# PERIMETER VERTICAL MOISTURE BARRIERS FOR RESIDENTIAL FOUNDATIONS ON CH SOILS

Mitigation Alternatives

Code Design Process

VMB Development Process

Installation Process

Beam Design Specifications

Barrier Specifications

Patent Documents

Mitigation Method Comparisons

Terra-Shield Introductions

- Expansive Soil Mitigation Alternatives

  - Site Preparation, Drainage, & Homeowner Maintenance
  - Remove & Replace
    - Can create settlement issues
  - Pier & Beam
    - Lost favor due to mold issues, performance & cost
  - Pier & Structural Slab with Void System
    - Requires void boxes or forms, introduces pier risk
  - Water Flood / Chemical Injection
    - Most common mitigation technique in DFW area
    - Application risks
    - Containment risks
    - Lost cycle time
    - Requires large source of water
  - Moisture Barriers – TOPIC OF TODAY'S DISCUSSION

- PERIMETER VERTICAL MOISTURE BARRIER
  - What does it do?
    - Vertical exterior barrier reduces moisture intrusion from sources adjacent to the foundation
  - Why does it work?
    - Local clay soils expand when moisture is added and contract when moisture is lost
    - Constant moisture content of expansive soil reduces soil movement which translates to reduced foundation movement
  - How are the affects calculated?
    - Structural foundation design is based on:
      - Em – edge moisture variation distance
      - Ym – differential soil movement

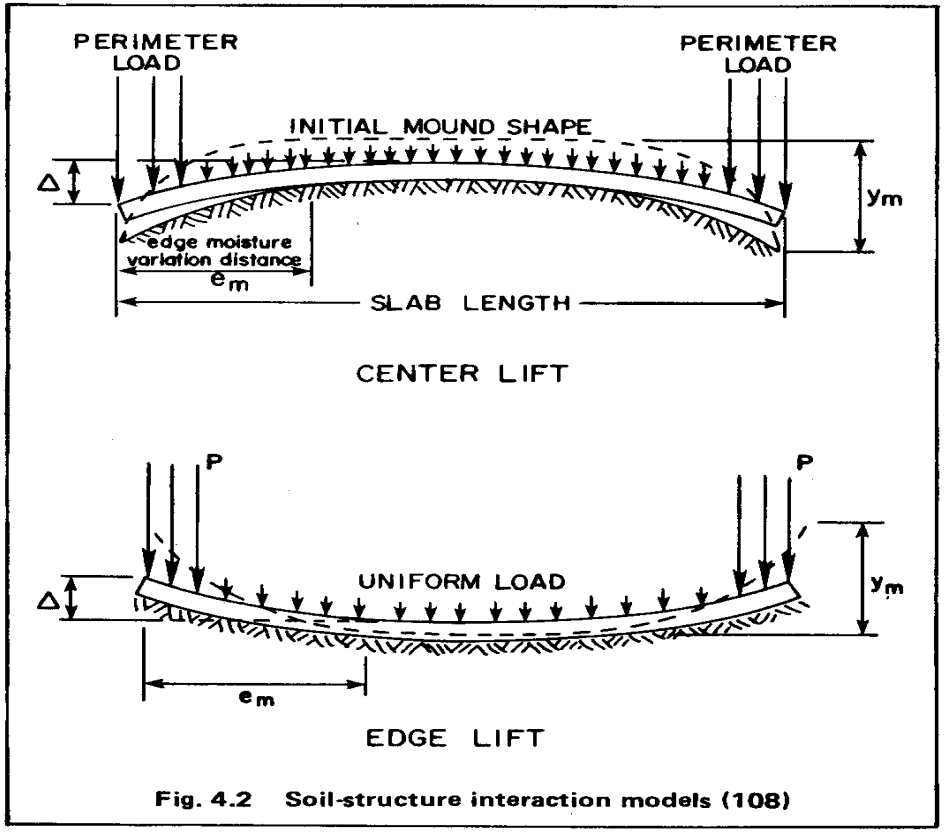


Fig. 4.2 Soil-structure interaction models (108)

Code History

# 2004 – Third edition of SOG design on expansive soils recognized benefit of reduction of Em

### 3.7 Moisture Barriers

Vertical moisture barriers may be used to reduce the soil support parameters ($e_m$ and $y_m$) provided the barriers are properly designed to virtually stop moisture migration to or from the foundation area on a permanent basis, around the entire perimeter.

The effect of a barrier on $e_m$ and $y_m$ may be estimated by the principles of un-saturated soil mechanics, most easily by the use of a two-dimensional moisture flow analysis computer program, such as VOLFLO[36].

A vertical barrier should extend at least 2.5 ft below adjacent ground surface to be considered as having any significant effect.

An approximation of the effect of a vertical barrier on $e_m$ can be obtained by using Table 3.8.

Table 3.8 Values of Reduced $e_m$ for Various Perimeter Vertical Moisture Barriers

| | | Depth of Barrier (ft) | | | | | |
|---|---|---|---|---|---|---|---|
| | | 2.5 | 3.0 | 3.5 | 4.0 | 4.5 | 5.0 |
| $e_m$ (ft) (Center or Edge) | 2 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| | 3 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| | 4 | 3.1 | 2.6 | 2.0 | 2.0 | 2.0 | 2.0 |
| | 5 | 4.3 | 4.0 | 2.8 | 2.0 | 2.0 | 2.0 |
| | 6 | 5.5 | 5.2 | 4.2 | 3.0 | 2.0 | 2.0 |
| | 7 | 6.5 | 6.3 | 5.5 | 4.5 | 3.2 | 2.0 |
| | 8 | 7.6 | 7.4 | 6.6 | 5.7 | 4.7 | 3.3 |
| | 9 | 8.6 | 8.5 | 7.7 | 6.9 | 6.0 | 4.9 |

The change of $y_m$ for various barrier depths requires analysis using a computer program, such as VOLFLO[36].

2012 – Newest Edition Revised Vertical Moisture Barrier Charts & Added Horizontal Barriers

## RECOMMENDATIONS

### 5.2.2 — Determination of $y_m$ by other methods

In lieu of computer methods, it shall be permitted to calculate $y_m$ as follows:

**5.2.2.1** — For layered soils, calculate a weighted $\gamma_h$ value $\gamma_{h\ mod}$ for swelling and shrinkage for each layer down to 9 ft (2.74 m) (or more, if justified by geotechnical analysis). Divide the total soil profile into three sections: the top third, the middle third, and the bottom third. Soil layers (or parts of layers) within the top, middle, and bottom thirds of the soil profile shall be assigned a weighting factor of 3, 2, and 1, respectively. $\gamma_{h\ mod\ swell}$ and $\gamma_{h\ mod\ shrink}$ shall be determined as the sum of the products of the weighting factor times the thickness of the layer (or part of the layer), times the value of $\gamma_h$ for that layer, divided by the sum of the products of the weighting factor, times the thickness of the layer (or part of layer). $y_m$ for each soil-structure distortion mode shall be taken as

$$y_{m\ swell} = \gamma_{h\ mod\ swell}\ (SCF)$$

$$y_{m\ shrink} = \gamma_{h\ mod\ shrink}\ (SCF)$$

**5.2.2.2** — If $\gamma_h$ varies by more than 10%, a computer modeling program is required to accurately calculate $y_m$. Nonexpansive layers shall be modeled using $\gamma_h$ equal to 0.01.

### 5.3 — Moisture barriers

It shall be permitted to use vertical and horizontal moisture barriers to reduce the soil parameters $e_m$ and $y_m$ if the barriers are designed and installed to mitigate moisture migration to or from the entire perimeter of the foundation area on a permanent basis.

Both vertical and horizontal barriers shall be protected to minimize damage and maintain the integrity of the barrier.

For CH soil, $e_m$ or $y_m$ with barriers shall not be less than 50% of the $e_m$ or $y_m$, respectively, without barriers. $e_m$ with barriers shall not be less than 2 ft (0.06 m).

## COMMENTARY

### R5.2.2 — Determination of $y_m$ by other methods

This method should only be used if a typical trumpet-shaped final suction profile can be assumed, and $\gamma_h$ does not vary by more than 10% between layers in the soil profile. Otherwise, this method may not be accurate. Table 5.2(a) assumes the initial suction to be at equilibrium from depth $z_m$ to the ground surface, then becoming wet or dry. This limitation would not yield accurate or conservative results in the case of a dry or wet initial suction profile followed by significant wetting or drying, tree effects, or other moisture anomalies.

### R5.3 — Moisture barriers

The effect of a barrier on $e_m$ and $y_m$ may be estimated by the principles of unsaturated soil mechanics.

Conditions can exist, such as desiccated clays; large vertical cracks; nonhomogeneous subsurface conditions (sand layers and so on); site slope; or vertical moisture movements, which may minimize or eliminate the effect of a vertical and/or horizontal barrier. The effect of all barriers should be evaluated by an LDP.



- **Permitted to use vertical moisture barrier to reduce Em & Ym**
- **Designed & Installed to Mitigate Moisture Migration to & from Entire Perimeter**
- **On a Permanent Basis**
- **Barrier Protected to Minimize Damage**
- **For CH Soils Em & Ym Limited to 50% Reduction**
- **Em limited to 2 Feet**
- **Em & Ym may be estimated by Principles of Unsaturated Soil Mechanics**

# History

2012 – Newest edition revised Vertical Moisture Barrier Charts & Added Horizontal Barriers



**RECOMMENDATIONS**

**COMMENTARY**

For non-CH soil, $e_m$ or $y_m$ with barriers shall not be less than 25% of the $e_m$ or $y_m$, respectively, without barriers. $e_m$ with barriers shall not be less than 2 ft (0.6 m).

**5.3.1 — Vertical barriers**

In lieu of computer methods, the effect of a vertical barrier on $e_m$ shall be obtained by using either Table 5.4(a) or 5.4(b).

A vertical barrier shall extend a minimum of 2 ft (0.6 m) below the adjacent ground surface to be considered to have an effect on $e_m$ and $y_m$. $y_m$ shall not be less than 80% of the $y_m$ without barriers for a vertical barrier less than 3 ft (0.9 m).

**Table 5.4(a)—Value of reduced $e_m$ for various perimeter vertical moisture barriers for CH soils**

| | | Depth of barrier, ft | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 | 4.5 | 5.0 |
| $e_m$, ft (center or edge) | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| | 3.0 | 2.2 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| | 4.0 | 3.5 | 3.1 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| | 5.0 | 4.6 | 4.3 | 4.0 | 2.8 | 2.5 | 2.5 | 2.5 |
| | 6.0 | 5.7 | 5.5 | 5.2 | 4.2 | 3.0 | 3.0 | 3.0 |
| | 7.0 | 6.7 | 6.5 | 6.3 | 5.5 | 4.5 | 3.5 | 3.5 |
| | 8.0 | 7.7 | 7.6 | 7.4 | 6.6 | 5.7 | 4.7 | 4.0 |
| | 9.0 | 8.8 | 8.6 | 8.5 | 7.7 | 6.9 | 6.0 | 4.9 |

- **In Lieu of Computer Methods: Em obtained using Table 5.4(a)**
- **Minimum Barrier Depth = 2 Feet to effect Em or Ym**
- **Barrier Less Than 3 Feet: Ym shall not be less than 80% of Ym without Barrier (Ym reduction limited to 20% @ < 3 Ft)**

**R5.3 — Moisture barriers**

The effect of a barrier on $e_m$ and $y_m$ may be estimated by the principles of unsaturated soil mechanics.

Conditions can exist, such as desiccated clays; large vertical cracks; nonhomogeneous subsurface conditions (sand layers and so on); site slope; or vertical moisture movements, which may minimize or eliminate the effect of a vertical and/or horizontal barrier. The effect of all barriers should be evaluated by an LDP.



**Conditions exist…which may minimize or eliminate the effect of a vertical and/or horizontal barrier:**

- **Desiccated clays**
- **Large vertical cracks**
- **Nonhomogeneous subsurface conditions (sand layers)**
- **Site slope**
- **Vertical moisture movements**

**The effect of all barriers should be evaluated by an LDP**

Grade beams proportioned in accordance with the above bearing capacity values will have a factor of safety of 3.0 and 2.0 with respect to shearing failure for dead and total loading, respectively. Footing weight below final grade can be neglected in the determination of design loading.

The differential movement values presented in this report are based on climate controlled soil conditions and are not valid when influenced by significant other conditions, such as trees, poor drainage, slope, cut and fill sections, etc. Due to the presence of expansive soils and trees on the site, we recommend the post-tensioned slab be stiffened such that minimum differential movements occur once a portion of the slab is lifted as a result of tree removal and the presence of expansive soils. The foundation system may experience tilt if designed as a stiff slab.

A bedding layer of leveling sand, one- to two-inches in thickness, may be planned beneath the floor slab. A moisture barrier should be used above the sands to prevent moisture migration through the slab. The excavations for the grade beams should be free of loose materials prior to concrete placement.

Information was not available on whether fill will be used to raise site grade prior to slab construction. In the event that fill is placed on site, specifications should require placement in accordance with our recommendations given in the "Site Preparation" section. Lack of proper site preparation may result in additional stress and inferior slab performance. The on-site soils, with the exception of silts and sands, free of root organics, are suitable for use as structural fill under a post-tensioned slab foundation. Sands should not be used as structural fill materials at this site (with the exception of top one- to two-inches of leveling sand under the slab).

## 6.4 Moisture Barriers

Since the subsoils are expansive, moisture barriers can be used to a depth of five-ft to reduce potential foundation movements due to seasonal moisture variations. The moisture barriers should be impervious. A brand name such as Stego Wrap Vapor Barrier 15 mils or vapor block 15 by Raven Industrial, 15 mils, can be used for design. The moisture barrier should have a vapor permeance per ASTM F 1249 of less than 0.009 perms, minimum puncture resistance per ASTM 1709 of 2300 grams and a minimum tensile strength per ASTM D 882 of 79.6lbf/in. The moisture barrier should be sealed against exterior grade beams in order to prevent water penetration under the slab.

Conditions can exist, such as desiccated clays; large vertical cracks; nonhomogeneous subsurface conditions (sand layers and so on); site slope; or vertical moisture movements, which may minimize or eliminate the effect of vertical barrier. Moisture barrier are less effective in areas of highly expansive soils, where trees are removed from under or near the foundation within five years of construction. The use of moisture barrier is most effective in areas of expansive soils where trees have been removed for at least five years prior to construction. Detailed design and recommendations for the use of moisture barrier can be developed, if requested. Foundation movement may continue even with presence of moisture barrier.



We understand that the residential structural loads will be supported on the post-tensioned slab type foundations. Our recommendations for this foundation type are presented in the following report sections.

**Post-Tensioned Slab Foundation**

We understand that the structural loads will be supported on a post-tensioned slab foundation. Our recommendation for the design of post-tensioned slabs is in general accordance with the PTI DC10.1-08, Third Edition with 2008 supplement (Ref. 4). Since the subsoil are highly expansive, we have also provided recommendations for a vertical moisture barrier. Our recommendations for conventionally reinforced slab as well as the post-tensioned slab are presented below:

| | | Existing Soils (Alternative 1) | Using 5-ft Vertical Moisture Barrier (Alternative 2) |
|---|---|---|---|
| Minimum Grade Beam Depth Below the Final Grade | : | 1.0-ft | 1.0-ft |
| Allowable Net Bearing Capacity | | | |
| Total (Dead + Live) Loading | : | 1,500 psf | 1,500 psf |
| Dead + Sustained Live Loads | : | 1,000 psf | 1,000 psf |
| Slab Subgrade Coefficient | | | |
| Slab-on-Vapor Sheeting over Sand | : | 0.75 | 0.75 |
| Edge Moisture Variation, $e_m$, feet | | | |
| Edge Lift | : | 4.8 | 2.5 |
| Center Lift | : | 5.0 | 2.5 |
| Differential Swell, $y_m$, inches | | | |
| Edge Lift | : | 1.7 | 1.2 |
| Center Lift | : | 1.9 | 1.4 |
| Effective Plasticity Index (PI) | : | 73 | 73 |
| Structural Fill Type | : | See Site Preparation Section | |
| The Required Minimum Fill Undrained Shear Strength | : | 1,000 psf | 1,000 psf |
| Thornthwaite Moisture Index | : | 18 | 18 |
| Design Suction Envelope | : | Post-Equilibrium | Post-Equilibrium |
| Potential Vertical Rise | : | 4.9 inches | 4.9 inches |

Should any loose sand or soft clays be observed under the grade beam, the allowable bearing capacity will be lower than values shown below. Soft or loose soils should be replaced with compacted structural select fill materials as subsequently defined in this report, or a geotechnical engineer should be contacted and the allowable bearing capacity reduced.

The grade beam may be supported at a minimum depth of 12, 18, 24, or 30 inches below the finish grade elevation founded within the undisturbed soils or compacted select fill. With decreased beam depth, consideration should be given to increased potential for susceptibility to intrusion of roots, loss of support due to erosion, soil moisture variations and associated soil volume changes in underlying subsoil beneath the foundations, and weathering in regions subjected to freezing temperatures. Based on a structural select fill elevated grade, the estimated bearing capacities are provided for each respective beam depth. The beam width is to be defined by the structural engineer.

**POST-TENSION PARAMETERS for Existing Soil Profile**
**(Post-Tensioning Institute Third Edition with 2008 Supplement Design )**

**SOIL PROFILE for PTI CALCULATION OF $E_m$ and $Y_m$**

| Stratum | Thickness, ft. | Plasticity Index, PI |
|---|---|---|
| Layer 1 | 6 | 37 |
| Layer 2 | 4 | 44 |

**PTI 3rd Edition POST-TENSION DESIGN PARAMETERS**

| | |
|---|---|
| Slab subgrade coefficient | |
| Slab-on-sand bedding | 1.00 |
| Slab-on-polyethylene over sand bedding | 0.75 |
| Fabric Factor, $F_f$ | 1 |
| Thornthwaite Index ($I_M$) | +18 |
| Approximate Depth to Constant Soil Suction, ft. | 9 |
| Constant Soil Suction, pF | 3.6 |
| Estimated Moisture Velocity, inch/month | 0.7 |
| Principal Clay Mineral | Montmorillonite |

**$E_m$ and $Y_m$ values based on final moisture profile and depth of vertical moisture barrier**

| Vertical Moisture Barrier see note (1,2) | **Center Lift**, -- drying of soil along foundation perimeter (wet to dry) $E_m$ = 7.2 ft. | **Edge Lift**, wetting of soil along foundation perimeter (dry to wet) $E_m$ = 4.8 ft. |
|---|---|---|
| Barrier Depth, inches | $Y_m$, Inches | $Y_m$, Inches |
| No barrier | 2.17 | 2.40 |
| 12 | 1.91 | 2.03 |
| 18 | 1.79 | 1.87 |
| 24 | 1.69 | 1.72 |
| 30 | 1.59 | 1.58 |

(1) Note: Vertical barrier depth defined as grade beam penetration depth into in-situ soil or compacted structural select soil (i.e. depth below finish grade of soil)
(2) Note: PTI states, "A vertical barrier should extend at least 2.5 ft. below the adjacent ground surface to be considered as having any significant effect".



along the perimeter of the slab resulting in an "edge lift" condition. The differential soil movements and moisture variation distances are influenced by soil properties.

Vertical moisture barriers can be effective in reducing differential soil movements. The "VOLFLO" computer program provides estimates of $E_m$ and $Y_m$ for post-tensioned slab design parameters as a function of vertical moisture barrier depths. Estimates of $E_m$ and $Y_m$ can be used to define structural select fill depths in conjunction with vertical moisture barrier depths that reduce the unrestrained differential soil movement.

**6.1 Estimates of Swell and Shrinkage for Combinations of Vertical Moisture Barrier Depths and Structural Select Fill Depths:**

| Vertical Moisture Barrier Depth, ft. | Soil Profile, depth and corresponding Plasticity Index (PI) | | Estimated Edge Moisture Variation Distance, ft. | Estimated Maximum Unrestrained Differential Soil Movement, inches |
|---|---|---|---|---|
| 2.0 | Existing Profile | Depth 0-6', PI=37<br>Depth 6'-10',PI=44 | Center Lift: 7.2<br>Edge Lift: 4.8 | Center Lift: 1.69<br>Edge Lift: 1.72 |
| 5.0 | Existing Profile | Depth 0-6', PI=37<br>Depth 6'-10',PI=44 | Center Lift: 7.2<br>Edge Lift: 4.8 | Center Lift: 1.19<br>Edge Lift: 1.09 |
| 5.0 | Profile with 2 ft. of Fill | Depth 0-2', PI=20<br>Depth 2'-6', PI=37<br>Depth 6'-10',PI=44 | Center Lift: 7.8<br>Edge Lift: 4.8 | Center Lift: 1.06<br>Edge Lift: 0.72 |
| 5.0 | Profile with 3 ft. of Fill | Depth 0-3', PI=20<br>Depth 3'-6', PI=37<br>Depth 6'-10',PI=44 | Center Lift: 8.0<br>Edge Lift: 4.8 | Center Lift: 1.01<br>Edge Lift: 0.64 |

Based on Post-Tensioning Institute (PTI) publication entitled "Design and Construction of Post-Tensioned Slabs on Ground", Montmorillonite is defined as the Principal Clay Mineral, a depth to constant soil suction of 9-ft., and a Thornthwaite Moisture Index of 18., and Structural Select Fill materials having a liquid limit less than 35 and a plasticity index (P.I.) between 10 and 20. The structural select fill materials should be filled according to the procedures prescribed in the initial report section "Structural Fill and Subgrade Preparation".

The above table is based upon our interpretation of the on-site soil conditions found at the time of our field investigation and the empirical data presented in "Design and Construction of Post-Tensioned Slabs on Ground." The table shows that a vertical moisture barrier depth of 5 ft., in combination with 3.0 feet of structural select fill provides an estimated maximum unrestrained differential soil movement of aproximately 1.00 inch.

For this option, three (3) feet of existing soil should be replaced by structural select fill; and a five (5) feet vertical moisture barrier should be used in conjunction with the structural select fill.

- DEVELOPMENT PROCESS

  - **STEGO PRODUCT DEVELOPMENT**
    - **Performance specification**
      - **Included long term durability**
    - **Our interest resulted in a new roll size manufacturing**
  - **INSTALLATION DEVELOPMENT**
    - **Proprietary equipment development**
    - **Many trials and testing**
    - **Resulted in adding industry experience: Terra-Shield**
  - **CONTINUED PROCESS DEVELOPMENT**
    - **Terra-Shield completed prototype equipment development**
    - **Terra-Shield completed prototype equipment fabrication**
    - **Refined beam design details**
    - **Process & equipment was tested on full scale jobs**
    - **Started patent process – APPARATUS AND METHOD FOR STABILIZING A FOUNDATION**
    - **Started contract work & marketing**
    - **Currently considering moisture monitoring systems**


OLD METHOD
APR 6 2004


OLD METHOD
APR 6 2004


OLD METHOD
APR 6 2004


OLD METHOD


OLD METHOD

PATENT PENDING/PROPRIETARY
DO NOT REPRODUCE/DISTRIBUTE

PATENT PENDING/PROPRIETARY
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PAD LAYOUT


TRENCHING & CLEANOUT


3 INCHES WIDE
5 FEET DEEP


Barrier Installation


Trench Backfill


Form Board Installation


Interior Beam Trenching


Final Make-Up
PATENT PENDING/PROPRIETARY
DO NOT REPRODUCE/DISTRIBUTE

PATENT PENDING/PROPRIETARY
DO NOT REPRODUCE/DISTRIBUTE

Exterior Beam Reinforcing


PATENT PENDING/PROPRIETARY
DO NOT REPRODUCE/DISTRIBUTE
Exterior Beam Reinforcing

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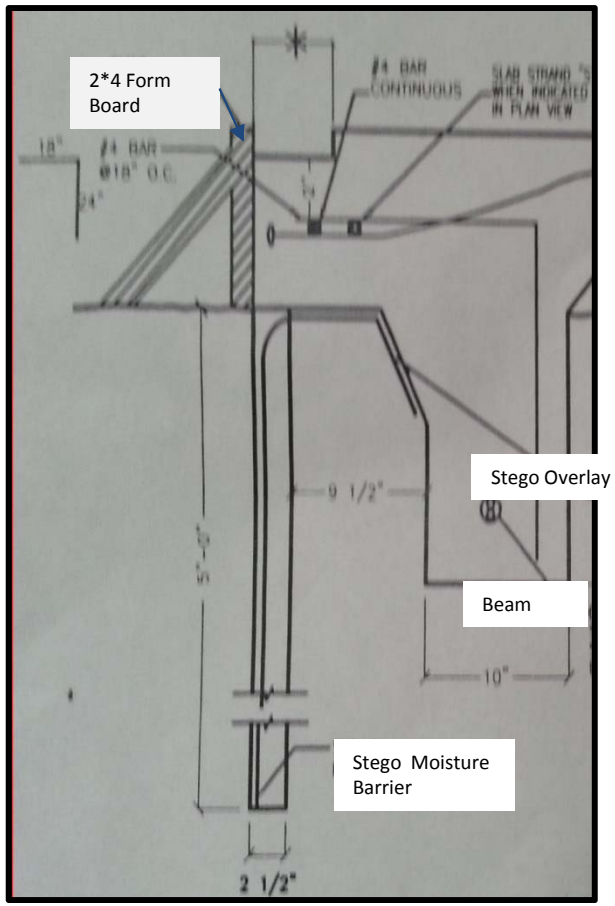
DO NOT REPRODUCE/DISTRIBUTE

Exterior Beam Reinforcing

# Terra-Shield Vertical Moisture Barrier

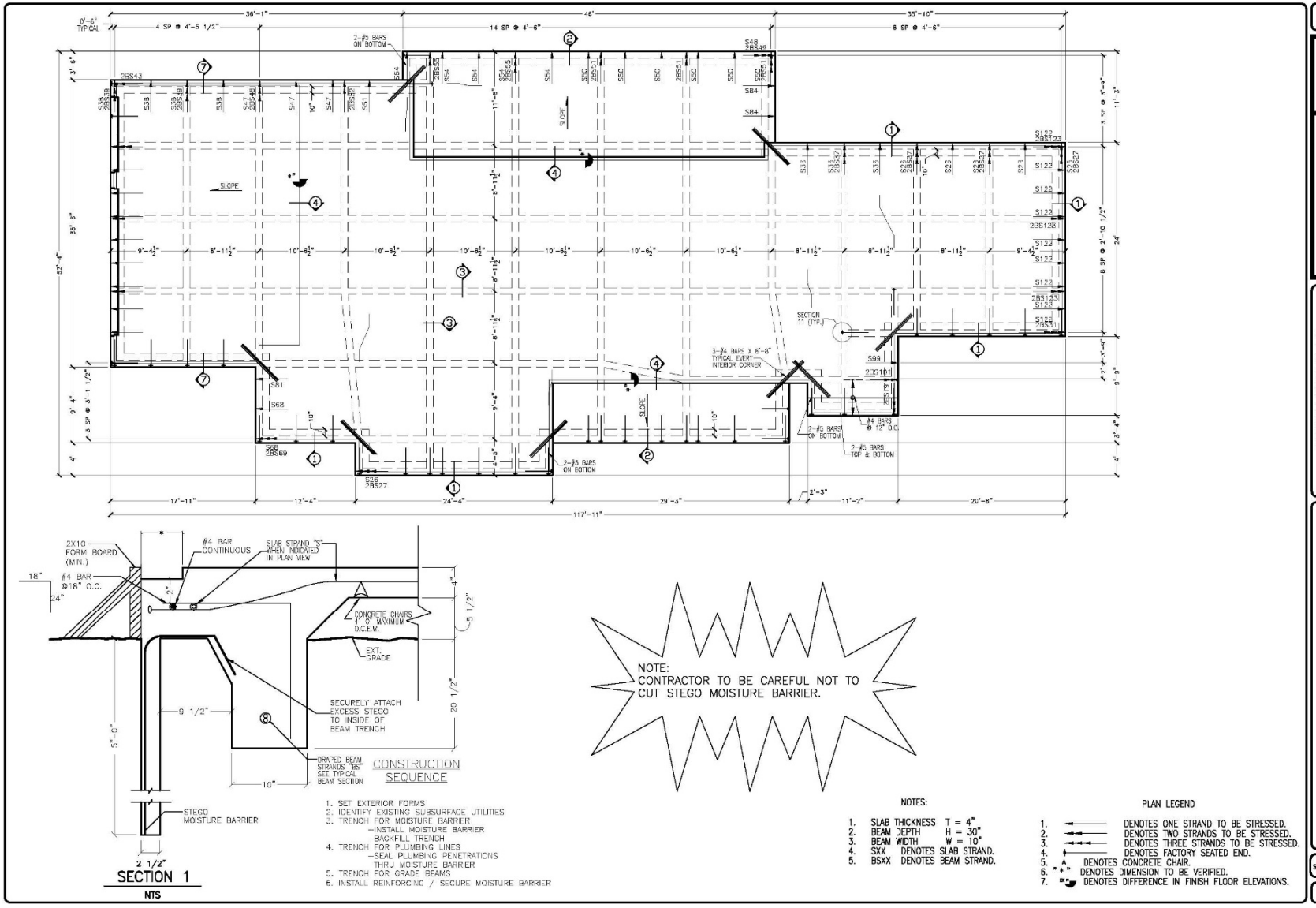
- Terra Shield vertical moisture barrier utilizes 15mil Stego wrap vapor barrier. Stego is made with a blend of prime virgin resins and additives it is an ASTM E 1745 Class A Vapor Barrier (Below 0.01 perms).
- Terra-Shield utilizes a specialized trencher to dig a trench 3” wide and 5’ deep trench matching the pattern of the slab form boards. 15mil Stego with a width of 7’ is installed into the trench with a 2’ overhang. Joints are secured with Stego Wrap Red tape. It is specially designed to seal seams and penetrations on Stego Wrap installations. The acrylic, pressure-sensitive adhesive provides permanent bonding and quick stick properties.
- The 2’ overhang is draped into the perimeter beam. Plumbing, sewer and electrical intrusions are taped and secured with Stego tape prior to being covered with soil.
- The foundation is poured creating a vertical moisture barrier at a 5’ depth completely around the perimeter of the home.

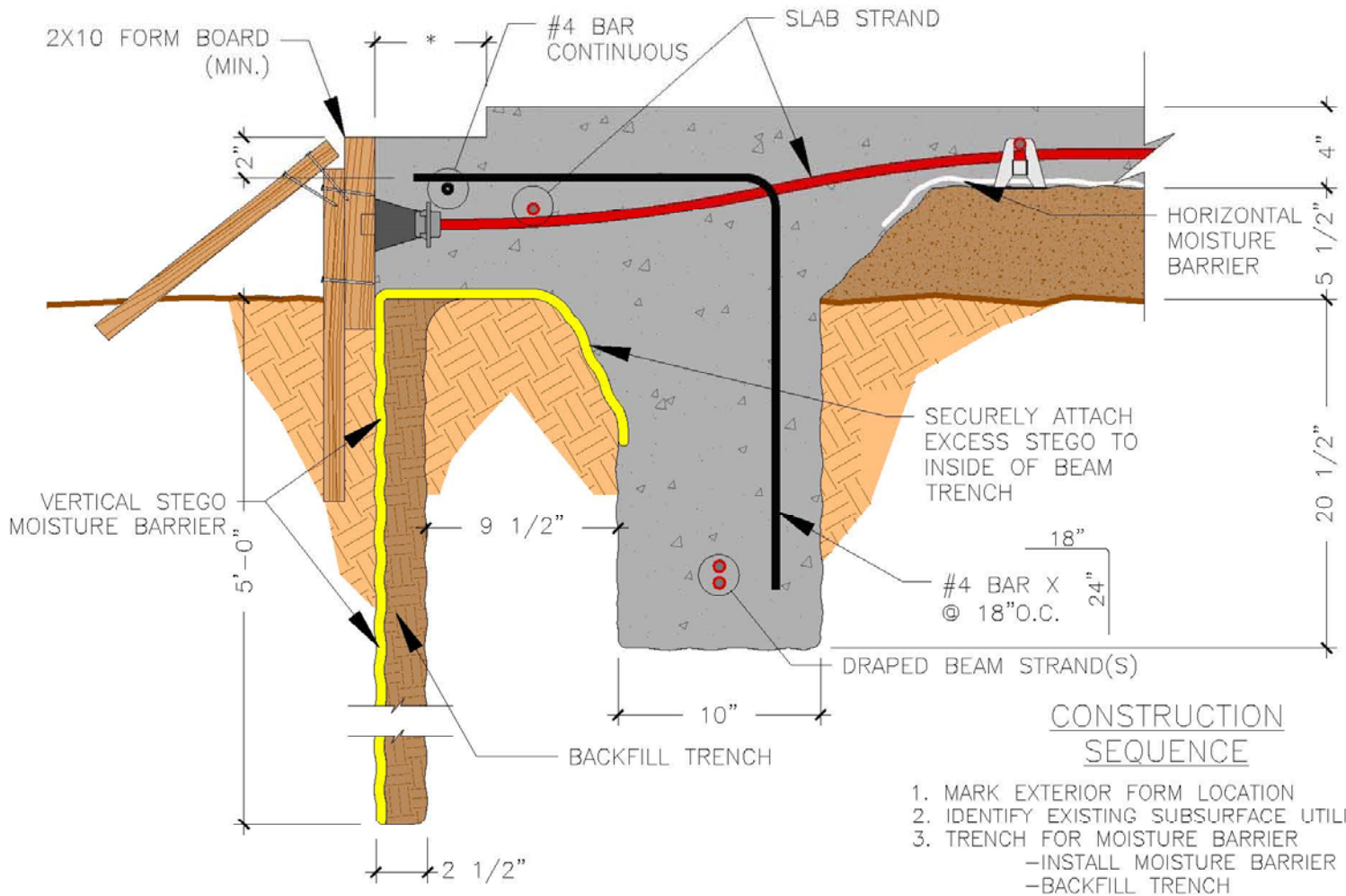


INSTALLATION SEQUENCE DESCRIBED IN PATENT APPLICATION

- Site Preparation
- Foundation outlined with chalk so the barrier trench can be properly located
- Barrier trench located a predetermined distance outside first grade beam (equal to or greater than grade beam width)
- Cut barrier trench equal to or less than 3 inches wide and 5 feet deep – barrier trench must be narrow to lessen the effect on the soils ability to support the structure
- Place moisture barrier membrane against outer wall of barrier trench (overlap and tape all seams)
- Membrane to extend 20-24 inches above grade so it can be wrapped to extend into the grade beam
- Secure barrier membrane against upper portion of grade beam trench
- Backfill trench
- Trench for plumbing lines, seal plumbing penetrations
- Install form boards
- Trench grade beams
- Secure barrier membrane
- Install proper reinforcing
- Pour concrete

# Custom House Design






## CONSTRUCTION SEQUENCE

1. MARK EXTERIOR FORM LOCATION
2. IDENTIFY EXISTING SUBSURFACE UTILITIES
3. TRENCH FOR MOISTURE BARRIER
   - –INSTALL MOISTURE BARRIER
   - –BACKFILL TRENCH
4. TRENCH FOR PLUMBING LINES
   - –SEAL PLUMBING PENETRATIONS THRU MOISTURE BARRIER
5. TRENCH FOR GRADE BEAMS
6. INSTALL REINFORCING / SECURE MOISTURE BARRIER

# STEGO® WRAP VAPOR BARRIER

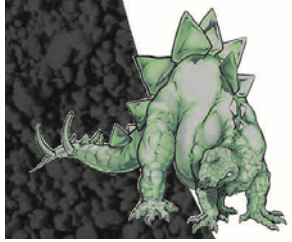
ASTM E 1745 Class A-B-C Compliant

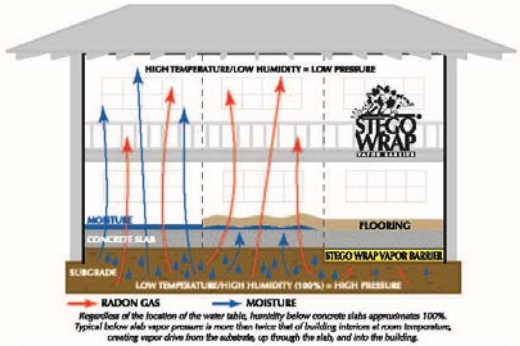
## STEGO® WRAP VAPOR BARRIER

is made with our proven trade secret blend of prime virgin resins and additives. Stego Wrap Vapor Barrier is an ASTM E 1745 Class A Vapor Barrier (Below 0.01 perms). We focus on producing a product that will maintain its extremely low permeance for the life of a building. The protection of Stego Wrap Vapor Barrier provides the flexibility to change flooring types and overall building use without worrying about below-slab moisture vapor.

### FEATURES & BENEFITS

- Unsurpassed Permeance Characteristics
- Life of the Building Protection
- Exceptional Tear and Puncture Resistance
- Easy, Reliable Installation
- Competitively Priced
- Available Nationwide
- Local Support






*Regardless of the location of the water table, humidity below concrete slabs approximates 100%. Typical below slab vapor pressure is more than twice that of building interiors at room temperature, creating vapor drive from the substrate, up through the slab, and into the building.*

## THE STEGO® ADVANTAGES

### SUPERIOR DEFENSE Against Floor Failures:

Experts say "the need for a vapor barrier (as opposed to a vapor retarder) is becoming increasingly clear." Concrete Construction Magazine, August 2003, p.18.

Infiltration of moisture through concrete slabs is a major building defect liability. Stego Wrap Vapor Barrier has an extremely low permeance preventing water vapor, soil gases (i.e. Radon), alkaline salts and soil sulfates from compromising the integrity of the building envelope and leading to serious problems with the concrete slab, floor coverings and indoor air quality. Stego Wrap Vapor Barrier is the best protection against these costly failures.

### MOLD PREVENTION:

Mold needs three things to survive: moisture, sustained temperature (between 50° and 122° F), and a food source (dust, drywall, etc.). In any given building environment, contractors can only control one of these variables: moisture. Mold spores are present in 100% of building interiors. If moisture is allowed into your building environment, mold can and will grow. Toxic molds like Stachybotyrus can be fatal for nearly 5% of people (Institute of Medicine 1993), and cause a variety of serious health problems in others. Several recent well-publicized cases involving toxic mold have resulted in multimillion-dollar insurance settlements. Many of the nation's leading insurance companies have severely limited or removed coverage for mold claims fearing that these claims will bankrupt their companies. Now more than ever, it is critically important that extra attention be paid to preventing the intrusion of moisture vapor from your below-slab environment. Stego Wrap Vapor Barrier offers the level of protection that many architects are now seeking and is considered to be inexpensive insurance against these costly failures.

### LONGEVITY AND STRENGTH:

Stego Wrap Vapor Barrier is NOT made with recycled materials and will not degrade. Prime, virgin resins are the key. Molecules within Stego Wrap "interlock" to provide strength, durability and unprecedented resistance to moisture vapor and radon gas. Stego Wrap's puncture resistance is excellent. Stego Wrap will not tear, crack, flake, snag or puncture, even when 18,000 lb. laser-screed machines are driving directly across the barrier (see the reverse side for Stego Wrap Vapor Barrier's specifications).


**Stego Industries, LLC · San Clemente, CA**
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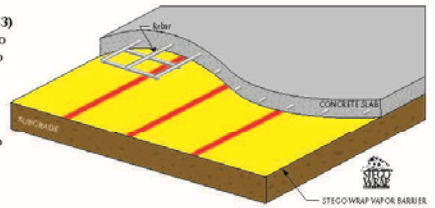
## STEGO® WRAP VAPOR BARRIER SPECIFICATIONS

| PROPERTIES | TEST METHOD | ASTM E 1745 Class A Requirements | TEST RESULT | EXPLANATION |
|---|---|---|---|---|
| Permeance | ASTM F 1249 | 0.1 perms | 0.0086 perms * 0.0036 WVTR | Very impermeable to water vapor |
| Puncture Resistance | ASTM D 1709 | 2200 grams | Method B 2266 grams | Resistant to puncturing from construction abuse |
| Tensile Strength | ASTM D 882 | 45.0 lbf./in. | 70.6 lbf./in. | Will not tear easily |
| Permeance After Conditioning (ASTM E 1745 Sections 7.1.2 - 7.1.5) | ASTM E 154 section 8 | 0.1 perms | 0.0098 perms | Permeance after wetting, drying, and soaking |
| | ASTM E 154 section 11 | 0.1 perms | 0.0091 perms | Permeance after heat conditioning |
| | ASTM E 154 section 12 | 0.1 perms | 0.0097 perms | Permeance after low temperature conditioning |
| | ASTM E 154 section 13 | 0.1 perms | 0.0095 perms | Permeance after soil organism exposure |
| Methane Transmission Rate | ASTM D 1434 | | **GTR = 192.8 mL(STP)/m²*day | Greatly impedes the transmission of methane gas |
| Radon Diffusion Coefficient | | | 5.5 x $10^{-14}$ $m^2$/second | Greatly impedes the transmission of radon gas |
| Thickness | | | 15 mils | Stronger, tougher and less permeable than much thicker membranes |
| Roll Dimensions | | | 14 ft. X 140 ft. | 1,960 $ft^2$/roll - allows for a minimum of seams |
| Roll Weight | | | 140 lbs. | Easy to unroll and install |

Note: perm unit = grains/($ft^2$*hr* in.Hg) * WVTR = water vapor transmission rate **GTR = Gas Transmission Rate

### INSTALLATION INSTRUCTIONS: (Based on ASTM E 1643)

Unroll Stego Wrap over the area where the slab is to be placed. Stego Wrap should completely cover the concrete placement area. Overlap seams 6 inches and tape using Stego Tape. All penetrations and blockouts should be sealed using a combination of Stego Wrap, Stego Tape and/or Stego Mastic. If the Stego Wrap is damaged, cut a piece from the Stego Wrap roll, place over the damaged area, and tape around all edges. Concrete may be placed directly on Stego Wrap. For additional information, please refer to Stego's complete installation instructions.




### STEGO® TAPE:

**STEGO WRAP RED POLYETHYLENE TAPE** (3.75" x 180'/roll) is specially designed to seal seams and penetrations on Stego Wrap installations. The acrylic, pressure-sensitive adhesive provides permanent bonding and quick-stick properties. The area to be bonded should be free of dust, dirt and moisture.

### WARRANTY:

**STEGO INDUSTRIES, LLC** believes, to the best of its knowledge, that specifications and recommendations herein are accurate and reliable. However, since site conditions and installations are not within our control, STEGO INDUSTRIES, LLC does not guarantee results from use of the information provided and disclaims all liability from any loss or damage. NO WARRANTY EXPRESS OR IMPLIED IS GIVEN AS TO THE MERCHANTABILITY, FITNESS FOR PARTICULAR PURPOSE, OR OTHERWISE WITH RESPECT TO THE PRODUCTS REFERRED TO.

Note: Test results above are for Stego Wrap products made as of March 15, 2013. If you have product made prior to March 15, 2013, please refer to Stego literature dated 10/12 for representative test results or call your local Stego Representative with questions.

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**04/2013**

# Stego® Wrap Vapor Barrier

STEGO INDUSTRIES, LLC

**Vapor Retarders**
**07260, 03300**

**Manufacturer**
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**Product Description**
USES: Stego Wrap Vapor Barrier is used as a true below-slab vapor barrier, and as a protection course for below grade waterproofing applications.
COMPOSITION: Stego Wrap Vapor Barrier is a multi-layer plastic extrusion manufactured with only the highest grade of prime, virgin, polyolefin resins.
ENVIRONMENTAL FACTORS:
Stego Wrap Vapor Barrier can be used in systems for the control of soil gases (radon, methane), soil poisons (oil by-products) and sulfates.

**Installation**
UNDER SLAB: Unroll Stego Wrap Vapor Barrier over an aggregate, sand or tamped earth base. Overlap all seams a minimum of six inches and tape using Stego Tape. All penetrations must be sealed using a combination of Stego Wrap Vapor Barrier, Stego Tape and/or Stego Mastic.

VERTICAL WALL: Install Stego Wrap Vapor Barrier over the waterproofing membrane while still tacky. Mechanically fasten Stego Wrap Vapor Barrier to the wall at the top with termination bar and concrete nails. Drape Stego Wrap Vapor Barrier down across the footer and under the french drain.

**Availability & Cost**
Stego Wrap Vapor Barrier is available nationally via building supply distributors. For current cost information, contact your local Stego Wrap distributor or Stego Industries' sales department.

**Warranty**
Stego Industries, LLC believes to the best of its knowledge, that specifications and recommendations herein are accurate and reliable. However, since site conditions are not within its control, Stego Industries does not guarantee results from the use of the information provided and disclaims all liability from any loss or damage. No warranty, express or implied, is given as to the merchantability, fitness for a particular purpose, or otherwise with respect to the products referred to.

**Maintenance**
None required.

**Technical Services**
Technical advice, custom CAD drawings, and additional information can be obtained by contacting Stego Industries' technical assistance department or via the website.

**Filing Systems**
- Stego Industries' website
- Buildsite
- GreenFormat
- 4Specs

## Technical Data

**TABLE 1: PHYSICAL PROPERTIES OF STEGO WRAP VAPOR BARRIER**

| PROPERTY | TEST | RESULTS |
|---|---|---|
| Under Slab Vapor Retarders | ASTM E 1745 Class A, B & C – Standard Specification for Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs | Exceeds Class A, B & C |
| Water Vapor Permeance | ASTM F 1249 – Test Method for Water Vapor Transmission Rate Through Plastic Film and Sheeting Using a Modulated Infrared Sensor | 0.0084 perms<br>*0.0035 WVTR |
| Puncture Resistance | ASTM D 1709 – Test Methods for Impact Resistance of Plastic Film by Free-Falling Dart Method | 2326 grams |
| Tensile Strength | ASTM D 882 – Test Method for Tensile Properties of Thin Plastic Sheeting | 79.6 lbf/in. |
| Permeance After Conditioning (ASTM E 1745 Sections 7.1.2 - 7.1.5) | ASTM E 154 Section 8, F 1249 – Permeance after wetting, drying, and soaking<br>ASTM E 154 Section 11, F 1249 – Permeance after heat conditioning<br>ASTM E 154 Section 12, F 1249 – Permeance after low temperature conditioning<br>ASTM E 154 Section 13, F 1249 – Permeance after soil organism exposure | 0.0091 perms<br>0.0092 perms<br>0.0089 perms<br>0.0092 perms |
| Methane Transmission Rate | ASTM D 1434 – Standard Test Method for Determining Gas Permeability Characteristics of Plastic Film and Sheeting | **149.6 GTR<br>2.12 x $10^{-6}$ perms |
| Radon Diffusion Coefficient | | 1.3 x $10^{-13}$ $m^2$/second |
| Thickness | ACI 302.1R-04 – Minimum Thickness (10 mils) | 15 mils |
| Roll Dimensions | | 14 ft. wide x 140 ft. long or 1,960 $ft^2$ |
| Roll Weight | | 140 lbs. |

Note: perm unit = grains/($ft^2$ *hr* in.Hg) * WVTR = Water Vapor Transmission Rate ** GTR = Gas Transmission Rate

# PATENT APPLICATION

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June 12, 2014

Mr. Scott Horn
Texas Pro-Chemcial Soil Stabilization, Inc.
4602 Lakepoint Ave.
Rowlett, Texas 75088

RE: U. S. Provisional Patent Appl. No. 62/010,873
*Apparatus and Method for Stabilizing a Slab Foundation*
Our File no. 25483.001

Dear Scott:

Enclosed for your records find a copy of the provisional patent application and support documents as submitted to the U. S. Patent and Trademark Office for the above-captioned case.

We will continue to keep you informed as to the progress of this application. Should you have any questions, do not hesitate to contact me.

Very truly yours,

Whitaker Chalk Swindle & Schwartz PLLC

Stephen S. Mosher

SSM/sh
Encl.

cc: Eric Davis

# Patent Figure 1



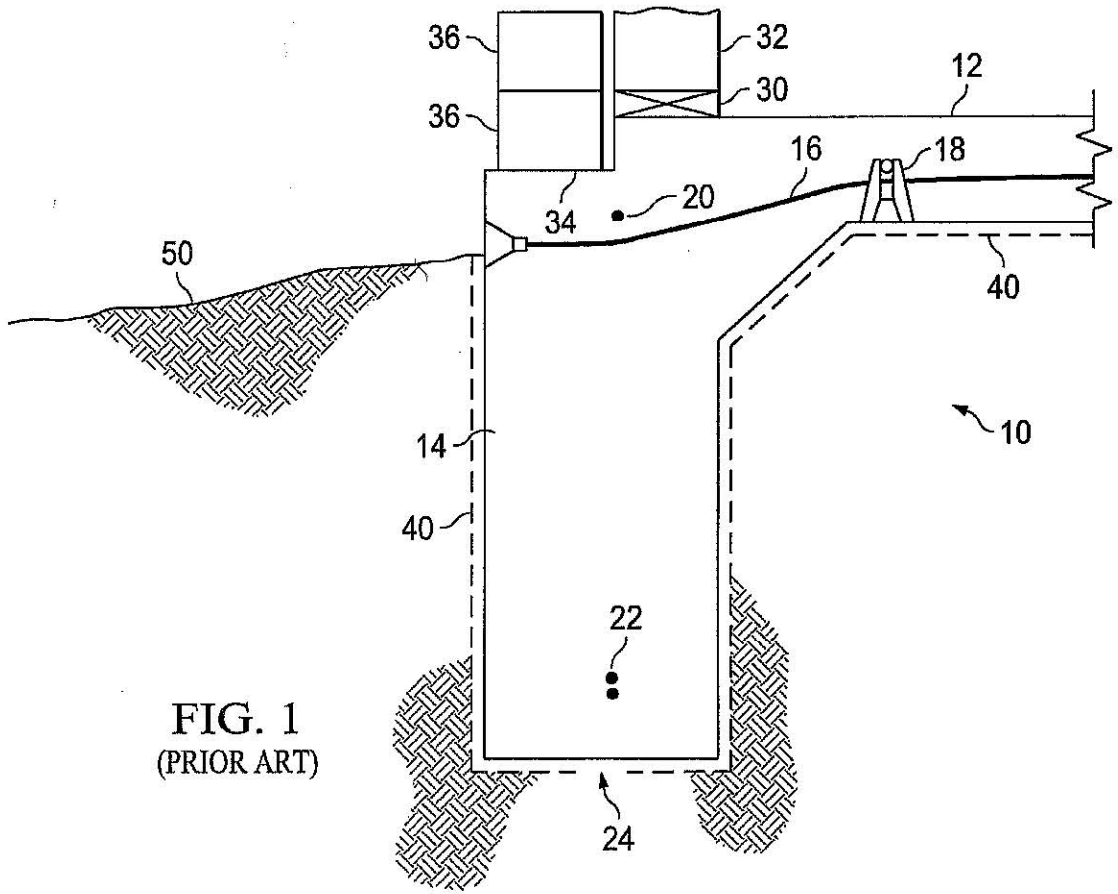


FIG. 1
(PRIOR ART)

# Patent Figure 2



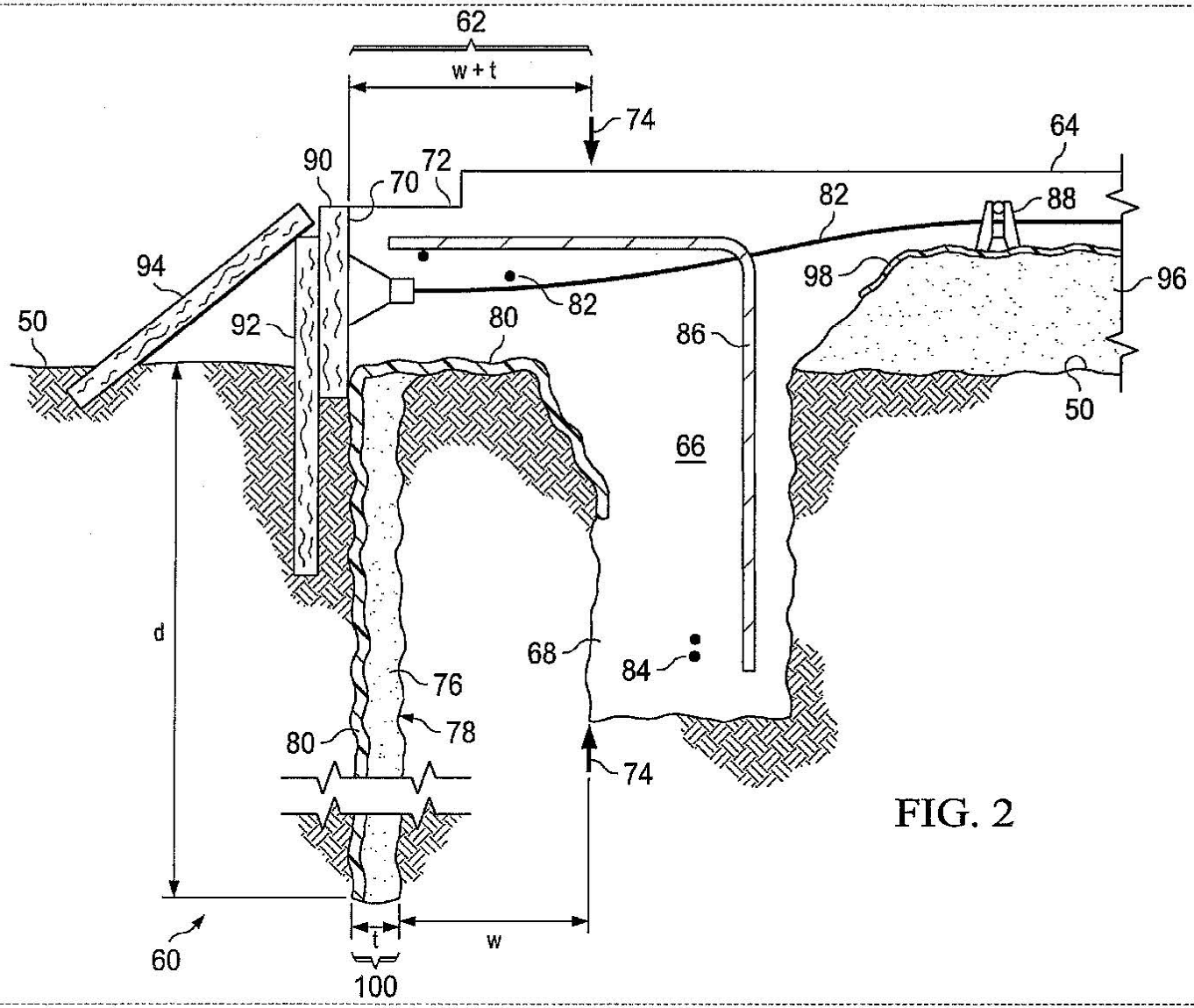


FIG. 2

Moisture Barrier Estimated Turnkey Installation Cost:

$17.50 / lf perimeter beam

Typical 50 x 60 plan = 268 lf (24 shape factor) x $17.50 = $4690

$1.56 / sf

Each foundation design must be estimated individually due to effect of shape factor on perimeter lineal feet

# COMPARISON OF MITIGATION METHODS

MOISTURE BARRIER COMPARISON

| MITIGATION TECHNIQUE | PROS | CONS/RISKS | COST COMMENTS |
|---|---|---|---|
| CURRENT PRACTICE | | | Most economical initial cost |
| PTI Design Method | | Soil movement resulting in tilt/deflection | |
| Proper Site Preparation | | Improper site preparation | |
| Proper Drainage | | Poor final grading and drainage | |
| Proper Maintenance | | Homeowner long term maintenance | |
| Remove & Replace | Mitigates soil movement in near surface soils | Limited to top 2-4 feet, Risk of proper soil compaction | Adds $2.00 - $5.00 / sf |
| Pier & Beam | Reduces soil interaction with foundation | Mold concerns, wood floors, architectural look, pier performance risk | Adds $5.00 - $10.00/sf |
| Pier & Structural Foundation | Reduces soil interaction with beams and slab | pier performance risk, void form performance and construction risk | Adds $5.00 - $10.00/sf cost |
| Water Flood / Chemical Injection | Reduces soil expansion characteristics, pre-swells soils | Application risk, containment risk, water source | Adds $2.00/sf??? |
| Moisture Barrier | Reduces risk of soil movement, reduces risk of expansion due to poor site prep & drainage, reduces risk due to poor homeowner maintenance, mitigates climate induced soil risk, | Only mitigates climate induced soil expansion risks | Adds $1.50 - $2.00 / sf |

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