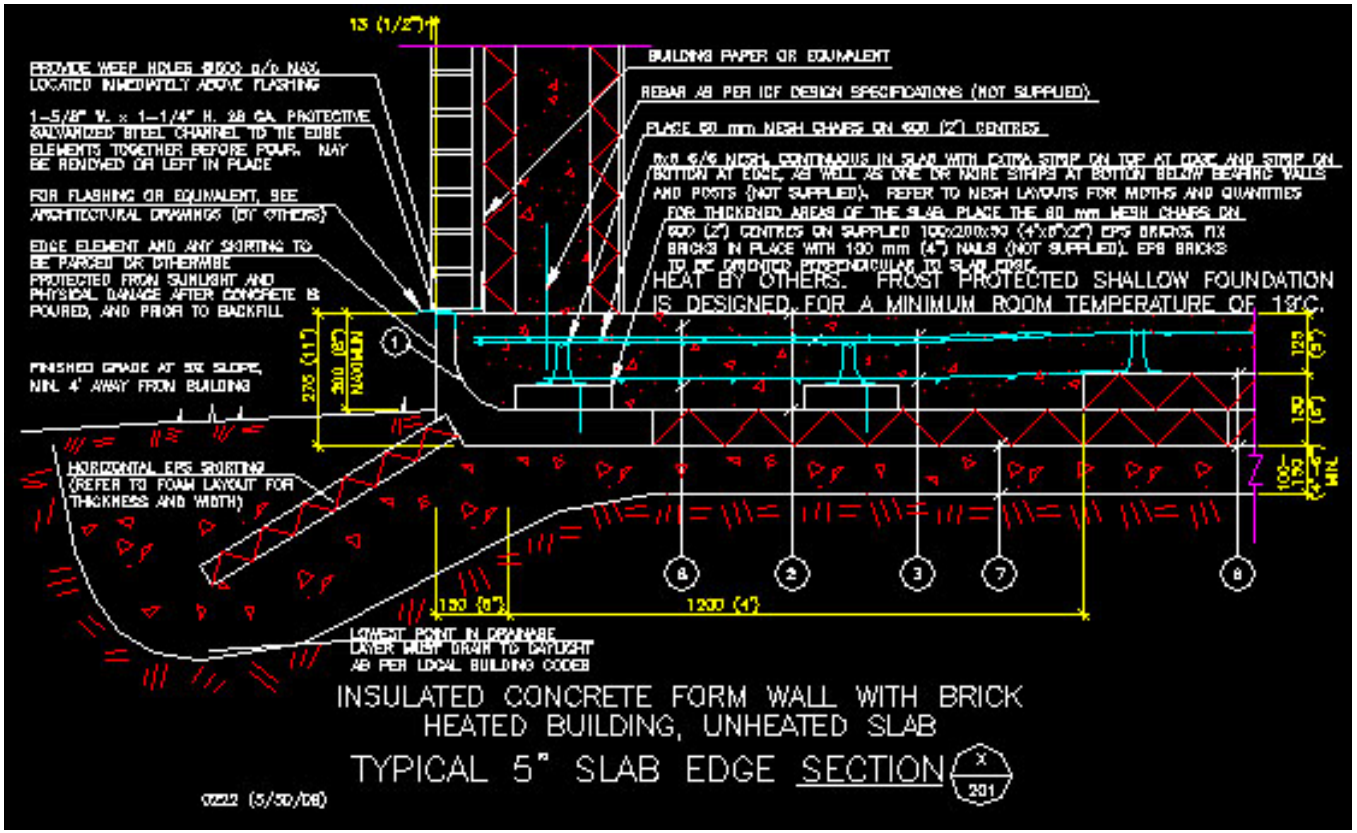
Typical Edge Detail

Illustrated below is a typical edge detail for a 5” unheated slab with ICF wall construction. The edge is thickened to 8” to accommodate bearing loads at the edge.



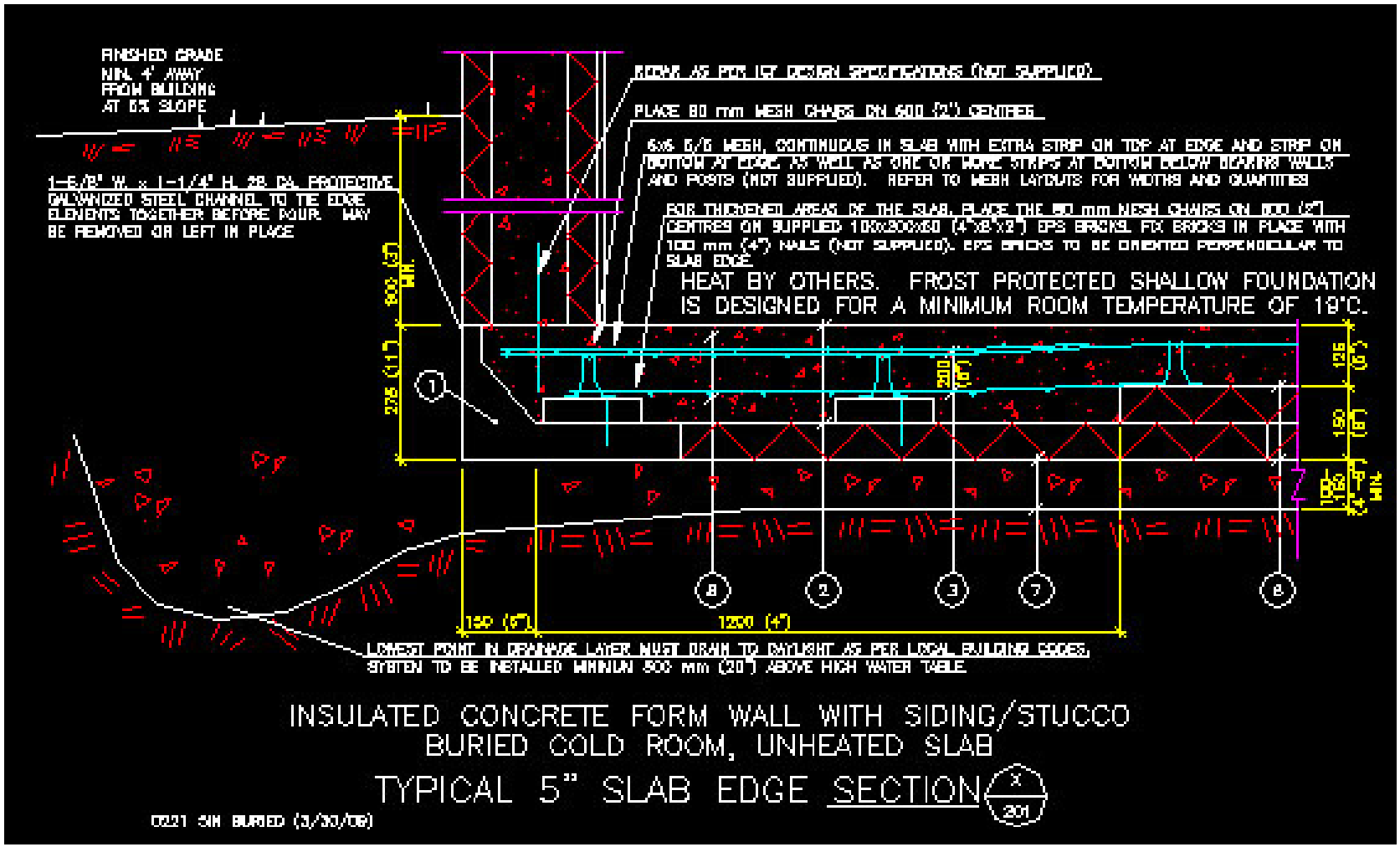
Typical Edge Detail

In this drawing, the GEO-Slab is constructed as a brick ledge and is designed to accommodate the extra loading.



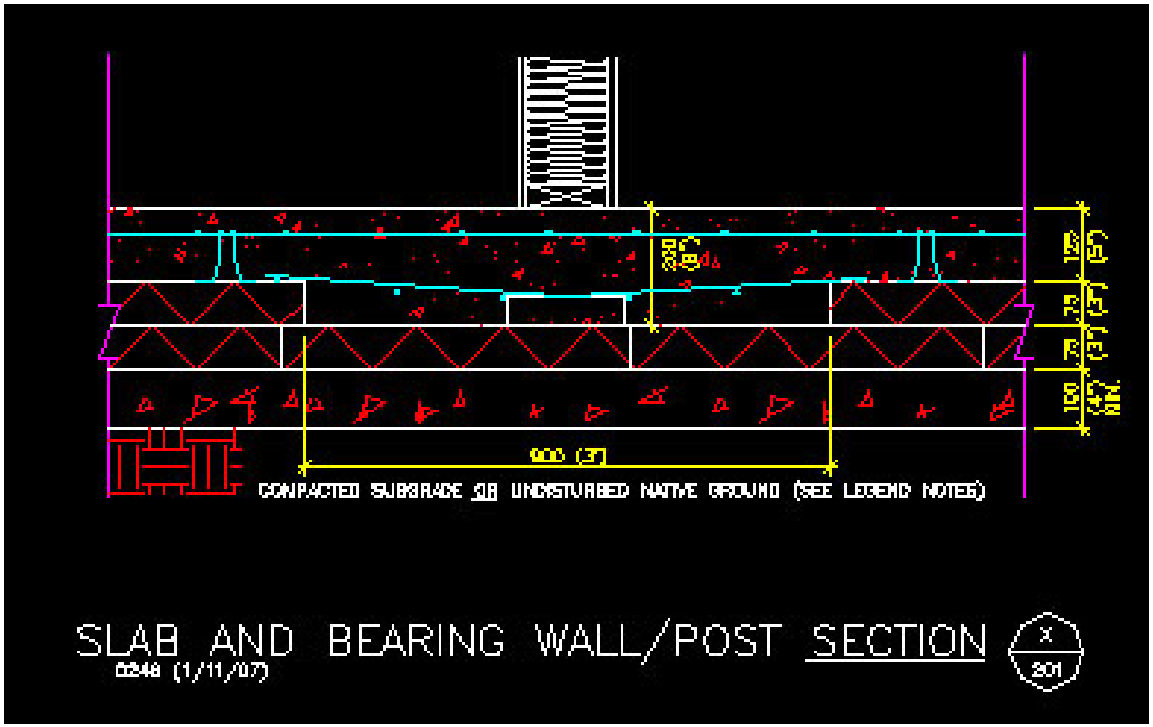
Walk-Out Basements

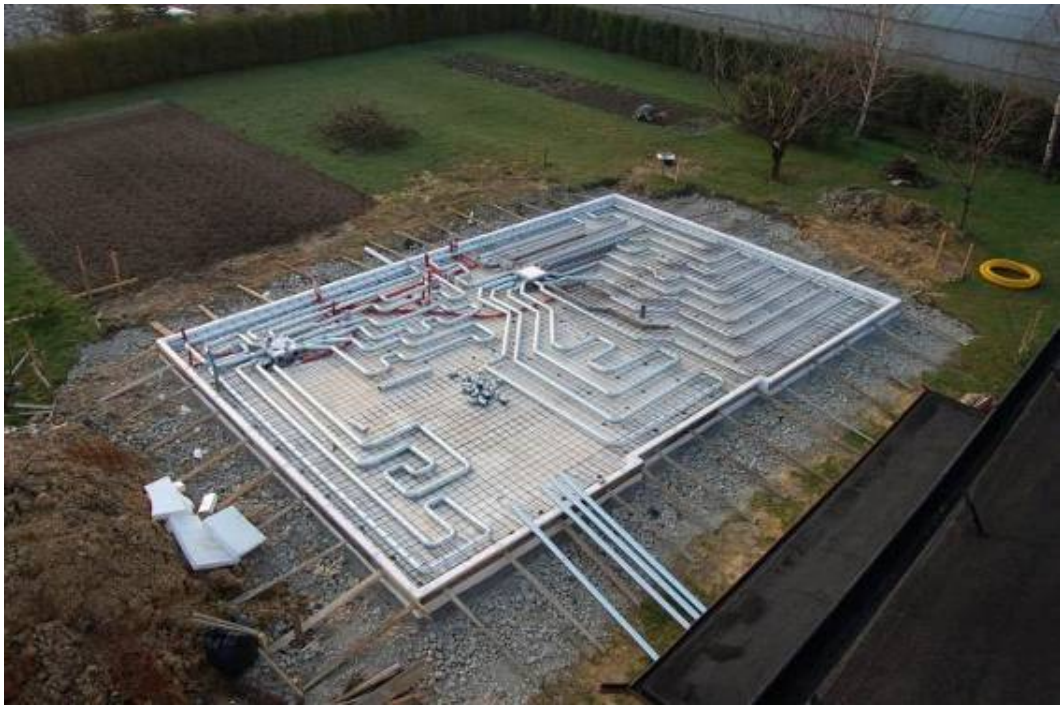
The GEO-Slab can also be buried and is a great solution to a walk-out basement.



Bearing Wall / Post

Bearing walls and posts are accommodated and reinforced within the thickness of the slab, avoiding complicated formwork.





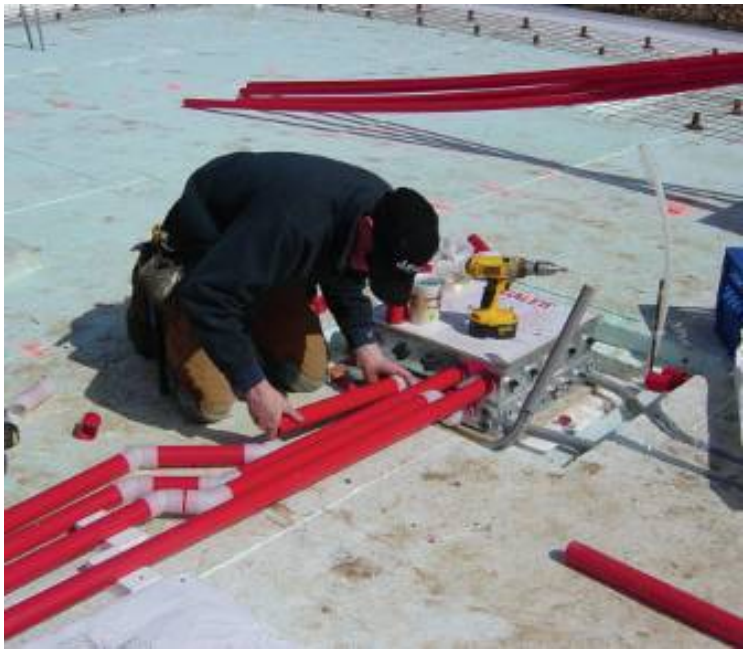
Green Benefits

Introduction

In this section, we review the green benefits of GEO-Slab construction, including a discussion on its relationship to LEED.

To begin, a GEO-Slab solution provides a reduction in energy consumption due to the following reasons:

- enhanced underslab insulation (R-24) and slab edge insulation (R-12) decreases energy loss to the ground
- room temperature can be lowered 3°C (5°F) while maintaining same level of comfort
- the ability to passively collect and distribute solar energy through the slab for heating
- increased thermal mass of the concrete
- reduced heat loss through ceiling through optimum temperature stratification



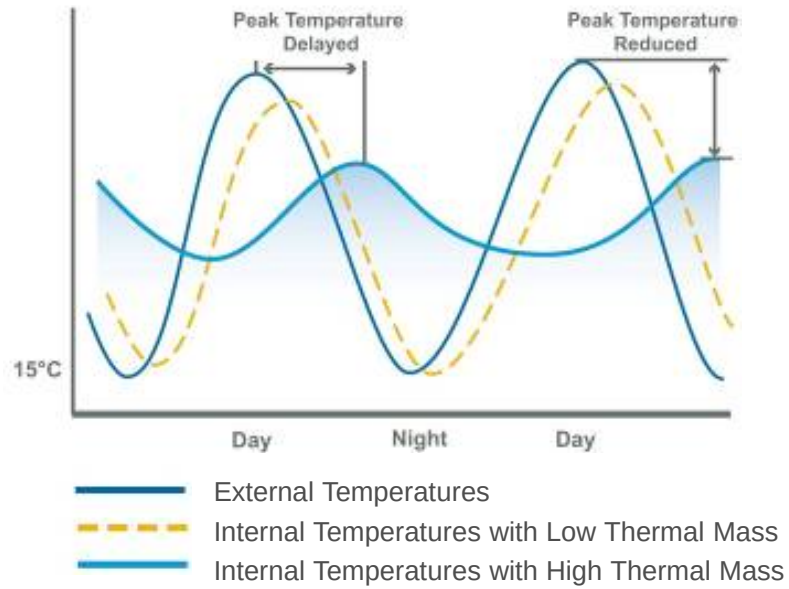
Thermal Mass

Along with reduced energy requirements, the advantages of increased thermal mass include moderation of internal temperature swings and increased occupant comfort.

A GEO-Slab can passively absorb energy from the daytime sun and distribute it at night, as well as store energy during off-peak periods, helping reduce energy costs.

Reduced energy spikes resulting from this storage capability allow for smaller sized, more efficient HVAC equipment.

In this chart, the area between the two curves indicates the energy savings that are derived from high thermal mass.



Improved IEQ / Reduced Waste

Indoor Environmental Quality (IEQ) is a primary concern in the building industry. A GEO-Slab system contributes to improved IEQ. The EPS used in a GEO-Slab has no CFCs, HCFCs, or off-gassing. Additionally, the airtight nature of the building provides better control of airborne contaminants by separating the ventilation system from the closed loop heating system. Since the heated slab is always warmer than the soil and crushed stone, moisture from soil migrates downward and away from the building, reducing the risk of mold and water damage.

A heated GEO-Slab system contributes to occupant comfort, as it has no reverse temperature stratification since the highest room temperature is at floor level. Additionally, temperature overshoot is less common due to low intensity of heating.

Waste is another concern of green building. Although GEO-Slab construction typically factors in a 3% waste when ordering materials, shop drawings are so specific that only minimal amounts of on-site waste (less then 1%) are incurred.

Overview: LEED® Certification

The U.S. Green Building Council (USGBC) is a 501(c)(3) non-profit organization composed of leaders from every sector of the building industry working to promote buildings and communities that are environmentally responsible, profitable and healthy places to live and work. USGBC developed the LEED (Leadership in Energy and Environmental Design) green building certification program, the nationally accepted benchmark for the design, construction, and operation of high performance green buildings.

LEED credit requirements cover the performance of materials in aggregate, not the performance of individual products or brands. Therefore, products that meet the LEED performance criteria can only contribute toward earning points needed for LEED certification; they cannot earn points individually toward LEED certification.

For detailed information about the council, their principles and programs, please visit www.usgbc.org.

LEED & GEO-Slab Construction

GEO-Slab construction contributes positively towards a more sustainable built environment, and it is recognized in the various LEED and NGBS rating systems. A performance summary of GEO-Slab in the different green building programs is outlined in this table.

Green Building Rating System	LEED Point Threshold				Related Pts	Potential Pt Contribution
	Certified	Silver	Gold	Platinum		
LEED 2009 NC	40 - 49	50 - 59	60 - 79	≥80	30	5
LEED 2009 NC Schools					31	7
LEED 2009 Canada-NC					30	7
LEED 2009 Retail					30	5
LEED 2009 Core and Shell					33	5
LEED 2009 Canada Core and Shell					33	7
LEED Canada - Multi-Unit Residential	26-32	33-38	39-51	52-70	19	3
LEED – Neighborhood Development	40 - 49	50 - 59	60 - 79	≥80	8	<1
LEED Homes	45-59	60 - 74	75 - 89	90 - 136	48	11
LEED Canada-Homes					48	15
National Green Building Standard	**Bronze**	**Silver**	**Gold**	**Emerald**	178	73
	222	406	558	697		

LEED & GEO-Slab Construction

A summary of the numerous environmental benefits associated with GEO-Slab Foundation Radiant Floor Heating Systems include:

Sustainable Sites:

- Lower bearing pressure on soils than with typical footings
- Reduced site effects for slab-on-grade, reduced impact on water table and reduced damage to tree root systems
- Less expensive and resource intensive construction, since there is no requirement for deep excavation, frost walls, footings, footing drainage, and sump pump pit(s)

Materials:

- Use of recyclable materials (EPS insulation, PVC/steel piping and reinforcing steel)
- Advantageous during construction due to permanent edging units which reduce need for forms (i.e. the forms become part of the structure when complete)

LEED & GEO-Slab Construction

Energy Savings:

- Enhanced underslab insulation (R-24) and slab edge insulation (R-12) decreases energy loss to the ground
- Room temperature can be lowered 3°C (5°F) while maintaining same level of comfort
- Two heating control zones for up to 1800 sq.ft. of floor area
- Reduce ventilation to absolute minimum required for ventilation only during occupancy
- Slab can passively absorb energy from the daytime sun and distribute it at night, as well as store energy during off-peak periods, helping reduce energy costs
- Reduced energy spikes resulting from this storage capability allows for smaller sized, more efficient HVAC equipment

LEED & GEO-Slab Construction

This table indicates the potential energy savings for different building types with GEO-Slab construction.

Building Type		% Building Energy for Space Heating[8,9,10]	Potential Space Heating Savings with GSF Systems	Potential Overall Energy Savings with GSF Systems	Relevant Rating System(s)
U.S.	Commercial	36.3%	30%	11%	LEED 2009 NC
	Schools	47.3%	30%	14%	LEED 2009 NCS
	Retail	33.5%	30%	10%	LEED 2009 NCR
	Residential	41.1%	46%	19%	LEED for Homes National Green Building Standard
CAN	Commercial	50.2%	30%	15%	LEED 2009 Canada-NC
	Residential - Detached	62.8%	46%	29%	LEED Canada for Homes
	Residential – Multi-Unit	57.6%	30%	17%	LEED MURB

8 Energy Use Data Handbook Tables, Natural Resources Canada, Residential and Commercial Sector. Accessed online 2010/11/1 @: http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/handbook_res_ca.cfm?attr=0

9 Commercial Building Energy Consumption Survey, U.S. Energy Information Administration, 2008, Table E2. Accessed online 2011/02/05 @: http://www.eia.doe.gov/emeu/cbecs/contents.html

10 Residential Buildings Energy Consumption Survey, U.S. Energy Information Administration, 2008, Table US12. Accessed online 2010/11/2 @: http://www.eia.doe.gov/emeu/recs/contents.htm

LEED & GEO-Slab Construction

Indoor Environmental Quality:

- Closed system allows for complete control of airborne contaminants and odor, not having to breathe air passing by heating element; reduced noise, since all heating air movement is buried in the slab
- No reverse temperature stratification since highest room temperature is at floor level
- Temperature overshoot is less common due to low intensity of heating
- Increased thermal mass of system provides for more stable interior temperature than thinner heated slabs
- Eliminates the dependence on air barrier to provide radon proofing since the 7-8” thick slab itself is an air barrier
- Reduced risk of mold and water damage: heat transfer medium is air instead of water; also, since slab is always warmer than soil and crushed stone, moisture from soil migrates downward and away from the building
- Warm floors, increased comfort due to warmth rising from the floor
- Two heating control zones for up to 1800 sq.ft. of floor area provide increased occupant comfort

Applications

Introduction

GSF systems are adaptable to nearly any building application and are especially well-suited for high-performance uses in a variety of markets, including:

- residential
- commercial
- industrial, and
- institutional.

Several case studies are presented in subsequent slides, followed by a discussion of the benefits of GEO-Slab construction to the architect, builder and owner.

Log Home

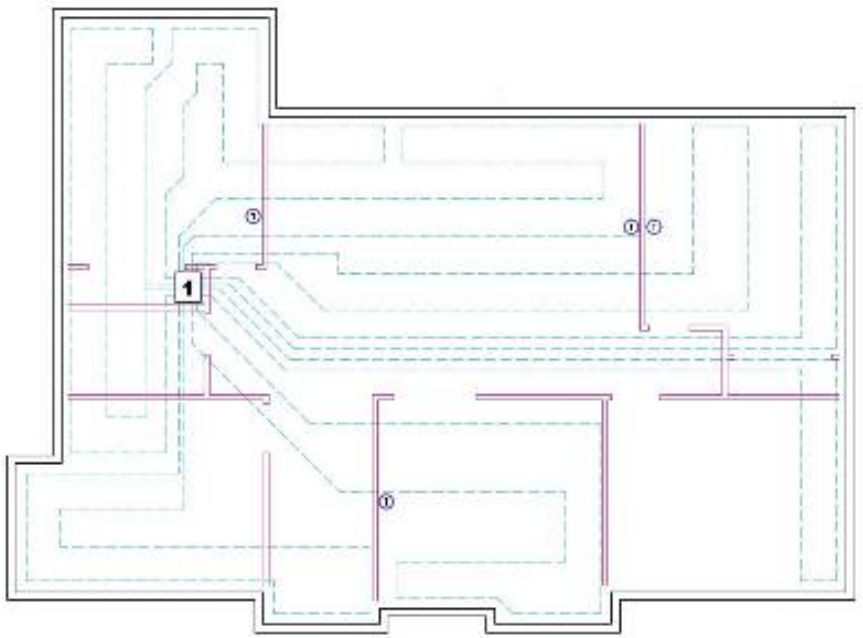
Daycare / Nursery

Case Study: Residential

This waterfront residence is built using GEO-Slab construction, which is the ideal solution for lots having high water tables.

Mechanically, the system consists of a water coil heater, heating four independent zones, controlled by means of programmable thermostats.

Long term benefits of choosing GEO-Slab for this installation include lower construction costs (no footings required), reduced heating costs (compared to conventional forced-air systems), comfortable warm floors and moisture-free indoor air quality.



Case Study: Apartment Complex

This case study involves two apartment complexes. The first one, comprised of 18 units, was constructed in 2008 with a poured footing and walls up to the first floor, then pour-on-grade floors.

Using GEO-Slab construction, the second complex (12 units) was built in June 2009. The total project was completed in December 2009, three weeks ahead of schedule, resulting in earlier revenue generation totaling $5,850.

Estimated construction material savings totaled $75,000. With no special manpower required, approximate labor cost savings were calculated at $32,000. The sum of the total savings for the GEO-Slab project totaled $112,850.

GEO-Slab Construction: 12-Unit Apartment Complex

Case Study: Community Church

The Challenge:

With this case study, the building lot had 7’ of existing mixed fill. The Engineer recommended traditional footings and frost walls that called for removal of all imported fill and replacement with 7’ of engineered fill. This recommendation would have resulted in prohibitive costs.

The Solution:

A GEO-Slab design allowed a simplified, cost-effective approach. The vegetative layer was removed and the subsoil was compacted for one day using a large vibrating roller. Next, 18” of granular material was added and compacted to 98%-100% Proctor. GEO-Slab was built on top of this base. A small construction crew with five-seven church volunteers installed the system from start to concrete-finish in seven days.

Case Study: Community Church

The Benefits of the GEO-Slab Solution:

- Savings over traditional process
- Short timeline for installation
- Energy efficient design
- Multiple zone heat control
- Fuel flexibility

Case Study: Winery

This 5,000 sq.ft. winery was built on a 2,400 sq.ft. GEO-Slab foundation. The owners chose this solution in part because of the requirement for absolute temperature stability that is needed for wine making.

Case Study: Winery

In addition, with the warm floor, frequent floor wash downs in the tank room are not a slip hazard, since the warm floor quickly dries the moisture.

Three heating zones were used for the tank room, barrel storage, and retail area, each zone with very different heating needs. Some rooms had no windows or roof, and others had 20’ ceilings, and even full wall glazing.

The structural strength of the GEO-Slab foundation also meant that it was easily able to support 20’ of concrete walls, a concrete intermediate floor, and even a concrete roof, all without frost walls or deep footings.

Benefits to Architect / Engineer

This course ends with a review of the benefits of GEO-Slab construction, beginning with the advantages it affords for today's architects and engineers.

- Easy to specify
- Negates the need for foundation design
- The design and full site-specific engineered modeling is supplied by the GEO-Slab manufacturer
- Easy to control job costing (foundation cost consistency)

Benefits to Builder

GEO-Slab construction offers the following benefits to builders:

- Ease of installation
- Less cut and fill/excavation/backfill
- Elimination of frost walls and interior footings

Please remember the **exam password** FOOTING. You will be required to enter it in order to proceed with the online examination.

Benefits to Owner

Heated GEO-Slab construction offers the following benefits to building owners:

- Warm, comfortable floors due to warmth rising from the floor
- Reduced operating costs as a result of:
  - passive solar collection
  - reduction in A/C requirements
  - make-up air operation is only required during occupancy

Retirement Residences

Industrial Building

Course Evaluations

In order to maintain high-quality learning experiences, please access the evaluation for this course by logging into CES Discovery and clicking on the Course Evaluation link on the left side of the page.

Conclusion of This Program

If you desire AIA/CES and/or state licensing continuing education credits, please click on the button below to commence your online examination. Upon successful (80% or better) completion of the exam, please print your Certificate of Completion.

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